SPARC newsletter n° 16
2001
March
STRATOSPHERIC PROCESSES AND THEIR ROLE IN CLIMATE
A Project of the World Climate Research Programme

Report of the Eighth Session of the SPARC Scientific Steering Group

Buenos Aires, Argentina, November 13-16, 2000

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This Eighth Session of the SPARC Scientific Steering Group (SSG) was held in Buenos Aires during the week following the SPARC 2000 General Assembly in Mar del Plata (see the Assembly report in this issue). First the Co-Chairs of the SSG offered their warm thanks to the Foreign Minister of the Republic of Argentina and the State Secretary of Science and Technology who had provided very nice facilities for the meeting.

The session started by reviewing the main events which took place in the last year, in particular the last SSG meeting, the meeting of the WCRP Joint Scientific Committee (JSC), that took place in Tokyo in March 2000, and the SPARC 2000 General Assembly. Marvin Geller first recalled the conclusions of the SSG meeting in Paris where the future SPARC overall strategy was discussed. It had been concluded that, after 8 years of fairly

Participants in the SSG in Buenos Aires, from left to right.
First row: P. Canziani, M. Geller, M.-L. Chanin, A. O'Neill.
Second row: V. Ramaswamy, D. Kley, R. Vincent, T. Shepherd, Ph. DeCola, J. Gille, R. Newson, S. Yoden, M. Baldwin, S. Pawson.
Third row: D. Karoly, K. Hamilton, Y. Koshelkov, P. Simon, T. Peter, U. Schmidt, W. Randel, A. R. Ravishankara.

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focused initiatives, it was now timely to integrate the knowledge acquired across SPARC, in order to progress towards the goal of an overall understanding of all aspects of stratospheric variability and change, its interactions with the troposphere, and its role in climate. This was going to be a main topic of discussion during the present SSG meeting. Among the points raised at the JSC, M. Geller mentioned that the unique quality that SPARC was bringing to the WCRP, the dynamics-chemistry-radiation linkage within the stratosphere, should even be amplified by a more active role in the JSC initiative on the climate-chemistry issue led by Susan Solomon. It should become an integrated joint venture with IGAC on the troposphere-stratospheric climate problem (including S/T coupling). Other ties should be amplified with CLIVAR on the possible links between the North Atlantic Oscillation and the Arctic Oscillation, and with the newly proposed IGBP Surface Ocean and Lower-Atmosphere Study (SOLAS) on the role of the UV radiation.

Alan O'Neill, Chair of the Scientific Organising Committee of SPARC 2000, reviewed the new scientific results presented during SPARC 2000 and the conclusions, which would need to be taken into account into the future development of SPARC. He remarked that the SPARC 2000 General Assembly has started integrating the different components of SPARC and that it should help the Project to develop a more holistic approach of the issues to be solved in the future. It was recognised that, in order to understand past changes, one needs to understand and bound natural variability and its patterns and look together at the observed fields of several variables as well as their simulations.

Then the leaders of the SPARC activities provided a review of the progress in the projects and activities organised under SPARC activities.

Modelling stratospheric effects on climate

Intercomparison of stratospheric models

The "GCM Reality Intercomparison Project for SPARC" (GRIPS) has grown both in the number of research groups involved and the range of tasks being tackled. During his presentation of the GRIPS highlights of the year, Steve Pawson raised the question of what GRIPS should do and should not do.

The results from the first phase of GRIPS and their scientific implications can be found in *Pawson et al.* (2000) in BAMS, *Koshyk et al.* (2000) in JGR, and *Amodei et al.* to appear in Annales Geophysicae. New data from several model groups have been collected and their analysis will focus on forcing mechanisms of stratospheric variability (wave forcing and diabatic forcing) and involve some focused model experiments (sensitivity studies for interactions between mechanisms).

The second phase of GRIPS, now in progress, involves further validation of models and carrying out controlled experiments to test parameterisation schemes, including radiation schemes, model response to the formulation of mesospheric drag, and of gravity wave (GW) parameterisation schemes (Hines' first and then McIntyre's). Models have been shown to be very sensitive to different radiation schemes, and the issue of radiation has become a major one to be solved in order for models to converge.

Goals for the third phase were defined during a very successful workshop held in 2000 in Toronto. The main goal is to explain the observed variability in the 1979-1999 period as a combination of natural variability and perturbations due to known forcing mechanisms: aerosols, solar variability, ozone change and CO2 change. As a further step, experiments will be run with imposed climate change scenarios for the period 2000-2020 (using the best possible predictions of trace gas concentrations).

A new GRIPS workshop is planned for February 26 to March 1, 2001 in Hamburg, Germany to discuss ongoing activities and plan future work. The role of GRIPS in the planned integrated SPARC activity mentioned above needs also further thought. One of the main output being the prediction of future climate/ozone interactions, it will also be discussed at the Joint SPARC/IOC ozone meeting in March 2001 to prepare for the upcoming WMO-UNEP Ozone Assessment.

Stratospheric reference climatology

It has been long recognised that a revised climatology of the averages and variances of basic stratospheric parameters was needed for GRIPS, as well as a number of other SPARC initiatives. In the last few years, a series of monthly global climatologies of temperature, zonal winds, and various atmospheric trace constituents (N_2O, O, CH_4, H_2O, O_3, NO_2, HNO_3, etc.) have been assembled from NCEP, UARS and other data. Monthly and daily stratospheric circulation statistics have been inferred from available stratospheric analyses or reanalyses. Other data compiled include upper-level radiosonde winds from Singapore (as an indicator of the phase of the QBO) and statistics on tropopause height. These data sets are now accessible from the SPARC Data Centre **(http://www.sparc.sunysb.edu/).**

W. Randel presented a draft of the technical report to be published as a SPARC Report in 2001, describing the data sets, comparing stratospheric circulation statistics, and quantifying uncertainties and interannual variability. This report entitled "SPARC Intercomparison of Middle Atmosphere climatologies" uses 10 sets of data (some including the mesosphere) and the UARS data from 1992-1997. W. Randel indicated his plans for the near future to include the rocketsonde data in the data intercomparisons. Furthermore he intends to organise a group meeting in spring/summer 2001 to complete the report and in particular to identify the biases in each data set, to identify the quantities which have high uncertainty and to discuss the strategies for comparison with models.

Climate Forcing in the Stratosphere

Under the auspices of SPARC, a review of stratospheric aspects of climate forcing had been undertaken in order to provide, for the use of the climate modelling community, the current best estimates of the relevant parameters. The work has been completed and a report by David Karoly was included in SPARC Newsletter No. 14 (January 2000). All the relevant data are available at the SPARC Data Centre.

D. Karoly, who had chaired this activity and is a Lead Author in the current IPCC/Third Assessment Report (TAR), reported on the way detection and attribution of a Stratospheric Role in Climate Change has been taken into account in the IPCC/TAR (see the paper by David Karoly in this issue of the Newsletter).

Stratospheric data assimilation

At its meeting in Paris in 1999, the SPARC SSG agreed that it would be useful and timely to review the status of stratospheric data assimilation and specific related problems (including stratospheric data availability). A. O'Neill, who was asked to report on

plans on this issue, informed the SSG that a DARC (Data Assimilation Research Centre) has been supported and set up in the UK by the Natural Environment Research Council, in view of the important role of data assimilation both for the climate studies and the numerical weather prediction (NWP). Atmospheric data assimilation will be based on the use of a general circulation model of the troposphere and stratosphere, which at this stage incorporates a parameterisation of ozone chemistry. More sophisticated chemistry is incorporated in an off-line, 4DVAR, chemical data assimilation system. The SSG supported a proposal to form a SPARC working group to focus on stratospheric data assimilation, and A. O'Neill has agreed to pursue this. Several meetings of potential European partners in the group have already taken place to make recommendations to EU towards the use of the ENVISAT data. A full meeting of all the parties is being planned to gather information on current activities and to discuss developments in stratospheric data assimilation that may be needed. This initiative will be closely co-ordinated with the Working Group on Numerical Experimentation, which has overall responsibility in the WCRP for data assimilation questions.

The data assimilation initiative is especially important in view of the new streams of stratospheric data coming on line from research satellites in the next few years (e.g., ENVISAT, HIRDLS, the NASA EOS series, etc.), as well as from operational ones.

Long-term changes in the stratosphere

Stratospheric temperature trends

The original objectives of SPARC activities in this area have been well fulfilled for the lower stratosphere. The results of the first phase of this initiative have formed the basis of the chapter 5 in the latest WMO/UNEP Ozone Assessment (1999). A summary will be published in Reviews of Geophysics in February 2001. The full account of the work is also in preparation as a SPARC Report to be edited by NOAA. The work carried out is also proving valuable input to the IPCC/TAR in particular for the discussion of radiative forcing of climate change, climate processes, and detection and attribution.

V. Ramaswamy reported that the views of the group are to pursue its activity in several directions: continuous update of the data and of model inferences, extension to the upper stratosphere and mesosphere, (this later part in liaison with ICMA and SCOSTEP), improved work on trends of quantities having high uncertainties (tropopause and stratopause temperatures). In parallel with this continuous activity, the need to have a more integrated perspective was recognised as temperature trends are closely linked with changes in other stratospheric parameters (ozone, water vapour, dynamical acti-vity, etc.), and activities will have to become increasingly integrated with other SPARC studies in these areas. A group meeting is planned for around mid-2001.

What has been strongly emphasised has been the value of the SPARC umbrella under which coherent international research into stratospheric temperature trends can be and has been carried out including the planning of future co-ordinated activities. It is viewed as important to keep together the international "expert" SPARC temperature trends group, comprising observationalists, modellers and diagnosticians.

Understanding ozone trends

After the major effort in 1998 to assess the trends in the vertical distribution of ozone (SPARC Report No. 1, 1998) and the contribution to the WMO/UNEP Ozone Assessment, 1999, thought had been given to the further development of studies in this area. Neil Harris (who sent his apologies for absence from the SSG meeting) had informed the SPARC co-chairs about a possible future workshop to be organised together by SPARC and IOC in conjunction with (and upon invitation of) the co-chairs of the Montréal Protocol Assessment Panel. This information has been confirmed since the time of the SSG meeting. The goal of this workshop is to review the scientific activity on the topic of stratospheric ozone changes and their causes. This topic will be among those addressed by the next WMO/UNEP Ozone Assessment, whose drafting will begin in the summer of 2001 and will be completed by the fall of 2002. This workshop to be held on March 7-9 at the University of Maryland, will bring together (upon invitation) leading scientists in this area of research to take stock of the current state of scientific understanding, to facilitate the formulation of common scientific viewpoints, and to encourage prompt submission of peer-reviewed publications that will form the basis of the 2002 Ozone Assessment.

In the longer term, an extension to study jointly trends in stratospheric parameters in general (including temperature, etc...) is foreseen by the ozone trends group.

Stratospheric and upper tropospheric water vapour

This SPARC initiative, originally set out to refine the water vapour climatology in the stratosphere and upper troposphere (S/UT), developed into a comprehensive Water Vapour Assessment, which investigated the concentration, distribution and variability (including the long-term changes or trends) of water vapour in this region. The processes controlling the present distribution of S/UT water vapour have also been studied. The Assessment Report is now completed and will be printed as SPARC Report No. 2, 2000 (and WCRP- 113, and WMO-TD-No. 1043). It will be available early in 2001.

The executive summary, printed in this Newsletter, gives the main conclusions as well as the recommendations for a further comprehensive and organised approach to monitoring water vapour in the S/UT. A summary of the Assessment has been provided in due time for inclusion into IPCC-TAR.

Understanding Stratospheric Climate Change

The proposal of a new integrated SPARC initiative, with a view towards "Understanding Stratospheric Climate Change (1979-1998)", was discussed at length during the SSG meeting, under the leadership of V. Ramaswamy. It was agreed that it should focus on the study of the consistency amongst the various observational data set and comparisons of model-simulated responses to well-characterised and known forcings with observations. The project should not be too ambitious to start with and should be accomplished in 3 years. Preliminary discussions about the input data and the type of models to be used took place during the meeting but should continue in the future months by email exchanges involving at least the SPARC group leaders of the trends issue and of GRIPS. This should help in preparing a workshop to be held in spring/summer 2001.

Stratospheric processes

Gravity wave processes and their parameterisation

The construction of a stratospheric gravity-wave climatology based on high-resolution radiosonde data is

proceeding as planned. Following the successful Abingdon workshop in July 1999 the participants reanalysed their data to generate climatological and research products. R. Vincent presented some of the highlights of the climatologies of wave energies and propagation directions as a function of latitude. In 2001 it is planned to submit for publication a series of articles describing the research efforts that have gone into the generation of the climatologies.

Kevin Hamilton described how the planning of the international field experiment ETCE (Effects of Tropical Convection Experiment) is progressing. ETCE is designed to investigate the gravity-wave field forced by tropical convection during a six-week intensive observation period (late October-early December 2002) over the Tiwi Islands, north of Darwin, Australia. A detailed plan of the scientific objectives and instrumentation to be deployed during the field campaign may be viewed at: http://www.princeton.edu/~kph/EXP2.

K. Hamilton also described a pre-ETCE campaign called DAWEX (Darwin Area Wave Experiment). This campaign, proposed by EPIC/SCOSTEP and SPARC, is planned for the Austral spring 2001 and is aimed at characterising the wave field in the middle atmosphere over Northern Australia prior to the onset of the diurnal convection, known locally as "Hector", and during the active Hector period. As it only involves ground-based equipment, the preparation's time is much shorter than for ETCE.

Lower stratospheric/upper tropospheric processes

Transport and mixing in the UT/LS are fundamental to SPARC and hold the key to many issues, e.g., the UT/LS ozone budget, mid-latitude water vapour distribution and tropical dehydration. However, there is still no overall strategy and theoretical framework for studying stratospheric-tropospheric exchange, paradigms that can be tested, or an obvious common measurement/diagnostic approach. Thus, the role played by SPARC in this area up to now has been to keep under review the basic questions that need to be addressed and to bring the different communities involved in this subject together in various focused workshops. In view of the importance of the tropopause (where climate/ozone issues come together), consideration has been given in the last two years to planning a "tropopause workshop". This workshop, organised under the leadership of Ted Shepherd and Peter Haynes, will take place in April 17-21, 2001 in Bad Toelz, Germany. The SSG was asked to review the list of invited participants.

A.R. Ravishankara reviewed the joint SPARC-IGAC activities on chemical processes in the UT/LS. On the issue of Organic Peroxy Radicals, which was reviewed in SPARC Newsletter No. 15, a paper is now in press in JGR. The work on the quantum yield of ozone photolysis reactions was presented at the Quadrennial Ozone Symposium in 2000 and is to be submitted to JGR. Such joint SPARC-IGAC activity is judged by the SSG to be extremely beneficial to both projects and crucial in the evaluation of important UT/LS chemical reactions. It generates an important interaction between the modelling and the field laboratory communities and brings new people into the process. The question of expanding the co-operation to other issues was discussed. The topic of UT/LS water vapour and the role played by subsonic aviation in the formation of contrails/cirrus was judged to be already receiving sufficient attention by the atmospheric community.

The other issue was the Upper Tropospheric Ozone (UT O3) climatology and trends. It was thought that SPARC should undertake this task and ask IGAC to join, as the contribution of the stratosphere is important enough to be taken into consideration. A leader of this new initiative has yet to be appointed. A workshop on the role of nitrogen oxides is being organised for March 2001 in Heidelberg.

Penetration of UV radiation into the lower stratosphere and troposphere

It is essential to know the actinic flux distribution in the lower stratosphere and troposphere and to determine the climatology of photodissociation rate constants (J values) for various radicals as a function of altitude to make marked progress in model calculations. The SSG at its 1999 meeting encouraged a joint SPARC-IGAC initiative on this issue, with the objectives of evaluating existing data (including J values and actinic flux measurements), considering the requirements for new instrumentation and organising validations of computations of radiative transfer at UV wavelengths. This activity, which should well complement the joint SPARC-IGAC studies of chemical processes in the UT/LS, has not started yet. Paul Simon will contact IGAC to help identify his counterpart within IGAC. The connection with IGAC clearly needs to be strengthened on this issue.

It was noted that the workshop on UV impacts, which took place at Mar del Plata, following the SPARC 2000 General Assembly attracted about 30 participants from the SPARC community. Pablo Canziani, who was the organiser of this workshop, asked whether this issue should not become a regular part of SPARC Assemblies. The SSG hesitated to include the impact aspect of UV within its thematics at the present time.

Other scientific issues

Dynamical coupling of the stratosphere and troposphere

At the SPARC SSG Paris meeting, two (somewhat speculative) aspects of what are thought to be manifestations of the dynamical coupling of the stratosphere and troposphere were discussed, the quasi-biennial oscillation (QBO) and the Arctic Oscillation (AO). On the first topic, an extensive review of the QBO and its role in coupling the stratosphere and troposphere was published in Reviews of Geophysics in October 1999, as a consequence of the SPARC QBO Workshop of March 1998. During this SSG session, Mark Baldwin was invited to present an update on the AO and its possible link to the NAO (North Atlantic Oscillation). He noted similarities between the NAO (North Atlantic Oscillation) observed in surface pressure and features of the AO (Arctic Oscillation), which was derived as a leading "mode" of variability of the combined troposphere-stratosphere system. He proposed that the NAO and AO were, in fact, different manifestations of the same underlying dynamical phenomenon, and showed evidence for the apparent downward propagation of the AO signal. Issues raised by these ideas concern the mechanism for downward propagation of the AO signal, whether the stratosphere can influence the large-scale variability of the troposphere, and whether one can predict changes of the large-scale circulation in the troposphere from prior knowledge of the state of the stratosphere. The issue was judged still too speculative to generate any SPARC initiative, besides a continuation of the investigation. This question of joint interest for CLIVAR and SPARC should be raised at the next JSC Meeting.

A presentation was then given by Shigeo Yoden on "Intra-seasonal

and interannual variations of the troposphere-stratosphere (T/S) coupled system" (see article in this issue). Results have been obtained from 1000-year runs using a hierarchy of numerical models assuming different types of linkages between the troposphere and the stratosphere. They show that the T/S system is highly non-linear and has large internal variability.

Solar forcing and climate variability

As requested by the JSC, SPARC is keeping under review research on solar forcing, its variability as a source of variations in climate and possible underlying mechanisms that could be put forward. The SPARC SSG noted last year that, although changes in the solar spectrum are known to affect ozone, temperature and the actinic flux in the middle atmosphere, there is still no consensus on whether tropospheric climate is influenced in any way by these changes. The data analysis planned in the European project SOLICE and the modelling activities in GRIPS and SOLICE, which are still at an early stage, should throw further light on this issue.

Research on links between solar forcing and climate variability is another example of a cross-cutting activity in the WCRP, where SPARC would be involved in studying the mechanisms involving the stratosphere, GEWEX on possible cloudiness variations linked to changes in solar cosmic rays, and CLIVAR in a rigorous interpretation of the observed climate signals.

Stratospheric aerosol climatology

The subject of stratospheric aerosol has attracted intense work in the past decades, but the need for an organised activity has been discussed for years without any success. The SSG decided to form a group with the mandate to look at the presently existing climatologies, identify their consistencies or inconsistencies and contribute to a better knowledge of the composition of aerosols. Two co-chairs will be named for a two-year mandate and should together with a small group prepare a report and eventually organise a workshop in this time frame.

Review of overall SPARC strategy and status of implementation

The SPARC SSG gave consideration to the overall strategy that has so far been followed and assessing whether any reorganisation of the programme is now appropriate. Hitherto, SPARC initiatives have been fairly focused and dealt with individually (by subproject working groups). Although some of the scientific issues taken up obviously still need specific continuing efforts, it appeared that it may now be timely to integrate the knowledge acquired across SPARC in order to progress towards the goal of an overall understanding of all aspects of stratospheric variability and change, its interactions with the troposphere, and its role in climate.

In some areas, focussed efforts are still clearly needed: gravity wave climatology and understanding the role of GW in stratospheric dynamics; UT/LS chemistry and microphysics; the tropopause; solar forcing and climate variability. SPARC also saw the need to assess observations of stratospheric aerosols (jointly with IGAC). Additionally, there is a range of specific modelling questions such as the parameterisation of radiation and GW, as well as the topic of stratospheric data assimilation.

The sort of basic structure foreseen for SPARC in the future would involve integration or synthesising the understanding of stratospheric trends of temperature, ozone and water vapour, and solar effects through modelling studies. These would be particularly aimed at elucidating UT/LS variability, and its role in the overall climate system by building on the modelling work already carried out in the stratospheric trends study and GRIPS. However, additional models (e.g., two-dimensional, chemical transport) which have not so far been exploited in SPARC would also be required, as well as developing the use of data assimilation techniques. Furthermore, although the number of climate models including the stratosphere is increasing, there is currently insufficient contact between the SPARC community and tropospheric climate modelling groups. The new SPARC initiatives on stratospheric data assimilation and UV penetration could help in building bridges. Within this framework, the main priority for SPARC is to continue generally to facilitate research on stratospheric processes and their role in climate by providing a forum or umbrella for international co-operation and encouraging inter-disciplinary exchanges. SPARC will thus remain science-driven, but, at the same time, it should be in a position to provide the best available information on relevant stratospheric questions for the periodic international assessments such as those of IPCC and WMO/UNEP. This requires a forward-looking approach to identify new questions that could arise.

Interactions with other programmes and activities

As noted earlier, SPARC maintains strong links and/or interacts widely as appropriate and necessary with several other programmes. Particularly noteworthy is the co-operation with IGAC (the joint SPARC-IGAC activity on UT/LS chemical processes; the proposed joint initiatives on the penetration of UV radiation into the lower stratosphere and troposphere, the possible joint assessment of observations of stratospheric aerosols). It was unfortunate that neither Guy Brasseur nor Stuart Penkett were able to attend this SSG meeting. It was decided that in view of the increasing IGAC/SPARC interactions, an alternative method for planning is needed. In particular, it was suggested that a small IGAC/SPARC liaison-planning group be formed to plan for SPARC/IGAC programs. Of course, those plans would need ratification of the SPARC and IGAC SSGs.

Reference was also made to the planned collaboration with SCOSTEP on upper stratospheric temperature trends and on the issue of solar influence on climate. The constitution of joint SPARC/SCOSTEP working groups on these issues was discussed. Possible members for these groups were discussed. The allocation of a US$ 6,000 grant by ICSU should assist the WCRP and SCOSTEP funding of these joint activities.

The SPARC Data Centre

The SPARC Data Centre, supported by NASA, has been operated by Petra Udelhofen at the State University of New York at Stony Brook for more than a year, and a significant start has been made on assembling key stratospheric data sets in a readily accessible form. New data sets have been added to the original ones: High-resolution temperature and wind data from radiosondes, data from the GRIPS model intercomparison, the Water Vapour Assessment (WAVAS) archives. (see SPARC Newsletter No. 15 and **http://www.sparc.sunysb.edu/).**

The SPARC Office

As well as its regular responsibilities of compiling and editing SPARC Newsletters, updating the SPARC mailing list, maintaining contacts with the SPARC community of scientists, organising various SPARC meetings and periodically revising the SPARC home page, particular support has been given to the preparation of the SPARC water vapour assessment report. Substantial efforts have also been devoted to seeking sponsors for the Second SPARC General Assembly, and assisting in the arrangements for the General Assembly. The composition of the SPARC Office has been changed during the year. In June 2000 the arrival of Catherine Michaut, who has a full time position of assistant engineer at CNRS, provided an efficient manager for the Office. In November 2000 Céline Phillips decided to leave the Office for a permanent position at ADEME. A half-time position of Project scientist is opened and the SPARC Office is looking for a post-doc candidate.

Meeting of the SPARC SSG *per se*

The SSG members met twice during the 4-day meeting to discuss the partial renewal of the SSG chairs and members. This was necessary as the mandates of several members are coming to an end. Marie-Lise Chanin has expressed her intention to step down from her post as co-chair of SPARC. She proposes to stay as Director of the SPARC Office for 1-2 years, until a new offer is made to welcome the SPARC Office. The composition of the renewed SSG will be submitted for approval to the JSC in March 2001 and will be announced on the web site and in the next Newsletter.

Next SSG meeting

K. Hamilton invited the SSG to meet in Hawaii in 2001. The invitation was unanimously welcome. The exact date has now been fixed to the 3-6 of December 2001.

Reference

Pawson, S. *et al.*, The GCM-Reality Intercomparison Project for SPARC (GRIPS): Scientific Issues and Initial Results, BAMS, Vol. 81, No. 4, April 2000.

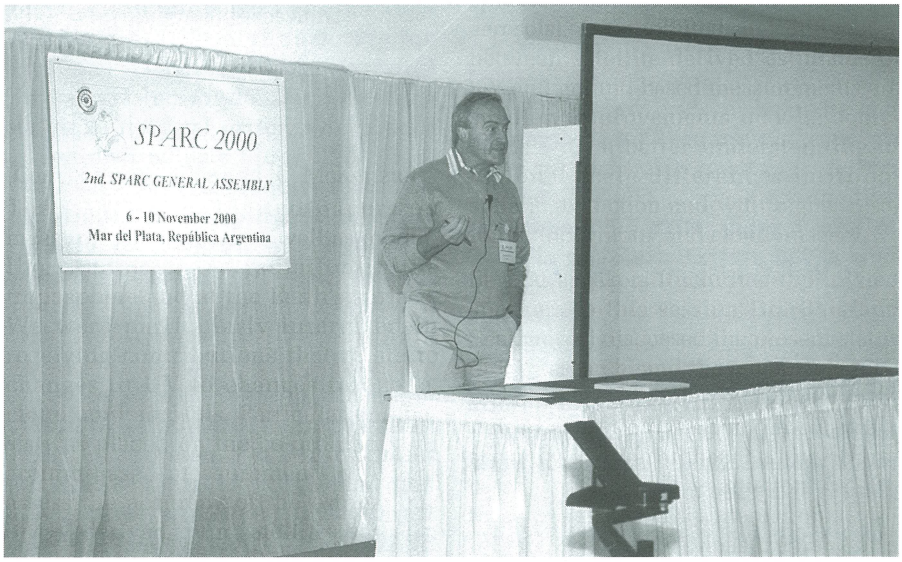
Report on the 2nd SPARC General Assembly (SPARC 2000)

6-10 November, Mar del Plata, Argentina

Conveners: A. O'Neill (Chair), S. Diaz, R. McKenzie, V. Ramaswamy, T. Shepherd and S. Yoden
Chair of Local Organising Committee: P. Canziani

A summary of some of the scientific highlights

Since the discovery of the ozone hole in the mid 1980s, great progress has been made in understanding the dynamical, chemical and transport processes that occur in the stratosphere. At the same time, the importance of the stratosphere as an integral part of the climate system has come to be more fully appreciated. Through exchanges of mass, momentum and energy, the stratosphere is strongly coupled to the climate system as a whole. Relevant processes are commonly non-linear (for instance, the dynamical coupling between the troposphere and stratosphere), and by no means fully understood. SPARC has been instrumental in promoting the science that has led to a wider appreciation of the importance of the stratosphere in climate. It has also been active in promoting greater integration between scientific disciplines involved in the broader World Climate Research Programme.



Alan O'Neill opening the SPARC 2000 General Assembly

The Scientific Organising Committee of the 2nd SPARC General Assembly (SPARC 2000) aimed to structure the scientific meeting in a way that emphasised the importance of the stratosphere in the wider context of climate change. The five-day meeting comprised four sessions. Session 1 emphasised fundamental processes and interactions among processes. Session 2 discussed observations relevant to these processes and indicative of