

Interactive comment on “Co-located column and in situ measurements of CO₂ in the tropics compared with model simulations” by T. Warneke et al.

Anonymous Referee #2

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1 General comments

The authors describe surface and column measurements of carbon dioxide acquired during six campaigns near Paramaribo, Suriname during 2004-2007. These measurements are compared with model simulations using the TM3 model. The measurements and model comparison are of interest, given the sparsity of measurements in the tropics and the need to characterise errors in model representations of atmospheric transport (particularly, vertical mixing). The manuscript is generally well written, but some aspects of the analysis need a more detailed description, as discussed in the specific comments below.

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2 Specific comments

2.1 Site description

Most people will not be familiar with Suriname and it would be very helpful to have a brief description of the environment (vegetation cover etc.) in the vicinity of the site and regionally.

2.2 In situ measurements

A brief description of the time of day and meteorological conditions (surface windspeed) when flask samples were acquired would help the reader interpret the surface data presented.

The top panel of Figure 2 does not illustrate the model-observation comparison well at all. I suggest a third panel is added, which shows model-obs scatter plots for the five campaigns (or similar). The model data could then be dropped from the upper panel.

To my knowledge, the method to correct observed CO₂ concentrations for local sources is not widely used. From the description in the text I assume it is applied as follows:

$$\text{CO}_{2,\text{back}} = \left(\frac{1}{\text{CO}_{2,\text{obs}}} - \frac{\delta^{13}\text{CO}_{2,\text{obs}} - \delta^{13}\text{CO}_{2,\text{back}}}{\kappa} \right)^{-1} \quad (1)$$

where κ are the regression slopes given in Figure 1 and $\delta^{13}\text{CO}_{2,\text{back}}$ are the NOAA/ESL measurements from Ascension Island and Ragged Point, as discussed in the text. This equation should be given explicitly in the text. More importantly, I do not see what benefit this correction has over the selection of the subset of observed data with $\delta^{13}\text{CO}_2$ within some specified range of the NOAA baseline measurements (time of day and surface windspeed might also be used to screen data which are strongly influenced

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by local sources due to near surface stratification). The authors should consider the use of subset selection, and/or make a clear case for favouring the correction method.

2.3 Column measurements

One of the important claims of this paper is that the TM3 model can simultaneously satisfy surface concentrations upwind from the site and observed column average dry air mole fractions (XCO_2), with a unique scaling relating Spitzbergen and Paramaribo XCO_2 to the TM3 model equivalent. However, there are several reasons why the column measurements at the two sites might not have the same model scale factor:

1. the XCO_2 retrieval has a known airmass-dependent retrieval bias. Measurements from the high latitude Spitzbergen site and the low latitude Paramaribo site will sample quite different ranges of solar zenith angle. Some discussion of airmass dependence and correction (if performed) or resultant site dependent biases (if no correction is performed) should be given in the manuscript.
2. the resolution of the Spitzbergen TCCON measurements and the Paramaribo measurements differ significantly. This could give rise to systematic differences in the retrievals and/or their airmass dependence.
3. ILS errors, which may differ between the two instruments, or vary from campaign to campaign in the IFS 120M used for Paramaribo measurements.
4. representation of CO_2 in the TM3 model stratosphere and differing relative contributions of the stratospheric column to tropical and high latitude column measurements.

While 1 is expected to be the most significant artifact, 2-4 should also be characterised/discussed. The text also needs to describe exactly how the model equivalent

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was calculated: were measurement averaging kernels and retrieval a priori's used to derive the model XCO_2 ?

2.4 Model predictions of CO_2 surface concentrations and XCO_2

The model predictions of upwind surface CO_2 concentrations and XCO_2 illustrated in Figures 2 and 3 show an astonishing degree of correlation: the two timeseries are not identical, but they are very nearly so. If this is not an error, then the correlation predicted by the model surely deserves some comment and interpretation.

Subject to the comments in 2.2–2.4, I would be happy with the conclusion that the TM3 model is capable of simulating surface and column observations at the Paramaribo site (possibly with caveats on the local/regional fluxes). The phrase 'at the same location' is not justified by the current study.

2.5 Title

Strictly the authors are justified in their claim to first ground-based column measurements in the tropics. However, it may be more meaningful to change 'the tropics' to 'tropical South America' and this would implicitly acknowledge the TCCON effort in Darwin, Australia.

3 Technical corrections

- use 'sampled' rather than 'probed'
- tidy up repeated use of '[XCO_2] was calculated by scaling the CO_2/O_2 column ratio ... to the degree required, constant in the atmosphere'.

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- Abstract and Conclusions
 - '... TM3 model is capable OF simulatING surface concentrations and COLUMN AVERAGE DRY AIR MOLE FRACTION correctly' and 'at the Suriname site' rather than 'at the same location' as above.
- Introduction
 - extra comma after Earth
 - least constrainED
 - expand TCCON acronym
- Results
 - suggest 'weakly influenced', rather than 'marginal influenced'

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3173, 2010.