Atmos. Chem. Phys. Discuss., 12, C11079–C11082, 2012
www.atmos-chem-phys-discuss.net/12/C11079/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Tropospheric impact of methane emissions from clathrates in the Arctic Region" *by* S. Bhattacharyya et al.

Anonymous Referee #2

Received and published: 26 December 2012

Review of the paper by Bhattacharyya et al. entitled: Tropospheric impact of methane emissions from clathrates in the Arctic Region

This paper by Bhattacharyya et al. presents and analyse the impact of potential additional emissions from hydrates on methane concentrations, temperature, ozone, and precipitation. To do so, the authors compare 2 simulations of the community Earth system model CESM model, which includes a fully interactive physical ocean and a fast atmospheric chemistry mechanism with explicit methane emissions. One simulation includes additional CH4 emissions to mimic possible future hydrates emissions. The paper addresses the scientific question of the impact of an increase of CH4 emissions in the Arctic region in the context of a changing climate. The paper is well organized and is pleasant to read, except for the conclusion (see specific comments)

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Interactive Discussion
Discussion Paper

General comments

-My main concern is about the hypothesis of additional emission of 139 TgCH4/yr advanced by the authors. I find the section justifying this choice rather poor. Few references are cited, both for CH4 emissions at seabed and for the fraction going to the atmosphere. The fraction going to the atmosphere is from 1% to 100% but can the authors narrow a bit this range based on litterature ? Is it more 1% or more 100% ? What is the extent in the case of 100% ? Same questions for the amount emitted at the seabed ? A 22% perturbation of the CH4 cycle is a large one. I kind of agree with the authors that it could also reflect possible perturbation from other sources (e.g. permafrost). Indeed, the precise location of CH4 emission perturbation in the arctic is probably less critical than at lower latitudes because of the fast horizontal transport and because CH4 has a 10y lifetime. However, I think the paper should be presented more in this sense then and not only focusing on (very uncertain) hydrate emissions. In a warming climate, additional emissions from permafrost and wetlands are likely to happen. In other words I am not convinced of a 139TgCH4/yr due to hydrates only but including all possible sources it becomes a more “plausible” scenario. Anyway, this part has to be reinforced largely (see also specific comments).

-Abstract does not reflect the quantitative results of the paper. Please rewrite to be more precise about the results obtained in the paper

-Sentences in the conclusions are too long. They have to be shortened and sometimes clarified. In the main text, some of the sentences can also be shortened and clarified. (see specific comments).

Specific comments

p26478-l22 : define long lifetime

p26479-l6 : considering the large range I suggest to remove “precise”

p26479-l8 : why separating “bubbles” Explain or modify.

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p26480-l14 : “large increases in atmospheric methane concentration Âż : please give orders of magnitude and appreciation of the spatial extension of such increases (probably very local around the bubbling) p26482-l9 : Âń with a uniform initial clathrate saturation of 0.03, reflecting the high end of the estimated global average saturation for such deposits Âż : unclear sentence (to me). Please be more clear. p26482-l20-25 : the origin of these scenario is unclear to me. Why 5/3/1° ? Adding 139 TgCH4/y is a huge change compared to the 500-600 TgCH4/yr global emissions. Please give the present global emissions in the for comparison. This is a 20% change ! Where does this number come from ? It needs justification and/or References. Also, can you relate this number with your figure 1. P26483-l9-12 : The hypothesis of 100% transmission from the seafloor to the atmosphere seems a bit extreme to me. Arguing that error in the transmission could be compensated by additional emisssion at the seabed cant be turned back : what if seafloor emissions are overestimated already ? This part needs more work : 1/1% to 100% range leaves large uncertainties. The authors have to give more literature about this to justify their approach of a maximum transmission. A 100% transmission implies is only credible for bubbling probably, as diffusion implies loss by oxidation. What is the part of bubbling in emission reaching the atmosphere ? 2//The authors can use maximum emissions to the atmosphere (large seabed emissions + 100% transmission) but they have to write clearly that this is a Âń maximum Âż scenario. P26483-l17 : add somewhere in the text the duration of the run and the machine used. P26483-l21 : add a reference for the present-day scenario of methane emissions. What is the total of surface emissions ? P26484-l6 : 629 TgCH4/yr is the total emissions ? total sink ? Please be more precise. If total emissions, this is larger than current estimates more around 550 TgCH4/yr. Please justify more what source causes this large number. Is this number kept constant all along the run ? What would be the impact of considering an accidental event (increasing and then decreasing pulse of additional emissions ? P26684-l15 : did you add point emissions in 3 pixels of the model ? In three zones covering several pixels ? Please be more precise on the method to inject methane in the atmosphere. Arrows on figure 1a are not visible. P26684-l21 : I

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would say more that this is an “extreme” scenario. Else the authors need to justify the fact that this is plausible with more references (see before). P26485 – l22 : OH is also controlled by CO and VOCs. How do you treat these gases in your modelling exercise ?

P26486 – l1-4 : What do you mean ? Unclear sentence, please rephrase to be less technical.

P26486 – l28 : “but the SNR is still generally greater than 3 over the poles“ This statement is not clear for the color scale of figure 3d P26487 – l7 : Would it be useful to have “coloured” methane chemical equations to partition stratosphere from troposphere for instance ? At least a suggestion of what to do to understand what happen here seems necessary P26487 – l18 : 39% or 38% ? P26488 – l5-10 : Can you be more precise on the patterns high lats vs low lats ? It seems also that organized patterns appear at mid latitudes for precipitation. Can it be related to changes in atmospheric dynamics ? P26488 – l24 : Recall in brackets what shows figure 2C. P28490 – l4 : Which regions are still significant for ozone ? Are southern regions still significant ? Why then this southern sensitivity ? Again even if no clear cause appear, ideas to diagnose why the observed changes occur should be given by the authors. P28490 – l26 : What would be the impact of emitting methane elsewhere in the Arctic regions (permafrost, gas, wetlands. . .) ? One can assume that the fast horizontal transport at high latitudes may limit the impact of the location of emissions. This indeed makes your study rather generic. This point may be discussed further in the discussion. P26491 – l6-end : the sentences of the conclusion are too long making them hard to read and understand. Please rephrase with shorter and clearer statements. Figures : Character size is too small on axes.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 26477, 2012.