2008

SPARC

WCRP
World Climate Research Programme

4th SPARC General Assembly
31 August – 5 September 2008
Bologna, Italy

Scientific Programme

SPARC 2008

4th General Assembly
Programme and Abstracts

SPARC: Stratospheric Processes And their Role in Climate
A Core Project of the World Climate Research Programme
31st August – 5th September 2008, Bologna, Italy

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This electronic Programme and Abstracts document is provided in .pdf format. It should be searchable by most modern pdf readers. Links are provided (blue arrows) to allow easy navigation through the document, in particular to link between the listing of a poster or talk and the corresponding abstract.

Cover Photo: Polar Stratospheric Clouds (PSCs) high above Arctic low clouds over central Norway on 14 January 2003 at ~8Z from the cockpit of the NASA DC-8 during the SOLVE-II campaign. A strong tropospheric jet from the west-northwest was flowing onshore into southern Scandinavia, right under a portion of the stratospheric polar vortex. This resulted in very strong gravity wave activity in the stratosphere. Photo courtesy of Paul Newman.

WELCOME!

Dear Colleagues,

We are delighted that you have come to Bologna to participate in the 4th General Assembly of the WCRP Project "Stratospheric Processes And Their Role in Climate". SPARC General Assemblies provide a venue for the exchange of scientific information related to SPARC research activities. They also provide a good venue for people to interact, one-on-one and in small groups, to discuss individual issues of mutual interest. They are held only in plenary format, i.e. with no parallel sessions, with a moderate number of oral contributions and an emphasis on poster sessions. As such, they are integrative in nature and complement the highly focused workshops that are the main venues for discussing some of the pressing questions addressed by SPARC. During this week in Bologna you will enjoy doing science in one of Italy’s most elegant and least discovered cities, known variously as *la dotta* (“the learned one”), *la grassa* (“the fat one”) or *la rossa* (“the red one”).

We welcome you and wish you all a rewarding and pleasant stay.

Tom Peter Co-Chair SPARC SSG Co-Chair SOC	Ted Shepherd Co-Chair SPARC SSG	Norm McFarlane Director, SPARC Office
Peter Haynes Co-Chair SOC	Elisa Manzini Co-Chair LOC	Susanna Corti Co-Chair LOC

Scientific Organizing Committee (SOC)

Peter Haynes (Co-Chair), University of Cambridge, UK
Tom Peter (Co-Chair), ETH Zürich, Switzerland
Mark Baldwin, Northwest Research Associates, USA
Greg Bodeker, NIWA, New Zealand
John Burrows, University of Bremen, Germany
Veronika Eyring, DLR Oberpfaffenhofen, Germany
Sachiko Hayashida, Nara Women's University, Japan
Anne Thompson, Penn State University, USA

Local Organizing Committee (LOC)

Elisa Manzini (Co-Chair) Chiara Cagnazzo Micaela Pantano	Susanna Corti (Co-Chair) Federico Fierli Elisa Palazzi
Centro Euro-Mediterraneo per i Cambiamenti Climatici, Bologna, Italy	CNR Istituto di Scienze dell'Atmosfera e del Clima, Bologna, Italy

Special thanks to:

Elizabeth Barrington-Light, Peter Braesicke, Rebecca Penkett
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National Aeronautics and Space Administration, USA

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CMCC	Centro Euro-Mediterraneo per i Cambiamenti Climatici, Italy
CNR-ISAC	Consiglio Nazionale delle Ricerche - Istituto di Scienze dell'Atmosfera e del Clima, Italy
COSPAR	Committee on Space Research
COST	European Cooperation in the Field of Scientific and Technical Research, Italy
CSA	Canadian Space Agency, Canada
ESA	European Space Agency
ETH	Eidgenössische Technische Hochschule Zürich, Switzerland
EUROCHAMP	Integration of European Simulation Chambers for Investigating Atmospheric Processes
IBM	
NASA	National Aeronautics and Space Administration, USA
NEC	
NIWA	National Institute of Water & Atmospheric Research, New Zealand
NSF	National Science Foundation, USA
PROGECTA	PROGECTA by CLU srl, Castelfranco Emilia, Italy
SCOUT-O3	Stratospheric-Climate Links with Emphasis on the Upper Troposphere and Lower Stratosphere
UCAM	University of Cambridge, United Kingdom
WCRP	World Climate Research Programme
WMO	World Meteorological Organization

Scientific Programme

Including oral and poster presentations

Daily themes are not intended to be exclusive – rather the General Assembly will provide a forum for presentation and discussion of *all* scientific issues relevant to SPARC. Posters are listed by session, in alphabetical order of presenter, after the oral programme.

Sunday 31 August

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Theme: Cross-cutting Issues

12:00 Registration opens – lunch available 12.30 – 13.45

13:00 Put up Session A Posters

14:00 Welcome and Overview

Session Chair: Thomas Peter

14:30 Opening Lecture:
Susan Solomon (invited)
From the IPCC Assessment to Current Research and Back:
An Overview of Key Findings and Issues in the Stratosphere and UTLS
(00400) ►

15:30 Break

Session Chair: Peter Haynes

16:00 Saroja Polavarapu (invited)
Recent Advances in Stratospheric Data Assimilation (00070) ►

16:30 Ulrike Lohmann (invited)
Cirrus Clouds and Ice Supersaturated Regions in Global Climate Models
(00304) ►

17:00 John Burrows (invited)
Observations of the Upper Atmosphere from Satellite Platforms:
Sensing and Sensibility (00148) ►

17:30 Francesco Cairo (invited)
The M55 Geophysica Deployment in West Africa:
An Overview of Processes Governing TTL Composition over West Africa
(00429) ►

18:00 Opening Reception and Poster Session A (posters unattended) ►

Monday 1 September

Theme: Stratosphere-Troposphere Dynamical Coupling

08.30 Registration Opens

09:00 Introduction by Mark Baldwin (Session Chair)

09:15 David Thompson (invited)
The Role of Tropospheric Dynamics in Stratosphere/Troposphere Coupling (00300) ►

09:45 Paul Kushner (invited)
Stratospheric Control of Tropospheric Annular Mode Responses to Climate Change (00444) ►

10:15 Coffee Break

Session Chair: Bo Christiansen

10:45 Rolando Garcia
Mechanisms for the Acceleration of the Brewer-Dobson Circulation in a Climate Change Scenario (00301) ►

11:00 Charles McLandress
Diagnosing the Causes of the Climate-Change Induced Strengthening of the Brewer-Dobson Circulation (00178) ►

11:15 Marco Giorgetta
Influence of the Mt Pinatubo Eruptions on the Dynamics of the Quasi-Biennial Oscillation (00010) ►

11:30 Richard Scott
Influence Of the Stratospheric Potential Vorticity Distribution on the Brewer-Dobson Circulation (00074) ►

11:45 Edwin Gerber
Stratosphere-Troposphere Dynamical Coupling and Tropospheric Predictability (00374) ►

12:00 Lunch Buffet

13:00 Poster Session A (posters attended) and Coffee ►

Session Chair: Shigeo Yoden

15:30 SPARC Lecture:
Tim Palmer (invited)
Towards the Seamless Prediction of Weather and Climate (00080) ►

16:30 Kaoru Sato (invited)
A Study of the Middle Atmosphere Dynamics Using a Gravity-Wave Resolving GCM (00025) ►

17:00 Katja Matthes
Modeling the Impact of the Solar Cycle and the QBO in the Atmosphere: Time-Varying Vs. Fixed Solar Conditions (00325) ►

17:15 Adam Scaife
Winter Weather and Stratosphere-Troposphere Coupling (00256) ►

17:30 Poster Session A (posters attended) with Drinks ►

19:30 End

Tuesday 2 September

Theme: Extratropical UTLS

08:30 Registration Opens - Take down Session A Posters

09:00 Introduction by Sachiko Hayashida (Session Chair)

09:15 Daniel Murphy (invited)
Chemistry of Aerosol Particles in the Upper Troposphere and Lower Stratosphere (00035) ►

09:45 Markus Rex (invited)
Impact of Recent Laboratory Measurements of the Absorption Cross Section of ClOOCl on Our Understanding of Polar Ozone Chemistry (00179) ►

10:15 Coffee Break (Put up Session B Posters)

Session Chair: Karen Rosenlof

10:45 Michael Pitts
Polar Stratospheric Cloud Composition Studies Using CALIPSO Lidar Data (00078) ►

11:00 Peter Spichtinger
Internal Dynamics of Cirrus Clouds – A Source for Ice Supersaturation (00402) ►

11:15 Joan Alexander
High Resolution Satellite View of Gravity Waves from Tropospheric Sources (00327) ►

11:30 Takeshi Horinouchi
Spatial Structures of Mesoscale Gravity Waves Derived From COSMIC GPS Occultation Data (00412) ►

11.45 John Gille
HIRDLS Observations of the 2-Way Exchange between the Tropical Upper Troposphere and the Extra-Tropical Lower Stratosphere (00382) ►

12:00 Lunch Buffet

13:00 Poster Session B (posters attended) and Coffee ►

Session Chair: Peter Hoor

15:30 Thomas Birner (invited)
The Tropopause Inversion Layer (00376) ►

16:00 Michaela Hegglin (invited)
Toward A Global View of Extratropical UTLS Tracer Distributions (00171) ►

16:30 Michelle Santee
Trace Gas Evolution in the Lowermost Stratosphere from Aura Microwave Limb Sounder Measurements: Subvortex Processing and Transport (00163) ►

16:45 Mijeong Park
Transport Pathways in the Asian Monsoon Anticyclone Diagnosed From Spaceborne Measurements and Model Simulations (00290) ►

17:00 Bönisch Harald
A New Approach for a Tracer Budget of the Extratropical Lower Stratosphere Using Simultaneous Measurements of SF_6 *and* CO_2 (00409) ►

17:15 Jose Rodriguez
Observations and Modeling of Composition of UTLS: Isentropic Mixing Events and Morphology of HNO_3 *as Observed by HIRDLS and Comparison with Results from Global Modeling Initiative* (00292) ►

17:30 Poster Session B (posters attended) with Drinks ►

19:30 End

Wednesday 3 September

Theme: Detection and Attribution of Stratospheric Change

08:30 Registration Opens

09:00 Introduction by Greg Bodeker (Session Chair)

09:15 Paul Newman (invited)
Detection and Attribution of the Recovery of Polar Ozone (00356) ►

09:45 Neil Harris (invited)
Understanding the Relation between V(PSC) and Arctic Ozone Loss (00289) ►

10:15 Coffee Break

Session Chair: Martin Dameris

10:45 Lon Hood (invited)
Effects of Solar Irradiance Variability and Particle Precipitation on the Stratosphere (00081) ► , see also (00375) ►

11:15 Daggumati Narayana Rao
Tropospheric Warming and Stratospheric Cooling Observed From GPS Radio Occultation Measurements (00234) ►

11:30 Mark Weber
Internannual Variability in Chemistry and Transport and Its Possible Link to Climate Change: Stratospheric Ozone and Water Vapor (00058) ►

11:45 Joanna Haigh
Trends and Influences on the Vertical Structure and Seasonal Evolution of the Antarctic Polar Vortex: The Apparent Downward Progression of Anomalies Does Not Imply an Unexplained Propagation (00154) ►

12:00 Ottmar Moehler
The AQUAVIT Formal Intercomparison of Atmospheric Water Measurement Methods (00443) ►

12:15 Ted Shepherd
SPARC – Quo Vadis?
15 Minutes on possible future developments in SPARC and the WCRP

12:45 Lunch

– Afternoon Free –

14:00 Special Afternoon Sessions (not Part of the Official Programme), e.g.
Kickoff meeting for the New SPARC Water Vapour Initiative;
SPARC-IPY meeting

19:00 SPARC GA Dinner – Basilica Santo Stefano e Palazzo Isolani

Thursday 4 September

Theme: Tropical Tropopause Layer

08:30 Registration Opens

09:00 Introduction by Anne Thompson (Session Chair)

09:15 Leo Donner (invited)
Current Perspectives on Deep Convection, Upper Troposphere, and Lower Stratosphere from General Circulation Models and Cloud-System-Resolving Models (00397) ►

09:45 Stephan Fueglistaler (invited)
The Diabatic Heat Budget of the Upper Troposphere and Stratosphere In ECMWF Reanalyses (00242) ►

10:15 Coffee Break

Session Chair: Kirstin Krueger

10:45 Daniel Grosvenor
Stratospheric Moistening by Overshooting Deep Convection from Cloud Simulations: Towards a Global Estimate (00445) ►

11:00 Michael Volk
Transport Across the Tropical Tropopause by Convection, Mixing, and Slow Upwelling: Insights from Recent In Situ Observations with the Geophysica Aircraft (00385) ►

11:15 Fumio Hasebe
Cold Trap Dehydration in the TTL Characterized By SOWER Observations in the Tropical Pacific (00194) ►

11:30 Thomas Hanisco
In Situ Observations of the Isotopic Composition of Vapor and Condensed Water in the Tropical Tropopause Layer (00408) ►

11:45 Björn-Martin Sinnhuber
Observations of BrO in the Stratosphere and TTL from SCIAMACHY: Implications for the Transport of Very Short-Lived Source Gases Into The Stratosphere (00127) ►

12:00 Lunch Buffet

13:00 Poster Session B (posters unattended) and Coffee ►

15:10 Take down Session B Posters

15:15 Put up Session C Posters

Session Chair: Marvin Geller

15:30 SPARC Lecture:
Thomas Koop (invited)
Atmospheric Water Vapor, Aerosols, and Clouds: A Microphysical Perspective (00352) ►

16:30 Masatomo Fujiwara (invited)
Observations of Ozone, Water Vapor, and Cirrus in the Tropical Tropopause Layer over the Pacific (00173) ►

17:00 Eric Jensen
Ice Concentrations and Extinctions in Tropical Tropopause Layer Thin Cirrus (00329) ►

17:15 Panuganti Devara
An Overview of Tropical Aerosol and Cloud Studies in the UTLS over India: Present Activities and Future Perspectives (00192) ►

17:30 Poster Session C (posters attended) with Drinks ►

19:30 End

Friday 5 September

Theme: Atmospheric Chemistry and Climate

08:30 Registration Opens

09:00 Introduction by Veronika Eyring (Session Chair)

09:15 Mark Lawrence (invited)
Effects of Deep Cumulus Convection on Atmospheric Chemistry (00225) ►

09:45 Kengo Sudo (invited)
Changes in Tropospheric Chemistry and Their Impacts on Climate: Roles of Climate Change and the Stratosphere (00247) ►

10:15 Coffee Break

Session Chair: Anne Douglass

10:45 Jessica Neu
Tropospheric Ozone: The Role of Stratospheric Variability (00343) ►

11:00 Camilla Mathison
Improving the Representation of Ozone in the UK Met Office Model (00014) ►

11:15 Lesley Gray
The Role of Ozone in Future IPCC Simulations (00278) ►

11:30 Kleareti Tourpali
Surface UV Simulations in the 21st Century (00438) ►

11:45 Claudia Timmreck
Impact of the 1991 Mt Pinatubo Eruption on the Hydrological Cycle With Implications for Geoengineering (00128) ►

12:00 Lunch Buffet

13:00 Poster Session C and Coffee (posters attended) ►

Session Chair: David Fahey

15:30 SPARC Lecture:
Darryn Waugh (invited)
Projections of Stratospheric Changes and Their Role in Climate (00065) ►

16:30 Thomas Reichler
What Determines Tropical Tropopause Parameters? A Modelling Study of Past and Future Trends with the AMTRAC Coupled Chemistry Climate Model (00372) ►

16:45 John Scinocca
The Sensitivity of Polar Ozone Recovery to Catastrophic Sea-Ice Loss In The Northern Hemisphere (00396) ►

17:00 Closing Remarks and Poster Award

17:30 Poster Session C (posters unattended) and Closing Drinks ►

19:15 Take down Session C Posters

19:30 Farewell

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POSTER SESSION A:

Dynamical Coupling, Gravity Waves, Data Assimilation

Poster Session A includes 3 viewing periods – 18:00 to 19:30 Sunday, 13:00 to 15:30 Monday and 17:30 to 19:30 Monday. Posters in Session A may be put up any time after 13:00 on Sunday and should be taken down by 09:00 on Tuesday. Presenters should display their posters on the assigned poster board and be present at the poster for at least the assigned viewing period. The information given after each presenter name, e.g. [P1/Monday 13:00], specifies the relevant poster board number and viewing period.

In cases where the submitter of a poster abstract is unable to attend the Assembly and has nominated a substitute presenter, the name of the latter is indicated in the Abstract -- underlined in red.

Arnone Enrico [P1/Monday 13:00]
Triggering of Sudden Stratospheric Warming In a Stratosphere-Mesosphere Model by Impulsive Regional Ozone Perturbations (00322) ►

Baier Frank [P2/Monday 17:30]
The PROMOTE 3D Ozone Record Service: Overview and First Evaluation of Stratospheric Ozone Reanalyzes Based On Satellite Observations between 1992 and 2004 (00294) ►

Baldwin Mark [P3/Monday 13:00]
Stratosphere-Troposphere Coupling In DynVar and CCMVal Models (00326) ►

Bates J. Ray [P4/Monday 17:30]
Stratosphere-Troposphere Dynamical Coupling: The Role of Analytical Studies in the Development of Our Understanding (00097) ►

Bell Chris [P5/Monday 13:00]
Stratospheric Communication of the ENSO Teleconnection to Europe (00286) ►

Bencherif Hassan [P6/Monday 17:30]
Investigation of Temperature Trends and Gravity Wave Characteristics from LIDAR Profiles Recorded at Reunion Island (20.8°S, 55.5°E) from 1994 to 2007 (00243) ►

Birner Thomas [P7/Monday 13:00]
Sudden Stratospheric Warmings as Noise-Induced Transitions (00378) ►

Bittner Michael [P8/Monday 17:30]
The World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT) (00245) ►

Bushell Andrew [P9/Monday 13:00]
Impacts upon the Evolution of the Met Office NWP and Climate Middle Atmosphere GCM due to Recent Improvements to Modelled Radiation and Ozone Interactions (00337) ►

Cagnazzo Chiara [P10/Monday 17:30]
Impact of Modeling the Stratosphere on the Winter Tropospheric Teleconnections between ENSO and the Northern Atlantic and European Region (00092) ►

Calvo Natalia [P11/Monday 13:00]
Transient Changes in the Brewer-Dobson Circulation Associated With ENSO (00299) ►

Castanheira José [P12/Monday 17:30]
Changes on Barotropic Planetary Waves Associated with Changes in the Northern Hemisphere Stratospheric Polar Vortex (00360) ►

Chan Cegeon [P13/Monday 13:00]
The Tropospheric Response to Stratospheric Perturbations and Its Sensitivities to Topographically-Forced Stationary Waves (00357) ►

Chane Ming Fabrice [P14/Monday 17:30]
Analysis of Gravity-Waves Produced By Intense Tropical Cyclones (00013) ►

Charlton-Perez Andrew [P15/Monday 13:00]
Changes to Sudden Stratospheric Warmings in Future Climates (00096) ►

Charlton-Perez Andrew [P16/Monday 17:30]
What Controls Dynamical Timescales near the Tropopause? (00098) ►

Chen Gang [P17/Monday 13:00]
The Tropospheric Jet Response to Prescribed Zonal Forcing in an Idealized Atmospheric Model (00165) ►

Chen Wen [P18/Monday 17:30]
Relationship between Stationary Planetary Wave Activity and the East Asian Winter Monsoon (00111) ►

Chen Yuejuan [P19/Monday 13:00]
The Anomalies of Polar Vortex before the Serious Snow Storm and Freeze Calamity in China 2008 (00086) ►

Chen Zeyu [P20/Monday 17:30]
Estimation and Attribution of the Temperature Variances in the Stratosphere (00006) ►

Choi Hyun-Joo [P21/Monday 13:00]
Factors to Determine Wave-Propagation Direction of Convective Gravity Waves: Application to a GWD Parameterization (00227) ►

Christiansen Bo [P22/Monday 17:30]
The Contribution from the Stratosphere to the Skill of a Dynamical Seasonal Prediction System (00236) ►

Claud Chantal [P23/Monday 13:00]
On Associations between the QBO, the 11-Year Solar Cycle and the Indian Summer Monsoon (00421) ►

Cooper Fenwick [P24/Monday 17:30]
The Response of Tropospheric Climate to Weak Perturbations, Including Stratospheric Perturbations (00205) ►

Corti Susanna [P25/Monday 13:00]
Large Scale Circulation Regimes: Troposphere-Stratosphere Connections (00332) ►

Coy Lawrence [P26/Monday 17:30]
The 360 K Potential Temperature Surface: A New Diagnostic for Stratospheric Prediction (00047) ►

Cui Xuefeng [P27/Monday 13:00]
The Influences of the Great Volcanic Eruptions and the Variations of Sea Surface Temperature on the Northern Stratospheric Polar Vortex (00198) ►

Das Siddarth Shankar [P28/Monday 17:30]
Characteristics of Kelvin-Helmholtz Instability Observed Using UHF/VHF Radars (00007) ►

de la Torre Alejandro [P29/Monday 13:00]
A Gravity Wave Analysis in Mendoza (Argentina), As Detected From GPS Radio Occultation Data and Mesoscale Numerical Simulation (00303) ►

de la Torre Alejandro [P30/Monday 17:30]
Seasonal Analysis of Gravity Waves over the Southern Andes and the Antarctic Peninsula by Means of GPS Radio Occultations (00306) ►

Deckert Rudolf [P31/Monday 13:00]
Higher Tropical SSTs Strengthen the Tropical Upwelling via Deep Convection (00115) ►

Dutta Gopa [P32/Monday 17:30]
VHF Radar Observations of Gravity Waves Generated By Convective Storms (00246) ►

Ern Manfred [P33/Monday 13:00]
Gravity Waves Resolved In ECMWF and Measured by Current and Future Satellite Instruments (00133) ►

Errera Quentin [P34/Monday 17:30]
Overview of Stratospheric Analyses Produced by the Belgian Assimilation System for Chemical Observations (BASCO) In the Framework of GSE-PROMOTE (00123) ►

Evan Stephanie [P35/Monday 13:00]
Intermediate-Scale Tropical Inertia Gravity Waves Observed During TWP-ICE Campaign (00371) ►

Farahani Ellie [P36/Monday 17:30]
The Structure and Evolution of the Polar Stratosphere and Mesosphere during IPY - Early Results from SPARC-IPY (00440) ►

Fletcher Christopher [P37/Monday 13:00]
Stratospheric Influence on the Extratropical Circulation Response to Surface Forcing in High-Top and Low-Top Models (00156) ►

Geller Marvin [P38/Monday 17:30]
Gravity Wave Analyses from Temperature, Wind, and Ascent Rates in US High Vertical-Resolution Radiosonde Data (00042) ►

Giorgetta Marco [P39/Monday 13:00]
Circulation Changes in Climate Models Related to the Representation of the Stratosphere (00196) ►

Gozzini Bernardo [P40/Monday 17:30]
Climate Change Impacts On Stratosphere-Troposphere Coupling (00144) ►

Grise Kevin [P41/Monday 13:00]
On The Role of Stratospheric Longwave Radiative Fluxes in Stratosphere-Troposphere Coupling (00101) ►

Grunow Katja [P42/Monday 17:30]
Climate Change and Arctic Winters: A Dynamical Feedback Mechanism? (00434) ►

Gruzdev Aleksandr [P43/Monday 13:00]
Statistical Relation between the Quasi-Decadal and Quasi-Biennial Variations in the Equatorial Stratosphere and Similar Variations in Solar Activity (00204) ►

Halenka Tomáš [P44/Monday 17:30]
On The Relations between Stratospheric Circulation and Heliogeophysical Parameters (00388) ►

Hardiman Steven [P45/Monday 13:00]
The Effects of Eurasian Snow Cover in General Circulation Models (00017) ►

Hertzog Albert [P46/Monday 17:30]
Tuning the Orographic and Non-Orographic Gravity Wave Drag Schemes with the Vorcore Long-Duration Balloon Observations (00262) ►

Hertzog Albert [P47/Monday 13:00]
Mesoscale Simulations of Gravity Waves Observed During VORCORE (00263) ►

Hertzog Albert [P48/Monday 17:30]
A Case Study of an Orographic Gravity Wave above the Antarctic Peninsula (00265) ►

Hocke Klemens [P49/Monday 13:00]
QBO in Solar Wind Variability and Its Relation to ENSO (00077) ►

Hooghoudt Jan-Otto [P50/Monday 17:30]
Stratosphere-Troposphere Singular Vectors Studied In Terms Of Potential Vorticity (00422) ►

Ichimaru Tomoko [P51/Monday 13:00]
Predictability of Stratospheric Circulations during Recent Sudden Warming Events (00189) ►

Ineson Sarah [P52/Monday 17:30]
Influence of ENSO on European Climate via the Stratosphere (00284) ►

Inoue Makoto [P53/Monday 13:00]
The Relationship between the Stratospheric Quasi-Biennial Oscillation (QBO) and Tropospheric Circulation from the Northern Hemisphere Summer to Winter (00180) ►

Kafando Petronille [P54/Monday 17:30]
Gravity Waves Induced by the West African Monsoon (00032) ►

Kawatani Yoshio [P55/Monday 13:00]
The Roles of 3-Dimensional Propagating Gravity Waves and Equatorial Trapped Waves on Driving the Quasi-Biennial Oscillation (00061) ►

Kawatani Yoshio [P56/Monday 17:30]
Global Distribution of Atmospheric Waves in the Equatorial Upper Troposphere and Lower Stratosphere Region: AGCM Simulation of Source and Propagation (00122) ►

Khokhlov Valeriy [P58/Monday 13:00]
Effects of North Atlantic Oscillation on Spatiotemporal Variations of Total Ozone over Europe (00310) ►

Kim Junsu [P59/Monday 13:00]
Simulation of Stratospheric Intraseasonal Variability with the GFDL Climate Model and Sensitivity to Climate Change (00361) ►

Kim Junsu [P60/Monday 17:30]
A Possible Mechanism for the Tropospheric Response to Stratospheric Forcing (00384) ►

Kim Young-Ha [P61/Monday 13:00]
A Numerical Study on Secondary Waves Forced by Breaking of Convective Gravity Waves (00226) ►

Kodera Kunihiko [P62/Monday 17:30]
Intercontinental Tropospheric Teleconnection by Planetary Wave Reflection in the Stratosphere (00169) ►

Kumar Kondapalli Niranjan [P63/Monday 13:00]
Characteristics of Inertia-Gravity Waves over Gadanki during the Passage of Deep Depression over the Bay of Bengal (00060) ►

Kuroda Yuhji [P64/Monday 17:30]
Role of Solar Activity in the Troposphere-Stratosphere Coupling in the Northern and Southern Hemisphere Winters (00095) ►

Lahoz William [P65/Monday 13:00]
Data Assimilation: A Tool for Climate-Chemistry Studies (00151) ►

Long David [P66/Monday 17:30]
Validation of Mesospheric Analyses (00449) ►

Mahmood Sana [P67/Monday 13:00]
A Study of the 2008 Stratospheric Sudden Warming in the Northern Hemisphere (00034) ►

Makarova Liudmila [P68/Monday 17:30]
Influence of the Space Weather and Conductivity of the Ground-Surface on Thermal Regime of the Stratosphere (00002) ►

Manzini Elisa [P69/Monday 13:00]
The Separate Influence of Recent Climate Change on Stratospheric Variability: Results from a Transient Simulation with a Middle Atmosphere Model (00053) ►

Marshall Andrew [P70/Monday 17:30]
Impact of Stratospheric Resolution on Seasonal Forecast Skill for Europe (00316) ►

Matthewman Joss [P71/Monday 13:00]
A Vortex Dynamics Perspective on Stratospheric Sudden Warmings: Observed Structure and Variability (00139) ►

Metzner Doreen [P72/Monday 17:30]
The Role of Stratospheric Resolution for Simulating ENSO Wintertime Teleconnections in Northern Extra-Tropics (00069) ►

Mohanakumar Kesavapillai [P73/Monday 13:00]
Stratospheric Variability - Before and After the mid-1970s Climate Shift (00181) ►

Mohanakumar Kesavapillai [P74/Monday 17:30]
Linkage between Stratospheric QBO and Tropospheric Biennial Oscillation in the Tropical Monsoon Regions (00183) ►

Mukougawa Hitoshi [P75/Monday 13:00]
Influence of Stratospheric Circulation on the Predictability of the Tropospheric Northern Annular Mode (00088) ►

Nath Debashis [P76/Monday 17:30]
Inertia-Gravity Wave Characteristics Observed Over a Tropical Station Using Intensive GPS Radiosonde Soundings (00112) ►

Nezlin Yulia [P77/Monday 13:00]
Impact of Tropospheric and Stratospheric Data Assimilation on the Mesospheric Prediction (00072) ►

Nishii Kazuaki [P78/Monday 17:30]
Modulations of Planetary Waves by Upward-Propagating Rossby Wave Packets Prior to a Stratospheric Sudden Warming Event: Observations and Ensemble Forecasts (00113) ►

Nurhayati Nunun [P79/Monday 13:00]
The Possibility Of The Wind Profiling Radar (WPR) On Study Effects Of Gravity Waves On A Corrugated Structure Of Reflection Surface (00403) ►

Oatley Clare [P80/Monday 17:30]
Use of an Adjoint Technique to Analyse the Dynamics of Vortex Splitting in the SH Stratosphere during 2002 (00207) ►

Orsolini Yvan [P81/Monday 13:00]
Tropospheric Precursors to a Cold Polar Stratosphere and a High PSC Volume (00271) ►

Osprey Scott [P82/Monday 17:30]
High-Frequency Variability in the Stratosphere Resolving Metum L60 and a Comparison with HIRDLS-Aura (00334) ►

Preusse Peter [P83/Monday 13:00]
Global Ray Tracing Simulations of the SABER Gravity Wave Climatology (00141) ►

Pulido Manuel [P84/Monday 17:30]
Determining Optimal Parameters for Gravity Wave Drag Schemes Using Data Assimilation Techniques: Twin Experiments (00167) ►

Reichler Thomas [P85/Monday 13:00]
Stratospheric Role for the Widening of the General Circulation (00373) ►

Ren Rongcai [P86/Monday 17:30]
Downward Propagation of Circulation Anomalies and the Out-Of-Phase Relationships of Temperature Anomalies between the Stratosphere and the Troposphere (00089) ►

Ren Shuzhan [P87/Monday 13:00]
The Constraint of Data Assimilation in the Stratosphere and Troposphere on Mesospheric Motions (00102) ►

Reszka Mateusz [P88/Monday 17:30]
Data Assimilation Experiments with New Covariance Models at Environment Canada (00162) ►

Rodas Claudio [P89/Monday 13:00]
The Dissipation of Transience Gravity Waves Propagating in a Shear Flow (00105) ►

Schmidt Torsten [P90/Monday 17:30]
A Global Analysis of Gravity Wave Activity in the Upper Troposphere and Lower Stratosphere Region Derived From GPS Radio Occultation Data (00152) ►

Sekiyama Thomas [P91/Monday 13:00]
Assimilation of Total Ozone Using a Local Ensemble Transform Kalman Filter (00405) ►

Sharma Som [P92/Monday 17:30]
Rayleigh Lidar Observed Stratospheric Sudden Warming (SSW) At Mount Abu: An Evidence of Interaction between Planetary Wave and Stratospheric Circulation (00272) ►

Shaw Tiffany [P93/Monday 13:00]
Spurious Sensitivity of a General Circulation Model to Model Lid Height due to Nonconservation of Angular Momentum (00083) ►

Shirochkov Alexander [P94/Monday 17:30]
The Big-Scale Climatic Anomalies in the Antarctica and Their Possible Connection with Precipitation of Energetic Electrons from Outer Belt into the Stratosphere above These Regions (00004) ►

Sigmond Michael [P95/Monday 13:00]
The Impact of the Stratosphere on Tropospheric Climate Change (00363) ►

Sigmond Michael [P96/Monday 17:30]
The Sensitivity of Modeled Climate Change to Orographic Gravity Wave Drag (00367) ►

Simpson Isla [P97/Monday 13:00]
Solar Influence on Tropospheric Circulation via the Stratosphere (00153) ►

Smy Louise [P98/Monday 17:30]
Influence of Stratospheric Potential Vorticity on Baroclinic Lifecycles (00052) ►

Sofieva Viktoria [P99/Monday 13:00]
Quantifying Gravity Waves and Turbulence in the Stratosphere Using Satellite Stellar Scintillation Measurements (00244) ►

Sofieva Viktoria [P100/Monday 17:30]
On Variability Of Temperature Profiles In The Stratosphere: Implications For Validation (00248) ►

Sparrow Sarah [P101/Monday 13:00]
Modes of Annular Variability in the Atmosphere and Eddy-Zonal Flow Interactions (00230) ►

Suvorova Ekaterina [P102/Monday 17.30]
Climatic Variability of the Stratospheric Dynamics: Results of Simulation and Data Analysis. (00176) ►

Taguchi Masakazu [P103/Monday 13:00]
Is There A Statistical Connection Between Stratospheric Sudden Warming And Tropospheric Blocking Events? (00037) ►

Thomas Manu Anna [P104/Monday 17.30]
Simulation Of The Dynamical Response After Volcanic Eruptions- The Challenge Remains! (00206) ►

Tsuda Toshitaka [P57/Monday 13:00]
Characteristics of Atmospheric Waves in the Stratosphere Revealed by GPS Radio Occultation (RO) Temperature Data (00033) ►

Wang Lei [P105/Monday 13:00]
Stationary Wave Response to Climate Change (00208) ►

Wang Lin [P106/Monday 17.30]
A Change of the Wintertime Ural Blocking Circulation Around 1976/77 and Its Relationship with East Asian Winter Climate (00036) ►

Wang Ling [P107/Monday 13:00]
Observation of Stratospheric Sudden Warmings and Gravity Wave Activity during the Northern Winter of 2007/2008 from COSMIC/CHAMP GPS Radio Occultation Profiles **(**00015) ►

Watanabe Shingo [P108/Monday 17.30]
General Aspects of a T213L256 Middle Atmosphere General Circulation Model (00209) ►

Winter Barbara [P109/Monday 13:00]
Stratospheric Response to Latitudinally Varied Surface Warming (00168) ►

Woollings Tim [P110/Monday 17.30]
Stratospheric Involvement in Blocking (00158) ►

Yan Xiuping [P111/Monday 13:00]
Global Observation of Gravity Waves Using HIRDLS Temperature Measurements (00200) ►

Yoden Shigeo [P112/Monday 17.30]
An Idealized-Model Experiment on the Remote Influence of Interannual Variations in the Tropics to the Winter Polar Vortex (00197) ►

Yudin Valery [P113/Monday 13:00]
Scale-Dependent Assimilation Schemes for Multi-Instrumental Constituent Observations: Forecast and Analysis of Vertical Ozone Structures in the UTLS (00369) ►

Zyulyaeva Yulia [P114/Monday 17.30]
Analysis of Three - Dimensional Elliassen-Palm Fluxes in the Lower Stratosphere (00094) ►

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POSTER SESSION B:

Extratropics, Detection and Attribution, Variability and Climate Change, Water Vapour

Poster Session B includes 3 viewing periods – 13:00 to 15:30 Tuesday, 17:30 to 19:30 Tuesday and 13:00 to 15:10 Thursday. Posters in Session B may be put up any time after 10:15 on Tuesday and should be taken down by 15:15 on Thursday. Presenters should display their posters on the assigned poster board and be present at the poster for at least the assigned viewing period. The information given after each presenter name, e.g. [P1/Tuesday 13:00], specifies the relevant poster board number and viewing period.

In cases where the submitter of a poster abstract is unable to attend the Assembly and has nominated a substitute presenter, the name of the latter is indicated in the Abstract -- underlined in red.

Abraham Nathan Luke [P1/Tuesday 13.00]
Ozone Flux across the Dynamical Tropopause: Does the PV Value Matter? (00288) ►

Anderson John [P2/Tuesday 17.30]
Introduction to the Halogen Occultation Experiment 4th Public Data Release (00346) ►

Arnone Enrico [P3/Tuesday 13.00]
The MIPAS2D: 2-D Analysis of MIPAS Observations of ESA Target Molecules and Minor Species (00279) ►

Austin John [P4/Tuesday 17.30]
The Advance of Ozone Recovery due to Climate Change (00041) ►

Baray Jean-Luc [P5/Tuesday 13.00]
Stratosphere-Troposphere Exchange Study in the Southern Subtropics Using Experimental Data, Trajectory and Reverse Domain Filling Calculations (00131) ►

Bingen Christine [P6/Tuesday 17.30]
The Model for Stratospheric Aerosol (MOSTRA): Some Results (00140) ►

Bönisch Harald [P7/Tuesday 13.00]
First Results of a Model Evaluation Based on a Tracer Budget of the Extratropical Lower Stratosphere Applied on Simulated and Measured SF_6 and CO_2 (00452) ►

Borsche Michael [P8/Tuesday 17.30]
GPS Radio Occultation Climatologies Retrieved With High-Altitude Initialization by ECMWF Forecasts for the Creation of a Continuous Climate Record (00432) ►

Bozem Heiko [P9/Tuesday 13.00]
The Influence of Deep Convection on HCHO, H_2O_2 and Organic Peroxides in the: Upper Troposphere over Europe (00232) ►

Braesicke Peter [P10/Tuesday 17.30]
Zonal Asymmetries in Age-Of-Air and Their Relevance for Transport into the Sub-Tropical Lowermost Stratosphere (00321) ►

Butler Amy [P11/Tuesday 13.00]
Spatial Structures in Lower-Stratospheric Temperature Trends (00160) ►

Casiccia Claudio [P12/Tuesday 17.30]
Stratospheric Ozone in the American South Cone and Antarctic Ozone Hole 1992-2007 (00048) ►

Chipperfield Martyn [P13/Tuesday 13.00]
Recent Modelling Studies Using Different Laboratory Data for ClOOCl Photolysis and Other Halogen Reactions (00425) ►

Choi Hyesun [P14/Tuesday 17.30]
Zonal Asymmetries in the Dynamic Fields and the Tracer Distributions in the Equatorial Mid-Stratosphere (00120) ►

Clémer Katrijn [P15/Tuesday 13.00]
Intercomparison of Integrated Water Vapour Measurements from Radiosonde, Sun-photometer, FTIR, and GPS Instruments (00406) ►

David Christine [P16/Tuesday 17.30]
Polar Stratospheric Clouds Formation and Evolution in Antarctica by Applying the "MATCH" Method to Lidar Investigations within the International Polar Year (00442) ►

De Wachter Evelyn [P17/Tuesday 13.00]
Stratospheric Water Vapour Profiles over Seoul, S-Korea (00147) ►

Dikty Sebastian [P18/Tuesday 17.30]
Variations in SCIAMACHY and SABER Ozone Data on Small Time Scales Induced by Solar Radiation Variations (00389) ►

Fioletov Vitali [P19/Tuesday 13.00]
Estimating 27-Day and 11-Year Solar Cycle Variations in Tropical Upper Stratospheric Ozone (00259) ►

Fiorucci Irene [P20/Tuesday 17.30]
Millimeter-Wave Measurements of Stratospheric O_3 and N_2O from the High-Altitude Station of Testa Grigia (Italy; 45.9°N, 7.7°E, 3500 m A.S.L.) (00269) ►

Flury Thomas [P21/Tuesday 13.00]
Response of the Mesosphere and Its Water Vapor Content to the Sudden Stratospheric Warming in February 2008 (00093) ►

Fueglistaler Stephan [P22/Tuesday 17.30]
Trends and Variability of Midlatitude Stratospheric Water Vapour Deduced from the Re-Evaluated Boulder Balloon Series (00394) ►

Funatsu Beatriz [P23/Tuesday 13.00]
Lidar Monitoring of Stratospheric Temperature: Impact of Spatial and Temporal Sampling (00420) ►

Gille John [P24/Tuesday 17.30]
HIRDLS Observations of Upper Tropospheric and Stratospheric Water Vapor (00379) ►

Gimeno Luis [P25/Tuesday 13.00]
Multiple Tropopause Events: Climatological Features and Analysis of the Relationship of Their Occurrence with Cut-Off Low Systems (00313) ►

Gruzdev Aleksandr [P26/Tuesday 17.30]
Observed Trends in Stratospheric NO_2 (00202) ►

Haefele Alexander [P27/Tuesday 13.00]
Evaluation of Available Data Sets of Stratospheric Water Vapor from Ground Based Microwave Radiometers. (00224) ►

Harris Neil [P28/Tuesday 17.30]
SPARC Initiative on Recent Laboratory and Theoretical Studies on the ClOOCl Photolysis and Other Halogen Reactions (00266) ►

Hassler Birgit [P29/Tuesday 13.00]
A Comparison of Trends in the Vertical Distribution of Ozone in True and Equivalent Latitude Coordinates: Implications for Radiative Forcing at Polar Latitudes (00119) ►

Hinssen Yvonne [P30/Tuesday 17.30]
How is the Potential Vorticity Distribution in the Stratosphere Established? (00136) ►

Hocke Klemens [P31/Tuesday 13.00]
Linear Trend and Solar Cycle in Stratospheric Ozone Profiles Observed by the GROMOS Microwave Radiometer in Switzerland (00413) ►

Hood Lon [P32/Tuesday 17.30]
Effects of EPP-NO_x *and Solar UV Variations on Ozone in the Polar Stratosphere: Correlative Studies Using UARS HALOE and SBUV(/2) Data* (00082) ►

Hoor Peter [P33/Tuesday 13.00]
Trace Gas Observations and Their Relation to the Tropopause Definition (00417) ►

Immler Franz [P34/Tuesday 17.30]
The GCOS Reference Upper-Air Network (GRUAN): Rationale, Progress, and Plans (00291) ►

Jackson David [P35/Tuesday 13.00]
Arctic Ozone Loss Inferred From Assimilation of EOS MLS and SBUV/2 Observations (00027) ►

Jégou Fabrice [P36/Tuesday 17.30]
Evaluation of the LMDz-INCA Chemistry-Climate Model in the Extratropical Tropopause Region (00344) ►

Jonsson Andreas [P37/Tuesday 13.00]
On the Radiative Forcing of Global-Mean Temperature Trends in the Middle Atmosphere (00324) ►

Kahn Brian [P38/Tuesday 17.30]
Ice Cloud and Humidity Distributions Observed by the A-Train (00104) ►

Karathazhiyath Satheesan [P39/Tuesday 13.00]
A Study of the Transport of Ozone into the Surface over Antarctica (00195) ►

Karpechko Alexey [P40/Tuesday 17.30]
Stratosphere-Troposphere Coupling and Trends in the Southern Hemisphere Tropospheric Circulation in CMIP3 (Models) (00184) ►

Kawa Randy [P41/Tuesday 13.00]
Sensitivity of Polar Stratospheric Ozone Loss to Uncertainties in Chemical Reaction Kinetics (00365) ►

Khosrawi Farahnaz [P42/Tuesday 17.30]
Monthly Averages of N_2O and O_3 Derived from Satellite Observations: A Method for the Evaluation of Atmospheric Chemical Models in the Lower Stratosphere (00126) ►

Kinnison Douglas [P43/Tuesday 13.00]
Evaluation of the Whole Atmosphere Community Climate Model Distributions of Chemical Constituents and Mixing Processes in the Extratropical UTLS (00353) ►

Kivi Rigel [P44/Tuesday 17.30]
Stratospheric Water Vapor as Observed by Balloon Borne Instruments in the Arctic (00185) ►

Krämer Martina [P45/Tuesday 13.00]
On Cirrus Cloud Supersaturations and Ice Crystal Numbers (00145) ►

Kreher Karin [P46/Tuesday 17.30]
Hemispheric Differences in NO_2 (Trends) (00213) ►

Krueger Kirstin [P47/Tuesday 13.00]
Studies of Stratopause Evolution Using Satellite Data and Meteorological Analyses: Stratospheric Sudden Warmings and Interannual/Interhemispheric Variability (00315) ►

Kyrölä Erkki [P48/Tuesday 17.30]
GOMOS O_3, NO_2 and NO_3 Measurements in 2002-2007 (00257) ►

Liberato Margarida [P49/Tuesday 13.00]
On The Effect of Planetary Rossby Waves on Total Ozone from GOME (00368) ►

Lastovicka Jan [P50/Tuesday 17.30]
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Lee Huikyo [P51/Tuesday 13.00]
A New Diagnostic for Evaluating Transport between the Tropical Upper Troposphere and Mid-Latitudes Lower Stratosphere in Chemistry-Transport Models (00450) ►

Liu Yi [P52/Tuesday 17.30]
Behavior of Atmospheric Tracers during the 2003-04 SSW and Change of Ozone Flux in the UT/LS (00050) ►

Livesey Nathaniel [P53/Tuesday 13.00]
Tropical Upper-Tropospheric Ozone Variability as Observed by the Aura Microwave Limb Sounder (00103) ►

Lossow Stefan [P54/Tuesday 17.30]
Odin/SMR Measurements of Mesospheric Water Vapour (00229) ►

Lu Daren [P55/Tuesday 13.00]
Seasonal Variation of Global Stratosphere-Troposphere Mass Exchange (00188) ►

Megner Linda [P56/Tuesday 17.30]
Increased Amount of Meteoric Material in the Winter Stratosphere-Implications for Heterogeneous Nucleation (00054) ►

Milz Mathias [P57/Tuesday 13.00]
UTH Measurements from Satellite-Borne Nadir Looking IR and MW Sensors: Possible Long Time Series with Complementary Instruments (00235) ►

Miyazaki Kazuyuki [P58/Tuesday 17.30]
Analysis of Mean Downward Velocity around the Antarctic Polar Vortex (00218) ►

Miyazaki Kazuyuki [P59/Tuesday 13.00]
Analysis of Extratropical UTLS Structure Using a High Vertical Resolution GCM (00252) ►

Möbius Tanja [P60/Tuesday 17.30]
Does the Brewer-Dobson Circulation Change? Three Decades of Mean Age of Air Data Derived From Stratospheric SF6 Measurements (00423) ►

Murtagh Donal [P61/Tuesday 13.00]
Ozone Loss Rates Determined by the Use of Odin and AURA/MLS Data Assimilation (00297) ►

Nakamura Noboru [P62/Tuesday 17.30]
Sensitivity of Global Mixing and Fluxes to Localized Transport Barriers (00275) ►

Nakamura Noboru [P63/Tuesday 13.00]
Amplitudes of Rossby Waves Based on the Bjerknes Circulation (00283) ►

Nardi Bruno [P65/Tuesday 13.00]
An Evaluation of the Capability of HIRDLS to Measure Thin Ozone Filaments during Tropopause Folding Events in the Extra-Tropical UTLS Using Co-Located Ozonesonde and Lidar In Situ Measurements (00377) ►

Newman Paul [P66/Tuesday 17.30]
The World Avoided: What Would Have Happened to Ozone, Surface UV, and the Stratosphere if CFC Emissions Continued to Grow Without Regulation? (00355) ►

Nieto Raquel [P67/Tuesday 13.00]
Identification and Climatology of Cut Offs Lows near the Tropopause from Two Different Kinds of Physical Approaches (00318) ►

Noel Vincent [P68/Tuesday 17.30]
Optically Thick Wave-Induced PSCs over Antarctica from CALIOP, 2006-2007 (00416) ►

Osprey Scott [P69/Tuesday 13.00]
On the Significance of Persistence Timescales in Geophysical Timeseries (00370) ►

Pan Laura [P70/Tuesday 17.30]
Observational Studies of the Extratropical Tropopause and Associated Transport Diagnostics (00056) ►

Pastel Maud [P71/Tuesday 13.00]
Trend Analysis of Tropical Stratospheric NO_2 Columns (00155) ►

Pendlebury Diane [P72/Tuesday 17.30]
Normal Mode Rossby Waves and Their Effects on Chemical Composition in the Late Summer Stratosphere (00193) ►

Peter Thomas [P73/Tuesday 13.00]
A Novel Radiosonde Payload to Study Upper Tropospheric / Lower Stratospheric Aerosol and Clouds (00448) ►

Petitta Marcello [P74/Tuesday 17.30]
Comparison of Lidar and Radio Occultation Temperature Profiles in Polar Regions (00241) ►

Pisso Ignacio [P75/Tuesday 13.00]
Quantification of Transport from Surface to UTLS and Calculation of Ozone Depletion Potentials for VSLS (00441) ►

Randel William [P76/Tuesday 17.30]
Origin of a Climatological Ozone Minimum near 15 km during Arctic Summer (00059) ►

Ratnam Madineni Venkat [P77/Tuesday 13.00]
Studies on Tropospheric and Lower Stratospheric (TLS) Structure and Dynamics Using GPS RO Technique (00020) ►

Reddmann Thomas [P78/Tuesday 17.30]
Multiannual Simulations with the KASIMA-CTM and Comparison with Observations (00348) ►

Remsberg Ellis [P79/Tuesday 13.00]
Solar Cycle Effects in the UARS-HALOE Ozone Dataset (00076) ►

Repossi Patricia [P80/Tuesday 17.30]
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Ribera Pedro [P81/Tuesday 13.00]
Quasibiennial Modulation Of The Southern Hemisphere Tropopause (00311) ►

Roscoe Howard [P82/Tuesday 17.30]
The Observed Trend In The Southern Annular Mode: Is It The Ozone Hole Or Is It Greenhouse Gases? (00018) ►

Sánchez Claudio [P83/Tuesday 13.00]
Water Vapour Isotopes in the Stratosphere: Comparison between a 2D Model and Observations by ODIN/SMR (00022) ►

Santee Michelle [P84/Tuesday 17.30]
Upper Troposphere/Lower Stratosphere (UTLS): Trace Gas Evolution in Recent Satellite Datasets: Relationships to the Subtropical Jet and Tropopause (00312) ►

Schiller Cornelius [P85/Tuesday 13.00]
SPARC Water Vapour Initiative (00222) ►

Schmidt Torsten [P86/Tuesday 17.30]
Trends in the Global Tropopause Estimated from GPS Radio Occultation Data (00150) ►

Sharma Som [P87/Tuesday 13.00]
Lidar Study of Stratospheric Thermal Structure and Long Term Trends over a Sub-Tropical Station Mount Abu (24.5°N, 72.7°E) (00270) ►

Shiotani Masato [P88/Tuesday 17.30]
Current Status of Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) (00190) ►

Shuckburgh Emily [P89/Tuesday 13.00]
Transport and Mixing in the Antarctic Vortex Edge Region (00177) ►

Sinnhuber Björn-Martin [P90/Tuesday 17.30]
What Controls the Inter-Annual Variability of Arctic Ozone? (00125) ►

Son Seok-Woo [P91/Tuesday 13.00]
The Effect of the Stratospheric Circulation on the Extratropical Tropopause Inversion Layer in a Relatively Simple GCM (00309) ►

Staten Paul [P92/Tuesday 17.30]
Space-Born Detection of Long-Term Tropopause Trends (00019) ►

Stiller Gabriele [P93/Tuesday 13.00]
Global Stratospheric Water Vapour Distributions from MIPAS/Envisat for the Period 2002 to 2008 (00090) ►

Sugita Takafumi [P94/Tuesday 17.30]
Temporary Denitrification in the Antarctic Stratosphere as Observed by ILAS-II in the 2003 Early Winter: Comparison with a Microphysical Box Model (00107) ►

Symington Angela [P95/Tuesday 13.00]
The Heterogeneous Interactions of Halogenated and Non Halogenated Organic Molecules with Ice Surfaces at Temperatures of the Upper Troposphere (UT) (00249) ►

Tegtmeier Susann [P96/Tuesday 17.30]
Seasonal Persistence of Northern Low and Middle Latitude Anomalies of Ozone and Other Trace Gases in the Stratosphere (00023) ►

Teitelbaum Hector [P97/Tuesday 13.00]
Observation of a Tongue Pulled Out from the Antarctic Vortex Edge due to Barotropic Instability (00068) ►

Thomason Larry [P98/Tuesday 17.30]
Consistency of Stratospheric Aerosol Measurements and Modeling: Results from ASAP and Beyond (00130) ►

Thompson Anne [P99/Tuesday 13.00]
Ubiquity of the Stratospheric Influence in Mid-Latitude Tropospheric Ozone: Evidence from North American Ozonesondes (IONS, 2004-2008) (00274) ►

Tilmes Simone [P100/Tuesday 17.30]
Toward An Aircraft In Situ Data Based Chemical Tracer Climatology for Model Evaluation in the UTLS Region (00354) ►

Tomikawa Yoshihiro [P101/Tuesday 13.00]
Ozone Enhanced Layers in the Antarctic Ozone Hole (00075) ►

Urban Joachim [P102/Tuesday 17.30]
Spatio-Temporal Variability of Middle Atmospheric Water Vapour as Observed by Odin (00317) ►

Van Delden Aarnout [P103/Tuesday 13.00]
Thermal Inertia and Radiative Imbalance as Factors Determining the Stratospheric Temperature (00134) ►

Van Malderen Roeland [P104/Tuesday 17.30]
*Trend Analysis of the Radiosonde Relative Humidity Measurements at Uccle, Belgium (*00118) ►

Volk C. Michael [P105/Tuesday 13.00]
Isentropic Transport and Mixing Between the Tropical UTLS and the Extratropical Stratosphere as Observed by In-Situ Measurements of Long-Lived Trace Gases (00359) ►

Wohltmann Ingo [P106/Tuesday 17.30]
An Update on Statistical Trend Analysis of Column Ozone from the CANDIDOZ Project: Influence of Dynamical and Chemical Processes (00039) ►

Wolfram Elian [P107/Tuesday 13.00]
The UVO3 Patagonia Project (00212) ►

Yushkov Vladimir [P108/Tuesday 17.30]
*Water Vapour in the Polar and Tropical UT/LS from Balloon and Aircraft Observations with FLASH Lyman-Alpha Hygromet*er (00307) ►

Zahn Andreas [P109/Tuesday 13.00]
Properties of the Extra-Tropical Tropopause Transition Layer (Ex-TL) from High-Resolution O_3, CO, H_2O, Acetone, and Acetonitrile Observations Onboard the CARIBIC Passenger Aircraft (00410) ►

Zhou Renjun [P110/Tuesday 17.30]
Aerosol Distribution Over the Qinghai-Xizang Plateau and Its Relationship with O_3 (00117) ►

Zondlo Mark [P111/Tuesday 13.00]
Vertical and Horizontal Extent of Supersaturated Regions near the Extra-Tropical Tropopause over North America (00439) ►

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POSTER SESSION C:

Tropics, Chemistry-Climate Coupling

Poster Session C includes 3 viewing periods – 17:30 to 19:30 Thursday, 13:00 to 15:30 Friday and 17:30 to 19:15 Friday. Posters in Session C may be put up any time after 15:15 on Thursday and should be taken down by 19:30 on Friday. Presenters should display their posters on the assigned poster board and be present at the poster for at least the assigned viewing period. The information given after each presenter name, e.g. [P1/Thursday 17:30], specifies the relevant poster board number and viewing period.

In cases where the submitter of a poster abstract is unable to attend the Assembly and has nominated a substitute presenter, the name of the latter is indicated in the Abstract -- underlined in red.

Akiyoshi Hideharu [P1/Thursday 17.30]
A CCM Simulation of the Change in Stratospheric Ozone, Temperature, Zonal-Wind, And Breakup Date of the Antarctic Polar Vortex in the Years 1980-2004 (00114) ►

Andreev Grigory [P2/Friday 13.00]
Computational Study of OH Radical Uptake by Atmospheric Aerosol (00335) ►

Andreev Grigory [P3/Thursday 17.30]
Theoretical Study of Ozone Interaction with Isoprene (00364) ►

Atlas Elliot [P4/Friday 13.00]
Stratosphere-Troposphere Analyses of Regional Transport 2008 (START08) Experiment (00063) ►

Backman Leif [P5/Thursday 17.30]
The Effect of Ozone Loss on the Antarctic Vortex - A Chemistry-Climate Model Study (00124) ►

Basha Shaik Ghouse [P6/Friday 13.00]
Study on Distribution of Tropical Tropospheric Water Vapor Using Global Positioning System (GPS) Radio Occultation (RO) Data (00091) ►

Baumgaertner Andreas [P7/Thursday 17.30]
A Transient Simulation for 1960-2000 with the Chemistry Climate Model ECHAM5/Messy1: First Results on Solar Variability Effects (00331) ►

Berthet Gwenael [P8/Friday 13.00]
Contribution to the Estimation of the Stratospheric Water Vapor Trend Using the ELHYSA Balloon-Borne Frost Point Hygrometer (00281) ►

Bonazzola Marine [P9/Thursday 17.30]
GCM LMDZ Simulations of Transport in the Tropical Tropopause Layer (00398) ►

Borsche Michael [10/Friday 13.00]
2001-2008 Tropical Tropopause Climatology from CHAMP Radio Occultation Compared to ECMWF and NCEP Analyses and Other Radio Occultation Missions (00431) ►

Braesicke Peter [P11/Thursday 17.30]
The Role of Tropical Vertical Velocities in Determining Tracer Gradients in the Upper Troposphere and Lower Stratosphere (00319) ►

Brohede Samuel [P12/Friday 13.00]
Odin Stratospheric Proxy NO_y *Measurements and Climatology* (00233) ►

Brühl Christoph [P13/Thursday 17.30]
Transient Simulation from 1960 to the Present with the CCM: ECHAM5/Messy1 (with Focus on Stratospheric Water Vapor) (00338) ►

Buontempo Carlo [P14/Friday 13.00]
Thermal Variability at the Tropopause (00239) ►

Butchart Neal [P15/Thursday 17.30]
Changes in Stratospheric Dynamics and Circulation Diagnosed from the CCMVal Reference Stimulations (00046) ►

Calisto Marco [P16/Friday 13.00]
Influence of Energetic Particle Precipitation on the Chemistry of the Middle Atmosphere and Climate (00254) ►

Chaboureau Jean-Pierre [P17/Thursday 17.30]
Cross-Tropopause Transport by Convective Overshoots in the Tropics (00009) ►

Clain Gaëlle [P18/Friday 13.00]
Ozone Climatology in the Southern Subtropics (00129) ►

Dameris Martin [P19/Thursday 17.30]
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Ozone flux across the dynamical tropopause: Does the PV value matter?

Presenter: N. Luke Abraham (luke.abraham@atm.ch.cam.ac.uk)

N.L. Abraham, Peter Braesicke (University of Cambridge, Cambridge, UK),
F. O'Connor (Met Office Hadley Centre, Exeter, UK),
O. Morgenstern, J.A. Pyle (University of Cambridge, Cambridge, UK)

The ozone flux from the stratosphere into the troposphere is an important tropospheric ozone budget determining quantity which is still uncertain. Observational assessments of this quantity are notoriously difficult, and model assessments of this quantity are quite often done using a closure assumption. In contrast, the global net ozone flux can be relatively easy calculated within a chemistry-climate model using the changing ozone mass in the troposphere due to transport. Even though such a model assessment is in principle simple, a couple of interesting questions remain: How do we choose a suitable tropopause definition? How does the flux depend on constraints on the ozone gradient? Here, we will explore those questions using an idealised model set-up of the Met Office Unified Model (UM). Idealised ozone tracers, which are relaxed to an ozone background climatology using different timescales, are used to diagnose the ozone flux across extratropical dynamical tropopauses as defined by different potential vorticity values (2 and 3.5 PVU). We assess the stratosphere-to-troposphere ozone flux with respect to the position of the tropopause and the resulting ozone distribution. Implications for budget studies will be discussed.

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A CCM Simulation of the Change in Stratospheric Ozone, Temperature, Zonal-wind, and Breakup Date of the Antarctic Polar Vortex in the Years 1980-2004

Presenter: Hideharu Akiyoshi (hakiyosi@nies.go.jp)

H. Akiyoshi (NIES, Tsukuba, Japan),
L. B. Zhou (Institute of Atmospheric Physics, Beijing, China),
Y. Yamashita (CCSR University of Tokyo, Kashiwa, Japan),
K. Sakamoto (ANA, Tokyo, Japan),
M. Yoshiki (The Boston Consulting Group, Tokyo, Japan),
T. Nagashima (NIES, Tsukuba, Japan),
M. Takahashi (CCSR University of Tokyo, Kashiwa, Japan),
J. Kurokawa (NIES, Tsukuba, Japan),
M. Takigawa (FRCGC, Yokohama, Japan),
T. Imamura (NIES, Tsukuba, Japan)

The changes in stratospheric ozone, temperature, zonal wind, and breakup time of the Antarctic polar vortex in the years 1980-2004 are examined using the output of CCM calculations, data from the NCEP/NCAR reanalysis, and data from the ERA40. The CCM used in this study is from the Center for Climate System Research/National Institute for Environmental Studies (CCSR/NIES). The CCM calculations are performed with the REF1 and REF2 scenarios of the CCMVal. The CCM simulates the development of the ozone hole from 1982 to 2000 as observed with TOMS, although ozone decreasing trends of two of the three CCM simulations are slightly underestimated. The trends in temperature and zonal-mean zonal wind are analyzed and compared with the observations. There is consistency among the trends in temperature, zonal-mean zonal wind, and total ozone, but they differ among the ensemble members and observations. The radiation and wave flux fields are investigated in order to explain the differences. A delay trend in the breakup time of the Antarctic polar vortex is obtained for the period 1980 to 1999 in the NCEP and ERA40 data. A similar trend is calculated using the CCM simulations, two of which show statistical significance. Because the trends in the wave flux from the troposphere and its deposition in the lower stratosphere are advanced, as opposed to delayed, breakup dates of the polar vortex, it is highly likely that the Antarctic ozone depletion and greenhouse gas build-up had some effect on the delay during the period 1980 to 1999, strengthening the polar night jet and the Southern Hemisphere annular mode. From 2000 to 2004, the NCEP data show a large variation in breakup time, which makes the delay trend much less important. It is likely that the large variation in wave flux masked the effects of the ozone loss and greenhouse gas build-up during that period. The two ensemble members of the REF1 simulation do not show such a dramatic change in the trend for the period 1980 to 2004, while REF2 show a smaller trend for the period 1980 to 2004 than that for 1980 to 1999 owing to an early Antarctic polar vortex breakup in 2003.

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High Resolution Satellite View of Gravity Waves from Tropospheric Sources

Presenter: M. Joan Alexander (alexand@cora.nwra.com)

M.J. Alexander, A. Grimsdell (NWRA/CoRA, Boulder, USA)

Tropspheric sources generate gravity waves that propagate vertically and dissipate in the middle atmosphere. Gravity wave dissipation in the stratosphere contributes to driving the Brewer-Dobson circulation, and shapes seasonal, latitudinal, and height variations in the stratospheric jets. Three tropospheric sources expected to generate large amplitude gravity waves that particularly affect the stratospheric circulation are convection, jet imbalance, and topography. Topographic waves are parameterized in climate and weather forecasting models of the general circulation. Waves from other sources are generally treated with non-orographic gravity wave parameterizations that have globally-smooth and time-invariant distributions in wave sources, yet convection and jet imbalance sources are likely sporadic and seasonally varying in time and localized geographically. These characteristics are not described in current operational applications of gravity wave parameterizations. Recent observations from two satellite instruments, AIRS (Atmospheric Infrared Sounder) and HIRDLS (High Resolution Dynamics Limb Sounder) provide high-resolution views of gravity waves in the stratosphere.

These data provide global views every 12 hours and span over three years of time. Examination of localized events in these data reveals cases of waves generated by the sources described above. We will present global views of sporadic gravity wave events and describe details of case studies of these events and their relation to the wave source in the troposphere.

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Introduction to the Halogen Occultation Experiment 4th Public Data Release

Presenter: John Anderson (John.Anderson@hamptonu.edu)

J. Anderson, J.M. Russell III (Hampton University, Hampton, USA),
R.E. Thompson, L.L. Gordley, M. McHugh, B. Magill (GATS Inc. Newport News, USA)

The Halogen Occultation Experiment (HALOE) operated essentially without flaw on the Upper Atmosphere Research Satellite since it was first turned on in orbit October 11, 1991, until it was turned off in November 2005. HALOE measured temperature and a suite of atmospheric constituent vertical profiles including O_3, HCl, HF, CH_4, H_2O, NO, NO_2 and aerosol extinction at four wavelengths. Measurements of some of these parameters, i.e. O_3, H_2O, NO and temperature versus pressure, extend from the upper troposphere to well into the mesosphere and/or lower thermosphere. This study focuses on the HALOE 4th public release (v20). This algorithm provides the first HALOE H_2O vertical profile data in the mid-to-upper troposphere. We will present results of initial validation studies using mainly satellite correlative measurements and summary's of the inter-comparison's of all species with the previous data version, highlighting the changes and improvements in the latest public release. The satellite correlative measurements used include the Atmosphere Infrared Sounder, the AURA Microwave Limb Sounder, and the Stratospheric Aerosol and Gas Experiment II. In addition, we will show comparisons of zonal averages, coincident measurements, and probability density functions.

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Computational Study of OH Radical Uptake by Atmospheric Aerosol

Presenter: Grigory Andreev (grigory_andreev@mail.ru)

G. Andreev (Karpov Institute of Physical Chemistry, Moscow, Russia)

The OH radical has been proven to be one of the most important oxidants in the atmosphere chemical cycle [1,2]. It is formed by different mechanisms including photolysis of water at higher altitudes, photolysis of ozone followed by the reaction of the excited oxygen atoms with water molecules, etc. Hydroxyl radical can enter water droplets from gas phase atmosphere or can be formed in aqueous particles by decomposition of HO_2 and further reaction with ozone. Several solutes can react photochemically in aqueous particles to produce hydroxyl radical. The characterization of interaction of hydroxyl radicals with its aqueous environment is particularly important for atmospheric chemistry, as many atmospherical chemical reactions occur in or on aqueous atmospheric aerosols, cloud droplets, and thin water films on particles. The reactivity of OH radical is influenced by its hydration structure and energetics. Values of the thermodynamic parameters of solvation of OH radical are also required for understanding of its uptake on aqueous surfaces.

We present here the results of theoretical study aimed to clarify the structure and behavior of mixed OH radical and H_2O clusters. Clusters with different OH:H_2O ratio were studied. For each of the clusters several alternative local minima were found. Vibration frequencies were obtained to verify that all the obtained structures are stable points on the potential energy surfaces. The frequency data were also used to estimate enthalpies and free energies. The binding energies were corrected for the basis set superposition error by counterpoise method.

All calculations were performed using GAMESS [3] and PC GAMESS [4] quantum chemistry packages. All structures were initially optimized with MP2 and DFT using aug-cc-pVDZ and cc-pVDZ basis sets. Energy calculations for optimized structures were also done at MP4, CCSD, CCSD[T], CCSD(T) levels of theory.

It should be noted that we used X3LYP functional in the DFT part of this study. In the past, the calculations of hydrogen bonded structures have been performed B3LYP functional. However, recent investigations proved that the B3LYP functional does not correctly account for nonbonded interactions. That is why we employed the X3LYP extended functional with improved descriptions of the equilibrium properties of hydrogen bonded and van der Waals systems [5].

Thermodynamic data for the hydroxyl-water clusters were calculated from the energies for optimized clusters as well as calculated harmonic vibration frequencies. Data on the solvation thermodynamics of OH radical in liquid water was obtained using hybrid method with the first solvation shell modeled by the OH(H2O)i cluster and long range solvent effect taken into account by means of self-consistent reaction field method (PCM).

This work was supported by the Russian Foundation of Basic Research (project # 07-03-00794).

[1] S. Manahan. Environmental Chemistry. CRC Press, New York, 2000

[2] W. Stumm, J. Morgan. Aquatic Chemistry. Wiley, New York, 1996

[3] M. Gordon, M. Schmidt. In: Theory and Applications of Computational Chemistry: the first forty years, Elsevier, Amsterdam, 2005, p. 1167

[4] A. V. Nemukhin, B. L. Grigorenko, A. A. Granovsky. Moscow University. Chem. Bull., 45 (2004), 75

[5] X. Xu, Q. Zhang, R. P. Muller, W. A. Goddard. J. Chem. Phys., 122 (2005), 14105

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Theoretical Study of Ozone Interaction with Isoprene

Presenter: Grigory Andreev (grigory_andreev@mail.ru)

G. Andreev (Karpov Institute of Physical Chemistry, Moscow, Russia)

Atmospheric photochemical oxidation of volatile organic compounds can be initiated by a variety of oxidant species, including OH and ozone. Alkenes make up the majority of nonmethane hydrocarbons existing in atmosphere. Interaction of ozone with unsaturated hydrocarbons is one of the sources of HOx radicals, which are important oxidants in the atmosphere. In the atmosphere where concentrations of unsaturated compounds are sufficiently high, ozone-alkene reactions can be a significant source of new HOx radicals. Isoprene is one of the most abundant alkenes emitted by from anthropogenic and biogenic sources. The ozonolysis of isoprene proceeds through a series of reactions and intermediates. The initial reaction between isoprene and ozone occurs by cycloaddition of ozone to the C=C double bond and results in forming the primary ozonide. By this means, five-membered ring is formed by addition of O_3 to either of double bonds of isoprene. The excited ozonide subsequently undergoes unimolecular decomposition to yield carbonyl oxide (also known as Criegee intermediate) and aldehyde. There are two primary reaction pathways for the carbonyl oxide, namely, ring closure to dioxirane or H-migration to form a hydroperoxide intermediate. The hydroperoxide can subsequently decompose to OH and RCO radicals.

Current knowledge of the ozone-isoprene interaction is very limited; except for the initial step, there are no experimental or theoretical kinetic results on the subsequent reactions. We present here study of the formation and unimolecular reactions of the intermediate species arising from the ozone-isoprene interactions. Density functional theory is employed to obtain the geometries and energetics of the primary ozonides and carbonyl oxides. The transition states of formation and unimolecular reactions of these intermediates are located to identify possible reaction pathways. All calculations were performed using GAMESS [1] and PC GAMESS [2] quantum chemistry packages. All structures were initially optimized with MP2 and DFT using aug-cc-pVDZ and cc-pVDZ basis sets. Energy calculations for optimized structures were also done at MP4, CCSD, CCSD[T], CCSD(T) levels of theory. The activation energies of O_3 cycloaddition to two different double bonds of isoprene were found to be near equal, i. e. the two pathways of initial O_3 addition are nearly equally probable. OH radical formation was shown to occur primarily by the decomposition of the carbonyl oxide (which is more favorable than isomerization with the formation of dioxirane). By this means, we studied several important aspects of the isoprene ozonolysis in atmosphere using quantum chemistry methods.

This work was supported by the Russian Foundation of Basic Research (project # 07-03-00794).

[1] M. Gordon, M. Schmidt. In: Theory and Applications of Computational Chemistry: the first forty years, Elsevier, Amsterdam, 2005, p. 1167

[2] A. V. Nemukhin, B. L. Grigorenko, A. A. Granovsky. Moscow University. Chem. Bull., 45 (2004), 75

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The MIPAS2D: 2-D analysis of MIPAS observations of ESA target molecules and minor species

Presenter: Enrico Arnone (arnone@fci.unibo.it)

E. Arnone (Universita' di Bologna, Italy),
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M. Carlotti (Universita' di Bologna, Italy),
B.M. Dinelli (ISAC-CNR, Bologna, Italy),
L. Magnani, E. Papandrea and M. Ridolfi (Universita' di Bologna, Italy)

Measurements from the MIPAS instrument onboard the ENVISAT satellite were analyzed with the Geofit Multi-Target Retrieval (GMTR) system to obtain 2-dimensional fields of pressure, temperature and volume mixing ratios of H_2O, O_3, HNO_3, CH_4, N_2O, and NO_2. Secondary target species relevant to stratospheric chemistry were also analysed and robust mixing ratios of N_2O_5, $ClONO_2$, F-11, F-12, F-14 and F-22 were obtained. Other minor species with high uncertainties were not included in the database and will be the object of further studies. The analysis covers the original nominal observation mode from July 2002 to March 2004 and it is currently being extended to the ongoing reduced resolution mission. The GMTR algorithm was operated on a fixed 5 degrees latitudinal grid in order to ease the comparison with model calculations and climatological datasets. The generated database of atmospheric fields can be directly used for analyses based on averaging processes with no need of further interpolation. Samples of the obtained products are presented and discussed. The database of the retrieved quantities is made available to the scientific community.

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Triggering of sudden stratospheric warming in a stratosphere-mesosphere model by impulsive regional ozone perturbations

Presenter: Enrico Arnone (arnone@fci.unibo.it)

E. Arnone (Universita' di Bologna, Italy),
P. Berg (Danish Meteorological Institute, Copenhagen, Denmark),
N.F. Arnold (University of Leicester, UK),
B. Christiansen, P. Thejll (Danish Meteorological Institute, Copenhagen, Denmark)

The behaviour of sudden stratospheric warming in a stratosphere-mesosphere model was studied under a range of imposed ozone perturbations. The model was forced at its lower boundary by NCEP geopotential heights which gives a natural variability to the middle atmosphere from planetary wave forcing.

The perturbation experiments were first performed imposing uniform reductions constant in time to the climatological ozone at various magnitude. Regional perturbation constant in time were then applied at different heights and latitude. Finally, the regional perturbations were applied impulsively with timescales of days. We found that the impulsive perturbation experiments were more efficient in altering the onset and duration of sudden stratospheric warming compared to the corresponding experiments that were constant in time. In particular, a polar stratopause impulsive (applied every 4 days) 10% ozone perturbation experiment led to occasionally large modifications of the onset and magnitude of sudden warmings, while the corresponding constant perturbation had a milder effect. This impulsive perturbation led to at least a 5% increase in the standard deviation of the yearly polar stratosphere temperature in about 40% more of the years compared to those affected by the constant perturbation, and a substantial alteration of the sudden warming events in about 20% of the winters.

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Stratosphere-Troposphere Analyses of Regional Transport 2008 (START08) experiment

Presenter: Elliot Atlas (eatlas@rsmas.miami.edu)

E. Atlas (University of Miami, Florida, USA),
Ken Bowman (Texas A&M University, Texas, USA),
Laura Pan (NCAR, ACD/TIIMES, Boulder, USA), and START08 Science Team

Investigation of chemical, dynamical, and microphysical processes occurring in the extratropical upper troposphere (UT) and lower stratosphere (LS) (the ExUTLS), the altitude region from ~5 to 15 km, is crucial for understanding long term global climate change and tropospheric air quality. It is a region where ozone is an effective greenhouse gas, and where water vapor, cirrus clouds, and aerosols have a strong influence not only on the atmospheric radiation budget, but also on chemical budgets. The ExUTLS is also a region where transport processes that couple the stratosphere and troposphere occur on a multitude of space and time scales. These transport processes, combined with the strong vertical gradients in many chemical constituents, present a challenge to observational techniques and numerical models.

The overall objective of the START08 experiment, to be conducted in April-June, 2008, is to use in situ chemical, microphysical, and dynamical measurements, satellite data, and models to better understand the dynamical processes that control the chemical composition and microphysics of the ExUTLS. The experiment is also motivated by the SPARC CCMVal project and is planned to provide additional model diagnostics for transport in the ExUTLS. Airborne measurements will be taken from the NSF HIAPER aircraft, which covers an altitude range up to approximately 14 km. In situ measurements of a wide range of trace gases, water vapor, aerosol properties, and vertical temperature structure will be obtained under targeted dynamical conditions to better understand transport and mixing regimes in the area of the ExUTLS. Model analyses and satellite retrievals are going to be used to integrate and to broaden the impact of the aircraft measurements.

This presentation will describe the START08 airborne instrument payload, will describe the different regimes that were examined during the START08 campaign, and will highlight examples of measurements and correlations that will be used to address START08 science objectives and CCMVal needs.

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The advance of ozone recovery due to climate change

Presenter: John Austin (john.austin@noaa.gov)

J. Austin, J. Wilson, V. Ramaswamy (GFDL, Princeton, USA)

A coupled chemistry-climate model is used to investigate the impact of climate change on ozone recovery in the 21st century. The model is an improved version of the Geophysical Fluid Dynamics Laboratory stratospheric model. Compared with the version previously published (Austin and Wilson, JGR, 2006) the model has a more realistic parameterisation of chlorine and bromine which are in better agreement with observations in the lower and middle latitudes in the lower stratosphere. The model also has an updated convection scheme leading to higher tropical tropopause temperatures in closer agreement with observations.

Two simulations are completed. The first simulation for the period 1960 to 2100 includes projected transient changes in the well-mixed greenhouse gases CO_2, CH_4 and N_2O, according to the A1B scenario, as well as variations in the CFCs and Halons to provide a source for active chlorine and bromine. Sea surface temperatures and sea ice (SSTs/SI) are supplied from observations for the past, and from a previous coupled atmosphere-ocean simulation of the GFDL model, but with a substantially reduced stratosphere. The second simulation covers the period 2000-2100 and uses climatological SSTs/SI. In this simulation CO_2, CH_4 and N_2O are fixed to 2000 values and the CFCs are the same as in the first simulation. The difference between the results of the simulations indicates the impact of climate change. The dates of full ozone recovery, indicated by the return to total ozone to 1980 levels, are compared for different latitude ranges and for the global average.

The dates of full ozone recovery, indicated by the return to total ozone to 1980 levels, are compared for different latitude ranges and for the global average. Globally, the effect of climate change is to advance ozone recovery by about 30 years. Climate effects are smallest over Antarctica (15 years) and largest over northern midlatitudes (50 years). The reasons for these differences will be discussed.

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The effect of ozone loss on the Antarctic vortex - A chemistry-climate model study

Presenter: Leif Backman (Leif.Backman@fmi.fi)

L. Backman, L. Thölix, and S.-M. Ojanen (Finnish Meteorological Institute, Helsinki, Finland)

Ozone is a radiatively active gas and it is generally accepted that the springtime cooling of the Antarctic vortex and delay of vortex break-up, are due to ozone depletion. In this study we test different schemes for polar stratospheric clouds (PSC) in the Hamburg Model of the Neutral and Ionized Atmosphere (HAMMONIA). The current model setup underestimates somewhat the polar ozone loss. The effect of an increased ozone loss on the vortex conditions will be analyzed. The development of ozone in the Antarctic vortex in HAMMONIA will be compared to ozone data from GOMOS stellar occultation profile data.

The chemistry-climate model HAMMONIA (Schmidt et al., 2006) is a chemistry-coupled GCM covering the height range from the surface up to the thermosphere. It has been developed at the Max Planck Institute for Meteorology in Hamburg. HAMMONIA is based on the MAECHAM5 with a vertical extension up to the thermosphere. HAMMONIA is a spectral model typically run at T31 with 67 (or 119) vertical levels up to 1.7e-7 hPa (ca. 250 km). The model has a full dynamic and radiative coupling with the MOZART3 chemical module. The model is typically integrated with a 10 min time-step.

Schmidt, H., G.P. Brasseur, M. Charron, E. Manzini, M.A. Giorgetta, T. Diehl V.I. Fomichev D. Kinnison, D. Marsh and S. Walters (2006) HAMMONIA - Hamburg Model of the Neutral and Ionized Atmosphere, J. Climate 19(16), 3903.

ID: 00294 ◀back

The PROMOTE 3D ozone record service: Overview and first evaluation of stratospheric ozone reanalyzes based on satellite observations between 1992 and 2004

Presenter: Frank Baier (frank.baier@dlr.de)

F. Baier, T. Erbertseder (German Aerospace Center, Wessling, Germany),
Q. Errera (Belgian Institute for Aeronomy, Brussels, Belgium),
J. Schwinger (Rhenish Institute for Environmental Research, Cologne, Germany),
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Data assimilation of atmospheric constituents is becoming more and more important as the number and quality of satellite observations increases. New assimilation methods allow us to derive continuous four-dimensional depictions of the atmosphere's chemical state. Within the European ESA/GMES project PROMOTE three CTM-based assimilation systems have been applied to derive long-term records of stratospheric ozone and related species from UARS/MLS, ERS2-GOME/NNORSY and ENVISAT/MIPAS ozone observations covering a time period from 1992 to 2004. Using ROSE/DLR (sequential), SACADA and BASCOE (both 4D-VAR) daily chemical analyzes and error statistics have been generated. We present first validation results using independent ground-based and satellite observations. With respect to climate research the benefit of data assimilation is sometimes called into question: e.g., forcing the model with observations may lead to inconsistencies in derived parameters, e.g. chemical ozone depletion rates. By means of cross-comparison we therefore discuss the possible model influence on final analysis results. We show that in most cases results are highly consistent showing errors well within expected error bars. However, under certain conditions and/or if observational coverage is poor, e.g., at the polar vortex edge during spring, specific model limitations have to be addressed and taken into account. Concerning stratospheric ozone, we discuss the applicability and potential of the PROMOTE data record for the SPARC community.

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Stratosphere-Troposphere Coupling in DynVar and CCMVal Models

Presenter: Mark Baldwin (mark@nwra.com)

M. Baldwin (Northwest Research Associates, Seattle, USA)

Although various diagnostics have been used to study stratosphere-troposphere coupling in observations, comparatively little work has been done with climate models. A goal of the SPARC DynVar project is to understand what is required of climate models to simulate realistic stratosphere-troposphere coupling. At the present time, our understanding is too vague to be able to specify to climate (and chemistry-climate) modelers what resolution and processes are needed so that tropospheric effects of stratospheric processes are well represented. I will discuss analysis of stratosphere-troposphere coupling in both DynVar and CCMVal models, and compare to observations. Several of the diagnostics are based on annular mode indices, including seasonally-varying timescale diagnostics.

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Stratosphere-troposphere exchange study in the Southern subtropics using experimental data, trajectory and Reverse Domain Filling calculations

Presenter: Jean-Luc Baray (baray@univ-reunion.fr)

J.-L. Baray, R. Delmas, G. Clain, F. Gabarrot (LACY, University of Reunion Island, France), J.-P. Cammas (LA, Toulouse, France), P. Keckhut (SA, Paris, France)

Ozone measurements are performed at Reunion Island (Southern Subtropics in the Indian Ocean since respectively 1992. Two major source for tropospheric ozone have been identified, stratosphere-to-troposphere exchange induced by the subtropical jet stream and/or tropical convection, and influence of biomass burning (Baray et al., 2003; Randriambelo et al., 2003). In order to separate these contributions, a trajectory tool, LACYTRAJ, has been developped. It is based on the ERA40 ECMWF database locally archived and regularly updated. A RDF (Reverse Domain Filling, Dritschel, 1988; Sutton et al., 1994) module is associated to the trajectories. RDF is a mapping technique based on trajectory and advection of a parameter assimilated to a tracer : Potential vorticity, water vapor or else. If the time of trajectory is adjusted to the lifetime of the tracer, this technique allows building under-grid fine scale structures of a profile, horizontal field or vertical cross section. An application of this tool on case studies of ozone measurements by lidar and radiosonde is presented and discussed.

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Study on Distribution of Tropical Tropospheric Water Vapor using Global Positioning System (GPS) Radio Occultation (RO) data

Presenter: Shaik Ghouse Basha (mdbasha@narl.gov.in, mdbasha@gmail.com)

S. G. Basha, M. Venkat Ratnam (National Atmospheric Research Laboratory, Tirupati, India), V.V.M. Jagannadha Rao (S.V. Govt. Polytechnic, Tirupati, India), D. Narayana Rao (National Atmospheric Research Laboratory, Tirupati, India)

Water vapor is the most important greenhouse gas in the Earth's atmosphere, inducing about two third of the natural greenhouse effect. As such, understanding the mechanisms that regulate it is of central importance for understanding past and future climate change. In the lower and middle troposphere, particularly in the tropical regions, changes in water vapor abundances provide one of the most sensitive indicators of modeled climate change. The lack of adequate data limits our ability to analyze or simulate important aspects of the global climate system. Various investigators have identified GPS RO measurements as a possible source of atmospheric water vapor data. GPS radio occultation (RO) soundings provide profiles of atmospheric refractivity with global coverage. Calibration-free measurements and retrievals recommend this technique especially for climate applications. These measurements are most sensitive to water vapor in the warmer regions of the troposphere, particularly in tropical regions where abundances are greatest.

In this study, the reliability and limitations of water vapor retrieval from GPS RO measurements combined with analyses from ECMWF/NCEP is investigated for tropical conditions. Intensive Väisälä radiosondes were specially launched for validation of COSMIC RO data from Gadanki (13.48ºN, 79.18ºE), a tropical site in India. In comparison with independent techniques like radiosonde (Väisälä) over 12 stations all over the world, it is found that COSMIC GPS RO wet profiles are more accurate up to 6-7 km (assuming radiosonde is standard technique).Being validated at several stations, we found that the southern hemisphere station like Darwin, Ascension and Seychelles are showing negative bias in water vapour while northern hemisphere station like Truk, Trivendrum are showing positive bias. Very good comparisons in water vapour between COSMIC and radiosonde both in trend and amplitude is noticed throughout the heights over Gadanki.

We also extended the study for monitoring the global distribution of water vapor from COSMIC data. Global distribution of relative humidity observed during the seasons from July 2006 to July 2007 show clear seasonal variation representing the Inter-tropical convergence zone (ITCZ). Quite different features are noticed during summer and winter over Indian sub-continent as expected. The Global distribution of Relative humidity is good correlated with refractivity and outgoing long wave radiation(OLR). COSMIC consists of 6 satellites, it is now possible to get global distribution on weekly basis. The other salient features will be presented during symposium.

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Stratosphere-Troposphere Dynamical Coupling: the Role of Analytical Studies in the Development of our Understanding

Presenter: J. Ray Bates (Ray.Bates@ucd.ie)

J.R. Bates (University College Dublin, Ireland)

Our current understanding of stratosphere-troposphere dynamical coupling is built on a combination of observational, analytical and numerical studies. The foremost contribution to our theoretical understanding of this area was the analytical study of Charney and Drazin (JGR, 1961), in which the basic dynamics of the vertical propagation of planetary-scale wave disturbances from the lower into the upper atmosphere was first elucidated.

The possibility of stratospheric dynamical influence on the troposphere through wave reflection and interference was implicit in the work of Charney and Drazin, and this topic was first studied explicitly in the paper of Bates (QJRMS, 1977), which was again analytical (a simplified version was presented in Bates, Solar Physics, 1981). In that paper, the contributions of topographically and thermally forced wave disturbances to the planetary-scale standing wave pattern in middle latitudes were studied and the effect of varying the stratospheric wind and static stability was investigated. The results indicated that the thermally-forced component of the wave pattern at the surface was relatively independent of stratospheric influences, but the topographically-forced component at the surface, as well as the contribution of the planetary-scale standing waves to the poleward eddy heat flux throughout the troposphere, were strongly influenced by stratospheric conditions.

The role of analytical studies in the development of our understanding of the dynamical influence of the stratosphere on the troposphere from that time to the present, when the subject is receiving increasing attention and explanatory mechanisms are increasingly being sought, will be surveyed, and the role that such analytical studies can play in the present era of comprehensive numerical models and powerful computers will be assessed.

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A transient simulation for 1960-2000 with the chemistry climate model ECHAM5/MESSy1: First results on solar variability effects

Presenter: Andreas J. G. Baumgaertner (abaumg@mpch-mainz.mpg.de)

A.J.G. Baumgaertner, Ch. Brühl, P. Jöckel (Max Planck Institute for Chemistry, Mainz, Germany),
U. Langematz (Freie Universität Berlin, Germany), and the MESSy developer team

Initial results from a transient simulation with ECHAM5/MESSy1 spanning several decades will be presented. The simulation was performed within the framework of the CAWSES/ProSECCO and SCOUT-O3 projects and follows mostly the CCMVal REF1 specifications. The simulation was performed at the resolution of T42L90MA with a model top at 0.01 hPa. The fully interactive model chemistry with approximately 50 species and 130 reactions and an internally generated QBO, which is weakly nudged in order to obtain a realistic phase, will allow to study fundamental questions regarding the 11-year solar signal and the causing mechanisms. Solar variability affects the model atmosphere through a high-resolution short-wave radiation scheme for photolysis and heating rates, solar proton events and downward transport of nitric oxides produced in the thermosphere. Additional variability over the simulation period is caused by varying sea surface temperatures (HadISST1), realistic boundary conditions and emissions of chemical species, as well as volcanic heating rates. An initial comparison between model results and observations will be presented in order to evaluate the model setup. We will then present first results focussing on the effects of solar variability on chemistry and temperature in the middle atmosphere.

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Stratospheric communication of the ENSO teleconnection to Europe

Presenter: Chris Bell (c.bell@rdg.ac.uk)

C. Bell, L.J. Gray, A.J. Charlton-Perez (University of Reading, UK)

An investigation into the response of the stratosphere and European winter surface climate to El Niño/Southern-Oscillation sea surface temperature forcing has been performed in an intermediate GCM with a well resolved stratosphere. Under warm ENSO conditions we find a weakening of the NH polar vortex and a change in variability, with an increase in the frequency of stratospheric sudden warming events over all winter months. The European wintertime surface response corresponds well to the 'canonical' mean sea-level pressure signature of a negative NAO mode which is observed to follow ~two-thirds of El Niño events. The role of the stratosphere in this Tropical Pacific-European teleconnection is investigated in a sensitivity experiment in which the mean state and variability of the stratosphere are degraded. The results suggest that the stratosphere plays an active role in the European ENSO response.

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Investigation of temperature trends and gravity wave characteristics from LiDAR profiles recorded at Reunion Island (20.8ºS, 55.5ºE) from 1994 to 2007

Presenter: Hassan Bencherif (hassan.bencherif@univ-reunion.fr)

H. Bencherif, V. Prasanth, Y. Courcoux (LACy, Reunion University, Reunion Island, France), V. Sivakumar (NLC/CSIR, Pretoria, South Africa), and P. Keckhut (SA/IPSL-CNRS, Paris, France)

Atmospheric Gravity Waves (GW) play a significant role in controlling middle and upper atmosphere structure and dynamics. Most of the GW generative mechanisms take place in the lower troposphere region by convective systems, wind shear, jet streams, topography etc. Depending on the wind characteristics, GW propagate upwards into the middle atmosphere and deposit momentum and energy through wave breaking and dissipation processes; thereby GW significantly alter the thermal structure and meridional circulations.

The most important GW sources in tropics are convective systems (Beres et al., 2002). Besides, jet streams are also identified as a source of GW generation in tropics/subtropics (Fritts and Luo, 1992). They indeed may significantly contribute to exchange processes between stratosphere and troposphere, and between the tropical stratospheric reservoir and mid-latitudes. However, there are few ground-based atmospheric measurements in the tropics, notably there are very few measurements in the southern tropics.

Since 1994, a Rayleigh-Mie LiDAR has been operating at Reunion Island (20.8ºS, 55.5ºE) to monitor atmospheric aerosol and temperature profiles, in the upper troposphere and lower stratosphere (8-35km) and in the middle atmosphere (30-75 km) regions, respectively. To enable temperature measurements in the Upper Troposphere - Lower Stratosphere, Reunion the LiDAR system was upgraded and a Raman-N2 channel was implemented since 2000.

The present study aims to combine temperature profiles derived from both Rayleigh and Raman-N2 return signals in order to:

- study trends and thermal structures in the middle atmosphere, and
- to investigate the mean characteristics and variability of gravity wave activity in different atmospheric layers, i.e., from the upper troposphere up to the lower mesosphere.

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Contribution to the estimation of the stratospheric water vapor trend using the ELHYSA balloon-borne frost point hygrometer

Presenter: Gwenael Berthet (gwenael.berthet@cnrs-orleans.fr)

G. Berthet, J.-B. Renard, B. Gaubicher (LPCE/CNRS, France),
J. Ovarlez and H. Ovarlez (LMD/CNRS, France)

It is commonly assumed that the stratospheric water vapor content has been increasing in the middle stratosphere by about 1% since 1950. Nevertheless, recent analysis seems to indicate that this trend has changed at least since 2001 with recent drop correlated with a decrease in tropical tropopause temperatures. It was suggested, but not proved, that the important volcanic eruptions that took place during the period 1960 to 1995 could explain the past positive trend. We present here an analysis of in situ measurements performed between 1989 and 2005 using the ELHYSA balloon-borne hygrometer to contribute to the estimation of the water vapor trend above the lower stratosphere. A careful examination of the 9 observed profiles and of the potential vorticity conditions is conducted in order to remove the seasonal variations, the tropical intrusions and perhaps polar dehydrated air masses. In mid-latitude conditions between 80 and 30 hPa, a strong increase of about 5% per year is observed in the 1989 - 1993 period. After 1993, a slight decrease of about 0.3% can be pointed out. In fact, this estimation is not very sensitive to the presence of tropical and polar intrusions. It could be proposed that this result is in favor of volcanic origin for the water vapor past increases.

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The MOdel for STRatospheric Aerosol (MOSTRA): Some results

Presenter: Christine Bingen (Christine.Bingen@aeronomie.be)

C. Bingen, Q. Errera, F. Daerden, S. Chabrillat, F. Vanhellemont, D. Fussen, J. Dodion, E. Dekemper, N. Mateshvili and N. Loodts
(Belgian Institute for Space Aeronomy, Brussels, Belgium)

We present the current state of the development of a microphysical/transport model called MOdel for STRatospheric Aerosol (MOSTRA). This model described the evolution in time and space of the aerosol distribution in the stratosphere.

Transport is modelled using a transport module adapted from the model used in the Belgian Assimilation System of Chemical Observations from Envisat (BASCOE), based on a flux-form semi-Lagrangian scheme developed by Lin and Rood (1996).

The microphysical module is developed using the PSCBOX model developed by Larsen (2000). Microphysical processes considered so far are sedimentation and coagulation.

References:

N. Larsen, Polar Stratospheric Clouds, Microphysical and optical models, Scientific Report 00-06, Danish Meteorological Institute, 2000

Lin, S.-J. Rood, R.B., Multidimensional Flux-Form Semi-Lagrangian Transport Schemes, Monthly Weather Review, 124, 2046-2070, 1996.

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The tropopause inversion layer

Presenter: Thomas Birner (thomas@atmosp.physics.utoronto.ca)

T. Birner (University of Toronto, Toronto, Canada)

Recent observational and model studies have revealed the climatological existence of an inversion layer just above the extratropical tropopause - the tropopause inversion layer (TIL). Temperature strongly increases within the TIL, i.e. over the first 1-2 km of the extratropical stratosphere. Static stability exhibits a corresponding maximum just above the tropopause with values 1.5-2 times larger than typical stratospheric values further aloft. In terms of its thickness and latitudinal extent the TIL roughly coincides with the extratropical transition layer (ExTL) found in trace gas distributions.

This talk will first summarize climatological characteristics of the TIL mainly in terms of spatial and seasonal variability of TIL thickness and strength. Second, the current understanding of processes that form and maintain the TIL will be discussed focusing on radiative and large-scale dynamical processes.

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Sudden Stratospheric Warmings as Noise-Induced Transitions

Presenter: Thomas Birner (thomas@atmosp.physics.utoronto.ca)

T. Birner (University of Toronto, Toronto, Canada),
P.D. Williams (University of Reading, UK)

Sudden stratospheric warmings (SSWs) are usually considered to be initiated by planetary wave activity. Here it is asked whether small-scale variability, e.g. related to gravity waves, can lead to SSWs given a certain amount of planetary wave activity that is by itself not sufficient to cause a SSW. A recently proposed highly vertically truncated version of the Holten-Mass model of stratospheric wave-mean flow interaction (Ruzmaikin et al., 2003) is extended to include stochastic forcing. In the deterministic setting, this low-order model exhibits multiple stable equilibria corresponding to the undisturbed vortex and SSW-state, respectively. Momentum forcing due to quasi-random gravity wave actitvity is introduced as an additive noise term in the zonal momentum equation. Two distinct approaches are pursued to study the stochastic system. First, initialized at the undisturbed state the system is numerically integrated many times in order to derive statistics of first passage times of the system undergoing a transition to the SSW-state. Second, the Fokker-Planck equation corresponding to the stochastic system is solved numerically in order to derive the stationary probability density function of the system. Both approaches show that even small to moderate strengths of the stochastic gravity wave forcing can be sufficient to cause a SSW for cases where the deterministic system would not have predicted a SSW.

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The World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT)

Presenter: Michael Bittner (michael.bittner@dlr.de)

M. Bittner, K. Hoeppner, B. Hildenbrand (German Aerospace Center (DLR), Oberpfaffenhofen, Germany)

This poster will be presented by Frank Baier

Since 2003 the Applied Remote Sensing Cluster of DLR has hosted and operated the World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT, http://wdc.dlr.de) under the non-governmental auspices of the International Council of Science (ICSU).WDC-RSAT offers scientists and the general public free access to a continuously growing collection of satellite-based atmosphere-related data sets and services. These data holdings range from raw data collected by remote sensors, to information products derived from the raw data ('value adding'). The current WDC-RSAT data holding contains data and information products addressing atmospheric trace gases, clouds, surface parameters, solar radiation, and special services as near-real time (NRT)information related to e.g. European air quality, UV radiation forecasts, global ozone level maps. In addition to archiving data sets, WDC-RSAT cooperates with other data centers and strives to provide additional services, which include data analysis and value adding, data summaries, campaign planning support, and data set validation and publication.

In Germany, three current ICSU World Data Centers, namely WDC-Climate (hosted by the German Climate Computer Center, DKRZ), WDC-MARE (co-hosted by AWI and the University of Bremen), WDC-RSAT (hosted by DLR), and the pending WDC-Terra (to be hosted by GFZ) founded in 2004 the German WDC cluster for 'Earth System Research', in order to promote Earth System Science and Research in Germany and abroad. This Cluster is actively pursuing a strategy, using information technology, to make data related to Earth Systems available to an as wide and as interdisciplinary possible audience.

In early 2006 a scientific advisory committee for WDC-RSAT was established. External experts representing space agencies, weather services, atmospheric remote sensing technologies, and atmospheric science help to guide WDC-RSAT in setting and reaching its goals. In cooperation with the World Meteorological Organization (WMO), WDC-RSAT is currently being implemented as part of the WMO-GAW Strategic Plan 2008-2015 especially in the context of IGACO within the WMO program Global Atmosphere Watch (GAW). This center would concern itself with linking different GAW-relevant data sets both with each other and with models. In this context WDC-RSAT will also handle non-satellite based data which is relevant within the context of validation. WDC-RSAT is envisaged to play a major role within the recently established international and global Network for the Detection of Mesopause Change (NDMC) with the mission to promote international cooperation among research groups active in the mesopause region (80-100 km height) to enhance the suitability of airglow observations for the detection of long-term trends. WDC-RSAT will serve as a communication and data management platform for this worldwide network of ground-based measurements.

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GCM LMDZ Simulations of Transport in the Tropical Tropopause Layer

Presenter: Marine Bonazzola (mbonaz@lmd.jussieu.fr)

M. Bonazzola, B. Legras, M. Bolot and R. James
(Laboratoire de Météorologie Dynamique, Paris, France)

The Tropical Tropopause Layer (TTL) is a transition region, extending vertically from the main convective outflow, to the cold point tropopause. Convection dominates in the lower portion, while the Brewer-Dobson circulation becomes increasingly important in its upper part. Outside of convective clouds, the radiative balance of the TTL, resulting from the absorption of infrared radiation by ozone and carbon dioxide, and the infrared cooling from water vapour, determines the direction and magnitude of vertical motion.

To understand how air and water vapour enter the stratosphere through the TTL, it is thus important to determine the role of cumulus convection overshooting its level of neutral buoyancy, and to analyse horizontal transport and slow diabatic motion, resulting from the radiative balance of the TTL.

We present some diagnostics of transport in the TTL, using the General Circulation Model (GCM) LMDZ with a vertical resolution of 50 levels. We analyse the sensitivity of transport to the radiation parametrizations, and to the representation of convection, using two distinct convection schemes, the Tiedtke's mass-flux scheme and the Emanuel (1994) multi-column scheme. We especially focus on the interactions between convection, large-scale circulation and water vapour variability in the Indian summer monsoon region of the TTL. Results are compared with the AURA/MLS data and with the ECMWF ERA-interim analyses.

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A new approach for a tracer budget of the extratropical lower stratosphere using simultaneous measurements of SF_6 and CO_2

Presenter: Harald Bönisch (boenisch@iau.uni-frankfurt.de)

H. Bönisch, A. Engel, J. Curtius (J.W. Goethe University of Frankfurt, Germany), P. Hoor (Max Planck Institute for Chemistry, Mainz, Germany)

Simultaneous in-situ measurements of CO_2 and SF_6 have been performed in the extratropical UTLS for the time period 2000 - 2003 during the SPURT (SPURenstoff-transport in der Tropopausenregion) project. SPURT delivered for the first time a detailed multi-year UTLS data record of both tracers for every season over a large range of latitudes.

The seasonal cycle of CO_2 in the troposphere propagates through the tropopause into the extratropical lower stratosphere (LS), while SF6 can be regarded as a seasonally undisturbed reference tracer. These different stratospheric input functions of both tracers allow characterising trace gas transport into the extratropical LS.

We will present an approach to calculate a trace gas budget for the extratropical LS based on simultaneous airborne measurements of SF_6 and CO_2. Our approach is based on the general assumption that transport into the extratropical LS can be described by bimodal age spectra (e.g. Andrews et al., 2001). This strategy offers a unique new aspect opposite to former trace gas budgets, e.g. Ray et al. (1999), Pan et al. (2000) and Hoor et al. (2004). Beside the fractions for the different transport pathways into the extratropical LS, we are able to deduce the associated mean transport time for the tropospheric fraction.

The results of this mass balance study will be shown and we will discuss the implications on troposphere-to-stratosphere transport.

ID: 00452

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First results of a model evaluation based on a tracer budget of the extratropical lower stratosphere applied on simulated and measured SF_6 and CO_2

Presenter: Harald Bönisch (boenisch@iau.uni-frankfurt.de)

H. Bönisch, A. Engel, J. Curtius (J.W. Goethe University of Frankfurt, Germany), P. Hoor (Max Planck Institute for Chemistry, Mainz, Germany)

In order to evaluate model transport in the extratropical UTLS region, SF_6 and CO_2 have been simulated with the three dimensional chemistry-transport Tracer Model version 5 (TM5) for the time period 2000 to 2003 [Bönisch et al, 2008]

The results have been compared to in-situ observations that were performed in the this region during the SPURT (SPURenstofftransport in der Tropopausenregion) project [Engel et al., 2006], which delivered for the first time a detailed highly resolved and high precision multi-year UTLS data record of both tracers in the northern hemisphere for every season over a large range of latitudes.

This model study utilises a new approach for a tracer budget of the extratropical LS. This approach is based on the general assumption that transport into the extratropical LS can be described by bimodal age spectra [e.g. Andrews et al., 2001]. CO_2 has a strong seasonal cycle, whereas SF_6 shows no such seasonal variations. The fact that the tropical tropospheric time series of SF_6 and CO_2 have these different characteristics that propagates into the stratosphere allows us to diagnose trace gas transport into the extratropical LS. Beside the fractions for the different transport pathways into the extratropical LS, we are able to deduce the associated mean transport time for the tropospheric fraction.

First results of this model-measurement-intercomparison will be shown and we will discuss the implications on troposphere-to-stratosphere transport.

References:

Andrews, A. E., K. A. Boering, S. C. Wofsy, B. C. Daube, D. B. Jones, S. Alex, M. Loewenstein, J. R. Podolske, and S. E. Strahan (2001), Empirical age spectra for the midlatitude lower stratosphere from in-situ observations of CO2: Quantitative evidence for a subtropical “barrier” to horizontal transport, J. Geophys. Res., 106, 10257–10274.

Bönisch, H., P. Hoor, Ch. Gurk, W. Feng, M. Chipperfield, A. Engel, and B. Bregman (2008), Model evaluation of CO2 and SF6 in the extratropical UT/LS region, J. Geophys. Res., 113, D06101, doi:10.1029/2007JD008829.

ID: 00431 ◀back

2001-2008 Tropical Tropopause Climatology from CHAMP Radio Occultation Compared to ECMWF and NCEP Analyses and Other Radio Occultation Missions

Presenter: Michael Borsche (michael.borsche@uni-graz.at)

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B. Pirscher, and G. Kirchengast (Wegener Center, University of Graz, Austria)

In recent years radio occultation (RO) data have become an integral part of monitoring the atmosphere because of their high vertical resolution, long-term stability (<0.1 K per decade expected), and inter-comparability between different satellite missions. Data from the CHAllenging Minisatellite Payload (CHAMP) satellite are available since September 2001, providing the first opportunity to create RO based multi-year climatologies. At the WegCenter, a near-seven year Sep 2001 to Jun 2008 monthly mean climatology dataset of tropical tropopause parameters is built, comprising the lapse rate tropopause as defined by the World Meteorological Organization (WMO) as well as the cold point tropopause, both temperature and altitude. CHAMP monthly mean tropopause parameters were compared against those of the operational analyses of the European Centre for Medium-Range Weather Forecasts (ECMWF) and against the lapse rate tropopause temperature of the re-analyses of the U.S. National Centers for Environmental Prediction (NCEP).

For further comparison and plausibility checks, tropopause parameters were calculated additionally from other RO missions for a few selected months distributed throughout the seven year CHAMP climatology. These additional data serve as 'anchor points' and include June, July, and August 2002 of the Argentine/US mission SAC-C, July 2006 of the German/US mission GRACE, and several months starting from August 2006 onwards of the Taiwan/US mission FORMOSAT-3/COSMIC. Furthermore, the corresponding anomalies of the tropical tropopause parameters were calculated, in order to highlight intra-seasonal and inter-annual variability. The anomalies are based on the subtracting the four year mean 2002-2005 seasonal cycle from the data set.

Validation against (lapse-rate) tropopause temperatures from the NCEP re-analyses showed NCEP warm deviations of about +4 K against CHAMP until the end of 2004, decreasing to about +2 K from 2005 onwards. ECMWF deviations of between -1 K to -2 K can be attributed to the lower vertical resolution and weaker representation of atmospheric wave activity in ECMWF analyses until January 2006. This evidence is confirmed by the data from February 2006 onwards, where an enhancement of the ECMWF analyses became effective in which the vertical resolution was effectively doubled in the UTLS region. The seasonal-mean tropopause temperature deviation against CHAMP was reduced by an order of magnitude from on average -1 K to the order of -0.1 K by this improvement. Comparing CHAMP tropopause parameters against other RO missions reveals very good consistency of these data collected with different instruments from different orbits: the lapse-rate tropopause temperature agrees within ~ 0.1 K to 0.3 K and lapse-rate tropopause height to about 50 m.

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GPS Radio Occultation Climatologies Retrieved with High-Altitude Initialization by ECMWF Forecasts for the Creation of a Continuous Climate Record

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In recent years radio occultation (RO) data have become an integral part of monitoring the atmosphere because of their high vertical resolution, long-term stability (<0.1 K per decade expected), and inter-comparability between different satellite missions. Data from the CHAllenging Minisatellite Payload (CHAMP) satellite are now available for almost seven years, providing the first opportunity to create RO based multi-year climatologies. At the WegCenter, zonally averaged monthly mean climatologies of atmospheric parameters such as refractivity, pressure, geopotential height, and dry temperature have been built from these data using operational analysis fields from the European Centre for Medium-Range Weather Forecasts (ECMWF) as background initialization and reference data. Due to the assimilation of RO data into the ECMWF analyses since December 2006, the analyses are not independent of RO data any longer. Therefore, at the WegCenter recently a re-processing of the complete CHAMP data set has been performed utilizing ECMWF 24 hrs / 30 hrs forecast fields for the initialization process instead of the analyses. Doing so enables a consistent and analysis-independent climate record, including for the times of assimilation of GPS RO data into the ECMWF system.

The newly processed climate record from September 2001 to June 2008 (almost seven years) is presented by comparing it to selected monthly mean data of other RO missions such as the Argentine/US mission SAC-C, the German/US mission GRACE, and the Taiwan/US mission FORMOSAT-3/COSMIC. Differences in monthly means between different RO missions amount to less than 0.5 K from North to South Pole and for the complete altitude range in which the climatologies are presented between 4 km and 35 km. Furthermore, a time period of nine months centered around December 2006 of the newly re-processed CHAMP record initialized with ECMWF forecast files is compared to the previous record initialized with the analyses. Differences are virtually non-existent below 30 km. At higher altitudes small warm differences of using the forecast fields, especially at northern high-latitudes, are visible over some months, reaching to near 0.5 K above 35 km altitude.

ID: 00232 ◀back

The influence of deep convection on HCHO, H_2O_2 and organic peroxides in the upper troposphere over Europe

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Deep convection is a highly efficient mechanism of vertical transport from the Earth's surface to the upper troposphere (UT). In convective clouds the rapid uplift of different trace gases with surface sources results in a C-shaped vertical profile and generally longer chemical lifetimes in the UT region affecting photochemical processes, e.g. ozone production. Formaldehyde (HCHO), hydrogen peroxide (H_2O_2) and organic peroxides, which are all important HOx precursors, are highly soluble trace gases. They can be efficiently scavenged and subsequently removed by precipitation in deep convective clouds.

The analysis of a case study of deep convection over Germany in summer 2007 within the framework of the HOOVER II project is presented. On July 19 three isolated convective cells developed along the south eastern edge of a north easterly moving mesoscale convective system (MCS) in the early afternoon. Airborne in situ measurements in the outflow and near the assumed inflow region of one of these isolated cells provide an excellent data set to study the influence of deep convection on the mixing ratios of many different species in the UT region. A comparison of outflow and boundary layer mixing ratios indicate an almost undiluted transport of the longer lived species (CO, CH_4) to the UT with [Outflow]/[BL] ratios of 0.95 ± 0.03 (CO) and 0.99 ± 0.01 (CH_4). For the highly soluble species HCHO and H_2O_2 the ratio still amounts to 0.55 ± 0.10 and 0.60 ± 0.05. Thus these species are not completely washed out in the convective updraft. Degassing during cloud drop freezing, i.e., a retention coefficient of less than unity, is one possible mechanism to contribute to the observed outflow value of these soluble species. For the organic peroxides the ratio is 1.47 ± 0.20 suggesting secondary production in the updraft or anvil region of the cloud. Box model calculations constrained by the measurement data of this case study are performed in order to better understand the effects of convection on the HOx budget in the tropopause region.

ID: 00319 ◀back

The role of tropical vertical velocities in determining tracer gradients in the upper troposphere and lower stratosphere

Presenter: Peter Braesicke (peter.braesicke@atm.ch.cam.ac.uk)

P. Braesicke, O. Morgenstern, P. Telford and J.A. Pyle (Univesity of Cambridge, UK)

Many chemistry-climate models (CCMs) have a tendency to overestimate ozone in the tropical upper troposphere and lower stratosphere (UT/LS). There are many possible reasons for this overestimation, including models' representation of the transition from the upward branch of the Hadley cell to the rising branch of the Brewer-Dobson circulation. We will analyse the spatial and temporal distribution of tropical vertical velocities in the UT/LS region through idealised studies employing the non-hydrostatic UK Chemistry and Aerosol community model (UKCA). Sensitivity studies will be performed to modify the spatial and temporal characteristics of the prognostic vertical velocities in the transport scheme. In idealised experiments we apply spatial-temporal filtering and a targeted addition of ascent velocities with the model free running and constrained through nudging. Tropical tracer gradients of ozone, methane and CO will be analysed and their changes described. First results confirm that part of the overestimation of UT/LS ozone can be explained by the characteristics of the modelled vertical winds in this transition region. We will quantify the effect, which, although it exploits a well known mechanism, is still challenging, and depends on model resolution.

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Zonal asymmetries in age-of-air and their relevance for transport into the sub-tropical lowermost stratosphere

Presenter: Peter Braesicke (peter.braesicke@atm.ch.cam.ac.uk)

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Age-of-air diagnostics help our understanding of large-scale transport processes and their characteristic timescales in the upper troposphere and lower stratosphere. In models, age-of-air can easily be calculated using a timed tracer. Observational evidence for age-of-air can be derived using inert tracers with a distinct temporal trend. One such tracer is SF_6 as measured by the MIPAS instrument on board ENVISAT. We simulate age-of-air using the Met Offices Unified Model (UM) at a horizontal resolution of N48 with 60 vertical levels from the surface up to around 83 km and validate the model performance with MIPAS derived estimates. Age-of-air zonal means show good agreement in the lower stratosphere. Some deviations are apparent at high altitudes over the Polar Regions. In the northern sub-tropical lowermost stratosphere modelled age-of-air displays pronounced zonal asymmetries overlaid with a seasonal cycle. Note that we contrast the measured variability of SF_6 derived age-of-air over the period 2002-2004 with climatological model results. Notwithstanding this limitation, good agreement is found in the seasonality of variability. Consequences for representing transport into the sub-tropical lowermost stratosphere in models are explored, including constituents' variability of e.g. ozone due to the Indian monsoon.

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Odin Stratospheric Proxy NOy Measurements and Climatology

Presenter: Samuel Brohede (samuel.brohede@chalmers.se)

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Five years of OSIRIS (Optical Spectrograph and InfraRed Imager System) NO_2 and SMR (Sub-Millimetre Radiometer) HNO_3 observations from the Odin satellite, combined with data from a photochemical box model, have been used to construct a stratospheric proxy NOy data set including the gases: NO, NO_2, HNO_3, $2xN_2O_5$ and $ClONO_2$. This Odin NOy climatology is based on all daytime measurements and contains monthly mean and standard deviation, expressed as mixing ratio or number density, as function of latitude or equivalent latitude (5 degree bins) on 17 vertical layers (altitude, pressure or potential temperature) between 14 and 46 km.

Comparisons with coincident NOy profiles from the Atmospheric Chemistry Experiment - Fourier Transform Spectrometer (ACE-FTS) instrument were used to evaluate several methods to combine Odin observations with model data. This comparison indicates that the most appropriate merging technique uses OSIRIS measurements of \\noo, scaled with model NO/NO_2 ratios, to estimate NO. The sum of $2xHNO_3$ and $ClONO_2$ is estimated from uncertainty-based weighted averages of scaled observations of SMR HNO_3 and OSIRIS NO_2. Comparisons with ACE-FTS suggest the precision (random error) and accuracy (systematic error) of Odin NOy profiles are about 15% and 20%, respectively. Further comparisons between Odin and the Canadian Middle Atmosphere Model (CMAM) show agreement to within 20% and 2 ppb throughout most of the stratosphere except in the polar vortices. A particularly large disagreement within the Antarctic vortex in the upper stratosphere during spring indicates too strong descent of air in CMAM.

The combination of good temporal and spatial coverage, a relatively long data record, and good accuracy and precision make this a valuable NOy product for various atmospheric studies and model assessments.

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Transient simulation from 1960 to the present with the CCM ECHAM5/MESSy1 with focus on stratospheric water vapor

Presenter: Christoph Brühl (chb@mpch-mainz.mpg.de)

C. Brühl, A. Baumgaertner, J. Lelieveld, P. Jöckel, B. Steil and the MESSy-Team
(Max Planck Institute for Chemistry, Mainz, Germany)

The chemistry climate model ECHAM5/MESSy1 with horizontal resolution T42 and 90 layers up to 80km is used for a transient simulation from 1960 (1958 for spinup) to about 2000 with the chemical and physical boundary conditions of the CCMVal-REF1 scenario. The model includes tropospheric and stratospheric chemistry and has a high vertical resolution near the tropopause. To achieve a quasi biennial oscillation exactly in phase with observations, the model's internally generated QBO is very weakly nudged in the lower stratosphere. We show that we are able to simulate the 'atmospheric tape recorder', the upward propagation of the seasonal signal of water vapor at the tropopause, and its modulation by the QBO, El Niño, volcanic heating, monsoon effects and atmospheric chemistry. The presentation will include also a comparison with observations and some analysis of modification of polar strato-spheric clouds by changing water vapor.

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Thermal variability at the tropopause

Presenter: Carlo Buontempo (carlo.buontempo@metoffice.gov.uk)

A.C. Buontempo (Met Office, Exeter, UK)

The tropopause thermal variability is analysed using the high resolution temperature profiles provided by the radio-occultation mission CHAMP. These profile are compared with those of co-located ECWMF analysis. In order to reduce the errors associated with the sampling of a non-stationary process both datasets are rebinned in tropopause-based coordinates. In this new reference the vertical profiles of specific variability obtained from radio occultations agree reasonably well with those derived from ECMWF in the extratropics. The situation is different in the tropics where a difference between the two can be noticed. This discrepancy seems to suggest a difference in the representation of the tropopause variability between GCMs analysis and radio occultation observations.

Suggestions on the origin of this discrepancy and on how this may represent a limiting factor in our analysis of the tropical tropopause structure are discussed.

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Observations of the Upper Atmosphere from Satellite Platforms: Sensing and Sensibility

Presenter: John Burrows (burrows@iup.physik.uni-bremen.de)

J. Burrows (University of Bremen, Germany)

Currently we are arguably in, or coming to the end of, a golden age of satellite remote sensing of the atmosphere. The current fleet of satellites, comprising for example elements of the A train (e.g. NASA AURA, and Calypso), the Morning Platforms (ERS-2, ENVISAT and Metop-A), the temporally spatially varying ODIN and occultation ACE missions are making a unique set of measurements of the upper atmosphere. These build on the first generation of instruments such as TOMS, SBUV and SAGE I and SAGEII, which started mapping the trace constituents in the upper atmosphere at the end of the 1980s. The instrumentation aboard these platforms utilises both passive remote sensing techniques, making observations of the upwelling radiation from the top of the atmosphere in spectral ranges from the microwave to the ultraviolet and very recently active remote sensing in addition. This presentation will give an overview of the current capability and some recent scientific highlights, addressing the stratospheric ad mesospheric chemistry and dynamics being probed by these missions

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Impacts upon the evolution of the Met Office NWP and Climate middle atmosphere GCM due to recent improvements to modelled radiation and ozone interactions

Presenter: Andrew Bushell (andrew.bushell@metoffice.gov.uk)

A. Bushell, C. Johnson, J. Manners, T. Hinton (Met Office, Exeter, UK),
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Work undertaken during development of a 60-level (middle atmosphere) version of the Met Office climate configuration HadGEM2-A highlighted the importance of choices that were made in relation to the behaviour of the radiation scheme at the reduced pressures encountered above the tropopause. This has led to a programme of activities to alter the number and range of the broad longwave and shortwave spectral bands used to parametrize radiation in the MetUM model, to improve the treatment of gaseous absorption within each band and to allow a more accurate response to irradiance changes in variable portions of the sun's spectrum over the 11-year solar activity cycle. The impact of radiative processes upon the model evolution is felt through heating and cooling of the atmosphere that results from interactions between solar and thermal radiation and various gases in the atmosphere, such as carbon dioxide, water vapour and ozone.

As a result, the distribution of ozone in the MetUM model, which is most usually represented via climatologies of zonal mean concentrations, has also been reassessed recently. Controlled experiments have been run to compare climate model performance with ozone climatologies of Li and Shine, SPARC and a new climatology assembled by Rosenlof and co-workers.

A package that combines the current best estimate for ozone climatology with recommended improvements to the model radiation offers the firmest basis for simulating key features of the model's middle atmosphere dynamics, such as the period of the quasi-biennial oscillation in zonal wind at the equator, which are sensitive to temperature changes in the lower stratosphere. This presentation investigates the downstream impact of changes to the radiation and ozone distribution upon the simulated climate of HadGEM2-A and considers the outcome of an assimilation trial designed to explore the effect which they might have upon systematic errors in the Numerical Weather Prediction (NWP) forecast.

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Changes in stratospheric dynamics and circulation diagnosed from the CCMVal reference stimulations

Presenter: Neal Butchart (neal.butchart@metoffice.gov.uk)

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Projected stratospheric climate and circulation changes for the 21st Century are obtained from chemistry-climate model simulations performed by SPARC's CCMVal activity in support of the 2006 WMO/UNEP ozone assessment report. The seasonal and spatial distributions of the temperature trends are compared in the different simulations and the secular trends separated from the low frequency variability. Changes in the winter and spring time conditions in the lower stratosphere relevant for the formation of polar stratospheric clouds are investigated. The Brewer-Dobson circulation is analysed in terms of the tropical upwelling mass flux entering the stratosphere with "downward control" integrals used to asses the contributions from resolved and parametrised waves to the driving, and changes, in the upwelling. The correlation between projected changes in the upwelling and age-of-air is compared in the different models.

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Spatial Structures in Lower-Stratospheric Temperature Trends

Presenter: Amy Butler (amy@atmos.colostate.edu)

A.H. Butler, D. Thompson (Colorado State University, Fort Collins, USA)

Lower-stratospheric zonal-mean temperature trends from the Microwave Sounding Unit (MSU) from 1979-2007 show stronger cooling in the extratropics relative to the cooling in the tropics. Previous studies suggest these extratropical cooling 'peaks' may be indicative of an expansion of the Hadley Cell. Our goal is to examine the robustness and seasonality of this trend pattern in detail, and to look for a similar spatial structure in ozone trends. The spatial structure of the lower-stratospheric trends is quite robust for a variety of different time periods, but has the strongest amplitude in Northern-Hemisphere winter. Seasonal analysis suggests that the location and strength of the extratropical cooling peaks shift from month to month. Trends in vertical profile ozone data are then compared to the trends in lower-stratospheric temperature to see if ozone trends in the lower-stratosphere have a similar spatial structure. Finally, we attempt to quantify the reduction of the MSU cooling trends in the tropical lower-stratosphere caused by the inclusion of a warming troposphere in the weighted layer-average that the MSU employs, which may be at least partly responsible for the weaker tropical lower-stratosphere cooling in the MSU data.

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Impact of modeling the stratosphere on the winter tropospheric teleconnections between ENSO and the Northern Atlantic and European Region.

Presenter: Chiara Cagnazzo (cagnazzo@bo.ingv.it)

C. Cagnazzo (Centro Euro-Mediterraneo per i Cambiamenti Climatici, Bologna, Italy) and E. Manzini (Istituto Nazionale di Geofisica e Vulcanologia and Centro Euro-Mediterraneo per i Cambiamenti Climatici, Bologna, Italy)

The possible role of stratospheric variability on the tropospheric teleconnection between ENSO (El Niño Southern Oscillation) and the North Atlantic and European (NAE) region is addressed by analyzing two ensembles of simulations performed respectively with an atmosphere general circulation model that fully resolve stratosphere (with top at 0.01 hPa) and its low top version with top at 10 hPa. It is found that both models capture the sensitivity of the averaged polar winter lower stratosphere to ENSO, in the Northern hemisphere. Instead, in the troposphere, in late winter and spring the ENSO response is somewhat different in the two models. Specifically, in February March the difference in the ENSO anomaly in sea level pressure, between the high and low top models is characterized by a large scale and coherent pattern, with higher pressures over Arctic and lower pressures over the western Europe and the North Pacific. In relative terms, the two models differ more in the Arctic and NAE region. Focusing on the NAE region, the difference in the ENSO anomalies in sea level pressure between the two models is associated with cooling in Northern and Central Europe region (as depicted by the anomaly in 1000 hPa temperature) and a southward shift of the Northern Atlantic storm track. In addition, it has been found that major sudden stratospheric warming events are virtually lacking in the low top model, while their frequency of occurrence is broadly realistic in the high top model. Given that this is a major difference in the dynamical behavior of the stratosphere of the two models and that these events are favored by ENSO, it is concluded that the occurrence of sudden stratospheric warming events is implicated in the reported difference in the ENSO anomaly in the troposphere in the two models. Given that the essence of this difference is a more annular (or zonal) pattern of the anomaly in SLP, relatively larger over the Arctic and the NAE regions, this interpretation is consistent with the observational evidence that sudden stratospheric warming play a role in the persistence of the surface Arctic Oscillation.

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The M55 Geophysica deployment in West Africa: An overview of processes governing TTL composition over West Africa

Presenter: Francesco Cairo (f.cairo@isac.cnr.it)

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The high altitude research aircraft M55 Geophysica was deployed in Ouagadougou, Burkina Faso, during the AMMA Special Observing Period of summer 2006. The campaign activity was carried out in conjunction with the German D-20 Falcon, and in close cooperation with the ongoing AMMA activities in West Africa. The M55 flights aimed at a better understanding of the large scale transport features in the region, at assessing the effect of lightning on the NOx production, and at studying the effects of intense mesoscale convective systems on the upper Troposphere and lower Stratosphere, with emphasis on their impact on the upward transport and redistribution of water, aerosol, dust and chemical species, at studying the cross-hemispheric transport of biomass burning pollutants emitted over central Africa (dry season) into TTL and mid-troposphere (MT) over West Africa during the summer monsoon (wet) season. Five scientific flights were successfully carried out on site, and four transfer flights allowed a characterization of the tropopaure region along a latitudinal transect from southern Europe to the Sahel. We will here provide a overview of the M55 Geophysica campaign and an interpretation of the observations accomplished.

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Influence of energetic particle precipitation on the chemistry of the middle atmosphere and climate

Presenter: Marco Calisto (marco.calisto@env.ethz.ch)

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The energetic particles entering the atmosphere are able to affect the composition of the middle atmosphere, ozone and climate. Energetic particles initiate ionization in the atmosphere followed by the NOy and HOx production, which has a big impact on ozone chemistry in the stratosphere with further implications for the climate. There are three main sources of energetic particles that enter the atmosphere: solar proton events (SPE), galactic cosmic rays (GCR) and energetic electrons precipitation (EEP). While we aim on the study of all sources and their role in the ozone layer evolution during the satellite era this paper is devoted to the study of the GCR effects. The known Heaps parameterization has been introduced to our 3-D chemistry-climate model SOCOL to describe the source of NOy and HOx. We have carried out 13-year long run, starting from 1976 to simulate the influence of the GCR on the atmosphere. The changes of the main chemical constituents (i.e. NOy, HOx and O_3), temperature and dynamics caused by the GCR and their statistical significance will be shown and discussed.

In addition, the influence of SPE effects is implemented in the model. For this, we have used the SPE induced ionization rates compiled by C. Jackman. We have carried out 1-year long ensemble-runs to see the short-term effects of October 2003 SPE on NOy, HOx, O_3 and temperature and dynamics which will be shown and discussed.

ID: 00299 ◀back

Transient Changes in the Brewer-Dobson Circulation Associated with ENSO

Presenter: Natalia Calvo (calvo@ucar.edu)

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Acceleration of the stratospheric Brewer-Dobson (BD) circulation in middle and high latitudes during strong El Niño-Southern Oscillation (ENSO) events has been documented in numerous works and has been related to anomalous Rossby wave propagation and dissipation in middle latitudes. We use NCAR’s Whole Atmosphere Community Climate Model WACCM3 to show that ENSO events can affect the BD circulation, not only at middle and high latitudes, but also in the tropical lower stratosphere. In this region, the mechanisms that accelerate the circulation are not so well understood. However, recent modeling work suggests that increases in greenhouse gases (GHG) also strengthen the BD circulation in the tropical lower stratosphere, and that this happens as a result of anomalous wave driving in the subtropics. Here we study the mechanisms whereby ENSO intensifies the BD circulation in the tropical lower stratosphere and compare them with those that operate under GHG increases.

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Stratospheric Ozone in the American South Cone and Antarctic Ozone Hole 1992-2007

Presenter: Claudio Casiccia (claudio.casiccia@umag.cl)

C. Casiccia, F. Zamorano, R. Viana (University of Magallanes, Chile)

During the recent decades there has been an increasing concern related to ozone layer and solar ultraviolet radiation (UV-B: 280-320 nm), reaching the surface of the earth The Antarctic Ozone Hole (AOH) is a phenomenon of strong ozone depletion in the Antarctic stratosphere, this is a consequence of heterogeneous chemical reactions and dynamical processes which enhance ozone losses by reactions with chlorine. Punta Arenas (53.0ºS, 70.9ºW) is the southernmost city in Chile with a population of approximately 120000. Due to its location, well within the area affected by the Antarctic Ozone Hole the ozone distribution is affected in different altitudes. Systematic observation of ozone and UV-B with a Brewer spectrophotometer have been made in order study during the ozone hole conditions. In addition, the vertical distribution has been investigated during campaigns in spring time, the last campaigns was in 2005. Since 2002 we are doing measurements of the vertical distribution using Umkehr technique, using the Brewer instrument. In this work we show the results the analysis of column ozone, vertical distribution of ozone and ultraviolet radiation UV-B made in Punta Arenas to period 1992-2007.

ID: 00360 ◀back

Changes on barotropic planetary waves associated with changes in the northern hemisphere stratospheric polar vortex

Presenter: José M. Castanheira (jcast@ua.pt)

J.M. Castanheira (CESAM, University of Aveiro, Portugal),
Margarida L.R. Liberato (UTAD, Portugal), L. de la Torre (University of Vigo, Spain),
H.-F. Graf (University of Cambridge, UK)
and C.C. DaCamara (University of Lisbon, CGUL, Portugal)

A study of the energy associated with barotropic and baroclinic planetary waves, during rapid stratospheric vortex decelerations and rapid accelerations, is presented. Positive energy anomalies associated with barotropic tropospheric planetary waves are observed during the phases of strong stratospheric vortex. High peak maxima of the energy associated with baroclinic planetary waves are observed during vortex decelerations. During the weak vortex periods, the energy associated with barotropic tropospheric planetary waves is smaller than the climatological values, and negative anomalies of the energy associated with baroclinic planetary waves occur during rapid vortex accelerations.

Results give clear evidence of the troposphere-stratosphere wave driven coupled variability: The vortex variability is forced by baroclinic planetary wave bursts. The barotropic tropospheric wave energy seems to respond to the vortex state. Energy anomalies of high statistical significance appears associated with barotropic waves of zonal wave numbers s=1 and 3. These wave numbers correspond to the dominant Fourier components of the topography, in the high latitudinal belt where the zonal mean zonal wind anomalies are stronger and seem to represent zonally symmetric coherent variability. Analytical calculation were done with the barotropic Rossby wave model of Charney-Eliassen model forced by the mean topography in the channel 55-65ºN. Using the analytical solution as an heuristic argument, it is suggested that the barotropic wave response is mediated by changes of the topographic forcing due to zonal mean zonal wind anomalies progressing downward from the stratosphere.

Finally, a filtered barotropic geopotential field was calculated as a linear combination of the zonal symmetric component and the zonal wave numbers s=1 and s=3. Composites of the filtered field were calculated for strong and weak vortex regimes. The composite differences gives a pattern that projects strongly on the NAO.

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Cross-tropopause transport by convective overshoots in the Tropics

Presenter: Jean-Pierre Chaboureau (jean-pierre.chaboureau@aero.obs-mip.fr)

J.-P. Chaboureau, P.J. Mascart, and J. Duron (Laboratoire d'Aerologie, University of Toulouse and CNRS, France)

The increase in the stratospheric water vapor is explained partly by the troposphere stratosphere exchanges in the tropics. However the mechanisms of exchange remain much discussed between slow transport by radiative forcing from the base of the layer of tropical transition (TTL) and fast convective transport directly to the lower stratosphere. The recent observations of particles and water vapour measured in the TTL and nearby the convective systems in Brazil and in Africa can be explained by transport through convection overshoots only. In support with these observations, the mesoscale models are a powerful means of interpretation whose contribution for the study of troposphere stratosphere exchanges will be re-examined. In a first numerical study combining in an original way hectometric resolution and real meteorological conditions, the role of the convection as elevator for stratosphere was shown. (Chaboureau et al. ACP 2007). The case is revisited using advanced advection and microphysical schemes. Plume statistics show the increase in vertical velocity with the plume size. The convection moistens the free troposphere with time, leading to a decrease in entrainment and an increase in the overshoot efficiency up to the lower stratosphere. The convection penetrating the stratosphere will be further demonstrated for an African squall line. The limits and the consequences on a global scale of the results from these case studies will be discussed.

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The tropospheric response to stratospheric perturbations and its sensitivities to topographically-forced stationary waves

Presenter: Cegeon Chan (cegeon@mit.edu)

C. Chan, R.A. Plumb (Massachusetts Institute of Technology, USA)

Observations have shown that changes in the stratospheric Northern Annular Mode can sometimes be precursors to same-signed changes in the troposphere. Furthermore, numerical modeling studies have shown externally-forced stratospheric perturbations being capable of affecting the tropospheric climate (e.g. Song and Robinson 2004; Kushner and Polvani 2004). However, a theory describing this coupling remains incomplete.

Stratospheric extratropical variability is generally dominated by the vertical propagation of planetary waves originating from the troposphere. Although the above studies have implicated planetary-scale waves in the vertical coupling, they did not examine how the strength of that coupling and its tropospheric impacts depend on the stratospheric wave climatology. The focus here is to examine the role of planetary waves of realistic amplitude in this context.

Using a simple AGCM, we investigate how topographically-forced stationary waves can influence stratosphere-troposphere coupling. More precisely, we systematically change the amplitude and location of the artificial, planetary-scale, and describe how the tropospheric response to imposed stratospheric perturbations depends on the stratospheric wave climatology, and the roles of eddy, mean flow, feedback in both the troposphere and stratosphere . We will also discuss how the tropospheric response may be understood in terms of the fluctuation-dissipation theorem.

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Analysis of gravity-waves produced by intense tropical cyclones

Presenter: Fabrice Chane-Ming (fchane@univ-reunion.fr)

F. Chane-Ming (Université de la Réunion, France),
Z. Chen (Chinese Academy of Sciences, Beijing),
F. Roux (Laboratoire d'Aérologie, Université Paul Sabatier, Toulouse, France)

Tropical Cyclones (TC) are threatening meteorological phenomena for islands and coastal regions in the tropics. Previous studies observed observation of oscillations of the storm track induced by GWs ((Willoughby et al., 1984) and release of GW energy during landfalls of TC Hudah over Madagascar and Mozambique (Chane-Ming et al., 2002). GWs reveal to be sources of atmospheric convective GW in the Upper Troposphere and the Lower Stratosphere (Sato, JAS 1993; Pfister et al., JGR 1993) and contribute to the dynamic and thermal structure of tropical cyclones.

The present study details GW activity of two intense TCs in the South-West Indian and the North-West Pacific basins. Spectral and energy parameters of GW are retrieved from radiosonde data using conventional and wavelet analyses. GW energies as a function of the convective activity of the basin and the TC intensity are investigated.

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Changes to Sudden Stratospheric Warmings in Future Climates

Presenter: Andrew Charlton-Perez (a.j.charlton@reading.ac.uk)

A.J. Charlton-Perez (University of Reading, UK),
L.M. Polvani (Columbia University, New York, USA),
J. Austin (Geophysical Fluid Dynamics Laboratory, Princeton, USA),
F. Li (Goddard Earth Sciences and Technology Center, University of Maryland, Baltimore, USA)

The dynamical coupling between the Stratosphere and Troposphere is strongest during extreme events in the Stratosphere known as Stratospheric Sudden Warmings (SSWs). Our recent work has focussed on establishing a new climatology of these events and developing, dynamically realistic benchmarks for their simultion in GCMs. Here we use these new tools together with a state-of-the-art coupled chemistry climate model (CCM) to investigate if either the frequency or character of SSWs is predicted to change over the coming century. Our motivation is simple, to understand what role the Stratosphere might play in future Tropospheric climate we must first understand and quantify future Stratospheric variability.

We investigate two sets of three ensemble member integrations, the first forced with observed SSTs and climate forcings between 1960 and 2000 and the second forced with SSTs taken from a coupled ocean atmosphere model experiment with climate forcings based on the IPCC SRES1B scenario. We find an upward trend in SSW frequency of 1 SSW dec-1 century-1 which is statistically significant at the 90% confidence level and is consistent over the two sets of model integrations. Comparison of the SSW climatology between the late 20th and 21st centuries in our model shows that the increase is largest toward the end of the winter season. Comparison of the dynamical properties of SSWs in the 20th and 21st centuries shows that the character of SSWs is not altered by the increase in SSW frequency. If the predicted trend in SSW occurrence is realistic, it will be difficult to detect in observed data for some time. It is therefore very important to compare predicted trends in SSWs across a range of CCMs.

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What controls dynamical timescales near the Tropopause?

Presenter: Andrew Charlton-Perez (a.j.charlton@reading.ac.uk)

A.J Charlton-Perez and A. O'Neill (University of Reading, UK)

The region of the northern hemisphere polar Stratosphere just above the Tropopause (100-300hPa) has an annular mode decorrelation timescale of around 40 days, the largest in the extra-tropical atmosphere. Some recent efforts to improve seasonal forecasting in the extra-tropics have focussed on exploiting this long decorrelation timescale to improve tropospheric predictability. In order to simulate this effect accurately in seasonal forecasting models it is necessary to understand if it is due solely to the long, local radiative timescales, or if its is related to the structure of stratospheric dynamical variability.

A simple dynamical core which parametrises radiation physics using a Newtonian cooling scheme is used to investigate annular mode dynamical timescales in the lower Stratosphere. Several experiments, with different Newtonian cooling timescales in the Stratosphere but identical Newtonian cooling timescales in the Troposphere are conducted. Dynamical timescales near the tropopause are shown to be related both to local Newtonian cooling timescales and those in the middle stratosphere. However, a simple relationship between middle and lower stratospheric dynamical timescales is not evident.

Furthermore, dynamical timescales at the surface also vary between our experiments, despite all of the changes to Newtonian cooling rates being restricted to the region above 100hPa. Dynamical timescales at the surface are strongly correlated with dynamical timescales near the tropopause. These results provide further evidence that stratospheric and tropospheric variability are linked, and that a poor simulation of stratospheric variability by more complex GCMs may have a detrimental impact on the simulation of tropospheric variability.

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The tropospheric jet response to prescribed zonal forcing in an idealized atmospheric model

Presenter: Gang Chen (gchenpu@mit.edu)

G. Chen (Massachusetts Institute of Technology, Cambridge, USA) and P. Zurita-Gotor (Universidad Complutense de Madrid, Spain)

This poster will be presented by Cegeon Chan

The authors explore the tropospheric jet shift to a prescribed zonal torque in an idealized dry atmospheric model with high stratospheric resolution. The jet moves in opposite directions for torques on the jet's equatorward and poleward flanks in the troposphere. This can be explained by considering how the critical latitudes for wave activity absorption change, where the eastward propagation speed of eddies equals the background zonal mean zonal wind. While the increased zonal winds in the subtropics allow the midlatitude eddies to propagate further into the tropics and result in the equatorward shift in the critical latitudes, the increased winds in the midlatitudes accelerate the eastward eddy phase speeds and lead to the poleward shift in the critical latitudes.

In contrast, the jet moves poleward when a westerly torque is placed in the extratropical stratosphere irrespective of the forcing latitude. The downward penetration of zonal winds to the troposphere displays a poleward slope for the subtropical torque, an equatorward slope for the high latitude torque, and less tilting for the midlatitude torques. The stratospheric eddies play a key role in transferring zonal wind anomalies downwards into the troposphere. It is argued that these stratospheric zonal wind anomalies can affect the tropospheric jet by altering the eastward propagation of tropospheric eddies. Additionally, the zonal wind response to a subtropical zonal torque in this idealized model is of value to understand the tropospheric jet sensitivity to the orographic gravity wave drag parameterization in a realistic climate model.

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Relationship between Stationary Planetary Wave Activity and the East Asian Winter Monsoon

Presenter: Wen Chen (chenw@mail.iap.ac.cn)

W. Chen (IAP/CAS, China)

The variability of both the stationary planetary wave activity and the East Asian winter monsoon is strongly associated with the thermal contrast between oceans and land masses. In this talk, we explore the relationship between the wave activity and the monsoon, with a focus on interannaul timescales. It is found that, compared to the winters of low wave activity, the equatorward propagation of planetary waves in the middle and upper troposphere is stronger in the high wave activity winters. During these high activity winters, the upward wave propagation from the troposphere into the stratosphere becomes weaker. This is accompanied by a smaller perturbation in the polar vortex, which tends to be colder and stronger. In the meantime, the East Asian westerly jet stream, the East Asian trough, the Siberian high, and the Aleutian low all become weaker apparently. In particular, the weakening of the Siberian high and the Aleutian low decreases the northeasterly wind over East Asia, leading to a warming condition in the region especially in northeastern Asia. The zonal wavenumber-2 pattern of planetary waves has been shown to contribute dominantly to the warming.

We will also show that above-mentioned relationship is modulated by the tropical quasi-biennial oscillation (QBO) wind in the stratosphere. In the QBO easterly phase, a significant warming appears in northeastern Asia in the presence of high wave activities. This corresponds to a weakened East Asian trough at 500-hPa, which determines the extent to which cold waves penetrate into East Asia. However, in the QBO westerly phase, both the surface warming and the weakening of the East Asian trough become insignificant in response to high wave activities. The possible mechanism for this QBO modulation on the tropospheric wave activities will be discussed too.

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The Anomalies of Polar Vortex before the Serious Snow Storm and Freeze Calamity in China 2008

Presenter: Yuejuan Chen (cyj@ustc.edu.cn)

Y. Chen, R. Zhou (University of Science and Technology of China, Hefei, China),
D. Shumei (Anhui Institute of Meteorological Sciences, Hefei, China),
Y. Mingjian (University of Science and Technology of China, Hefei, China),
Liu Yi (Chinese Academy of Sciences, Beijing, China)

A serious snow storm and freeze calamity occurred in south part of China in Jan. 2008, which was seldom seen in the history with its extension, strength and long duration. In order to investigate the relationship between the anomaly of the stratospheric polar vortex and the serious snow storm and freeze calamity, the day by day variation of the stratospheric polar vortex from December 2007 to February 2008 has been analyzed using NCEP data. The results show that before the occurrence of the snow storm and freeze calamity the stratospheric north polar vortex strengthen clearly with the NAM indices as lager as +3.0 in the first ten days of January 2008; At the same time the polar vortex deformed and expanded to Asia and North America and the pressure went up over north Pacific and north Atlantic; The stratosphere over north part of Asia was dominated by a strong low trough one month before the serious snow storm and freeze calamity. Moreover, the stratospheric circulation in middle-lower latitudes also changed significantly. These anomalies of the stratospheric circulation propagated downward and affected the troposphere. It is significant that as the stronger low trough extend downward, it moved to the east. Therefore the East Asian Trough in 500hPa was shift to the east of Siberia and the pressure in most part of Eurasia raised, and then a strong blocking high was developed in the region from Mediterranean Sea to the Ural Mountains since the middle of January, which moved slowly to the east and dominated Eurasia. The north-westerly flow in the front of the blocking high leaded the cold air from north area entered into China, which met the warm and wet air from Bay of Bengal and South China Sea in south part of China, and then caused the serious snow storm and freeze calamity. Our results show that this exceptionally serious snow storm and freeze calamity was connected not only with the changes of the tropospheric circulation, but also with the changes of the stratospheric circulation. Meaningfully, the changes of the stratospheric circulation ware more than one month ahead of the snow storm and freeze calamity. Therefore it is helpful to improve the middle and long term weather forecast, especially for the serious meteorological calamity forecast, if we use the information of the stratospheric circulation to the weather prediction.

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Estimation and Attribution of the Temperature Variances in the Stratosphere

Presenter: Zeyu Chen (z.chen@mail.iap.ac.cn)

Z. Chen, D. Lu (Chinese Academy of Sciences, Beijing, China)

The SABER/TIMED temperatures collected during 2002 to 2006 are used to estimate the variances of temperature (Temp-VARs) that are contributed from non-stationary perturbations in the stratospheric portion (20~60 km height range), and the attributions of the Temp-VARs are analyzed. The current estimation results disclose that the temperature variances induced by tidal components, in particular the migrating diurnal and semi-diurnal tide, can account for significant amount of the Temp-VARs. The Temp-VARs are estimated by using the measurements taken in a 60-day period when the major hemispheres are the same for each sounding day, i.e., the soundings can reach 85º latitude for the same hemisphere all the days, thus, the estimates are available at the polar latitudes. In each of the one-year course among the years from 2002 to 2006, there are six such kind 60-day periods that are repeatedly centered on DOY 46, DOY 109, DOY 169, DOY 231, DOY 293 and DOY 352. The major hemisphere is in the northern hemisphere for the 60-day period centered on DOY 46, DOY 169, and DOY 293, but is in the southern hemisphere for the 60-day period centered on DOY 109, DOY 231, and DOY 352. Furthermore, following the season of the northern hemisphere, they are referred to as late-winter, spring, mid-summer, late-summer, autumn, and mid-winter, respectively.

For each of the seasons, significant Temp-VARs are only seen in the extra-tropical latitudes for both hemispheres, which attain 8 K in term of the standard deviations of temperature (T-SDEVs). Across the two tropics and the equator, a quiescent slab is located at 20 km height where the T-SDEVs reach a minimum, less than 1.5 K. Above the slab, the T-SDEVs increases monotonically and slowly with height, but less than 4 K for most of the seasons. In the mid-summer, the slab extends to the mid-latitudes of the mid-summer hemisphere, then, large T-SDEVs greater than 4 K can only be seen in the extra-tropics of the opposite hemisphere.

Tidal signals are extracted independently from each of the 60-day data by using the conventional procedures. The migrating diurnal and semidiurnal tides are considered of most important, which can account for significant amount of the T-VARs. It is surprisingly found that during the spring time, the contribution from the migrating diurnal tide predominates the spring and mid-summer extra-tropics centering at 40ºlatitude in height range 40~60 km, which accounts for 50% of the T-VARs in the spring time. Significant contributions of the migrating diurnal tide are also seen in the whole of the polar stratosphere in the autumn and late-winter.

The contributions of the migrating semidiurnal tide are also significant, in particular at high latitudes in all the seasons when soundings are available. An interesting feature is seen in the boreal spring season, which corresponds to the austral autumn. The high extra-tropics in the two hemispheres are all strongly disturbed. As already introduced in the above, 50% of the boreal upper stratospheric T-VARs is accounted by

the contribution of the migrating diurnal tide, the contributions of the migrating semi-diurnal tide explain the disturbances in the austral autumn.

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Recent modelling studies using different laboratory data for ClOOCl photolysis and other halogen reactions

Presenter: Martyn Chipperfield (martyn@env.leeds.ac.uk)

R. Salawitch (University of Maryland, USA),
M. Chipperfield (University of Leeds, UK),
SPARC Halogen Chemistry Modelling/Analysis Focus Group

Until recently, the chemical processes responsible for the formation of the "Ozone Hole" in the spring polar stratosphere seemed to have been reasonably well understood: The chlorine reservoir species HCl and $ClONO_2$ are activated on the surfaces of polar stratospheric clouds, and the activated species - mainly ClO and its dimer ClOOCl - participate in the ClO-dimer and ClO-BrO catalytic cycles that rapidly destroy ozone at cold temperatures and high solar zenith angles. In 2007, a publication by Pope et al. suggested that the photolysis of ClOOCl - according to current belief the reaction that essentially governs the rate of catalytic ozone destruction - proceeds much slower than previously thought. The new result is clearly incompatible with atmospheric observations and implies that the known chemistry could no longer explain the formation of the ozone hole. Obviously this may have severe implications for our ability to predict future polar ozone depletion - in particular with stratospheric conditions expected to be altered by climate change.

A SPARC initiative "The Role of Halogen Chemistry in Polar Ozone Depletion" has been set up to deal with this issue on a broad scale, with one focus on modelling of polar halogen chemistry and associated ozone loss. This presentation will summarise the results presented and discussed at a workshop held in June 2008 in Cambridge. An overview will be given on the recent modelling and analysis work that has been carried out to test the implications of the Pope et al. data. Results from chemical box models, using different assumptions for key rate data, will be compared with observations of halogen species in the polar lower stratosphere. The kinetic data which best fits the observations will be discussed. Then, results from 3D and other models will be used to test the implications of the different photochemical data, including the Pope et al. cross sections, for our understanding of polar ozone loss. Possible explanations for the apparent incompatibility of the Pope et al. data and observations will be summarised.

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Zonal Asymmetries in the Dynamic Fields and the Tracer Distributions in the Equatorial Mid-Stratosphere

Presenter: Hyesun Choi (kenvie95@snu.ac.kr)

H. Choi, W. Choi (Seoul National University, Korea)

Zonal asymmetries in geopotential height, zonal wind, and the conservative tracers in the mid-stratospheric equatorial region are investigated during the Northern hemisphere winter (January-March) based on the ECMWF ERA-40 reanalysis and Halogen Occultation Experiment data. The zonal asymmetries in those fields on the 10 hPa level were shown to be dependent on the phase of the QBO and the latitude. At the equator geopotential height is almost zonally symmetric during the both westerly and easterly phases. At 10ºN, however, geopotential height shows a significant zonal asymmetry during westerlies and a symmetric pattern during easterlies. Zonal asymmetries in geopotential height at 10ºS, where easterlies are always observed during the analysis period, are small. Contrary to the geopotential height field the zonal asymmetry in the field of zonal winds at the equator is large in the westerly phase and small in the easterly phase. At the 10ºN the zonal asymmetry is also dependent on the phase of the zonal wind. Zonal asymmetry appeared in the dynamic fields were compared with those of the zonal distributions of methane and hydrogen fluoride. The zonal asymmetries observed in methane and hydrogen fluoride at 10 hPa and 10ºN were large only during the westerly phase. At the equator, however, zonal asymmetries were small regardless of the direction of the zonal wind, which is similar to the geopotential height. Possible mechanisms for influence of the QBO on the geopotential height, zonal wind, and the zonal distribution of tracers are suggested, and the dynamic features at the equatorial mid-stratospheric region are discussed.

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Factors to Determine Wave-Propagation Direction of Convective Gravity Waves: Application to a GWD Parameterization

Presenter: Hyun-Joo Choi (chjoo@yonsei.ac.kr)

H.-J. Choi, H.-Y. Chun (Yonsei University, Seoul, South Korea)

Recently, a new parameterization of gravity wave drag induced by cumulus convection is developed based on the ray theory by Song and Chun (LSGWDC), and its impacts in the middle atmosphere climate models such as NCAR WACCM and NASA GEOS5 have been investigated. Among various parameters included in LSGWDC, wave-propagation direction is found to be one of the most important factors to determine the location and magnitude of gravity wave drag. In the present study, we investigate the factors that determine the wave-propagation direction (WPD) of convective gravity waves, which is chosen arbitrary in the current GWD parameterizations. For this, an ensemble 3-D numerical simulation of the gravity waves generated by convective clouds is conducted in various basic-state conditions. The new WPD scheme depending on this basic-state condition and convective forcing is implemented into LSGWDC and gravity wave temperature calculated by off-line LSGWDC using reanalysis data is compared with satellite observations. In addition, a climate simulation of WACCM by including LSGWDC with the new WPD scheme is conducted. Impact of WPD in LSGWDC and large-scale circulations will be discussed in the meeting.

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The Contribution from the Stratosphere to the Skill of a Dynamical Seasonal Prediction System

Presenter: Bo Christiansen (boc@dmi.dk)

B. Christiansen (Danish Meteorological Institute, Copenhagen, Denmark)

It is well known that at mid-latitudes, during winter months, statistically significant correlations can be found between the stratospheric circulation and surface weather parameters when the stratosphere leads with 5-60 days.

In this study we analyze to which extent this stratosphere-troposphere coupling is already represented in ECMWFs new dynamical seasonal prediction model (system 3). With this system, re-forecasts are available for 25 years starting in 1980. We investigate the connection between the stratospheric vortex and both the large scale surface circulation (AO, NAO indices) and local surface parameters such as temperature and wind. The results are compared to a simple linear statistical forecast model.

As previously shown, the skill of the simple statistical model utilizing the stratospheric information compares well to the dynamical prediction system on lead times larger than 10 days when the surface circulation is considered. When stratospheric circulation is considered the dynamical prediction system has more skill than the statistical model for all timescale.

We show that the dynamical prediction system does include the coupling between the stratosphere and the troposphere. However, this coupling is too strong compared to observations. This overestimation may be connected to a comparable overestimation of the decorrelation time in the dynamical model.

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Ozone climatology in the southern subtropics

Presenter: Gaëlle Clain (gaelle.clain@univ-reunion.fr)

G. Clain, J.L. Baray, R. Delmas (LACy, Université de la Réunion, France),
R. Diab (University of KwaZulu-Natal, Durban, South Africa),
J. Leclair de Bellevue (Service d'Aéronomie, Univ. Pierre et Marie Curie, France),
F. Posny (LACy, Université de la Réunion, France), and
J.P. Cammas (Laboratoire d'Aérologie, France)

Ozone measurements are performed at Reunion island (Southern Subtropics in the Indian Ocean since respectively 1992. Two major source for tropospheric ozone have been identified, stratosphere-to-troposphere exchange induced by the subtropical jet stream and/or tropical convection, and influence of biomass burning (Baray et al., 2003; Randriambelo et al., 2003). The tropospheric ozone climatology is based on a multi-instrumental dataset : PTU-O3 radiosoundings, DIAL LIDAR, and Dasibi UV ground based measurements. The climatology of ozone over Reunion island South Africa are compared using MOZAIC airborne instrumentation and PTU- O_3 radiosoundings over Irene. A one year campaign of ground based Dasibi UV ozone measurement, in association to the radiosoundings, is used for the lower tropospheric study. The seasonal cycle is comparable for the two datasets, with Dasibi UV values displaying slightly higher values. The results show that average ground level concentrations measured on the summits of the island is representative of the lower free troposphere ozone concentration at the same altitude (~ 2000 m) whereas night-time data would be representative of tropospheric concentration at a higher altitude (~ 3000 m) due to the subsidence effect. In the future, it will be possible to perform other ground level measurement campaigns at the observatory that will be built in 2010 on the top of the Maôdo Peak in the north-west of the island at 2200 m altitude. This observatory will be devoted to long term atmospheric composition measurements in the framework of monitoring networks such as GAW (Global Atmospheric Watch) and NDACC (Network for Atmospheric Composition Changes).

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On associations between the QBO, the 11-year solar cycle and the Indian Summer Monsoon

Presenter: Chantal Claud (chclaud@lmd.polytechnique.fr)

C. Claud, Bernard Duchiron (LMD/IPSL, Ecole Polytechnique, Palaiseau, France), P. Terray (LOCEAN/IPSL, Paris, France)

The associations between the Indian Summer Monsoon (ISM) and the stratospheric Quasi-Biennial Oscillation (QBO) on one side and the 11-year solar cycle on the other side have been investigated by a statistical analysis of surface and atmospheric fields provided by the NCEP2 and CMAP (Climate Prediction Center Merged Analysis Precipitation) reanalyses.

Zonal winds at 15hPa during the preceding winter (January-February) are the best stratospheric predictor of the summer rainfall over the Indian subcontinent as a whole. This relationship mainly holds for August and September, or the late ISM. Westerly QBO years are associated with a weaker monsoon surface circulation with, in particular, a weakening of the Somali Jet at the beginning of the monsoon, but a much stronger circulation in September. At that time, the Tibetan High is reinforced, the tropical easterly jet at 200 hPa is stronger over India and the local reversed Hadley circulation is also strengthened north of the equator. Our results provide support for an out of phase behavior of convective activity between the Indian sub-continent and the equatorial Indian Ocean induced by the QBO phase, especially during the late ISM. Associated with a westerly QBO phase, convective activity is, in September, enhanced over India, which brings higher precipitation, compared to the east phase. This work also suggests that the winter QBO at 15 hPa could have some skill in foreshadowing the subsequent late monsoon.

Concerning the 11yr-solar cycle, the most striking features appear in August and to some extent in July, where for higher solar activity, precipitation is reduced over the equatorial Indian Ocean and increased over the western Pacific Ocean and to a lesser extent over part of the Indian subcontinent. In terms of mechanisms, it is suggested that these associations result from a combination of effects: on one side, an effect which maximizes in July-August with warmer temperatures in the lower stratosphere for maximum solar activity, and is consistent with a reduction of the convective activity in the equatorial region and an enhancement in off-equatorial regions; on the other side, a modulation of the mean sea level pressure fields, with a more southerly position of the monsoon trough in June, and a northwestward shift of the Mascarene High in July-August consistent with a stronger monsoon circulation. High solar activity could also cool the February-March SST in the southern Indian Ocean, which weakens the subsequent monsoon. Observations over the period 1871-2001 confirm these associations. As a result of the reported mechanisms, the 11-year solar cycle has only poor skill for foreshadowing the ISM as a whole.

ID: 00406 ◀back

Intercomparison of integrated water vapour measurements from radiosonde, sunphotometer, FTIR, and GPS instruments

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Being the number one greenhouse gas, water vapour has attracted the attention of atmospheric scientists for many years. Not only does it affect the energy budget, but it also plays a key role in many atmospheric processes such as the development of atmospheric convection and cloud cover. Recent reports indicate that the stratospheric water vapour as well as the tropospheric specific humidity has increased over the past decades (IPCC 2007).

To obtain a better monitoring and understanding of the changing water vapour content in the atmosphere several experimental techniques have been developed measuring the integrated water vapour (IWV), all exhibiting their specific methodology and processing. One of the main issues is the assessment of the èquality' of the different measurements, e.g., the precision, accuracy, and performance.

We report on a(n inter)comparison of the IWV data from radiosondes and from three remote-sensing techniques, being a sunphotometer employed in the Aerosol Robotic Network (AERONET), a GPS system, and a ground-based Fourier Transform Infrared (FTIR) spectrometer. One of the main aims of this study is to characterize and improve the quality of the IWV measurements.

We dispose of IWV data sets from these four instruments taken simultaneously at Uccle (Belgium, 50º48'N, 4º21'E, 100 m asl) during the June 2006 - July 2007 period. The results indicate that the FTIR instrument exhibits the largest dry bias and hence seems to give rise to a systematic underestimation of the IWVs. Also the radiosondes show a tendency to underestimate the IWV when compared against the sunphotometer and GPS observations. A very small bias was observed between the sunphotometer and the GPS IWV observations. In all comparisons with GPS IWV measurements, it turns out that, for large IWV values, the GPS observations are in general stronger than the simultaneous IWV data retrieved from other instruments, leading to a slope in the range 0.8-0.9 for the regression when comparing the data from these other instruments with the GPS IWVs. Additionally, comparing the GPS and sunphotometer IWVs, two important remarks should be made. First a seasonal variation of their relative difference was observed, opposite to the annual variation of the IWV. Secondly, a large relative difference (>40 %) was observed in the first part of September 2006. The observations will be presented and compared with previous reports. Explanations for observed trends and possible improvements of the retrieval methods will be discussed.

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The response of tropospheric climate to weak perturbations, including stratospheric perturbations

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Calculation of the response of the tropospheric circulation to a perturbation in the stratosphere can be seen as part of the more general problem of the response of the tropospheric circulation to any perturbation. If the perturbation is weak then there is a linear operator which predicts the response. The properties of this operator control, for example, the typical spatial structure of the response and its dependence on the location and type of perturbation.

One approach to determining the operator is to carry out several perturbation experiments. Another is to exploit the fluctuation-dissipation theorem (FDT) which provides a method of calculating the response to forcing of a system by simply observing its variability. Here we apply the FDT to a simplified GCM in a similar manner to Gritsun and Branstator (2007). We compare the FDT calculated response to forcing and the response calculated from perturbation experiments with the GCM's actual response. Paying attention to statistical accuracy, we compare the various approaches with the goal of performing the calculation with the minimum computational effort.

ID: 00332

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Large scale circulation regimes: troposphere-stratosphere connections

Presenter: Susanna Corti (s.corti@isac.cnr.it)

S. Corti (Istituto di Scienze dell'Atmosfera e del Clima - Consiglio Nazionale delle Ricerche, Italy)

We investigate the large-scale circulation regimes over the North Hemisphere extratropical region as seen as large ensembles in historical coupled seasonal forecasts made with the latest seasonal prediction model of the European Centre for Medium-Range Weather Forecasts (System 3). We identify the regimes as a function of time of year, assess their realism, and their dependence on global SST patterns. The link between tropospheric and stratospheric circulation is then investigated. The model results are compared with the observed dataset (ERA40 reanalyses) and the degree of predictability of the large scale atmospheric circulation is evaluated.

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The 360 K potential temperature surface: a new diagnostic for stratospheric prediction

Presenter: Lawrence Coy (coy@nrl.navy.mil)

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Tropospheric weather systems that are associated with extremely cold temperatures near 100 hPa can have dramatic effects on the stratosphere, especially when the cold temperatures occur below the stratospheric vortex edge. These events are associated with a large vertical flux of planetary wave activity (EP flux) that can lead to planetary wave breaking and stratospheric sudden warmings (SSW). They are often associated with low ozone, mini-hole, events. Here we use GEOS (Goddard Earth Observing System), NOGAPS-ALPHA (Navy Operational Global Atmospheric Prediction System- Advanced Level Physics High Altitude), and Met. Office analyses along with forecasted meteorological fields to examine several cold upper tropospheric temperature events and the subsequent changes forced in the stratosphere. Results show that upper tropospheric disturbances over the North Atlantic in January 2003 and January 2004 were both followed by stratospheric wave breaking in the tropics, advection of low potential vorticity (pv), tropical air over the pole, and major SSWs. A strong cold upper troposphere temperature region over the South Atlantic, associated with a large vertical EP flux also occurred prior to the major SSW in September 2002. It was found that these cold upper tropospheric temperatures are best identified by examining the heights of the 360 K potential temperature surface, which are greatly elevated in response to the cold temperatures. While typically ranging from 10-13 km, in extreme events these 360 K heights can rapidly exceed 15 km, acting as transient "moving mountains" that dynamically force the stratosphere at the lower boundary.

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The Influences of the Great Volcanic Eruptions and the Variations of Sea Surface Temperature on the Northern Stratospheric Polar Vortex

Presenter: Xuefeng Cui (x.cui@liv.ac.uk)

X. Cui (University of Liverpool, UK), Q. Li (University of Edinburgh, UK)

Three major volcanic eruptions happened in last century as Gunung Agung in March 1963, El Chichon in May 1982 and Mt. Pinatubo in June 1991. This study investigates the influences of such great volcanic eruptions on the stratospheric polar vortex in the Northern Hemisphere used the ECMWF ERA40. We found stronger stratospheric polar vortex and weaker tropospheric jet than normal in the two winters after these volcanic eruptions. Our previous study showed that the stronger polar vortex appears when less planetary wave propagates from the troposphere to the stratosphere. We also notice a more complicated feature of the stationary planetary wave propagation in the winters which volcanic erupted than general winter. More planetary waves propagate from the troposphere to the stratosphere in the mid-latitudes. However, the signals possibly involve the influence of sea surface temperature variations, for example the El Niño events during the winters after eruption, which can lead to a weaker stratospheric polar vortex (Manzini et al, 2006). To further identify the influence of volcanic eruption on planetary wave propagation, comparisons with that of other El Niño years are also conducted in this study.

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Lagrangian Transport in the CCM E39C: Benefits for Stratospheric Dynamics and Chemistry

Presenter: Martin Dameris (martin.dameris@dlr.de)

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Coupled chemistry-climate models (CCMs) are a common tool for studying the past and assessing the future evolution of stratospheric dynamics and chemistry. An ensemble of long-term transient simulations (1960-2020) with the CCM E39C has been analysed and evaluated in a number of scientific investigations (e.g. Dameris et al., 2005, 2006; Eyring et al., 2006). It turned out that E39C is able to reproduce important features of the stratosphere, but also some obvious deficiencies have been identified which must be eliminated before providing adequate estimates of future changes.

In an updated version of E39C, i.e. E39C-A, a variety of model developments have been implemented. The most important advancement concerns the change of the advection scheme from a semi-Lagrangian approach by Rasch and Williamson (1994) to the full Lagrangian transport scheme ATTILA (Reithmeier and Sausen, 2002). Since ATTILA is a numerically non-diffusive scheme, it is able to maintain steeper and therefore more realistic gradients than the semi-Lagrangian scheme.

Results of a new transient model simulation (period from 1960 to 2004) with E39C-A show, that several model deficiencies are eliminated and that the updated model is clearly superior to the CCM E39C. Specific improvements are discussed in detail: The Lagrangian transport scheme leads to a significant advancement of the simulated water vapour distribution which in turn results in a significant reduction of the cold bias in the extra-tropical lowermost stratosphere. Stratospheric wind variations are now in better agreement with observations, e.g. E39C-A is able to reproduce the stratospheric wind reversal in the Southern Hemisphere in summer which was not captured by E39C. Furthermore, simulated tracer distributions in the stratosphere are very much improved. For example, the vertical distribution of stratospheric chlorine (Cly) is now in agreement with analyses derived from observations and other CCMs which leads to a better assessment of ozone destruction rates. Consequently, the simulated temporal evolution of stratospheric Cly in the past is realistically reproduced which is an important step towards more reliable projections of future changes, especially of stratospheric ozone.

ID: 00007 ◀back

Characteristics of Kelvin-Helmholtz instability observed using UHF/VHF radars

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Kelvin-Helmholtz instability (KHI) is a form of dynamic instability produced within a hydrostatically stable flow in the presence of sufficiently strong vertical wind shear and is probably responsible for most occurrence of clear air turbulence (CAT). High resolution measurements of UHF and VHF radars located at Gadanki (13.5ºN, 79.2ºE) along with simultaneous balloon borne measurements are used to characterize the occurrence of KHI from boundary layer to lower stratosphere. UHF radar observations shows the occurrence of KHI in the atmospheric boundary layer (< 4 km) and VHF radar shows few cases of KHI at middle troposphere, vicinity of tropopause and in the lower stratosphere. Study of KHI are also carried out during the passage of tropical cyclone and convection. In the present study, KHIs are categorized in term of shear thickness, which is observed from 500-1000 m. All the cases show the existence of hydrostatically stable layer in proximity to the layer of strong stratified wind shear, i.e., enhancement of the stability parameter (N^2) in the vicinity of strong winds shear zone (S_2) with Richardson number (Ri) <0.25. The enhanced fluctuation in the vertical velocity with the reversal before and after the occurrence of KHI, enhancement of spectral width and successive power bursts pattern in the radar received vertical beam echoes are also observed during the occurrence of KHI. One of the important finding is that the characteristics of KHI for different height levels in the troposphere associated with different weather conditions are similar with a period of 11-18 min. This study reveals that the characteristics of KHI are independent of altitude and in different weather conditions. The observations also emphasized the importance of thickness of shear layer in the formation of KHI billows. The KHI observed at upper troposphere and lower stratosphere (UTLS) contributes to Stratosphere-Troposphere exchange (STE) processes. The detailed results will be discussed in the upcoming symposium.

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Polar Stratospheric Clouds formation and evolution in Antarctica by applying the 'MATCH' method to Lidar investigations within the International Polar Year

Presenter: Christine David (christine.david@aero.jussieu.fr)

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The International Polar Year (IPY) objectives are to seek major advances in knowledge and understanding and to obtain a snapshot of the current state of the Polar Regions. IPY focus on latitudes between 60 and 90º (both hemispheres) and any relevant region. The timeframe is set from 1st March 2007 to 1st March 2009. The project 'Ozone layer and UV RAdiation in a changing CLimate Evaluated during IPY' (ORACLE-O3) is one of the coordinated international proposals selected for the IPY.

One part of this global project is called 'Lagrangian Observations with Lidar Investigations and Trajectories in Antarctica and Arctic, of PSC (LOLITA-PSC) and is devoted to Polar Stratospheric Clouds (PSC) studies. Understanding the formation and evolution of PSC particles is an important issue to quantify the impact of climate changes on their frequency of formation and, further, on chlorine activation and subsequent ozone depletion. For the first time, the 'MATCH' method is applied to lidar observations of PSC. This lead to combine ground-based and space-borne lidar observations, with Lagrangian trajectory forecasts, in order to infer information on formation processes of each PSC type and assess our ability to predict PSCs for various environmental conditions. The campaigns take place in Antarctica during winters 2007 and 2008 and a pre-campaign was preformed in 2006 to test the methodology. At the final stage, microphysical model calculations will be performed for analysing the data and testing PSC formation scenarii along the trajectories. Correlations between evolutions of the air masses thermodynamical conditions and the type of PSC formed should arise.

Here we present the first results obtained for the 2006 pre-campaign. Lidar ground-based measurements are obtained for the three PSC lidar implemented in Antarctica, in the Dumont d'Urville (66.67ºS, 140.01ºE), Davis (68.00ºS, 78.50ºE) and McMurdo (77.86ºS, 166.48ºE). They are compared with CALIPSO space-borne lidar observations over Antarctica. All measurements are coupled using lagrangian trajectories calculations.

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A gravity wave analysis in Mendoza (Argentina), as detected from GPS radio occultation data and mesoscale numerical simulation

Presenter: Alejandro de la Torre (delatorr@df.uba.ar)

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Global maps of potential wave energy per unit mass, recently performed with the GPS (Global Positioning System) Radio Occultation (RO)technique and different satellite missions (CHAMP since 2001, GRACE since 2006 and COSMIC since 2006) revealed in Argentina, at the eastern side of the highest Andes Mountains, a considerable wave activity in comparison with other extra-tropical regions. The main gravity wave sources in this natural laboratory are deep convection (mainly during late Spring and Summer), topographic forcing (during stable conditions) and geostrophic adjustment (expected but not clearly identified up to now during highly variable tropospheric jet conditions). The mesoscale numerical model WRF (Weather Research and Forecasting model) was used to simulate the atmospheric parameters during representative RO events showing an apparent intense WA in this region. The significance of the relative position of the RO lines of sight, line of tangent points and gravity wave phase surfaces during each event is discussed in relation with the apparent wave activity detected. We also discuss the relative contribution of high and medium intrinsic frequency mountain waves regularly observed, coexisting with inertio gravity waves, their origin and propagation characteristics. Random and systematic errors associated to the RO technique are estimated.

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Seasonal analysis of gravity waves over the southern Andes and the Antarctic Peninsula by means of GPS radio occultations

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The Global Positioning System (GPS) Radio Occultation (RO) technique has global coverage and is capable of generating high vertical resolution temperature profiles of the troposphere and lower stratosphere with sub-Kelvin accuracy and long-term stability, regardless of weather conditions. Fluctuations in these profiles give information about gravity wave potential energy per unit mass (Ep).

This study employed 6261 temperature profiles obtained by the CHAMP (CHAllenging Minisatellite Payload) and SAC-C (SatÉlite de Aplicaciones CientÌficas-C) missions over the years 2002-2005. An analysis of monthly averages of Ep showed enhancements during September and October in the wave activity over the whole area.

Some of the most energetic RO events were detected over zones where the topography is expected to play an important role, however intense RO events were also found over the ocean too.

According to the morphology of the mountains in the studied region, near-meridional alignment of the line of sight (LOS), would improve the detection of mountain waves. Nevertheless, no predominant orientation for the LOS was found for RO with high Ep values.

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Stratospheric water vapour profiles over Seoul, S-Korea

Presenter: Evelyn De Wachter (dewachte@iap.unibe.ch)

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The observational record of stratospheric water vapour (H_2O), as provided by ground-based instruments, balloon measurements and satellites, is sparse. Stratospheric H_2O plays an active role chemically and radiatively and its influence on stratospheric ozone, surface climate and climate feedbacks is of undeniable importance. H_2O provides the main source of the hydroxyl (OH) radical, which plays a role in ozone depletion, and is used as a tracer for dynamical processes. H_2O also contributes to radiative cooling by infrared emission in the stratosphere.

SWARA, the Stratospheric WAter vapour RAdiometer, is a microwave radiometer designed to measure H_2O profiles in the middle atmosphere (from about 25 to 80 km), covering the stratosphere and mesosphere. The instrument has been operational in Seoul (37.32 N, 126.57 E) since middle October 2006.

Ground-based radiometers provide long-term stability and high time resolution, so are in this sense ideal for short time-scale variability studies, monitoring long-term trends and validation of satellites. We would like to present here a first almost 2 year time-set of stratospheric water vapour profiles over Seoul, thereby providing a first ground-based stratospheric H_2O data set over the Asiatic region.

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Higher Tropical SSTs Strengthen the Tropical Upwelling via Deep Convection

Presenter: Rudolf Deckert (rudolf.deckert@dlr.de)

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Recent observations show a distinct cooling of the tropical lower stratosphere, and chemistry-climate models (CCMs) suggest a spatial coincidence of the cooling with a stronger upward advection of ozone-poor tropospheric air. This advection increase appears to result from a currently unexplained strengthening of the planetary-wave driven mean meridional transport, arguably relating to increases in greenhouse gas concentrations from anthropogenic activity.

The present study explores the strengthening by comparing realisations of two different scenarios with the CCM E39/C. Both share the same boundary conditions including concentrations of ozone-depleting substances, but differ in their climate forcing via sea surface temperatures (SSTs) and well-mixed greenhouse gas concentrations.

In the summer hemisphere tropics, higher SSTs for the warmer scenario amplify deep convection and hence the convective excitation of internal planetary waves. These waves travel upward through the tropical easterly winds while dissipating, but still carry enough of the signal into the lower stratosphere to intensify the mean meridional transport. The transport change in turn strengthens the input rate into the tropical lower stratosphere of ozone-poor tropospheric air, ultimately weakening lower-stratospheric ozone concentrations via higher tropical SSTs.

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Effects of the eruption of Mount Pinatubo on the quasi-biennial oscillation as revealed with MRI chemistry-climate model

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The equatorial quasi-biennial oscillation (QBO) is characterized by interesting irregularities in its period of oscillation. One possible perturbation that causes such irregularities is a large increase in aerosol abundance following a large volcanic eruption. The influence of the eruption of Mount Pinatubo on the QBO is investigated by using a coupled chemistry-climate model of Meteorological Research Institute (MRI CCM) that reproduces internally generated QBO and incorporates full interactions between radiation, dynamics and chemistry in the middle atmosphere. The simulated ensemble run shows that after the Pinatubo eruption the modeled downward propagation of the phase of the QBO is slower and frequently suspended in the easterly shear zone with the elongation of the period of its oscillation by several ~10 months.

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An Overview of Tropical Aerosol and Cloud Studies in the UTLS over India: Present Activities and Future Perspectives

Presenter: Panuganti Devara (devara@tropmet.res.in)

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Atmospheric aerosols and high-altitude cirrus clouds, particularly around tropopause, play an important role in atmospheric dynamics in the upper troposphere and lower stratosphere (UTLS) region (Liou, 1986; Haywood and Ramaswamy, 1998; Peter et al., 2003). The properties of tropospheric aerosols are more variable in both spatially and temporally because of short residence time and wide distribution of sources, and hence they produce regional and seasonal effects, while the stratospheric aerosols, due to their long residence time, they produce long-term global effects (Ramachandran and Jayaraman, 2003; Ramanathan et al., 2005; Rosenfeld, 2006). They also effect stratospheric chemistry and thus influence the Earth's climate system (Shepherd, 2007). The first part of this communication deals with an overview of the properties of aerosols and clouds along with mass-exchange processes in the vicinity of tropopause that have been studied using vertical wind-influenced aerosols as tracers measured by the polarization lidar and MST radar systems and column integrated features using solar radiometers over a tropical station, Gadanki (13.5ºN, 79.2ºE, 340 m AMSL), India. The second part highlights the future plans that have been in progress in India towards better understanding of the impacts of gases, aerosols and clouds on space weather and monsoon. Vertical profiles of aerosols reveal layer formations just above the cold point tropopause (CPT) indicating trapping of aerosols around that altitude. The results also show significantly large mass-flux (polarity indicates cloud growth or dissipation) during the presence of cirrus clouds and smaller values during clear-sky days. The lidar depolarization ratio (LDR) is found to be an useful parameter for understanding spatio-temporal distribution of mass flux throughout the cloud region and for characterizing cirrus clouds in terms of their phase (Devara et al., 2004).

Recently, there have been many plans (Devara, 2007) to strengthen research activities relating to aerosols and clouds, especially their interactions in the UTLS and their impact on Asian monsoon in general and Indian monsoon system in particular. They mainly include (i) Megha Tropiques (MT), an unique satellite that allows study of water cycle and energy exchanges through three sensors operating in optical (Scarab), thermal (Madras) and microwave (Saphir) regions for characterizing land-atmosphere-ocean parameters and Earth's radiation budget, (ii) Small Satellites for Atmospheric and Space Sciences (SSASS), emphasizing vertical coupling between lower and upper atmosphere and solar-terrestrial interactive processes, (iii) The Indian SaTellite for Aerosols and Gases (I-STAG), focusing on changes in aerosols and trace gases in south and south-east Asian region and climate, and estimate their impact on atmospheric radiation budget, chemistry and climate, (iv) Space Borne Lidar (SBL) and Indian LIdar NetworK (I-LINK), purporting physico-chemical, dynamical and radiative coupling between mesosphere-stratosphere-troposphere. In addition to

the above National and also Bi-lateral Programs being executed by different Indian Institutions, some cutting-edge research facilities have been operating by some premier research organizations, for example, the Dual Polarization Micro Pulse Lidar (DPMPL) at the IITM, Pune, India for investigating the inter-play between aerosols (including shape) and clouds (including phase) and environment, and its impacts on weather and climate (Devara et al., 2008).

References

Devara, P.C.S., and Co-authors (2004): Polarization lidar probing of clear and cloudy atmosphere over Gadanki, A remote continental station in India. Proc. 14th International Conference on Clouds and Precipitation (ICCP), Bologna, Italy, 18-23, July 2004, pp. 1066-1069.

Devara, P.C.S. (2007): Role of INTAR in understanding coupled process: Some research gap areas. Proc. INTAR Colloquium-International Network of Atmosphere Radar (Eds. V.K. Anandan, J. Rottger and D.N. Rao), NARL, 20-22 January 2005, pp. 132-138.

Devara, P.C.S., and Co-authors (2008): Mobile lidar profiling of tropospheric aerosols and clouds. J. Atmos. Ocean. Tech. (in press).

Haywood, J. M. and V. Ramaswamy (1998): Global sensitivity studies of the direct radiative forcing due to anthropogenic sulfate and carbon aerosols. J. Geophys. Res., 103, 6043-6058.

Liou, K.N. (1986): Influence of cirrus clouds on the weather and climate processes. Mon. Wea. Rev., 114, 1167-1199.

Peter, T., and Co-authors (2003): Ultrathin tropical tropopause clouds (UTTCs): I. Cloud morphology and occurrence. Atmos. Chem. Phys., 3, 1083-1091.

Ramachandran, S. and A. Jayaraman (2003): Balloon-borne study of the upper tropospheric and stratospheric aerosols over a tropical station in India. Tellus, 55B, 820-836.

Ramanathan, V., and Co-authors (2005): Cloud radiative forcing and climate: Results from earth radiation budget experiment. Science, 243, 57-63.

Rosenfeld, D. (2006): Aerosols, clouds and climate. Science, 312, 1323-1324.

Shepherd, T.G. (2007): Transport in the middle atmosphere. J. Meteorol. Soc. Japan, 85B, 165-191.

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Variations in SCIAMACHY and SABER ozone data on small time scales induced by solar radiation variations

Presenter: Sebastian Dikty (dikty@iup.physik. uni-bremen.de)

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The thermal structure, dynamics, and chemistry of the Earth's middle atmosphere is dominantly influenced by altering solar radiation levels. Most studies of the solar influence concentrate on the 11-year solar cycle but satellite observations so far cover only three complete solar cycles. The 27-day solar rotational cycle helps to understand changes in the composition of middle atmospheric compounds. Modifying stratospheric and mesospheric ozone and other trace gases formed by photolysis is due to the direct radiation effect and a dynamical response of solar variability (indirect effect). In particular, the UV radiation response to ozone above 60 km is not well established.

We perform a Fourier analysis to time series of height resolved SABER (25 -105 km altitude) and SCIAMACHY (35-65 km) limb ozone to detect a solar signal from the 27-day solar rotation period from which the magnitude of ozone sensitivity to UV radiation is estimated. As a proxy for UV irradiance variability we use the SCIAMACHY Mg II index. SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography) aboard ENVISAT and SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) aboard the TIMED satellite, have been launched in 2002 and 2001, respectively.

Besides the 27-day solar signal it is also possible to detect a diurnal solar signal in the SABER ozone data. Because of its non-sunsynchronous orbit the equator crossing time of the TIMED satellite changes each day and with it the local times of satellite measurements at any given latitude. After about 60 days the satellite performs a yaw manoeuvre and reverses its viewing angle. Within that period SABER is able to cover almost all local times. The solar zenith angle (SZA) dependence of mesospheric ozone is by a factor of up to 50 larger than on a 27-day scale. Within the stratosphere the diurnal signal is weaker than in the mesosphere.

Diurnal and 27-day solar variations and their impact on ozone are also studied with a simple 2D global-chemistry-model (GCM) and compared with satellite observations. The results from this study will be discussed with respect to findings from earlier studies.

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Current Perspectives on Deep Convection, Upper Troposphere, and Lower Stratosphere from General Circulation Models and Cloud-System-Resolving Models

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Understanding the tropical tropopause layer and lower stratosphere is key to developing a capability for comprehensive, coupled modeling of the troposphere and stratosphere. Possible links between multi-year variability in the troposphere and stratosphere and observed secular trends in stratospheric water vapor are both problems of central scientific importance, relevant to global change and decadal prediction. Coupled troposphere-stratosphere modeling is essential to progress on both.

Advective and convective processes are both likely to be important in the tropical troposphere layer and lower stratosphere, and ice microphysics has been speculated upon as critical, as well. Although cloud-system resolving models and general circulation models include this region, most insights to date have resulted from more conceptual models and analysis of observations. Successful comprehensive modeling of the tropical tropopause layer will require more attention to the details of convection, microphysics, and advection (algorithms and resolution) in general circulation models. There are opportunities for using cloud-system-resolving models to approach this problem, but treatment of microphysics, upper-tropospheric forcing, and upper-tropospheric resolution must be refined to do so.

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Comparisons Of Aura Observations In The Upper Troposphere/Lower Stratosphere With Simulated Constituent Fields

Presenter: Anne Douglass (Anne.R.Douglass@nasa.gov)

A. Douglass, R.S. Stolarski and S.E. Strahan (NASA GSFC, USA)

The Global Modeling Initiative Chemistry and Transport Model (GMI-CTM) has been used to produce simulations of ozone and related constituents in the troposphere and stratosphere. Meteorological fields from the Goddard Earth Observing System Data Assimilation System (GEOS-DAS) and from the GEOS general circulation model (GEOS-GCM) are used in GMI-CTM. These off-line simulations are several years duration, and the direct comparisons with observations for simulations using DAS fields combined with the statistical comparisons for CTM simulations using GCM fields are an important bridge to evaluation of the coupled chemistry climate models. The GEOS-CCM uses the same stratosphere/troposphere chemical mechanism that is used in the GMI-CTM. We focus on comparisons of simulated fields with ozone observations from instruments on NASA's Aura that provide new information about the troposphere and the lower stratosphere. We make use of the following Aura fields: ozone profiles from the High Resolution Dynamic Limb Sounder; ozone profiles from the Tropospheric Emission Spectrometer (TES), and the tropospheric ozone column that is calculated by subtracting the stratospheric column determined by Microwave Limb Sounder (MLS) from the total ozone column observed by the Ozone Monitoring Instrument (OMI). The comparisons of GMI-CTM fields with observations are used to develop appropriate comparisons with fields from GEOS-CCM.

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VHF radar Observations of gravity waves generated by convective storms

Presenter: Gopa Dutta (gopadutta@yahoo.com)

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Vertically propagating gravity waves are known to play significant role in transporting energy and momentum from the lower atmosphere to middle and upper atmosphere. Both theoretical and observational studies have suggested convection to be the most important source of gravity waves in the tropics. Deep cumulus convection during summer season is supposed to generate a spectrum of gravity waves. MST radar at Gadanki (13.5ºN, 79.2ºE) was operated for a few hours during two convective events on 16th May and 5th June 2006. Strong vertical wind disturbances with rising volume reflectivity and weakening of tropopause could be observed. The high resolution (3.5 minutes and 150 m) radial wind data have been used to study short period (< 2 hr) gravity wave spectra. Waves with dominant periods between (10-20) min, (25-30) min, (55-90) min and in the vertical wavelength range (6-9) km are found to get enhanced during the events. Gravity wave propagation could be seen in the wind data after the events in upper troposphere and lower stratosphere region. Vertical wave number spectra of horizontal radial velocities show steeper slopes (~ -3.2 to -3.4) during convection which slowly reduced to its normal value (~ -2.3). Some characteristics of gravity waves (e.g. phase and group velocities) have been delineated. The direction of propagation of the waves with respect to storm has also been estimated.

ID: 00221 ◀back

Tropical cirrus clouds variation during the southern stratospheric sudden warming in 2006 and 2007

Presenter: Nawo Eguchi (eguchi.nawo@nies.go.jp)

N. Eguchi (NIES, Tsukuba, Japan) and K. Kodera (Nagoya Univ., Nagoya, Japan)

Although cirrus clouds play an important role in climate variation, there is only limited information on cirrus clouds because the detection of the thin cirrus clouds is difficult. Using cloud data from MODerate resolution Imaging Spectroradiometer (MODIS), Eguchi and Kodera [GRL, 2007] found a variation of the tropical cirrus clouds caused by the southern hemisphere (SH) stratospheric sudden warming (SSW) event in September 2002. However, the MODIS data do not provide a vertical profile of the cloud which is important for understanding the involved processes. In the present study the impact of SSWs of 2006 and 2007 are investigated by making use of the Cloud Aerosol LIdar with Orthogonal Polarization (CALIOP) on board CALIPSO. We chose to study the SH SSW because the background cirrus cloud variation is less important in September-October than January-February due to higher temperature in the tropical tropopause layer (TTL).

The result of our analysis shows that the variation of the cirrus cloud top and the tropopause height (temperature) is positively (negatively) correlated during both SSW events of 2006 and 2007. Averaged tropopause height and cirrus cloud top in the tropics increased by a few km after the SSWs. Low temperature in the TTL due to the upwelling induced by the SSW led to an increased cirrus formation and a higher cirrus cloud top. The tropopause temperature was lower after the SSW than before with the maximum difference of 10 K.

There are, however, important differences between the two events. In the case of the SSW of October 2006, convectively active and frequent cirrus cloud formation regions are located in both north and south sides of the equator at the beginning and the during the SSW. After the SSW the convection became more active at the south side of equator, in particular, in the western Pacific, Africa and South America. These features are similar to those found during the 2002 SSW. It is noted that not only the frequency but also the top height of cirrus clouds in the tropics increased in the SH after the SSW.

In the case of the SSW in September 2007, the cirrus cloud frequency and the top height increased at the south side of equator. However, the convective activity was not increased in the SH tropics after the onset of SSW. Instead, convective clouds in the northern hemisphere inter tropical convergence zone (ITCZ) became active and the northerly wind across the equator became stronger in the upper troposphere. It is suggested that high frequency cirrus clouds in the tropical region after the SSW is caused by the moisture air from the convection and low temperature due to the Kelvin wave response to a deep convection in the northern tropical region triggered by the SSW. During August-September 2007, convective activity zone was anomalously shifted northward. The difference of the spatial structure of the response to the SSW between 2006 and 2007 events could be attributed to the difference of the distribution of the convective activity in the tropics.

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The water budget of the uppermost tropical troposphere

Presenter: Patrick Eriksson (Patrick.Eriksson@chalmers.se)

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Measurements of humidity and cloud ice mass in the upper parts of the tropical troposphere are associated with important uncertainties. This has the consequence that the exact nature of the processes responsible for the moistening of the upper tropical troposphere is still uncertain. For example, the significance of evaporation of cloud ice, transported up by deep convection, has been disputed. Some recent microwave instruments have the potential of providing improved global measurements of both water vapour and cloud ice mass, and a more detailed view of the water budget of the tropical tropopause layer (TTL) and the adjacent altitude ranges could be obtained.

A first algorithm to retrieve tropical UT water from Odin-SMR observations has been developed. The algorithm provides the relative humidity in two layers (12 and 15 km) and the integrated ice mass above about 12 km. Detailed comparisons have been performed for both data products. A comparison with Aura MLS and the older UARS MLS showed an agreement between local (all weather) mean values inside 15 %. The same good agreement was obtained for MIPAS IR retrievals as well, but only for cloud free regions. This indicates that the average tropical humidity in considered altitude range can now be measured from satellites with an accuracy of about 15 %.

Cloud ice mass retrievals are associated with much higher uncertainties. A comparison between CloudSat, Aura MLS and Odin-SMR cloud ice mass retrievals revealed altitude dependent differences of 60-300 %. On-going work for all three instruments should decrease the retrieval uncertainty considerably, but already this limited accuracy has been found sufficient for pointing out shortcomings in atmospheric models.

Based on the experience from these comparisons, altitude resolved measurements from Aura MLS and cloud ice from CloudSat have been used to investigate the ratio of ice mass to total water. Horizontal and vertical ice-fraction distributions in the altitude range 9.7-16.6 km over the tropical region have been derived. They reveal that the ice-fraction is normally less than 10 % around 10 km and outside regions of deep convection in the altitude levels above. On the other hand, the ice-fraction can be significant at higher altitudes in regions of deep convection, reaching values of around 80 %. Below the TTL, ice and water vapour distributions have similar spatial patterns indicating that water in both phases is transported up to the upper troposphere by the same processes. The ice fraction is locally high in the TTL, but the dissimilar patterns of ice and water vapour could be interpreted as that the cloud ice gives a limited final moistening effect.

More information on the diurnal variation of cloud ice mass is obtained by also considering the Odin-SMR retrievals. A pronounced cycle exists up to the TTL in the regions of substantial ice mass. The cycle is the strongest and has most homogeneous phase above the convectively active land areas. The maximum is in general found during afternoon and late night above land and ocean, respectively. A first comparison with some global atmospheric models shows a general tendency of the models to underestimate both mean values and amplitude of the diurnal cycle of the cloud ice mass at high altitudes.

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Gravity waves resolved in ECMWF and measured by current and future satellite instruments

Presenter: Manfred Ern (m.ern@fz-juelich.de)

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The limited resolution of most global circulation models (GCMs) is not sufficient to simulate gravity waves (GWs) explicitly. ECMWF (European Centre for Medium-Range Weather Forecasts) data now have a grid resolution of 1/4 degree, allowing part of the mesoscale GWs to be resolved but most source processes are still sub-grid phenomena. Therefore we validate the GW spectrum contained in ECMWF with a measured global data set. We simulate measurements of the infrared limb sounder SABER based on ECMWF temperature fields and compare them in a study with real atmospheric measurements of this instrument. For this comparison in both data sets the GW spectrum is separated from the background atmosphere and in the simulated data effects of the radiative transfer are taken into account.

Global variations of the GW distribution can be attributed to several GW sources and the modulation of the GW spectrum by the background winds. This study indicates that mountain waves e.g. over the southern tip of south America or over Scandinavia are resolved as well as GWs over the polar vortex on the winter hemisphere. Also GWs from equatorial sources associated with convective systems are included in both data sets. The vertical distribution of temperature amplitudes indicates that in ECMWF data the waves are damped at altitudes above 50km.

In a second step we also simulate measurements of a next-generation infrared limb imager with strongly increased horizontal resolution. It is shown that such kind of instrument can fully characterize the three-dimensional structure of mesoscale GWs. We demonstrate how data measured by this instrument can be employed to derive currently missing quantities such as propagation direction and momentum flux of GWs and how GW source processes can be identified and quantified by e.g. back-tracing the observed waves into the troposphere.

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Overview of Stratospheric Analyses Produced by the Belgian Assimilation System for Chemical Observations (BASCO) in the Framework of GSE-PROMOTE

Presenter: Quentin Errera (quentin@oma.be)

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The Belgian Assimilation System of Chemical Observations (BASCO) takes part in two PROMOTE services: The Stratospheric Ozone Profile Record service and the Stratospheric Aerosols and Gas service. In the first service, BASCO is intent to provide ozone analyses and other chemical constituents related to ozone based on the assimilation of UARS MLS and Envisat MIPAS data. In the second service, BASCO will provide methane and water vapor based on the same datasets. In this contribution, a description of the system and an overview of the BASCO results will be given.

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Intermediate-scale Tropical Inertia Gravity Waves observed during TWP-ICE campaign

Presenter: Stephanie Evan (stephanie.evan@colorado.edu)

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In tropical Australia, the area of Darwin constitutes an ideal site to study convection as this region is under the influence of the Asian and Indian monsoons. In addition, both maritime and continental convective conditions occur.

Therefore, the Tropical Warm Pool International Cloud Experiment (TWP-ICE) was conducted from 23 January to 13 Febuary 2006 in this area. The experiment goal was to describe the evolution of tropical convection, including the large-scale heat, moisture, and momentum budgets, while at the same time obtaining detailed observations of cloud properties and the impact of clouds on the environment.

In this study, we describe a 2-day wave event observed in high-resolution radiosonde soundings of horizontal wind and temperature taken during the experiment. The vertical profiles of temperature, zonal and meridional wind

speeds are analyzed using the S-transform wavelet analysis. Results of the analysis reveal the presence of 2-day inertia gravity waves in the stratosphere between 20 and 27km. The maximum wave amplitude is observed in the middle of the campaign and corresponds to a wave with vertical and horizontal wavelengths of around 6km and 7220km respectively. This wave was observed to propagate southeastward during the end of the easterly phase of the QBO. The total vertical momentum flux associated with the wave is estimated to be of the same order of magnitude as previous observations of 4-10 day Kelvin waves in the lower stratosphere. Additionally information on the wave event is obtained from the ECMWF analyses.

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The Structure and Evolution of the Polar Stratosphere and Mesosphere during IPY – Early Results from SPARC-IPY

Presenter: Ellie Farahani (elham@atmosp.physics.utoronto.ca)

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The overall objective of SPARC-IPY is to document the dynamics, chemistry and microphysical processes within the polar vortices during IPY, with a focus on the stratosphere-troposphere and stratosphere-mesosphere coupling. To achieve this goal the SPARC-IPY project is facilitating analysis of available research and operational satellite data while encouraging work on data assimilation and inter-comparison of assimilated data sets. Deliverables of this project for the IPY period consists of a well-organized data set of polar observations as well as analysis products from two Canadian assimilation systems (GEM-BACH and CMAM-DAS) and major operational centers (ECMWF, Met Office, NCEP, GMAO, and KNMI), which are being archived at the SPARC Data Center. The analysis products will cover the period of IPY (March 2007 to March 2009) and will be among the best available self-consistent representations of the state of the atmosphere during this period.

Currently, one of the most active components of SPARC-IPY is the data assimilation activity with its focus on the large-scale circulation associated with the polar vortex during IPY and associated physical and chemical features. Analysis of the dynamics and chemistry associated with Stratospheric Sudden Warmings (SSWs) in the Arctic during IPY is of particular interest to SPARC-IPY. To date the Canadian Middle Atmosphere Model, which extends from the ground to above the mesopause and includes comprehensive and coupled chemistry, radiation and dynamics has been used together with a 3D-Var data assimilation scheme to perform SSWs analysis for the pre-IPY period. Some preliminary results from the analysis of SSWs will be presented as an example of the above.

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Statistical analysis of TTL tracer data

Presenter: Federico Fierli (f.fierli@isac.cnr.it)

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The distribution of tracers and water vapour in the tropical tropopause layer (TTL) is analysed taking into account statistical properties inferred from in-situ aircraft measurements. The approach is based on the computation of probability density functions (PDFs) of the observed concentrations since they are suitable to characterize the transition of tracers across dynamical barriers. We investigate the variability of the PDFs function of the position relative to the tropopause and to the sub-tropical barrier to infer the role of different processes in determining the tracers variability. The observed PDFs are also compared on a qualititive basis with a simplified model to estimate the variability of the convective flux and to assess the role of different transport mechanisms in determing the PDFs shape.

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Estimating 27-day and 11-year solar cycle variations in tropical upper stratospheric ozone

Presenter: Vitali Fioletov (vitali.fioletov@ec.gc.ca)

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Spectral analysis of the Solar Backscatter Ultraviolet satellite instrument (SBUV) ozone and solar flux time series was used to estimate ozone response in the tropical upper stratosphere to solar flux harmonics of the 27-day sun rotation cycle with periods of 9, 13.5, and 27 days. Solar UV flux at 205 nm, Mg II index, composite Solar Lyman-alpha, and 10.7 cm solar flux data sets were tested as proxies for the solar signal. Mg II index data have the highest coherency with tropical ozone in the upper stratosphere among all solar proxies. The analysis show that, during the periods of high solar activity, about half of the ozone variance for periods of 13.5 and 27-days can be attributed to the solar signal fluctuations. During the periods of low solar activity, the 27-day signal is below the 90% statistical significance level, while the 13.5-day signal could still be significant. Also, a 9-day period can be seen in ozone data during the time of low solar activity. The ozone response to solar variations with a 27-day period was used to estimate the 11-year solar cycle amplitude in tropical ozone. Unknown biases in individual SBUV instrument data were included as a part of the statistical model. In that case, the estimates from the 27-day period minimum-to maximum range of the 11-year cycle is about 2% and it agrees with the data in layers 8-9 (38-43 km) derived from the SBUV data set. Below these layers, the amplitude of the 11-year cycle is only about one third of those estimated from the 27-day cycle. Above these layers, the amplitude of the 11-year cycle is larger then that estimated from the 27-day cycle, but it is primarily due to the high amplitude of the 11-year cycle in the Nimbus 7 SBUV data.

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Millimeter-wave measurements of stratospheric O_3 and N_2O from the high-altitude station of Testa Grigia (Italy; 45.9ºN, 7.7ºE, 3500 m a.s.l.)

Presenter: Irene Fiorucci (fiorucci@ingv.it)

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We present measurements of stratospheric trace gases carried out from the Italian Alpine station of Plateau Rosa (or Testa Grigia, 45.9ºN, 7.7ºE, elev. 3490 m) by means of a Ground-Based Millimeter-wave Spectrometer (GBMS). Observations of O_3, N_2O, HNO_3, CO, HCN, and HDO took place during 4 winter periods, from February 2004 to March 2007, for a total of 116 days of measurements. The GBMS allows the retrieval of vertical profiles of stratospheric and mesospheric trace gases by measuring their rotational spectra between 230 and 280 GHz. In order to obtain vertical profiles from rotational spectra the technique takes advantage of the dependence of the line broadening on atmospheric pressure, and hence on altitude. Considering that collisional line broadening is about 3 MHz/mb, that the GBMS bandwidth is 600 MHz, and that its spectral resolution is about 65 kHz, the GBMS allows the retrieval of vertical profiles from approximately 17 to 75 km. Deconvolution (or inversion) techniques adopted to retrieve vertical profiles from the emission spectra measured by the GBMS limit the vertical resolution of profiles to ~ 6 km in the lower to mid-stratosphere, increasing to more than 10 km in the upper stratosphere. Uncertainties on retrieved concentration profiles depend on the observed chemical species and amount to 13% and 15% for O_3 and N_2O mixing ratio values, respectively.

In this contribution, we first show that Testa Grigia is an excellent location for carrying out observations in the spectral range of the water vapor continuum, given their need for very low water vapor column contents. At Testa Grigia we measured less than 1 mm of total integrated water vapor column, which is comparable to values observed at the South Pole. We then move on illustrating the behavior of stratospheric O_3 during the entire period of operation at Testa Grigia, using nearly concurrent measurements of N_2O for determining the origin of the observed air masses. Mid-latitude O_3 columnar content as estimated using GBMS measurements can vary by large amounts over a period of very few days, with the largest variations exceeding 50% observed in December 2005, February 2006, and March 2006, confirming that the Northern winter of 2005-06 has been characterized by a particularly intense planetary wave activity. During most times of GBMS observation a large part of the variability is concentrated in the column below 20 km, with tropospheric weather systems and advection of tropical tropospheric air into the lower stratosphere over Testa Grigia having a large impact on the observed variations in column contents. Nonetheless, a great variability is also found in middle stratospheric GBMS O_3 measurements, also

owing to advection of polar air identified by lower N_2O mixing ratio values with respect to the mid-latitudes. We find that O_3 mixing ratios at ~32 km are very well correlated with the solar illumination experienced by air masses over the previous ~15 days, showing that already at 32 km altitude ozone photochemistry dominates over transport processes.

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Climate Variability in the Stratosphere during the 20th Century

Presenter: Andreas Fischer (andreas.fischer@env.ethz.ch)

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The stratosphere exhibits chemical and dynamical variability on different time scales, ranging from day-to-day variability to interdecadal variability and trends. Volcanic eruptions, solar variability, ozone depletion, or El Niño Southern Oscillation (ENSO), affect both troposphere and stratosphere, and it is an open question to what extent the climate effect proceeds via the stratosphere. The current data records as well as model simulations addressing stratospheric chemical climate variability mostly cover the past few decades only, which often is not sufficient to address interannual-to-decadal variability.

Here we present results of transient simulations with the chemistry-climate model (CCM) SOCOL, spanning the whole 20th century. SOCOL is a combination of the middle atmosphere version of ECHAM4 (MPI, Hamburg) and the chemistry-transport model MEZON (PMOD/WRC, Davos). The simulations are carried out in ensemble-mode (9 members) prescribing sea surface temperature, sea ice distribution, volcanic aerosols, solar variability, greenhouse gases, ozone depleting substances, land surface changes, and QBO.

Results on the effect of solar and volcanic forcings as well as on the effect of ENSO on the stratosphere will be presented for model results as well as observational data sets. We further address the relation between tropospheric low-frequency variability modes upon stratospheric chemistry and climate and provide a model validation against various observational and (prior to 1957) reconstructed upper-air datasets.

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Stratospheric influence on the extratropical circulation response to surface forcing in high-top and low-top models

Presenter: Christopher Fletcher (cgf@atmosp.physics.utoronto.ca)

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Variability in the spatial extent of fall season snow cover over the Eurasian sector has been linked in observations to a teleconnection with the winter Northern Annular Mode pattern. Here, the dynamics of this teleconnection are investigated in 100-member ensembles of transient integrations using “high-top” and “low-top” versions of the GFDL AM2 general circulation model (i.e., with and without a well-resolved stratosphere). The models are perturbed with a simple persisted snow anomaly over Siberia and integrated from October through December. A planetary wave activity response drives wave-mean flow interaction in the lower stratosphere and subsequent downward propagation of a negative phase Northern Annular Mode response back into the troposphere. The high-top model exhibits a faster and weaker response to snow forcing and this difference is tied to the unrealistically fast timescale of fall season internal variability in that model.

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Response of the mesosphere and its water vapor content to the sudden stratospheric warming in February 2008

Presenter: Thomas Flury (thomas.flury@iap.unibe.ch)

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A sudden stratospheric warming (SSW) happened in February 2008 over Bern, Switzerland. The temperature at 30 km altitude increased by 60 K within 1 day. During this time two microwave radiometers for water vapor and ozone operating at Bern, Switzerland, in the frame of the Network for the Detection of Atmospheric Composition Change, NDACC, measured an enhancement of mesospheric water vapor by almost 25 percent accompanied by a depletion in the stratospheric ozone volume mixing ratio by 30 percent. SSW events play a crucial role for vertical coupling between the lower, middle, and upper atmosphere as well as for mixing processes between air masses from middle and high latitudes. The observed enhancement of water vapor and the ozone depletion might be the consequence of planetary wave breaking in the presence of an anticyclone. In this study we will further analyze the factors leading to SSW events. The extreme variability of water vapor and ozone over Bern during the SSW event of February 2008 is interpreted by means of air parcel trajectory calculation with ECMWF wind fields. Horizontal and vertical transport processes of water vapor and ozone are discussed over an extended altitude range during the SSW.

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The diabatic heat budget of the upper troposphere and stratosphere in ECMWF reanalyses

Presenter: Stephan Fueglistaler (s.fueglistaler@damtp.cam.ac.uk)

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Assimilated data such as ERA-40 are widely used to study the planetary energy budget, and atmospheric eddies, temperatures and transport. Typically, analyses of assimilated data focus on wind, temperature, moisture and cloud fields, and surface and top of atmosphere radiative fluxes. Here, we present an analysis of the diabatic terms in the thermodynamic energy equation, that is the temperature tendencies arising from radiation and latent heat exchange. We compare data from ERA-40 with a new ECMWF interim reanalysis project. We analyse the clear sky radiative heating rates, the cloud radiative effects, and the net impact from latent heat exchange and mixing, and close the diabatic heat budget with the calculation of the temperature assimilation increment. We show that the previously noted excessive tropospheric overturning circulation at low latitudes in ERA-40 is also reflected in the diabatic heat budget, and that the temperature assimilation increment acts to cool the excessive model heating. Conversely, the interim reanalysis requires heating from the assimilation increment at low latitudes, suggesting too little convection. In the TTL, both reanalyses show a strong net heating from the interaction of clouds with radiation. Lack of independent, accurate calculations renders the cloud radiative impact in the TTL highly uncertain. The cooling impact of the assimilation increment in both reanalyses in the TTL suggests that the models may overestimate the cloud radiative heating, but it could also imply a missing cooling from, for example, convective overshoot. In the stratosphere, ERA-40 shows highly unrealistic radiative heating rates due to problems in the vertical temperature structure, and the diabatic heat balance is dominated by the contribution from the assimilation increment. Conversely, the temperature increment of the interim reanalysis is much smaller, and the structure of radiative heating at low latitudes and radiative cooling at high latitudes is much more realistic. Overall, the new interim reanalysis that employs a 4-dimensional data assimilation scheme provides a much improved residual circulation, but uncertainties in the magnitude of terms in particular around the tropical tropopause remain large.

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The transport of water through the tropopause studied from its isotopic fractionation

Presenter: Stephan Fueglistaler (s.fueglistaler@damtp.cam.ac.uk)

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Stratospheric water is an important greenhouse gas and plays a major role in ozone chemistry as a source of HOx radicals. Measurements suggest an increasing trend of stratospheric H_2O, indicating that some aspects of troposphere-to-stratosphere transport are poorly understood. Observations of the stratospheric distribution of isotopic water vapor, or fractionation, can provide important additional information on transport processes in the tropopause region. Isotope measurements suggest a significant role for convectively lofted ice as source of stratospheric water and it has been suggested that the amount of ice delivered to the stratosphere increases with time. HDO provides a sensitive test of whether ice lofting contributes significantly to the observed variability of H_2O. Here, we report the HDO fractionation of water vapor measured in the stratosphere with 2-3 km vertical resolution using solar occultation spectra obtained from a balloon-borne spectrometer between 1989 and 2006. Combined with in situ measurements of tropospheric CH_4, H_2 and their isotopologues CH_3D and HD, we derive the water vapor concentration and fractionation at entry into the stratosphere. We find that seasonal variations in H_2O at entry into the stratosphere are accompanied by variations in isotopic fractionation of order 100permille. The observed covariance of H_2O and HDO at entry is consistent with expectations based on simple Rayleigh fractionation. From measurements at higher altitude in well mixed stratospheric air, where the seasonal variations are damped, we observe well-correlated variations of H_2O and HDO at entry on longer timescales (years) and a slight but significant trend. We find no significant deviation from Rayleigh-variations over the measurement period 1989-2006. Our data allows for the first time to constrain possible trends in H_2O at entry from particulate water. The observations suggest that there has been no significant trend in the input of convectively-lofted particulate water.

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Trends and variability of midlatitude stratospheric water vapour deduced from the re-evaluated Boulder balloon series

Presenter: Stephan Fueglistaler (s.fueglistaler@damtp.cam.ac.uk)

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We present an updated trend analysis of water vapour in the lower midlatitude stratosphere from the Boulder balloon-borne NOAA frostpoint hygrometer measurements. Two corrections for instrumental bias are applied to homogenise the frostpoint data series, and a quality assessment of all soundings after 1991 is presented. Linear trend estimates based on the corrected data for the period 1980 - 2000 are up to 40% lower than previously reported. Vertically resolved trends and variability are calculated with a multi regression analysis including the quasi-biennal oscillation and equivalent latitude as explanatory variables. In the range of 380 to 640K potential temperature (about 14 to 25 km), the frostpoint data from 1981 to 2006 show positive linear trends between 0.3+/-0.3 and 0.7+/-0.1%/yr. The same dataset shows trends between -0.2+/-0.3 and 1.0+/-0.3%/yr for the period 1992 to 2005. In the lower stratosphere, a rapid drop of water vapour is observed in 2000/2001 with little change since. At higher altitudes, the transition is more gradual, with slowly decreasing concentrations between 2001 and 2007. This pattern is consistent with a change induced by a drop of water concentrations at entry into the stratosphere. Previously noted differences in trends and variability between frostpoint and Halogen Occultation Experiment observations remain for the homogenised data. Due to uncertainties in reanalysis temperatures and stratospheric transport combined with uncertainties in observations, no quantitative interference about changes of water entering the stratosphere in the tropics could be made with the mid latitude measurements analysed here.

ID: 00173 ◀back

Observations of ozone, water vapor, and cirrus in the tropical tropopause layer over the Pacific

Presenter: Masatomo Fujiwara (fuji@ees.hokudai.ac.jp)

M. Fujiwara (Hokkaido University, Japan)

Organized cumulus clouds in the tropics generate a pair of equatorial Kelvin and Rossby waves, i.e., the so-called Matsuno-Gill pattern. This mechanism primarily determines the large-scale temperature distribution and flow pattern in the tropical tropopause layer (TTL) with both seasonal and intra-seasonal time scales.

In the tropical Pacific, we have been making several balloon-borne ozone and water vapor soundings since the 1990s and lidar cirrus measurements since the early 2000s under the projects, the Soundings of Ozone and Water in the Equatorial Region (SOWER), the Southern Hemisphere Additional Ozonesondes (SHADOZ), and other programs. These measurements have revealed the important role of large-scale equatorial waves in the dynamics, transport, and cloud physics in the TTL.

In this talk, I will present some of the results from our activities, including (a) the observations of large-amplitude, breaking Kelvin waves that contribute to the dehydration and irreversible stratosphere-troposphere exchange, (b) the “match”-type, coordinated multi-point campaigns aiming at measuring the Lagrangian dehydration process in the tropical western Pacific, and (c) the ship-borne lidar cirrus measurements in the tropical western Pacific in three northern winters. It is found from (c) that equatorial Kelvin waves are the important dynamical process that controls the cirrus variation in the TTL, but the dry-air horizontal transport from the midlatitude lower stratosphere and the wet-air vertical transport near the tropical convergence regions should also be considered for a full explanation of the cirrus observations in the TTL.

ID: 00420

◀back

Lidar monitoring of stratospheric temperature: impact of spatial and temporal sampling

Presenter: Beatriz Funatsu (funatsu@lmd.polytechnique.fr)

B.M. Funatsu, C. Claud (LMD/IPSL, Ecole Polytechnique, Palaiseau, France),
P. Keckhut (SA/IPSL, Verrieres le Buisson, France)

The stratosphere has been cooling signifantly over the last three decades due to changes in stratospheric ozone, well-mixed greenhouse gases, water vapor and sea surface temperatures. However, the present reduction of anthropogenic halogen loading should lead to ozone recovery and subsequent changes in the cooling rates. This effect may be counter-balanced by the increasing concentrations of greenhouse gases, thus adding to the uncertainty as to whether the stratosphere will stop cooling or not. Since changes in stratospheric temperature and dynamics impact the climate, a precise monitoring of stratospheric temperature is of essential importance.

The only global long-term source of temperature of the middle atmosphere is provided by satellites. The main source of satellite-based upper air temperature records for the period 1979-2004 was the Stratospheric Sounding Unit (SSU) and to some extent the Microwave Sounding Unit (MSU), onboard NOAA polar satellites. They have been replaced in the late 1990s by the Advanced Microwave Sounding Unit (AMSU) with improved vertical and horizontal resolutions. Another source of temperature throughout the stratosphere (30-80km) is provided by the surface-based lidar measurements. There is a limited number of stations and time series are available for one or two decades, and they will continue in the future.

There is a need for an improved understanding of the reliability of the data used for assessing the trends. This study is part of this effort and aims at better characterizing the impact of the temporal and spatial sampling of the lidar data on the trend calculations. Temporal sampling is associated with the fact that lidar measurements are made in nights with clear sky only, and the spatial sampling results from the fact that this is a localized measurement. To this end, lidar observations are compared with AMSU brightness temperatures which provide twice-daily (ascending and descending passes) global coveraged,independent of cloud cover.

ID: 00138 ◀back

The influence of zonally asymmetric stratospheric ozone on temperature, planetary wave propagation and atmospheric circulation

Presenter: Axel Gabriel (gabriel@iap-kborn.de)

A. Gabriel, D. Peters (IAP, Kühlungsborn, Germany),
I. Kirchner (Meteorologisches Institut, Freie Universität Berlin, Germany),
H.-F. Graf (University of Cambridge, UK)

Long-term changes of zonally asymmetric stratospheric ozone (deviation from zonal mean ozone) have been derived from assimilated ozone data (ERA-40) and from satellite data (SAGE, GOME). For northern winter hemisphere, we found a pronounced quasi-stationary wave one structure in stratospheric ozone with minimum values over Northern Europe and North Atlantic and maximum values over the Aleuts and Northern Asia. The amplitude of the wave one structure shows a linear increase of approximately 0.2 mg/kg during the last 4 decades reaching values of about 10% of zonal mean ozone during the 1990s. Model calculations with the GCM MAECHAM5 were carried out with and without zonally asymmetric ozone to investigate the effects via radiative forcing on temperature, planetary wave propagation and atmospheric circulation in troposphere and stratosphere. The results reveal significant changes in stratospheric temperature due to an ozone-induced increase in amplitude and a shift in phase of stratospheric wave one. Further we found an induced shift of the quasi-stationary polar low from regions over Northern Europe / Northern Asia to regions over North Canada / Greenland accompanied by a shift of up- and eastward directed stationary wave trains from the eastern to the western hemisphere. Particularly, we found an induced change in tropospheric circulation patterns from positive to negative phase in NAO signature, which is obviously due to an efficient feedback mechanism between the ozone-induced changes in the zonal asymmetries of the westerly large-scale flow and regional Rossby wave breaking patterns. Overall, observed long-term means in planetary wave structures are better described by the model if zonally asymmetric ozone is included. The results suggest that long-term changes in zonally asymmetric ozone may contribute significantly to climate variability and long-term trends.

ID: 00301 ◀back

Mechanisms for the Acceleration of the Brewer-Dobson Circulation in a Climate Change Scenario

Presenter: Rolando R. Garcia (rgarcia@ucar.edu)

R.R. Garcia (National Center for Atmospheric Research, Boulder, USA),
N. Calvo (National Center for Atmospheric Research, Boulder, USA and Universidad Complutense, Madrid, Spain),
W. Randel (National Center for Atmospheric Research, Boulder, USA)

The evolution of the Brewer-Dobson (BD) circulation as a result of climate change has been analyzed using NCAR's Whole Atmosphere Community Climate Model (WACCM3). Two experiments, one with fixed greenhouse gas concentrations from 2000 onwards and the other with concentrations that follow the A1B IPCC scenario have been compared for the period 2000-2050. In both experiments the sea surface temperatures are specified from existing runs of NCAR's coupled atmosphere-ocean model that follow the same scenarios. The comparison shows that the Brewer-Dobson circulation in the tropical lower stratosphere strengthens when the greenhouse gases increase. This acceleration is due to changes in the Eliassen-Palm (EP) flux divergence in the subtropical lower stratosphere. In this work, we will show the waves responsible for the changes in EP flux divergence and the mechanisms whereby these changes take place.

ID: 00042 ◀back

Gravity Wave Analyses from Temperature, Wind, and Ascent Rates in US High Vertical-Resolution Radiosonde Data

Presenter: Marvin Geller (Marvin.Geller@sunysb.edu)

M.A. Geller, J. Gong (School of Marine and Atmospheric Sciences, Stony Brook University, USA)

In the presence of a spectrum of gravity waves, different waves are preferentially measured by the different variables obtained from high vertical-resolution radiosonde soundings. This is shown by the relatively low correlations among the 'observed' gravity wave kinetic energy, potential energy, and the energy in the ascent rate fluctuations as well as similar plots produced by simple simulations. Latitude-time sections are shown for the gravity wave kinetic, potential, and vertical fluctuation kinetic energies in both the troposphere (2-9 km) and lower stratosphere (18-25 km). The kinetic and potential energies tend to show maxima during the winter months in both the troposphere and lower stratosphere, whereas the tropospheric vertical fluctuation energy has a clear summer maximum. We hypothesize that the vertical fluctuation energy is a good indicator of convectively forced gravity waves whereas the kinetic energy indicates inertial gravity waves forced by spontaneous emission. We show correlations among different bits of gravity wave information with information on physical sources such as indicators of convection and the source terms for spontaneous gravity wave emission through dynamical imbalances. We also show properties of gravity waves identified as being from different physical sources, and interpret the observations through ray tracing experiments.

ID: 00374 ◀back

Stratosphere-Troposphere Dynamical Coupling and Tropospheric Predictability

Presenter: Edwin Gerber (epg2108@columbia.edu)

E.P. Gerber, C. Orbe, Lorenzo M. Polvani (Columbia University, New York, USA)

We investigate stratosphere-troposphere coupling following Stratospheric Sudden Warming (SSW) events in an idealized atmospheric General Circulation Model (GCM), with a focus on the predictability of the stratosphere's impact on the troposphere. Baldwin and Dunkerton (2001) find a seemingly downward propagating signal in the Northern Annular Mode following SSWs, in which the tropospheric jet shifts equatorward a few days after the abrupt weakening of the stratospheric polar vortex, and remains (on average) in this negative index state for up to two months following the event. This behavior was captured in a primitive equation GCM by Gerber and Polvani (2008), where long integrations enable one to collect a much larger set of SSW events than available in the observational record. Here we use these simulated warming events to examine the predictability of the tropospheric signal, taking advantage of the large sample size to quantify the predictability. Given an SSW event in the model integration, we run a series of ensemble forecast around the control integration, to determine the sensitivity of the tropospheric response to changes in the baroclinic and planetary scale eddies. We find that the tropospheric response to the weakening of stratospheric vortex is robust, but that the recovery of the vortex itself is quite sensitive to the tropospheric flow. Thus the predictability of the tropospheric circulation depends on two way interactions between the stratosphere and troposphere succeeding the SSW event.

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Ice Supersaturation in the UTLS and its Effect on Climate and Chemistry

Presenter: Andrew Gettelman (andrew@ucar.edu)

A. Gettelman (National Center for Atmospheric Research, Boulder, USA)

Supersaturation with respect to ice in the atmosphere is a common occurrence. This work will briefly evaluate satellite humidity observations of supersaturation from multiple sources. These sources include satellites (the Atmospheric Infrared Sounder) and newly available in-situ humidity observations of supersaturation from commercial aircraft (the Water Vapor Sensing System II on commercial cargo aircraft). Observations are be used to constrain a new advanced ice microphysics formulation in a global chemistry-climate model (the Whole Atmosphere Community Climate Model) that allows supersaturation with respect to ice and ice nucleation on aerosols. Model results indicate significant effects of including supersaturation on climate and chemistry, affecting cloud and humidity distributions in the UTLS and the stratosphere, with impacts on chemistry and transport. Sensitivity tests with the model also indicate that ice microphysical processes (such as ice nucleation on aerosols) may alter the global radiation balance by changing cirrus clouds. Prospects for using these large scale tools to help constrain our understanding of ice nucleation processes are also discussed.

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Processes Regulating Short Lived Species in the Tropical Tropopause Layer

Presenter: Andrew Gettelman (andrew@ucar.edu)

A. Gettelman, M. Park, D. E. Kinnison (National Center for Atmospheric Research, Boulder, USA)

Processes in the Tropical Tropopause Layer (TTL) are important for setting the chemical boundary conditions of stratosphere. This is particularly true for short lived species, with lifetimes less than several months. Short lived species containing Bromine, in particular, are critical for understanding stratospheric chemistry. This study investigates the processes responsible for TTL transport and how they affect short lived species. The study uses satellite and in-situ observations and simplified process models to better understand processes and results from global Coupled Chemistry Climate Models.

An idealized model of mean tropical transport with representations of large scale transport and mixing, convective transport and chemistry is used to simulate tracers with various lifetimes. The results are compared to satellite observations of species with multiple lifetimes from 4 days to 6 months, and to global model simulations using many of the same compounds. A simple model can explain the processes responsible for many features observed in short lived species concentrations, including the annual cycle of short lived species at the tropopause, and why the peak in tracer concentrations is often above the altitude of maximum convective outflow.

ID: 00379 ◀back

HIRDLS Observations of Upper Tropospheric and Stratospheric Water Vapor

Presenter: John Gille (gille@ucar.edu)

J. Gille, B. Nardi, C. Hartsough, V. Yudin, S. Karol, D. Kinnison and R. Khosravi
(NCAR, Boulder, USA)

Version 004 retrievals from the High Resolution Dynamics Limb Sounder (HIRDLS) instrument on NASA's EOS Aura satellite contain water vapor profiles with high vertical resolution and quasi-global coverage for 3 years. HIRDLS is a 21 channel limb scanning infrared radiometer which was specifically designed to observe the upper troposphere lower stratosphere region. HIRDLS incorporates 2 channels to measure radiances from which the water vapor profiles are retrieved from 8-40 km altitude with a vertical resolution of 1 km. Preliminary results of detailed validation will be presented. Analysis of 3 years of these data show a region of low water vapor (hygropause) slightly above the tropopause and extending from the tropics to high latitudes, supporting suggestions of horizontal exchange in a thin layer in the lower stratosphere. Other features include the tropical pipe and the seasonal variation in its width, within which the tape recorder signal is seen. The Asian monsoon over Tibet is also seen as a region of high water vapor at the 100-80 hPa levels. The possibility of isentropic transport of upper tropospheric water vapor into the lower stratosphere will be discussed.

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HIRDLS Observations of the 2-way Exchange Between the Tropical Upper Troposphere and the Extra-tropical Lower Stratosphere

Presenter: John Gille (gille@ucar.edu)

J. Gille, V.A. Yudin, B. Nardi, S.I. Karol, D. Kinnison, and the HIRDLS Science Team
(NCAR and University of Colorado, Boulder, USA)

Plots of retrievals from the High Resolution Dynamics Limb Sounder (HIRDLS) along its scan track show thin layers of upper tropospheric air in the extra-tropical lower stratosphere. HIRDLS, on NASA's EOS Aura satellite, is a 21-channel infrared limb sounder that was specifically designed to observe the upper troposphere and lower stratosphere. The data have a unique 1 km vertical resolution and the ability to sound the tropopause region to determine temperature and the mixing ratios of ozone, water vapor and nitric acid. Measurements along the scan track have scale-consistent vertical and horizontal resolutions for observing dynamics and transport in the extra-tropical stratosphere. In this study the new version (V004) of multi-year 2005-2008 HIRDLS data are employed to locate regions in which thin layers of upper troposphere (UT) air masses appear in the mid-latitude lower stratosphere (LS), including their seasonal and year-to-year variations. The GMAO/GEOS-5 meteorological analyses are used to interpret the evolution of the observed events. During initial stages the poleward motion of UT air along isentropes (often near 380 K) is limited by contours of potential vorticity, especially the rapid increase associated with the dynamical tropopause. Subsequent equatorward motions of LS air masses at lower levels lead to isolation of thin layers of low-ozone (UT) air. During these phases the ozone and nitric acid distributions are closely tied to contours of potential vorticity (PV). As the most active phase of the baroclinic eddies ends, PV contours poleward of the laminae relax to lower latitudes, leaving the remnants of the layers mixed with the surrounding LS air. The morphology and preferred locations and times for these mixing events were identified based on 3 years of HIRDLS temperature and constituent data. The role of these events on ozone transport and mixing in the LS of the Northern Hemisphere will be discussed.

ID: 00313 ◀back

Multiple tropopause events: Climatological features and analysis of the relationship of their occurrence with cut-off low systems

Presenter: Luis Gimeno (j.gimeno@uvigo.es)

Juan A. Añel (Universidad de Vigo, Ourense, Spain, and CESAM, Universidade de Aveiro, Portugal), J.C. Antuña (Estaciûn Lìdar de Camagüey, Cuba), L. de la Torre (Universidad de Vigo, Ourense, Spain, and CESAM, Universidade de Aveiro, Portugal), J.M. Castanheira (CESAM, Universidade de Aveiro, Portugal), Raquel Nieto (Universidad de Vigo, Ourense, Spain and Universidade de Lisboa, Portugal), L. Gimeno (Universidad de Vigo, Ourense, Spain)

This study examines various climatological features related to multiple tropopause events (MT events). The analysis is based on the lapse rate definition of the tropopause and IGRA radiosonde data and builds on previous work by part of the authors that describes global statistics of MT events, without reference to their seasonality or geographical distribution. Our results are in moderate qualitative agreement with earlier studies. They reinforce the findings of analysis made by other researchers, though at the same time highlighting important differences in both the number and position of the centres of maximum occurrence of these events. In our study, we found four centres of multiple tropopause occurrence in the Northern hemisphere and three in the Southern hemisphere, which coincided with identified zones of maximum cyclogenesis. We also found a close relationship between the occurrence of MT events and the development of cut-off low systems.

ID: 00010 ◀back

Influence of the Mt. Pinatubo eruptions on the dynamics of the quasi-biennial oscillation

Presenter: Marco Giorgetta (marco.giorgetta@zmaw.de)

M.A. Giorgetta, M.A. Thomas (Max Planck Institute for Meteorology, Hamburg, Germany)

When Mt. Pinatubo erupted in June 1991, the quasi-biennial oscillation (QBO) had nearly terminated a westerly wind phase. Observations showed that the westerly phase remained in the lower tropical stratosphere, and was slightly lifted upward in the months after the eruption, until the westerly wind was terminated in spring 1992. This study tests the hypothesis that the radiative forcing resulting from the observed stratospheric aerosol layer, which developed after the Pinatubo eruption, is the cause of the observed temporal extension and lifting of the westerly wind in the lower tropical stratosphere. For this purpose the MAECHAM5 GCM, which simulates the QBO from resolved and parameterized wave mean-flow interaction, is employed in two ensemble simulations. The control ensemble simulates the QBO without any external perturbation. The aerosol ensemble includes an externally prescribed distribution of sulfate aerosols, following observations after the Mt. Pinatubo eruption. This presentation compares the ensemble mean evolution of the QBO in both cases, and analyzes the differences in the QBO forcing terms that can cause the observed temporal extension of the westerly wind phase of the QBO.

ID: 00196 ◀back

Circulation changes in climate models related to the representation of the stratosphere

Presenter: Marco Giorgetta (marco.giorgetta@zmaw.de)

M.A. Giorgetta (Max Planck Institute for Meteorology, Hamburg, Germany),
E. Manzini (Centro Euro-Mediterraneo per i Cambiamenti Climatici, Bologna, Italy)

Coupled atmosphere ocean climate models do not generally include a proper representation of the stratosphere. Specifically, they may neglect or underestimate stratospheric variability. Therefore such models may simulate the lower stratospheric response to tropospheric dynamical forcing, but they likely distort any influence of the stratosphere on the troposphere. To evaluate the systematic influence of the stratosphere on the simulated climate, two coupled atmosphere ocean models that differs only in their representation of the stratosphere and mesosphere have been assembled: the first is the ECHAM5/MPIOM (T63L31) model with top of the atmospheric component at 10 hPa (the low top model); the second is the MAECHAM5/MPIOM (T63L47) model with top at 0.01 hPa (the high top model). Results are reported for multi-decadal simulations performed with both climate models. A nearly uniform warming is found in the troposphere of the high top model with respect of that of the low top model. This warming is largest in the tropics (~0.5 K) and a cooling (~2 K) in the lower tropical stratosphere. The connection of this result to the modelling of the stratosphere is reported in the changes between the high and low top models in the Brewer-Dobson circulation related to both resolved and parameterized wave driving.

ID: 00144 ◀back

Climate change impacts on stratosphere-troposphere coupling

Presenter: Bernardo Gozzini (gozzini@lamma.rete.toscana.it)

B. Gozzini, D. Grifoni, G. Messeri, G. Maracchi (CNR-IBIMET, Italy),
F. Piani (Hydrological Service Tuscany Region, Italy),
C. Tei (CNR-IBIMET, Italy)

In the recent past many authors have studied the stratosphere-troposphere dynamical coupling to understand the level of potential predictability for extreme cold events. In particular Baldwin has highlighted that the main anomalies of the stratosphere influence a period of about 60 days in the troposphere (Baldwin, M.P. and T.J. Dunkerton, 2001). In fact an anomalous heating of the stratosphere (Major Warming) with a value of NAM calculated at 10 hPa lower than -3.0 tends to be followed by a period of about 2 months with negative anomalies of the surface air temperatures. At the same time, stratospheric events with NAM values superior to 1.5 tends to be followed by positive anomalies for 60 days. The areas that are more sensitive to stratospheric anomalies are the mid and low latitudes. In this study the temperatures of the 60 days following an event of Major Warming (from 1979 to 2007) at the Mediterranean latitudes has been analysed using reanalysis data to calculate the NAM values, using the algorithm developed by Baldwin. The air temperature anomalies have been calculated at 850 hPa considering climatological values of period 1979-2007. The anomalies of the period of 60 days following the Major Warming has been analysed to detect the presence of a trend that it seems in an opposite way, negative anomalies until 1989 and positive starting from 1989. The time series taken into account (1979-2007) don’t show any significant trend in the cold air strength in the 60 days following the event of NAM < -3.0, but warm advections have become more consistent. These preliminary results could be ascribed to a climate change warming at the mid and low latitudes with an increase of temperature associated with winter southern currents, while the temperatures associated to the northern flows seem to remain nearly unchanged.

A possible partial explanation could be an important modification of the mechanisms of atmospheric circulation connected to the climate change such to modify the weather predominant regime also in the 60 days following to the Major Warming.

ID: 00278

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The role of ozone in future IPCC simulations

Presenter: Lesley Gray (l.j.gray@rdg.ac.uk)

L.J. Gray (NCAS-Climate, Reading University, UK),
M. Dall'Amico (DLR, Oberpfaffenhofen, Germany),
S.T. Rumbold (Reading University, UK),
K.P. Shine (Reading University, UK)

In recent IPCC studies ozone trends have been generally assumed to be an anthropogenic forcing. While this has been acceptable to date, since studies have imposed only a simple EESC-derived trend, it is not appropriate when more realistic ozone changes are employed, for example when imposing observed time-dependent ozone or using coupled-chemistry models. Evidence for the importance of ozone forcing associated with natural variability, which has impacts both in the stratosphere and the troposphere, will be shown using model results and a satellite-based ozone dataset.

An IPCC 'all-forcings' simulation of the past 25 years has been run using a coupled ocean-atmosphere model (HADGEM) with imposed, realistic, time-varying ozone and compared with results using the standard EESC-derived ozone trend. Only the simulations using realistic ozone capture the step-like feature in lower stratospheric temperatures observed after the two major volcanic eruptions. The origin of the step-like feature is investigated using a mechanistic model which suggests that the solar cycle variation in lower stratospheric ozone is a major contributor. Additionally, the inclusion of realistic time-varying ozone and a nudged QBO greatly increases the variability of parameters at the Earth's surface, which has implications for attribution studies. The simulation also captures a significant trend in mean sea level pressure reminiscent of the observed positive trend of the southern annular mode (SAM), which demonstrates that changes in the SAM even on decadal timescales are largely affected by stratospheric variability.

ID: 00101 ◀back

On the Role of Stratospheric Longwave Radiative Fluxes in Stratosphere-Troposphere Coupling

Presenter: Kevin Grise (kgrise@atmos.colostate.edu)

K.M. Grise, D.W.J. Thompson (Colorado State University, Fort Collins, USA),
Piers M. de F. Forster (University of Leeds, UK)

Most proposed mechanisms for stratosphere-troposphere coupling are based upon particular facets of atmospheric dynamics and neglect the role of radiative fluxes. Because both the Antarctic ozone hole and sudden stratospheric warmings produce sizeable temperature anomalies in the polar stratosphere, smaller, similarly-signed temperature changes in the upper troposphere during these events could be attributable to modulations in the longwave radiation downwelling from stratospheric levels. Fixed dynamical heating calculations demonstrate that these upper tropospheric temperature anomalies are likely caused by fundamentally different processes. The longwave radiative influence of the Antarctic ozone hole strongly peaks in December, exactly when the stratosphere-troposphere coupling signal becomes apparent in observations. In contrast, the observed upper tropospheric temperature features during a sudden stratospheric warming are more consistent with fluctuations in residual vertical velocity than longwave radiative fluxes. Overall, these results suggest that the mechanisms responsible for stratosphere-troposphere coupling differ greatly between the Antarctic ozone hole and sudden stratospheric warmings.

ID: 00445 ◀back

Stratospheric moistening by overshooting deep convection from cloud simulations: towards a global estimate

Presenter: Daniel Grosvenor (daniel.grosvenor@manchester.ac.uk)

D. Grosvenor, T. Choularton (University of Manchester, UK)

Recent observations reported in the literature have provoked renewed interest in the effects of deep convection on the water content of the stratosphere. Measurements of ice crystals in the lower stratosphere above tropical continental regions and frequencies of occurrence of overshooting deep convection suggest that such clouds inject ice into the stratosphere and that the moistening effect is likely to be greater than previously thought.

Here Cloud Resolving Model (CRM) simulations are presented of overshooting tropical convection over Brazil (22.36 S, 49.03 W), for various degrees of overshoot strength, in an attempt to quantify the effect on stratospheric moisture produced by different clouds. The vigour of the clouds was found to produce a large effect on the amount of moistening suggesting that trends in the number of severe overshoots could lead to stratospheric vapour trends if the overall convective effect is globally significant.

Extrapolations to a global effect based on satellite observations of tropical cloud frequencies indicate that moistening above the tropopause from convection similar to that in the strongest case simulated could account for up to ~134 % of the slow uplift flux of moisture across the tropopause by the Brewer Dobson circulation. This would make tropical convection the major contributor to stratospheric moisture and would mean that its contribution is ~6 times large enough to allow it to have caused the unexplained portion of the observed stratospheric moisture increases from 1954-2000. However, the weaker cases, which produced moistening of the stratosphere more consistent with the limited observations available (only one case), only predict enough moistening for trends of between ~11 and 42 years.

ID: 00434

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Climate change and Arctic winters: A dynamical feedback mechanism?

Presenter: Katja Grunow (Katja.Grunow@met.fu-berlin.de)

K. Grunow, U. Langematz (FU Berlin, Germany), M. Rex (AWI Potsdam, Germany)

This poster will be presented by Anne Kubin or Katja Matthes

The extent of conditions for the formation of Polar Stratospheric Clouds in the Arctic stratosphere (Vpsc) is very variable from year to year. The maximum value of Vpsc reached during the "coldest" winters increased significantly over the past four decades. This change has contributed to the large degrees of ozone losses that have been observed during some winters since the 1990ies (Rex et al., GRL, 2006).

The change in temperature required to produce the observed trend in maximum Vpsc is much larger than can be explained by the direct radiative effect of increasing greenhousegas (GHG) concentrations. We will carry out analyses of assimilated meteorological fields and of meteorological analyses from the Free University of Berlin (FUB) as well as analyses of data from 3d model runs to identify whether a potential dynamical feedback mechanism exists in the atmosphere, that amplifies the cooling signal from increasing GHG concentrations for dynamically quite Arctic winters.

ID: 00202 ◀back

Observed trends in stratospheric NO_2

Presenter: Aleksandr Gruzdev (a.n.gruzdev@mail.ru)

A. Gruzdev, A.M. Obukhov (Institute of Atmospheric Physics, Moscow, Russia)

Ten to twenty six years of spectrometric ground based measurements of the NO_2 column abundance during morning and evening twilights at seventeen stations of the Network for the Detection of Atmospheric Composition Change (NDACC) are analyzed for linear trends. The multiple regression model used for trend estimates takes into account the seasonal variation, the effects of the 11-year solar activity cycle, the quasi-biennial oscillation and the El Niño - Southern Oscillation, and the effects of the El Chichon and Pinatubo eruptions. Latitudinal dependence of the NO_2 trends reveals features peculiar for different latitude bands and regions in the southern (SH) and northern (NH) hemispheres. The annual trends statistically significant at 95% level are observed in the middle latitudes of the two hemispheres. These trends are positive in the SH middle latitudes but negative in the European sector of the NH middle latitudes, with module values generally within 6-12% per decade. In the Middle Asia (~ 40N), the positive annual trend of smaller magnitude is observed. The annual trend estimates in the low, high and polar latitudes of the two hemispheres are usually statistically insignificant except in the NH high latitudes (67-68N) where positive trends ~7% per decade are noted in Eastern Siberia and negative trends of about -2-4% per decade can be observed in Europe. Seasonal trend estimates can differ from the annual estimates. For example, in winter and spring, statistically significant NO_2 trends are observed in the SH and NH low latitudes (~20 degrees), positive in the SH and negative in the NH. Large positive trend of about 17% per decade is observed in spring in the Antarctic (~78S). Summer trends are usually positive in the high latitudes of the two hemispheres (60-68 degrees). Unlike at other stations, the signs of the seasonal trends at midlatitude stations of Lauder (New Zealand), Jungfraujoch and Zvenigorod (the both in Europe) do not depend on season and coincides with the signs of the annual trends (positive in the SH and negative in the NH). For interpretation of the observed NO_2 trends, an analytical model and a 2-dimensional numerical model were used. Effects of the increase in N_2O, the decrease in stratospheric ozone and temperature on stratospheric NO_2 trends were studied analytically. It has been shown that the total effect is sensitive to concrete conditions but is expected to be of positive or negative trend of small magnitude (~1% per decade or less). This has been confirmed by 2-D model calculations. The discrepancy between the observed and calculated NO_2 trends may in particular be due to regional (longitude) dependence of the observed trends which is not taken into account in the used models. The effect of the 11-year solar activity cycle on stratospheric NO_2 derived from the multiple regression analysis is negative in the middle latitudes of both the SH and NH: according to observations the NO_2 column in the middle latitudes is generally smaller during solar activity maximum than during solar activity minimum. The difference can approach 9% in the NH. The magnitude of the midlatitude effect decreases with latitude decrease and in the NH changes to positive values observed south to 40N. The significant negative solar activity effects in NO_2 is observed at stations in regions where significant positive effects in total ozone is observed.

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Statistical relation between the quasi-decadal and quasi-biennial variations in the equatorial stratosphere and similar variations in solar activity

Presenter: Aleksandr Gruzdev (a.n.gruzdev@mail.ru)

A.N. Gruzdev, V.A. Bezverkhny, A.M. Obukhov (Institute of Atmospheric Physics, Moscow, Russia)

We report statistical investigation of possible relations between the zonal wind velocity, temperature and ozone concentration in the equatorial stratosphere, on the one hand, and the 10.7 cm solar radio flux, on the other hand, at the quasi-decadal (QD) and quasi-biennial (QB) time scales using the high resolution cross-spectral analysis and cross-wavelet analysis techniques. For the analysis, monthly mean data of (1) the equatorial zonal wind velocity at pressure levels from 70 to 10 hPa from the Free University of Berlin (B. Naujokat), for the period 1953-2004, (2) the zonal mean zonal wind velocity and temperature at levels up to 1 hPa from National Meteorological Center (NMC), for the period 1979-1995, and (3) the daily mean zonal mean ozone mixing ratios at pressure levels from 50 to 0.5 hPa from SBUV measurements (version 8), for the period 1979-2003, are used. Spectral analysis shows significant coherency between zonal wind and ozone, and the 10.7 cm solar radio flux time series at the QB and QD periods almost at all levels (except for ozone above 5 hPa level at the QB period). The QD variations of the zonal equatorial wind above and below 20-30 hPa layer are generally in anti-phase to each other, and the QD wind variations above the 20 hPa level are approximately in phase to the 11-year solar cycle. The altitude dependences of the phase lags of the QB and QD wind variations relative to similar variations of the solar radio flux follow the descent of the equatorial quasi-biennial oscillation (QBO) taking into account the change of the QD wind variations to opposite phase below the 30 hPa level. Decreasing with altitude, the time lag of the QB wind variations approaches the value of a few months (more certainly, 1 month for the NMC data) at the 1 hPa level (near the stratopause). This nearly inphase relationship between the wind and solar QB variations suggests a possible influence of solar activity on the equatorial QBO, probably by radiative effects of solar ultraviolet variations. One important agent of these effects in the stratopause layer is ozone. Although the coherency between ozone concentration and solar variations at the QB scale significantly decreases above the 5 hPa level (~35 km), the coherency between variations of the meridional ozone gradient in the stratopause layer and solar flux variations is significant (about 0.8). The QB variations in the meridional gradient of ozone concentration are in anti-phase to the QB solar variations (the time lag is close to zero). Supposing that variations of the ozone gradient may result in similar variations in the meridional heating rate gradient, and probably in the temperature gradient, the associated variations in the zonal wind velocity should be approximately in phase to the QB solar variations (according to thermal wind equation) as just observed. Therefore these results indicate to ozone as a possible agent in the solar effect on the circulation in the neighborhood of the stratopause at the QB scale. Concerning the QD scale, three aspects of the 11-year solar cycle effect on the equatorial zonal wind are distinguished: (1) the influence on the zonal wind velocity described above, (2) modulation of the amplitude of the wind QBO in the middle stratosphere

(above 15 hPa), which increases with decrease in solar activity, and (3) the variations in the wind QBO period. The QD ozone concentration variations in the stratopause layer lag the QD solar variations by a few months (up to 4 months) being therefore approximately in phase to the 11-year solar cycle.

ID: 00224 ◀back

Evaluation of available data sets of stratospheric water vapor from ground based microwave radiometers

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California Institute of Technology, Pasadena, USA),
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Ground based microwave radiometers are able to retrieve middle atmospheric water vapor from as low as 25 km to as high as 80 km. Nowadays there are only a few instruments in operation, but the number is increasing as there is a big need for such instruments. Especially the aspect of long term measurements under stable conditions and also the good time resolution makes these measurements essential to study trends and the variability of middle atmospheric water vapor at all time scales.

In this work we evaluate the ability and the consistency of a selection of ground-based instruments, most of which are part of the Network for the Detection of Atmospheric Composition Change (NDACC). For this purpose we make use of the global measurements of stratospheric and mesospheric temperatures of the Aura/MLS instrument, which will be used, along with a common a priori, in the water vapor retrievals for all of the ground-based radiometers. Then we perform a cross validation between the ground-based instruments from 2004 to the present using the water vapor data sets from Aura/MLS and ODIN as references and investigate the latitudinal and temporal variations of the ground-based instruments.

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Trends and influences on the vertical structure and seasonal evolution of the Antarctic polar vortex: the apparent downward progression of anomalies does not imply an unexplained propagation

Presenter: Joanna Haigh (j.haigh@imperial.ac.uk)

J. Haigh (Imperial College, London, UK),
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Using multiple linear regression analysis we have studied the influence of various natural and anthropogenic factors on the vertical structure and temporal evolution of temperatures and geopotential heights at southern high latitudes and of the Southern Annular Mode (SAM). The data are monthly means from 1978 to 2006 of NCEP Reanalysis parameters between 60 and 90 ºS. The SAM index was calculated at each standard level between the surface and 10 hPa based on the weighting of the first EOF of geopotential heights. The factors investigated included ozone mass deficit (OMD, representing stratospheric ozone depletion), a linear trend (greenhouse gases), the QBO, solar variability, ENSO and stratospheric aerosol loading (explosive volcanic eruptions). We have also carried out a separate analysis of temperatures at 100, 50 and 30 hPa acquired from daily radiosonde ascents at Halley and South Pole between 1957 and 2006.

Similar to previous studies we can identify a cooling trend in the stratosphere in spring which appears to propagate downwards taking 2 to 3 months to reach the tropopause and progressing throughout the troposphere in summer. At most altitudes the long term trend is better identified with the time dependence of OMD than with a linear trend. The other factors, particularly a compound solar-QBO index, also show regions of maximum influence progressing downward in late spring.

We define the date of final warming at each pressure level as that when the second derivative (with respect to time) of temperature - or geopotential height - is a minimum. We find that the apparent downward progression in the cooling anomaly associated with OMD, and also that associated with solar variability and the QBO, is a natural consequence of the similar downward progression of the mean date of the final warming. Thus a cooler stratosphere is associated with a vertical structure, throughout the lower stratosphere and troposphere, which delays the final warming at all levels: no additional dynamical mechanisms need be invoked to explain the apparent downward progression.

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High Resolution Modelling of Climate Change Impact on Atmospheric Chemistry in Troposphere

Presenter: Tomáš Halenka (tomas.halenka@mff.cuni.cz)

T. Halenka, P. Huszar, M. Belda (Charles University, Prague, Czech Republic)

Recent studies show considerable effect of atmospheric chemistry and aerosols on climate on regional and local scales. For the purpose of qualifying and quantifying the magnitude of climate forcing due to tropospheric ozone on regional scale, the development of coupling of regional climate model and chemistry/aerosol model was started on the Department of Meteorology and Environmental Protection, Faculty of Mathematics and Physics, Charles University in Prague, for the EC 6FP Projects QUANTIFY and CECILIA. Climate is calculated using model RegCM while chemistry is solved by model CAMx. A preprocessor utility was developed on the department for transforming RegCM provided fields to CAMx input fields and format. Meteorological fields generated by RegCM drive CAMx transport and dry/wet deposition.

As the first step, the distribution of pollutants is simulated off-line in the model couple. There is critical issue of the emission inventories available when going to very high resolution of 10 km as scheduled in framework of CECILIA Project. Sensitivity of the model couple to the high resolution land use with emphasis to the possible changes of biogenic emissions and interactions with the other sources of emissions is studied for the EC projects QUANTIFY and CECILIA. Preliminary results of the ozone and its precursors concentrations are compared with measured data for reanalysis driven run. Long period runs of one way coupled climate/chemistry/aerosol models are scheduled in this project with further studies of on-line impact implementation in regional climate simulations. As the second step, on-line impact of the changes in the atmospheric composition is tested in the RegCM to see the potential of climate change impact air quality feedbacks.

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On the Relations between Stratospheric Circulation and Heliogeophysical Parameters

Presenter: Tomáš Halenka (tomas.halenka@mff.cuni.cz)

T. Halenka, J. Dosek (Charles University, Prague, Czech Republic)

The previous analysis of long-term behaviour of global circulation structures and their connections to some helio-geophysical influence, especially solar and geomagnetic activity has been updated recently including NCEP/NCAR reanalyses data up to 2007. To represent an objective characteristics of circulation patterns the spectral structure of both stratospheric and tropospheric fields is analysed in terms of spherical harmonics coefficients of expansions for selected parameters available. Temporal analysis of significant spherical harmonics is introduced as well as the comparison of their changes with respect to the changes of different sets of solar, geomagnetic and global circulation indices. A strong connections to a set of extraterrestrial parameters appear for some distinctive shapes of polar vortex as presented in composites for solar maximum and minimum in vertical structure. The natural variability connected to the extraterrestrial influence is studied as well as interannual variability with the emphasis to the QBO and ENSO. The systematic review of the appropriate correlations and linear regression analysis are presented and decadal variability and long-term trends are pointed out for some of wave numbers. Long-term changes in the variability of the circulation patterns are analysed by means of wavelet analysis as well.

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In Situ observations of the isotopic composition of vapor and condensed water in the tropical tropopause layer

Presenter: Thomas Hanisco (hanisco@huarp.harvard.edu)

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We present the first simultaneous measurements of the isotopic composition of total water (vapor + condensed) and water vapor in the tropical upper troposphere and lower stratosphere (TTL). The isotopic composition of the condensed phase is derived from the difference between the total and vapor phase measurements of the Harvard Hoxotope and ICOS instruments flown on the NASA WB-57 during TC4 flown in summer 2007 in Houston and Costa Rica. Observations in the tropical tropopause layer (TTL) and in mid-latitudes are used to identify mechanisms for water transport into the TTL and lower stratosphere. Observations within clouds over the Eastern Pacific show little difference between the vapor and condensed phase isotope ratios. The uniformity of isotope ratio is consistent with equilibrium thermodynamics and rapid exchange of water with the surrounding airmass. Observations of thin outflow clouds or streamers indicate a higher condensed phase ratio, consistent with transport of water from lower altitudes. Further observations of outflow from deep convection directly into the overworld stratosphere extend the observational database that supports a mechanism for adding water to the stratosphere that bypasses the tropical tropopause.

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The effects of Eurasian snow cover in General Circulation Models

Presenter: Steven Hardiman (sch28@cantab.net)

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October snow fall over Eurasia is strongly correlated with Northern Hemisphere wave activity flux from troposphere to stratosphere in December and sea level pressure in January. The suggested mechanism is that snow cover locally increases the zonal temperature gradient leading to an enhancement in planetary wave formation. These planetary waves propagate into the stratosphere and break, warming the stratospheric polar vortex. This perturbation of the vortex causes a Baldwin and Dunkerton like downward phase migration in the dynamical fields, reaching the surface in January.

In this work it is shown that, whilst present in observations, this mechanism is not reproduced by any of the IPCC AR4 GCMs. Thus these models do not capture what may be an important influence on Northern Hemisphere winter climate. We suggest and investigate possible reasons for the absence of this mechanism in GCMs.

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SPARC Initiative on Recent laboratory and theoretical studies on the ClOOCl photolysis and other halogen reactions

Presenter: Neil Harris (Neil.Harris@ozone-sec.ch.cam.ac.uk)

N.R.P. Harris (University of Cambridge, UK), M. von Hobe (FZJ, Germany)
and the 'Halogen Chemistry Laboratory/Theory Focus Group'

Until recently, the chemical processes responsible for the formation of the "Ozone Hole" in the spring polar stratosphere seemed to have been reasonably well understood: the chlorine reservoir species HCl and $ClONO_2$ are activated on the surfaces of polar stratospheric clouds, and the activated species – mainly ClO and its dimer ClOOCl – participate in the ClO-dimer and ClO-BrO catalytic cycles that rapidly destroy ozone at cold temperatures and high solar zenith angles. In 2007, a publication by Pope et al. suggested that the photolysis of ClOOCl – according to current belief the reaction that essentially governs the rate of catalytic ozone destruction – runs much slower than previously thought. The new result is clearly incompatible with atmospheric observations and implies that the known chemistry could no longer explain the formation of the ozone hole. Obviously this may have severe implications for our ability to predict future polar ozone depletion - in particular with stratospheric conditions expected to be altered by climate change.

A SPARC initiative 'The Role of Halogen Chemistry in Polar Ozone Depletion' has been set up to deal with this issue on a broad scale, with one focus on laboratory experiments and theoretical calculations of the ClOOCl photolysis rate and other key halogen reactions. This presentation will summarise the results presented and discussed at a workshop held in June 2008 in Cambridge. An overview will be given on laboratory and theoretical studies that are being carried out to test the Pope et al. results, and possible explanations for discrepancies between various studies will be presented. In addition, any new studies related to other key parameters such as the ClOOCl formation rate and the ClO/ClOOCl equilibrium constant will briefly be reviewed.

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Understanding the Relation between V(PSC) and Arctic Ozone Loss

Presenter: Neil Harris (Neil.Harris@ozone-sec.ch.cam.ac.uk)

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Chemical ozone loss in the Arctic vortex is extremely variable with losses varying from close to zero in warm winters to as much as 70% at certain altitudes. This inter-annual variability is caused by changes in atmospheric meteorology from year to year. While the overall notion that colder winters with larger volumes of polar strato-spheric clouds V(PSC) produce larger ozone losses directly follows from our photo-chemical understanding, the observed compactness and linearity of the relation be-tween the accumulated ozone loss and V(PSC) is surprising and to date it has not been satisfactorily understood.

Here we present a more detailed examination of the relationship. In particular we look at the altitude dependence, the definition of PSC boundary and the timing of the ozone loss within a winter. The relation is also found to hold well at specific altitudes within the range between 400 and 525K, only breaking down in the coldest Arctic winters as a result of de(re)nitrification. At altitudes where denitrification takes place, it leads to an enhancement of the ozone loss, while at lower altitudes where renitrifi-cation takes place, there is a reduction. The effect on the column loss is to large de-gree self-cancelling. Noticeable deviations can also occur when large ozone losses occur at unusually low altitudes (2005). We further argue that the compactness of the relation is largely determined by photochemical processes with longer time-scales than the rapid ozone depleting photochemistry and present box modelling studies to illustrate this.

The interplay of the photochemical processes can be quite subtle - for example, lar-ger ozone losses are caused by activation events early in winter than by later ones. This non-intuitive finding (implicitly present in all models) results from a competition between the photolysis rates of Cl_2O_2 and HNO_3, with the latter increasing more as the solar zenith angle increases. Later in winter the larger ozone loss rates caused by faster Cl_2O_2 photolysis are more than offset by the reduced duration of the period of ozone loss as a result of the acceleration in the deactivation of ClOx by the reaction of $ClO + NO_2 \rightarrow ClONO_2$ whose rate is limited by the formation of NO_2 through photolysis of HNO_3.

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Cold trap dehydration in the TTL characterized by SOWER observations in the tropical Pacific

Presenter: Fumio Hasebe (f-hasebe@ees.hokudai.ac.jp)

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N. Nishi (Kyoto University, Japan),
S. Ogino (JAMSTEC, Japan),
T. Shibata (Nagoya University, Japan),
S. Iwasaki (National Defense Academy, Japan),
K. Miyazaki (JAMSTEC, Japan), I. Matsui, A. Shimizu,
N. Sugimoto (National Institute for Environmental Studies, Japan),
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A basic understanding of the stratospheric water vapor starts with the idea that it must reflect the temperature history the air experienced before entering the stratosphere. Among many processes hypothesized, the ‘cold trap’ theory in which air parcels are dehydrated during the horizontal advection in the tropical tropopause layer (TTL) of the western tropical Pacific (Holton and Gettelman, 2001) is becoming widely accepted as a key dehydration process. The Lagrangian temperature history along trajectories has been conveniently used to study the dehydration of such air parcels (e.g. Jensen and Pfister, 2004; Fueglistaler et al., 2004, 2005; Fueglistaler and Haynes, 2005). The effectiveness of trajectory-based estimation, however, still awaits support from observational data. Aircraft measurements such as those conducted during the Pre-AVE have shown water vapor profiles with high vertical resolution (Richard et al., 2006) over tropical Central America. However, there is little in situ water vapor data in the TTL over the western tropical Pacific where the ‘cold trap’ dehydration is supposed to be taking place. The Soundings of Ozone and Water in the Equatorial Region (SOWER) project is intended to have ozone and water vapor profiles in the troposphere and the lower stratosphere in the tropical Pacific by radiosonde observations. It has been operating chilled-mirror hygrometers such as NOAA frostpoint hygrometer, Snow White and the University of Colorado Cryogenic Frostpoint Hygrometer (CFH, Voemel et al., 2007) to accurately measure water vapor profiles since 1998. It has also operated lidars to observe thin cirrus clouds simultaneously with in situ water vapor measurements (Shibata et al., 2007). A bundle of isentropic trajectories are used to characterize the life history of air parcels observed by water vapor sondes. Variations of the observed water vapor mixing ratio (OMR) in the TTL are examined in terms of the origin of the air parcels and by the minimum saturation mixing ratio (SMR_{min}) of the air parcels being exposed during horizontal advection. A preliminary analysis showed that the OMR in the lower TTL was about twice as much as SMR_{min} (Hasebe et al., 2007). Mutual relationships between the two are further examined by updating the data taken at Tarawa (1N, 173E), Biak (1S, 136E), Kototabang (0S, 100E), Hanoi (21N, 106E), and San Cristobal (1S, 90W). Those features are interpreted in terms of meteorological conditions such as local convective activity, isentropic levels, season and ENSO status. The comparison on

the basis of each sounding between the water profile and corresponding trajectories provides useful information on the details of dehydration during the advection. The discussion could be more specific when the same air parcels are sampled by two or more sonde soundings (water vapor match). Some of such examples are discussed after applying appropriate screening procedures to better confirm the match condition.

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A comparison of trends in the vertical distribution of ozone in true and equivalent latitude coordinates: implications for radiative forcing at polar latitudes

Presenter: Birgit Hassler (b.hassler@niwa.co.nz)

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A new database of high vertical resolution trace gas and aerosol measurements, with global coverage, has been developed. It includes data from different satellite (HALOE, POAM II and III, SAGE I and II) and ground-based measurement systems (ozone sondes). Measurements of temperature and ozone (the primary products), as well as measurements of aerosol extinctions, NO_2 and H_2O were added if the measurements passed multiple, very strict quality checks. For every measurement an error estimate is also stored. To facilitate analyses in different coordinate systems, three instances of the data base have been created defined by the most commonly used latitudinal and vertical coordinates: geographic latitude and altitude (in 1 km steps), geographic latitude and pressure (pressure levels given by $p=p_0 \exp(-j/7)$, j=1...70), and equivalent latitude and potential temperature (8 levels spanning 300K to 650K). For measurements stored in the first two instances of the database, corresponding equivalent latitude values were also stored.

Decreases in polar stratospheric ozone during the 1980s and 1990s affected radiative forcing during this period with associated changes in atmospheric dynamics. To date, calculations of this radiative forcing have used ozone trends calculated as a function of geographic latitude and altitude as input. The calculation of zonal mean ozone close to the vortex edge in geographic latitude flattens the steep horizontal gradients in ozone across the vortex edge because of mixed sampling of inner and outer vortex air. This is likely to lead to an underestimate of ozone trends on the poleward side of the vortex edge and an overestimate of ozone trends on the equatorward side of the vortex edge. In turn this may have implications for calculations of ozone radiative forcing in the polar regions. In the tropics and mid-latitudes where gradients in the ozone trend are flat, trends derived from geographic latitude zonal mean ozone are expected to be similar to trends derived in equivalent latitude zones.

To test the effects of the choice of latitude coordinate, a linear least-squares regression model was applied to monthly mean zonal mean ozone (10º latitude bands), on a 1 km vertical grid, where the zonal means were calculated first in geographic latitude coordinates and then in equivalent latitude coordinates. In the regression model most known sources of stratospheric ozone variability, such as stratospheric halogen loading, the QBO, the solar cycle, volcanic effects and an annual cycle, were included. Differences between the ozone trends in the two different coordinate systems will be presented and the implications of those differences for radiative forcing calculations will be discussed.

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Toward a global view of extratropical UTLS tracer distributions

Presenter: Michaela Hegglin (michaela@atmosp.physics.utoronto.ca)

M.I. Hegglin (University of Toronto, Canada)

The upper troposphere/lower stratosphere (UTLS) plays a key role in the climate system due to strong interactions between chemical tracer distributions, radiation, and dynamics. Particularly ozone and water vapor (and cirrus clouds) exert a strong radiative forcing in the UTLS. Yet their spatial distributions are affected by transport processes on a wide range of length and time scales. In other words, distributions of ozone and water vapor both shape and are shaped by climate. Most of our knowledge about UTLS tracer distributions and how they are affected by different transport processes stems from high-resolution and high-precision aircraft measurements which, however, are limited in space and time. The new generation of satellite instruments allows us to move toward a global view of UTLS tracer distributions. This talk will present recent results obtained from the ACE-FTS satellite, discuss issues of validation of space-based measurements, and potential resolution and sampling limitations. It will also delineate some key science questions and how these can be addressed by a combination of models and measurements.

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A fine Structure of Atmospheric (static) Stability near the Tropopause over Kototabang, West Sumatera, Indonesia Based on the Equatorial Atmosphere Radar (EAR), the Boundary Layer Radar (BLR), and Radiosonde Data Analysis

Presenter: Eddy Hermawan (eddy_lapan@yahoo.com)

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This paper is mainly concerned to the analysis of atmospheric stability especially near the tropopause layer as well as the variaton on wet and dry seasons over Kototabang area, West Sumatera (0.2ºS; 100.32ºE) using Equatorial Atmosphere Radar (EAR), Boundary Layer Radar (BLR) and radiosonde data. The Observation of atmosphere stability nearby the tropopause layer is very important, considering its function as a buffer of an air masses exchanges from troposphere to stratosphere layer and so the contrary, which is usually called as Stratosphere - Troposphere Exchange (STE). Data analysis divide in two stages, firstly is the short periode data analysis from April, 10th until May, 9th of 2004 with the main purpose of validation between vertical echo power (VEP) from EAR and Brunt-Väisälä Frequency Squared (N^2) from radiosondes. The result shows that the average of correlation coefficient from 9 observations is 0.81. This point shows EAR's ability to replace radiosondes data to inform atmosphere stability. The second stages, contain the long periode data analysis from June and November in the years of 2001 until 2004. Both month representing dry and wet seasons based on monthly Global Precipitation Climatology Project (GPCP) data over 25 years (1979-2004) observations in Sumatera Island area, specifically for Kototabang. Final result shows that the tropopause height variation in dry season (November) is easier to identify. In the other side, zonal wind dominant on November compare to vertical wind on July. This situation probably because the strong monsunal effect in wet seasons. The tropopause height is also estimate have no significant effect to rain intensity.

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Analysis of Relationship between Total Precipitable Water and Radar Reflectivity

Presenter: Eddy Hermawan (eddy_lapan@yahoo.com)

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Y. Handayati (Geophysics and Meteorology Department, Bandung Institute of Technology, Indonesia)

This paper is mainly concentrated to the correlation between Total Precipitable Water (TPW) on one single column of the vertical air mass and radar reflectivity (Z) over Kototabang (0.2°S; 100.32°E), Bukittinggi, West Sumatera based on to the analysis of Radio Acoustic Sounding System (RASS) and Boundary Layer Radar (BLR) data during the Coupling Processes of Equatorial Atmosphere (CPEA) Campaign I from April 10 to May 9, 2004 was going on. We firstly reviewed the basic concept of TPW using the Weisner method to estimate the TPW value from the radiosonde data, We reviewed the basic concept of RASS and BLR system also, especially on the Z data analysis. By arranging the mean value of RASS data every 10 minutes and 150 meter in height, respectively, we estimated the TPW values from the RASS data. By analysing the Cross Correlation Function (CCF) of both values taken from SPSS software version 13, we found a good agreement between TPW and Z parameter, especially on 5 May, 2004. The correlation values are 0.05 and 0.61 at around 2.7 and 2.25 km, respectively. Although, the maximum correlation value is only 0.61, but this is still good enough to describe the correlation between TPW and Z.

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The Utilization of Aspect Sensitivity Method in Determining the Tropopause Height Variation During the Active Phase of MJO Phenomenon Passing over Kototabang, West Sumatera, Indonesia

Presenter: Eddy Hermawan (eddy_lapan@yahoo.com)

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This paper is mainly concerned to the utilization of aspect sensitivity (Pv/Po) method to define the tropopause height over the equatorial Indonesia, nearby Kototabang (0,2oS; 100,32oE), Bukittinggi, West Sumatera using the Equatorial Atmosphere Radar (EAR), especially during the Coupling Processes Equatorial Atmosphere (CPEA) Campaign I in 2004 was being done. It is very important to be done since the tropopause is the buffer layer between troposphere and stratosphere (and also contrary) that usually called as the Stratosphere-Troposphere Exchanged (STE) (Holton, 1996).

Validation's results with the radiosonde data shows that Pv/Po relatively higher than radiosonde data. They are about 712 meter and 961 meter for Cold Point Tropopause (CPT) and Lapse Rate Tropopause (LRT) version, respectively. The mean difference between CPT and LRT itself is about 248 meter. This is enough valid considering to the maximum difference between of them not more 500 meter Haynes dan Shepherd, 2001). This result then be applied in determining of tropopause height variation over Kototabang, especially when the Madden-Julian Oscillation (MJO) passed over this region from November to December 2001. It shown that there are no significant differences between the active phase and in-active phase of MJO on the tropopause height determination. They are 17.98 km and 17.73 km, respectively.

The most important point of this study is the tropopause height variation looks larger during the active phase than in-active phase of MJO. We suspect it caused by the turbulence activity nearby the tropopause layer. To get the better understanding of tropopause height variation, especially with good time and spatial height resolution, the utilization of EAR and other instruments at Kototabang are very needed.

ID: 00262

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Tuning the orographic and non-orographic gravity wave drag schemes with the Vorcore long-duration balloon observations

Presenter: Albert Hertzog (albert.hertzog@lmd.polytechnique.fr)

A. Hertzog, F. Lott, G. Boccara, F. Vial (Laboratoire de Météorologie Dynamique, IPSL/CNRS, France)

The Vorcore long-duration balloon campaign (Sept. 2005 - Feb. 2006) provided results on the geographical distribution of gravity-wave momentum fluxes entering in the stratosphere around 50 hPa. It allows to separate the contribution of the orographic and non-orographic gravity waves to these fluxes. It also gives information about the intermittency of gravity waves over Antarctica and the surrounding Oceans (Hertzog et al, 2008). These information are employed to constrain the orographic (Lott and Miller, 1997) and non-orographic (Hines, 1997, Manzini et al. 1997) gravity-wave drag parameterization schemes used in the LMDz general circulation model (Lott et al. 2005). In this presentation, the parameterization schemes are run offline, using the ECMWF analyses, and tuned to fit the balloon observations.

References

Hertzog, A., et al., 2008, J. Atmos. Sci, in press.
Hines, C. O., 1997, J. Atmos. Solar Terr. Phys., 59, 371--386.
Lott, F., and M. Miller, 1997, Q. J. R. Meteorol. Soc., 123, 101--127.
Lott, F., et al., 2005, Clim. Dyn., 25, 851-868.
Manzini, E., et al, 1997, J. Geophys. Res., 102, 25,751--25,762.

ID: 00263 ◀back

Mesoscale simulations of gravity waves observed during VORCORE

Presenter: Albert Hertzog (albert.hertzog@lmd.polytechnique.fr)

A. Arsac, R. Plougonven, A. Hertzog, L. Guez and F. Vial (Laboratoire de Météorologie Dynamique, IPSL/CNRS, France)

The VORCORE campaign (September 2005-February 2006) has provided a unique dataset for the investigation of gravity waves and the associated momentum fluxes in the lower stratosphere (16-19 km) above Antarctica. Because the measurements were made with superpressure balloons that behave as quasi-Lagrangian tracers, they provide direct estimates of key quantities such as the intrinsic frequencies of the gravity waves. In order to investigate further the gravity wave field, numerical simulations with the mesoscale meteorological model Weather Research and Forecast have been conducted on a domain covering the Antarctic continent, for several periods during the VORCORE campaign. The VORCORE dataset is used to test several modelling issues:

1) what part of the gravity wave spectrum can we simulate with available resolutions (typically 15 to 20 km in the horizontal, and more than a hundred levels in the vertical, up to the mid-stratosphere)?
2) How does the agreement between model and observations vary for different types of gravity waves (e.g. orographic waves / non-orographic waves, low-frequency / high frequency)?
3) How sensitive are the simulated waves to different parameters of the model setting (length of simulation, height of model top, sponge layer, parameterizations for boundary layer)?

Simulations have been conducted in different settings to bring answers to these questions and determine how close an agreement we can expect to find between observations and simulations. To the extent that such simulations reproduce quantitatively well the gravity wave field in the locations where observations are available, they can be used to investigate other aspects of the wave field. For example, a more global view of the momentum fluxes, their variability and their evolution with height can be obtained. Also, the sources of the gravity waves, in particular of non-orographic inertia-gravity waves, can be investigated.

ID: 00265

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A case study of an orographic gravity wave above the Antarctic Peninsula

Presenter: Albert Hertzog (albert.hertzog@lmd.polytechnique.fr)

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The observations gathered during the Vorcore long-duration balloon campaign in Antarctica are used to document an intense mountain wave above the Antarctic Peninsula. This large amplitude wave induced peak-to-peak vertical displacements of 1.7 km and temperature perturbations of 17 K in the lower stratosphere. The observations are complemented by a high-resolution simulation performed with the WRF mesoscale model. The simulations succeeded in reproducing a wave with characteristics (wavelengths, amplitudes, momentum flux) similar to those inferred from the balloon observations. The simulations and a radiosounding made downstream of the mountain provide evidence that the wave is breaking through static instability in the lower stratosphere. The frequency of such wave events above the Peninsula, and their consequences on the circulation in the stratosphere (forcing of the mean flow, generation of secondary wave) will be discussed.

ID: 00136

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How is the potential vorticity distribution in the stratosphere established?

Presenter: Yvonne Hinssen (y.b.l.hinssen@uu.nl)

Y. Hinssen, A. van Delden (Utrecht University, The Netherlands)

Because potential vorticity (PV) is the central dynamical variable in the atmosphere, it is of great importance to know what processes are responsible for establishing the PV-distribution in the atmosphere. Through the invertibility principle, PV determines the wind and temperature distribution. From the solution of the invertibility principle we find that the wind near the Earth's surface is determined for a significant part by the PV in the lower stratosphere. It is thought that human-induced changes in the concentration of ozone, carbon dioxide and water vapour are responsible for changes in the PV-distribution and thus for changes in the atmospheric circulation that have occurred over the North Atlantic in the past 20 years.

Using a primitive equation model with simplified physics we evaluate the role of radiation, the hydrological cycle and isentropic mixing due to the breaking of planetary waves in determining the PV-distribution in the atmosphere in different seasons. We compare the stratospheric PV-distribution produced by this model with the ERA-40 climatology.

Among other we find that the concentration of well-mixed greenhouse gases affects the PV poleward of 40ºlatitude, especially over the winter pole. Absorption of Solar radiation by ozone is very important in determining the PV above a height of about 30 km (10 hPa). Release of latent heat is very important in determining PV in the (sub)tropical upper troposphere and lower stratosphere. Mixing due to wave-breaking is most important below 10 hPa in the winter hemisphere.

ID: 00386 ◀back

Conditions for Polar Stratospheric Cloud formation in the Canadian Middle Atmosphere Model

Presenter: Peter Hitchcock (peterh@atmosp.physics.utoronto.ca)

P. Hitchcock, T. Shepherd, C. McLandress (University of Toronto, Canada)

Observations of the Arctic stratosphere over the past four decades suggest that the thermodynamic conditions required for PSC formation have become increasingly widespread in the northern hemisphere (Rex et al. GRL 2004, 2006). The trend is only apparent during winters with a cold, undisturbed Arctic stratosphere. The mechanism responsible remains unclear. We analyze the polar stratospheric temperatures in an ensemble of three, 150 year integrations of the Canadian Middle Atmosphere Model (CMAM), an interactive chemistry-climate model which simulates ozone depletion and recovery, as well as climate change. In the Antarctic stratosphere, cold temperature extremes required for PSC formation increase in the model as ozone is depleted, but remain steady through the twenty-first century as trends from ozone recovery and climate change balance out. The trend in cold temperature extremes in the model Arctic through the latter half of the twentieth century is weaker and less statistically robust than the observed trend. It does not continue in the model future. In general, the response of the CMAM in the Arctic stratosphere to radiative forcings is much weaker than the response in the Antarctic. Ozone depletion is weaker in the modelled Arctic than in observations and much weaker than in the Antarctic. Cooling in the Arctic winter due to climate change is compensated by an increase in dynamically driven downwelling over the pole.

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QBO in solar wind variability and its relation to ENSO

Presenter: Klemens Hocke (klemens.hocke@iap.unibe.ch)

K. Hocke (University of Bern, Switzerland)

The Interplanetary Monitoring Platform (IMP) performed long-term monitoring of the solar wind at about 30 Earth's radii which is the orbit altitude of the IMP-1 to IMP-8 satellites from 1963 to 2000. The solar wind observations are supplemented and continued by other satellites such as ISEE, Wind, and ACE. We analyze the time series of solar wind speed and the times series of solar wind speed variability (periods 3-50 days). In agreement with Kulcar and Letfus (1988), we find strong QBO variations in both time series. How to explain the strong QBO in the solar wind series? The observed solar wind speed and its variability increase if corotating magnetic flux ropes reach from solar coronal holes to the Earth. In addition the pointing of the Earth's magnetic dipole (relative to the magnetic flux rope vector) seems to play a crucial role for acceleration or deceleration of the solar wind plasma in the near Earth's environment. Thus the solar wind at the Earth has annual, semi-annual, 11- and 22-year variations due to periodic changes of the configuration between magnetic flux ropes and the Earth's magnetosphere. A biennial oscillation (BO) arises from the annual oscillation. The interaction of the BO with the 11-year solar cycle explains the QBO which we found at 0.6 cycles per year in the bispectrum of the solar wind variability. The amplitude of the QBO of the solar wind variability is closely related to the ENSO index showing major maxima in 1983, 1992 and 1997. Possibly the solar wind variability induces anomalous winds in the polar atmosphere with influence on global atmospheric circulation processes (Troshichev et al., 2005).

ID: 00413 ◀back

Linear trend and solar cycle in stratospheric ozone profiles observed by the GROMOS microwave radiometer in Switzerland

Presenter: Klemens Hocke (klemens.hocke@iap.unibe.ch)

K. Hocke, N. Kämpfer (University of Bern, Bern, Switzerland)

The ground-based microwave radiometer GROMOS at Bern continuously measures ozone profiles from 20 to 70 km since November 1994. The ozone series have been reprocessed with the retrieval software Qpack on fixed pressure levels. The series have only minor data gaps, and the measurements cover all seasons and daytimes. By means of multiple linear regression, we derive the amplitudes and phases of the solar cycle, QBO, annual and semi-annual oscillation and the linear trend as function of pressure level for the time interval from January 1995 to January 2008. The solar cycle effect at Bern is stronger (about twice) than the zonal average of the solar cycle in SAGE II observations. The solar cycle and the annual oscillation of ozone have similar phase reversals at about h=40 km. The linear trend changes between -5% at 50 hPa and +4% at 10hPa. Ambiguities and shortcomings of the multiple linear regression method are addressed.

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Solar Cycle Variation of Temperature and Ozone in the Tropical Lower Stratosphere: Improved Empirical Tests of the Kodera Mechanism

Presenter: Lon Hood (lon@lpl.arizona.edu)

L.L. Hood, B.E. Soukharev (Lunar and Planetary Laboratory, University of Arizona, Tucson, USA)

This work will be presented together with ID 00375 by Randall et al.

Recent work has shown that tropospheric climate responses to solar induced changes in the stratosphere are sensitive to perturbations in tropical lower stratospheric temperature (e.g., Haigh et al., J. Climate, 2005). Observations (e.g., Soukharev and Hood, JGR, 2006; Labitzke et al., JASTP, 2002) indicate a significant increase in both ozone and temperature in the tropical lower stratosphere (~ 50 - 100 hPa) from solar minimum to maximum. It is therefore important to (a) verify the existence of the indicated lower stratospheric ozone and temperature perturbations; and (b) identify the cause(s) of these perturbations using both mechanistic models and full chemistry climate model simulations.

We have previously investigated whether the observed increases in tropical lower stratospheric ozone and temperature under solar maximum conditions could be caused by reductions in the ascending branch of the meridional Brewer-Dobson (B-D) circulation (Hood and Soukharev, JAS, 2003). In this mechanism, which was originally proposed by Kodera and Kuroda (JGR, 2002), the main direct effect of solar UV heating on stratospheric dynamics is to modify the circulation in the upper stratosphere and lower mesosphere so that the wintertime stratopause subtropical jet persists longer and reaches a higher speed. This in turn causes upward propagating planetary waves to be deflected poleward, producing an increase in Eliassen-Palm (E-P) planetary wave flux divergence at midlatitudes and an associated weakening of the B-D circulation. The weakened tropical upwelling rate near solar maximum yields positive temperature anomalies especially in the lowermost equatorial stratosphere where the radiative relaxation time is long.

In this paper, this proposed mechanism is tested further using monthly mean meridional eddy heat flux (a close proxy for E-P flux divergence). Evidence is obtained for a decadal variation of deseasonalized eddy heat flux at a series of pressure levels near 60N where the seasonal cycle in wave forcing has a maximum amplitude. We investigate whether these decadal variations are sufficient to explain the observed decadal tropical temperature and ozone perturbations using a simplified mechanistic model together with empirical relationships between extratropical eddy heat flux and equatorial temperature and ozone tendencies observed on shorter time scales. The empirical analysis is improved over that of Hood and Soukharev (2003) by (a) considering only NH heat flux data where planetary wave amplitudes are larger and the data are more reliable; (b) considering a wider range of ozone photochemical lifetimes and radiative lifetimes in the mechanistic model; and (c) using heat flux data at the pressure level and latitude where short-term changes in heat flux have the largest tropical upwelling response.

ID: 00082 ◀back

Effects of EPP-NO_x and Solar UV Variations on Ozone in the Polar Stratosphere: Correlative Studies Using UARS HALOE and SBUV(/2) Data

Presenter: Lon Hood (lon@lpl.arizona.edu)

L.L. Hood, B.E. Soukharev (Lunar and Planetary Laboratory, University of Arizona, Tucson, USA)

In this paper, we report correlative studies of satellite remote sensing measurements of high-latitude odd nitrogen (NOx) and ozone versus a series of solar and geomagnetic indices. One objective is to evaluate the relative importance of solar proton events (SPEs) and magnetospheric energetic electron precipitation (EEP)in producing downward descending NOx in the springtime polar stratosphere on interannual time scales. A second objective is to evaluate the relative importance of energetic particle precipitation induced changes in NOx (EPP-NOx) and changes in solar ultraviolet (UV) spectral irradiance on polar ozone as a function of season. For this purpose, we employ NOx and ozone profile data covering a 12-year period from the Upper Atmosphere Research Satellite (UARS) Halogen Occultation Experiment (HALOE) instrument and a merged ozone profile data set covering a 25-year period based on measurements from the Solar Backscattered Ultraviolet (SBUV) instruments on Nimbus 7 and a series of NOAA operational satellites (S. Frith and R. Stolarski, private communication). Included among the solar and geomagnetic indices are the Auroral Ap index, solar wind plasma speed, solar proton atmospheric ion production rates (C. Jackman, private communication), and the Mg II solar UV index.

In the Southern Hemisphere (SH) where correlations are most significant, results show that the high-latitude spring HALOE NOx data for the upper stratosphere and lower mesosphere correlate best (e.g., 0.86 at 1 hPa) with the Ap index, a measure of magnetospheric electron precipitation. Correlation coefficients are significantly reduced when either the solar proton ion production rate (R = 0.54) or the Mg II index (R = 0.45) are assumed as the forcing variable. Therefore, although SPEs can dominate over short time periods or even a single 3-month period, EEP appears to mainly determine interannual NOx variability over the whole 12-year interval analyzed here. Correlation coefficients continue to be significant down to pressure levels of about 10 hPa. Also in the SH, a negative correlation is obtained between HALOE ozone (sunrise plus sunset) and NOx (sunset) data at high latitudes during spring. This negative correlation is also significant down to about the 10 hPa level and is interpreted to be a consequence of direct photochemical destruction of ozone by downward descending EPP-NOx. However, during the summer season, evidence is obtained for a positive solar cycle variation of SBUV ozone at high latitudes near the stratopause. This summertime ozone variation at high altitudes is interpreted to be a consequence of solar UV-induced changes in the ozone production rate.

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Stratosphere-troposphere singular vectors studied in terms of potential vorticity

Presenter: Jan-Otto Hooghoudt (otto.hooghoudt@knmi.nl)

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In a previous study, we have calculated initially ‘pure’ stratospheric singular vectors (confined between 10 and 100 hPa), which were optimized to maximize the total energy in the low troposphere (below 500 hPa) after 5 days. For these computations a recent version of the ECMWF model with 60 levels in the vertical and the top level at 0.1 hPa was used. This study has shown that in terms of the total energy norm, amplification factors above 50 occur for these SV’s and that, initially, their vertical structure is tilted against the background wind shear. Further it appears that this kind of SV’s quickly transfer perturbation energy to tropospheric regions, were baroclinic instabilities are likely to occur.

To quantify these results in a more thorough way, in this study we have analyzed the above described SV’s in terms of Potential Vorticity (PV). We have found that the total energy below 500 hPa is maximized by a two-stage process. During the first half of the integration, PV anomalies grow around 300hPa due to the advection of background PV by the anomalous wind field of the stratospheric PV anomaly. In the second half, the PV-anomalies around 300 hPa (while they continue to gain in strength) are responsible for the growth of PV-anomalies at the surface.

We will use quasi-geostrophic PV theory to explain the temporal behavior of the PV anomalies and to understand the two-stage growth process. Further the PV distribution and its development will be studied in terms of wave action density and the divergence of Eliassen- Palm flux.

ID: 00417

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Trace gas observations and their relation to the tropopause definition

Presenter: Peter Hoor (hoor@mpch-mainz.mpg.de)

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We use airborne in-situ observations of various trace gases obtained over the last 15 years to investigate the distribution of distinct species at the tropopause. Special focus will be given to CO, ozone and water vapor in the tropopause region. We use only measurements during ascent and descent of the aircraft when vertical profiles of trace gases and tempertaure were obtained. Depending on the choice of the tracer different definitions for e.g. the ExTL (extratropical transition layer) arise. We will investigate the role of different trace gas properties and which role they play for the definition of the ExTL. In addition the importance of tropopause definitions and tropopause based coordinate systems will be adressed. Special focus will be given to the static stability and potential vorticity and their relation to the trace gas distribution.

ID: 00412

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Spatial structures of mesoscale gravity waves derived from COSMIC GPS occultation data

Presenter: Takeshi Horinouchi (horinout@rish.kyoto-u.ac.jp)

T. Horinouchi, Y. Azuma, T. Tsuda (Kyoto University, Japan)

COSMIC/FORMOSAT-3 satellites have been providing GPS radio occultation (RO) data in unprecedented sampling density. The six low-earth-orbit (LEO) satellites were launched with a rocket in April 2006, so they were initially on one orbit. Raising the altitudes one by one, the satellites were dispersed slowly, but after about a year since the launch, three of them were still on the same orbit. Therefore, data density was especially high in the vicinity of the orbit over about a year.

In earlier studies, GPS RO data have been used to study global distribution of atmospheric gravity waves, where gravity-wave signals were derived from vertical profiles associated with RO events. In this study, it is found that the tangent points of the occultation events observed by the COSMIC satellites on the same orbit are often aligned closely. (Also, there are interesting features in the distribution of RO events, which are to be presented.) By using the features, a large number of vertical cross sections of temperature were obtained, and spatial structures of mesoscale gravity waves were studied. Many case studies revealed gravity-wave features such as wavelengths and propagation directions from low to high latitudes (on, for example, the waves in low latitudes and around the edge of the polar vortex). In terms of statistics, it is shown that a large fraction of gravity waves in the low-latitude lower stratosphere have wavelengths greater than 2000 km even in the meridional direction.

We have also developed a method to derive girdded dataset along the swath of multiple LEO satellites. We will present its results and statistical features, along with case studies on the three-dimensional structures of gravity waves.

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The Transport of Bromine & Iodine to the Stratosphere: 3-D Modelling of Very Short-Lived Source Gas Degradation in the Upper Troposphere

Presenter: Ryan Hossaini (m.chipperfield@see.leeds.ac.uk)

R. Hossaini, M. Chipperfield (University of Leeds, UK)

Very short-lived halogenated source gases (e.g. $CHBr_3$, CH_2Br_2) are known to provide an additional supply of bromine to the stratosphere (e.g. Ko, Poulet et al., WMO, 2003). Deep convection in tropical regions allows for the rapid transport of such gases from the boundary layer to the upper troposphere. From here the source gas and/or degradation products may enter the lower stratosphere via either the source gas injection (SGI) or the product gas injection (PGI) pathways respectively (e.g. WMO, 2007). The additional bromine supplied from the so-called very short-lived species (BryVSLS) is poorly quantified. Current estimates range from 3-8 pptv. VSLS are currently neglected in most 3-D chemical transport models (CTMs) and chemistry-climate models (CCMs). This omission needs to be addressed to allow an assessment of their contribution to the stratospheric halogen budget, and their effect on ozone.

We will present results from a study using the TOMCAT/SLIMCAT 3-D CTM (e.g. Chipperfield, 2006). We have developed a scheme describing the tropospheric degradation of a number of bromine and iodine-containing VSLS, including $CHBr_3$, CH_2Br_2, CH_3I and CH_2I_2. This scheme was included in a version of the 3-D model with simplified chemistry for the halocarbon source gases. This model was then used to assess the relative amounts of the surface-emitted species which reach the stratosphere (BryVSLS and IyVSLS) by both the SGI and PGI routes. Following this, we used a full chemistry version of the CTM to study the impact of the estimated extra BryVSLS on stratospheric ozone.

ID: 00320 ◄back

Modelling of transport processes in the tropical upper troposphere and lowermost stratosphere

Presenter: Christopher Hoyle (c.r.hoyle@geo.uio.no)

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As part of the SCOUT-O3 (Stratospheric-Climate Links with Emphasis on the Upper Troposphere and Lower Stratosphere) project, a model intercomparison was carried out, with the aim of assessing current shortcomings in the representation of tropical tracer transport. The intercomparison included global chemistry-transport models, mesoscale models as well as climate-chemistry models. Using idealised tracers with a range of lifetimes, the effects of processes such as boundary layer mixing, convective transport, advective transport, and wet deposition on tracer distributions were compared. Initial results indicate large differences in the vertical profile of species with a source at the surface, resulting from different boundary layer mixing schemes. Wet deposition is also found to lead to large differences between the models, in the fraction of soluble species reaching the upper troposphere and lower stratosphere. The use of species such as ozone, carbon monoxide and ethane, with simplified chemistry, allows a qualitative comparison with in situ measurements carried out during the various SCOUT-O3 measurement campaigns.

ID: 00211 ◀back

Quantifying key sensitivities in the interaction between climate change and Antarctic ozone depletion in observations and CCMs

Presenter: Petra Huck (p.huck@niwa.co.nz)

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A key process in the Antarctic stratosphere that links changes in climate to reductions in ozone is the heterogeneous activation of chlorine on polar stratospheric clouds (PSCs) and the subsequent destruction of ozone by the activated chlorine. Increases in greenhouse gases cool the Antarctic stratosphere, increasing the frequency and ubiquity of PSCs, and promote ozone destruction. On the other hand, increases in dynamical activity in the Antarctic stratosphere, for example increases in wave disturbances of the vortex edge and increases in the Brewer-Dobson circulation, would warm the Antarctic stratosphere and reduce ozone destruction. Evaluating the ability of chemistry-climate models to adequately simulate this key process is central to their success in projecting the recovery of the Antarctic ozone hole.

To this end two semi-empirical models have been developed which capture key sensitivities in the interaction between climate change and Antarctic ozone depletion. The first semi-empirical model describes the time rate of change of activated chlorine (ClOx) as a function of the fractional area of the Antarctic polar vortex covered by PSCs, the fractional area exposed to sunlight, and total chlorine loading (Cly). The second semi-empirical model describes the time rate of change of ozone mass deficit (OMD), a measure of springtime chemical ozone loss over Antarctica. This pair of semi-empirical models incorporates the principal physical and chemical processes responsible for stratospheric ozone destruction within the Antarctic polar vortex. The models are trained on observations and/or model output of temperature, ClO and OMD and incorporate climate feedback effects and natural variability. By applying the semi-empirical models to both observations and CCMs, and by comparing the model coefficients between CCMs and observations, the CCMs can be subjected to a process oriented evaluation that disaggregates the effects of the chemistry and climate drivers of Antarctic ozone depletion.

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Predictability of stratospheric circulations during recent sudden warming events

Presenter: Tomoko Ichimaru (ichimaru@geo.kyushu-u.ac.jp)

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It is well known that the variability of stratospheric circulations is amplified during stratospheric sudden warming events. Our former studies (e.g., Mukougawa et al., 2005; Hirooka et al., 2007) showed that some warming events are predictable with a long lead time of more than two weeks. However, plausible conditions of such high predictability are still unclear. Hence, extracting sudden warming events occurring in recent five Northern Hemisphere winters, we statistically examine the predictability of stratospheric circulations during the sudden warming events, by the use of the Japan Meteorological Agency (JMA) ensemble one-month forecast data. In this study, each predictable period is estimated by a root-mean-square error (RMSE) and an anomaly correlation (AC) in the ensemble-mean geopotential height on 10 hPa.

Generally, the RMSE tends to be large during the sudden warming events. In some cases, however, the RMSE remains under an estimated climatological standard deviation within a forecast period of more than two weeks. Resultantly, the predictable period ranges from 3 days to 19 days and the mean value is about 10 days. The predictable period crucially depends on the time evolution of the warming events: The lead time for the prediction is relatively long in the case of warming events in which only the wavenumber-1 component essentially contributes to their occurrence. In particular, the warming events after cold and undisturbed early winters show extremely high predictability. On the other hand, the lead time is relatively short in the case of warming events with significant contributions of wavenumber-2 and 3. Similar results are also obtained by the predictability estimation based on the AC evolution. These results imply that the predictable period of sudden warming events might depend on horizontal scales of contributing planetary waves. Hence, we will discuss the predictability of individual wave components and zonal mean circulations in the presentation.

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The GCOS Reference Upper-Air Network (GRUAN): Rationale, Progress, and Plans

Presenter: Franz Immler (Franz.Immler@dwd.de)

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While the global upper-air observing network has provided useful observations for operational weather forecasting for decades, its measurements lack the accuracy and long-term continuity needed for understanding climate change. Consequently, the scientific community faces uncertainty on such key issues as: the nature of temperature trends in the troposphere and stratosphere; the climatology, radiative effects, and hydrological role of water vapour in the upper troposphere and stratosphere; and the vertical profile of changes in atmospheric ozone, aerosols, and other trace constituents. Radiosonde data provide adequate vertical resolution to address these issues, but they have questionable accuracy and have time-varying biases due to changing instrumentation and techniques. Although satellite systems provide global coverage, their vertical resolution is sometimes inadequate and they require independent reference observations for sensor and data product validation, and for merging observations from different platforms into homogeneous climate records. To address these shortcomings, and to ensure that future climate records will be more useful than the records to date, the Global Climate Observing System (GCOS) program is initiating a GCOS Reference Upper Air Network (GRUAN) to provide high quality observations using specialized radiosondes and complementary remote sensing profiling instrumentation that can be used for validation. This paper outlines the scientific rationale for GRUAN, its role in the Global Earth Observation System of Systems, network requirements and likely instrumentation, management structure, current status and future plans. It also illustrates the value of prototype reference upper-air observations in constructing climate records and their potential contribution to the Global Space-Based Inter-Calibration System. We invite constructive feedback on the GRUAN concept and the engagement of the scientific community.

ID: 00451 ◀back

Equatorial Kelvin waves and the occurrence of extremely thin ice clouds at the tropical tropopause

Presenter: Franz Immler (Franz.Immler@dwd.de)

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A number of field-campaigns in the tropics have been conducted in the recent years with two different LIDAR systems at Paramaribo in Suriname (5.8º N, 55.2º W). The lidars detect particles in the atmosphere with high vertical and temporal resolution and 5 are capable of detecting extremely thin cloud layers which frequently occur in the tropical tropopause layer (TTL).

Radiosonde as well as operational ECMWF analysis show that temperature anomalies caused by equatorial Kelvin waves propagate downward, well below the cold point tropopause (CPT). We find a clear correlation between the temperature anomalies introduced by these waves and the occurrence of thin cirrus in 10 the TTL. In particular we found that extremely thin ice clouds form regularly where cold anomalies shift the tropopause to high altitudes. This finding suggests an influence of Kelvin wave activity on the dehydration in the TTL and thus on the global stratospheric water vapour concentration.

ID: 00284

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Influence of ENSO on European climate via the stratosphere

Presenter: Sarah Ineson (sarah.ineson@metoffice.gov.uk)

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Observational evidence indicates a link between ENSO and climate over the North Atlantic-European area, with late winter cold northern European temperatures and a pattern resembling the negative phase of the North Atlantic Oscillation associated with many (but not all) El Niño events. Here we use an ensemble of experiments using an extended (60-level) version of the Hadley Centre model to demonstrate that the effect of El Niño is communicated via a teleconnection to the extratropics, an altered stationary eddy field in the extratropical troposphere, a subsequent response in the stratospheric circulation and a slow descent of signals back into the troposphere where they affect surface climate over Europe. Our analysis supports the growing evidence that the late winter European surface response to El Niño is via a stratospheric pathway and indicates a potential source of seasonal predictability for Europe.

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The relationship between the stratospheric quasi-biennial oscillation (QBO) and tropospheric circulation from the Northern hemisphere summer to winter

Presenter: Makoto Inoue (otenki@ccsr.u-tokyo.ac.jp)

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The influence of the stratospheric quasi-biennial oscillation (QBO) on tropospheric circulation over the Northern hemisphere is studied over a 25-year period (1980-2004), using NCEP/NCAR reanalysis data. Seasonal evolution of the interaction between the stratospheric QBO and tropospheric circulation is focused from the Northern hemisphere summer till winter. All analyses are shown as the differences in the easterly phase and westerly phase of the QBO.

The analyses of the zonal-mean zonal wind indicate significant easterly anomalies at the high latitudes (50-90N), westerly anomalies over mid-latitudes (30-50N) and easterly anomalies in the low latitudes (10-30N) in winter (December-February). Each term of the transformed Eulerian-mean (TEM) equations was calculated for the differences of the QBO to examine the cause of the significant wind anomalies. The diagnosis of Eliassen-Palm fluxes and their divergence in summer (June-August) and autumn (September-November) reveals that wave forcing at mid-latitudes seems to contribute to westerly acceleration (30-40N) and deceleration (20-30N) in the upper troposphere. In autumn, transient eddies (period < 10 days) are effective in westerly acceleration, while quasi-stationary waves (period 10-30 days) are associated with westerly deceleration. Equatorward fluxes on the latter disturbance are responsible for westerly deceleration near the tropopause in the low latitudes. The local time change of zonal wind is positive in the mid-latitudes and negative in the low latitudes during summer and autumn. This contribution seems to establish a part of Holton-Tan oscillation in winter. In the stratosphere at the low latitudes where the QBO is visible, residual circulation is likely to play a crucial role.

These results indicate the importance of wave activities in mid-latitudes with the QBO on extratropical circulation from summer to winter. Future analyses are needed to get a better understanding how westerly acceleration (deceleration) at mid-latitudes can be caused during easterly (westerly) phase of the QBO.

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Arctic ozone loss inferred from assimilation of EOS MLS and SBUV/2 observations

Presenter: David Jackson (david.jackson@metoffice.gov.uk)

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We use data assimilation to infer the amount of ozone destroyed in the Arctic stratosphere by heterogeneous chemistry in recent winters. Our method relies on assimilating ozone observations from the Earth Observing System Microwave Limb Sounder (EOS MLS) and the Solar Backscatter Ultraviolet Radiometer (SBUV/2) into the Met Office data assimilation system, and can better account for mixing processes than other methods. The ozone assimilation is univariate and is based on a 3D-Var approach. The difference between the assimilated ozone and a reference ozone transported by the same wind fields is attributed to chemical ozone loss, plus some transport-related errors.

Our estimate of ozone loss for the winter of 2004/05 is slightly more conservative than those inferred by most other methods, but peaks at the same altitude range. Some initial results for the 2006/07 winter will also be presented.

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Extreme low tropopause temperature and tropical mesoscale convection activity over Bay of Bengal and Arabian Sea: Implication for the stratosphere-troposphere exchange (STE)

Presenter: Atma Jain (jain_ar@rediffmail.com)

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The stratosphere-troposphere exchange processes are important for understanding the coupling between lower and middle atmosphere. The height structure of the tropopause region plays an important role in stratosphere-troposphere exchange (STE) as it tends to inhibit such exchange. The tropics being the source region of the tropical convection and cyclone systems it influence the characteristics of the tropical tropopause region and thus play an important role in STE.

Observations over the eastern coastal stations and over the Bay of Bengal during the summer monsoon season have shown that extreme cold tropopause temperature (≤191K) occur over a wide geographical area which covers north-eastern India, north-central Bay of Bengal, Bangladesh and northern Myanmar. Tropical mesoscale convection systems (TMCS) are generally considered as one of the causative mechanism for the appearance of such cold tropopause. A more recent analysis has indicated a close association between the occurrence of the areas of low tropopause temperature (LTT) and the monsoon associated TMCS activity. These studies have been limited mainly to the Bay of Bengal region. In the present study this work has been extended to cover the Arabian Sea region. Monthly mean OLR observations from INSAT-1D satellite and ECMWF reanalysis of temperature at 100mb level are examined for the years 1994-2001 with a focus on summer monsoon Period (June-September). This study has revealed that during monsoon season, spatial distribution of the monthly mean OLR and tropopause temperature over the Bay of Bengal and Arabian Sea shows an excellent correlation with the lower values of both parameters over the Bay of Bengal. These observations are consistent with higher sea surface temperature (SST) over the Bay of Bengal. It provides direct evidence of i) the role of TMCS in cooling the tropopause region and of ii) deeper penetration of Atmosphere - Ocean interaction.

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Observations of Extremely low tropopause temperatures, during ARMEX campaign summer monsoon season, over the Arabian Sea region

Presenter: Atma Jain (jain_ar@rediffmail.com)

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Extreme cold tropopause temperatures (≤ 191K) have been reported in the tro-popause region over the Bay of Bengal, North East India and adjoining areas. In this paper, we extend these studies to cover the Arabian Sea region. Radiosonde /GPS sonde observations carried out in campaign mode during Arabian Sea Monsoon experiment (ARMEX) are used. This campaign was carried out in Monsoon season of 2002 (June- August). In addition observations of atmospheric temperature by CHAMP satellite, for the same period, are also made use of.

These observations do show that CPT temperatures which are ≤191K do occur over the Arabian Sea region also. The CHAMP satellite observations, which give a broader view of the Indian tropical region, indicate frequency of occurrence of cold tropopause temperature over the Arabian Sea is relatively less as compared to the observations over the Bay of Bengal. Occurrence of such cold temperature is more frequent during the month of July which is a peak monsoon month. Observations of such extreme cold temperature in the tropopause region, over the Arabian Sea, have not been reported so far. These observations do indicate that, on day to day basis, in addition to North-East and Bay of Bengal region, Arabian Sea region may also be contributing to Troposphere-Stratosphere Exchange during the monsoon season. Further work on these lines is in progress.

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Dehydration processes in the Indian monsoon anticyclone: Lagrangian analysis and sensitivity to vertical wind fields

Presenter: Ronan James (james@lmd.ens.fr)

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In the Asian monsoon region, a large water vapour maximum is observed between 150 and 68 hPa during summer (Park et al. 2007), and coincides with an ozone and potential vorticity (PV) minimum. Deep convective events, slow ascent in the tropical tropopause layer (TTL) and the Asian monsoon anticyclonic transport barrier are the ingredients to understand the water vapour distribution in this region. However, the specific role and interactions of the different processes is still the subject of an active debate. In this context, we focus on the ability of large-scale wind fields to determine the water vapour patterns in the tropical lower stratosphere during the Asian monsoon season.

This study is based on back-trajectory calculations using different representations of the vertical motion (clear sky, cloudy sky and total heating rates), coupled to a simple microphysical model allowing supersaturation. The wind fields and heating rates are from the new ERA-Interim reanalysis dataset of the ECMWF and the calculations are compared with AURA/MLS observations at 100 hPa. It is shown that reconstructions of the water vapour maps are in excellent agreement with the observations when the radiative impact of the clouds, which appears as an essential transport mechanism in the TTL, is taken into account.

Convective sources are determined from the intersection of the clouds, as given by CLAUS dataset, by back-trajectories. The major source that lifts parcel up to 350-360~K is located over the Bay of Bengal. Dehydration occurs mostly in the same area but in a separated range of altitudes (360-380~K). The water vapour maximum is shown to result from a “warm trap” effect due to the horizontal advection within the easterly branch of the Monsoon anticyclone rather than from deep convection events. Simulations of Calipso retrievements of thin cirrus clouds show that the freeze-drying processes along the large scale transport path can explain the observed distribution in the TTL.

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Evaluation of the LMDz-INCA chemistry-climate model in the extratropical tropopause region

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the AMMA science team, the SCOUT-O3 science team

LMDz-INCA is a coupled Climate-Chemistry Model developed to study the interactions between dynamical, physical and chemical processes in the troposphere and stratosphere and in particular the upper troposphere and lower stratosphere. The model uses 50 vertical levels from the surface to 76 km and a horizontal resolution of 2.5º in latitude and 3.75º in longitude and includes methane oxidation and stratospheric chemistry. A first reference simulation was run for the period 1980-2006 (REF2 CCM-Val simulation). This transient simulation includes all anthropogenic and certain natural forcings based on changes in trace gases, and sea surface temperatures from HadISST1. Surface emissions were from the RETRO inventory. In a second simulation, the model was nudged with the ECMWF winds over the period 1995-2007. This period was chosen to coincide with aircraft campaigns such as POLARIS, CRYSTAL-FACE, SPURT, AMMA and SCOUT-O3.

The model runs have been evaluated by making comparisons with in situ observations of ozone, carbon monoxide and water vapor profiles from these aircraft campaigns and also with stratospheric balloon data. Different diagnostics are used to evaluate the performance of the model in the region of the extratropical upper troposphere and lower stratosphere (UTLS). We also evaluate this version of LMDz-INCA by making comparisons with LMDz-REPROBUS (stratospheric chemistry model) and the 19-level tropospheric version of the LMDz-INCA model which includes NMHCs (Folberth et al., 2006). Sensitivity simulations, including runs with tracers, have also been performed to examine the role of transport processes such as convection in governing the chemical composition of the tropopause region.

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Ice Concentrations and Extinctions in Tropical Tropopause Layer Thin Cirrus

Presenter: Eric Jensen (eric.j.jensen@nasa.gov)

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Recent in situ measurements of subvisible cirrus from the CRAVE and TC4 field experiments indicate ice number concentrations less than 100/L that are far lower than homogeneous-freezing nucleation theory predicts. Comparisons between in situ measurements and airborne lidar extinctions precludes the possibility of numerous small crystals that the microphysics probes are not detecting. In addition, the measured size distributions are much broader than theoretical models predict. Consistent with the apparent overestimate of ice concentrations by numerical models, we find that simulated extinctions are substantially larger than those measured by CALIPSO. All of this evidence points to a fundamental problem with our theoretical understanding of ice cloud formation processes at low temperature with important implications for cloud radiative properties and dehydration of air entering the stratosphere.

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On the radiative forcing of global-mean temperature trends in the middle atmosphere

Presenter: Andreas Jonsson (andreas.jonsson@utoronto.ca)

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Global-mean temperature trends in the middle atmosphere can be explained by changes in the radiative energy budget forced by the atmospheric composition changes. Here, we analyze past and future temperature trends and changes in radiative heating agents in model simulations performed with the Canadian Middle Atmosphere Model (CMAM). We identify two periods of near-linear changes: 1970-1990, during the period of ozone depletion, and 2010-2040, during the period of ozone recovery. Using a 1D radiative-convective model it is shown that the past and future temperature trends can be understood as a combination of effects from changes in CO_2, O_3 and H_2O. The results confirm the generally accepted view that while enhanced CO_2 acts to cool the middle atmosphere, temperature trends are modulated by long-term changes in O_3 concentrations: Halogen-induced ozone depletion in the past has lead to enhanced cooling whereas ozone recovery in the future will reduce the CO_2 effect. Increases in H_2O, mainly due to surface trends in CH_4, provide a large fraction of the cooling in the lower stratosphere. The importance of changes in the 9.6 um O_3 band cooling and in the mesospheric NIR CO_2 heating is also analyzed.

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Characteristics of Tropical Convection in the Indian Monsoon System

Presenter: K. N. Uma (urmi82@rediffmail.com)

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Characteristics of tropical convection in the Indian monsoon system have been studied using the data collected with the Indian MST radar during the passage of 62 convective storms. Various stages of convection have been discerned from radar time-intensity plots of vertical air velocity and data have been stratified into shallow, deep and decaying convection. The cores in deep systems show a wide variety of life times (overpass time) with updraft cores persists for longer duration than downdraft cores. Considerable number (about 2%) of core tops in this category seems to penetrate the tropopause into the lower stratosphere. Decaying systems seem to have more number of downdraft cores, some of them persist for longer periods. The greater core top heights seen in this category are thought to be associated with the gravity wave activity induced by the storm. The shallow and deep convections are dominated by low level descent and mid-high level ascent, while nearly uniform distribution is seen in decaying convection. The structure of the convection is studied by subjecting the convective cores to 2D autocorrelation analysis. The shallow systems are characterized by narrow and erect coherence structure, while a number of cores in deep and decaying systems exhibit inclined structures. In all types of convection, the downdraft cores show inclination angle close to 90º indicating that they are more coherent than the updraft cores. The convection height distribution for all cores together shows a bimodal distribution with the lower peak near the freezing level and a broad upper level peak in the upper troposphere. Characteristics of convection in different monsoon regimes, active and break, are distinctly different with the convection in the active monsoon rain regime is found to be more intense, in terms of velocity distribution, mean vertical velocity and the convection top height, than in break monsoon.

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Gravity waves induced by the West African Monsoon

Presenter: Petronille Kafando (petronille.kafando@univ-ouaga.bf, kafandopetronille@yahoo.fr)

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A climatology of gravity wave activity over the tropical West Africa is derived from six year radiosounding data produced by African meteorological stations located in the 18ºN and 05ºS.

Seasonal variations of gravity wave energy are first analyzed in the lower stratosphere at Niamey (13.48-2.16ºE) and Ouagadougou (12.35ºN-1.51ºW). Relation between gravity wave activity and indices of convection and monsoon show in the one hand that convection seems to be one of the sources and, in the other hand the activity presents a variation with the different stages of the monsoon.

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Ice cloud and humidity distributions observed by the A-train

Presenter: Brian Kahn (brian.h.kahn@jpl.nasa.gov)

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We quantify the variability of relative humidity (RH) within and outside of ice clouds using coincident, spatially and temporally continuous observations of temperature, water vapor, and cloud properties from AIRS, CALIPSO, and CloudSat. AIRS shows the highest RH values, as well as increased frequency of supersaturation with respect to ice, to be coincident or nearly coincident with cirrus cloudiness in the upper troposphere. Cloudy and clear RH mean and variance fields show strong seasonal, latitudinal, and height dependences. The modulation of these dependences by dynamical processes is investigated using AIRS temperature variability. We show that the spatial and temporal variability of temperature variance explains a significant portion of the spatial and temporal variability of RH variance. This work suggests that the inference of ice nucleation mechanisms from cloudy RH distributions, as suggested by previous studies, must first consider dynamical controls on RH.

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A study of the transport of ozone into the surface over Antarctica

Presenter: Satheesan Karathazhiyath (satheesan@irf.se)

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Surface ozone plays an important role in the chemistry and radiative budget of the of the troposphere. Ozone is a precursor to the hydroxyl radicals that control the chemical cycles of many important tropospheric trace gases. Tropospheric ozone is also an important greenhouse gas contributing significantly to the total anthropogenic radiative forcing. The radiative effects of the tropospheric ozone are more significant in the polar regions because of the low water vapour and thus its low radiative effects. The distribution of ozone in the troposphere composed of in-situ production and transported from the stratosphere. The in-situ photochemical and distribution of ozone in the troposphere exceeds the downward flux of ozone from the stratosphere. Nevertheless, the ozone flux across the tropopause is an important source of surface ozone. The present work focuses on the mechanism that transport ozone from stratosphere into troposphere in Antarctica. In-situ observations of ozone were made at Wasa, Antarctica (73° S, 13° W) in January 2008 along with complementary wind and turbulence from a radar. The variation of ozone during this period and its source are studied using a stratospheric ozone tracer generated by the FLEXPART Lagrangian particle dispersion model. The model was driven by the European Center for Medium range Weather Forecast (ECMWF) analysis and forecast data. The model simulates the transport and dispersion of linear tracers by calculating the trajectories of a multitude of particles. The results of this study are presented.

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Stratosphere-troposphere coupling and trends in the Southern Hemisphere tropospheric circulation in CMIP3 models

Presenter: Alexey Karpechko (a.karpechko@uea.ac.uk)

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The circumpolar circulation in the Southern Hemisphere intensified during last decades of the 20th century with changes being observed mostly in austral summer and autumn. This intensification has been attributed to external forcing such as stratospheric ozone depletion and greenhouse gas (GHG) increases, although some studies suggest that it may be just a manifestation of natural variability. There is strong observational evidence that trends in the troposphere are linked to those in the stratosphere but the exact physical mechanisms of the downward trend propagation are not yet understood. Several studies have shown that atmospheric models (coupled to either a simplified or dynamical ocean) are able to simulate observed changes when forced by observed ozone trends or combined ozone and GHG trends. However, as some of these studies suffered from erroneously specified forcing, the reason for intensification of circulation remains debatable. Here, we re-approach this issue using data from CMIP3 coupled climate models. Some of these models accounted for stratospheric ozone depletion while others did not. Separation of these models allowed us to isolate the effect of ozone depletion while the multi-model averaging enhanced the ratio of forced signal to noise (interannual variability). We demonstrate that only models that include ozone depletion simulate downward propagation of the circulation changes from the stratosphere to the troposphere similar to that observed, with influence from the GHG increase being detectable only in the lower troposphere. These changes are simulated by the majority of the ozone-forced CMIP3 models except in those with the lowest vertical resolution in the lower stratosphere.

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Sensitivity of Polar Stratospheric Ozone Loss to Uncertainties in Chemical Reaction Kinetics

Presenter: Randy Kawa (stephan.r.kawa@nasa.gov)

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Several recent observational and laboratory studies of processes involved in polar stratospheric ozone loss have prompted a reexamination of aspects of our understanding for this key indicator of global change. To a large extent, our confidence in understanding and projecting changes in polar and global ozone is based on our ability to simulate these processes in numerical models of chemistry and transport. The fidelity of the models is assessed in comparison with a wide range of observations. These models depend on laboratory-measured kinetic reaction rates and photolysis cross sections to simulate molecular interactions. A typical stratospheric chemistry mechanism has on the order of 50-100 species undergoing over a hundred intermolecular reactions and several tens of photolysis reactions. The rates of all of these reactions are subject to uncertainty, some substantial. Given the complexity of the models, however, it is difficult to quantify uncertainties in many aspects of system. In this study we use a simple box-model scenario for Antarctic ozone to estimate the uncertainty in loss attributable to known reaction kinetic uncertainties. Following the method of earlier work, rates and uncertainties from the latest laboratory evaluations are applied in random combinations. We determine the key reactions and rates contributing the largest potential errors and compare the results to observations to evaluate which combinations are consistent with atmospheric data. Implications for our theoretical and practical understanding of polar ozone loss will be assessed.

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The roles of 3-dimensional propagating gravity waves and equatorial trapped waves on driving the Quasi-Biennial Oscillation

Presenter: Yoshio Kawatani (yoskawatani@jamstec.go.jp)

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A high-resolution atmospheric general circulation model (AGCM) has been developed to study various aspects of small-scale phenomena including gravity waves and their role on the large-scale fields in the middle atmosphere (Watanabe et al. 2008). Our spectral model has a T213 truncation in the horizontal (horizontal resolution of about 60 km) and 256 layers (L256) in the vertical from the surface to about 85 km with an interval of 300 m in the upper troposphere and above. No gravity wave parameterizations are included in our model and hence all gravity waves are spontaneously generated. The model simulates large-scale oscillations with realistic amplitudes in the equatorial atmosphere such as the quasi-biennial oscillation (QBO) and semi-annual oscillation (SAO), although the period of the QBO-like oscillation is shorter (about 1.5 years) than the real one.

Model outputs with a time interval of 1 hour are analyzed to elucidate relative importance of the internal gravity waves (IGWs) and equatorially-trapped waves (EQWs) to drive the QBO-like oscillation. It is shown that the zonal wavenumber versus frequency spectra of simulated precipitation and outgoing long wave radiation (OLR) represent realistic signals of convectively-coupled EQWs. The horizontal wind spectra reveals clear signals of equatorial Kelvin waves, Rossby-gravity waves, and n=0 eastward, n=1 and n=2 eastward/westward propagating gravity waves in the stratosphere. These wave signals are separately extracted for further examination following Wheeler and Kiladis (1999). The horizontal distribution of each EQW amplitude generally corresponds well to that of the activity of cumulus convection. On the other hand, it is seen that IGWs are strongly influenced by the vertical wind shear associated with the Walker circulation in the troposphere, which results in different distribution of IGW amplitudes between the eastern and western hemisphere. In the westerly shear phase of the QBO-like oscillation, IGWs contribute to 50-70% of the total eastward acceleration. The equatorial Kelvin waves contribute to the largest forcing among EQWs especially around the altitude with a zonal wind of 0 m/s, while the forcing due to n=0, 1, 2 eastward-propagating EQWs becomes comparable to that of Kelvin waves at higher altitudes. It is interesting that the distribution of the wave forcing is not zonally uniform and is different depending on the wave types.

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Global distribution of atmospheric waves in the equatorial – upper troposphere and lower stratosphere region: AGCM simulation of source and propagation

Presenter: Yoshio Kawatani (yoskawatani@jamstec.go.jp)

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Global distributions, source and propagation of atmospheric waves in the equatorial upper troposphere and lower stratosphere are investigated using the atmospheric general circulation model (AGCM) with resolution of T106L60. The QBO-like oscillation with a period of about 1.5-2yr is well simulated in the model. The simulated wave potential energy (PE) distributions are compared with those by the COSMIC observation. The global distributions of atmospheric waves from the upper troposphere to the stratosphere are significantly influenced by source distributions, the Walker circulation and the phase of the QBO. The zonal wavenumber versus frequency spectra of temperature in the stratosphere reveal dominant signals of equatorial trapped gravity waves (EQWs). The EQWs waves from n=-1 (Kelvin waves) to n=2 eastward/westward gravity waves are separately extracted. Each EQW in the stratosphere generally corresponds well to sources of each convectively coupled EQW activity in the upper troposphere. The propagation of Kelvin waves, MRG and n=0 EIGW are strongly influenced by the Walker circulation and the phase of the QBO. PE of EQWs with vertical wavelength less than 7km (<7km) accounts for up to ~30-40% of total PE<7km in the stratosphere. GWs generated by a diurnal cycle of convection are clearly obvious over the Africa, Amazon and Indonesian region, which result in localized wave distribution.

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Geo-engineering side effects: Heating the tropical tropopause by sedimenting sulphur aerosol?

Presenter: Patricia Kenzelmann (patricia.kenzelmann@env.ethz.ch)

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Anthropogenic greenhouse gas emissions tend to warm the global climate. Various geo-engineering ideas are currently discussed that might help extending the grace period for appropriate countermeasures. Sulphur aerosols may cool the Earth surface by reflecting solar short wave radiation back to space. A part of the anthropogenic climate warming might be compensated by increasing the amount of sulphur aerosols in the stratosphere, for example by sulphur injections. However, we are only at the beginning of understanding possible side effects. One possible side effect of such a geo-engineering fix might be the warming of the tropical tropopause and consequently the increase of the amount of stratospheric water vapour. Using the 2D AER Aerosol Model we calculated the aerosol distributions for injections of 1, 2, 5 and 10 MT sulphur into the lower tropical stratosphere. The results serve as input for the 3D chemistry-climate model SOCOL, which allows calculating the aerosol effect on stratospheric temperatures and chemistry. A scenario with continuous SO_2 injections into the lower stratosphere may provide conditions for efficient condensation of H_2SO_4 onto pre-existing stratospheric aerosols, which subsequently grow to large sizes and sediment into the tropical tropopause region. As this aerosol also absorbs IR radiation, tropopause temperatures rise and the entry mixing ratio of water vapour increases. The extreme scenario of annual injections of 10 MT S yields about a doubling of stratospheric humidity. This enhances the expected ozone loss following a volcanic eruption, because of enhanced heterogeneous aerosol chemistry affecting the NOx, HOx and ClOx catalytic ozone destruction cycles. Sensitivity studies show that stratospheric ozone would decrease significantly after sulphur injections even in a future atmosphere with possibly lower Cly concentrations and with lower stratospheric temperature resulting from anthropogenic greenhouse gases emissions.

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Effects of North Atlantic Oscillation on spatiotemporal variations of total ozone over Europe

Presenter: Valeriy Khokhlov (vkhokhlov@ukr.net)

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It is known that there exists the spatial correlation pattern between the tropopause pressure and the North Atlantic Oscillation (NAO). The pattern is a tri-pole: during positive NAO phases tropopause pressure is higher at high latitudes and sub-tropical band, but is lower at mid-latitudes. As tropopause pressure variations are proportional to total ozone variations, a similar space dependent correlation between the NAO and total ozone was formerly found for monthly time series. For daily time series, correlation coefficients between NAO indices and total ozone at certain site are insignificant, although some visual coherency (e.g. maxima of NAO indices coincide with maxima of total ozone near Iceland) have place. To detail NAO-induced variations of total ozone, we apply cross wavelet transform to cold-season (DJFM) daily time series of NAO index and total ozone data (TOMS) at many sites in Europe. The cross wavelet transform is an approach providing the information about relationships in time-frequency space and phase angle statistics between two time series. Moreover, the approach allows assessing the statistical significance against white (red) noise backgrounds. More generally, the cross wavelet transform determines frequencies with significant coherent (or incoherent) variations of NAO index and total ozone, as well as periods of time when these frequencies are observed. Our results show that some features are registered in the relationship between the variations of NAO index and total ozone during single cold period. Firstly, significant frequencies are defined, as a rule, by the two periods: about 7-10 days and about two-three weeks; another periods have place in a few cases only. The first period is well-known feature of NAO intraseasonal variability. Also, the areas in the time-frequency domain of wavelet decomposition, where significant frequencies occur during whole cold period of year, are absent. Secondly, most sites can be divided into three parts subject to their locations (mentioned above) relative the main pattern of the NAO. Thirdly, the cross wavelet transform show that NAO and total ozone are in anti phase in all the sectors with significant common power at the frequencies 7-10 days for the sites with higher tropopause pressure, and are in phase for the sites with lower tropopause pressure, but in the latter case the significant common power is registered at the frequencies 16-25 days. In the other words, there exists some time lag for the response of total ozone on the two-three week variability of the NAO.

ID: 00126 ◀back

Monthly averages of N_2O and O_3 derived from satellite observations: A method for the evaluation of atmospheric chemical models in the lower stratosphere

Presenter: Farahnaz Khosrawi (farah@misu.su.se)

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Monthly averages of nitrous oxide (N_2O) and ozone (O_3) have been suggested as a tool for the evaluation of atmospheric photochemical models. Satellite measurements in general have a good spatial and temporal resolution and provide data sets for both, the Northern and Southern Hemisphere. Here, we present two data sets, one derived from the Improved Limb Atmospheric Spectrometer (ILAS and ILAS-II) and one from the Odin Sub-Millimetre Radiometer (Odin/SMR). From both data sets 1-year climatologies of monthly averaged N_2O and O_3 were derived for the lower stratosphere by partitioning the data into bins of potential temperature. Thereby, a 1-year climatology for the polar region was derived from ILAS/ILAS-II and a 1-year climatology for the entire Hemisphere as well as climatologies separated into low latitudes, midlatitudes and high latitudes from Odin/SMR. The resulting families of curves help to differentiate between O_3 changes due to photochemistry from those due to transport. These 1-year climatologies are used for the evaluation of two Chemical Transport Models (CTMs), the Karlsruhe Model for the Middle Atmosphere (KASIMA) and the Chemical Lagrangian Model of the Stratosphere (CLaMS) as well as for one Chemistry-Climate Model (CCM), the atmospheric chemistry general circulation model ECHAM5/MESSy1 (E5M1) in the Northern Hemisphere lower stratosphere. Since the Odin/SMR measurements cover the entire hemisphere the evaluation is performed for the entire northern hemisphere as well as for the low latitudes, midlatitudes and high latitudes using the Odin/SMR 1-year climatologies as reference. However, to assess the impact of using different data set we repeat the evaluation for the polar lower stratosphere using the ILAS/ILAS-II climatology. Thereby, only small difference are found due to the usage of ILAS/ILAS-II or Odin/SMR as a reference. The evaluation of CLaMS, KASIMA and E5M1 shows that all models are in good agreement with Odin/SMR and ILAS/ILAS-II. Differences are generally in the range of ± 20\\%.

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Airborne Water Vapor Lidar Measurements in the Tropical Upper Troposphere during TROCCINOX and SCOUT-O3

Presenter: Christoph Kiemle (christoph.kiemle@dlr.de)

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The research aircraft Falcon of the Deutsches Zentrum für Luft- und Raumfahrt (DLR) carried a water vapor differential absorption lidar (DIAL) during the Tropical Convection, Cirrus and Nitrogen Oxides Experiment (TROCCINOX) in 2004 and 2005 in Brazil, and the SCOUT-O3 campaign in 2005 in Darwin, Australia. Extended aerosol and water vapor measurements in the upper troposphere (UT) and partly in the lower stratosphere (LS) were performed during the campaigns and along the intercontinental transfer flights to these campaigns. Over Brazil the DIAL sampled both the background UT humidity in the absence of convection, as well as air masses affected by tropical deep convective systems and the anvil outflow of near-by thunderstorms. A considerable number of water vapor profiles in the tropical tropopause layer (TTL) were collected, showing the large variation range of TTL humidity.

In Northern Australia, a 90% cloud cover of optically thin (optical thickness <0.5) but geometrically thick cirrus (typically extending between 12 and 17 km) with embedded outflow from deep convection was observed in all campaign flights in November and December 2005. The persistent cirrus layer originated from the SE Asian warm pool region located to the north and disappeared over the central Australian continent. The transfer flights to and from both campaigns offered the unique opportunity to perform extended aerosol and water vapor measurements in mid-latitudinal, subtropical and tropical air masses. Of particular interest are the transfer flights between Europe and Australia where the subtropical jet stream was crossed several times and the Asian monsoon region was traversed. The UT water vapor distribution is found to be altered by these dynamical processes. The DIAL profiles are compared with ECMWF analyses to investigate the model's skill in reproducing the observed water vapor distributions and to interpret the observations by showing the underlying dynamical structures.

Since aircraft DIAL measurements in the UT/LS are novel, an extensive quality control is mandatory. A sensitivity analysis reveals that the DIAL profiles have an accuracy of 5% between altitudes of 8 and 16 km. The TROCCINOX experiment allowed intercomparisons with hygrometers onboard the Russian M-55 Geophysica research aircraft and the MIPAS instrument onboard ENVISAT. On average the relative differences between the DIAL and the Geophysica FISH and FLASH Lyman-alpha hygrometers are found to lie within the specified instruments' accuracies (<9%). This confirms the excellent ability of FISH, FLASH and DIAL to measure water vapor in the UT/LS. Six tropical under-flights of MIPAS on board ENVISAT gave an average relative difference of (8 +- 49) % between altitudes of 10 and 17 km at an average air mass distance of 315 km. Here the large standard deviation is indicative of high atmospheric variability, although mostly cloud-free and homogeneous meteorological situations had been selected to cope with the fact that the measurements could not be exactly co-located in space and time. Nevertheless the overall average deviation between MIPAS and DIAL is low, too.

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Simulation of stratospheric intraseasonal variability with the GFDL climate model and sensitivity to climate change

Presenter: Junsu Kim (junsu.kim@utah.edu)

J. Kim, T. Reichler (University of Utah, Salt Lake City, USA)

Understanding stratospheric influences on the troposphere requires models with realistic simulations of the dynamical behavior of the polar stratosphere and its two-way coupling with the troposphere. However, it is an open question how well current models simulate the relevant phenomena and how essential a well-resolved stratospheric component is for good simulations.

We address this important question from two idealized multi-century long equilibrium climate simulations conducted with the latest version of the GFDL climate model. The first simulation uses a stratosphere resolving version of the model; the second the standard version with only few stratospheric levels. We compare the two runs against reanalysis and against each other to characterize how well stratospheric intraseasonal variability is simulated by the models and how important good stratospheric resolution is for such simulations. Some of the aspects examined are: time scales and spectra of the annular modes; frequency, intensity, and structure of stratospheric sudden warmings and their tropospheric precursors; characteristics of downward propagation into the troposphere; timing of final warming events; and relationship of the vortex to the underlying topography. We will show that the stratosphere resolving model is generally in very good agreement with the observations, and that on the other hand the troposphere-only model has various deficits in simulating some of the basic aspects of stratospheric variability.

Given the good performance of the stratosphere resolving model, we conduct additional sets of simulations, now driven by varying amounts of greenhouse gas, ozone, and SST forcings. We compare the simulations against the unforced control runs to demonstrate how future climate change might impact the stratospheric circulation and its downward influence into the troposphere.

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A possible mechanism for the tropospheric response to stratospheric forcing

Presenter: Junsu Kim (junsu.kim@utah.edu)

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In this study, we explore the dynamics of extratropical zonal-mean flow anomalies that are observed to propagate downward from the stratosphere into the troposphere. These signals, which are connected to multiple-week tropospheric circulation forecasts, have been well documented in various observation and model based studies, but the exact dynamical processes by which the tropospheric circulation responds to changes in the stratosphere remain still elusive. Here, we propose and explore the validity of a new mechanisms which may help to explain the observed response of the troposphere to stratospheric sudden warming events (SSWs).

The mechanism assumes that negative wind anomalies in the lower stratosphere caused by SSWs decelerate the phase speed of the tropospheric eddies. As first proposed by Chen and Held (2007), this decrease in phase speed is accompanied by an equatorward displacement of the region of subtropical wave breaking, which leads to a same signed shift of the eddy driven jet. This shift positively reinforces the negative annular mode during the downward propagating phase and leads to a redistribution of tropospheric momentum.

The validity of this mechanism is explored through the detailed analysis of atmospheric observations and multi-century long integrations with the GFDL climate model.

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ID: 00226

A Numerical Study on Secondary Waves Forced by Breaking of Convective Gravity Waves

Presenter: Young-Ha Kim (kimyh@yonsei.ac.kr)

Y.-H. Kim, H.-Y. Chun (Yonsei University, South Korea)

Gravity waves generated by tropospheric convective forcing in various basic states are simulated using a two-dimensional mesoscale model. In every experiment, convective gravity waves propagate to the mesopause within ~50 min, having characteristics similar to the tropospheric forcing. The breaking of convective gravity waves occurs near the mesopause, and secondary gravity waves generated by the breaking of the primary convective waves propagate outside the breaking region. Characteristics of the secondary waves in various basic states are investigated. The horizontal wavenumber and frequency of the secondary waves are about twice of those of the primary waves in quiescent environment. In uniform-wind condition, on the other hand, secondary waves have frequencies similar to and horizontal wavenumber smaller than the primary waves. In sheared-wind condition, very high-frequency waves are generated, although most of them are evanescent as they propagate through the mesosphere. The diversity of secondary wave characteristics in various basic states is due mainly to the difference in the propagation condition rather than in the sources of the secondary waves.

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Evaluation of the Whole Atmosphere Community Climate Model Distributions of Chemical Constituents and Mixing Processes in the Extratropical UTLS

Presenter: Douglas Kinnison (dkin@ucar.edu)

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In this study we will evaluate the upper troposphere lower stratosphere (UTLS) seasonal distributions of chemical constituents in the Whole Atmosphere Community Climate Model, version 3 (WACCM3). Recently, a new version of the WACCM3 model has been developed that allows the model to be run with specified (external) meteorological fields. These meteorological fields can come from data assimilation centers or from pre-existing climate models simulations. This approach essentially turns the WACCM3 model into a chemical transport model, which is useful for studies that involve synoptic scale comparisons to satellite and aircraft data. In this work, meteorological fields from the NASA Global Modeling and Assimilation Office (GMAO) Goddard Earth Observing System Model version 5 (GEOS-5) reanalysis will be used to drive the specified meteorological version of WACCM3. Comparisons of the WACCM3 O_3, HNO_3 in the UTLS region will be made with the NASA Aura High Resolution Dynamics Limb Sounder (HIRDLS) instrument. The HIRDLS data is uniquely suited to evaluate model HNO_3 distributions since the retrieved vertical resolution approaches 1 km in this region. In addition, WACCM3 constituent distributions will also be compared with aircraft observations taken from Stratosphere-Troposphere Analysis of Regional Transport (START08) campaign. This campaign took place in Spring 2008. These WACCM3 (Eularian model) results will also be compared with a Lagrangian model (CLAMS, also run for START08) simulation where extratropical UTLS mixing processes are explicitly represented. These model results along with aircraft observations will be examined to evaluate how well mixing processes are represented in the two transport frameworks.

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Stratospheric water vapor as observed by balloon borne instruments in the Arctic

Presenter: Rigel Kivi (rigel.kivi@fmi.fi)

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During the years 2002-2008 we have made a series of stratospheric water vapor measurements at two Arctic sites: Sodankylä (67.4º N 26.6º E) and Ny-Alesund (78.9º N 11.9º E) using balloon borne sondes. Most of the soundings were made during the winter/spring period, which allowed frequent sampling of the air inside the stratospheric vortex and at the vicinity of the vortex depending on the vortex movement above the stations. Here we present average inside and outside vortex profiles from different winters and a selection of case studies focusing on the explanation of fine scale anomalies found in the vertical profiles. We present cases, which can be explained by differential transport of air in the lower stratosphere and other cases, which are related to the dehydration of water vapor due to extremely low temperatures in the vortex. Such examples can be found at both sites. Compared to Sodankylä, the Ny-Alesund site is more often sampling air from the Arctic vortex and the stratospheric observations are less often affected by gravity waves, though evidence exists that local orographic waves may have impact on the stratospheric processes above Ny-Alesund as well. At both sites light weight in situ instruments were used for the measurements. At Ny-Alesund most of the data were obtained by the Fluorescent Lyman-alpha Stratospheric Hygrometer for Balloons (FLASH-B) of the Central Aerological Observatory. At Sodankylä we have data from two instruments, the FLASH instrument and the cryogenic frost-point hygrometer (CFH), which is currently built at the University of Colorado. One of the first versions of the CFH instrument was tested at Sodankylä during the LAPBIAT Upper Troposphere LOwer Stratosphere (LAUTLOS) campaign in February 2004. Since then the instrument has been improved and the new version of the instrument has been flown in Sodankylä since December 2005. In Sodankylä we have also performed several comparison flights of the CFH and FLASH instruments. These flights have showed generally a good agreement between these two balloon-borne stratospheric water vapor instruments, though there are some examples of disagreement between the instruments, which remain under investigation.

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Intercontinental tropospheric teleconnection by planetary wave reflection in the stratosphere

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A possibility of the stratosphere-troposphere coupling through a reflection of planetary waves in the stratosphere was proposed a long time. However, the impact of the wave reflection from the upper stratosphere is usually considered to be negligible in the troposphere because of the difference of the air density. Recently, tropospheric impact of the reflection of the planetary waves in the stratosphere was statistically demonstrated by Perlwitz and Harnik by using a lagged correlation analysis.

However, it is extremely difficult to clearly separate the impact of reflected planetary waves from the tropospheric variation itself because the planetary waves are generally created in the troposphere. Here we found a special case in which the wave propagated upward from Eurasia and was reflected back to the North American-Atlantic sector. In this event we can follow the evolution of wave field and clearly identify the impact of reflected waves because the upward- and downward-propagating regions differ.

Zonal propagation and reflection of the planetary waves is demonstrated with the longitude-height sections of the eddy geopotential height and the vertical and zonal component of the three-dimensional wave activity flux by Plumb. A wave packet propagating upward and eastward from Eurasian continent was reflected by a negative wind shear in the upper stratospheric westerly jet caused by stratospheric warming. Waves then propagated downward to the American-Atlantic sector of the troposphere, which led to a formation of a deep trough over the Atlantic and brought very cold weather to the northeastern part of the American continent.

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Composition of air and its seasonality within the TTL: Impact of Asian monsoon

Presenter: Paul Konopka (P.Konopka@fz-juelich.de)

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The tropical tropopause layer (TTL) has been described as a transition layer coupling the convectively dominated free troposphere with the Brewer-Dobson circulation in the stratosphere. Multi-annual simulations (2001-2006) with the Chemical Model of the Stratosphere (CLaMS) are used to study transport of air and its seasonality within the TTL.

In agreement with recently published satellite and in-situ observations at the tropical tropopause, CLaMS simulations show a pronounced annual cycle in O_3, CO and, in addition, also in HCl and in the mean age. This seasonal variability occurs primarily due to variation in vertical transport that responds to the well-known annual cycle of the temperature with enhanced upwelling during the boreal winter. This annual cycle is overlaid by a semi-annual cycle, with strongest upwelling around April and November, and by a clear annual cycle of horizontal in-mixing from the northern hemisphere stratosphere into the TTL. During the boreal summer, about 10-20% of the air at the equatorial tropical tropopause originates from the sub- and extra-tropics. Both, CLaMS simulations with mixing and pure trajectory calculations show that this equatorward transport is mainly driven by the Asian monsoon anticyclone that extends in summer between 150 and 70 hPa pressure levels.

ClaMS simulations reproduce the transport barrier between interior and exterior of the anticyclone fairly well compared to the recent observations from the satellites (MLS, AIRS). Both, enhanced vertical velocities within the upper part of the anticyclone and the enhanced mixing mainly along the inner flanks of the jets drive in CLaMS an effective upward transport up to 70 hPa level.

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Atmospheric Water Vapor, Aerosols, and Clouds: A microphysical Perspective

Presenter: Thomas Koop (thomas.koop@uni-bielefeld.de)

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A general overview will be given about several microphysical processes that are important for the formation of ice clouds from preexisting aerosols. These processes will be discussed with special consideration to field observations of high humidities in the upper troposphere that seem to contradict current microphysical understanding. Most notably, high supersaturations of water vapor with respect to ice were observed both in clear air outside ice clouds and within clouds. In principle, ice supersaturation may exist intermittently for short time periods, however, the duration and magnitude of the observed humidities seem to be at odds with current knowledge of the microphysics of aerosols, ice particles and water vapor, requiring an assessment of how ice clouds form.

Ice particle formation in the upper troposphere occurs by two consecutive mechanisms: nucleation of ice in or on aerosol particles and subsequent growth of the nucleated ice particles through condensation of excess gas phase water vapor. The kinetics of both processes is strongly dependent on the surrounding water partial pressure; in turn, ice particle formation and growth significantly alters the magnitude of the surrounding water partial pressure and, thus, supersaturation. Normally, we expect a threshold supersaturation to be required before nucleation can occur. This supersaturation is relaxed to saturation when a sufficient number of ice particles grow from condensation of vapor phase water molecules, thereby reducing the water partial pressure to saturation with respect to ice. However, the aforementioned field data reveal strong and persistent supersaturations both outside and within ice clouds.

In this presentation several explanations that potentially might be able to explain these observations will be discussed and critically assessed. The focus will be on processes that occur in aerosol and cloud particles, i.e., on microphysical mechanisms (established or speculative) that might allow for the sustainment of high supersaturations. For this matter, the thermodynamics of aqueous phases at low temperatures will be reviewed: hexagonal ice, cubic ice, supercooled aqueous solutions, and amorphous solids such as glassy aqueous mixtures. In addition, a discussion will follow on the kinetics of several processes which can inhibit or retard nucleation and growth of ice crystals in the upper troposphere: phase transition kinetics, crystal growth, liquid phase diffusion, and water accommodation from the vapor phase.

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On Cirrus Cloud Supersaturations and Ice Crystal Numbers

Presenter: Martina Krämer (m.kraemer@fz-juelich.de)

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The water partitioning inside and outside of cirrus clouds is closely linked to their pathway of formation: for homogeneously/heterogeneously formed cirrus, the maximum clear sky relative humidity over ice is expected to correspond to the respective cirrus freezing threshold. Inside of a cirrus cloud, the supersaturation should decrease to saturation due to water vapour consumption of the ice crystals on a time-scale strongly determined by the number of ice crystals.

Here, we present high quality aircraft in-situ observations of supersaturations and ice crystal numbers observed during many flights in tropical, mid-latitude and Arctic field experiments in the temperature range 185- 240K. We show that low ice crystal numbers measured at temperatures <200K may be responsible for the high, persistent supersaturations observed inside of cirrus in this temperature range. We further show that these low ice crystal numbers could only be explained by homogeneous ice nucleation in case of very low (about 1 cm/s) vertical velocities. If higher vertical velocities -that are very likely to occur- would have been present, the number of ice crystals must have been larger and the high supersaturations could not persist over a longer time period.

That means, either only very small temperature fluctuations are present in the uppermost tropical troposphere allowing cirrus to form by pure heterogeneous ice nucleation, or mechanisms yet unknown exist that can suppress or slow down the homogeneous formation of ice crystals at temperatures below 200 K.

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Hemispheric differences in NO_2 trends

Presenter: Karin Kreher (k.kreher@niwa.co.nz)

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As summarized in the WMO 2006 report (Chapter 3, Global Ozone), currently available evidence suggests that the NO_2 (nitrogen dioxide) trends in the Southern Hemisphere are significantly larger than in the Northern Hemisphere. This finding is based on the trend analysis of long-term observation of NO_2 made at Lauder (45S), New Zealand using UV-visible spectroscopy and at the Jungfraujoch (47N), Switzerland using Fourier transform spectroscopy (FTS). A linear increase of 6.2 +/- 1.8% per decade (am) and 5.7 +/- 1.1% per decade (pm) was inferred for Lauder, while the trend analysis using the same algorithm for the Jungfraujoch data set produced a linear trend of 1.5 +/- 1.0% per decade. While the trend at Jungfraujoch is consistent with the 2.4% per decade increase in tropospheric N_2O (nitrous oxide), the WMO 2003 report concluded that both the observed N_2O increase and the decrease in ozone explained a trend in NO_2 of 5 +/- 1% per decade. The SAGE II data also show a large hemispheric asymmetry, with no significant trend at Northern Hemisphere midlatitudes. The origin of the apparent hemispheric difference in trend remains unexplained as yet.

To investigate and interpret this difference further, we will present a statistical analysis of long-time series of NO_2 from ground-based measurements made at several locations in the Northern and Southern Hemisphere (including Jungfraujoch and Lauder), using two independent ground-based techniques (UV-visible spectroscopy and FTS) and one satellite data set (SAGE II).

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A semi-empirical approach to projecting the recovery of the Antarctic ozone hole using a range of emission scenarios

Presenter: Stefanie Kremser (stefanie.kremser@met.fu-berlin.de)

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In this study we use semi-empirical models of chlorine activation and ozone depletion in the Antarctic stratosphere to project the recovery of the Antarctic ozone hole. Chemistry-climate models (CCMs) are traditionally used for such studies and remain the optimal method for making such projections. However, CCM projections are uncertain as a result of uncertainty in future emissions and as a result of uncertainties in their internal parameterizations of various processes. Ideally, the projections should be based on an ensemble of model simulations which encompass the full range of uncertainty. However, due to their complexity, these models are extremely computationally demanding and for recent international policy relevant reports, ensembles included at most just a few model simulations. This poster presents a method, complementary to CCMs, that can be used to conduct fast and inexpensive projections of Antarctic ozone recovery. Because the semi-empirical models used are sensitive to changes in stratospheric climate, the coupling between climate change and stratospheric ozone depletion is accounted for. Preliminary projections of Antarctic ozone depletion based on the semi-empirical models are presented. Future changes in Antarctic temperatures are obtained from GCMs that include realistic transient changes in ozone and are archived in the CMIP3 data base. In addition we present how Antarctic ozone recovery is likely to be influenced by different SRES emission scenarios. A discussion of the next steps in this research will also be presented.

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Interannual variability of residence time in the TTL

Presenter: Kirstin Krüger (kkrueger@ifm-geomar.de)

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The tropical tropopause layer (TTL) is the main entrance region for trace gases traveling from the troposphere into the stratosphere. For this reason it is important to understand the underlying dynamical and microphysical processes in this region. Some important factors affecting the trace gas content and variability in the stratosphere are the temperature history and the amount of water vapour of the air parcels, their residence time in the TTL and the geographical distribution of their individual transition into the stratosphere. A better representation of these factors in transport models will also help to clarify which role very short lived substances (VSLS) like bromocarbons could play in depleting stratospheric ozone (WMO, 2007).

Multi-year calculations of radiative heating rates and isentropic trajectories have been carried out to investigate the residence time in the upper part of the TTL with an alternative approach. For this purpose we have developed a different approach to better constrain the vertical velocities in trajectory models of this region of the atmosphere: a reverse domain filling trajectory model driven by diabatic heating rates from the ECMWF's radiative transfer model. The multi-year time series is covering the ERA40 and operational ECMWF analyses period from the 1960s to 2000s during northern hemispheric winter months, which show the lowest temperatures during the seasonal cycle and hence the lowest stratospheric water vapour mixing ratios.

Recent results using the above described approach for the NH winter 2000/2001, showed a mean residence time of ~38 days for the 360-380K layer and ~43 days for the NH winter 2001/2002 in ECMWF assimilations (Krüger et al., 2008). This time is twice as long as derived from trajectory calculations using vertical winds from ECMWF. These results lie in the middle of the uncertainty range of 20 and 80 days for the 360-380K layer published by WMO (2007), which are only given for single years. To study the interannual variability of the residence time is important for long-term transport studies of VSLS and to limit the range of uncertainty within the TTL, which is the purpose of this study.

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SFB574: Modelling climate effects and feedbacks of past Central and South American major volcanic eruptions

Presenter: Kirstin Krüger (kkrueger@ifm-geomar.de)

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Investigating climate feedbacks is a central research task of the SFB 574 at Kiel University "Volatiles and Fluids in Subduction Zones: Climate Feedback and Trigger Mechanisms for Natural Disasters". Volcanic eruptions play a significant role on the global climate of the Earth system and can delay and attenuate the global warming due to anthropogenic climate change. Major volcanic eruptions, which directly inject gases, aerosols and volcanic ash into the stratosphere, have a strong and long lasting impact on the global climate depending on their geographical latitude and their SO_2 and halogen (Cl, Br, I) release. We will use state of the art climate models to study the climate effects and feedbacks of past Central and South American major volcanic eruptions analysed with the petrologic method. Simulations with different complexity of climate models enable us to assess their effect on the paleo and present day climate but also to assess their possible effect in a future climate scenario. Special emphasis will be placed on the global role of volcanically released halogen species on atmospheric chemistry and the possibility of a volcanically induced pre-industrial Ozone hole. The role of ocean- atmosphere interactions during major volcanic eruptions is an important climate feedback (e.g. ENSO, ocean heat content and sea level response), which will be investigated in more detail. The climate relevance of major volcanic eruptions from the tropical Central American Volcanic Arc, investigated during the first two phases of the SFB 574 and covering a time interval between 1950 AD and 191,000 BP, will be assessed with the help of an earth system climate model of intermediate complexity. As soon as volcanic volatile flux data become available from planned work in Chile, the effect of large volcanic eruptions from southern hemisphere mid-latitudes will be considered as well.

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Changes of the Brewer Dobson Circulation due to major volcanic eruptions in different ECHAM simulations

Presenter: Kirstin Krüger (kkrueger@ifm-geomar.de)

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Major volcanic eruptions have a significant impact on stratospheric and tropospheric climate, chemical composition and the atmospheric circulation. The climate effects are global if the volcanoes are located in the tropics and subtropics. As the last three major volcanic eruptions (1963 Mt. Agung, 1982 El Chichon and 1991 Mt. Pinatubo) occurred during strong El Niño events, no stratospheric observations are available since the 1950s demonstrating a pure volcanic signal in the atmosphere.

Based on the coupled chemistry climate model (CCM) MAECHAM4CHEM and on atmospheric general circulation model (GCM) MAECHAM5 we want to investigate the changes of the Brewer Dobson Circulation (BDC) following major volcanic eruptions. The CCM is coupled to an interactive stratospheric chemistry module taking the chemical feedbacks of volcanic aerosols into account. Two transient experiments were run one from 1960 to 1999 and one from 1980 to 1999 forced by prescribed observed sea surface temperatures, Quasi-Biennial Oscillation phases, solar cycle and volcanic eruptions. To derive a better understanding of the BDC changes of these transient model runs, a set of single GCM forcings will be used to distinguish the effects of volcanic eruptions (Mt. Pinatubo) from the ocean, QBO and ozone forcing on the BDC. Deficiencies of the different model set-ups and agreements with observations will be used to derive a better understanding of the important atmospheric processes and for a process-oriented validation.

ID: 00315 ◀back

Studies of Stratopause Evolution Using Satellite Data and Meteorological Analyses: Stratospheric Sudden Warmings and Interannual/Interhemispheric Variability

Presenter: Kirstin Krueger (kkrueger@ifm-geomar.de)

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Until the past several years, daily global or hemispheric temperature datasets extending through the mesosphere were largely unavailable. With the launch of the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument in 2002 and the Aura Microwave Limb Sounder (MLS) in 2004, we now have a wealth of such data. Some data centers, particularly the European Center for Medium-Range Weather Forecasting (ECMWF) and NASA's Global Modelling and Assimilation Office (GMAO) are providing operational assimilated meteorological analyses extending into the mesosphere; above the upper stratosphere, there are no direct data constraints, so the fields depend strongly on the dynamics and parameterizations in the underlying general circulation models, and there have heretofore been few data with which to compare them. We use MLS and SABER, data to detail the evolution of the stratopause during recent polar winters, and to assess the skill of the analyses in capturing the observed behavior. The operational analyses show serious deficiencies in reproducing extreme events such as the prolonged stratospheric sudden warming in the 2005-2006 Arctic winter. New research assimilation products show promise in improving the representation of the stratopause with higher model tops, more sophisticated gravity-wave drag parameterizations, and/or assimilation of MLS and SABER data. The interannual and interhemispheric variability of stratopause evolution and its representation in data assimilation systems is explored.

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Chemical-dynamical feedback of the 11-year solar signal in a Chemistry-Climate Model Simulation

Presenter: Anne Kubin (anne.kubin@met.fu-berlin.de)

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We present a model study of the 11-year solar signal performed with the new chemistry climate model system ECHAM5/MESSy. Two equilibrium runs were performed with prescribed 11-year solar cycle maximum and minimum irradiance conditions, respectively, and using climatological SSTs as lower boundary condition. We use assimilated equatorial winds to include the dynamical feedback associated with the QBO. The dynamical and chemical response to the applied forcing is analysed in detail, e.g. the alteration of planetary wave propagation conditions or changes in the mean meridional circulation as suggested by Kodera and Kuroda (2002). Special focus is laid on the transfer of the solar signal into the troposphere.

ID: 00026 ◀back

Analysis of the Tropical Tropopause Layer using the global nonhydrostatic atmospheric model

Presenter: Hiroyasu Kubokawa (uma@ees.hokudai.ac.jp)

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The tropical tropopause layer (TTL) is the main entrance where the tropospheric air passes through before entering the stratosphere. Water vapor mixing ratio which affects the stratospheric ozone is determined by both dynamics and transport in the TTL. In this study, we attempt to understand the effective processes with small to planetary scales controlling the TTL dynamics and dehydration using the global nonhydrostatic atmospheric model, NICAM. The NICAM is operated on the Earth Simulator, and has cloud-scale horizontal resolutions. Three hourly time-series data (horizontal resolution, dh=7 km) and an instantaneous output data (dh=3.5 km) of an aqua-planet experiment are analyzed. Following results are obtained.

(i) The TTL definitions are reconsidered by using the temperature profiles, cloud data, and vertical wind data. For the 3.5-km instantaneous data, convective clouds are found to overshoot the TTL bottom defined by the lapse rate minimum in 22.2% of the 5N-5S region, and to overshoot the cold point tropopause in 0.2% of the same region.

(ii) Convective clouds are organized to become convectively coupled Kelvin waves with a zonal scale of 12,000km. Also, there is a single, large-scale convective system (hereafter CS) with a scale of 700 km. The former systems generate large-amplitude Kelvin waves in the TTL, which make the dominant contribution to the temperature perturbations in this region. A part of the latter system penetrates the cold point and produce coldest tropopause with a scale of 200km.

(iii) For the 7-km time-series data, the downward motion associated with the Kelvin waves mainly control the variation of the water vapor mixing ratio in the TTL. For both 3.5-km and 7-km data, it is found that Kelvin waves make a dominant contribution to producing low saturation-mixing-ratio regions in the TTL. Also, large-amplitude gravity waves with a scale of 600 km are found to be superimposed in the cold phase of Kelvin waves, producing one of the coldest regions around the tropopause. It is suggested that the combination of Kelvin waves and gravity waves are one of the most effective dehydration processes in the TTL.

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Lidar and SAGE II comparison of aerosol characteristics over Gadanki, a tropical station in India

Presenter: Padmavati Kulkarni (padma.narl@gmail.com)

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Aerosol characteristics and life time are altitude dependent, hence vertically resolved measurements of aerosol characteristics are important in assessing the role aerosols play in altering the radiation budget of the Earth's atmosphere. The tropical Upper Troposphere (UT) and the Lower Stratosphere (LS) is a region of highly coupled dynamics to understand aerosol characteristics and stratosphere-troposphere exchange. The observational site Gadanki (13.2ºN, 79.2ºE) is a tropical station and continuous monitoring of UTLS aerosols is in progress from March 1998 till date using a polarization 0.532 µm elastic backscatter ground based lidar. SAGE II (Stratospheric Aerosol Gas Experiment) measures aerosol extinction at 0.385, 0.453, 0.525, and 1.02 µm wavelengths at 0.5 km resolution. The paper focus on extensive comparison of the aerosol extinction coefficients derived from lidar and SAGE II measured values during volcanically quiescent condition. Systematic comparison of lidar and SAGE II are mostly confined to midlatitudes and high latitudes with few comparisons reported at tropical station, as tropical region either lack lidars or observations severely hampered by its wet climate. Using seven years of data (Mar 1998-Aug 2005) from lidar, extensive comparison has been made in this work using coincident criteria.

Lidar aerosol extinction coefficients were derived at 0.532 mm at 300 m vertical resolution between 9-33 km. The extinction derived using Klett inversion method with constant Ba=0.020 (backscatter to extinction value) and Rayleigh backscatter coefficients using National Meteorological Center (NMC) molecular profile form each SAGE II event. Version 6.0 SAGE II measured aerosol extinctions at 0.525mm are sampled using following the criteria: measurements within ±5º in latitude, ±25º in longitude, and ±24 hours in time to get good number of data sets for SAGE II and lidar comparison over Gadanki. The individual lidar and SAGE II extinction comparison shows better agreement above 25 km and systematic difference below 25km with higher values of lidar in all seasons. The uncertainty exists in both instruments as before deriving extinction profiles both the instrument require some assumptions on the optical properties of aerosols, which leaded to the difference and are discussed. The comparison study also includes the observation of high altitude cirrus clouds observed by SAGE II and lidar within coincident criteria. Comparison shows good agreement by observing nearly same cloud height occurrence measured with both instruments at upper tropospheric altitudes. The cirrus clouds are unusually horizontally homogeneous, with extent of up to 2700km and their lifetime varies from few hours to few days.

The observational period also measures two minor eruptions, with signatures in both lidar and SAGE II. The first eruption was on 3 November 2002 at El Reventador (0.077ºS, 77.656ºW) Ecuador and the formation of an eruption column reaching

20km height. El Reventador exploded at Volcano Explosive Index (VEI) of 4 with ash and gases (mainly H_2O and SO_2) continued until January. Second eruption was on 27-28 January 2005 Manam volcano in Papua New Guinea (4.10ºS, 145.06ºE) are discussed. Volcanic layer produce a small but significant depolarized value measured with polarization lidar indicating presence of some non-spherical particles or spherical particles containing inclusion of irregular shapes with differing refractive index. The wavelength exponent gives an idea of the size distribution of particles and whether smaller or bigger particles dominated the size distribution, is also calculated for eruption layer and shows smaller value 1.19 at eruption layer indicating presence of larger size particles after the eruption. Seasonal variation of wavelength exponent for winter (DJF) and summer (JJA) shows values 2.08 and 2.10 respectively between 18-30km indicating aerosols of tropical origin with smaller size.

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Characteristics of inertia-gravity waves over Gadanki during the passage of deep depression over the Bay of Bengal

Presenter: Kondapalli Niranjan Kumar (niranjan@narl.gov.in)

K. Niranjan Kumar, T. K. Ramkumar (National Atmospheric Research Laboratory, India)

During the period of southwest monsoon (June-September) over the Indian subcontinent, a number of lows and depressions form over the Bay of Bengal and mostly they move west-northwestward direction and get dissipated after the passage over the land. Some of these develop into deep depressions or cyclonic storms. Monsoon depression is an atmospheric vortex with a central region of low pressure. In the northern hemisphere, the winds blow round the center in counter-clockwise direction. The intensity of the vortex is determined by the strength of winds. Monsoon depressions over the Bay of Bengal, producing large amounts of rainfall over India, are the most important components of monsoon circulation. The horizontal scale of the depressions is about 2000-3000 km and of the vertical scale is about 10 km. The intense close vortex has a well-defined cold core in the lower troposphere and warm core above 500mb.

It is identified one of such low pressure system formed over east-central and adjoining west-central Bay of Bengal concentrated into a depression near latitude. 15.5 N, longitude 86.0E on 0830hrs. IST on 21 June 2007 reported by the India Meteorological Department(IMD). Moving west-northwest wards it intensifies into a deep depression around the same evening. As the Indian MST radar is located near the eastern coast in Andhra Pradesh, attempt has been made to study in detail, the characteristics of gravity waves generated from this low pressure system. In the present work, it is reported the observation of generation of inertia-gravity waves from latent heating of the atmosphere associated with convective clouds during the passage of deep depression. Filtering and hodograph analyses of horizontal winds indicate upward energy propagation above the latent heating region of 4-6 km, which is manifested as significant enhancement in signal to noise ratio observed by the MST radar in this height range. This height range of latent heating during the period of monsoon depressions is also in agreement with the earlier modeling and observational reports. The observation of horizontal propagation of inertia-gravity waves in South west and South East ward directions before and after the passage of deep depression from the observational site indicates that these waves are associated with it and propagated outward, which is in agreement with earlier theoretical expectations. The vertical and horizontal wavelengths of gravity waves are found to be ~ 2.2 km and ~ 240km respectively in the troposphere.

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Representation of the Asian summer monsoon circulation in Chemistry climate models

Presenter: Markus Kunze (Markus.Kunze@met.fu-berlin.de)

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M. Chipperfield (University of Leeds, UK),
M. Dameris (Deutsches Zentrum für Luft- und Raumfahrt, Oberpfaffenhfn, Germany),
R. Garcia (National Center for Atmospheric Research, Boulder, USA),
M. Giorgetta (Max-Planck-Institut für Meteorologie, Hamburg, Germany)

This poster will be presented by Anne Kubin or Katja Matthes

The effect of the northern hemispheric summer monsoon circulation on the upper tropospheric and lower stratospheric dynamics and tracer concentrations has recently been addressed by several publications.

Here we focus on the climatological monsoon features in recent chemistry-climate model (CCM) runs. It is a contribution to the ongoing process orientated validation of CCMs within the Chemistry-Climate Model Validation (CCMVal) activity for Stratospheric Processes and their Role in Climate (SPARC) project.

We use REF1/REF2 simulations of chemistry climate models (CCMs) performed for the WMO/UNEP assessment of stratospheric ozone 2006, to analyse the impact of the Asian summer monsoon circulation on the temperature structure, and the water vapour and ozone concentration in a changing climate. The results include the five CCMs E39C, MAECHAM4CHEM, LMDZrepro, UMSLIMCAT, and WACCM.

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Role of solar activity in the troposphere-stratosphere coupling in the northern and southern hemisphere winters

Presenter: Yuhji Kuroda (kuroda@mri-jma.go.jp)

Y. Kuroda (MRI, Tsukuba, Japan)

The effects of the 11-year solar cycle on the troposphere-stratosphere (TS) coupling in the northern and southern hemisphere (NH/SH) active season (mid-winter in the NH, and late winter/spring in the SH) are examined through the analysis of observational data. It is found that the strength of the TS couplings in both the NH and SH active season are significantly modified according to the solar cycle; the dynamical coupling between the annular modes in the troposphere and stratosphere have a tendency to be stronger with increasing solar activity. Such a modulation of the TS-coupling in the SH by small spectral changes in the ultra-violet radiation is well simulated by a chemistry-climate model of Meteorological Research Institute, Japan. Source of such a modulation of TS-coupling via radiative change is also discussed.

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Stratospheric control of tropospheric annular mode responses to climate change

Presenter: Paul Kushner (paul.kushner@utoronto.ca)

Paul Kushner (University of Toronto, Canada)

A key problem in extratropical climate prediction is to determine the projection of the pattern of climate change onto the Northern and Southern Annular Modes. Observed Annular Mode indexes are influenced by many different climate forcings and exhibit significant multidecadal variability. As a result, their future trends remain uncertain. Analogously, simulated annular mode responses to climate forcings in climate models are prominent but model dependent, particularly in the Northern Hemisphere. In this talk, we review the dynamical influence of the stratosphere on the annular mode response to climate change in comprehensive and simplified atmospheric general circulation models. Models generally display a consistent stratosphere-troposphere annular mode response such that, for example, a stronger polar vortex goes hand in hand with a tropospheric westerly jet that is intensified on the poleward side. But the amplitude of the response, and the amplitude of the tropospheric compared to the stratospheric part of the response, is highly non-robust. As one example of this kind of non-robustness, we discuss how the simulated annular mode response to CO_2 doubling in a comprehensive GCM varies with stratospheric representation and with settings of orographic gravity wave drag parameterization. In simulations where the vertical resolution of the stratosphere and the gravity wave settings are varied to satisfy independent tuning requirements, it is the variations in the gravity wave settings that exert the stronger influence on the annular mode response. As another example, we discuss how, in a simplified GCM, the presence or absence of zonal asymmetries greatly influences the tropospheric annular mode response to stratospheric thermal forcing. We argue that recent fluctuation-dissipation theoretic ideas might make a dynamical connection between these examples.

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GOMOS O_3, NO_2 and NO_3 measurements in 2002-2007

Presenter: Erkki Kyrölä (erkki.kyrola@fmi.fi)

E. Kyrölä, J. Tamminen, V. Sofieva, S. Tukiainen (Finnish Meteorological Institute, Helsinki, Finland),
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D. Füssen, F. Vanhellemont (Institut d'Aeronomie Spatiale de Belgique, Brussels, Belgium),
O. Fanton d'Andon, G. Barrot, M. Guirlet (ACRI-ST,Sophia Antipolis, France),
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The Global Ozone Monitoring by Occultation of Stars (GOOS) instrument onboard the European Space Agency's ENVISAT satellite measures ozone, NO_2, NO_3, H_2O, O_2, and aerosols using the stellar occultation method. Global coverage, good vertical resolution and the self-calibrating measurement method make GOMOS observations a promising data set for building various climatologies. In this paper we present GOMOS nighttime measurements of ozone, NO_2, and NO_3 profiles during the five years 2002-2007. Using these measurements we have calculated zonally averaged global climatologies for the profiles. We compare GOMOS nighttime ozone climatology with the daytime ozone climatology from the OSIRIS/Odin instrument. We present also a time series analysis aimed at detecting annual and semiannnual variation of the profiles as well as understanding how the solar cycle and the QBO affect the time development of the profiles.

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On the effect of planetary Rossby waves on total ozone from GOME

Presenter: Margarida L. R. Liberato (mlr@utad.pt)

M.L.R. Liberato (University of Trás-os-Montes e Alto Douro, Portugal),
C. Gouveia (University of Lisbon, Portugal),
J.M. Castanheira (University of Aveiro, Portugal),
C.C. DaCamara (University of Lisbon, Portugal),
M. Weber, J.P. Burrows (University of Bremen, Germany)

Using a 3-Dimensional normal mode expansion of the atmospheric general circulation we highlight the distinction in the dynamics involved in stratospheric sudden warming (SSW) events of the displacement and split types.

This analysis scheme was applied to the NCEP/NCAR reanalysis dataset. Our approach mainly departs from traditional ones in what respects to the wave forcing, which is here assessed in terms of Total (i.e. Kinetic + Available Potential) atmospheric energy associated with the waves instead of heat and momentum fluxes.

Composite analyses show that SSWs of displacement type are forced by positive anomalies of the energy associated with the first two baroclinic modes of planetary Rossby waves with zonal wavenumber 1; SSWs of the split type are in turn forced by positive anomalies of the energy associated with the planetary Rossby wave with zonal wavenumber 2, and the barotropic mode appears to be an important component.

The high interannual variability of winter/spring ozone has been subject of much research, and here it is related to the energy variability of the forcing planetary waves. We discuss the effect of planetary Rossby waves on ozone and its dynamical control. Total ozone data products from GOME derived at the Institute of Environmental Physics of the University of Bremen were used in this study.

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Data assimilation: a tool for climate-chemistry studies

Presenter: William Lahoz (wal@nilu.no)

W. Lahoz (NILU, Kjeller, Norway)

In Numerical Weather Prediction, the routine confrontation of short-range weather forecasts with observations, facilitated by the analyses-prediction-comparison cycles built into the data assimilation method, has identified numerous shortcomings in the forecast model, leading to steady improvements in model performance over the years. This approach has not been hitherto applied to climate models (or climate-chemistry models), though the scientific value of doing so has been recognized, largely because these models are not generally developed in conjunction with an appropriate data assimilation scheme. Constituent data assimilation is now becoming mature and as well as being used to provide forecasts and analyses, it is being used to evaluate observations and models. Thus, it is timely to explore its use as a tool for improving climate-chemistry models and reducing their uncertainty. This talk will provide a brief review of the current state of stratospheric constituent data assimilation, with emphasis on ozone and water vapour, and will discuss possible strategies for implementing data assimilation in climate-chemistry studies.

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Long-term Trends in Ozone Laminae and Stratospheric Dynamics at Middle Latitudes in Relation to Upper Atmosphere Trends

Presenter: Jan Lastovicka (jla@ufa.cas.cz)

J. Lastovicka, P. Krizan, M. Kozubek (Institute of Atmospheric Physics, Prague, Czech Republic)

Laminae in ozone profiles at northern middle latitudes display a principal change in long-term trends in the mid-1990s like the total ozone does; laminae are no more reduced. This change is believed to be of predominantly dynamical origin. We will present behaviour of trends of laminae of different thickness, which have different seasonal variation and partly different origin. This will be compared with behaviour of some characteristics of stratospheric circulation and first results of such comparisons will be presented. Similarities and dissimilarities in trend behaviour in the (lower) stratosphere versus the global pattern of long-term trends and changes in the mesosphere and at higher levels will briefly be mentioned.

ID: 00414 ◀back

The impact of very short-lived organic substances on stratospheric ozone depletion - A case study

Presenter: Johannes Laube (j.laube@iau.uni-frankfurt.de)

J.C. Laube, A. Engel, Harald Bönisch, T. Möbius (University of Frankfurt, Germany),
D. R. Worton (University of East Anglia, UK, now at UC Berkeley, USA),
W.T. Sturges (University of East Anglia, United Kingdom)

The impact of very short-lived substances (VSLS) on the abundance of the summed-up bromine and chlorine in the stratosphere remains unsure. Due to the high ozone destruction efficiency of bromine especially the brominated VSLS are believed to significantly contribute to stratospheric ozone depletion. We present results from balloon-borne observations performed above Brazil in 2005 in the main stratospheric entrance region – the tropical tropopause layer (TTL) – and above. The collected whole air samples from altitudes between 15 and 34 kilometres were analysed using pre-concentration techniques followed by Gas Chromatography with Mass Spectrometric detection. A set of 28 chlorinated and brominated substances was quantified including ten substances with an atmospheric lifetime of less than half a year. We find the VSLS to elevate the effective equivalent stratospheric chlorine (EESC) by 2.9 %. Furthermore we present indications for additional organic brominated substances to be present in the tropical upper troposphere and stratosphere.

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ID: 00225

Effects of Deep Cumulus Convection on Atmospheric Chemistry

Presenter: Mark Lawrence (lawrence@mpch-mainz.mpg.de)

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C. Brühl, P. Jöckel, P. Hoor, J. Lelieveld (MPI-Chemistry, Mainz, Germany)

Deep cumulus convection has several important influences on atmospheric chemistry, such as vertical transport, scavenging of soluble gases and aerosols by precipitation, and generation of lightning, which produces NO. Deep convection also effects atmospheric chemistry indirectly through its contributions to solar and infrared radiation budgets, and to both synoptic and global scale circulations. At our institute, we have been employing a global chemistry-climate model, a global chemistry-transport model and a limited area cloud system resolving model, together with information from field observations, to develop a better understanding of this relationship between deep convection and atmospheric chemistry. Several key aspects and highlights from this work will be presented, focusing particularly on issues relevant to the chemistry of the UT/LS region, and relevant to the IGAC/SPARC AC&C activity 2 (processes controlling vertical distributions of trace gases and aerosols).

ID: 00450 ◀back

A new diagnostic for evaluating transport between the tropical upper troposphere and mid-latitudes lower stratosphere in chemistry-transport models

Presenter: Huikyo Lee (kyo@atmos.uiuc.edu)

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D. Youn (University of Illinois, Urbana, USA, and Seoul National University, Seoul, South Korea),
D. Wuebbles, K. Patten (University of Illinois, Urbana, USA)

Horizontal transport from the equator to mid-latitude summer is one of the major routes of stratosphere-troposphere exchange. In comparing two chemistry-transport models, MOZART-3.1 and GMI, with the observational database from satellites and aircraft campaigns, we found that conventional analyses on isobaric surfaces cannot be readily applied to the upper troposphere and lower stratosphere region where chemical tracers show strong vertical gradients. We adopted the thermal tropopause-relative altitude system as a vertical coordinate which gives finer vertical resolution to satellite data in the UT/LS region. As effective methods for diagnosing this transport process in chemistry-transport models, we examined probability density functions in chemical tracer profiles in the upper troposphere and lower stratosphere region and compared the results with AIRS and MLS satellite observations. To minimize the difference between the model meteorological fields and the real atmosphere, we classified data by the tropopause height and found observational evidence of the tropical air intrusion in the mid-latitudes. To verify whether the tracers during the high mid-latitude tropopause events originated from the tropics, we utilized two different tracer-tracer correlation maps, CO-O_3 and H_2O-O_3, that vary based on origin. Also through a case study, we found favorable synoptic conditions for air mass exchange between the tropics and mid-latitudes, and calculated the cross-tropopause flux of chemical tracers. Using the frequency of high tropopause occurrence at mid-latitudes, we developed a simple index indicating horizontal exchange between the tropical troposphere and mid-latitude stratosphere and examined its interannual variation and possible future changes due to climate change.

ID: 00280

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EOF Analysis of Temperature Anomalies in the Tropics with Radiosonde Data from the SHADOZ Program

Presenter: Sukyoung Lee (sl@meteo.psu.edu)

D.M. Shelow, S. Lee, Anne M. Thompson, S. K. Miller (Penn State Meteorology, University Park, PA, USA),
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A principal component analysis is performed on the vertical temperature and ozone profiles of the Southern Hemisphere Additional Ozonesondes (SHADOZ) soundings (1998-2006). Because the soundings are launched at 5-10 day ntervals, the analysis resolves variability at time scales that range from approximately two weeks to eight years. For selected SHADOZ sites, which are distributed throughout the tropics close to the equator, the two most dominant empirical orthogonal functions (EOFs) together represent the Quasi-biennial Oscillation (QBO) in the stratosphere.

The third most dominant temperature EOF is found to be closely associated with the El Niño-Southern Oscillation (ENSO). While the principal component (PC) time series of the third EOF is significantly correlated with the SOI index, the time series also shows much shorter time scale fluctuations. The vertical scale of the temperature associated with the ENSO is consistent with vertically propagating Kelvin waves. These results indicate that next to the QBO, ENSO has the most significant impact on the tropical low stratosphere (LS) temperature signal, and that this LS/ENSO relationship may be realized through vertically propagating Kelvin waves, which have much shorter time scales than ENSO itself.

ID: 00267 ◀back

Age of air and heating rates in the new ECMWF reanalysis

Presenter: Bernard Legras (legras@lmd.ens.fr)

B. Legras (LMD/ENS, Paris, France) and S. Fueglistaler (DAMTP, Cambridge, UK)

The age of air in the stratosphere is often used as a test for the good representation of the Brewer-Dobson circulation by atmospheric models. This is a critical requirement to modelize the distribution of long-lived species in chemical models. It is often advocated that using heating rates for vertical transport in the stratosphere performs better that standard analysed velocities from weather centers. This work is based on an extensive comparison of the age of air using 5 years of heating rates from the ERA-40 reanalysis and from the new ERA-interim reanalysis built with 4D-Var assimilation. The ERA-40 exhibits both too young ages with analyzed velocities and too old ages with heating rates. The reason for too young ages is spurious transport associated with too noisy wind, as a result of 3D-Var assimilation. Heating rates provide a much less noisy meridional circulation and preserve transport barriers and polar vortex confinement. However, excessive cooling near 30 hPa in the tropics blocks the ascending motion within the tropical pipe over extended periods of time inducing very old ages. This effect is usually corrected by an empirical correction which can exceed in some regions the calculated heating rate in magnitude, with opposite sign. We relate this correction to the assimilation temperature increment that is required to compensate the bias of the model, notably the excessive negative heat transport due to the noisy vertical velocities and the lack of mass conservation in the isentropic frame. The new ERA-interim exhibits much reduced noise in the vertical velocity and is ten times less diffusive than the ERA-40 in the tropics. Age of air is then found to be slightly older than given by the observations. The biases in the heating rate have also been considerably reduced with respect to ERA-40 and the assimilation increment is now only a fraction of the heating rate. The age of air is in fairly good aggreement with the observations at 20 km and higher altitudes. Further improvements combining heating rates and a filtered version of the assimilation increment for vertical transport in the stratosphere are discussed. We study the effect of restoring the mass conservation by recalculating a mass divergence balancing the modified heating rates. The new velocity dataset generated in isentropic coordinates is then used to study the interranual variability of the Brewer-Dobson and of heating rate, in relation with the QBO cycle.

ID: 00199 ◀back

The Stratosphere-Troposphere Exchange of Hydrogen Cyanide over the Tropics: the Aura MLS Observations and Model Simulations

Presenter: Qian Li (q.li@ed.ac.uk)

Q. Li, P. Palmer, H. Pumphrey (University of Edinburgh, UK)

The global 3-D chemical transport model GEOS-Chem is implemented to interpret the tropical atmospheric distributions of HCN which has been observed by NASA Aura Microwave Limb Sounder (MLS) instrument during recent years. The main sources of hydrogen cyanide (HCN) are from the burning of biomass and domestic fossil fuel while the main sink is ocean uptake, resulting in a tropospheric lifetime of around 5 months. An annual cycle in the troposphere is found from the intermittent tropospheric HCN column data from ground-based instruments across the tropics, which can also be reproduced by our model simulations. The lifetime of HCN is sufficiently long that the variability introduced by the surface sources and sinks can be observed in the tropical upper troposphere and stratosphere. Recently, Aura MLS data revealed a 2-year cycle in the HCN concentrations in the stratosphere, partly attributed to the variability of biomass burning in Southeast Asia. In this study, we will use the GEOS-Chem simulations to reconcile the discrepancy between the space-borne and ground-based observations of HCN over the tropics. Particular attention will be paid on the stratosphere-troposphere exchange of HCN.

ID: 00214

◀back

Dynamical and Photochemical Couplings in the Middle and Upper Stratosphere during the remarkable 2003-04 Stratospheric Sudden Warming

Presenter: Chuanxi Liu (lcx@mail.iap.ac.cn)

C. Liu, Y Liu (Chinese Academy of Sciences, Beijing, China)

The global 3-D stratospheric/tropospheric chemical transport model MOZART-3 is applied to study the dynamical and photochemical couplings in the middle and upper stratosphere during the 2003-04 remarkable stratospheric sudden warming event in the Northern polar region. Analysis of the chemical tracers shows that, during the warming event, three-dimensional transports associated with the evolution of polar vortex play important roles in controlling the polar ozone and odd nitrogen (NO_x) inside the mid-stratospheric vortex. In the early winter, the polar vortex was located in the region of polar night, where the night-time chemistry dominated the partitioning in the odd nitrogen family (NO_y). As soon as the warming event occurred, the strong planetary wave disturbances weakened the vortex. As a result, the enhanced cross-edge exchanges increased the concentrations of ozone and nitrous oxide (N_2O) inside the vortex. Followed by the rapid recovery of the upper stratospheric polar vortex in early January, prominent descents from the upper stratospheric vortex transported NO_x-rich air masses downward into the middle stratosphere. Subsequently, the stratospheric ozone inside the polar vortex underwent prominent losses through the enhanced NO_x catalytic cycles. Meanwhile, the downward transport of O_3 and N_2O-poor air from the upper stratosphere diluted the air inside the underlying vortex slightly. Moreover, the SSW event also disturbed the wintertime photochemistry inside the stratospheric polar vortex. The strong activity of planetary waves shifted the isolated vortex air into the sunlit mid-latitudes, where the light-sensitive nitrate radical (NO_3) decomposed rapidly. In brief, a picture of the dynamical-photochemical couplings in the middle stratosphere during the 2003-04 SSW event has been presented in our study.

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Behavior of Atmospheric Tracers during the 2003-04 SSW and Change of Ozone Flux in the UT/LS

Presenter: Yi Liu (liuyi@mail.iap.ac.cn)

Y. Liu, C. Liu, H. Wang, S. Gao (Chinese Academy of Sciences, Beijing, China), X. Tie, G. Brasseur (National Center of Atmospheric Research, Boulder, USA)

In this paper, we use the stratospheric/tropospheric chemical transport model (MOZART-3) developed at the National Center for Atmospheric Research (NCAR) to study the distribution of stratospheric O_3 during the 2003-04 remarkable Stratospheric sudden Warming event in the Northern polar region. The comparison between the model simulations and the ENVISAT/MIPAS observations demonstrates that the evolution of polar vortex and planetary waves during the SSW events play important roles in controlling the spatial distribution of stratospheric ozone and the downward ozone flux in the upper troposphere and lower stratosphere region. Compared to the situation in 2002-03, lower ozone concentrations are transported from the polar regions (polar vortex) to middle latitudes, leading to exceptional large areas of low ozone concentrations outside the polar vortex and to ‘low-ozone pockets’ in the middle stratosphere. The unusually long-lasting stratospheric westward winds (easterlies) during the 2003-04 event greatly restricted the upward propagation of planetary waves, which may have been responsible for the little intrusion of ozone-rich air into the polar regions. Moreover, the restricted wave activities also reduced the downward ozone flux between the lower stratosphere (LS) and the upper troposphere (UT), especially in East Asia. Consequently, during wintertime (December and January), the column ozone between 100 and 300 hPa over East Asia has been lower by about 10% during the 2003-2004 event compared to the 2002-2003 situiation.

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An intercomparison of different approaches to calculating trajectories in the tropical tropopause layer

Presenter: Yu Liu (yl238@damtp.cam.ac.uk)

Y. Liu, P. Haynes (University of Cambridge, UK)

The concentration of many chemical species in the stratosphere depend crucially on the pathways and timescales involved in transport through the Tropical Tropopause Layer (TTL), the main source region for air entering the stratosphere. In the TTL large-scale, convective and microphysical processes all play important roles.

Calculations based on trajectories driven by large-scale meteorological analysis winds and temperature fields have been employed with some success in previous studies to investigate transport in the TTL (e.g. Bonazzola and Haynes 2004, Fueglistaler et al. 2004, 2005). In particular, this can account for many details of the seasonal and inter-annual variations of water vapour in the tropical lower stratosphere. However, large-scale winds cannot capture all TTL processes, and water vapour is controlled as much by the temperature distribution as by transport, the usefulness of trajectory approach for other purposes, e.g. assessment of transport of very short lived species (VSLS) remains uncertain.

In this study we perform a systematic examination of the trajectory method, by using input wind fields from a range of models (e.g. Reanalyses, GCMs, diabatic heating rates) and with range of temporal resolutions. By examining the impact on predicted mixing ratios of chemical species such as water vapour and carbon dioxide, we aim to quantify and evaluate the limitations of using trajectories to estimate troposphere-to-stratosphere transport.

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Tropical upper-tropospheric ozone variability as observed by the Aura Microwave Limb Sounder

Presenter: Nathaniel Livesey (livesey@mls.jpl.nasa.gov)

N. Livesey, L. Froidevaux, M. Santee, D. Wu, J. Jiang, H. Su, W. Read, A. Lambert, M. Schwartz (Jet Propulsion Laboratory, California Institute of Technology, USA)

We present a survey of nearly 4 years of upper tropospheric ozone observations from the Microwave Limb Sounder (MLS) on NASA's Aura spacecraft. The abundance of ozone in the upper troposphere, where it is a strong and poorly-understood greenhouse gas, is controlled by a variety of processes. These include transport of ozone-rich air from the lower stratosphere, horizontal transport within the upper troposphere, in-situ formation from precursor species, and transport of potentially low-ozone air from the lower troposphere through processes such as convection. Uncertainties in the impact of these processes on the tropospheric ozone budget represent a challenge to projections of future climate. New vertically resolved upper tropospheric observations from Aura MLS can help reduce these uncertainties. Temporal and geographical variations seen in MLS tropical upper tropospheric ozone data will be described. The occurrence of 'low ozone events' will be quantified, and compared to prior observations. Relationships among MLS ozone, carbon monoxide and cloud ice (indicative of convection) observations, and parameters such as tropopause altitude, will be discussed. The large volume of MLS data enables a statistical assessment of the behavior of upper tropospheric ozone to be compiled.

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Cirrus clouds and ice supersaturated regions in global climate models

Presenter: Ulrike Lohmann (ulrike.lohmann@env.ethz.ch)

U. Lohmann, P. Spichtinger, T. Peter (ETH Zürich, Switzerland)

At temperatures below 238 K cirrus clouds can form by homogeneous and heterogeneous ice nucleation mechanisms. A parameterization for homogeneous freezing that includes the effects of aerosol size (Kärcher and Lohmann, 2002) was implemented in the ECHAM5 global climate model (Lohmann, 2007). We assume that the soluble/mixed Aitken, accumulation and coarse mode aerosols are available for homogeneous freezing. For the heterogeneous freezing simulations, we consider the insoluble accumulation and coarse mode aerosols to act as ice nuclei initiating freezing at 130% relative humidity with respect to ice. The model results of the represented ice supersaturation in the upper troposphere/lower stratosphere region are compared with satellite data and aircraft data of ice supersaturated regions (Spichtinger et al., 2003).

When changing the mass accommodation coefficient □ of water vapor on ice crystals from 0.5 in the standard ECHAM5 simulation to 0.005 as suggested by previous laboratory experiments, the number of ice crystals increases drastically (by several hundred percent) caused by the delayed relaxation of supersaturation. As the ice water content changes only slightly, the ice crystals are much smaller so that the shortwave and longwave radiation both change by around 3 Wm^{-2}. Changes in alpha; or when assuming heterogeneous freezing instead of homogeneous freezing affect the frequency of ice supersaturation.

<u>References:</u>

Kärcher, B., and U. Lohmann, A parameterization of cirrus cloud formation: Homogeneous freezing including effects of aerosol size, J. Geophys. Res., 107, doi: 10.1029/2001JD001429, 2002.

Lohmann, U., Global anthropogenic aerosol effects on convective clouds in ECHAM5-HAM, Atmos. Chem. Phys. Discuss. 7, 14639-14674, 2007.

Spichtinger, P., K. Gierens, W. Read, The global distribution of ice-supersaturated regions as seen by the Microwave Limb Sounder. Quart. Jour. Roy. Meteorol. Soc., 129, 3391-3410. 2003.

ID: 00449 ◀back

Validation of Mesospheric Analyses

Presenter: David Long (dl226@exeter.ac.uk)

D. Long, J. Thuburn. (University of Exeter, UK) D. Jackson (Met. Office, UK)

Recent results at the Met Office have shown that extending the domain of their forecast model to around 63 km. improved the quality of their tropospheric forecasts. It is expected that further extending the model upper boundary from 63 Km to 80 Km to include the majority of the mesosphere will lead to further forecasting benefits. In order to maximise these benefits this project will make the first proper quality assessment of current Met. Office mesospheric products. The validation is performed by comparing Met. Office mesospheric temperature analyses with independent temperature profiles obtained from the earth observational satellite microwave limb sounder (EOS MLS) experiment. The analyses used in this project are the Met. Office stratospheric assimilated data set which ranges from October 1991 to the present date. The EOS MLS data set ranges from August 2004 to the present date. The results of the temperature validation are displayed in monthly zonal mean differences between the analyses and EOS MLS profiles from August 2004 to the present date. The latitude range is from 80 degrees North to 80 degrees South with a vertical range of roughly 0-63 km. Consideration of major changes in both the model and data assimilation scheme is important in obtaining accurate validation of mesospheric products. With this consideration in mind additional results shown are the averaged values of the monthly zonal mean temperature differences over the following three temporal ranges. August 2004 to December 2004 where the analyses are produced using the N48L50 global forecasting suite. January 2005 to February 2006 where the analyses are produced again using the N48L50 suite with observational temperature data from the atmospheric infra-red sounder (AIRS) used in the data assimilation process. March 2006 to present date where the analyses are produced by the new N320L50 global forecasting suite without out data from the AIRS experiment. The validation results from each month over the EOS MLS range show that there is a strong seasonal variation in the temperature bias between the analyses and EOS MLS profile values. In particular the maximum error is a cold bias that occurs at high latitudes in both the northern and southern winter in the lower mesosphere. Therefore further additional results shown are the averaged values of the monthly zonal mean temperature differences for the following months in each year. Northern winter months of November,December and January. Southern winter months of May,June and July. The results from this validation will hopefully show which part of the forecasting process, model or data assimilation, is most in need of improvement and therefore development.

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Odin/SMR measurements of mesospheric water vapour

Presenter: Stefan Lossow (stefan.lossow@misu.su.se)

S. Lossow (Stockholm University, Stockholm, Sweden),
J. Urban, P. Eriksson, D. Murtagh (Chalmers Technical University, Göteburg, Sweden)

The Odin satellite provides informations of several parameters interesting for the understanding of the mesosphere in a global scale. The Sub-Millimetre Radiometer (SMR) measures the thermal emission of several trace gases in a frequency range between 480 GHz and 580 GHz. Mesospheric water vapour is derived from the 557 GHz emission line. This line is the strongest water line in the millimetre and sub-millimetre frequency region and provides water vapour informations up to an altitude of 110 km with a 3 km vertical resolution.

Here we will present results of the mesospheric semi-annual oscillation in water vapour in the tropics and the general water vapour distribution in lower thermosphere. Furthermore we will present some preliminary results of influence of the solar cycle on the water vapour distribution in the upper mesosphere and lower thermosphere.

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Equatorial wave packets in the LMDz stratospheric model and in the ERA40 reanalysis

Presenter: Francois Lott (flott@lmd.ens.fr)

F. Lott, F. Vial (LMD/CNRS Ecole Polytechnique, France),
J. Kuttipurath (SA, CNRS, Paris, France)

In the tropics, the variability in the low stratosphere is in part driven by equatorial waves issued from the tropical troposphere. As the low stratosphere is quite near aloft the tropospheric sources of these waves, the equatorial waves there are still grouped in packets. These packets need to be represented correctly in General Circulation Models, to determine the physical processes that yield to their dissipation, or to estimate the characteristic Temperature anomalies they produce in the low stratosphere. In this presentation, these tropical wave packets are analyzed using a method that mixes spectral analyses techniques with the equatorial waves theory.

For the Kelvin Waves packets, we use the theoretical fact that they yield to zonal wind anomalies that are almost uniform in latitude and over the Equatorial band. Hence, an horizontal wavenumber versus frequency Spectral Analysis of the zonal wind averaged over the tropics, reveals the dominant frequencies and horizontal wavenumbers associated with these waves in our datasets. These spectral analysis permits to build space-time band pass filters that retains the zonal wavenumbers and frequencies of interest. A composite analysis of the filtered data, keyed to the upper troposphere zonal wind anomalies that are uniform in latitude and over the Equatorial band, permits to extract the characteristic life cycle of the Kelvin Wave packets that enter in the tropical stratosphere.

For the Rossby Gravity wave packets, the same method is used but using the meridional wind anomalies that are almost uniform in latitude and over the Equatorial band.

In this presentation, the equatorial wave packets are extracted in a 25 years-long integration with the LMDz model and compared with those extracted from the ERA40 reanalysis during the 1978-2003 period. A special emphasis is given to the wave packets with zonal wave numbers $1<s<6$ (Kelvin), and $3<s<8$ (Rossby-Gravity).

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Seasonal Variation of Global Stratosphere-Troposphere Mass Exchange

Presenter: Daren Lu (ludr@mail.iap.ac.cn)

D. Lu (Chinese Academy of Sciences, Beijing, China)

By using the Wei-Formula in pressure coordinate, global stratosphere-troposphere mass exchange (STME) is diagnosed by using 44-year ECMWF reanalysis data-set spanning over 1958-2001. Investigation results show that the areas where the mass flux points from troposphere to stratosphere are centered at Indonesia, the Bay of Bengal and the middle of the western coast of South Africa, respectively. In compensation, downward mass fluxes are found mainly at mid-latitudes. At high latitudes, the area with upward mass flux and that with downward mass flux are staggered along the zonal cycles. It is observed that significant downward mass flux happens in autumn and winter season. Our results further show that over the course of a year, the mass flux across Eastern-Asia is always downward, which contributes 15.83% of the net mass exchange of the Northern Hemisphere, although the area only accounts for 5.6% of the area in the northern hemisphere. The details of the investigation will be introduced in current presentation.

ID: 00005 ◀back

Intra-seasonal oscillations of total ozone over the Indian region during the dry monsoon year 2002 - A study based on Morlet wavelet analysis

Presenter: Vazhathottathil Madhu (madhuv@cusat.ac.in)

V. Madhu and V. Sabeer (Cochin University of Science and Technology, India)

In the present study we used the total column ozone over the Indian subcontinent based on Earth probe TOMS Satellite over pass data during the deficit Indian summer monsoon year 2002 were analyzed using the advanced statistical method (Morlet wavelet analysis) to explore the Intraseasonal oscillations present in the total ozone. We found that the prominent oscillations present in the total ozone, one with a periodicity of 30 to 50 day oscillations (i.e. Madden Julian Oscillation) and other with a periodicity varying from 15 to 20 days. It was also seen that all these temporal variability in total ozone were due to the monsoonal induced circulation over the Indian subcontinent and were found significant at above 95% level of confidence when we performed the power spectrum analysis.

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A Study of the 2008 Stratospheric Sudden Warming in the Northern Hemisphere

Presenter: Sana Mahmood (sana.mahmood@metoffice.gov.uk)

S. Mahmood (Met Office, UK)

The work presented focuses on the Stratospheric Sudden Warming (SSW) that occurred in Feb/March 2008. The characteristics of this warming are looked at in detail by following the development of a range of diagnostics including zonal-mean zonal wind and Eliassen-Palm fluxes over the course of the event using Met Office daily stratospheric analyses. The multi-year database at the Met Office is utilised in performing the same analysis for the past 16 winters from 1991/92 for comparison with the current winter in order to highlight any features specific to this year's warming event.

Studies of this type can contribute to increasing our understanding of mechanisms that instigate SSWs and in investigating the troposphere-stratosphere dynamical interaction. This is important particularly in the context of a stratospheric influence on surface weather patterns and climate. Better knowledge of this potential tropospheric response to these warming phenomena could be useful in enhancing seasonal weather predictability.

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Influence of the Space Weather and conductivity of the ground-surface on thermal regime of the stratosphere

Presenter: Liudmila Makarova (lumak@aari.nw.ru)

L. Makarova, A. Shirochkov (Arctic and Antarctic Research Institute, Saint-Petersburg, Russia)

Numerous investigations of possible influence of the Space Weather on the Earth's atmosphere showed that the stratosphere is under impact of two factors: a) precipitation of charged particles, and b) electromagnetic energy of the solar wind which is transferred into the near – Earth space in the form of electric fields and currents. It was proved experimentally that maximum of the charged particles is formed at stratospheric altitudes, which is a component of the global electric circuit. This stratospheric layer of the charged particles is under control of the solar wind energy as well as of the solar activity. Electric currents flowing through this stratospheric layer could influence thermal regime of the stratosphere. Numerical calculations in framework of model simulations proved reality of such physical mechanism. Experimental data also disclosed dependence of the stratospheric temperature variations on the electrical conductivity of the ground - surface. It is well known that this parameter varies in great interval of magnitudes. The polar regions demonstrate such variations especially clear. There are regions of open water with high level of salinity (i.e. with good conductivity) in the Northern Atlantic Ocean as well as the regions covered by ice for a long time (i.e. with low conductivity) in the most of the Arctic Ocean. The satellite measurements of the atmospheric temperature above the Arctic in winter 2007 -2008 demonstrate existence of two different regions. One of them located above the Northern Atlantic Ocean is characterized by low values of stratospheric temperature (-80ºC at baric surface of 50 hPa) while the other region located above the central Arctic Ocean showed much more warm stratosphere (-45ºC at the same baric surface). Our explanation of existence of these different regions is connected with peculiarities of the solar activity at this period. The level of the solar activity in winter months of 2007-2008 was determined by very low flare activity and low intensity of the solar big-scaled magnetic fields. Under these circumstances the stratosphere above the regions with low conductivity of the ground surface turned out to be excessively warmed. As a result of this abnormal thermal regime of the stratosphere the whole system of atmospheric circulation has changed. So, in this case the stratosphere could be considered as indicator of the Earth's climate dynamics.

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The separate influence of recent climate change on stratospheric variability: Results from a transient simulation with a middle atmosphere model

Presenter: Elisa Manzini (manzini@bo.ingv.it)

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Recent observed variations in the Brewer-Dobson Circulation (BDC) may have arisen for a number of reasons, including ongoing tropospheric climate change, stratospheric ozone depletion or internal dynamical variations of the troposphere-stratosphere system, as well as perturbations from volcanic aerosols and variations in solar irradiance. In order to disentangle the various causes that may contribute to variations in the BDC, it is necessarily to perform numerical experiments with comprehensive models that include only selected aspects of the range of these possible factors that may influence the stratosphere. The focus of this work is on the connection between stratospheric variability and recent climate change, without considering the perturbation to the stratosphere induced by ozone depletion. Influences from volcanoes and solar cycle variations are also excluded. To this aim, a simulation with a relatively high horizontal resolution atmosphere general circulation model that includes a well resolved stratosphere is performed, with varying sea surface temperature and sea ice concentration, greenhouse gases and sulfate aerosols, for the 1950-2000 period. The varying fields follow the observed changes. The ozone field is specified to a pre-ozone depletion climatology (estimated for 1950-1970). Results are reported for variations in the BDC and their connection to tropospheric variability (from intra-seasonal to inter-annual) and change, with the focus on the Northern Atlantic and European region.

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Role of chemistry in the action of solar variability on stratospheric dynamics and chemistry

Presenter: Marion Marchand (marion.marchand@aero.jussieu.fr)

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F. Lefèvre, S. Bekki (UPMC/SA-CNRS, Paris, France),
P. Keckhut, G. Thiullier, A. Hauchecorne (UVSQ/SA-CNRS, Paris, France),
L. Jourdain (JPL, Pasadena, USA) F. Hourdin (UPMC/LMD-CNRS, Paris, France)

Solar ultraviolet irradiance is much more variable than the total solar irradiance. Atmospheric effects of the solar irradiance variations are investigated using a set of time slice simulations of the stratospheric version of the LMDZ and LMDZ-REPRO models at different levels of solar activity. The LMDz version used here is the stratospheric extension of the LMDz fourth-generation atmospheric GCM described in Lott at al. (2005) that is one of the components of the IPSL earth system model. LMDZ-REPRO is a fully coupled Chemistry-Climate Model (CCM) [Eyring et al., 2006] that combine interactively LMDZ to the chemistry module of the REPROBUS (REactive Processes Ruling the Ozone BUdget in the Stratosphere) chemistry transport model (LefÈvre et al, 1994, 1998). The objective is to estimate the role of chemistry in the action of solar variability on stratospheric dynamics and chemistry and, in particular on polar ozone chemistry.

ID: 00436

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Observations of vertical air mass exchange and new particles formation at Everest-Pyramid GAW Station

Presenter: Angela Marinoni (a.marinoni@isac.cnr.it)

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E.Vuillermoz, G.P. Verza (Ev-k2-CNR Commettee, Bergamo, Italy),
P. Bonasoni (ISAC-CNR, Bologna, Italy)

In the framework of the Ev-K2-CNR SHARE (Stations at High Altitude for Research on the Enviroment) and UNEP ABC (Atmospheric Brown Clouds) projects, the Everest-Pyramid monitoring station is active since March 2006 in the Khumbu valley (Nepal), at 5079 m asl in order to make up for a lack of information at high altitude in Himalayan region performing continuous measurements of chemical, physical and optical properties of aerosol and tropospheric ozone, as well as non-continuous measurements of halocarbons and other greenhouse gases. First two years of measurements describing the behaviours of aerosol, ozone and GHGs showed that this remote area can be affected by local, regional or long range transports of air masses, as well as frequent vertical air exchanges. Air mass intrusions from stratosphere or upper troposphere are characterized by simultaneous rise of ozone content and diminution of relative humidity. During several events of Statosphere (Upper troposphere) - Troposphere Exchange (STE), a sudden increase of ultrafine particles number was observed at the end of STE event. The interface between very clean air and the more polluted air has been identified as an efficient mechanism for new particles formation. We found that aerosol concentrations are driven by intense nucleation events; over a one year period, new particles formation events took place on more than 35% of the days, predominantly during sunny conditions, the highest frequency reported so far.

Correlation between STE and new particles formation, as well as quantification of STE influence on ozone budget at the station will be performed in this study.

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Impact of stratospheric resolution on seasonal forecast skill for Europe

Presenter: Andrew Marshall (andrew.marshall@metoffice.gov.uk)

A.G. Marshall, A.A. Scaife, S. Ineson (Met Office Hadley Centre, UK)

We assess the impact of stratospheric resolution on forecast skill in the Hadley Centre's atmospheric circulation model. The standard version of the model without stratospheric resolution has 38 vertical levels (L38), while the extended version with stratospheric resolution has 60 levels (L60). We conducted 5-month ensemble hindcasts for a suite of 15 winters within the last 45 years to assess the forecast skill and atmospheric response of each model to volcanic aerosols, the El Niño Southern Oscillation (ENSO), stratospheric warming events, and North Atlantic sea surface temperature tripole patterns.

The anomaly correlation of wintertime European surface temperature with respect to ERA-40 shows higher skill in the L60 model than in the L38 model. Both models generally reproduce the observed atmospheric response to ENSO, but show a weak response to volcanic aerosols. The volcanic response is greatly improved however when the vertical distribution of volcanic aerosol is modified to produce maximum anomalous warming (2-3K) over the cold point tropical tropopause. Agreeing with earlier hypotheses, this results in a significant 40-50% increase in water vapour transport from the troposphere into the lower stratosphere, which in turn strengthens the stratospheric circulation and invokes a stronger and more realistic surface response to an enhanced polar vortex.

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Improving the representation of ozone in the UK Met Office model

Presenter: Camilla Mathison (camilla.mathison@metoffice.gov.uk)

C. Mathison, D. Jackson, M. Keil (UK Met Office)

Ozone is an important trace element in the atmosphere, both at the surface where it poses risks to health and in the stratosphere where it protects the earth surface from harmful ultraviolet radiation.

Ozone can potentially have a large impact on NWP products. Improved representations of ozone can lead to better temperature analyses and forecasts via more accurate radiative heating rates and better assimilation of satellite radiances. Improved ozone analyses can also lead to improved surface UV forecasts, and potentially the correlations between ozone and wind can be used to improve upper troposphere or lower stratosphere wind forecasts. The increased availability and quality of ozone observations together with a more comprehensive understanding of ozone assimilation techniques has enabled these issues to be revisited.

The work presented focuses on impacts of different representations of ozone on analyses and forecasts. Currently ozone is represented by the Li and Shine climatology in the Met Office forecast model (MetUM). We compare this with 4 other methods of representing ozone, including;

- An alternative climatology provided by SPARC.
- An ozone field from the European Centre for Medium-range Weather Forecasting, ECMWF model.
- A 3D-Var assimilation system using two ozone observation sources - Earth Observing System Microwave Limb Sounder (EOS MLS) and the Solar Backscatter Ultraviolet Radiometer (SBUV/2).
- A 3D-Var assimilation system using only observations available in real-time, namely SBUV/2.

The experiments were run from 1st January to 15th February 2006. This period is of particular interest, because record low ozone was recorded over the UK at this time.

The results presented suggest that replacing Li and Shine with the more up to date SPARC climatology would improve other fields e.g. temperature, without incurring additional running cost to the system. The 3D-Var systems tested also showed a positive impact on analyses and forecasts. Thus indicating that there may be greater benefit, although also a cost, from including ozone within an assimilation system.

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Modeling the Impact of the Solar Cycle and the QBO in the Atmosphere: Time-Varying vs. Fixed Solar Conditions

Presenter: Katja Matthes (katja.matthes@met.fu-berlin.de)

K. Matthes (FU Berlin, Germany/NCAR, Boulder, USA),
R. Garcia (NCAR, Boulder, USA), D. Marsh (NCAR, Boulder, USA)

To investigate the impact of time-varying versus fixed solar conditions on the evolution of the solar signal in the atmosphere, its interaction with the QBO, and its transfer to the troposphere, a comprehensive set of experiments made with NCAR's Whole Atmosphere Community Climate Model (WACCM3), a chemistry-climate model that incorporates the whole atmosphere up to the thermosphere, is presented. A 110-year solar cycle experiment with WACCM3, wherein the solar cycle varies in time, is compared to two 30-year equilibrium runs under fixed solar maximum and solar minimum conditions, respectively. All experiments have in common a prescribed, time-varying QBO. The 110-year experiment shows good agreement with observations, especially regarding the dependence of the polar vortex evolution on the solar-QBO phase. These results are compared to the fixed solar cycle runs; the impact on the atmospheric solar signal of time-varying versus fixed solar cycle forcing is studied systematically to elucidate the importance of continuously varying solar forcing.

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A vortex dynamics perspective on stratospheric sudden warmings: observed structure and variability

Presenter: Joss Matthewman (jmatt@math.ucl.ac.uk)

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L.M. Polvani (Columbia University, NY, USA)

The vertical structure of the polar vortex is investigated for observed stratospheric sudden warmings (SSWs) during the period 1957-2002, using ECMWF ERA-40 reanalysis fields. The observed events are divided into 15 wave-1 (displacement) and 14 wave-2 (splitting) events. Composites of a suitably scaled potential vorticity are used to illustrate typical vortex behaviour with an emphasis on highlighting differences in the evolution of the vertical structure of the vortex during each type of event.

For wave-2 SSWs, the composite potential vorticity fields demonstrate that to a good approximation, the polar vortex split occurs simultaneously over the altitude range of 20-45 km. In contrast, for wave-1 SSWs the composite potential vorticity fields indicate that the breakdown of the polar vortex is strongly dependent on altitude, with the vortex completely destroyed at upper levels (35km) during the warming, while it remains at lower levels (20km). For both types of SSW, the composite fields show that in relation to the underlying topography, the orientation of the polar vortex during the breakdown is approximately the same for each event. Finally, similarities between the observed SSWs and SSW-like events induced in a simple quasi-geostrophic model of a columnar vortex are discussed.

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Stratospheric Ozone and Temperature Interannual Variability (1994-2007) from Lidar Measurements at Mauna Loa Observatory, Hawaii

Presenter: Stuart McDermid (mcdermid@jpl.nasa.gov)

I.S. McDermid, T. Leblanc, T. Li (JPL-TMF, California Institute of Technology, USA)

Interannual variability associated with the 11-year solar cycle, El Niño-Southern Oscillation (ENSO), and the Quasi-Biennial Oscillation (QBO) has long been found to be prominent in the lower and middle atmosphere, and plays a key role in the overall balance of its composition and circulation. Despite a wealth of observations and simulation studies, these variations and their coupling are still far from being fully understood. Quantifying and understanding the processes associated with them is an important step towards improving numerical models and contributing to understanding and predicting global climate change. The routine measurements by the Jet Propulsion Laboratory (JPL) ozone differential absorption (DIAL) and Rayleigh-Raman lidar located at Mauna Loa Observatory (MLO), Hawaii (19.5ºN, 155.6ºW) constitutes a unique and valuable dataset to study the long-term middle atmospheric ozone and temperature variability in the tropical/subtropical region. More than 2000 regular nighttime measurements have been made by the lidar since 1994 under the framework of the Network for the Detection of Atmospheric Composition Change (NDACC, formerly NDSC).

High vertical resolution ozone time-series were computed, deseasonalized, and then fitted using a multi-component linear regression model including the QBO, ENSO, the solar cycle, and a term representative of meridional transport. Each regression term contains an annual and semi-annual component. Using the same regression tool, the MLO lidar results were compared to the zonal mean ozone dataset obtained from SAGE-II over the same period. Not surprisingly the QBO and meridional transport are the principal source of variability, accounting for 80% of explained variance throughout the stratosphere while the solar cycle accounts for up to 25-30% at 23 km and 34 km, with an increased but statistically less significant contribution above 46 km. An ENSO statistically significant contribution was identified only at- and below 22 km and does not exceed 40% of explained variance. An interesting but not statistically significant ENSO signature was also extracted at 44-47 km. The results from the lidar time series are in very good agreement with those from the SAGE II zonal mean time series at 20ºN.

Similarly, using the monthly mean temperature vertical profiles observed by the JPL lidar (35-85km) and nearby radiosondes (0-30km), and with the linear regression analysis, we were able to extract the temperature trend, solar cycle, ENSO, and QBO signals from the troposphere to the upper mesosphere. The derived temperature trend shows only a minor trend at MLO. The solar cycle response in temperature is generally positive above the middle stratosphere and negative in the troposphere. During the El Niño events, warmer temperatures in the troposphere and upper mesosphere, and colder temperatures in the stratosphere and lower mesosphere were observed. The analysis revealed the dominance of the QBO (1-3 K) in the stratosphere and mesosphere, and a strong winter signature of ENSO in the troposphere

and lowermost stratosphere (~1.5K/MEI). Additionally, and for the first time, a statistically significant signature of ENSO was observed in the mesosphere, consistent with the findings of recent model simulations. The annual mean response to the solar cycle shows two statistically significant maxima of ~1.3 K/100 F10.7 units at 35 and 55 km. The temperature responses to QBO, ENSO, and solar cycle are all maximized in winter. Comparisons with the global ECMWF temperature analysis clearly showed that the middle atmosphere above MLO is under a sub-tropical/extra-tropical regime, i.e., generally out-of-phase with that in the equatorial regions, and synchronized to the northern hemisphere winter/spring.

This work was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under an agreement with the National Aeronautics and Space Administration.

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Diagnosing the causes of the climate-change induced strengthening of the Brewer-Dobson circulation

Presenter: Charles McLandress (charles@atmosp.physics.utoronto.ca)

C. McLandress, T. Shepherd (University of Toronto, Canada)

Recent studies using simulations from a number of comprehensive middle atmosphere models predict a strengthening of the Brewer-Dobson circulation (BDC) in response to climate change. Such a strengthening requires an increase in stratospheric wave drag. To gain confidence in the physical realism of this result it is important to quantify and understand the contributions from different components of the wave drag. In this study we analyze Middle Atmosphere Model (CMAM), and perform a comprehensive diagnostic analysis which allows us to attribute the reasons for the strengthening of the BDC. We find the increase in net tropical upwelling to be roughly equally due to increases in both parameterized orographic gravity wave drag and resolved planetary wave drag, with synoptic wave drag being of only secondary importance. We also examine the latitudinal and vertical structure of the climate-change response. In particular, we find that there is no straightforward connection between the low-latitude and high-latitude changes: while the CMAM results show an increase in Arctic downwelling in winter they also show a decrease in Antarctic downwelling in spring. Both changes are attributed to changes in stationary planetary waves propagating upward from the troposphere.

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Increased Amount Of Meteoric Material In The Winter Stratosphere: Implications For Heterogeneous Nucleation

Presenter: Linda Megner (linda@misu.su.se)

L. Megner (Stockholm University, Sweden)

Poster will be presented by Farahnaz Khosrawi

Every day of the order of 100 tonnes of meteoric material enters the atmosphere and ablates around the mesopause. This material is expected to recondense to nanometer-sized meteoric smoke particles, and sediment to the lower atmosphere. This material has been suggested to provide surface for heterogeneous chemistry and to be of importance for stratospheric nucleation processes. Studies concerned with these processes have so-far been based on 1-dimensional models of meteoric material, which cannot properly handle atmospheric transport. The first 2-dimensional model, which includes both the coagulation and transport of meteoric material, shows that this material effectively is transported to the winter stratosphere. The majority of the global semi-annual influx of material is therefore funneled into the winter vortex. The number and size distributions of meteoric smoke are therefore, unlike what is implicitly assumed with a 1-dimensional model, highly dependent on latitude and season. We here present the new estimates of number densities and particle area expected in the stratosphere, and discuss the possible influence on stratospheric processes.

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Longitudinal and seasonal characteristics of the tropical mean lapse rate and tropopause observed by high resolution GPS RO and radiosonde data

Presenter: Sanjay Kumar Mehta (sanjaymehta@narl.gov.in, ksanjaym@gmail.com)

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In the present paper an attempt has been made to study the mean tropical temperature lapse rate and tropopause behavior using high resolution observations obtained from CHAMP GPS radio occultation (RO),radiosonde and NCEP data during 2001-2006. On an average lapse rate between 13 and 16 km over 20ºS to 20ºN across the globe show high lapse rate (~ 7.5 K/km) in the longitude region 100-200ºE and also in narrow region around 300ºE reaching maximum during northern hemisphere (NH) winter months. More or less similar features are also noticed in NCEP data in the same regions although detailed features are absent, however, lapse rate from NCEP show ~2-3K/km less than that observed by CHAMP GPS RO. We also analyzed temperature data from 12 radiosonde stations (Ouagadougou, Trivandrum, Gadanki, Truk, Rochambeau, Bogota, Singapore, Tarawa, Nairobi, Seychelles, Darwin, and Ascension) distributed across the globe within ±13º from equator where data are available with good vertical resolution. The radiosonde data confirmed the observed high lapse rate behavior in the areas where it is observed more than 7.5K/km similar to that revealed by CHAMP GPS RO data.

The high vertical resolution radiosonde data are further utilized to study the longitudinal variation of tropopause characteristics within the tropical latitudes. It is observed that the cold point tropopause altitude (CPH) is around ~17.5 km and the cold point tropopause temperature (CPT) varied from ~ -82ºC to -87ºC during NH winter months. Lowest temperatures (<~-82ºC) during NH winter (Dec-Jan-Feb) months not only occur in Indian Ocean region to maritime continent but also at other places in equatorial belt. The lapse rate average between 13 km and 16 km, 13 km to cold point tropopause and CPT also show different characteristics among the stations. The day to variation of the CPT among stations is different. The correlation analysis of the time series of CPT after high pass filter with cutoff period 3 days suggest that the day to day variability of the CPT is not only cause by planetary wave but also with wave of periodicity less than 3 days.

Clear annual cycle is observed in upper tropospheric lapse rate with increase in amplitudes as tropopause is approached. The lapse rate between 15 km-CPH changed from 6ºC/km in January to 1ºC/km in July for the stations Truk, Tarawa and Singapore situated in the longitude zone 103ºE - 173ºE whereas the rest of the stations showed smaller annual variation. However, all the stations except Gadanki and Trivandrum showed minimum lapse rate in the NH summer months and maximum lapse rate in NH winter months. Gadanki and Trivandrum which are in the Indian summer monsoon region showed quite the opposite variation, ie., maximum in NH summer and minimum in NH winter. Correlation analysis of temperature data revealed that the CPT is more influenced by stratospheric processes than tropospheric

processes irrespective of the season. To delineate the modulation of the tropical tropopause, spectral analysis of the CPT, upper tropopspheric and lower stratospheric temperature and wind in different season and in different station is carried out. The implications of these will be discussed

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The role of stratospheric resolution for simulating ENSO wintertime teleconnections in northern extra-tropics

Presenter: Doreen Metzner (dmetzner@ifm-geomar.de)

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A number of observational and modelling studies demonstrate an extra-tropical El Niño/ Southern Oscillation (ENSO) signal in the stratosphere. The influence of ENSO on European climate is more strongly debated. Here, we investigate ENSO winter-time teleconnections to Europe, and assess the role played by the stratosphere.

Simulations with two different versions of the atmosphere general circulation model ECHAM5 forced by observed sea surface conditions are analysed: A six-member ensemble covering the period 1900-1999 with a low-top (10 hPa, ~30 km altitude) 19-layer version, and a five-member ensemble covering the period 1950-2005 with a high-top (0.01 hPa, ~80 km altitude)) 39 layer version. Both are run with T31 horizontal resolution.

Composites of El Niño events show, as observed, a warm and weak polar stratospheric vortex due to enhanced planetary wave driving. The reverse is found for La Niña events. Significant teleconnection patterns that agree with observations are only found in the high-top model version. Furthermore we consider the role of inter-annual variability within the stratosphere (sudden stratospheric warmings) and the role of the Quasi-Biennial Oscillation (QBO) in observations (ERA40 data), as the QBO does not spontaneously occur in the model.

Recent observational results indicate a surface signal over Northern Europe during El Niño events resembling the negative NAO phase due to the downward propagation of the stratospheric anomalies. Therefore we examine the role of stratosphere-troposphere coupling on the ENSO teleconnections by analysing time-height sections of zonal mean temperature and wind differences between El Niño and La Niña events.

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UTH measurements from satellite-borne nadir looking IR and MW sensors: Possible long time series with complementary instruments

Presenter: Mathias Milz (mathias.milz@ltu.se)

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Water vapor is the most relevant greenhouse gas. Especially in the upper troposphere, water vapor has a dominating role in the radiative budget as well as its link to the formation of clouds. The water vapor content in the upper troposphere is described by the upper tropospheric humidity (UTH). Satellite-borne instruments offer the opportunity to measure UTH with global coverage both with good horizontal and temporal resolution. Continuous satellite-borne UTH measurements since the early 1980s offer a good base to examine time series with global coverage and to validate climate models which show large discrepancies in their UTH products. However, instrumental peculiarities and the spectral regions used for the measurements lead to certain differences in the results between different satellite instruments. Measurements of UTH from infrared and microwave instruments are compared. The differences are assessed and analyzed. Goal is a consistent and well described time series of UTH datasets from complementary satellite-borne instruments, which help to validate and improve the UTH representation in different climate models and to understand their differences.

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Analysis of mean downward velocity around the Antarctic polar vortex

Presenter: Kazuyuki Miyazaki (kmiyazaki@jamstec.go.jp)

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Downward motion around the Antarctic polar vortex plays an important role in the constituent distribution and heat balance. However, it is too slow to be directly observed by any measurements, and its variation is difficult to be investigated. Several diagnosis methods have been developed to approximately analyze the Lagrangian-mean motion and evaluate the mean vertical velocity. Nevertheless, limitations of conventional analysis methods may hinder accurate analysis of the mean vertical velocity. In this study, the Lagrangian characteristics of vertical motions around the Antarctic polar vortex are studied using a general circulation model (GCM) with various analysis methods.

A trace analysis, which estimates the vertical velocity from the vertical displacement of tracer isopleths, confirmed that, zonal means at geographical latitudes give Lagrangian mean circulation around the Antarctic polar vortex, similar to those at equivalent latitudes. In the mass-weighted isentropic zonal means, the mean vertical velocity dynamically estimated from the meridional velocity shows strong downward motion outside the Antarctic polar vortex around 45S-55S in the lower stratosphere, consistent with those thermodynamically estimated from the diabatic heating rate. Compared to them, transformed Eulerian mean analysis tends to overestimate downward velocity outside the Antarctic polar vortex and underestimate it inside. Trace analysis produces a good approximation of the dynamic estimate inside the Antarctic polar vortex, but does not capture the strong downward velocity outside the vortex because of active horizontal mixing. If eddy mixing effects are included in the mean-meridional transport equation, the trace analysis agrees well with the dynamic estimate. It is found that mean downward motion outside the Antarctic polar vortex causes adiabatic heating and importantly contributes to the formation of the polar night jet stream from the lower to middle stratosphere through the thermal wind balance. Finally, an attempt of diagnosing actual vertical velocity showed that compared to GCM outputs, mean vertical velocities estimated from the reanalysis products are very noisy because of dynamical inconsistency caused by the analysis increment.

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Analysis of extratropical UTLS structure using a high vertical resolution GCM

Presenter: Kazuyuki Miyazaki (kmiyazaki@jamstec.go.jp)

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The structure of the extratropical upper troposphere and lower stratosphere (UTLS) has been studied using a vertically high resolved general circulation model (GCM). The GCM has a T213 truncation in the horizontal and 256 levels in the vertical from the surface to about 85 km with a vertical interval of about 300 m in the upper troposphere and above. Such a high vertical resolution GCM allows us to analyze a fine structure in the extratropical UTLS. All gravity waves are explicitly simulated by the GCM because no gravity wave drag parameterizations are included. The simulated thermal and dynamic structure reveals the existence of the tropopause inversion layer (TIL) just above the extratropical tropopause. Within the TIL, the temperature rapidly increases with height. The thickness of the simulated TIL is about 2 km, and a maximum of static stability in the TIL (approximately $6.5x10^{-4}$ s^{-2}) is observed 40 K above the dynamical tropopause in mid latitudes during winter. During summer the TIL is about 3 km thick in mid latitudes. These simulated TIL features are consistent with observations.

Potential vorticity (PV) fields diagnosed from the model outputs with a time interval of 1 hour are analyzed to investigate structure of the extratropical dynamical tropopause and transport processes in the UTLS. A large isentropic PV gradient around the extratropical tropopause indicates that the tropopause acts as a barrier for isentropic mixing between the troposphere and stratosphere, whereas the PV gradient is rather small inside the TIL. A meridional transport analysis on the basis of the mass-weighted isentropic zonal means demonstrates that tropospheric eddy motions mainly due to synoptic-scale weather disturbances decreases the PV gradient in the troposphere but increase it in the uppermost troposphere and around the tropopause (approximately from 1 to 4 PVU during winter). Stratospheric mean downward motion strongly converges in the lowermost stratosphere and sharpens the PV gradient around the extratropical tropopause (approximately from 2 to 6 PVU) during winter. An interesting finding is that the adiabatic diffusion coefficient derived from the PV fields is large inside the TIL especially at its upper part (approximately from 7 to 12 PVU) above the region of the maximum static stability throughout the year, indicating that the isentropic mixing is active there. In contrast, the diabatic diffusion coefficient is small around the dynamical tropopause and at the lower part of TIL (approximately from 2 to 7 PVU), showing that the vertical mixing is strongly suppressed there. This weak mixing region with a large PV gradient can be interpreted as a transition layer between two well-mixed regions, the extratropical troposphere and the upper part of TIL, as similarly indicated by Birner (2006). It is also shown that, in the well-mixed

region of the TIL, the active horizontal mixing is mostly attributed to the atmospheric disturbances with horizontal scales shorter than several thousand kilometers. In the presentation, we will further discuss the UTLS processes associated with various wave phenomena including gravity waves.

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Does the Brewer-Dobson Circulation change? Three Decades of Mean Age of Air Data Derived from Stratospheric SF_6 Measurements

Presenter: Tanja Möbius (moebius@iau.uni-frankfurt.de)

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The increase in the atmospheric greenhouse gas loading is known to cause a warming of the troposphere, which is expected to lead to an increase in wave forcing. Model studies, as referenced in the WMO/UNEP Scientific Assessments of Ozone Depletion 2006, predict that this increase leads to an intensification of the overturning mean meridional circulation of the middle atmosphere, the Brewer-Dobson circulation. Mean age of air represents the mean transit time of an air parcel to reach a certain location in the stratosphere. Therefore the mean age is a good proxy for the strength of the overturning meridional circulation. Mean age can be derived from measurements of very long-lived tracers such as SF_6 and CO_2.

We have reanalysed stratospheric air samples collected with balloon-borne whole-air samplers. By combining this set of reanalysed data with other stratospheric SF_6 measurements, we obtain for the first time a high quality data set of in-situ SF_6 measurements on a consistent calibration scale spanning three decades from 1975 until 2006. This unique SF_6 data set was used to investigate changes in the stratospheric mean age of air between 25-30 km altitude. For minimization of the uncertainty, fitting algorithms for the vertical age of air profiles were used and the mean age of air was derived for specific altitude intervals. In order to test the stability and significance of the derived long term trend, sensitivity studies were performed by varying the input data set, taking into account the limited number of in-situ measurements and their seasonal and spatial distribution. Summing up all results we show in contradiction to the model studies, that our data do not support an intensification of the Brewer-Dobson circulation in the middle atmosphere during the past three decades.

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Stratospheric Variability - Before and After the mid-1970s Climate Shift

Presenter: Kesavapillai Mohanakumar (kmkcusat@gmail.com)

K. Mohanakumar, P.A. Pillai (Cochin University of Science and Technology, India)

Climate changes might occur as result of gradual drift to a new state, a series of long-term swings, or a sequence of abrupt steps. The climate record of last 100 years or so exhibits ample evidence for all these types of variations. It is now widely accepted that a climatic regime shift transpired in the North Pacific Ocean in the winter of 1976-77. During the 1976-77 winter season, the atmosphere-ocean climate system over the North Pacific Ocean was observed to shift its basic state abruptly. The Aleutian Low deepened causing the storm tracks to shift southward and to increase storm intensity. It has been suggested independently by several investigators that the 1976-77 shift was caused by remote forcing from the tropical Pacific Ocean, where a contemporaneous warming of SST occurred, via well known as the tropics-high latitude teleconnection.

Along with this climate shift in 1976, significant increase in SST was found in the central and eastern Pacific and in the Indian Ocean. These are linked to the enhanced convective activity in the tropical regions also. These features affected many properties of ENSO like its periodicity, intensity and direction of propagation. Its periodicity changed to 5 years. It also affected ENSO-Monsoon relationship. The long-term negative correlation of ENSO and monsoon is weakened after the shift. The Walker circulation shifted southeastward and increased temperature gradient over Eurasia are suggested as reasons for this weakening of ENSO effect on monsoon.

It is interesting to see that many parameters in the stratosphere also show remarkable variations after 1976. One of the important changes in the stratosphere is the formation of Antarctic ozone hole, which develops and intensifies after 1976 in the southern hemispheric spring season. Continuous decrease in stratospheric temperature is also found after the climate shift period. Similarly the formation of North Atlantic Oscillation has also changed after this climate shift. Based on the ERA-40 data reanalysis data available, a detailed investigation has been carried out grouping the data before 1976 as the pre-climate shift period and after 1976 as the post-climate shift time. The stratospheric variability is found to be more distinct in the high latitude regions. The stratospheric variability of various parameters is then compared with the tropospheric weather changes before and after the climate shift, and the results will be presented.

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Linkage between stratospheric QBO and Tropospheric Biennial Oscillation in the tropical monsoon regions

Presenter: Kesavapillai Mohanakumar (kmkcusat@gmail.com)

K. Mohanakumar, P.A. Pillai (Cochin University of Science and Technology, India)

Quasi-biennial oscillation (QBO) is the most regular oscillation in the tropical lower stratosphere. Similar biennial oscillation is also observed in the tropical Indian and Pacific Ocean regions and of Asian-Australian monsoon, referred as Tropospheric Biennial Oscillation (TBO). The present study is to understand the possible relationship between stratosphere and troposphere over the different regions of the tropics where the effect of TBO can be felt. We estimated the QBO-TBO relationship over for different areas in the tropics like Indian monsoon region (100N-300N, 600E-950E) equatorial region (50S-50N, 600E-950E), North Australian (50S-150S, 1100E-1500E) and over the northwest Pacific (50N-200N, 1200E-1600E), using the zonal wind data from ECMWF for 1960-2002.

Over the Indian monsoon region the zonal winds from the lower stratosphere propagates downwards to troposphere with varying speeds at different levels. The downward propagation from the tropopause to lower troposphere characterizes three distinct layers having different descending rate. The zonal wind anomalies exhibit dipole structure in the troposphere, which alternately changes with the strength of the monsoon. Zonal wind anomalies in the previous winter are a good predictor for the forthcoming monsoon. Lower stratospheric westerly anomalies in the winter indicate a strong monsoon in the next summer and easterlies a weak monsoon.

But over the equatorial region, the winds from troposphere weaken on reaching the tropopause level. From the lower troposphere a weak zonal wind anomaly propagates upwards and meets that from stratosphere at 100 hPa level, creating a dipole like wind structure between lower and upper troposphere. In the Australian region also the stratospheric winds weakens on reaching tropopause. At the same time the trropsphere winds propagate upwards to tropopause level. In this region the propagation is slower than that at the equator. Over the Western Pacific region the stratospheric winds propagates downwards to the troposphere, but the extension speed is very slow. It takes almost 20 months to reach from 10 hPa to 100 hPa and takes another 20 months to reach the lower troposphere

The stratosphere-troposphere interaction exists in the entire tropical regions in association with TBO, but is most prominent and strong over the Indian monsoon region. Thus there may be a major role of the biennial oscillation of the Indian summer monsoon in the stratosphere-troposphere exchange over that area, which must be focused for more studies in the troposphere-stratosphere coupling.

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The AQUAVIT formal intercomparison of atmospheric water measurement methods

Presenter: Ottmar Möhler (Ottmar.Moehler@imk.fzk.de)

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and the AQUAVIT Team

Accurate measurements of water vapour and total water concentrations are prerequisite for assessing and understanding upper tropospheric and stratospheric water and energy budgets, cirrus formation, fluxes of water, radiation, and atmospheric chemical processes. The discovery of unusually high supersaturations with respect to ice in upper tropospheric cloud-free air and inside cirrus clouds is one example that calls into question our understanding of the physics of ice cloud formation or the accuracy of the humidity measurements.

The AQUAVIT campaign offered a framework for a formal intercomparison of water vapour measurement techniques at the AIDA (Aerosol Interaction and Dynamics in the Atmosphere) facility of Forschungszentrum Karlsruhe. A number of 22 different instruments, both state-of-the-art and newly developed techniques, were provided by 17 groups from 7 countries. All major groups which are currently employing sophisticated water vapour instruments on U.S. and European research aircraft, participated in the AquaVIT campaign and agreed on a data protocol which assured a careful and blind intercomparison of the data from the different instruments. The authors of this abstract were asked to act as independent referees, with the tasks of collecting the data sets, preparing the intercomparison plots, and leading the evaluation and discussion of the results.

Only a few instruments measured water vapour directly inside the large vessel (84 m3 volume) of the AIDA facility. Most of the instruments were connected to the vessel by heated high-quality stainless steel tubes. A calibrated permeation source and a high-quality frost point mirror were also available for additional calibration runs of the different instruments.

In a series of five experiments with constant temperatures of 243, 223, 213, 196, and 185 K, respectively, measurements were performed with cloud-free conditions in the AIDA vessel, which was basically used as a large reservoir with a well defined temperature, pressure, and water content. The latter was unknown to the instrument PIs. During each of the five experiments, the pressure was step-wise varied between 50 and 500 hPa, and thereby the water mixing ratio was varied from about 0.5 to 100 ppmv.

In a second series of five experiments, the pressure, temperature, and water mixing ratio were dynamically changed on short time scales of the order of minutes, which simulated the increase of ice supersaturation and the formation of cirrus clouds in updrafting cloud parcels. For these experiments the temperature was varied between 243 and 185 K, the pressure was varied between 50 and 300 hPa, and the water mixing ratio varied from about 0.5 to 3740 ppmv.

This contribution is intended to give a brief introduction to the AquaVIT team and the experimental activities, to present in detail the intercomparison results, which should be available until the meeting in Bologna, and to discuss possible conclusions and implications for atmospheric water measurements and upcoming activities.

ID: 00132 ◀back

Stratospheric methane and water vapour parameterisation for global models

Presenter: Beatriz Monge-Sanz (beatriz@env.leeds.ac.uk)

B. Monge-Sanz, M. Chipperfield (Leeds University, UK)

For a better assimilation of stratospheric radiances, and therefore more realistic transport, it is necessary to improve the descriptions of radiatively active gases in numerical weather prediction (NWP) models and data assimilation systems (DAS). Ozone has been included with reasonable success in NWP/DAS systems, however significant difficulties still exist in modelling humidity in the stratosphere, and other important gases (CH_4, CFCs) are not yet even included except as possible a global mean value. The chemical accuracy and experience of full-chemistry CTMs can be used to create sufficiently realistic chemical schemes for the NWP/DAS model.

An accurate simulation of stratospheric water vapour is a complicated task that requires different aspects of the DAS/NWP model to interact with a similar accuracy so that larger biases in one factor are not detrimental for the others. Up-to-date stratospheric water vapour simulations within 3D global models have been problematical due to the variety of processes involved, the number of feedbacks between them (e.g. radiation, stratospheric circulation and tropical tropopause temperatures) and the dependency these processes also present on others, like tropospheric entry rate depending mainly on convection and tropopause temperatures. As methane oxidation is the main source of stratospheric water vapour, including a parameterization of methane in a global model would allow for modelling both methane and water vapour in the stratosphere.

In this work, a new linear approach for modelling stratospheric methane has been developed and tested with the help of a chemical transport model (CTM). The CTM used is TOMCAT/SLIMCAT. The derived parameterisation scheme is suitable for any global model. We tested it within our CTM and within the ECMWF model. In the CTM, the performance of the scheme has been compared against full-chemistry runs of the model. This provided valuable information on the regions and times where the scheme is most suitable. We also compare the CH_4 distributions obtained with a nudged version of the ECMWF GCM, with the free-running ECMWF model and with the CTM using the same methane parameterisation. A parameterisation for water vapour from our methane scheme has also been implemented and tested within the CTM.

All model results have been compared against HALOE CH_4 and H_2O observations. The schemes perform well and results obtained are in good agreement with observations, in particular modelled CH_4 vertical profiles and zonally averaged distributions agree very well with HALOE measurements.

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Stratospheric transport in a CTM driven by DAS and GCM winds

Presenter: Beatriz Monge-Sanz (beatriz@env.leeds.ac.uk)

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Off-line chemical transport models (CTMs) can be forced by meteorological fields from a data assimilation system (DAS) or from a general circulation model (GCM). The major advantage of using assimilated fields is that in such a case the results from the CTM are directly comparable with observations on a particular day. However, the data assimilation process itself introduces discontinuities in the physical state of the numerical weather prediction (NWP) model that can affect the assimilated winds and consequently the modelled tracer transport. Therefore, a debate currently exists on the suitability of DAS winds for stratospheric long-term studies.

This study compares new ECMWF (re)analyses with previous existing datasets and shows large improvements in stratospheric transport, due to recent developments included in the ECMWF NWP/DAS system. We have run the TOMCAT/SLIMCAT off-line 3-D CTM with different assimilation products from the ECMWF: ERA-40 reanalyses (3D-Var), year 2000 operational analyses (4D-Var) and several ERA-Interim experiments (3D-Var and enhanced 4D-Var). A set of GCM winds based on the ECMWF model used to produce ERA-40 has also been used to force the CTM.

Diagnostics performed include age-of-air calculations (mean-age and spectrum), ètape recorder' representation and Lagrangian simulations. Trajectory calculations allow us to see how the use of a 4D-Var assimilation technique considerably reduces vertical spurious diffusion, compared to the less sophisticated 3D-Var technique. Also the effect of different lengths of the assimilation window is investigated. The more realistic transport achieved in the tropical region with the new DAS system is further confirmed by the ètape recorder' simulations. The tape recorder signal obtained with the new ECMWF ERA-Interim experiments is in good agreement with observations, and more realistic than that obtained with assimilated winds from previous ECMWF systems (ERA-40 and operational). Age-of-air calculations demonstrate that the improvements consistently extend outside the tropical region.

The effect of two different frequencies for the wind update in the CTM has been also investigated, which has shown that there is a threshold to the analysis frequency a CTM can use to correctly simulate stratospheric transport. In particular, the use of 12 hourly and 6 hourly winds has been compared, the longer frequency resulting in very unrealistic transport in the stratosphere. Some transport deficiencies attributed in the past to the use of DAS winds in CTMs appear to be due to the use of unsuitable too long update frequencies.

ID: 00088 ◀back

Influence of Stratospheric Circulation on the Predictability of the Tropospheric Northern Annular Mode

Presenter: Hitoshi Mukougawa (mukou@dpac.dpri.kyoto-u.ac.jp)

H. Mukougawa (DPRI, Kyoto University, Japan),
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Recently downward influence of the stratospheric circulation on the troposphere has been a central issue in the stratosphere-troposphere dynamical interaction inspired by the work of Baldwin and Dunkerton (1999). In the current study, the influence of the stratospheric circulation on the predictability of the tropospheric circulation is examined using 1-month ensemble forecast dataset provided by the Japan Meteorological Agency (JMA) for five boreal winters from 2001/2002 through 2005/2006. In particular, the predictability is discussed in the framework of the Northern Annular Mode (NAM).

Concerning the forecast of the NAM index in the troposphere, the ensemble-mean forecast error with the lead time of 3 to 11 days is found to be significantly small when the negative NAM anomaly is observed in the lower stratosphere (50hPa) at the initial time of the forecast in comparison with the case of the positive NAM anomaly. However, the predictability of the tropospheric NAM index is not significantly related to the observed NAM index at 1000 hPa at the initial time of the forecast. These facts indicate that the stratospheric NAM anomalies significantly affect the predictability of the tropospheric NAM variations.

On the other hand, we also detect a significant relationship between the ensemble-mean forecast error of the tropospheric NAM index and the zonal-mean zonal wind anomalies in the stratosphere. Westerly anomaly around 50N, 50hPa tends to associate with large ensemble-mean forecast error of the tropospheric NAM index with 7-day lead time. Moreover, the vertical propagation of zonal wavenumber one component in the lower stratosphere tends to be weaker and its propagation into lower latitudes tends to be enhanced in the troposphere when the forecast error of the NAM index is large. These results indicate that the predictability of the tropospheric NAM variations depends on the propagation property of planetary waves. Hence, it would be suggested that the stratospheric NAM anomaly influences the predictability of the tropospheric NAM variations by affecting the propagation property of planetary waves in the lower stratosphere. We will also discuss the influence of the stratospheric NAM anomaly on the predictability of the regional tropospheric variability such as the North Atlantic Oscillation (NAO).

ID: 00035 ◀back

Chemistry of aerosol particles in the upper troposphere and lower stratosphere

Presenter: Daniel Murphy (daniel.m.murphy@noaa.gov)

D. Murphy (NOAA, Boulder, USA)

Chemical analysis of single particles in the lower stratosphere can distinguish three kinds of particles: particles containing meteoric elements that were formed in the upper stratosphere, particles without meteoric elements that were formed in the lower stratosphere, and particles transported into the stratosphere from the troposphere. Sorting chemical analysis by these three types of particles teaches important lessons about the sources and sinks of particulate organic material. Particles in the upper tropical troposphere are not primarily sulfuric acid. Instead, they can have high organic content and significant neutralization. This has implications for nucleation of ice near the tropical tropopause.

ID: 00297

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Ozone loss rates determined by the use of Odin and AURA/MLS data assimilation

Presenter: Donal Murtagh (donal@rss.chalmers.se)

D. Murtagh, J. Rösevall, J. Urban (Chalmers University, Sweden)

Ozone Data from the Odin/SMR and Aura/MLS instruments are assimilated into a simple isentropic transport model (DIAMOND) driven by analysed wind field from ECMWF. Initialisation is performed by first assimilation data for a 3 month period up until ozone loss is expected to occur. Two separate ozone fields are then generated: one by passively advecting the initial field and one where new data is continuously ingested.

The difference between the fields is ascribed to chemical ozone loss. Vertical transport is implemented in two ways: 1) by use of N_2O as a tracer and 2) using diabatic cooling rates taken from the SLIMCAT model. Results for the different techniques are compared and ozone losses for all Odin winters are presented.

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Sensitivity of global mixing and fluxes to localized transport barriers

Presenter: Noboru Nakamura (nnn@uchicago.edu)

N. Nakamura (University of Chicago, USA)

Climate models and chemical transport models give disparate estimates of global transport and mixing in the upper troposphere and lower stratosphere. Whilst it is easy to blame the models' shortcomings for this discrepancy, it is also possible that something about the transport is inherently difficult to model. We demonstrate the sensitivity of the global isentropic mixing to a localized transport barrier, represented by a minimum in effective diffusivity. Both an idealized 1D model with a prescribed diffusivity and offline isentropic advection-diffusion calculations driven by the Met Office winds reveal that the tracer structure, flux, and decay rates all depend sensitively on the geometry of the barrier, particularly when it is deep and narrow. To the extent that the barrier properties are sensitive to the errors in the advecting winds and model numerics, this may explain, at least partially, the disparate model estimates.

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Amplitudes of Rossby waves based on the Bjerknes circulation

Presenter: Noboru Nakamura (nnn@uchicago.edu)

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The traditional Eulerian definition, “departure from the zonal mean,” is not necessarily a best way to quantify eddy amplitude, because when the amplitude is large, eddy modifies the zonal mean: that is, the reference state itself becomes a function of eddy, obscuring the true magnitude of eddy and its tendency. In this paper, we introduce a method to quantify eddy against an invariant reference state and thereby avoid this difficulty. The eddy amplitude is characterized by the èwaviness’ of closed quasi-material contours on the isentropic surface, quantified as the deviation in the planetary circulation from the zonally symmetric state. This definition provides an absolute measure of eddy amplitude, unaffected by the eddy-mean flow interaction. We use this method to analyze the climatology of the eddy amplitude in the upper troposphere and lower stratosphere with the Met Office Stratospheric Analysis for the period of 1992-2005. In the meridional plane spanned by potential temperature (265-2059 K) and equivalent latitude, the amplitudes are large (small) at the flanks (axes) of the jets. This is similar to effective diffusivity in the same coordinate but differs significantly from the more traditional Eulerian-mean eddy norms that show maxima at the jets.

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An Evaluation of the Capability of HIRDLS to Measure Thin Ozone Filaments During Tropopause Folding events in the Extra-Tropical UTLS Using Co-Located Ozonesonde and Lidar in situ Measurements

Presenter: Bruno Nardi (nardi@ucar.edu)

B. Nardi, J.C. Gille, V.A. Yudin (National Center for Atmospheric Research, Boulder, CO, USA)
and the HIRDLS Team

Stratosphere-troposphere exchange and a related poleward transport of extra-tropical upper tropospheric air into the lower stratosphere appear to frequently occur along fast moving tropopause folding events. Folding events are especially prevalent in Northern Hemisphere late winter and early spring. The High Resolution Dynamic Limb Sounder (HIRDLS) on board the Aura satellite has a demonstrated ability to measure ozone with approximately 1 km vertical resolution into the upper troposphere / lower stratosphere (UTLS) region to about 200 hPa. It is the first satellite instrument with sufficient vertical resolution and coverage to observe many such events in the UTLS. HIRDLS measurements of ozone and temperature during folding events show the typical features of low ozone pockets above relatively ozone rich layers. We will provide a quantitative and statistical assessment of the ability of HIRDLS to detect these events, by doing a systematic comparison with collocated in situ ozonesonde and lidar measurements over several years (2006-2008), from multiple ozonesonde stations within the World Ozone and Ultraviolet Radiation Data Centre (WOUDC) and from several lidar stations within the Network for the Detection of Atmospheric Composition Change (NDACC).

ID: 00112 ◀back

Inertia-gravity wave characteristics observed over a tropical station using intensive GPS Radiosonde soundings

Presenter: Debashis Nath (debashis@narl.gov.in, debashis.narl@gmail.com)

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Inertia-gravity waves play an important role in the large-scale circulation, structure and the variability of the middle and upper atmosphere by transporting momentum and energy. Several earlier attempts had been made to characterize the Inertia-gravity wave in the upper troposphere and lower stratosphere (UTLS) region using VHF radar, routine balloon soundings and space based satellite data. But all these instruments have their own limitations. In order to overcome some of these limitations, a major campaign was conducted where more than 270 Väisälä (RS-80 & RS-92) GPS sonde balloons were launched over Gadanki (13.48N, 79.2E) from April 2006 to March 2007 almost daily at 12GMT (17:30 LT). Individual wind and temperature profiles are subjected to a polynomial fitting of order two in order to extract the fluctuation part. The vertical wavelengths are calculated for individual components in two different height regions 0-14 km and 18-25 km. The dominant wavelength lies in the range of 3-4 km in all the 3 components (U, V, T). The polyfitted fluctuations are then subjected to bandpass filter of 3-4 km spatially in both the height regions. Clear downward phase propagation of the gravity wave is prominent in the filtered profiles. The individual filtered profiles are then subjected to sinusoidal fitting in order to extract the quasi-monochromatic gravity wave and these sine-fitted data were subjected to hodograph analysis in order to extract different gravity wave parameters.

The intrinsic frequency and horizontal wavelengths of the gravity waves are f (coriolis frequency) and 1.5 f and 250-500 km and 250-1000 km in the troposphere and lower stratosphere, respectively. The direction of propagation is found to be downward and upward in troposphere and lower stratosphere, respectively, during monsoon whereas it is upward during winter from 10 km onwards. The intrinsic vertical phase velocity is mostly negative but concentrated around zero in the stratosphere but almost symmetric in all the seasons (ranges between -0.4-0.4 m/sec). The horizontal propagation direction is mainly eastward in stratosphere and westward in troposphere during monsoon and post-monsoon season but during winter the propagation is almost symmetric in both the directions. The horizontal intrinsic phase speed varies from 5-30 m/sec.

Clear semi-annual variation in the kinetic energy (Ek) is found with maximum during Summer and Winter and minimum during pre-monsoon and post-monsoon seasons both in troposphere and lower stratosphere, although lower stratospheric amplitudes are less during winter. This kind winter enhancement is not expected at this tropical latitude. Interestingly the contribution of meridional component is found larger to the total kinetic energy during winter. Strong eastward shear due to TEJ is found responsible for generating the gravity wave during the monsoon. Gravity wave generation

during winter season is thought to be due to strong meridional wind shear above 10 km but needs further investigation before arriving at conclusion.

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Tropospheric ozone: The role of stratospheric variability

Presenter: Jessica Neu (jneu@uci.edu)

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We examine the degree to which trends and variability in tropospheric ozone are driven by changes in the stratosphere. Preliminary results from the UCI chemistry transport model (CTM) with an updated linearized stratospheric ozone chemistry (LI-NOZ) show that the stratosphere is responsible for peak to peak seasonal variations of 8 DU in the tropospheric ozone column at northern midlatitudes and that ozone depletion has decreased the stratosphere-troposphere flux of ozone by 5-8% in the Northern Hemisphere and 10-15% in the Southern Hemisphere. We extend these results by including full tropospheric chemistry in the CTM. Using fixed emissions, we examine the variability in tropospheric composition due to solely to changes in the stratosphere-troposphere ozone flux. We then compare the variability due to changes in the stratosphere to interannual variability arising from changes in anthropogenic emissions and biomass burning.

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The World Avoided: What would have happened to ozone, surface UV, and the stratosphere if CFC emissions continued to grow without regulation?

Presenter: Paul Newman (Paul.A.Newman@nasa.gov)

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G. Velders (Netherlands Environmental Assessment Agency, Bilthoven),
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E. Fleming, N. Krotkov, S. Frith, C. Jackman, S. Pawson, J.E. Nielsen, A. Douglass,
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The discovery of the linkage of chlorofluorocarbons (CFC) to ozone depletion by Molina and Rowland (1974) led to the signing of the landmark Montreal Protocol agreement in 1987. In this model study, we explore what would have happened if this CFC-ozone depletion hypothesis had not been discovered. We use both the 3-D GSFC GEOS-CCM and the GSFC coupled 2-D model. In this alternate world, emissions of CFCs increase by 3% each year. By the year 2020, total chlorine reaches a level of 9 ppb (approximately 3 times higher than the maximum observed in 2000). These large chlorine loadings lead to global ozone depletions of 12% by 2020. The 40 km layer had decreases of 30-40% between 1980 and 2020. Polar ozone shows severe depletion. There is 100% depletion of ozone at South Pole for the 50 hPa level during October. At the North Pole, the depletion averages about 70% for the 50 hPa level during March, with 100% depletion in some years during this 2020 period. In addition to ozone depletion, we will show the associated surface UV increases and the dynamical changes to both the stratosphere and troposphere.

Reference

Molina, M. J., and F. S. Rowland, Stratospheric sink for chlorofluoromethanes: chlorine atom catalyzed destruction of ozone, Nature, 249, 810-814, 1974.

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Detection and attribution of the recovery of polar ozone

Presenter: Paul Newman (Paul.A.Newman@nasa.gov)

P.A. Newman, E.R. Nash, A.R. Douglass, J.E. Nielsen, S. Pawson, R.S. Stolarski
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The Antarctic ozone hole develops each year and culminates by early spring (late September - early October). The severity of the hole has been assessed from satellites using the minimum total ozone value from the October monthly mean (depth of the hole), calculating the average area coverage during this September-October period, and by estimating ozone mass deficit. Profile information shows that ozone is completely destroyed in the 14-21 km layer by early October. Ozone is mainly destroyed by halogen (chlorine and bromine) catalytic cycles, and these losses are modulated by temperature variations.

Because atmospheric halogen levels are responding to international agreements that limit or phase out production, the amount of halogens in the stratosphere should decrease over the next few decades. Both models and projections of ozone depleting substances (ODSs) into the 21st century reveal that polar ozone levels should recover in the 2060-2070 period. In this talk, we will review current projections of polar ozone recovery. Using models and ODS projections, we explore both the past, near future (2008-2025), and far future (> 2025) levels of polar ozone. Finally, we will discuss various factors that complicate recovery such as greenhouse gas changes (e.g., cooling in the upper stratosphere) and the acceleration of the Brewer-Dobson circulation.

ID: 00072 ◀back

Impact of tropospheric and stratospheric data assimilation on the mesospheric prediction

Presenter: Yulia Nezlin (yulia.nezlin@ec.gc.ca)

Y. Nezlin, Y. Rochon, Saroja Polavarapu (Environment Canada)

Numerical experiments are used to assess the potential benefit of the assimilation of tropospheric and stratospheric observations on the mesosphere. A simulated atmosphere taken as truth is created using the Canadian Middle Atmosphere Model (CMAM). The truth is sampled at the locations of the measurements from the actual observing system to produce observations which are then assimilated with the CMAM-DAS (Data Assimilation System). Obtained forecasts are compared with the truth and error statistics are calculated. An assessment based on predictability shows that upward propagation of information resulting from the assimilation of tropospheric and stratospheric observations improves the mesospheric forecast in the largest scales (with horizontal wave numbers less than 10). Nevertheless, the same system with the same observations does not resolve mesospheric small-scale waves.

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Identification and Climatology of Cut offs Lows near the Tropopause from two different kinds of physical approaches

Presenter: Raquel Nieto (rnieto@uvigo.es)

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M. Sprenger (ETH Zürich, Switzerland),
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Cut-off low pressure systems (COLs) are important as a mechanism of stratosphere troposphere exchange (STE). In cut-off low systems, the tropopause is anomalously low, thus contributing to produce STE. The STE associated with COLs is essential to explain anomalous values of tropospheric ozone. Here we present three upgraded climatologies of these systems developed by Nieto et al. (2005) and by Wernli and Sprenger (2007), and a comparison between the results, for the whole extratropical Northern hemisphere (from 20ºN to 70ºN). We use two reanalyses datasets, NCAR-NCEP and ERA-40, checking their area of occurrence, seasonal and monthly cycle. The first two climatologies are built from 6-hourly data from the ERA-40 and from the NCEP-NCAR and based on the conceptual model of COL developed by Nieto et al (2005). This approach uses geopotential, zonal wind, and temperature daily data from 200, 300 hPa with a 2.5º by 2.5º resolution. The third climatology was developed using potential vorticity as the physical parameter of diagnosis following the previous methodology by Wernli and Sprenger (2007). This analysis is based also upon the 40 year re-analysis ERA-40 6-hourly data set from the ECMWF. The required fields (horizontal wind components, temperature, geopotential) are available every 6 hours onto a regular grid with 1º horizontal resolution. Secondary fields like potential temperature and potential vorticity (PV) have been calculated on the original hybrid model levels. Finally, the PV field was interpolated to a stack of isentropic levels from 300 to 350K, separated by 10K. The analyses cover the time period from January 1958 to December 2002.

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Modulations of planetary waves by upward-propagating Rossby wave packets prior to a stratospheric sudden warming event: observations and ensemble forecasts

Presenter: Kazuaki Nishii (nishii@eps.s.u-tokyo.ac.jp)

K. Nishii, H. Nakamura (University of Tokyo, Japan)

Enhancement of Rossby wave-activity injection into the stratosphere observed before and during a major stratospheric sudden warming (SSW) event in January 2006 is analyzed with emphasis on the role of localized upward-propagating Rossby wave packets. The particular viewpoint enables us to pinpoint the tropospheric circulation anomalies that acted as the local sources of the wave packets and to discuss how circulation anomalies both in the troposphere and stratosphere associated with those wave packets modulate the amplitude and phase of the climatological-mean planetary waves to enhance the injection of their wave activity into the stratosphere.

From early to mid-January of 2006, the stratospheric polar-night jet (PNJ) was decelerated into easterly by the above-normal upward injection of wave activity from the troposphere in association mainly with zonally-confined Rossby wave packets. Those wave packets were emanated from a tropospheric cyclonic anomaly over the North Pacific and a blocking high over Europe in early January. In mid-January another wave packet was from an tropospheric anticyclonic anomaly over the North Atlantic that developed associated with downstream development of baroclinic waves from the Pacific to the Atlantic. The upward component of the wave-activity flux can be decomposed into the three terms of climatology-climatology, climatology-anomaly and non-linear anomaly-anomaly terms. The second and third terms can contribute to the rapid PNJ deceleration. While the third term represents the contribution from wave-packet propagation itself, the second term represents the effect of the modulations added to the climatological-mean planetary waves by the zonally-confined wave packets. In early January, the upward-propagating wave packets enhanced the injection of wave activity not only by themselves but also by modulating the climatological planetary waves through the superposition of the associated anomalies onto the ridge and trough of the climatological-mean planetary waves. In mid-January , however, the wave packet is found to be the primary contributer to the enhanced upward planetary wave-activity injection. Rather, the wind and thermal anomalies associated with the wave packet modulated the climatological-mean planetary waves, yielding a negative contribution to the upward planetary wave-activity injection. Therefore, the relative importance in enhancing the wave activity injection into the stratosphere between a zonally confined Rossby wave packet and its modifying effect on the climatological planetary waves will vary from one SSW event to another.

We also analyzed the particular SSW event by using operational ensemble forecast by Japan Meteorological Agency (JMA) with its lead time about one week before the SSW. The ensemble "spread" in the forecast evaluated as the variance among the ensemble members initially large around a developing synoptic-scale cyclone in the central North pacific, and then the center of the large spread moves eastward with the observed downstream development of synoptic-scale disturbances along the stormtrack.

Finally, the spread is maximized to the north of the tropospheric anticyclonic anomaly over the Atlantic, until it extends upward into the stratosphere following the observed upward-propagating Rossby wave packet. This evolution of the ensemble “spread” is consistent with the result of our simple sensitivity analysis where the prediction skill of the particular SSW event was found sensitive to initial errors associated with the developing cyclone about one week before the event.

These results based on the JMA ensemble forecast thus confirms the importance of the tropospheric circulation anomalies we have focused on in our analysis that acted as a critical trigger of the SSW event, and they also confirm the usefulness of the particular framework we have adopted in our analysis.

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Optically thick wave-induced PSCs over Antarctica from CALIOP, 2006-2007

Presenter: Vincent Noel (vincent.noel@lmd.polytechnique.fr)

V. Noel, A. Hertzog, H. Chepfer (LMD/UPMC, IPSL, France)

Ground-based and satellite observations across polar regions have hinted at the existence of optically thick PSCs, even if the available litterature is sparse and optical depth values hard to come by. A case of visible PSC observed from the spaceborne lidar CALIOP, with optical depths up to 0.8, will be presented. Comparisons with multiple temperature fields, including reanalyses and results from mesoscale simulations, suggest that intense small-scale temperature fluctuations due to gravity waves play an important role in the formation of this PSC. Meso-scale simulations show the use of low-resolution temperature fields could underestimate visible PSC temperatures by as much as 10º.

Analysis of the entire CALIOP dataset south of 60ºS during the 2006 and 2007 austral winters will be presented, showing that similar visible PSCs are rare (less than 1% of profiles) and concentrated over areas where strong polar vortex winds hit steep ground slopes in the Western hemisphere, especially over the Peninsula. Visible PSCs are colder than the general PSC population, and their detections are correlated with daily temperature minimas across Antarctica. The geographic distribution and microphysical properties of visible PSCs (using lidar and depolarization ratios) are very similar to the case study, which suggests they might share the same formation mechanism.

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Propagation and the Vertical Structure of the Madden-Julian Oscillation over Kototabang, West Sumatera, Indonesia (0.2° S; 100.32° E), especially During the first CPEA-Campaign in 2004

Presenter: Nunun Nurhayati (nunun_nurhayati@yahoo.co.id)

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The Madden-Julian Oscillation (MJO) dominates tropical variability on timescales of 30-70 days. During the boreal winter/spring it is manifested as an eastward propagating disturbance with strong convective signature over the eastern hemisphere. The space-time structure of the MJO is described using the Outgoing Longwave Radiation (OLR) over the Indonesian maritime continent. The Hovmoller technique is used to identify the convective signature of the MJO, and the regression is used also to identify key relationships with the convection, especially relationship between OLR and rainfall intensity over Kototabang and surrounded area. Compared to analysing successive years of data, the selection of years of strong MJO activity results in a more robust lead/lag structure and an increase in explained variance. The MJO exhibits a rich vertical structure, with low-level moisture being well defined when the convective anomalies are strong, and there is evidence that free-tropospheric processes also play a role in the MJO life-cycle. The westward vertical tilt is most apparent over the Western Pacific. Over the Indian Ocean the system is more vertically stacked, principally due to the strong subsidence of the inactive phase of the MJO, which lies to the east of the convection. By applying the power spectrum density (PSD) analysis, we found that the peak maximum of OLR data is slowly decrease to east direction. It may indicate that the center convection is slowly move to the east direction over Indonesia.

Keywords : Propagation, Vertical Structure, OLR and EAR

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The Possibility of the Wind Profiling Radar (WPR) on Study Effects of Gravity Waves on a Corrugated Structure of Reflection Surface

Presenter: Nunun Nurhayati (nunun_nurhayati@yahoo.co.id)

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Eddy Hermawan (Institute of Aeronautics and Space, Bandung, Indonesia)

We have introduced a new Wind Profiling Radar (WPR) under the HARIMAU (Hydrometeorological Array for Intraseasonal Variation Monsoon Automonitoring) as a collaboration research project between Research Institute for Sutainable Humanosphere (RISH), Kyoto University, Japan and Indonesia. This radar is mainly concerned to observe winds and turbulence in the troposphere and lower stratosphere with a good time and spatial height resolution. Numerous study or research programs with the EAR are still developing. In this paper, one possibility an application of WPR on study effects of gravity waves on a corrugated reflection surface is discussed. For the reference, we investigated the azimuth angle variations of clear air echo in the troposphere and lower stratosphere by using the MU (Middle and Upper Atmosphere) Radar in Shigaraki, Japan (34º51'N; 136º06'E). We used a data set positions at the same zenith angle of 6º and the azimuth angle being changed every 30o. We have detected considerable amplitudes in the azimuth angle variations of echo power suggest that the reflection surface is characteristics of zonal and meridional wind velocity observed with WPR May 24-25, 2007 over Kototabang, Pontianak, and Biak, respectively. The long-term observations of the variations of zonal and meridional wind velocity from March 2007 to March 2008 as one of the most important parameter needed to explain the mechanism of gravity waves is also discussed.

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Use of an adjoint technique to analyse the dynamics of vortex splitting in the SH stratosphere during 2002

Presenter: Clare Oatley (swr06clo@rdg.ac.uk)

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In September 2002, the stratospheric polar vortex in the southern hemisphere split in two, an event not witnessed before. Similar events were previously thought to be confined to the northern hemisphere. Traditionally, they have been studied using the framework of wave, mean-flow interactions, within which transient planetary waves are hypothesized to be generated in the troposphere and to propagate upward and break in the stratosphere.

This paper presents an alternative dynamical perspective. It is proposed that cyclogenesis in the troposphere under the tip of an elongated stratospheric vortex contributed to the split, and that in its elongated state the stratospheric vortex was conditionally unstable. This hypothesis is tested in a version of ECMWF's global atmospheric model by using an adjoint technique, to calculate the linear dynamical sensitivity of the stratospheric polar vortex to perturbations in the troposphere and stratosphere. A region of high sensitivity, underneath the tip of the elongated polar vortex is highlighted, in a similar position and of a similar spatial scale as a growing tropospheric PV anomaly associated with strong cyclogenesis.

Using a further iterative procedure, perturbations which optimally prevent the vortex from splitting can be calculated. To examine the non-linear impact of the optimal perturbations, 10 day forecasts, free running after 48 hours, are used. Perturbations confined to the troposphere are able to successfully prevent a major stratospheric sudden warming at 10hPa. The results lend support to the alternative hypothesis, and provide a useful perspective on the validity of the localised view. The paper concludes by outlining the wider potential of the adjoint technique for dynamical studies of troposphere-stratosphere interactions.

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Amplifying effect of seasonal Ozone fluctuations on Temperature variability in the near Tropical Tropopause at selected stations

Presenter: Jack Ogaja (opanga_ogaja@hotmail.com)

J. Ogaja, N.J. Muthama, F.J. Opijah (University of Nairobi, Kenya)

Ozone profiles from SHADOZ network of tropical balloon soundings in three selected stations in the tropical region namely; Nairobi (1°S, 37°E), Java-Watukosek (7°S, 113°E), and Kuala Lumpur (3°N, 102°E) are used to determine ozone seasonal gradients between Upper Troposphere (UT) and Lower Stratosphere (LS) regions. Ozone seasonal gradients between the two regions fluctuate throughout the year with higher values between the months of July and September and relatively lower values in the months of January and December.

A time series of ozone mean monthly mixing ratios in the UT, Tropical Tropopause Layer (TTL), and LS reveals variability that increases in going from the UT through the TTL to the LS. This is further supported by Climate Chemistry Models from Chemical Weather Forecasting System of Japan Agency for Marine-Earth Science and Technology (JAMSTEC). The time series indicates relatively higher quantity of ozone in the months of July to September in the TTL and LS regions which coincides with the ozone seasonal gradient relative higher values.

Radiosonde temperature profiles at Nairobi station with simultaneous observations of temperature and ozone derived from the tropical balloon soundings from all the three stations are used to calculate statistical correlation coefficient between ozone and temperature in the UT, TTL and LS regions of the stations. There is a strong significant positive statistical correlation between ozone and temperature at the Cold Point Tropopause (CPT) which is consistent in all the three stations and throughout the study period. In the UT and LS regions the statistical correlation coefficient between ozone and temperature changes inconsistently between positive and negative correlations from station to station and year to year. The level of significance for the correlations also varies from station to station and year to year in the two regions at the three stations.

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Explaining Differences in the Long-Term Changes in Tropical Upwelling and Stratospheric Mean Age among Chemistry-Climate Models

Presenter: Luke Oman (oman@jhu.edu)

L. Oman, D. Waugh (Johns Hopkins University, Baltimore, USA),
S. Pawson, R.S. Stolarski, P.A. Newman (NASA GSFC, Greenbelt, USA)

A common feature of nearly all chemistry-climate model simulations of the past or future is an increase in tropical upwelling and decrease in stratospheric mean age. However, there is a large variation in the simulated rate of increase (e.g. Butchart et al. 2006). Through a series of runs using the Goddard Earth Observing System Chemistry-Climate Model (GEOSCCM) we quantify the impact of changes in tropical sea surface temperature, CO_2, and polar ozone on the stratospheric circulation. All three factors cause changes in the mean age, but the relative impact of each factor depends on the time period analyzed. For example, over the past 30-40 years polar ozone depletion is the primary factor causing the decrease in mean age, whereas the continued increase in SSTs is the primary cause of the decrease in mean age over the next 50-60. This new understanding of the relative role of these factors helps explain the large differences in the rate of tropical mass flux change seen in Butchart et al. (2006) among chemistry-climate models.

ID: 00271

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Tropospheric precursors to a cold polar stratosphere and a high PSC volume

Presenter: Yvan Orsolini (orsolini@nilu.no)

Y. Orsolini (Norwegian Institute for Air Research, Oslo Norway),
A lexey Karpechko (University of East Anglia, UK),
G. Nikulin (Swedish Meteorological and Hydrological Institute)

We investigate the variability of northern hemisphere winter polar lower strastopheric temperatures over the last four decades in meteorological re-analyses. A measure of the coldness of the winter stratosphere that is widely used in ozone research is the Polar Stratospheric Cloud (PSC) volume, which shows high variability from monthly to decadal time scales. We hence examine meteorological conditions in the troposphere, which lead to a cold polar stratosphere and a high PSC potential in the northern hemisphere. In addition to the well-established connection between the North Atlantic Oscillation and the polar vortex, we demonstrate the large influence of disturbances over the Far East and the North Pacific, the region of maximum climatological upward wave activity flux. A mechanism is proposed, by which poleward wave breaking events in the troposphere, over the Pacific, contribute to the strenghtening of the East Asian winter monsoon, and ultimately to a cold stratosphere.

ID: 00334 ◀back

High-Frequency Variability in the Stratosphere Resolving MetUM L60 and a Comparison with HIRDLS-Aura

Presenter: Scott Osprey (sosprey@atm.ox.ac.uk)

S. Osprey, J. Barnett, C. Wright (University of Oxford, UK),
L. Gray (University of Reading, UK)
J. Gille (University of Colorada, Boulder, USA),

An examination is made of high frequency wave variability within the United Kingdom Met Office stratosphere resolving MetUM L60. Specifically, we examine the resolved and parameterised waves associated with the Quasi-Biennial Oscillation in the tropical stratosphere, and characteristics of orographic gravity waves over Patagonia. Special attention is paid to orographic gravity wave momentum fluxes and concomitent wave intermittency. These are compared against 3 complete years of temperature variance data from HIRDLS-Aura. The availability of these high resolution observations provide key insight into the global distribution of gravity waves in the lower atmosphere and important constraints on their prescription and representation in GCMs

ID: 00370 ◀back

On the significance of persistence timescales in geophysical timeseries

Presenter: Scott Osprey (sosprey@atm.ox.ac.uk)

S. Osprey (University of Oxford, UK),
L. Gray, A. Charlton-Perez (University of Reading, UK)

The nature of persistence timescales are examined in the context of annular mode variability. In particular, the nature of seasonal persistences are examined and their significance is assessed. It is found that standard time filtering used to remove variability on various timescales, impacts on the size of persistences seen. These results suggest a reinterpretation of what persistence timescales are and how they might be better evaluated.

ID: 00161 ◀back

Evaluation of the capability of ECHAM-MESSY in the Tropical Tropopause Layer: comparison with aircraft data

Presenter: Elisa Palazzi (e.palazzi@isac.cnr.it)

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F. Ravegnani (ISAC-CNR, Institute for Atmospheric Sciences and Climate, National, Research Council, Italy),
C. Schiller (FZJ, Forschungzentrum Jülich, Germany),
S. Viciani (INOA-CNR, Istituto Nazionale di Ottica Applicata, Italy),
C. M. Volk (J.W. Goethe University, Frankfurt, Germany)

The aim of the work is to evaluate the capability of the chemical circulation model ECHAM5-MESSy to reproduce the observed distributions of chemical species and tracers in the Tropical Tropopause Layer (TTL). For that purpose, the ECHAM5-MESSy model is run at T42 resolution on 90 vertical levels (700 m is the vertical resolution in the TTL) and is forced only by climatological SSTs. Two-years simulation is performed to cover a full QBO cycle.

We have used the in-situ profiles of water vapour, CO_2, CO, O_3, CH_4, and N_2O measured on board the M55 Geophysica aircraft during four tropical campaigns: APE-THESEO (Seychelles, February-March 1999), SCOUT-O3 (Australia, November-December 2005), TROCCINOX (Brazil, January-February 2005) and AMMA (West-Africa, August 2006).

Data are analysed using specific diagnostics that can be compatible with CCM outputs to infer average properties for each region. Each measurement campaign is considered representative of a monthly average for the sampled region and compared directly to the daily output of the CCM for the same region and for similar QBO phase.

Results of the comparison show that ECHAM5/MESSy is able to resolve water vapour and tracers distribution in the TTL, with significant regional and temporal variability. Local factors cannot be captured by the model (e.g. overshooting convection), but can be isolated on the analysis of observations. Analysis of H_2O, CO and CO_2 tape-recorder signals from the CCM seems to correlate well with observed variability among different campaigns.

In some cases, discrepancies occur between the observed and modelled vertical profile of the species under examination and their correlations. Explainations for such differences are proposed and discussed.

ID: 00080

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Towards the Seamless Prediction of Weather and Climate

Presenter: Tim Palmer (tim.palmer@ecmwf.int)

T. Palmer (ECMWF, UK)

The WCRP strategy calls for the development of seamless prediction systems for weather and climate. What are these, and what benefits will the development of such systems bring? A review of the notion of seamless prediction will be given, including the relevance, where appropriate to middle atmosphere studies.

ID: 00056 ◀back

Observational Studies of the Extratropical Tropopause and Associated Transport Diagnostics

Presenter: Laura Pan (liwen@ucar.edu)

L. Pan, W. Randel (NCAR, Boulder, USA),
K. Bowman (Texas A&M University, USA),
P. Konopka (Forschungszentrum Jülich, Germany),
J. Gille (NCAR, Boulder, USA) and the HIRDLS team,
E. Atlas (University of Miami, USA) and the START08 Team

Definition of the extratropical tropopause is important to understanding the dynamical structure of the UTLS and quantification of STE. Using new aircraft and satellite observations, we examine the 3 existing models of the extratropical tropopause, i.e., the thermal, the dynamical tropopause and the extratropical transition layer, ExTL. The results we present focus on the transport associated with the separation of the thermal and dynamical tropopause, the subtropical tropopause break and the double tropopause. The region of significant separation between the thermal and the dynamical tropopause was investigated using ozone and water vapor measurements on NCAR research aircraft HIAPER during the Stratosphere-Troposphere Analyses of Regional Transport experiment in 2005 (START05) and will be investigated further using a larger suite of chemical tracers in April-May 2008 during the START08 campaign. On the transport related to the subtropical break and the double tropopause, we find that the occurrence of the poleward extending double tropopause is a sign of deep tropospheric intrusion into lower stratosphere. Combined analyses of satellite data from Aura/HIRDLS and dynamical variables provide a 3-dimensional structure of the deep tropospheric intrusion. The core of the intruding layer is typically between 370-400 K, but clearly impact the ozone above 400 K, the lower boundary of the overworld. A number of intrusion events over the continental US in 2006 and 2007 are examined. An effective diagnostic for the intrusion is developed using high-resolution meteorological analyses, which allows forecasting of the intrusion events for field studies. Investigating the chemical composition of the intruding layer will be a focus of the START08 experiment this spring. Initial results of the experiment and the relevance to the SPARC CCMVal project will be discussed.

ID: 00290

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Transport pathways in the Asian Monsoon Anticyclone diagnosed from Spaceborne Measurements and Model Simulations

Presenter: Mijeong Park (mijeong@ucar.edu)

M. Park, W.J. Randel, L.K. Emmons (NCAR, Boulder, USA)

The Asian monsoon anticyclone is a thermally direct circulation persistent during Northern Hemisphere summer in the upper troposphere and lower stratosphere (UTLS). This circulation is forced by persistent convective heating over India, and variability of the circulation is strongly tied to deep convection from synoptic to seasonal time scales. The anticyclone is associated with maxima in tropospheric trace constituents, due to vertical transport in deep convection and horizontal confinement by the strong anticyclonic circulation. A number of chemical tracers measured from satellites (CO from the Microwave Limb Sounder on Aura and CO, HCN, C_2H_6, and C_2H_2 from the Atmospheric Chemistry Experiment Fourier Transform Spectrometer) show enhancements within the anticyclone over India and Middle East up to the tropopause. The fractional enhancement of constituents inside the anticyclone is dependent on the respective photochemical lifetimes. This work focuses on understanding the transport of tropospheric pollutants from the surface source regions into the Asian monsoon anticyclone in the UTLS region. Simulations from a global chemistry transport model (MOZART 4) show reasonable agreement with UTLS observations of CO from MLS. We then use the model to examine the detailed transport pathways to the UTLS, and in particular how convective transport versus large-scale circulation contributes to the CO budget within the Asian monsoon anticyclone.

ID: 00155 ◀back

Trend analysis of tropical stratospheric NO_2 columns

Presenter: Maud Pastel (pastel.maud@aerov.jussieu.fr)

M. Pastel, F. Goutail, J.P. Pommereau, A.Pazmiño (Service d'Aéronomie, CNRS, France),
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T. Portafaix (Laboratoire de l'Atmosphère et des Cyclones, Université de La Réunion, France)

The tropical region is the main entry point of stratospheric chemical species lifted by convection and transported into the stratosphere across the tropopause. It is therefore the most sensitive region to dynamical and chemical change. Long series of NO_2 columns have become available from SAOZ (uv-visible spectrometer) at Bauru (Brazil, 22ºS) since 1995 and at Reunion Island (21ºS) since 1993. The seasonal variation of NO_2 (in the order of $4\pm1\text{x}10^{15}$ molecule/cm^2) present a large inter annual variability, which have been analysed using a multi linear regression model. The influence of dynamical parameters such as quasi-biennal oscillation (QBO), El Niño-Southern Oscillation (ENSO), and Eliassen Palm fluxes (EP) have been studied. The solar spectrum changes, due to the 11 year solar cycle, are also included as well as stratospheric aerosols from volcano's eruption. The impact on NO_2 are not the same in these two stations due to the surrounding area, indeed, NO_2 columns at Bauru are mostly controlled by the QBO (≈13%) while at Reunion Island the solar flux (≈8%) is the most influent parameter. After removing the signal from all the statistically significant parameters, the residual is less than $\pm0.2\text{x}10^{15}$ molecule/cm^2 at both stations. In addition, an increase of NO_2 columns is observed during the past years. Same analysis applied to GOME satellite NO_2 columns above the stations present similar behaviour. Trends of NO_2 columns from SLIMCAT 3D CTM will also be presented.

ID: 00336 ◀back

Performance of Versions 1, 2 and 3 of the GEOS CCM

Presenter: Steven Pawson (Steven.Pawson@nasa.gov)

S. Pawson, R.S. Stolarski, J.E. Nielsen, B.N. Duncan and the GEOS CCM Team
(NASA Goddard Space Flight Center, Greenbelt, USA)

Version 1 of the Goddard Earth Observing System Chemistry-Climate Model (GEOS CCM) was used in the first CCMVal model evaluation and forms the basis for several studies of links between ozone and the circulation. That version of the CCM was based on the GEOS-4 GCM. Versions 2 and 3 of the GEOS CCM are based on the GEOS-5 GCM, which retains the "Lin-Rood" dynamical core but has a totally different set of physical parameterizations to GEOS-4. In Version 2 of the GEOS CCM the Goddard stratospheric chemistry module is retained. Differences between Versions 1 and 2 thus reflect the physics changes of the underlying GCMs. Several comparisons between these two models are made, several of which reveal improvements in Version 2 (including a more realistic representation of the interannual variability of the Antarctic vortex). In Version 3 of the GEOS CCM, the stratospheric chemistry mechanism is replaced by the "GMI COMBO" code that includes tropospheric chemistry and different computational approaches. An advantage of this model version is the reduction of high ozone biases that prevail at low chlorine loadings in Versions 1 and 2. This poster will compare and contrast various aspects of the three model versions that are relevant for understanding interactions between ozone and climate.

ID: 00193 ◀back

Normal mode Rossby waves and their effects on chemical composition in the late summer stratosphere

Presenter: Diane Pendlebury (diane@atmosp.physics.utoronto.ca)

D. Pendlebury, T.G. Shepherd (University of Toronto, Canada),
M. Pritchard (University of California, San Diego, USA),
C. McLandress (University of Toronto, Canada)

During past MANTRA campaigns, ground-based measurements of several long-lived chemical species have revealed quasi-periodic fluctuations on time scales of several days. These fluctuations could confound efforts to detect long-term trends from MANTRA, and need to be understood and accounted for. Using the Canadian Middle Atmosphere Model, we investigate the role of dynamical variability in the late summer stratosphere due to normal mode Rossby waves and the impact of this variability on fluctuations in chemical species. Zonal wavenumber 1, westward travelling waves are considered with average periods of 5, 10 and 16 days. Time-lagged correlations between the temperature and nitrous oxide, methane and ozone fields are calculated in order to assess the possible impact of these waves on the chemical species. Using Fourier-wavelet decomposition and correlating the fluctuations between the temperature and chemical fields, we determine that variations in the chemical species are well-correlated with the 5- and 10-day waves between 30 and 60 km, although the nature of the correlations depend strongly on altitude. Interannual variability of the waves is also examined.

ID: 00186 ◀back

Unprecedented evidence for deep convection hydrating the tropical stratosphere

Presenter: Thomas Peter (thomas.peter@ethz.ch)

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R. Matthey, V. Mitev (CSEM, Neuchatel, Switzerland),
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G. Shur, N. M. Sitnikov (CAO, Moscow, Russia)

We report on in situ and remote sensing measurements of ice particles in the tropical stratosphere found during the Geophysica campaigns TROCCINOX and SCOUT-O3. We show that the deep convective systems penetrated the stratosphere and deposited ice particles at altitudes reaching 420 K potential temperature. These convective events had a hydrating effect on the lower tropical stratosphere due to evaporation of the ice particles. In contrast, there were no signs of convectively induced dehydration in the stratosphere.

ID: 00448 ◀back

A novel radiosonde payload to study upper tropospheric / lower stratospheric aerosol and clouds

Presenter: Thomas Peter (thomas.peter@env.ethz.ch)

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Dehydration mechanisms driven by the formation of visible and subvisible cirrus clouds determine the atmospheric water vapor budget and thus the chemical and radiative properties of the upper troposphere and the stratosphere. In contrast to previous understanding recent in situ observations have revealed high supersaturation with respect to ice of several 10% occurring not only in clear air surrounding cirrus clouds but also inside the cirrus themselves, and apparently also in large interconnected regions where they cannot be explained easily in terms of local upwelling. It is not well understood how such supersaturations, if not caused by instrumental artifacts, can be maintained within clouds exposing large ice surface areas to the water vapor. Precise and frequent measurements of cirrus properties and relative humidity using independent instrumentation are required to obtain a better understanding of dehydration processes and of their influence on the global atmospheric radiation budget.

To this end a radiosonde payload was developed that is launched regularly on meteorological sounding balloons from Zurich and Payerne since summer 2008. The same payload will be launched as part of the small-balloon campaign in Niamey, Niger, in September 2008, within the EU project SCOUT-O3.

A pTu sonde along with the ‘SnowWhite’ frost point Hygrometer (meteolabor SRS-C34, night-time version) is supplemented by the new Compact Optical Backscatter AerosoL Detector (COBALD). This lightweight (500 g, including power supply) and cost-effective sensor applies high power LEDs to measure optical backscatter at wavelengths centered around 455 and 870 nm. We demonstrate the potential of the new COBALD sonde for the characterization and understanding of cirrus nucleation and growth. The sonde observations provide estimates of particle surface area densities vis-a-vis relative humidity in the clouds. Special attention is paid to COBALD's performance during the first flights including a launch carried out in February 2007. During this flight the sonde traversed a cirrus cloud just below the tropopause and detected a layer of high aerosol loading in the stratosphere between 16 and 19 km altitude, which is also discernible in satellite observations and may be attributed to recent volcanic activity. In summary, owing to its dynamical range COBALD is capable of measuring particulate matter from the boundary layer to the top of the stratospheric aerosol layer.

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Comparison Of Lidar And Radio Occultation Temperature Profiles in Polar Regions

Presenter: Marcello Petitta (marcello.petitta@roma1.infn.it)

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A. di Sarra (ENEA/CLIM-OSS, Rome, Italy),
I. Bordi, D. Fuà (Università di Roma 'La Sapienza', Roma, Italy)

Temperature profiles derived from Constellation of Observing System for Meteorology (COSMIC) radio occultation (RO) measurements are compared with lidar observations carried out at Thule (76.5ºN, 68.8ºW), Greenland, in winter 2006-2007. Temperature profiles between 25 and 70 km altitude are derived from the daily lidar measurements performed in the investigation period. In winter, the lidar at Thule samples stratospheric air masses belonging to the inner, to the edge, or to the outer part of the Arctic polar vortex. More than 2000 occultations from COSMIC RO constellation were registered in the area around Thule in coincidence to the lidar soundings.

Lidar and COSMIC temperature profiles in the 23-40 km altitude range were used in the comparison. When the polar vortex includes both the lidar and RO profiles, the average bias between the two dataset is small (less than 5 K), while the root mean square deviations are less than 7 K at heights above 37km. Outside the polar vortex the temperature differences increase, due the smaller homogeneity of the atmospheric structures.

ID: 00351 ◀back

Simulations of Clouds and Water Vapor in the Tropical Tropopause Layer

Presenter: Leonhard Pfister (leonhard.pfister-1@nasa.gov)

L. Pfister, E.J. Jensen (NASA/Ames Research Center, USA)

The Tropical Tropopause Layer (dubbed the TTL), roughly between 13 and 18 km altitude, is one of the coldest parts of the earth's atmosphere. In contrast to the rest of the global tropopause region, radiative heating rates are positive and mean vertical motion is upward. It is thus the pathway for constituents into the stratosphere, and the cold temperatures lead to the well-known very dry stratospheric conditions. This simple picture is made more complicated by the interaction of convective injection, horizontal advection through cold regions (and consequent dehydration), and the slow ascent, all of which have comparable effects on the water vapor distribution. In addition, the thin clouds resulting from convection and subsequent cooling affect the TTL's radiation budget. Though the overall input of mass into the stratosphere from the TTL is dynamically driven and thus not affected by these clouds, cloud distributions will produce variations of vertical motion within the TTL that can affect upward constituent fluxes.

The advent of detailed water and cloud measurements in the TTL provides new constraints on models and the processes that they purport to simulate. Satellite measurements give global distributions of clouds and water vapor, while in situ data provides microphysical details and special transport indicators such as water isotopes. This paper, using a trajectory based, full microphysical model with observationally based convective injection, will present simulations of clouds and water in the TTL for both the boreal winter and summer season. A number of simulations for three different boreal winter seasons have been done, and the results show good agreement with measured water vapor values within the TTL, including most aspects of the horizontal distribution. These simulations also show that minimum horizontally averaged TTL water vapor mixing ratios cannot be simulated properly without including both microphysics and convective injection. These two processes add about .8 ppmv to water vapor at 100mb (as opposed to simply removing water above saturation), bringing the simulation into better agreement with satellite measurements. This work will also investigate cloud distributions and, to a lesser extent, water isotopes. The effect of varying microphysical parameters and convective injection will be explored.

ID: 00441 ◀back

Quantification of transport from surface to UTLS and calculation of ozone depletion potentials for VSLS

Presenter: Ignacio Pisso (i.pisso@damtp.cam.ac.uk)

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Lagrangian trajectory calculations are a suitable tool for the assessment of troposphere to stratosphere exchange. In particular, the proportion of air that was previously in contact with the boundary layer during some specified time period, provides a large scale description of the position and structure of the transport barrier formed by the tropopause and the subtropical jets, which can be also used to investigate the influence of the boundary layer on the stratosphere. The characteristics of this description depend on the meteorological fields used for advection and the parametrization of physical processes like convection. Comparison is made to corresponding CTM results. Applications to the definition of ozone depleting potentials for very short lived species are discussed.

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Polar Stratospheric Cloud Composition Studies using CALIPSO Lidar Data

Presenter: Michael Pitts (Michael.C.Pitts@nasa.gov)

M. Pitts, L. Thomason (NASA Langley Research Center, Hampton, USA), L. Poole (Science Systems and Applications Inc., Hampton, USA)

After more than 25 years of study, a great deal has been learned about polar stratospheric clouds (PSCs) and how they perturb stratospheric chemical cycles and catalyze ozone depletion. But the observational database is actually rather sparse, and there are still outstanding scientific issues, such as how low number density, large solid PSC particles form and lead to stratospheric denitrification. Progress is being made in these areas using data collected by contemporary spaceborne instruments. The CALIOP (Cloud-Aerosol LIdar with Orthogonal Polarization) lidar system onboard the CALIPSO (Cloud-Aerosol-Lidar and Infrared Pathfinder Satellite Observations) spacecraft has been operating nearly continuously since mid-June 2006 and offers the opportunity to characterize PSCs on spatial and temporal scales previously unattainable. Measurements are made at latitudes up to about 82 degrees, resulting in a wealth of PSC observations over two complete 'seasons' in both the Antarctic and Arctic. CALIOP backscatter data are collected in three receiver channels: 532-nm parallel-polarized, 532-nm perpendicular-polarized, and 1064-nm total backscatter coefficient, which together provide information on PSC particle shape and size, and hence composition. Our second-generation CALIOP PSC detection algorithm utilizes both the 532-nm scattering ratio (ratio of total-to-molecular backscatter) and 532-nm perpendicular backscatter coefficient, as well as a successive horizontal averaging scheme that enhances the detection of very tenuous PSCs. The PSCs are then separated into composition classes based on their ensemble optical properties in a manner analogous to that used in previous ground-based and airborne lidar PSC studies. This paper will discuss the detection algorithm and provide an overview of the first two years of CALIOP PSC observations.

ID: 00345 ◀back

CMAM Projections of the Dynamical and Chemical Effects on Ozone through the 21st Century

Presenter: David Plummer (david.plummer@ec.gc.ca)

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T.G. Shepherd (University of Toronto, Canada),
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K. Semeniuk (York University, Toronto, Canada)

A three-member ensemble of transient simulations with the Canadian Middle Atmosphere Model (CMAM) covering 1950-2100 was run with the specified REF2 forcings for the previous Chemical Climate Model Validation (CCMVal) intercomparison. As these simulations began before halogen loadings in the stratosphere were large enough to significantly perturb ozone and the simulations continue to 2100, when halogen loadings have returned to pre-1980 values, it is possible to analyze these runs to separate out the effects of halogen loading and dynamical changes on the ozone distribution. The effects of changing halogen concentrations and the well-known 'super-recovery' of upper stratospheric ozone, due to CO_2-driven cooling, are clearly seen. The effects of changing stratospheric dynamics are also shown to have a pronounced effect on the distribution and seasonal cycle of ozone. Earlier model intercomparisons have shown an increase in the stratospheric residual circulation is a robust signal of climate change in CCMs (Butchart et al., Climate Dynamics, 27, 727-741, 2006). For the CMAM simulations analysed here, changes in the Brewer-Dobson circulation are tied to a decrease in lower stratospheric ozone at tropical latitudes and a corresponding increase in ozone at mid-latitudes. The increase at mid-latitudes is largest in spring, reflecting the enhanced dynamically driven build-up of ozone over the preceding winter. The CMAM model results also display a marked asymmetry between the northern and southern hemispheres, reflecting the relative changes in wave forcing in the two hemispheres. We find that over many latitude bands the dynamically induced changes in ozone have a very substantial effect on the projected recovery of ozone through the 21st century.

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Recent advances in stratospheric data assimilation

Presenter: Saroja Polavarapu (saroja.polavarapu@ec.gc.ca)

S. Polavarapu (Environment Canada, Toronto, Canada)

Data assimilation involves combining measurements with model output to get a best estimate of the state of the atmosphere. This estimate, called an “analysis”, can be used for launching numerical weather forecasts. In the context of climate research, analyses are often used for process studies or diagnostics, since they contain the information of observations but on a regular model grid. Physically-based diagnostics can also provide feedback to data assimilators, shedding light on deficiencies as well as advantages of analyses. This talk will describe some recent advances in stratospheric data assimilation as well as future prospects.

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Global ray tracing simulations of the SABER gravity wave climatology

Presenter: Peter Preusse (p.preusse@fz-juelich.de)

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R.G. Roble (NCAR, Boulder, USA),
S. Schroeder, M. Riese (Forschungszentrum Jülich, Germany),
J.M. Russell III (Hampton University, USA),
M.G. Mlynczak (NASA Langley Research Center, Hampton, USA)

Since February 2002 the SABER instrument on board the TIMED satellite has measured temperatures throughout the entire middle atmosphere. We deduce five years of gravity wave (GW) temperature variances from 20~km to 100~km altitude. A typical annual cycle is presented by calculating averages for the individual calendar months.

Findings are consistent with previous results from various satellite missions. Based on July data and zonal mean GW momentum flux from CRISTA a homogeneous and isotropic launch distribution for the Gravity wave Regional Or Global RAy Tracer (GROGRAT) is inferred. The launch distribution contains different phase speed mesoscale waves, some of very high phase speed and extremely low amplitudes, as well as long horizontal waves of several thousand kilometer horizontal wavelength. Global maps for different seasons and altitudes as well as time series of zonal mean GW squared amplitudes based on this launch distribution well match the observations.

Based on this realistic, observation tuned, model run we can calculate quantities which cannot be addressed by measurements and which are speculated to be major uncertainty sources in current generation GW parameterization schemes. Two examples shown are the average cross-latitude propagation of GWs and the relative acceleration contributions provided by saturation and dissipation on the one hand and the horizontal refraction of GWs by horizontal gradients of the mean flow on the other hand.

ID: 00167 ◀back

Determining optimal parameters for gravity wave drag schemes using data assimilation techniques: Twin experiments

Presenter: Manuel Pulido (pulido@unne.edu.ar)

M. Pulido (Universidad Nacional del Nordeste, Argentina),
S. Polavarapu, T. Shepherd (University of Toronto, Canada),
J. Thuburn (University of Exeter, UK)

Because most gravity wave drag schemes assume instantaneous vertical propagation of gravity waves in a column, observations in a single column can be used to obtain information about input parameters to a gravity wave drag scheme. Here, a 1D variational assimilation technique is developed to estimate parameters from gravity wave schemes. The cost function measures the differences between the zonal and meridional components of the 'observed' gravity wave drag field and the gravity wave drag calculated with a scheme. The gradient of the cost function is calculated with the adjoint of Scinocca's gravity wave scheme. In this work the sensivity of some key parameters to changes in the gravity wave drag and horizontal wind and temperature profiles is calculated with the adjoint model and the performance of the technique is evaluated through twin experiments.

ID: 00043 ◀back

A combined Eulerian-Lagrangian model study of QBO effects on stratospheric transport

Presenter: Heinz Jürgen Punge (heinz.juergen.punge@zmaw.de)

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R. Müller (Forschungszentrum Jülich, Germany),

The quasi-biennial oscillation affects transport and mixing in the tropical stratosphere in multiple ways. We present a novel approach feeding chemistry-climate model (CCM) results into a Lagrangian transport model to investigate these effects. The CCM MAECHAM4-CHEM gives distinctly different results for a free run and one nudged to reproduce the observed QBO in terms of potential vorticity, suggesting a QBO effect on the tropical-subtropical transport barrier. Backward trajectories with the Lagrangian transport model CLaMS confirm the existence of a subtropical transport barrier in summer during years with easterly QBO phase.

Furthermore, trajectories over 90 days illustrate the different origins of tropical air at a given level in dependence of QBO phase and season. E.g., the ascent rate of air parcels over 3 months differs by up to 100 % between easterly and westerly shear phases. We also found a major fraction of the air parcels to originate from the subtropics on the summer hemisphere during the solsticial seasons in both CCM runs, but the amount is variable in the QBO run. When averaged over several annual and QBO cycles, the regions of origin still differ clearly among the model experiments with and without representation of the QBO.

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The Net effect of including the QBO in a chemistry-climate model

Presenter: Heinz Jürgen Punge (heinz.juergen.punge@zmaw.de)

H.J. Punge, M.A. Giorgetta (Max Planck Institute for Meteorology, Hamburg, Germany)

The quasi-biennial oscillation (QBO) of zonal wind is a prominent mode of variability in the tropical stratosphere. It affects not only the variability in the transport and chemistry of trace gases but also their climatological long-term mean. This net impact can be analyzed using general circulation models that extend into the middle atmosphere and have a chemistry and transport component, so-called Chemistry Climate Models (CCMs).

We compare 20-year experiments with the CCM MAECHAM4-CHEM that differ by including or not including the QBO. In the 'QBO' run the nudging of zonal winds towards the observed QBO leads to realistic QBO signals in temperature and trace gas distributions. The QBO signal in ozone is found to be influenced considerably by the QBO in nitrogen oxides NOx.

The net differences in the climatological mean fields of wind, temperature, mass stream function, and trace gases are presented. Besides a weakening of the summer easterlies, differences are also found in the strength and duration of the polar vortices.

A net effect of the QBO's secondary meridional circulation is seen in temperature and trace gas fields and exhibits a strong seasonal dependence. Furthermore, the different circulation in the two model runs leads to differences of up to 30% in methane and nitrous oxide, locally. Interestingly, an 15% increase of NOx in the upper stratosphere does not affect ozone concentrations significantly.

Our findings underline the importance of a representation of the QBO in models. The nudging mechanism used for our experiments is a good substitute where direct modeling of the QBO is not possible.

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Effects of Solar Variability on the Stratosphere

Presenter: Cora Randall (randall@lasp.colorado.edu)

C.E. Randall (University of Colorado, Boulder, USA),
Lon L. Hood (LPL, Tucson, USA),
C.H. Jackman (GSFC, Greenbelt, USA),
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Extended remote sensing data sets of stratospheric ozone make it possible to quantify both long- and short-term variations, and observations in recent years enable detailed studies of the processes forcing the changes. In addition, coupled chemistry climate models are now being applied to help interpret the observations. It is clear that solar forcing can have significant effects on ozone distributions throughout the stratosphere, but questions persist regarding the magnitude of the perturbations and the interplay between dynamics and chemistry in controlling the distributions. In this talk we will summarize our current understanding of the effects of solar variability on stratospheric ozone and related constituents, focusing particularly on the effects of energetic particle precipitation (EPP). These effects will be compared to current estimates for the impact of solar irradiance variability on stratospheric ozone, and we will highlight areas where models and measurements disagree. The discussion will include time scales ranging from days to decades, and will thus include direct perturbations from solar proton events (SPEs) as well as indirect perturbations arising from SPEs and lower energy (e.g., auroral) particle precipitation. Particular emphasis is placed on the role of meteorology in determining the response of the stratosphere to solar variability, and possible avenues of atmospheric coupling.

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Triggering of strong El Niño events as a result of the influence of interaction between tropical lower stratospheric QBO and the tropospheric dynamics

Presenter: Thokuluwa Ramkumar (tkram@narl.gov.in)

T.K. Ramkumar (National Atmospheric Research Laboratory, India)

This poster will be presented by Kondapalli Niranjan kumar

The importance of down penetration to troposphere of equatorial lower stratospheric quasi-biennial oscillation in zonal wind, particularly over the Indian Ocean region, on the triggering of great El Niño events like the ones occurred in the years of 1972-73, 1982-83 and 1997-87 is stressed using zonal wind velocity and intensity of outgoing long wave radiation obtained over both the equatorial Indian and Pacific Oceans. Monthly averaged zonal wind velocity measured with Indian MST radar at Gadanki (13.5ºN, 79.2ºE) in the heights of 14-20 km during the period of September 1995 to October 2003; with radiosonde over the near by station (~150 km radial distance towards south) of Chennai (13ºN, 80.2ºE) during January 1990 to December 2003 and near the heights of 70 hPa (~18 km), 50 hPa (~21 km), 40 hPa (~23 km), 30 hPa (~25 km), 20 hPa (~27 km) and 15 hPa (~29 km) during (1) 1953-67 over Canton Island (2.46ºS, 171.43ºW), (2) 1967-75 over Gan/Maldives (0.41ºS, 73.09ºE) and (3) 1975-2001 at Singapore (1.22ºN, 103.55ºE) is utilized for the present study. Moreover, using the NCEP-NCAR reanalyses data, zonal wind velocity obtained on the surface, near the tropopause height and in the lower stratosphere, and the intensity of outgoing longwave radiation obtained over both the Indian (10ºN-10ºS; 60-160ºE) and Pacific sectors (10ºN-10ºS; 160-260ºE) are utilized to describe on how the lower stratospheric QBO through down penetration over the Indian Ocean region affects the Walker circulation associated with both the Indian and Pacific ocean sectors. Using combined empirical orthogonal function (principal components) and wavelet analyses of the data obtained, it is shown in the present work that the stratospheric QBO (both the phases) can actively affect the east- west Walker circulation through down penetration, leading to triggering of greater El Niño events.

From 1963 to 2005, the combined EOF and wavelet analyses of outgoing long wave radiation and zonal winds obtained from NCEP-NCAR reanalyses data have clearly shown that the distinct QBO observed on the earth's surface and near the 150 mb level (~14 km) over both the equatorial Indian Ocean region (10ºN-10ºS; 60-160ºE) and the central to eastern Pacific region (10ºN-10ºS; 160-260ºE) during the above mentioned three great El Niño events is preceded by about one year the occurrence of distinct and strong QBO in zonal wind speeds at ~ 21 km over the Indian Ocean region. Moreover, wavelet analyses of monthly averaged zonal wind velocity measured with Indian MST radar, radiosondes in the equatorial regions have also indicated that down penetration of equatorial stratospheric QBO started to occur about one year before the triggering of great El Niño events.

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Origin of a climatological ozone minimum near 15 km during Arctic summer

Presenter: William Randel (randel@ucar.edu)

W. Randel, D. Kinnison (NCAR, Boulder, USA)

Ozone profile data from balloons and satellites show a minimum in ozone density near 15 km over high northern latitudes during summer. This minimum begins to form during late spring, persists through summer, and appears as a climatological feature. Corresponding structure is observed in other long-lived constituents. From diagnostic and modeling studies we show that this ozone minimum occurs due to transport of ozone poor air from lower latitudes, over isentropic layers centered near ~380-400 K. Air above and below this layer appears to be effectively isolated during northern summer.

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Tropospheric Warming and Stratospheric Cooling observed from GPS Radio Occultation Measurements

Presenter: Daggumati Narayana Rao (profdnrao2001@yahoo.com)

D. Narayana Rao (National Atmospheric Research Laboratory, Tirupati, India),
P. Kishore (Dalhousie University, Halifax, Canada)

In the recent years GPS Radio Occultation has emerged as a powerful technique for obtaining vertical profiles of atmospheric density, radio refractivity, pressure, temperature and water vapor with a high degree of vertical resolution and providing global coverage in all weather conditions. Accurate, global and stable long-term observations are essential to study the changes in climate such as tropospheric warming and stratospheric cooling.

The availability of global coverage of GPSRO provides a new perspective for simultaneous probing of troposphere and stratosphere and offers a great potential for long-term studies of the troposphere, stratosphere including tropospheric warming and stratospheric cooling. GPSRO measurements are capable of providing a climate record that is free from the constraints associated with other space-borne and ground based measurements.

The bending angle profile obtained from GPSRO measurements depends on refractivity, which itself depends on atmospheric density: thus from the mid-troposphere upwards the primary dependence is on temperature and pressure, while in the lower troposphere water vapor also makes a significant contribution. The variation in the bending angle is a resultant parameter manifested due to the changing temperature structure of the troposphere and stratosphere, increased water vapor in the troposphere and expansion of the atmosphere due to the warming.

The bending angle profiles obtained from CHAMP (CHallenging Mini Payload) during May 2001-November 2007 have been analysed to study tropospheric warming and stratospheric cooling in different latitudinal regions. The trend in warming/cooling has been estimated using the least square regression.

In the tropics and extra tropics a decrease in the bending angle is observed in the upper troposphere due to warming, an increase in the bending angle in the lower and mid-stratosphere due to cooling. The warming (decrease of bending angle) is larger in the upper troposphere than in the lower troposphere- a consequence of moist adiabatic lapse rate decreasing with the increasing temperatures. It is also observed that in the tropical region major warming is seen at 17 km and the largest cooling (increase of bending angle) is at 23 km. Warming reversed to cooling at 19 km and this region delineates the warming of the troposphere due to increased green house gases from the cooling of the stratosphere.

At mid latitudes in the northern and southern hemispheres (30N-60N; 30S-60S) major warming is seen at 9 km and major cooling is observed at 16-17 km and warming reversed to cooling at 11-12 km. It is intersting to note that the magnitude of warming at mid latitudes is significantly larger than that observed in the tropics and extra tropics.

Major cooling is observed at 10 km in the northern polar latitudes (60N-90N) and at 12 km in the southern polar latitudes(60S-90S). Another intersting result is that at polar latitudes decrease in the bending angle which represents a warming is observed from 19 km upwards and with major warming seen in the height region of 23-25 km.

The study demonstrates that the bending angle profile could be used to study tropospheric warming and stratospheric cooling and the height at which the warming reverses to cooling. Also the bending angle profile could be used for global monitoring of the climate. Although it might initially appear to be a somewhat esoteric quantity, changes in the bending angle due to climate change can be readily understood and interpreted in terms of more familiar geophysical parameters. The results also suggest that the bending angle data being provided by missions such as CHAMP and COSMIC will be an important resource to study the tropospheric warming and stratospheric cooling and the climate change.

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Studies on Tropospheric and Lower Stratospheric (TLS) structure and dynamics using GPS RO Technique

Presenter: Madineni Venkat Ratnam (vratnam@narl.gov.in)

M. Venkat Ratnam (National Atmospheric Research Laboratory, Gadanki, India), V.V.M. Jagannadha Rao (Government Polytechnique, Tirupati, India), T. Tsuda (Research Institute for Sustainable Humanosphere, Kyoto University, Japan), S. Mehta, G. Basha, D. Nath (National Atmospheric Research Laboratory, Gadanki, India)

The GPS Radio occultation technique has emerged as a powerful tool for exploring the earth's atmosphere from ground to the height region of around 40 km and also in the ionosphere after the successful launch of GPS/MET which has provided a 'proof of concept' of GPS RO technique. Several missions were followed by GPS/MET such as Oersted and SAC-C. CHAMP (German mission) was a successful mission which provided a wealth of information by not only providing profiles with good accuracy but also on long-term basis. Recently the Constellation Observing System for Meteorology Ionosphere and Climate (COSMIC)/Formosa Satellite 3 (FORMOSAT-3), which is a US and Taiwan joint mission, was launched on 14 April 2006 consisting of six-satellites with dual frequency GPS receivers on board. By taking advantage of tracking the signals in both rising and setting occultations, COSMIC could provide ~ 2200 (final target is around 2500-3000 occultations per day) occultations per day across the globe which is about 10 times larger than CHAMP observations.

This data set has been successfully used to study global morphology of gravity waves, planetary scale waves, their effects on tropopause structure. Some new characteristics in the global tropopause and mean temperature lapse rate behavior have also been observed. Correlation analysis of temperature data (obtained from both ground based and GPS RO) revealed that the cold point tropopause (CPT) is more influenced by stratospheric processes than tropospheric processes irrespective of the season. It is also observed that this data set can be used effectively to monitor/predict the onset on Indian Summer Monsoon (ISM). Few case studies are also presented how better information can be achieved by utilizing the combined measurements of high vertical resolution ground based measurements and good spatial resolution GPS RO measurements. We also propose few studies with our missions like Radio Occultation Sounder for Atmosphere (ROSA) and Megha Tropquies (20º, low inclination) which were not possible with the existing GPS RO missions.

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Convection, Extratropical Mixing, and In Situ Freeze Drying in the Tropical Tropopause Layer

Presenter: William Read (bill@mls.jpl.nasa.gov)

W.G. Read, M.J. Schwartz, A. Lambert, H. Su, Nathaniel J. Livesey, W.H. Daffer (JPL-Caltech, USA),
C.D. Boone (University of Waterloo, Ontario, Canada)

Mechanisms for transporting and dehydrating air across the tropical tropopause layer (TTL) are investigated with a conceptual two dimensional model. This poster is a follow-on of the Read et al. ACPD 8, 3961—4000 (2008) study now using MLS v2.2 data and extending the time series from 2.5 to 4 years. We will investigate different convective processes such as dehydrating convection with direct ice injection versus direct injection of 100% relative humidity with respect to ice air without ice. We will compare results from our convection cold trap tropical tropopause model to the improved v2.2 MLS data with its longer time series. We will also show some initial comparisons between modeled ice and measurements by Calipso.

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Multiannual simulations with the KASIMA-CTM and comparison with observations

Presenter: Thomas Reddmann (thomas.reddmann@imk.fzk.de)

T. Reddmann (University of Karlruhe and Forschungszentrum Karlsruhe, Germany)

The question how much chemistry vs. dynamics contribute to recently observed changes of trends of ozone in mid latitudes and if ozone is already recovering through measures such as the Montreal protocol is still under debate as state-of-the-art CTMs generally show significant deviations from observations of total ozone which are of the order of the trend itself. In addition, CCM simulations indicate significant changes of the strength of the Brewer-Dobson circulation during the last half century which should have observable consequences for distributions of trace species.

Here we analyse the results of a multiannual run of the KArlsruhe SImulation model of the Middle Atmosphere (KASIMA) spanning the ERA-40 period and compare them with satellite and ground based observations in order to examine if signs of changes in transport can be found. The model runs in a nudged version yielding generally good agreement for mean age of air. We compare the model results of long-term tracers as CH_4, HF, N_2O and others with satellite data and ground based observations, and analyze the results for ozone by comparing them with longer-lasting data records from satellites and of the WOUDC.

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What determines tropical tropopause parameters? A modelling study of past and future trends with the AMTRAC coupled chemistry climate model

Presenter: Thomas Reichler (thomas.reichler@utah.edu)

T. Reichler, J. Austin (UCAR/NOAA GFDL, USA)

The tropical tropopause layer is important for the dynamics, radiation, and chemistry of the stratosphere. For example, tropopause temperatures determine the amount of water vapor entering the stratosphere, which in turn controls the chemistry and the radiative budget of the stratosphere. On the other hand, tropopause height and temperature may be influenced by the strength of the Brewer-Dobson circulation. Therefore, changes in tropical cold point parameters are closely related with stratospheric climate change, but the exact cause-and-effect relationship between the two and the role of tropospheric climate change for such change still remains to be determined.

Here, we use a model-based approach to investigate tropical tropopause trends and how they relate to stratospheric and tropospheric climate change. In particular, we investigate three simulations with a coupled chemistry climate model and explore long-term trends in tropical tropopause parameters over the period 1960 to 2100. We find that the tropopause height increases almost steadily during the 140 simulation years. On the other hand, tropopause temperature shows a marked and climatically important transition near the year 2000, with cooling in the past and warming in the future. Using multi-linear regression, we show that long-term trends in tropopause parameters can be fit to high accuracy to terms representing total column ozone, tropical mean sea surface temperatures, and tropical mass upwelling. The change in tropopause temperature trend near the year 2000 is related to the change in the sign of the stratospheric ozone trend.

We further use a conceptual tropopause model to relate tropopause change to stratospheric and tropospheric climate change. The results confirm the regression analysis in showing the importance of tropospheric warming and stratospheric cooling. In the past, global warming and ozone depletion have opposite effects on the tropopause temperature, which consequently decreases. For the future, global warming and ozone recovery are expected to reinforce, which consequently increases the tropopause temperature.

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Stratospheric role for the widening of the general circulation

Presenter: Thomas Reichler (thomas.reichler@utah.edu)

T. Reichler, G. Chen (MIT, USA), J. Lu (NCAR, USA)

Several lines of research indicate that the tropical Hadley cell and the associated subtropical dry zones have expanded poleward over the past few decades and that this expansion is likely to continue in the future. This trend is associated with important changes in tropical and extratropical circulation, and to shifts in wind, precipitation, and other climate patterns. The expansion of the Hadley cell may also be connected to a poleward movement of the storm tracks and surface westerlies, and to positive trends in the annular modes. The widening of the Hadley cell and the Tropics therefore represents an important new aspect of climate change. However, our overall understanding of this phenomenon is still very limited.

Here, we use a model based approach to study the importance of stratospheric climate change for the widening trend. We drive a stratosphere resolving version of the GFDL climate model with varying amounts of greenhouse gas, ozone, and SST forcings. Similar simulations are also conducted with a troposphere-only version of the GFDL model in order to understand how important a good stratospheric resolution is for the proper simulation of the widening.

We will present how much widening has already occurred in the past and how much is still expected to happen in the future. We will further discuss the consequences of the widening in terms of the changes in surface climate, and we will explain what role the stratosphere has for this trend. The detailed analysis of the effects seen in the different forcing simulations will help to understand the underlying mechanisms for the widening.

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Solar Cycle Effects in the UARS-HALOE Ozone Dataset

Presenter: Ellis Remsberg (Ellis.E.Remsberg@nasa.gov)

E. Remsberg (Hampton, Virginia, USA)

A set of 14-year time series of ozone from the HALOE experiment of the UARS satellite has been analyzed for seasonal, interannual, solar cycle (SC), and trend effects. The ozone time series were obtained for 45S to 45N in 20-degree wide latitude bins and for 13 'half-Umkehr' layers of about 2.5 km thickness and extending over the range of 63 hPa to 0.7 hPa. Multiple linear regression (MLR) techniques were applied to each of those 130 separate time series of about 200 zonally-averaged, sunrise plus sunset points. The average point spacing is about 25 days, which is an adequate sampling rate for resolving the SAO and longer-period cycles. QBO (28 mo.) and sub-biennial (21 mo.) cycles were found throughout this domain of latitude and pressure-altitude. A simple sinusoidal term of 11-yr period was fit to the time series residuals after accounting for the seasonal and interannual terms. The phase of this 11-yr term was noted, and in almost all cases it is in-phase with that of the more standard proxies for the solar uv-flux. This analyzed, SC-like response profile for the stratospheric ozone agrees well with that reported by others using fairly simple models that include the maximum-to-minimum forcing of the 11-yr variations for the uv-flux.

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Downward propagation of circulation anomalies and the out-of-phase relationships of temperature anomalies between the Stratosphere and the troposphere

Presenter: Rongcai Ren (rrc@lasg.iap.ac.cn)

R.-C. Ren (Chinese Academy Sciences, Beijing, China),
B. Ming (Florida State University, USA)

This work provides evidences showing that, accompanying with the occurrence of the polar vortex oscillation, the downward propagation of stratospheric circulation anomalies doesn't directly reach the lower troposphere, and the temperature as well as the potential vorticity anomalies between the stratosphere and the troposphere mostly exhibit an out-of phase relationship. The seemingly barotropic distributions of zonal wind and geo-potential height anomalies are basically resulted from the different response of the circulation to similar heating anomalies from the stratosphere and the troposphere, saying that there is always cold low in the stratosphere but cold high in the troposphere. The existence of minimum values of zonal-mean-zonal wind (and geo-potential) around the tropopause level also supports this paradigm. However, it is also found that the stratospheric circulation anomalies that induced the polar vortex oscillation are seen being generated from the deep tropics and propagated poleward, while the tropospheric temperature anomalies are seen being propagated equatorward. Further, when the poleward propagating temperature anomalies in the lower stratosphere reach the polar region, the tropospheric temperature anomalies are always out-of phase and begin to be propagated equatorward. This demonstrates that the stratosphere-troposphere dynamical coupling is intimately related with the vertical coupling of the opposite meridional propagations from the stratosphere to the troposphere. This poleward and equatorward propagation from the stratosphere to the troposphere can be interpreted by applying the global mass circulation concept. The daily NCEP/NCAR reanalysis II from 1979 to 2003 were used in this work.

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The constraint of data assimilation in the stratosphere and troposphere on mesospheric motions

Presenter: Shuzhan Ren (shuzhan.ren@ec.gc.ca)

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T. Shepherd (University of Toronto, Canada)

Due to the poor data coverage in the mesosphere, motions in the mesosphere are largely unconstrained by observations in most data assimilation systems. It is well known that the mesosphere is largely controlled by vertically propagating waves from below. Since these waves (gravity waves, planetary waves etc.), originating in the troposphere and propagating through the stratosphere, can be better represented below the mesosphere by a data assimilation system, it is expected that the information of data assimilated below the mesosphere can be carried into the mesosphere by the ‘corrected’ waves, and consequently can drive the mesosphere close to reality.

In the Canadian middle atmosphere data assimilation system (CMAM-DAS) the forecast model (CMAM) has the model lid at 100km and the observations assimilated in the 3dvar system are below the stratopause (1mb). Therefore it is an ideal tool to examine the constraint on motions in the mesosphere imposed by the data assimilation below.

We first launch two assimilation experiments starting from different mesosphere. The differences in the mesosphere drop very quickly after a few assimilation cycles and become very small after about one month indicating a strong constraint on the mesosphere from the data assimilation below. To see if the constraint is realized mainly via gravity waves, another assimilation experiment with different initial mesospheres and non-orographic gravity wave drag turned off is launched. Unlike the first two experiments mesospheric differences in this experiment increase steadily with time (temperature difference in the two poles and wind difference almost everywhere in the mesosphere). This suggests that gravity waves are important agents through which the data assimilated below the mesosphere is able to imposes a constraint on mesosphere.

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Atmospheric Disturbances generated by ENSO events in the South Hemisphere

Presenter: Patricia Repossi (repossip@yahoo.com)

P. del V. Repossi (Pontificia Universidad Catolica Argentina, Buenos Aires, Argentina),
P.O. Canziani (Pontificia Universidad Catolica Argentina, Buenos Aires, Argentina, and CONICET, Buenos Aires, Argentina)

Modified Yamomoto`s test is a useful tool for detection of atmospheric high frecuency perturbations (Repossi and Canziani, 2008). This test was applied to geopotential time series in order to study the height-time evolution of the perturbations introduced in the atmosphere by ENSO events. All the events that happened during the sample (1973-2002) were detected.

In order to study the propagation of the perturbations generated by La Niña and El Niño events, the evolution of the perturbation was analysed over the Pacific, Atlantic and Indian Ocean basins. The detection over the tropical Pacific Ocean is useful to study the height evolution of the perturbation generated by the event, and the analysis over other latitudes in this basin, is important to the understanding of the teleconection mechanisms.

The results show that for strong events (1982-83, 1994-95, 1997-98 El Niño) the ascendent behavior of the propagation is remarcable over the three oceans basins. These perturbations reach up to 30 hPa in several cases. For weaker events, the direction of the propagation cannot be assesed.

In all the cases, the dates for which the perturbations were detcted over the tropical, subtropical and polar troposphere agree with results obtained by other autors who used composites of metereological variables to study teleconections.

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Data Assimilation Experiments with New Covariance Models at Environment Canada

Presenter: Mateusz Reszka (mateusz.reszka@ec.gc.ca)

M. Reszka, S. Polavarapu, Y. Rochon (Environment Canada, Toronto, Canada)

An atmospheric data assimilation study, which tests two new covariance schemes for the dynamics variables, is presented. The 3D-Var global assimilation system used is similar to the current operational system of the Canadian Meteorological Centre but has a higher lid (0.1 hPa). The forecast model is a variant of the Global Environmental Multiscale (GEM) model. A covariance model is introduced at the assimilation step based on the Charney balance and hydrostatic balance, incorporating a linearization about the background state. This coupling between the temperature field and streamfunction allows for flow dependence, and has been shown to improve the quality of analysis increments, particularly in regions of strong flow curvature. A coupling between the streamfunction and the velocity potential is also implemented, by exploiting the quasigeostrophic omega equation and continuity equation, again linearized about the background fields. This approach yields a balanced divergence, and serves as a constraint on high frequency vertical motions, which are believed to cause spurious mixing in many assimilation systems. The separate and combined effects of both approaches are discussed through comparisons with a control experiment. Although the new constraints have a weak effect on time-averaged statistics such as global scores or variability, positive impacts can be seen locally. In particular, single-observation experiments show that resulting increments are asymmetric and aligned with the background mean flow.

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Impact of recent laboratory measurements of the absorption cross section of ClOOCl on our understanding of polar ozone chemistry

Presenter: Markus Rex (Markus.Rex@awi.de)

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Uncertainties of the photolysis cross sections of ClOOCl have long been a limiting factor in our theoretical understanding of the rate of polar stratospheric ozone losses. Previous work suggested that values slightly larger than current recommendations, which are based on laboratory measurements, result in improved agreement between model calculations of polar stratospheric ozone loss rates and observations while at the same time also leading to improved agreement between observations of the diurnal variation of ClO and model calculations of this species. But new laboratory work (Pope et al, 2007) on the cross sections of ClOOCl suggest that its photolysis under polar stratospheric winter/spring conditions is nearly an order of magnitude slower than what would be required to explain the observations of ozone loss and ClO in the atmosphere and a factor of six slower than a value based on the current recommendations. We show what the impact of these new results on our understanding of polar ozone chemistry is.

In model calculations that are based on the new cross sections and for typical Arctic conditions ratios of ClO/ClOx decrease by about a factor of two. The ozone loss rate by the ClO-dimer cycle, so far believed to be the most efficient ozone loss cycle, drops by about a factor of four and the loss rate by the coupled ClO-BrO cycle by nearly a factor of two. Overall ozone loss rates calculated based on the known ozone loss mechanisms drop by a factor of two to three and become much smaller than observations. Also the calculated levels of ClO become much smaller than those observed in the stratosphere. These results demonstrate the tremendous uncertainty of current ozone loss calculations that comes from the broad range of the published cross sections for ClOOCl. In particular they suggest that, if the most recent publication of the cross sections (Pope et al., 2007) is correct, a major fraction of observed polar ozone loss is due to a currently unknown mechanism - clearly are a major challenge of our fundamental understanding of the polar stratospheric ozone loss process.

We will discuss potential chemical mechanisms that would lead to improved agreement between calculations of ozone loss based on the new cross sections with in-situ observations of ClO and ozone loss rates in the stratosphere.

ID: 00311 ◀back

Quasibiennial modulation of the Southern Hemisphere tropopause

Presenter: Pedro Ribera (pribrod@upo.es)

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The equatorial quasibiennial oscillation (QBO) is known to influence tropopause characteristics over the whole globe. In the present analysis, we compare the modulation exerted by the QBO over the southern hemisphere tropopause characteristics using different data sources: ERA-40 reanalyzed data from the European Centre for Medium-Range Weather Forecasts (ECMWF); data from a set of 22 observatories included in the Integrated Global Radiosonde Archive (IGRA); and ozone data from TOMS for the 1979-1999 period. The QBO modulation of the tropopause characteristics from these databases is estimated through the application of the multitaper-singular value decomposition method (MTM-SVD) for the 1979-1999 period.

Monthly data from teseh databases were used to characterize the evolution of tropopause characteristics through a QBO cycle. It is observed that the SH polar vortex gets slightly accelerated (decelerated) during the QBO west (east) phase. The acceleration of the polar vortex is accompanied by negative (positive) anomalies of the pressure at the tropopause at polar (subpolar) latitudes. In general, there is a good agreement between the results obtained from reanalyzed and from sounding data.

An additional analysis was done using only November data, since it is during this month when the extratropical influence of the QBO over the SH is most intense. The new analysis shows anomalies more intense but of the same sign as those obtained with the complete monthly series, where the acceleration (deceleration) of the polar vortex that occurs during the QBO west (east) phase is accompanied by a higher (lower) polar tropopause.

The comparison between reanalyzed and radiosonde data shows a good agreement but slight discrepancies are observed at two observatories situated in the southernmost part of South America.

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Equatorial Vertical Transport as diagnosed from Nitrous Oxide Variability

Presenter: Philippe Ricaud (philippe.ricaud@aero.obs-mip.fr)

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Time evolution of nitrous oxide (N_2O) in the equatorial stratosphere is examined by combining measurements from the ODIN satellite and simulations of chemical transport models (MOCAGE and SLIMCAT) over the period 2000-2006. This data set helps identifying the different processes explaining N_2O variability. In the mid-to-upper stratosphere, the quasi-biennial and the semi-annual oscillations are consistent within all the data sets whilst, in the lower stratosphere, the measured annual oscillation (AO) is more intense than modeled. The Upper Troposphere-Lower Stratosphere temporal evolution of N_2O measured over the 7-year period is examined with respect to the vertical and zonal wind evolutions over different regions (Central Africa vs. Western Pacific) in order to infer the impact of deep land-convective systems and overshootings onto the N_2O annual oscillations.

ID: 00105 ◀back

The dissipation of transience gravity waves propagating in a shear flow

Presenter: Claudio Rodas (rodas@exa.unne.edu.ar)

C. Rodas, Manuel Pulido (Universidad Nacional del Nordeste, Corrientes, Argentina)

Transience gravity waves that are propagating in a shear flow toward their critical levels are examined using ray tracing technique and a higher degree approximation (quasi-optical approximation). Three breaking regimes as a function of frequency spectrum width and the wave amplitude are found. Conservative waves with enough amplitude and narrow frequency spectrum attain the convective instability before they reach the maximum wave amplitude. On the other extreme, small amplitude highly transience conservative waves reach the convective instability for very long times and small amplitudes. Through numerical experiments we show that highly transience gravity waves propagating towards their critical levels in a viscous medium (we use viscocity values representative of the middle atmosphere) are dissipated without reaching the convective instability threshold for their entire life cycle. The consequences of these results in orographic waves propagating in a wind turning with height are also examined.

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Observations and Modeling of Composition of Upper Troposphere/Lower Stratosphere (UT/LS): Isentropic Mixing Events and Morphology of HNO_3 as Observed by HIRDLS and Comparison with Results From Global Modeling Initiative

Presenter: Jose M Rodriguez (Jose.M.Rodriguez@nasa.gov)

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Isentropic exchange of air masses between the tropical upper troposphere and mid-latitude lowermost stratosphere (the so-called ‘middle world’) is an important pathway for stratospheric-tropospheric exchange. A seasonal, global view of this process has been difficult to obtain, in part due to the lack of the vertical resolution in satellite observations needed to capture the laminar character of these events. Ozone observations at a resolution of about 1 km from the High Resolution Dynamic Limb Sounder (HIRDLS) on NASA’s Aura satellite show instances of these intrusions. Such intrusions should also be observable in HNO_3 observations; however, the abundances of nitric acid could be additionally controlled by chemical processes or incorporation and removal into ice clouds. We present a systematic examination of the HIRDLS data on O_3 and HNO_3 to determine the seasonal and spatial characteristics of the distribution of isentropic intrusions. At the same time, we compare the observed distributions with those calculated by the Global Modeling Initiative combined tropospheric-stratospheric model, which has a vertical resolution of about 1 km. This Chemical Transport Model (CTM) is driven by meteorological fields obtained from the GEOS-4 system of NASA/Goddard Global Modeling and Assimilation Office (GMAO), for the Aura time period, at a vertical resolution of about 1 km. Such comparison brings out the successes and limitations of the model in representing isentropic stratospheric-tropospheric exchange, and the different processes controlling HNO_3 in the UT/LS.

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The observed trend in the Southern Annular Mode: Is it the ozone hole or is it greenhouse gases?

Presenter: Howard Roscoe (h.roscoe@bas.ac.uk)

H.K. Roscoe (BAS, Cambridge, UK),
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We present results of multiple regressions of the leading mode of atmospheric variability at southern high latitudes: the Southern Annular Mode (SAM). It is regressed against indices with large inter-annual variability, and one of several trend indices in order to determine which trend term gives the optimum fit. We use SAM in sea-level pressure from station data in order to provide a long time series, from 1957 to 2005. The regression indices are stratospheric volcanic aerosol, solar activity, the quasi-biennial oscillation (QBO), the El Niño-Southern Oscillation, together with either a linear trend, or the effective equivalent stratospheric chlorine (EESC) that depletes polar ozone, or ozone mass deficit (OMD) in the Antarctic vortex. We find a significant linear trend in SAM, but there is a major increase in significance using EESC2 and a further increase using OMD. We make no direct attempt to identify cause and effect, but if the trend is due to human influence then ozone loss is at least 9 times more likely the principle cause of the trend in SAM than greenhouse gases. Monthly and seasonal regressions show a maximum correlation with OMD between December and May (summer and autumn), consistent with previous work on stratospheric change as a cause of change in the troposphere.

The increase in SAM is important because it has increased winds and reduced the uptake of CO_2 in the Southern Ocean, and, caused melting of a large Antarctic ice shelf. Its cause is important because the ozone hole will recover during the 21st century whereas greenhouse gases will further increase.

ID: 00079 ◀back

Trends in the temperature and water vapor content of the tropical lower stratosphere: A possible sea-surface connection

Presenter: Karen Rosenlof (karen.h.rosenlof@noaa.gov)

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The tropical lower stratosphere is an important region of the atmosphere, where strong convective activity in the underlying troposphere affects both its chemical and dynamical properties. Temperatures near the tropopause influence the input of water vapor from the troposphere and act as an indicator of the dynamical properties of the region. This paper addresses long-term trends in the temperature of the tropical lower stratosphere. Correlations with recent changes in tropical stratospheric water vapor are also noted. Special attention is given to the convectively active tropical western Pacific Ocean, where sea-surface temperatures (SSTs) are among the highest in the world. The region contains several island radiosonde stations with records reliably extending over several decades. Results show only weak cooling trends occurred before the 1990s, but a strong and rapid cooling of 4º to 6ºC took place in the mid-1990s, and has persisted since that time. The properties of the temperature records during and following this cooling event are discussed, and a significant anticorrelation with SST anomalies in the underlying ocean is noted. The rate of ocean warming increased in the early 1990s, coinciding approximately with the mid decade cooling event, while individual monthly anomalies in both time series are also anticorrelated. Past work has shown that cooling of the tropical lower stratosphere is a dynamical result of tropospheric convection, which in turn partially depends upon sea-surface temperatures. Convection may therefore be the link between the ocean and the stratosphere, and the increased cooling may be an indication of strengthening tropical convection.

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The response of the ozone and temperature to the solar irradiance variability during 20th century

Presenter: Eugene Rozanov (e.rozanov@pmodwrc.ch)

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It is important to understand the effects of different natural forcing and their dependence on the atmospheric state. To elucidate the influence of the solar irradiance variability we have carried out the 9-member 100-year long transient ensemble simulation with the CCM SOCOL spanning the entire 20th century, driven by the prescribed time evolution of the sea surface temperature, sea ice distribution, volcanic aerosols, solar spectral irradiance, greenhouse gases, ozone depleting substances, sources of CO and NOx, land use, and quasi-biannual oscillation. The simulated time series have been analysed by using a linear multiple regression technique to extract the ozone and temperature sensitivity to the solar irradiance variability. The solar signal in the zonal mean stratospheric ozone and temperature obtained from the entire time series (1901-1999) resembles the solar signal obtained earlier from CCM SOCOL simulation covering the last 25 years of the 20th century.

To assess the time evolution of the solar signal we applied the same method consecutively to the 33-year long sub-series of the tropical mean ozone and temperature. The first sub-series is centred at 1918 and the subsequent time-series cover entire century with 1 year increment. The results reveal that ozone response to the solar variability is almost constant in the 35-60 km layer. In the mesosphere the magnitude of ozone response decreases significantly with time from ~9% at the beginning to ~4% at the end of the century. Ozone response also has a substantial time evolution below 35 km with a clear separation around 1945. The same behaviour can be also seen for the temperature response. It is rather stable in the 35-60 km layer, while its magnitude increases from 0.8 to 1.6 K in the mesosphere. Similarly there is a clear difference between the temperature response in the lower stratosphere during the first and second half of the century. The causes of such behaviour will be discussed.

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Convective Transport of VSLS to the TTL in a High Resolution Global Model

Presenter: Maria Russo (maria.russo@atm.ch.cam.ac.uk)

M. Russo, J.S. Hosking, M. R. Russo, Peter Braesicke, J.A. Pyle (University of Cambridge, UK)

Convection plays an important role in shaping the structure and composition of the tropical tropopause region. Transport of boundary layer pollutants to the upper troposphere and lower stratosphere (UTLS) can be separated into two main components, convective and large scale. The extent to which these contribute to the overall transport is unclear; furthermore both components have spatial and temporal variations therefore quantifying their relative effect on global stratospheric ozone and water budget is complex.

Coarse resolution climate models lack the ability to resolve the smaller spatial scales associated with tropical convection. By using a high resolution version of the Unified Model many features associated to large storms and tropical convective systems start to emerge; analysis of such features and comparison against satellite data and ECMWF analysis, show that the model is capturing the extent and spatial distribution of the mean convective activity within the tropics.

We investigate the Australian-Indonesian pre-monsoon period (November 2005) to quantify the relative effect of convective overshooting and large scale transport on the composition of the UTLS. Particular attention is given to short-lived halogenated species (e.g. bromoform). If transported quickly to the lower stratosphere, these shortlived species are likely to contribute to ozone depletion.

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Odin-SMR retrievals of water in the tropical tropopause layer

Presenter: Bengt Rydberg (benryd@chalmers.se)

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Cloud ice mass and water vapour in the tropical upper troposphere are two connected components affecting the Earth's climate, by controlling the Earth's radiation balance. Also, the transport of water vapour from the upper troposphere to the stratosphere can be connected to high altitude ice clouds. The knowledge of these parameters is relatively poor.

Odin-SMR (Sub-Millimetre Radiometer) is a passive limb-sounding radiometer operating at around 500 GHz and has the possibility, opposite to more traditional sensors, to observe these quantities simultaneously. Odin was launched into a sun-synchronous orbit, with an ascending node around 18:00 local time, in 2001. The stratospheric mode of Odin-SMR, suitable also for upper tropospheric measurements, uses two frequency bands around 501 and 544 GHz, which have sensitivities down to around 12 and 14.5 km respectively.

Retrieval scheme, results, and comparisons of cloud ice mass (partial ice water path above 12 km) and humidity (in two layers around 200 and 130 hPa) from Odin-SMR to similar instruments and climate models have been published. Mean cloud ice mass results from Odin-SMR have been shown to be close to Aura-MLS but more than 50% lower than CloudSAT.

The humidity climatology derived from Odin-SMR has been shown to be consistent (differences less than 15% RHi) with UARS-MLS, Aura-MLS, and MIPAS.

The inversions of cloud ice mass from this first retrieval scheme is subject to relatively large error uncertainties. Two major retrieval uncertainties have been identified: the assumptions of cloud microphysics, and cloud inhomogeneity. An updated Bayesian retrieval scheme, where these uncertainties are more sophisticated handled, will make simultaneous inversions of humidity and cloud ice mass possible, and also provide a better vertical resolution of the cloud ice mass and better error estimates. The retrieval scheme is based on generating a database of realistic and variable atmospheric and cloud states and simulated measurements on these states. Inversions from measurements can then be performed by "interpolating" between simulated measurements that match the actual measurements. The improved retrieval scheme is achieved by combining:

- 2-D cloud structure data from the CloudSat radar, and a Fourier transform algorithm program to generate stochastic 3-D cloud structures, in order to deal with cloud inhomogeneities
- in-situ collected cloud microphysics data from sensors onboard airplanes, to include the observed variability of these properties in the cloud states
- atmospheric data from ECMWF to include the variability of temperature and water vapor in the atmospheric states
- a radiative transfer Monte Carlo forward model to simulate measurements

- a Bayesian retrieval algorithm, to deal with the non-uniqueness of the inverse problem.

Obtained results of upper tropospheric cloud ice mass and humidity, in the form of climatologies, and uncertainties, from the improved retrieval scheme are presented.

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FASTOC II – Further development of the FAst STratospheric Ozone Chemistry scheme

Presenter: Andrew Ryzhkov (andrew@meteo.mcgill.ca)

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Poster cannot be presentated due to technical problems

With the development of three-dimensional Climate-Chemistry Models in the recent years and the necessity to represent stratospheric ozone in operational forecasting systems, a strong need has emerged for fast stratospheric chemistry schemes. Such fast schemes allow a redirection of computer resources, as for instance towards raising spatial resolution. While most developments have been carried towards linearised chemistry schemes, a non-linear fast chemistry scheme was recently proposed with the FAst STratospheric Ozone Chemistry (FASTOC) model.

In this paper, we present the new version of FASTOC with an evaluation of its accuracy and performance. This new version is built to mimic the comprehensive stratospheric photochemistry model from the Belgian Institute for Space Aeronomy. The latter was thoroughly validated and is currently used in the systems BASCOE and GEM-BACH. It is composed of 57 chemical species and 200 chemical reactions, including halogen reactions and heterogeneous processes. FASTOC has a 24h time step and employs a family approach to reduce the number of advected species. This new version is evaluated (i) on short time scales by direct comparison with the reference photochemistry scheme throughout the stratosphere, and (ii) on a climatological basis when incorporated on-line in a Climate-Chemistry Model. This new version of FASTOC is shown to preserve a good accuracy throughout the stratosphere and on all time scales. Benchmarks show that the computational cost is reduced by several orders of magnitude as compared to the reference photochemistry model.

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West African Weather Systems in the Development of Tropical Cyclones

Presenter: Tairu Salami (adesat2002@gmail.com)

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Tropical Cyclones have their origins from areas of low atmospheric pressure over warm waters in the tropics or subtropics. We have have carefully studied the interconnection between the West African Weather Systems (WAWS) and their subsequent development into Tropical Cyclones.

Between 2004 and 2005, we studied the interconnection and the teleconnection between the WAWS and the various occurrences of Tropical Cyclones and their eventual development into Hurricanes. We noted that critical synoptic characteristics and the environmental properties of the Systems;the thermodynamic conditions of the storms trajectory and the conditions of the ocean are all closely linked. It is therefore believed that proper understanding and monitoring of these systems will play a very vital role in early detection of potential WAWS that may develop into Tropical Cyclones and even Hurricanes. More practical issues will be presented.

It was recorded that over the period 1992-2001, weather and climate-related disasters especially those of Tropical Cyclones origin killed about 622000 people, affected more than two billion, left millions more homeless, devastated arable land and spread diseases.

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Water Vapour Isotopes in the Stratosphere: Comparison between a 2D Model and Observations by ODIN/SMR

Presenter: Claudio Sánchez (claudio@chalmers.se)

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Humidity is important for the dynamics of the UTLS and the entire middle atmosphere, as well as for stratospheric ozone depletion. The study of the isotopic depletion/enrichment supplies information on the origin of stratospheric water vapour and on exchange processes between troposphere and stratosphere: Transport of tropospheric air through the tropical tropopause layer (TTL) vs. in situ chemical production by methane oxidation. In order to analyze and assess the dynamics and the long term changes of stratospheric water vapour, a comparison of fields of water isotopes (H_2O, HDO) obtained from a 2D model (CHEM2D) with data of the Odin Sub-Millimetre Radiometer (SMR), has been carried out, along with a study of the variability in the 7 year Odin/SMR water vapour isotopes times series. We report on the results of the comparison and discuss how the model may be improved.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (TEKES), France (CNES), and the European Space Agency (ESA).

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Trace Gas Evolution in the Lowermost Stratosphere from Aura Microwave Limb Sounder Measurements: Subvortex Processing and Transport

Presenter: Michelle Santee (mls@mls.jpl.nasa.gov)

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and New Mexico Institute of Mining and Technology, USA)

Daily global trace gas measurements from the Microwave Limb Sounder (MLS) on NASA's Aura satellite, launched in July 2004, have enabled the first comprehensive examination of the interhemispheric and interannual variations in chemical processing and the evolution of transport barriers in the lowermost stratosphere. We will use recently-released version 2.2 measurements from MLS, including HNO_3, H_2O, O_3, CO, HCl, and ClO, to analyze chemical processing in and dispersal of chemically-processed air from the lowermost portion of the polar vortex and the "subvortex", the region below the strong confinement of the vortex proper. The seasonal evolution of and interannual variability in MLS trace gases in these regions will be characterized, as will the contrast in the behavior of the subvortex in the two hemispheres. Evidence for mixing in the lowermost stratosphere in the region between the vortex and tropopause transport barriers, as well as possible transport of processed air into the troposphere, will be presented. Particularly over Antarctica, such mixing of processed air out of the vortex / subvortex may significantly affect the composition of the extratropical lowermost stratosphere and upper troposphere.

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Upper Troposphere/Lower Stratosphere (UTLS) Trace Gas Evolution in Recent Satellite Datasets: Relationships to the Subtropical Jet and Tropopause

Presenter: Michelle Santee (Michelle.L.Santee@jpl.nasa.gov)

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A method is developed of categorizing the location and characteristics of upper tropospheric jets. This method is applied to define the position, width and dynamical characteristics (e.g., windspeed/direction, potential vorticity, temperature, static stability, etc) of the primary subtropical jet (STJ) core, as well as similar information on multiple jets in the extratropical (ET) UTLS. Jet characteristics during quasi-isentropic stratosphere-troposphere exchange (STE) events and seasonal evolution of STJ structure are investigated in Goddard Earth Observing System Version 5 (GEOS-5) and other meteorological analyses. Satellite trace gas measurements from several current instruments, including the Aura Microwave Limb Sounder (MLS), Atmospheric Chemistry Experiment-Fourier Transform Spectrometer (ACE-FTS) and the Aura High Resolution Dynamics Limb Sounder (HIRDLS), are studied to further our understanding of the seasonal evolution ET-STE events in relation to the STJ and the tropopause.

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Aerosol modelling for regional climate studies: Application to a dust event over a Mediterranean domain

Presenter: Monica Santese (monica.santese@le.infn.it)

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The spatial and temporal distributions of aerosols tend to be highly inhomogeneous on regional scales due to their relatively short lifetimes. Three-dimensional chemical transport models that simulate emissions, transport, conversion and removal process of different aerosol species are important tools to characterize the aerosol spatial distributions on global/regional scales, to assess the aerosol impact on the radiative energy balance of the Earth-atmosphere system, and to assess the aerosol climate effects (Schimel et al., 1996).

Because the aerosol effects are especially important at the regional scale, the recent development of high-resolution regional climate models (RCMs) offers useful tools to assess the regional impacts of aerosols. Compared to global climate models (GCMs), the relatively high-resolution and detailed physical parameterizations by RCMs are particularly suitable to describe the complexity of aerosol processes (Solmon et al., 2006).

In the past, a number of efforts have been made to simulate the desert dust cycle in climate models, particularly at the global scale (Joussame, 1990; Cakmur et al., 2004, 2005; Miller et al., 2004, 2006; Zender et al., 2004; Luo et al., 2003). Fewer studies are available on the inclusion of dust processes in regional climate models (Gong et al., 2003; Song and Carmichael, 2001; Nickovic et al.,2001). Dust radiative effects on climate are likely to be especially important at the regional scale, thus RCMs can be particularly useful tools to investigate the regional climate effects of dust outbreaks (Zakey et al., 2006).

In this work, we will use the regional climate model RegCM (Version 3.1), developed at the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, to investigate dust particle impacts over the Mediterranean basin. In particular we have considered two strong Saharan dust outbreaks that occurred in the second half of July 2003, which have spread large tongues of dust particles all over the central Mediterranean basin.

The main peculiarity of the RegCM model is that it makes use of by two different modules: an aerosol module that includes sulphur dioxide, sulphate, hydrophobic and hydrophilic black carbon (BC) and organic carbon (OC) and a dust module (Zakey et al., 2006) that includes dust particles. To this end, it is worth noting that the Mediterranean basin is characterized by a complex atmospheric chemistry influenced by regional and long-range transported emissions from both the continental Europe and the Africa deserts (Santese et al., 2007).Then, it is very important to use a model where the contribution of different aerosol components is considered even during dust events .

Here, we will test the model performance in simulating aerosol parameters against station and remotely based observations for two different domains and for different periods of simulation.

In particular, the main aim of this study will be to understand how the choice of both the temporal and the spatial range of the run simulations may influence model results.

At first, results for a simulation done for a longer temporal range, that includes the dust events of July 2003, and for a domain of 10010 km abstracts_allaccepted.txt affiliation.ksh presenters_sorted.txt presenters.txt programme_draft.txt programme1.ksh programme2.ksh sessionA.txt sessionB.txt sessionC.txt 4542 km centered at latitude of 30º and longitude of 5º with horizontal spacing of 50 Km will be present.

Then, model results done for a short temporal range, that includes the dust events, and for two different Mediterranean domains (the first of ~ 10010 km abstracts_allaccepted.txt affiliation.ksh presenters_sorted.txt presenters.txt programme_draft.txt programme1.ksh programme2.ksh sessionA.txt sessionB.txt sessionC.txt 4542 km centered at latitude of 30º and longitude of 5º and a horizontal spacing of 50 Km and the second of ~ 4995km x 2227km centered at a latitude of 30º and a longitude of 5ºwith a horizontal spacing of 50 Km) will also be presented.

The main goal of this work is that to compare RegCM results with observations to test the model performance and to contribute to the establishment of models more dependent on measurements.

In particular, AODs from AERONET sunphotometer over different sites over the Mediterranean Basin and AODs from MODIS satellite measurements, will be compared with the aerosol optical depth values provided by the RegCM.

Moreover, extinction coefficient vertical profiles (obtained from laser Lidar measurements retrieved at two Mediterranean sites (Lecce and Etna) will be compared to the corresponding profiles provided by the RegCM model.

Then, ground aerosol parameters as PM mass concentrations obtained by ground-based particulate matter samplers and provided by ARPA (Regional Agency of Environmental Protection) and by RegCM model over different Mediterranean sites will be also compared in this work.

The results that we will report in the work will demonstrate the capability of the RegCM model to simulate main dust event impacts.

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A Study of the Middle Atmosphere Dynamics Using a Gravity-Wave Resolving GCM Simulation

Presenter: Kaoru Sato (kaoru@eps.s.u-tokyo.ac.jp)

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A high-resolution atmospheric general circulation model has been developed to study various aspects of small-scale phenomena including gravity waves and their role on the large-scale fields in the middle atmosphere. Our spectral model has a T213 truncation in the horizontal (horizontal resolution of about 60 km) and 256 layers (L256) in the vertical from the surface to about 85 km with an interval of 300 m in the upper troposphere and above. No gravity wave parameterizations are included in our model and hence all gravity waves are spontaneously generated. The GCM reproduced realistic general circulation in the stratosphere and mesosphere in middle and high latitudes. In order to investigate relative importance of planetary waves, large-scale gravity waves, and small-scale gravity waves for the maintenance of the meridional structures of the zonal mean zonal wind in the middle atmosphere, Eliassen-Palm (E-P) diagnostics are separately applied for the three groups of waves with different horizontal wavelengths. An interesting finding is that small-scale gravity waves seem to affect largely the upper shapes of the mesospheric jets (Watanabe et al. 2008).

Our model also simulates large-scale oscillations with realistic amplitudes in the equatorial atmosphere such as the quasi-biennial oscillation (QBO) and semi-annual oscillation (SAO), although the period of the QBO-like oscillation is shorter (about 1.5 years). Model outputs with a time interval of 1 hour are analyzed to elucidate relative importance of the internal gravity waves (IGWs) and equatorially-trapped waves (EQWs) to drive the QBO-like oscillation. It is shown that horizontal wind components as well as precipitation and outgoing long wave radiation (OLR) have realistic characteristics in terms of zonal wavenumber versus frequency spectra which clearly shows the existence of convectively-coupled EQWs. It is seen that IGWs are strongly influenced by the vertical wind shear associated with the Walker circulation in the troposphere, which results in different distribution of IGW amplitudes between the eastern and western hemisphere. In the westerly shear phase of the QBO-like oscillation, IGWs contribute to 50-70% of the total eastward acceleration, though equatorial Kelvin waves contribute largest among the EQWs. It is also shown that the distribution of the wave forcing is not zonally uniform depending on the wave types (Kawatani et al., in preparation). Another interesting finding of our model study is the existence of an isolated temperature maximum around the winter subtropical stratopause. It is shown that this maximum is maintained by a downward branch of the meridional circulation driven by the E-P flux convergence associated with planetary waves propagating from below in the winter hemisphere. This meridional circulation crosses the equator where the angular momentum has a structure of 'corridor' for such a flow on account of the SAO easterly (Tomikawa et al., 2008).

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Winter weather and stratosphere-troposphere coupling

Presenter: Adam Scaife (adam.scaife@metoffice.gov.uk)

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The influence of stratospheric variability on surface winter climate is investigated in modelling experiments and observational datasets. Stratospheric changes are important for the recent rapid warming of Europe in winter and associated changes in the frequency of surface climate extremes. The winter of 2005/6 is used as a case study to illustrate how this influence occurs in individual years. Finally, we use high-top and low-top models to show that a good representation of the stratosphere is important for surface climate change.

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SPARC water vapour initiative

Presenter: Cornelius Schiller (c.schiller@fz-juelich.de)

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An update of the SPARC water vapour assessment of 2000 seems to be timely. The SPARC Scientific Steering Group therefore proposed to initiate a new water vapour initiative. In particular, there is a need to summarise the relevant results over the past decade from various field experiments, laboratories and models in a comprehensive report or review publication. The major goal of such an exercise is to assess the value and the accuracy of recent measurements and to give new recommendations and guidelines for future research on UTS water vapour. The major topics to be addressed are:

1. Data quality: How reliable are in situ and remote sensing field data in terms of accuracy and precision?
2. Clear air and in-cloud supersaturation: Can the observations be explained within the framework of our current knowledge or do we need new theoretical concepts and new laboratory investigations, e.g. of ice growth at extreme temperatures?
3. Recent observations of UTS water vapour changes: Are these observations mutually consistent, do we understand them, and what are our abilities for future predictions?
4. Impact on atmospheric chemistry and climate: What are the implications of changing UTS water vapour for radiation, dynamics, chemistry, clouds and climate?

Here, we give an outline of the initiative to stimulate discussions for the kick-off workshop during the Assembly.

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Drying and moistening at the tropical tropopause

Presenter: Cornelius Schiller (c.schiller@fz-juelich.de)

C. Schiller, P. Konopka, M. Krämer, S. Rohs, F. H. Silva dos Santos, N. Spelten (FZJ Germany), D. Brunner (EMPA Switzerland),
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Aircraft data of total water and water vapour from SCOUT-O3 (Australia), TROCCINOX (Brazil), AMMA (West Africa) and APE-THESEO (Indian Ocean) will be analyzed for the ice water content of cirrus and RHice at very low temperatures: Formation of ultrathin cirrus clouds and freeze-drying results in very low mixing ratios, sometimes below 2 ppmv. Deep convection leads to injection of moist air into the TTL and lower stratosphere. We will discuss the local cloud formation and dehydration processes as well as those having occurred before the observations analyzing the airmass history along backward trajectories.

ID: 00150

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Trends in the global tropopause estimated from GPS radio occultation data

Presenter: Torsten Schmidt (tschmidt@gfz-potsdam.de)

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We examine global tropopause variability on the basis of zonal monthly means using GPS radio occultation (RO) data from 2001-2007. The RO technique uses GPS signals received aboard low Earth orbiting satellites for atmospheric limb sounding. Atmospheric temperature profiles are derived with high vertical resolution. Due to its long-term stability, all-weather capability and global coverage the GPS RO technique offers the possibility for global monitoring of the tropopause and for detection of changes in tropopause parameters. The German CHAMP mission delivers RO data continuously since May 2001, thus generating the first long-term GPS RO data set. In our study we found a global increase of the tropopause height between 26-44 m during the observation period depending on the binning method (5 deg or 10 deg latitude bands) and the used tropopause detection algorithm. The corresponding trend errors vary between 18-21 m. The inclusion of the QBO in the regression model leads to a global increase of the LRT height up to 5 m (10%) during the time period depending on the binning. The global tropopause height variations are positively correlated with upper tropospheric (500-100 hPa) and anti-correlated with lower stratospheric (100-30 hPa) temperature variations.

ID: 00152

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A global analysis of gravity wave activity in the upper troposphere and lower stratosphere region derived from GPS radio occultation data

Presenter: Torsten Schmidt (tschmidt@gfz-potsdam.de)

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Global gravity wave (GW) potential energy distributions are retrieved from GPS radio occultation (RO) data from different satellite missions: CHAMP since 2001, GRACE and COSMIC since 2006. The RO technique uses GPS signals received aboard low orbiting satellites for atmospheric limb sounding. Atmospheric temperature profiles are derived with high vertical resolution. The GPS RO technique is sensitive to GWs with small ratios of vertical to horizontal wavelengths. The specific potential energy as a measure of GW activity is usually deduced from the temperature profile for each occultation event up to 35 km. To separate the GWs from the background a band-pass filter associated to different vertical wave lengths is applied to the measured temperature profiles. This GW analysis technique introduces significant artificial enhancement of wave activity at the tropopause, mainly in the tropics, depending on the ability of the band-pass filter to reproduce the tropopause kink. As an alternative to the usage of the temperature profile alone we discuss two additional methods for the derivation of the GW activity: (1) The GW analysis is considered for the troposphere and lower stratosphere separately by applying the band-pass filter up to the tropopause and from the tropopause to the end of the temperature profile. (2) Instead of the usage of temperature profiles we adopt potential temperature and refractivity profiles for the calculation of GW activity, taking into account the less abrupt course of this parameters in the vicinity of the tropopause region. The specific potential energy derived from the different methods will be discussed globally with respect to geographical regions/seasons and altitude intervals, whereas special attention is given to the tropical region.

ID: 00395

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Comparison of Tropospheric Ozone Residual Methods

Presenter: Mark Schoeberl (mark.r.schoeberl@nasa.gov)

M. Schoeberl, J. Ziemke, B. Bojkov, X. Liu (UMBC, Baltimore County, USA)

Tropospheric ozone residual (TOR) is the difference between the stratospheric ozone column and the total column. Because of the low stratospheric column variability in the tropics, the tropical TOR is fairly easy to compute using stratospheric ozone climatology. Extra-tropical daily TOR estimates present a different challenge because of high stratospheric variability and low spatial coverage by the stratospheric limb sounders used to estimate the stratospheric column. Two methods have been used to boost the spatial resolution of the stratospheric ozone column, trajectory accumulation of several days of data and PV-Theta mapping. These two methods are compared to each other and to direct retrievals from TES and OMI as well as the ozonesonde data base.

ID: 00302 ◀back

Conceptual investigation of the interaction of water vapor and Br_y transport across the tropical transition layer

Presenter: Robyn Schofield (robyn.schofield@awi.de)

R. Schofield (Alfred Wegener Institute, Potsdam, Germany),
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The process of water vapor transport across the tropical transition layer involves both microphysical and convective processes. The bromine budget of the stratosphere can not be reconciled with ground-based bromine measurements using long-lived bromine containing substances alone. In this study we look at the interaction of the water vapor transport processes in the context of very short lived (VSL) bromine species. Lagrangian back trajectories initiated in the stratosphere are generated using ECMWF reanalysis data. A simplified microphysical and bromine chemistry representation are then calculated along the trajectories. We present the transport of the VSL bromine in a conceptualized form and investigate sensitivities to the general chemical, microphysical and convective processes that result in VSL bromine contributing to the stratospheric bromine budget.

ID: 00396 ◀back

The sensitivity of polar ozone recovery to catastrophic sea-ice loss in the northern hemisphere

Presenter: John Scinocca (john.scinocca@ec.gc.ca)

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A.R. Ravishankara (NOAA, Boulder, USA)

The potential for the catastrophic loss of sea-ice in the northern hemisphere (NH) during summer (Holland et al, 2006) raises the question of its impact on predictions of NH polar ozone recovery as modelled in the recent WMO/UNEP Ozone Assessment (2007). In that assessment chemical-climate models were forced by sea-surface temperatures and sea ice that were specified from existing coupled atmosphere-ocean GCMs (typically from IPCC AR4 simulations). Such coupled models typically show a slow reduction of sea-ice mass in the NH during the 21st century and so do not include the potential influence of catastrophic sea-ice loss.

In this study we employ the Canadian Middle Atmosphere model (CMAM) to investigate this issue by performing the REF2 scenario (1950-2100) of the WMO/UNEP Assessment with a fully coupled atmosphere-ocean GCM. An ensemble three is used to provide a control and a second ensemble of three is initiated in 2025 with catastrophic sea ice loss induced in the NH. This is accomplished by changing the albedo of sea-ice in the model in the perturbed ensemble. Comparison of the two ensembles allows an evaluation of the potential impact of sea-ice loss on polar ozone recovery in the NH. Preliminary results indicate that the sudden loss of sea ice results in systematically lower springtime column ozone for several decades after the event suggesting a slower recovery than was simulated in the recent WMO/UNEP Assessment.

ID: 00074 ◀back

Influence of the stratospheric potential vorticity distribution on the Brewer-Dobson circulation

Presenter: Richard Scott (rks@mcs.st-and.ac.uk)

R.K. Scott (University of St Andrews, UK)

The winter stratospheric Brewer-Dobson circulation is determined to a large extent by zonal mean momentum forcing associated with the dissipation, through wavebreaking, of planetary scale Rossby waves. While these waves are forced at the ground and in the troposphere, their propagation within the stratosphere, and hence the location of their eventual breaking, is determined in turn by the distribution of zonal mean potential vorticity throughout the stratosphere. Steep potential vorticity gradients at the vortex edge act as a wave-guide, allowing wave propagation to higher altitudes before wave breaking occurs. Conversely, weak potential vorticity gradients allow wave breaking at lower altitudes, particular in low latitude critical layers (leading to homogenization and steepening of the original potential vorticity distribution). The distribution of wave-induced zonal mean momentum forcing thus depends on the stratospheric potential vorticity distribution.

In this work, we examine the above dependence using two approaches. First, we consider a simple model of the winter polar vortex in which the vortex edge is represented by a linear potential vorticity profile of varying thickness and gradient. We examine the vortex response to a single pulse of wave forcing at the tropopause, in particular how the distribution of wave flux divergence (equal to the zonal momentum forcing) and hence the (transient) Brewer-Dobson circulation depends on the vortex edge width.

In the second approach, we consider forced-dissipative experiments, under perpetual January radiative conditions and with steady wave forcing at the tropopause. This system exhibits strong internal variability, with the polar vortex undergoing a series of quasi-periodic sudden warmings separated by a period of gradual vortex recovery under radiative forcing. Wave breaking in this system has a tendency to steepen potential vorticity gradients, however, the extent to which this is possible depends on the horizontal resolution: gradients at the vortex edge are limited by the number of grid points across the edge. Horizontal resolution thus plays the role of edge width in this system. In general, the time-average vertical upwelling at low latitudes in the lower stratosphere is relatively insensitive to changes in the horizontal resolution; changes in the wave breaking are balanced by changes in diffusion, resulting in similar zonal mean momentum forcing. Under certain forcing parameters, however, the horizontal resolution is able to influence qualitatively the nature of the internal variability. The distribution of wave flux convergence, details of the potential vorticity distribution, and structure of the Brewer-Dobson circulation are investigated across a range of horizontal resolutions spanning those currently used in climate modeling.

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Assimilation of Total Ozone using a Local Ensemble Transform Kalman Filter

Presenter: Thomas Sekiyama (tsekiyam@mri-jma.go.jp)

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A four-dimensional local ensemble transform Kalman filter (4D-LETKF, cf. Miyoshi et al., 2007) is applied to MRI-CTM (Chemistry Transport Model developed by the Meteorological Research Institute of Japan, cf. Sekiyama et al., 2005, 2006) to assimilate total ozone columns which are observed by satellite instruments - such as TOMS or OMI. The 4D-LETKF data assimilation system, which is based on the system originally developed by the Japan Meteorological Agency (JMA) for routine weather forecasts, (1) provides analysis for the detailed global distribution of stratospheric ozone, and (2) supplies the initial conditions of total ozone distribution to forecast ultraviolet (UV) irradiance at the surface accurately. The assimilation results are compared with ground-based observations including vertical ozone profiles - such as Brewer Umkehr and Sonde observations operated by JMA. We present the advantages of this assimilation system by comparison with another simpler assimilation process for total ozone, that is to say, the Newtonian relaxation (= Nudging method) which has been used by JMA for its UV index forecast daily/routinely.

ID: 00270 ◀back

Lidar study of stratospheric thermal structure and long term trends over a sub-tropical station Mount Abu (24.5ºN, 72.7ºE)

Presenter: Som Sharma (somkumar@prl.res.in)

S. Sharma, S. Lal, Y.B. Acharya, H. Chandra (Physical Research Laboratory, India)

Stratosphere plays very vital role in deciphering various geophysical phenomena taking place in the Earth's atmosphere. It is also a well known reservoir of ozone which protects us from the hazard of the UV radiation emanating from the Sun. For more than two decades, Rayleigh Lidar has become a dynamic atmospheric probe for providing height profile of temperature in the middle atmospheric region. A Nd: YAG laser based Rayleigh Lidar was set up, at a high altitude observatory near Mount Abu (24.5ºN, 72.7ºE, altitude 1.7 km), in the Indian sub-tropical region, to study the Earth's neutral atmospheric temperature structure. The system is transmitting pulses of 7 ns duration at a frequency of 10 Hz with average power about 350 mJ at 532 nm. For the study of temperature climatology in the stratosphere, we have used the Rayleigh lidar data collected for about seven years from 1997 to 2003. The temperature profiles are derived from photon count profiles followed by Hauchecorne and Chanin (1980). The systematic and statistical errors in deriving temperature are found to be less than ~1 K below 50 km. The monthly mean temperature profiles obtained are compared with three different model atmospheres (CIRA-86, MSISE-90 and Indian low latitude model). Below the stratopause, model temperatures are in agreement with the observed values. To study the year to year variability, mean monthly temperature profiles have been estimated for different years. The variability is least around 40-50 km with a value of 5 K. The mean stratopause height and its temperature are found to be 48 km and 270 K respectively. Interesting features, like the double stratopause structure around 40-52 km has also been found. For the study of long term changes in the thermal structure of the Stratosphere, consistently good data series for 1997-2006 has been investigated. Monthly mean temperature profiles for each month individually have been used to remove seasonal variability. A multivariable analysis is used to consider natural variability (Solar Cycle and QBO) and similarly the changes in stratospheric ozone concentration due to anthropogenic activity have also been taken into account in trends estimations. We have selected different height regions 36-40, 41-45 and 46-50 km for trends analysis. Linear Regression analysis is applied to calculate temperature trend in different altitude regions. Considering the imprints of seasonal, QBO and solar cycle variability, a linear decreasing temperature trend in stratospheric temperature has been found using the data from 1997-2006. In this paper, long term trends in temperature at a subtropical high altitude station will be presented and discussed.

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Rayleigh Lidar observed Stratospheric Sudden Warming (SSW) at Mount Abu: An evidence of interaction between planetary wave and stratospheric circulation

Presenter: Som Sharma (somkumar@prl.res.in)

S. Sharma, S. Lal, Y.B. Acharya (Physical Research Laboratory, Ahmedabad, India)

A Nd: YAG laser based Rayleigh Lidar is regularly operated at a sub-tropical station Gurushikhar, Mount Abu (24.5ºN, 72.7ºE, MSL height 1.7 km) since 1997, to study the temperature structure of the Earth's middle atmosphere. The system is transmitting pulses of 7 ns duration at a frequency of 10 Hz with an average power of about 350 mJ at 532 nm. Atmospheric density profiles derived from Lidar returns are used for temperature derivation following the method given by Hauchecorne and Chanin (1980). We take utmost care to avoid possible systematic errors. Nevertheless, overall systematic and statistical errors in deriving temperature are found to be about ~1 K at 50 km, ~3 K at 60 km and ~10 K at 70 km. One spectacular transient phenomenon in the middle atmosphere is the Stratospheric Sudden Warming (SSW) and has been studied mostly in the high and mid latitudes regions. Usually during Northern Hemisphere winter there is one major warming event, but in the year 1998-99 there were more major warming events. We have studied the SSW events during 1998-99 using ground based Lidar data collected at sub-tropical location, Mount Abu. Observed stratospheric temperatures are higher by more than ~15 K during a major warming event. Besides, the lidar data, we have used data from Halogen Occultation Experiment (HALOE) on board the UARS satellite. Zonal-mean temperature and zonal-mean zonal wind data, from NCEP reanalysis, also have been used to characterize the processes operative during SSW's. During winter of 1999, a SSW event was observed at Mount Abu for five continuous days. Using this data, we have studied the age of a SSW event at a Sub-tropical location. Observed sequence of temperature profiles, revealed the decay process of a warming episode, over a subtropical station. Most of these warmings are attributed to increased Planetary Wave (PW) activity and their breaking. The calculation on Eliassen-Palm (E-P) flux show propagation of PW from high and mid - to- low latitudes during the major warming event. This study substantiates the fact that a SSW is not only focused to high/mid latitudes, it can even propagate to low and equatorial latitude depend on the strength of warming and meridional circulation.

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Spurious Sensitivity of a General Circulation Model to Model Lid Height due to Nonconservation of Angular Momentum

Presenter: Tiffany Shaw (tshaw@atmosp.physics.utoronto.ca)

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We examine the sensitivity of the zonal-mean climate of the Canadian Middle Atmosphere Model to raising the model lid height from 10 to 0.001 hPa, with and without conservation of angular momentum. The two models are identical below 10 hPa. Here nonconservation is considered in terms of the neglect of parameterized gravity wave momentum flux at the model lid. When the model lid is placed at 10 hPa, and parameterized momentum flux is conserved, the zonal-mean climate below 10 hPa is very similar for the 10 hPa and 0.001 hPa model lids. However, when momentum is not conserved there are missing vertical mass fluxes at the top of the 10 hPa model because of missing torques and the zonal-mean climates below 10 hPa are very different. The impact of this sensitivity on the troposphere is found to be particularly large in winter at high latitudes. The sensitivity to model lid height is quantified via changes in the vertical component of the residual circulation due to both parameterized and resolved waves. Similar sensitivity is found when the climate is perturbed by a radiative forcing characteristic of that due to the ozone hole.

ID: 00424 ◀back

Spatial structure of the quasi-biennial oscillation in zonal wind and ozone simulated with the MRI-CCM

Presenter: Kiyotaka Shibata (kshibata@mri-jma.go.jp)

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Two middle-atmosphere simulations have been made with a chemistry-climate model (CCM) of the Meteorological Research Institute (MRI). One is an ensemble simulation (five members) of the past 25 years (from 1980 to 2004) under the CCMVal REF1 scenario, i.e., observed forcings of sea-surface temperature, greenhouse gases, halogens, volcanic aerosols, and solar irradiance variations, and the other is the simulation from 1980 to 2099 under the CCMVal REF2 scenario based on observed or projected forcing of sea-surface temperature, greenhouse gases, halogens. The dynamics module of MRI-CCM is a spectral global model truncated triangularly at a maximum wavenumber of 42 with 68 layers extending from the surface to 0.01 hPa (about 80 km), wherein the vertical spacing is 500m from 100 to 10 hPa. The chemistry-transport module treats 51 species with 124 reactions including heterogeneous reactions. Transport of chemical species is based on a hybrid semi-Lagrangian scheme, which is a flux form in the vertical direction and an ordinary semi-Lagrangian form in the horizontal direction. The parameters of gravity wave drag scheme were different between the two simulations, resulting in different QBO periods: 27-month for the REF1 simulation and 22-month for the REF2 simulation. Multiple linear regression analysis is used to isolate the QBO signals from the zonal-mean anomalies in temperature, zonal wind, and ozone. Reference (explanatory) variables are the mean value, the linear trend, the QBOs at 20 and 50 hPa and ENSO for the REF2 simulation, while volcanic aerosols of El Chichon and Mount Pinatubo, and the 11-year solar cycles are also introduced for the REF1 simulation. Coefficients are expanded by annual, semiannual, and triannual cycles to explain seasonality. The annual mean QBO signals of temperature and zonal wind are well reproduced as for the meridional structures, which have two- or three-cell forms of alternating sign in the stratosphere in the two simulations, in spite of different QBO periods. Similarly, the simulated ozone QBO signals also capture the observed meridional structure of vertical multi-cells.

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Current Status of Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)

Presenter: Masato Shiotani (shiotani@rish.kyoto-u.ac.jp)

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and the JEM/SMILES Mission Team

Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) was designed to be aboard the Japanese Experiment Module (JEM) on the International Space Station (ISS) as a collaboration project of Japan Aerospace Exploration Agency (JAXA) and National Institute of Information and Communications Technology (NICT). Mission Objectives are: i) Space demonstration of superconductive mixer and 4-K mechanical cooler for the submillimeter limb-emission sounding, and ii) global observations of atmospheric minor constituents in the stratosphere (O_3, HCI, CIO, HO2, HOCI, BrO, O_3 isotopes, HNO_3, CH_3CN, etc), contributing to the atmospheric sciences. The SMILES observation is characterized as aiming at variation and its impact of radical species in the stratosphere. Based on its high sensitivity in detecting atmospheric limb emission of the submillimeter wave range, JEM/SMILES will make measurements on several radical species crucial to the ozone chemistry (normal O_3, isotope O_3, ClO, HCl, HOCl, BrO, HO_2, H_2O_2). The SMILES will also try to observe isotopic composition of ozone. Developments in the SMILES components/subsystems have been done, and SMILES is now in the system integration phase. Proto flight test of SMILES will start from June 2008 aiming at the launch scheduled in 2009 summer by the H-II Transfer Vehicle (HTV).

ID: 00004

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The big-scale climatic anomalies in the Antarctica and their possible connection with precipitation of energetic electrons from outer belt into the stratosphere above these regions

Presenter: Alexander Shirochkov (shirmak@aari.nw.ru)

Alexander Shirochkov, L. Makarova (Arctic and Antarctic Research Institute, Saint-Petersburg, Russia)

The big-scale climatic anomalies in the Antarctica and their possible connection with precipitation of energetic electrons from outer belt into the stratosphere above these regions.

1. Both experimental and model studies of long-term climate changes above the Antarctica continent indicate presence of strong climate warming at the region around the Antarctic Peninsula which differs significantly from the climate tendency in other parts of the Antarctica. This warming is the most intense on the Earth together with similar regions of warming located in Alaska and in North-East Siberia. Another climatic anomaly in this region is a giant spot of the open water (polynya) in the Weddell Sea which does not freeze in wintertime. Up to now all attempts to explain these phenomena by the traditional meteorological factors turned out to be inadequate.
2. It is shown in this paper that the region of intense global warming around Antarctic Peninsula as well as the polynya location precisely coincides with a stable maximum of energetic electron precipitation (E > 1 MeV) from the Earth radiation belts. Depth of penetration of these particles into atmosphere could be as low as 20-40 km.
3. Energetic resources of this phenomenon as well as their ability to change chemical composition of the stratosphere are quite sufficient in order to supply input of thermal energy capable to warm up atmosphere in this region.
4. Several possible scenarios of sequence of physical processes which could explain influence of precipitating fluxes of relativistic electrons on thermal regime of the stratosphere are discussed. Among them there is downward transfer of excessive number of NOx molecules which could diminish ozone density and enhance atmospheric temperature as well as interaction with geomagnetically conjugate region etc.
5. Exploration of these climatic anomalies is a part of the Russian program for International Polar Year (IPY).

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Transport and mixing in the Antarctic vortex edge region

Presenter: Emily Shuckburgh (emsh@bas.ac.uk)

E. Shuckburgh and H. Roscoe (British Antarctic Survey, UK)

The transport and mixing structure of the Antarctic vortex edge region is analysed using observations and numerical modelling. During the Vorcore campaign in September and October 2005, superpressure balloons were launched from McMurdo station in Antarctica and drifted for months in the lower stratosphere at a constant density level. The mean flight duration is greater than 2 months and the longest flight lasted 109 days. Previous studies (such as those using the effective diffusivity diagnostic, e.g. Haynes and Shuckburgh, 2000; Lee et al 2001) have indicated that there is very weak mixing within the vortex edge region, which acts as a barrier to eddy transport. The studies have further indicated that some mixing occurs in the interior of the vortex. The trajectories of the Vorcore balloons are analysed and their lateral movement as a function of equivalent latitude is determined to ascertain whether or not their motion is consistent with this transport and mixing structure.

Recent work using the effective diffusivity diagnostic in an oceanographic context has developed its use as a quantitative (rather than purely qualitative) diagnostic of eddy diffusivity. New calculations of effective diffusivity for the Antarctic stratosphere, using a passive tracer advected by winds from the ECMWF operational analysis for the time period of the Vorcore campaign are presented. These results are compared quantitatively with those coming from analysis of the balloon trajectories. The implications of the results in the context of ozone chemistry are discussed.

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The impact of the stratosphere on tropospheric climate change

Presenter: Michael Sigmond (sigmond@atmosp.physics.utoronto.ca)

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The atmospheric circulation response to CO_2 doubling in various versions of an atmospheric general circulation model (AGCM) with a poor representation of the stratosphere ('low-top' model) is compared to the response in a version of the same AGCM with a well-represented stratosphere ('high top' model). The doubled CO_2 response of the 'best-tuned' (i.e. operational) low-top model version is significantly different from that in the best-tuned high-top model version. Additional experiments show that this difference is not caused by the model lid height, but instead by differences in the settings of parameterized orographic gravity-wave drag which control the strength of the zonal wind in the mid- to high-latitude lower stratosphere and the mean sea-level pressure distribution. These findings suggest a link between the strength of the winds in the mid- to high-latitude lower stratosphere and tropospheric annular mode responses, and have implications for how to proceed with high top low-top model intercomparisons.

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The sensitivity of modeled climate change to orographic gravity wave drag

Presenter: Michael Sigmond (sigmond@atmosp.physics.utoronto.ca)

M. Sigmond (University of Toronto, Canada),
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Orographic gravity waves significantly influence the mean climate of the lower stratosphere. Since much of the spectrum of these waves can not be explicitly resolved by climate models, their source, propagation and dissipation must be parameterized. While there are a variety of orographic gravity-wave drag (GWD) parameterizations, each seeming to possess parameters unique to their particular formulation, there are one or two key parameters in each that are effectively similar. The value of these parameters should be constrained from observations but this is a non trivial exercise, which to date has left significant freedom in their specification. Therefore, sensitivity of the climate change response to such parameters would represent a significant source of uncertainty for future climate change projections.

In the present study we employ several versions of the Canadian AGCM with different model lid heights to investigate the sensitivity of the doubled CO_2 response to settings in orographic GWD parameterization schemes. Consistent with a previous study (Sigmond et al, GRL, 2008), our results show that in Northern Hemisphere (NH) winter, the pattern of the near-surface circulation response to climate change significantly depends on the GWD efficiency factor, which scales the total amount of momentum launched. This sensitivity to GWD is obtained for all model lid heights, and is demonstrated for two very different orographic gravity wave parameterization schemes. We also find that the Brewer-Dobson Circulation response to climate change is similarly sensitive to the orographic GWD settings, which has implications for the temperature response in the NH polar lower stratosphere, a crucial region for ozone chemistry. We demonstrate that in these simulations the near-surface and stratospheric climate change response sensitivity to the GWD involves interaction between parameterized and resolved waves in these simulations. Potential mechanisms for this interaction will be presented.

ID: 00153 ◀back

Solar influence on tropospheric circulation via the stratosphere

Presenter: Isla Simpson (isla.simpson05@imperial.ac.uk)

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There is increasing evidence that changing solar activity over the 11-year solar cycle influences the Earth's climate. However, as yet the mechanisms involved remain uncertain. One of the main problems is that the observed tropospheric response appears to be too large to be entirely explained by changes in the direct radiative forcing of the troposphere.

With the now widely accepted view that there is a two way dynamical coupling between the stratosphere and troposphere, a possible explanation for the tropospheric response to solar activity is through a dynamical response to the larger heating that occurs in the stratosphere.

A weakening and poleward shift of the mid-latitude jets along with a weakening and expansion of the Hadley cells and poleward shift of the Ferrell cells is found at solar maximum compared to solar minimum in the observations. This is accompanied by a banded increase in temperature in mid-latitudes. Previous results using a simplified general circulation model (GCM) have demonstrated that a similar response in the troposphere to that seen over the solar cycle can be produced by simply heating the stratosphere in the equatorial region. Spin-up ensemble experiments using this simplified GCM have been used to further investigate the mechanisms by which altered stratospheric heating can produce a response in the troposphere. Results suggested that changes in eddy propagation are important in producing the tropospheric response.

We now investigate the cause of the changes in eddy propagation by using the quasi-geostrophic index of refraction. It is found that the change in vertical temperature gradient around the tropopause is primarily what influences eddy propagation along with a contribution from the change in vertical wind shear in response to altered latitudinal temperature gradients in the stratosphere. Furthermore there is a feedback with zonal wind changes in the troposphere also influencing eddy propagation. We then test these refraction ideas by investigating the tropospheric response to stratospheric heating with various tropospheric jet structures. Specifically we look at the effect of introducing a localized storm track and the effect of varying jet latitude and strength.

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What controls the inter-annual variability of Arctic ozone?

Presenter: Björn-Martin Sinnhuber (bms@iup.physik.uni-bremen.de)

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Understanding the processes that control the inter-annual variability of Arctic total ozone during winter and spring is important to predict how the ozone layer will evolve in the coming decades. It is now well accepted that high latitude total ozone during spring is largely controlled by the flux of planetary-scale waves into the stratosphere during mid-winter, as measured by the Eliassen-Palm (EP) flux. E.g., years with low wave activity during mid-winter exhibit reduced poleward and downward ozone transport, enhanced confinement of air masses at high latitudes and low temperatures that favour chemical ozone destruction.

Here we show that the inter-annual variability of Arctic total ozone during March is highly correlated with high latitude ozone in the mid-stratosphere during the previous summer and autumn, based on an analysis of high latitude ozone sonde observations. Moreover, observed mid-stratospheric ozone during summer and autumn is highly correlated with the EP flux during the following February and with stratospheric meteorological conditions (such as polar temperatures or the strength of the polar vortex) in February and March. In order to further investigate the mechanisms involved, we are currently performing an assimilation of long-term satellite ozone observations into a chemical transport model. Although we presently cannot give any definite explanation for the observed persistence of ozone anomalies from summer or autumn to the following spring throughout the winter, this unexpected finding raises the question of what controls the inter-annual variability of meteorological conditions and ozone in the Arctic stratosphere during spring.

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Observations of BrO in the stratosphere and TTL from SCIAMACHY: implications for the transport of very short-lived source gases into the stratosphere

Presenter: Björn-Martin Sinnhuber (bms@iup.physik.uni-bremen.de)

B.-M. Sinnhuber, A. Rozanov, G. Kiesewetter, N. Wieters, J. Burrows (University of Bremen, Germany)

In recent years it has been realized that in addition to long-lived source gases, very short-lived substances (VSLS), mostly of natural origin, contribute significantly to the stratospheric bromine loading. Measurements from SCIAMACHY/ENVISAT provide near global observations of stratospheric bromine monoxide (BrO) profiles for more than 5 years now. Previously we have shown that the SCIAMACHY BrO observations are consistent with a contribution of roughly 5 pptv to the stratospheric bromine loading. Here we will now present the seasonal and inter-annual variability of observed BrO in the stratosphere and tropical tropopause layer (TTL). SCIAMACHY BrO observations in the tropopause region show clear signatures of deep convection with lowest BrO in actively convective regions. These observations will be compared with calculations from our chemical transport model and implications for the transport of very short-lived source gases into the stratosphere will be discussed.

ID: 00052 ◀back

Influence of Stratospheric Potential Vorticity on Baroclinic Lifecycles

Presenter: Louise Smy (lsmy@mcs.st-and.ac.uk)

L.A. Smy, R.K. Scott (University of St Andrews, UK)

We address the question of the dynamical coupling between the stratosphere and the troposphere by considering the effect of perturbations to stratospheric potential vorticity on the evolution of baroclinic instability in the troposphere. In light of observed downward migration of zonal mean stratospheric anomalies and their projection onto the Arctic Oscillation, we give careful attention to the evolution of zonal mean surface patterns during the instability. Our work follows recent studies that have examined the effect of perturbations to stratospheric zonal winds, either through the modification of stratospheric shear or the addition of a stratospheric jet, on the development of baroclinic lifecycles. The crucial difference is that, here, we consider only perturbations to the stratospheric potential vorticity. Our approach is motivated by the observation that stratospheric sudden warmings are essentially a rearrangement of the stratospheric potential vorticity that occurs through wave breaking. We use a continuously stratified quasigeostrophic model in a cylindrical (polar f-plane) domain. The model is simple enough to allow easy initialisation of both zonal and non-zonal potential vorticity anomalies and clear interpretation of dynamical processes, yet captures the main features of baroclinic development. Baroclinic instability is generated by a basic surface temperature gradient and potential vorticity distribution concentrated in a thin horizontal layer at the tropopause, in an Eady-type configuration. We then consider the effect of perturbations to the stratospheric potential vorticity that may be zonal (a crude representation of a strong vortex) or highly asymmetric (a crude representation of a vortex following a sudden warming). Although the background tropospheric winds may change as a result of the stratospheric perturbations, changes to the vertical shear near the tropospheric jet are small. The extreme case in which the stratospheric potential vorticity is exactly zero is used as a control.

Both types of perturbation result in dramatic changes to the baroclinic development of the control case. A modest zonal perturbation changes the character of the surface temperature evolution on synoptic scales and leads to significant changes in the surface winds and tropospheric eddy kinetic energy. These changes are larger than those found in recent studies that confined perturbations to the stratospheric zonal winds. Similarly dramatic changes in the tropospheric evolution are found with asymmetric polar vortex perturbations. In particular, there is a large difference in the tropospheric evolution between the cases with zonal (strong vortex) and asymmetric (sudden warming) perturbations due to the growth of lower wavenumbers, which project strongly onto the zonal mean. We examine the growth of these wavenumbers with Eliassen-Palm fluxes and interpret zonal mean changes in terms of the model counterpart to the Arctic Oscillation.

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Quantifying gravity waves and turbulence in the stratosphere using satellite stellar scintillation measurements

Presenter: Viktoria Sofieva (viktoria.sofieva@fmi.fi)

V.F. Sofieva (Finnish Meteorological Institute, Finland),
A.S. Gurvich (A.M. Oboukhov Institute of Atmospheric Physics, Russia),
F. Dalaudier (Service d'Aeronomie, CNRS, France)
and the GOMOS team (FMI, Finland; Service d'Aeronomie, France;
BIRA-IASB, Belgium; ACRI-ST, France; ESA, Netherlands and Italy)

Stellar scintillations observed through the Earth atmosphere are caused by air density irregularities generated mainly by internal gravity waves (GW) and turbulence. The strength of scintillation measurements is that they cover the transition between the saturated part of the gravity wave spectrum and isotropic turbulence. This allows visualization of gravity wave breaking and of resulting turbulence. We analyzed the scintillation measurements by GOMOS fast photometers on board the Envisat satellite in order to quantify GW and turbulence activity in the stratosphere.

The analysis is based on reconstruction of GW and turbulence spectra parameters by fitting the modeled scintillation spectra to the measured ones. We use a two-component spectral model of air density irregularities: the first component corresponds to the gravity wave spectrum, while the second one describes locally isotropic turbulence resulting from GW breaking and other instabilities. The retrieval of GW and turbulence spectra parameters - structure characteristics, inner and outer scales of the GW component - is based on the maximum likelihood method.

In this presentation, we show global distributions and seasonal variations of the GW and turbulence spectra parameters retrieved from GOMOS data in 2003, for altitudes 30-50 km. In addition, we show global distributions of GW potential energy per unit mass and of turbulent structure characteristic C C_T^2. Since other measurements at such small scales are very scarce in this altitude range, the obtained global distributions provide unique and complementary information about small-scale air density irregularities. At altitudes and locations overlapping with other measurements, the IGW and turbulence parameters retrieved from scintillations are in a good qualitative and quantitative agreement with that obtains from other measurements. Our main findings and observations are:

(i) Strong enhancement of gravity wave activity at high latitudes in winter, accompanying with a strong turbulence appearing at altitudes above 40-45 km; indication on breaking of gravity waves in the polar night jet;

(ii) The turbulent structure characteristic C_T^2 can reach values of 0.003 K^2 $m^{-2/3}$ in high-latitude winter stratosphere; these values are comparable with that in the boundary layer;

(iii) Moderate turbulence enhancements in the tropics, located mainly over continents and related probably to tropical deep convection;

(iv) Increase of GW outer scale in the equatorial region;

(v) Exceptional gravity wave spectra and a very strong turbulence during sudden stratospheric warmings.

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On variability of temperature profiles in the stratosphere: implications for validation

Presenter: Viktoria Sofieva (viktoria.sofieva@fmi.fi)

V.F. Sofieva (Finnish Meteorological Institute, Finland),
F. Dalaudier (Service d'Aeronomie, CNRS, France),
E. Kyrö, R. Kivi (Finnish Meteorological Institute, Finland)

Defining space-time collocation criteria for validation of measurements requires the information about natural variability of geophysical parameters. In this work, we analyzed the variability of small-scale structure of temperature field in the stratosphere using temperature profiles from radio-soundings at Sodankylä with small time difference between sonde launches. We found that the small-scale structures in temperature profiles become different when the horizontal separation of measurements exceeds 20-30 km. The set of the collocated temperature profiles has allowed obtaining experimental estimates of the horizontal structure function of temperature fluctuations. The spectral analysis of the profiles has shown that vertical wavenumber spectra of temperature fluctuations are similar, even for profiles separated significantly in space and in time (a few hundreds of kilometers, a few hours).

Implications of these results for validation of high-resolution profiles are also discussed.

ID: 00400 ◀back

From the IPCC Assessment to Current Research and Back: An Overview of Key Findings and Issues in the Stratosphere and UTLS

Presenter: Susan Solomon (susan.solomon@noaa.gov)

S. Solomon (NOAA, Boulder, USA)

The Intergovernmental Panel on Climate Change (IPCC) has issued a series of comprehensive assessment reports and special reports that have included coverage of key policy-relevant advances in understanding the stratosphere and the upper-troposphere/lower stratosphere. The most recent of these was the IPCC Fourth Assessment Report (2007), and planning has already begun for the IPCC Fifth Assessment cycle. In this talk, relevant key findings of past IPCC assessment reports will be briefly reviewed, and, where appropriate, the ways in which they have been useful to the policy community will be described. Recent research since the 2007 report was completed has identified a range of important new results and emerging issues, and selected highlights of these will be briefly reviewed. Finally, the talk will include a personal perspective on some of the most critical needs and opportunities in future assessments of stratospheric and upper-tropospheric information and research.

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The effect of the stratospheric circulation on the extratropical tropopause inversion layer in a relatively simple GCM

Presenter: Seok-Woo Son (sws2112@columbia.edu)

S.-W. Son, E.P. Gerber, L.M. Polvani (Columbia University, USA)

Idealized GCM integrations have shown that, in the absence of complex radiative-convective processes, the dry dynamics associated with synoptic-scale baroclinic eddies are able to produce an extratropical tropopause inversion layer (TIL). This inversion layer is qualitatively similar to the observations, but somewhat weaker in amplitude and thicker in the vertical. Extending that study, the impact of the stratospheric circulation on the extratropical TIL is examined by introducing a polar vortex and a topographically-induced stratospheric variability in a relatively simple GCM. It is found that the stratospheric circulation tends to slightly weaken and narrow the extratropical TIL in the model winter hemisphere, where the stratosphere is most active. In all integrations, however, the winter TIL in the model is found to be stronger than the one in the summer hemisphere, in stark contrast to observations. While further studies are need, these preliminary results suggest that the stratospheric circulations are not a key player in setting the characteristics of the extratropical TIL. Other physical processes, notably radiation and convection, are likely to play an important role, especially for determining the different TIL structure in the summer and winter hemispheres.

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The Impact of Stratospheric Ozone on the Southern Hemisphere General Circulation: Tropopause, Westerly Jets, and Hadley Cell

Presenter: Seok-Woo Son (sws2112@columbia.edu)

S.-W. Son, L.M. Polvani (Columbia University, USA),
D.W. Waugh (Johns Hopkins University, USA),
J. Perlwitz (Colorado University, USA),
S. Pawson (NASA/GSFC, USA),
and the SPARC CCMVal PIs

The tropopause in the Southern Hemisphere (SH) has been observed to rise in the recent past. At the same time, the westerly jet has been strengthening on the poleward side and Hadley cell has been expanding poleward. These trends in the SH general circulations are predicted to continue in the future by the IPCC AR4 model integrations, and attributed to the combined anthropogenic effects of increasing greenhouse gases and decreasing stratospheric ozone concentrations. In this study, these results are compared with predictions of SPARC CCMVal models in which stratospheric chemistry is fully interactive. The CCMVal models predict strong increase of stratospheric ozone in the 21st century, which is either underestimated or absent in the AR4 models.

The CCMVal models predict that the rising trend of SH tropopause will be much weaker in the 21st century due to ozone-induced stratospheric warming in high latitudes. This warming also affects the trends in westerly jet position and Hadley cell width, especially during SH summer when ozone chemistry is active: CCMVal models predict that the poleward intensification of the westerly jet and poleward expansion of the Hadley cell will be much weaker or even reversed in the future. These results suggest that stratospheric ozone is important for predicting SH climate changes in the troposphere, and should be more carefully considered in the next set of IPCC model integrations.

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Long-Range Transport of Black Carbon in the Tropical Tropopause Layer

Presenter: Ryan Spackman (ryan.spackman@noaa.gov)

J.R. Spackman, J.P. Schwarz, R.S. Gao, L.A. Watts, D.W. Fahey (NOAA, Boulder, Colorado, USA),
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While most black carbon (BC) aerosol is removed in the lower troposphere, a small fraction is lofted to higher altitudes via convection. Measurements of BC mass loadings have now been performed aboard the NASA WB-57F research aircraft during both wet and dry seasons in Costa Rica. In both seasons, BC mass mixing ratios declined sharply with altitude from the ground to approximately 5 km. During the dry season, BC remained nearly constant from the middle troposphere to the lower stratosphere. However, up to 5 times more BC was measured in the tropical tropopause layer (TTL) during the wet season, observed as an increase in BC with altitude from the middle troposphere to the tropopause. These BC enhancements are examined using back trajectories to determine the most recent influence from convection. Preliminary results from this analysis indicate the contribution from long-range transport to the BC enhancement observed in the TTL is larger than that from local convection. These results suggest convective lofting of BC from local pollution sources followed by long-range transport may have a global impact on BC mass loadings in the upper troposphere and lower stratosphere.

ID: 00230 ◀back

Modes of Annular Variability in the Atmosphere and Eddy-Zonal Flow Interactions

Presenter: Sarah Sparrow (s.sparrow@imperial.ac.uk)

S. Sparrow (Imperial College London and University of Reading, UK),
M. Blackburn (University of Reading, UK),
J. Haigh (Imperial College London, UK)

Idealised-forcing experiments have been performed previously using a simplified, Newtonian forced, global circulation model. In each of these experiments, changes to the stratospheric equilibrium temperature distribution lead to changes in the strength and position of the tropospheric mid-latitude jets and storm-tracks and to the extent of the Hadley cells and mean meridional circulation. The work presented here investigates how such shifts in the tropospheric jet can be understood by examining combined fluctuations of the first two modes of annular variability. Attention is paid to the evolution of the flow on different timescales as defined by empirical mode decomposition and related to the autocorrelation timescale for the mode of variability.

At low frequencies the zonal flow and baroclinic eddies are in quasi-equilibrium and anomalies propagate poleward. The eddies are shown primarily to reinforce the anomalous state and are closely balanced by the linear damping, leaving slow evolution as a residual. At high frequencies the flow is strongly evolving and anomalies are initiated on the poleward side of the tropospheric jet and propagate equatorward. The eddies are shown to drive the evolution more strongly. Eddy amplitudes reflect the past baroclinicity and their feedback on the mean flow can be understood in accordance with traditional ideas of baroclinic lifecycle events.

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Internal dynamics of cirrus clouds - a source for ice supersaturation

Presenter: Peter Spichtinger (peter.spichtinger@env.ethz.ch)

P. Spichtinger (ETH Zürich, Switzerland)

The occurrence of cirrus clouds and their potential formation regions, i.e. ice-supersaturated regions in the extra tropics is strongly correlated to large-scale dynamics, i.e. weather systems along their storm tracks (e.g. Wylie and Menzel, 1999; Gierens et al., 2000). The vertical velocities produces by these systems in the upper troposphere are moderate (w < 10 cm/s) but could last for hours. This large-scale feature should form quite homogeneous layer of ice clouds, as sometimes observed. On the other hand, we know from several measurements that these clouds layers often are not homogeneous in terms of ice crystal number density and relative humidity. This points to dynamics on small scale or mesoscale inside cirrus clouds, producing an internal structure. Dynamics on smaller scales depends strongly on the environmental conditions (thermal stratification, wind speed and shear).

On the other hand, the occurrence of persistent high ice supersaturation is still not well understood - high relative humidites wrt ice inside cirrus clouds were measured with many different measurement techniques and it seems that also for the "high" temperature range (T>200 K) this phenomenon could be observed (Peter et al., 2008) . While in many other investigations the focus is on microphysics, in this contribution I will focus on internal dynamics of cirrus clouds.

The dynamics inside cirrus clouds during large-scale ascents (w ~ 5 cm/s) is investigated using different idealized environmental conditions. For this purpose the anelastic non-hydrostatic model EULAG (Smolarkiewicz and Margolin, 1997) together with a recently developed and validated ice microphysics scheme (Spichtinger and Gierens, 2008) is used.

It turns out that dynamics on smaller scales inside cirrus clouds originally triggered by large-scale updrafts also affects the relative humidity distribution inside the clouds. In some cases, high supersaturations inside thick clouds (i.e. cirrus with high ice crystal number densities) could exist as a transition phenomenon. However, these findings partly could explain the high supersaturation puzzle (Peter et al., 2006), at least for mid latitude cirrus clouds.

References:

Gierens, K., U. Schumann, M. Helten, H. Smit, P.-H. Wang, 2000: Ice-supersaturated regions and subvisible cirrus in the northern midlatitude upper troposphere. J. Geophys. Res. 105, 22743-22753.

Peter, Th., C. Marcolli, P. Spichtinger, T. Corti, M. Baker, T. Koop, 2006: When dry air is too humid. Science, 314, 1399-1402.

Peter, T., M. Kraemer, O.Moehler, 2008: Upper Tropospheric Humidity, SPARC/WCRP Newsletter, http://www.atmosp.physics.utoronto.ca/SPARC/Newsletter30Web/index_30.html .

Smolarkiewicz, P., and L. Margolin, 1997: On Forward-in-Time Differencing for Fluids: an Eulerian / Semi-Lagrangian Non-Hydrostatic Model for Stratified Flows. Atmos.-Ocean special 35, 127-152.

Spichtinger, P. and K. M. Gierens: Modelling cirrus clouds. Part 1: Model description and validation. Atmos. Chem. Phys. Diss., 8, 601-686, 2008.

Wylie, D. P. and W. P. Menzel, 1999: Eight years of high cloud statistics using HIRS. J. Climate, 12, 170-184.

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Space-born detection of long-term tropopause trends

Presenter: Paul Staten (paul.staten@utah.edu)

P.W. Staten, T. Reichler (University of Utah, USA)

Accurate determination of the global tropopause is critical to understanding the interaction between atmospheric processes in the stratosphere and in the troposphere. Tropopause structure can both indicate and modulate changes in processes such as the Brewer-Dobson circulation and stratosphere-troposphere exchange. The Global Positioning System radio occultation (RO) technique shows tremendous potential for space-born monitoring of the global tropopause due to its precision, temporal consistency, and global measurement density. This study examines the capability of RO to monitor global long-term tropopause structure and variability by addressing three specific objectives: (1) determine the long-term stability of RO tropopause parameters with respect to those obtained from radiosondes, (2) compare RO tropopause measurements from different RO products, and (3) examine the long-term trends in climatological tropopause parameters. We address these three objectives using data from four different RO missions, including the recent COSMIC mission. Our results demonstrate the precision of RO tropopause data and the importance of consistent processing.

ID: 00215 ◀back

Stratospheric Aerosol Cooling Impacts Accumulated in Oceans

Presenter: Georgiy Stenchikov (gera@envsci.rutgers.edu)

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Sulfate aerosols resulting from strong volcanic explosions last in the lower stratosphere for 2-3 years. Therefore it was traditionally believed that volcanic impacts could produce only short-term transient climate perturbations. However, the ocean integrates volcanic radiative cooling developing disturbances on a spectrum of longer time scales. This study focuses on quantification of long-term ocean-related processes forced in the climate system by explosive volcanism. We employ the coupled climate model CM2.1, developed recently at the NOAA's Geophysical Fluid Dynamics Laboratory (GFDL), to simulate the 1991 Pinatubo and the 1815 Tambora eruptions, which were the largest in the 20th and 19th centuries, respectively. We conduct a few series of ensemble runs accounting for the observed phase of El Niño-Southern Oscillation (ENSO) for each volcano. The simulated anomalies of sea level, surface air temperature, and ocean heat content compare well with available observations for the Pinatubo period. The stronger Tambora forcing produces responses with higher signal-to-noise ratio. Volcanic impact tends to strengthen the meridional overturning circulation. The sea ices appear to be sensitive to volcanic forcing especially during the warm season. The volcanic temperature signals scale roughly linear with respect to radiative forcing. Volcanic impacts on the ocean provide an independent means of assessing climate sensitivity. Because of the extremely long relaxation time of ocean subsurface temperature, sea level, and overturning circulation, their perturbations caused by the Tambora eruption could well last into the beginning of the 20th century.

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Global stratospheric water vapour distributions from MIPAS/Envisat for the period 2002 to 2008

Presenter: Gabriele P. Stiller (gabriele.stiller@imk.fzk.de)

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Vertical profiles of water vapour from the upper troposphere to the stratopause have been derived from MIPAS observations in the full spectral measurement mode (MIPAS-FR, operational from 2002 to 2004) and the reduced spectral resolution measurement mode (MIPAS-RR, operational from 2005 to present). The different measurement modes of MIPAS in combination with various observation geometries are a particular challenge for deriving a self-consistent data set on water vapour, and the measures to ensure this goal will be described. The water vapour profiles were validated versus satellite instruments and various field instruments operated from the ground, on balloons, and on aircrafts. Seasonal and inter-annual variation within the MIPAS water vapour time series will be discussed.

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The GEOS Chemistry Climate Model: Comparisons to Satellite Data

Presenter: Richard Stolarski (Richard.S.Stolarski@nasa.gov)

R.S. Stolarski, A.R. Douglass (NASA Goddard, USA)

The Goddard Earth Observing System Chemistry Climate Model (GEOS CCM) has been developed by combining the atmospheric chemistry and transport modules developed over the years at Goddard and the GEOS general circulation model, also developed at Goddard. We will compare model simulations of ozone, and the minor constituents that affect ozone, for the period around 1980 with newly-released revised data from the Limb Infrared Monitor of the Stratosphere (LIMS) instrument on Nimbus 4. We will also compare model simulations for the period of the early 2000s with the data from the Microwave Limb Sounder (MLS) and the High Resolution Dynamic Limb Sounder (HIRDLS) on the Aura satellite. We will use these comparisons to examine the performance of the model for the present atmosphere and for the ozone loss that has occurred during the last 2 decades due to chlorine and bromine compounds released from chlorofluorocarbons and halons.

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Evaluation of stratospheric transport in chemistry climate models

Presenter: Susan Strahan (susan.e.strahan@nasa.gov)

S. Strahan (University of Maryland, USA),
J. Neu (University of California Irvine, USA)

Chemistry climate models (CCMs) representing the stratospheric ozone layer are key tools for the detection, attribution and, especially, prediction of the response of stratospheric ozone to ozone-depleting substances and other factors. It is essential that we quantitatively assess the confidence that can be placed in the CCMs. Here we summarize our efforts to evaluate the representation of stratospheric transport processes in CCMs. This work supports the SPARC report on the evaluation of Chemistry Climate Models.

The wealth of satellite (e.g., from UARS and Aura) and aircraft measurements of species such as H_2O, CH_4, and N_2O that has become available over the past 2 decades has allowed the development of observationally-derived diagnostics for many aspects of stratospheric transport such as the formation, maintenance, location, and strength of transport barriers, and tropical ascent and polar descent rates. Many of these diagnostics were developed as part of the SPARC Chemistry Climate Validation project, CCMVal*. Here we apply them to a large number of CCM simulations of present day and future climate scenarios. Objective criteria are developed for each diagnostic that evaluate the credibility of model representation of a particular process or phenomenon with respect to observations. Each participating CCM is evaluated with the same set of criteria. Some of the process-oriented diagnostics used in this effort include:

1. Propagation of the water vapor tape recorder phase - assesses tropical ascent rate
2. Propagation of water vapor tape recorder amplitude - assesses horizontal mixing in the subtropical lower stratosphere
3. Mean age at 20 km - is an integrated measure of stratospheric circulation
4. Tropical-extratropical CH_4 pdfs - assesses horizontal mixing into the tropical pipe in the middle stratosphere
5. Polar descent and isolation using CH_4 pdfs - assesses model ability to create and maintain a chemically perturbed vortex in winter and spring
6. Upper boundary for the UT/LS (N_2O) - assesses the effect of the residual circulation on the seasonally varying composition of the lower stratosphere

These diagnostics provide insight into the strengths and weaknesses of model representation of many different transport processes and may also provide feedback for model improvements. For the purposes of the SPARC model evaluation report, this work contributes to the assignment of uncertainty in each participating model's predictions. The overall goal is to reduce the combined model uncertainty in prediction of the stratospheric response to changing composition and climate.

* CCMVal: http://www.pa.op.dlr.de/CCMVal/CCMVal_EvaluationTable.html

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Changes in tropospheric chemistry and their impacts on climate: roles of climate change and the stratosphere

Presenter: Kengo Sudo (kengo@nagoya-u.jp)

K. Sudo (Nagoya University, Japan)

This talk will introduce our chemistry-climate model simulations of global tropospheric ozone and related species, particularly focusing on their relationships with climate change and stratospheric ozone change. In the past simulation (hindcast) for the 20th century, tropospheric ozone largely increases due to precursors emissions increases. This emission-induced ozone increase is, however, significantly reduced by the decreased ozone input from the stratosphere associated with the stratospheric ozone depletion during 1970s to 2000, which is well in line with the ozone soundings; the STE ozone flux decreased by about 40% in this study. Climate change during this time period appears to play a minor but significant role in ozone change as well. Future simulations (projection) show that both climate change (warming) and stratospheric ozone change (ozone recovery), expected during the 21st century, have large impacts on tropospheric ozone chemistry including time evolution of methane for any emission scenarios (SRES B1, A1, and A2).

For examining the impacts of global ozone changes on climate, we study the climate response to changes in global tropospheric and stratospheric ozone (O_3) distributions from preindustrial times (PI) to the present day (PD) through a set of model simulations. We performed distinct scenario experiments to isolate the impacts of (1) increases in long-lived GHGs (LLGHGs), (2) emission-induced increase in tropospheric ozone (TOZ), and (3) halogen-induced decrease in stratospheric ozone (SOZ). Climatologies of the global O_3 distributions in PI and PD for each of TOZ and SOZ are generated using the chemistry climate model CHASER with PI and PD precursor emissions and halogen loading. In the simulation, tropospheric O_3 burden increases by ~10 DU (0.49 W m^{-2} radiative forcing) up to the present due to the emission increases (TOZ), but decreases by ~1 DU due to the halogen-induced O_3 depletion (SOZ). As an equilibrium response, the emission-induced O_3 increase (TOZ) causes a global and annual mean surface temperature increase of 0.29ºC (NH: 0.31, SH: 0.27ºC), equivalent to 13% of the estimated LLGHGs impact (2.29ºC). Responding to TOZ, particularly large warming occurs in North America, Middle East, and Asia, apparently reflecting the spatial distributions of the radiative forcing from TOZ. Our sensitivity simulation with evenly distributed TOZ increase suggested that such inhomogeneous warming response largely reflects the horizontal pattern of the tropospheric O_3 increases as well as inherent sensitivity of the climate model. The SOZ decrease, causing decreases in long-wave heating and O_3 input to the troposphere, leads to a surface cooling of -0.06ºC. Both TOZ and SOZ cause cooling in the lower to middle stratosphere (0.5-1.0ºC). LLGHGs also cool the middle to upper stratosphere, but warm the lower stratosphere in the extratropics due to adiabatic heating associated with the enhanced Brewer-Dobson circulation.

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Temporary denitrification in the Antarctic stratosphere as observed by ILAS-II in the 2003 early winter: Comparison with a microphysical box model

Presenter: Takafumi Sugita (tsugita@nies.go.jp)

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To examine the characteristics of polar stratospheric clouds (PSCs) in the Antarctic, we have analyzed short-time (within 5 days) changes in nitric acid (HNO_3) and aerosol extinction coefficient (AEC) at 780 nm, focusing near 20 km altitude in June 2003 as observed by the Improved Limb Atmospheric Spectrometer (ILAS)-II. The Match technique based on the air parcel trajectory was applied to the ILAS-II data. The several Match pairs have revealed decreased HNO3 values with increased AEC values within the short times, indicating temporary denitrification. It is also suggested that the observed PSCs could be nitric acid trihydrate (NAT) particles, considering that the temperatures were above existence temperatures for supercooled ternary solution (STS), but below those for NAT. Given appropriate size distributions for NAT particles, it is suggested that the median radius of particles was less than 3 micron.

For these cases where temporary denitrification by NAT particles were found, a Lagrangian microphysical box model (including nucleation, growth, and sedimentation) was used to calculate the temporal changes in HNO_3 along the Match trajectories. The model utilizes a mechanism that nucleation of nitric acid dihydrate (NAD) on STS droplet surfaces takes place and then instantaneous conversion of NAD nuclei into NAT occurs. A parameterization for the free energy of NAD nucleus formation on the STS surfaces will be discussed from a view point of HNO_3 variations between measurement and model results.

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Climatic variability of the stratospheric dynamics: results of simulation and data analysis

Presenter: Ekaterina Suvorova (ev-suvorova@yandex.ru)

E. Suvorova, E. Savenkova, A. Kanukhina, A. Pogoreltsev (RSHU, Saint-Petersburg, Russia)

The climatic variability of stationary and traveling planetary waves in the lower stratosphere has been investigated using the data of NCEP/NCAR reanalysis. The results obtained show that during the last decades winter-time averaged geopotential height amplitude of the stationary planetary wave with zonal wave number 1 (SPW1) increases at the higher-middle latitudes of the northern hemisphere. It was suggested that the SPW1 amplitude increase should be accompanied by the growth in the amplitude of the stratospheric vacillations. To investigate a possible climatic change of the stratospheric dynamics, two sets of runs (using zonally averaged temperature distributions in the troposphere observed in January 1960 and 2000) with the Middle and Upper Atmosphere Model (MUAM) were performed. The results obtained show that in averaged the calculated amplitude of the SPW1 increased during the last decades and there is also an increase of its intraseasonal variability conditioned by nonlinear interaction with the mean flow. The analysis of the SPW1 behavior in the NCEP/NCAR data set supports these calculations and shows a noticeable increase in the amplitudes of SPW1 variability. However, in spite of the rise in the amplitudes of stratospheric vacillations, the amplitudes of the normal atmospheric modes, the so-called 10- and 16-day waves, diminish. It is supposed that one of the possible reasons for this decrease is the growth of the radiative damping rate caused by CO_2 content increasing. It is noted that observed increase in the amplitudes of stratospheric vacillations during the last decades indicates that stratospheric dynamics becomes more stochastic. These irregular oscillations of the SPW1 and mean flow in the stratosphere can be extended into the troposphere as it was demonstrated in the latest papers on the stratosphere-troposphere coupling.

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The Heterogeneous Interactions of Halogenated and non Halogenated Organic Molecules with Ice Surfaces at Temperatures of the Upper Troposphere (UT)

Presenter: Angela Symington (ams85@cam.ac.uk)

A. Symington, M.A. Fernandez, L.M. Leow, R.A. Cox (University of Cambridge, UK)

Cirrus clouds are high altitude clouds that consist mainly of ice particles that reside in the Upper Troposphere (UT). Because cirrus clouds provide the largest surface area in the UT, trace gas-ice interactions are important. The amount of trace gases scavenged scales with both the surface area of the clouds and the reactivity of the molecule with the surface.

These interactions have attracted attention in recent years because there is strong evidence from both field measurements and laboratory experiments that ice clouds can scavenge trace gases and support chemical reactions. These processes can modify the chemical composition and can consequently play a role in ozone and hydroxyl radical budgets in the UT.

In this work, the interactions of small organic molecules with ice have been investigated using a coated wall flow tube coupled to a mass spectrometer to investigate molecular properties affecting uptake. Results will be presented showing the correlation of partition coefficients with pKa.

ID: 00037

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Is There a Statistical Connection between Stratospheric Sudden Warming and Tropospheric Blocking Events?

Presenter: Masakazu Taguchi (mtaguchi@auecc.aichi-edu.ac.jp)

M. Taguchi (Aichi University of Education, Kariya, Japan)

This study presents statistical analyses of possible associations between stratospheric sudden warming (SSW) and tropospheric blocking events in the Northern Hemisphere using NCEP-NCAR reanalysis data from 1957/58 to 2005/06. Existing definitions are used to identify the SSW and blocking events. Using a random shuffling, or bootstrap, method, our analyses have explored a first hypothesis that blocking events with amplifying planetary waves (PWs) in the middle troposphere occur preferentially and last longer in a pre-SSW period. A similar hypothesis is also examined for regional blocking events as a whole in a post-SSW period (hypothesis 2). Hypothesis 1 comes from the conventional idea about possible ability of blocking events to increase PW activity entering the stratosphere. Hypothesis 2 is based on the observations of post-SSW tropospheric anomalies like the negative phase of the Arctic Oscillation (AO), and the greater frequency of blocking days during the negative phase of the AO.

Our shuffling tests, in which the SSWs are randomly redistributed to evaluate statistical significance of linked cases in the original data, do not overall support either hypothesis when treating the 30 major SSWs all together. This suggests that such hypothesized associations are not dominant for all of the SSWs, even if some specific cases may have demonstrable linkages.

To better understand the nonsupport of hypothesis 1, we examined PW properties in comparison to the occurrence of SSW and blocking events. The results suggested that occurrence of blocking events is related too weakly to PW activity entering the stratosphere to make hypothesis 1 significant. As for the nonsupport of hypothesis 2, it is suggested that the occurrence of blocking events is related only weakly to AO variability, whereas post-SSW anomalies at the surface are also variable in terms of the AO index.

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Seasonal persistence of northern low and middle latitude anomalies of ozone and other trace gases in the stratosphere

Presenter: Susann Tegtmeier (susann@atmosp.physics.utoronto.ca)

S. Tegtmeier, V.E. Fioletov (Environment Canada, Toronto, Canada),
T.G. Shepherd (University of Toronto, Canada)

Analysis of observed ozone profiles in northern hemisphere midlatitudes reveals the persistence of ozone anomalies throughout the year in both the lower and upper stratosphere. Principal Component Analysis was used to detect that above 16 hPa the persistence is strongest in the latitude band 15ºN-40ºN, while below 16 hPa the strongest persistence can be seen over 45Nº-60ºN. In both cases, ozone anomalies persist through the entire year from November to October. The persistence of ozone anomalies in the lower stratosphere is presumably related to the wintertime ozone buildup with subsequent photochemical relaxation through summer until autumn, as previously found for total ozone. The persistence in the upper stratosphere is more surprising, given the short lifetime of Ox at these altitudes. It is hypothesized that this 'seasonal memory' in the upper stratospheric ozone anomalies arises from the persistence of transport-induced wintertime NOy anomalies, which perturb the ozone chemistry throughout the rest of the year. This hypothesis is confirmed by analysis of observations of NO_2, NOx, and various long-lived trace gases in the upper stratosphere, which are found to exhibit the same seasonal persistence. A similar persistence of upper stratospheric ozone anomalies has been found for the southern hemisphere.

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Observation of a tongue pulled out from the Antarctic vortex edge due to barotropic instability

Presenter: Hector Teitelbaum (teitel@lmd.ens.fr)

H. Teitelbaum (Laboratoire de Meteorologie Dynamique, Paris France),
M. Moustaoui (Arizona State University, USA)

During the VORCORE campaign, 27 superpressure balloons were launched in the southern polar vortex at altitudes of 16-19 km. On November 25, one balloon was advected out of the vortex through a tongue expelled from the edge. Using the ECMWF analysis the evolution of the tongue is studied.It is shown that few days before, the necessary conditions for barotropic instability exist. The role of the barotropic instability in the formation of the tongue is supported by using a two dimensional barotropic model.The model show that a circumpolar vortex perturbed by a localized cyclonic anomaly at its edge, develops a tongue in a region where the necessary conditions for barotropic instability are satisfied.

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Reassessment of the Atmospheric Response to the Pinatubo eruption using a nudged CCM

Presenter: Paul Telford (paul.telford@atm.ch.cam.ac.uk)

P. Telford, Peter Braesicke, O. Morgenstern, J. Pyle (University of Cambridge, UK)

The eruption of the Pinatubo volcano resulted in the largest stratospheric aerosol loading in the twentieth century. This produced significant temperature and ozone deviations in the stratosphere and global cooling in the troposphere. Ozone concentrations in the lower stratosphere were affected by changes in temperatures, the mean circulation and the extent of heterogeneous activation of ozone-destroying species.

We investigate intra-seasonal deviations in ozone and dynamics using a nudged version of the new UKCA model. The UKCA model combines the Met Office's New Dynamics Unified Model with a new description of chemistry. Nudging constrains the model using the ERA-40 analysis data to reproduce the observed meteorology from 1990 onwards.

The nudging will allow the post-Pinatubo temperature excursion and associated changes in circulation to be reproduced. The strength of nudging required to produce these excursions will be studied to quantify the volcanic impact. The effect of these anomalies, and of the increased aerosol loading, on ozone will be studied and comparisons will be made to observations.

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Particle microphysics in the UTLS region and its association with the prevailing dynamics

Presenter: Bijoy Thampi (bijoyvthampi@yahoo.com)

A. Bijoy V. Thampi, B. S V Sunilkumar, C.K. Parameswaran (Indian Space Research Organisation, Trivandrum, Kerala, India)

Properties of suspended particulate in the Upper Troposphere-Lower Stratosphere (UTLS) region which play a key role in climate and chemistry is governed mostly by the exchange process between stratosphere and troposphere, transport, microphysics and chemical processes. They strongly contribute to the stratospheric radiative balance by scattering and absorbing the solar radiation and also acting as a precursor to the catalytic destruction of ozone in the lower stratosphere. Most of the available information on the properties of these particles are from satellite borne sensors which though has a very good global coverage lacks temporal and spatial resolutions. In the present study, the characteristics of particulate matter (which include fine aerosols as well as ice crystals of thin cirrus clouds) in the UTLS region are examined using a dual polarization lidar (laser wavelength: 532 nm) from a tropical station Gadanki [13.5N, 79.2E]. Altitude profiles of particulate extinction coefficient, backscatter coefficient, volume depolarization ratio etc. estimated from the lidar data during the period 1998-2003 are used for studying the seasonal/annual variation of these parameters in the UTLS region. Particulate extinction in this region shows a prominent annual variation with high values during winter and summer months. In the lower stratosphere (LS) it also shows a prominent peak during the April-June period followed by a secondary peak during winter months of November-January, with a clear minimum during the S-W monsoon period. In the UT region the mean particulate extinction shows a minimum during the July to October period. An interesting feature observed is the prominent peak in particulate extinction in the LS region during May associated with a sharp dip in the UT region. The volume depolarization ratio (VDR) in the LS also shows a pronounced seasonal variation with a prominent peak during the summer monsoon period notwithstanding a small secondary peak during the dry (winter) months and minimum values during April and November. Large values of VDR (>0.04) in UT can mainly be attributed to the presence of highly non-spherical ice crystals (in the prevailing cirrus). An excellent similarity is observed in the annual variation of VDR and Convective Available Potential Energy (CAPE) which indicates that high VDR in the UT region during southwest monsoon period is associated with cirrus particles originated from convective anvils. The mean extinction coefficient just below the tropical cold point tropopause also shows a similar variation to that of CAPE. Strength of tropospheric convection which can also be assessed based on OLR, choosing a threshold value of 200 W m^{-2} which when declines is treated to be associated with deep convection. With this condition, the frequency of occurrence of such low OLR in different months is used as an indicator of the strength of prevailing convection in the troposphere. The annual variation of this frequency of occurrence also shows a peak during SW monsoon period. Low values of VDR in the UT during dry months indicate the paucity of non-spherical ice crystals. Values of VDR and its day-to-day variation in the LS is more during the southwest (SW) monsoon period when semitransparent cirrus with high VDR prevails in UT.

The value of VDR shows a steady decrease with increase in altitude in the LS region implying a decrease in particle non-sphericity with increase in altitude. The vertical mass flux estimated from vertical wind data of MST radar also showed a pronounced seasonal variation in the UTLS region. The temporal variation of mean aerosol extinction compares favorably with that of the mass flux indicating the role of dynamics in governing the seasonal variation of aerosol properties in this region.

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Simulation of the dynamical response after volcanic eruptions- The challenge remains!

Presenter: Manu Anna Thomas (manu.thomas@zmaw.de)

M.A. Thomas (University of East Anglia, Norwich, UK),
C. Timmreck, M.A. Giorgetta (Max Planck Inst. for Meteorology, Hamburg, Germany),
H.-F. Graf (Cambridge University, UK),
G. Stenchikov (Rutgers – The State University of New Jersey, USA)

Volcanic radiative forcing causes significant changes in stratospheric and tropospheric circulation patterns producing global and regional climate effects. One of the major impacts of the tropical eruptions is the dynamical response produced at the surface in the high latitudes in the winter hemisphere associated with the strengthening of the polar vortex. This feature is observed for two winters following the eruptions. The previous studies carried out so far are not able to simulate this response realistically (including the IPCC models). In this study, for the first time, attempts are made to simulate this dynamical response after Mt. Pinatubo eruption including all the known factors such as volcanically produced ozone anomalies, observed sea surface temperatures and the observed phase of quasi biennial oscillation. For this, the middle atmosphere version of the general circulation model, MAECHAM5.4 is employed to carry out ensemble simulations in both T42L39 and T42L90 resolutions. In this study, the model is forced by zonally averaged values of aerosol extinction, single scattering albedo and asymmetry parameter on the model grid. Our results show that even after considering all the factors realistically and increasing the vertical resolution, the model could not simulate the dynamical response accurately. The possible reasons and further improvements needed to simulate this response realistically are also discussed.

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Consistency of Stratospheric Aerosol Measurements and Modeling: Results from ASAP and Beyond

Presenter: Larry Thomason (l.w.thomason@nasa.gov)

L. Thomason (NASA LaRC, Hampton, VA, USA),
T. Peter (ETH, Zürich, Switzerland),
D. Weisenstein (AER, Cambridge, USA),
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T. Deshler (University of Wyoming, Laramie, USA)

Measurements and modeling of stratospheric aerosol were extensively compared in SPARC's Assessment of Stratospheric Aerosol properties. ASAP focused on long-term space-based (e.g., SAGE II and HALOE) and in situ (e.g., the University of Wyoming OPC) measurement data sets. These systems measure some but not all, aspects of the complex aerosol composition-size system. Key chemical/radiative properties are inferred to varying degrees from the measured quantities. The models included both 2-d (e.g., the AER model) and 3-d models that follow the formation, transport, and ultimate loss of aerosol from the stratosphere. Since these models produce detailed aerosol composition and size distribution information, geophysical physical parameters can be directly computed. This presentation will highlight the results of ASAP and more recent studies that provide an assessment of how well parameters derived from the measurements and models agree particularly during low aerosol loading periods.

We find that, while broad consistency was observed between these data sets, depending on the parameter compared, noteworthy differences between various observations as well as models exist. We will present analyses that illuminate these differences. For instance, a thorough evaluation of the ability to derive aerosol surface area density (SAD) using SAGE II observations has been completed. This indicated that there is an inherent uncertainty on the order of a factor of two in these estimates during low aerosol loading periods. Similarly, we find that the change in the number of channels available (from 3 to as many as 11) in OPC measurements impacts inferences of some bulk properties including SAD. Models generally produce significantly higher SAD values (by factors as large as 3) than SAD inferred from the space-based instruments. This is not surprising since it is well known that these instruments are insensitive to small particles that can significantly contribute to the bulk SAD. At the same time, the models tend to over-estimate some measured bulk quantities (e.g., extinction) by somewhat smaller factors (~50%) so the final interpretation of the model-measurement comparisons remain problematic.

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Latitudinal and longitudinal gradients in GW/KW signatures in the TTL Inferred from Ozonesondes

Presenter: Anne Thompson (anne@met.psu.edu)

A.M. Thompson, S. Lee , S.K. Miller, A. Loucks (Penn State University, USA),
G.A. Morris (Valparaiso University, USA),
H. Voemel (CIRES, NOAA, USA)

Ozone laminae in the free troposphere and lower stratosphere are remarkably persistent and have been used to infer the presence of wave activity in sonde profiles. With the Laminar Identification (LID) method of Thompson et al. (2007; after Teitelbaum et al, 1994; Pierce and Grant, 1998), applied to 9 years of SHADOZ data, indices for gravity wave/Kelvin wave (GW/KW) are developed to evaluate wave influence throughout the troposphere and lower stratosphere (Loucks, 2007). GW/KW maximize in the TTL (13-17 km) , occurring in 20-80% of profiles, depending on location and time of year. In the Southern Hemisphere, wave activity is greatest: (1) during October-February (wetter, spring-summer); (2) near the equator, decreasing with latitude; (3) over the western Pacific and eastern Indian Ocean, with a minimum over the Atlantic.

The above wave activity characteristics are consistent with the spatial structure of the equatorially trapped Kelvin wave, a class of gravity waves. A recent theoretical and modeling study (Ryu et al. 2008) finds (1) that equatorially trapped Kelvin waves play a central role in intraseasonal time-scale fluctuations of TTL temperature, and (2) that these Kelvin waves attain the largest amplitude over the western Pacific and in the TTL, as in the LID diagnostics. This spatial variation in the Kelvin wave amplitude arises through wave modulations caused by zonal and vertical variations in the climatological DJF background state.

In addition to the SHADOZ record, broadly consistent patterns of GW/KW waves activity have been identified in soundings from recent tropical and sub-tropical campaigns (SOWER, CR-AVE, IONS-06, TC4).

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Ubiquity of the Stratospheric Influence in Mid-latitude Tropospheric Ozone: Evidence from North American Ozonesondes (IONS, 2004-2008)

Presenter: Anne Thompson (anne@met.psu.edu)

A.M. Thompson (Penn State University, USA),
J.E. Yorks (Penn State University, now at SSAI, Lanham, USA),
S.K. Miller, A. Luzik (Penn State University, USA),
J.C. Witte (SSAI, Lanham, USA),
S.J. Oltmans (NOAA/ESRL/GMD, Boulder USA),
D.W. Tarasick, Environment Canada Toronto, Canada)

Ozone soundings integrate models, aircraft and ground-based measurements for better interpretation of atmospheric losses (stratosphere) and pollution (troposphere) while validating satellite measurements. A well-designed network of ozonesonde stations answers questions about mechanisms and variability not possible with short-term aircraft campaigns or current satellite technology. Short-term strategic ozonesonde networks operated over North America in July-August 2004 within the ICARTT/INTEX-A/NEAQS (International Consortium on Atmospheric Research on Transport and Transformation)/Intercontinental Chemical Transport Experiment/New England Air Quality Study), during the 2006 INTEX-B (INTEX Ozonesonde Network Study/MILAGRO (Megacities Initiative: Local and Global Research Observations) (<http://croc.gsfc.nasa.gov/ intexb/ions06.html>), in the TEXAQS/GOMACCS (Texas Air Quality Study/Gulf of Mexico Atmospheric Composition and Climate Study; August 2006) and the ARCTAS IPY-related experiment in 2008 (<http://croc.gsfc.nasa.gov/arcions>. Tropospheric ozone budgets are determined for each sounding using the laminar identification method [Thompson et al., 2007; after Teitelbaum et al., 1994] in which free tropospheric ozone is assigned to stratospheric (ST) sources, convective redistribution of ozone and/or its precursors, including lightning (RCL); advected pollution and background amounts (AD). Stratospheric ozone is surprisingly robust, 20-25%, on average, of the tropospheric ozone column in mid-latitude summertime sondes. On º of days sampled for pollution, free tropospheric ozone ST fractions exceed 0.4. Day-to-day variability in ozone sources is illustrated, and comparisons of ST amounts over the various IONS campaigns are made at prototype locations (Trinidad Head, California; Beltsville, Maryland; Rhode Island; BC and Nova Scotia; Houston). The UT/LS is examined in the context of meteorological analyses.

ID: 00300 ◀back

The role of tropospheric dynamics in stratosphere/troposphere coupling

Presenter: David Thompson (davet@atmos.colostate.edu)

D. W. J. Thompson (Colorado State University, Fort Collins, Colorado, USA)

In this talk, I will review our current understanding of the internal tropospheric dynamics that play a key role in stratosphere/troposphere coupling. I will review the dynamics of large-scale patterns of tropospheric variability and discuss how stratospheric processes project onto those dynamics. I will review the key processes thought to underlie the tropospheric dynamical response to stratospheric variability. And I will argue that a complete theory for stratosphere/troposphere coupling can not be developed without a more complete understanding of the relevant internal tropospheric dynamics. I will conclude with thoughts on key avenues for future research.

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Toward an aircraft in situ data based chemical tracer climatology for model evaluation in the UTLS region

Presenter: Simone Tilmes (tilmes@ucar.edu)

S. Tilmes, Laura Pan, D. Kinnison, A. Gettleman (NCAR, Boulder, USA)

The representation of chemical transport processes that couple the upper troposphere (UT) and lower stratosphere (LS) in CCMs is a key component for the models to simulate future climate scenarios. The aircraft in situ data are important resources for model diagnostics and constraints. Yet the use of the sparsely sampled data with global climate models is not straightforward. Here we propose a method form a climatology of aircraft data for the model evaluation in the UTLS region.

The method we introduce uses the tropopause height to separate UTLS data in to tropical, sub-tropical and extra-tropical / polar regions. This separation is consistent with the characteristics of the underlying transport characteristics. This criterion is applied to various aircraft observations to establish a climatology. Using this climatology based on aircraft observations, we discuss differences of relative altitude of O_3, CO and H_2O, and the O_3/CO and O_3/H_2O tracer-tracer correlations in different regions and seasons. As a result of the different characteristics between the two tropospheric tracers, CO and H_2O, we are able to separate the influence of horizontal and vertical mixing processes in sub-tropics and extra-tropics. Results are compared to four different WACCM3 model simulations to explore the importance of horizontal and vertical resolution, and the chemical description (with or without a detailed tropospheric description) in the model simulations.

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Impact of the 1991 Mt. Pinatubo Eruption on the Hydrological Cycle with Implications for Geoengineering

Presenter: Claudia Timmreck (claudia.timmreck@zmaw.de)

C. Timmreck, S. Hagemann, M. Esch, H. Graf, J. Jungclaus, F. Landerer, H. Schmidt, M.A. Thomas (Max Planck Institute for Meteorology, Hamburg, Germany)

In the last years the discussion of geo-engineering actions to reduce the magnitude of future climate change has intensified. One geo-engineering strategy that has recently received considerable attention is the artificial increase of the stratospheric aerosol loading to reduce the amount of incoming solar radiation absorbed by the Earth. Large volcanic eruptions are a good analogue for this albedo enhancement strategy. In particular the June 1991 Mt. Pinatubo eruption serves as a good test bed to investigate possible side effects as it was the best observed eruption that ever happened. After the Mt. Pinatubo eruption not only a decrease in surface air temperature, atmospheric water vapor and sea level have been observed but also a substantial decrease in runoff and in precipitation over land. During the winter following the Mt. Pinatubo eruption an El Niño took place. It is currently uncertain to what degree this has influenced the response to high stratospheric aerosol loading. Hence, we have carried out a series of Mt. Pinatubo experiments with a fully coupled Atmosphere-Ocean GCM (ECHAM5/MPIOM) to improve our current understanding of the impact of a large stratospheric sulphur loading on the hydrological cycle. The volcanic forcing is calculated online in the model using a realistic space-time distribution of aerosol optical parameters derived from satellite observations. Here, we present results of ensemble simulations for Pinatubo-like eruptions occurring during different states of the ocean circulation: before the onset of an El Niño, during an El Niño event, and for a climatological mean state. The discussion includes changes in radiation, temperature and the hydrological cycle (precipitation, trans-/evaporation, run off , atmospheric water vapor content).

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The Climate Impact of very Large Volcanic Eruptions: An Earth System Model Approach

Presenter: Claudia Timmreck (claudia.timmreck@zmaw.de)

C. Timmreck and Super Volcano Group (Max Planck Institute for Meteorology, Hamburg, Germany)

Very large volcanic eruptions constitute extremely strong forcing to the Earth System, which can affect it for longer times than the pure residence time of the volcanic aerosol in the atmosphere. Depending on the location of the volcano these effects can be global or hemispheric. In the case of a very large eruption, volcanic sulphate aerosol can persist in the stratosphere for several years up to a decade, scattering incoming radiation back to space and absorbing outgoing longwave radiation. This will lead to large negative temperature anomalies at the surface and significant warming of the aerosol containing layers altering substantial atmospheric and ocean circulation and composition. Simulations of past historic eruptions show that the ocean heat content is reduced after large volcanic eruptions, and that these anomalies can persist for decades. Dominantly cooler surface temperatures, as expected for a few years after a super eruption, might alter dramatically the terrestrial and marine biosphere, necessarily impact vegetation, especially tropical rain forests, and have at least a transient effect on the carbon and other biogeochemical cycles. Analyzing and understanding the climate effects of a very large volcanic eruption is a quite difficult task due to the various complex interactions between chemical, microphysical, dynamical and biological processes affecting the whole suite of processes (ocean, atmosphere, chemistry, land surface, vegetation, cryosphere, carbon cycle etc.). Hence, the simulation of a very large volcanic eruption requires the full complexity of an Earth system model. Here we present simulations of very large volcanic eruptions; the unknown 1258, the largest eruption in the last 10,000 years and a Northern Hemisphere mid-latitude super eruption (Yellowstone) with a fully coupled Earth system model. The volcanic climate impact is investigated by analyzing changes in atmospheric and ocean dynamics, the hydrological and the carbon cycle, marine bioproductivity and terrestrial vegetation.

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Ozone Enhanced Layers in the Antarctic Ozone Hole

Presenter: Yoshihiro Tomikawa (tomikawa@nipr.ac.jp)

Y. Tomikawa (NIPR, Tokyo, Japan) and K. Sato (University of Tokyo, Japan)

Ozone enhanced layers observed inside the Antarctic ozone hole were investigated using ozonesonde data at Syowa and Neumayer Stations during the ozone hole recovery period in 2003. The ozone enhanced layers observed between 14 and 19 km in the lower stratosphere always had a thickness thinner than 1.6 km. Maximum ozone mixing ratios in the ozone enhanced layers suggested that the layers had their origin in the vortex boundary region. A reverse domain filling analysis indicated that air parcels originating in the vortex boundary region reached Syowa and Neumayer Stations in a form of horizontally-thin filaments. These filamentary structures were generated through chaotic advection due to transient planetary-scale Rossby waves, and became thin also in the vertical because of the vertical shear of horizontal wind. A contribution of the ozone enhanced layers to the ozone hole recovery was estimated at 4 DU or less, which is much smaller than the ozone hole recovery due to the downward transport of ozone-rich air associated with the Brewer-Dobson circulation.

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Surface UV simulations in the 21st century

Presenter: Kleareti Tourpali (tourpali@auth.gr)

K. Tourpali, A.F. Bais, A. Kazantzidis (Aristotle University of Thessaloniki, Greece)

The total ozone columns and vertical profiles of ozone and temperature from coupled Chemistry-Climate Models (CCMs) are used to project future solar ultraviolet radiation levels at the surface in the 21st century. The CCM simulations are used as input to a radiative transfer model to calculate future UV irradiance levels under cloud free conditions. Time series of monthly erythemal irradiance received at the surface during local noon are produced for the period 1960 to 2100.

Future UV levels are likely to be affected by factors influenced by climate change, such as cloudiness, surface albedo and aerosols. Here we estimate the effect of cloudiness changes through the 21st century, from simulations of the General Circulation Models (GCMs) used in the IPCC AR4. The Cloud Modification Factor is derived from the GCM shortwave radiation under clear skies and all sky conditions. Changes in albedo from the same source are also taken into account in the radiative transfer calculations.

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Characteristics of Atmospheric Waves in the Stratosphere Revealed by GPS Radio Occultation (RO) Temperature Data

Presenter: Toshitaka Tsuda (tsuda@rish.kyoto-u.ac.jp)

T. Tsuda, S. Alexander (RISH, currently at Australian Antarctic Division, Japan),
Y. Kawatani (Frontier Research Center for Global Change, JAMSTEC, Japan)

The GPS radio occultation (RO) is an active limb-sounding satellite measurement, which provides an accurate temperature profile below about 40 km. The GPS RO is characterized by a good height resolution, comparable to a radiosonde, and they are particularly valuable in the region where routine balloon soundings are sparse, such as the tropics and polar regions.

Using the GPS RO data obtained with the German CHAMP satellite during 2001-2006, we studied climatological characteristics of atmospheric gravity wave energy (temperature variance) in the polar region, and discussed wave generation due to geostrophic adjustment of jet stream and orographic effects. Results from the Antarctic stratospheric polar night jet show that large wave energy is associated with strong mean wind speeds, rotating around the continent. The seasonal variation of the gravity wave activity during the spring-time vortex breakdown is related to the Eliassen-Palm flux divergence.

We also employ the GPS RO data with the FORMOSAT-3/COSMIC program from September 2006 onwards. As the COSMIC data density is much higher, they are used to study the vivid behavior of atmospheric waves. The gravity wave generation in the tropics is coupled with deep convective activity. Interactions and filtering by the background QBO winds are clearly apparent.

Equatorially trapped Kelvin waves, Mixed Rossby Gravity Waves and Equatorial Rossby waves with zonal wavenumbers $s < 9$ are obtained by bandpass filtering wavenumber - frequency spectra. Their temporal, spatial, hemispheric and vertical structure, propagation and wave-mean flow interaction is examined with respect to the background tropospheric and stratospheric winds.

In the northern hemisphere winter months, most of the gravity wave energy is related to the sub-tropical jet. The AGCM (T106L60) confirms that the potential energy observed by COSMIC is due to waves propagating upward from the jet core, mainly with ground based phase speeds of less than ~10 m/s.

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Comparing vertical columns of ozone measured by nadir and limb viewing instruments

Presenter: Simo Tukiainen (simo.tukiainen@fmi.fi)

S. Tukiainen, E. Kyrölä, J. Tamminen, S. Hassinen, P. Verronen
(Finnish Meteorological Institute, Finland)

Nadir looking instruments provide measurements of the atmospheric total ozone content above the clouds, while clear sky observations also include the tropospheric ozone column. Instruments using limb viewing geometry observe the vertical structure of ozone usually above the altitudes of 15 km. Thus, when comparing vertical ozone columns from nadir and limb viewing instruments, we can estimate the tropospheric ozone (when clear sky) and validate the measurements of both instruments (when cloudy sky). In this study we use nadir observations from OMI/EOS-Aura and compare OMI data with the total ozone calculated from the high resolution ozone profiles from GOMOS/Envisat and OSIRIS/Odin. We also use cloud data to investigate clear sky and cloudy conditions separately.

ID: 00317 ◀back

Spatio-temporal variability of middle atmospheric water vapour as observed by Odin

Presenter: Joachim Urban (jo.urban@rss.chalmers.se)

J. Urban, D. Murtagh, C. Sánchez, A. Jones, P. Eriksson (Chalmers University of Technology, Göteborg, Sweden),
S. Lossow (Stockholm University, Sweden)

Global data from the Odin satellite for the period between 2001 and 2008 are used to study the global distribution and spatio-temporal variability of middle atmospheric water vapour in relation to global circulation patterns and the transport between different spheres.

The presentation focuses on results obtained for water vapour and its isotopes (H_2O, H_2O-18, H_2O-17, HDO) as well as longer lived target species such as nitrous oxide (N_2O) and carbon monoxide (CO) in stratosphere and mesosphere, useful information for example for the assessment of transport in chemistry-climate models. Spectral lines of water vapour, a key target of Odin, are measured in several different spectral bands in the 486-581GHz range providing well resolved vertical profile information from the UT/LS region up to the lower thermosphere. Water vapour data are, for example, used to derive upward transport rates in the tropical lower(most) stratosphere ("tape-recorder effect") and to study its seasonal and multi-annual variability (SAO, AO, QBO, trends) by combining it with measurements of the long-lived species nitrous oxide. Measurements of N_2O and H_2O are also valuable for studying the transport of stratospheric air towards high latitudes and the variability of downward transport during winter in the polar branches of the Brewer-Dobson circulation. The measurements of CO, along with H_2O, provide on the other hand information on the global overturning circulation in the mesosphere and lower thermosphere.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (TEKES), France (CNES), and the European Space Agency (ESA).

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Thermal inertia and radiative imbalance as factors determining the stratospheric temperature

Presenter: Aarnout van Delden (a.j.vandelden@uu.nl)

A. van Delden, Y. Hinssen (Utrecht University, The Netherlands)

During the past few decades the stratosphere has cooled. This is in accord with General Circulation Model calculations, which indicate that increasing well mixed greenhouse gas (i.e. CO_2-) concentrations and decreasing ozone concentrations in the stratosphere will lead to increasing temperatures in the troposphere and decreasing temperatures in the stratosphere. Here we focus on the explanation of the decreasing temperatures in the stratosphere. Qualitative arguments used to explain this cooling are usually based on radiation flux balance. We demonstrate that this is not always correct. In fact, flux imbalance is sometimes an essential part of the explanation of the cooling.

The observed cooling of the upper stratosphere (above 20 km) in the summer hemisphere, and the part of the winter hemisphere receiving Sunlight, is the result of both the decrease in heating by absorption of short wave Solar ultraviolet radiation as a result of decreasing ozone concentrations and the increased emission of long-wave radiation due to increased greenhouse gas concentrations.

The observed cooling in the lower stratosphere (between 200 and 50 hPa) can hardly be associated with decreased absorption of Solar ultraviolet radiation, because this radiation is depleted almost completely above this level. At these levels ozone, carbon dioxide, water vapour and many other trace gases behave as a greenhouse gas, i.e. they have an influence on the long wave radiation balance. Assuming energy flux balance at all levels in the atmosphere, the presence of these gases at levels between 200 hPa and 50 hPa has the effect of warming the layers below 50 hPa.

This is in apparent contradiction with the statement that increasing greenhouse gas concentrations will lead to decreasing temperatures in the stratosphere. The explanation of this apparent contradiction lies in the fact that the stratosphere is usually not in radiative flux balance, due to its thermal inertia.

The extreme example of radiation flux imbalance is encountered over the winter polar cap. Here the atmosphere cools due to long wave radiation emission to space. This cooling becomes more efficient with increasing greenhouse gas concentration.

In explaining the cooling of the stratosphere over the summer hemisphere (in the northern hemisphere this would be in the period 21 March to 21 September) and in the tropics (all year round) we must again discriminate between the upper stratosphere and the lower stratosphere.

The temperature of the upper stratosphere in the summer hemisphere and in the tropics depends on the response principally to direct heating of this layer due to absorption of short wave radiation, which is counteracted by emission of long wave radiation to space and towards lower layers in the atmosphere.

The emission of long wave radiation to space will increase with temperature and with increasing greenhouse gas content. If there are no greenhouse gases, other than ozone itself, the upper part of the ozone layer will become very hot! If, on the other hand, greenhouse gases are abundant in this layer a lower temperature will suffice to balance the radiation budget. The radiation budget is balanced most closely in the tropics

Explaining the temperature of the lower stratosphere in the summer hemisphere and in the tropics is a bit more difficult. The temperature in this case depends on principally the absorption of upwelling and downwelling long-wave radiation, which is counteracted by upward and downward emission of long-wave radiation. In the tropics these fluxes are approximately in balance because seasonal variations in insolation are weak. Over the summer pole this is certainly not the case. What happens then is illustrated with results from controlled numerical model experiments that separate the different thermal effects of radiation and dynamics.

ID: 00118 ◀back

Trend analysis of the radiosonde relative humidity measurements at Uccle, Belgium

Presenter: Roeland Van Malderen (roeland.vanmalderen@kmi-irm.be)

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Water vapour trend analysis suggests that the stratospheric water vapour increased at a rate of 1%/yr over the past 45 years. There is also evidence for global increases in tropospheric specific humidity over the past two decades, which is consistent with the observed increases in tropospheric temperatures and the absence of any change in relative humidity (IPCC 2007).

We dispose of a uniform time series of radiosonde humidity profiles at Uccle (Belgium, 50º48'N, 4º21'E, 100 m asl) since January 1990. These humidity profiles have to be first corrected for a dry bias (due to instrumental artifacts) and a time lag error. We investigated two different correction methods and set up a small intercomparison campaign of different Vaisala radiosonde types. Additionally, we compared the integrated water vapour (IWV) column values, calculated from the vertical relative humidity profiles, with the IWVs measured by a sun photometer and GPS. These (inter)comparisons gave us the opportunity to make an assessment of the uncertainties of the relative humidity profiles measured by radiosondes.

The more than 15 years of corrected vertical humidity profiles constitutes a unique data set, which allowed for trend and climatological analyses of the tropospheric and lower stratospheric humidity field above Uccle. We find a significant moistening of the troposphere until 2001, with no trend (LT) or drying (UT) afterwards. The tropopause dynamics did not show a significant change during whole the time period. The lower stratosphere, on the other hand, underwent a global drying since 1990, with an increased drying since the middle of 2004. Possible explanations for these trends will be discussed.

ID: 00339 ◀back

Condensed Phase Organic Photochemistry in UTLS Aerosols: Implications for Direct and Indirect Aerosol Climate Forcing

Presenter: Annalise Van Wyngarden (Annalise.L.VanWyngarden@nasa.gov)

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Many organic compounds that have been either observed or proposed to exist in atmospheric aerosols have significant ultraviolet-visible (UV-vis) absorption cross-sections in the atmospheric window. Thus, photo-initiated reactions of these compounds may be important sinks for the particle-phase reactants as well as sources for new organic products in both the particle and gas phases. Currently, relatively little is known about the chemical fate of most organic compounds that absorb UV-vis radiation in the condensed phase, especially under the highly acidic conditions typical of sulfate aerosols in the upper troposphere and lower stratosphere (UTLS). Here we present results that demonstrate chemical changes upon UV-vis irradiation of various organic compounds (e.g., methylglyoxal, diacetyl) in sulfuric acid/water solutions under a range of acidities relevant for UTLS aerosol particles and cloud droplets. Loss of organic reactant and the appearance of photo-products are monitored by various techniques, including High Performance Liquid Chromatography and UV-vis and Attenuated Total Reflectance-Fourier Transform Infrared spectroscopies. These results are used to address the potential effects of particle-phase organic photochemistry on the optical properties and/or cloud processing of atmospheric aerosols.

ID: 00231

◀back

Volcanic tracers in the TTL

Presenter: Jean-Paul Vernier (jean-paul.vernier@aerov.jussieu.fr)

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During the SCOUT-O3-AMMA balloon field campaign held in West Africa in August 2006, all particles sensitive systems have reported an aerosol layer between 19-21 km altitude made of undepolarized particles of 1.2-1.3 scattering ratio an 0.1µm radius. The observations are consistent with the existence of a sulphate aerosol layer injected in the lower stratosphere after the eruption of La SoufriÈre Hills volcano in Montserrat Island on 20 May 2006, as shown by an SO_2 cloud reported by AURA / OMI. The volcanic aerosols could also be followed after averaging on 1-degree latitude bins, the nighttime total attenuated backscatter of the CALIOP Lidar onboard CALIPSO satellite from the beginning of it observation on June 2006. With the same method, a second volcanic layer was detected at 17-18 km from the Tarvurvur volcano which erupted on 7 October 2006 in Papua New Guinea.

The volcanic cloud used as a tracer provides an estimation of the vertical velocity in the TTL (Tropical Tropopause Layer). A relatively fast (0.7 km/month) upwelling is observed immediately above 16.5 km from October to November, surmounted by a sharp minimum of 0.2 km/month at 20 km during the boreal summer, increasing again higher up in the lower stratosphere. Consistent with model calculations, there is an indication of a large seasonal modulation. CALIPSO offers an unique opportunity for better understanding the still debated dynamical and microphysical processes related to troposphere/stratosphere exchanges in the tropics.

ID: 00358 ◀back

Influence of convection on the TTL over Brazil: Analysis of airborne in situ trace gas measurements

Presenter: C. Michael Volk (M.Volk@iau.uni-frankfurt.de)

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We present in situ aircraft measurements from Aracatuba, Brazil (21 S, 50 W) during the Tropical Convection and Nitrogen Oxides Experiment (TROCCINOX) in February/March 2005. One main objective of the TROCCINOX aircraft campaign was to analyse the influence of deep convection on the trace gas composition in the tropical tropopause layer (TTL). The upward transport to altitudes above the neutral buoyancy level at ~350 K (~13 km) can be achieved if air overshoots this level and mixes irreversibly with its surroundings. Convection and mixing processes can be diagnosed by observations of CO, CO_2, O_3, and nitrogen oxides. These tracers were measured on board of the high flying aircraft M55 Geophysica: CO_2 by the University of Frankfurt`s High Altitude Gas Analyzer (HAGAR), CO by the Cryogenically Operated Laser Diode (COLD), O_3 by the Fast Ozone ANalyzer (FOZAN) and NO and NOy by SIOUX.

We focus on selected case studies to understand the mechanisms responsible for mixing following deep convection. We distinguish between uplifted air recently influenced by local thunderstorms and signatures of aged convection in the tropical tropopause region. In the first case - the local 'thunderstorm chase day' on February 4th, 2005, CO_2 and CO can be used as tracers for the planetary boundary layer, where - compared to the mid-troposphere - CO is relatively high and CO_2 is depleted due to uptake by vegetation. The outflow of the thunderstorm caused low CO_2 (374 µmol/mol) and high CO (130 nmol/mol) mixing ratios in an altitude range of 13-17 km. Mixing with the background TTL air is indicated by mixing lines apparent in the CO-O_3 and CO_2-O_3 correlations.

In the second case study for the flight on February 12th similarly anti-correlated signatures of CO_2 and CO are observed at an altitude of 15 km, although a low NO/NOy ratio argues against the influence of recent convection. The trajectory model FLEXPART indicates that this air was lifted to the upper troposphere in the Western part of South America several days earlier and travelled in the Bolivian High before measured by the Geophysica at 15 km. Correlations of CO and CO_2 with O_3 show mixing signatures also in this case.

ID: 00359 ◀back

Isentropic transport and mixing between the tropical UTLS and the extratropical stratosphere as observed by in-situ measurements of long-lived trace gases

Presenter: C. Michael Volk (M.Volk@iau.uni-frankfurt.de)

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Transport processes between the extratropical stratosphere and the tropical UTLS region critically control the chemical composition of the TTL and the tropical lower stratosphere and thus the composition of air masses transported further upward into the stratosphere. We present evidence of frequent quasi-horizontal transport and mixing in the sub-tropical UTLS, both across and above the tropopause, from in-situ measurements of long-lived trace gases over southern Brazil. The observations were obtained with the M55 Geophysica aircraft operating from AraÁatuba (21º S, 50º W) during the “Tropical Convection, Cirrus and Nitrogen Oxides Experiment II” (TroCCiNox II) aircraft campaign in January / February 2005. Among other species the High Altitude Gas AnalyzeR (HAGAR) measured N_2O, CO_2, CH_4, CFC-12, CFC-11, H-1211 and SF_6. Ozone was obtained by the Fast Ozone ANalyzer (FOZAN), CO by the Cryogenically Operated Laser Diode (COLD), and NOy by the chemiluminescence instrument SIOUX.

The summer subtropical lower stratosphere over Brazil appeared to be a zone where vigorous large-scale mixing across the subtropical barrier was common during the campaign period. Although most of the flights were performed in the latitude band between 18º S and 23º S, the measurement region covered a large range of equivalent latitudes from 5º S to 65º S.

Above the tropopause, tracer mixing ratios ranging from typical tropical to typical midlatitude values, often over short flight distances, indicate active isentropic mixing. Events of isentropic mixing are also apparent as mixing lines in the tracer-tracer correlations. Numerical simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS) reproduce such events fairly well, even when the mixing structures are not visible from the PV-field anymore.

Below the tropical tropopause we find layers exhibiting significant anti-correlations between long-lived tracers and ozone, indicating air of stratospheric origin within the TTL. Measurements of N_2O and O_3 show that the upper part of the TTL (above 365K) was significantly influenced by stratospheric air masses. In agreement with this, Lagrangian simulations with the CLaMS model give a fraction of 30% - 40% of air in the upper TTL having stratospheric origin.

CLaMS simulations from a long-term model run, as well as comparisons with other tropical aircraft campaigns (APE-THESEO, SCOUT-O3-Darwin and AMMA-SCOUT-O3) are presented in order to place our observations into a climatological context.

ID: 00385 ◀back

Transport across the tropical tropopause by convection, mixing, and slow upwelling: Insights from recent in situ observations with the Geophysica aircraft

Presenter: C. Michael Volk (M.Volk@iau.uni-frankfurt.de)

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We present an analysis of in situ trace gas observations in the tropical tropopause layer (TTL) and the lower stratosphere (up to 20 km) obtained during the recent deployments of the M55 Geophysica over Brazil (TROCCINOX, 2/2005), the Maritime Continent (SOCUT-O3 11-12/2005) and West Africa (AMMA/SCOUT-O3 8/2006). On board the aircraft long-lived tracers (N_2O, CH_4, CO_2, H_2, F-12, F-11, H-1211, SF_6) were measured by the University of Frankfurt's High Altitude Gas Analyzer (HAGAR), CO by the Cryogenically Operated Laser Diode (COLD), and O_3 by the Fast Ozone ANalyzer (FOZAN). The three campaigns comprise over 30 tropical flights, including survey flights aimed at improving our understanding of large-scale transport and flights above and around mesoscale convective systems under both continental and maritime conditions aimed at investigating their impact on the tropical UTLS.

The focus of our study will be the principal transport processes that control the chemical composition of the TTL and the entry of air into the tropical stratosphere, i.e. deep convection, vertical mixing, horizontal mixing from the extratropical stratosphere, and slow upwelling. We examine vertical profiles and correlations between the various species, serving as stratospheric tracers, as boundary layer tracers, or age-of-air tracers in order to assess the influences of the key transport processes named above. Isentropic mixing across the subtropical tropopause is prevalent over Southern Brazil during TROCCINOX, but appears to be hardly detectable for the Darwin and West Africa campaigns. Vertical mixing throughout the depth of the TTL (350-385 K potential temperature) brings down O_3 from the tropopause level while lifting CO across the tropopause from the main convective outflow level at ~355 K. This is observed over Brazil and can be clearly associated with overshooting deep convection. Evidence for such vertical mixing is also found over Darwin; here backward trajectories suggest that in this case it is more likely caused by strong vertical wind shear in the vicinity of the subtropical jet than by local convection. The tracers can be used to separate background TTL air from air recently affected by convection, vertical mixing or isentropic in-mixing from the stratosphere. The background TTL above 360 K generally exhibits rather coherent CO_2 profiles with a clear seasonal tape recorder signal due to the vertical propagation of the tropospheric seasonal cycle. We will use this seasonal signal to estimate the residence time and rates for diabatic ascent in the TTL during NH summer and winter.

The observations taken during the three recent campaigns will be compared with each other as well as with data from the earlier APE-THESEO campaign (1999). Comparisons will also be made with simulations by the Lagrangian CLaMS model and the results will be put into a climatological context.

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Water Vapor, Clouds, and Supersaturation in the Tropical Tropopause Transition Layer

Presenter: Holger Vömel (Holger.Voemel@Colorado.edu)

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Water vapor and ozone in the tropical upper troposphere and lower stratosphere play an important role in climate; however, their distribution and correlation in this region have not been well characterized. Water vapor and ozone have been measured by balloon borne sondes during a number of tropical campaigns over the last eight years using the Cryogenic Frostpoint Hygrometer (CFH). These soundings provide a distribution of water vapor, relative humidity over ice, and ozone in the tropical tropopause transition layer (TTL). Furthermore, observations of cirrus clouds were obtained by lidar at some sites and balloon borne backscatter sonde for two soundings. Despite strong differences in the seasonal and geographical variation of water vapor and ozone in the tropical TTL, the distribution of relative humidity shows only a weak dependency on the geographical and seasonal variation.

This distribution shows significant supersaturation in the tropopause region, with few observations reaching supersaturations where rapid freezing of pre-existing aerosol particles and subsequent condensation of water vapor are expected to limit the level of supersaturation. The observations also show that large supersaturations can occur within cirrus clouds as well as in cloud free air. The observations are discussed in the context of the accuracy of CFH water vapor measurements.

ID 000453 ◀back

Development of a Climatological Data Set from the Atmospheric Chemistry Experiment for Validating Atmospheric Model Simulations

Presenter: Kaley Walker (kwalker@atmosp.physics.utoronto.ca)

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A new climatological data set is being developed using recent satellite-based trace gas measurements. The goal is to provide a new comparison data set that will extend the range of species available for model evaluation and assessment. Atmospheric profiles from the first five years (2004-2008) of the Atmospheric Chemistry Experiment (ACE) satellite mission will be the basis of this data set. ACE, also known as SCISAT-1, is a Canadian scientific satellite to perform remote sensing measurements of the Earth's atmosphere. Launched on 12 August 2003, it has been operational for over 4.5 years. The ACE instruments use the solar occultation technique and atmospheric profiles are routinely produced for almost 30 different trace gases. This paper will present the plans for development of this new climatological data set and potential applications.

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Stationary wave response to climate change

Presenter: Lei Wang (lei@atmosp.physics.utoronto.ca)

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Climate change has a significant impact on the stationary wave field, especially in the stratosphere. The stationary wave response to climate change simulated by coupled global climate models is diagnosed with a nonlinear baroclinic stationary wave model. The stationary wave model is constructed from a GCM dynamical core, and is able to diagnose the maintenance mechanics of the stationary wave field by a variety of forcings such as diabatic heating, transient eddies, topography and stationary nonlinearity. Changes in the zonal mean basic state and zonally asymmetric forcings both account for the stationary wave response to climate change, whose relative importance is diagnosed individually. The statosphere-troposhpere dynamic coupling is explored by dividing the the stationary wave response into four components: the response in the stratosphere / troposphere induced by the forcing in the stratosphere / troposphere. The enhancement of the Brewer Dobson circulation (BDC) due to anthropogenic forcings is also investigated to verify a recently raised hypothesis that the enhanced BDC due to global warming is likely related to the changes in the stationary wave activity.

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A change of the wintertime Ural blocking circulation around 1976/77 and its relationship with East Asian winter climate

Presenter: Lin Wang (wanglin@mail.iap.ac.cn)

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Blocking variability over the Ural Mountain region in the boreal winter and its relationship with the East Asian winter climate is investigated. A clear change of the blocking pattern occurred around 1976/77. In contrast with the years before 1976/77, the Ural blocking signal after 1976/77 is found to propagate less into the stratosphere and more eastward in the troposphere to East Asia, which therefore exerts more influence on the East Asian winter climate. This enhanced Ural blocking-East Asian climate relationship amplifies the impact of Ural blocking on East Asia and, with the background of decreasing Ural blocking, contributes to the higher frequency of warm winters in this region. Further analyses suggest that the stratospheric polar vortex and its modulation on the propagation of atmospheric stationary waves can account for this change, with the key area being located in the North Atlantic region.

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Observation of Stratospheric Sudden Warmings and Gravity Wave Activity during the Northern Winter of 2007/2008 from COS-MIC/CHAMP GPS Radio Occultation Profiles

Presenter: Ling Wang (lwang@cora.nwra.com)

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Stratospheric sudden warmings (SSWs) are large-scale transient events in the winter middle atmosphere. They are the most dramatic example of dynamical coupling of the lower and middle atmosphere. Due to their ability to change the background atmosphere, SSWs affect gravity wave (GW) propagation and transmission in the middle atmosphere profoundly. GWs could also affect the mean atmosphere via the downward control principal. In this study, we use the combined COSMIC and CHAMP GPS temperature retrievals to investigate the 2007/2008 northern hemisphere SSWs and the accompanying gravity wave activity. Independent temperature measurements from HIRDLS and SABER (as well as reanalysis data) are also used to supplement and validate the GPS analysis.

We observe from the GPS data three minor and one major warmings in the northern hemisphere during the 2007/2008 winter. All the events displayed the classic downward progression of warm stratospheric temperatures and the accompanying mesospheric coolings. By combining GPS and HIRDLS analyses, we find that gravity wave (GW) activity was enhanced in the stratosphere but subdued in the mesosphere during those events, and the timing of GW enhancement/suppression with respect to SSWs was generally close. Geographically, GW amplitudes were generally larger at the polar vortex edge and smaller in the vortex core and outside of the vortex, and there was clear evidence of selective transmission of GWs. Using ray-tracing simulations, we find that the observed temporal evolution of GW activity during SSWs can be explained largely by wave propagation considerations, i.e., the dramatically changing background winds during SSWs likely refracted GWs arising from the lower atmosphere in such a way that more waves could be observed by GPS (and HIRDLS) in the stratosphere, but the existence of critical levels near the stratopause prohibited transmission of GWs to the mesosphere. Validations of GPS zonal mean temperatures, and large- and small-scale temperature variability are also discussed.

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General Aspects of a T213L256 Middle Atmosphere General Circulation Model

Presenter: Shingo Watanabe (wnabe@jamstec.go.jp)

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A high-resolution middle atmosphere general circulation model (GCM) developed for studying small-scale atmospheric processes is presented, and the general features of the model are discussed. The GCM has T213 horizontal resolution and 256 vertical levels extending from the surface to a height of 85 km with a uniform vertical spacing of 300 m. Gravity waves (GWs) are spontaneously generated by convection, topography, instability, and adjustment processes in the model, and the GCM reproduces realistic general circulation in the extratropical stratosphere and mesosphere. The oscillations similar to the stratopause semi-annual oscillation and the quasi-biennial oscillation (QBO) in the equatorial lower stratosphere are also spontaneously generated in the GCM, although the period of the QBO-like oscillation is short (15 months). The relative roles of planetary waves, large-scale GWs, and small-scale GWs in maintenance of the meridional structures of the zonal wind jets in the middle atmosphere are evaluated by calculating Eliassen-Palm diagnostics separately for each of these three groups of waves. Small-scale GWs are found to cause deceleration of the wintertime polar night jet and the summertime easterly jet in the mesosphere, while extratropical planetary waves primarily cause deceleration of the polar night jet below a height of approximately 60 km. The meridional distribution and propagation of small-scale GWs are shown to affect the shape of the upper part of mesospheric jets. The phase structures of orographic GWs over the South Andes and GWs emitted from the tropospheric jet stream are discussed as examples of realistic GWs reproduced by the T213L256 GCM.

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Quantitative Performance Metrics for Stratospheric-Resolving Chemistry-Climate Models

Presenter: Darryn Waugh (waugh@jhu.edu)

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A set of performance metrics is applied to stratospheric-resolving chemistry-climate models (CCMs) to quantify their ability to reproduce key process relevant for stratospheric ozone. A single metric is used to assign a quantitative measure of performance ("grade") to each model-observations comparison. This procedure is applied to the 13 CCMs that performed simulations for the WMO (2006) ozone assessment. A wide range of grades is obtained, both for different diagnostics applied to a single model and for the same diagnostic applied to different models, highlighting the wide range in ability of the CCMs to simulate key processes in the stratosphere. No model scores high or low on all tests, but differences in the performance of models can be seen, especially for transport processes where several models get low grades on multiple tests. The grades are used to assign relative weights to the CCM projections of 21st century ozone. However, only small differences are found between weighted and unweighted multi-model mean ozone projections. Although several issues with the grading and weighting of CCMs that need further examination are identified, this analysis provides a framework that will enable quantification of model improvements and assignment of relative weights to the model projections.

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Projections of stratospheric changes and their role in climate

Presenter: Darryn Waugh (waugh@jhu.edu)

D.W. Waugh (Johns Hopkins University, Baltimore, USA)

In this presentation I will review projections of changes in the stratosphere during the 21st century. These projects show stratospheric ozone increasing as the abundance of halogenated ozone-depleting substances decrease to 1960 values. However, the evolution and "recovery" of ozone varies between regions, and depends not only on changes in halogens but also changes in stratospheric temperatures and transport and other compositional changes. I will discuss the relative contribution of different mechanisms to projected changes in ozone, as well as the sensitivity of the stratospheric evolution to assumed greenhouse gas scenario. Finally, I will discuss the impact of stratospheric ozone changes on tropospheric climate during the 21st century.

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Links between ENSO Convection and the Tropical Stratosphere

Presenter: Bryan Weare (bcweare@ucdavis.edu)

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The wave-like responses of the tropical stratosphere to El Niño/Southern Oscillation (ENSO) convective variations are explored using Multi-Lag Singular Value Decomposition (MLSVD). The analyses use ERA-40 departures of zonal (u) and meridional (v) winds, temperature (T) and ozone mixing ratio (O3) at the 10, 20, 30, 50, 70, 100, 150 and 200 hPa levels, which have been projected onto the Rossby solutions on an equatorial beta plane. The anomalies are formed by removing long term monthly means, the influences of trends, volcanoes, the solar cycle and the Quasi-Biennial Oscillation (QBO), and instantaneous zonal averages. The MLSVD relates interannual OLR variations with the tropical projected anomalies at multiple levels and temporal lags.

The two most important OLR SVDs are related to the canonical ENSO with eastward propagation features stretching along the equator. These modes are linked to upward propagating perturbations of u, v, T and O_3 throughout the column at a wide range of lags. These anomalies are generally equatorially trapped with a wave number one structure and propagate to the east at a speed of less than 1m/s. The implied vertical propagation has a scale height of greater than 10km and no systematic eastward or westward tilt. In the regions of strong convection (low OLR) there are easterly zonal wind anomalies and divergence at the lowest levels. In the lower stratosphere these changes are accompanied by lower temperatures and reduced ozone mixing ratios, consistent with rising low ozone air that is cooled adiabatically. Higher in the stratosphere near 20hPa at these longitudes equatorial ozone perturbations are strongly negative.

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Internannual variability in chemistry and transport and its possible link to climate change: stratospheric ozone and water vapor

Presenter: Mark Weber (weber@uni-bremen.de)

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Both transport via the Brewer-Dobson circulation and chemistry changes driven by stratospheric temperature variations contribute to the observed interannual variability in middle to high latitude total ozone as observed from 12 years of data from GOME and SCIAMACHY. The high correlation between the winter average eddy heat flux, which is a common measure of the strength of the Brewer-Dobson circulation in a given winter and the accumulated winter transport, correlates well with spring total ozone, on one hand, and anti correlates with OClO observations, a measure of the chlorine activation (and cold temperatures) inside the polar vortex, on the other hand.

This type of relationships are also investigated with a SCLIMCAT CTM and Unified Model runs. Despite the interannual variability, it is evident that SH total ozone over the polar cap do not show yet a clear sign of recovery. This is not unexpected since the stratospheric chlorine load has just passed its maximum during this decade assuming a stratospheric age of 5-6 years over the polar region.

Both transport and chemical ozone loss are closely tied and an important question is how they will evolve in a changing climate. A very sensitive indicator of circulation and transport changes is stratospheric water vapor near the tropical tropopause. Observations from HALOE and SAGE II indicated a drop in tropical lower stratospheric water vapor after year 2000 likely related to an enhancement in the winter BD circulation in both hemispheres. Extending satellite time series with water vapor observations from other available satellites, we investigate the question if the dry period in tropical stratospheric water vapor still persists.

ID: 00415

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An intercomparison of water vapor measurements in the TTL and lower tropical stratosphere during AVE-WIIF, CRAVE and TC4: The importance and implications of laboratory calibrations with water vapor mixing ratios from 0-10 ppmv

Presenter: Elliot Weinstock (emweinstock@yahoo.com)

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Systematic differences in measured water vapor in the tropopause region and lower stratosphere between in situ instruments on the WB57, the NOAA Colorado frostpoint hygrometer (CFH), and satellite borne instruments such as the Microwave Limb Sounder (MLS) and the Halogen Occultation Experiment (HALOE) are well-documented. A series of aircraft campaigns were organized as part of an effort to validate instruments on the Aura satellite, while at the same time to increase our understanding of the lowermost stratosphere, the tropical tropopause layer, and the mechanisms that control stratospheric water vapor. These missions, which included the AVE-WIIF (Aura Validation experiment-Water Isotope Intercomparison Flights) mission in July 2005, the CRAVE (Costa Rica Aura Validation mission) in January and February of 2006, and the TC4 (Tropical Composition, Clouds, and Climate Coupling) mission in July 2007. A principal goal of all of these missions was a careful intercomparison of satellite-borne, balloon-borne, and aircraft-borne water vapor measurements in the upper troposphere and lower stratosphere. Results from CRAVE, presented during a water vapor workshop organized as part of the CRAVE science meeting, provided continued confirmation of the differences mentioned above. The availability for the first time of multiple robust intercomparisons between these instruments led to the conclusion that at low water mixing ratios (less than 10 ppmv), the differences appear to be well-represented by an offset of about 1.5 to 2 ppmv with in situ instruments on the WB57 measuring higher than MLS and CFH. This enduring discrepancy precludes both a satisfactory validation of satellite retrievals of stratospheric water vapor profiles. In this talk we will compare intercomparison data taken during these recent aircraft campaigns through TC4. We will then summarize the recent low water calibration runs in our laboratory that validate the measurements of the Harvard Lyman-α instrument at low water in the UT/LS. Additionally, implications of the results from the AquaVIT (Aqua Validation and Instrument Tests) campaign on stratospheric water vapor measurements will be discussed.

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Stratospheric Response to Latitudinally Varied Surface Warming

Presenter: Barbara Winter (barbara.winter@mail.mcgill.ca)

B. Winter, M. Bourqui (McGill University, Montreal, Canada)

GCM studies have shown that doubled-CO_2 conditions lead to increased propagation of planetary waves into the stratospheric polar vortex, and thus to a weaker vortex and warmer lower stratosphere at high latitudes. Surface temperatures of a doubled-CO_2 world can be approximated by horizontal bands of warm anomalies, the strongest of which occur in the northern mid- to high latitudes, due to the land masses there. We have used an atmospheric GCM to simulate the effects of applying idealized, zonally symmetric positive temperature forcings in distinct latitude bands. The magnitude of the forcing is 3 degrees in mid-latitude (30-60 degrees, N or S) and polar (60-90 degrees, N or S) bands, and 2 degrees in the equatorial band (30 S - 30 N).

The effect of winter-time forcing in the mid-latitudes is the same in both winter hemispheres: cold anomalies are induced in the high-latitude lower stratosphere; the polar vortex strengthens; and the Brewer-Dobson circulation weakens by the same amount in each hemisphere. This degree of symmetry suggests that the effect of the forcing is proportional to the magnitude of the forcing itself, not to the a priori state of the atmosphere in each hemisphere.

Although such a 3-degree forcing in the northern mid-latitudes most closely mimics the surface warming effect of doubled-CO_2 conditions, its effect on the stratospheric circulation is the opposite. In contrast to the symmetric response to mid-latitude forcing, when temperature forcing is applied in the equatorial band, winter-time responses are asymmetric between the two hemispheres.

These results are interpreted in light of the distribution of the “refractive index” of the atmosphere. The sensitivity of the results to the latitudinal width of the applied forcing, and to its position relative to mid-latitude baroclinic zones, are examined.

ID: 00012 ◀back

The Tropopause Height during the Transition Season over Tropical Maritime Continent

Presenter: Joko Wiratmo (wiratmo@geoph.itb.ac.id)

J. Wiratmo (Institute of Technology Bandung, Indonesia),
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The tropopause is a boundary between troposphere and stratosphere layers whose height is varies with time. During the wet season, the tropopause height is relatively easier to be identified compared with that in dry season. In fact, its height is not always linierly correlated with rainfall intensity measured below. This result was obtained in the wet and dry season which is clearly seen in contrast. Apart from these season, the transition season in troposphere over the maritime continent region is indicated by unsteady and unpredictable the wind patterns. During this season the clouds which do not always produce rainfall may affect the tropopause height. A study will be conducted to investigate the variation of tropopause height during the transition season over the maritime continent region Indonesia. Data from EAR (Equatorial Atmosphere Radar) and BLR (Boundary Layer Radar) observations in Kototabang, West Sumatra (0.2ºS, 100.32ºE) will be used.

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An update on statistical trend analysis of column ozone from the CANDIDOZ project: Influence of dynamical and chemical processes

Presenter: Ingo Wohltmann (ingo.wohltmann@awi.de)

I. Wohltmann, M. Rex (Alfred Wegener Institute, Potsdam, Germany)

The determination of the importance of dynamical processes in comparison to chemical processes is of paramount importance for understanding trends in mid-latitude column ozone and their reasons. A better representation of these processes in statistical regression models of column ozone (like these used in the WMO reports) is a key issue.

We introduce new dynamical proxies for processes largely neglected in many of these statistical regression models, most importantly a proxy modelling ozone changes due to long- and short-term changes in tropospheric and stratospheric pressure systems. The proxy describes changes in ozone both due to horizontal isentropic transport and convergence and divergence of mass (both effects e.g. causing lower ozone columns over tropospheric highs). It is based on an equivalent latitude profile transformed into an ozone profile and integrated to give an ozone column.

We examine the impact of these dynamical changes on the observed long-term trend of ozone, and the quantitative contribution of this dynamical variability to the variability of ozone.

Other new proxies models the effect of the residual circulation and of heterogeneous polar ozone depletion and dilution of vortex air in mid-latitudes.

We present results for the variability and trends of Dobson measurements of column ozone in different regions (ranging from several mid-latitude regions to Antarctica or the Tropics) and seasons. The ozone time series and proxies were extended to 2007 and updated to the newest revised versions compared to our published results (e.g. JGR, 112, doi:10.1029/2006JD007573). We show that dynamical trends can have a substantial influence on the overall trend of column ozone in mid-latitudes, but with large differences between seasons and geographical regions. However, the trend caused by anthropogenic changes in homogeneous ozone chemistry is still the main driver of the trends consistently in all regions and seasons.

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The UVO3 Patagonia Project

Presenter: Elian Wolfram (ewolfram@citefa.gov.ar)

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N. Paes Leme (INPE, Brasil),
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Since October (middle) 2007, Argentina and Chile with the financial support of JICA, has joined scientific efforts to develop the UVO3 Patagonia project, following the SOLAR campaign (2004-2007). It has as main objectives monitoring ozone and UV radiation and other atmospheric parameters, in southern Patagonia. The Laboratorio de Ozono y RUV (LabO3RUV) of the Universidad de Magallanes, located in Punta Arenas, Chile (53.03 S , 70.85 W) and the CEILAP (CITEFA-CONICET) located in RÌo Gallegos, Argentina (51.6 S, 69.3 W), far 200 km from the first one, are the execute Institutions (laboratories) of this project.

Brewer spectrophotometer and UV radiometers (LabO3RUV) and a differential absorption lidar (DIAL), a backscattered Raman Rayleigh lidar, an AERONET (NASA) Cimel, a SAOZ spectrometer and other UV radiometers (CEILAP), are between the principal instruments involved in this project, devoted in the measurement of total ozone column and surface UV irradiance and ozone number density profiles between 14 - 45 km range, and also aerosols and water vapour (profiles and columns). Monitoring the ozone hole overpasses on high inhabitant cities as Punta Arenas and RÌo Gallegos and the stratospheric polar vortex dilution process are reported in this paper as examples of geophysical products that are produced in this project. It will be held between 2007 and 2011.

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Stratospheric involvement in blocking

Presenter: Tim Woollings (t.j.woollings@rdg.ac.uk)

T. Woollings (University of Reading, UK)

The word 'blocking' describes a synoptic situation in which the prevailing midlatitude westerlies and storm tracks are blocked and/or diverted by large, persistent 'blocking' anticyclones. It is now generally accepted that these events arise due to the breaking of synoptic and planetary scale Rossy Waves in the upper troposphere. Blocking has a dramatic effect on local weather conditions, but it is not well simulated even by current state-of-the-art climate models. A potential-vorticity-based blocking index is used to identify blocking in ERA-40 data by its characteristic wave-breaking signature. Wintertime blocking occurrence is then correlated with indices of stratospheric variability, showing that there are significant links between blocking and variations of the stratospheric polar vortex. There are stratospheric links to classical mid-latitude blocking and also to the high-latitude blocking events which correspond to extreme negative phases of the NAO/NAM. The stratospheric and tropospheric events often develop in tandem, suggesting that they may be acting to amplify one another. This suggests that poor representation of the stratosphere could be contributing to the underestimate of wintertime blocking occurrence in climate models.

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The stratospheric and tropospheric variability around the North Pole associated with the solar cycle and the QBO

Presenter: Yousuke Yamashita (yousuke@ccsr.u-tokyo.ac.jp)

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The 11-year sunspot cycle is a well known cycle of the solar activity. The total change of the solar irradiance related to the 11-yr solar activity is very small (0.1%), while the energy flux of the ultraviolet (UV) radiation changes few percent with the 11-year solar cycle (Lean et al., 1997). The temperature in the stratosphere is affected by the direct radiation with ozone, while the lower atmosphere can be influenced through the interaction with dynamics (Kodera and Kuroda, 2002). The relationship between the 11-year solar cycle and the polar temperature changes according to the phase of the Quasi-biennial Oscillation (QBO). Labitzke (1987) found that on the westerly phase of the QBO the NDJF mean temperature over the North Polar Region indicates warm anomaly in the high solar period (HS) and cold anomaly in the low solar period (LS) with Berlin data. But further studies showed that the lager correlation comes from the JF mean data (Labitzke and van Loon, 1988; Naito and Hirota, 1997); the relationship between the QBO, solar cycle and temperature over the North Polar Region is only seen in the late winter (JF), while no correlation with the solar cycle is found in the early winter (ND). In addition, horizontal structure of the temperature anomaly indicates north-south dipole structure between the North Pole and mid latitude (Labitzke, 2005), which is similar to the Arctic Oscillation (AO) or Northern Hemisphere annular mode (NAM). And variation of the AO/NAM is related to the intensity of the polar jet.

The vertical connection over mid and high latitudes of the northern hemisphere is also modulated by the solar cycle. Kodera and Kuroda (2005) mentioned that in the early winter of the HS the downward extension of zonal wind anomalies from the stratosphere to the troposphere forms meridional dipole type (AO-like) anomalies in the troposphere, while the downward extension is weak in the LS. The waves maintain the anomaly over the troposphere in the HS.

It is important to analyze the above-mentioned relationships with outputs of the atmospheric general circulation model (AGCM) which can be used to indicate the mechanism of these relationships. Since, we analyze the changes with solar cycle, we use the AGCM include the chemical interaction with ozone (Chemistry Climate Model).

In this study, we analyze the solar cycle modulations of the stratospheric variability and the stratosphere-troposphere coupling around the North Pole with observational datasets and the Chemistry Climate Model (CCM) outputs. The CCM in this study is based on the AGCM developed in the Center for Climate System Research (CCSR) and the National Institute for Environmental Studies (NIES), which include the effects of the 11-year solar cycle, QBO, and volcanic aerosol with observations. The CCM runs are performed with the REF1 scenario of Chemistry-Climate Model Validation

(CCMVal-REF1, Eyring et al., 2006). The analysis period is 1980-2000, and the 3 ensemble member is used.

We analyze the NCEP/NCAR reanalysis dataset for 1980-2000. In the late winter, the polar temperature is warm/cold at solar maximum/minimum in westerly phase of the QBO, which is similar to the late winter result in Naito and Hirota (1997). In contrast, the polar temperature in early winter is warm/cold at solar minimum/maximum in westerly phase of the QBO, while the statistical significance is low. This relationship is reverse of the results in late winter. We show the vertical connection and the results of the CCM in the presentation.

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Global Observation of Gravity Waves using HIRDLS Temperature Measurements

Presenter: Xiuping Yan (xy12@le.ac.uk)

X. Yan, N.F. Arnold, J.J. Remedios (University of Leicester, UK)

Previous studies have demonstrated the importance of the effect of gravity wave dissipation on the large-scale circulation and the thermal and constituent structures of the middle atmosphere. However, this effect has not been realistically represented in gravity wave parameterizations employed in most numerical models due to a lack of observations of the global distribution of gravity wave sources, propagation, growth and breakdown. Therefore, developing a global climatology of gravity waves has great potential for example for weather and climate and atmospheric chemistry applications. Satellite observation of gravity waves is in an advantageous position because of its consistent global coverage. Compared with previous instruments, HIRDLS (HIgh Resolution Dynamics Limb Sounder) has the highest vertical resolution (~1 km). This makes it suitable for globally observing vertically propagating gravity waves. A gravity wave extraction algorithm has been developed at the University of Leicester to extract and isolate gravity waves using HIRDLS temperature measurements. In the algorithm, the gravity wave temperature perturbations are calculated by removing the background field which includes stationary and slowly moving planetary waves. We then dynamically filter thermal tides, fast-moving planetary waves, equatorial Kelvin waves, and possible system effects from HIRDLS instrument and other effects from background atmosphere. Gravity wave temperature variances that represent the squared wave amplitudes are computed from the gravity wave temperature perturbations and investigated for seasonal gravity wave features. In this presentation, the development of the algorithm for extracting gravity waves will be explained and examples of the global gravity wave patterns in HIRDLS temperatures will be shown and discussed. The observed gravity waves will be further supported by a simulation model for HIRDLS gravity wave observations.

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An Idealized-Model Experiment on the Remote Influence of Interannual Variations in the Tropics to the Winter Polar Vortex

Presenter: Shigeo Yoden (yoden@kugi.kyoto-u.ac.jp)

S. Yoden, K. Ito and Y. Naito (Kyoto Univ., Kyoto, Japan)

Stratospheric sudden warming (SSW) is a major event to produce intraseasonal and interannual variations of winter stratospheric circulation in the Northern Hemisphere, of which signal propagates downward to the lower stratosphere and the troposphere with a time scale of O(10 days) as a leading annular pattern. It is considered as an important candidate to cause the remote influence of interannual variations in the tropics, such as the quasi-biennial oscillation (QBO) of the zonal mean zonal wind in the lower stratosphere and the 11-year solar cycle (SC) modulations of temperature around the stratopause level associated with the corresponding variation of solar ultraviolet radiation, to the interannual variations in high-latitudes in winter hemisphere (e.g., Labitzke, 1987, 2006; Labitzke and van Loon, 1988). Modulation of the propagation route of planetary waves is a possible mechanism to cause such remote influence to winter polar region (e.g., Holton and Tan, 1980, 1982; Kodera and Kuroda, 2002). However, rather rareness of the SSW events and highly nonlinear nature of the breakdown of the polar vortex make it difficult to obtain a clear dynamical understanding of the relationship.

In order to clarify such remote dynamical influences, we have performed numerical experiments on the effects of the equatorial QBO on SSWs by using an idealized global circulation model with a zonal momentum forcing to mimic a phase of the QBO. Naito and Yoden (2006) obtained almost one thousand SSW events by long time integrations under perpetual solstice condition, and showed the existence of 'Holton-Tan' relationship in the occurrence frequency of SSWs. We also found with statistical significance that the upward Eliassen-Palm (EP) flux in the troposphere after SSW events is still larger in the westerly forcing runs than in the easterly forcing runs.

In addition to the westerly or easterly forcing of the equatorial QBO, temperature anomaly around the stratopause level that mimic the SC modulations is introduced in another series of the numerical experiments by sweeping the latitudinal extent of the anomaly from the summer hemisphere. Some statistically significant relationship of the occurrence frequency of SSWs and mean intensity of the polar vortex is obtained for the combination of the equatorial QBO and the temperature anomaly around the stratopause consistent with the observations (Labitzke, 1987, 2006), although the 'solar' influence is much weaker than the QBO influence. Possible explanation of the relationship will be given by the dynamics of planetary waves diagnosed by EP flux.

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Scale-dependent Assimilation Schemes for Multi-Instrumental Constituent Observations: Forecast and Analysis of Vertical Ozone Structures in the UTLS

Presenter: Valery Yudin (vyudin@ucar.edu)

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The paper examines the ability of operational analyses of ozone (O_3) in the UTLS (upper troposphere and lower stratosphere) to reproduce vertical profiles observed by the Aura HIRDLS and MLS O_3 retrievals as well as by other available space-borne and in situ ozone measurements. Results suggest that inadequate application of assimilation algorithms to data characterized by insufficient vertical resolution may degrade vertical structures of constituents predicted by models and confirmed by observations with high vertical resolution. The scale-consistent horizontal and vertical scanning of the stratosphere by the HIRDLS instrument highlights the frequent formation of thin (2-4 km) layers of ozone and nitric acid observed between 10 and 20 km. These ozone lamina associated with event-driven air-mass intrusions between the tropics, mid- and high latitudes can be simulated by chemistry transport models driven by analyzed winds, however they appear to be destroyed by analysis of smoothed ozone profiles or partial sub-columns. In the extra-tropical UTLS these shortcomings of analyses can break the correlations between ozone and potential vorticity attributable to these thin layers introducing errors in the cross-tropopause transport and mixing of chemical tracers. Scale-dependent algorithms for analysis of data that cannot provide vertical resolution comparable to O_3 forecast are discussed. These schemes can be considered as pathways for analysis of the multi-instrumental ozone data reported by instruments with different horizontal and vertical probing of the UT and stratosphere. The role of resolution kernels in assimilation of constituents is discussed for combined analysis of nadir-viewing and limb-viewing measurements. Along with appropriate algorithms, the pre-assimilative screening of retrieved ozone profiles and corresponding resolution kernels provides the opportunity to establish data quality control procedures that help to prevent degradation of ozone vertical structures resulting from analysis of noisy and rank-deficient constituent retrievals. Scale-dependent data analysis outlined in this talk highlights the physical foundation of the statistical assimilation. It illustrates the importance of adequate forward and backward propagation of information (and its uncertainties) between observable and simulated scales with scale-dependent reduction of forecast errors after each analysis step. The topics discussed will be illustrated by assimilation case studies during Arctic winters of 2006-2008.

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Water vapour in the polar and tropical UT/LS from balloon and aircraft observations with FLASH Lyman-alpha hygrometer

Presenter: Vladimir Yushkov (vladimir@caomsk.mipt.ru)

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E.Kyrö (Finnish Meteorological Institute, Finland)

We present a summary of in-situ water vapour measurements using FLASH Lyman-alpha hygrometer flown on board both balloon and M55-Geophysica aircraft during the recent years. The high quality and performance of the FLASH instrument has been confirmed by a number of field and laboratory intercomparison campaigns (LAUTLOS-WAVVAP, AQUAVIT).

The series of water vapour profiles obtained using balloon FLASH-B sensor at the two Arctic stations (Ny-Alesund, 79 N and Sodankyla, 67.4 N) during 2004/05, 2005/06 and 2007/2008 winters allows case studies and detailed characterization of stratospheric water vapour vertical distribution within different conditions in the Arctic Polar stratosphere.

Vertical profiles of water vapour obtained with FLASH-B above Western Africa in August 2006 during SCOUT-O3-AMMA balloon campaign show evidence of the presence of local accumulations of water vapour enhanced layers between the tropopause at 370 K and the 450 K level. Most of them are shown connected with overshooting events upwind identified from MSG satellite IR images, flown over by the air mass probed by the sondes along three days backward trajectories. In the case of a local overshoot identified by echo tops turrets up to 18.5 km in the C-band radar, tight coincidence was found between enhanced water vapour, ice crystal and ozone dip layers indicative of fast uplift of tropospheric air across the tropopause. The water vapour mixing ratio in the enriched layers, higher than that of condensation at the tropopause, and the coincidence with the presence of ice crystals strongly suggest hydration of the lower stratosphere by geyser-like injection of ice particles over overshooting turrets.

Cases of supersaturation inside and outside the clouds from both balloon and airborne observations in the upper troposphere are considered.

ID: 00410 ◀back

Properties of the extra-tropical tropopause transition layer (ex-TL) from high-resolution O_3, CO, H_2O, acetone, and acetonitrile observations onboard the CARIBIC passenger aircraft

Presenter: Andreas Zahn (andreas.zahn@imk.fzk.de)

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The extra-tropical tropopause (transition) layer (ex-TL) names a layer sandwiched at the lower border by the (chemically defined) extra-tropical tropopause and at the upper border by the unperturbed lowermost stratosphere (LMS) not influenced by recent in-mixing of tropospheric air. The ex-TL is usually identified by tracer-correlations observed onboard aircraft. Many properties of the ex-TL such as its seasonal variation, its ventilation/turnover time, or its short-term variability, in particular its convection-induced impact from chemically young low-tropospheric air are badly quantified, yet. Likewise, its relation to the recently discovered and meteorologically defined tropopause inversion layer (TIL) is not known, yet.

A unique dataset collected during more than 100 flights onboard the CARIBIC passenger aircraft as of May 2005 contains a wealth of new information on the ex-TL between ~100ºW and ~100ºE and ~35ºN and 60ºN. Here, we concentrate on O_3, CO, H_2O, and organic compounds such as acetone and acetonitrile. All these trace gases show a pronounced seasonal variation around the extra-tropical tropopause with partially surprisingly little short-term variability. For instance, acetone as a major precursor of OH around the tropopause varies by a factor of three between summer and winter. Derived OH production rates from the photolysis of O_3 and acetone are discussed. Year-around in-mixing of tropospheric air into the LMS, i.e. a presence of an ex-TL was observed. However, in summer the ex-TL seems to reach far higher into the stratosphere and the dispersion of injected tropospheric air could be followed until about November when the subsidence of clean O_3-rich air from higher altitude set in. The contribution also elucidates the different information inferred from the different types of analyzed tracers. For instance, the O_3-H_2O correlation derived ex-TL shows a stronger seasonal variation compared to the one inferred from the O_3-CO relationship. The different tracer lifetimes enable us to estimate the turnover times of the ex-TL.

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Aerosol Distribution over the Qinghai-Xizang Plateau and Its Relationship with O_3

Presenter: Renjun Zhou (zrj@ustc.edu.cn)

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Using the HALOE data (from October 1991 to November 2005), the distributions and variations of aerosol concentration, volume density, surface area density over the Qinghai-Xizang Plateau have been analyzed, and their relationships with ozone have discussed, then the aerosol distribution and the relationship between aerosol and ozone over the Qinghai-Xizang Plateau are compared with those over the eastern part of China and over the North Pacific. The following conclusions are made: The influence of Pinatubo volcanic eruption on aerosol volume density, area density over the Plateau appeared significantly in 1991 to 1995; however the effect on aerosol concentration was not as clear as the volume density and area density. There is a higher value of aerosol concentration near the tropopause over the Plateau which locates beneath the tropopause (~120 hPa) in summer and above the tropopause (~100 hPa) in winter. The main differences in aerosol densities over Qinghai-Xizang Plateau, the eastern part of China and North Pacific occur below 60 hPa. The differences are the most notable in summer: aerosol concentration at 120 hPa over the Plateau is 1.8 times as large as that over the Plain, and 5.5 times as large as that over the Ocean. Near the tropopause and in the low stratosphere, the aerosol concentration and ozone mixing ratio have a good negative correlation over the Plateau, but they have a significant positive correlation above 20 hPa. Compared the relationship between aerosol and ozone over the three regions, the results indicate: Near the tropopause and in the low stratosphere, the negative correlation of aerosol concentration and ozone mixing ratio is obvious over the Plateau and over the Plain, but their correlation over the Ocean is not clear. Aerosol concentration and ozone mixing ratio appear a good positive correlation above 20 hPa over the three regions.

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Do atmospheric aerosols form glasses?

Presenter: Bernhard Zobrist (zobrist@env.ethz.ch)

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A new mechanism is presented by which organic enriched aerosols might influence ice nucleation and ice growth: the formation of glassy aerosol particles. Glasses are disordered amorphous (non-crystalline) materials that behave mechanically like solids. Glasses can be formed by cooling a liquid until the viscosity increases exponentially and molecular motion practically ceases. At this point, many thermodynamic properties of the liquid change abruptly to that of a solid, defining this as the glass transition temperature, Tg. We have experimentally determined the Tg-values and homogeneous ice freezing temperatures of organic, inorganic and multi-component aqueous solutions as a function of the solute concentration using a Differential Scanning Calorimeter. We show that aqueous solutions of inorganic solutes have Tg-values that are too low to be of atmospheric importance. In contrast, our results suggest that purely organic or organic enriched aqueous solutions can readily form glasses at temperatures and relative humidities relevant forthe upper troposphere. The results further imply that glass forming abilities of organic substances depends foremost on the molar mass of the organic molecules, and to a minor effect also on the structure and hydrophilicity of the molecules. Therefore, aerosol particles containing larger and more hydrophobic organic molecules are more likely to form glasses at intermediate to high relative humidities in the upper troposphere. From our results one can conclude that ice nucleation as well as ice crystal growth can be significantly reduced and/or even completely inhibited in organic aerosols at upper tropospheric temperatures with implications for cirrus cloud formation and upper tropospheric relative humidity.

ID: 00439 ◀back

Vertical and horizontal extent of supersaturated regions near the extra-tropical tropopause over North America

Presenter: Mark Zondlo (mzondlo@princeton.edu)

M. Zondlo, M. Paige, J. Silver, S. Massick (Southwest Sciences, Inc., USA) and START08 Science Team (NCAR, Boulder, USA)

Ice supersaturations in clear skies are important in the transport, microphysics, and radiative properties of the upper troposphere and lower stratosphere. Yet there remain many questions with regard to their extent, depth, and frequencies of occurrence in this region. In addition, very little information is available on supersaturated regions near the extratropical tropopause. Because high-altitude research aircraft usually focus on the tropical tropopause and more conventional tropospheric research aircraft often have difficulty exceeding 12 km for long periods, the NSF G-V is an ideal platform to probe this region. The NSF G-V aircraft is flying for 150 hours over North America this spring to examine the transport and chemistry between the troposphere and stratosphere in the extratropical region as part of the NSF START08 (Stratosphere-Troposphere Analyses of Regional Transport 2008) field campaign. This campaign will focus on the extratropical tropopause region that usually spans the 12-15 km region during spring in most of North America. The START08 campaign is also the first time the vertical cavity surface emitting laser (VCSEL) hygrometer will be used for routine deployments on the G-V.

As with all water vapor instruments (especially new ones), it is important to document VCSEL hygrometer performance under in-flight conditions as much as possible. The precision and accuracy of the sensor will be initially discussed based upon recent field and laboratory studies. Flight data from the campaign have shown excellent precision in-flight at 14.9 km (134 hPa) with 25 Hz deviations of < 2.6% (1 sigma) at 3.5 ppmv and overall accuracies between 5-10% based on the Aqua-VIT field campaign, comparison to other sensors, and additional laboratory studies. In this regard, a novel method for calibrating the sensor will be briefly discussed. The calibrations consist of sealing the optical portion of the instrument in a small (~ 0.5 L, 2.5 cm inner radius, 25 cm length), high-vacuum chamber (no o-rings) with ambient levels of water vapor. The sealed chamber is then immersed in a constant temperature, organic slush bath made with liquid nitrogen. Vapor deposition to the interior walls results in a frost layer equilibrating to the gas phase within the sealed chamber. The phase change of the organic solvent maintains a constant, accurate, and reproducible temperature inside the chamber for hours. Baths can be readily made from chloroform (209.7 K) among other solvents at different temperatures. These baths also avoid the use of flows which can create large offsets from outgassing of room-temperature lines and fittings and unknown amounts of water vapor in source air cylinders.

Water vapor measurements from the VCSEL hygrometer during START08 will be presented in the context of identifying the spatial extent, depth, and frequency of occurrence of ice supersaturated regions over mid-latitude North America. The 25 Hz sampling rate of the VCSEL hygrometer also allows for finer resolution of the structure within and near supersaturated regions, particularly with respect to localized updrafts in highly turbulent regions near the jet stream. The START08 results will be

compared to other measurements including AIRS satellite data, MOZAIC-IAGOS results, and other field campaigns. In addition, this dataset will be the starting point for additional measurements onboard the G-V over the next 2-3 years including seasonal longitudinal transects from the Arctic to the Antarctic regions being planned for the NSF G-V, plus other campaigns.

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Analysis of three-dimensional Elliassen-Palm fluxes in the lower stratosphere

Presenter: Yulia A. Zyulyaeva (yulia@sail.msk.ru)

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Using the monthly mean NCEP/NCAR reanalysis dataset, the three-dimensional Elliassen-Palm (EP) fluxes of quasi-stationary wave propagation were calculated in the lower stratosphere for each month (November-March) 1958-2007. Results showed that the strong planetary wave propagation from the troposphere to stratosphere occurs over the northern Eurasia, while their weak downward propagation is observed in Labrador and South Greenland regions in the lower stratosphere. The interannual variations of the vertical EP fluxes also have dipole-like anomalies in the western and eastern hemispheres which are most prominent in January-February. There are large differences in the interaction between the zonal mean circulation and wave processes in the early winter (November-December) and mid-to-late winter (January-March). Amplification of the penetration into the stratosphere and the focusing to polar regions of the planetary waves in December are associated with the changes of stratospheric dynamics in January, creating of ìpreconditioningè for stratospheric warming appearances. This gives an evidence of a long lifetime (~ one month) in the stratospheric zonal-wave interaction during this period. In years with the weak polar vortex in January-March, the simultaneous weakening of planetary wave penetration into the stratosphere over the northern Eurasia and downward vertical EP fluxes over North Atlantic is observed. In contrast, a ‘stratospheric bridge’ with a strengthening of the EP downward propagation over North Atlantic is being formed during years with the trong polar vortex. Causes of interannual wave activity variations and possible mechanisms of the stratosphere-troposphere coupling are discussed.

Directions

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For details see http://www.cmcc.it/web/public/sparc-ga2008

ROTONDA C.N.R.
Lower symbol: Main entrance of CNR Conference Center (on the back of via Gobetti 101. Final stop of bus 87. →

ROTONDA GOBETTI
Stop of Bus 11A. From here Continue on foot (10') to "Rotonda CNR" (blue path). Bus back to downtown leaves on the other side of the street. →

Savhotel, Via F. Parri, 9
Phone 051-361361 →

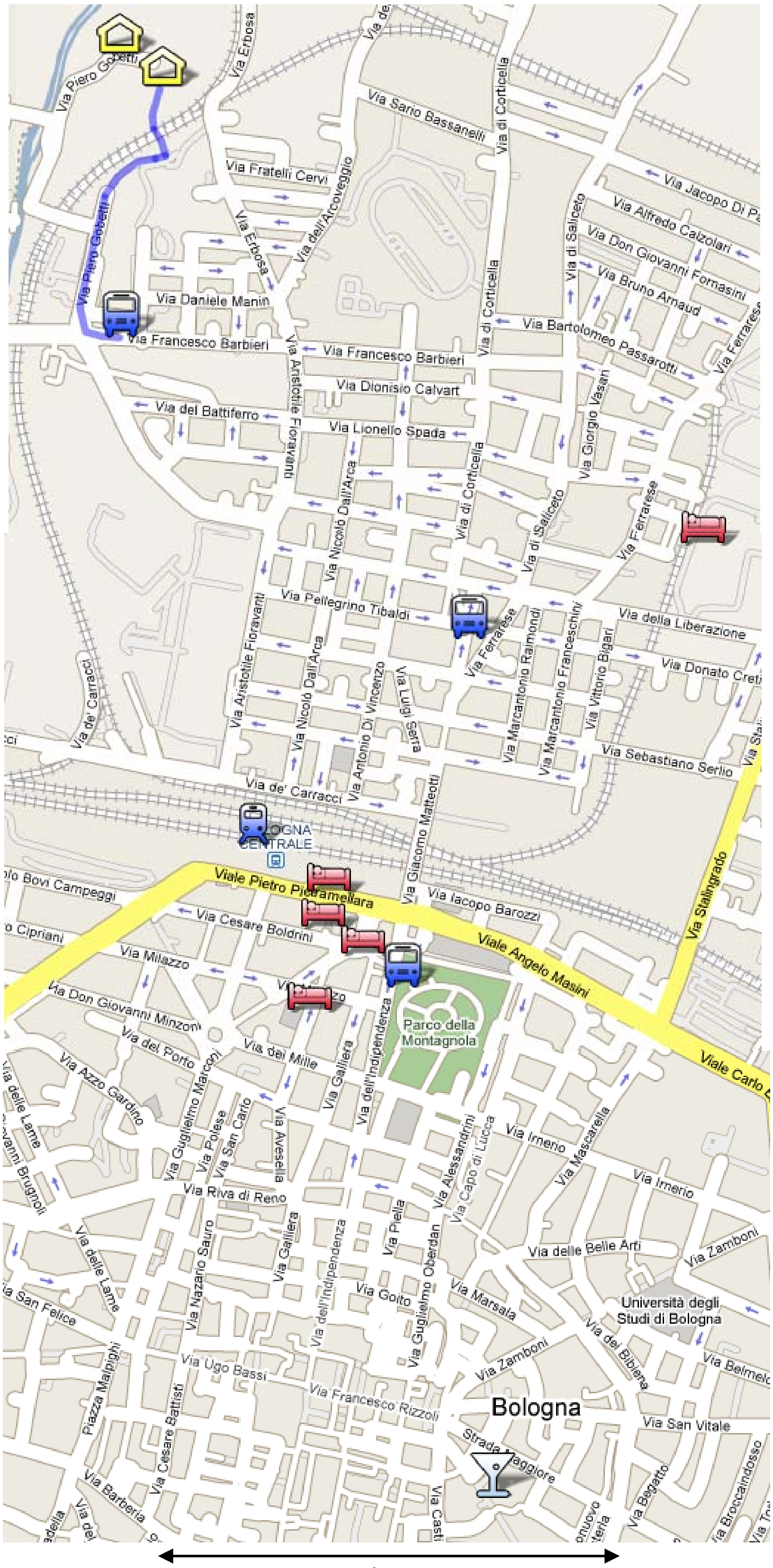
PIAZZA DELL`UNITA` →
Stop of SPARC shuttle and public buses 11A (for Rotonda Gobetti) and 87 (for Rotonda CNR).

BOLOGNA CENTRALE
Central station and stop of "Aerobus" from/to airport. Departs every 15', takes 30-60'. →

AUTOSTAZIONE – SPARC shuttle stop. Also public buses:
87 (for Rotonda CNR) and 11A (further down the road). →

Hotels (from N to S): ↗
(1) Mercure Bologna Centro
59, Vl. Pietramellara ; 051-42211
(2) Starhotel Milano Excelsior
Viale Pietro Pietramellara, 51; 051-246178
(3) Jolly Hotels De La Gare
Piazza Venti Settembre 2 ; 051-281611
(4) Albergo Royal Hotel Carlton
Via Montebello, 8; 051-249361

Palazzo Isolani
SPARC GA Dinner →
Via Santo Stefano 16, Bologna



1 km

Rotonda = roundabout

The SPARC Shuttle Bus

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Time table for the direct SPARC shuttle to and from the CNR Conference Center. Each bus carries about 100 people (43 seated, the rest standing).

The buses will have posted the sign “RISERVATO” “SPARC”.

The time is the departure at the “**Autostazione**” stop, also the stop of public bus **87** (close to the end of via Indipendenza, before the end of the arcade) for “Rotonda CNR”. Shortly thereafter (after the arcade is finished) there is public bus **11A** for “Rotonda Gobetti”.

The departure times at the “Piazza dell’Unita” stop (also bus stop of bus **11A** and close by also bus **87**) are a few minutes later.

(Note that, in case you wish to take the public bus instead of the SPARC shuttle, bus 11C does NOT drive to “Rotonda Gobetti”. Ticket Fare 1 Euro)

	Autostazione => CNR	**CNR => Autostazione**
31 / 08 Sunday	11:30, 11:35, 12:00, 12:05	19:30, 19:35, 19:50, 19:55
01 / 09 Monday	8:00, 8:05, 8:30, 8:35	18:50, 19:20, 19:50
02 / 09 Tuesday	8:00, 8:05, 8:30, 8:35	18:50, 19:20, 19:50
03 / 09 Wednesday	8:00, 8:05, 8:30, 8:35	13:30, 14:00, 14:30
04 / 09 Thursday	8:00, 8:05, 8:30, 8:35	18:50, 19:20, 19:50
05 / 09 Friday	8:00, 8:05, 8:30, 8:35	18:50, 19:20, 19:50

Taxi: downtown / airport to the CNR Conference Center, about 10-15 Euro

Public Bus No. 87

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The nearest stop to the Central Train Station is AUTOSTAZIONE (piazza XX Settembre).

The fare is 1 euro for a 60 minutes ticket; otherwise you can buy a daily ticket (3 euro) or a CITY PASS 8 trips (6,50 euro). You must buy the ticket in advance, at the ATC ticket office in the Station, or at the news-stands.

The following is an excerpt from the public bus time table, i.e. only times of potential interest for SPARC GA participants are shown:

To reach C.N.R. (the bus comes from Castelfranco Emilia - to Bologna)

BORGO PANIGALE	7.27	7.45	8.00	8.15	8.35	8:58	9:28	9:58	10.28	10.58	11.28	11.58	12.28	12.58	13.28	13.58
V.MARCONI	7.57	8.15	8.30	8.45	9.05	9:25	9:55	10.25	10.55	11.25	11.55	12.25	12.55	13.25	13.55	14.25
AUTOSTAZIONE and Railway Station	8.01	8.19	8.34	8.49	9.09	9:29	9:59	10.29	10.59	11.29	11.59	12.29	12.59	13.29	13.59	14.29
C.N.R.	8.10	8.28	8.43	8.58	9.18	9:38	10.08	10.38	11.08	11.38	12.08	12.38	13.08	13.38	14.08	14.38

To leave C.N.R. (the bus continues to Castelfranco Emilia)

C.N.R.	12.55	13.25	13.55	14.25	14.55	15.25	15.55	16.25	16.55	17.25	17.55	18.25	18.55	19.25
AUTOSTAZIONE and Railway Station	13.04	13.34	14.04	14.34	15.04	15.34	16.04	16.34	17.04	17.34	18.04	18.34	19.04	19.34
V.MARCONI	13.10	13.40	14.10	14.40	15.10	15.40	16.10	16.40	17.10	17.40	18.10	18.40	19.10	19.40
BORGO PANIGALE	13.32	14.02	14.32	15.02	15.32	16.02	16.32	17.02	17.32	18.02	18.32	19.02	19.32	20.00

In case you got lost:

CNR Conference Center
Via Gobetti 101
Bologna

SPARC GA
Registration Desk
Victoria De Luca
Tel.: +39.051.6398153

2008

SPARC