

Review of “Reanalysis intercomparison of potential vorticity and potential-vorticity-based diagnostics” by Luis Millan et al. submitted to Atmospheric Chemistry and Physics.

Summary: In this manuscript, the authors present a thorough intercomparison of reanalysis potential vorticity and diagnostics related to potential vorticity. One modern reanalysis product from four of the major global operational and research centers are selected: CFSR/CFSv2, ERA-Interim, JRA-55 and MERRA2. As part of the SPARC Reanalysis Intercomparison Project, this paper provides clear advice to users of reanalysis PV diagnostics as well as recommends reanalysis centers to consider including PV on model levels in future products for optimal comparisons and scientific studies in the future. My one concern is the number (15) and size (multi-panel) of the figures relative to the text, however I do not see any that can be cut down in size or removed from the main text and included in a supplemental instead. Therefore, I recommend this paper for publication after my minor and technical comments below are addressed.

Comments:

Pg 1 Line 8, Pg 2 Line 32: Add “NASA” before “Modern” since the reanalysis center for the other three products is given.

Pg 2 Line 21: I think the comma after “Nash et al., 1996),” should either be a semi colon or a period.

Pg 3 Line 4: Update Table 1 MERRA2 reference to match Gelaro et al. 2017 reference used here.

Pg 3 Line 4: Is there a reason ERA-Interim is used instead of ERA-5, the latest ECWMF reanalysis?

Pg 3 Line 7: Why is the period 1980 through 2014 used?

Pg 3 Line 11, Pg 5 Line 21: I checked the ERA-Interim website and I see "Vorticity (relative)" for ERA-Interim on Model Levels. <https://apps.ecmwf.int/datasets/data/interim-full-daily/levtype=ml/>

Pg 3 Line 26: ERA-Interim and JRA-55 have coarser resolution than 0.5x0.5 degree. Could this impact your study?

Pg 4 Line 9, Pg 5 Line 2: Correct me, but I do not see the different processing streams discussed or labelled on Figure 1 or 3, so do we assume that this does not impact PV anomalies? There is mention of a “CFSR to CFSv2 transition” on Pg 8 Line 6 but when this occurred is not stated.

Pg 4 Line 12: Should “regions” be singular since only the south pole is referenced here and not both poles?

Pg 4 Line 32: Can the authors comment on the fact that the CFSR differences are of opposite sign to the other reanalyses.

Pg 5 Line 11: Can the authors comment on what may cause this difference at CFSR at 2500K? Is this at all related to the model resolution or how the model treats the upper atmospheric levels? or that CFSR has the lowest Lid height (0.26 hPa, Table 1)?

Pg 5 Line 12: “near 850K” looks more like 850-1000K to me. Are the pixels centered on an isentropic level?

Pg 6 Line 1: UTLS is not defined.

Pg 6 Line 15: The lowest levels are not of interest to this study but can the authors comment on the “highest levels”. Does the top of the atmosphere change between the models that this criterion matters at all?

Pg 6 Line 17: It is hard to see along the bottom of the figure. What is the lower limit on Figure 5? Is it 400 K?

Pg 6 Line 21: Suggest adding “; however” connecting these two sentences.

Pg 6 Line 31-Pg 7 line 2: Can the authors comment on why this might be?

Pg 7 Line 4: This looks less evident for MERRA2 after 2005

Pg 7 Line 19: is altitude above sea level or above surface (ground-level)?

Pg 7 Line 26: “can be up to 1 km”, does this have anything to do with the difference model resolution in the UTLS?

Pg 8 Line 12: add “(not shown)”

Pg 8 Line 14: In general for this section, do the authors use the native resolution or the 0.5x0.5 degree interpolated resolution?

Pg 9 Lines 30-31: I suggest referencing Figure 11 here since later in this paragraph you reference Figure 12.

Pg 10 Line 3: Is there a reference for selecting this vortex area of $0.15 \times 10^7 \text{ km}^2$?

Pg 10 Line 17: capitalize “southern”

Pg 10 Line 20: Looks to me CFSR is at 500K and 440K.

Pg 10 Line 22: Suggest moving the sentence starting with “MERRA-2” to after “midwinter).” to keep the upper-level discussion together.

Pg 10 Line 26: add “both” before “showing”

Pg 10 Line 26-27: Could the discontinuity in ERA-I be related to a change in processing streams?

Figures:

Figure 3: The y-axis has minor ticks which seem to be greater than the resolution of the pixels. I recommend reducing the minor ticks. Can annual minor ticks be added to the x-axis on this and the other figures?

Figure 7: Can the y-axis include 30degree latitude interval labels since it is referenced several times on Page 7.