The proposed "SPARC Reanalysis/Analysis Intercomparison Project (S-RIP)"

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1. Summary

- Reanalyses are invaluable datasets for middle atmosphere science community, serving as proxies for the real atmosphere in process studies, as verification data for chemistry climate model validations, and perhaps eventually for trend analyses. Reanalyses are found to differ in various aspects concerning the middle atmosphere such as the strength of the Brewer-Dobson circulation, polar vortex evolution, temperature trends, tropical wave spectra and tidal depiction.
- Thus, in order to provide guidance to middle atmosphere scientists as well as feedback to reanalysis data providers, a new SPARC (Stratospheric Processes and their Role in Climate) project has been proposed in which all available global reanalysis data sets will be examined in terms of some key middle atmospheric diagnostics.
- This is a collaborative effort between the SPARC and reanalysis communities.
- The main goals of this project are to open a good communication platform between the SPARC and reanalysis communities, to understand the current reanalysis products, and to contribute to future reanalysis improvements in the middle atmosphere region.
- The project will hold two or three dedicated workshops, where analysis results are discussed among the SPARC community and the reanalysis centers, and produce the final report as a SPARC report, which reviews the then past and near-future publications. The project duration is expected to be 3-5 years for the first phase.

2. Available Global Reanalysis Data Sets

Product	Centre	Period	Resolution and Lid Height of the Forecast Model
NCEP-1	**NCEP and NCAR**	**1948-present**	**T62, L28; 3 hPa**
NCEP-2	**NCEP and DOE AMIP-II**	**1979-present**	**T62, L28; 3 hPa**
ERA-40	**ECMWF**	**1957-2002**	**TL159 and N80 reduced Gaussian, L60; 0.1 hPa**
ERA-Interim	**ECMWF**	**1979-present**	**TL255 and N128 reduced Gaussian, L60; 0.1 hPa**
JRA-25/JCDAS	**JMA and CRIEPI**	**1979-present**	**T106, L40; 0.4 hPa**
MERRA	**NASA**	**1979-present**	**(2/3)x(1/2) deg., L72; 0.01 hPa**
NCEP-CFSR	**NCEP**	**1979-present**	**T382 (T574 for post 2010), L64; 0.266 hPa**
NOAA-CIRES 20th Century Reanalysis (20CR)(*)	**NOAA/ESRL PSD**	**1871-2009**	**T62, L28; 2.511hPa**

(*) 20CR assimilates only surface pressure reports and uses observed monthly sea-surface temperature and sea-ice distributions.

- New reanalysis data sets coming soon (within a few years):
  - NCEP-CFSR-Lite, ERA-20C (and ERA-SAT), and JRA-55 (and JRA-55C)
- Some available "analysis" data sets:
  - Met Office stratospheric assimilated data, operational ECMWF and NCEP analyses, NASA GEOS-5, NOGAPS-ALPHA, etc.

3. Possible Diagnostics

- Region of interest: Middle atmosphere, including the upper troposphere lower stratosphere (UTLS) region and the troposphere which is coupled with the stratosphere
- Possible middle-atmosphere diagnostics include:
  - e.g., climatology, interannual variations, trends; Brewer-Dobson circulation and age of air, Stratosphere-Troposphere dynamical coupling, UTLS sciences, events (volcanoes, unstable/stable polar vortex), mass conservation, trajectories, etc.
  - i.e., "key" for middle atmosphere sciences
  - more appropriate diagnostics grouping?: e.g., those affecting
    - ✓ stratospheric ozone
    - ✓ water vapor
    - ✓ circulation (Brewer-Dobson circulation)
    - ✓ climate (interannual variations and trends)
  - need to ensure overlap with the requirements of other SPARC activities (e.g., CCMVal, DynVar)
  - the actual diagnostics will be suggested by the Scientific Working Group and determined by individual researchers
- Suggestions of diagnostics from reanalysis data providers/technical experts: e.g.,
  - Transport fidelity (why are some reanalyses better than others?)
  - How can operational satellite instrument (MSU/AMSU) data be better assimilated? What is relative instrument bias?
  - How can tides be better represented in analyses?
  - Can we integrate limb and other research satellite observations usefully?
  - How can we correct biases in middle atmosphere analyses?

4. Operation and Schedule

Scientific Working Group (~10 members; to be formed soon)
- suggests the diagnostics and specific approaches of data analyses
- finds the researchers to lead each chapter of the final report and those to work on each of the diagnostics
- edits the final report and makes the reviewer assignments
- gathers all the necessary technical information of the reanalysis data sets for the interpretation of the comparison results

All SPARC-related researchers
- perform the data analysis
- write journal papers
- contribute to the S-RIP workshops and reports

Schedule :
- June 2011: The S-RIP idea first discussed at SPARC Data Assimilation workshop
- January 2012: Proposal article appeared in SPARC Newsletter
- February 2012: S-RIP was officially proposed at the SPARC SSG meeting
- May 2012: 4th WCRP International conference on Reanalyses, Silver Spring, USA
- June 2012: 9th SPARC DA workshop, New Mexico, USA (S-RIP session)
- June 2012: SPARC workshop on the Brewer-Dobson circulation, Switzerland
- 2013-4: 2-3 dedicated workshops on S-RIP
- 2015-6: Write final (SPARC) report
- Post 2016: Additional phases as reanalysis centres envisage a 7-year period between new generations of reanalysis products

5. Some Examples (based on the monthly averaged data sets provided by the renalysis centers)

5-1. Global 70 hPa temperature

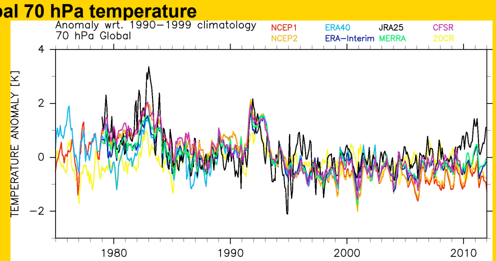

Figure 1. Time series of global-mean 70 hPa temperature anomalies with respect to the 1990-1999 climatology for each data set. The two volcanic signals in 1982 (El Chichon) and 1991 (Pinatubo) are visible with different magnitude and duration. For other periods, some outliers are also seen.

5-2. Tropical 100 hPa temperature climatology during the 1990s

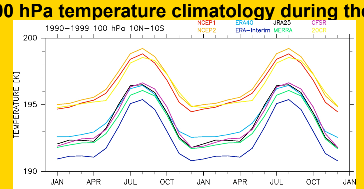

Figure 2. 10N-10S 100 hPa climatology during 1990-1999. NCEP1 and NCEP2 show higher values (with negative trends during the 1990s which are not shown). ERA-Interim show ~1 K lower values compared to ERA-40 and other data sets. Note that 1 K difference at 100 hPa roughly corresponds to 0.5-1 ppmv difference in saturation water vapor mixing ratio, while tropical lower stratospheric water vapor concentration is 3-4 ppmv. Therefore, the above mentioned differences are serious.

5-3. Polar 50 hPa temperature anomalies

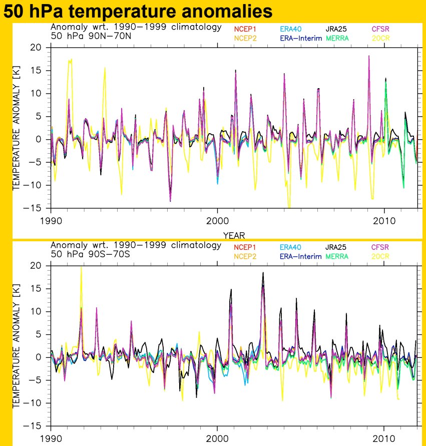

Figure 3. Arctic (90N-70N, top) and Antarctic (90S-70S, bottom) 50 hPa temperature anomalies with respect to the 1990-1999 climatology for each data set. In the Arctic region (top), year-to-year variability is large in northern winter-spring months, while in Antarctica (bottom), year-to-year variability is large in southern spring months. Differences are seen in different reanalyses. (Note that polar temperatures are key for PSC formation and ozone depletion and that 196 K and 188 K are approximate threshold temperatures for the formation of Type I PSC (NAT) and Type II PSC (water ice), respectively, at HNO_3=10 ppbv and H_2O=5ppmv.)

Reference: Fujiwara, M., S. Polavarapu, and D. Jackson, A proposal of the SPARC Reanalysis/Analysis Intercomparison Project, *SPARC Newsletter*, No. 38, 14-17, January 2012.