SPARC Reanalysis Intercomparison Project (S-RIP) Planning Meeting,
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The SPARC community has been using reanalysis datasets to understand atmospheric processes and variability, and to validate chemistry-climate models. Currently, there are eight global atmospheric reanalysis datasets available and four more will be available soon (Table 1). The SPARC Reanalysis Intercomparison Project (S-RIP) is an emerging SPARC activity that was proposed last year (Fujiwara *et al.*, 2012). The goals of S-RIP are to create a communication platform between the SPARC community and reanalysis centres, to understand current reanalysis products, and to contribute to future reanalysis improvements. By August 2012, the working group (WG) with 11 members had been formed, and the reanalysis centre contacts for the project had been confirmed. The WG discussed chapter titles, co-leads, and initial contributors to the final SPARC report and planned a kick-off meeting. This article summarises the discussions held during the S-RIP Planning Meeting hosted at the Met Office, Exeter, UK, from 29 April-1 May 2013. There were 39 participants, 20 oral presentations, and 21 poster presentations.

Table 1. Global atmospheric reanalysis datasets available or soon to become available (the latter in square brackets)

Reanalysis Centre	Name of the Reanalysis Product
ECMWF	ERA-40, ERA-Interim, [ERA-20C], [ERA-SAT]
NOAA/NCEP	NCEP/NCAR (R-1), NCEP/DOE (R-2), NCEP-CFSR
JMA	JRA-25/JCDAS, [JRA-55]
NASA	MERRA, [MERRA-2]
NOAA – CIRES	20CR

Meeting Outline

The purposes of the meeting were to finalise the report outline, to determine the diagnostics list and observational data for validation required for each chapter, to agree on the general guidelines and protocols, and to define the project timetable. Based on past SPARC activities (*e.g.*, SPARC CCMVal, 2010), the WG initially proposed 11 chapters. The first four “basic” chapters are the Introduction, Description of the Reanalysis Systems, Climatology and Interannual Variability of Dynamical Variables, and Climatology and Interannual Variability of Ozone and Water Vapour. The following, “advanced” chapters were initially proposed to be: The Brewer-Dobson Circulation, Stratosphere-Troposphere Coupling, The Upper Troposphere and Lower Stratosphere (UTLS), Polar

Processes, The Quasi-Biennial Oscillation (QBO), The Upper Stratosphere and Lower Mesosphere (USLM), and Gravity Waves. Prior to the meeting two co-leads were confirmed for most of the chapters. At the meeting, all chapters, except for the introduction, were given one hour for a presentation by the co-leads and discussion with the participants. The Brewer-Dobson Circulation session included short invited talks by some of the main contributors to the chapter (Hella Garny, Gabriele Stiller, Bernard Legras, and Howard Roscoe). For each chapter, the co-leads and two rapporteurs prepared a one-page summary slide for the wrap-up on the final day. The finalised chapter list with the co-leads' names is shown in Table 2. We decided to divide the UTLS chapter in two, one focusing on the extra-tropical UTLS (ExUTLS) and the other on the Tropical Tropopause Layer (TTL), with a section in the ExUTLS chapter summarizing overlapping issues between the two chapters. Also, issues related to transport processes and gravity waves will be distributed to various chapters (Simon Chabrillat and Nedjeljka Žagar led the discussion on these issues at the meeting). There were also a large number of poster presentations that stimulated discussion.

Table 2. Chapter titles and co-leads finalised at the meeting.

	Title	Co-leads
1	Introduction	Masatomo Fujiwara, David Jackson
2	Description of the Reanalysis System	Masatomo Fujiwara, David Tan, Craig Long
3	Climatology and Interannual Variability of Dynamical Variables	Craig Long, Masatomo Fujiwara
4	Climatology and Interannual Variability of Ozone and Water Vapour	Michaela Hegglin, Sean Davis
5	Brewer-Dobson Circulation	Thomas Birner, Beatriz Monge-Sanz
6	Stratosphere-Troposphere Coupling	Edwin Gerber, Yulia Zyulyaeva
7	ExUTLS	Cameron Homeyer, Gloria Manney
8	TTL	Susann Tegtmeier, Kirstin Krüger
9	QBO and Tropical Variability	James Anstey, Lesley Gray
10	Polar Processes	Michelle Santee, Alyn Lambert
11	USLM	Diane Pendlebury, Lynn Harvey
12	Synthesis Summary	Masatomo Fujiwara , David Jackson

At the meeting it was also decided that the project would focus solely on reanalyses (although some chapters may include diagnostics from operational analyses). Therefore, we decided to slightly rename the project to the **SPARC Reanalysis Intercomparison Project**, (*i.e.*, "analysis" has been dropped from the name suggested in the original proposal). For most of the chapters, we will compare newer reanalyses, *i.e.*, MERRA, ERA-Interim, JRA-25/JCDAS, NCEP-CFSR, and 20CR. We also aim to include JRA-55, ERA-20C, ERA-SAT, MERRA-2, *etc*., when available. Some chapters may include older reanalyses such as R-1, R-2, and ERA-40, because they have been heavily used in the past and are still being used for certain studies, and to gain insight into potential shortcomings of past research results. At the beginning of each chapter an explanation will be given as to why specific reanalyses were included/excluded. The intercomparison period is 1979-2012, *i.e.*, “the satellite era,” but some chapters will also consider the pre-satellite era before 1978.

On the first day of the meeting, before starting the chapter discussion, there were seven presentations by reanalysis centres. David Tan presented introductory comments on reanalyses and then talked about both the JMA’s activities (JRA-25/JCDAS and JRA-55), on behalf of Yayoi Harada, and the ECMWF’s activities (ERA-Interim, ERA-20C, ERA-SAT, etc.). Craig Long presented NOAA’s activities (R-1, R-2, CFSR, and 20CR), while Paul Berrisford presented routine diagnostics activities for various reanalyses carried out at ECMWF. Steven Pawson presented NASA’s activities (MERRA and MERRA-2) remotely. Adrian Simmons discussed detailed comparisons of MERRA and ERA-Interim temperatures and assimilated observations.

The chief outcome of the meeting was the drafting of plans for Chapters 2-11 of the S-RIP final report. These plans are briefly summarized as follows:

Chapter 2. Description of the reanalysis systems

This chapter shall include a detailed description of the forecast model, assimilation scheme and observational data assimilated for each reanalysis, together with information on each reanalysis “stream” and on what data are archived.

Chapter 3. Climatology and interannual variability of dynamical variables

A climatology of major dynamical variables, created from an ensemble of the newer reanalyses for the period 1979-2012 (1979-2001, allowing comparison with ERA-40, in the appendix) will be created on both standard pressure levels and potential temperature levels. Various key plots of the ensemble climatological means and individual reanalysis anomalies from these means will be created and presented in an online atlas. Inter-reanalysis variations will be quantified. Observations for validation include radiosondes, lidars, rocketsondes and various satellites, whose data were not assimilated in the reanalyses.

Chapter 4. Climatology and interannual variability of ozone and water vapour

This chapter will include a detailed evaluation of ozone and water vapour in the reanalyses using a range of observations obtained from sonde, aircraft, and satellite instruments. The diagnostics considered will include climatological evaluations, seasonal cycles, interannual variability, and trends. Other, more event-based diagnostics such as the tape recorder, QBO, and polar dehydration will be used to understand differences in the climatological evaluations, while detailed analysis of these processes will be covered in the “advanced” chapters. In addition, relevant information on the assimilated ozone and water vapour, and the prognostic representation of these fields in the reanalyses will be summarized.

Chapter 5. Brewer-Dobson circulation

This chapter will evaluate stratospheric circulation using diagnostics such as the age-of-air (mean age and spectrum), metrics for the strength of mixing barriers, and residual circulation quantities. Tendencies for heat and momentum as well as analysis increments will be considered. Eulerian chemistry transport models and trajectory calculations will be used. Results will be validated against satellite, ground-based, balloon, and aircraft observations of SF_6, CO_2, and NO_2, including the recent MIPAS datasets. Both climatological results and trends in the main diagnostics will be examined.

Chapter 6. Stratosphere-troposphere coupling

This chapter covers two-way coupling between the troposphere and stratosphere, focusing in particular on extra-tropical coupling on daily to intraseasonal time scales, and how this shorter-term variability is modulated on interannual time scales (*e.g.*, by ENSO). The chapter will synthesize and compare established approaches with more recent metrics to characterize planetary wave coupling and blocking, coupling of the zonal mean flow (*e.g.* the annular modes), and the mechanism(s) connecting the stratosphere and troposphere (*e.g.*, changes in tropopause height). There has been recent discussion on how to best characterize Stratospheric Sudden Warmings (SSWs). The established and alternative definitions of SSWs and the resulting impact on diagnostics of stratosphere-troposphere coupling will be explored.

Chapter 7. Extra-tropical UTLS

The diagnostics to be produced will include various tropopause identification methods, multiple tropopauses, the tropopause inversion layer, UTLS jet characterisation, estimates of horizontal boundaries between the ExUTLS and TTL, trajectories, and Rossby wave breaking. This chapter will also have a section that reviews common diagnostics for the ExUTLS and TTL.

Chapter 8. TTL

The diagnostics shall include the general TTL structure (cold point and lapse rate tropopause, *etc.*), clouds and convection (cloud fraction profiles, OLR, *etc.*), diabatic heat budget, transport (Lagrangian cold point, residence time based on vertical winds and heating rates, *etc*.), wave activity, and long-term changes (*e.g*., tropical belt widening).

Chapter 9. QBO and tropical variability

Diagnostics for this chapter will include analysis of the tropical QBO, its extra-tropical teleconnections (as well as other relevant teleconnections such as with ENSO and the solar cycle), its zonal momentum budget, and spectral characteristics of tropical waves including modal analysis and equatorial wave energetics. Observations for validation include operational and campaign radiosondes, rocketsondes, and satellites such as HIRDLS and SABER. Information regarding non-orographic gravity wave parameterization (if present) and analysis increments may also be utilised.

Chapter 10. Polar processes

This chapter will cover the formation of polar stratospheric clouds, chlorine activation, denitrification and dehydration, and (possibly) chemical ozone loss in the lower stratospheric winter polar vortices. Focus will be on process-oriented and case studies. The chapter will also include a review of previous works showing significant biases in lower stratospheric temperature, winds, or vortex strength/structure/evolution rendering some reanalyses (*e.g*., R-1, R-2, and ERA-40) unsuitable for polar process studies.

Chapter 11. USLM

This chapter will look at diagnostics including the Semi-Annual Oscillation, climatology of the winter polar vortex, SSWs focusing on stratopause evolution and mesospheric cooling, various waves (tides, two-day wave, and normal modes), inertial instability of the tropical stratopause, and Hadley circulation of the stratopause region. Observations including SABER, MLS, the NDACC database, and CMAM20 (a model nudged to reanalysis), will be used for validation purposes and to extend our knowledge of the state of the middle atmosphere. NOGAPS–ALPHA may also be considered for case studies.

Overview of the Project Schedule

We shall finalize the “basic” chapters (*i.e*., Chapters 1-4) within 2 years. The “advanced” chapters (5-12) will evolve slightly more slowly, with an interim report every year. We will have dedicated S-RIP meetings every year and side-meetings at various occasions.

We welcome your contributions to this project. Please contact the authors of this article and/or the co-leads of the relevant chapters directly. Up-to-date information will be made available through the S-RIP website (temporally at http://wwwoa.ees.hokudai.ac.jp/~fuji/s-rip/).

Acknowledgments

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Reference

Fujiwara, M., S. Polavarapu, and D. Jackson, 2012: A proposal of the SPARC Reanalysis/Analysis Intercomparison Project, *SPARC Newsletter*, **38**, 14-17.

SPARC CCMVal (2010), *SPARC Report on the Evaluation of Chemistry-Climate Models*, V. Eyring, T. G. Shepherd, D. W. Waugh (Eds.), SPARC Report No. 5, WCRP-132, WMO/TD-No. 1526.

Figure Caption:

Figure 1: Participants of the S-RIP Planning Meeting.