

Interactive comment on “PEATBOG: a biogeochemical model for analyzing coupled carbon and nitrogen dynamics in northern peatlands” by Y. Wu and C. Blodau

Y. Wu and C. Blodau

y_wu0003@uni-muenster.de

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“In the evaluation the emphasis is on daily C fluxes. The model simulates the seasonal developments based on daily fluxes quite well, however it would be more interesting to see whether the model can also simulate the year-to-year variation in annual fluxes.”

We inserted a new table (Table 6) that compares simulated and observed annual average C fluxes and growing season water table depth.

“Another issue is how the model takes the generally low decomposition rate of Sphagnum moss into account, which leads to over-representation of Sphagnum remains in the peat (e.g. Clymo papers). It is not clear what the influence of the PFTs is on the

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decomposition rates, which might be relevant for long-term simulations.”

We agree that the partitioning of the carbon was not sufficiently made clear. The model differentiates the 3 PFTs (moss, graminoids and shrubs) regarding the quality of their litter. The different decomposability of the litter types is simply represented by the different mass fractions of the labile carbon pool in the litter, as we decide not to attempt tracking the different sources of litter once it is incorporated into the peat. The fraction of labile litter was assumed to be 0.1, 0.3 and 0.2 in mosses, graminoids and shrubs, respectively (Inglett et al., 2012). Once the litter is deposited the litter merges into one labile and one recalcitrant soil organic matter pool. The remaining fraction of the plant litter is assigned to be recalcitrant and represents the input into the recalcitrant soil organic matter pools. This way the total decomposition rate of the soil varies with the change in vegetation composition yet without creating a large number of carbon pools belowground. We added the information to the manuscript (p. 5, line 6 to line 11).

Specific comments p.1625, l.13 error of measured(?) GPP? Is the unit g CO_2 (as in line 1) or $\text{g C m}^{-2} \text{d}^{-1}$?

We are thankful for this comment, as there was an error in the units. The unit should be $\text{g CO}_2 \text{ m}^{-2} \text{d}^{-1}$ for the observed mean error of daily GEP and $\text{gC m}^{-2} \text{d}^{-1}$ for the simulated mean difference of modeled and observed GEP. We revised the text accordingly (now p. 16, line 8 and 9).

p.1629 Details of the sensitivity analyses are missing. What changes were applied to the environmental drives and other parameters? This is important to know when you state that some fluxes are less sensitive to precipitation than to temperature.

We have inserted more detailed information on the sensitivity analysis (now p. 16, line 33 to line 40).

p.1630, l.6-10 “How come that shrubs benefit from increases in precipitation and are there observations that support this? It is counterintuitive as shrubs generally grow on

drier positions within peatlands.”

We agree that this effect is counterintuitive. One reason for this finding may be that the model models a hummock to lawn position in terms of land-surface elevation. The moisture effects thus occur within a hummock, which would be fairly dry in the uppermost rooted peat. In a model scenario that represents a hollow with high water tables, the effect may have been different. From a more mechanistic point of view, the increase in shrub NPP with increased precipitation was due to a stronger effect of precipitation on autotrophic respiration than on the GEP production of shrubs (Table 5). This was due to the weaker moisture limitation on photosynthesis rate than on respiration rate that was modeled similarly to the Hurley Pasture Model (Thornley, 1998): The effects of moisture on the photosynthesis rates of shrubs $f_{m,\alpha,j}$ were: (Eqn. 45) The effects of moisture on autotrophic respiration in shrubs $f_{m,sh,j}$ and $f_{m,rt,j}$ were: (Eqn. 52), where $a_{m,sh,j}$ and $a_{m,rt,j}$ are the moisture levels in the shoot and root of a PFT, which were determined by the water table depth. Our simulation results were consistent with the field study on the responses of NEE in the shrub dominated bog area and the sedge dominated fen area at the Mer Bleue Bog, which showed that drought had little or a negative effect on the photosynthesis of the shrub dominated bog area. This finding indicated that shrubs on dry peatlands, such as the Mer Bleue bog, might be at the dry end of their moisture tolerance level (Bubier et al. 2003). In addition, shrubs had larger respiration rates in drier years relative to photosynthesis rates, which inhibited growth of shrubs in the dry summer (Bubier 2003b). Similar simulation results were drawn from the ecosys model, which explicitly modeled the subsurface hydrology of peatlands and moisture in plants (Dimitrov et al., 2011). Varied water table depth within a normal range had minor effects on the stomatal and non-stomatal performance of vascular plants, and thus minor effects on the vascular GEP.

p.1632, l.7 “Please indicate what k_{potL} and k_{potR} are”.

The information was added (now p. 18 line 39).

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p.1633, l.2 Fig. 11f instead of 11d.

We changed “Fig. 11f” to “Fig. 11d”.

p.1634, l.4-5 Where do I see that the trends in interannual variation of GPP with precipitation and temperature were met? In the clouds of daily values I want to see whether the simulations match the observations. It would be interesting to have the comparison of summer and/or annual GPP over the years in a figure.

We inserted a new table (Table 6) with comparison of the simulated and observed annual average C fluxes and growing season water table depth.

p.1634, “l.9 32 to 85 g C m⁻² year⁻¹ instead of day⁻¹?”

We changed g C m⁻² day⁻¹ to g C m⁻² yr⁻¹ (now p. 21, line 34)

p.1634, from l.22 This discussion seems less relevant to me. It may be that the discussion of model simulations on short time scales may be less relevant from the overall perspective of nitrogen deposition and climate change, yet the model can be used to such analyze short-term dynamics of C and N cycling, for example as a result of regimes of drought and rewetting, which may change in a future climate. Moreover, the seasonal and multi-year C and N fluxes represent aggregates of data that have been generated on the daily time scale. We thus believe that a discussion of model performance (and model limitations) on these shorter time scales will still be useful for readers and future model application. As the reviewer did not specifically request to eliminate the discussion we did not eliminate it for this reason.

p.1640, l.21 Please repeat or summarize the objectives outlined earlier.

We agree and rephrased the beginning of the conclusion accordingly (now p. 25, line 18 to 21).

p.1670 Wccap: g H₂O g dry mass⁻¹

We changed g H₂O dry mass⁻¹ to g H₂O g dry mass⁻¹.

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p.1670 Crt,subs,j: Root substrate instead of structural, the same in the following two lines

We changed “structural” to “substrate”.

p.1672 rRMstem,j: Stem instead of Leaf

We changed “leaf” to “stem”.

p.1673 rhoN,j: resistance parameter : : : of substrate N instead of C

We changed “C” to “N”.

p.1675 fracN2iñAχmoss: value is in Gram column instead of Moss column

We changed the value to “Moss column”.

p.1676 Conf.: 1 = low, 3 = high conĩñAđence?

We added information to the notes of table 4.

p.1677 What model output is compared: daily values, annual values, overall average? What is the unit of the values, e.g. relative change per degree Celsius? Kpot = kCpot in Table 4?

We added information to the legend of table 5.

References:

Aber, J. D., and Federer, C. A.: A generalized, lumped-parameter model of photosynthesis, evapotranspiration and net primary production in temperate and boreal forest ecosystems. *Oecologia*, 92(4), 463-474, 1992.

Bubier J., Crill, P., Mosedale, A., Froking, S. and Linder, E.: Peatland responses to varying interannual moisture conditions as measured by automatic CO2 chambers, *Global Biogeochemical Cycles*, 17, 1066, doi: 10.1029/2002GB001946, 2003.

Bubier, J. L., Bhatia, G., Moore, T.R., Roulet, N.T., and Lafleur, P.M.: Spatial and
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temporal variability in growing season net ecosystem carbon dioxide exchange at a large peatland in Ontario, Canada, *Ecosystems*, 6, 353–367, 2003.

Dimitrov, D. D., Grant, R. F., Lafleur, P. M., and Humphreys, E. R.: Modeling the effects of hydrology on gross primary productivity and net ecosystem productivity at Mer Bleue Bog, *Journal of Geophysical Research*, 116, doi:10.1029/2010jg001586, 2011. Inglett, K.S., Inglett, P.W., Reddy, K.R., Osborne, T.Z.: Temperature sensitivity of greenhouse gas production in wetland soils of different vegetation, *Biogeochemistry*, 108, 77-90, 2012.

Thornley, J. H. M.: *Grassland dynamics: An ecosystem simulation model*, CAB International Wallingford UK 241 pp ISBN 0–85199–227–7, 1998.

Please also note the supplement to this comment:

<http://www.geosci-model-dev-discuss.net/6/C644/2013/gmdd-6-C644-2013-supplement.pdf>

Interactive comment on Geosci. Model Dev. Discuss., 6, 1599, 2013.