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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Improved agreement of AIRS tropospheric carbon monoxide products with other EOS sensors using optimal estimation retrievals" *by* J. X. Warner et al.

Anonymous Referee #2

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General comments : This paper presents an alternative retrieval algorithm for the AIRS CO product. Differently to the operational AIRS product, the authors used the Optimal Estimation (OE) method for retrieving the CO since this method is currently used for both TES and MOPITT products. The paper is well written and then it is easy to understand. The authors proposed to use this OE method in order to have a more realistic product than the operational one.. Then with the OE method, the data are well characterized (in terms of errors) and associated averaging kernels can be used easily for validating different products or in assimilation. Particularly because of this reason, I recommend the publication of this paper after the following revisions.

1. When comparing the OE AIRS product with TES, it would be interesting to discuss also the covariance matrix or other parameters to show what is the information brought by the measurement itself. For example the percentage of a priori contamination in the measurement and/or the error of the measurement for each level of OE AIRS profiles could be useful to estimate the quality of data. The authors could comment on this.

2. The DOF of both OE AIRS and operationnal AIRS CO data are less than 1 meaning there is less than one information in the vertical. That means also probably the best information from AIRS is the total column. Why not comparing AIRS with the total column using the aircraft data? The authors should add comments on this.

3. It would be also useful to study the sensitivity of the sensor over land or over sea and during daytime and nighttime to estimate the quality of this new set of OE AIRS data as it is done for the operational products. Could the authors add something about this in the text?

Minor comment and technical corrections

Introduction

p 11853:

Earth is written with a capital letter and not in the rest of the paper. Please be consistent.

l 24 and l 28 : The version numbers of AIRS operational products are confusing, which one is used ? V5 or version 4. What are the differences. Please clarify.

P 11854 :

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Give also the spectral sample spacing for AIRS as well as the Signal to Noise Ratio for both TES and AIRS. (see other comment below). Please also add which spectral sampling is used for TES in the CO band (is it 0.08 or 0.02 cm-1)? The pixel sizes of AIRS, TES and MOPITT should be the values at nadir. Please add nadir for AIRS and MOPITT. The grid of MOZART model at global scale is higher (should be 2.8x2.8 degrees)

2 background : CO differences between AIRS and TES operational products

P 11856 :

AIRS and TES have different sizes of footprint and then the scene measured by each sensor is probably different. Then the representiveness of measurement for AIRS and TES is also different and could add a bias or larger variability. The authors should comment this in that section.

P 11857 :
Could you add also the bias in terms of percent.

P 11860 :
Define X (should be the Truth).

4 AIRS CO retrievals using OE

p 11861 :

l 1: add operational or V5 for AIRS CO.
L 26 Please add the number of levels for MOPITT V4

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Figure 3 : Please add time of the aircraft spiral profile and if possible error bars for each level of AIRS CO products (for example the diagonal of the covariance matrix). On this figure, there is a clear maximum at about 500 hpa which probably represents the transport of a CO plume at this altitude. However, the sensor is also supposed to have a good sensitivity at this altitude. Then why there is a corresponding local minimum at this altitude for all AIRS retrievals and even in the convolved profile? Perhaps it comes from the sensitivity of AIRS with a DOF less than 1 and in this case only allows the capture of the total column. The authors could add a comment probably linked to the question of what kind of measurement information brings AIRS vs the a priori?

P 11863 :

l 24: The second maximum near 850 hPa is not really obvious to see. Could you help the reader by adding an arrow or changing the axis of Fig 5. Is this slight second maximum sufficient for adding some measurement information at this level? Please comment.

5-Comparison of global tropospheric CO of AIRS OE with TES and MOPITT

P 11864 :

l 15 : Could you please give more explanation on how to reduce the effect of the apriori by using the averaging kernels? Do you replace the X in the formulae (5) by TES CO? I don't see mathematically the point since TES is not the Truth and has its own averaging kernels and a priori profiles. Please could you add more information.

P 11865 :

l 20: MOPITT CO (blue) replace by MOPITT CO (black) same in figure 9

l 25-26: The DOF depends on the SNR and spectral resolution, not just the resolu-

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tion. TES is a spectrometer and AIRS a grating spectrometer, the couple (SNR and spectral resolution) gives the adequate instrument to measure CO. Probably for a grating spectrometer, we might have a coarser resolution but a higher SNR whereas for a spectrometer this is the opposite.

Figure 9: I don't see why the DOFs of AIRS are better than TES or MOPITT at higher latitudes? Do the authors have an explanation? If yes please add in the paper.

l 28 : MOPITT V4 instead of V3

p 11866 :

l 12-15 : Please add the overpass time at the equator for each satellite.

L 14 : I think when there is high thermal contrast, there is more vertical sensitivity of Infrared sensor and probably because the CO is directly emmited from the surface then the CO is relatively larger in the lowest troposphere. I think there is no direct link between high thermal contrast and larger value of CO in the mid troposphere?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 11851, 2010.