

Interactive comment on “Inverse modeling of European CH₄ emissions: sensitivity to the observational network” by M. G. Villani et al.

Anonymous Referee #3

Received and published: 10 December 2009

General comments:

The paper addresses an important issue, namely the constraint that a network of observing stations can have on methane budgets on regional to continental scales. The paper is well written, and the study uses an appropriate methodology. I have a concern however that the estimation of posterior uncertainties for methane fluxes is not necessarily a conservative one, which makes it hard to use the results quantitatively. In my comments below I have detailed this, and I would recommend addressing these issues in the next version of the manuscript.

Model representativeness error: On page 21078, 3rd paragraph, a reference is given for the method to estimate the model representativeness error, however the Bergamaschi et al. 2009 paper does not elaborate on this; instead it is mentioned that the new

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scheme will be discussed in more detail elsewhere. Given the importance of understanding how well different sites are represented within the model framework I would strongly recommend this to be discussed within this paper. Also it is not clear how the 50% is justified. It should be kept in mind that this error needs to account for model-data-mismatch due to several issues: neglected subgrid scale variations in emissions, but also transport model error in advection and vertical mixing (including neglecting of mesoscale circulations of stations in complex terrain or close to the sea). It should also be justified why this uncertainty can be represented as random, uncorrelated noise. Both, transport errors and lack of subgrid variability might have a component that is correlated from day to day, or even a bias component. For example having a site that is 80 km away from a larger city, the site could still be in the same gridcell as the station and would thus continuously “see” average emissions rather than sporadic influence depending on wind direction. For a conservative estimate of the constraint that the network has on CH₄ emissions a careful treatment of this is recommended.

Specific comments:

P 21077 L 6: “6-h forecasts”: given the 12 hour cycle of the ECMWF IFS, either analysis fields plus 6h forecasts are used, or hours 3-12 from each forecast cycle is used. This should be specified.

P 21078 L 27: Do the synthetic measurements include gaps due to instrument breakdown as usually happens in a real network? To make the estimate conservative I would recommend this, or at least assessing the potential impact.

P 21080 L 15: It should be explained in more detail what is meant by “Gaussian functions” for spatial correlations.

P 21086 L 27: I disagree with the statement. The change in correlation length scale from 50 km to 200 km causes a larger change in the En-EU27 than changing from S1 to S2 or S3, and the same holds for changing the prior uncertainty from 300% to 1000%. This means that the impact of an improved network is smaller than that of a

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change in prior correlations.

P 21092 L 15: "emission peak values are smaller compared to the S1 and S1.1 scenarios" this does not seem to be the case for the area north-east of the HU1 site. Is there an explanation for this?

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 9, 21073, 2009.

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