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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.

Anonymous Referee #1

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General comment

This manuscript 'Comparison of improved Aura Tropospheric Emission Spectrometer (TES) CO2 with HIPPO and SGP aircraft profile measurements ' deals with ACP main topic : space-borne product validation and error quantification by comparisons with scientific aircraft measurements. The manuscript is well structured and clear.

This interesting and necessary work about TES CO2 error/bias quantification over land and ocean is very useful for scientific analyses and models assimilation. Method Improvements from older version of TES CO2 products and validation methodology to estimate errors and bias are valid, complete and precise.

However, I have some specific and technical comments (listed below), and general concerns :

-It is not clear in the paper that most of the results and comparisons correspond to TES CO2 511hPa level. So, I have difficulties with the term 'profile' in the title and the abstract. It is not clear in this paper, (as the authors say §4.3) how the improved TES CO2 product can capture CO2 vertical structure. In particular conclusion of §4.2.1 shows that TES CO2 is not really sensitive to CO2 above 5 km.

-It would have been very interesting not to give only global rms error and bias of TES CO2 products but also to provide latitudinal and seasonal variation of these important parameters for model assimilation. I guess the main problem is the number of collocated measurements, but even if error increases their variations can provide useful information on TES CO2 products. You should try to plot it.

- Time and latitude best averaging of TES products is not clear and discussed enough, it appears sometimes in contradiction with authors average choices.

Then, I notice that units are missing in most of tables and text is sometimes mixed with formulae (see technical comments).

Specific comments

P6284 Abstract :

Two main information are missing in the abstract : the latitudinal range of comparisons (1st sentence), and the pressure/altitude of quoted errors in the sentence L12-15.

L11 : Even if TES CO2 products capture well seasonal cycle and latitudinal variation, you should mention that this paper provide only global bias and error and do not give information about error and bias variations with season and latitude.

P.6285. L16-L30: Is this paragraph necessary ? It might be shorter, in particular from L26 to L4 P6286.

P6287 : What is the SGP measurement accuracy ? You should mention it.

P6287 : L13 Why this sentence inside brackets ? It is an important point. You should insert that TES spatio-temporal range impact is discussed at §4.1.2.

P6287 : L25 : meaning of flag ' ..P ' ?

6289 : L27 : Are you sure that extending v2 band do not increase TES CO2 sensitivity to water vapor uncertainties?

6294 : L11 . Averaging kernel is a matrix (A), AK corresponds to row of A each row corresponding to a TES level. You should be more precise.

6295 : Why do you use a different latitudinal range (4° for HIPPO and 5° for SGP)? Is there a specific reason ?

6299 : L19 : Looking at table 5b, for latitude, actual error decrease from 4° (medium criteria) to 6° (loose criteria), from you should mention it even if bias increase. You must discuss this point in term of best latitude range for TES average.

6299 :§4.1.3: Do you obtain such results on longitudinal shift with SGP comparisons ?

6300 : L12: From conclusion of §4.1.2, the best time average is 14 days, so, why do you average TES over 1 month for SGP comparisons ?

6301 : L10 : The conclusion is : missing validation data above 5 km create at least a mean bias uncertainty of 0.3 ppm. You should add ' for TES CO2 for 511 hPa level'. Can you compare this value (0.3 ppm) with the mean difference between the 3 profiles (above 5km) you use to create the 'true profile' ?

6303 : §4.3 is not so clear, the conclusion seems to be : TES CO2 for 511 hPa level

6304 : L22 : You mention that "averaging TES within 5° latitude, 10° longitude and 14 days gives the best results" , you should add that is true only for ocean retrievals (not been tested for SGP over land), then you didn't test 5° latitude but only 4° and 6° and

it is not clear that the best range is between 4° and 6° (see previous remark).

A more general comment about your conclusion : over land you use 1 month time average, so the number of TES measurements averaged is more important than over ocean for HIPPO comparisons (14 days average), so it is difficult to compare land and ocean rms and bias values of TES CO2 products. It can be very intersting to discuss the difference between the TES CO2 product quality over land and over ocean.

6316 - 6317 : Legend of table 5 and table 6. Can you precise what is the "mean" : it is not clear why the number 'n' is not the sum of others 'n' ?

It seems that you make an average of the results of each flight, why don't you re-calculate parameters using the 3 campaign together ? The result should be quite different as the number "n" will be higher.

6317-63199 : Actl error : why do you use a ratio ? I think that actual errror in ppm would be easier for interpretation.

Technical comments

6287, L9 : WMO signification ?

6291 : L8 : In the text use logarithm instead of "log" (just my opinion, to be confirmed with editor). Check it everywhere in the text.

6291 : L8-L9 : you should write :

where Xest , Xtrue and Xa are the logarithm of the estimate, the true state and the a priori constraint vector, A is the averaging kernel (sensitivity of the estimate to the true state), G is the gain . . ..

You should remove '=dXest/dXtrue' from the text.

6291 : L15 , replace "the retrieved parameter is x = log (VMR)" by "the retrieved parameter,x, is the logarithm of the gas volume mixing ration (VMR)"

6294 : You should replace “ reduced by 1/sqrt(40)” by ‘reduced by a factor square root of 40’. Generally, you should try to avoid to insert in the text ’1/sqrt(# measure)’ : To be confirmed by the editors.

6297 : L16 : Error in the sentence ’ comparisons nd predicted ’, what is nd ??

6299 : L11. sect “4.1.3” instead of “4.1.2”

6299 : L20 : You should remove a dot just after ’improve..’

6299 : L 21 : A “n” is missing in longitudinal (title 4.1.3)

6313 : A ’ End ’ is missing in the last row of “step 2”

6315 : Errors Unit are missing in table 4

6316 : Errors and bias Unit are missing in Table 5

6316 : a bracket is missing line 9 of the legend.

6317 : Errors and bias Unit are missing in Table 6

6317 : In the last sentence you say “latitude” instead of “longitude”.

6318 : You should mention that column signification correspond to the previous figure.

6320 : Problem with left panel x-axis in figure 1

6321 : Problem with middle and right panels x-axis in figure 2

6326 : L6 of the legend, replace “Eq. 6d, ” by “Eq. 6 (d),”

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