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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A comparison of Loon balloon observations and stratospheric reanalyses products" *by* Leon S. Friedrich et al.

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We would like to thank the reviewers for their insightful questions and suggestions for improvement that they have provided. In the remainder of this document bold text identifies responses to reviewers comments.

Author team.

Reviewer 2 Comments and Responses

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Discussion paper

The authors compared zonal and meridional winds of ERA-Interim, MERRA, MERRA–2 and NCEP CFSv2 reanalyses with those derived from X Project Loon. The goal of this study is to test the potential for the Loon to be used in the evaluation of reanalyses. Because the Loon data is not assimilated in each reanalysis, the Loon should provide a useful independent test of atmospheric reanalysis winds. The purpose of this study is well written. This paper includes very new results contributing to reanalysis communities. X Project Loon might have large potential to improve reanalyses in the future. I believe this paper is suitable for the publication in ACP. I have a few comments written below.

<Specific comments> (1) Abstract: "All reanalysis data sets accurately describe the winds, with biases in zonal winds of less than 0.37m/s and meridional biases of less than 0.08m/s. The standard deviation on the differences between Loon and reanalyses zonal winds is latitude dependent, ranging between 2.5 and 3.5 m/s increasing equatorward"

P3L2–3: "Both analyses accurately represented the winds with biases of less than 0.3 m/s and standard deviations ranging from 2.3 to 2.7 m/s", and also P3L8, P3L14, P3L18, P4L3–5 etc.

The bias and standard deviation depend on time scales analyzed (i.e., hourly, daily, monthly). The authors should indicate output intervals analyzed in each case. In addition, as the authors sometimes speculate differences due to gravity waves, differences between reanalyses and observations also depend much on their vertical resolutions. More careful explanations are needed.

Throughout this study our analysis uses this 1 minute temporal resolution data for comparison with interpolated reanalysis data or trajectories derived from that data.

We have now added information on the temporal resolution of the previous studies and also highlighted that the current measurements are compared to the interpolated reanalyses output at a 1 minute interval. The large number of samples this allows in this study is therefore likely to explain the strong statistical significance of our results. For example, we have added the following line in the methodology section of an updated document:

Throughout this study our analysis uses this 1 minute temporal resolution data for comparison with interpolated reanalysis data or trajectories derived from that data.

(2) Kawatani et al. (2016) may be useful for this paper, which shows the standard deviations calculated by monthly mean data among several reanalyses show large values in the equatorial stratosphere, and their geographical distributions in the lower stratosphere are closely related to the density of in-situ radiosonde observations. Kawatani, Y., Hamilton, K., Miyazaki, K., Fujiwara, M., and Anstey, J. A.: Representation of the tropical stratospheric zonal wind in global atmospheric reanalyses, Atmos. Chem. Phys., 16, 6681-6699, doi:10.5194/acp-16-6681-2016, 2016.

We have added the following text in an updated document at the end of the Introduction section:

"More recent work detailed in Kawatani et al. (2016) also suggests that at 50-70a hPa the geographical distributions of the disagreement between the different reanalyses is closely related to the density of radiosonde observations."

(3) P4L21: The authors mention the balloons is considered to be undergoing an

altitude control whenever a pressure change greater than 5 hPa occurs within one hour. Providing height information of Loon flights in Fig. 1 should be useful for reads to Imagine.
We have now included the pressure histogram for all the flights in Figure 1 as requested by Reviewer 1 and we feel that this inclusion covers this point. Please see updated Figure 1 in response to reviewer 1

(4) P4L29–31: "The upper bound on the pressure sensor uncertainty is rather large and could potentially lead to uncertainties when vertically interpolating the reanalyses data sets to the balloon locations" I guess uncertainties depend much on the wind profiles as the vertical resolutions of reanalyses are coarse. Could you specify uncertainties more quantitatively?

Please see the back of the envelope calculation completed for Reviewer 1. We have now added the following text into the updated manuscript:

"Using the hydrostatic equation shows that a 1.5 hPa pressure uncertainty equates to about 300 m in altitude. Given a 3.0 m/s change over 2 km at the bottom of the stratospheric jet in the Southern hemisphere winter (approximated from ERA-Interim climatology) this equates to about 0.4 m/s at worst case."

(5) Table 1: As the top boundary of each reanalysis is different, showing layer numbers between 30 and 70hPa (i.e., the varying pressure levels of the balloon flights) should be useful.

This information has been added to the Table as requested.

(6) P6L31–33: How the phases of the Quasi-Biennial Oscillation play the role of difference between this study and Podglajen et al. (2014)? The authors could provide their speculation in more details.
This point was related to wave propagation differences into the tropical lower stratosphere due to the Holton-Tan effect. However, clearly we do not have enough data to test this and thus have decided to leave out this extra speculation.

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