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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of improved Aura Tropospheric Emission Spectrometer (TES) CO_2 with HIPPO and SGP aircraft profile measurements" *by* S. S. Kulawik et al.

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The authors present a thorough validation of a new TES CO2 product with several aircraft in-situ and AIRS satellite observations.

The most problematic issue is the somewhat arbitrary correlation criterion for comparisons with the HIPPO campaign. The time window is large but statistics on the actual time match quality or e.g. back trajectory analyses are not provided. I think some more justification beyond a better fit between TES and HIPPO is needed. For SGP comparisons, monthly mean comparisons seemed to be fine. It is not clear why this was not also done for HIPPO.

Another point is that since this article is an update of a previous data version, it should be more clearly pointed out what is new and what is essentially the same as in Kuwalik et al. 2010. This mainly affects Section 3.

General comments:

- the title only mentions HIPPO and SGP. However, you also use CONTRAIL and AIRS for your validation.

- TES matching criteria: 10 deg latitude, 4 deg longitude, 14 (!) days. That sounds like a very broad range. Can you justify especially the large temporal match criterion? In 14 days, an air parcel would be transported over a much larger geographical range than your lat/lon criterion.

- logarithmic retrieval, p. 6291: I understand that log retrievals are typically used to handle large dynamic range of a species (e.g. H2O) or to force positive values for small values with comparatively large noise. It is not obvious to me why this would be optimal for CO2. Please explain why a log scale retrieval was chosen (or provide a reference if it is explained elsewhere).

- througout the text, the term "target" is used without a clear definition.

- Section 3.2: it is not clear to me if this is new or a summary of the procedure that has also been used before.

- target-averaging: I am not convinced that averaging over some 40 targets will reduce biases in the 1-2

- the term volume mixing ratio (VMR) is used but it should probably rather be dry-air mole fraction (DMF). For species in the ppm region, the difference between the two is very small. However, for abundant species like N2 DMF(N2)=0.8 while VMR(N2)=4!

- many of the figures are hard to read and look pixeled even if enlarged by 400

Specific comments:

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Introduction: I miss information on the temporal range for which TES data is available.

p. 6286, l. 8: providing some more details on the vertical width of the TES averaging kernel would be useful here. Also, please provide approximate altitude in meters with the pressure values. This makes it easier to compare this with the flight altitude range mentioned earlier.

p. 6286, l. 21: better write "660 cm^{-1} to 2260 cm^{-1}". BTW: the TES L1B data product quality description (V2) lists 650 cm^{-1} as the lower wavenumber range and suggests not using data within 30 cm^{-1} of the spectral range boundaries of the individual filters.

p. 6286, l. 25: Table 1 lists 500 obs/day instead of 2000-3000. Why the discrepancy?

p. 6287, l. 7-9: again, pressure + altitude and more information on the vertical range of the TES averaging kernel would be useful here.

p. 6287, l. 11-13: the sentence about the matching criteria should not be in brackets.

p. 6287, l. 13: strange term: "HIPPO-identified"?

p. 6287, l. 14: Please explain CO2-QCLS and CO2-OMS

p. 6287, l. 17: "at levels of 2 ppm or more"? Do you mean more than 2 ppm difference between flask sample values and continuous in-situ measurements?

p. 6287, l. 18: please provide flight altitudes consistently, either in m or km.

p. 6289, l. 1: please also provide wavenumber values for nu_2 and the laser bands for readers not familiar with Kulawik et al. 2010. How many laser bands are there? If too many, please add a table.

p. 6289, l. 8: what is "cloud pressure"?

p. 6289, l. 12: "biased even more" means with a larger low bias than the 511 hPa level?

p. 6291, Eq. 3: The S matrices in Eq. 3 are not explicitly defined, so it is hard to follow

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the transition from Eq. 2 to Eq. 3. If you are using the same steps and notation of Connor et al. 2008, please say so.

p. 6292, l. 19: how would spectroscopic/calibration errors contribute to random error?

p. 6292, l. 22: I think the validation with the aircraft profile should be a separate subsection.

p. 6292, l. 24: I am confused with the different pressure grids used so far (I counted three so far: 5-level, 65-level, Table 3). Could you please add a table that lists them or explain them somewhere in Section 2.

p. 6293, l. 14: in what sense is your retrieval "non-linear"? Do you run several iterations?

p. 6294, l. 6: Please use math symbols instead of sqrt().

p. 6294, l. 13: I disagree with "This AK shows the potential for resolving CO2 at diïňĂerent pressure levels once the spectroscopy is addressed". The step 1 AK may allow something like two seperate altitude retrievals. However, the kernel rows for step 2 basically overlap completely with a peak at the same altitude.

p. 6295, l. 14: please use consistent naming for the HIPPO campaigns (not "HIPPO 3", "HIPPO-3" etc.

p. 6304, l. 11, 15, 18: please fix at least 3 misspellings of "sensitivity" on this page.

p. 6320, Fig. 1: the bottom right plot misses the tick marks for pressure, the pressure axis should be labeled with units

p. 6321, Fig. 2: the small text on the figure is hard to read and looks pixeled.

p. 6322, Fig. 3: the SGP plot looks very pixeled, the latitud labels are unreadable.

p. 6323, Fig. 4: the right panels might go into a separate figure to be better readable. What is the black dashed line on the right panels?

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p. 6324, Fig. 5: there are no (a), (b), or (c) labels on the actual panels.

p. 6325, Fig. 6: the statistical info on the panels is very interesting but hard to read. You might want to put is just to the right of each panel.

p. 6326, Fig. 7: sorry, I did not understand from the figure caption what the difference between the orange and red TES data is.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 6283, 2012.