

Author comments in reply to the anonymous referee on “A tropospheric chemistry reanalysis for the years 2005–2012 based on an assimilation of OMI, MLS, TES and MOPITT satellite data” by K. Miyazaki et al.

We want to thank the referee for the helpful comments, compliments on the quality of the manuscript and positive recommendation for our paper to be published. We have revised the manuscript according to the comments, and hope that the revised version of the manuscript is now suitable for publication. Below are the referee comments in italics with our replies in normal font.

Reply to Referee #2

Page 8690, Line 24: suggest clarifying what is meant by “bottom-up” in line with the description of “top-down” in the following sentence.

The sentence has been rewritten as follows:

‘Currently available bottom-up inventories of emissions, produced based on statistical data such as emission related activities and emissions factors, contain large uncertainties’

Page 8693, Line 20: clarify that the 2.8 degree resolution is for longitude and latitude?

The sentence has been rewritten as follows:

‘...T42 horizontal resolution (2.8° for longitude and the T42 Gaussian grid for latitude)...’

Page 8696, Line 15: the context for this sentence isn’t very clear - suggest linking better to the previous sentence and clarifying that the optimization will lead to the reduction in the initial bias in the a priori emissions.

The sentences have been rewritten as follows:

‘The emission sources were optimised at every analysis step throughout the reanalysis period, which reduced the initial bias in the a priori emissions during the data assimilation cycle.’

Page 8696, Line 18: suggest changing to “The EnKF approach always has. . .” .

Corrected.

Page 8697, Line 1: suggest changing to “One difference to the study of. . .” .

Corrected.

Page 8697, Line 15: I’ m not sure this statement on the averaging kernel is strictly true. The averaging kernels give the sensitivity of the retrieved state to the true state and the a priori dependence is only removed when the innovation is calculated, i.e. as in equation (4) and not in equation (7) which is what this statement appears to allude to. Please clarify this in the text.

The sentence has been rewritten as follows:

‘The averaging kernel A defines the vertical sensitivity profile of the satellite observation. Even though the retrieval y^0 and the model equivalent y_i^b both depend on the a-priori, the use of the kernel removes the dependence of the analysis or the relative model--retrieval comparison $(y_i^b - y^0)/y_i^b$ on the retrieval a-priori profile (Eskes and Boersma, 2003; Migliorini, 2012).’

Page 8698, Line 4: suggest using “simulation” or “model simulation” rather than “calculation” .

Replaced by ‘data assimilation calculation’.

Page 8698, Line 5: the sentence beginning “Eight series of...” isn’ t very clear in its meaning, please rewrite and clarify.

The sentences have been rewritten as follows:

‘Eight series of one-year calculations from the 1 January of each year in 2005-2012 with a two-month spin-up starting from the 1 November of the previous year were conducted to produce the eight-year reanalysis data set,. Each one-year run was parallelized on 16 processors. ‘

Page 8699, Line 12: I think “onboard” can be replaced with “on” .

Replaced.

Page 8706, Line 7: Model underestimates of CO is a fairly persistent issue for a number of different models and the low bias relative to MOPITT shown in Figure 2 would appear to be consistent with this. It may be useful for the reader to acknowledge how the CHASER global CO field generally performs with respect to other models, and if this could also contribute to the OmF statistics in this study. This is

commented on in Section 5.2.1 but could also be mentioned here.

The following sentence has been added to the paragraph:

‘The underestimation of tropospheric CO by CHASER was found to be very similar to that in most of the other CTMs (Shindell et al., 2006).’

Page 8707, Line 20: I think that this statement on the TES information content is consistent with the literature showing that the TES O₃ averaging kernels have distinct peak sensitivities in the lower and upper troposphere – it would be useful to the reader if this was acknowledged/cited here.

The sentences have been rewritten as follows:

‘Jourdain et al. (2007) showed that the TES retrievals have 1-2 DOFs in the troposphere, with the largest DOFs for clear-sky scenes occurring at low latitudes where TES can distinguish between lower and upper tropospheric O₃. The obtained analysis increments correspond well to the OmF in the control run at the same altitude (figure not shown), confirming that the data assimilation effectively reduced the model errors through the analysis steps.’

Page 8709, Line 1: I think “measurement” here should be “retrieval” to indicate that it refers to the satellite data as the ozonesondes don’t have low sensitivity in the lower troposphere.

Replaced by ‘retrieval’.

Page 8710, Line 28: Is it possible to back up the statement that the improvement in O₃ relative to MOZAIC at cruise altitude is due to the MLS assimilation. Have the authors performed any sensitivity tests which quantify the relative contributions of the different assimilated datasets to the analysis? While it is clear that the MLS data could bring about this improvement, a supporting statement could be useful for the reader.

The sentences have been rewritten as follows:

‘A substantial improvement is observed at the aircraft-cruising altitude around the tropopause (between 300 and 200 hPa) at the NH high-latitudes; the mean positive bias is reduced from +8 % in the control run to +3 % in the reanalysis. By separately assimilating individual measurements through the Observing System Experiments (OSEs), we confirmed that the improvement is mainly attributed to the MLS assimilation (not shown).’

Page 8711, Line 8: “attributing” should be “attributed”.

Corrected.

Figures 9 and 13: I found each panel to generally be too small and could be made bigger using common y-axis titles.

Corrected.