Annual Report

SPARC 2012

SPARC

Stratospheric Processes And their Role in Climate

ANNUAL REPORT - For the year ending 31 December 2012

Table of Contents

Annual Report
SPARC 2012

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Overview from the Co-Chairs

This has been a busy and productive year for SPARC. Two Scientific Steering Group (SSG) meetings were held, the first in Zürich in early February and the second in Buenos Aires in late November. The SSG meeting in Zürich provided an opportunity to celebrate the 20th anniversary of SPARC for which a small booklet of recollections from past and present co-chairs was created to celebrate the occasion. This was also the first year that the new SPARC Project Office was fully up and running in Zürich, after the transition year of 2011. SPARC has also continued to evolve in terms of the science that it supports, with three new, emerging activities maturing through the course of the year. These are the SSiRC (Stratospheric Sulfur and its Role in Climate), SNAP (Stratospheric Network for the Assessment of Predictability), and S-RIP (SPARC Reanalysis/analysis Intercomparison Project) activities, discussed in greater detail below.

SPARC co-chairs 2012, Greg Bodeker (left) and Ted Shepherd (middle), and new co-chair as of January 2013, Joan Alexander (right).

SPARC has also been responsive to the needs of its parent organisation, the World Climate Research Programme (WCRP; sponsored by WMO, UNESCO's IOC and ICSU), by actively participating in the development of the WCRP Grand Challenges, taking the lead on the new WCRP Polar Climate Predictability Initiative and deciding on a new name in response to our updated mandate (see below for further details). SPARC has also maintained strong connections with the other core WCRP projects as well as with other organisations coordinating international global change research. This document describes another successful year in the life of SPARC, demonstrates the value that SPARC brings to the international climate research community, and outlines SPARC's plans for the future. This year also marks the end of an era for SPARC with Ted Shepherd rotating off as SPARC co-chair as well as the SSG. On 1 January 2013 Joan Alexander joined Greg Bodeker as SPARC co-chair.

This very first annual report provides an opportunity to demonstrate what SPARC has carried out over the past year and presents an outlook for SPARC's active and productive future.

A rose by any other name, would still smell as sweet

During the course of the year SPARC finalised its name change. After many discussions, deliberations and heated blog postings, SPARC's new name will be 'Stratosphere-troposphere Processes And their Role in Climate'. A new SPARC logo will be designed over the coming year to reinforce that SPARC's research interests now extend to those aspects of tropospheric climate that have a link to the stratosphere. The new name and logo will be rolled out at the SPARC General Assembly in January 2014.

A word from the Project Office

2012 was a busy and productive year at the Zürich Project Office, based at ETH Zürich. The year started off with a bang, with the hosting and organisation of the 19th SSG meeting and 20th anniversary celebrations in February (see SPARC Newsletter No. 39[1]). Thereafter, the Project Office was involved with the organisation of several workshops and meetings, including two held in Switzerland: the 'IGAC/SPARC Global Chemistry-Climate Modelling and Evaluation Workshop', held in Davos, and the 'SPARC Workshop on Brewer-Dobson Circulation', held in Grindelwald. Finally, a second SSG meeting was also organised in Buenos Aires, Argentina, at the end of November. In addition, the Project Office was involved with the planning, editing and printing of the two 2012 Newsletters (allowing for full colour on all pages); introduced the new SPARC eNews information concept; commenced the development of a new members database; and contributed scientifically to several SPARC activities.

The Zürich SPARC Project Office. From left to right: Carolin Arndt (Communications Manager), Anke Witten (Office Manager), Johannes Staehelin (Director) and Fiona Tummon (Project Scientist). Not in photo: Diane Pendlebury (based in Toronto, Canada).

The SPARC Project Office currently has five staff members, all of whom work part-time for SPARC: Johannes Staehelin, the SPARC Office Director, is supported by Anke Witten, Carolin Arndt, Fiona Tummon and Diane Pendlebury. Amongst his numerous tasks, Johannes also participates in the WCRP Joint Scientific Committee meetings together with the SPARC co-chairs, as well as several other scientific meetings relevant to SPARC. The SPARC Office also works closely with the WCRP liaison, Vladimir Ryabinin.

Anke Witten, the office manager, is responsible for organising SPARC meetings and workshops (including SSG and other SPARC meetings supported by the Zürich SPARC Project Office) and the SPARC/WCRP travel budget (together with Isabel Hall of the WCRP Joint Planning Staff in Geneva). She also takes care of all SPARC Office emails and the internal SPARC budget, as well as supporting the work of the other SPARC Office members. Anke was the main organiser of the Zürich SSG meeting, and she assisted with the organisation of the November SSG meeting in Buenos Aires as well. Over the past year Anke has worked extensively with a small IT-company to produce a

[1] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/39_SPARCnewsletter_Jul2012_web.pdf

comprehensive SPARC address database, containing names, functions (SSG members, activity leaders, etc.), and email and postal addresses of the 3'000-people strong community interested in SPARC.

Carolin Arndt, the SPARC communication manager, is responsible for the SPARC website (http://www.sparc-climate.org/), taking care of the news portal and all content updates. She also created the contemporary look-and-feel of the SPARC visual identity of all outreach materials, including the biannual newsletter. Carolin introduced the new SPARC information concept, meaning that we only use emails for high priority information that is of interest to the entire SPARC community, whereas all other information is made available via our website. Every two months Carolin produces a short summary of the new information available on the website, which is sent by email to the SPARC community (the SPARC eNews). Carolin has also been strongly involved in developing SPARC's capacity development concept.

Fiona Tummon and Diane Pendlebury are the SPARC Project Scientists. Fiona is funded by the Swiss National Science foundation, and works at the Zürich Project Office. She works 50% for the SPARC Office, editing newsletters and reports, and helping with other SPARC Office tasks, and 50% on scientific research related to SPARC activities, including CCMI, the Lifetime of Halogen Source Gases and Ozone Profile activities. Diane works out of Toronto and is supported by the Canadian Space Agency. She is currently engaged in the WCRP Polar Predictability Initiative and also works on editing SPARC newsletter and reports.

After one year's experience, we have found that the available manpower resources are sufficient to fulfil the core tasks of the SPARC Office. This also implies, however, that only limited resources are available for additional tasks.

Workshops & Meetings held in 2012

6 – 10 February
SPARC 19th SSG Meeting (by invitation)
Zürich, Switzerland

22 – 24 February
SPARC Workshop on Stratospheric Sudden Warming and its Role in Weather and Climate Variations
Kyoto, Japan

2 – 4 April
WCRP/IASC Polar Climate Predictability Workshop
Toronto, Canada

21 – 24 May
IGAC/SPARC Global Chemistry-Climate Modelling and Evaluation Workshop
Davos, Switzerland

11 – 13 June
9th SPARC Data Assimilation Workshop
Socorro, New Mexico, USA

25 – 29 June
SPARC Workshop on Brewer-Dobson Circulation
Grindelwald, Switzerland

16 – 20 July
WCRP 33rd Session of the Joint Scientific Committee (by invitation)
Beijing, China

9 – 12 October
1st joint SPARC/SOLARIS-HEPPA Workshop
Boulder CO, USA

26 – 27 November
Regional SPARC Workshop
Buenos Aires, Argentina

27 – 30 November
SPARC 20th SSG Meeting (by invitation)
Buenos Aires, Argentina

Participants of the 20th SPARC SSG held in Buenos Aires, 27-30 November 2012.

SPARC Activity Report Summaries

IGAC/SPARC Chemistry-Climate Model Initiative (CCMI)

This activity presents a new era of cooperation between SPARC and IGAC (International Global Atmospheric Chemistry, IGBP core project). It builds on the previous success of the SPARC CCMVal activity and, in response to SPARC's goal of extending its reach into the troposphere, incorporates core aspects of the former IGAC/SPARC Atmospheric Chemistry and Climate collaboration.

Figure 1: Group Picture of the IGAC/SPARC Global Chemistry-Climate Modelling and Evaluation Workshop that was held in Davos, Switzerland, 21-24 May 2012.

Achievements for 2012

IGAC/SPARC convened a joint workshop to discuss emerging themes in chemistry-climate modelling of the stratosphere and troposphere. The focus of the workshop was on improved comparisons of model output with in-situ, aircraft-based and satellite measurements for process-oriented model evaluation. Approximately 130 scientists from 16 different countries over four continents attended the workshop. Through a combination of invited and contributed talks, poster sessions and working group discussions, workshop participants identified science questions relevant to chemistry-climate model evaluation, the specific physical or chemical processes associated with each question, and the relevant observations.

In addition, the workshop participants agreed on a new set of community-wide simulations to support upcoming ozone and climate assessments and to make progress in process understanding (see details at http://www.pa.op.dlr.de/CCMI/). The workshop participants recommended the creation of a joint IGAC/SPARC Chemistry-Climate Model Initiative (CCMI) to coordinate future (and to some extent, existing) IGAC and SPARC chemistry-climate model evaluation and associated modelling activities. A brief workshop report was published in EOS as well as the IGAC and SPARC newsletters, and an overview of the CCMI community simulations in support of upcoming ozone and climate assessments was published in SPARC Newsletter No. 40[2].

Plans for the Coming Year

- Finish the definition of PHASE 1 CCMI community simulations and make the forcings available through a central website.
- Define the output and format for the CCMI-1 simulations.
- Form the CCMI Scientific Steering Committee.
- Discuss scientific results at the CCMI 2013 workshop in Boulder, USA, 14-16 May 2013.

[2] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/40_SPARCnewsletter_Jan2013_web.pdf

Gravity Waves

Small-scale atmospheric waves, called gravity waves or buoyancy waves, have sources in the troposphere such as flow over topography, convection, and jet imbalance. As these waves propagate upward, they play an important role in the atmospheric circulation at altitudes near the tropopause, and well above in the stratosphere and mesosphere. Global circulation models used for weather forecasting and climate prediction are beginning to resolve some of these waves, but the gravity wave sources in these models are poorly resolved (e.g. topography) or are parameterized processes (e.g. convection).

Achievements for 2012

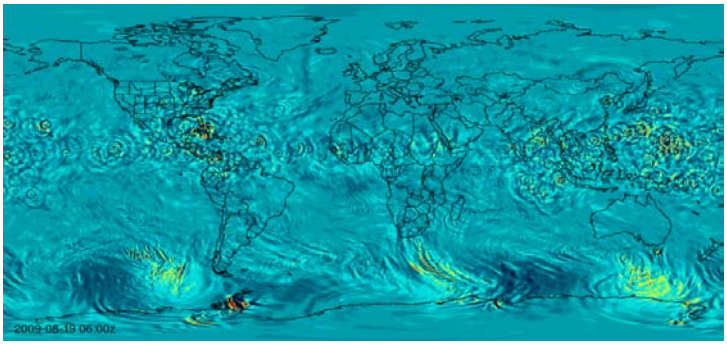

Figure 2: Instantaneous vertical motions on the 50 hPa pressure surface from a GEOS-5 [Rienecker *et al*., 2011] atmospheric simulation run at 7km horizontal resolution representing one day in August 2009. The motions are predominantly due to atmospheric gravity waves. Figure courtesy William Putman.

The Gravity Waves activity has completed an international team effort aimed at comparing various global data sets and model estimates of gravity wave momentum fluxes, their global distributions, as well as seasonal and interannual variations. Momentum flux is a key measure of the importance of gravity waves to the general circulation of the middle atmosphere. Dissipation of gravity wave momentum flux and gravity wave drag are key processes controlling stratospheric temperatures and winds in climate models, yet such mesospheric processes, as applied in models, have had little opportunity to use observational constraints because of a lack of global data. In the last few years, several satellite data sets have been utilised to create global estimates of gravity wave momentum flux, yet this new information could not readily be used to guide global models because the quantities derived from satellite data were not directly comparable to any published quantities in the models, nor with simple tuning parameters applied in the models. With the help of the International Space Science Institute (ISSI) and SPARC/WCRP, we formed a group of experts to accomplish a meaningful comparison of data and models by computing and archiving appropriate quantities from the models and observations, and we now have a publication describing the results in review in the Journal of Climate [Geller *et al*., 2012[3]]. The manuscript focuses on monthly-mean momentum fluxes in January and July data from three years, and also focuses on data in the stratosphere where the satellite results are meaningful

A second manuscript of this team's work, still in preparation, will compare local instantaneous measures of momentum flux in observations and models. This second work is aimed at illuminating the intermittent nature of gravity waves that is hidden when we examine monthly means and large-area averages. These local instantaneous properties are a second crucial piece of information needed to constrain the effects of gravity waves on the general circulation.

Plans for the Coming Year

- A new group within the Gravity Wave activity was formed in 2012 to focus on a comparison of various measures of gravity wave drag (or momentum forcing) from both observations and models. This group, 'Forces and Sources,' will have their first meeting in Bern, Switzerland, April 8-12 2013 (in association with ISSI).

[3] Geller *et al.*, 2013, A Comparison Between Gravity Wave Momentum Fluxes in Observations and Climate Models, *J. Climate*. doi:10.1175/JCLI-D-12-00545.1, in press.

SOLARIS-HEPPA - Solar Influences

This working group (renamed SOLARIS-HEPPA in 2012) was created to clarify the effects of solar influence on climate by radiation and particles, with special focus on the importance of middle atmospheric chemical and dynamical processes and their coupling to the Earth's surface with state-of-the art chemistry-climate models (CCMs), as well as mechanistic models and observations.

Achievements for 2012

Figure 3: Group Picture of the joint SOLARIS-HEPPA Meeting in front of Center Green from 9-12 October 2012 at NCAR in Boulder, Colorado. Photo: Courtesy Dan Marsh.

The first joint SOLARIS-HEPPA (SOLARIS: SOLAR Influences for SPARC, HEPPA: High Energy Particle Precipitation in the Atmosphere) meeting was held from 9-12 October 2012 in Boulder, Colorado, hosted by the National Center for Atmospheric Research. 60 participants from 12 countries attended the four-day workshop focusing on observational and modelling studies of the influences of solar radiation and energetic particle precipitation (EPP) on the atmosphere and climate. In order to join the two partly different communities, the first three days were organised with a mixture of invited tutorial and overview talks for a general audience in plenary sessions and extended poster sessions. The tutorials and overviews covered topics from the causes and phenomenology of solar radiation and energetic particle variability, to mechanisms by which radiative and particle forcing affect atmospheric chemistry and dynamics, and contributions of solar and EPP forcing to climate variability and space weather, to the current state-of-the-art and future needs in space observations and chemistry-climate models. The three two-hour poster sessions with a total of 52 poster presentations dealt with solar and particle variability in general, solar and particle effects on the stratosphere and above, solar and particle effects on the troposphere and climate-atmosphere and ocean-atmosphere coupling, as well as tools for assessing solar and particle influences. Each of the poster sessions was introduced by one-slide summaries of the posters in the plenary session in order to advertise and provide an overview of the poster contents. The last day of the meeting was reserved for the SOLARIS and HEPPA model/measurement intercomparison working groups, which were open to all interested participants.

An overview paper on recent spectral solar irradiance measurements and their impact on climate modelling has been published (Ermolli *et al*., 2012[4]). This provides the spectral solar irradiance data not only for the new CCMI recommendations but also for the SOLARIS-HEPPA coordinated sensitivity experiments to study the uncertainty in solar forcing on the atmosphere in a more consistent way (see below).

Plans for the Coming Year

- Publish SOLARIS-HEPPA Workshop summary in SPARC Newsletter
- Publish SOLARIS-HEPPA white paper
- Continue HEPPA-II measurement-model intercomparison study
- Publish solar signal in CMIP5 simulations

[4] Ermolli *et al*., 2012, Recent variability of the solar spectral irradiance and its impact on climate modelling, *Atmos. Chem. Phys. Discuss*., **12**, 24557–24642, 2012

- Conduct coordinated model runs to study uncertainty in solar forcing
- Provide recommendations/parameterizations for predominant EPP indirect effects (polar winter descent of NO_x produced by energetic electrons) in low-top atmospheric models (i.e. upper lid below the EPP source region around 100km) on the basis of observed stratospheric EPP-NO_x depositions.
- Coordinated evaluation of the solar cycle signal in CCMI hindcast simulations and satellite observations. This working group shall (i) assess existing analysis tools (multiple regression) and define a common method for extracting the solar signal from observed and modelled data records; (ii) interpret differences of the extracted signals (between models and observations as well as between different models); and (iii) analyse/quantify individual contributions to the solar signal (solar irradiance and particle signals by means of additional model experiments with partial forcing terms).
- Create a joint SOLARIS-HEPPA website.

DynVar - Dynamical Variability

The focus of the DynVar activity is on modelling the dynamics and variability of the stratosphere-troposphere system, with particular emphasis on the two-way dynamical coupling between them. The activity aims to promote the development, use and analysis of coupled atmosphere-ocean-sea ice general circulation models with tops above the stratopause, to ask how the stratospheric circulation:

- affects the tropospheric mean climate?
- impacts climate variability on all timescales?
- impacts climate change?

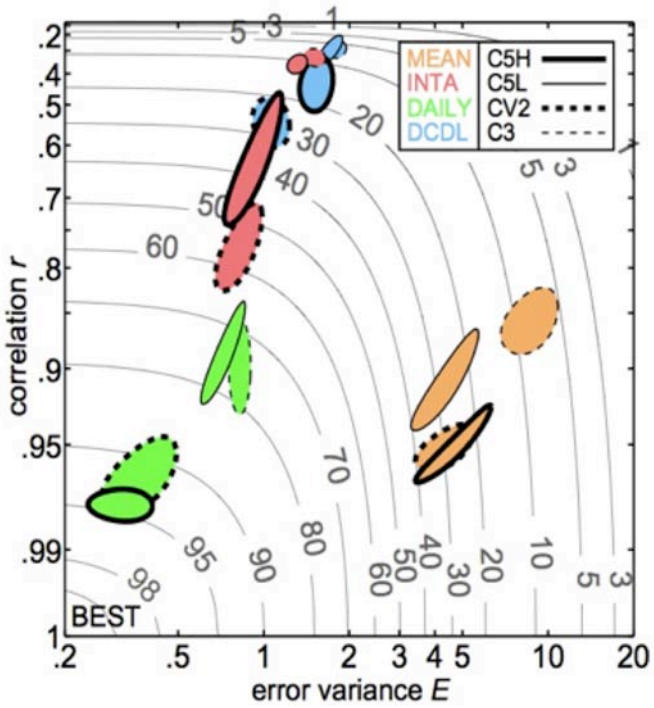

Figure 4: Simulation performance (90°S-90°N, 100-10hPa) for different model ensembles and aspects of climate. Best performing ensembles are located at the lower left. Grey contours show the skill score S (in %), which combines E and r into a single index. Oval shapes indicate ±2 standard deviation uncertainty intervals, derived by bootstrapping results from individual models within a specific ensemble. C5H: CMIP5 high-top model ensemble, C5L: CMIP5 low-top model ensemble, CV2: CCMVal-2 model ensemble, and C3: CMIP3 model ensemble. MEAN: mean climate, INTA: internannual variability, DAILY: daily variability, and DCDL: decadal variability. Courtesy Charlton-Perez *et al*. (2012).

Achievements for 2012

DynVar has called for analysis of the stratosphere and its dynamical influence on the troposphere in CMIP5 and WGSIP's SHFP simulations using ensembles of models. The call for such analysis has and will be disseminated in various ways:

- Newsletter article (CLIVAR Exchange: Stratosphere-resolving Models in CMIP5, Manzini *et al*. 2011[5]).
- Article in BAMS (Assessing and Understanding the Impact of Stratospheric Dynamics and Variability on the Earth System, Gerber *et al*. 2012).
- The SPARC DynVar Activity Stratosphere-Troposphere Coupling Poster Cluster at the WCRP Open Science Conference, October 2011, included presentation of the first results from CMIP5 analyses.

[5] http://www.clivar.org/sites/default/files/imported/publications/exchanges/Exchanges_56.pdf

- Invitation to present the poster "Surface Climate Change in the CMIP5 simulations: Role of Stratospheric Variability" to the CMIP5 analysis workshops, WCRP/WGCM, March 2012.
- Invited presentation at the WGCM meeting, September 2012.

Plans for the Coming Year

- DynVar will complete the two manuscripts (Charlton-Perez *et al*.; Manzini *et al*.) regarding the evaluation of stratospheric variability in CMIP5 models and the role of stratospheric dynamics in Northern winter climate, respectively.
- The 3rd DynVar workshop will be held in collaboration with SNAP in April 2013. DynVar presentations on CMIP5 and SHFP model outputs are expected. During the workshop discussion will be dedicated to:
  - Identifying the most critical deficiencies in the representation of the stratosphere in CMIP5 and SHFP simulations. Where and how can models be improved?
  - Bringing insights from theory and observations to model development and consequently to prediction efforts.
  - Exploring the possibility of DynVar playing a more active role in CMIP6, by proposing idealised experiments and diagnostics to illustrate the role of stratospheric dynamics in climate change.

Trace Gas Climatologies – SPARC Data Initiative (SDI)

The SPARC Data Initiative (SDI) has performed the first comprehensive comparison of vertically resolved trace gas and aerosol observations from all available limb-viewing satellite instruments. The observational records include 25 different chemical trace gas species and aerosol, span the time period 1979-2010, and were collected by the CSA, ESA, NASA, JAXA, and other national space agencies. These observations are generally used as the basis for empirical studies of stratospheric climate and variability, as well as for the validation of transport and chemistry in chemistry-climate models. Our knowledge of the quality of the different data sets is currently limited, but crucial for rendering these scientific applications meaningful. The SDI will make a major contribution toward the characterisation of measurement uncertainty, thereby improving our knowledge of the state of the atmosphere.

Achievements for 2012

The activity has made a major step forward in the production of the SDI report, with the completion of two major chapters on the satellite instruments and data sets (chapter 2) and on the methodology to produce and evaluate the different trace gas climatologies (chapter 3). These chapters have undergone a thorough review process and are currently at the proofreading stage. In addition, two major trace gas evaluation chapters (ozone and water vapour) of the report have been completed and are currently in production at the former Toronto SPARC office. A final report on the International Team Activity has been delivered to the International Space Science Institute (ISSI) in Bern (Switzerland), which hosted the SDI for two successful meetings in November 2010 and June 2011. Side meetings with the SDI team were also held during the CCMI workshop in Davos in May 2012 and at the QOS in Toronto in August 2012.

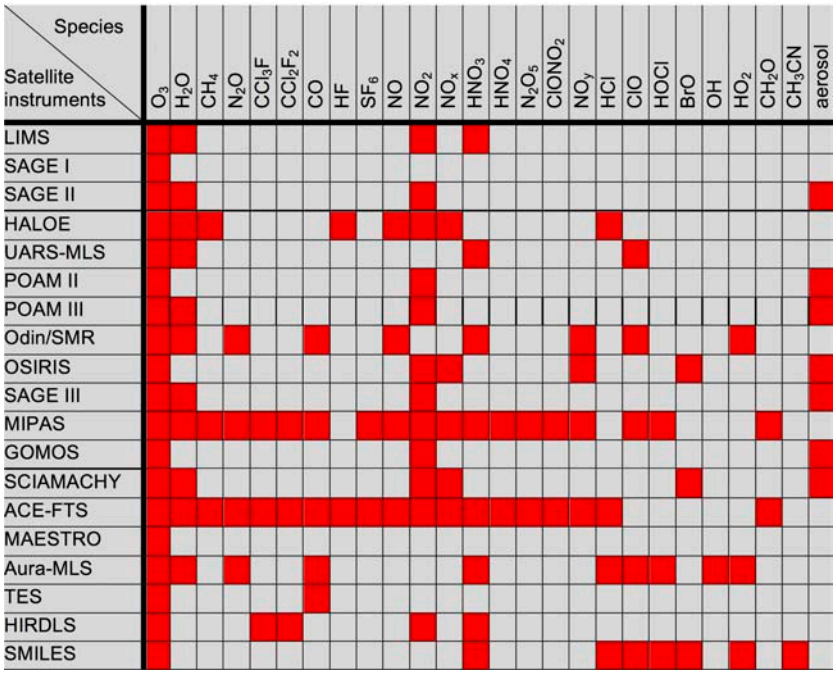

Figure 5: Atmospheric constituent climatologies of the SPARC Data Initiative, listed by satellite instrument.

Plans for the Coming Year

- The main deliverable planned for next year is the finalisation and printing of the SDI report. This will require the completion of all trace gas evaluation sections (which are currently completed to approximately 50%), as well as the summary chapter.
- Based on the finalised chapters on ozone and water vapour, two papers (Tegtmeier *et al.*; Hegglin *et al.*) will be submitted in early 2013 to a JGR special issue on the SPARC Data Initiative. Additionally, around six more publications, presenting an overview on the SPARC Data Initiative and scientific results from the activity, are planned for publication in the same special issue in 2013.
- The SDI ozone climatologies will be made publicly available through the SPARC Data Center in early 2013. All other climatologies will be made available at the time of publication of the report, in the second half of 2013.
- A workshop for the SDI team aimed at the finalisation of the report, including the executive summary, and intended to serve as a kick-off meeting for follow-on activities is planned for spring/summer 2013 in Europe.

Data Assimilation Working Group (DAWG)

Achievements for 2012

The Data Assimilation activity had an article about their 2011 workshop published in the SPARC Newsletter (Jackson and Polavarapu, SPARC Newsletter No. 38[6]). There were six goals set during this workshop. The first two of these were concerned with setting up the new SNAP and S-RIP activities, which was done during 2012 (see 'Emerging Activities' below). During the year outline plans for SNAP and S-RIP were developed, associated SPARC Newsletter articles were published, and both SNAP and S-RIP were approved by the SPARC SSG.

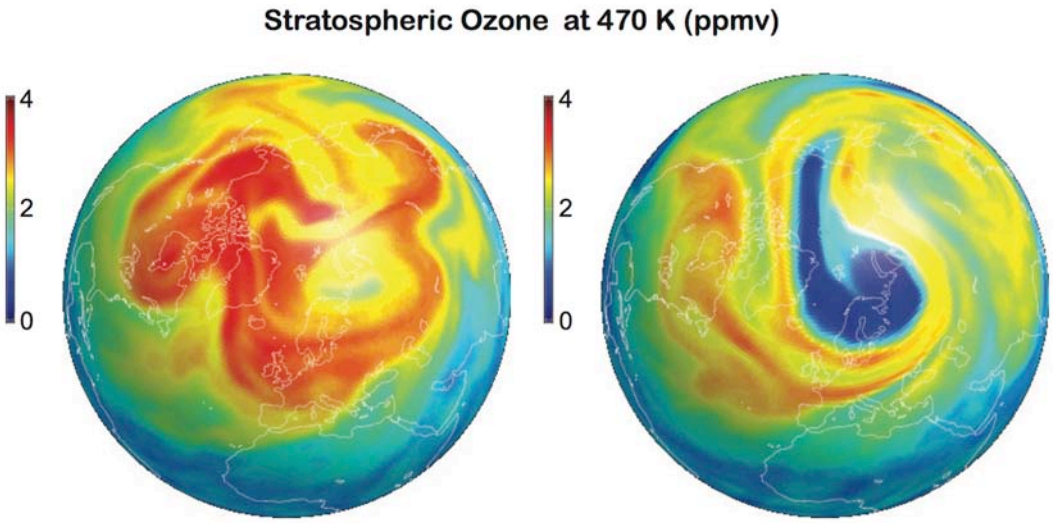

Figure 6: Ozone analysis by IFS-MOZART, the main NRT Forecast System of MACC, at the 470K isentropic level, showing ozone depletion on the 27th of March 2011 (right) compared to the same day in 2010 (left). At this level, the ozone analysis simulated ozone volume mixing ratios as low as 0.5ppmv above Scandinavia and Northwest Russia. The data comes from ECMWF and is generated for the EU FP7 project MACC (http://www.gmes-atmosphere.eu/), in which BIRA-IASB is in charge of the stratospheric ozone service (http://www.gmes-stratosphere.eu/). Figure courtesy Karolien Lefever, BIRA.

The themes for the 2012 workshop were as follows:

- Stratosphere/troposphere coupling and SNAP
- Assessment of middle atmosphere analyses and S-RIP
- Gravity waves and their representation in models and analyses.

A newsletter article on the 2012 workshop appeared in SPARC Newsletter No. 40[7].

Plans for the Coming Year

- Continue to consider developing a model vertical resolution project (in association with WGNE), and/or a gravity waves/model resolution project (in association with the SPARC gravity wave activity).

[6] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/38_SPARCnewsletter_Jan2012.pdf

[7] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/40_SPARCnewsletter_Jan2013_web.pdf

WAVAS II - Water Vapour Phase II

Achievements for 2012

This group has not completed any major deliverables over the past year. However they have reorganised their lead committee: Gabi Stiller has taken over for Cornelius Schiller. Gabi's focus will be on the quality assessment of water vapour data from satellite remote sensing instruments, while the data quality issues of in situ measurements will be partly taken over by the supersaturation activity led by Tom Peter. This group has also decided on the scope of the 3 review-type papers they intend to prepare.

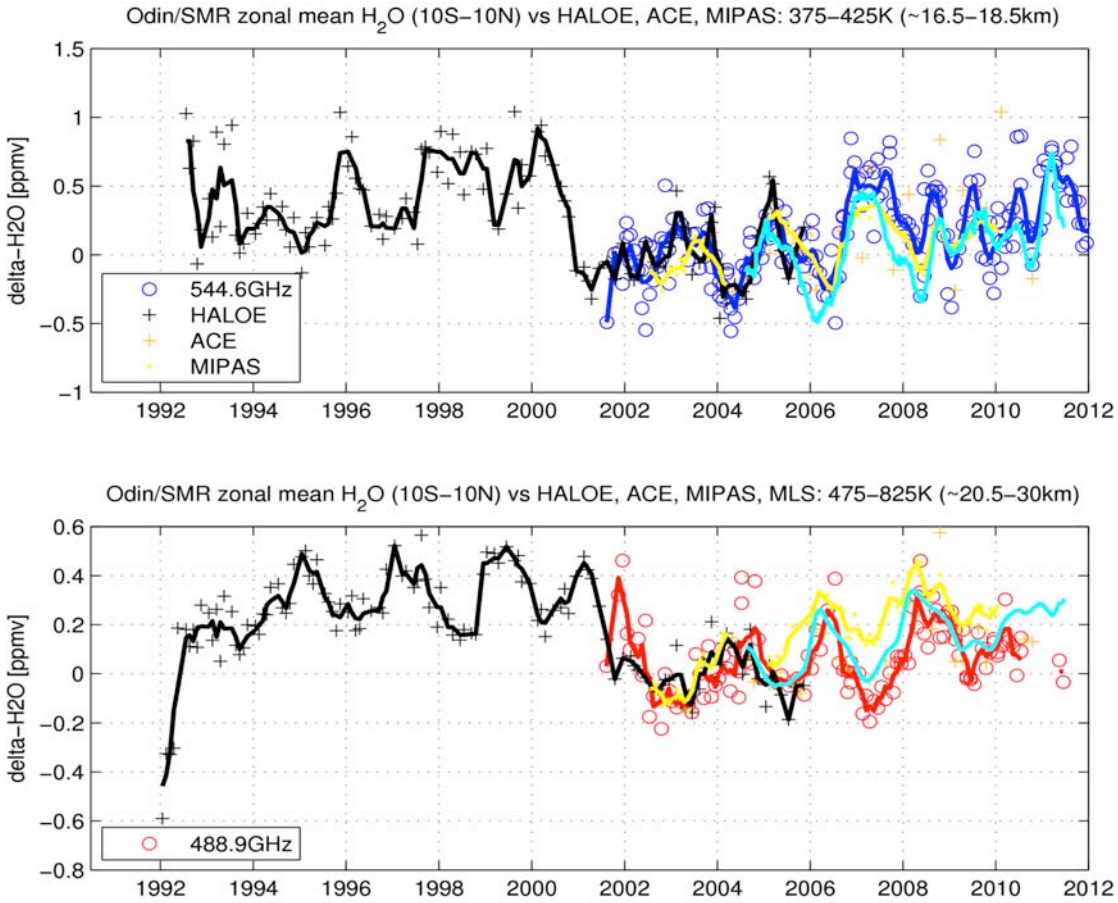

Figure 7: Anomaly of zonally averaged water vapour in the tropical tropopause region (10°S-10°N) in the potential temperature range 375-425K (~16.5-18.5km) derived from UARS/HALOE (black), Odin/SMR 544.6GHz band (dark blue), Envisat/MIPAS (yellow), ACE-FTS (orange), and Aura/MLS (cyan, based on daily zonal mean data). Time-series data have been deseasonalised and offset corrected in their overlapping periods with HALOE. Data are smoothed with a 90-day running mean filter (solid lines). Bottom: Same for the 475-825K (20.5-30km) potential temperature range in the lower stratosphere. Odin/SMR water vapour data are taken from the 488GHz band (red). Figure from: Urban, J., D.P. Murtagh, G. Stiller, and K.A. Walker, Evolution and variability of water vapour in the tropical tropopause and lower stratosphere region derived from satellite measurements, in Proc. ESA Atmospheric Science Conference: Advances in Atmospheric Science and Applications, 18-22 June 2012, Bruges, Belgium, edited by L. Ouwehand, European Space Agency publications ESA-SP-708 (CD-ROM), ISBN-978-92-9092-272-8, ISSN-1609-042X, Noordwijk, The Netherlands, November 2012.

Plans for the Coming Year

- Completion of the first paper on in situ data quality and the question of supersaturation in the upper troposphere/lower stratosphere by the middle of 2013.

Ozone Profile Phase II (SI2N Initiative)

Achievements for 2012

Several meetings were held during the year to discuss and coordinate the activities of the various groups contributing to "Past Changes in the Vertical Distribution of Ozone". A plenary meeting (with 48 scientists) was held from 16-18 April near Baltimore, USA, and all groups contributing to the activity participated. This workshop included discussion about the quality of the ozone data sets, how the relevant research would be reported, and the time plan for the last year of the initiative. Other meetings were organised for individual groups, such as the ozonesonde community and the NDACC community. An updated report about the SI2N activity was published in SPARC Newsletter No. 39[8].

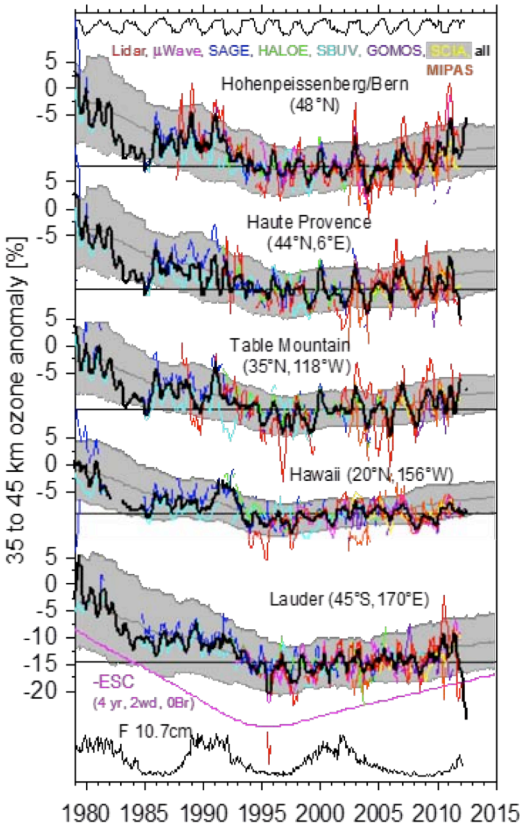

Figure 8: Ground-based and satellite ozone measurents at NDACC stations. Figure courtesy W. Steinbrecht.

Underlying this organisational progress is a great deal of research. This is reflected in the high level of interest in the joint special issue of ACP, AMT and ESSD, which has been organised for publication of relevant papers. This special issue will also include three overview papers described below. This is a new mechanism for the production of SPARC reports that could allow greater flexibility in format and a transparent review process while maintaining the usual level of rigour. This approach also means that the work involved is directly published in the fully peer-reviewed literature.

Plans for the Coming Year

- The activity will continue over the coming year, and much of the research will be coordinated within the five working groups:
  - Umkehr
  - Ozonesondes
  - Ground-based systems (NDACC)
  - Long-term satellite records
  - The last decade (satellites)
- Papers will be prepared for publication in the ACP/AMT/ESSD special issue and other journals. In parallel, three overview papers will be prepared on the following topics: Measurement Techniques (lead B. Hassler); Comparison and Validation (lead J-C. Lambert); and Analysis and Interpretation (lead N.R.P. Harris).
- A review meeting is planned for Helsinki in September 2013 (as part of the journal review process) in order to critically assess the results of the entire activity, mainly by reviewing the three summary publications of the activity.
- The final versions of the papers will be ready in late 2013 and therefore will be available for consideration in the next WMO/UNEP Ozone Assessment Report. This collection of papers should provide an excellent basis for this report as well as a good framework in which to interpret any new work published in the interim.

[8] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/39_SPARCnewsletter_Jul2012_web.pdf

Lifetime of Halogen Source Gases

Achievements for 2012

In the last 12 months, the Lifetimes activity has made significant progress towards producing a final document that will be published in the spring of 2013. Model simulations for the activity were generally completed by April 2012 and have been archived at the BADC. The first, second and third drafts have been completed, and revisions of the final draft are in progress.

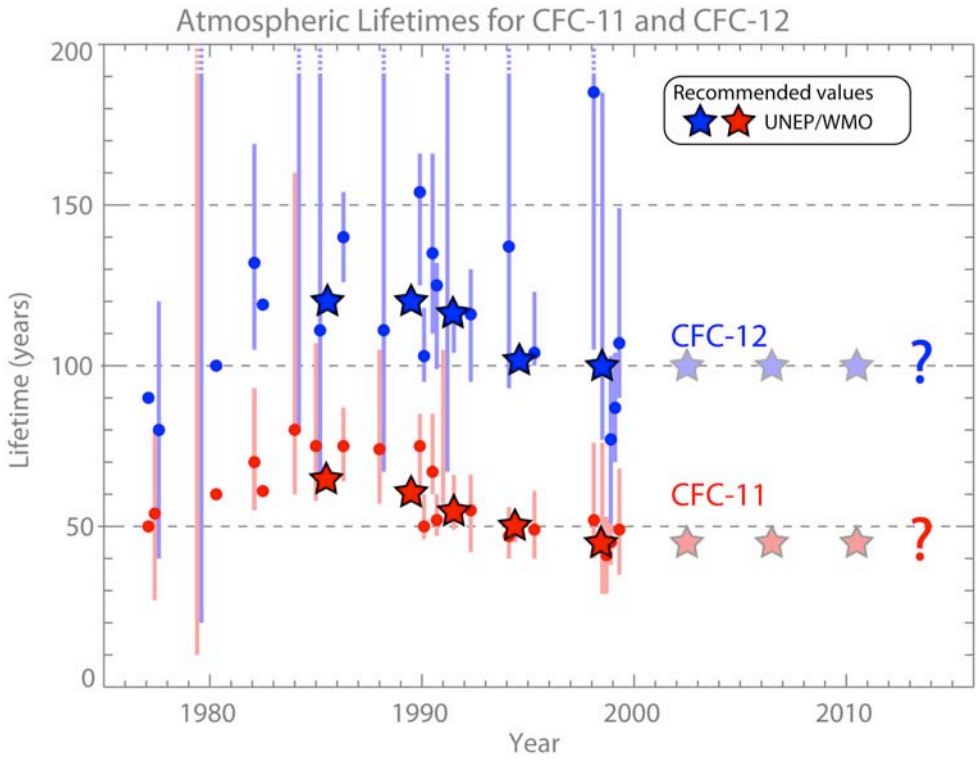

Figure 9: Atmospheric lifetimes of CFC-11 (red) and CFC-12 (blue) estimated from various reports between 1976 and 2010. Uncertainty estimates (or ranges) are shown as vertical bars. Stars represent values reported in ozone assessment reports.

Plans for the Coming Year (October 2012 – 2013)

- The third draft was revised in December 2012. A draft version of Chapter 6 was written during this period, summarizing the results of the first five chapters and providing a set of recommended lifetimes for the substances being assessed.
- The third draft was reviewed at a "Les Diablerets-style" meeting held from 14-18 January 2013 in Zürich, Switzerland.
- The final draft will be delivered in February/March 2013 and the report will be released in March/April 2013.

Temperature Trends

Achievements for 2012

Comparisons between a newly developed SSU temperature data set and the previous version of SSU showed substantial differences for trends over 1979-2005. The Temperature Trends group has focused on studying these differences and making comparisons with model simulations (from CCMval2 and CMIP5; see Figure 10). A new paper was written highlighting the data uncertainties and differences with model results (Thompson *et al.*, The Mystery of Recent Stratospheric Temperature Trends, Nature, 491, 692-697, 2012). The group also held a two-day meeting in Washington D.C. in November 2012, focusing on the SSU data issue, intercomparisons among different data sets, and making plans to extend stratospheric temperature time series to current time.

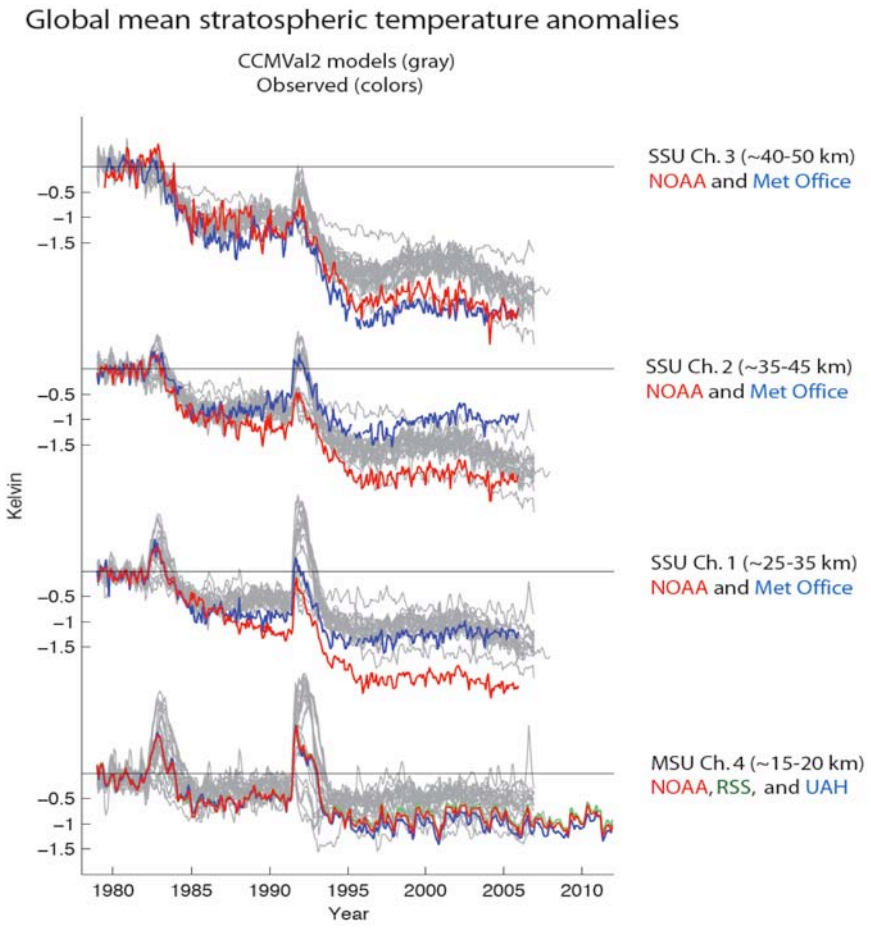

Figure 10: Global-mean stratospheric temperature anomalies since 1979. Time series of monthly-mean, global-mean stratospheric temperature anomalies are shown for the altitude ranges, data sets, and model output indicated. Red, blue and green lines indicate results based on observations. Grey lines indicate results from the coupled chemistry climate model runs available through the CCMVal2 archive. Time series are plotted so that their 1979-1980 means are zero. Adapted from Thompson *et al.*, Nature, 491, 692-697, 2012.

Plans for the Coming Year

- Current work is focused on extending the SSU data (1979-2006) with AMSU and other satellite temperature measurements, and the group is aiming to have one or more versions of updated data made available to the community in the coming year (including publications describing these data sets).
- The group also highlighted the SSU uncertainties in a presentation at the annual American Meteorological Meeting in January 2013.

Emerging Activities

S-RIP - SPARC Reanalysis/analysis Intercomparison Project

Achievements for 2012

An outline of a plan has been developed for S-RIP and an associated SPARC Newsletter article was written (Fujiwara *et al*., SPARC Newsletter No. 38[9]). S-RIP was approved by the SPARC SSG in 2012. A Scientific Working Group has been formed (see the membership at a tentative S-RIP website, http://wwwoa.ees.hokudai.ac.jp/~fuji/s-rip/).

An S-RIP session was held during the 2012 SPARC Data Assimilation workshop (Socorro, USA, June 2012). Presentations and discussions were also made at the:

- Workshop on Stratospheric Sudden Warming and its Role in Weather and Climate Variations (Kyoto, Japan, February 2012)
- SPARC Workshop on the Brewer-Dobson Circulation (Grindelwald, Switzerland, June 2012).

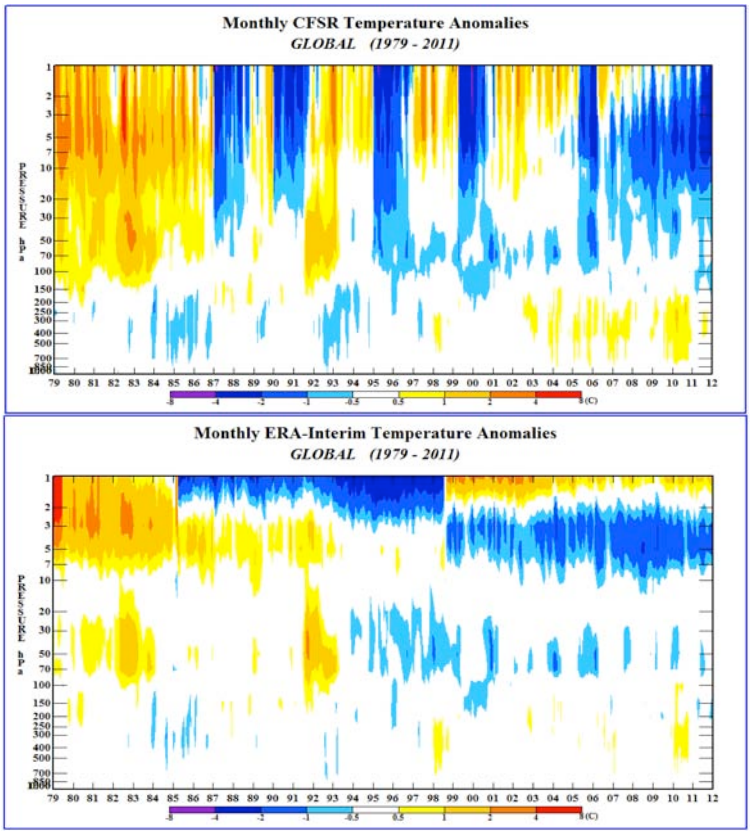

Figure 11: Global temperature anomaly time series with respect to pressure for NCEP-CFSR (top) and ERA-Interim (bottom) reanalyses. The global temperature anomaly time series' are useful for detecting significant events, trends and discontinuities in the long-term record of reanalyses and analyses. The warm temperature anomalies associated with the El Chichón and Mt. Pinatubo volcanic eruptions can be seen between 100-20hPa around the 1982 and 1991 time periods. Discontinuities that occur between the six streams used to create the CFSR are apparent in the mid to upper stratosphere. The transition from SSU to AMSU-A observations in 1999 in the upper stratosphere is apparent in the ERA-Interim time series. The discontinuity in 1985 occurs when the NOAA-9 SSU data became available.

Plans for the Coming Year

- April 2013: Planning Meeting. Decide structure of report and assign chapter lead authors.
- Rest of 2013: Start analysing data and writing chapters.

[9] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/38_SPARCnewsletter_Jan2012.pdf

SSiRC - Stratospheric Sulfur and its Role in Climate

Achievements for 2012

SSiRC was successfully accepted as an official SPARC activity by the SPARC SSG in November 2012. In the meantime, the SSiRC team has produced a white paper and a summary of this paper was published in the SPARC Newsletter (M. Rex *et al*., Stratospheric Sulphur and its Role in Climate (SSiRC), SPARC Newsletter No. 39[10]).

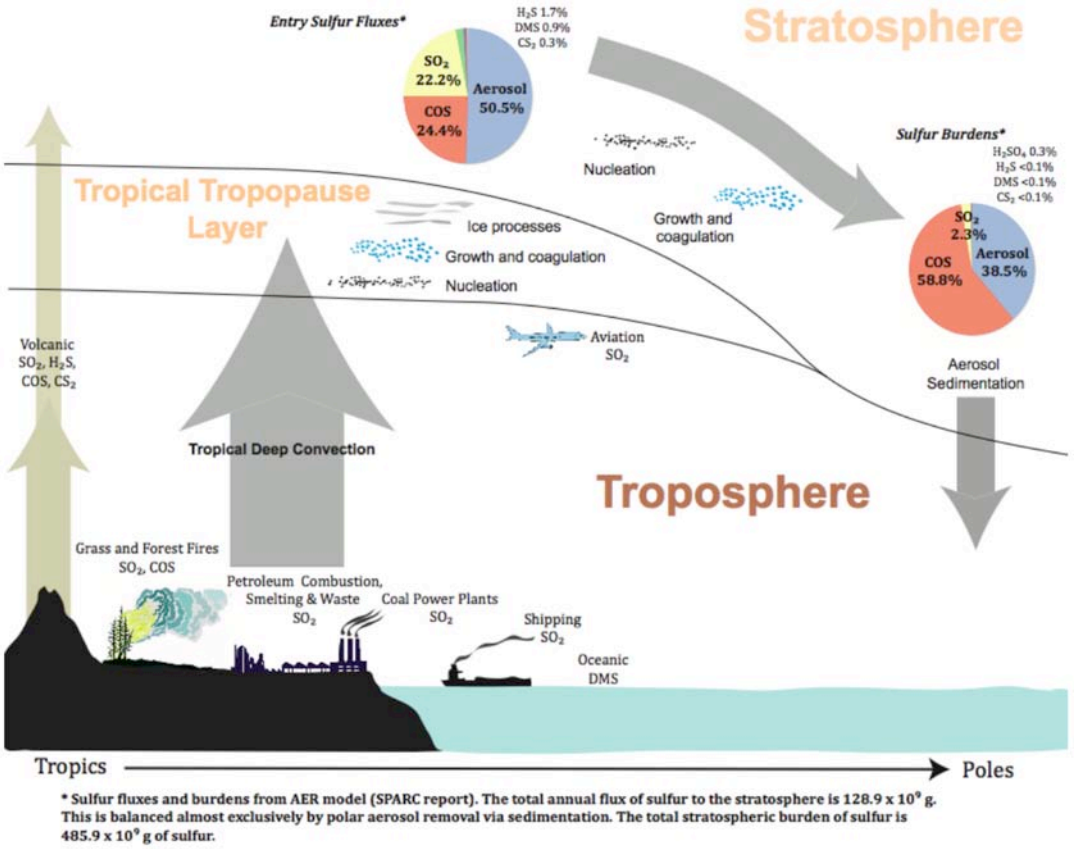

Figure 12: Schematic overview of the atmospheric sulphur cycle including recently discovered sulphur transport pathways into the stratosphere (modified after Thomason and Peter, 2006).

A kick-off meeting was held in Bern, Switzerland from 31 October to 2 November 2012 in association with ISSI, which is funding a series of SSiRC international team meetings. At the Bern meeting, an implementation plan and preliminary time schedule was developed. A rudimentary SSiRC web page was set up in late 2012 for the ISSI project "Stratospheric Sulfur and its Role in Climate Workshops" (http://www.issibern.ch/teams/ssirc/), which will be complemented by an official SSiRC website in early 2013.

Plans for the Coming Year

- First SSiRC open science workshop to be held end October 2013.
- Database: SSiRC will implement and maintain a website featuring a comprehensive collection of links to available laboratory measurements, in-situ and remote sensing data sets from ground-based, aircraft, balloon and satellite platforms.
- For an overview of the many individual activities, please refer to the implementation plan.

[10] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/39_SPARCnewsletter_Jul2012_web.pdf

SNAP - The Stratospheric Network for the Assessment of Predictability

Achievements for 2012

An outline plan has been developed for SNAP, and an associated SPARC Newsletter article was written (Charlton-Perez and Jackson, SPARC Newsletter No. 39[11]). SNAP was approved by the SPARC SSG in 2012.

Funding was approved by NERC, and a Project Scientist has been hired (commencing January 2013). A new SNAP website has also been established at: www.sparcsnap.org.

Research was presented in a SNAP session at the 2012 SPARC Data Assimilation workshop.

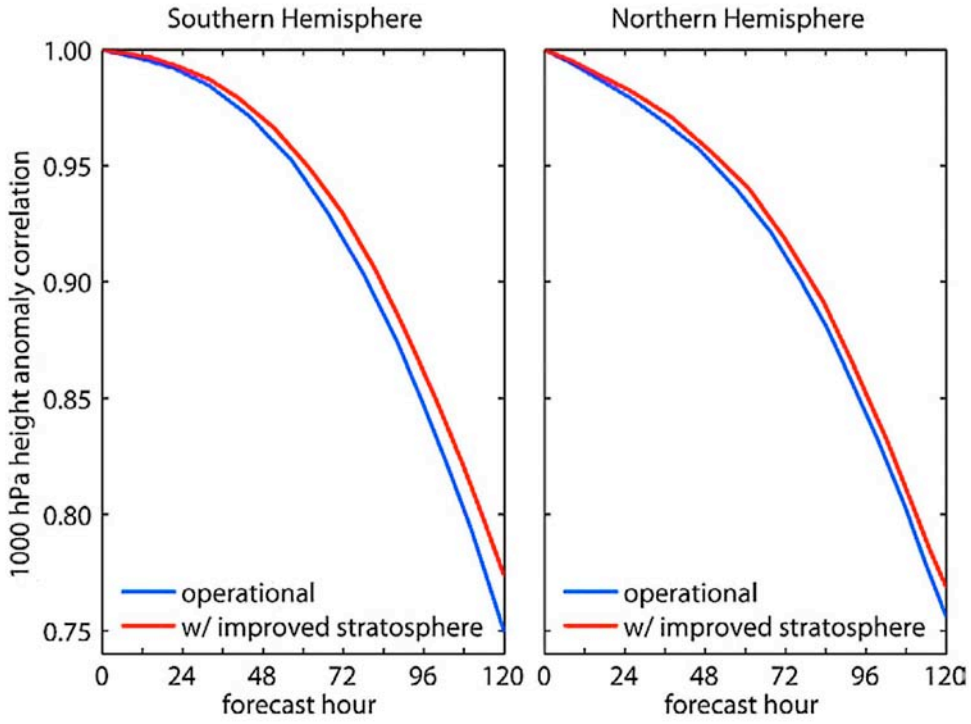

Figure 13: Impact of stratospheric resolution and data assimilation on surface weather forecast skill. Plots compare the 1000hPa geopotential height anomaly correlation, averaged over 5-day forecasts made between July and September 2010, with two versions of the Navy Operational Global Atmospheric Prediction System (NOGAPS). Curves reveal an improvement in forecast skill in a version of the model with enhanced stratospheric representation (red), as compared to the operational model (blue). Figure courtesy Ben Ruston.

Plans for the Coming Year

- January 2013: Form Steering Committee
- Early 2013: Write review paper on the role of the stratosphere in predictability (led by Project Manager)
- April 2013: First Workshop – review existing science and future directions; design a stratospheric predictability experiment; produce an experimental strategy
- From June 2013: Start running stratospheric predictability experiments

[11] http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/39_SPARCnewsletter_Jul2012_web.pdf

Connections

CliC

The CliC (Climate and Cryosphere) Scientific Steering Group (SSG) held its 9th session from 4-7 February 2013. Since April 2012 the CliC International Project Office (CIPO) in Tromsø has had a new Director, Dr Jenny Baeseman, and, at the end of 2012, an office manager Ms Heidi Isaksen joined the CIPO. In 2012 seven new members joined the CliC SSG, including the new Chair, Dr Gregory Flato from Environment Canada. The new foci of CliC activities are aimed at:

- increasing confidence in climate models and their prediction/projection of cryosphere changes, including those on regional scale;
- improving information regarding future changes in the cryosphere, with a specific focus on information relevant for impact assessment and adaptation decision making, such as the timing of the Arctic multi-year sea ice disappearance, the fate of mountain glaciers, etc.;
- more comprehensive, quality-controlled observational, observationally-based, and proxy datasets of cryospheric variables suitable for a range of research and model evaluation activities;
- better quantitative understanding of processes involved in cryosphere-climate interactions and better representation of these processes in global and regional climate predictions from months to decades ahead, as well as longer-term projections, particularly with respect to the effect of terrestrial- and sub-sea permafrost-sequestered carbon on the atmosphere, the role of ice sheet dynamics in sea level rise, etc.

GEWEX

SPARC continued to work closely with GEWEX (Global Energy and Water Exchanges) on topics of common interest through 2012. Greg Bodeker attended the GEWEX scientific steering group meeting in Sydney from 15-18 October 2012. One issue arising from this meeting, requiring a greater degree of collaboration between GEWEX and SPARC, is the potential for a gap to grow in WCRP research related to large-scale dynamical processes in the troposphere. CLIVAR, one of the other four core WCRP projects, recently redefined its scope in such a way that it is less likely to conduct research on large-scale dynamical processes in the atmosphere. It will become the combined responsibilities of SPARC and GEWEX to fill this gap as soon as possible, since one of the primary manifestations of climate change will be in the form of changes in large-scale tropospheric dynamics. Research on surface climate is managed by a number of international bodies. The large-scale dynamics of the stratosphere is well covered by SPARC. While the GASS (Global Atmospheric System Studies) panel of GEWEX coordinates research on parameterized processes within climate models, this leaves a gap in terms of the large-scale dynamics of the troposphere and synthesis of dynamical processes across the atmosphere as a whole. SPARC will need to liaise with GEWEX over the coming year to assess the extent to which this constitutes a gap in WCRP's skills and expertise base, develop a plan for a number of activities to address the gaps identified, and to constitute research groups to tackle those activities.

CLIVAR

The WCRP core project CLIVAR (Climate Variability and Predictability, see www.clivar.org) deals with climate aspects related to the atmosphere and ocean, as well as focusing on the interactions between ocean and atmosphere relevant to climate variability and climate change. These interactions play a key role in climate modelling, particularly relevant for CCMI (Climate Chemistry Modelling Initiative), a SPARC/IGAC activity developing and studying chemistry and chemistry-

climate interactions in global models. Other interactions between CLIVAR and SPARC are carried out within the WCRP Working Groups (WMAC, WDAC – see below).

AOPC

The Atmospheric Observations Panel for Climate (AOPC) is jointly sponsored by the Global Climate Observing System (GCOS) and WCRP, and is seen as a key partner for SPARC. Greg Bodeker attended the 17th meeting of the AOPC in Geneva from 30 April to 3 May 2012 and gave a presentation on SPARC perspectives, including a presentation of the outcomes of the SPARC Data Initiative (see above) in which AOPC had a particular interest. An overview was given of how SPARC operates, its objectives and its governance structure. A short summary of the new SPARC initiative to define measurement requirements was also presented, as this was also highly relevant to AOPC. Updates were also given on the SPARC ozone profiles activity, the SPARC temperature trends activity (including the outcomes of the recent reprocessing of the SSU data). Key additional points of discussion during the meeting were how AOPC would need to adapt to meet the needs of Future Earth and the implementation of the Global Framework for Climate Services. There was also some concern expressed over announcements of recent site closures. This too is a concern for SPARC.

WGNE

Over the past few years stronger links between SPARC and the Working Group on Numerical Experimentation (WGNE) have been developed, with the aim of strengthening connections between SPARC and the NWP community. To this end, a SPARC representative attends WGNE meetings to discuss progress and possible collaboration. The feedback from the most recent WGNE meeting (held in Toulouse, France, in November 2012) was that WGNE offers general support for work to improve stratospheric physics and understanding of errors, and in particular welcomes the emerging SPARC activities SNAP and S-RIP. In addition, WGNE encouraged the modelling centres to follow the activities of SPARC DynVar, which will hold its 3rd workshop, jointly with the 1st SPARC SNAP workshop, in April 2013 in Reading, UK. WGNE welcomed the possibility of a new SPARC activity focused on model vertical resolution, but cautioned against a study with a very broad scope. WGNE offered to help with recent SPARC attempts to write a summary report on how the stratosphere is represented in global NWP systems by proposing that modelling centres provide David Jackson (SPARC/WGNE point of contact) with the names of focal points for stratospheric issues.

WGSIP

SPARC is working with the WCRP's Working Group on Seasonal to Interannual Prediction (WGSIP) to examine the improvement in long-range forecasts from better representing the stratosphere in forecast systems. Amy Butler is coordinating the analysis of hindcasts provided by WGSIP members through the Climate Historical Forecast Project: http://chfps.cima.fcen.uba.ar/, with help from Adam Scaife who co-chairs WGSIP. Amy will summarize early results at the upcoming DYNVAR meeting in February 2013.

WGCM

The 16th Session of the Working Group on Coupled Modelling (WGCM) was held from 24-26 September 2012 at the Max Planck Institute for Meteorology in Hamburg, Germany. The objectives of the 16th Session were to review the 5th phase of the Climate Model Intercomparison Project (CMIP5) in terms of the lessons learned from the experiences of the climate modelling centres, and to start thinking about the next round of experiments, CMIP6, building on where CMIP5 has left gaps or raised new scientific questions that could be addressed through coordinated work. The meeting also addressed WGCM discussion topics on how observations and performance metrics for climate

model analysis are being developed in an increasingly consistent way with the CMIP protocol, the documentation of models and model simulations, and model tuning practices. WGCM will lead the WCRP Grand Challenge on clouds, circulation and climate sensitivity and will be a key contributor to the Grand Challenge on the provision of regional climate information. The final part of the meeting was held jointly with the Working Group on Seasonal to Interannual Prediction (WGSIP) on the common topic of decadal climate prediction. Veronika Eyring, who represents SPARC on the WGCM, reported on chemistry-climate modelling activities within SPARC and IGAC. The full report of the 16th session of WGCM is available at http://www.wcrp-climate.org/documents/wgcm16_report.pdf.

WDAC

In 2012 the WCRP constituted a new council, the WCRP Data Advisory Council (WDAC), with a mandate to act as a focal point for all WCRP data, information, and observation activities with its sister programmes. The council is also to coordinate their high-level aspects across the WCRP, ensuring cooperation with the main WCRP partners such as GCOS and other observing programmes. The intention is that the WDAC will work with the WCRP Modelling Advisory Council (WMAC - see below) to promote effective use of observations with models and to address issues related to the coordinated development of data assimilation, reanalysis, Observing System Sensitivity Experiments, as well as paleoclimatic data and their assessments. Kaoru Sato, SPARC's representative to WDAC was unfortunately unable to attend the inaugural WDAC meeting in Beijing on 16 July 2012, and so Greg Bodeker attended in her stead. Terms of Reference were defined for the WDAC and an immediate-term action plan was agreed upon. A full report on the outcomes of the WDAC meeting is available at http://www.wcrp-climate.org/documents/WDAC1_report.pdf

WMAC

In 2012 the WCRP approved the terms of reference and "populated" its Modelling Advisory Council (WMAC), which had its first session held in conjunction with the 33rd meeting of the JSC in Beijing in July 2012. In partnership with WCRP projects and working groups WMAC acts as a focal point for WCRP modelling activities. Its main role will be to advise the JSC and WCRP community on related issues, assess modelling capabilities within WCRP and identify gaps and opportunities for synergy. Main responsibility for working level coordination will remain with the individual modelling groups. A joint WMAC task team with IGBP is being developed to focus on prediction of the Earth system.

The Polar Climate Predictability Initiative

The WCRP has continued to develop its Polar Climate Predictability Initiative (PCPI). A planning meeting was held in Toronto in April 2012, conducted in cooperation with the International Arctic Science Committee Working Group on Atmosphere. The meeting agreed on a draft implementation strategy, which was subsequently completed and presented to the 33rd session of the WCRP JSC and was approved. The PCPI can be seen as an "incubator" for generating community research efforts that could be adopted, in the longer term, by more permanent components of the WCRP or of partner organisations. SPARC will continue developing the initiative, and CliC was assigned by the JSC to lead the implementation of activities as a part of the WCRP Cryosphere Grand Challenge.

ESA SPARC Initiative

A consortium of SPARC researchers was successful in securing ESA funding to progress the development of ozone, aerosol, temperature and water vapour climate data records for the stratosphere. This ESA-SPARC Initiative (SPIN) commenced in February 2012 and will run for two years. The goal of the project is to generate and validate new climate data records of stratospheric ozone, temperature, water vapour and aerosols. Seven research organisations are participating in SPIN. More information on SPIN is available at http://www.esa-spin.org/.

The SPARC Data Centre

During 2012 the SPARC Data Center continued to support SPARC activities in a number of ways. New data set entries were initiated for both the SPARC Data Initiative and the ESA SPARC Initiative. Data upload and public/restricted access arrangements for both of these are expected to be completed later in 2013. New high-resolution radiosonde data from US upper air stations acquired for the SPARC Gravity Wave Activity were added to the existing data set, which now spans the period 1998-2011. Further work on the SPARC Gravity Wave activity being undertaken at NASA GISS was supported through intermittent temporary hosting of GCM output on the SPARC Data Center. The SPARC Data Center served as a distribution point for the Lifetimes of Halogen Source Gases report, through which the coordinator could upload documents as they became available and subsequently grant access to the appropriate authors and reviewers.

Access was maintained to all of the previously established data sets in the ftp database. Usage of the website and ftp download activity was double that of the previous year. There was also a significant increase in the number of registered users. The SPARC Data Center continued to provide support for individual SPARC scientists and external users with specific queries on issues such as technical data for observational equipment, data download and reading, references to publications relevant to data sets and contacting other relevant scientists and organisations. The SPARC Data Center continued to be funded by NASA under ACMAP during 2012.

Workshops & Meetings 2013

14 – 18 January
Lifetimes Document Review Meeting
Zürich, Switzerland

20 – 21 February
SPARC Data Requirements Workshop
Frascati, Italy

25 February – 1 March
Climatic Effects of Ozone Depletion in the Southern Hemisphere
Buenos Aires, Argentina

1 – 3 April
Stratosphere-troposphere Processes and their Role in Climate Workshop
Kyoto, Japan

22 – 26 April
Gravity Waves Group 'Forces & Sources' Meeting
Bern, Switzerland

22 – 26 April
SNAP / DynVar Workshop
Reading, UK

29 April – 1 May
S-RIP Planning Meeting
Exeter, UK

13 – 17 May
CCMI 2013 Workshop
Boulder, USA

27 – 29 May
Research Applications of High-resolution Radiosonde Data
Stonybrook, New York, USA

17 – 21 June
DAWG Side Meeting at AMS Conference
Newport, USA

28-30 October
SSiRC Open Science Meeting
Atlanta, USA

15-20 November (likely dates)
Ozone Profile (II) Review Meeting
Helsinki, Finland

Find all meetings at: http://www.sparc-climate.org/meetings/

Acronyms

AOPC – Atmospheric Observations Panel for Climate
BADC – British Atmospheric Data Centre
BAMS – Bulletin of the American Meteorological Society
CCMI – Chemistry-Climate Model Initiative
CCMs – Chemistry-Climate Models
CCMVal2 – Chemistry-Climate Model Validation project 2
CliC – Climate and Cryosphere
CLIVAR – Climate Variability and Predictability
CMIP3 – Coupled Model Intercomparison Project 3
CMIP5 – Coupled Model Intercomparison Project 5
CSA – Canadian Space Agency
DynVar – Dynamical Variability
ESA – European Space Agency
GEWEX – Global Energy and Water Exchanges
ICSU – International Council for Science
IGAC – International Global Atmospheric Chemistry
IGBP – International Geosphere-Biosphere Programme
IOC – International Oceanographic Commission of UNESCO
ISSI – International Space Science Institute
JAXA – Japanese Aerospace Exploration Agency
JSC – Joint Scientific Committee
NASA – National Aeronautics and Space Administration
NDACC – Network for Detection of Atmospheric Composition Changes
NWP – Numerical Weather Prediction
PCPI – Polar Climate Predictability Initiative
SHFP – Stratosphere-resolving Historical Forecast Project
SNAP – Stratospheric Network for the Assessment of Predictability
SOLARIS-HEPPA – SOLAR Influences for SPARC – High Energy Particle Precipitation in the Atmosphere
S-RIP – Stratospheric Reanalyses Intercomparison Project
SSG – Scientific Steering Group
SSiRC – Stratospheric Sulfur and its Role in Climate
SSU – Stratospheric Sounding Unit
WCRP – World Climate Research Program
WDAC – WCRP Data Advisory Council
WGCM – Working Group on Coupled Modelling
WGNE – Working Group on Numerical Experimentation
WGSIP – Working Group on Seasonal to Interannual Prediction
WMAC – WCRP Modelling Advisory Council
WMO – World Meteorological Organisation


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