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REPORT OF THE ELEVENTH SESSION OF THE SCIENTIFIC STEERING GROUP ON STRATOSPHERIC PROCESSES AND THEIR ROLE IN CLIMATE (SPARC)

(Frankfurt am Main, Germany, 22-25 September 2003)

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TABLE OF CONTENTS

Page No.

1. Introduction

1.1. Opening of the session, introductory comments

The eleventh session of the SPARC Scientific Steering Group (SSG) was held in a guesthouse of the Johann – Wolfgang Goethe University of Frankfurt am Main, Germany, from 22-25 September 2003, at the kind invitation of Prof. Ulrich Schmidt of the Institute for Meteorology and Geophysics, University of Frankfurt-am-Main, and a member of the SPARC SSG. A list of the meeting participants is given in the Appendix.

Opening the session, the SSG Co-chairs, Prof. A. O'Neill and Dr Ravishankara, welcomed the new SSG members, Profs. D. Hartmann and J. Burrows, and expressed their expectation that the new SSG members would make an excellent contribution to the project. The chairs noted with appreciation the attendance of all ex-officio members representing the World Meteorological Organisation Global Atmospheric Watch WMO/GAW (Dr M. Proffitt), the Committee on SPACE Research COSPAR (represented by Dr M.L. Chanin), the Scientific Committee on Solar Terrestrial Physics SCOSTEP (Prof. M. Geller) and the Network for the Detection of Stratospheric Change NDSC (Dr M. Kurylo) as well as presence of Dr D. Parish of the International Global Atmospheric Chemistry (IGAC) project and Dr T. Wehr of the European Space Agency. They also thanked Prof. U. Schmidt, Dr M.-L. Chanin and Ms C. Michaut for their work in preparing the meeting, which resulted in excellent local arrangements.

After a round of self-introductions, the chairs briefly introduced the current status of SPARC development. The new directions of SPARC research were discussed at the tenth SSG meeting in Kyoto and presented to a 24th Session of the World Climate Research Programme (WCRP) Joint Scientific Committee (JSC, 17-22 March 2003, Reading, UK) and the Committee approved them. The JSC session put forward a new initiative on the development of the Climate system Observational and Prediction Experiment (COPE), which was expected to become a major WCRP overarching theme for the coming decade. The chairs called on the SSG members to think how SPARC would fit within COPE and contribute to it. Evaluating the current status of SPARC, the chairs noted that the stratosphere was getting more recognition in climate research and numerical weather prediction, as well as in modern observing systeMs The general goals of the eleventh SSG meeting were to continue the discussion how SPARC would evolve as a collective project. SPARC needs a new Implementation Plan that would move forward SPARC research and would also facilitate integration of the project into other WCRP activities.

Having wished the participants a successful and fruitful outcome, the co-chairs gave the floor to Prof. U. Schmidt who welcomed the guests to Frankfurt and provided information on logistics and facilities.

1.2. WCRP comments

The introductory part of the session was continued by Dr V. Ryabinin. He gave an overview of the WCRP activities. The goal of the WCRP is the determination of the predictability of climate and the effect of human activities on climate. Historically, the programme focuses primarily on the physical domain of the climate system, and, as Prof. G. Brasseur showed in an opening speech of the 2003 International Geosphere-Biosphere Programme (IGBP) Congress, the majority of the hotspots in the Earth System were indeed associated with that domain.

Dr V. Ryabinin briefly described most important activities of the WCRP projects, their recent achievements and main events. CLIVAR (Climate Variability and Predictability project of the WCRP) activities are vast and include, among others, the continued development of the ARGO array, El Niño forecasting, unfolding monsoon studies in various parts of the world. In 2004, CLIVAR is holding the First CLIVAR Science Conference (Baltimore, USA, June 2004). GEWEX (Global Energy and Water Cycle Experiment of the WCRP) is active in developing the Co-ordinated Enhanced Observing Period (CEOP). It will include a very elaborate data-processing system, which includes specialised centres distributed around the world. The Arctic Climate System Study (ACSYS) is finishing in 2003 with a Final Science Conference to be held in St. Petersburg, Russia, in November 2003. Dramatic changes are being observed in the cryosphere by the Climate and Cryosphere project (CliC) scientists. The project is defining its main project areas and developing its implementation activities. The First CliC Science Conference will be held in 2005. In 2003, the Global Climate Observing System (GCOS) published its second report on the adequacy of climate observing system. Stratospheric elements were sufficiently well represented in the report.

The JSC for WCRP, at its 24th session, considered outstanding science questions of the programme. The following ones were indicated: hydrological cycle and its changes; modelling of clouds, radiation, and precipitation; sea level rise due to glacier/ice sheet melt; a possibility of an abrupt climate change due to regime shift in the cryosphere; mechanisms of natural climate variations; effects of atmospheric composition on climate; anthropogenic impacts; inclusion of biosphere in climate models; and studies of the effect of bio-geo-chemical cycles on climate.

The JSC session decided to launch a new, WCRP-wide activity called “Climate system Observational and Prediction Experiment” (COPE, 2005-2015). The first focus of COPE is to be the seasonal and interannual prediction, which will constitute the basis for the terms of references for a new task force. COPE may require a change in the WCRP structure, and the JSC has resolved to establish two WCRP councils, on observations and modelling, to review their status and contribution to COPE.

Summarising his review of the WCRP, Dr V. Ryabinin presented a following list of issues of high importance for SPARC in 2004/2005: SPARC Assembly in August 2004, move of the International Project Office from Paris, smaller budget at the Joint Planning Staff (JPS) of the WCRP; new tasks for WCRP as a whole such as Task Force on Seasonal Prediction, possible changes in the WCRP structure, International Polar Year (2007-2008).

1.3. Report from the Gordon conference

Prof. V. Ramaswamy continued the introductory session by reporting on a Gordon Research Conference on Solar Radiation and Climate, which was held at the Colby-Sawyer College, New Hampshire, USA on 13-18 July 2003. Out of 168 accepted participants 147 were able to attend the event. Four people could not obtain visas. 107 participants were from the USA, and 40 were from elsewhere. 34 students and 14 post-docs came to the conference. 62 posters were presented. SPARC co-financed the conference, and this made possible the participation of students and post-docs from Cameroon, Kenya, India (2), Japan, and Bulgaria. The Conference evaluations in categories science/ideas, discussions, management/organisation, atmosphere, overall conference suitability were all within the upper percentiles for such conferences. Most of the comments were positive. The conference summarised current research on physical and chemical factors in the observed radiative properties and energy budget of the planet and this led to a consideration of how perturbations of the radiative energy budget affect climate variations at several time scales, from seasonal to interannual and decadal. The SSG session participants, some of whom attended the Conference, were unanimous in the their opinion that the Conference was very interesting and successful. They warmly thanked Prof V. Ramaswamy for his efforts in organising and chairing it.

1.4. Strategic development of SPARC

On behalf of the two SSG Co-Chairs, Prof. A. O’Neill addressed the session presenting new ideas on the strategic development of SPARC. He reiterated the main aim of the project, which is to bring stratospheric expertise to bear on scientific issues concerned with climate processes and climate prediction, for the benefit of WCRP, WMO/UNEP (UN Environment Programme) Ozone Assessment, Intergovernmental Panel on Climate Change (IPCC), and space agencies. The approach is to deal with manageable scientific tasks, with a well-defined outcome, over a relatively short period of time, while seeking to anticipate needs of the wider community.

Recent SPARC activities have been concerned with stratospheric indicators of climate change, study of stratospheric processes, development of modelling, various assessments and development of data assimilation. The recent deliverables have been: an assessment report "Stratospheric temperature trends: observations and model simulations" (paper awarded the WMO Norbert Gerbier-MUMM Award, 2003); a stratospheric reference climatology report, WMO/UNEP Ozone Assessment 2002, Chapter 4 of the publication “Global Ozone: past and future”.

Looking to the future, the JSC of WCRP indicated the following wishes for SPARC: to lead collaboration with IGBP/IGAC on chemistry-climate interactions, to focus on issues raised by recent studies of Arctic Oscillation, to liaise with SCOSTEP on solar radiative forcing and temperature trends, to work with WMO GAW on ultra-violet radiation penetration, and to contribute to international assessments and mission planning.

In response to these wishes, Prof. O'Neill described the three newly proposed main directions of SPARC studies, which focus on detection and attribution of past stratospheric changes, stratospheric chemistry and climate, and stratosphere – troposphere coupling. He presented the main science questions for each of the themes, as follows:

Detection and Attribution of Past Stratospheric Changes:
- What are the past changes and variations in the stratosphere?
- How well can we explain past changes in terms of natural and anthropogenic effects?

Stratospheric Chemistry and Climate
- How will stratospheric ozone and other constituents evolve?
- How will changes in stratospheric composition affect climate?
- What are the links between changes in stratospheric ozone, UV radiation and tropospheric chemistry?

Stratosphere-Troposphere Coupling
- What is the role of dynamical and radiative coupling with the stratosphere in extended range tropospheric weather forecasting?
- What is the role of dynamical and radiative coupling in determining long-term trends in tropospheric climate?
- By what mechanisms do the stratosphere and troposphere act as a coupled system?

Expected future deliverables by SPARC will be:
- a temperature trend assessment report,
- an aerosol assessment report,
- a review on Arctic Oscillation / North Atlantic Oscillation for stratosphere - troposphere system,
- a review of gravity-wave parameterisations,
- a review of scientific issues in the domain of chemistry and climate,
- a review on global circulation models / chemical transport models with focus on ozone and predictions of mid-latitude ozone,
- a contribution to IPCC process.

A recently established working group, the Data Assimilation Working Group, is planning to collect information on stratospheric data sets on meteorology and chemistry, to review data quality and availability of data-processing software, to undertake a process-focused quality data assessment, and to collect and document information in the corresponding data assimilation systeMs

Prof. O'Neill concluded his presentation by indicating the most important links of SPARC with other WCRP Projects. There are well-established links with the Working Group on Numerical Experimentation (WGNE) on data assimilation, WGCM (Working Group on Coupled Modelling) on climate modelling, GEWEX on studies of aerosols. Closer links are needed with CLIVAR on predictability issues, GEWEX on research on water vapour, hydrological cycle and radiation, ACSYS and CliC on studies of polar regions, and WGSIP (Working Group on Seasonal and Interannual Prediction) on long-term forecasting. In addition to this, SPARC has to strengthen links to IGBP/IGAC on chemistry – climate interactions, SCOSTEP and CAWSES (Climate and Weather of the Sun-Earth System), on various issues, WMO GAW, NDSC, COSPAR, Integrated Global Observing Strategy (IGOS) and International Global Atmospheric Chemistry Observations (IGACO).

In the subsequent discussion, the SSG members agreed that the three main streams of the future SPARC research were indeed the issues of highest priority. The lack of a dedicated WCRP project addressing chemistry in troposphere was seen as a problem. The group felt that it was very important to move ahead from detection of trends towards their understanding and attribution. The meeting decided to embark on preparations of a new implementation plan for SPARC.

1.5. The stratosphere in the climate system: an overview

The introductory part of the session was concluded by a new SSG member, Prof. D. Hartmann, who gave an overview of the stratosphere in the climate system focussing mostly on dynamical aspects. He started his talk by presenting a list of research topics of importance for SPARC. They were stratospheric warmings, mechanisms for the impact of the stratosphere on the troposphere, annular modes of variation and long-term trends, possible slow down of the Brewer – Dobson circulation in a warmer climate, explanation of trends in stratospheric water vapour, studies of radiation, convection and circulation of the tropical tropopause.

Describing annular modes, Prof. D. Hartmann has emphasised that they represent the dominant pattern of variability in the both hemispheres and are driven by non-linear interactions between mean flow and eddy – type disturbances. In the southern hemisphere, transient baroclinic eddy feedbacks prevail, while in the northern hemisphere both transient and stationary wave feedbacks are strong contributors. The eddy-driven mid-latitude westerly jets are the region of the greatest instability where baroclinic eddies are generated. Then the eddies propagate from their source region and dissipate, and the associated eddy momentum flux reinforces the westerly jet. Such a positive feedback between the jet and eddies leads to the growth of amplitude and supports the persistence of annular modes.

Concerning stratospheric warmings and their effect on tropospheric weather, Prof. D. Hartmann asked how such effects would alter under a warmer climate. He presented an analysis of data studies, experiments and modelling results that exhibited features of downward control from stratosphere to troposphere. He stated that the tropospheric response takes form of natural mode of variation, which is close to Northern Annular Mode (NAM), and requires a large wave-like forcing from the stratosphere. Prof. D. Hartmann also gave some evidence that there was a trend towards poleward displacement of mid-latitude jets and reduction of warming events. This trend can be simulated by models forced by an increase in the greenhouse gases and requires inclusion in the models of a "realistic" stratosphere. The strengthening NAM index is apparently related to stronger thermal forcing of the jet, which, through the downward control, generates a positive feedback on stratospheric jet. Prof. D. Hartmann concluded his lecture with emphasising the importance of studying the tropical tropopause layer. The interplay of radiation, convection, cloud formation processes and large-scale dynamics makes the studies complex.

2. The new SPARC strategies

2.1. Detection and attribution of past stratospheric changes

Dr W. Randel presented this item on behalf of a group of SPARC specialists. He reported on preparation of a one-day workshop on understanding of seasonal temperature trends in the stratosphere, which was going to be held in Silver Spring, USA, on 5 November 2003, following a symposium honouring the career of Dr J.K. Angell. The workshop was being organised by the SPARC Stratospheric Indicators of Climate Change Initiative. It was supposed to address observations, model simulations of stratospheric temperature changes and their interpretation, and the effect of stratospheric variability and circulation on trends. The following questions are posed to the participants:

- What are the current key questions and observational priorities for understanding stratospheric temperature changes and trends?
- What is limiting the current understanding?
- How can we improve the detection, attribution and prediction of stratospheric change?
- What can SPARC do to help move forward as a community?

From the viewpoint of observations, two important issues were noted by Dr W. Randel. They are the continuity of stratospheric temperature data sets and data on stratospheric water vapour changes. Changes in meteorological analysis procedures or in data characteristics strongly influence current stratospheric data sets. There are significant uncertainties in all analyses associated with the change of data source from TOVS to ATOVS Polar Orbiting Sounding products. This will affect future assessments. The only two continuous data sets for atmospheric water vapour (HALOE, 1991-2003, Boulder frost-point balloon data, 1980-2003) disagree in the estimated trends for their overlap period of 1992-2002. The most important long-term meteorological analyses include CPC (1979-present), UK METO (1991-present), FUB (1964-2001, Northern Hemisphere 100-10 hPa only), NCEP reanalyses (1957-present), ERA40 reanalyses (1957-2002). For the further studies it is important to recognise the inherent observational uncertainties. SPARC should encourage efforts to improve the observational record in the future. There must be work on a more integrated understanding of past changes, which would involve studies of trends in ozone, temperature and water vapour trends as well as aerosol assessments. Modelling results should be more widely used to explain and verify the trends. Two forthcoming workshops (the SPARC workshop following the Angell Symposium and a workshop on coupled climate models in Garmisch-Partenkirchen, November 2003) could be instrumental in finding better ways of studying the trends. Opportunities to link activities with those of GRIPS should be explored. SPARC has to develop other strategies for the attribution of stratospheric trends and this can contribute well to interests of wider communities such as WMO, IPCC assessments and goals of environmental agencies. Prof. V. Ramaswamy concurred with points made by Dr W. Randel and mentioned that high natural variability in the atmosphere created particular difficulties for water vapour trend analysis in the latitudinal belt from 60° to 90° of winter hemisphere.

According to the views of Dr S. Pawson, "understanding the past" could be a new major direction for GRIPS. It could be a natural development of existing level-3 GRIPS activities. This would be a solid contribution to detection and attribution work of SPARC. A "climate – chemistry" component of GRIPS could form as a new level-4 activity, which would fit perfectly the new SPARC research directions. Successful implementation of these tasks would open the way for level-5 activities, which could be devoted to predictive experiments. It will be essential to use in such experiments credible atmospheric global circulation models with full troposphere, robust radiation codes, parameterisations for hydrological cycle and other physical factors and with upper boundaries in the mesosphere. The SSG agreed with these comments and expressed a view that GRIPS leaders should seek to encourage the GRIPS community to participate fully in these scientific challenges.

The SSG requested Drs W. Randel, S. Pawson, and K. Kodera to lead further development of SPARC activities in the area of change detection and attribution. The group felt strongly that GRIPS was able to contribute crucially in this stream of SPARC science.

2.2. Stratospheric chemistry and climate

Dr A.R. Ravishankara introduced this item. Significant progress in reviewing of the current state of affairs and in planning was achieved at a joint SPARC-IGAC workshop on Climate-Chemistry interactions held in Giens, France, on 3-6 April 2003. A joint program of research on these issues is a natural progression of current activities and has good reasons to exist, the main one being that it is basically one pool of scientists and resources. The discussions at the workshop have highlighted five major topics, which are: aerosols and climate, water vapour and clouds, stratospheric ozone and climate, tropospheric chemically active greenhouse gases, stratosphere - troposphere interactions. A paper summarising the results of the workshop will be written in time for the 3rd SPARC General Assembly. It will be available on the SPARC and IGAC web sites.

Atmospheric measurements alone are not capable of providing reliable information on abundance of short-lived greenhouse species and therefore their representation in models requires extensive process studies. The aim of the new program will be to reduce the uncertainties in chemically dependant climate forcings, for which aerosols is one significant issue. Aerosol forcing is regional, and the proposed approach will be to run high-resolution regional models fed by well-defined measurements and then to scale up to global climate models. The aerosol indirect effect is a complex process involving interactions between the aerosol, dynamics, cloud microphysics, and the gas phase. It, too, requires a coupled approach of using high-resolution models and well-defined measurements. For the water vapour, the key question will be the mechanisms that control the humidity in the upper troposphere and stratosphere as well as its long-term changes. There is a link to aerosols, through cloud formation, evolution, their effect on radiation, precipitation and chemical composition of atmosphere. Important climate-chemistry feedbacks need to be quantified while models representing them need to be systematically compared. Satellite data should help to reduce uncertainties in data on emissions of aerosols and ozone precursors. Careful evaluation of such data as GOME and SCIAMACHY at highest possible resolution is needed to have solid confidence in the products. In order to address stratosphere – troposphere interactions, one needs to assess the representation in global models of the spatial distribution and temporal variability of constituents (including aerosols) in the lowermost stratosphere and tropical tropopause layer and to establish metrics based on observations of long-lived stratospheric tracers. Without this it will be difficult to ensure realistic representation in models of the fluxes of mass, ozone, and other constituents from the stratosphere to the troposphere.

The scientific problems, presented above, could form the foci of strong collaboration between SPARC and IGAC. The following topics are indicative of priorities:

- The role of UTLS (upper troposphere - lower stratosphere) aerosol and clouds in chemistry, in climate, and in their interactions: understanding and representing microphysical, chemical and radiative processes in numerical models.
- The role of convection (both deep and warm) in controlling UTLS water and chemical constituents.
- Tropical tropopause layer and climate-chemistry interactions.
- The extent and role of stratosphere-troposphere exchange in controlling the abundances of ozone and other species in the upper troposphere and lower stratosphere and, specifically, an accurate quantification of the stratosphere-troposphere exchange contribution to tropospheric and upper-tropospheric ozone budget.

- The use of tracers and their variability in observations and in models to identify and diagnose roles and contributions of processes, an assessment of the role of inter-annual variability in the circulation patterns affecting the distribution of chemical constituents in the stratosphere and troposphere.
- The role of lightning in the production and distribution of nitrogen oxides.
- Determination of the fundamental parameters in kinetics, heterogeneous chemistry (specifically aerosols and ice in upper troposphere), photolytic processes, spectroscopy, and optical properties via laboratory studies.
- Satellite observations of trace species and meteorological parameters in the troposphere and lower stratosphere, assimilation of satellite observations, evaluation of models by using satellite data.

Prof. J.P. Burrows picked up the last theme and attempted to further elaborate the SPARC strategy in developing observations for studying climate - chemistry interactions. The classical view on this is that chemistry changing from both natural phenomena (e.g., volcanic emissions) and anthropogenic activity (e.g. pollution, emissions, land use etc.) results in changes in surface spectral reflectance, the composition of trace gases and aerosol, which are both chemically and radiatively active, radiation, cloud cover, precipitation rates, i.e. weather (short term), and climate (in the medium and long term). However, the system is nonlinear and includes feedbacks.

Important issues are the extent and non-linearity of the coupling and interaction between the chemistry, weather and climate, and the attribution of the natural and anthropogenic contributions to changing and variable atmospheric composition and conditions. Emphasis needs to be focussed on regional air quality, long-range transport and transformation of pollutants, the atmospheric lifetime and turnover of greenhouse gases and aerosol.

For the stratosphere the questions are as follows. Will ozone recover from chlorine driven depletion as predicted? What is the role of tropopause height changes in ozone trends, in climate and chemistry interactions? What is the role of Bromine? Will the dynamics and circulation remain stable and what will be the impact of a changing circulation on the chemical composition?

Additional scientific questions arise in connection with the mesosphere. Are the mesospheric composition changes a potential early warning signal for climate change? What is the nature of the noctilucent clouds, their cover and frequency? To what extent is the mesosphere an NO_x source for the stratosphere? Do we understand well enough all the processes involved in transformations between O_2 and O_3 in the mesosphere?

Some of these questions will be addresses by forthcoming satellite missions, which will provide a basis for first sensitivity studies. The goal will be to estimate, based on given instrument performance, the mean noise-induced error on geophysical parameters. The method is based on the radiative transfer simulation, instrument model and retrieval algorithm. It has been already applied in various sensitivity studies in the MIPAS, GOME, GOME-2, GOMOS and SCIAMACHY projects.

The integrated observing strategy, as seen by the current CEOS-IGOS-IGACO activities, comprises high-resolution spatial and temporal measurements of key constituents. Three to four geostationary and two low orbit satellites would constitute the space segment, which should be complemented by ground based measurements and aircraft process studies campaigns. Continuity is an absolute requirement for the satellite systeMs

Summarising his presentation, Prof. J. Burrows informed the meeting that a SPARC-IGAC First International UV/vis Limb Scattering Workshop took place in Bremen, Germany, on April 14-15, 2003. He also named several ongoing European projects, which were presented to the SPARC SSG on 24 September 2003. He concluded by stating that more observations were necessary, that satellites were demonstrating some interesting capabilities, and that there was a true need to move towards an integrated observing system addressing key atmospheric constituents, comprising satellites, ground based measurements and campaigns with aircraft.

Prof. J. Burrow's presentation generated a discussion on the current situation of the satellite observing system. A concern has been raised that at the moment the system was unable to provide continuity for trend analysis.

On behalf of Dr N. Harris, Dr A. Ravishankara presented an eight-year UK NERC funded thematic programme UTLS OZONE. It started in 1998 to study ozone in the upper troposphere and lower stratosphere. The Programme aims to make authoritative statements on chemical, dynamical and radiative processes controlling the distribution of ozone in the upper troposphere and lower stratosphere at middle latitudes.

Studies related to pollution (from surface sources and from aircraft) and to chemistry/climate interactions will be in scope. In total, 45 projects have been funded within the programme. Some of the programme findings are summarised below.

Stratospheric humidity affects both radiative forcing of climate, and stratospheric composition including ozone abundance. Current observational data are unable to tell us whether the humidity of air entering the stratosphere through the tropical tropopause is controlled by slow dehydration in weak mean ascent, or by rapid dehydration in cumulus clouds overshooting. Experiments performed within the UTLS OZONE Programme using a numerical cloud-resolving model clearly favour the slow-dehydration scenario.

Research within the UTLS OZONE Programme has identified a number of important oxygenated volatile organic compounds released from soot during oxidation by ozone. This is previously unreported in the literature (although water soluble species have previously been observed to be formed and retained under similar conditions). This observation may explain some of the measured complexity of organic species present in urban atmospheres.

Model simulations have been used to investigate how the ozone layer will recover, as chlorine concentrations decrease during the next decades, but concentrations of greenhouse gases increase. Results indicated that global ozone would decrease by 1% between 1979 and 2060 when the increases of greenhouse gas concentrations were ignored. When greenhouse gases were included, ozone was found to increase by 0.5%. The work on the causes of observed temperature trends in the stratosphere has input directly into the WMO/UNEP Scientific Assessment of Stratospheric Ozone 2002, which supports the Montreal Protocol process, and which aims to protect the ozone layer.

As part of the UTLS OZONE Programme, the photo dissociation quantum yields of acetone were measured over atmospherically relevant ranges of wavelengths, pressures and temperatures. In particular, the first temperature dependent yields of acetone were measured. The photolysis frequency in the UTLS region was calculated to be a factor of 2 lower than using the literature values. The increase in OH or O_3 concentrations associated with a convective influx of acetone in the UTLS is much reduced if the lower quantum yields are used. As such, the lifetime of acetone in the UTLS is a factor of 2 longer in the UTLS using the new quantum yields.

The UTLS OZONE discussions are on-going regarding the possibility of installing equipment to measure trace gases on British commercial aircraft. A workshop “Aerosols in the UTLS” will be held at the University of Oxford, 17-18 December 2003, to be organised jointly with the CWVC Programme. CIRRUS and ITOP campaigns will be held following launch of the new FAAM BAE-146 aircraft.

Prof. T. Peter took the floor and discussed related studies of cirrus clouds and tropical tropopause layer. Analysing the radiative properties of the clouds, he emphasised a need to better understand the nucleation of ice particles. Other issues are whether there is a trend in tropical tropopause layer water vapour concentrations and/or whether there is a trend in cirrus coverage in the tropical tropopause layer. One needs to understand the relative roles of cirrus and deep convection in the dehydration mechanism. Prof. T. Peter emphasised a need for an explanation of the stratospheric humidity increase and presented a number of related findings. For example, high tropical cirrus clouds need to have low particle number densities in order to develop particles sufficiently large for dehydration via sedimentation. Ultra thin tropical tropopause clouds are often the last point of contact of the air with the ice phase – they are more efficient at leading to dehydration. Ultra thin tropical tropopause clouds are ice crystals with r ~ 5 micrometer requiring vertical velocities of order of ~ 5 mm/s, i.e. 10-times higher than expected from zonal average, to maintain them. ECMWF analysis reproduces such large upwelling in the regions where the ultra thin tropical tropopause clouds were observed, but the reason is unclear. Trajectories based on ECMWF analyses suggest the maritime continent as major source of stratospheric air.

Dr W. Randel presented a new initiative called Integrated Study of Dynamics, Chemistry, Clouds and Radiation of the Upper Troposphere and Lower Stratosphere. The scientific significance is this initiative stems from the importance of the radiative and chemical impacts of UTLS ozone, water vapour, cirrus clouds, and aerosols. The initiative is based on active utilisation of new observational capabilities: aircraft HIAPER (2005), the AURA satellite (2004) and other A-train platforms, GPS/COSMIC (2005). A UTLS community workshop is planned for October 27-28, 2003, at NCAR, Boulder, USA. A science working group will be formed to plan integrated research using HIAPER; optimize integration with satellite programs and multi-scale models.

The SSG requested Profs. A. Ravishankara, J. Burrows, T. Peter to lead further development of SPARC activities in the area of climate - chemistry coupling. Some experts outside the SPARC SSG could be invited to further strengthen the transition team.

2.3. Stratosphere – troposphere dynamical coupling

Dr M. Baldwin started the discussion of this topic and informed the meeting of a workshop "The Role of the Stratosphere in Tropospheric Climate", which took place in Whistler, British Columbia, Canada, on 29 April – 2 May 2003. Dr M. Baldwin was one of the workshop organisers. The purpose of the Whistler workshop was to bring together scientists, post-docs, and students from the international community with the goal of improving the understanding of the role of the stratosphere in tropospheric climate on sub-seasonal to multi-annual timescales. The focus was on understanding the dynamical mechanisms that link the variability in these two regions.

The workshop was very successful. A short perspective and review paper will be prepared in the near future. A summary of the discussions at the workshop contains, *inter alia*, the following conclusions:

- The stratosphere influences the troposphere.
- Together with the tropical troposphere, the stratosphere is a player in determining the memory of the climate system.
- The influence is mainly during northern winter and southern spring.
- The stratosphere may play an important role in climate variations through downward coupling to SSTs, sea ice, and the high-latitude oceans.
- The most pressing issue is to better understand the dynamical processes by which the tropospheric circulation responds to changes in the stratosphere.

Dr M. Baldwin also presented some observational results depicting stratosphere – troposphere interactions. For that he used a decomposition of the total atmospheric pressure variability into empirical orthogonal functions and considered the dominant pattern, the Northern Annular Mode. He showed several examples favouring the concept of the leading role of stratosphere in variations extending through both stratosphere and troposphere, such as variations triggered by stratospheric warmings. He also showed some model results that claimed that without an account of stratospheric variability, the time scale of autocorrelation of daily surface Arctic Oscillation Index was significantly shorter. A link to the strength of the circumpolar vortex was also traced. This may lead the research into an area where changes in the circulation due to ozone loss and/or greenhouse gas concentration are considered.

Dr M. Baldwin was able to show that it was possible to develop a statistical approach to Arctic Oscillation Index forecasting that would exploit the enhanced timescale of the Arctic Oscillation during winter and predict the average index for a period of 10–40 days. One or more linear predictors were used: the present value of the AO and/or the present values of the annular modes at all atmospheric levels including the stratosphere. Enhanced predictability showed that there was a mechanism coupling stratosphere and troposphere. This mechanism is not understood. An "amplifier" is needed to communicate circulation anomalies in the lowermost stratosphere to the surface. The amplifier likely involves both planetary and synoptic scale waves near in the tropopause region.

The conclusions by Dr M. Baldwin are:

- Persistence and predictability of the Arctic Oscillation depend on the long timescale of large circulation anomalies in the lowermost stratosphere.
- The most pressing issue in stratosphere and troposphere coupling is to better understand the dynamical processes by which the tropospheric circulation responds to changes in the stratosphere.
- This understanding may help to better predict not only the weather on monthly and seasonal time scales, but also the climatic effects of greenhouse gas increases, stratospheric ozone depletion, solar changes and volcanoes.

Prof. F.-J. Lübken added to the presentation a comment that mesosphere winds could act as early precursors of changes in stratosphere.

Prof T. Shepherd continued the discussion of the stratosphere – troposphere coupling studies by reviewing the major peculiarities of the stratosphere – troposphere system. First of all, the system is open because cooling to space takes place. Secondly, its angular momentum budget is tightly constrained. Apart from seasonal cycle, the short-term variability of the system is driven by variability in the Eliassen - Palm flux divergence, which is generated either by tropospheric wave sources or internally in stratosphere. This results in a stronger or weaker circumpolar vortex. The stratosphere can exhibit downward propagation of wind anomalies and has long-term memory compared with the troposphere. The studies of stratosphere – troposphere coupling receive considerable attention and are supported sufficiently well by funding agencies. There is need to strengthen the connections to the tropospheric science community including IPCC.

A targeted workshop as a follow-on from the SPARC Assembly may be required. It could well be organised as a SPARC-WCRP workshop and would cover a range of time scales from seasonal to long-term ones.

Prof. S. Yoden presented to the SSG a series of experiments with so called mechanistic circulation models, which contained a simplified physical package in comparison with full climate models but enabled longer time integration (up to millennium) and ensemble experiments. The model included an imposed quasi-biennial oscillation. Seasonal composites of zonal mean temperature were analysed. Statistical analysis of the long series generated significant estimates of distributions, which can form the basis for understanding climate variability and change.

The SSG felt that Dr M. Baldwin and Profs. T. Shepherd and S. Yoden were in excellent position to lead further the development of SPARC in the area of stratosphere – troposphere coupling. It also requested Dr M. Baldwin to represent SPARC in the WCRP Task Force on Seasonal Prediction.

3. Cross-cutting and supporting projects

3.1. Data Assimilation

Prof. A. O'Neill started his analysis with a list of data assimilation requirements for SPARC science. They include:

- Long term, global data sets for the troposphere and stratosphere, free of artificial trends.
- 3-D velocity fields with reduced data assimilation "noise" at an interval of several hours.
- Estimates of mass fluxes associated with sub grid-scale processes.
- Diabatic heating rates.
- Ozone, tracers and aerosols.
- Attention to bromine in the UTLS region.

To fulfil these requirements is the goal of the SPARC data assimilation initiative. A data assimilation working group has been established, which

- collects information on stratospheric data sets on meteorology and chemistry (quality, availability, software…);
- undertakes process-focused quality assessments;
- collects and documents information in data assimilation systems;
- liaises with space and other agencies on SPARC data needs.

In June 2003 SPARC organised two meetings on stratospheric data assimilation, an ASSET/SPARC workshop in Florence, Italy, and an ECMWF/SPARC workshop in ECMWF, Reading, UK.

In the work on collecting information on stratospheric data sets, the group objectives are to:

- overview most used datasets (UK Meteorological Office, ECMWF, NCEP, etc.),
- prepare a web site with links to information on each dataset and related publications,
- produce a test dataset for SPARC intercomparisons (a proposal is already available).

The aim of process-focused quality assessments is to compare different analyses using diagnostics tailored to particular probleMs The developed diagnostics focuses on the following issues:

- polar processes (Arctic polar stratospheric clouds, chlorine activation, areas of low temperatures);
- fine-scale structure and filamentation;
- mixing and transport barriers;
- wave propagation into stratosphere & effects on modelling studies;
- stratosphere – troposphere exchange and tropics, O_3 mini holes.

The group collects and documents information on stratospheric data assimilation systems for global circulation models (e.g. DARC/UK Meteorological Office, ECMWF, Canadian Meteorological Service), chemical transport models (e.g. KNMI, BIRA-IASB, UPMC, DAO), and coupled systems (e.g., Météo-France). It liaises with space and other agencies on SPARC data needs and tries to anticipate their requirements.

Space agencies mostly require:

- information on instruments (past, current and future) and how good they are;
- feedback on observation strategies: what and how to measure;
- exploitation of datasets: calibration/validation and quality-control, access by earth observation community, to achieve best use of investment.

Meteorological services mostly need:

- stable, high-quality (good resolution, good error characteristics, good coverage and near real time) data with "pedigree";
- data that can improve forecast skill (i.e., confront models with observations);
- to improve and extend services to society (e.g., "chemical weather").

3.2. Stratospheric processes

Prof. T. Shepherd and Dr A. Ravishankara presented this item based on contributions from several scientists including Dr K. Hamilton who submitted an analysis of the SPARC Gravity Wave Initiative activities.

Radiosonde Climatology

This SPARC-coordinated activity looks at the climatology of wavelike fluctuations in ultrahigh-resolution radiosonde wind and temperature data. It has involved participants from eleven countries and data at over 200 stations worldwide. Some of the individual participants in the project have submitted papers on analysis of their own national data. Dr R. Vincent and co-authors are completing a draft of a journal paper discussing the climatology produced by analysis of the entire data set. A preview of this paper is available in SPARC Newsletter 20. There is a question of how much of the original data used in the study can be made available through the SPARC Data Centre. The plan is to contact each of the participants and see if they are willing (and legally able) to send their data to the SPARC Data Centre. It is believed that the SPARC Data Centre is the only location where a substantial collection of the high-resolution balloon data will be conveniently available to the research community.

DAWEX Experiment

The DAWEX experiment to examine the middle atmospheric gravity wave field in the Northern Australian region and its relation to tropospheric convection was held October-December 2001. At a small workshop to discuss analysis of results, which was held in Honolulu in December 2002, the participants decided to produce coordinated manuscripts for submission to a special issue of a journal.

An overview paper, a paper reviewing the meteorology of the region during DAWEX, a paper on radiosonde observations taken during DAWEX, four papers on airglow imager observations, and two papers on numerical modelling of conditions during DAWEX will be prepared. A brief overview of the experiment and a discussion of the Honolulu workshop were given in an article in SPARC Newsletter 20.

Chapman Conference

As discussed at the SPARC SSG meeting in Kyoto in November 2002, the SPARC Gravity Wave Initiative co-chairs had produced a proposal to American Geophysical Union (AGU) to hold a Chapman Conference on Gravity Wave Processes and Parameterization. This proposal was accepted by AGU and the conference is scheduled for 10-14 January 2004 at Waikoloa, Hawaii. This is intended to be a focused meeting that brings together interested scientists in the middle atmosphere gravity wave community and the global climate modelling community. It may be regarded as the sequel meeting to the earlier NATO Advanced Research Workshop on "Gravity Wave Processes and Parameterization in Global Climate Models" held in 1996, which was co-sponsored by SPARC.

The meeting will involve about 30 invited speakers and about 50 other participants. Most participants will cover their own travel expenses and registration fees. Some funding from the US National Science Foundation has been secured to help cover some travel expenses for graduate students and other young scientists. A possibility of producing an AGU Geophysical Monograph in conjunction with the conference is being explored with AGU.

Prospects for the Gravity Wave Initiative

Over the year 2004 the main projects that the Gravity Wave Initiative has pursued, namely the radiosonde climatology and the field experiment in Northern Australia, should be essentially completed. At the SSG 2004 it should be possible to give final reports on these projects and to review the Hawaii Chapman Conference. Thus the 2004 SSG meeting might be the logical time to review the overall status of the Gravity Wave initiative and possibly consider its objectives completed. Of course, many uncertainties in the gravity wave problem will still remain, and there may still be a useful role for SPARC in coordinating some research activities. The more "engineering" aspects of the gravity wave parameterisation issue may passed to the GRIPS initiative (and possibly also the data assimilation initiative). An important remaining issue is possible SPARC involvement with future field experiments that includes studies of convective forcing of gravity waves. The US ARM program is planning a large campaign based in Darwin for January 2006. There is some European funding for Geophysica / Falcon campaign in the western tropical Pacific region in 2006 or 2007.

The SPARC SSG meeting in Kyoto SSG decided to look into possibilities of organizing an equatorial super-pressure balloon campaign. Dr K. Hamilton enquired with a few specialists and concluded that there was enthusiasm and interest for a campaign that would, at a minimum, produce new in situ wind data in the equatorial lower stratosphere. Such a campaign should be coordinated with stratospheric data assimilation efforts. The SCOUT project, which was presented to the SSG later in the meeting (see below), is expected to stimulate a long duration balloon campaign at the equator funded mostly by national sources. The COSPAR meeting of 2004 and the third SPARC General Assembly in August 2004 will provide an opportunity to discuss the scope for such a campaign (e.g. whether chemical measurements could be included in it) and find out how a SPARC group could facilitate national efforts.

Past and future “laboratory” Projects

As reported by Dr A. Ravishankara, this activity started in 1999, when a peer-reviewed paper on small organic peroxy radicals was published in the J. of Geophysical Research (JGR). In 2002 laboratory data evaluation resulted in updated data for quantum yields for production of $O(^1D)$ in the ultraviolet photolysis of ozone, also published in JGR, 2002. A co-chair of the IPCC Working Group 1 Dr S. Solomon requested a SPARC sponsored study of the global warming potential of hydrofluorocarbons (HFC) 134a. Five groups of specialists are currently involved in this activity. Associated radiative forcings and their uncertainties will be estimated, mostly using line-by-line models with account of vertical profile of HFC, clouds, typical temperature profiles inclusive of tropopause. Some preliminary results were presented to the SSG session. There is some discrepancy in the results. Its origin will be investigated and the results will be recalculated. A paper should be prepared for submission by the end of 2003.

3.3. SPARC Aerosol Assessment

Prof. T. Peter, also on behalf of Dr L. Thomason, presented the status of ASAP, the SPARC Aerosol Assessment. After the kick-off meeting at CNES in November 2001, there have been an informal meeting at Spring AGU Washington, DC, in May 2002, and a lead-author meeting in July 2003.

The scope of the prepared report comprises aerosol processes, precursor gases, aerosol instruments and measurements, aerosol records and climatology, trend analysis, and related modelling. The aerosol record will be presented in the coordinates of equivalent latitude and potential temperature.

The main data sources for ASAP are measurements by SAGE (Stratospheric Aerosol and Gas Experiment), HALOE, optical particle counters, lidar data sets. From primary measurements of extinction, backscatter, size distribution data sets of surface area density (SAD), effective radius, volume/mass were derived. The available data sets are for the period 1979-2003.

The following problems of measurements and analysis were noted. Satellite-based SAD tends to underestimate in situ measurements particularly those including small particle sizes. The scale and ubiquity of the problem is not clear. Size-resolved (>= 10 nm) aerosol observations in the stratosphere are therefore needed. The importance of meteorites and smoke is uncertain. There is significant uncertainty in trends, which makes it difficult to even detect their sign.

Extinction ratios (size) are inconsistent between models and measurements. Modelled lower stratospheric tropical extinctions are too low for the measured SAD. Work in underway on processing data from major volcanic eruptions.

The assessment should be completed in 2004. The chapter drafts completion is expected by the end of November 2003. A lead author meeting is being organized at the Atmospheric and Environmental Research Inc. in Lexington, USA, 18-21 January 2004. The draft assessment report is expected in February 2004. After a peer-review, the assessment will be printed.

3.4. SPARC Data Centre

The aim of the SPARC data centre is to provide data to the SPARC scientific communities and their major prograMs Prof. M. Geller reviewed the status of the SPARC Data Centre. The web site is located at http://www.sparc.sunysb.edu. Dr X.L. Zhou is the centre manager. Available data include:

- Cold point tropopause data from ECMWF (1979-1993)
- Temperature field near the tropical tropopause
- Small organic peroxy radicals data
- SPARC Reference Climatology Project data
- US high resolution sounding data for SPARC Gravity Wave Initiative
- GCM Reality Intercomparison Project for SPARC (GRIPS) data
- Stratospheric Aspects of Climate Forcing data
- Water Vapour Assessment (WAVAS) Archive
- Rocket sounding data
- Tropical tropopause, tropospheric and stratospheric climatological radiosonde-derived datasets
- Quantum yields for production of $O(^1D)$ in the ultraviolet photolysis of ozone data

The SPARC FTP Server is located at ftp://atmos.sparc.sunysb.edu, directory: /pub/sparc. There is a link to numerous other data centres. The new acquisitions include daily mean temperatures, geopotential heights, pressures, and saturation mixing ratio of water vapour at the tropical cold point tropopause, derived from ECMWF reanalysis; a data set of temperature field near the tropical tropopause; the US high resolution radiosonde data set, which includes data from 93 stations for 1998-2001 (data for 2002 will be put online when available). The data was obtained from NOAA.

Currently there is only 30 GB of disk space available at the data centre. Some data may be removed from an on-line archive. The SPARC grant period is from February 2002 to January 2005 (inclusive). Work is underway to renew the grant and upgrade the data centre computer.

The SSG discussed the status of the data centre. It thanked Prof. M. Geller and Dr X.L. Zhou for their efforts aimed at successful operation of the centre. An idea of having a back-up centre was proposed and Prof. S. Yoden agreed to consider its possible location in Japan. A problem of data certification was raised. High quality of all data available at the centre needs to be ensured.

3.5. Co-operation with IGAC/IGBP

The SSG session benefited from the participation in it of two scientists from IGBP, the Chair of the IGBP Scientific Committee Prof. G. Brasseur and Dr D. Parrish of the International Global Atmospheric Chemistry project (IGAC).

Prof. G. Brasseur gave a broad introduction to the IGBP activities and its co-operation with the WCRP in the framework of the Earth System Science Partnership (ESSP). The goal of IGBP is to describe and understand Earth System dynamics focusing on the interactive biological, chemical and physical processes, the changes that are occurring in the dynamics, and the role of human activities in these changes. At present the programme has entered its Phase II and has a new structure built around the three compartments of the environment namely atmosphere, land, ocean, their respective boundaries and needed integration activities. Prof. G. Brasseur introduced all major components of the IGBP II and the four joint projects of the ESSP, on water, food, global carbon and human health as well as the Global Change System for Analysis, Research and Training (START). Areas where interactions occur with WCRP projects, were indicated. A new development in the ESSP is the start of the Integrated Regional Studies, which involve all sciences: natural, social, economic.

Prof. G. Brasseur introduced in more detail the IGAC and its two overarching questions: What is the role of atmospheric chemistry in amplifying or damping climate change? What effects do changing emissions and deposition, long-range transport, and transformations have on the chemical composition of the atmosphere and on air quality? The programme needs to operate across traditional organizational boundaries at regional to global scales, integrating traditional troposphere (IGAC), stratosphere (SPARC), and measurement (GAW, IGOS) programmes. It needs to develop strategies in concert with ocean and terrestrial scientists to quantify the exchange of chemical species, between the atmosphere / ocean / land / biosphere and to build a common interactive emission database.

Dr D. Parrish spoke at the session as a representative of the NOAA Aeronomy Laboratory (Tropospheric Chemistry Group), as an IGAC SSC member and SPARC liaison, and as the Intercontinental Transport and Chemical Transformation (ITCT) task coordinator. The importance of the UTLS region for the task is related to the fact that much of the surface emissions transport is taking place through the upper troposphere and the ozone budget in troposphere strongly depends on the stratosphere. Dr D. Parrish presented activities of the task team and concluded that UTLS and SPARC are of significant interest for IGAC and for the ITCT task team. Possible joint actions of SPARC and IGAC could include coordination of measurements campaigns and development of joint observational strategy. There may be a need in high-resolution (~100 m) observations in the tropopause layer as proposed by Prof. G. Brasseur. Dr D. Parrish also emphasised the high efficiency of using aircraft observations for atmospheric chemistry observations, because the cost of one satellite is comparable to the cost of using tens of aircrafts.

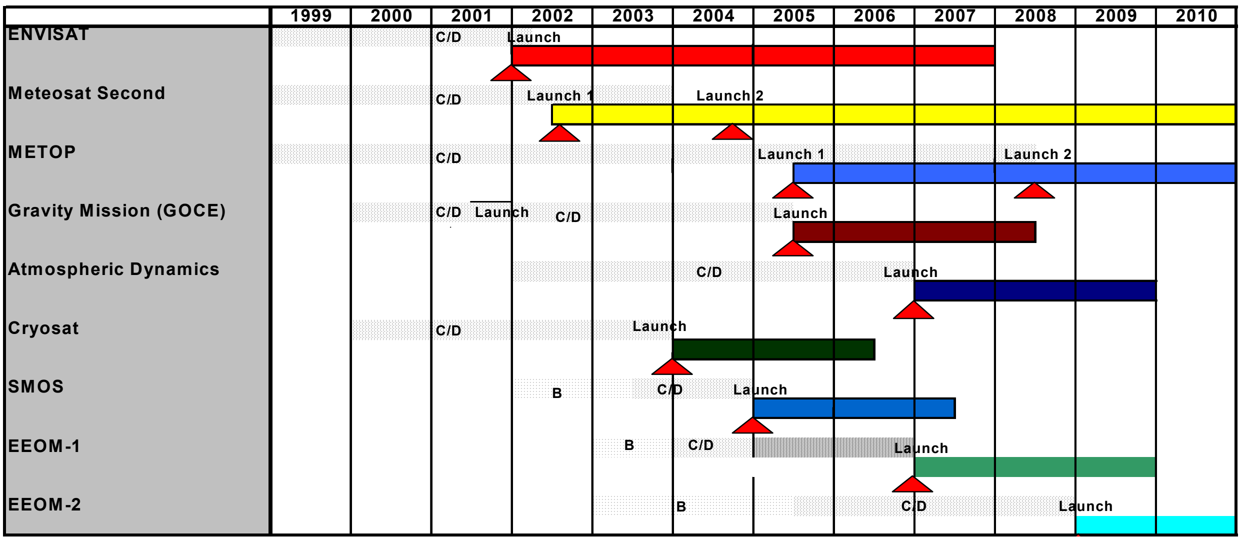
3.6. Co-ordination with other programmes

European Space Agency, National Aeronautics and Space Administration of the USA

Dr T. Wehr represented the ESA at the meeting. He gave a very comprehensive account of current and future ESA programmes and related activities including the following atmospheric missions:

- Individual Optional Missions ERS-2 (GOME), Metop (GOME-2, GRAS), METEOSAT and MSG, Envisat (MIPAS, GOMOS, SCIAMACHY);
- Earth Explorer Missions (ADM-Aeolus, EarthCare, WALES, ACE, EGPM, SWIFT);
- Earth Watch Mission (Atmospheric Chemistry Monitoring within Earth Watch).

Selected Earth Explorer Core Missions include GOCE and ADM-Aeolus and Opportunity Missions are Cryosat and SMOS. The overall launch schedule looks as follows:



Additional and access to data can be obtained via an Open Distributed Information and Services for Earth Observation (ODISSEO) at http://odisseo.esrin.esa.it/. Dr T. Wehr also presented in more detail

- the Atmosphere and Climate Explorer Mission (ACE+), which will perform atmospheric profiling using radio occultation,
- stratospheric wind interferometer for transport studies (SWIFT) onboard GOSAT, which is a European -Japanese-Canadian stratospheric dynamics mission, and

- WALES, which is intended to determine profiles of water vapour accurately and at high vertical resolution from space with global coverage, using Nadir-viewing water vapour Differential Absorption Lidar (DIAL) System.

Dr T. Wehr described current ESA research activities and drew attention of SPARC to the following. In the last quarter of 2003 ESA/ESTEC was planning to issue an invitation to tender for a study of advances in the research in atmospheric chemistry and dynamics by development of coupled chemistry-dynamics data assimilation models. On 20-21 January 2004 European Space Agency, Earth Observation Science and Applications Department and GMES-GATO EU FP5 project are organizing an Atmospheric Chemistry Applications Workshop (ESTEC, Noordwijk, The Netherlands).

The "Integrated Global Observing Strategy" (IGOS) partnership approved a theme on "Integrated Global Atmospheric Chemistry Observations" (IGACO). The IGACO team is currently developing a strategy for the evolution of the global atmospheric composition observation system and the integration of data.

Dr P. DeCola of NASA was unable to attend the session and Dr M. Kurylo presented some of the related activities and especially the extensive program of aircraft atmospheric chemistry measurements, which extends from tropics to the polar regions.

COSPAR

Dr M.-L. Chanin, that time in her capacity of the Chair of the Scientific Committee of the next COSPAR General Assembly (COSPAR 2004) to be held in Paris, France, from July 19 to 24, gave first hand information about the important event. She mentioned that out of the five interdisciplinary lectures planned, two would be of direct interest for the SPARC Community. Paul Crutzen will present the "First results from ENVISAT" and Claus Frôhlich will give a talk on "Solar radiation and climate". There will also be a panel on "The role of space in monitoring global change" where the issue of long-term commitment to atmospheric observations will be raised.

Among the disciplinary sessions of COSPAR 2004, four are co-sponsored by SPARC. They are:
A1.1 - Atmospheric Remote Sensing: Earth's Surface, Troposphere, Stratosphere and Mesosphere. Chair: J. Burrows
C2.3 - Long-term Changes of Greenhouse Gases and Ozone and their Influence on the Middle Atmosphere. Chair: D. Chakrabarty
C2.5. - Structure and Dynamics of the Arctic and Antarctic of the Middle Atmosphere. Chair: M. Rapp
D2.1/C2.2/E3.1 - Influence of the Sun's Radiation and Particles on the Earth's Atmosphere and Climate. Chair: J. Pap

SCOSTEP

Prof. M. Geller represented the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) at the meeting and, after a brief reminder of the nature and structure of SCOSTEP (more information is available at the URL www.ngdc.noaa.gov/stp/SCOSTEP/scostep.html), he focussed his talk on the major SCOSTEP project entitled "Climate and Weather of the Sun-Earth System" (CAWSES), which is a new and dynamically developing SCOSTEP Program for 2004-2008. CAWSES collects data records and documents, with increasing fidelity, various aspects of the Sun-Earth system, uses physically based models for assimilating observed data and deriving enhanced outputs for segments of the solar-terrestrial system, and mobilises SCOSTEP researchers to work together to understand variability throughout the entire solar-terrestrial system.

There are four CAWSES themes. The theme "Solar Influence on Climate" assesses related evidence at time scales from paleo to solar cycle and evaluates statistical evidence. It looks into theories and tests them using models and data with the focus on ultra violet heating and ozone changes in stratosphere, global electric field effects and the influence of galactic cosmic rays on clouds. The theme "Space Weather: Science and Applications" addresses solar processes producing space weather, Sun-Earth system elements and linkages that determine the severity of space weather disturbances. Its sub-theme "Space Weather Data Product Implementation" conducts data set analysis and integration and develops related information technology. Within the theme "Atmospheric Coupling Processes", the following studies are underway: dynamical coupling (planetary waves, gravity waves, tides, turbulence) and its role in the energy and momentum budget of the middle atmosphere, particles and minor constituents in the upper atmosphere, solar/terrestrial influences and their role in climate, coupling by electrodynamics including ionospheric / magnetospheric processes, detection of related trends. The theme "Space Climatology" works on the assessment of the Sun-Earth climatology (or climatological data), studies drivers, mechanisms and develops modelling of the Sun-Earth system climate. CAWSES has a capacity building and education dimension. It plans to hold meetings and provide specialised training courses for scientists from developing nations and help them with computational and data resources, establish partnerships between developing and industrialised nations and develop material to educate the public about solar-terrestrial science, its impact on technology and the global environment.

The successful implementation of CAWSES will provide an integrated scientific framework for solar-terrestrial research in the future, and produce an informed basis for guiding later programs under different solar conditions and changing anthropogenic influences and as made necessary by new human institutions and technological advances.

NDSC accomplishments and the future

Dr M. Kurylo updated the SSG on the progress in the development and activities of the Network for the Detection of Stratospheric Change (NDSC). The goals are to:

- study the temporal and spatial variability of atmospheric composition and structure,
- provide early detection and subsequent long-term monitoring of changes in the chemical and physical state of the stratosphere and upper troposphere,
- provide the means to discern and understand the causes of such changes,
- establish links between changes in stratospheric ozone, UV radiation at the ground, tropospheric chemistry, and climate,
- provide independent validations, calibrations, and complementary data for space-based sensors,
- support field campaigns focusing on specific processes occurring at various latitudes and seasons,
- provide verified data for testing and improving multidimensional chemistry and transport models of the stratosphere and troposphere.

NDSC operates a set of high-quality, remote-sensing research stations for observing and understanding the physical and chemical state of the stratosphere, assessing the impact of stratospheric changes on the underlying troposphere and on global climate. It measures ozone, key ozone-related species and parameters, and tracers of chemistry and of atmospheric motions. For more information, visit http://www.ndsc.ws. The web page is continually being updated. NDSC strives to ensure data quality. The investigators subscribe to a protocol designed to ensure that archived data are of as high a quality as possible within the constraints of measurement technology and retrieval theory. NDSC data validation is a continuing process. Instruments and data analysis methods are evaluated prior to NDSC acceptance and are continuously monitored throughout their use. Formal intercomparisons are used to evaluate algorithms and instruments.

4. German and European research programmes

A half-day of the meeting was devoted to a joint session with German and European scientists who presented an impressive review of national activities and their research under the framework of European Programmes. Prof. U. Schmidt opened the session and introduced the German colleagues.

4.1. German Atmospheric Research Programme AFO 2000

Dr M. Dameris has presented to SPARC a very impressive Atmospheric Research Programme 2000, which is a component of the „Research for the Environment" of the German Federal Government. AFO 2000 has been in place since July 2000. It includes 155 scientific contributions organised in 25 joint projects and 11 individual projects and 5 young scientist research groups. According to Dr M. Dameris, the financial support available for the programme until March 2006 exceeds 40 Million Euros.

The programme is divided into 4 theme groups.

The theme group 1 "Surface-Atmosphere Interactions" focuses on studies of momentum-, energy-, moisture-, and trace gas fluxes between the Earth surface and the atmosphere (emissions, deposition, energy-fluxes).

The theme group 2 "Chemistry, Dynamics, Radiation, and their Interactions" is centred around research on the interaction of the mesosphere, stratosphere, and troposphere, as well as on the mutual effects of dynamical, physical, and chemical processes. It includes several projects directly related to SPARC, namely

- CARIBIC (Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container)
- CASH-AIC (Compact Airborne Sampling Humidity with Automatic In flight Calibration)
- SPURT (Spurenstoffe in der Tropopausenregion) on trace gas transport in the tropopause region
- IsoStrat (Investigation of chemical and dynamical processes in the Stratosphere and upper troposphere using Isotopes as process tracers)
- CRISCA (Analysis of stratospheric dynamics on small and intermediate scales using CRISTA data)
- LEWIZ (Inertia-gravity waves and their connections to breaking Rossby waves)
- KODYACS (Kopplung von Dynamik und Atmosphärischer Chemie in der Stratosphäre) on coupling of stratosphere dynamics and chemistry
- MEDEC (Mesospheric Dynamics, Energetics and Chemistry)
- OPOSSUM (Physics Of Small Scale structures in the Upper Mesosphere)

The theme group 3 “Multiphase Processes” studies aerosols and cloud systems including polar stratospheric clouds. Within the theme, there is a project entitled

- POSTA (Multiphase Processes in the Polar Stratosphere: In-situ Measurements and Simulations).

The theme group 4 “Atmosphere-System Analysis: Models and Data” represents a combination of studies based on observations and complex numerical models. The following projects are of direct interest to SPARC:

- TRACHT (Transport, chemistry, and composition in the tropopause region)
- DYCHO (Effects of dynamical and chemical influences on the ozone layer in the changing atmosphere)
- SACADA (Synoptic analysis of chemical constituents by advanced satellite data assimilation)
- INVERT (Inversion of vertically resolved trace gas profiles from ERS-2 GOME total columns using the NCAR-ROSE Chemical Transport Model)
- GOMSTRAT (Vertical ozone distribution and stratospheric columns of NO_2, OClO, and BrO from GOME and SCIAMACHY)
- COMMIT (Community Model initiative)

More details about the programme AFO 2000 and links to its projects are available on the web at the following URL: http://www.afo2000.de. There is an AFO 2000 newsletter, which is published every 3 months.

4.2. Mesospheric Research – an overview of German activities

Prof. F.-J. Lübken presented in his talk the results of several areas of mesospheric research. Data from several instruments and stations were used. Prof. F.-J. Lübken described modern observations of noctilucent clouds and polar mesospheric summer echoes. Further insight into the problem became possible when this data was analysed jointly with K-lidar measurements of temperature. Mesospheric summer echoes were observed at heights of order of 75 km. First observations of mesosphere winter echoes were made at station Kühlungsborn in February 2003. Using data from several lidars, gravity wave climatology is being compiled at the Leibniz Institute of Atmospheric Physics. Available data made it possible to embark on estimation of trends in the mesosphere. It was possible to estimate trends of summer temperature including its profile up to the height of approximately 80 km, noctilucent clouds, their frequency of occurrence, their altitudes, seasonal heights of polar mesospheric clouds. In general the observed trends correspond to model predictions, in which variations of CO_2 and ozone are used as forcing. Observed temperature at the height of 82 km in polar latitudes was not changing significantly, the height of the noctilucent clouds was not changing either, while the albedo did change.

4.3. UTLS

A new concept for atmospheric measurement campaigns for studies of stratosphere - troposphere exchange was presented by Dr A. Engel. It is being implemented by the AFO2000 project SPURT with the objective to investigate transport, mixing (and chemistry) in the extratropical tropopause region based on regular airborne observations of chemical composition. Answers to the following scientific questions are sought:

- What is the seasonal / interannual variability of trace gas concentration in the UTLS?
- When and how does mixing between the UT and the LS occur?
- How strong is the coupling between UT and LS as a function of latitude and season?
- Which dynamical processes influence the trace gas distribution?

The observations are made with help of the LEARJET 35a aircrafts using a flexible aircraft operation scheme and a tight time schedule. The scientists obtain operational assistance including meteorological forecasts and can concentrate on their primary tasks of running their instruments and working with the data. This makes it possible to carry out fast and cost-effective campaigns and to achieve seasonally resolved observations of chemical composition of the UTLS. Based on these new observations, new series of studies of variability, seasonal cycle, interannual variation and some case studies have started.

4.4. Results of a 40-year simulation with ECHAM

Dr V. Grewe presented new simulation results based on the ECHAM climate model, version E39/C, which is a fully coupled stratosphere-troposphere chemistry-climate model. The atmosphere circulation model is a global spectral model with semi-Lagrangian advection of water vapour, cloud water and tracers. It is run at resolution T30 with 39 layers and the top layer centred at 10 hPa (~30 km). The physical package includes parameterisations of radiation, clouds, precipitation, convection, and diffusion. The chemistry module has the following transported species: H_2O, CH_4, N_2O, HCl, H_2O_2, CO, CH_3O_2H, $ClONO_2$, HNO_3+NAT, ICE, ClO_x, NO_X, O_X, includes 37 species and 107 gas-phase reaction, methane oxidation, polar stratospheric cloud formation with 4 related heterogeneous reactions, parameterisation of dry/wet deposition, lightning and surface emissions. Physical and chemical modules are interactively coupled at every time step.

The goal of on-going experiments is to realistically simulate the Earth‘s atmosphere from 1955 to 2000 using (only) the following forcing data:

- Emissions of NO_x, CO, CO_2, N_2O, CH_4, CFCs, as observed or estimated by IPCC;
- Quasi-biennial oscillations nudged in tropical stratosphere;
- Effect of volcanoes (Agung, El Chichon, Pinatubo) on chemistry and radiation;
- Observed sea surface temperatures (Hadley-GISS data);
- 11-year solar cycle.

One out of three transient simulations had just been finished, and Dr V. Grewe presented preliminary results. First comparison to observations was qualified as realistic. The following are most interesting features of the simulation results. High total ozone variability was found with 20 Dobson Units decline from 1960 to 2000. Noticeable tropospheric ozone variations were mainly in the Northern Hemisphere, with increase of order of 4 Dobson Units. Pattern of lightnings reflected some impact by ENSO. The model produced realistic positive water vapour trend of 0.8 – 1.0 ppmv for the period 1980-2000 and, as well, large interannual variations. The forcing attributed to the Pinatubo eruption caused a temperature increase of 1.8 K at 50 hPa, which led to more water vapour, more HO_x, less NO_x destruction, and global ozone decline.

The analysis of first data had just started and further simulations were running. The preliminary conclusions at this stage were that E39/C was able to reproduce important troposphere - stratosphere and climate - chemistry interactions and realistically simulate atmospheric changes during 1955 – 2000.

4.5. New results from ENVISAT

ENVISAT has been successfully launched on the night from 28 February to 1 March 2002. German participants in the SSG session reported on their work with several sensors on the satellite.

New results from MIPAS

Prof. H. Fischer has presented the status of the MIPAS (Michelson Interferometer for Passive Atmospheric Sounding), which is a mid-infrared high resolution limb sounder, and described an experiment with its data. The testing of the instrument has been performed and the first spectra obtained. The data will be processed to derive global distributions of temperature and more than 25 trace constituents. In addition, the detected broadband spectra will allow determination of polar stratospheric clouds properties and, in case of high load, aerosol amount. Derived vertical profiles of trace constituents will be inter-compared with validation measurements.

New results from SCIAMACHY

The table below shows SCHIAMACHY products in near real time and off-line (see ESA Envisat home page at http://envisat.esa.int):

	Nadir			Limb		
	UV/Vis	IR	UV/Vis/IR	UV/Vis	IR	UV/Vis/IR
NRT	O_{3^*}, NO_2, SO_2^*, $OClO^*$, H_2CO^*	H_2O, CO, N_2O, CH_4	Clouds, Aerosols			
Off-Line	O_3, NO_2, BRO, SO_2^*, $OClO^*$, H_2CO^*	H_2O, CO, CO_2, N_2O, CH_4, P, T	Clouds, Aerosols	O_3, NO_2, BrO	H_2O, CO, CO_2, N_2O, CH_4, P, T	Aerosols

Prof. J. Burrows continued the review of products obtainable from Envisat instruments and presented new results from SCIAMACHY and some information about GOME (on ERS-2). These results were part of an extensive validation campaign aimed at quantification of error budgets of all data products with independent measurements. In the attempt to ensure high quality data products over the lifetime of SCIAMACHY, Germany is supporting a major part of the SCIAMACHY Validation Structure. There are 20 national projects involving ground-based and ship-born data from aircraft, balloons, and satellites.

The German SCIAMACHY homepage is located at http://www.schiamachy.de. The SCIAMACHY Operations Support Team's web site is located at http://atmos.af.op.dlr.de/projects/scops. GOME and SCIAMACHY continue to demonstrate and exploit the potential of passive remote sensing in the ultra violet, visible, near infrared and shortwave infrared spectral bands.

First results from GOMOS

Among the products of the novel ENVISAT instrument GOMOS (Global Ozone Monitoring by Occultation of Stars theme) are the following atmospheric constituent profiles: vertical and line density profiles of ozone, NO_2, NO_3, O_2, H_2O, aerosols, temperature, turbulence. Dr A. Hauchecorne presented the status of some related calibration / validation activities, which involved intensive intercomparison with independent data sources. Primary mission objectives were to estimate day- and night-side measurement capability of profiles of ozone, NO_2, NO_3, temperature, water vapour, and aerosols.

A validation workshop in December 2002 at ESRIN revealed several shortcomings in the algorithms and decided that they should be adjusted. The new version of algorithms was completed in July 2003. In September 2003 data reprocessing took place, and a validation workshop at ESRIN was being planned for November 2003.

For the updated algorithms the currently estimated accuracy of a single profile is as follows. For O3: 3 to 5% (20-65 km); for NO_2: 15% (30-40 km); for NO_3: 30% (30-45 km). There is systematic bias in O_2 (the study is on-going). H_2O data is of reasonable quality in the lower stratosphere (15-30 km) but noisy on individual profiles. Encouraging preliminary results were obtained for high-resolution temperature profiles.

The overall conclusions are that after 18 months of flight, GOMOS operates well. Data processing algorithms for dark limb occultations are in process of improvement. Bright limb occultations are not yet processed. Validation studies indicate no significant bias in O_3 (and probably in NO_2 and NO_3 when a Differential Optical Absorption Spectroscopy retrieval is used), proving that GOMOS fulfils well its main objective, the determination of the global ozone climatology in the stratosphere and in the mesosphere. The systematic data processing at ESA and the data distribution to principal investigators are expected to commence after the November 2003 validation workshop at ESRIN.

4.6. SCOUT – EC 6FP proposal

SCOUT-O3 (stratosphere-climate links with emphasis on the UTLS) is a new proposal for an integrated project, which would unify over sixty institutions and more than a hundred scientists. It was submitted for funding under the Sixth Framework Programme of the EC. The central aim of the project is reliable prediction of future evolution of the ozone layer and surface ultra violet radiation with a focus on the interaction between the Montreal and Kyoto Protocols. Dr M. Dameris presented it to the SPARC SSG on behalf of the project leadership.

The project activities are subdivided into work packages, which form several areas, as follows:

- Ozone, climate and UV predictions
- SCOUT-O3 Tropical
- Extra-tropical ozone and water vapour
- UV radiation
- Chemistry and Particles: studies of kinetics, photochemistry, heterogeneous processes and nucleation
- Global diagnostic chemical transport modelling
- SCOUT-O3 database and public outreach
- Management

4.7. Workshop on "Process oriented validation of Chemistry/Climate Models"

Dr V. Eyring presented to SPARC SSG the preparations for a workshop planned for 17-19 November 2003 in Grainau / Garmisch-Partenkirchen, Germany. The goal was to develop criteria to validate the models with a focus on their ability to predict future ozone. The motivation is that coupled chemistry-climate models, which have been developed in recent years with an emphasis on the stratosphere, vary considerably in complexity and cover a wide range of time scales of integration. A number of systematic biases or large discrepancies in these models have been identified such as an overestimate of the area weighted hemispheric total ozone, strong cold temperature bias, variations in simulated polar stratospheric clouds, underestimated water vapour trend, downward trend in planetary wave propagation, etc. These findings lead to a series of questions, e.g.

- What are the causes for the cold temperature bias problem?
- Why do models underestimate ozone depletion in the Northern Hemisphere?
- Why do models overestimate ozone columns in mid-latitudes in spring and does this have an impact on polar Arctic ozone?
- Why do models overestimate total ozone in the Northern Hemisphere summer?

The scope of the proposed workshop is to develop a standard for model validation and by doing so to facilitate answers to the following key science questions:

- How will stratospheric ozone levels change as greenhouse gases and ozone depleting substances change?
- When will the ozone hole recover?
- How will changing ozone levels impact climate change?

The approach to the key science questions lies through more specific questions, namely:

- What are the key underlying processes that impact stratospheric ozone change?
- How predictable is the evolution of stratospheric ozone and its impact on climate (or what is the expected ratio of "signal" to climate "noise")?
- Is it possible to assess how well chemistry-climate models represent these key processes and, if yes, how?
- What are the key parameters for validating the processes impacting ozone change and for assessing the models?

The scientific topics of the workshop are:

- Transport Characteristics
- Stratospheric Dynamics
- Stratospheric Chemistry & Aerosols
- Impact of UTLS including Tropical Tropopause Layer
- Tropospheric Forcing
- Radiative Transfer and Balance

The workshop is expected to significantly develop a Unified Chemistry Model Evaluation Strategy (UCMES), which is needed to:

- aid in development of new models through provision of clearly defined benchmarks;
- quantify model errors and uncertainties in a statistically robust manner;
- assist in assessment activities by providing traceable record of model performance.

If successful, UCMES should become a permanent tool for evaluation of chemical tracer and chemistry-climate models. The SPARC SSG felt strongly that the chemistry - climate model validation workshop was timely and strongly needed. The group recommended to SPARC to co-sponsor it.

5. SPARC project office and future plans

The SPARC office actively pursued its activities in 2003 namely contacts with the JPS of WCRP, WCRP projects, IGBP, other partner programmes, with the SPARC community of scientists; organisation of SPARC meetings, compiling and editing SPARC Newsletters (2 a year), updating the SPARC mailing list, maintaining the SPARC website, preparation of SPARC reports for publication). A new SPARC brochure has to be prepared soon. The session warmly thanked the director and the office staff, Dr M-L Chanin, as well as Ms C. Michaut and Dr Y. Koshelkov, for their excellent support. During 2003, Dr Y. Koshelkov retired. A new SPARC scientist was hired for the office. Dr E. Oikonomou started his duties on 1 June 2003 using a grant provided by the ESA. Half of his time is supposed to be used for SPARC office activities and the other half on research on the Envisat data. The SSG appreciated very much the support received from the ESA.

In 2004 the SPARC office is expected to move from Paris. After many years of outstanding service, the director, Dr M.-L. Chanin, will pass her duties to a new person in charge of the office. Activities to find a new home for the office were presented to the SSG. A proposal to move the office to the Department of Physics, University of Toronto, was submitted by Prof. T. Shepherd and Prof. N. McFarlane to several Canadian organisations. Expectations were high that the proposal would be considered favourably and approved. In that case, there would be a transition period. The operation of the office in Paris would not stop abruptly. Ms C. Michaut agreed to visit the new office in Toronto and help speed up operations there. Full transition to the base would be completed after the SPARC General Assembly 2004. At the end of this discussion Prof. M. Geller expressed a wish that not only Canada but some other countries could help to support the SPARC project office.

6. Next SSG Meeting and SPARC General Assembly 2004

Prof. T. Shepherd reviewed the preparations for the Third General Assembly of SPARC, 1-6 August 2004, Victoria, Canada. The web site of the Assembly is located at http://sparc.seos.uvic.ca. The scientific program of the Assembly will cover all the topics of relevance to SPARC, including:

- Stratospheric climate and indicators of climate change
- Stratospheric data assimilation
- Transport and mixing in the stratosphere and between stratosphere and troposphere
- Gravity-wave processes and their parameterization
- Stratospheric and upper tropospheric water vapour
- Chemistry, radiation, aerosols and dynamics in the upper troposphere/lower stratosphere
- Chemistry-climate modelling of the stratosphere

A particular emphasis for this General Assembly will be chemistry-climate coupling.

Profs. T. Shepherd and A. Ravishakara will co-chair the Scientific Committee. Prof. N. McFarlane will be the chair of the Local Organising Committee.

The session considered proposals by the organisers on the actual arrangements. The venue will be the Victoria Conference Centre. The maximum capacity of the Centre is 400 people. The abstract deadline date was set on 31 January 2004. The group agreed with the proposed registration fees and the assumptions on required budget, options for accommodation, and transportation.

Profs. T. Shepherd and N. McFarlane proposed to hold the Twelfth Session of the SPARC SSG in Canada, after the SPARC General Assembly. This offer was accepted with appreciation. Three possible locations were given for the meeting: University of British Columbia, Vancouver, University of Toronto, Toronto, and Dunsmuir Lodge, Victoria. Having discussed the options, the group named Dunsmuir Lodge at the first preference. The dates for the session were set on 9-12 August 2004.

7. SPARC SSG composition

The group resolved that there would be no changes in the SPARC SSG membership in 2004.

8. Closure of session

Before closing the session, the participants considered and agreed upon a list of follow-up actions. In particular, it was decided that the new Implementation Plan of SPARC should be prepared during the year 2004 and submitted for discussion at the next SPARC SSG session. Some SSG members were asked to lead the preparation of individual chapters. The SSG members felt that discussion at a SPARC SSG session could require more time.

Closing the session, the co-chairs, Prof. A. O'Neill and Dr A. Ravishankara, thanked SSG members for their contribution to the discussion. In particular, they noted that Dr M. Proffitt of WMO was an excellent contact point and for many years had contributed valuable knowledge and expertise to the group. The group gave him a round of applause.

Noting that the next SSG session would be held after the SPARC General Assembly and that the current session might be the last SSG session, which Dr M.-L. Chanin and Ms C. Michaut organised in the capacity of the project office director and manager, respectively, the co-chairs, on behalf of the SPARC project and all participants in the meeting, deeply thanked Dr M.-L. Chanin for her outstanding leadership of the project for the whole period of its existence. Ms C. Michaut was thanked for her excellent work at the office. This emotional moment was celebrated by presenting little memorable gifts and flowers to Dr M.-L. Chanin and Ms C. Michaut.

The eleventh session of the SPARC SSG finished at noon of 25 September 2003.

Appendix

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