

Comment on **essd-2021-247**

Anonymous Referee #1

Referee comment on "An 11-year record of XCO₂ estimates derived from GOSAT measurements using the NASA ACOS version 9 retrieval algorithm" by Thomas E. Taylor et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-247-RC1>, 2021

Review of the manuscript "An eleven year record of XCO₂ estimates derived from GOSAT measurements using the NASA ACOS version 9 retrieval algorithm" by Taylor et al.

In this manuscript the authors present a unique XCO₂ data record from GOSAT using the ACOSv9 retrieval algorithm. The quality of the data is thoroughly assessed by comparison to TCCON measurements, to OCO-2 measurements as well as to in-situ based inverse model systems. The main strengths of the data set are the long time span of the data (2009-2020) and the thorough and global comparison to state-of-the-art XCO₂ measurements, which makes the data set very useful for the carbon cycle community. The article is well structured and concisely presented. I recommend publication in ESSD and have only few specific questions and some technical remarks prior to publication.

Specific questions/remarks:

- Figure 5: It would be interesting to add a column c) ACOSv9- ACOSv7 to also see the spatial and temporal differences of the retrieval versions.
- Fig 10: You explain the filter criteria of the MMM (L239f). As the models will deviate from each other more where prior uncertainties are high and assimilating data coverage is low, the models will deviate more in remote regions. Thus, data in remote regions will be rejected for quality assessment. Therefore, a map showing the data density of co-located samples would be useful to the reader. If filtered data coverage of MMM in remote regions is small, also a discussion of how this might influence/limit the quality assessment should be given.
- L482f: In the manuscript you explain why you use OCO₂-v10 and GOSATv9. You make the decision to compare results across satellites AND retrieval versions. However, you

then decide to account for parts of the differences in retrieval algorithm (only for different CO₂ priors) to compare the products. This is not consistent. I think you should not correct for the different priors used in the comparison as it is not a valid comparison to OCO-2 in any version otherwise. If possible, a short discussion of the effect of the different updates of the retrieval versions would be interesting instead.

Technical correction:

- L7: Explicitly state here that no satellite data has been used in the assimilation system here.
- L17: wording "Similarly," does not fit. Do you mean "Further, "?
- L71: Why is XCH₄ out of the scope of the manuscript? Can you refer the reader to further literature?
- L133: L2FP is used, but abbreviation is only introduced in line 139
- Table 2: For clarity, you could add superscripts of the respective figures in Fig. 1?
- L204: see above: in-situ assimilating models?
- L214f: What is the reason for the spatial collocation criteria of +/- 2.5 ° lat and +/-5! Lon? Have you performed, or can you reference a footprint analysis here?
- L259: You refer the reader to O'Dell et al. 2020 for details about the bias correction. At least some details on the correction (maybe equation 6 in O'Dell et al., 2018?) would help the understanding and flow of the paper.
- L282: The mean bias should be nearly zero after the bias correction. Why does a median bias persist? Can you add a sentence here?
- L293: delete "of"
- Figure 7: In the figure caption add where to find the statistics of individual stations.
- L382: Any ideas why MAE is a function of latitude?
- L395: Why do you use a more restrictive collocation criteria then the one presented before? This seems inconsistent to me.
- L421: delete "time"
- L444: Add a remark what Müller et al. (2021) suggest as it is of high importance for this work as well.
- L474-479 are repetitive to Section 3.1 and could be deleted.
- L539: Add sth like " but further investigation is required to explain the remaining disagreement over large spatial and temporal scales."
- L543: What do you mean with "uncounted for hemispheric and time differences"?