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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Impact of Transport Model Differences on CO_2 Surface Flux Estimates from OCO-2 Retrievals of Column Average CO_2" *by* Sourish Basu et al.

Anonymous Referee #2

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The manuscript presents an assessment of errors in atmospheric transport modelling from the context of trace gas transport, with a particular focus on carbon dioxide. It is a synthetic data experiment, using realistic sampling, but no actual measurements. Several different transport models are used for forward simulations, to assess the divergence of simulated concentration values based on the same fluxes. The effect on inferred fluxes is also assessed, by using one of the transport models to invert the pseudomeasurements produced by the other transport models. In general, the approach is very similar to that of previous studies (Chevallier et al., 2010; Houweling et al., 2010; Locatelli et al., 2013), which the authors do cite. The main difference seems to be the focus on OCO-2 for the source of satellite sampling (in addition to in situ

measurements), and the separation of different measurement modes in the inversions (ocean glint, land glint, land nadir, etc.). This leads to the interesting finding that sampling differences can be larger than flux uncertainties due to transport differences. In general the paper is quite well written and presented, and appropriate for publication in ACP, once some concerns have been addressed.

Comments:

P12,L13-15: This claim is made repeatedly throughout the paper, that the larger differences in concentrations over land are because of larger differences in the vertical mixing over land. One would expect this to be true, one should also consider the fact that the spatiotemporal variability of the fluxes is also considerably higher over land, and what you're assessing is the differences in the concentration fields, not the air mass fluxes themselves. The oceans may show less agreement also because the flux pattern is comparatively heterogeneous there. (Consider the extreme case with a well-mixed atmosphere and zero fluxes: the differences in concentration space would be zero amongst the different transport models.) Please include this in your discussion, here and elsewhere.

P20,L12-14: Same thing. The flux variability is also higher in the summer. You're only looking at the tracer concentrations, which are a result of the mixing plus the fluxes themselves.

P12,from L16: In general the discussion around Figure 3 was very difficult to follow. What is meant by "venting"? This has to be defined. The sign of the fluxes changes over the year, so if a "higher venting" means more mixing with the free troposphere, this would change signs throughout the year (lower than the median in winter, higher than the median in summer). In this case, I think that TM5 shows higher venting than LMDZ over the northern hemisphere winter, doesn't it? And how much of this "venting" is simply a different PBL height? Or is something else meant here altogether? Later on it is mentioned that fluxes are vented to the south - so is this more a measure of interhemi-

spheric and long-range transport? Or does the venting discussion include land-ocean longitudinal transport? If so, this can't be seen from the zonal plot presented here.

Please change either Figure B1 or Figure 3 to put the rows in the same order.

P12,L25: The reference to Boreal Eurasia: This can't be seen from the zonal plot, please refer to the figure in the appendix here.

P18,L15-16: You mention that the observation mode changed (from 16-day nadir-/glint-only cycles), but don't state exactly when, and if you can see any effect of this in the time series of your retrieved fluxes. Please add this information.

Minor technical comments:

P7,L28: "from assimilating a more limited, mostly background sites": Maybe missing "set of", or remove "a"?

Figure 4 (and other similar figures): It's a minor thing, but many in this community have the standard order of the TransCom regions (at least over land) more or less memorized. Why switch Europe and Australia? Sticking to the standard order would make it easier for the reader.

P20,L34: "the uncertainty in flux estimates due to transport model errors are lower ": subject and verb don't agree (are->is).

P21,L20-21: "the range of monthly fluxes obtained from synthetic XCO2 over land (LN, LG and LNLG) often do not overlap": subject and verb don't agree (do->does).

P22,L23-24: "the spread among IS inversions over Temperate North America and Europe in figure 4 are as large as their spreads over Tropical Asia and Temperate South America": again: (are->is), plus I would keep "spread" singular in the second instance as well.

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