

## Author response to Referee 2 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.

### Major comments:

I think the summary and discussion should be expanded a bit. What does it mean for the quality of the reanalysis if the AMIP type experiment has too little variability? I guess you would expect that if the model was perfect then the statistics of the AMIP experiment would be similar to the statistics of the reanalysis. Do the results of this paper mean that we should expect the number of sudden warmings to be underestimated in the reanalysis products?

I have added a discussion sentence suggesting that even STDD (or CONV) may underestimate stratospheric variability (p. 11, l.27).

It is generally accepted that sudden warmings include some preconditioning. It could be the case that the general lower wave-forcing in the AMIP experiment leaves the vortex very strong so that even after a strong wave event we don't see a sudden warming. Perhaps this is discussed in the text with other words but I would like the authors to include the concept of "preconditioning".

I have added a sentence that suggests a possible relationship of the stronger vortex to a lack of preconditioning in AMIP (p. 12, l. 9).

### Minor comments:

Perhaps the title could be more precise on what the paper is about. I would suggest that the words "reanalysis" and "assimilation" should be included in the title. Not everybody knows what the "JRA family" is.

I have added a subtitle "Impacts of assimilation of observational data in JRA-55 reanalysis data" as suggested.

p1, 115: This sentence is unclear.

I have rephrased a few sentences around it (p. 1, l.15-17).

p2, 116: ".. will also be investigated". Does that refer to the S-RIP or the present paper?

I have added a word "there" at the end of sentence, so that this sentence refers to the S-RIP work, not the present study (p.2, l. 17).

p5, top: The degrees of freedom used in the statistical tests should be given. I guess you treat all months as independent. But this assumption at least requires some discussion.

I have mentioned that the degree of freedom in the test is equated to the number of years (p. 5, l.2). This is a reasonable treatment since the test uses DJF or SON means for the target years and they can be regarded independent from year to year.

p11, 13: over 4 -> above 4

This part has been removed.

p17, 18 RMSE -> RMSD?

Fixed (p. 8, l. 18).

p5, 122: The sentence "The zonal wind at the gridpoints" does not make sense.

I have rephrased it (p. 5, l. 24).

p5 130: It should be made clear here that this sentence refers to a single event.

I have rephrased the sentence slightly, so that it is clearer that it refers to a single event of the SH MSSW in September, 2002 (p. 6, l.1).

p6, 16: The difference in the widths of the pdf's is very small.

I have rephrased the sentence avoiding the use of "narrow(er)" at p. 6, l. 9-10.

p6, 128: Why is there this linear relationship between AR and CL? It seems that if the displacement is large then the change in shape is large? Is this physically based or an effect of the way the parameters are calculated?

Please note that a large displacement of the vortex is captured by a large decrease in CL. The next sentence also explained/explains how the linear relationship between AR and CL arises for the MSSWs (p. 7, l. 1-2).

Table 1: Why is the AMIP experiment not in the table?

The MSSW dates in AMIP were/are not included in Table 1, since it will not make much sense to compare the AMIP dates to the STDD or CONV dates. The MSSWs in AMIP (free-running simulation) are internally generated, and their exact dates are irrelevant from those in STDD and CONV.