Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-267

Anonymous Referee #1

Referee comment on "A new algorithm to generate a priori trace gas profiles for the GGG2020 retrieval algorithm" by Joshua L. Laughner et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-267-RC2, 2022

Review of Laughner et al. "A new algorithm to generate a priori trace gas profiles for the GGG2020 retrieval algorithm"

General comments:

This manuscript introduces a set of updated a priori trace gas profiles in the GGG2020 package. The profiles are the critical inputs for TCCON retrievals and have also been adopted by OCO2/3, and will have a broader usage for many existing/incoming GHG-targeted missions. Deliberate processing methods have been developed for long-lived trace gases (CO2, N2O, CH4) based on flask measurements at MLO and SMO, and more variable trace gases (CO, H2O, HDO, O3) based on model simulations from GEOS5. The generated profiles are compared with independent measurements and show encouraging improvements. Overall, this paper is very well structured and written, and the motivation/rationale for this work is very well explained. This paper is suitable for AMT and can be published after several minor changes, please see my comments below.

Specific comments:

The comparison result from CO in Section 5.1 is a little bit disappointing, but not surprising given that CO is very variable. The explanation of model simulations using static emissions makes sense to some extent but is not enough and may make users less confident in the CO a priori profiles. Re-running the whole model using different model simulations of CO may take a long time, but I would like to see two extra comparisons that can be done quickly. One is the improvements of GGG2020 compared to GGG2014 after removing Armstrong and Lamont sites; The other is the comparison between GEOS-5 CO with other observation-assimilated CO simulations (for example, the CAMS global atmospheric composition forecast model, link below) over these two sites to see if the CO overestimate/underestimate is heavily model-dependent.

https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-atmospheric-composition-forecasts?tab=overview

Line 44: The description of the "1%" error in the shape of CO_2 is a little bit ambiguous to me, and can be more specific, although you already have supplementary materials to explain that. One or two more sentences to explain that in the main text may help. Also, a change in the lower troposphere by 4ppm is not the same as changing the XCO_2 by 1%. Similarly, the different scenarios in Figure S1 may represent different changes in XCO_2, which may be confusing when compared to the retrieval error of <0.025% which is for XCO_2.

Minor comments

- Line 6: "improving the description of CO_2, CH_4, N_2O, HF, and CO in the stratosphere", please rephrase.
- Figure 12: Please add a unit (or is it just fraction/ratio?) for the x-axis of the lower panel.
- Figure 12: In the caption: The fit is a robust fit using a Tukey biweight function with no intecept. Please explain "Tukey biweight function". Also "intecept" is a typo.