The original comments are in bold text and the answers are in normal text.

Answers to:

Interactive comment on "Atmospheric constraints on the methane emissions from the East Siberian Shelf" by A. Berchet et al.

by
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Received and published: 21 November 2015

We think that the detailed answer we provided on Nov 12th to your comment of Nov 2nd was professional and addressed all your questions. We recall the answers already made on Nov 12th below, by extracting the relevant paragraphs to the four questions raised:

I sincerely hope that the authors of the ms can provide a professional response to the following questions regarding the methods that lay the basis for their whole paper. 1) What mathematical method allows integration between 1700 grid cells without having a single data point within the domain?

Extracted from synthesis Section 1/A of our previous answers :
"Atmospheric transport integrates the heterogeneity of surface emissions and, before suppressing gradients by mixing, it produces peaks of concentrations at sampling stations located downwind the emissions zones. This is physics and it is used every day by all atmospheric scientists working on greenhouse gases, air pollution, aerosol pollution, and even radio-element pollution, at various spatial scales from local to global. With few atmospheric sites, and continuous observations, it is therefore possible to test emission scenarios using a transport model to link emissions to concentrations…"

Extracted from page 4 of our previous answers:
"The atmosphere efficiently transports and mixes air masses (especially in the Arctic with fast horizontal advection). Downwind a given region, it is possible to get integrated information about the past emissions of the region crossed by the sampled air mass if travel time is shorter than diffusion time. As shown and discussed in the paper (and the supplementary material), the ESAS region can be very efficiently connected by atmospheric transport to nearby (TIKSI, within hours) and remote (ALT, BRW, ZEP, within days) atmospheric stations continuously measuring methane in the air…."

2) What physics allows the occurrence of higher atmospheric concentrations of methane (the peaks of methane that the authors refer to) downwind as compared to upwind?

Extracted from page 4 of our previous answers:
"Any emission contributes to increase the atmospheric concentrations of the emitted gas on the top of the initial conditions (background), which are the result

of the transport of all past emissions. We think that it is clear from figure 4 (e.g. at ALT or TIK) that emissions from the modeled domain contribute to fill the gap between contributions of the boundary conditions (black line) and atmospheric observations (grey line). As ESAS contribution largely overcomes this gap on a yearly basis, again, ESAS emissions are not compatible with atmospheric observations on a yearly basis, although some consistency is found in July-August as written in the paper and shown by figure 5 …"

3) What method allows decreasing uncertainties in the absence of any ground-truthing (that is, without actual measurements of atmospheric methane levels up- and down-wind)?

Extracted from page 4 of our previous answers (partly the same as question 1 above):
"The atmosphere efficiently transports and mixes air masses (especially in the Arctic with fast horizontal advection). Downwind a given region, it is possible to get integrated information about the past emissions of the region crossed by the sampled air mass if travel time is shorter than diffusion time. As shown and discussed in the paper (and the supplementary material), the ESAS region can be very efficiently connected by atmospheric transport to nearby (TIKSI, within hours) and remote (ALT, BRW, ZEP, within days) atmospheric stations continuously measuring methane in the air…."

4**) What improvements could be made in assessing the contributions of different end- members to the observed integrative isotopic signature of atmospheric methane without knowing the isotopic signatures of the end-members themselves?**

Extracted from page 7 of our previous answers:
"Thanks for this important and useful comment … Indeed you are right that the range of isotopic signature for hydrates is too narrow considering the literature and the facts that hydrates can be of thermogenic or biogenic origin, and that it is largely variable and unknown. We will change this in the updated version using the larger range reported in Milkov 2005. Concerning natural microbial sources, there is a variety of signature reported for high latitude ecosystems ranging from -70/-60‰ for wetlands, -75/-55‰ for tundras, -80/-60‰ for thermkarst lakes (e.g. table 2 of Fisher et al., 2011). This is why we used the quite large range of -75/-60‰ for microbial signature. We do not intend to solve a three-unknown problem (wetlands, gas, ESAS emissions) with only one equation as we agree that there is an infinite number of possibilities. We just want to raise the point that, considering the range of isotopic signature for wetlands and gas, whatever methane comes out of ESAS region, it is of biogenic origin (at the moment 13C observations were made), which is consistent with what you suggest in your previous publications about ESAS. One cannot explain a -68/-65‰ observed source signature in another way with the mixture of air sampled when the observations were made at ZEP. We cannot say more than that about whether this is hydrates or not and we will rephrase the text to be clearer on this point"

Neither these nor many other questions were addressed. Instead I received wordy and irrelevant responses. Very disappointing. For details, see the attached point-by-point comments to the authors' responses.

We do not agree and we think we carefully answer and address your questions in our detailed answers of Nov 12th, as illustrated with the four questions above.

We understand that our work is in partial contradiction with your own results. We think we did a rigorous scientific work based on an independent atmospheric method (top-down approach) to test your emission scenario, which is based on oceanographic observations (bottom-up approach). We think we bring an important and serious piece of work with this paper. From now on, other groups, both on the experimental and on the modelling sides have to try to reproduce your results and our results in order to solve the existing discrepancies. This is a normal scientific situation when incompatible results show up in science.