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**STRATOSPHERIC PROCESSES AND THEIR
ROLE IN CLIMATE (SPARC)**

ANNUAL PROGRESS REPORT

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END USERS OF ACTIVITY / EXPECTED PROJECT OUTCOMES

The central goal of the SPARC project is to address key issues related to the stratosphere and its role in climate, from both scientific and policy information perspectives. As the science and science-policy needs have evolved during its lifetime, SPARC has refocused its activities to provide the most useful research and information. The current SPARC programme focuses on finding answers to fundamental questions in three key themes of modern climate science:

(1) Climate-Chemistry Interactions

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

(2) Detection, Attribution, and Prediction of Stratospheric Change

- What are the past changes and variations in the stratosphere?
- How well can we explain past changes in terms of natural and anthropogenic effects?
- How do we expect the stratosphere to evolve in the future, and what confidence do we have in those predictions?

(3) Stratosphere-Troposphere Dynamical Coupling

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

Research on these main themes is complemented by a number of cross-cutting activities with specific foci. Current prominent SPARC activities include the Chemistry-Climate Model Validation project (CCMVal), the Data Assimilation Working Group (SPARC-DAWG), the activity on Solar Influence (SOLARIS), and the recently initiated Dynamical Variability (DynVar) activity.

MAJOR ACTIVITIES AND ACHIEVEMENTS IN 2007

Contributions to International Assessments. Through its ongoing scientific activities, specialized reports and newsletter articles, SPARC has had a significant impact on IPCC and WMO/UNEP assessments. SPARC played a central role in the preparation of the 2006 WMO/UNEP Scientific Assessment of Ozone Depletion. In particular the CCMVal project, a major activity within SPARC, organized the key element of the assessment process, the Chemistry Climate Model simulations. These simulations were of critical importance in assessing the evolution of ozone, temperature, and trace species in the stratosphere in the recent past, as well as in making projections of ozone recovery in the 21st century. Key science results from this CCMVal modelling activity have been published in the peer reviewed literature in the past year. (More information and a list of recent publications are available from the CCMVal web site:

http://www.pa.op.dlr.de/CCMVal/List_CCMValCollaborators.html.)

Ozone Recovery and its Relationship to Climate Change. It is now clear that ozone recovery and climate change are so closely linked that future efforts to improve predictions of long term variability and change, for both stratosphere and troposphere, will require taking the role of stratospheric ozone fully into account. After the key contribution to the

2006 WMO/UNEP Scientific Assessment of Ozone Depletion, SPARC is now engaged in new activities that will ensure an even stronger contribution to future assessments. These activities were fleshed out at a CCMVal Workshop in Leeds, UK, in June 2007. Work on a SPARC CCMVal Report, which will be used as a key source of input for both the 2010 Ozone Assessment and the next IPCC assessments, is fully under way, with lead and contributing authors having been appointed and new CCM simulations being carried out. SPARC is collaborating with the Working Group on Coupled Modelling (WGCM) in planning and executing modelling activities for future climate change assessments (AR5 and beyond).

Stratosphere-troposphere Dynamical Coupling and its Role in Dynamical Variability and Predictability from Days to Decades. SPARC has contributed to the WCRP activities on prediction in a number of important ways. SPARC was well represented at the WCRP Workshop on Seasonal Prediction that was held in Barcelona in June 2007. In addition to a keynote talk by Mark Baldwin (SPARC representative on the TFSP) there was a SPARC session entitled Stratospheric Processes and Seasonal Prediction. In order to develop linkages with CLIVAR on decadal predictability, Noel Keenlyside from IFM-Kiel was invited to make a presentation on the topic to the 2007 SPARC SSG in Bremen, Germany. The SPARC sponsored Chapman Conference in Santorini (September 24-28, 2007) was well attended and covered a broad range of topics on stratospheric processes and modelling, includes seasonal prediction and climate change. The conference was the subject of a News & Views article in the first issue of Nature GeoScience (January 2008).

As global climate models, which typically represent the stratosphere poorly, become increasingly comprehensive, important questions arise: How does a poor representation of the stratosphere degrade the simulation of tropospheric circulation in climate models? Furthermore, how does stratospheric representation affect the simulated circulation response to climate change? To address these questions SPARC initiated the Dynamical Variability project (DynVar). This activity was proposed at the 2006 SSG meeting and subsequently endorsed by the JSC at its March 2007 meeting. In the intervening time substantial progress has been made in developing DynVar, following the plan published in SPARC Newsletter No. 29. A web site for the Activity has been set up at <http://www.sparcdynvar.org/>. Preliminary analyses are being carried out to refine the science goals. The first DynVar workshop will be held in Toronto in March 2008.

The SPARC Tropopause Initiative. A number of SPARC workshops dealing with tropopause related topics have been held since 1993 and reported on in SPARC newsletters. The areas of research dealt with in these workshops can be broadly subdivided into topics relating to the tropics (TTL), extratropics (ExTL), tropical-extratropical interaction, and climate change. In regard to the tropics the research situation and state of activities is relatively healthy. A TTL paradigm has emerged and evolved over the last 10 years and remains an active research area. In regard to the extratropics there have been activities stimulated by previous and new observations and measurement campaigns, but there has not yet been a significant convergence of ideas. At the 2006 SPARC SSG meeting a small task group was asked to examine the status of tropopause research and report back on the merits of an organized activity on this topic. A summary article which included a proposal for such an activity was published in SPARC Newsletter No. 29. A web site (<http://www.acd.ucar.edu/sparctrop>) has been set up as a communication medium with links to the SPARC Office, data, papers, and other activities (e.g. CCMVal). Relevant activities include the UTLS session at the Fall 2007 AGU meeting, and TTL and Extratropical UTLS sessions at the Spring 2008 EGU meeting.

Tropical Tropopause Layer – SPARC/IGAC/GEWEX Links. The collaborative activity between SPARC, GEWEX, and IGAC on the role of deep convection in the tropical tropopause layer (TTL) began with the TTL workshop in Victoria, Canada in 2006. A number of the issues raised at this workshop have been addressed in subsequent meetings and activities. The supersaturation question was a major topic in the RHI workshop in Karlsruhe

in June 2007 and subsequently at the AIDA hygrometer intercomparison campaign AquaVIT in October 2007, the results of which will be assessed in a follow-on workshop in Zurich in May 2008. A TTL case study is being developed to evaluate the role of different microphysical processes in cloud resolving models in the water vapour budget of the TTL and water vapour transport across the cold point. A case study based on the TWP-ICE Campaign is being designed as a new GEWEX/GCSS multi-model comparison project, to allow it to address the role of over-shooting convection on the structure of the TTL. The ability of GCMs to simulate key large-scale features of the TTL continues to be an important study area in SPARC with some recently published work on this topic being reported upon at the SPARC SSG meeting in September 2007.

Atmospheric Chemistry and Climate (AC&C) Initiative. The AC&C Initiative is a major joint effort of WCRP and IGBP, with the SPARC and IGAC projects leading it. A plan and time line for this activity was set out at the twenty-seventh session of the JSC in Pune in 2006. A report published in SPARC Newsletter No. 29 summarizes the background and motivation for AC&C and provides details of its structure and activities. The first phase of this activity involves a modelling effort, which is building upon the SPARC CCMVal activity, so as to move toward a broader based activity that utilizes modelling and observational activities in a synergistic way to define gaps in understanding, quantifying, and modelling chemistry-climate interactions. The AC&C initiative is progressing well and is discussed in greater detail in the companion report on this activity for the current session of the JSC.

The SPARC-IPY Science Program. SPARC initiated the IPY activity entitled “The Structure and Evolution of the Polar Stratosphere and Mesosphere and Links to the Troposphere during IPY” (<http://www.ipy.org/development/eoi/proposal-details.php?id=217>). The central goal of the SPARC-IPY activity is to produce a comprehensive picture of the dynamics, chemistry and microphysical processes within the polar vortices during the IPY, supported by a well organized data set of measurements and analyses of the polar stratosphere. The activity is being coordinated through the SPARC IPO and carried out with the oversight of the SPARC SSG. National funding for several of the specific sub-projects within this activity has been awarded and work on the data acquisition and assimilation components has begun within the SPARC-DAWG. SPARC-IPY adds value to and has common interests with a number of other IPY activities including POLARCAT, ORACLE-O3, PANSY, and IASOA. During the last year funding was acquired to hire a coordination scientist for the SPARC-IPY Activity. Dr. Elham Farahani was hired in June, 2007 to fill this role.

SPARC Co-Sponsored Workshops. Several well attended workshops were sponsored or co-sponsored by WCRP/SPARC in 2006: (i) The third biennial CCMVal workshop (Leeds, UK), (ii) The combined SPARC Data Assimilation and IPY workshops (Toronto, Canada), (iii) The workshop on Upper Tropospheric Humidity (RHI) (Karlsruhe, Germany), (iv) The Chapman Conference on the Role of the Stratosphere in Climate and Climate Change (Santorini, Greece), (v) The 4th International Atmospheric Limb Workshop (Virginia Beach, USA), (vi) The SPARC/SCOUT-O3/NDACC/CNRS Reunion Island International Symposium (RIIS) on the Tropical Stratosphere – Upper Troposphere (Saint-Gilles les Bains, Reunion Island).

SPARC SSG Meeting. The 15th Session of the SPARC Scientific Steering Group was held in Bremen, Germany (September 18-21). This year’s SSG meeting marked a year of significant developments within SPARC, with the appointment of new Co-Chairs, four new SSG members, and with new and rejuvenated activities getting under way. A full report on this meeting is included in SPARC Newsletter No. 30.

GOALS AND PLANS FOR MAJOR ACTIVITIES IN 2008 AND INTO 2009

The Fourth SPARC General Assembly (GA). The SPARC GAs are held on a four-year basis. They have become major international science conferences and have played a key role in assessing the state and development of SPARC science as well as in pointing to

fruitful new directions for the SPARC programme. The Fourth GA will be held in Bologna, Italy, from 31 August – 5 September 2008. Dr. Elisa Manzini, a member of the SPARC SSG, is chair of the Local Organizing Committee. The scientific programme committee, jointly chaired by Drs. Peter Haynes and Tom Peter, is coordinating planning of the programme with the corresponding committee for the IGAC conference which will be held in the following week in Annecy-le-Vieux, France. Agreement has also been reached on coordination of registration fees for these two conferences to encourage cross-participation. The SPARC GA web site is now in operation (<http://www.cmcc.it:8080/web/public/sparc-ga2008>).

Existing SPARC Activities. The SPARC activities described for 2007 are all ongoing and their future plans and directions are indicated above, so they will not be repeated here. We thus list only the one new activity:

Gravity-Wave Initiative. Although activity within the SPARC gravity-wave initiative had waned in recent years, the role of gravity waves in the dynamics of the atmospheric general circulation and improving gravity-wave drag parameterizations continue to be critical modelling issues. At the 2007 SPARC SSG meeting it was agreed that a rejuvenated SPARC gravity-wave initiative will be synergistic with the DynVar activity and that the two efforts should evolve in a closely collaborative way. The proposed first step of holding a gravity-wave workshop jointly with the DynVar workshop in March 2008 was endorsed by the SSG. The rejuvenated SPARC gravity-wave initiative will be led by Dr. Joan Alexander.

INTERACTIONS (ESPECIALLY WITH WCRP'S SPONSORS & PARTNERS)

SPARC relies on nationally funded research activities to produce the science outcomes of its programme. SPARC delivers its programme by engendering cohesion and collaboration between these nationally funded research programmes. The synergy which SPARC is able to achieve in this critical role stimulates and provides an international context for national programmes on the role of the stratosphere in the climate system.

CHALLENGES AND CONSTRAINTS

Notwithstanding the limitations of reduced financial support from the WCRP and the added responsibility of managing the AC&C cross-cutting activity, both SPARC and AC&C were able to maintain high levels of achievement in the past year. When possible the SPARC IPO has provided small amounts of supplementary support for workshop costs and this was done for some of the SPARC meetings that were held in the past year. However the SPARC IPO has limited resources for this purpose. The SPARC General Assembly, as a major international conference for stratospheric science and a key SPARC conference, is expected to attract a large number of young scientists and participants from developing countries if support can be provided to enable their attendance. However the resources available for this purpose from the WCRP are expected to be substantially less than they were for the last SPARC General Assembly in 2004. The SPARC IPO is currently working with scientists in the SPARC community to secure support from national funding sources to provide financial assistance for participation of young scientists in the General Assembly.

PUBLICATIONS AND OTHER PRODUCTS

Newsletters. The SPARC newsletters are published twice per year, the most recent (No.30) having been published in January 2008. All newsletters are available on line from the SPARC web site (<http://www.atmosp.physics.utoronto.ca/SPARC/>). The SPARC Newsletter continues to be widely read and cited (192 times in the Web of Science) because of its brief thought-provoking scientific contributions, topical mini-reviews and rapporteur summaries of science meetings.

SPARC Reports. SPARC issues comprehensive scientific reports on key aspects of the stratosphere and its role in the climate system. These reports are issued on a timely basis and address essential scientific gaps in the knowledge of the stratosphere and its representation in models. Without the corporate work of SPARC their completion would be

impossible. SPARC Assessment Reports are peer-reviewed and are fully acknowledged by and have served as bases for the international WMO/UNEP and IPCC Reports. They have been cited a total of 54 times in the Web of Science. A comprehensive report on the achievements and findings of the SPARC Chemistry-Climate Modelling Activity (CCMVal) is now in preparation with a planned publication date in 2009. Earlier reports are available from the SPARC Office or may be downloaded from the SPARC web site.

Other Products. In addition to SPARC publications, a number of output products from SPARC activities are publicly accessible. A variety of data sets are stored at the SPARC Data Center and may be accessed through its web site (<http://www.sparc.sunysb.edu/>). Much of this data has been assembled in support of SPARC activities but remains accessible and continues to be widely used, an example being the high resolution radiosonde data that is a unique and valuable data set. Output from the aforementioned chemistry-climate model simulations carried out within the CCMVal project is accessible to scientists wishing to become CCMVal collaborators, through the CCMVal web site. A total of 30 analysis projects using these data have so far been defined. Also, within the SPARC IPY activity the SPARC-DAWG is assembling various stratospheric chemical and dynamical analyses from both operational and research data assimilation systems during the IPY period, which are publicly available (via registration) through the SPARC Data Center.

OUTREACH AND CAPACITY BUILDING ACTIVITIES

The current mailing list for the SPARC Newsletter, which is mailed out in hard copy, comprises 2613 addresses of which more than 600 are in developing countries. The nature of the articles published in the SPARC Newsletter ensures that the publication is a key means for scientists to keep abreast of the latest scientific trends and developments, and learn about new data sets, even if they are unable to physically attend the meetings. Although the printing and mailing of a hard-copy edition is a very significant expense for the SPARC IPO budget, feedback from the community is resounding that this is a valued format. As in previous years, a number of SPARC workshop participants in the past year were young scientists and several came from developing countries. Financial support from the WCRP or the SPARC IPO for travel costs was usually essential for allowing this to happen. This was especially the case for the RIIS symposium, which by its nature and location was a major draw for scientists from developing countries in the tropics/subtropics.

IPO, PROGRAM ADMINISTRATION AND MANAGEMENT

The operation of the SPARC IPO is supported jointly by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), the Canadian Space Agency, Environment Canada, and the University of Toronto. In late 2006 additional funding was secured from CFCAS to support the continued operation of the SPARC IPO in its current location in the Department of Physics, University of Toronto, through 2010.

ADDITIONAL COMMENTS FOR THE JSC

The future of SPARC as for the other core projects is an issue that must be addressed in the relatively near future. The mandate of CFCAS, currently the major sponsor of the SPARC IPO, ends in December 2010. In the absence of a renewal of the CFCAS mandate and an associated renewed commitment to support the SPARC IPO, it will have to cease operations in its current location in early 2011. This situation is a factor that may affect the future of the SPARC project as a whole.

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