

Author response to Referee 1 comments

I thank the referee for reviewing the manuscript. I have tried to address all of the comments and revise the manuscript, and hope the revision is satisfactory. Before responding to each comment, I note several changes:

-Figures 10 and 11 now include results from CONV.

-Figure 12 in the previous version has been removed. The figure and discussion were a bit lengthy compared to the messages obtained. I mention the results from the figure in the text only, so that this does not affect the overall argument in this study.

-I have corrected some existing figures (Figs. 2c, 5b, 9a,b), but this does not affect the argument. Figure 5b in the previous version used the (CL, AR) data for STDD on the MSSW onset dates identified in CONV. It now uses the (CL, AR) data for STDD on the MSSW onset dates identified in STDD. In Figs. 2c and 9a,b, a few color shades did not appear as intended.

Please also note that the pages and numbers in my response below refer to those in the (unformatted) manuscript.

One general but minor comment I have is that the use of the STDD, CONV, and AMIP acronyms was not particularly useful and in fact made things more muddled. I would recommend just sticking with JRA-55, JRA-55C, and JRA-55AMIP. If the author thinks the acronyms add something, then the acronyms should at least be used earlier in the abstract/introduction so that readers become used to seeing them prior to section 2.

Because this study deals with the JRA-55 family data only, the “JRA-55” part in JRA-55 (standard), JRA-55C, and JRA-55AMIP are obvious and redundant, and hence could be removed. One could then refer to the products as standard, conventional, and AMIP: I simplify these by using the acronyms (STDD, CONV, and AMIP), and I think these are clear and easy to remember when reading the manuscript. I have introduced these acronyms in Abstract and Section 1, as suggested.

The other general comment I have is that I appreciated the creativity the author used to make the plots, some of which were very useful ways of visualizing the results; but Figure 8 went a bit overboard, with different symbols, colors, letters and numbers. Some of these attributes may be useful, like the colors; but the different symbols didn't seem to point to anything of particular interest. Right now the text reads (Page 8, Line 21-22 and Line 27-28): “Both overestimations and underestimations in the zonal wind by CONV occur for these cases”, which indicates that these symbols are not adding much to our understanding and making the plot more difficult to read. The author could just make a note in the text that they also considered biases in the CONV winds relative to the STDD winds but didn't notice any systematic relationship.

As suggested, I have simplified Fig. 8 and added a note in the text (p. 8, l.23).

Specific Comments

Page 1, Line 9, 19: It is not entirely clear what “conventional” observations include until section 2. It would be better to directly state here that this means everything except satellite data.

Fixed.

Page 1, Line 13: Readers unfamiliar with vortex geometry diagnostics may be unfamiliar with “aspect ratio” of the polar vortex; might be good to briefly relate this to displacements/splits here to be clear. Also in section 2.2.2.

I have added “in which the vortex is highly stretched or splits” to clarify MSSW features of high aspect ratio of the polar vortex (p. 1, l. 15). In Section 2.2.2, we already mentioned that AR is a measure of how stretched the vortex is. A more specific relationship of CL and AR is explained when presenting results (p. 6, l. 30-).

Page 2, Line 17: Here, is “This study” referring to S-RIP, or to the current study?

Fixed. I have rephrased this part as “The present study”.

Page 3, Line 21: prior to 1979, how different are the CONV and STDD products?

CONV is different from STDD even before 1979, as Kobayashi et al. (2014) state “The JRA-55C covers the period from November 1972, when the JRA-55 starts to use satellite data, to 2012”. Figure 12 does not suggest a gap in RMSD between before and after 1979 for NH winter or SH spring.

Page 5, Line 9-10: Might mention that the tropospheric jets seem shifted, which may (or may not) be consistent with biases in the stratosphere.

I have added a sentence about the zonal wind differences in NH for DJF (p. 5, l. 11-).

Page 6, Lines 32-33, Figure 5: Maybe I’m just confused about what exactly this plot is showing, but I don’t understand why in panel (b), the black dots representing STDD don’t seem to match the location of the STDD dots in panel (a). This makes lines 32-33 also confusing, as the statement does seem accurate based on the red/black dots in panel (b) but does not seem accurate when comparing panel (b) to panel (a).

Figure 5b is now corrected to use the (CL, AR) data for STDD on the MSSW onset dates identified in STDD. The description about Fig. 5b is modified at p. 7, l. 3.

Page 7, Line 5-6: Might mention that this implies few splits in AMIP.

Fixed. I have added a sentence mentioning this.

Page 8, Line 19-20: the closeness to the y-axis may indicate a large contribution from the wave component, but in terms of proximity to the y-axis, there seems to be many “red”/weak wind points as

well as strong ones. Might need to rephrase to clarify that for large values of the y-component, the zonal wind is stronger.

I have explained that the zonal wind in STDD is relatively strong when the y-component is large (≥ 100 m) at p. 8, l. 21.

Page 9, Line 5: Just to clarify, in Figure 9 are you comparing the products using dates from STDD for both, or the central dates of each product?

We take the former option in Fig. 9. Namely, it uses the dates defined in STDD.

Page 10, Line 12-13: Just to clarify, in Figure 11 are the grey lines all the cases between 25-75th percentile?

I guess “the grey lines” may be thin blue or red lines in Fig. 11. Anyway, yes, this figure used all the 25th to 75th percentile values of the maximum heat flux in STDD, but the thin lines are removed for simplicity, and only the composites are shown.

Also, is the number of cases in your stated 25-75th percentile range similar for AMIP and STDD? It looks somewhat similar in Figure 10 but might be worth mentioning.

I have added the values for AMIP (p. 10, l. 19).

Also you could consider drawing in light dashed lines the 25th and 75th percentile lines in Figure 10, as a way to clarify what you are plotting in Figure 11.

Fixed.

Page 12, Line 10-12: Is there a difference in latitude of maximum heat flux/EPFD forcing, or a difference in the maximum winds of the climatological polar jet in these data sets (or the edge of the vortex)? Could that also have an influence?

The climatological polar night jet in AMIP is stronger than in STDD, and the maximum is located somewhat more poleward (see Fig. A1, attached below). This feature is also seen in Fig. 1c. On the other hand, the latitudinal profiles of the maximum heat flux are similar between STDD and AMIP. The stronger climatological jet in AMIP may play a role in the different vortex responses (as discussed in Section 5) of AMIP from STDD

Page 15, Table 1 caption: make clear that “differences” are the number of days between onset dates.

Fixed.

Page 16, Figure 1: It wasn't entirely clear from this figure whether values between -5 to +5 are not significant (since they still are shaded)- could this be more clear? Or are any shaded values significant? I guess it's confusing since the colorbar doesn't have any white, non-significant level.

Yes, any shaded values in Fig. 1 are judged to be significant, as “Color shades (in Fig. 1) plot only differences of CONV or AMIP from STDD that are judged to be statistically significant”. I have added the word “only” here (p. 4, l. 28).

Page 18-19, Figures 3-4: I think these could be made more clear by staying consistent across panels and always making STDD line dashed, even in panel (a),(d). Also state in the caption what the non-bold and bold lines refer to.

Fixed.

Page 19, Figure 4: I would add in DJF to the plot titles for the top row and SON to the plot titles for the bottom row.

Fixed.

Page 26, Figure 11: by residual [v], do you mean the TEM term \bar{v} star? Or what is meant by residual [v]? (and page 10, line 17).

Yes, the “residual [v]” means the TEM term \bar{v} star. I have explained this at p. 10, l. 24, and Fig. 11 caption.

Technical Corrections

Page 1, Line 18: change “It shows” to “We find”

Fixed (p. 1, l. 20).

Page 1, Line 21: “vital” is maybe not quite the right word here

I have rephrased the word to “important” (p. 1, l. 23).

Page 1, Line 26: “Some of weak conditions”! remove “of”

Fixed (p. 1, l. 28).

Page 2, Line 5: “the middle atmosphere science”; remove “the”, change to middle atmosphere dynamics

Fixed.

Page 2, Line 10: Missing “with” after “associated”

Fixed.

Page 2, Line 11: “metrological” should be “meteorological”

Fixed.

Page 2, Line 13: I would change “go along with” to “are part of”

Fixed.

Page 2, Line 33: I’m not sure what is meant by “articulate design”. Maybe “meticulous” would work better? Same with Page 11, Line 25.

Rephrased as suggested.

Page 5, Line 22: change “at the grid points are” to “at this location is”

Fixed.

Page 5, Line 32: delete “the”, change “wind” to “winds”

Fixed.

Page 7, Line 23: should be Fig 6b,d.

Corrected.

Page 8, Line 3: change “whereas even in” to “and even” (remove “in”)

Fixed.

Page 8, Line 10: change to “Figure 8 presents scatter plots of the zonal and wave components contributing to the total RMSD values for these cases.”

Fixed.

Page 8, Line 12: Change “on” to “of”

Fixed.

Page 9, Line 20-21: change to “explained in terms of wave forcing from the troposphere and/or the vortex response in the stratosphere.”

Fixed.

Page 10, Line 13: change to “25th” and “75th”

Fixed.

Page 10, Line 16: might say “This feature is quite similar between the two products by construction” since you have chosen the range of heat flux values to be similar.

Fixed.

Page 10, Line 23: not sure “contributed by” is the right phrase here. Maybe “can be attributed to”.
Fixed.

Page 10, Line 33: change “use” to “uses”

This part has been removed (Fig. 12 in the previous version).

Page 11, Line 15: change “larger in magnitude as going toward” to “increases in magnitude toward”

Changed as suggested (p. 11, l. 10).

Page 11, Line 30: change “These differences of CONV” to “The differences in CONV”

Changed as suggested (p. 11, l. 25).

Page 12, Line 19: change “should” to “could” (since model biases are potentially possible in CONV as well, given lack of non-satellite data in stratosphere).

Changed as suggested (p.12, l. 18).

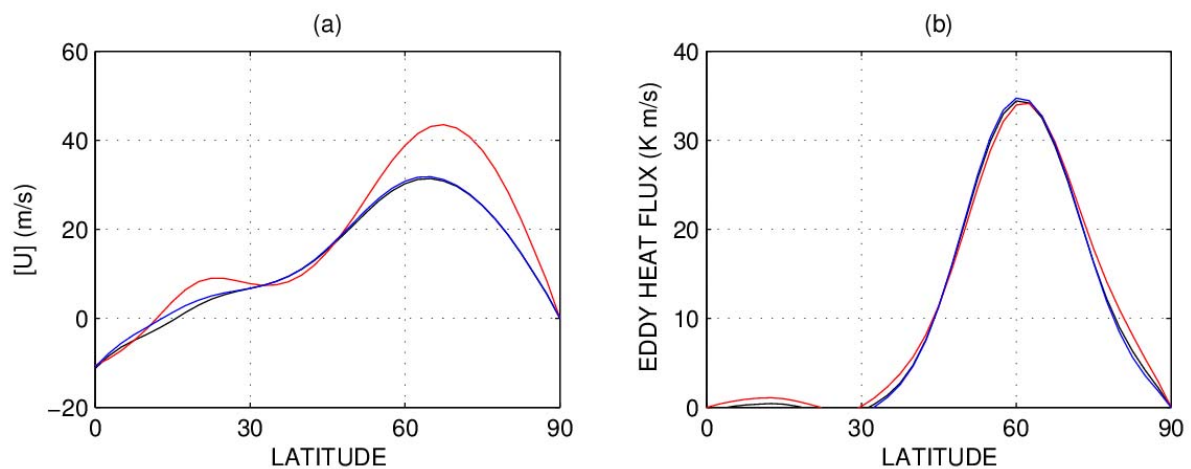


Figure A1: (a) Latitudinal distributions of the climatological zonal mean zonal wind at 10 hPa: (black) STDD, (blue) CONV, and (red) AMIP. Panel (b) is similar, but plots poleward eddy heat flux of waves 1-3 at 100 hPa averaged from lag= -20 to 0 day. Here, the lag= 0 day is when the 21-day mean heat flux in 40-90N, 100 hPa maximizes for each DJF season (as in Fig. 10b).