Geoscientific
Model Development
Discussions

Interactive comment on "Process-based modelling of the methane balance in periglacial landscapes with JSBACH" *by* S. Kaiser et al.

Anonymous Referee #1

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The importance of methane balance for Earth System modelling is beyond question. Modelling methane emission and oxidation in the context of Earth System studies is a very complicated task, and accordingly, relatively little progress has been made over the years in this direction. The situation is probably even worse for high latitudes, where very specific processes and phenomena need to be taken into account. Therefore, the work presented here is of importance, and it is clearly a timely effort that must be pursued. In my point of view, it is only a first step towards a really useful methane scheme for periglacial landscapes in JSBACH, but it is a necessary step, and it is a sufficiently large one to warrant publication, provided some revisions detailed below.

- The model is tested only at one single site, for very short periods. There are quite some other usable sites which would have provided a useful, more general picture of the performance and applicability of the model. I would really encourage the authors to

consider using some other sites, such as Zackenberg (e.g. Juncher Jørgensen et al., Nat Geosci 2015, doi:10.1038/NGEO2305) or Barrow (e.g. Zona et al., PNAS 2016, doi:0.1073/pnas.1516017113). In particular, it would be useful to extend the temporal coverage (in terms of seasons, covering shoulder seasons and winter). Late-season processes (see, e.g. Mastepanov et al., Nature 2008, doi:10.1038/nature07464) should also be looked at.

- In the same vein, the paper here talks a lot about springtime emission bursts after snowmelt. Can this actually be seen somewhere?

- I understand that you limited methane exchanges in winter (i.e. when snow > 5 cm) because you had strong methanotrophy. But wouldn't that be naturally limited at very cold temperatures? Why isn't it? As is, your modelled impact of snow is not much more that volontary error compensation.

- I do not understand why you talk about a 0.5 degree resolution here. Isn't the model setup a site setup? In that case, "spatial resolution" does not make much sense.

- More generally, I would have really liked to see a sensitivity study concerning the parameters of the model, such as in Khvorostiyanov et al. (Tellus, 2008; part 2 of a paper of which you cite part 1. doi:10.1111/j.1600-0889.2007.00336.x). In particular in your case, this would be very useful - you already state that many model parameters are quite uncertain.

- I am not totally convinced that a large-scale evaluation of the model would not make any sense yet, as you state. One could probably gain some understanding of the sensitivity of the model, and possibly see if orders of magnitude of methane fluxes of large scales are OK.

- This scheme is designed by Earth System modelling applications, or at least, it is implemented in a land surface module that was designed for such applications. As for now, you need to run it twice for rims and polygon centers. Clearly, in an ESM context,

this is not a practical solution. I encourage you to discuss ways forward to solve that issue.

- I'm not a native speaker, but to me the use of the English language in the manuscript seems to deserve some improvement.

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