Atmos. Chem. Phys. Discuss., 14, C4943–C4946, 2014
www.atmos-chem-phys-discuss.net/14/C4943/2014/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Top-down estimates of European CH_4 and N_2O emissions based on four different inverse models" *by* P. Bergamaschi et al.

Anonymous Referee #1

Received and published: 16 July 2014

European emissions of CH4 and N2O were estimated using 4 independent inverse modeling systems. By evaluating intra- and inter-model uncertainties, conclusions on the uncertainties of the UNFCC inventories were drawn. The idea of this study was well conceived. However, I think that it could have been executed better. My main concerns are:

(1) The setup of each inverse model is different and needs to be justified. How the choices of model setup affects the inversion results needs to be discussed.

(2) The ensemble is very small. With only 3-4 inverse modeling results, the statistical significance of the inter-model difference is low. I am not convinced that good agreement among three inverse modeling results would necessarily indicate that the

uncertainties in the a posteriori emissions are low.

(3) An important and unexplored aspect of the study is to understand the contributions of the observation data at 9-10 sites to the inverse modeling results. In addition, the models simulate some sites poorly after the inversion. The biases at some sites are consistent among the models. Would it be an indication that the inter-model difference under-represents the uncertainties of model estimates (Figs. 5 and 11)?

While I believe that the analysis results are important to be published in a journal paper, I think that this paper in its current form requires substantial revisions to address the above concerns.

Detailed comments on the three concerns:

1. Inversion setup

(a) Table 5 could be more informative. Please add the information on spatial and temporal correlation scales and give the type of a priori emissions used in S2 inversions.

(b) How were spatial and temporal correlation scales chosen for each model? If the assimilated model is representative of the state of the atmosphere, why was there significant difference in correlation scales among the models? Why did the spatial and temporal correlation scales change from S1 to S2 inversion using the same model?

(c) Why was there no S2 inversion using LMDZ-4DVAR? Why was a random a priori emission field used in NAME-INV but not the other two models in S2 inversions?

(d) Please give the spatial and temporal correlation scales (or something equivalent) for NAME-INV inversions?

(e) Only TM5-4DVAR inversions had 4 difference source groups. All the other inversions had 1 source (the total emission). How would TM5-4DVAR results change if the inversion is for the total emission only?

(f) The emission mask description (P. 15699) should be presented in Section 3.2. Why

would NAME-INV use a different emission mask from all the other models?

(g) The stated model resolution for NAME-INV is 0.56x0.37. However, the inversion results shown in Figs. 1 and 7 suggest a lower spatial resolution of this model than TM5-4DVAR's 1x1 inversion results. Why is that? Was there an error in NAME-INV inversion results (which could lead to lower posteriori emissions than the other models)?

(h) Please show the a priori model results in Figure 6. To what extent did the a priori information contribute to the good agreement of the vertical profile comparison?

(i) P. 15700, Line 19-24, please show the equations for the uncertainty estimates.

2. Ensemble representativeness

(a) Figure 3: If NAME-INV results were removed, it seems that the results of inter-model uncertainties would be very different. I am concerned that one outlier result was given too much weight in this analysis.

(b) Figure 9: Assumptions in the inversion, such as a small oceanic source in the a priori emissions, could be a reason that the inter-model difference is relatively small for N2O. It is very difficult to know that the ensemble of 3-4 models properly represented the uncertainties in inverse modeling. How robust were the ensemble results? Uncertainties of a small ensemble are difficult to assess statistically.

3. Correlation and RMS analysis (a) Please add the model results using the a priori emissions in Figures 5 and 11. It would be useful to understand how inverse modeling improved the model performance.

(b) If possible, it would be useful to discuss the contribution of each observation site to the inversion results. This would be a function of the correlation scales, of course. It is also important to know the sensitivity of inversion results to the model set up assumptions.

(c) For both CH4 and N2O, there are some sites that have low R values and other

sites that have high RMS values, and the biases can be consistent among the models. What are the reasons? Would this result imply that the ensemble of a small number of models cannot appropriately represent the uncertainties of the inversions?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 15683, 2014.