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Intergovernmental Oceanographic Commission

World Meteorological Organization

WORLD CLIMATE RESEARCH PROGRAMME

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

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0. Introduction

The tenth session of the SPARC Scientific Steering Group (SSG) was held in the Kansai Seminar House, in Kyoto, Japan, at the kind invitation of Prof. S. Yoden of the University of Kyoto and a member of the SPARC SSG. A list of the meeting participants is given in Appendix.

The meeting started with a moment of silence in memory of Dr. Petra Udelhofen, who tragically died. She was key in starting and operating the SPARC data Centre at Stony Brook.

In their opening address the SSG co-chairs, Profs. M. Geller and A. O'Neill, briefly listed top priority issues of SPARC research. The co-chairs recalled that the SSG session was preceded by a very interesting "International Symposium on Stratospheric Variations and Climate", which was organised by Dr S. Miyahara with the help of Prof. S. Yoden in the Kyushu University, Fukuoka, Japan, on 12-15 November 2002. On behalf of all SSG members who attended the symposium, the co-chairs expressed their gratitude to Dr S. Miyahara and Prof. S. Yoden and other organisers of the symposium for a remarkable meeting, which set the high tone for the SSG session.

Another very positive news was that, by decision of the WMO Executive Council, the STTA group of SPARC led by Dr V. Ramaswamy was recently awarded the annual WMO Norbert Gerbier-MUMM International Award for 2003 for the paper entitled "Stratospheric temperature trends: observations and model simulations" published in Rev. Geophys., 19, 2001. The official award ceremony will take place during the next session of the WMO Executive Council.

The co-chairs expressed their satisfaction that almost all SSG members were able to attend the session. They welcomed warmly Dr V. Ryabinin who is a new member of the Joint Planning Staff (JPS) for the WCRP, and our liaison with the JPS, since Mr R. Newson departed for retirement. They also welcomed Prof. Shaw Liu, a co-chair of IGAC, to the meeting. Particularly gratifying was the fact that space agencies were well represented at the meeting. Having wished the participants a successful and fruitful outcome, the co-chairs gave the floor to Prof. S. Yoden who welcomed the guests to Kyoto and provided logistical information.

The introductory part of the meeting was concluded with a brief overview of the WCRP activities, which was given by Dr V. Ryabinin. He first presented the current composition of the JPS and the distribution of tasks and stated that, for the first time in several years, experts within the JPS working on a full-time basis occupied all professional posts.

Dr V. Ryabinin continued with a description of the Earth System Science Partnership (ESSP) activities and corresponding joint projects, the area, in which WCRP collaborated with the International Geosphere Biosphere Programme (IGBP), DIVERSITAS, and International Human Dimension Programme (IHDP). He described the three joint ESSP projects, namely on water, global carbon, and food systems and indicated that another project on health was expected to follow.

The attention of the SSG session was then drawn to following important developments in the WCRP projects. After the assessment of its first phase, the GEWEX (WCRP Global Energy and Water Cycle Experiment) project entered its second phase, which will be focussed on integration of data into diagnosis of variability and predictability of global and energy water cycle. WOCE (World Ocean Circulation Experiment) was about to finish producing the fist globally coherent snapshot of the global ocean circulation. CLIVAR (Climate Variability and Predictability) project continued studies of seasonal and inter-annual climate phenomena, decadal modes, anthropogenic climate change and paleo-climate. ACSYS (Arctic Climate System Study) was finishing with a major wrap-up conference planned for 2003. CliC (Climate and Cryosphere) was in the development stage. Other developments in the WCRP included preparatory work of setting up a co-ordinating mechanism for activities in the area of air-sea fluxes, formulation of WCRP requirements in satellite observations, and an initiative on data management. Considerable attention was being paid to a new WCRP "banner", which envisioned an extension of WCRP studies of predictability. Finally, Dr V. Ryabinin presented some additional information on activities, which were formally outside WCRP but were related to it. This included the Global Climate Observing System (GCOS) activities, such as continuing development of Global Terrestrial Networks, finalisation of the second GCOS adequacy report, preparation of the Science and Implementation plan for the Atmospheric Observation Panel for Climate (AOPC).

1. Modelling Stratospheric effects on climate

Intercomparison of stratospheric models

Dr S. Pawson and Dr K. Kodera gave a progress report on GRIPS ("GCM Reality Intercomparison Project for SPARC").

The first GRIPS results were published in 2000 (BAMS and JGR) and the recent results are now submitted to JAS (Horinouchi *et al*., 2002). The highlights of 2002 included several events. At a workshop in Tsukuba, Japan, the participants agreed on a further distribution of tasks within GRIPS. There were 12 participants in the project at the time of the presentation. A project web site was established at: http://userpages.umbc.edu/~pawson/html_flies/grips.htm.

Among the tasks of level 1, which aim to answer the question “How well we simulate the present-day climate system?”, studies of sudden stratosphere warming events, atmospheric tides and travelling waves, computation of spatial wave number spectra were considered close to completion. The work was pursued on preparation of model documentation, generation of basic climatological data, troposphere-stratosphere connection and exchange, polar vortices, and Southern Hemisphere variability.

The level 2 tasks are aimed at development of parameterisations and studying model sensitivity to them. Simulation experiments on imposed mesospheric forcing were successfully completed. Progress was reported in experiments on the evaluation of gravity-wave drag schemes. Evaluation of corresponding radiation schemes and retrieval of gravity-wave drag data in diagnostic mode need attention.

The level 3 tasks are supposed to study mechanisms by which various forcing factors control the atmospheric circulation and how they are represented in models. The experiments on intercomparison of model response to the Mount Pinatubo eruption conditions and on response to ozone trends were proceeding satisfactorily. At the same time assessment of ozone related sensitivity faces uncertainties in perturbation levels and even the base state. Therefore one of the GRIPS Level 3 tasks should be to lead the efforts to resolve existing uncertainties in time for the next WMO-UNEP and IPCC assessment.

The SSG noted that the year 2003 was seen as the right time for completion of GRIPS level 1 and level 2 tasks. The following GRIPS workshop was expected to take place in March in the Washington DC area. The SSG felt that it was important to support further studies of GRIPS level 3 tasks, which would require forcing simulation by complex models and would focus on climate – atmospheric chemistry interactions. It was also mentioned that the experience of model intercomparisons in the WCRP was very significant, particularly under the auspices of the CAS-WCRP Working Group on Numerical Experimentation (WGNE) and the Working Group on Coupled Modelling (WGCM). Relationships of SPARC and GRIPS with these groups need to be strengthened.

Dr K. Kodera’s presentation on level 2 tasks completed the presentation. He presented some results of experimentation related to the temperature and ozone concentration response to solar forcing. A paper on those initial results has been submitted to Meteorology and Geophysics (Matthes *et al.*, 2002). Disparities between model responses were very significant. The effort was aimed at finding regular patterns of the response and suggesting the dominant mechanisms for it. The experimentation highlighted a need for better observational data to compare temperature and ozone variations and additional evaluation of two mechanisms likely to be important in linking ozone and temperature changes to chemical interactions in the lower stratosphere and dynamical response in the tropical and subtropical stratopause.

The participants agreed that SPARC and specifically GRIPS should co-ordinate future efforts in forthcoming ozone and related climate change assessments, mostly concerning water vapour, column ozone, aerosol and solar cycle effects.

Stratospheric reference climatology

In the subsequent presentation Dr W. Randel summarised results of a compilation of middle atmosphere climatological data sets. This study was ready to be published as a SPARC technical report "SPARC Intercomparison of Middle Atmosphere Climatologies" in December 2002. The SPARC reference Climatology Group was able to combine 12 different data sets. The inclusion of rocketsonde and lidar data into the data intercomparisons allowed the extension of the climatology of temperature and winds up to the middle mesosphere. Despite the significant difficulties due to the scarcity of rocketsonde and lidar sites, the

non-simultaneity of the data sets, discontinued character of the rocket series, the work was successfully completed. The group was able to include ERA40 from ECMWF into the data intercomparison.

Dr W. Randel presented results showing typical vertical profile of parameters associated with quasi-biennial and semi-annual oscillations, variations of temperatures in polar regions and over the equator zone, and comparisons of results with rocketsonde data.

The SSG was very pleased to hear about the completion of this important task and applauded Dr W. Randel for his leadership in this important project. The reference climatological data will facilitate further studies under GRIPS and will benefit other SPARC activities.

SPARC data assimilation

Based on the initial efforts of the SPARC SSG co-chair Prof. A. O'Neill, a SPARC initiative in data assimilation started to develop. Dr I. Stajner reported on the progress. The state of the art was discussed at the first SPARC data assimilation workshop that took place in Catonsville, Maryland, USA, on 10-12 June 2002. NASA/Goddard Space Flight Centre Data Assimilation Office and the University of Maryland Baltimore County hosted the workshop. The participants from16 research groups gave presentations on stratospheric data assimilation techniques, data intercomparisons, constituent satellite data, reconstruction of potential vorticity, assimilation of ozone and chemical composition data. The results of the workshop were published in the SPARC Newsletter N^{o}. 19 in July 2002.

As a result of the above efforts the SPARC Data Assimilation Working Group was formed. Its meetings are anticipated on a yearly-basis. The group's plans are:

- to collect information on availability, quality, formats, reading software and documentation for stratospheric meteorological data sets that can be used in the intercomparisons;
- to perform process-focussed quality assessments of stratospheric meteorological data;
- to collect, validate, and intercompare chemical assimilated data,
- to collect information on CTM and GCM assimilation systems that are available for intercomparison and coupling.

The group has prepared a progress report on the first of the above tasks, has established a web site at http://polar.gsfc.nasa.gov/sci_research/cooperative_ventures/sparc. A mailing list was set up for this activity: sparcda@dao.gsfc.nasa.gov.

The session was pleased to learn the progress in the SPARC data assimilation activities and emphasised that data assimilation was seen by the group as the most efficient technique to obtain global quality controlled, internally consistent data sets of the dynamic and chemical state of the stratosphere.

2. Long-term changes in the stratosphere

Stratospheric temperature trends

Dr V. Ramaswamy presented the update of the stratosphere temperature trends for the periods 1979-2000 and compared them with the previous 1979-1994 SPARC studies. A significant and relatively clearly seen temperature trend was reported for the summer 50 hPa series at 70°N. Recently the new focus has been on observed seasonal trends (winter/spring versus summer) and on understanding the causes of global-mean trends, in particular, the role of trace gases changes (ozone, greenhouse gases, and water vapour) in generating the trend. The results demonstrated that model simulations had a tendency to underestimate observed stratospheric cooling. Winter anomalies showed some variability of unknown origin and it would be interesting to trace their connections, if possible, to events such as El Niños. Dr V. Ramaswamy also presented some preliminary projections of 50 hPa temperature variations up to the year 2020. The results indicated the relative signs and amplitudes of the variations under the different forcing mechanisms. Another area of intensive research was focussed on transient experiments aimed at explanation of observed annual variability. The simulations included effects of aerosol variations, chlorine and bromine concentration variations, and solar radiance.

The SSG noted that the Temperature Trend Assessment report had been delayed in order to include the seasonal variations, but will be completed soon under the NOAA-SPARC auspices. A meeting of the Stratosphere Temperature Trends Assessment team was considered useful in 2003 or 2004. However future thrusts in the stratospheric indicators activities area will be on the agenda of the Angell Symposium,

which will be an opportunity for the community to meet. Another venue for presenting these results would be the Gordon Conference “Solar Radiation and Climate” in July 2003.

SPARC/SCOSTEP assessment of upper atmosphere temperature trends

Dr V. Ramaswamy, Profs. M.-L. Chanin and M. Geller commented on the output of the Heraeus Seminar on trends in the upper atmosphere which took place in Kühlungsborn, Germany, in May 2002 (see report in SPARC Newsletter N° 19). This seminar co-sponsored by SPARC and SCOSTEP showed the difficulty encountered in the determination of trends in these upper layers due to the lack of long series of data and indicated that further work is needed. However the updated trend detection in the upper mesosphere using all the rocket data should be available soon.

Ozone trends and WMO/UNEP report

Dr N. Harris, unable to attend, had sent a report on the activities of the group during the year. Dr W. Randel presented the item.

Most of the effort of the ozone trend community went into the Ozone WMO-UNEP Assessment 2002. An important milestone in this work was a SPARC/IOC (International Ozone Commission) workshop on Understanding of Ozone trends was held at the University of Maryland on 7-9 March 2001. A summary of the workshop was published in the SPARC Newsletter (N. Harris and R. Hudson, SPARC Newsletter N° 17, 2001). The main aims of the workshop were to identify the major current issues concerning ozone trends, to improve quantification of the contributions and uncertainties of the chemical and dynamic mechanisms to observed ozone trends, particularly at mid-latitudes and to identify how to assess the consistency of these proposed contributions. The main emphasis was on the dynamical influence on the ozone trends.

Chapter 4 of the WMO-UNEP assessment "Global Ozone: Past and Future " was led by Dr W. Randel and Dr M. Chipperfield and two SSG SPARC members were co-authors: Prof. T. Shepherd and Dr T. Peter. Both commented on the contents of the chapter as well as on the state of other chapters. Consideration of the ozone changes suggested that a cooler stratosphere would act so as to prolong ozone recovery. Nevertheless, ozone is likely to recover in the next 50-100 years.

To move forward on the issue of Arctic ozone, a workshop on Arctic Ozone Loss was organised at the Alfred Wegener Institute in Potsdam, Germany from 4-6 March 2002. The relevance of this workshop to the Assessment is related to the fact that the two chemical, ozone-depletion processes about which there is most confidence are the high-altitude and polar-ozone losses, together with the subsequent impact on mid latitudes. About seventy scientists attended the workshop (see report by M. Rex *et al*., SPARC Newsletter N° 19, 2002).

SPARC Aerosol Assessment

Aerosol in the upper troposphere/lower stratosphere (UT/LS) can have a significant impact on climate through radiative effects and on stratospheric chemistry, particularly on ozone. Accounting for aerosol effects properly is a key component of modelling climate/chemistry effects properly. The SPARC Assessment of Stratospheric Aerosol Properties (ASAP) is being led by Drs L. Thomason and T. Peter. Its status was presented at the SSG by Dr T. Peter. The focus of this initiative is to develop the scientific understanding of UT/LS aerosol and critically consider available aerosol measurements.

The assessment was initiated with a workshop in Paris, France on November 4-6, 2001. Five project areas were identified namely: aerosol processes, precursor gases, aerosol record, trend analysis, and modelling. The assessment is underway. Dr T. Peter presented the state of the five chapters.

An intermediate result of the work would be a 20-year long, gap-free higher spatial, temporal and spectral resolution data set. It will be available at the SPARC Data Centre.

The work was hampered by the sparseness of stratospheric profile measurements of OCS and SO2. The authors had little confidence in source gas distributions. An open question was the quality of model transport. Nevertheless, the study was progressing at a good pace and the report draft should be sent out for review in August 2003 and the report would be ready for publication in January 2004.

Indices for Antarctic ozone depletion

This agenda item was presented by Prof. D. Karoly and Dr M. Proffitt. At the SPARC SSG meeting in November 2001, there was discussion on the need to assess the different indicators used to describe the interannual variability of the size, intensity and duration of the Antarctic ozone hole. The aim was to develop small set of agreed indices that could be used to describe the ozone hole variability and its expected future recovery. There was a similar discussion during the preparation of the current WMO/UNEP ozone assessment report. At the SPARC SSG meeting of 2001, Prof. D. Karoly agreed to co-ordinate a small working group that would undertake this project.

Dr M. Profitt of the WMO has prepared a list of possible indicators. This list is not comprehensive, but gives an idea of some different indices that are being used at present. It would be desirable to intercompare groups of the indicators with other indices and to decide on a smaller set of agreed indices of key aspects of the ozone hole such as size (area), intensity (mass deficit, minimum column ozone, etc.) and duration (date of break-up). A short paper in a refereed journal will be produced. The exceptional case of the winter Antarctic 2002 should be included in this article.

The agreed participants include D. Karoly (Australia), M. Proffitt (WMO), G. Bodecker (New Zealand), V. Fiolatov (Canada), P. Newman (USA), W. Randel (USA), and O. Uchino (Japan). The draft manuscript including comparisons of groups of indices and recommended set of key indices should be ready for June 2003.

3. Stratospheric processes

Gravity Wave processes and their parameterisation

Dr K. Hamilton reported on the SPARC Gravity Wave (GW) initiative. It had two main goals: to produce a global climatology of the GW field in the middle atmosphere using high-resolution radiosonde observations, and to improve the parameterisation of GW processes in climate models.

The meridional and seasonal dependence of the potential energy associated with GW in the lower stratosphere was determined using high-resolution data. Participants from 13 countries are involved. The results will be published in a joint article and the data set will be available through the SPARC Data Centre.

A workshop on Darwin Experiment organised by Dr K. Hamilton was to be held in Honolulu, Hawaii, on 3-5 December 2002. The analysis of DAWEX data will likely span 2002-2003. They expect most papers resulting from DAWEX (including an overview paper) will be submitted by the end of 2003. Then the GW initiative should continue to be involved in planning for a much larger field experiment (ETCE) to study effects of Hector convection in 2005 or later.

Future efforts will focus on reviewing existing data and encouraging appropriate new observational and modelling projects to characterise the spectrum of GW momentum fluxes, including its geographical and seasonal dependence and its short-term intermittence. The aim will be to distil the available observational data and limited-area model results to provide as much guidance as possible for the formulation of source specifications and saturation mechanisms for parameterisation schemes. The GW initiative will concentrate on this aspect for the next 2 years, while leaving the main focus of GW parameterisation to GRIPS.

The SSG confirmed its agreement with Dr K. Hamilton plans and proposals, but suggested a sunset for this activity in 2 years from now. In particular, the session agreed that there was a need to hold a fairly large (about 70 participants) Chapman Conference in 2003, which would initiate a general discussion of GW parameterisation issues.

In relationship with the detection of high resolution GW, Dr F. Vial was invited to present the status of the VORCORE (“vortex core”) Experiment. The experiment will allow the study of the stratospheric Antarctic polar vortex core at the end of winter, when it is well isolated, up to its final breakdown. Together with VOREDGE this experiment represents a part of the STRATEOLE experiment. STRATEOLE goal is a study of the dynamics of the stratospheric Antarctic polar vortex, the transport of minor constituents and its interaction with ozone chemistry in late winter and spring. The main element of the STRATEOLE observing system is a set of small superpressurised balloons (SPB) (few hundred cubic meters) drifting for long duration flights (months) at two different constant density levels (about 50 and 70 hPa). Balloons are equipped with lightweight (10-20 kg) instrumented gondolas.

In the course of VORCORE, 20 SPB will be launched by CNES from McMurdo (166.37°E, 77.51°S) during September - December 2004. The balloons will fly for about two-three months at two different constant density levels of about 50 hPa (13 balloons) and 70 hPa (7 balloons). The data will lead to a better understanding of the vortex core dynamics. It will make it possible to obtain estimates of 2-D turbulence (dispersion rates), evaluate intensity of subsidence inside the vortex core, derive infrared radiation budget and study vertical fluxes of energy, detect sources of Antarctic GW, which was observed in the vortex. It is hoped that the Envisat observations will complement the data set.

The SSG expressed great interest in the prospects of this experiment. A thought was also expressed that a similar (in scope) experiment in the equatorial zone would be very valuable in a 5-year time frame.

Dynamic coupling of the stratosphere and troposphere

Dr M. Baldwin presented recent results on the coupling between the stratosphere and the troposphere. The Northern Annular Mode (NAM) patterns are the leading empirical orthogonal functions (EOF) of low-frequency geopotential height variability. This mode patterns exhibited marked similarity over the whole height range from Earth's surface to more than 50 kilometres. M. Baldwin showed evidence of the apparent downward propagation of anomalies from the stratosphere to the troposphere, implying that knowledge of the state of the Arctic Oscillation AO in the stratosphere could increase predictive skill for the troposphere.

The analysis of the composites of weak and strong vortex regimes revealed that surface pressure anomalies after stratospheric events look like the AO signatures. Examination of AO persistence in winter and summer showed that winter signatures of the AO were more persistent. Similar behaviour was characteristic for NAM in the stratosphere and could be traced in the tropospheric NAM. This apparent influence of the stratosphere on the troposphere could be a factor in increasing the predictive skill of atmospheric GCM. For example, the UK Meteorological Office (UKMO) Unified Model gained additional skill at forecast ranges from 5 to 30 days by taking into account stratospheric layers (Norton, 2002). These results indicated a possibility of using AO indices and indices of annual modes for long-range atmospheric predictions of NAM (10-40 days during wintertime). The lowermost stratosphere happened to be the best predictor of the future (surface) AO. It was also mentioned that observations above 10 hPa would be useful to know the precursor.

The tropospheric Southern Annual Mode (SAM) was found to be most persistent during November-December, when the stratospheric polar vortex broke down, *not* during midwinter.

Numerical studies of trends of AO in the stratosphere in response to greenhouse gas increase remain contradictory. Some models (e.g., Shindell *et al*., 1999) predict that increasing greenhouse gases will result in a stronger, colder stratospheric polar vortex–and a large positive AO trend. Other models (e.g., Gray, Manzini) predict that increased tropospheric wave driving will result in a warmer, weaker vortex–and only a small positive AO trend. These contradictions should be addressed through such SPARC initiatives as GRIPS.

In conclusion, Dr M. Baldwin posed a series of questions which will be the focus of attention at a workshop "The Role of the Stratosphere in Tropospheric Climate", which is being organised in Whistler, British Columbia, Canada, on 29 April to 2 May, 2003. More than 60 scientists and students are expected to participate. Funding was requested from SPARC, NASA, ESA, NSF, NOAA, NASDA, and RPI, to cover travel and meeting costs.

Prof. M. Geller pointed out that the SPARC/WGNE project on stratospheric predictability should have to be extended to include tropospheric predictability. The SSG agreed that the focus on the role of stratosphere in tropospheric deterministic forecast would be the desired focus of the SPARC/WGNE initiative. At the same time, the role of stratosphere in statistical dynamic climate prediction on a variety of time scales was also considered a relevant theme. The group recommended that these thoughts were discussed at the workshop in Whistler and supported the idea of organising such a workshop.

Upper troposphere / Lower Stratosphere Processes (UT/LS)

Prof. T. Shepherd started his presentation of this agenda item by stating that it was the lowermost stratosphere (i.e. heights below 20 km) where the ozone variability occurred. The decreases of ozone content are observed mostly in late spring/summer and accompany the ozone build up in winter/early spring.

Dynamical variability was certainly playing a role in this pattern, which was confirmed by the fact that ozone variations were associated with AO changes and variations in the tropopause height (H_{trop}). He emphasised that the causality of these relationships was unclear, as the H_{trop} may be only a proxy for something else. The anti-correlation of H_{trop} changes and ozone changes up to 20 km is not understood, and furthermore the long-term ozone changes below 20 km is not yet very well known. This indicates a need to focus studies on the mechanisms governing relations between ozone, dynamics and radiation in the lowermost stratosphere.

Participants in the subsequent discussion agreed with Prof. T. Shepherd's thoughts and stressed that to understand processes in the UT/LS an integrated approach was needed because chemical, radiative and dynamical processes there were strongly coupled. Cloud microphysics in the UT/LS also plays an important role.

Chemistry/climate interactions. SPARC-IGAC initiative

Prof. A.R. Ravishankara introduced this agenda item by reviewing most important climate forcing agents: greenhouse gases, ozone, and aerosols. Through the review of existing issues, Prof. A.R. Ravishankara substantiated a need for a joint program between SPARC and the International Global Atmospheric Chemistry (IGAC) Project of the IGBP. This joint activity was felt as a natural progression of previous activities, which were conducted by practically the same pool of scientists based on nearly the same pool of resources.

Previous discussions (including a meeting at ETH, Zurich, hosted by Dr T. Peter in July 2002) indicated the major topics and most significant research interests for this joint activity. They are both described in the report of the Zurich meeting in the SPARC Newsletter N° 19, 2002.

The IGAC community was given an opportunity to look at these issues and topics and decide on their interests at the IGAC symposium in Crete in September 2002, where Profs. A.R. Ravishankara and A. O'Neill were requested to make a presentation (see a report in SPARC Newsletter N° 20, 2003).

To proceed further in the concrete planning, a joint workshop is being organised by Profs. A.R. Ravishankara and A. O'Neill of SPARC and by Prof. Shaw Liu and Dr U. Platt of IGAC. The workshop will take place in Giens, France, on 2-6 April 2003. Dr C. Granier and the SPARC Office will act as the local host. SPARC will co-sponsor the workshop jointly with IGAC.

Prof. Shaw Liu was given the floor. He briefly reviewed the IGAC meeting in Crete on 18-25 September 2002. He reported that the idea of having a joint initiative created enthusiasm and about 100 participants attended the evening SPARC/IGAC meeting. More than 20 proposals were put forward as potential joint research topics.

He also presented the new structure of IGAC (IGAC-II). It will be organised around a set of scientific questions. The limited lifetime tasks will focus on specific scientific question relevant to IGAC and IGBP, will include a timetable of research activities with a completion date, develop a quality assurance and data plans, which will include public access to data, provide a brief annual summary to the IGAG SSC, and have a peer-reviewed manuscript as a final product. IGAC nominated Drs K. Law, D. Parrish and Prof. Shaw Liu as liaison points for SPARC. Much was expected from the joint SPARC/IGAC workshop on chemistry and climate in Giens.

As a result of the subsequent discussions the following issues of potentially highest interest for SPARC were agreed:

- The role of convection (both deep and warm) in controlling UT/LS water vapour abundance and redistribution of chemical constituents (with IGAC).
- Tropical tropopause layer and climate/chemistry interactions.
- A need to achieve greater confidence in projecting future polar ozone.
- The role of UT/LS aerosol and clouds in chemistry, climate, and their interactions (with IGAC).
- A need for relevant laboratory studies (with IGAC).
- Stratosphere/troposphere exchange (with IGAC).

4. Interaction with other programmes and activities

International Global Atmospheric Chemistry (IGAC)

The interactions with IGAC have been described just above. Prof. Shaw Liu, representing IGAC, expressed enthusiasm of the project on climate/chemistry interactions with regard the collaboration with SPARC. Other areas of constant interest for IGAC are air pollution and air quality.

Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)

Prof. M. Geller introduced the item. Besides the joint activity on upper atmospheric trend mentioned above, a need of co-operation with SCOSTEP was again emphasised, particularly with its CAWSES project. SCOSTEP has initiated a project entitled CAWSES (Climate and Weather of the Sun-Earth System), which is expected to run from 2004 to 2008 or so. The project will deal with mechanisms governing solar influences on climate, foster a scientific approach to understanding the short term ("Space Weather") and long term ("Space Climate") variability of the integrated solar-terrestrial environment. Specifically attention will be paid to mechanisms, through which the solar variability influences the atmosphere.

CAWSES is expected to provide a forum to bring together the international solar-terrestrial science community to help define future programs. It will contribute solar-terrestrial information to the Global Change community. It also plans to review the quality of solar-terrestrial databases and derived information and improve metadata for solar-terrestrial products so that they meet scientific community needs.

The presentation of CAWSES created interest among the SSG session participants. It was felt that co-operation between SPARC and CAWSES would be very desirable. SPARC should inform CAWSES and SCOSTEP about what it is doing. It was also felt that there was no shortage of links between SCOSTEP and SPARC because one of the present co-chairs of the SPARC SSG, M. Geller, was at the same time the President of SCOSTEP.

WMO Global Atmospheric Watch (GAW)

Dr M. Proffitt of the WMO presented the current state of the related activities of the WMO/GAW. The system is based on a number of so-called "Dobson Centres" ensuring continuing maintenance and calibration of ozone measurement instruments (calibration has to be performed every 3-4 years). Such centres existed in Europe (Germany, Czech Republic), South America (Argentina), Africa (South Africa), Asia (Japan), South-West Pacific (Australia). The World Calibration Centre is located in the USA. The World Training Centre is located in Czech Republic. The GAW ozone network was based on 119 Dobson stations. The GAW also maintained a list of regularly reporting ozonesonde stations. More than 50 stations are operational. Important information was being gathered from several satellites systems, one of the most valuable sources being Total Ozone Mass Spectrometer. The system operationally monitors the global ozone. The WMO uses every opportunity to expand the system and maintain its performance (see for more information SPARC Newsletter N° 18, p 24-27).

Network for the Detection of Stratospheric Change (NDSC)

Dr M. Kurylo provided the update of the NDSC, which had been in operation for more than 10 years. A symposium was held in Arcachon, France in September of 2001 to mark this anniversary (see report in SPARC Newsletter N° 19, p 30). The NDSC working groups are involved in the following activities: lidar measurements, microwave techniques, sounding, Dobson/Brewer instruments, theory and analysis, UV and visible remote sensing techniques, spectral UV techniques and Fourier Transform IR spectrometry. New developments were related to the inclusion of water vapour and air temperature in data sets. The network considers SPARC as a major customer.

COSPAR (Committee on Space Research)

Dr J. Gille submitted a report on the SPARC Session of the 34th COSPAR Scientific Assembly (the 2nd World Space Congress) to the SSG session. The Symposium "Climate change processes in the stratosphere and at the tropopause" was sponsored by SPARC and NASA. The meeting was very successful and well attended. Initial results from the Envisat sensors, from SAGE III and a preview of AURA sensors were presented. A review was conducted of long-term changes in the stratosphere. Vertical transports of atmospheric constituents and trace gas transports at the tropopause were discussed as well.

European Commission

Dr G. Amanatidis presented to the session an impressive review of corresponding research supported by the European Commission, particularly under the 6th Framework Programme (FP6), which was expected to cover 2002-2006. The research funding was subdivided into three "pillars" covering sustainable energy systems, sustainable surface transport, and global change and ecosystems. A call for applications for the Integrated Projects or Network of Excellence was expected on 17 December 2002, with closure data of 8 April 2003. Information on FP6 is located at: http://europa.eu.int/comm/research/nfp.html. The EU research web site can be found at: http://www.cordis.lu/en/home.html. Current European stratospheric research related to SPARC is extensive. The funding going into the stratosphere is significant with 31 projects in the 5th Framework Programme, 23 of them being directly linked to stratospheric issues. They were closely associated with major national programmes and related satellite observations. Five research clusters are covering UV radiation, aviation impact in the UT/LS, global atmospheric measurements, ozone/climate interactions, stratospheric ozone loss. A sound basis for planning is created by past assessments of European Research in the stratosphere (1997, 2001), major field experiments such as (EASOE, SESAME, THESEO) and regular European Symposia on stratospheric ozone.

In conclusion, Dr G. Amanatidis presented a programme "Validation of International Satellites and study of Ozone Loss" (VINTERSOL), which is described in more detail in this issue. A major report on Ozone-Climate interaction is being prepared in Europe under the editorship of I. Isaksen. Several meetings are expected in 2003.

The presentation of Dr G. Amanatidis created considerable interest. A need of commitments for long-term observations was expressed in the subsequent discussion.

IGOS (Integrated Global Observing Strategy) / IGACO (Integrated Global Atmospheric Chemistry Observations)

Prof. M.-L. Chanin informed the meeting of the situation with the IGACO Project, a new component of IGOS. This theme builds on the CEOS ozone Project which delivered a WMO/CEOS report on the strategy for integrating satellite and ground-based observations for ozone (see report in SPARC Newsletter N° 16, p 22-25), but extends its scope to atmospheric composition measurements of all climate relevant species. The project is in its phase of definition and Prof. M.-L. Chanin who was member of the IGACO team and attended the first two meetings asked to be replaced. It was decided that Drs T. Peter and C. Granier will represent SPARC in this project starting in 2003.

Other Projects of WCRP

Discussion of this agenda item re-confirmed that SPARC needed extended co-operation with projects and programmes outside WCRP. Closer ties are needed with CLIVAR on the issues of predictability, GEWEX on studies of water vapour, hydrological cycle, and radiation, and ACSYS and CliC on utilisation of results of reanalysis in polar regions. It was recommended that SPARC findings should be presented to the WCRP WGSIP (Working Group on Seasonal and Interannual Prediction). Interaction with WGNE on data assimilation was considered essential.

European Space Agency (ESA)

Dr E.-A. Herland gave a detailed overview of the ESA Earth observation programmes. He started the review with the Living Planet Programme Earth Explorer core missions (GOCE; Gravity field and steady-state ocean circulation and ADM-Aeolus: Atmospheric Dynamics) and opportunity missions (Cryosat and SMOS: Soil Moisture and Ocean Salinity); and then presented operational and planned missions of the Earth Watch Programme (GMES: Global Monitoring for Environment and Security, first and second generations of Meteosat, MetOp: polar orbiting operational meteorological satellite, ERS 1 and 2: Earth Remote Sensing satellites of 1991 and 1995, and Envisat). Some of the missions were operated or developed jointly with other agencies, e.g. NASDA. Envisat successful operation is of major relevance to SPARC (see first Envisat results by T. Wehr *et al*., in SPARC Newsletter N° 19).

With current ESA plans SPARC can count on having in the future cloud, aerosol and radiation measurements leading to heat flux estimates at the top of atmosphere with an accuracy of the order of 10 W/m^2. ESA considers WCRP one of the major customers also affecting future operational requirements. Recognising the role of the WCRP and SPARC in particular, ESA was trying to provide funding for a post-doctoral position in the SPARC office.

The review created deep interest among the participants. The offer of a postdoctoral fellowship was accepted by the SPARC SSG with great enthusiasm.

National Aeronautics and Space Administration (NASA)

Dr Ph. Decola presented relevant activities of NASA. His presentation started with a brief review of the Stratospheric Aerosol and Gas Experiment (SAGE III) onboard Meteor-3M satellite. The launch of Aura is expected at the beginning of 2004. The mission will measure ozone, aerosols, and several key atmospheric constituents. The objective is a study of the chemistry and dynamics of UT/LS in the height range of 0-30 km. CloudSAT will carry radar to provide data on clouds. The launch is expected at the end of April 2004. Other missions and activities of interest for SPARC included: ozone mapping and profiler suite (OMPS), Integrated Atmospheric Chemistry Mission (2003-2010), tropical Composition and Climate Coupling Mission, CALIPSO (aerosol and cloud properties), and several others.

National Space Development Agency of Japan (NASDA)

This item was presented by Dr M. Suzuki. The Earth Observation Research Centre (EORC) of NASDA was preparing for launch of the Advanced Earth Observing Satellite (ADEOS –II). Among other sensors it carries ILAS (Improved Atmospheric Limb Spectrometer), which monitors high altitude atmospheric ozone and several species related to ozone depletion.

Other sensors/missions of interest included GCOM-A1/ODUS (Ozone Dynamics Ultraviolet Spectrometer), Jem/SMILES (Superconducting Submillimetre-wave Limb-Emission Sounder). These missions are expected to take place in 2007-2008. The EORC also was conducting a Global Atmospheric Chemistry Experiment.

A reorganisation of several agencies involved in space research in Japan was expected.

Other areas of collaboration

Dr V. Yushkov presented plans of an UT/LS water vapour validation project initiated by the Central Aerological Observatory (CAO) of Russia. The description of the proposed campaigns is given in SPARC Newsletter N 20, 2003.

Co-ordination of international stratospheric field campaigns

Determining the wind fields in the equatorial stratosphere on a global basis is a challenging problem due to the scarcity of *in situ* observations and the limited value of satellite-derived temperature in constraining the wind field at low latitudes. Current stratospheric meteorological analyses display much more significant deficiencies in the equatorial region than elsewhere on the globe. Recent developments in the technology of long-lived constant level balloons and new satellite instruments to be deployed in the next few years will allow for more complete observations of the stratospheric wind field. By the end of this decade there will be a need for extensive validation field campaigns with a focus on low-latitude stratospheric wind. The SPARC SSG sees a need for international co-ordination of such campaigns that should include conventional radiosonde observations and remote sensing observations, and also co-ordination of field campaigns with on-going data assimilation efforts. It is the intention of the SPARC SSG to initiate planning for international co-ordination of such campaigns.

5. Future SPARC activities and directions

Prof. A. O'Neill led this discussion. He felt that, first of all, SPARC must be outward looking. The group agreed that a new structure for SPARC was indeed required and that the three first "pillars", i.e. stratospheric indicators, processes, modelling should be modified to represent better the new goals.

After a long and active discussion, the session established three basic research themes, which contained fundamental questions each of them being of interest to the "outside" world. The themes and questions are as follows:

1. 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?

2. Stratosphere-troposphere coupling

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

3. Detection and attribution of past stratospheric changes

- What are the past changes and variations in the stratosphere?
- How well we can explain past changes in terms of natural and anthropogenic effects?

A need for an update of the SPARC brochure and of the SPARC Web site in the light of these discussions will be needed in a near future

6. The SPARC Office

The SPARC office continued its regular activities in 2002 (compiling and editing SPARC Newsletters, updating the SPARC mailing list, maintaining contacts with the SPARC community of scientists, organising various SPARC meetings, maintaining the SPARC website, preparation of SPARC reports for publication).

The session applauded the director and the office staff, Ms C. Michaut and Dr Y. Koshelkov for their excellent intersessional support. Continuation of the office operation in France after the retirement of the director, Prof. M.-L. Chanin, depended on the availability of funding, which has been provided by CNES and CNRS. Developments on this issue should be monitored closely.

7. The SPARC Data Centre

Prof. M. Geller presented the work of the centre. After the tragic death of its chief scientist, Dr P. Udelhofen on 17 May 2002 who had been in charge of the centre operations for about 3 years, Dr X. Zhou continued support to the centre since August 2002. NASA supports the SPARC Data Centre. New updates of the centre holdings included quantum yields and some USA high-resolution radiosounding data (http://www.sparc.sunysb.edu). The centre administrator was compiling a new user list and an update of the operating system of the centre computer was taking place. A link to the WCRP Initiative on Data (WIND) was mentioned as a possible new development for the centre.

8. Next SSG Meeting

Dr U. Schmidt who was unfortunately unable to attend the 10th SSG session in Kyoto kindly extended an invitation for the next session. This invitation was accepted with appreciation. The 11th session of the SPARC SSG will take place in Frankfurt on 22-25 September 2003.

9. SPARC General Assembly in 2004

Dr N. McFarlane described facilities available for the SPARC General Assembly to be held in Victoria (BC), Canada, in 2004. His talk included estimates of financial resources needed to hold the session as well as expected contributions by sponsors. Due to a date conflict with the next COSPAR Assembly (18-25 July, Paris, France), Dr N. McFarlane was asked to negotiate alternative dates for the Assembly. It was then planned to hold the assembly on 1-6 August 2004 with subsequent SSG meeting on 8-11 August 2004. The programme committee will be run by Profs. T. Shepherd and A.R. Ravishankara.

10. SPARC SSG composition

Having concluded the presentations, the SSG members discussed the future composition of the group. Since the term of service for Prof. M. Geller expired, he stepped down from the group and from the position of the SSG co-chair. The group unanimously elected Prof. A.R. Ravishankara as a co-chair. The group deeply thanked Prof. M. Geller for his long, devoted and very productive service for SPARC in various capacities including the one of SSG co-chair. Prof. D. Karoly, another member of the SSG is stepping down. He was warmly thanked for his contribution during his mandate. Proposals of 2 new members will be submitted at the next JSC.

11. Related Japanese Research Programmes

On the last day of the SSG session, several leading Japanese scientists gave a review of national research activities in areas close to SPARC. Prof. S. Yoden opened the series of talks and introduced the audience into the organisation of stratospheric research in Japan. A special issue of the Journal of the Meteorological Society of Japan (Vol. 80, N° 4B, September 2002) was devoted to most recent findings in the areas of stratosphere/troposphere coupling.

Dr S. Fukao reported on an Equatorial Atmosphere Radar, which was installed in West Sumatra of the Republic of Indonesia in March 2001. The data cover the height range of 2-20 km and include wind speeds. The results are instrumental for studying coupling processes in the equatorial atmosphere and provide continuous record of the tropopause record.

Dr T. Tsuda demonstrated the concept of observing the humidity in the lower troposphere, temperature in the stratosphere, electron density in the ionosphere using the occulted GPS radio signals. The system is intended for the Equatorial Atmosphere Research Satellite, which is planned for launch by Brazil, Canada, Japan and USA in 2006. The technique produce high resolution data at low latitudes, which are useful for studying dynamical coupling processes in the equatorial region.

The talk by Dr J. Inatani was on superconducting submillimetre-wave limb emission sounder (ISS-JEM-SMILES). It is based on a research project “Space Superconductivity” conducted by NASDA in 1998-1995. The system permits monitoring of the following species: ozone, ozone-isotopes, HCl, ClO, HO_2, H_2O_2, HOCl, BrO, HNO_3, CH_3CN, SO_2. The latitude coverage is approximately 38°S–65°N. Daily mapping is possible. The results are characterised by high sensitivity to thermal emissions of atmospheric constituents. The system is capable of measuring key species responsible for atmospheric ozone depletion. An early experiment was required to test the technique.

Two presentations by Dr H. Akimoto and Prof. T. Matsuno of the Frontier Research System for Global Change were devoted to an impressive global change modelling facility, which was created around the Earth Simulator, the most powerful scientific computer in the world. The architecture of the Earth Simulator was described. Unprecedented performance of the supercomputer enabled scientists at the Earth Simulator Centre to run a GCM with the highest resolution. Several areas of the modelling system development were presented. Some of the results (in English) can be accessed at: http://www.es.jamstec.go.jp/esc/eng/index.html.

The status and results of SOWER (Soundings of Ozone and Water in the Equatorial/Pacific Mission) were given by Dr M. Shiotani.

Dr K. Sato concluded the presentation session with a talk on the Program of the Antarctic Syowa Mesosphere – Stratosphere – Troposphere / Incoherent Scatter Radar (PANSY). Such a VHF monostatic Doppler radar would contribute to studies of relevance to SPARC science.

The SPARC SSG strongly supported the idea of the establishment of such a radar at the Japanese Antarctic Station, Syowa, and welcomed the provision of data from the radar to the international scientific community.

APPENDIX

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