

Interactive comment on “The Impact of Transport Model Differences on CO₂ Surface Flux Estimates from OCO-2 Retrievals of Column Average CO₂” by Sourish Basu et al.

Anonymous Referee #1

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This study reports observing system simulation experiments aiming at assessing the impact of atmospheric transport model uncertainties on inverse modelling estimated sources and sinks of carbon dioxide using surface and satellite measurements. The results confirm the outcome of similar studies conducted in the past indicating that transport models are a potentially performance limiting component in the translation of atmospheric measurements to surface fluxes. This study takes a further step to compare the role of transport in inversions using either surface or satellite data. Conclusions are drawn on the importance of homogeneous sampling and the sensitivity of the use of satellite or surface measurements to important uncertain factors in the transport models. In my opinion, as explained below, these conclusions need to be

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better supported by the results (or the way in which the results are assessed) to make this study acceptable for publication.

GENERAL COMMENTS

Sections 4.2 and 4.4, which present the experimental evidence for the conclusions drawn in section 5, provide almost no numbers. The discussion is on a very qualitative level. This makes it difficult to judge the significance of the conclusions and will make it difficult for future studies to compare results to what was found here. Further effort is needed to repair this and to ensure that the main conclusions are supported by actual numbers and corresponding uncertainties. To assess significance requires being able to compare the impacts of transport model uncertainty on the fluxes to the uncertainty of the estimated fluxes themselves. Right now, it is difficult to judge whether the impacts are in the noise of the estimates (probably not), or limiting the overall performance.

In the discussion about the main factors explaining the impact of transport model uncertainties on the estimated fluxes using surface or satellite data, suggestions are made about the role of horizontal and vertical sampling. Since several factors vary at the same time, I don't see how the importance of these impacts can be addressed in isolation. It would require a total column measurement at the times and locations of the surface measurements or satellite measurements being sensitive only to the surface. Even then it not easy to account for differences in measurement constraints on the inversion influencing the impact of transport model uncertainties on the optimized fluxes. In the discussion, it should be made clearer that the experiments do not provide direct evidence for specific causes.

SPECIFIC COMMENTS

page 5, line 10: What motivates the chosen time span?

page 7, line 6: item 2: Is daytime sampling used for marine background sites also?

page 9, line 10: Why were posterior fluxes from CarbonTracker chosen as prior? They

are not independent from the data that are used to derive the truth ... to me it seems more logical to take the CarbonTracker prior. How consistent is the choice of prior covariances in this case?

page 10, line 12: What is N_{ret} typically? Does ϵ^2/N_{ret} yield a realistic systematic error?

page 11, line 5: Even if all the models had the same random noise added to the data, this would not have changed the inter model spread in the fluxes. However, if the importance of transport model uncertainty is assessed in relation to overall posterior flux uncertainty then measurement uncertainties do matter (whether or not you would add random noise to the data in this case depends on the method for calculating posterior flux uncertainties).

page 11, equation 6: So, in this case the difference between 2 models doesn't even depend on the choice of prior flux. This means that my earlier remark about the use of CarbonTracker posterior fluxes actually doesn't matter. It would still be useful to point out that the prior fluxes that are described in detail aren't really relevant to the problem .. well, they are to the extent that the a priori fluxes are used to define a priori flux uncertainties. Some further sentences clarifying this would be useful.

page 12, line 8: what do you mean by 'lateral' grid cell? Each individual grid cell?

page 14, line 17: 'due to chance' you mean 'due to differences in transport'?

page 19, line 25: but since the sampling is also very different between surface and satellite there is no way to isolate the impact of PBL versus total column.

page 22, line 21: I wonder if this difference between this study and Baker et al (2006) could be influenced by the choice of an El Nino year for the current inter-comparison, which may not be well representative of a typical year (so my earlier remark about justifying the chosen times window).

page 22, line 28: .. but could also be due to a more even sampling coverage.

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TECHNICAL CORRECTIONS

page 4, line 26: 'initial' i.o. 'intial'

page 7, line 31: 'referred' i.o. 'refered'

caption figure 3: 'color bar' i.o. 'colorbar'

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