Geosci. Model Dev. Discuss., 8, C2598–C2602, 2015
www.geosci-model-dev-discuss.net/8/C2598/2015/

Geoscientific Model Development Discussions

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

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Received and published: 23 October 2015

We thank the Anonymous Referee 2 for the comments and the requests for clarifications. We considered the comments modified the text according to the reviewer's suggestions, and we think that these modifications increased the quality of the manuscript. Our answers are below Referee's comments (in italics).

1) *I suggest writing out more explicitly how the three different models depended on forcing data in the different simulations.*

- *The Hotspot model was parameterized using years 1976-2005. So did you use for all the years 2006-2099 this same temporal pattern of q, i.e. was the area density of saturated surface always as shown by the dotted line in Fig. 2? Or did it change with*

climate in the future projection runs?

Yes, we used the same parameterization of the saturated area fraction q (showed in Figure 2 as you noticed) also for the future simulations 2006-2099. This robustness test showed that despite the hotspot parameterization being tuned for the 1976-2005 period, it still holds for future simulations.

- *Did the water tables of the saturated areas change with meteorological forcing in the Hotspot simulations? Or was the water table in the saturated areas always randomly something between -10 and 15 cm as shown in Eq. 5? How about the non-saturated areas, did the water table vary there?*

In the HH model with the Hotspot parameterization the water table changes according to the precipitation input in the non-saturated area (1-q)A, whereas in the saturated area qA it is computed randomly between -10 and 15 cm. We included this observation in the revised version of the text.

- *Did the Microtopography (HH) version simulate the water tables continuously, depending on the input data?*

Yes, it did. All versions of the model continuously compute water table according to Equations 1 (Microtopography) and 2 (Single Bucket and Hotspot). The main difference is that in the Hotspot parameterization the water table dynamics is the result of a weighted mean of the water table computed in Equation 2 and the water table in saturated area, which does not depend on the input data.

- *You could discuss this: is it probable that the saturated surface area would change in the future and does it affect the results?*

It is possible that in the future the saturated area will change. In the RCP simulations, though, even though precipitation changes in respect to present day and among the scenarios, the differences are not so large to cause significant effects on methane emissions. We show this result in Figure 4. In panels a, c, and e, the black and the

red lines, i. e., the outputs of the Microtopography and the Single Bucket versions, have water table explicitly depending on precipitation simulated in the RCP scenarios. The blue lines (i. e., the Hotspot parameterization), despite using the saturated area dynamics for the years 1976-2005, are quite close to the methane emissions from the Microtopography version. We then conclude that the potential bias introduced by using a fixed saturated area dynamics (the one for the period 1976-2005) and not a dynamic one is negligible.

We included this discussion in the revised version.

We thank the reviewer for the comments and we clarified the points more explicitly in the revised version of the text.

2) *P. 8523 and 8526: Can you clarify the relationship between water table level W and surface S. Is W negative below the surface? Are the equations on page 8526 (the ones defining the surface types) correct? What is S there?*

We clarified this information in the revised version when describing the water table dynamics. Water table below the surface is negative, and it is positive above it. Equations on page 8526 contain a mistake, it should simply be Wt instead of S-Wt, since the water table is always computed in respect to the surface level S. Thank you for the observation.

3) *P. 8523, Eq. 1 and its explanation: is snowmelt denoted with Sn or S?*

It should be Sn, we modified it in the text, thank you.

4) *Page 8526, l 17: should the W^{sat} be W^s like in Eq. 5?*

Yes, it should be W^s everywhere, we modified it.

5) *P. 8524 l. 20: Add a reference to a paper that uses the Walter Heimann model.*

We added the references to Schuldt et al., 2013, Petrescu et al, 2008, and Zhang et al., 2002.

Page 8528, l. 5: Add a basic reference to what is RCP.

We added the reference to Taylor et al., 2012.

6) Table 2: It was difficult to understand the parameterization of the Hotspot model (P. 8529) since the text in Table 2 is slightly confusing. E.g. "initial day of the year of maximum saturation" sounds like there was a "year of maximum saturation", which apparently is not the case. I suggest you re-formulate these somehow, for instance "Initial date of maximum saturation" if it seems appropriate Thank you for the comment, we modified the parameter names according to your suggestion.

7) *Page 8531, line 5: should it be ". . .simulated by the models"? Same page, lines 8-10; can you re-formulate the sentence, it is unclear.*

Yes, it should be plural. We reformulated the sentence as:

... Melton et al. (2013) did not find a large significant trend in methane emissions simulated by the models participating in the inter-comparison project because of increased temperature or of precipitation trends. We use these two variables to force the HH model coupled with the methane emission model.

References:

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Karl E. Taylor, Ronald J. Stouffer, and Gerald A. Meehl, 2012: An overview of cmip5 and the experiment design. Bull. Amer. Meteor. Soc., 93, 485–498. doi:

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