**Atmospheric
Measurement
Techniques**
Discussions

Open Access

Interactive comment on "Characterization of aura tropospheric emissions spectrometer carbonyl sulfide retrievals" *by* L. Kuai et al.

Anonymous Referee #1

Received and published: 22 August 2013

The paper by Kuai et al. presents retrievals of carbonyl sulfide (OCS) from thermal emission spectra collected over the oceans by the tropospheric emission spectrometer (TES) onboard the Aura satellite. The spectroscopic retrieval of OCS is challenged by small absorption cross sections and interference with other molecular absorption/emission. The paper provides on overview of retrieval characteristics and some comparison to independent airborne and ground-based OCS measurements.

The study addresses the relevant aspects for characterizing a new retrieval product which is of interest to scientific community although I do not entirely understand why the study is restricted to oceans only. The methods appear adequate and mostly robust. Therefore, I recommend publication in AMT after considering the following comments.

Comments:

- The typical degrees-of-freedom for signal (DOF) of the OCS retrieval from TES are found 0.67. While being methodological valid, this seems a very low number of DOF in the view of science applications. Given that the a priori covariance matrix is anyway chosen in an ad-hoc way, why is it not chosen such that one gets at least DOF ~ 1? Figure 6 indicates that there is non-vanishing contributions from noise and smoothing error to the total error. Allowing for more freedom in the retrieval would increase the noise error but decrease the smoothing error such that the total error might not change too much.

- Figure 3: Why is the structure of the CO_2 and OCS a priori covariances so different? Are the secondary diagonal elements for OCS larger than the variances on the diagonal? Is the vertical grid different for H_2O and CO_2, OCS? Please clarify and reason why.

- For comparison to the airborne data, the TES OCS retrievals are averaged over several years (for the same month of the year). This results in sometimes smaller error bars than those of the comparison data set (figure 8 and 9). So, reducing the averaging periods would not hurt too much in terms of TES error bars. How does the comparison change when you restrict the TES averaging to single years or other subsets of the 2006-to-2010 period? Is there inter-annual variability detectable? Does selecting smaller geographic bins impact the conclusions?

- Conclusions on TES successfully catching the OCS seasonal cycle are based on comparisons at a single ground-based station (Mauna Loa) that provides local in-situ concentrations instead of vertical profiles or (partial) column estimates. OCS seasonal cycle amplitude will certainly depend on altitude. Did you investigate whether data exist from other validation sources such as ground-based solar-viewing FTS (e.g. NDACC) or ACE-FTS data that could help making the comparisons more robust.

- In some parts, I had the impression that the paper was written in a hurry. I strongly

recommend revising the paper with a view on language issues. Examples:

* Title, introduction: "tropospheric emissionS spectrometer" $< -?- >$ "tropospheric emission spectrometer"

* p6978, l17: "b and ba represent the true state and the a priori of the state" This is wrong, b and ba are forward model parameters that are not part of the state vectors x and xa.

* p6978, l20: While the (unimportant) Jacobian matrix Kb with respect to the forward model parameters is explicitly defined, the (important) Jacobian matrix K with respect to the state variables is not defined. K in equation (3) is not Kb.

* p6979, equation (4): There is no link of equation (4) to the preceding text.

* p6986, l36: "Figure 9 shows the correlation of TES monthly OCS corresponding all HIPPO estimates convolved with the TES operator. TES OCS shows fairly well correlation (R=0.66) with these bias corrected in situ data, which were applied with the TES operator during different months of the year. The bias has been removed using the TES operator …" $- >$ How often did you apply the TES operator?

* p6980, l27: alia $- >$ alias

* p6983, equation (5): The TES a priori state xa is already in logarithmic units. The new greek variable is probably meant to be the (non-logarithmic) concentration profile corresponding to xa but it is not defined as such. Further, all the Greek variables are supposed to be vectors (vertical profiles) and thus, should be bold face (likewise equation (6)).

* p6984, l21 to p6985, l9: Please clarify the text here. I cannot follow the various averaging procedures. If I understand correctly, a single data point for each latitudinal bin is compared in the end. Why not including the vertical averaging procedure in equations (5) and (6) by introducing a tropospheric column operator in order to make the text clearer here?

C2188

* table 1, "TES sample number": I guess the sample number is given as a range because sample number varies for the latitudinal bins. This should be mentioned somewhere in the caption.

* Figure 5: "the one tenth of" $- >$ "one tenth of the"

* Figure 6: "compare" $- >$ "compared".

* Figure 10: The caption should cover an explanation of what is shown.