

We would like to thank anonymous referee #2 for their helpful comments on this work. Below, original comments are in italics and our responses are in bold.

1. In Figure 1 coverage of the TES orbit is shown. Figure 2 shows the emissions in GEOS-Chem. I think the colour bar is a bit clunky as it seems from that plot that emissions at higher latitudes are zero or between 0 and 50 Gg yr⁻¹. Figure 5 and Figure 6, respectively show posterior scaling factors which are more in agreement with the global coverage of TES observations presented in Figure 1. I would suggest (but only if it is easy to do so) to redo the plot with a logarithmic colour bar or to include a finer resolution, e.g. 0-25 Gg yr⁻¹ colour code.

Thank you for the suggestion. We have replotted this figure in units of molecules cm⁻² s⁻¹, and have added increments at the low end of the color scale (0, 0.1, 0.2, 0.5, 2.0, 5.0, 10.0). We have also changed the plot from annual emissions to seasonally-averaged emissions in DJF and JJA. These two changes help to highlight regions and seasons when emissions are relatively low.

2. I think the authors need to add a sentence if a seasonal inversion for the "extra tropical regions" would give different results. I understand that TES sampling at high latitudes is the limiting factor here. But the posterior adjustments are largest for these regions and in fact contribute the most to the upward adjustment of prior emissions. This needs to be addressed. The scaling factors are often quite large due to the small magnitude of prior emissions in the extratropical regions to account for the large underestimation of prior emissions.

We have already looked extensively at the extratropical seasonality of methanol emissions in our previous work (Wells et al. 2012), and have used those findings to constrain the seasonality of biogenic emissions in this current work. Figure 7 shows good agreement between TES and the model in extratropical regions in all seasons except winter. The winter underestimate is discussed in Section 6, and we have added some text to quantify the good agreement in other seasons. We feel this agreement supports our previous optimization of the MEGANv2.1 seasonality of emissions, and the use of an annual inversion in these regions.

3. Pseudo observation test of the adjoint method. An OSSE (observing system simulation experiment) will always work most of the time and it will recover the truth within uncertainty. The proof lies in the application of real data. It would be interesting to know if methanol chemistry is broadly speaking linear or not in your model.

While it is true that OSSEs are somewhat idealized, they are helpful because in them we know the right answer. In the application of real data, the "truth" is not known. As such, we find it a useful way to estimate how well (and at what spatial resolution) the real data will be able to constrain methanol emissions. As for the methanol chemistry, we do assume it is linear, and we are using offline OH fields. Increases in methanol of the magnitude obtained in our optimization will not appreciably change OH.

4. *Figure 5. I think this is once more a plotting issue. I noticed over South America most of the posterior adjustments are along the coast. But Figure 2 shows there are substantial emissions coming out from the Amazon basin region. Please check the Figure 5 again and make sure the white areas correspond indeed to 0.75–1.25 in the colour bar.*

Otherwise it looks as if there is a problem with the separation between land and ocean in the rather large 4x5 model grid box. As far as I understand the authors do not include the oceans in the inversion and the inversion is just being carried out over land. However, land and ocean will fall into the same 4x5 grid-box for some coastal locations.

You are correct that the inversion is just being carried out over land. The color bar for Figure 5 appears to be correct. It is difficult to interpret the spatial pattern of results too closely, as we don't necessarily have the ability to resolve emission fluxes in every individual grid box. Additionally, the magnitude of the scaling factors is often high in regions where the a priori emissions are quite low, as you mentioned in comment #2. We suspect this is what is driving the scaling factor magnitudes in the coastal grid boxes over South America—a priori emissions are lower here than the inland regions because only a portion of the box is land and they are also located away from the emission hotspot over the Amazon basin. However, if we look at the a posteriori error estimate in Fig 6E, we see that the error has been reduced over a broader region encompassing both the Amazon basin and the coastal region, which supports the emissions revisions over the entire region.

5. *Your comparison to aircraft profiles over the ocean. The lifetime of methanol is rather short and you applied scaling factors over land emissions. The scaling factors move the posterior profiles away from the prior but there is still a large gap between observations and model for some profiles. It would raise alarm bells if the model profiles and observations would perfectly match up though. But maybe you should add a sentence or two if the source from the oceans is important or not (although a net sink but it is a large reservoir after all).*

To address the impact of the ocean source/sink on our results, we have conducted two additional sensitivity tests in which we changed the assumed seawater concentration of methanol by ± 48 nM from our assumed concentration of 118 nM. Details are provided in the text (Section 7), but we note that both tests result in net fluxes that are within the range of current estimates. We find low sensitivity to our assumptions related to the ocean flux outside of the tropics, but results are somewhat more sensitive (varying by up to 15%) in tropical regions where terrestrial emissions are happening in close proximity to the ocean. Our aircraft comparisons over the ocean would also be more sensitive to such uncertainties in the ocean source/sink. We now make mention of this in the discussion of the aircraft profiles.