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Interactive comment on “Stratospheric and mesospheric HO₂ observations from the Aura Microwave Limb Sounder” by L. Millán et al.

Anonymous Referee #2

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The manuscript “Stratospheric and Mesospheric HO₂ Observations from the Aura Microwave Limb Sounder” by Millán et al. presents new HO₂ data derived from the AURA/MLS. Compared to the standard MLS version, these new data provide significant improvements with in particular information at high altitudes (up to ~0.003 hPa) covering the mesospheric peak of HO₂. These data are important to address opened issues such as the underestimation by the models of middle atmospheric O₃ and daytime HO₂. The error analysis and the comparison with two other instruments (FIRS-2 and JEM/SMILES) demonstrate the good quality of the dataset. Also the comparisons with WACCM (3-D climate model) and the Caltech/JPL 1-D chemical model confirms the problems to reproduce HO₂ mesospheric abundance with current chemistry models. They also discuss the origin of this problem and conclude that the issue is related

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to the source and sink of HO_x and not its partitioning. I think the manuscript can be published in ACP but before I would like the authors to check an issue related to Figure 12:

For me, the kinetic-2 and MLS profiles (upper panels) are in very good agreement at about 0.02 hPa (HO₂ peak). The agreement is much better than the value of 20% seen in the lower subplots. Also even considering that the upper panel profiles are not smoothed (is-it correct ?), I don't understand why the absolute and relative differences show that the maximum difference is around 0.02 hPa. I may have misunderstood something, please check.

I have also some minor comments that I have listed below:

P22909, Line 5: Are these data currently publicly available ? Will they become part of the standard MLS dataset ?

P 22911, Line 6: Are the selected radiances include bands 28 and 30 ? Are you including other bands? Have you compared only band 28 vs bands 28+30 ? Using band 30 should increase the contamination from the O₃ line and, hence, increases the sensitivity of the retrieval to uncertainties on the O₃ VMR, temperature and spectroscopy. Are these errors taken into account in the measurement covariance matrix? A comment about this issue could be added in the paper.

P 22912, Line 15: I understand that only HO₂ VMR is retrieved and other relevant atmospheric parameters (e.g., temperature, O₃) are fixed (based on the standard MLS products). Is-it correct ? Are any other parameters retrieved to correct instrumental baseline ?

P 22915, Line 5: Would it be possible to provide the order of magnitude of the differences between a single profile at the FIRS-2 position and the zonal mean profile? For instance, the authors could use a model like WACMM or the MLS water vapour profiles a proxy.

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The smoothing of the FIRS-2 profile and the day-night difference MLS profile indicated in the caption of Fig. 5 could also be indicated in the text.

The night-time MLS profile could also be plotted in Fig. 5.

What is the highest altitude of the FIRS-2 profile (before smoothing)? Is the FIRS-2 profile extrapolated for the interpolation at the higher altitudes ?

P 22915, Line 7: Is-it the monthly mean of the differences (SMILES-MLS) or the difference of the monthly mean profiles?

P 22916, Line 8: How the SMILES profiles have been smoothed in the upper altitude range of the retrieval (need of altitude extrapolation) ?

It should be indicated that unlike MLS, SMILES data are not regularly distributed over a month. This could explain some of the differences seen between SMILES and MLS in the mesosphere since the HO₂ mesospheric peak shows large month to month variability.

P 22918, Line 14. It should be also mentioned that the underestimation of daytime HO₂ in the model is seen above 1 hPa at all latitudes. This is consistent with previous studies given in the introduction of the paper (Sandor et al., 1998 and Khosravi, 2013).

I haven't seen any comment on the large overestimation of the model near 0.2 hPa.

P 22918, Line 15. I would rather consider the range 10 to 1 hPa since a quasi-systematic underestimation of the WACCM HO₂ occurs above 1 hPa.

P22919, Line 12. Does Fig. 12 shows the daytime MLS profiles? This information should be indicated in the caption or in the text.

The size of the lowest subplots could be increased. What is the meaning of the dashed lines?

P22919. It would like to have a short comparison with the conclusions from previous

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studies. Are these results in contradiction with the study by Canty et al. who used the standard MLS data in the lower-mesosphere ?

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