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Atmospheric Chemistry and Physics Discussions

Interactive comment on "High-resolution inversion of OMI formaldehyde columns to quantify isoprene emission on ecosystem-relevant scales: application to the Southeast US" *by* Jennifer Kaiser et al.

Anonymous Referee #1

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Review of Kaiser et al.

The authors present an adjoint inversion of isoprene emissions over the SE US based on OMI HCHO observations. The results are evaluated on the basis of independent aircraft data and interpreted in terms of their implications for our understanding of isoprene emission drivers, and for regional ozone and PM.

Overall the analysis is well-done, and provides a useful and interesting addition to the literature in this area. Analysis techniques are state-of-the-art, and the topic is germane

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Discussion paper

to ACP. I have some comments and suggestions for improving the manuscript below. Once these are addressed the paper merits publication in ACP.

Science comments.

The sensitivity / error analysis only addresses assumptions for the error covariance matrices, and also a clustering approach for optimization. Model errors are not addressed. This gravity of this is lessened by the fact that many of the key variables have been separately evaluated with SEAC4RS data in prior publications. However, remaining errors in these parameters can still be expected to affect your results. A more thoughtful error analysis should be done, and would make your results more convincing. For example, a more comprehensive set of sensitivity inversions with altered assumptions for key variables (e.g., model NOx, temperature, mixing heights, OMI cloud threshold, . . .).

How accurate are the GEOS-FP temperatures over these regions? What model temperature (skin, surface, 2m, lowest-box) is used to compute emissions? Are we sure that meteorological biases are not a significant part of the discrepancies you see?

8-11. " We attribute this to a bias in the background". This implies that your background correction approach is not working properly. The background bias would then also apply to the high-isoprene areas. Since isoprene gives rise to an HCHO enhancement on top of that background, wouldn't this mean that your downward isoprene adjustments should be even larger? I.e. if the blue color everywhere in Fig 4 is really due to a background bias unrelated to isoprene, then surely if the isoprene adjustments were physically correct one would expect the same blue color throughout Figure 4 (bottom-right panel). Visually it appears that the high-isoprene areas average to ∼zero in the a posteriori, but this is not the case elsewhere in the domain.

Figure 4. It is interesting that while the inversion clearly improves agreement over the high-isoprene areas, it appears to make the low-bias worse in adjoining areas like Tennessee/Kentucky and east Texas. Posteriori biases there look to be larger than the generic background bias elsewhere. What do you make of this? Does this imply an

over-correction of the isoprene emissions, or some spatial mis-representation of the isoprene-HCHO conversion?

Fig 7- The improved agreement with respect to (nearly) all the related SEAC4RS tracers is a very nice result. Do you attribute any significance to the fact that agreement worsened somewhat for ISOPN?

2-10, where is this 1/3 estimate coming from?

2-24, "the largest uncertainty stems from the base emission rates". I don't think this is necessarily categorically true anymore. Certainly it will depend on the location and spatial scale being examined. If the land cover is wrong (are there oak trees or not, for example) that will give a very large emission error. Assimilated meteorological fields are frequently wrong by a degree or 3, which again can cause major emission biases. In some cases and places I'm sure you're right that emission capacities are the biggest source of error but I disagree that is always the case.

2-26, yes, the environmental factor dependencies are fairly well understood but that doesn't mean a model has the temperature right, or for that matter the distribution of temperature through a plant canopy.

P9-L10 "The relatively low correlation between spatially averaged isoprene and formaldehyde (r = 0.49, Figure 6) illustrates the importance of accounting for transport in inversions of HCHO data to infer isoprene emissions." Sure, but this importance depends on the resolution at which one is attempting to compute emissions. At the resolution used here it is clearly quite important.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-1137, 2017.