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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "A framework for comparing remotely sensed and in-situ $CO_2$ concentrations" *by* R. Macatangay et al.

**Anonymous Referee #1**

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The aim of this study is to present a method for validating FTS total column measurements. A thorough understanding of FTS total column measurements is needed, since they are playing an increasingly important role in the validation of satellite measurements. As such this study addresses a scientifically highly relevant topic. The proposed approach is to validate FTS measurements using in-situ measurements that are transformed in a way that allows comparison with the FTS measurements. However, the results do not really seem to refer to such a transformation, which would require the model (Stilt in this case) to be optimized using the in-situ data before simulation of the total column, which - unless I missed something - is not done in this work. This and several other issues will need to be explained better, as described in more detail below, to make this manuscript suitable for publication.

Major comments

The abstract mentions that Stilt transfers the information from in-situ measurements to the total column. I had expected that the model would be brought into agreement with the in-situ data (e.g. through a source/sink inversion) first, after which the total column could be derived from the optimized model. Here, however, it seems like the model is just run in forward mode. Then the question is whether the model validates the FTS or vice verse.

Given that there is no optimization, it is not clear what the remaining innovation of the paper is. Of course, a verification of the accuracy of FTS measurements is useful, but in that case I would have expected that high spectral resolution FTS measurements were used and a comparison and reference to previous work.

A justification is needed for the use of balloon data from Mexico for determining the total column over France. As shown in Figure 8 the variation in the lower stratosphere of the column is sizable, and expected to be significant since the averaging kernel peaks near the tropopause. Generally, it is not clear how the uncertainty of the aircraft measurements, balloon measurements and the model based-extrapolations have been combined to determine the overall uncertainty in the total column, as presented in Figure 9. This should be explained in further detail.

Minor comments

page 1550, line 6: what is meant by "the global calibration scale"?

page 1550, line 25: water vapor is the most significant greenhouse gas not carbon dioxide.

page 1550, line 26: What is meant by "absorption characteristics of CO2". It's spectroscopy? I would think that that is not a limiting factor for understanding the relationship between the carbon cycle and climate change.

page 1553, line 4: What wavelength is used? The Planck function peaks around 500



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nm. As far as I know there is no CO2 line there.

page 1556, line 4: "The O2 VMR varies ..." Please explain due to what. The way it is written now suggests that O2 actually varied over that range, which I understand is not what is meant.

page 1556, line 23: I suppose that instead of minimum and maximum diurnal variations the most negative and positive deviations of the mean are meant (the minimum variation is clearly not the same as the most negative deviation)

page 1557, line 1-10: Some more explanation is needed of what these values are supposed to represent. They seem to have been used in figure 9 to represent the uncertainty of the FTS. However, some of the variation represents signal and not error (for CO2 I mean). In this respect the use of "diurnal variation" is dangerous, as it is usually associated with the diurnal cycle of CO2, whereas - as confirmed by fig. 5 - this variation is dominated by noise. I was surprised that the relative variation of the CO2 mixing ratio is lower than that of O2. This is unexpected since the CO2 column averaged mixing ratio is derived by O2 normalization and therefore carries the combined uncertainty of the O2 and CO2 FTS measurements. This should be explained.

page 1557, line 18: How can Domina and the FTS measure the same airmass?

page 1558, line 1-9: First pressure is converted into vertical elevation and then converted in pressure again. The reason for this procedure should be explained.

page 1558, line 10: It is unclear how the 0.75 ppm has been derived. This should be explained.

page 1558, line 25: Looking at the right panel of Fig 8 I see much more variation in the vertical profile then can possibly be explained by the averaging kernel. Actually the averaging kernel only expresses the sensitivity to the total column and has no relation with the number of degrees of freedom at which the vertical profile is resolved.



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Nevertheless it is clear that to resolve the vertical profile like in the right panel requires much more vertical resolution than an FTS could provide. This should be explained.

Technical corrections

page 1550, line 1: The sentence becomes much easier to read when "has been developed" is placed after "A framework".

page 1551, line 10: "This makes ..." please explain what is meant by "This".

page 1554, line 1: what is meant by "the combined dataset"?

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