

Interactive comment on “Upscaling methane emission hotspots in boreal peatlands” by F. Cresto Aleina et al.

Anonymous Referee #3

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The manuscript presents a new method for upscaling the more accurate but computationally expensive Hummock-Hollow model of Cresto Aleina et al. (Biogeosciences, 2015) for wetland methane fluxes. This allows it to be computationally comparable to the "single bucket" version, but avoiding much of the systematic underestimation of the fluxes by taking into account not just the mean water table, but what fraction of the domain is in the highly productive saturation zone. There is still some underestimation of methane fluxes, particularly at the beginning and end of the season, but the improvement is substantial. This holds promise for improving the implementation in a global model, but the absence of relevant driving data, in particular measurements of the micro-relief for regions outside the specific boreal peatland considered in this study. In general the paper is clearly written and easy to follow, and appropriate for publication

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in GMD. There are some minor comments with respect to clarity of language, and some technical errors, some of which have already been mentioned by Referee 2.

Minor comments:

There are several errors in the formulae, such as inconsistent use of S_n and S for snowmelt, W_t^s vs. W_t^{sat} , and the definitions of wet, saturated or dry surfaces. Most of these have already been mentioned by Referee 2. For the definitions of the three surface types, it would be useful to define the sign convention. (This is likely obvious, but in trying to make sense of the erroneous equations I tried various things, as it wasn't defined in the text. A definition would make this more clear.)

While it's clear that it's not realistic to have theodolite microtopographic measurements globally, it would be useful to the reader to have a bit more discussion about how such an upscaling might be upscaled further, to improve the model on a global scale. Are there any remote-sensing products that might provide similar information, at least stochastically, about the distribution of surface elevation? Perhaps airborne lidar? Of course the application to this scale is beyond the scope of the current study, but some discussion of how this could practically be done would aid the discussion.

Figure 4: The caption describing panels b, d, and f is rather unclear, especially the sentence "We illustrate the ratio between the methane emitted from the Microtopography configuration and from the Single bucket configuration (red lines) and from the Microtopography configuration and from the Hotspot parameterization (black lines)." This implies that the ratio is the opposite of what (I think) it is. I would suggest instead "We illustrate the ratio of methane emissions with respect to the Microtopography configuration for the Hotspot parameterization (in BLUE) and the Single Bucket configuration (in red)." As indicated by this suggestion, I think the line for the ratio of Hotspot/Microtopography should be blue, to be more consistent with panels a, c, and e. Furthermore, the labelling of panels b, d, and f is unnecessarily complicated. The y-axis is unitless: it's a ratio. Perhaps change it to "ratio of fluxes to Microtopography

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configuration", and then the legend could simply read "Single Bucket" and "Hotspot".

Technical comments:

P8520, L8: remove comma

P8520, L10: add comma after "century"

P8520, L22: insert "have" between "studies" and "focused"

P8521, L15: landscape -> landscapes

P8521, L16: non linear -> nonlinear

P8521, L23: "e. g. by Baird" -> "by e.g. Baird"

P8522, L8: "part of methane" -> "part of the methane"

P8523: In the introduction of Equation 1, the reader is referred to the Biogeosciences paper of Cresto Aleina et al. (2015), but this paper does not include the snowmelt term. Perhaps this difference should be explicitly mentioned?

P8523: L 19, L22: S -> Sn

P8523: L22: Appendix -> Appendix A

P8524, L11: Here it is a bit unclear what is meant by "overly deep". This could sound like the water table position is too high (i.e. deep water), whereas I think the opposite is meant. Perhaps "too low" would be clearer.

P8524, L19: Model -> Models

P8525, L8: "of water" -> "of the water"

P8525, L15: Similar to previous comment, instead of saying that the water table "deepens" quickly, perhaps say it "drops" quickly?

P8525, L16-17: "the Appendix" -> "Appendix B"

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P8525, L20: Remove "though," it's redundant.

P8526, L8: "of the oxidation to happen" -> "oxidation"

P8526, L12: "translates" -> "results"

P8526, L20: "where r is a random number" -> "where r is a random number between 0 and 1"

P8525, L21: I think this should be referring to Equation 2.

P8527, L16: "Appendix" -> "Appendices"

P8530, L24: "in respect" -> "with respect"

P8531, L4: "model" -> "models"

P8531, L5: "or of" -> "or"

P8531, L11-19: The section starting with "If we include" should be rewritten for clarity, so it can be easily read aloud. Perhaps start with something like "If we include the Hotspot parameterization, the simulated annual methane emissions range from $2.831 - 4.321 \times 10^4 \text{ mgm}^{-2}$ with the RCP8.5 forcing. This is 83.9-101.5% of the emissions simulated by the Microtopography configuration." And so on. And really, are all those digits significant?

P8531, L26: "between Microtopography" -> "between the Microtopography"; "configuration" -> "configurations"

P8532, L1: "between in the" -> "between the"

P8532, L11-12: "being near to 1 for this period" -> "is near one" (The period was already specified explicitly in the same sentence.)

P8532: Based on the graphs that are shown, it's clear that the Microtopography fluxes are higher than the Hotspot fluxes in the spring and fall, and that the ratios shown in Figure 4 (panels b, d, and f) are the Hotspot and Single Bucket fluxes divided by the

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Microtopography fluxes (which are generally larger, thus the ratio is generally less than one). However this is exactly the opposite of what is stated in the text. This really needs to be fixed. You divided the daily emissions from the Single Bucket and Hotspot runs by the Microtopography fluxes, and not the other way around. Likewise, when you refer to the ratio between A and B, it means A/B (and not B/A). These errors are found in the caption to Figure 4 as well, as mentioned above.

P8532, L23: "hollow" -> "hollows"

P8534, L6: "micro-relieves" -> "micro-relief"

P8534, L17: insert "and" before "Runkle"

P8534, L20: "surface. Evapotranspiration" -> "surfaces. The evapotranspiration"

P8534, L24: "Gregorian" -> "the Gregorian"

P8535, L4: "if water" -> "if the water"

P8535, L6: "evapotranspiration" -> "the evapotranspiration"

P8535, L14: "Other parameters" -> "Another parameter"

P8536, L24: Update reference, no longer in discussion.

P8541: Here the caption specifies that days are calculated using the Julian calendar, in Appendix A it said the time step was in days of the Gregorian calendar. So which is it? Or are these not using the same calendar?

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