Atmos. Chem. Phys. Discuss., 10, C3514–C3518, 2010
www.atmos-chem-phys-discuss.net/10/C3514/2010/

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 #1

Received and published: 3 June 2010

General comments: The results in this paper are an important step forward in understanding thermal infrared remote sensing of atmospheric CO from different satellite measurements. The paper is well written with relevant tables and figures. I recommend publication after minor revisions.

1) There needs to be more description of the measured radiances. Are they from the AIRS cloud-cleared radiance product, or individual spectra. How is the measurement error covariance constructed?

2) The apriori constraint matrix used in the retrievals can have a large effect on both CO profiles and DOFS, as shown in Ho et al., 2009 and Deeter et al., 2010. This

needs further discussion here since you are comparing results with different constraint matrices as well as different apriori profiles. (See specific comments as well).

3) Since you are using the global/static apriori covariance and profile from MOPITT V3 for the AIRS OE retrievals why do you compare to MOPITT V4? Maybe you could also show comparisons to MOPITT V3.

4) The abstract should include a quantitative measure of improvement for AIRS OE vs. AIRS V5.

Specific comments:

1) Intro 3rd para, give frequency range for TES CO retrievals: 2080-2180 cm-1. (Worden et al, 2004)

2) Intro 4th para – 'similarly to TES' here sounds like TES is closer to MOPITT V3, when it is actually closer to MOPITT V4, i.e., also uses log VMR parameters. I would remove 'similarly to TES' and add later, 'MOPITT V4, like TES, also uses a log-normal VMR. . ..'

3) Intro 5th para –Add a reference for how the AIRS operational algorithm formulates AK & DOFS - Maddy et al.?

4) Sec. 2 4th para – Description of Fig. 2 states SDVs are smaller for 800 hPa than 500 hPa – I don't see this in Fig 2. Vs Fig 1. – please clarify.

5) Sec. 2 4th para – Fig. 2 also demonstrates the monthly varying apriori used by TES since 800 hPa is more influenced by the prior for TES than 500 hPa– the description of Fig. 2 should mention this.

6) Sec. 3.2 Eq. 5 – capital X not defined – do you mean x = true state?

7) Sec. 4 2nd para. Last sentence should include that MOPITT V4 products are on 10 pressure levels.

8) Sec. 4 4th para. If the first guess for AIRS V5 and the apriori for AIRS OE are the same, (as they are in Fig. 4 & 5) then both results should go the apriori value if there is no sensitivity. Maybe the different behavior is due to the apriori correlation in the OE retrieval. The MOPITT V3 constraint matrix has a longer correlation distance than MOPITT V4 and if the V3 constraint is used by the AIRS OE retrieval, it could influence the values near the surface more, as discussed in Deeter et al 2010. The effects of apriori correlation need to be included here.

9) Sec. 5 3rd para – The discussion of algorithm differences should include the differences due to constraint matrices with a reference to Ho et al, 2009 (see below) which shows the effects of using different/same constraint matrices in TES and MOPITT retrievals, as well as the same apriori vectors.

10) Sec 5. 3rd para. – The latitudinal dependence of the TES DOFS is also due to a change in the Tikhonov constraint at ± 18 deg. latitude, [Kulawik et al, 2006], which should be mentioned in the description for the DOFS fig. 9.

11) Table 1. Should also include the terms "static" for AIRS OE and MOPITT V3 and "monthly mean" for both TES and MOPITT V4.

12) Fig. 1a and 1b captions should state differences are between AIRS V5 operational and TES V3 products.

13) Figs 4 and 5 should also show TES apriori profiles.

14) Fig. 7 – This shows the global PDFs for AIRS OE – TES differences. If possible, show the same N/S Hemis, ocean/land cases that are shown in Fig. 1a and 2a so that these can be compared more directly.

15) Fig. 8 – per 3rd general comment above – consider adding MOPITT V3 comparison.

Technical corrections:

1) Abstract – add 'the' when before 'AIRS operational algorithm' and 'OE technique' and add change 'selected levels' to 'selected pressure levels'

2) Introduction line 2nd para, last sentence 'bursts' – maybe 'enhancements' is better?

3) Intro 3rd para, change 'NCAR/Atmospheric Chemsitry Division' to MOZART reference Brasseur et al., 1998 (or a website link)

4) Intro 4th para – take out 'the' before 'tropospheric carbon monoxide and methane'

5) Intro 5th para – change 'the sensitivities' to 'the vertical sensitivities'

6) Intro 6th para – change 'as similarly as possible' to 'as closely as possible'

7) Sec 3.1 1st para. 'physical retrieval algorithm' is not really defined here – maybe change 'The current AIRS physical retrieval algorithm' to 'The AIRS V5 operational algorithm'

8) Sec. 4 2nd para. Change 'dynamic' to 'monthly mean' to be more specific for a priori.

9) Sec. 4 2nd para. Deeter et al, 2010 has 2.8x2.8 deg for the MOZART climatology used in MOPITT V4 (interpolated to measurement locations) – not 1°x1°.

10) Sec. 4 6th para What is meant by 'selected from 34th in layers'?

11) Sec. 4 7th para – change 'The V5 CO' to 'The AIRS V5 CO'

12) Fig. 7 caption – change 'convoluted' to convolved.

References to add:

Brasseur GP, et al. (1998), MOZART, a global chemical transport model for ozone and related chemical tracers 1. Model description, J. Geophys. Res.-Atmospheres, 103, 28265-28289.

Ho, S., D. P. Edwards, J. C. Gille, M. Luo, G. B. Osterman, S. S. Kulawik, and H.

Worden, A global comparison of carbon monoxide profiles and column amounts from Tropospheric Emission Spectrometer (TES) and Measurements of Pollution in the Troposphere (MOPITT), J. Geophys. Res., 114, D21307, doi:10.1029/2009JD012242, 2009.

Kulawik, S. S., G. Osterman, D. B. A. Jones, and K. W. Bowman (2006), Calculation of altitude-dependent Tikhonov constraints for TES nadir retrievals, IEEE Trans. Geosci. Remote Sens., 44, 1334 – 1342, doi:10.1109/TGRS.2006.871206.

Worden, J.; Sund-Kulawik, S.; Shephard, M. W.; Clough, S. A.; Worden, H.; Bowman, K.; Goldman, A., Predicted errors of tropospheric emission spectrometer nadir retrievals from spectral window selection (2004) J. Geophys. Res., Vol. 109, No. D9, D09308, 10.1029/2004JD004522

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