

Interactive comment on “Improving a plot-scale methane emission model and its performance at a Northeastern Siberian tundra site” by Y. Mi et al.

Anonymous Referee #3

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Mi and colleagues present a new methane model evaluation at a Northeastern Siberian tundra site for a long data time series. This is a substantial contribution to our understanding of processes controlling methane emissions in this remote place. The manuscript is well structured and also very well written. I thus recommend publication after some minor revisions.

General:

I am surprised that the method for the calculation of GPP does NOT matter that much for final CH₄ emissions. Thinking that GPP drives plant growth and finally SOM input should matter for the CH₄ production, one would expect total annual CH₄ emissions being very dependent on it. One could argue that SOM input only depends on the mobilization of organic soil carbon and thus predominantly depends on the temperature.

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Just from this study it is not clear to me how the model simulates the carbon fluxes from GPP to C_{fresh}, and whether the carbon budget is closed. This point needs some more information about the model for the revised manuscript.

I find the aspect of heterogeneity within the peatland plot very interesting. Are there any general conclusions that can be drawn for upscaling to a landscape scale. e.g. could the model simulate average CH₄ emissions for an averaged temperature over all subplots?

Specific:

- p.20007, l.6: Peatlands also occur in non-permafrost region in the northern high latitudes. So, potential area in northern high latitudes is slightly larger $\sim 4.0 \times 10^6 \text{ km}^2$ (e.g. Yu et al., 2010).
- p.20007, l.14: Please update the reference to the newest AR5 IPCC report, if possible.
- p.20009, l.14: Is the permafrost layer really 300 m thick vertically?! Please confirm.
- p.20011, eq (1): How is the diffusive flux F_{diff} calculated? Do you separate CH₄ into water dissolved and gaseous amounts in each soil layer? What diffusion constants are you using for the calculation of F_{diff} : Diffusion constant in air and/or water?
- p.20012, l.16: Is there a specific reason for using GPP instead of NPP (net primary productivity) as the input to SOM? NPP would sound more logical as also peatland vegetation has autotrophic respiration that reduces carbon fluxes from GPP to NPP. Also the LPJ model (Sitch et al., 2003; Wania et al., 2009b) uses NPP for vegetation C allocation, and successively SOM input. Usually NPP is about 50% of GPP.
- p.20013, l.9: typo: "Finally, the .."
- p.20016, l.7: Which parameters are tested? Are these the parameters in Table 1?
- p.20017, l.9: What is dataset one? Is it the two-meter air temperature record from Chokurdakh? Please clarify.

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- p. 20017, l.25: replace "wholly" by "fully"
- p.20020, l.7: typo: "Model responses to the other parameter changes are negligible."
- p.20022, l.7: Does the model include insolation of the soil by the snow layer in winter? Does heat diffusion thus further depend on the timing of snow melt?
- p.20024, l.4: How does the carbon flux from GPP finally end up as C_{fresh} in SOM, which is the substrate for CH_4 production according to eq (2)? What happens in the case when GPP is "turned off", e.g. where is the carbon coming from? Some information would help a lot in the context of the discussion of runs with different GPP methods.
- p.20025, l.11: Zürcher et al. 2013 corrected some coding issues in LPJ-WHyMe (Wania et al. 2010) and redid the calibration for the same sites, with better success. Moreover they compare the cumulative flux over the period (days to months) when measurements were available. Would that method help with the correlation also in this study? Please discuss this also in the following paragraph about method of model-data validation.

Figures:

- Figure 1: If possible please increase the resolution of the photograph.
- Figure 2: The blue lines are hardly visible. What are the red crosses?
- Figure 4: Missing Y axis label.
- Figure 9: typo in caption: "proportion"
- Figure 11: Repetition of explanation of red and blue curves is not needed again.

Tables:

- How can W_{min} be 10cm below surface at minimum, when water table drops to 30cm in Fig. 3 and 15cm in Fig. 5?

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References:

Yu et al., Global peatland dynamics since the Last Glacial Maximum, *Geophysical Research Letters*, Volume 37, Issue 13, July 2010

Zürcher, S., Spahni, R., Joos, F., Steinacher, M., and Fischer, H.: Impact of an abrupt cooling event on interglacial methane emissions in northern peatlands, *Biogeosciences*, 10, 1963-1981, doi:10.5194/bg-10-1963-2013, 2013.

Interactive comment on *Biogeosciences Discuss.*, 10, 20005, 2013.

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