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# The 2017 S-RIP workshop and the 13<sup>th</sup> SPARC data assimilation workshop

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## DATES:

23 - 27 October 2017

## ORGANISERS:

Rossana Dragani (ECMWF, UK), Beatriz Monge-Sanz (ECMWF, UK), Quentin Errera (Belgian Institute for Space Aeronomy, Belgium) John McCormack (Naval Research Laboratory, USA), Masatomo Fujiwara (Hokkaido University, Japan), Gloria Manney (NorthWest Research Associates, USA, and New Mexico Institute of Mining and Technology, USA), and Lesley Gray (University of Oxford, UK, and NERC National Centre for Atmospheric Science, UK)

## HOST INSTITUTION:

European Centre for medium Range Weather Forecasts

**NUMBER OF PARTICIPANTS: ~35**

## SPONSORS:



## WORKSHOP WEBSITE:

<https://events.oma.be/indico/event/18/overview>

## ACTIVITS WEBSITE:

<http://www.sparc-climate.org/activities/data-assimilation>

<http://www.sparc-climate.org/activities/reanalysis-intercomparison>

The 2017 SPARC Reanalysis Intercomparison Project (S-RIP) workshop and the 13<sup>th</sup> SPARC Data Assimilation Working Group (DAWG) workshop were held together at the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, United Kingdom on 23-27 October 2017. The first two days were dedicated to discussions related to S-RIP, focusing on progress on the S-RIP Report. The third day was a joint session for S-RIP and DAWG participants, while days four and five consisted of DAWG presentations. Six posters were presented throughout the week. On October 24 and 26, some participants enjoyed a guided tour of the ECMWF's supercomputer system. For more information on DAWG, see <http://www.sparc-climate.org/activities/data-assimilation>. For more information on S-RIP, see <http://www.sparc-climate.org/activities/reanalysis-intercomparison> and Fujiwara *et al.* (2017). The agenda of both meetings and the list of participants can be accessed by following the relevant links at <https://events.oma.be/indico/event/18/>.

## S-RIP Workshop

The S-RIP is a coordinated activity to compare reanalysis data sets using a variety of key diagnostics and to write up two SPARC reports, the interim report (covering only Chaps. 1-4, see below for the chapter titles; currently under revision) and the full report (with updated Chaps. 1-4 and Chaps. 5-12; the manuscript to be submitted to the SPARC Office in August 2018). During the two-day workshop, one of the co-leads of each chapter presented an overview and progress report on the chapter, along with scientific talks relevant to the chapter (some S-RIP presentations were also in the joint session and posters). At the end of the workshop, general discussions were held on the contents of Chap. 12 (synthesis summary), on planned activities in 2018 (a possible two-day chapter-lead meeting in June or July, and a side meeting during the General Assembly), and on the future of this project after the full report is published.

**Masatomo Fujiwara** presented the progress on the project in the past year and update plans for Chap. 1 (Introduction). **Jonathon Wright**, **Craig Long**, and **Michaela Hegglin** presented the update plans for Chap. 2 (Description of the Reanalysis Systems), Chap. 3 (Climatology and Interannual Variability of Dynamical Variables), and Chap. 4 (Climatology and Interannual Variability of Ozone and Water Vapour), respectively. As a contribution to Chap. 4, **Kris Wargan** presented the approach, validation, and science for ozone in MERRA-2 reanalysis.

**Beatriz Monge-Sanz** presented the overview of Chap. 5 (Brewer–Dobson Circulation). **Bernard Legras** (on behalf of **Mohamadou Diallo**) discussed effects of natural variability on the Brewer-Dobson circulation and stratospheric water vapour in ERA-Interim and JRA-55 reanalyses, **Marta Abalos** presented an intercomparison of residual circulation diagnostics using four modern reanalyses, and **Simon Chabrillat** presented an intercomparison of mean age of stratospheric air since 1985 using five modern reanalyses. **Ed Gerber** presented both the overview of Chap. 6 (Stratosphere-Troposphere Coupling) and inter-comparisons of the annular modes in reanalyses. **Hua Lu** (on behalf of **Andrew Orr**) discussed stratosphere-troposphere coupling associated with the Antarctic ozone hole, the uncertainties in zonal mean circulation, and wave forcing. **Cameron Homeyer** presented the overview of Chap. 7 (Extratropical Upper Troposphere and Lower Stratosphere). The overview of Chap. 8 (Tropical Tropopause Layer, TTL) was given by **Kirsten Krüger**, followed by two contributed presentations to this subject: **Bernard Legras** discussed heating rates and clouds in the TTL in ERA5 (for 2010-2016) versus ERA-Interim reanalyses, and **Matthias Nützel** showed the analyses and inter-comparison of Asian summer monsoon characteristics. Chap. 9 (Quasi-Biennial Oscillation (QBO) and Tropical Variability) was presented by **Lesley Gray**, again followed by a presentation given by **Hua Lu**, who discussed the Holton-Tan effect and its mechanisms in modern reanalyses, and **Corwin Wright**, who discussed QBO-driving gravity waves resolved in reanalyses compared to satellite observations. **Michelle Santee** presented both the overview of Chap. 10 (Polar Processes) and observational and model comparisons of polar processing diagnostics in Arctic and Antarctic regions using MLS measurements and a chem-

ical transport model BASCOE driven with five modern reanalyses. Finally, **Lynn Harvey** presented the overview of Chap. 11 (Upper Stratosphere and Lower Mesosphere), and **Toshihiko Hirooka** discussed the climatology and variability of the semiannual oscillation and the related tropical circulation.

### Joint Session

The joint S-RIP/DA activities began with updates from four reanalysis centres. **Craig Long** presented an update on activities at NOAA/NCEP. **Kris Wargan** presented an overview of recent activities at NASA/GMAO that included a description of updates to the MERRA-2 system (Gelaro *et al.*, 2017) and future plans that included development of a “replay” capability for generation of dynamically self-consistent chemical reanalyses and adoption of all-sky radiance assimilation for rainfall information. **Yayoi Harada** described JMA’s upcoming JRA-3Q reanalysis (1947-present, to be released in 2022) with the global spectral model’s TL959 dynamical core, an improved convection scheme, and the assimilation of GPS bending angle information in place of refractivity. The reanalysis centre updates concluded with **Rossana Dragani’s** discussion of recent ECMWF activities regarding the production plans for the new ERA5 reanalysis (2010-2016 already released; 1979-2009 will be released in 2018; 1950-1978 in 2019), with improved usage of various observational data including assimilation of 21-level SBUV V8.6 ozone data, and a proof-of-concept coupled ocean/atmosphere/ice reanalysis experiment named CERA-SAT (2008-2016).

The centre updates were followed by science presentations in areas of common interest to S-RIP and DA participants. These began with a presentation on the strength of the diabatic circulation and age of air by **Ed Gerber**, which emphasized the importance of trends in lateral gradients in age-of-air estimates. This was followed by an invited talk by **Peter Hoor** on the emerging OCTUV-UTLS activity and the use of both adiabatic and tracer-based coordinate systems for identifying chemical versus dynamical variability in UTLS composition. **Michaela Hegglin** then gave a presentation on variability and trends in upper tropospheric jets from five different reanalyses, which was followed by a presentation on empirical analysis of the Brewer-Dobson circulation through



**Figure 11:** Participants at the 2017 S-RIP workshop and the 13th SPARC data assimilation workshop held together at ECMWF, Reading, UK.

inversion of the continuity equation by **Thomas von Clarmann**. The session continued with an invited presentation by **Adrian Simmons** that described the ERA5 reanalysis and compared its performance to date with the ERA-Interim data set. This was followed by a presentation on solar cycle signals in atmospheric and oceanic reanalyses by **Stergios Misios**. The final science presentation of the joint session was an intercomparison of tidal and planetary wave signals in upper stratospheric and lower mesospheric reanalyses by **John McCormack**.

The joint S-RIP/DA session concluded with an invited presentation from **Judith Perlwitz** of the SPARC Scientific Steering Group on the future of SPARC and the role of the different activities and working groups in helping to identify strong scientific themes that are relevant to SPARC's mission.

### SPARC DAWG Workshop

The Data Assimilation Working Group (DAWG) coordinates and promotes data assimilation research relevant to SPARC. This is done primarily through regularly held workshops that bring together data assimilators, data providers, modellers and users of data assimilation products to summarize the state of the art and identify outstanding issues for the SPARC Scientific Steering Group. This year's DAWG workshop focused on the following themes: (1) Development of new

observing systems for the middle atmosphere; (2) Stratospheric data assimilation in support of assessing UTLS trends; (3) New data assimilation techniques and their application to stratospheric observations.

The first day of the DAWG workshop began with a combination of invited and contributed presentations on these themes. **Patrick LaLoyaux** delivered an invited presentation describing new variational bias correction and weak-constrained 4D-Var data assimilation methods to be implemented at ECMWF. Next, **Bruce Ingleby** discussed aspects of stratospheric radiosonde data assimilation that included processing of drift information to improve wind analyses in the lower stratosphere and the question of how to treat resolved gravity waves in sonde profiles. **Quentin Errera** gave a presentation on the BASCOE Reanalysis of MLS (BRAM) and suggested using this type of system to help identify and correct biases between different instrumental records. In his invited talk **Mark Olsen** described reanalysis-constrained model simulations using MERRA2 as a means to quantify cross-tropopause mass fluxes. **Nathaniel Livesey** then gave an invited presentation that began with an overview of current stratospheric limb profiler and nadir sounder instruments, and then discussed possible strategies for the SPARC DA community to pursue in order to help improve future prospects for spaceborne measurements that are needed for continued stratospheric reanalysis.

The remainder of the day was devoted to updates on other SPARC activities relevant to DAWG research themes. The first update was from **Federico Fierli**, who described the objectives and current efforts of the ACAM activity. This was followed by updates from **Andrew Charlton-Perez** on the SNAP activity and **Scott Osprey** on the QBOi activity. **Fuqing Zhang** delivered a report on the gravity wave activity and **Irina Petropavlovskikh** then delivered a summary of the LOTUS activity. The SOLARIS-HEPPA activity update was given by **Bernd Funke**, followed by an update on the Atmospheric Temperature Changes activity from **Amanda Maycock**. The final update was given by **Ed Gerber** describing the DynVar MIP activity, which was followed by a short group discussion that identified areas of common interest between these activities and DAWG that can aid the development of new scientific themes for SPARC.

The second day of the workshop was devoted to extension of DA systems to higher altitudes and the role of reanalyses for whole atmosphere modelling. **John McCormack** described results from observation sensitivity experiments using a high-altitude analysis system extending to the lower troposphere that highlighted the importance of stratospheric limb sounder measurements for constraining analysed tidal signatures. **Kris Wargan** discussed the extension of the GEOS ozone observing system to include OMPS limb profiler data. **Nick Pedatella** presented recent results of analysis and forecast experiments describing the chemical and dynamical variability of the stratosphere and mesosphere during the 2009 sudden stratospheric warming. The session concluded with **Valery Yudin's** discussion of tidal dynamics in whole atmosphere models that use specified meteorology from reanalysis data sets.

The DAWG workshop ended with a general discussion among the participants to help determine future directions for the group. From these discussions, three potential themes were identified: (1) Activities supporting the development of a new satellite limb sounder mission for the stratosphere and mesosphere; (2) Constituent assimilation and chemical reanalysis inter-comparisons; (3) The role of "high top" reanalyses for whole atmosphere modelling via model initialization, model validation, and specified dynamics (i.e., nudging). The possibility of a DAWG side meeting during the SPARC General Assembly in Kyoto next year was also discussed. Preparation of a SPARC newsletter article describing future plans for DAWG is planned for early 2018.

### Acknowledgments

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### References:

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- Gelaro, R., et al., 2017: The Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2). *J. Climate*, **30**, 5419-5454, doi:10.1175/JCLI-D-16-0758.1.

## SPARC Office: move from Zurich to Oberpfaffenhofen

SPARC science relies on voluntary cooperation on a global scale. In this respect, the SPARC Office has been providing an organizational and scientific backbone for no less than a quarter of a century (see article on page 30, this issue). During the years 2012 to 2017 colleagues from the Institute for Atmospheric and Climate Science of ETH Zurich acted most efficiently at the interface of science and management on behalf of the World Climate Research Programme.

After a six-monthly transition period, the Institut für Physik der Atmosphäre of DLR in Oberpfaffenhofen ([www.dlr.de/pa/en](http://www.dlr.de/pa/en)) is now acting as the fourth host-institution for the SPARC Office ([www.sparc-climate.org/about/SPARC Office](http://www.sparc-climate.org/about/SPARC%20Office)). We will try hard to keep the high standard set by **Johannes Stachelin**, **Fiona Tummon**, **Carolin Arndt** and **Petra Bratfisch**. And we are looking forward to interacting with many members of the broad SPARC community.

*Hans Volkert, Mareike Kenntner, and Brigitte Ziegele*