SPARC

1994 newsletter n°4 december

STRATOSPHERIC PROCESSES AND THEIR ROLE IN CLIMATE

A Project of the World Climate Research Programme

Greetings

Two years after it has been established, SPARC is now entering in its active phase. Nine activities have now been selected by the SSG as first priorities to be carried out by SPARC (see below); we hope that within your national programme you can contribute to this international effort, as their success depends upon you. This issue of the Newsletter and the preceding ones give an overview of the scientific contents of the national programmes and this information will be very precious to identify your contribution to the SPARC activities.

Furthermore the synergy generated by these scientific issues is such that new activities are constantly being developed and you may want to update the contents of your national contribution; we invite you to inform the SPARC Office in due time, so that **updated national contributions could be published in the Newsletter N° 5 in July 1995.**

As the end of the year is close-by while this Newsletter goes to press, I would like to take this opportunity to send you my very best wishes for a successful year in your private and professional lives.

● Marie-Lise Chanin,
SPARC Co-Chair

SPARC Activities

Fax in parentheses

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2- Reference Climatology Chairman : Dr. B. M. Randel (+1-3034971492)

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8- Ozone Trends Assessment Chairman : Dr. N. Harris (+44-223467390), Vice-Chairman : Dr. J. Kaye (+1-2023582770)

9- UV-B Monitoring and Modelling (within WMO/GAW) SPARC Representative : Dr. P. Simon (+32-23748423)

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Report from the Second SPARC SSG Session

(Princeton, NJ, USA, September 20-23, 1994).

M. Geller who chaired the session welcomed the participants and thanked J. Malhman to have taken in charge the organisation of the meeting.

Prof. L. Gates, new President of the JSC/WCRP, and R. Newson, WCRP Executive Director by interim until H. Grassl took his new position on October 1, informed the SSG about the evolution of the **WCRP** Programme which was discussed at the recent meeting of the JSC Officers. The programme exists to provide research coordination when necessary but is not supposed to cover all the issues. Closer cooperation and coordination with IGBP is clearly needed. The subject of anthropogenic climate change should be given more attention within WCRP. SPARC should contribute to the inventory (to be performed in the next 6 months) of WCRP contributions to anthropogenic climate change issues. Future emphasis for the whole WCRP will be put on coordination of modelling activities, climate diagnosis in modelling and documentation of climate change. The financial situation of WCRP has to be improved through new type of fundings, to provide more help for the WCRP projects. A new WCRP Newsletter will be published twice a year. The JSC considers that SPARC is developing efficiently and in the right direction. In the light of the new WCRP priorities, there should be no need for SPARC to intervene on issues where science goes well on the national and regional scale.

Recently, two major **international assessments** relevant to SPARC were carried out - the WMO/UNEP Scientific Assessment of Ozone Depletion, 1994 and the Radiative Forcing of Climate Change, 1994 Report by WG1 of IPCC. Both stress the fact that stratospheric ozone losses cause global - mean negative radiative forcing, but its precise evaluation is dependent upon the vertical distribution of the ozone changes, particularly near the tropopause, which are difficult to estimate due to lack of reliable observations. From the discussions and the written contribution of S. Solomon, the message to the SPARC SSG was to support efforts to determine ozone trends in the Upper Troposphere/Lower Stratosphere.

SPARC Initiatives

Six initiatives had been taken at the Cambridge SSG meeting, and the chairmen of the relevant study groups presented their reports. The SSG decided to modify the mandate of some groups and to generate new ones when gaps in on-going research were obvious. Also, the need for interaction between the groups was stressed.

Stratospheric Models Intercomparison. S. Pawson and K. Kodera, co-chairmen of this initiative, presented a two-phase **G**CM-**R**eality **I**ntercomparison **P**roject for **S**PARC **(GRIPS).**

Phase 1 is to forge initial links between the participants and to validate some aspects of the performance of tropospheric-stratospheric models. The tasks are : models documentation, GCM climatologies validation, simulation of sudden stratospheric warmings (SSW), troposphere-stratosphere connections during SSW, tropical stratosphere simulation (wind/budget, wave spectra), radiation scheme test, gravity wave drag test.

The objectives of phase 2 will be to integrate the GCMs under (as) identical (as possible) conditions in order to intercompare the models and examine the stratosphere-troposphere links. These objectives will be specified at the IUGG SPARC Workshop (Boulder, 1995) and groups able to participate in GRIPS will be identified.

Gravity wave (GW) Processes and Parameterization. The participants stressed the vital importance (as well as difficulties) of the GW parameterization on valid physical grounds. K. Hamilton summarised basic aims of the initiative and ways of advance (observations, documentation of existing evidence of high frequency motions, detailed simulations of 2D- and 3D- GW fields, and their parameterization in GCMs. A NATO ARW on GW is planned for April 1996 in Santa Fé, USA.

Composition of the SPARC OFFICE

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SPARC Scientific Steering Group

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SCOSTEP WG & : P. Simon (B)
SCOSTEP WG 5 : K Labitzke (G)
WMO/GAW : R. Bojkov (C)
SCOPE : E. De Fabo (USA)
COSPAR : J. Gille (USA)
ICTP : S. Radicella (A)

R. Vincent presented the document «Recommendation for High-Resolution Archiving of Routine Radiosonde Data» based on Allen and Vincent's results (JGR 1994). He urges national agencies to start such archiving as soon as possible (following the initial example of the Australian Bureau of Meteorology and more recently of Météo-France). Concern was stressed that the issue of the future radiosonde network itself is threatened.

Stratosphere-Troposphere Exchange (STE). The major goal of the STE initiative was specified at the previous SSG meeting : 1) to identify a measurement strategy to produce the needed understanding and the quantification of STE involving the complex interplay of lower stratosphere chemistry and dynamics; 2) to define a framework for international co-operation so that the relatively disconnected existing national and international programmes can best mount a coordinated effort to advance progress in this area.

However, after a deeply sounded discussion the SSG agreed that its previously decided action was not the most effective mode of addressing this issue. J. Mahlman presented arguments for a strategy to study STE on the basis of models, even to quantify the exchange of conservative tracers. The discussion dealt with the type of observed parameters needed (mean fields and variances of conservative quantities, high frequency vertical mixing...), the need for both data (aircraft, ground-based) and models and the development of trace gas climatology. It led to the conclusion that the existing STE Planning Committee was not properly composed to fill that duty. It was decided to disestablish it and to establish a SPARC Group of Experts (with T. Shepherd as chairman) to develop a general strategy/programme and recommendations, aimed at different agencies, to further the understanding of STE

Water Vapour Instrumentation and Climatology. A report will be prepared by the group chaired by J. Gille on the state of the measurement techniques, the present plans for acquiring, processing and validating data, and proposed recommendations. The SSG urged that the report should be available for the next SSG meeting. It was suggested to add E. Remsberg, S. Oltmans and K. Kelly to the group. Interaction with the GEWEX/G-Vap Working Group was recommended to avoid duplication of effort. M.-L. Chanin reported on recent developments of the Raman lidar method very promising for NDSC as a water vapour profiler between 5-20 km.

Stratospheric Temperature Trends Assessment (STTA). The SSG approved V. Ramaswamy's approach to the problem : it involves bringing together different trend analyses in a common framework, trying to understand causes for discrepancies between the analyses, comparing observed and model trends and looking for causes of differences, relating the trends to changes in the atmospheric composition, planetary waves, QBO, ENSO, solar and volcanic forcings.

Reports from the STTA Group are expected at the IUGG SPARC Symposium and at the SPARC Assembly.

UV Monitoring. P. Simon reported on the WMO Meeting of Experts on UV-B Monitoring, Data Quality and Standardization of UV indices (Les Diablerets, July 1994). Coordination between different UV communities was found badly needed, and WMO will take charge of it. An ad-hoc committee was formed (J. Miller (chairman), R. McKenzie, A. Kricker, P. Simon, B. Whetherhead) to nominate the members of the UV Scientific Steering Committee (SSC) (10-12 persons) and define its mandate. This SSC will oversee the design and execution of UV-B measurements. It will cooperate with IAMAS, IO_3C, IRC, national agencies, SPARC, SCOPE, IGBP, etc. It will form 5 working groups : instruments, quality control/quality assurance, data assimilation/radiative transfer model, data centre, user community.

On the issue of UV monitoring at the top of the atmosphere, the decision taken recently by NASA to stop flights of SSBUV beginning from 1995 was discussed. Since the latter is a key instrument for calibrating TOMS, SBUV and GOME, the SPARC co-chairs will prepare a letter to be addressed by the JSC to NASA emphasing the acute need for an adequate calibration/validation programme involving SSBUV to ensure the accuracy of the ozone monitoring from space, and stressing the fact that the overall monitoring of climate (including trends) depends on international cooperation, and unilateral intervention needs to be discussed.

Three new SPARC Initiatives were decided in Princeton :

Reference Climatology. The requirement for a reference climatology was stressed in connection with the modelling activity. The SSG decided to set up a Study Group with the aim to produce a SPARC - reference climatology (up to the lower mesosphere), intercomparing the existing analyses, including tropical wind measurements, etc. The climatology is needed for means and standard deviations, stationary and transient eddies, wave fluxes, tropical winds.

The sources to be used are : NMC analyses including the stratosphere, GFDL climatology, Berlin FUB dataset, SSU-UKMO data, MSU data on the lower stratosphere, as well as ECMWF/Reading climatology, assimilated stratospheric data, Japanese, Australian and other contributions. The proposed chairman of that group would be W. Randel. The group to be formed has to prepare recommendations within the next year. A group meeting should be planned in 1995.

Upper Troposphere/Lower Stratosphere Chemistry (UTLS). This topic is of high priority to many problems involving ozone changes near the tropopause layer which received too little attention. D. Ehhalt made a presentation on the impact of NO_x from commercial aircraft on tropospheric ozone. He stressed the need for studies of the NO_x budget in the upper troposphere. M. Geller spoke on large efforts in the US to study aircraft-related chemistry in both the

upper troposphere and lower stratosphere. This being a subject of interest for both SPARC and IGAC, it was recommended that a SPARC/IGAC Expert Group may be formed under the chairmanship of I. Isaksen to critically examine various aspects of the problem, e.g. photolysis rates, water vapour field, ozone production rates, sources of NO_x. Within this group, SPARC is also to consider the dynamical/chemical interface, transport issues, chemistry impact on climate.

Ozone Trend. The SSG found it reasonable that SPARC should provide the continuity between the successive ozone trend assessments. J. Kaye indicated that NASA would support the idea of reanalysing ozone data if found necessary. A SPARC group (with N. Harris as chairman and J. Kaye as vice-chairman) should be formed : to critically examine the underlying research in the existing ozone trends assessment, and to look at plans for the monitoring of ozone (space-and ground-based) to see if the gaps are filled and calibrations ensured. The group should make its recommendations at the next SSG meeting.

SPARC Interaction with Other Programmes

The need of close cooperation with the WCRP WG on Numerical Experimentation **(WGNE)** was mentioned in connection with the modelling SPARC Initiative, and between the H_2O Climatology SPARC Initiative and **GEWEX** GVap effort.

M. Caldwell reported that at the **GCTE** meeting in Woods Hole, USA, the GCTE/SSC was divided on the impact of elevated UV-B on terrestrial ecosystems as compared to that of elevated CO_2 and temperature. Anyhow **GCTE** accepted to support two projects - an agricultural pilot project as part of TIGER and a project on terrestrial ecosystems in Southern Argentina. A project on subarctic vegetation in northern Sweden also may be added to the two existing core projects on UV-B.

E. de Fabo wrote to the SSG on the **SCOPE** involvement on the impact of UV-B radiation on the Arctic environment (a report will be out in spring of 1995).

As for **SCOSTEP,** P. Simon, M. Geller and K. Labitzke reported on the development of WG 1, 4 and 5 respectively. M. Geller informed the SSG that the President of SCOSTEP is now Prof. C. H. Liu and that STEP was extended to the end of 1997. Two new proposals as a follow-on of STEP have been received at the time of the SSG meeting : «A Meridional chain of radars and optical instruments» (G. Shepherd), and «Equatorial Atmosphere Transport and Variation International Programme - EATVIP « (S. Fukao, H. Fukunishi, Y. Iwasaka, M. Geller, M.-L. Chanin, R. Vincent, S. Pawson, K. Labitzke, K. Cole). EATVIP includes SPARC - related subprojects : ICEAR-International Centre for Equatorial Atmosphere

Future SPARC and related meetings

Future SPARC meetings :

3-7 April 1995 : EGS General Assembly : Middle Atmosphere Science : Progress in the SPARC and UARS Projects, Conveners : A. O'Neill (CGAM, Dept. of Meteorology, University of Reading, PO Box 239, Reading RG6 2AU, UK) and D. Cariolle (EERM/CNRM, 42 Av. Coriolis, 31 057 Toulouse Cédex, France).

15-20 May 1995 : «International Conference on Ozone in the Lower Stratosphere». Local Organiser : Prof. C. S. Zerefos (Lab. Atmos. Phys., Aristotle Univ. of Thessaloniki, 54006 Thessaloniki, Greece), Halkidiki, Greece.

12 July 1995 : SPARC Symposium, IUGG General Assembly, Conveners : M. -L. Chanin (CNRS/SA, BP3, 91370 Verrières Le Buisson, France) and M. Geller (ITPA/SUNY, Physics Building, B-106, Stony Brook, NY 11794-5000, USA), Boulder, CO, USA.

5-15 September 1995 : NATO ASI on «The Stratosphere and its role in the climate system» Director : G. Brasseur (NCAR, PO Box 3000, Boulder 80307, Co, USA), Québec, Canada.

1995/96 : Tentative Joint US/Japan meeting on «QBO/ENSO Variations in the Global Stratosphere/Troposphere System», Conveners : T. Matsuno (Center for Climate System Research, University of Tokyo, 4-6-1 Komaba, Meguroku, Tokyo 153, Japan) and M. Geller.

April 1996 : NATO ARW «Gravity Wave Climatology and Parameterization», Convener : Kevin Hamilton (GFDL, PO Box 308, Princeton, NJ 08542, USA), Santa Fe, NM, USA.

December 1996 : First SPARC General Assembly, Australia. Conveners : M. Geller and D. Karoly.

July 1997 : IAMAS General Assembly, SPARC Session, Uppsala, Sweden.

SPARC related meetings :

July 1995 : SPARC related Workshops, IUGG General Assembly, Boulder, CO, USA :

- **11 July** : Intercomparison of Middle Atmosphere Models, Convenors : S. Pawson (Institut für Meteorologie, Freie Universität Berlin, Carl-Henrich-Becker-Weg 6-10, 12165 Berlin, Germany).
- **13 July** : Gravity wave Sources and Parameterizations, Convenor : D. Fritts (LASP, University of Colorado, Boulder, CO 80309-0392, USA).

Research, EPIC-Equatorial Processes Including Coupling, CDME-Chemical and Dynamical Modification in Equator; the proposed time schedule is : 1996-proposals to governments to construct equatorial facilities, 1998-start of continuous measurements for 5-10 years, 2000-2002-intensive field campaigns.

Some **national programmes** were commented : H. Tanaka outlined the Japanese SPARC programmes to be carried out by the University Group and by the National Institute Group; the SPARC budget is still under study. D. Ehhalt reported on the creation in Julich **(Germany)** of the Institute for Stratospheric Chemistry (director D. Mckenna). M.-L. Chanin mentionned that the French programmes on Middle Atmosphere and on tropospheric trace gases have been merged into an unique programme on atmospheric physics and chemistry.

M.-L. Chanin informed the SSG of a programme on «**Environmental Sciences for Developing Countries**» proposed at the ICTP in Trieste. It was agreed that the SSG should be kept informed of its development.

SPARC Office activities

M.-L. Chanin stressed the difficulties she is meeting to support a permanent scientific staff at the Office and asked for suggestions. A financial support from different organisations should be facilitated by a direct action of the WCRP Executive Director. Several suggestions for candidate were made and will be studied.

Yu. Koshelkov spoke about the preparation of the Newsletter N°3: about 20 national SPARC-related programmes were described, and some more will be published in the Newsletter N°4, together with reports from this SSG and other scientific meetings. The SSG approved the format and contents of the first three Newsletters. It was suggested to publish a yearly update of the national contributions in the Newsletter, to publish a list of reports (Assessments, NASA reports) of interest to SPARC scientists, indicating how to receive them and to publish summaries of the activities of the SPARC Initiatives groups.

M.-C. Torre described the SPARC Directory, which now includes nearly 2000 names. The SPARC Office offers to make this directory available for SPARC scientists - either by e-mail or by diskette.

Future meetings

J. Kaye presented the contents of the International Conference on Ozone in the Lower Stratosphere (Halkidiki, Greece, 15-20 May 1995), with 8 topics : ozone trends; NO_y observations/interpretations; HO_x; halogen compounds; uncertainties in chemistry/transport; aerosol observations/interpretation; laboratory measurements; radiation. According to H. Tanaka, Prof. Matsuno has obtained support for the QBO/ENSO joint US/Japan meeting planned for late 1996. The one-day IUGG SPARC symposium in Boulder will be made of a series of invited papers given by the chaimen of the SPARC Initiatives. Contribution for oral or poster presentations should be sent before 15 March to the SPARC chairmen. A SPARC session is also planned at the 1997 IAMAS meeting in Uppsala.

The SSG accepted enthusiastically the proposal of D. Karoly to hold the First SPARC General Assembly in Australia in early December 1996 (the first circular is to appear in March 1995) (D. Karoly and M. Geller co-chair the organising committee), with sessions on Stratospheric Modelling (S. Pawson and K. Kodera, conveners), GW Processes (K. Hamilton and R. Vincent), Reference Climatology (B. Randel), Climatology and Trends (Ozone - N. Harris, Temperature - V. Ramaswamy, Water Vapour - J. Gille), STE (T. Shepherd), Upper Troposphere/Lower Stratosphere Chemistry (I. Isaksen), UV-B (P. Simon).

It was decided to accept the kind invitation of K. Labitzke to hold the next **SPARC SSG meeting** in Berlin in 1995.

SPARC ACTIVITIES : STUDY GROUPS REPORTS

Stratospheric Models Intercomparison (Project GRIPS)

S. Pawson, K. Kodera - Co-Chairs

The intercomparison of GCMs which extend from the surface through the stratosphere was given the name **GRIPS** (GCM-Reality Intercomparison Project for SPARC). Participation is open to groups running GCMs with full representations of physical processes in the troposphere and stratosphere, including the hydrological cycle and radiative transfer. All participating GCMs will then be applicable to climatic studies. A document describing the aims of GRIPS is available from the chairmen.

Discussions with several potential participants showed that resources are too scarce to launch into full intercomparisons of multi-year integrations; there are also scientific reasons for starting at a lower level of intercomparison. So a **preliminary intercomparision** will be made using existing integrations, with emphasis on several aspects of the GCM performance directly related to their ability to capture specific circulation features and hence produce a realistic climatology. These are :

a) Documentation of the participating GCMs in a common format.

b) Comparison of climatologies; the identification of common problems.

c) The generic ability of these GCMs to develop sudden warmings.

d) Interactions between the stratosphere and troposphere during sudden warmings.

e) Long-period oscillations in the tropical stratosphere and the absence of a realistic QBO.

f) Intercomparisons of the radiative transfer schemes : heating rates and dissipation of temperature perturbations.

g) Predictability experiments for sudden warmings.

This will bring participants together and open discussions for a **second stage.** This will involve more detailed intercomparisons of the GCMs through the definition of some well-defined integrations which all groups would perform. Some agreement must be reached about which experiments are scientifically useful while remaining affordable.

Small workshops are needed at least once a year. Some discussions will be held in workshop MW5 «Intercomparison of Middle Atmospheric Models» at the IUGG Assembly in Boulder; all participants are encouraged to submit posters tabulating their GCM.

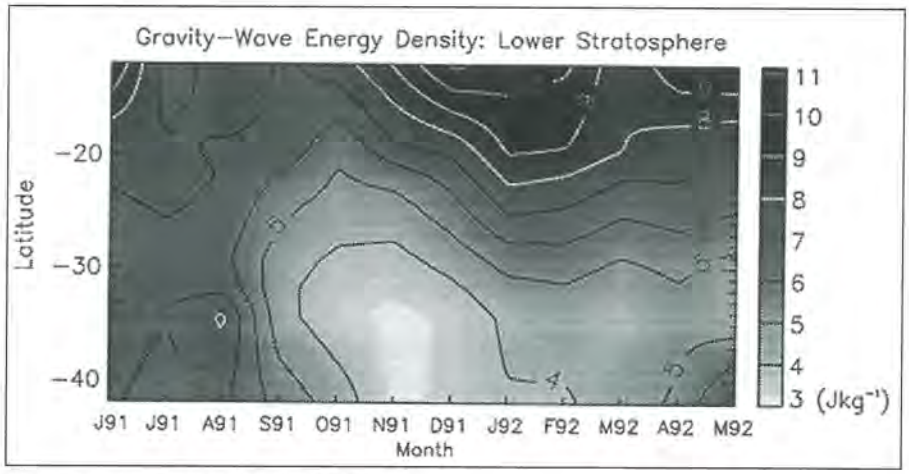
Gravity Wave Processes and Parameterization (GWPP)

K. Hamilton, R. Vincent - Co-Chairs

The committee has had two main activities during its first year. One focus has been the planning of a small (~35 participants) **scientific workshop** (in spring of 1996) to address the GW parameterization issue. Funding has been sought from NATO and other sources, and considerable progress has been made in formulating the scientific programme for this meeting.

The other activity has been lobbying for **archiving routine radiosonde** observations at high resolution throughout the world. The goal is described below.

GWPP - Recommendations for High Resolution Archiving of Routine Data



Gravity wave energy density, 17-24 km, in the Australian region from June 1991 to May 1992

Observational evidence for GW and their role in the atmosphere have come from remote-sensing radars, lidars, and satellites as well as in-situ aircraft and rocket measurements. However, information on GW is still deficient, particularly at heights near 20 km (above the operational limit of most wind radars and below the region where lidars obtain density and temperature data). Quantitative estimates of wave parameters are needed in this region if numerical models are to be properly initialized and constrained.

Operational balloon observations provide a potential source for **research into GW** up to 30 km. While they do not have the temporal resolution of radars and lidars, radiosonde networks have global coverage. Unfortunately, the data are usually recorded and archived with a vertical resolution too coarse to be of use in GW research. However, the Australian Bureau of Meteorology started in 1991 to routinely record and archive temperatures at vertical resolutions of 50 m. **S. J. Allen and R. A. Vincent (J. Geophys. Res.,in press, 1994)** were able to study the spatial/seasonal variability of wave activity in the troposphere/lower stratosphere and the degree to which the wave spectrum at high wavenumbers is «universal». The figure based on temperature data from Australian stations shows estimates of energy density at 17-24 km; there are clear variations in the wave energy on both seasonal and latitudinal basis which reflect changes in tropospheric wave sources and the filtering effect of the background winds. Where wind and temperatures are simultaneously available with comparable resolution, it is also possible to obtain such wave parameters as horizontal scales and directions of propagation. Access to data from other radiosonde networks would enable to see if the findings of S. J. Allen and R. A. Vincent are globally valid.

Archiving high-resolution data would provide a valuable resource also for **research in numerical weather prediction.** Developments in computing make very high resolution models practical, but the provision of radiosonde data at present mandatory levels is inadequate. Many prediction models employ vertical grid spacing finer that the archived levels. This mismatch will become more severe as the model resolution improves. The use of high-resolution radiosonde data could be a very effective way of improving numerical forecasts.

The following motion was passed at the **SPARC SSG meeting in Princeton : SPARC recommends to the WMO that it encourage national meteorological services to archive operational radiosonde data at the highest available resolution.**

Individuals in the SPARC community are urged to bring the resolution to the notice of their national service.

Finally, readers with Internet access should note that the GW

Initiative now has its own ***World Wide Web*** *home page with address : http://www.gfdl.gov/SPARC/SPARC.html*

Stratospheric Temperature Trends Assesssment (STTA)

V. Ramaswamy - Chair

The action plan involves :

1. Bring together existing datasets on to a «common space-time plane». There are concerns about discrepancies between different datasets used in trends analyses, and their respective quality and calibration problems. The task would consist of analysing available datasets and the trends reported to-date in a critical but pragmatic manner (e.g., highlighting inherent deficiencies and problems of the datasets, pointing out the strengths and weaknesses of the various trend analyses).

2. The time periods proposed for the analyses of temperature changes are early 1960s to present and late 1970s to present (the latter being the period of the most severe ozone losses; also, satellite information is available). The domain to be considered is from the lower stratosphere to the mesosphere, at low, middle and high latitudes.

3. Same as in # 2, but for the model results (stratospheric trends).

4. Identify disagreements between different datasets (and accompanying trends) and attempt to find the causes, e.g., spatial inhomogeneities, sampling biases, calibration problems.

5. Compare the observed and modelled trends. Also compare with prior stratospheric temperature trends works, e.g., the 1988 Temperature Trends Panel report.

6. Using the trends analyses and model results, to what extent can we unambiguously ascribe physical reasons (e.g., well-mixed GHGs, water vapor, ozone, volcanos, QBO, ENSO, solar cycle, SSTs, tropospheric dynamics) to the temperature changes ?

A meeting of the Study Group is planned for early 1995 to sustain the progress on the aspects listed above.

Water Vapour Instrumentation and Climatology

J. Gille - Chair

Summary of the report «Present state of measurement techniques, present plans for acquiring, processing, and validating data, proposed recommendations».

1. Introduction : importance of lower stratosphere water vapour, outline of the rest of report.

2. Local Measurements : General comments; Improved radiosondes; Frost point instruments (developments, deployment plans, present status of data record); Lyman-alpha instruments (developments, etc.); Tunable-diode instruments (developments, etc.); Raman lidar techniques (developments, etc.); DIAL lidar techniques (developments, etc.).

3. Global measurements : General comments; Nadir-viewing IR and microwave sounders (Present status HIRS/AMSU, AIRS/AMSU/MHS-projections, future plans; IASI/HIS-projections, future plans); Occultation measurements (SAGE II, HALOE, ATMOS, Data status, Future plans); Microwave emission measurements (UARS MLS-present status of validation and data record; EOS MLS-projections, plans); IR limb emission measurements (History-LIMS, UARS; HIRDLS projections, plans).

4. Summary of Present Status of Measurement Technique (accuracy, vertical resolution, size of data record, plans for acquisition of additional data, plans for validation, processing and dissemination of data).

5. Comparison of Present and Planned Data Base with Requirements.

6. Recommendations.

Stratosphere-Troposphere Exchange (STE)

T. Shepherd - Chair

The chaiman is currently canvassing the views of researchers in the area of STE, with a view to organise a focused workshop to help coordinate future research, especially in terms of comparison between observations, modelling, and theory.

References of SPARC related Reports

References Available from WMO, 41 Av. Guiseppe Motta, CP 2300, 1211 Geneva 2, Switzerland.

1 - The 1994 Report of the Scientific Assessment Working Group of IPCC : Radiative Forcing of Climate Change.

2 - The WMO-UNEP Scientific Assessment of Ozone Depletion : 1994. WMO-Global Research and Monitoring Project.

References Available from NASA, Office of Mission to Planet Earth, Science Division, Washington DC, USA

1 - NASA's Upper Atmosphere Research Program (UARP) and Atmospheric Chemistry Modeling and Analysis Program (ACMAP). Research summaries 1992-1993, January 1994

2 - NASA reference Publication 1339, January 1994

Report on concentrations, lifetimes and trends of CFCs, halons and related species. Edited by J. A. Kaye and S. A. Penkett, Co-Chairs, and F. M. Ormond. Convening lead authors : P. Fraser, D. Fisher, P. Bloomfield, S. P. Sander and M. K. W. Ko

3 - STS-66 payload handbook ATLAS-3

Effects of the mount Pinatubo eruption on the atmosphere and climate

(NATO ARW, Rome, September 26-30, 1994)

The workshop, initiated by SPARC, was held mainly at the Societa Geografica Italiana. Prof. G. Fiocco was the ARW director and Prof. G. Visconti-the codirector. The themes discussed at the workshop included : aerosol load after the eruption, climatic effects, ozone loss, chemical/photochemical impacts on the stratosphere, radiative and dynamical effects. Altogether, nearly 40 reports were presented by 43 participants representing Italy (14), USA (12), Germany (5), UK (4), France (2), Canada (1), Cuba (1), Denmark (1), Japan (1), Norway (1), Russia (1).

Aerosol load. The Pinatubo aerosols were recorded by a variety of instruments : lidars including the University of Rome network (Rome, Thule, South Pole), Frascati (Italy), Garmisch-Partenkirchen (Germany), OHP (France), Dumont D'Urville (Antarctica), Lauder (New Zealand), Wakkanai, Tsukuba, Fukuoka, Okinawa (Japan), etc.; aircraft campaigns in the Arctic (AASE, SPADE, etc.); about 10 satellite-borne instruments (SAGE II, ISAMS, etc.); dustsondes (Wyoming), photometers (Mauna Loa), and so on. The aerosol parameters, either directly measured or infered from the data, included : particle number concentration /size, aerosol surface area, column mass, optical depth, atmospheric extinction coefficient, heterogeneous reaction rates (R. Grainger and A. Lambert, from ISAMS data) as well as temperature and relevant chemical species. There was general agreement among the observations except between the optical depths measured by AVHRR and SAGE (M. Schlesinger).

The large intensity of the Pinatubo eruption was stressed : the volcano of the century (S. Solomon), Pinatubo is second after Krakatoa (M. Schlesinger), about twice as large as El Chichón (J. Hansen). More aerosol was recorded to reach the southern than the northern hemisphere. At Frascati, a 10-fold growth of aerosol was reported as early as in summer of 1991 (G. Gobbi et al.). Over southern Germany (H. Jäger) and France (S. Godin) the peak concentrations were recorded in early 1992; over Cuba (J.-C. Antuña) there was a decreasing tendency in 1992-93; a general decrease was going on in these years over Europe, though it was slower than in the case of El Chichón, and large concentrations of aerosol were seen, e.g. by the OHP lidar in summer of 1993 (S. Godin). At the South Pole (G. Fiocco et al.), Pinatubo-related increases of aerosol were registered first in mid-December 1991, then in July 1992; a decrease in concentration took place during early 1993. The Thule lidar fixed the first appearance in September 1991, and the largest steep rise occurred in early spring of 1992. The aircraft observations (S. Borrmann) indicated a decrease with time of aerosol variability in the Arctic : plumes in September 1991, a more distributed pattern in the winter of 1991-92, and slight variability in November 1992. After the eruption, SAGE II observed aerosol as high as 35 km in the tropics (L. Thomason); satellite data showed that there was maximum aerosol concentration in the tropics and additional maxima in polar regions in winter, with lower values at 20-40°. Detailed comparisons of satellite data to lidar results are still to be performed.

After an eruption, interactions among different particles proceed intensively (R. Turco). The number of smaller particles increases first, these coagulate then into larger particles with a total decrease of their number (as observed both in the Antarctic (M. Cacciani et al.) and Arctic (S. Borrmann). The centre of the aerosol cloud was reported at many sites to lower with time (e.g. from 20 to 16 km in 2 years in Germany). According to P. Hamill's modelling of the volcanic cloud evolution, aerosols form within 4 days of the SO_2 injection : the model provides the Pinatubo cloud particle size/surface area distribution, optical depth, deposition rates, etc. N. Larsen studied particle evolution by modelling and conducting flights at Thule and Alert. A 2D-model was applied by L. Ricciardulli et al. to depict the Pinatubo particles size evolution. A 1D-model was presented (G. Panegrossi et al.) simulating PSC evolution after the eruption. Microphysics and chemistry along parcel trajectories were considered by V. Rizi et al. in a single box model.

Radiative and dynamical effects. The warming effect in the stratosphere related to the eruption was larger in the southern hemisphere and peaked near the equator (J. Angell) or near 20°N (K. Labitzke). Different techniques were applied to distinguish between the volcanic and concurrent El Niño and QBO effects. The heating was accompanied by a temperature dip a year or two later. The thermal effect over the South Pole was different after Agung, El Chichón and Pinatubo (J. Angell). The northern winters following the 3 eruptions had lowered stratospheric temperature and heights (K. Labitzke), with no major warmings (in contrast, 5 cases of El Niño were accompanied by high 30 hPa polar temperatures). Modelling (H. Graf) also indicated that after the eruption the vortex remained stable. A. O'Neill emphasized some aspects of transport on the basis of air trajectory analysis, in particular the possibility of exchange between the vortex and extra-vortex areas in the lower stratosphere. K. Labitzke and C. Marquardt stressed specific features of the QBO after the Pinatubo eruption (extended duration of easterly winds, delay in their further downward penetration). This was interpreted as due to diabatic heating.

Ozone loss. Heavy ozone loss was reported to have occurred in 1992 and 1993. R. Bojkov stressed the increase in negative ozone trends in recent years which he said coincided in time with the west QBO phase-related deficiencies, and therefore only 2-3% of the decline could be due to the Pinatubo aerosol impact. In the vertical profiles, anticorrelation was high between ozone and aerosol concentration in Boulder (D. Hofmann) and at high latitudes (A. di Sarra et al., S. Borrmann). Ozone depletion in the lower stratosphere in the period following the Pinatubo eruption was reported over Haute Provence (S. Godin), US and the South Pole (D. Hofmann), Germany (H. Jäger), the equator (W. Grant); increase of ozone above 25-28 km was sometimes observed. According to J. DeLuisi, model calculations of the UV irradiance charge indicate that at middle latitudes a possible decrease of 3-4% could have occurred at 310 nm during the winter of 1991-92; such a small change would be very difficult to detect from the normal climatological variations that occur at this wavelength, and with the instrumentation that has been used in the past.

Chemical and photochemical effects. The chemical/photochemical impacts of Pinatubo on the stratosphere were addressed in some models. Increased dehydration/denitrification was obtained for 1993 in a 1D PSC model (G. Fiocco et al.). Considerable ozone depletion should follow SO_2 and H_2O injections (2D- and 3D-models of G. Visconti and G. Pitari). I. Isaksen used a 2D-model with heterogeneous effects to estimate changes in chlorine, bromine, nitrogen species and ozone. In particular, increases in N_2O_5 and ClO were noted. Ozone reduction, due to combined effects of PSC and Pinatubo, was 7 to 8% in spring and should enhance UV-B radiation and, possibly, tropospheric OH. In 1993 mainly PSC contributed to ozone loss, with less particles (and hence PSC) in 1994. S. Solomon stressed the intensification of some reactions on aerosol surface (increased by a factor of 100 after Pinatubo) under low temperatures and obtained ozone loss 5 to 15% below 20 km at 60°S, with a 5% increase above 26 km; a reduction in NO_2 was noted, consistent with evidence from New Zealand; iodine and aerosol chemistry are still not clear. G. Brasseur, introducing SO_2 into the NCAR 2D chemical-transport model, also obtained depletion of NO_2, growth of ClO and a 10% ozone loss in the first months after the eruption due to heterogeneous reactions and photolysis; if allowed for the temperature change, the model could account for ozone loss of 6, 10-12 and 2% in northern springs of 1992, 1993 and 1994, respectively (slightly less than observed; the latter may be however due also to dynamical effects like blocking, as stressed by A. O'Neill).

Climatic effects. Century-scale positive trends are evident in global and hemispheric temperature records (P. Jones). There are difficulties in distinguishing between volcanic and ENSO effects with certain eruptions. The effect of Pinatubo on large-scale temperatures was a cooling of between 0.2 and 0.3 C in annual temperatures for 1992 and 1993. Temperatures during 1994 recovered dramatically. K. Kondratyev analysed environmental consequences of volcanic eruptions in the context of global change. O. Uchino indicated lower troposphere temperature anomaly in January 1992 after the Pinatubo eruption. Removing ENSO effects and applying the superimposed epoch analysis to 6 large eruptions (5 in the tropics and Katmai in Alaska), A. Robock obtained a cooling signal (0.1 C) in summer 0-2 years after an eruption (the northern hemisphere being more reliable), and a warming over northern continents in winter; the results however were not statistically significant. Comparison with AMIP results showed that winter warming over the Northern Hemisphere continents was significantly greater than that simulated by the average of many GCMs forced only by ENSO SST patterns, suggesting that the difference was caused by the El Chichón cloud. J. Hansen compared observed temperature changes with predictions of an 8 by 10 degree model made right after the Pinatubo eruption. Observed surface cooling over land had a maximum about 0.6 C in summer and fall of 1992, in good agreement with the model, but the ocean surface did not cool as much as in the model. Observed Northern Hemisphere winters were much warmer than in the model. The GISS group now has calculations underway with an improved higher resolution model. M. Schlesinger, using Khmelevtsov's (1994) optical depths for 2-6 years after the eruption and including the greenhouse gas and anthropogenic sulphate aerosol effects succeeded in simulating the general positive trend in surface temperature and the cooling after Pinatubo but the simulated cooling after Krakatoa was much larger than shown by the IPCC observations. H. Graf with the ECHAM3 T21 model obtained warming at mid-latitudes in winter after the Pinatubo eruption (with cooling in Greenland and Mediterranean) (thus volcanic aerosols enlarging the natural pattern), and tropospheric (850 hPa) cooling in summer over continents. A warming in Sahara was modelled but not seen in the observations; for this region, there was consistency between the modelled and observed rainfall. A cooling in the lower troposphere (900 hPa) was obtained by R. Ferretti and T. Paolucci who used the NCAR mesoscale model (14 levels, time step 100 s, resolution 1.5 deg., detailed surface physics, CCM 1 radiation transfer scheme, aerosol cloud at 18-23 km, initialization with ECMWF data, start in October 1991); as for other levels, heating near 80 and 300 hPa are noteworthy.

The last day of the workshop held at the Academia Nazionale dei Lincei was devoted to overviews of key problems in stratospheric aerosol physics, chemistry of the stratosphere, and climate change.

As a result of the ARW, a book of about 300 pages edited by Prof. G. Fiocco is planned to be published by the middle of 1995.

Yu. P. Koshelkov

STRATOSPHERIC MODELLING WORKSHOP

(Melbourne, Australia, 28-30 September, 1994)

The 3-day workshop hosted by the recently established Cooperative Research Centre (CRC) for Southern Hemisphere Meteorology at its Monash University site attracted 52 participants from 6 countries. It focussed on Stratospheric Dynamics, Stratospheric Chemistry and ASHOE/MAESA, and comprised for each topic a keynote address followed by presentations by the participants.

Michael McIntyre provided the address on «**Dynamical Aspects of Stratospheric Modelling.**» After an introductory «busman's tour» of stratospheric dynamical theory, he addressed three important issues. The first was the overall control on the global stratospheric circulation by the wave-induced «extratropical pump», as distinct from the rate at which cross-tropopause exchange occurs at more local scales. The second was the relative importance of small-scale (erosion) versus larger scale («schlooping») contributions to quasi-horizontal eddy transport and cross-tropopause exchange, and the third was the still-debated issue of polar vortex throughput.

Prof. McIntyre's address was followed by 17 presentations on stratospheric dynamics. Of these, about half examined stratospheric performance of global analysis/prediction systems currently in use at NASA/GSFC, UKMO, Japan Meteorological Agency, NMC, ECMWF and the Australian Bureau of Meteorology. The remainder of the presentations dealt with modelling or observational studies of gravity waves (GW) in the southern hemisphere stratosphere, and other recent progress in dynamical modelling.

Dr. Jose Rodriguez gave the keynote address on «**Chemical Aspects of Stratospheric Modelling.**» By tracing the historical development of understanding provided by observations and the progressive attempts to explain them, he provided an overview of the concepts and techniques used in modelling stratospheric chemistry, described some of the more recent developments in, and outstanding questions pertaining to, laboratory kinetics, stratospheric observations and modelling. He concluded that further advances in understanding will require the identification and characterization of stratospheric heterogeneous and microphysical processes, comprehensive observations at altitudes above 20 km, and realistic parameterizations of chemical and microphysical processes in 3D models.

Dr. Rodriguez' s address was followed by 8 presentations on chemical modelling, with some preliminary results from Harvard University, GSFC, CSIRO Division of Applied Physics, CNRM/Meteo-France, and NASA/LRC.

Adrian Tuck's address on «**The ASHOE/MAESA Mission**» provided both an overview of the mission and a status report on the aircraft flights conducted during the first three deployments. Dr. Tuck described a number of the chemical and «derived» tracers useful in identifying either the source of a stratospheric air sample or characteristics of the sample's recent chemical history. He concluded the address with an interim summary of the results of the first three deployments of the mission.

Dr. Tuck's address was followed by 6 presentations on ASHOE/MAESA (analyses of ASHOE/MAESA data were also included in several of the earlier presentations) dealing with an intercomparison of High resolution Interferometer Sounder (HIS) data with cross-sections from several of the global analysis/assimilation schemes, an analysis of Airborne Chromatograph for Atmospheric Trace Species (ACATS) data to provide estimates of the total stratospheric chlorine budget and constraints on the stratospheric lifetimes of a number of the longer-lived stratospheric species, and 2 presentations on the use of Meteorological Measurement System (MMS) and Microwave Temperature Profiler (MTP) data to diagnoze the occurrence of inertia GW, GW and turbulence in the lower stratosphere.

● Roger Atkinson

SPARC in Action
National contributions to SPARC

Argentina

The **National Meteorological Service** (SMN) operates a Dobson spectrophotometer in Buenos Aires since 1958, ozone sounding at Marambio (64°S, 57°W) together with a Brewer spectrophotometer, recently started Dobson measurements at Ushuaia (54°S, 68°W). The Institute of Environmental Studies (IEMA) in Mendoza makes MW spectroscopy measurements (32°S, 70°W) jointly with the Max-Planck Institüt für Aeronomie of Lindau (H2O, O3, ClO, NO2). They contribute to ATLAS/MAS and SEAM (Spectroscopy of the Earth Atmosphere at high Mountain). The **Laboratory for the Study of Ecological and Environmental Systems** (LISEA) at the Universidad Nacional de la Plata (UNLP) started UARS-based studies (Dr. P. O. Canziani) of transport processes and mid-latitude impact on the vortex breakdown in southern spring, together with other national organisations and in cooperation with the University of Washington.

As for the UV-B issue (of great scientific and social interest here), a

high-resolution spectrometer was set up in 1988 at Ushuaia by the NSF (in addition to its earlier organised similar observations at McMurdo, South Pole and Palmer) and is operated cooperatively by several national agencies; ozone estimates from it are in good agreement with TOMS data.

A chain of UV monitors is being formed (Dr. L. Orce) by five GUV-511 from La Quiaca (22°S, 65°W) to Ushuaia. The **Centre for Optical Research** (Dr. J. O. Tocha) in collaboration with the universities in Spain and Chile is designing a field portable UV sensor (at 305 and 313 nm) promising also for Total Ozone (TO) retrievals.

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Brazil

Efforts were made recently for systematic monitoring of UV-B radiation at several locations. Two new sensors (Biometers) measuring total UV-B radiation from solar light were recently added to the network of stratospheric ozone monitors (Revista Brasileira de Geofisica, 11 (2), 205-213, 1993), one in Natal and the other in Saõ José dos Campos. More sensors of the same type are planned to be installed shortly, probably in Santa Maria and Punta Arenas, Chile. A spectrometer GUV-511 from Biospherical is also being added to the network. The monitoring sites in Brazil (plus Punta Arenas, in cooperation with Chile) are as follows : 1. Natal (6°S, 35°W) - Brewer and Biometer (since October 1994), 2. Cuiaba (16°S, 56°W) - Brewer since October 1990, Biometer planned, 3. Saõ José dos Campos (23°S, 46°W) - Biometer since August 1994, GUV-511 planned, 4. Santa Maria (29.5°S, 53.5°W) - Brewer since May 1992, Biometer planned, 5. Punta Arenas (52.5°S, 71°W) - Brewer since August 1992, Biometer planned.

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Bulgaria

The Bulgarian Academy of Science through its National Institute of Meteorology and Hydrology (NIMH), Geophysical Institute (GI) and Solar-Terrestrial Influences Laboratory (STIL) organise SPARC-related activities in several domains :

1. Monitoring of total ozone - at 2 stations by M-124 filter ozonometer (P. Videnov, NIMH). The data are being sent to Ozone WDC in Canada. Also, there were weekly balloon ozone soundings in 1982-1993 (stopped due to financial problems).

2. Structure and Dynamics of the Middle Atmosphere (MA) in the South-East of Europe (from rocket data) (L. Milenkova, NIMH). Studies are : mechanisms of the troposphere-stratosphere interaction and stratospheric warmings. Also, an empirical model of the MA for the SE of Europe was constructed from 10-year rocket sounding at Ahtopol site.

3. Relationships between Thermosphere/Ionosphere and MA during Stratospheric Warmings (Prof. D. Mishev - STIL, NIMH, GI).

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India

Indian Space Research Organisation.

1. **Chain of UV-B and multiwavelength radiometers.** Measurements were made at 6 stations since 1987 and erythemal doses computed. Total Ozone (TO) derived from the UV-B data compares well with TOMS. A gradual positive trend in UV-B was noted for Trivandrum during 1982-1992. Over Delhi, 8 years of UV-B data show anticorrelation with TO for clear days; trends could not be ascertained here. Also, aerosol optical depths are monitored by multiwavelengh radiometer (vis/near IR).

2. **Aerosols.** The vertical structure of the atmosphere (3-45 km) is monitored at PRL (Ahmedabad) by a Nd : YAG laser-based lidar at 532 nm, The evolution of the aerosol layer after Mt. Pinatubo eruption was observed. Dense Pinatubo aerosol layers were recorded also over Hyderabad by ballon-borne sun-tracking photometer in October 1991 and April 1992. A high-power pulsed ruby system observed aerosol distribution up to 30 km in Trivandrum.

3. **Stratospheric minor species.** A cryogenic air sampler was used on board a high altitude balloon flown from Hyderabad in April 1994 to measure CH_4, NO_2, CO_2, CFS_s, Halons 1211 and 1301, CH_3Br, CO; flights are planned once a year for trend studies.

4. **Reference climatology** for 20-80 km over Thumba was derived from 18 year long rocket sounding, and the QBO, Semiannual Oscillation (SAO) and annual oscillation were studied. Correlation between SAO anomalies and annual rainfall over India was noted.

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India Meteorological Department. IMD maintains an ozone monitoring network. The National Ozone Centre serves as the Regional Ozone Centre for the Regional Association II (Asia) of the WMO. Daily TO and Umkehr observations are made with Dobson and Brewer Ozone Spectrophotometers. UV-B is measured (Brewer) at 2 sites. Ozone profiles (balloon) are observed fortnightly at 3 sites. Surface ozone is measured by chemical sensors. Improvement of data quality is planned through calibration and checks using portable spectrophotometers, intercomparisons, modernization of instruments.

Research is focused on ozone production/distribution/destruction mechanisms, trends, instrumentation, ozone and the ecosystem; (planned - climatology of tropospheric ozone, effect of ozone variation on climate of India). A 1-D coupled climate-chemistry model is used to study interaction between changing

stratospheric chemistry and climate in the tropics.

Regular ozonesondes are taken at the Antarctic station Maitri to study ozone depletion.

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Italy

Research on stratospheric processes and their role in climate is conducted in : Institutes for Atmospheric Physics of the National Research Council (FISBAT/CNR, Bologna and IFA/CNR, Roma), Institute for Research on Electromagnetic Waves (IROE/CNR, Firenze), Antarctic Program of the National Agency for Energy and Environment (PNRA/ENEA), University of Firenze, University of L'Aquila, University of Roma «La Sapienza». Large efforts are devoted to the development of ground-based and balloon borne instruments (lidars, spectrometers, scatterometers, ozone sensors, etc.) deployed in Italy (Brasimone, Firenze, Frascati, Monte Cimone, Roma, L'Aquila) or at remote sites (Antarctica, Arctic, New Zealand). Many of the activities are pursued as part of international cooperative projects such as SESAME. **Lidar** systems collect data to study : ozone distribution and evolution, microphysical and radiative properties of volcanic aerosol and PSC properties and climatology, MA thermal structure (climatological and dynamical phenomena). Some of the lidars are part of the instrumentation of NDSC primary sites. **UV-visible spectrometers** are used to observe the column content of several trace gases in the stratosphere and UV-B radiation near the ground. **Balloons** are used to measure the chemical composition of the stratosphere through far **IR high resolution spectrometers** and the characteristics of volcanic aerosols and PSCs through **multiple-wavelength scatterometers. Ozone soundings** are also carried out routinely at a station in Italy. Several instruments (Rayleigh lidar, multi-wavelength scatterometer, ozone sensor, far IR spectrometer, UV-visible spectrometer) will be installed on the M55 «**Geophysika**» aircraft (the first campaign planned for the 1995-96 winter in the Arctic). **Modelling** studies involve 2D and 3D dynamical, chemical and radiative stratospheric models and 1D PSC models; most of the activities deal with the role of heterogeneous reactions and of the dynamical and radiative processes influencing ozone distribution.

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Japan

Two SPARC research groups, the University group chaired by Prof. I. Hirota and National Institute group chaired by Dr. O. Uchino are now running in parallel with mutual collaboration and making efforts to get national fundings. In the National Institute for Environmental Studies (NIES), Drs. H. Nakane and Y. Sasano lead research of remote sensing of ozone and other trace gases by lidars and ADEOS satellite, respectively.

Wide areas of stratospheric research together with some tropospheric research are incorporated into the SPARC plans in both groups. The university group has several subgroups : 1. Aircraft observations of aerosols and trace gases (Prof. Y. Kondo); 2. Ground-based remote sensing of chemical substances (Prof. H. Fukunishi and Y. Iwasaka); 3. Remote sensing of dynamical quantities (Prof. S. Fukao); 4. Data analysis of dynamical and chemical quantities (Prof. T. Hirooka); 5. Global and process modelling study (Prof. S. Miyahara). As there is no special aircraft for stratospheric measurements, collaborative observations are carried out with USA (NCAR, NASA), Germany, and other countries. The MU radar of RASC (Kyoto University) has produced outstanding activities of MA dynamics. Nevertheless, additional radar stations should be built, particularly in the western equatorial Pacific, in order to complete a global radar network.

Important remote sensors are developed to observe atmospheric properties and chemical substances (Mie and Rayleigh lidars, Raman lidar, FTIR, heterodyne lidars, and heterodyne millimeter wave radiometers) in both groups. Some of them are organised in global networks. Data analyses were conducted using TOMS, UARS, and other global data. ADEOS data will be almost ready to be analysed when the satellite is launched in near future.

GCMs including chemical/radiative processes are now under development (Kyushu University, Tokyo University, Hokkaido University, MRI, NIES). There are plans to make one or two big GCMs able to simulate intraseasonal, seasonal, interannual and decadal changes of ozone, temperature, water vapour, wave activity, etc.

The Japanese SPARC programme would like to proceed in collaboration with scientists from other countries.

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Korea

Ozone is monitored (Dobson) at the **Yonsei University**, Seoul (37.5°N, 127°E) since 1984 in the frame of WMO/GO_3OS (Beck #124). A statistically significant trend of -3.77 % per decade is obtained from May 1984 through April 1994, greatest in winter (-4.93) and lowest in autumn (-1.71). Also, UV-B radiation is observed since 1993. The **Korean Meteorological Administration**

recently installed Brewer spectrophotometer and UV-Biometer at Pohang (36°N, 129°E). A lidar is operated at the Kyonghee University, Suwon (37°N, 127°E) since 1992. **The Korea Aerospace Research Institute (KARI)** made first rocket ozone measurements launching 2 rockets at Anheung (37°N, 126°E) on June 4 (15-35 km) and August 31 (15-45 km), 1993. A full 3D stratospheric circulation model is being developed by **the Korean Meteorological Research Institute, KARI, and universities** to study circulation and ozone trends, in collaboration with NASA/Langley and ADEOS/ILAS.

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Malaysia

Ozone and UV radiation measurements started at the **University of Science of Malaysia (USM)** in Penang in late 70's in an integrated programme. This phase of the programme was terminated in 1988 with a view to start a new phase with better infrastructure and instrumentation. To facilitate it, a separate set up, the Astronomy and Atmospheric Science Research Unit (AASRU) was established in 1990, with various laboratories, a radiation platform, new sets of photometers & associated instrumentation and ozonesonde balloon launching facilities. The 2nd phase of experimental work was activated in mid-1994 when ozonesonde measurements, UV-B, UV-A and other solar radiation observations were initiated. The new system has good data quality control. Also, in the next 2-3 years the newly formed Sheikh Tahir Astro-Geophysical Centre at the western side of Penang Is. will establish an extended research programme.

In 1993, **the Malaysian Meteorological Services (MMS)** started monitoring ozone (balloon-borne) and UV radiation in Kuala Lumpur (in cooperation with USM). Surface air pollution/ozone are studied at the **Agriculture University of Malaysia and the Malaysian Department of Environment.**

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Norway

SPARC related activities include :

Observations : TO monitoring, with Dobson and Brewer instruments at 3 locations : Oslo, Tromso and Spitsbergen (Universities of Oslo (UO) and Tromso (UT); UV monitoring also at these locations (Norwegian Institute for Air Resarch (NILU); Ozone soundings (NILU) at Gardermoen, Orlandet and Bear Is.; Trace gas column measurements (SAOZ) at Spitsbergen (NILU).

Modelling : 3D modelling of the stratosphere as well as the troposphere, at the UO and Bergen (UB); 2D modelling of the stratosphere and the troposphere (UO, UB, and NILU); Trajectory modelling of the stratosphere and free troposphere (NILU, UO and UB); Radiative transfer modelling (NILU, UO).

A wide range of issues are studied based on the activities and methods described above : Ozone budgets in the stratosphere as well as the troposphere; Ozone depletion by chlorine and bromine; Ozone changes due to aircraft emissions by subsonic as well as supersonic aircraft; STE, satellite data analyses; Climate impacts of changes in ozone, especially near the tropopause.

These issues are studied in a range of international projects : several projects within SESAME (European Union, EU); two EU projects studying effects of aircraft emissions at cruise altitude : AERONOX, POLINAT; Ozone as a climate gas (the Nordic Council of Ministers).

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Republic of Philippines

SPARC-related activities concern ozone studies in the **Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).** A preliminary analysis of the Dobson TO data for 1979-1992 for Manila shows no definite trend in the yearly data. The monthly mean data are found to have a pronounced bimodal distribution, the seasonal variation is similar to that at Bangkok and Japan but opposite to that of Samoa. Studies are also taken of possible relation of ozone to the 11-year solar cycle.

TO satellite mesurement is still at its infancy stage. The present method developed in Australia has to be calibrated to suit local conditions; the technique has also to be refined using the Dobson data from Manila.

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Poland

In the **Institute of Geophysics (IG)** of the Polish Academy of Sciences (PAS), the interannual ozone and stratospheric temperature variability (QBO, ENSO, quasi-decadal forcing) and trends are studied using statistical models (Dr. J. W. Krzyścin). Also, UV-By radiation was measured (by Robertson-Berger meter) daily at Belsk since 1975 (since March 1992, a UV-Biometer 501A is used; also, a Brewer spectophotometer with UV-B monitor since February 1991). Uncertainties due to changes in calibrating procedure are studied, to provide data for trend analysis (Prof. J. Borkowski).

Fundamental research of atmospheric sounding by passive optical methods in the **Space Research Centre** of PAS (Prof. A. Jurewicz) involves : a) Investigation of concentration/spatial distribution of trace gases/aerosols by the IR spectrophotometer «Istok-1», to be placed on board the orbital station

«Mir» (designing of a digital VIS TV camera and tester coupled to the spectrophotometer) planned to be launched for the fall of 1995; b) preparation for atmospheric studies by an IR Fourier Spectrometer from CESAR (Central European Satellite for Advanced Research) planned for 1997. Also, passive microwave ground-truth radiometers to calibrate ERS-1 are being constructed.

In the **Institute of Meteorology and Water Management** : a) Weekly ozone soundings were performed since 1979 at Legionowo (52°N, 21°E). Daily TO fields are being calculated for Central Europe from TOVS/NOAA since 1993. UV-B Biometers were established at 3 sites, ozone influence on UV-B is studied (Dr. Z. Lityńska); b) Relations between stratospheric parameters (predictors) and subsequent monthly mean temperature pattern in Poland are found and used for long-range forecasting (Dr. J. Pawlowska).

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Portugal

The **Institute of Meteorology** (IM) carries out ozone and UV-B radiation studies. First TO (Dobson) measurements started in 1951 at Santa Maria Is. (Azores). In 1960 the instrument was moved to Lisbon, and regular TO and Umkehr measurements are made since 1967; these were accomplished later with weekly ozone sounding, surface ozone and UV-B radiation measurements (Robertson-Berger, since 1983). To assure the Dobson network calibration, the IM participated in the WMO intercomparison sessions. Recently, 3 ozone stations were installed at Funchal (Madeira Is.,1989), Angra do Heroismo (Terceira Is., 1992) and Penhas Douradas (Portugal, 1994) equipped with automated Brewer spectrophotometers (TO, total SO_2, Umkehr, UV-B); in addition, surface ozone (photometric UV absorption) and CO_2 (NDIR techniques) are monitored here. Some effort is being made to upgrade the UV-B network. The ozone data are submitted to WODC. The IM participated in EASOE, NARE (North Atlantic Regional Experiment) and in Winter-spring Near-to-real Ozone Data Exchange. Papers are published on the ozone layer over Portugal and main processes responsible for ozone and UV-B variations; efforts are made to find relationships between TO and stratospheric parameters, and to develop methods of daily TO and UV-B forecasts.

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South Africa

The South African (SA) National Ozone Research Program was founded in 1989, with the main participants from the Weather Bureau and a Group from the University of Natal in Durban. The coordination of national interests has not yet been fulfilled, and other institutes (with limited efforts) are also involved.

SA Weather Bureau : TO measurements were made with Dobson No 89 in Pretoria in 1964-1972 and resumed since 1989. The data reveal an 8% increase from the mid-60's to early 90's (largely due to a more than double increase in tropospheric ozone, the latter presumably related to an increase in NOx and hydrocarbons in connection with industrial growth in the area). TOMS data over SA reveal a 2 to 6.5 % ozone decline since 1979 to 1991; the Dobson No 89 data confirm the decline since 1989. TO observations are made daily and are supplemented with Umkehr measurements which reveal a 6-7% depletion in the lower stratosphere since the mid-60's while no noticeable changes were recorded in the upper stratosphere. During August 1990-October 1993 weekly ECC ozonesonde measurements were made (stopped due to financial constraints). The newly acquired Dobson No 132 is earmarked for operation at Springbok from early 1995. Great emphasis is placed on meeting the international requirements towards instrument standards and data integrity. Research is being done on our own available data.

Since the beginning of 1994, in cooperation with the Medical University of Medunsa, a network of four UV-B biometers is maintained, and the information is being channelled to the general public during Weather Broadcasts, with classification of moderate, high, dangerous and very dangerous sunburn values. Actual (4 pm) sunburn values are shown, and a technique will be soon applied for forecasting the following day's values.

University of Natal : The emphasis is mainly on research efforts (mass transport of ozone and associated weather conditions, ozone trends, STE, biomass burning influences, etc.). A SAOZ spectrophotometer is operated in Durban since 1993, another one at SANAE base in Antarctica since 1992. Other monitoring activities include surface ozone and UV-B.

Earth, Marine and Atmospheric Science and Technology (EMATEC) : a BAPMON station at Cape Point is operated since 1978. Since the implementation of the Montreal Protocol, a significant decrease in the growth-rate of CFC-13 was recorded. In collaboration with the Fraunhofer institute in Germany, this station was upgraded and formal acknowledgement as a GAW Baseline station is anticipated in near future.

Future plans : to expand the current networks and research, to enhance collaborative activities in the South African region.

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Acronyms

AASE : Airborne Arctic Stratospheric Expedition

ADEOS : Advanced Earth Observing Satellite

AIRS : Atmospheric InfraRed Sounder

ALOMAR : Artic Lidar Observatory for Middle Atmospheric Research

AMSU : Advanced Microwave Sounding Unit

ARW : Advanced Research Workshop

ASHOE : Airborne Southern Hemisphere Ozone Experiment

ATLAS : ATmospheric Laboratory for Applications and Science

ATMOS : ATmospheric Trace Molecule Spectroscopy

CCM : Community Climate Model

CNES : Centre National d'Etudes Spatiales

CNRM : Centre National de Recherche Météorologique

CNRS : Centre National de la Recherche Scientifique

CSIRO : Commonwealth Scientific and Industrial Research Organization

DIAL : Differential Absorption Lidar

EASOE : European Arctic Stratospheric Ozone Experiment

ECMWF : European Center for Medium range Weather Forecast

EISCAT : European Incoherent SCATter radar

ENSO : El NINO Southern Oscillation

EOS : Earth Observing System

GAW : Global Atmospheric Watch

GCM : General Circulation Model

GCTE : Global Change and Terrestrial Ecosystems

GEWEX : Global Energy and Water cycle EXperiment

GFDL : Geophysical Fluid Dynamics Laboratory

GOME : Global Ozone Monitoring Experiment

GRIPS : Gcm-Reality Intercomparison Project for Sparc

GSFC : Goddard Space Flight Center

GW : Gravity Wave

HALOE : HALogen Occultation Experiment

HIRDLS : High-Resolution DynamicsLimb Sounder

HIRS : High Resolution Infrared Radiation Sounder

HIS : High-resolution Interferometer Sounder

IAMAS : International Association of Meteorology and Atmospheric Science

IASI : Infrared Atmospheric Sounding Interferometer

IGAC : International Global Atmospheric Chemistry

IGBP : International Geosphere Biosphere Programme

IO_3C : International Ozone Commission

IPCC : Intergovernmental Panel on Climate Change

IRC : International Radiation Commission

ISAMS : Improved Stratospheric And Mesospheric Sounder

IUGG : International Union of Geodesy and Geophysics

JSC : Joint Scientific Committee

LIMS : Limb Infrared Monitor of the Stratosphere

MAESA : Measurements for Assessing the Effects of Stratospheric Aircraft

MAS : Microwave Atmospheric Sounder

MHS : Microwave Humidity Sounder

MLS : Microwave Limb Sounder

MSU : Microwave Sounding Unit

NCAR : National Center for Atmospheric Research

NMC : National Meteorological Center

OHP : Observatoire de Haute-Provence

PMSE : Polar Mesosphere Summer Echo

PSC : Polar Stratospheric Cloud

QBO : Quasi-Biennal Oscillation

SAGE : Stratospheric Aerosol and Gas Experiment

SAO : Semi-Annual Oscillation

SAOZ : Système d'Analyse par Observation Zenithale

SBUV : Solar Backscattered Ultra-Violet

SCOPE : Scientific Committee on Problems of the Environnements

SCOSTEP : Scientific Committee on Solar-Terrestrial Physics

SPADE : Stratospheric Photochemistry, Aerosols & Dynamics Expedition

SSBUV : Shuttle Solar Backscatter Ultra-Violet

SSG : Scientific Steering Group

SST : Sea-Surface Temperature

SSU-UKMO : Stratospheric Sounding Unit-UK Met. Office

STEP : Solar Terrestrial Energy Programme (SCOSTEP)

TIGER : Thermal Infrared Ground Emission Radiometer

TO : Total Ozone

TOMS : Total Ozone Mapping Spectrometer

UARS : Upper Atmosphere Research Satellite

WCRP : World Climatic Research Programme

WMO : World Meteorological Organization

Taiwan

The National Central University (NCU) in Chung-Li established a VHF (52 MHz) radar, GW and STE are studied now (Prof. S. I. Su and Prof. C. H. Liu). Also, a lidar is operated at NCU since summer 1993 (Prof. J. B. Nee-studies of thin subvisual tropopause clouds observed in summer confirming recent SAGE II evidence, structured distribution of stratospheric aerosols in relation to upper tropospheric winds and temperature; lidar temperatures show also strong GW propagation). Laboratory studies at NCU (Prof. J. B. Nee) concern photoabsorption of ozone-related halogen compounds and photodissociation of atmospheric molecules (currently O_2 using synchrotron radiation facility). In the **National Tsing-Hua University,** Prof. Y. P. Lee studies sulfur-containing molecules; a lot of laser spectroscopy and rate constants measurements were made. Ozone sounding is started since 1993 twice a month in Northern Taiwan by the **Central Weather Bureau;** Dobson data show some trend since 1965 probably related to air pollution.

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Thailand

Regular ozone observations (Dobson # 90) are made at Bangkok (13°N, 101°E) since January 1984. No definite trend can be seen throughout 1984-1994, minima in the yearly data were observed in 1985-86 and 1992 and a maximum in 1989-91. The annual variations indicate a peak mostly in April-June and low values in November through February.

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