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Atmospheric Chemistry and Physics Discussions

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Interactive comment

Interactive comment on "Detectability of Arctic methane sources at six sites performing continuous atmospheric measurements" *by* Thibaud Thonat et al.

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We thank Referee #1 for her/his fruitful comments and general appraisal of the manuscript. Here are our answers.

Specific comments

*Line 79 and later. What is the status of the Poulter et al. (submitted) publication which is referred to several times? If this has not been published then some more detail will be required regarding the wetland emissions taken from that manuscript.

–> Poulter et al. is still under review for minor revisions. The latest (minor) comments

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Discussion paper

have been addressed and the authors are waiting for the final decision of the editor. However, the model results have already been used in the Global Methane Budget synthesis (Saunois et al., 2016). Saunois et al. (2017, in review in ACPD) also use this ensemble and analyse some characteristics of the wetland emissions produced by these models. Note that the references for all process-based wetland models are already listed in Table 2. The "wetland part" of Section 2.3 has been reorganised to be more precise about the Poulter ensemble.

Line 274: "The version of ORCHIDEE used in this study comes from Poulter et al. (submitted) (see also Saunois et al. (2016)), like the ten other land surface models used for sensitivity studies (cf. section 3.2). Following Melton et al. (2013), net methane emissions have been computed under a common protocol; the models use the same wetland extent and climate forcings. Wetland area dynamics are based on global wetland datasets produced with the GLWD (Global Lakes and Wetlands Database), combined with SWAMPS (Surface WAter Microwave Product Series) inundated soils maps. The emissions from these ten other models range from 10.1 up to 58.3 TgCH4 yr-1"

A reference to Saunois et al. (2016), who describe the ensemble in more details, is also made in Section 3.2.

*Introduction. It would be interesting to note the global and Arctic estimated methane emissions to give perspective to the size of emissions from this region.

–> Thank you, this has been inserted in the second paragraph of the introduction.

Line 78: "The Arctic represents now about 4% of the global methane budget (23 vs. 568 TgCH4 yr-1 for 2012, according to Saunois et al. (2016)). This budget is lower than bottom-up estimates (range 37-89 TgCH4 yr-1, according to the review by Thornton et al. (2016b)), which are affected by large uncertainties. Although there is no sign of dramatic permafrost carbon emissions yet (Walter Anthony et al., 2016), thawing permafrost could double 21st century's Arctic methane budget and impact climate for centuries (Schuur et al. 2015)."

*Line 178. Why was the year 2012 chosen?

–> 2012 was chosen because it was the most recent year available to us in terms of computed wetland emissions, for the 11 wetland models used here. This explanation has been added in the last paragraph of the introduction.

Line 178: "The study focuses on 2012, since this is the most recent year for which wetland emissions are available for a set of models in a controlled framework."

*Line 189. Note (and perhaps give reasons for) also the long periods of missing data at Zeppelin, Pallas and Cherski.

–> This has been added in the manuscript.

Line 202: "Gaps in Cherskii (October-January), Pallas (August-mid-October), and Zeppelin (January-April) data are due to instrument issues."

*Line 193. Why was just background data selected for Barrow and Pallas. Could you give details of the criterion used to filter the data? Were all data included for the other sites or were they filtered at all?

–> To be consistent, we decided to remove the filters used for Barrow and Pallas and use all data for all sites.

Line 210: "All valid data from the sites are used in this study, with no filter applied."

One of the motivations of this paper was to look at the performances of the model at the sites. So, even though a data selection is crucial when using observations to invert the fluxes, in our case it is not necessary.

Table 6 and Fig. 6, 7 and 9 have been updated accordingly.

Please note that Tables 5 and 6 have been additionally slightly modified because of a mistake found in the calculation of the figures.

These changes do not alter our conclusions.

*Line 236. Have you assumed anthropogenic emissions are constant all year? Is this realistic? Are emissions expected to be higher in the winter due to more emissions from fossil fuels for heating purposes? Would we expect seasonality in gas extraction in Russia?

–> Yes, we assumed constant anthropogenic emissions. It is expected that emissions are in part correlated to household heating. However, we assume that anthropogenic emissions also happen in summer, following for example Berchet et al. (Biogesciences, 2015; see Fig. 6 and section 5.2.2). Maintenance and welling works taking place in Russia during summer cause methane seepages that can be of importance. In the absence of more precise information, we keep anthropogenic emissions constant all year round.

*Line 261. Does Orchidee include any emissions from wetlands in winter which according to Zona et al., 2016 may be significant?

–> ORCHIDEE does not include winter emissions, like the other wetland models. A sentence has been added in the conclusion concerning this issue in wetland emission models.

Line 729: "In subsequent modelling studies, if wetland emission models still have the same seasonality, ways to somehow force winter emissions should be considered."

*Line 701. You could also bring in a discussion of Warwick et al., 2016 here. That paper found a closer agreement between modelled and measured methane mole fraction and isotopic composition at Arctic sites by delaying the seasonality in wetland emissions.

–> Warwick et al. (2016) is indeed a good element for the discussion. It is now part of the conclusion:

Line 725: "The forward modelling study of Warwick et al. (2016) also reached the same conclusions. To better capture the seasonal cycle of methane, wetland emissions needed to start no sooner than June and peak between July and September. This result was backed by isotopologues data that suggested large contributions from a biogenic source until October."

*Table 1: Why don't Alert and Tiksi have both altitude and intake height? What do the numbers in that column refer to for those sites?

–> The correct numbers have been added in Table 1.

Technical corrections

*Line 57. Schwietzke is misspelt.

–> This has been corrected.

*Line 117. The 2.9 Tg CH4 yr-1 should be referred to as an estimated annual emission for the ESAS rather than a measured flux.

–> Our sentence has been rephrased properly.

*Line 152. Missing full stop at the end of this line.

*Line 183. Earth System Research Laboratory (add the word Research)

*Line 197. Integrated is misspelt.

–> These mistakes have been corrected.

*Thompson et al. has now been published in Atmos. Chem. Phys. so this reference should be updated.

–> The reference has been updated.

*Figure 1: It would be helpful if some of the gridlines were labelled with longitudes and latitudes.

–> Figure 1 has been improved accordingly.

References :

Berchet et al.: Natural and anthropogenic methane fluxes in Eurasia: a mesoscale quantification by generalized atmospheric inversion, Biogeosciences, 12, 5393-5414, doi:10.5194/bg-12-5393-2015, 2015.

Saunois et al.: Variability and quasi-decadal changes in the methane budget over the period 2000-2012, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2017-296, 2017.

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