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Atmospheric Measurement Techniques Discussions

Interactive comment on "Comparison of CO_2 from NOAA Carbon Tracker reanalysis model and satellites over Africa" *by* Anteneh Getachew Mengistu and Gizaw Mengistu Tsidu

Anonymous Referee #1

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The authors evaluated two versions of the CarbonTracker inversion system by comparing its posterior simulation with satellite XCO_2 retrievals over the African continent. This regional focus is interesting but the paper is loosely written and often reads like a technical report. Throughout the text, there are many vague or awkward expressions that induce misleading or erroneous statements. There are both some small repetitions and some out of scope paragraphs (e.g., the parts about growth rate). The content of the cited papers does not always correspond to what is said of them in the citing paper. Retrievals are used and cited without any reference to specific versions while they may

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Discussion paper

be quite different from one to the next (e.g., are the authors using v7 or v8 OCO-2 retrievals from NASA?). I argue that much effort is needed to check the content of each sentence and improve the general presentation, before the paper can be published.

I am therefore skipping the numerous details in order to concentrate here on general issues.

The introduction (p.2-3) is unnecessarily long and convoluted, and it poorly motivates the study. For instance, the paragraph about TCCON is disconnected from the rest. More importantly, there is a silent shift of meaning for "model" from "Earth system model" to "transport model" without any concern about consistency in the logic flow. Some statistics are given without any reference to specific retrieval versions.

The method (p. 5) does not mention the retrieval averaging kernels. The authors need to clearly state the fact that they have used them, or redo their study if they have not used them yet.

Statistical quantities are not mathematically defined and there are many in this paper. For instance, the False Alarm Ratio (FAR) is simply defined by "identifies the fraction of events captured by simulation but not available in reference observation", but there is no obvious "event" for XCO_2 (in contrast to rain for instance). An equation would explain what the authors mean, but at first glance FAR seems ill-suited for a continuous variable. From the values they find, the authors seem to be concerned by the fact that the model does not capture the higher end of the retrieval distribution, but what does it mean? The model could, e.g., slightly misplace fire plumes in time or space without affecting its overall realism. A simple scatter plot could efficiently replace the series of categorical indices that the authors use and simplify the message. Also about statistics, it is not even clear whether they are computed over 5 years, or over 5 years and 3 months. Last, some error bars are put on monthly-mean and area-mean retrieval values in the figures. We may suppose that they are standard deviations (the legend does not mention them), but they seem to be way to large for that (only random errors

are given in satellite products and by default they should decrease as 1/sqrt(n)).

Table 1 is very intriguing. First, the focus area is made of 428 grid points and the data spans about 5 years, but the statistics are made over 750 data points only. Second, if we assume that GOSAT errors and CT errors are uncorrelated, we deduce a 1-σ error for CT XCO_2 over Africa of $(3.47^2\text{-}0.9^2)^{0.5}$ = 3.4 ppm, marginally smaller than the variability of the retrieved XCO_2 (σ = 4.3 ppm). Such a poor skill is hard to believe. By comparison, I downloaded the CAMSv17r1 data (http://apps.ecmwf.int/datasets/data/cams-ghg-inversions/) and compared it with the ACOS GOSAT v3.5 retrievals for the same period (5 years and 3 months) with the proper averaging kernels. For individual values, I find a model-minus-retrieval bias of -0.41 ppm (similar to what is shown in the paper if we except the sign, that is undefined in the table legend) and a standard deviation of 2.2 ppm, for a number of data points of 266,662. That makes a model uncertainty of $(2.2^2\text{-}0.9^2)^{0.5}$ = 2 ppm, ie 35% less than for CT. If we account for the fact that the estimated retrieval precision may be wrong by a factor of ˜1.5 (see O' Dell et al 2012 for a previous ACOS release, http://dx.doi.org/10.5194/amt-5-99-2012), we find a model random uncertainty a bit better than the retrievals, as expected. The correlation also rises from 0.73 in the paper to 0.87. CAMS and CT are different products, but we do not expect such a difference in quality.

Talking about CAMS, there was a comparison between MACC13r1 and ACOS GOSAT v3.5 a few years ago with some focus over Africa savannahs, that suggested deficiencies in the retrievals (in terms of systemetic errors and in terms of averaging kernel shape) (Chevallier et al. 2015, http://dx.doi.org/10.5194/acp-15-11133-2015). If the authors use a more recent version, these artifacts may have disappeared, but this needs to be looked at. If the authors use the same version, this needs to be accounted for when using the retrievals as a reference.

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