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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Prior biosphere model impact on global terrestrial CO_2 fluxes estimated from OCO-2 retrievals" *by* Sajeev Philip et al.

Anonymous Referee #4

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Review of "Prior biosphere model impact on global terrestrial CO2 fluxes estimated from OCO-2 retrievals" from Sajeev Philip et al

This work details a set of pseudo-data experiments in which the prior flux and prior flux uncertainty are varied in a systematic manner in order to assess the sensitivity of atmospheric inversions with satellite data to the prior flux constraint. The manner in which this is carried out is a good template for assessing sensitivity to inversion system ingredients.

General comments: 1. The presentation in terms of images makes some of the conclusions and discussion difficult to assess. Specifically I'm referring to Figures 3-5, where the "meat" of the results is contained. I would suggest that the NEE range differences are great material for a table, and that the other two columns are perfect to be

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condensed into stacked bars or something similar for ease of visibility.

2. My main complaint with this is that there are a few papers out there now that use ensembles of models for inference (Basu et al, 2018; Crowell et al, 2019; older ones like Peylin et al, 2013), and that this would be a much more effective paper if it were to place itself in the context of the "uncertainty budget" for these other papers. For example, Crowell et al (2019) presents results in the form of ensemble means and standard deviations, and Basau et al (2018) presents ensemble members individually, and the results here could be placed beside the Basu et al (2018) results to attempt to explain the scatter in the flux results in Crowell et al (2019). That sort of analysis would elevate the messages in this paper to a greater impact.

Specific comments: Page 4, Line 28 - how much do the models really vary using this approach? I'd guess not much. Can you provide a figure at a well known flux tower site as a demonstration?

Page 7, Line 16-18 Chevallier et al also went after this by looking at structural uncertainties in the ORCHIDEE ecosystem model. Chevallier, F., Viovy, N., Reichstein, M., & Ciais, P. (2006). On the assignment of prior errors in Bayesian inversions of CO 2 surface fluxes. Geophysical Research Letters, 33(13), L13802. https://doi.org/10.1029/2006GL026496

Page 8, Lines 5-9 - these errors are even smaller than those predicted by the Level 2 retrieval, and those are known to be underestimated (from various uncertainty quantification talks). I wonder, could this really be a sign that your prior errors need tuning, rather than your observation errors? In the OSSE setting, it's equivalent which way you go, but in real data settings, this choice can matter a lot. There are other metrics to optimize the prior errors vs. the observational error statistics, such as the Desrozier approach (commonly used in numerical weather prediction)

Page 10, Lines 34-35 - this is often called the "uncertainty reduction", assuming the standard deviation is a proxy for the uncertainty

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