

Interactive comment on “Sources of variations in total column carbon dioxide” by G. Keppel-Aleks et al.

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Summary:

This article provides an exhaustive attempt to simulate how changes in the atmospheric CO₂ distribution that are caused by various processes would affect the observations of the ground based FTIR network TCCON. This is a very useful study that tells us what kind of signals we could expect in the time series provided by the TCCON stations and what precision we need to observe them. This provides the theoretical foundation that is needed for the further development of the network and the interpretation of the existing data.

The article relies completely on atmospheric simulations with the AM2 GCM model. All

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TCCON site total column observations have been synthesized from the model output. This is an interesting self-consistent approach which avoids the rather difficult problem of linking model output to real-world measurements. The authors promise to complete this missing step in a follow-up publication which I would be very interested to see.

An important result is that total column measurements indeed seem to be very robust against uncertainties in vertical transport and local influence. Beyond that, not being a modelling expert myself, I have very little to add to the detailed discussion of the model setup and results by the other referee Peter Rayner. I would just add some minor comments and suggestions that might improve the article and make it more readable.

General Comments:

- I find Sec 3.2 rather unclear, there are many figures and only very short explanations to some of them.
- There are many plots: 19 figures containing 46 individual subplots. Some of them could be left out without sacrificing the results.
- The conclusions should be more concise. Also the results should be discussed in the same order as they appear in Sec. 3.
- A large part of the total column is contained in the stratosphere. How good is the AM2 model at altitudes above the tropopause?
- Table 1: no tropical site was selected even though there is an operational one (Darwin) and a planned one (Ascension Island) in TCCON. So what would we see at a tropical site?

Minor comments:

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- Hovmöller-diagram: when you mention the name you might also want to add the reference Tellus, Volume 1, Issue 2, pages 62–66, May 1949 to honour the inventor Ernest Hovmöller.
- Table 1: why are the acronyms not consistent with the usual TCCON site IDs?
- Order of figures: Figs. 1b/2b are not discussed in the text until after Fig. 3a
- Fig. 4: why where these locations chosen? They do not correspond to the stations in Table 1.
- Fig. 7 is hardly explained in the text, could it be left out completely?
- Fig. 9 and following plots: you only selected 5 of the 6 sites from Table 1. Why these? Also the choice of colors is not ideal. Especially BIK is very hard to distinguish from ORL.
- Fig. 11: what is the difference between contrast and actual contrast? The explanation in the text is also not very clear.
- Fig. 12: the color problem from Fig. 9 at its worst. BIK and ORL look almost the same.
- Page 30585, last paragraph: the AM2/TM5 comparison and Fig. 19 should not appear in the middle of the conclusions.
- Page 30581: it is awkward to have the discussion of Fig. 8b appear at this position in the text.

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