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Interactive Comment

Interactive comment on "First space-based derivation of the global atmospheric methanol emission fluxes" *by* T. Stavrakou et al.

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We would like to thank the reviewer for the constructive criticism. In the following, we address the concerns raised. Reviewer's comments are *italicized*.

General comments

1) The uncertainties on the a priori emissions and on the observations are only slightly discussed in the paper. The authors write that the uncertainties on the IASI observations are large (50% + 10^{16}). Do these large uncertainties permit to reduce the error estimate on the a posteriori emissions? Is there a real gain using these observations? The paper would be much stronger if this point is addressed. A view of the variation of *the spatial variability of the errors of the observations correlated with the regions not considered for the inversion would be helpful for the reader.*

The uncertainties on the a posteriori emission estimates have been calculated by using an off-line iterative approximation of the inverse Hessian matrix based on the widely accepted Davidon-Fletcher-Powell (DFP) updating formula, described in the new section 9 of the revised manuscript. The error reductions per emission category are given in Table 3 for large continental regions. The largest error reductions are achieved for the biogenic source over regions where forests are dominant, like South America and the Former Soviet Union, where the a posteriori uncertainties are reduced by 50% and 67%, respectively. Significant reductions are also found over Europe (40%) and North America (35%). The error on the biogenic source is decreased globally by 43%. As expected, lower error reductions are calculated for the vegetation fires source, since it represents only 3% of the global methanol source : on the order of 14% on the global scale, 10-12% over Africa and southern Asia, and almost negligible error reductions over other regions.

Furthermore, to address the criticism of Reviewer#1, we have included in the new Section 10 of the revised paper a tentative assessment of model errors, based on a set of sensitivity inversions aiming at investigating the influence of uncertainties on meteorological parameters, on methanol sink processes, and on the a priori methanol plant emission source. The performed inversions and the corresponding tropical (25 S-25 N), extratropical and global biogenic source inferred in each case study are summarized in Table 5. Moreover, Figures 13-15 illustrate the changes induced from the sensitivity inversions. The inferred emission estimates are found to be quite robust in the different sensitivity cases, with global estimates differing by less than 10%, although differences on the order of 30% are found on the regional scale (see Sect. 10 for a thorough discussion of these results).

Another issue concerning the IASI observations is their vertical sensitivity. The author

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mentioned they use different averaging kernels to reproduce a similar vertical sensitivity in the model. Providing a representation of this sensitivity would also help the reader. Are the IASI observations sensitive to the lower troposphere, the free troposphere?

This important issue is fully described in Razavi et al. (2011). IASI total column averaging kernels (Fig. 3 of Razavi et al., 2011) peak between 5 and 10 km and are very broad, suggesting that only very limited vertical resolution can be achieved. IASI measurements are thus shown to be mostly sensitive to free to mid tropospheric columns. In the CTM, mean averaging kernels, differentiated over land and ocean, are used in order to account for the vertical sensitivity of the measurements. A comment on this issue is added in Section 5.1.

2) Another interesting information to quantify the gain using the IASI observations as constraint would be to use the Jacob et al. (2005) inventory as a priori for the inversion. Does it lead to similar results and conclusions?

To assess the sensitivity of the derived fluxes to the choice of the a priori biogenic inventory, we have conducted a sensitivity inversion (OptS1, Table 5) which updates on the Jacob et al. (2005) inventory. The results are found to be only moderately different from those deduced with the standard OptS2 inversion (Fig. 15, Table 5). The global a posteriori biogenic emission amounts to 103.8 Tg/yr, and lies very close to the global emission derived by OptS2.

3) Regional differences between the two a priori methanol distributions, the a posteriori distribution and the IASI distribution are extensively discussed. However, no specific comment is given on the differences observed over Siberia with the optimized inventory (and MEGAN also). The agreement is better between IASI and the columns calculated from the Jacob et al inventory than between IASI and the MEGAN and the optimized inventory. Comments would be welcome.

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This is true only in terms of annual average (Fig. 3). As illustrated in Fig. 5 (third column, first plot), the columns calculated using the Jacob et al (2005) inventory are strongly overestimated in summertime and underestimated from January to April over Siberia (54-66 N, 60-130 E), leading thus to an annual average in better match with the satellite data. The columns calculated using the MEGANv2.1 inventory in the a priori (S2) as well as after optimization (OptS2), agree much better with IASI data in summertime, despite persistent underestimations in the beginning of the year.

4) The comparison with the different aircraft campaign is made using the model simulations in 2009. However, the aircraft measurements usually occur at different years. What about the interannual variability of methanol? Is it negligible?

We expect interannual variability of methanol mixing ratios to be generally small in comparison with the model/data discrepancies at most locations.

Specific comments

- Paragraph 5.1 - discussion on the IASI errors: it is not clear if the error given here reports to the monthly averaged column or the each individual column.

The error reports to the monthly averaged column. This is now made clear in the text.

- P 5239 - lines 10-15: The authors discuss the methanol emission capacity of desert vegetation. However, they mention earlier in the text that the IASI observations are perturbed over desert due to large changes in emissivity. Can the observations over the regions discussed here also affected by this emissivity issue and then lead to “erroneous" columns?

Yes, IASI measurements could be biased above desert surfaces. However, IASI data have been filtered out where surface emissivity is low and strongly wavelength dependent (see Razavi et al., 2011). These are typically sand surfaces. It is obviously difficult

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to draw a line between problematic surfaces and the filtering was done conservatively on a best effort basis. We believe that in arid places where emissivity is relatively constant, the retrievals perform well.

- Fig. 3 and Figures comparing IASI and model columns: Do the modeled columns represented include the averaging kernel of IASI? It is not written in the caption. I would recommend to plot the modeled columns smoothed with the averaging kernel in order to compare similar product.

The modelled columns in Fig. 3 and elsewhere in the manuscript account for the averaging kernels of IASI. This is now made clear in the caption of Fig. 3.

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