Comment on acp-2021-440
Anonymous Referee #1

Referee comment on "Investigation and amelioration of long-term instrumental drifts in water vapor and nitrous oxide measurements from the Aura Microwave Limb Sounder (MLS) and their implications for studies of variability and trends" by Nathaniel J. Livesey et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-440-RC1, 2021

This is a well written paper with a clear motivation, sound methods and result sections, and a recommendation valuable to data users in the conclusion. I agree with the editor that the paper should, strictly spoken, be redirected to AMT since it deals with instrument issues, and not with findings on the atmosphere. However, also in consent with the editor, I find that the paper is of high importance to all MLS data users, for instance in the framework of model validation. For this reason, I concur with the editor that it should better remain in ACP. In this case, however, I also find that a "sexier" title, putting less weight on the instrumental issue and more on the impacts wrt trend estimation would be recommendable. I find the editor's suggestions appropriate, and I'd strongly recommend to change the title for a better fit into ACP.

The figures of the paper are clear and useful, and the assessment of the contribution of the sideband fraction to the overall drift is absolutely sound. The short introduction of MLS v5 is concise yet clear. Remaining non-explained differences to water vapor trends measured by balloon-borne frost point hygrometers are openly discussed.

I have only few minor or technical issues to be raised for a revision of the manuscript:

1. **Title:** see my remarks above (and those of the editor).

2. **Figure 1 and related text:** The description of the fit approach could go a little more into detail. In particular, I miss any explanation how measurement errors were taken into account. Have the individual data points been weighted by their uncertainty within the trend/drift fit? If so, which uncertainty has been used? I am asking since MLS H2O is retrieved in log space as far as I know. If errors due to measurement noise are more or less constant for all atmospheric situations in log space, this may lead to the conclusion that they can be ignored within the trend fit since they put the same weight on every data point. However, it has to be noted that errors from log(vmr) retrievals scale with the retrieved vmr amount, and, thus, are not equal in vmr space.

3. **P5, l 8/9:** "These 2- to 4-periods ..."; a reference for this statement should be provided.
4. Section 2.1.3: As far as I know, the WVMS groups use MLS as a priori in their retrievals. How far can the WVMS measurements be considered independent of the MLS a priori? Some more information about the a priori content of WVMS measurements used for validation of MLS would be helpful.

5. A remark on Fig. 7: I find the consistency between the ozone measurements at 240 and 640 GHz impressing. Congratulations to this data product!

6. Table 2 and Fig.14: For clarity, it should be mentioned in the captions of the figure (and maybe also of the table) that they refer to water vapour (and not N2O) drifts.

End of review