Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Characterizing biospheric carbon balance using CO$_2$ observations from the OCO-2 satellite" *by* Scot M. Miller et al.

Anonymous Referee #2

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This study presents a method to quantify the information that is provided by the greenhouse gas observing satellite OCO-2 on surface fluxes of CO2, as derived from the data using inverse modelling techniques. The approach is interesting because it provides an alternative to methods that have been used in the past for quantifying satellite instrument performance. Whereas those methods used uncertainty reduction to measure performance, this method quantifies the number of independent pieces of information provided by the data. The application to OCO-2 suggests that only a few independent pieces of information can be extracted from the data, mainly because of the size of the errors involved. In my opinion, this manuscript is suitable for publication in ACP provided that the following comments – mostly requests for further clarification

– are adequately addressed.

GENERAL COMMENTS

In Figure 3 the single sounding error of OCO-2 is compared to the signal from uncertainties in biospheric CO2 fluxes. The question is if this comparison makes much sense, since the error budget of OCO-2 has a large random component. The impact of biospheric flux uncertainties is more coherent in space and time, i.e. has very different statistics. Because of this the signal/noise ratio could look very different after space-time averaging of the data.

It is not clear to me what fraction of the flux uncertainty space is spanned by the flux patterns that are used in the regression. Probably many of the patterns are not independent, in which case it is not a surprise that many are not selected. This probably goes back to the question whether the range of estimates of the underlying models provides a fair estimate of the overall uncertainty. This is not easy to prove, but with only a single ocean pattern and a single anthropogenic emission pattern it seems conceivable that the uncertainty space is underestimated (by the way, how about uncertainties in land-use change?). Some discussion is needed of how such factors may influence the results, and what the implication could be for the estimated OCO-2 performance.

SPECIFIC COMMENTS

page 1, line 23: 'unlike previous missions' .. but this was the case also for GOSAT and SCIAMACHY.

page 2, line 12: references are needed to the recent special issue on OCO-2 in Science.

page 3, line 17-20: unless 'region' is defined more quantitatively these sentences are too vague.

page 3, line 19-23: Explain the motivation for this second approach? Is one considered to be more realistic than the other?

page 5, line 9: the constant fluxes need to be defined more quantitatively. What did you use? The same flux for each region and month? Are they estimated per region? Does it mean that the regressed flux patterns have zero mean? If so please mention.

page 7, line 25: should we conclude that OCO-2's glint mode retrievals do not provide significant independent information?

page 8, line 18: I would argue that the ocean is too strongly constraint by allowing only a single pattern to be adjusted in the regression. If more degrees of freedom would be assigned to the ocean, wouldn't that influence OCO-2's flux resolving performance over land?

page 8, line 21: this means that the biospheric flux patterns are specified per region and month, or?

page 8, line 27: 'stringent' in what sense? (I'd say they are rather less well contraint)

page 8, line 31: Would this goal be achieved if the 7 biomes could be resolved by OCO-2? Some quantitative information on how to relate surface and satellite measurements is needed here.

page 9, line 26-32: Should the reader conclude from this that we don't know whether the signal/noise analysis in figure 3 means anything?

page 10, line 16: 'scales smaller than hemispheric in about half of the cases'. How can you infer information about hemispheres from a split between Tropics and Extra Tropics? The way I look at it only a single pattern is selected in 3 out of 4 seasons. Is that sufficient to resolve two pieces of information? The text suggests that OCO-2 does better than 2 ...

page 10, line 18: 'we choose flux patterns ...' does this mean 1 or more?

page 10, line 32: Why is n* going down with the number of regions? Wouldn't you expect the residuals to become more random when fitting more regions? Shouldn't

that make V more diagonal?

page 11, line 31: Or underestimate noise? Is there a factor in the synthetic experiments that accounts for retrieval noise?

page 11, line 33: It doesn't really become clear what is mean by this "salient role". Can this be seen in the presented results?

page 12, line 19: Does the relative role of transport and measurement uncertainty follow from the results of this study, or is this just speculation? It seems to me that the study should provide information on this.

page S4, line 141: 'Consistency check'. What potential inconsistency is checked? Do you mean sensitivity or robustness check?

TECHNICAL CORRECTIONS

page 2, line 7: 'the the'

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