Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-289-AC1, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Climatology and Interannual Variability of Dynamic Variables in Multiple Reanalyses Evaluated by the SPARC Reanalysis Intercomparison Project (S-RIP)" *by* Craig S. Long et al.

Craig S. Long et al.

craig.long@noaa.gov

Received and published: 18 July 2017

We thank Referee #1 for these valuable comments and suggestions.

This study provides a comprehensive overview of the temperature and zonal wind biases in eight reanalysis data products, with a focus on stratospheric levels. The study identifies biases in each reanalysis from the "reanalysis mean" (defined as the mean of the MERRA, ERA-Interim, and JRA-55 reanalyses). It then examines reanalysis temperature biases with respect to HIRDLS (an independent satellite measurement)

Printer-friendly version

Discussion paper

and MSU/AMSU/SSU satellite data products. The authors identify systematic biases and notable change points in the reanalyses associated with discontinuities in data sources, such as the transition from TOVS to ATOVS around 1998-1999. One of the key conclusions of the study is the pervasive uncertainty in zonal winds in the tropical stratosphere, largely because of the inability of reanalyses to resolve the waves that drive zonal wind variability in this region.

This paper is not likely one that most readers will read from beginning to end, as it contains a highly technical description of reanalysis biases. While many of the issues discussed have been discussed in previous literature, this document serves a centralized review by the SPARC S-RIP Project of these issues, providing a guidance document to reanalysis users (to understand biases) and to reanalysis data centers (to improve upon existing reanalysis products). For these reasons, I recommend publication of this manuscript. However, I think the paper would be more useful if it provided more detailed guidance and suggestions as to the improvements necessary in future reanalysis products. Comments and suggested revisions are detailed below.

Response: In the summary we will include comments about the TOVS period and the transition to ATOVS. The TOVS time period may never be as good as the ATOVS period due to the sparsity of data. Model improvements, improvements to the Variational Bias Corrections (VBC) to handle the broad SSU weighting functions, and non-orographic gravity wave parameterization improvements (so the forecast models can generate a QBO on their own) are some of the ways this period can be improved upon.

Minor Revisions 1. The authors could do more to provide guidance to improve future reanalysis products, particularly focusing on what improvements were already made from ERA-40 to ERA-Interim, JRA-25 to JRA-55, and MERRA to MERRA-2 to reduce biases. This knowledge would be particularly helpful in interpreting the results in Figs. 6-9, where the authors compare the biases among these reanalysis products. For example, if ERA-Interim has smaller biases than ERA-40 in a certain region, it would be useful to more clearly emphasize what improvements might have reduced these

biases.

Response: We will add a section briefly highlighting the improvements from the older version to newer reanalysis. The common improvements are to the Radiative Transfer Model (RTM) in both the forecast model and that used in the assimilation step, model horizontal and vertical resolution, and bias correction.

2. I'm curious as to why the authors did not directly evaluate the reanalysis temperatures against GPSRO data. GPSRO provides high vertical resolution satellite-derived temperature measurements up to 40 km altitude. It is clear from Fig. 15 that the inclusion of GPSRO data in some reanalysis products had a substantial impact after 2006.

Response: A section with supporting figures will be added showing the comparisons of the more recent reanalyses (CFSR, ERA-I, JRA55, MERRA, and MERRA2 vs COSMIC monthly zonal mean temperature from 400-10 hPa for the years 2007-2014.

3. I'm also curious about why the authors focus on the polar regions and tropics and do not discuss biases at midlatitudes. Is there a reason why midlatitudes are not discussed in this paper?

Response: A section (without supporting figures) will be added discussing the midlatitudes.

4. The paper deserves a thorough and careful proofreading. I caught a number of inconsistencies between the manuscript text and the figures, which need to be corrected prior to publication. I've listed some examples below, but I'm sure there are others that I may have missed. a. p. 8, Line 27: In Fig. 4c, the disagreement between 7 and 5 hPa appears to terminate in 2002, not in 1998 (TOVS/ATOVS transition).

Response: Will check and correct text as needed.

b. p. 11, Line 11: persistent cool bias from August to November

Response: Will do

c. p. 11, Line 12: upper stratosphere warm bias

Response: Will do

d. p. 12, Line 14: In Fig. 8i, the CFSR biases near 100 hPa appear to stop at the TOVS/ATOVS transition, not continue through it as the text states.

Response: Will do

e. p. 12, Line 16: 0.5 to 2 K

Response: Will do

f. p. 12, Lines 19-28: Please double-check the magnitudes in this paragraph, as they seem inconsistent with Fig. 8f.

Response: Will do

g. p. 13, Line 25: It does not appear from Fig. 9m that the westerlies are stronger during the TOVS period. They look stronger throughout the entire data record.

Response: Will check and correct text as needed.

h. p. 15: The color ranges in Fig. 11 do not match those discussed in the text in section 5.

Response: Will check and correct text as needed.

i. p. 17, Lines 4-6: In Fig. 14b, the MERRA warm bias only occurs in November through February during the first year (Nov. 2005-Feb. 2006). After that, the warm bias is primarily confined to the 5-10 hPa pressure range.

Response: Will check and correct text as needed.

j. p. 20, Line 14: cool bias at 1 hPa and warm bias between 2-3 hPa

Response: Will check and correct text as needed.

k. Line-by-line comments

p. 1, Line 19: among the reanalyses themselves

Response: Will do

p. 2, Line 19: I didn't see any mention of the v and w wind fields in the text.

Response: We focused this paper upon temps and zonal winds.

p. 5, Line 13: The volcanic warming is primarily confined to the lower stratosphere.

Response: Yes

p. 6, Line 27: Why do the minimum temperatures occur before the winter solstice?

Response: The polar circulation forms in austral fall at the top of the stratosphere shutting out horizontal advection. Radiative cooling takes over and progressively moves towards the surface.

p. 7, Line 12: This sentence seems out of place. The QBO and SAO are not introduced until the following paragraph.

Response: Will check and correct text as needed.

p. 9, Line 27: How large are the 20CR biases in the stratosphere? It might be useful to warn readers against using 20CR data, as large biases in stratospheric dynamics might also have a substantial impact at tropospheric levels.

Response: Will add text to summarize the following deficiencies of the 20CR in the stratosphere: - 20CR does not have a QBO, hence no time variability of temps and winds in the lower stratospheric tropics, - 20CR does not capture SSW, hence NH winter temps are > 5C colder, and polar jets are stronger - 20CR is 3-4C warmer at 100 hPa in the tropics (possible result of coarse model vertical resolution) - 20CR has larger annual temp oscillation from 200-850hPa in the tropics.

p. 14, Lines 5-11: MERRA-2 is not discussed in this paragraph, but it looks as if it also has sizeable wind biases in the tropical troposphere.

Response: Will check and correct text as needed.

p. 14, Line 20: 1980-2014 period

Response: Will check and correct text as needed

p. 15, Lines 26-29: I'm not sure that I understand how a year-round temperature bias (+ for CFSR and – for JRA-55) impacts the amplitude of the annual cycle. Perhaps this could be clarified.

Response: Clarification will be added.

p. 16, Lines 3-8: Why would a sudden stratospheric warming increase the amplitude of the annual cycle in the Northern Hemisphere but decrease it in the Southern Hemisphere (2002)?

Response: The cold temp anomalies following the warming in the upper stratosphere enlarge the winter_min/summer_max difference. The 2002 SH warming (which occurred in SH spring) did not have cold air following the warming. In fact the winter time temps were warmer than normal thus decreasing the annual amplitude for that year. This will be added to the text.

p. 18, Line 13: 0.5 K

Response: Will check and correct text as needed

Figs. 4-5: The authors need to more clearly describe what they are plotting in these figures. The standard deviation of 3 data sets seems somewhat of an unusual metric, as standard deviation is typically used for larger sample sizes than 3. It might be clearer to simply show the difference between the maximum value of the 3 reanalyses and minimum value of the 3 reanalyses at each month/latitude/pressure.

Response: Keeping st dev just as an index of the degree of disagreement.

Fig. 9: It might be helpful to mark the QBO phases somehow on these figures. Otherwise, it is extremely difficult to see what the authors are discussing in section 4.2.3.

Response: Understood. But difficult to add that to these plots.

Fig. 10: Pressure axis needs to be labeled.

Response: Will do

Fig. 15: It would useful to give the approximate altitude/pressure ranges for the TLS, SSU1, and SSU2 weighting functions, as some readers may not be familiar with them.

Response: Agreed, these will be included in text.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-289, 2017.

Printer-friendly version

Discussion paper