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Geoscientific Model Development Discussions

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

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We thank the Anonymous Referee 3 for the constructive comments. We modified the text according to the reviewer's suggestions, and corrected the mistakes in the text and in the formulas spotted by the Referee. Our answers are below Referee's comments (in italics).

There are several errors in the formulae, such as inconsistent use of Sn and S for snowmelt, Ws t vs. Wsat t , 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.)

Thank you for this comment. As we described in our answer to Referee 2, we made a mistake in the formulas and we corrected it in the revised version of the paper. Water table is positive if above the surface, negative below. We inserted this clarification in the text and we corrected the errors.

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.

Aerial photographs provide some information on micro-topography, but generally at a too corse scale. Statistical downscaling methods as the ones used, e. g., by Muster et al. (2012) give us information on surface heterogeneities, but not necessarily on micro-topography elevation. Airborne measurements could aid in giving qualitative and stochastic information also on structural peatland patterns, such as the ones described by Couwenberg and Joosten (2005). This information could be used by the HH model to realize non random configurations, potentially investigating the influence of structured patterns on hydrology and methane emissions. We inserted thin information in the discussion, as the Referee suggested, and we added the references.

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 Microtopogra-

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

Thank you for this comment, we think that the modified sentence suggested by the Referee greatly improves the clarity of the message of our figure. We included these modifications in the revised version of the paper.

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"

Done, thank you.

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

Done, thank you.

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?

Thank you for the comment. It is true that we did not consider snowmelt in the Biogeosciences paper, since we started the simulation later on in the year and we initialized the water table to match the observed water table position at the end of April. We do not have any data to match in this paper, and therefore we included the snowmelt. We

discussed this difference between this paper and the one in Biogeosciences more in detail in the revised version of the paper.

P8523: L 19, L22: S -> Sn

P8523: L22: Appendix -> Appendix A

Thank you, we modified them.

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

We modified this part of the sentence to “too low” in the revised text.

P8524, L19: Model -> Models

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

Done, thank you.

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

We changed “deepens” to “drops quickly below the surface” in the new version of the text.

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

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"

We changed the text accordingly, thank you for the comments.

P8526, L21: I think this should be referring to Equation 2.

Yes, it should be Equation 2 indeed. We corrected the text.

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

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

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

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

Done, thank you.

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 × 104mgm−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?

We modified the sentences according to the Reviewer's suggestions. The digits are 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.)

Done, thank you.

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

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.

We fixed the information in the text, now it reads correctly.

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.

Done, thank you.

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?

It is the Julian calendar. We now specify this information in the Table, and we corrected this mistake in the Appendix A in the Evapotranspiration description.

References:

Muster S., Langer M., Heim B., Westermann S., and Boike J.: Subpixel heterogeneity of ice-wedge polygonal tundra: a multi-scale analysis of land cover and evapotranspiration in the Lena River Delta, Siberia, Tellus B, 64, 2012.

Couwenberg, J., and Joosten, H.: SelfâĂŘorganization in raised bog patterning: The origin of microtope zonation and mesotope diversity. Journal of Ecology, 93(6), 1238-1248, 2005.

Interactive comment on Geosci. Model Dev. Discuss., 8, 8519, 2015.