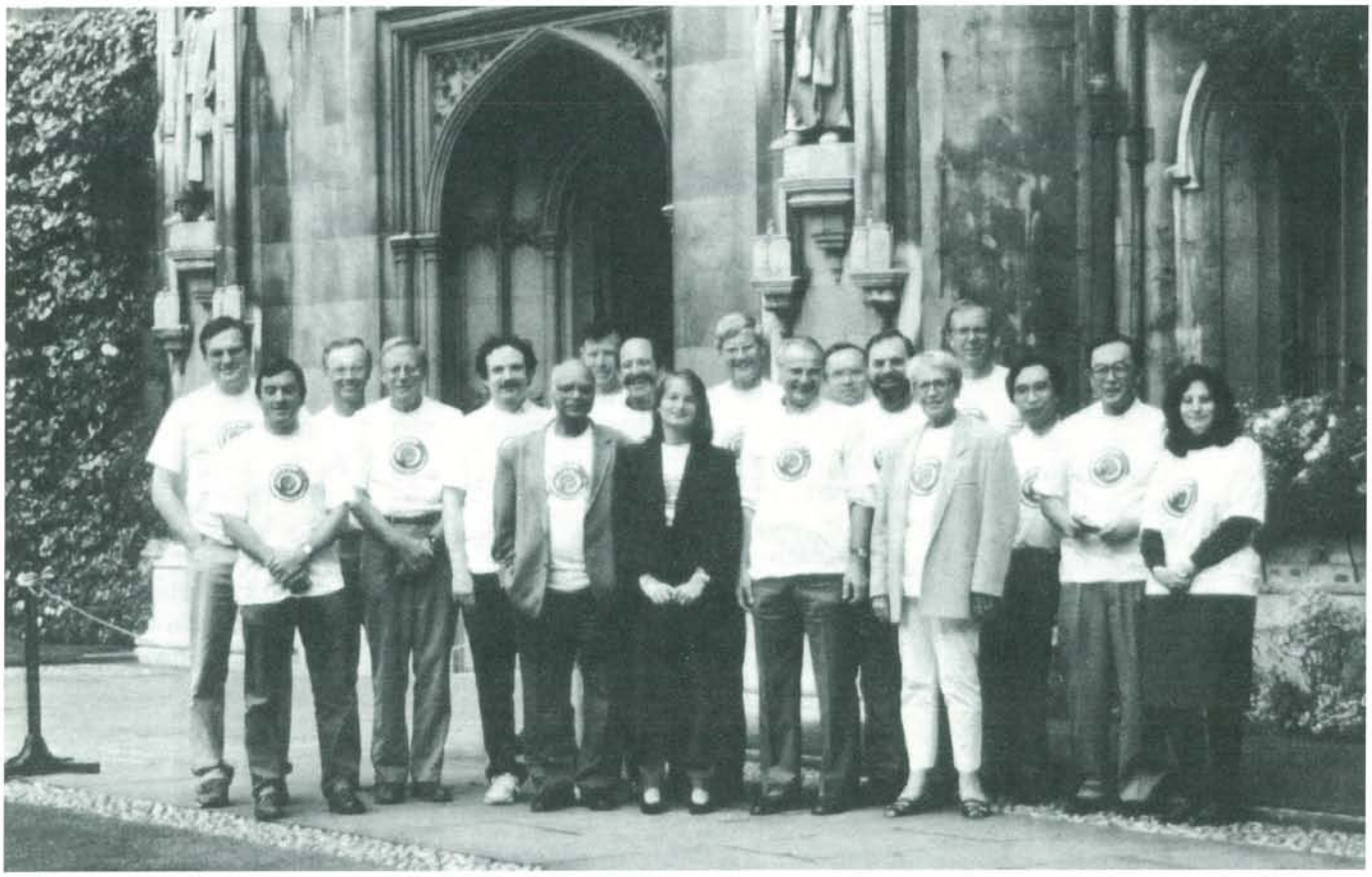
SPARC newsletter n° 2

1993
December

STRATOSPHERIC PROCESSES AND THEIR ROLE IN CLIMATE

A Project of the World Climate Research Programme



Members of the SPARC SSG, SPARC Office and attendees taking a break in Corpus Christi Courtyard, during the SSG Meeting held in Cambridge, UK, September 10-12, 1993. From left : I. Isaksen, J. Pyle, J. Gille, G. Reid, J. Kaye, S. Chandra, R. Newson, M. Geller, M.-C. Torre, J. Mahlman, D. Ehhalt, V. Khatattov, E. D. Fabo, M.-L. Chanin, P. Simon, T. Matsuno, H. Tanaka, S. Solomon

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Edited
by SPARC Office

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Greetings

The numerous and positive comments that we have received welcoming the first SPARC Newsletter have been very gratifying. I hope that the future issues will fulfil your expectations. The last few months have been very active for both the Steering Group and the Office, and this second Newsletter reflects the emergence of new ideas that should help SPARC in energising the scientific community and, by increasing international cooperation, help in answering the numerous questions that have been put forward in our planning document. Obviously, the quality of the science depends on you, the practitioner, but it is my wish that SPARC may be of assistance to you in establishing the multidisciplinary contacts required to pursue your objectives and provide a useful forum in which to discuss your results. Since this second Newsletter should hopefully reach you before the end of the year, I would like to take this opportunity to send to each of you my warmest personal wishes for 1994 to be a very happy and successful year in both your personal and professional lives.

● Marie-Lise Chanin,
SPARC Co-Chair

Report of the SPARC SSG Meeting held on Sept. 10-12 93 at Cambridge, UK

General

The first formal meeting of the SPARC Scientific Steering Group (SSG) was held at Cambridge, United Kingdom, from 10 to 12 September 1993, following the NATO Advanced Research Workshop on Stratosphere-Troposphere Exchange. The meeting was attended by the members of the SSG, the ex-officio members, and a few invited observers.

The SSG discussed the general philosophy that should drive the programme; the general feeling was that SPARC should energise and nurture science rather than overcoordinate it. SPARC should not intervene when not needed but should identify the gaps and the lack of knowledge around which activities should be focused. Along these lines, a number of specific objectives were formulated. They do not, at this stage, pretend to cover the whole range of needs, but the ones with the highest priority. They are described in detail under "SPARC Initiatives" in this Newsletter.

Several requests were put to the SSG to endorse individual scientific or national projects as a contribution to SPARC. The SSG agreed that, to be endorsed, such projects must be related to SPARC scientific objectives or to the specific SPARC initiatives now being planned. Proposals for which endorsement is required should be submitted to the SPARC Project Office, with clear description of the work to be carried out and the personnel involved. They would then be reviewed at the following SPARC SSG meeting.

The SSG discussed the draft of the document "Initial Review of SPARC Objectives and Scientific Issues". It was agreed that, following inclusion of a number of amendments, the document should be published and made available to the SPARC community as quickly as possible. However, it should be updated regularly as the need arises.

An important focus of SPARC studies will be the stratospheric modelling. Dr. R. Rood (NASA/Goddard Space Flight Center), who has agreed to take the responsibility for formulating this activity, discussed plans to assess the present state of troposphere-stratosphere general circulation modelling, strategies for model intercomparisons and plans to improve their capability for studying problems related to SPARC. Two central issues are to help understanding the role of the stratosphere in the present climate and the impact of possible changes of the stratosphere on the troposphere.

Dr. R. Rood observed that a number of three dimensional models have internally self-consistent physics and the capability to resolve the troposphere and the stratosphere. He proposed strategies for intercomparing these models as follows :

a) All models would perform a specified experiment to remove as many uncertainties as possible (e.g., same initial conditions, specified boundary conditions, solar constant, CO_2 amount, same grid resolution).

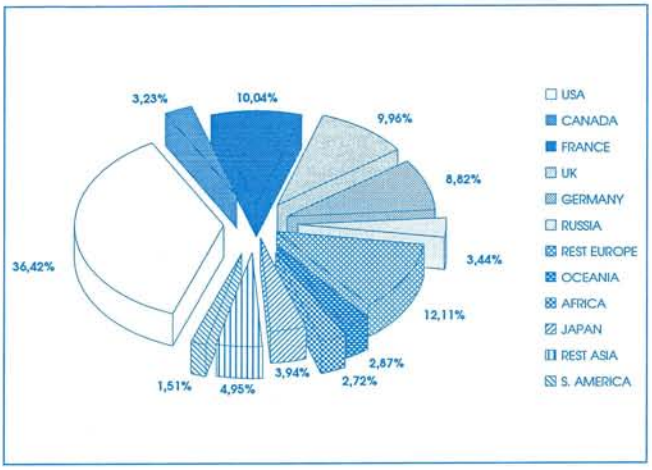
b) All models should provide a specified set of output in a specified format.

c) Focus Teams will then analyse the results from all the contributing models and present the results at the IUGG workshop in Boulder in 1995.

On behalf of the U.S. Department of Energy Program for Climate Model Diagnosis and Intercomparison (PCMDI), Prof. W. L. Gates has offered the infrastructure that has been put in place for the Atmospheric Model Intercomparison Project (AMIP) to store data from these experiments and

the powerful PCMDI software facilities for producing the required diagnostics.

Dr. P. Haynes presented highlights of the NATO Advanced Research Workshop on Stratosphere-Troposphere Exchange (STE). The topics discussed at the Workshop included large scale dynamics, chemical observations and modelling, observational aspects of STE, tropopause dynamics and exchange in mesoscale models, numerical weather prediction models and general circulation models (GCMs). A summary of the NATO/ARW workshop by Dr. P. Haynes is included in this Newsletter.



World Repartition of the SPARC Mailing List which amounts to 1451 names (November 1993)

Dr. P. Liss, new chairman of the IGBP-SC, attended a part of the SSG meeting and commented on interactions between IGBP and SPARC, mainly with the following IGBP projects : IGAC, GCTE, JGOFS and LOICZ (For details see "Interaction with IGBP" in this Newsletter). Dr. E. de Fabo presented the outline of the second SCOPE report on the "Effects of Increased UV Radiation on Global Ecosystems", which he distributed in its draft form and is soon to appear in print. The monitoring of UV-B is of very high concern for SPARC and the co-ordination of the numerous but independent initiatives is one of the SPARC priorities and is at the base of its co-operation with the biological community.

Activities of the SPARC Office, in Verrières-le-Buisson, France

The establishment of the SPARC Office was described by Dr. M.-L. Chanin who reviewed the initial activities of the Office : completion of the document describing SPARC Objectives, organisation of SPARC related meetings (Carqueiranne, Wiesbaden, Yokohama), assistance in the organisation of the annual SPARC SSG, constitution of the SPARC directory, contact with national programmes and private initiatives, preparation of the first SPARC Newsletter. Dr. S. Chandra presented the outline of this Newsletter and Ms M.-C. Torre discussed the constitution of the SPARC directory and presented the geographical distribution of the scientists receiving the Newsletter (see figure).

Role of SPARC in IPCC/WMO-UNEP Assessments

The time-table for the preparation of the next IPCC Scientific Assessment was presented. Several SSG members are active in these assessment activities, and the part played by SPARC in reducing uncertainties in the role of the atmosphere in climate change should therefore be reflected in the IPCC report. Moreover, SPARC initiatives could help in filling gaps in the required knowledge. in particular, the need for an in-depth assessment of stratospheric temperature trends is one of the issues where SPARC can assist; it was decided to undertake a review of this issue and plan the work to be carried out with international co-operation.

Dr. K. Shine, Dr. S. Solomon and Dr. V. Ramaswamy are lead authors for the "Radiative Forcing" Section of IPCC document which is going through revision in 1994/1995 and they will be our contact with IPCC.

A new WMO/UNEP Assessment is also being prepared at this time, and many SPARC individuals are included in this activity.

Relevant programmes/ activities of different agencies :

SPARC is following with attention the relevant programmes and activities of different national and regional agencies such as NASA, NOAA, DOE, CEC... and will depend on the support of these agencies to implement activities. The details about these programmes will be published in the following Newsletters.

Involvement of developing nations in SPARC

Dr. M.-L. Chanin described the programme led by the International Centre for Theoretical Physics, (ICTP), in Trieste, in particular the atmospheric component under the directorship of Dr. S. Radicella. A most important contribution is made by the training school which organises courses comprised half and half by tutorial lectures and sessions carrying out research investigations using computer facilities and global data sets provided by the international community. The next Workshop is planned for Feb-Mar 1994 in Trieste. Scientists interested in this or future workshops should contact Prof. S. M. Radicella, ICTP, PO Box 586, 34100 Trieste, Italy.

NATO Advanced Research Workshop on "Stratosphere-Troposphere Exchange"

Cambridge, England, 6-9 September 1993 (Director : J. R. Holton, Co-Director : P. H. Haynes)

It is certainly the modern view that the dynamics of the troposphere and the lower stratosphere cannot be sensibly separated. But there are still many reasons, particularly associated with relevant chemical and physical processes, why it remains useful to distinguish between the troposphere and the stratosphere and therefore to seek to quantify the exchange between them. This workshop, reviewed our current qualitative understanding of mechanisms for mass-exchange between troposphere and stratosphere and the associated quantitative estimates of exchange rates.

The workshop covered the following topics :

- The large-scale dynamics of exchange (speakers : M. E. McIntyre, P. H. Haynes, R. A. Plumb).
- Tropopause dynamics (speakers : J. Egger, H. Kelder, B. J. Hoskins, J.-F. Lamarque, D. O'Sullivan, W. R. Peltier, L. J. Gray, V. Wirth).
- Observational aspects of exchange (speakers : H. C. Davies, J. R. Holton, M. Follows, M. Shiotani, M. Hitchman, M.-L. Chanin, K. S. Gage, L. Pfister, W. Norton, R. Swinbank).
- Chemical aspects of exchange in models and observations (speakers : G. Brasseur, A. Douglass, A. F. Tuck, C. Varotsos, G. Vaughan).
- Exchange in numerical models, including GCMs (speakers : H. Elbern, A. J. Simmons, N. A. McFarlane, J. Thuburn, K. Shibata, L. Bengtsson, D. Cariolle, B. A. Boville, J. D. Mahlman).

and the attendance reflected this spread of interests.

Some of the important processes in stratosphere-troposphere exchange are summarised in the figure on page 5. Since the tropopause is a sloping boundary, it is useful to distinguish between components of cross-tropopause transport along and across potential temperature surfaces. However it should be remembered that the tropopause is a quasi-material boundary and reversible changes in its position and shape, however large and rapid, are of little significance to exchange in themselves. What is significant is the irreversible transport across the tropopause that results from such changes (and as the workshop heard, quantifying this is a difficult and subtle problem for modellers and for data analysts).

Many aspects of stratosphere-troposphere exchange may be regarded as part of the mean large-scale transport. This transport is controlled primarily by the distribution of dissipating eddies, which disperse tracers rapidly along potential temperature surfaces and also drive the mean diabatic circulation which moves tracers across potential temperature surfaces. The idea that the eddy dissipation exerts a "downward control" on the mean circulation is useful in some parameter regimes. More generally the control of the mean circulation by the eddies is non-local, rather than purely downward. The measure of stratosphere-troposphere exchange needed to calculate the global budget of molecules such as CFCs, which have a tropospheric source and a sink only in the photochemically active regions well above the tropopause, is primarily determined by the large-scale diabatic circulation. Processes such as tropopause folds and tropical cumulus anvils are somewhat irrelevant. On the other hand, these processes would have to be taken into account when calculating a measure of stratosphere-troposphere exchange relevant to a species with a source or sink close to the tropopause, perhaps below the 400K potential temperature surface.

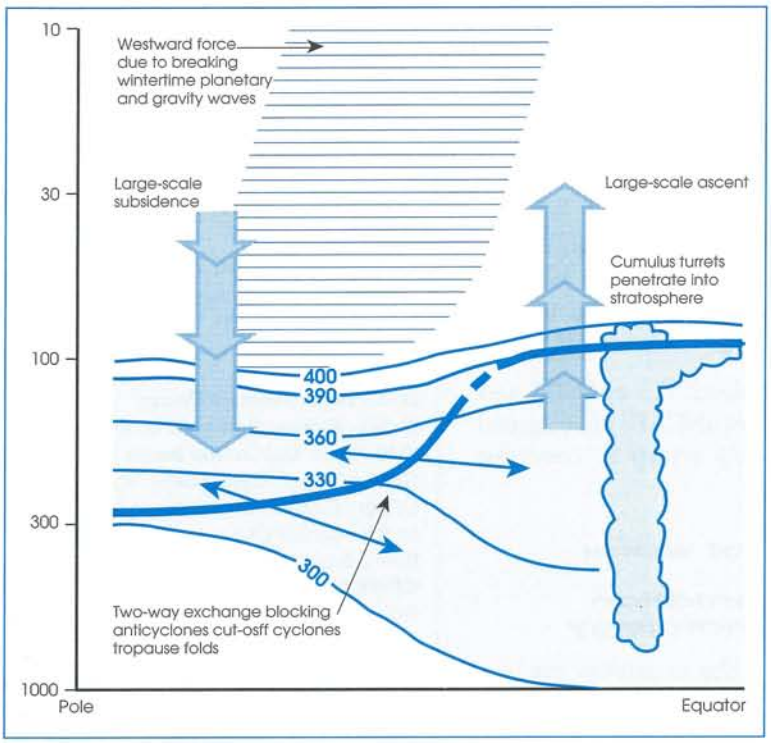
It is widely appreciated that the structure and position of the tropopause is determined both by radiative-convective adjustment (particularly in the tropics) and the action of baroclinic eddies (particularly in the extratropics). But a coherent overall picture of how the different processes act together to maintain the observed tropopause is still lacking. Mid-latitude exchange from stratosphere to troposphere is likely to occur when baroclinic instability and cyclogenesis lead to deformation of the tropopause and thence to tropopause folds. Our qualitative

News from our readers

We are happy to publish the following text from Prof. Michael McIntyre about his recent publication, which happens to be in close relationship with the subject of the NATO Workshop summarised here. It is entitled "Atmospheric Dynamics : Some Fundamentals, with Observational Implications", by McIntyre, M.E. (1992) and published in Proc. Int. School Phys. "Enrico Fermi" CXV Course "The use of EOS for Studies of Atmospheric Physics" eds. J. C. Gille & G. Visconti, North Holland pp 313-386 (1992).

"It sets out some dynamical fundamentals in a way that requires no dynamical specialists knowledge, in particular the reasons why long-time-average stratosphere-troposphere exchange rates are non locally controlled (page 331) and the reasons, well known to dynamists but not yet universally appreciated, why it is incorrect to think of diabatic descent ascaused by cooling (page 326, "polar cooling thought experiment"). There are also some notes on the different, incompatible uses of the words "source", "sink", "transport", etc., page 369.

Comments, criticisms, and request of reprints etc., are welcome at e-mail mem2@ phx.cam.ac.uk. Updates of a correction sheet are available from ftp atm.amtp.cam.ac.uk"



The tropopause is marked by the thick line. The quasi-horizontal curves are potential temperature surfaces (300K, 330K, 360K, 390K and 400K). In the blue shaded region the potential temperature surfaces span the tropopause, which may be deformed by rapid adiabatic motion. Such deformation, in cut-off cyclones, tropopause folds and in blocking anticyclones, leads to irreversible exchange across the tropopause in mid-latitudes. In the tropics exchange occurs as cumulus turrets penetrate into the stratosphere. In addition there is large-scale ascent across potential temperature surfaces at low latitudes and corresponding large-scale descent at mid latitudes, driven by the westward force exerted by breaking planetary and gravity waves in the stratosphere (primarily in the region shaded with horizontal lines). This large-scale diabatic flow may be an important contribution to exchange across the tropopause itself, but it is the dominant contribution to the rate of exchange across potential temperature surfaces (e.g. the 400K surface) in the lower stratosphere. For some purposes these are suitable control surfaces between the troposphere and the regions of the stratosphere where there are important photochemical sources and sinks, and in this sense the transport across them is a useful measure of stratosphere-troposphere exchange. (The figure develops an earlier idea of B. J. Hoskins.)

understanding of such processes has been improved by simulation in large-scale models. But it may well be that currently only in simulations in mesoscale models are the small-scale structure of tropopause sufficiently well-resolved, and the various physical processes well enough represented, for accurate calculations of exchange. The possible contribution of mid-latitudes to exchange from troposphere to stratosphere, in decaying anticyclones, should not be neglected and there is tracer evidence for such exchange.

Satellite observations of both tracers and dynamical quantities can be exploited for large-scale observational estimates of stratosphere-troposphere exchange. Estimates of exchange based on "downward control" are in reasonable agreement with those estimated from the global budget of CFCs, at around 3×10^{17} kg/yr. Aircraft campaigns have successfully observed some of the smaller-scale aspects of exchange in tropical cumulus towers and anvils, and in particular they have validated some of the basic details of suggested mechanisms for dehydration. But the dehydrating effect is not universal and there are some cases where the effect of the cumulus has moistened the lower stratosphere. Meteosat water vapour images show the ubiquity at mid-latitudes of filamentary structure near the tropopause likely to be associated with exchange processes. New techniques such as lidar and Doppler wind profilers, also have potential for revealing some of the quantitative detail of exchange at midlatitudes.

Ozone entering the troposphere through stratosphere-troposphere exchange plays an important oxidising role in tropospheric chemistry. Under current scenarios this effect is probably somewhat less important on a global scale to tropospheric chemistry than the "remote" effect of the stratosphere in controlling the amount of UV-B that reaches the troposphere. But there may be local exceptions to this. Three-dimensional models are beginning to be widely used for chemical studies of the troposphere and lower stratosphere. Results suggest that, in general, the two-dimensional chemical models conventionally used for assessment studies are not adequate to address issues involving stratosphere-troposphere exchange. Good simulation of stratosphere-troposphere exchange is a severe challenge for numerical weather prediction models and general circulation models, involving as it does a subtle interplay between advection and physical processes on small and large scales. Higher resolution (particularly vertical resolution) in numerical weather prediction models has allowed better use of observations and has improved the simulation of upper tropospheric and lower stratospheric features. In general circulation models simulation of stratosphere-troposphere exchange is but one aspect of the problem of the simulation of dynamics and transport. Tracer studies, particle studies and new diagnostics are all throwing light on the shortcomings and successes of the models.

The workshop concluded with a discussion session, one purpose of which was to provide input to the SPARC SSG meeting following. The prime long-term need was felt to be more and better observations, both for the purpose of understanding details of specific stratosphere-troposphere exchange processes and to allow more rigorous testing of the large-scale general circulation models.

● Peter Haynes

Nota : A review paper on stratosphere-troposphere exchange, by J. R. Holton and other workshop participants, is planned for publication in Reviews of Geophysics, and will include material presented at the workshop.

SPARC Initiatives

Investigations and activities proposed by the SPARC SSG :

Troposphere-Stratosphere Modelling

To assess the present state of troposphere-stratosphere general circulation modelling, strategies for model intercomparisons, and plans to improve their capability for studying problems related to SPARC. This activity is led by Dr. R. Rood (NASA/Goddard Space Flight Center) and Dr. S. Pawson (FUB).

Gravity wave climatology and parameterisation

To produce a climatology of gravity waves as a basis for a better parameterisation of gravity waves in atmospheric models and to assess the needs in terms of instrumentation, data analysis, and modelling. A planning group (Co-chairmen, Dr. K. Hamilton (GFDL) and Dr. R. Vincent (U. of Adelaide), has been designated to draw up proposals in this area.

Assessment of Stratospheric Temperature Trends

To evaluate stratospheric temperature trends in the middle atmosphere using and intercomparing all available sources of data. This should include an assessment of the consistency of temperature trends with the observed ozone trends and with model predictions (in collaboration with IPCC activities in this domain). The SSG established a study committee under the chairmanship of Dr. V. Ramaswamy (GFDL) to undertake this assessment.

Lower Stratosphere/Upper Troposphere Exchange

1) To identify a measurement strategy to produce the needed understanding and the quantification of ST exchange and to understand the complex interplay of lower stratospheric chemical and dynamic problems.

2) To define a framework for improved co-ordination of existing national and international activities in this area.

Dr. Ivar Isaksen (U. of Oslo) and Dr. Brian Ridley (NCAR) have agreed to lead a study group to consider these issues.

Review of water vapour instrumentation and climatology

To review the available measurement techniques for determining the values of water vapour in the lower stratosphere and to consider the feasability of establishing a water vapour climatology (as a complement to the GEWEX water vapour climatology project, G.Vap). A small study group, chaired by Dr. J. Gille (NCAR) will report to the next session of the SPARC SSG.

UV-B Monitoring

To review the scientific requirements for UV-B monitoring and to examine the feasability of sufficiently accurate and spectrally resolved ground-based measurements. Concern over the penetration of UV-B radiation is common to SPARC, several IGBP Core Projects and SCOPE. Consultations will therefore be organised between representants of SPARC, IGAC, JGOFS, GCTE, SCOPE, GAW and CIMO.

Dr. P. Simon (IASB) has been selected as the representative of SPARC.

Acronyms

AMIP : Atmospheric Model Intercomparison Programme
ARW : Advanced Research Workshop
ASI : Advanced Study Institute
CEC : Commission of the European Communities
CFC : ChloroFluoroCarbon
CIMO : WMO Commission for Instruments and Methods of Observation
COSPAR : COmmittee on SPAce Research
DOE : Department Of Energy
ENSO : El Niño Southern Oscillation
FUB : Freie Universitat Berlin
GAW : Global Atmospheric Watch
GCMs : General Circulation Models
GCTE : Global Change and Terrestrial Ecosystems
GEWEX : Global Energy and Water Experiment
GFDL : Geophysical Fluid Dynamics Laboratory
IASB : Institut d'Aéronomie Spatiale de Belgique
ICTP : International Centre for Theoretical Physics
IGAC : International Global Atmospheric Chemistry programme
IGBP : International Geosphere Biosphere Programme
IPCC : Intergovernmental Panel on Climate Change
IUGG : International Union of Geodesy and Geophysics
JGOFS : Joint Global Ocean Flux Study
LOICZ : Land-Ocean Interactions in the Coastal Zone
NASA : National Aeronautics and Space Administration
NATO : North Atlantic Treaty Organization
NCAR : National Center for Atmospheric Research
NOAA : National Oceanic and Atmospheric Administration
PCMDI : Program for Climate Model Diagnosis and Intercomparison
QBO : Quasi-Biennal Oscillation
SC : Scientific Committee
SCOPE : Scientific Committee on Problems of the Environnements
SPARC : Stratospheric Processes and their Role in Climate
SSG : Scientific Steering Group
STE : Stratosphere-Troposphere Exchange
STEP : Solar-Terrestrial Energy Program
UNEP : United Nations Environment Program
UV-A : 320-400 mn UV Wavelength Interval
UV-B : 280-320 mn UV Wavelength Interval
WCRP : World Climatic Research Programme
WHO : World Health Organization
WMO : World Meteorological Organization

WCRP Report on SPARC Objectives and Scientific Issues

An initial review of SPARC objectives and scientific issues was first developed in 1991 as a basis for the adoption of SPARC as a WCRP Project. The review has been updated during the last two years by a selected group of qualified scientists and recently by the SPARC Steering Group. Its purpose is to set forth the general scientific issues to be addressed by SPARC.

As a complement, the next SPARC publication will deal with project activities in specific areas rather than the broad scientific issues. On a rather longer time scale, it is likely that new scientific issues may arise or there may be increased appreciation of research issues that have not yet received sufficient emphasis. In this case a revised appraisal of SPARC scientific issues will be needed, leading to an update of the existing review.

The document will be published as a WCRP Report in the next few weeks and will be available to all the members of the community. You will receive it without further action if you are on the Newsletter mailing list.

We encourage our readers to indicate where they see important gaps in the plans for SPARC that need to be addressed. For these and other relevant purposes, please contact the SPARC Office at Verrières-le-Buisson, France.

Interaction with IGBP and the Biological Community (SCOPE)

SPARC seeks to cooperate with the following IGBP projects : IGAC, GCTE, JGOFS, and LOICZ. An obvious issue common to all these projects is the monitoring of UV-B.

IGAC

The two main areas of SPARC-IGAC interactions are as follows :

1) The impact of UV-B on tropospheric chemistry, which requires the SPARC activity on monitoring and modelling stratospheric ozone changes, and the consequent effects on UV flux from the stratosphere to the troposphere.

2) The flux of trace gases from troposphere to stratosphere - a subject where a better knowledge of STE is needed.

GCTE

The issue of the possible effect of change in UV-B on terrestrial ecosystems has been formulated in the GCTE scientific programme. To ensure the appropriate liaison, Dr. M. Caldwell, who has been involved with the SPARC community, will be invited to SPARC SSG meetings, as ex-officio member representing GCTE, subject to the agreement of GCTE and IGBP.

JGOFS

After consultation between the SPARC Co-chairpersons and Dr. J. Priddle, ex-officio member representing JGOFS, and Dr. H. Marchant from the Australian Antarctic Division, the proposed co-operation between SPARC and JGOFS was presented at the SPARC-SSG. One recommendation is that JGOFS and SPARC should co-operate in fostering the WCRP radiation studies which will lead to improve the computation of short wavelength radiation and would serve a range of biospheric studies.

LOICZ

LOICZ, approved only recently as an IGBP Core Project, is expected to co-operate with SPARC in dealing with issues related to coastal zones and shallow waters where the UV-B effects could be important.

Role of SCOPE

Dr. E. de Fabo, ex-officio member representing SCOPE, presented the outline of the second SCOPE report on the "Effects of Increased UV Radiation on Global Ecosystems". This report discusses the change to the biosphere caused by the increased level of solar UV-B radiation. The role of SCOPE is to assess the state of knowledge but not to implement programmes. Therefore the recommendations contained in this report and the preceding one on UV-B effects are expected to be carried out by IGBP and the relevant WHO projects. It is to be hoped that the international co-operation dealing with these questions will be put in place as soon as possible.

Future SPARC and Related Meetings

25-29 April 1994 : SPARC Session at the EGS General Assembly "Dynamical processes in the stratosphere relevant to natural variability and climatic changes", Conveners : M.-L. Chanin, A. O'Neill, F. W. Taylor, Grenoble, France.

September 1994 : NATO ARW : "The Effect of Pinatubo on climate", Director : G. Fiocco, Roma, Italy

1995 : "Topical meeting on Stratospheric Ozone". Preliminary Organising Committee : J. Kaye, J. Pyle, S. Solomon. Tentative date and place : May 1995, Keystone, Co, USA

July 1995 : SPARC Symposium, IUGG General Assembly, Conveners : M. Geller, Boulder, Co, USA

September 1995 : NATO ASI on "The role of the Stratosphere on the Troposphere and the Climate" Director : G. Brasseur, Canada

1995 : Joint US/Japan meeting on "QBO/ENSO Variations in the Global Stratosphere/Troposphere System", Conveners : T. Matsuno, M. Geller

SPARC related meetings

February 1994 : ICTP Workshop on Study of Atmospheric Interactions by remote sensing. Directors : S. M. Radicella, M.-L. Chanin, Trieste, Italy

June 1994 : SPARC related Session during STEP Symposium in Sendai, Japan

July 1994 : COSPAR Symposium "Middle Atmosphere and Global Change" co-sponsored by WCRP/SPARC, Hambourg, Germany

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

- Gravity wave Sources and Parametrisations, Convenor : D. Fritts.
- Intercomparison of Middle Atmosphere Models, Convenors : S. Pawson, R. Rood

Call for papers

Papers dealing with SPARC Science are welcome for the future SPARC related Sessions mentioned above :

The deadlines are :

For EGS, January 1, 1994
For COSPAR, January 15, 1994
For STEP, February 20, 1994
} **Urgent**

and For IUGG, February 1, 1995

The names of the conveners are given in the SPARC MEETINGS block above.

Composition of the SPARC OFFICE

Co-Chair : M.-L. CHANIN
Project scientist : S. CHANDRA
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M. Geller (USA)

Members
D. Ehhalt (Germany)
I. Isaksen (Norway)
V. Khattatov (Russia)
J. Mahlman (USA)
T. Matsuno (Japan)
J. Pyle (UK)
S. Solomon (USA)
H. Tanaka (Japan)
R. Turco (USA)