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Biogeosciences Discussions

Interactive comment on "Sensitivity of wetland methane emissions to model assumptions: application and model testing against site observations" *by* L. Meng et al.

Anonymous Referee #2

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Meng et al. present a sensitivity analysis of a methane emission model in the Community Land Model (CLM4) of the Community Earth System Model. This study very nicely highlights the difficulties of simulating methane emissions from wetlands on a global scale. The authors find very large global emissions of 256 Tg CH4 /yr, whereof the contribution from northern peatlands and wetlands (12 Tg CH4 /yr) are substantially lower than previous estimates. Beside the standard parametrisations of heterotrophic soil respiration and net primary production, CH4 emissions are also parametrised as a function of soil pH and redox potential. Simulated emission are compared to site data with acceptable agreement.

Unfortunately, beside the site data there are no real constraints for the model results on a regional or global scale. This makes it impossible to understand why the presented global emissions show these considerable differences to previous estimates. Another shortfall, is the lack of a discussion of the models hydrology that plays a major role in the CH4 emission parametrisation. The sensitvity study shows that model parameters affecting the production and plant mediated transport are most important. Thus the vegetation representation in the CLM4 and the deduced heterotrophic respiration and the net primary production are essential, and deserve a more thorough analysis in a revision of the manuscript.

—- General —-

It is very crucial that a global CH4 emission model is somehow validated against a global observational data set. An evaluation at site level is certainly helpful for the processes, but can not replace a global comparison. Global sources of 256 Tg CH4 /yr, already including the terrestrial soil sink of $\sim$30 Tg CH4 /yr, are difficult to reconcile with anthropogenic CH4 emissions, the atmospheric CH4 sink and the atmospheric CH4 burdon.

A global comparison has been done partially for the initial model version by Riley et al. 2011. What are the big differences in spatial emission distributions compared to Riley et al. 2011? From Fig. 15 it is obvious that norhern high latitude emissions are much larger in Riley et al. 2011 as proposed to the 12 Tg CH4 /yr in this study. I assume that in both studies the vegetation and carbon fluxes are simulated by the same land model and that the inundation fraction is identical. So why is there this big difference? It obviously can not be the underestimated vegetation productivity as claimed in section 5.1.

In the model description it is mentioned that a fraction of the grid cell is non-inundated and emissions are reduced compared to the inundated fraction, and depend on the water table depth. How big is this difference per unit area? How much do CH4 emissions from non-inundated areas contribute to the annual total? Could this explain the large emissions in the tropics despite a reduced inundation area?

It is further mentioned that you do not simulate wetland pfts, but that e.g. gas transport through grass arenchyma, which is determined by pft type, is most important for methane emissions and oxidation. One could thus argue that pft dependent parameters in the CH4 emission parametrisation differ for inundated and non-inundated wetlands and for northern peatlands. For which region are the impacts of parameter uncertainty, as given in Tab. 5, largest?

—- Specific —-

p. 6102, l. 20: How is the water table level calculated in the non-inundated fraction of the grid cell? What is the total soil layer depth and the soil layer resolution?

p. 6104, l. 15: What is the reason for weighting the inundation fraction with NPP? Since you do not simulate a wetland pft, I assume NPP is not affected by inundation. Why would years with high NPP from a non-wetland pft lead to an increased mean inundation fraction? Is the weighting calculated annually or monthly?

p. 6105, l. 8: How big are the errors of simulated NPP compared to MODIS NPP at the global scale? Is the NPP comparison at the sites (Fig. 6) representative for the globel errors?

p. 6114, l. 8: Do you mean "seasonal mean and maximum fluxes" in units of "CH4 emissions per day"? It looks like to me that in Fig. 11a there is not a daily mean and maximum flux for each day.

p. 6117, l. 5: Are there measurements for aerenchyma properties in tropical grass? Wania et al. 2010 used peatland specific parameters. A better parametrisation of this obviously important parameter could help to narrow down the uncertainty.

p. 6118, l. 7: The fact that CLMNC overestimates NPP in the tropics could be one main reason for the high tropical production. What is the quantitative effect on CH4 emis-

sions originating from this bias? l. 16: Did Riley et al. 2011 get the same production in northern high latitudes (see general point above)? l. 26: Some numbers got mixed up, compare text and table 6.

Figs. 1, 2, 14A: lines and dots leave the plotting range.

Fig. 15: There have been great efforts in constraining global wetland emissions over the last 10 years through global satellite concentration data, biogeochemical modelling and atmospheric inversions. So, it is kind of unfair to compare emissions to results from the 80s and 90s that did not have the information at hand. Maybe you could add newer biogeochemical studies, e.g. Ringeval et al., 2010, Spahni et al., 2011, that have been evaluated themselves using atmospheric transport and chemistry models.

—- References —-

Riley, W. J., Subin, Z. M., Lawrence, D. M., Swenson, S. C., Torn, M. S., Meng, L., Mahowald, N. M., and Hess, P.: Barriers to predicting changes in global terrestrial methane fluxes: analyses using CLM4Me, a methane biogeochemistry model integrated in CESM, Biogeosciences Discuss., 8, 1733–1807, doi:10.5194/bgd-8-1733-2011, 2011.

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Spahni, R., Wania, R., Neef, L., van Weele, M., Pison, I., Bousquet, P., Frankenberg, C., Foster, P. N., Joos, F., Prentice, I. C., and van Velthoven, P.: Constraining global methane emissions and uptake by ecosystems, Biogeosciences Discuss., 8, 221-272, doi:10.5194/bgd-8-221-2011, 2011.

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