

Interactive comment on “Validation of Aura MLS retrievals of temperature, water vapour and ozone in the upper troposphere and lower–middle stratosphere over the Tibetan Plateau during boreal summer” by X. L. Yan et al.

X. L. Yan et al.

j.s.wright@gatech.edu

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Our thanks to Anonymous Referee #1 for their contributions, and particularly for raising several pertinent questions that have helped to improve the clarity and completeness of the manuscript. Our responses and a summary of related changes to the manuscript are given below.

(1) In section 2.2, the authors note “... v4 provides increased data yields in this region relative to v3...” It’s not entirely clear as to why this is the case. Were flag thresholds revised, for instance, and if so, why?

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(2) What is the impact of clouds in v4? Are clouds being addressed differently in this new version?

The answers to these two questions are coupled. Improving the behavior of the MLS upper tropospheric composition observations in the presence of clouds was a primary goal of version 4. To accomplish that, the way in which individual limb spectra (of which there are 120 per vertical scan of the MLS antenna) were flagged as possibly being affected by thick clouds was redesigned, and the effects of these flags were changed to reject limb measurements both below and at the flagged location. These changes improved the handling of thick clouds, which have strong nonlinear effects on the observed radiances and must therefore be identified and rejected.

In addition, the representation of cloud structures in the atmosphere in the forward model and retrieval algorithm was changed, effectively increasing the vertical resolution. These changes improved the handling of thin cloud effects on the measured composition profiles, which can be represented directly and do not require measurements to be rejected.

These changes in how the retrieval algorithm handles clouds necessarily resulted in changes in the behavior of quantities used for data screening (quality, convergence, etc.); therefore, the post-processing flag thresholds were also changed. These changes are summarized in the v4 data documentation (Livesey et al., 2015), and are applied in our analysis of v4 data. Updates to the retrieval algorithm and the resulting changes in quality screening thresholds both contribute to increased data yields when using v4 relative to v3 in this region.

We have reorganized the text and added a few lines at the end of Section 2.2 to address this comment:

“The mean profiles shown in Fig. 2 are based on slightly different samples due to differences in the retrieval algorithm and quality control criteria. Specifically, v4 provides increased data yields in this region relative to v3 (10% more temperature pro-

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files, 32% more water vapour profiles and 29% more ozone profiles). These increased data yields primarily reflect changes in the MLS quality screening criteria, which have been updated to account for changes in the way that clouds are handled during the retrieval step. One of the primary goals of MLS v4 was to improve the behavior of MLS upper tropospheric composition retrievals in the presence of clouds. This was accomplished by redefining the manner in which clouds were represented in the MLS forward model, and by redesigning the method by which the strongest cloud signals in the MLS radiances are flagged and excluded from the retrievals. These changes significantly reduce the sensitivity of the MLS composition observations to cloud scattering signals. Relative differences between v3 and v4 are effectively unchanged when the comparison is limited to retrievals that meet quality control criteria in both v3 and v4.”

(Fig 2) It is very difficult to see the uncertainties in these plots as presented, since the magnitudes of the mean values are much larger and hence mask the magnitudes of the uncertainties. Consider plotting the uncertainties separately or instead of the means, if that is the focus of the plot. In addition, why average together different years and different seasons into one plot?

This plot is meant to serve as context for the plots of mean / median / RMSE bias plots to follow, and we intended the mean profiles and not the uncertainties to be the focus of the plot. The locations where differences exceed the combined uncertainties are described in detail in the text; however, for completeness, we will rearrange the plot to include the v4–v3 differences (including combined uncertainties) on separate narrow axes attached to each panel.

The different years, seasons and regions that are used in the average correspond to the four measurement campaigns, and mirror the combination of the four campaigns in the following plots of average biases. This approach is meant to capture a sample like “profiles that were or could have been included in the validation”.

(Fig 4) It is difficult to see if any differences exist between the error bars on the

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mean (set as 2-SEM) and the error bars on the median (set as the IQR) in both (a) and (b). Consider offsetting them in the vertical.

This issue seems to be due to an incomplete description of the figure in the caption. The error bars on the mean are represented by a shaded blue envelope, which is continuous from the bottom to the top of the profile. Values of the standard errors at MLS levels can be inferred by following variations in the thinner blue lines (at the edges of the envelope) between levels. This vertical continuity in the mean+standard error profiles is meant to serve the same purpose as a vertical offset. The error bars on the median are shown only at the MLS levels, and are consistently larger than the error bars on the mean (in this figure, though this is not necessarily true in other figures). We have updated the caption for this figure to clarify that uncertainties in the mean biases are shown as blue shaded envelopes bounded by thin blue lines.

(Figs 7, 9, 10, 12) The “x” axes in these figures should be labelled with the tracer names, similar to how it was done in Figs 5 and 6, for quick visual reference.

We agree, and have changed the figures accordingly — thanks for pointing this out.

References

Livesey, N. J., Read, W. G., Wagner, P. A., Froidevaux, L., Lambert, A., Manney, G. L., Millán-Valle, L. F., Pumphrey, H. C., Santee, M. L., Schwartz, M. J., Wang, S., Fuller, R. A., Jarnot, R. F., Knosp, B. W., and Martinez, E.: Version 4.2x Level 2 data quality and description document, Tech. Rep. JPL D-33509, NASA Jet Propulsion Laboratory, version 4.2x-1.0, 2015.

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