

Interactive comment on “Inverse modeling of GOSAT-retrieved ratios of total column CH₄ and CO₂ for 2009 and 2010” by S. Pandey et al.

Anonymous Referee #1

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This paper presents an inversion of CH₄ and CO₂ using GOSAT column retrievals and surface observations. The central theme of the paper is a comparison of flux inversions derived from an assimilation of the XCH₄/XCO₂ ratio (also constrained by surface observations) to “proxy” or “surface only” retrievals. The paper is suitable for publication in ACP, provided that some of the comments below are addressed.

General comments

- Use of bias correction. As the authors themselves note (P18, line 29), there appears to be a double counting of the surface observations in the satellite inversions, because a “bias correction” has been applied, based on previous satellite-only and surface-only inversions. In addition to this double-counting, I suggest that there are two problems with this approach: a) any discrepancy between these two inversions is likely to be an

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indicator of systematic model errors, which are likely to result in a relatively complex “offset” between two such inversions (indeed, this appears to be indicated in Figure 12). Therefore, the use of a linear “correction” would leave out some potentially important features un-accounted for; b) any uncertainty associated with this correction is not propagated through the inversion. Instead of imposing this correction as a hard constraint, why not include it in the inversions? Point a) above could also be addressed by disaggregating this potential error into more than two components (i.e. an intercept and a gradient).

- Uncertainty quantification. Given the rather extensive discussion of potential biases and uncertainties associated with the retrievals and the model, the uncertainties derived in Figures 3, 4, 5 and 7 seem very optimistic to me. I think the paper would benefit from a much broader discussion about any limitations in the uncertainty quantification methods employed in this paper (preferably with reference to other methods that have been used in the literature). This should also include a discussion of the choices made about the a priori uncertainties. For example, it appears that a choice of 50% uncertainty for each grid cell for the CH₄ prior was used with a temporal correlation of 3 months and length scale of 500km. Why were these figures chosen? What might be the influence on the inversion of choices of this nature? When aggregated together, it appears that this uncertainty leads to a prior uncertainty on continental scales of about 5-10% (Figure 3). Does this seem realistic? It seems small to me, especially since it is apparently inconsistent with the outcome of the inversion for several regions. There are several systematic factors that could also strongly influence the outcome of the inversion (e.g. convection, OH uncertainty), which should be discussed.

Minor comments

- P2 L5: “still consistent results are obtained”. Consistent with respect to what?
- P2 L10: “original information”? I'm not sure what this means.
- P4, Section 2: This could do with a brief overview of the chemical transport model

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setup (fluxes, OH fields, dynamics, etc).

- P5 L4:7. Are these choices largely subjective? Reasons should be given, and a discussion of the implications. See general comment above.
- P5 L14: Missing full stop before The RemoTeC
- P5 L18: referred to as
- P5 L25: Use of “additional” here. . . additional to what (I presume it means in addition to the TCCON bias correction, which is described in the section below).
- P8 L1: Use of uncorrelated observation/model errors. Is it realistic to assume that the observation and model representation errors are uncorrelated in space and time? What might be the implications of this choice?
- P8 L18: Re-word “relatively less errors” is not grammatically correct.
- P11 L9: “do not show an important seasonal dependence”. This needs re-wording. I don’t understand what an “important seasonal dependence” means.
- P11 L18: “information that is used” (remove comma).
- P17 L18: “poorer” rather than “lesser”
- P21 L4: Isn’t it fairer to say that they “largely cancel out”? The cancellation is not 100%.
- P23 L8: Isn’t 5x5 degrees quite a large area? Can this analysis be carried out over smaller scales?

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