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Author(s)	Fujiwara, Masatomo; Errera, Quentin; Gray, Lesley J. et al.
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The 12th SPARC Data Assimilation Workshop and 2016 S-RIP Workshop

Masatomo Fujiwara[1], Quentin Errera[2], Lesley J. Gray[3,4], Gloria L. Manney[5,6], John McCormack[7], and James Anstey[8]

[1]Hokkaido University, Japan, **fuji@ees.hokudai.ac.jp**, [2]Belgian Institute for Space Aeronomy, Belgium, [3]University of Oxford, UK, [4]NERC National Centre for Atmospheric Science, UK, [5]NorthWest Research Associates, USA, [6]New Mexico Institute of Mining and Technology, USA, [7]Naval Research Laboratory, USA, [8]Environment and Climate Change Canada, Canada.

The 12th SPARC Data Assimilation (DA) workshop and the 2016 SPARC Reanalysis Intercomparison Project (S-RIP) workshop were held together in Victoria, Canada, from 17-21 October 2016. Similar to the 2014 and 2015 workshops (see Errera *et al.*, 2016), days one and two were dedicated to discussions related to DA activities, days four and five were for S-RIP, and on day three a joint session was held. Eight posters were presented during the week. For more information on each activity see **www.sparc-climate.org/activities/data-assimilation** and Fujiwara *et al.* (2016). The agenda of both meetings, the list of participants and the presentations of the SPARC DA workshop (including the joint session) can be downloaded from **https://events.oma.be/indico/event/12/overview.**

SPARC DA Workshop

The DA workshop focused on three general themes: (1) the representation of the stratosphere and mesosphere in models and analyses; (2) future directions in instruments, modelling, and DA methods; and (3) harmonization and bias correction of long-term reanalyses. The first DA session began with a series of six presentations addressing the representation of the stratosphere and mesosphere in models and analyses. The first three presentations described different aspects of the recently developed

high-altitude version of the US Navy numerical weather prediction (NWP) system related to the use of ensemble-based methods to improve the background error covariance specification in the stratosphere and mesosphere (**David Kuhl**), validation with independent mesospheric wind observations (**John McCormack**), and examination of specific terms in the momentum budget from the analyzed winds to improve understanding of gravity wave effects on the mesospheric zonal winds (**Stephen Eckermann**). A presentation on the Belgian Assimilation System of Chemical Observations (BASCOE) by **Quentin Errera** then described efforts to improve analyses of constituent transport and photochemistry throughout the stratosphere and lower mesosphere using a chemical transport model and either 4-dimensional variational or ensemble-based Kalman filter DA algorithms. This was followed by a presentation from **Yvan Orsolini** on modelling the effects of energetic particle precipitation in the mesosphere and lower thermosphere using the Whole Atmospheric Community Climate Model (WACCM) with specified dynamics from stratospheric reanalyses. The final presentation in this theme was made by **Martin Charron**, who discussed recent developments in modelling the stratosphere and mesosphere with the Canadian Global Environmental Multi-Scale (GEM) NWP system.

The next session of the DA workshop consisted of three presentations focusing on the future directions theme. The first of these presentations, by **Nick Pedatella**, described the development of ensemble DA methods in WACCM. This was followed by an overview of the ALTIUS (Atmospheric Limb Tracker for the Investigation of the Upcoming Stratosphere) satellite mission that described the project status and expected constituent measurements (**Emmanuel Dekemper**). The session concluded with a presentation by **Moudi Pascale Igri** describing regional applications of three-dimensional variational DA to understand variations in the location of the inter-tropical convergence zone over West and Central Africa.

The third DA session on harmonization and bias correction of long-term reanalyses consisted of four presentations, beginning with **David Plummer** discussing the use of reanalyses to constrain atmospheric dynamics in decadal chemistry-climate simulations. Next, **Gloria Manney** gave an update on the Mesospheric and Upper Stratospheric Temperature and Related Datasets (MUSTARD) project which aims to produce long-term records of temperature and geopotential height by combining observations from a variety of past and present limb-sounding radiometers and occultation instruments. This was followed by an overview of the second phase of the SPARC Water Vapour Assessment (WAVAS) activity from **Gabriele Stiller** that highlighted several recent results to be published in an ACP/AMT/ESSD inter-journal special issue. The session concluded with a presentation by **Thomas von Clarmann** on the TUNER project (Towards Unified Error Propagation).

Joint Session

The goal of the S-RIP activity is to produce two SPARC reports, one as an interim report containing the first four "basic" chapters and the other a full report in 2018 containing both "basic" (updated from the interim report) chapters and seven "advanced" chapters. **Masatomo Fujiwara**, **Jonathon Wright**, **Craig Long**, and **Sean Davis** presented overviews of Chapter 1 (Introduction), 2 (Description of the Reanalysis Systems), 3 (Climatology and Interannual Variability of Dynamical Variables), and 4 (Climatology and Interannual Variability of Ozone and Water Vapour), respectively. The review process for the S-RIP interim report was started in early December 2016. **Jonathon Wright** also described the current status of the S-RIP special issue in Atmospheric Chemistry and Physics (**www.atmos-chem-phys.net/special_issue829.html**).

Presentations from four reanalysis centres followed. **Kris Wargan** presented NASA/GMAO's evaluation of the MERRA-2 reanalysis and future reanalysis plans of GMAO. **Rossana Dragani** presented the production plans of the new ECMWF reanalysis, ERA5, whose 2010-2016 data and 1979-2009 data will be made available in the beginning of 2017 and 2018, respectively. **Craig Long** presented NOAA/NCEP's recent upgrades and future plans for the Global Forecast System, Climate Forecast System, and several other model/assimilation systems, and showed comparisons of the recently produced Conventional Observations Reanalysis (CORe) with the NCEP R-1 reanalysis over the period 1950-2009. Finally, **Yayoi Harada** gave an overview of the JRA-55 family, and presented the plans of JMA's new reanalysis, JRA-3Q, whose data will be made available in 2022.

The remainder of the talks in the joint session were science talks including several invited S-RIP talks that are described in the S-RIP section below. In addition to

these: **Toshiki Iwasaki** discussed impacts of low-level polar cold air outbreaks on the Brewer-Dobson circulation using the mass-weighted isentropic zonal mean framework; **Thomas von Clarmann** discussed diagnosing the Brewer-Dobson Circulation through the direct inversion of the continuity equation; and **Tianbao Zhao** evaluated atmospheric precipitable water from several reanalyses using homogenized radiosonde humidity data over China.

Figure 17: Participants at the 12th SPARC data assimilation workshop and the 2016 S-RIP workshop held together in Canada.

S-RIP Workshop

During the two-day S-RIP workshop, the co-leads of seven "advanced" chapters provided overviews of the progress and discussion points for each chapter. Each chapter also had one to three invited scientific talks (some presented in the joint session on Wednesday), highlighting important and interesting results obtained so far.

Beatriz Monge-Sanz and **Thomas Birner** gave the overview of Chapter 5 (Brewer-Dobson Circulation). **Simon Chabrillat** presented comparisons of age-of-air in four modern reanalyses through offline modelling of SF6 transport, while **Gabi Stiller** discussed possible mechanisms for age-of-air trend patterns obtained from MIPAS SF6 measurements. In the joint session on Wednesday, **Paul Konopka** discussed trends in stratospheric water vapour and age-of-air using a chemical transport model (CLaMS) driven by different reanalyses.

Patrick Martineau gave an overview of Chapter 6 (Stratosphere-Troposphere Coupling) and also presented comparisons of the momentum budget for Sudden Stratospheric Warmings using several reanalyses. In the joint session on Wednesday, **Peter Hitchcock** discussed the importance of reanalysis data spanning the period prior to 1979 to the present (*i.e.*, much more than ~40 years) for studies of stratosphere-troposphere coupling.

Gloria Manney gave the overview of Chapter 7 (Extra-tropical Upper Troposphere and Lower Stratosphere). **Luis Millan Valle** presented reanalysis comparisons of the climatology of dynamically-induced low ozone events. **Susann Tegtmeier** gave the overview of Chapter 8 (Tropical Tropopause Layer) and **Jonathon Wright** discussed the evaluation and intercomparison of tropical high clouds in reanalyses. In the joint session on Wednesday, **Tao Wang** presented Lagrangian cold-point temperatures and transit times inferred from a forward trajectory model using four modern reanalyses. **Alex Boothe** and **Gloria Manney** gave talks encompassing material from both Chapters 7 and 8, the former on Lagrangian calculations of stratosphere-troposphere exchange, and the latter on trends and variability in the upper tropospheric jet streams; both discussed the implications of their results for trends.

The overview of Chapter 9 was given by **James Anstey**. **Young-Ha Kim** described tropical wave activity and its forcing of the QBO in the five modern reanalyses. **Kevin Hamilton** presented results from the Kawatani *et al.* (2016) study examining inter-reanalysis differences in tropical stratospheric winds and comparing them with observations from the Integrated Global Radiosonde Archive (IGRA) data set.

The overview of Chapter 10 (Polar Processes) was presented by **Michelle Santee**. Gloria Manney presented **Zachary Lawrence**'s work updating intercomparisons of the polar processing diagnostics derived from temperatures and potential vorticity originally described in Lawrence *et al.* (2015). Michelle also presented **Alyn Lambert**'s work investigating polar stratospheric cloud formation temperatures using the thermodynamics of super-cooled ternary solutions and the ice frost-point as a temperature reference to compare reanalysis data in the polar regions.

Finally, **Lynn Harvey** presented an overview of Chapter 11 (Upper Stratosphere and Lower Mesosphere). **Takatoshi Sakazaki** presented comparisons of atmospheric tides in the stratosphere and lower mesosphere from several reanalyses, and **Toshihiko Hirooka** discussed the climatology and interannual variability of the equatorial semi-annual oscillation using modern reanalyses.

Announcements

In November 2016 John McCormack was officially made co-chair of the SPARC DA activity, serving together with Quentin Errera. The SPARC DA and S-RIP activities will hold their next joint workshop from 23-27 October 2017 at ECMWF (UK).

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SPARC meetings

13 – 15 March 2017
LOTUS Workshop, Paris, France

10 – 12 June 2017
ACAM Workshop and Training School, Guangzhou, China

13 – 15 June 2017
SPARC/IGAC CCMI Science Workshop 2017, Toulouse, France

15 –16 June 2017
TUNER Project Meeting
Saskatoon, SK, Canada

20 – 22 Juni 2017
WAVAS II, Toronto, Canada

18-20 July 2017
OCTAV-UTLS, Boulder, CO, USA

2 – 5 September 2017
Training School on Stratosphere-Troposphere Interactions, Cape Town, South Africa

9 – 14 October 2017
FISAPS, QBOi, SATIO-TCS joint workshop, Kyoto, Japan

16 – 20 October 2017
Local Workshop and SSG meeting, Seoul, Korea

SPARC-related meetings

10 – 13 April 2017
GAW 2017 Symposium, Geneva, Switzerland

2 – 3 May 2017
First ALTIUS Symposium, Brussels, Belgium

12 – 14 June 2017
9th Atmospheric Limb Workshop, Saskatoon, SK, Canada

Find more meetings at www.sparc-climate.org/meetings/

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SPARC Office

Director
Fiona Tummon
Project Scientist
Johannes Staehelin
Communication Officer
Carolin Arndt
Office Manager
Petra Bratfisch

Contact
SPARC Office
c/o ETH Zurich
Institute for Atmospheric and Climate Science (IAC)
Universitaetstrasse 16
CH-8092 Zurich
Switzerland
office@sparc-climate.org