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WORLD CLIMATE RESEARCH PROGRAMME

STRATOSPHERIC PROCESSES AND THEIR ROLE

IN CLIMATE (SPARC)

REPORT OF THE THIRTEENTH SESSION OF THE SPARC SCIENTIFIC STEERING GROUP

(Oxford, UK, 26-29 September 2005)

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1. Introduction

The 13th session of the SPARC Scientific Steering Group (SSG) was held at the Lady Margaret Hall, University of Oxford, at the invitation of **A. O'Neill**, Co-Chair of the SPARC. In opening remarks **A. Ravishankara**, Co-Chair of SPARC, noted that SPARC was at an important stage in its lifecycle, taking on new issues in the framework of the three-theme project structure. The development of COPES presents new challenges and opportunities for the WCRP, necessitating even stronger interactions with IGBP and other agencies. The IPCC AR4 and WMO/UNEP Ozone Assessment are in full swing so that the next 2-3 years will provide the opportunity to shape the science for future assessments and to position SPARC to make key contributions.

2. COPES and SPARC

P. Lemke, Chair of the WCRP JSC, presented an overview of WCRP achievements and its future activities in the context of the COPES strategic framework. The WCRP has worked towards understanding and predicting the Earth system through international coordination of global observation, process studies and modelling. These activities have been carried out within the WCRP projects and various working groups. Through such interaction, the WCRP has helped to enhance the understanding of the climate system, make significant improvements in observing systems, improve coupled climate models, and make advances in assimilation techniques and forecast models.

Future activities within the WCRP must address a number of outstanding science questions relating climate variability and change, including causes of potential abrupt climate change (mechanisms and thresholds), simulation of ice age cycles, prediction of sea level rise, studies on the role of chemistry and its interaction with climate, and interaction of water vapour, clouds, radiation, precipitation and aerosols. Development of ensemble methods will enable the prediction of extreme events, and understanding, quantifying and reducing uncertainties of future predictions and projections. Society will benefit from decision-making based on regional climate prediction and early warning systems.

Several task forces and coordinating bodies have been established by the WCRP to facilitate implementation of COPES initiatives. The new WCRP Modelling Panel and Observations and Assimilation Panel (WMP and WOAP) have a coordinating role. The Task Force on Seasonal Prediction (TFSP) determines the seasonal predictive skill achievable with today's models and observations. The goal is to identify sources for as yet untapped additional predictive potential. More task forces will be established in the near future to address studies of monsoons, atmospheric chemistry and climate and, possibly other topics. P. Lemke noted that SPARC will continue to address and provide leadership for a number of issues that overlap with other WCRP projects, working groups, and partner organizations, especially in the area of chemistry and climate.

V. Ryabinin informed the meeting about the new COPES project office in Paris. It has been in operation since March 2005 and has already supported several important WCRP events. Jean Jouzel is the Administrative Director and Hervé Le Treut is the Scientific Director. The office may be reached by email at copes@ipsl.jussieu.fr. More information may be obtained on the website at http://copes.ipsl.jussieu.fr. The office is supporting the organization of the ESSP Open Science Conference on Global Environmental Change (9-12 November 2006, see www.essp.org/essp2006).

A. O'Neill discussed overarching issues for SPARC, and developments since the last SSG meeting. He noted that a wider range of questions will be considered in future SPARC activities, and that the SPARC themes and activities emphasising prediction, predictability and observations map directly onto COPES. The questions put to the JSC in regard to the chemistry and climate issue, and the JSC response, were summarized in SPARC Newsletter No. 25. In regard to this issue, the JSC re-affirmed the need to develop a road map for chemistry-climate models (CCMs), observations and process studies. The establishment of a joint WCRP-IGBP Task Force was proposed, and planning is now under way for a small group to meet in Boulder later this year to discuss the way forward. The need for inter-calibration of

stratospheric data from various satellites was drawn to the attention of GCOS, and a "reprocessing" project has been proposed under WOAP to increase the accuracy of climate data sets obtained from remote sensing. The concept of this project is being developed. Several workshops joint with other WCRP and IGBP projects are in the planning stages for 2006/2007. In addition, SPARC will work with WGCM to update top-of-atmosphere solar forcing data, and will continue to pursue activities and interests in solar effects on composition and atmospheric variability.

The JSC strongly encouraged SPARC working with CLIVAR. This was explored further at the joint SPARC-CLIVAR session at the AMS meeting in June 2005, which served to highlight a number of overlapping SPARC and CLIVAR interests:

- Stratosphere-troposphere coupling and the North Atlantic Oscillation (NAO)
- Detection, attribution and prediction of stratospheric changes and the CLIVAR themes of climate change detection, attribution and prediction
- Chemistry-Climate Interactions (IGBP/IGAC)

A joint CLIVAR/SPARC Workshop on the NAO in the "fully" coupled system was proposed, probably in 2007. This workshop will focus on mechanisms, and NAO predictability and timescale. A goal of the workshop is production of reader-friendly review article on the state of knowledge and where we go next.

3. SPARC THEMES: PROGRESS and ISSUES

3.1. Stratosphere – Troposphere Dynamical Coupling

S. Yoden discussed recent and ongoing work in regard to this theme, with relevance to the TFSP. The timescales considered are intraseasonal to seasonal (*e.g.* wave dynamics, 10 days to several months), interannual (*e.g.* internal variations, responses to 'external' forcings such as the QBO and ENSO), and interdecadal and longer (*e.g.* changes in the Brewer-Dobson circulation and polar vortex). Processes that involve stratosphere – troposphere coupling include stratosphere – troposphere exchange and transport processes, changes in the Brewer - Dobson circulation, processes involving the polar vortex, extreme weather events, *etc*. Evidence was presented of an internal intraseasonal variation that showed persistent circulation anomalies in the lowermost stratosphere, and allowed for extended-range forecasts of the monthly-mean Arctic Oscillation (AO), especially during boreal winter.

The TFSP held a workshop on Seasonal Prediction in Trieste, Italy, August 22-24, 2005 (http://users.ictp.trieste.it/~h093/) with a focus on 'seamless' weather to climate prediction, and the importance of the stratosphere in forecasting models. In addition, a joint CLIVAR/SPARC workshop on the NAO and the stratosphere has also been proposed (noted above), as well as a SPARC stratosphere-climate workshop. The next ST Coupling Workshop will also be a Chapman conference on Santorini (Greece) in June 2007. This will be a natural fit after the experience with the Chapman Conference on Jets held in Savannah, January 2006.

P. Kushner and W. Robinson have proposed a SPARC project to explain the dynamics of the most robust results among current climate models using dynamical analysis and simple dynamical models. The questions to address are: (a) Why would we expect the Brewer-Dobson Circulation (BDC) to strengthen? (b) Which parts of the BDC response to climatic change are attributable to the greenhouse gas warming and which to ozone depletion? (c) To what extent are the models sensitive to their treatment of unresolved (*e.g*. gravity) waves and other dissipative processes? A subproject will systematically examine the dynamics of the BDC response to climate change, using a variety of tools including stationary wave modelling, diagnosis of reflective surfaces, zonally symmetric model calculations, and simplified GCMs. Still needed are: (a) a better characterization of planetary wave-drag (PWD) variability and its chemical consequences; (b) a distinction in model diagnostics between the pure radiative response to a forcing and the PWD feedback; (c) understanding of tropospheric *vs*. stratospheric effects on PWD; (d) reduction in uncertainty of PWD predictions; (e) ensembles of model integrations; (e) PDFs of short-term behaviour.

3.2. Detection/Attribution/Prediction

W. Randel noted that the main thrust of this theme at the moment is the updated trend assessment. The scope is to provide an update of the observed stratospheric temperature record (through 2004), and improve the understanding of past changes and predictions of future stratospheric temperature changes, especially by reducing uncertainties in the predictions. The first meeting occurred in March 2005 in Reading to plan the scope of the project and to take an initial look at the updated observations. It was decided that the group would first write a paper on the updated observations, with focus on satellites, radiosondes and lidar data. A draft should be completed before 2nd meeting planned for Oct 20-21 in Boulder.

The initial results show a flattening of trends at the stratopause, and a small long-term cooling in middle stratosphere. However, biases in the data are as large as the signal and these biases extend into the upper and middle troposphere. Some key points to consider are that the stratospheric temperature record is highly dependent on SSU data (currently, only one analysis of combined SSU record), and that there are small trends in tropical lower stratosphere in MSU4 and SSU15x data and that these trends are very different from ones obtained using radiosonde data. This is probably a result of artificial cooling biases in the radiosonde ascent observations, causing jumps in the timeseries at some stations. The strong upper stratospheric cooling ends after 1995, in reasonable agreement with the HALOE data, and there are small global trends in the middle stratosphere in the SSU data. A small cooling trend is also seen in the tropics when the less biased sondes are used.

Two questions that arise are: a) Why are the middle atmosphere trends so small? and b) Why does the Boulder data not agree with the HALOE data, which shows a sharp drop in water vapour after 2001? Of all the data, the Boulder data is the only data that are not fully understood. In addition, it has been shown that using reanalysis or operational analyses/reanalyses data sets is problematic for studying trends.

T. Shepherd continued discussion of the Detection, Attribution and Prediction theme by highlighting questions concerning understanding of the natural variability. In 1997, there was considerable concern about the rapid decrease seen in both temperature and ozone in Arctic spring. Today, that behaviour looks more like a fluctuation. In addition, changes in total ozone over the last 25 years in both hemispheres seem roughly consistent with Cl_y loading, but there are also shorter-term fluctuations that we would like to understand. This may be possible using imposed “forcings” (volcanic aerosols, solar, SSTs, QBO), however, some of these forcings are actually internal variability, and so imposing these in models gives only partial understanding of the climate system. One key question for the attribution, detection and prediction theme is quantifying the natural variability, which appears to possess long time-scales that are comparable to the perturbations themselves. It cannot be assumed that every decadal fluctuation is a trend.

3.3. Chemistry-Climate

A. Ravishankara opened the discussion on the Chemistry-Climate Interactions theme. This is becoming of major importance for SPARC because of the CCMVal activity, now the umbrella for chemistry-climate modelling, and interactions with other agencies such as IGAC, which force us to consider including the ‘lower’ atmosphere in our work. Clearly, the SPARC mandate now includes the upper troposphere. Key questions for this theme are to determine if we are on the right track and to identify the needs for future assessments and the community.

There have also been collaborations with IGAC on some activities (usually reviews, reports, workshops, “priming” participants for assessments, *etc*.). Issues for discussion now are how to manage the activities of CCMVal, how to collaborate with other WCRP and IGBP projects, in anticipating the key needs for the future, and the SPARC contribution to IPY.

V. Eyring discussed the current structure and ongoing activities of CCMVal. In consultation with the CCM community, CCMVal has proposed reference simulations for ensemble predictions to support upcoming ozone and climate assessments (published in SPARC Newsletter No 25). In order to serve the CCM

community, and to facilitate the set-up and encourage the use of the reference simulations, a website where the forcings for the simulations can be downloaded has been established at http://www.pa.op.dlr.de/CCMVal/Forcings/CCMVal_Forcings.html.

The proposed scenarios were developed to address the following key questions outlined by the WMO/UNEP Steering Committee to be of significance to the upcoming assessment:

- How well do we understand the observed changes in stratospheric ozone (polar and extra-polar) over the past few decades during which time stratospheric climate and constituents (including halogens, nitrogen oxides, water, and methane) were changing?
- What does our best understanding of the climate and halogens, as well as the changing stratospheric composition, portend for the future?
- Given this understanding, what options do we have for influencing the future state of the stratospheric ozone layer?

In order to address the first questions, two reference simulations and two sensitivity simulations have been proposed and the forcings have been made available on the website. Ftp sites are currently available to store CCM data at the UK Met Office, the British Atmospheric Data Centre (BADC), and the SPARC Data Center.

A comprehensive intercomparison of CCM results and observations has successfully started. The CCMVal 2005 workshop in Boulder will assess progress in the validation of current CCMs and assess how CCMs model results can support the 2006 UNEP/WMO Scientific Assessment of Ozone Depletion.

C. Granier discussed two other international chemistry-climate projects using a multi-model approach similar to CCMVal — the SANTAFE project coordinated by NCAR, and the ACCENT European network, funded by the EC (2004-2009). The focus of the SANTAFE project is to produce simulations for the 1850-2000 and 2000-2100 periods with no specification of emissions except for 2100 (scenario A2). A paper analysing nitrogen deposition has been accepted for publication. ACCENT/IPCC had a larger number of models involved and a central goal of providing information for the IPCC assessment.

These exercises have made clear that fully coupled CCMs, some including oceans and biospheres, are becoming more available for such experiments. However, these models require large computer (and human) resources. A coordination effort in defining the intercomparisons and runs for assessments is needed so that both tropospheric and stratospheric studies may be done with as much overlap in the computer experiments as possible, with similar boundary/initial conditions, and overlapping archives. To this end, SPARC would need to establish formal contacts with other WCRP/IGBP groups. It is noteworthy that the AIMES Project (Analysis, Integration and Modelling of the Earth System) of the IGBP is now under way and will hold its first steering committee meeting in November 2005.

T. Shepherd described the proposal to support Canadian contributions to SPARC for the 2006-2011 period, which had been submitted to Canadian funding agencies (CFCAS and NSERC). The Canadian proposal follows the main SPARC themes and includes a component on stratospheric and mesospheric data assimilation. The issue of understanding natural variability and long-term memory enters the proposal plans in various ways: (a) statistical analysis of coupled (A-O) transient simulations, (b) separating direct and indirect response to forcings, (c) analysis of the statistics of extreme events and short-term trends (and their sensitivity to SST variability and the QBO).

On behalf of S. Pawson, **N. McFarlane** presented a plan to do AMIP-style evaluations for GCMs with well-resolved stratospheres. The participating models would preferably have the capability of running with chemistry, but would not run with chemistry for these runs. The study focuses on the abilities of the models to represent the basic dynamical features of the middle atmospheric circulation, as well as their links with the troposphere. There is an emerging realization that statistical uncertainty limits confidence in comparisons, and that model simulations of only a decade or so may be inadequate to properly characterize variability in the stratosphere. The AMIP-style experiments, like GRIPS, would focus on the stratosphere, but would have more constraints.

The proposed activity should complement CCMVal, in which the main focus is chemistry-climate, and processes-oriented validation. There remain a number of first-order questions about GCM performance such as the ability to represent polar vortices, sudden warmings and final breakdowns, stratosphere-troposphere relationships, tropical dynamics, and stratosphere-troposphere exchange. These issues are unlikely to be impacted by the inclusion of chemistry, and multi-annual simulations are needed to study them, making runs with full chemistry expensive. While there was general support among the SSG for this proposed activity, the matter of organizing it and determining when it may take place was left for further discussion at the CCMVal workshop, or following it.

A. Ravishankara led a brief discussion on the WMO/UNEP 2006 Ozone Assessment and SPARC's possible contributions to it. The assessment is well under way and the first draft is due at the beginning of November. A large number of SPARC members are the lead authors for the assessment and T. Shepherd, M.-L. Chanin and A. Ravishankara are on the scientific steering committee. CCMVal runs will be a major input, and many of the SPARC assessments (ASAP, temperature trends, PSC report) will provide direct input. The joint SPARC/IGAC UTLS workshop in May 2005 also provided some key legwork on bromine.

G. Braathen gave a short presentation on WMO matters. In regard to ozone bulletins, he identified some outstanding issues and posed several questions to SPARC:

- Is there a better way to characterize the polar vortex dynamics?
- Can the SPARC community assist ECMWF in fixing the problem of spurious oscillations in analysis data?
- Ozone Recovery: How can we measure it? Where can we measure it? What are the criteria? How can we be sure that a change in ozone is due to reduced EESC?
- Can the SPARC community help GAW/NDSC to look out for recovery?

L. Thomason summarized key features of the Aerosol Assessment Report (ASAP), which is near completion and will be printed in November 2005. Key results from the report are summarized later in this issue of the newsletter. Briefly, it was found that no long-term trends in stratospheric aerosol have been observed, the dominant precursor gases are OCS and SO_2, and that disagreements between the various data sets and models indicate that substantial questions remain regarding the nature of stratospheric aerosol during volcanically quiescent periods particularly in the lower stratosphere. In addition, it was found that in the last three decades only the last several years can be confidently referred to as 'background'.

T. Peter presented an update on the SPARC PSC Assessment (SPA) report and the kick-off meeting for the lead authors, on behalf of K. Carslaw. The SPA Kick-Off meeting was held at the Coolfont Resort in West Virginia, USA in March 2005. An update report on the main progress at the KO meeting was included in SPARC Newsletter No. 25 (July, 2005). Agreement on the organisation of the chapters and writing tasks was achieved at this meeting, including the possibility of adding a chapter aimed at the broader atmospheric science community entitled "Twenty Questions About PSCs". A further SPA Science meeting (for review and discussion of preliminary chapters) will be held in April 2006. The target date for completion is the end of 2006.

4. The Role of SPARC in IPY

N. McFarlane presented progress in developing a proposal for IPY. On behalf of SPARC, an Expression of Intent (EoI) was submitted to the IPY International Programme Office with the title "The structure and evolution of the stratospheric polar vortices during IPY and links to the troposphere" (SPARC-IPY, EoI #807). This EoI proposed to (a) coordinate the IPY related activities of the SPARC community, (b) promote initiatives to increase understanding of the polar middle atmosphere during the IPY period in the context of the SPARC thematic programmes, (c) make available the services of the SPARC Data Center to facilitate acquisition and archiving of key data that will be used for projects or generated by them during the IPY period.

Preliminary recognition was awarded by IPY Joint Committee (JC) in mid-April with an invitation to submit a full IPY Activity proposal by one of the three posted deadlines dates. The IPY JC assigned proposals to "clusters" with certain EoIs as "lead" proposals. SPARC-IPY was selected as a lead EoI for Cluster 7.1 (IPY SPARC) and requested to prepare a full proposal, which includes other EoIs in the cluster and links to other full proposals that have relevant/related activities. At the time of the SSG meeting an activity proposal was in preparation with the tentative title: "The Structure and Evolution of the Polar Stratosphere and Mesosphere and links to the troposphere during IPY". In addition to the EoIs that are clustered with SPARC-IPY there are a number of other IPY Activity proposals that are closely related and of interest to SPARC. Among these are the POLARCAT proposal and the ORACLE-O3 proposal.

K. Law presented a summary of the POLARCAT (Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport) proposal. The overall goal of POLARCAT is to study the role of long-range poleward transport of aerosols and trace gases for climate change in the Arctic. It will include two multi-aircraft campaigns - a winter/spring 2007/8 campaign, and a summer 2008 campaign, as well as several smaller field studies. The summer campaign will focus on the transport of pollution from boreal forest fires to the Arctic troposphere and stratosphere. The winter/spring campaign will target transport of anthropogenic pollution, in particular from Eurasia, to the Arctic. There will be extensive use of satellite data, ground-based lidars, Lagrangian balloons, surface station measurements, and models, to support the campaigns.

G. Braathen presented a summary of the ORACLE-O3 (Ozone layer and UV radiation in a changing climate evaluated during IPY) proposal. The main foci of this proposal are (a) Ozone loss (detection and impact on UV radiation), (b) PSC (polar stratospheric clouds) and cirrus, (c) Atmospheric chemistry, (d) UV radiation, (e) Ozone and climate change and feedback, (f) Data management, (g) Education, outreach and communication.

In discussion it was noted that IPY presents an opportunity to do new science and to leave a legacy of research and data. The SSG supported the overall structure and aims of the SPARC-IPY proposal and encouraged completion and submission to meet the 30 September 2005 deadline. *(Postscript: The SPARC-IPY Activity Proposal was submitted and is listed as IPY Activity 217 on the IPY website. It has been awarded recognition by the IPY JC).*

5. Cross-Cutting Issues

M. Geller discussed issues and activities of joint interest to SPARC and SCOSTEP/CAWSES. There are four themes under CAWSES: (a) Solar Influence on Climate; (b) Space Weather (Science and Applications); (c) Atmospheric Coupling Processes; (d) Climatology of the Sun-Earth System. The first of these themes was the focus of the ISSI workshop on Solar Variability and Planetary Climates held in Bern, Switzerland, June 6-10, 2005. Some conclusions from this workshop which are relevant to the WCRP are: (a) there is considerable uncertainty in the reconstructions of past variations in solar irradiance (total and spectral); (b) this, together with predictability issues, makes attribution of cooling in the mid-20th century to variations in solar output very uncertain; (c) significant progress is taking place on modelling solar UV effects of the troposphere-stratosphere system (good agreement with Labitzke and van Loon, and Kodera results); (d) IPCC models are likely not including solar effects properly at the present time.

Future CAWSES efforts include holding a small meeting (20-30 people) at ISSI, April 19-21, 2006, to move forward plans to write review papers covering (1) observational evidence for solar influences on climate; (2) our ability to make reliable reconstructions of solar outputs that influence climate; and (3) what the isotopic record tells us about solar influences on past climates.

K. Kodera discussed the SOLARIS Project (Solar Influence Study for SPARC), a follow-on project from the GRIPS solar influences activity. Its objective is to model and understand the solar influence on climate through stratospheric chemical and dynamical processes. There are currently 13 participating modelling groups, and there are new aspects which go beyond the original GRIPS comparisons. These include modelling solar influences using fully coupled models with oceanic components, chemistry, resolved mesospheres and, for some groups, extensions into the thermosphere.

A SOLARIS planning meeting was held in Toulouse in July 2005. A number of questions were addressed including time-varying *vs*. perpetual solar max/min runs, multiple forcing *vs*. solar only forcing, spatial structure of solar signals, solar cycle modulation of the QBO period, and influence of energetic particles in the stratosphere. Several coordinated studies are under way: (i) TMST-model (Thermospheric and mesospheric response - coordinated by V. Fomichev); (ii) CCM Ozone and temperature response (continuation from GRIPS coordinated by U. Langematz); (iii) AGCM Dynamical response and the role of the QBO (coordinated by L. Gray).

N. McFarlane and **S. Woolnough** (representing the GEWEX Global Cloud System Study) discussed plans and motivation for a joint SPARC-GEWEX/GCSS-IGAC workshop on modelling of deep convection and its role in the tropical tropopause layer (TTL). The purpose of this workshop is to bring together expertise from the SPARC, GEWEX, and IGAC communities to initiate collaborative activities to study key processes within the TTL. The goals of the workshop are to discuss key scientific questions and recent results, develop research strategies, and evaluate modelling and observational capabilities and constraints. This workshop will be held in Victoria, BC in the period June 12-15, 2006.

M. Geller discussed a possible new SPARC initiative on QBO influences on tropical convection. He noted previous work identifying apparent correlations between the phase of the QBO and tropical systems such as the incidence of hurricanes (Gray *et al*. 1984), and modulation of outgoing longwave radiation, highly reflective cloud index, tropopause pressure, and 50-200 hPa zonal wind shear (Collimore *et al.* 2003). Possible lines of research on this topic include studies using ISCCP data, and using cloud-resolving models (CRMs) to examine individual effects. It was suggested to hold a SPARC workshop on "QBO Influences on Tropical Convection" in late 2006. This workshop would include papers on observational analyses, GCM modelling and analyses, CRMs, and lead to discussion of future actions.

S. Polavarapu discussed recent activities of the SPARC Data Assimilation Working Group (SPARC DA WG). The activities of the SPARC-DA group focus on physical aspects of middle atmosphere data assimilation and on science issues that drive the need to improve assimilation techniques and draw on experts in SPARC themes. Middle atmosphere DA has to deal with problems that are not so critical in NWP focused DA (bias, accumulation of errors over long time scales, large mesospheric variability, vertical coupling). The goals of the SPARC-DA group are achieved through holding thematic workshops, preparation of reports and review articles, and intercomparison/collaborative projects. The recent Joint SPARC Workshops on DA and Stratospheric Winds was held in Banff, Alberta, Canada in September 2005 and was very successful. The next SPARC-DA workshop will be held in Noordwijk, The Netherlands in conjunction with ADM workshop 26-28 September 2006.

S. Liess reported on the current status of the SPARC Data Center (DC) and plans for the near future. The SPARC DC has been operational since July 1999 at Stony Brook University, NY, supported by NASA, with M. Geller as the principal investigator. However, present funding is exhausted. Interim funding has been requested but none had been received as of the reporting date. Currently the SPARC DC has a total of approximately 40 Gb of data holdings. Proposed upgrades would increase this capacity to 1.1 Tb. This upgrade in hardware is critical for expected future needs of the CCMVal project and the data archiving anticipated for SPARC-IPY. Additional features, which the SPARC DC hopes to provide in the future, include an online plotting capability and enhanced security. Last year, the SPARC scientific steering group requested that the SPARC scientist become a full-time position. Thus, the position for the research scientist is proposed to be 50% Data Center administrator and 50% research scientist within SPARC. However, the SPARC DC funding crisis must be solved as soon as possible for the Data Center to continue its operation.

S. Yoden discussed plans to mirror all or a subset of the SPARC DC data holdings at Kyoto University in Kyoto, Japan. Data accessibility will be enhanced and downloading times will be shortened, since the bandwidth will be shared between SPARC DC and its mirror. The security of a remote backup will protect from data loss.

6. Co-ordination with other Agencies/Programmes

S. Doherty discussed IGAC/SPARC interactions. IGAC activities address two important questions: (a) What is the role of atmospheric chemistry in amplifying or damping climate change? (b) Within the Earth System, what effects do changing regional emissions and depositions, long-range transport, and chemical transformations have on air quality and the chemical composition of the planetary boundary layer? The science involved in dealing with these questions has much in common with SPARC themes, particularly that of Chemistry-Climate. SPARC-IGAC interactions that have taken place and are in progress include: (a) the SPARC/IGAC Chemistry-Climate Workshop (Giens, 2003); (b) the SPARC/IGAC Workshop: Processes controlling mid-latitude UTLS chemical composition (Mainz, 2005), (c) the POLARCAT (IPY) Project, (d) parts of the IGAC AICI project – i.e. ice phase chemistry), and (e) discussions on next steps at both SPARC/IGAC and WCRP/IGBP level.

V. Ryabinin reported on the SOLAS and OASIS programmes. Although these programmes deal primarily with processes at the surface and in the lower troposphere, their focus on surface fluxes and emissions of key constituents are of interest to SPARC in that they provide critical information for a comprehensive understanding and modelling of the transport and transformation of these constituents in the troposphere and stratosphere. The goal of SOLAS (Surface Ocean Lower Atmosphere Study) is to achieve quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and the atmosphere, and how this coupled system affects and is affected by climate and environmental change. The goal of OASIS (Ocean-Atmosphere-Sea Ice-Snowpack) is to determine the importance of chemical, physical and biological exchange processes on tropospheric chemistry, the cryosphere, and the marine environment, and their feedback mechanisms in the context of a changing climate.

V. Yushkov summarized the second expert meeting on the LAUTLOS campaign (Helsinki, 29-31 August 2005). A paper on the vertical distribution of water vapour in the Arctic stratosphere in January-February 2004 from data of the LAUTLOS field campaign is now available (Yushkov *et al*. 2005). Some preliminary results were also summarized in the SPARC Newsletter 25. The campaign provided vertical profiles of water vapour between 0 to 70 km, and the database is now open for users.

M. Kurylo gave a presentation on the NDSC (http://www.ndsc.ws), which is a set of more than 70 high-quality, remote-sensing research sites for observing and understanding the state of the stratosphere and upper troposphere, and assessing the impact of stratospheric changes on the underlying troposphere and global climate. The goals of the NDSC are to study the temporal and spatial variability of atmospheric composition and structure, to provide early detection and subsequent long-term monitoring of changes in the chemical and physical state of the stratosphere and upper troposphere, and to provide the means to discern and understand the causes of such changes. The NDSC also provides independent validations, calibrations and complementary data for space-based sensors, supports field campaigns, and provides verified data for testing and improving chemistry and transport models. The NDSC has participation by more than 20 countries and is still expanding.

One of NDSC operating principles is that investigators subscribe to a protocol designed to ensure that archived data are of as high a quality as possible within the constraints of measurement technology and retrieval theory. Instruments and data analysis methods are evaluated prior to NDSC acceptance and are continuously monitored throughout their use. Data must be submitted to the central archive within one year of the measurement, and are made available within two years of measurement. In some cases, this timescale is much shorter.

NDSC measurement contributions to GAW and IGACO include stratospheric temperatures, total ozone, ozone profiles, compounds related to ozone loss, greenhouse gases and water vapour, stratospheric aerosols and PSCs, and UV radiation. The ground–based measurements are consistent with satellite observations and indicate that the upper stratosphere ozone decline is not continuing. Whether this indicates recovery of the ozone layer will be clearer after the next solar minimum. In addition, it appears that the increase in water vapour is not continuing. Future developments include water vapour in the UTLS from Raman Lidar and balloon soundings, closer collaboration with other networks such as SHADOZ, establishment of more stations in the tropics, and provision of data in near real time.

Following this presentation M. Kurylo discussed the NASA programme in considerable detail, first summarizing the current Climate Science and Technology Management structure within the US Federal Government and noting that the new Presidential initiatives on space exploration includes National Objective 5: "To Study the Earth system from space and develop new space-based and related capabilities for this purpose." The new Science Mission Directorate includes Space Science and Earth Science components.

The Aura mission, designed to answer questions about changes in our life-sustaining atmosphere, was successfully launched. The observatory is in a nominal and stable operating condition. MLS, TES and OMI instruments are operating and returning exciting observations, and while HIRDLS has experienced an anomaly, it is likely to achieve much of its science payoff. The validation and operations phase of Aura is now under way with several validation campaigns to be carried out. The Aura satellite is a component of the Earth Observation System A-Train (Aerosol/Clouds/Radiation), which relies on the "formation flying" concept to sample the same air parcel over approximately 20 minutes.

T. Wehr described the current and future ESA missions. ESA's current operational satellite missions for Earth observation include ERS-2 (with GOME) launched April 1995, ENVISAT (including MIPAS, GOMOS, SCIAMACHY) launched March 2002, METEOSAT and MSG, a meteorological mission in cooperation with EUMETSAT consisting of at least three geostationary weather satellites, and PROBA, a microsatellite with an high-resolution imaging spectrometer, high-resolution camera, wide-angle camera, Space Radiation Environment Monitor (SREM), and Debris In-orbit Evaluator (DEBIE), launched 2001. ESA missions are organized within the framework of the Earth Observation Envelope Programme (EOEP). This programme has two major components: (i) the Earth Explorer Programme, which has as subcomponents Earth Explorer Core Missions and Earth Explorer Opportunity Missions; (ii) the Earth Watch Programme which has as subcomponents Cooperative Missions with EUMETSAT and GMES (Global Monitoring of Environment and Security). ADM-Aeolus and EarthCARE have been selected for Phase A studies as future Earth Explorer missions, and will focus on atmospheric measurements. The SWIFT mission to measure stratospheric winds was not selected for Phase A but remains a Canadian national project.

ADM-Aeolus, to be launched in 2006, is a Doppler Wind LIDAR Mission. Winds are derived from back-scattered laser light, Doppler-shifted by aerosols and molecules along the lidar line-of-sight. In addition to wind profiles, variability, and clear air turbulence it will provide cloud profile and cover (cloud heights, extinction, optical thickness), and tropospheric aerosol extinction, optical thickness and stratification. The Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) mission will be launched in 2012. Its scientific objective is to quantify aerosol-cloud-radiation interactions so they may be included correctly in climate and numerical weather forecasting models. It includes a lidar which will provide vertical profiles of aerosols and clouds (but is attenuated by thick clouds), and a Doppler Cloud Radar, a Multi-Spectral Imager (MSI) to provide high resolution data to supply the horizontal context of the vertical column observations, and a Broad Band Radiometer (BBR) which measures the SW and LW radiances at the top-of-the-atmosphere.

In addition to providing a comprehensive description of the above missions and an overview of ESA future missions, T. Wehr also summarized other climate and atmospheric chemistry preparatory activities within ESA. These include activities in atmospheric chemistry research and monitoring, stratospheric dynamics and ozone transport, and data assimilation, which includes support for SPARC-DA workshops.

S. Hayashida reported on progress in research on Polar Stratospheric Cloud (PSC) within the ILAS/ILAS-II projects, which operated onboard the AEOS/ADEOS-II satellites in the periods November 1996 – June 1997 and April – October 2003 respectively. To understand the interaction of PSCs and gas species, simultaneous measurements of PSCs and gas species are highly needed. However, optical remote sensing cannot achieve this easily because of interference of light scattering by particles with gas absorption spectra. A new retrieval algorithm was developed for the ILAS instrument to derive aerosol/PSCs and gas species simultaneously (Oschepkov *et al.* 2005). The data quality of methane, NO2, and water vapour is remarkably better with the new (Version 7) algorithm, the data set includes both PSC and non-PSC cases, and seems to be promising for investigating microphysical and chemical processes related to PSCs. In addition to development and validation of the new algorithm, ongoing activities include PSC analysis, ongoing analysis of temperature history and denitrification/dehydration

with improved N_2O and CH_4, and analysis (Ver. 6, Hayashida *et al*. submitted to JGR) and reanalysis (Ver. 7) of $ClONO_2$ activation/deactivation.

7. The Next SPARC General Assembly

E. Manzini offered to form a local organizing committee to facilitate hosting of the next SPARC General Assembly (GA) in Italy in 2008. Two possible locations have been considered. The SSG expressed its appreciation to E. Manzini for her offer and efforts and encouraged her to continue to interact with the SPARC IPO to finalize the decision as to the location of the next GA and form a local organizing committee.

8. Venue and dates of the next SSG meeting

Offers to host the next SSG meeting were received from P. Canziani and A. Ravishankara. The SSG expressed its appreciation for these offers. After some discussion it was decided to hold the next SSG meeting in Boulder, CO, USA during 9-12 October 2006.

9. Closure of the Session

The 13th Session of the SPARC SSG was closed at noon on Thursday, 29 September 2005. The SSG unanimously thanked A. O'Neill and J. Fillingham for organizing the excellent local arrangements for the session in the very congenial setting of Lady Margaret Hall in Oxford.

10. References

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APPENDICES

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Final Agenda

INTRODUCTION
Opening of session, introductory comments
Logistical and practical information
Discussion of the agenda

MAIN ISSUES FACING SPARC
COPES and SPARC
COPES
Overarching issues for SPARC
Responses to findings from last SSG, JSC, and other events
SPARC participation in COPES panels
COPES and what it means to SPARC
Task force on Climate-Chemistry-with WCRP and with IGBP

SPARC THEMES: PROGRESS and ISSUES

Stratosphere-Troposphere Dynamical Coupling
- Key Issues and Priorities
- Summary of Presentations at the AMS meeting
- CLIVAR/SPARC Interactions
- Stratosphere-trop coupling workshop

Detection/Attribution/Prediction
- Key Issues and Priorities
- Links to other tasks
- Update on trends workshops

Chemistry-Climate
- Key Issues and Priorities
- CCMVal
- AMIP Style Intercomparison for GCMs with Well Resolved Stratospheres
- Contributions to future assessments (IPCC, WMO/UNEP Ozone)
- Defining timetable for various assessments
- Needs for upcoming 2006 WMO assessment
- Thoughts from other organizations and assessments
- Report on PSC climatology (SPA)
- Aerosol Assessment (ASAP) report

SPARC'S ROLE IN IPY

CROSS-CUTTING ISSUES
- Role of SPARC in Modelling Panels
- Joint activities with SCOSTEP/CAWSES
- Role of convection in the TTL
- Cloud resolving models, collaboration with GEWEX/GCSS
- Coupling between the QBO tropopause variations convection
- Solar Variability
- Related Activities

UPDATES AND PROGRESS REPORTS
- Data Assimilation
- Tropical wind experiment
- Report from the SPARC Data Center
- Mirroring of the SPARC Data Center

CO-ORDINATION WITH OTHER AGENCIES/PROGRAMMES
SPARC/IGAC interactions
Chemistry of ice (OASIS/SOLAS)
LAUTLOS
NDSC
Space Agencies – ESA / NASA

FUTURE MEETINGS
Location of the next SPARC General Assembly
Location/date of the next SSG meeting

REVIEW OF ACTIONS TO BE TAKEN

CLOSURE OF SESSION