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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Inverse modelling of European CH_4 emissions during 2006–2012 using different inverse models and reassessed atmospheric observations" *by* Peter Bergamaschi et al.

Anonymous Referee #3

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Summary/General comments: The manuscript presents 'top-down' optimized methane emissions for Europe for the 2006-2012 time period. A new, harmonized 18 site-monitoring network is used with seven inverse models and four experiments. Optimized emissions are reported (and are overall consistent between top-down and bottom-up), biases are assessed using aircraft data, and the inference of a non-negligible wetland source is intimated. Overall it is interesting and important work to pursue. It is not easy to use this many different model/inverse approaches to one regional question, and this can potentially provide substantially more information and understanding for

how to best quantify fluxes with atmospheric observations. This paper is well-placed in ACP. However, there are a couple important gaps that need to be addressed before I can recommend publication. Most importantly, the description of different models and inverse methods is somewhat lacking, this should be a central element of this work, and this needs to be improved before I can recommend publication.

Major comments: Models/Inverse methods: There is limited discussion of the different models, and specifically, of the inverse methodology being employed by each model. I understand much of this is referenced to various previous publications, and the supplement does go through each model independently, but it is important for the reader to see more comparative details in this manuscript to be able to understand the differences between models/inversions and possible nuanced causes. A succinct but clear description in its own section of the different inverse approaches used and the subtle "expert-user" choices made to define the inversion would be essential. For example the prior uncertainties and correlations lengths, which are defined differently in the different inversions, could be rather impactful on the results. How were these different priors chosen, and how important is this choice? The authors have conducted multiple experiments – they need to better convey to the reader the differences between the inversions and experiments so we can better assess the meaning of similar/different results. In many ways this could be one of the biggest contributions of this paper.

Sensitivity of network to domain: Western Europe has the highest density of observation sites, and measurement density (and sensitivity to emissions) falls off rapidly in other regions of Europe. Given this, how appropriate is it to lump the entirety of the domain together? I'd like to see a little more discussion of the sensitivity of the network and therefore dependence of prior/assumptions in some of the domains. Another way to consider this question is how many regions can the network distinguish, and how do these regions compare with geopolitical domains? This impacts my next point.

Importance of wetlands: I'm not sure if from this analysis alone the authors can conclude substantial wetland source are or are not required to match observations.

The largest prior wetland estimate (and seasonality) is in Northern Europe, where there are few observation points and the inverted seasonality is actually smaller than WETCHIMP models. When aggregating all of Europe together, it would appear the added emissions and seasonality from WETCHIMP is helpful in bringing bottom-up and top-down closer together – but given this point of spatial/seasonal errors in the Northern Europe domain I'm not sure this overall improvement is indicative of a better representation or coincidence where the inversion finds large seasonality in other regions of Europe where WETCHIMP models do not expect significant wetland sources. I would think the authors should tone done the statement of wetlands importance in the abstract, and also would like to see further defense of the seasonality signal observed and attribution that it must be wetlands.

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