

Review of “Interpretation of Aura satellite observations of CO and aerosol index related to the December 2006 Australia fires” by Luo et al., submitted to Atmospheric Chemistry and Physics Discussions.

The manuscript evaluates the potential of CO data from TES and MLS, and AI data from OMI, in interpreting the evolution of plumes from fire events in Australia during December 2006. The manuscript provides a good overview of the relative abilities of three satellite instruments, utilising different viewing geometries and measurement techniques, for studying such events. It also notes the challenges in interpreting these data in conjunction with chemical transport models, which do not fully represent physical processes such as pyro-convection. It is not clear, however, if the conclusions drawn by the authors, related to the limitations of satellite data to a study such as this, are valid just in this case or more generally.

My specific comments on the manuscript are as follows:

Page 23666, line 12: “The enhanced CO observed by TES **in**...”

Line 17: is drastic the appropriate word to use?

Lines 24-26: not required in the abstract – better suited to the conclusions

General comment on the Introduction: the introduction is a little over long and I feel that the extensive discussion of biomass burning events in North America, Europe and northern Africa is not particularly relevant to a manuscript focussing on Australian fires during one burning season – I suggest that this discussion should be removed.

Page 23667, line 11: extra space “(OH)”

Page 23671, line 8: punctuation – “CO observations from TES and MLS, and UV absorbing indices (AI) obtained from OMI, on the...”

Lines 10-12: suggest specifying nadir-viewing/limb-viewing rather than nadir/limb

Line 20: “...hundred...”, “...thousand...”

Line 22: “215 **hPa**”

Lines 27-28: use of the word taken is a bit vague – suggest changing to measured

Line 28: “...a one-day on followed by one-day off mode” isn’t very clear – change to explain that TES global surveys are measured every other day.

Page 23672, line 1: clarify that the MLS data used in the study are co-located to the TES observations. Also, what do you mean by “field patterns” in the following sentence? The figure shows the gridded CO distributions from TES and MLS.

Line 4: “degrees of freedom for signal” – DOF should be changed to DOFS on this line and elsewhere in the manuscript.

Lines 5-7: the ranges for the latitude bands should be defined in the first sentence.

Line 7: suggest the authors use Rodgers (2000) rather than Rodgers (1998) as it is a more general reference for retrieval theory.

Line 8: “from remote sensing spectra” is not necessary,

Line 10: “In cases 49 to 72...” is not very clear – suggest “For the latitude band between 49 and 72...”.

Lines 11-12: “influenced heavily by the true CO values at 400–250 hPa” isn’t very clear – the averaging kernels show that the CO retrieved from TES is largely sensitive to 400-250 hPa.

Lines 12-14: the final sentence looks out of place here – wouldn't it be better suited to the discussion/conclusions? Also, can the authors be sure that high CO in the lower troposphere downwind of Australia are so unusual? My understanding is that Figure 3 shows mean averaging kernels but do the averaging kernels for those retrievals between 16 and 17 December show the same sensitivity?

Line 15-16: needs clarifying to explain how the MLS profiles are convolved/smoothed with the TES averaging kernels – this is the first use of “TES operators” so please also clarify somewhere in the text if this means the averaging kernels and a priori profile. The reference to Luo et al 2007 looks out of place – this procedure is explained in the TES Users' Guide or Rodgers (2000).

Line 16: the MLS CO profiles are used as the “**truth**”

Line 23: “...are **a** good indicator...”

Line 27: change “11-14 December” to “11 and 14 December”

Line 28: “**This** second event...”?

Page 23673, line 2: change “identify” to “evaluate”?

Line 4: “...of **the** orbit passes...”

Line 8: OMI AI data does not **contain** vertical information

Lines 9-11: the values of 1.0 and 1.4 are the average DOFS for the two latitude bands used in Figure 3 – are they still representative of the full range of the DOFS over this region? Also this sentence isn't very clear - the averaging kernels show that while the TES data is relatively insensitive to the boundary layer, the information is reasonable well constrained in the mid-troposphere. Is the point being made here that there is a mismatch in the sensitivities of the different datasets? If so, this isn't clear from the text.

Lines 12-13: while I appreciate that it is difficult to directly compare the TES CO and OMI AI data, is it not possible to infer a relationship based on the residence time of CO and aerosol in the troposphere?

Line 13: change “simultaneous” to “concurrent”

Line 14: 215 **hPa**

Lines 22-23: suggest changing sentence to “...air parcel trajectory model to trace high CO observations backward in time to confirm their origin”

Line 23: swap model name with acronym – “...Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT)...”

Lines 25-26: “wind field” unnecessary, also swap model name with acronym as above.

Page 23674, line 1: “...trajectories started **from**...”

Line 6: “also marked...”

Line 10: “However, **in** the lower troposphere...”

Lines 25-29: needs rewriting to explain what supporting data are available for the period of interest, i.e. CALIPSO and CloudSat, before acknowledging the gap in the CALIPSO record.

Page 23675, lines 4-5: this sentence doesn't make sense, please clarify.

Lines 11-12: please emphasise that this is the case for this study. The statement reads as though it is not at all possible to use satellite data in this way.

Line 14: the sentence reads as though the GEOS-Chem output is provided by Bey et al (2001), please clarify.

Line 15: clarify that the GEOS-Chem output is sampled at the times and locations of the TES profiles.

Lines 23-25: this procedure has been described earlier in the manuscript, also it's not clear that this sentence adds anything to the discussion – why not show the GEOS-Chem output smoothed by the TES averaging kernels?

Page 23676, lines 1-4: please clarify if this sentence is describing the TES data or the GEOS-Chem output. If it is GEOS-Chem then the word “observed” should not be used later in the sentence.

Line 5: how does the GEOS-Chem output in this study compare to the TES data? It's not clear how the first sentences link to the results of Nassar et al (2009).

Page 23677, line 1: rearrange the sentence to read “Dirksen et al. (2009) used the TM4 chemistry transport model, constrained by OMI O₂-O₂ and AAI retrievals, to...”

Line 9: change to read “where it is actually being observed”

Lines 18-19: too many uses of “CTM”

Lines 17-22: suggest combining the two sentences in this section of text as the use of the Hyer et al (2007) reference is a little repetitive.

Page 23678, line 9: “...Australian fires **of** December 1996”

Lines 22-26: this section will need rewriting to be consistent with the changes suggested for page 23672, lines 12-14, at present it's not clear what conclusion the authors are drawing from Figures 2 and 3.

Page 23679, lines 2-3: change to read “...model output co-located to the location and time of the TES profiles”

Lines 16-18: while this is a valid point, the authors need to acknowledge that improved spatial and temporal coverage is already being provided by instruments such as GOME-2 and IASI. Also the final sentence of the abstract should be included here at the end of the conclusions.

Figure 1 caption: point out that the colour scales of the two plots are different?

Figure 2: please add missing units to the plots; “TES operator applied” should be consistent with the main text of the manuscript; “footprint” is ok for TES but not for MLS – do you mean the tangent point?

Figure 3: the plot axes and titles should be darker; clarify that the pressures in the colour bar are for the TES retrieval levels?; the text describing the profile selection criteria should be in the main body of the text and not in the caption.

Figure 5: needs replotting as the axis and colour bar text is not very clear; change “illustrations” to “plots” in the caption.

Figure 7 caption: it's not clear what “(or zero)” refers to.