Biogeosciences Discuss., 9, C5652–C5656, 2012
www.biogeosciences-discuss.net/9/C5652/2012/

Biogeosciences Discussions

Interactive comment on "Modelling holocene carbon accumulation and methane emissions of boreal wetlands – an earth system model approach" *by* R. J. Schuldt et al.

Anonymous Referee #2

Received and published: 14 November 2012

Schuldt et al. describe in their manuscript the implementation of peat accumulation and methane emissions in the JSBACH land surface model of the MPI-ESM. This is an important step forward in Earth System modelling that is missing in other models. I thus encourage the authors to consider the general and specific points below, and strongly support the publication of the paper after a revision. The MS is very well written and structured in a concise way.

General:

The authors apply thier peat and methane model to boreal wetlands. I presume that wetlands include here specificly peatlands (bogs and fens), but also seasonally inun-

dated areas. While the peat model in JSBACH is tailored to peat C accumulation in peatlands, methane emissions from all kind of wetlands are important. It is thus needed to define the ecosystem represented by the model more specificly.

This has consequences for the veryfication of simulated peat C densities and methane emissions in the selected regions of HBL and WSL. In this study the map of Kleinen et al., 2012 is used for the distribution of wetlands. It is based on a TOPMODEL approach and agrees well with observation based inundation area (Kleinen et al., 2012; Prigent et al., 2007). However, Melton et al., 2012 highlight in their wetland intercomparison that inundation and TOPMODEL simulated areas differ quite considerably from peatland area from soil maps (Tarnocai et al., 2007). The latter is based on soil surveys and maps areas where actually peat layers exist.

As an example the map used in this study has very small area fractions in the HBL; maximum fractional wetland area is further east in Quebec and New Fundland (Fig. 3). As a consequence maximum emissions are in the same region (Fig. 7). This region is known for very large lake systems, but main peatland area is further east in the HBL (Tarnocai et al. 2007).

I understand that for an Earth System Model this small mismatch plays only a minor role. Nevertheless, the peatland distribution matters for the calibration of total peat C accumulation and methane emissions, which is then applied globally.

I thus suggest to additionally use the peatland distribution map by Tarnocai et al. 2007, and recalculate peat C content and methane emissions. This sensitivity test would certainly strengthen the quantitative conclusions.

Specific:

- p. 12676, line 2: Please spell out LAI or refer to Table 2.

- p. 12676, equation 3: To my understanding there is a C_L missing as the carbon flux scales with the litter C pool. It should read dC_S/dt = beta_L*R_L*C_L - R_S*C_S.

This also applies to eq. 8 on page 12677. Is this correct?

- p. 12676, equation 4: What is gamma_G ? Couldn't find it in Table 2 nor the entire text. Also an introduction of C_G_max, sla and LAI in this equation would be helpful for the reader here.

- p. 12677, line 10: add h_A symbol for height

- p. 12677, line 13ff: How are turnover times estimated?

- p. 12678, equation 14: Are CH4 emissions from litter possible?

- p. 12679, line 4ff: What thresholds are used for concentration to form bubbles and pressure for ebullition? Is CO2 partial pressure also calculated and can it trigger an ebullition event?

- p. 12679, line 15: So 2 layers, where "layer" means acrotelm and catotelm, each with 1cm resolution? Please clarify.

- p. 12680, line 26: What are the initial conditions for the catotelm pool? As the size of C_C matters for the respiration and the net C balance in eq. 9, it is important for the peat C accumulation. Does it matter for your simulations (beginning at 6kyr BP) whether you have a C stock accumulated over 10kyr or if you start from scratch?

- p. 12681, line 12ff: So does your comparison only include sites which are younger than 6000 years or did you run the model for the time period according to the basal date of the individual peat-core data? Please clarify.

- p. 12682, line 20ff: Is the emission area between model and data comparable?

- p. 12683, line 17ff: In Fig. 11 did you plot average soil C density for peatland C or all soils including permafrost C? The NCSCD data set also includes a sub-set for peatland C density only (Tarnocai et al., 2007), which should be shown.

- p. 12684, line 23ff: I agree that simulated wetland area might be an equivalent

alternative to wetland maps from observations. But I suggest to differentiate in the text between "wetlands" and "peatlands" (see my general comment). Since your model is actually simulating peat accumulation, a comparison with surveys showing the location of soil containing peat layers is better suited than maps or estimates of inundated areas.

- p. 12684, line 18: repetition of "mostly"

- p. 12688, line 6: Does the model have an N cycle, and if yes do you apply N deposition to peatlands? In the literature it is highly discussed topic as how strong anthropogenic N deposition can affect the mostly N limited peatlands.

- p. 12697, Table 1: Wania et al. 2009a,b does actually include peat accumulation rate calculations. The description of methane emissions is described in a later paper: Wania et al., 2010.

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Interactive comment on Biogeosciences Discuss., 9, 12667, 2012.