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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spatially resolving methane emissions in California: constraints from the CalNex aircraft campaign and from present (GOSAT, TES) and future (TROPOMI, geostationary) satellite observations" *by* K. J. Wecht et al.

Anonymous Referee #3

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This study investigates the use of inverse modeling for verifying existing emission inventories of methane for the state of California. It is found that emission inventories underestimate the emissions. Results using aircraft measurements are compared with those using space borne measurements from the GOSAT and TES satellite instruments. These currently operational missions impose a weaker constraint on the sources than the aircraft data. Significant improvements in the performance are ex-

pected for future mission such as TROPOMI and GEO-SCAPE. The manuscript is very well structured and written, which makes it easy and the fast to read. Existing methods are used, that seem to perform fairly well for the case that is studied. Useful results are obtained confirming conclusions drawn in earlier studies that emissions inventories tend to underestimate the Californian emissions, although the attribution of this difference to specific sources remains uncertain. Provided that authors manage to adequately address the issues that are raised below, I see no reason to uphold publication in ACP.

GENERAL COMMENTS

In my opinion the most critical assumption underlying the results and the conclusions is that the extrapolation of inversion-derived bimonthly fluxes to annual totals introduces errors that are small enough for the difference with the emission inventories to remain significant. A few sentences are spent on this extrapolation step, discussing the seasonal cycle of biological sources. However, the role of the seasonality in energy production, and corresponding emissions from fossil fuel use receives too little attention. It shouldn't take much effort to look up statistics on domestic heating vs air conditioning, and the difference in energy use between 2008 and 2010. A related problem is in the comparison between the use of aircraft measurements and GOSAT and TES. The advantage of the latter is that data are available for the whole year. Therefore it doesn't seem fair to use only 2 months of data to conclude that the derived constraints on annual sources are only weak. To estimate the performance of future missions using two months worth of data also doesn't seem defensible. The easiest fix seems to address the performance of the inversion on the monthly time scale (with 2 estimates from 2 months), rather than the annual time scale.

The analysis of the capability of the inversion to resolve process specific emissions highlights the difficulty to trace back the diagnosed problem in the inventories to the process level. In the conclusion section, however, it is mentioned that the limited correlation between prior and posterior emission patterns per processes points to problems

in the spatial pattern of emissions in the inventories. Some sentences are needed here to put the ability of the inversion to resolve such patterns and to separate between processes in better perspective.

In addition to information about DOFs and how they compare between the different inversions, it would be useful to quantify the uncertainty reduction that is achieved. As an advantage of the matrix inversion approach this information should readily be available.

The discussion about the concentration boundaries requires some more attention to the eastern boundary of the domain. If the dominant wind direction is from the west, then the observed east to west concentration gradient should provide a reliable constraint on the emissions in the coastal zone. If winds from the east are important, however, the increased emissions could be a compensation for underestimated eastern boundary conditions, which are more difficult to constrain than the oceanic background. Some further model analysis and discussion is needed to assess the possibility of such a mix up between emissions and boundary conditions.

SPECIFIC COMMENTS

P4125, line 23: The spatial pattern of fossil fuel emissions is used to infer which component is most important. However, it should be realized that population density is often used as a proxy to disaggregate emissions in emission inventories. Therefore finding that this is the case need not say much about the contribution of specific processes.

P4130: Does the ranking of process specific correlation coefficients correspond to the ranking of the importance of each process using fixed contributions per grid box?

P4132: It is mentioned that the DOFs of GOSAT for the Los Angeles basin are dominated by three near by measurements. Has this been tested by using only these measurements?

P4133: What is the basis for the 80% cloud cover of satellite retrievals. Shouldn't it be

different for Tropomi and GEO-SCAPE given the difference in footprint size?

P4133: When emission estimates using TROPOMI and GEO-SCAPE are compared with the truth it becomes important whether or not the synthetic data have been perturbed randomly according to So. Has this been done?

TECHNICAL CORRECTIONS

Table 1: The unit in the top row is shifted between columns

Equation 5: I recommend changing the notation such that measurements can easier be distinguished from model results (right now X and omega mean could mean both)

Equation 6: z-hat is missing in the left hand side of the equation.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 4119, 2014.