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Biogeosciences Discussions

Interactive comment on "Sensitivity analysis of a wetland methane emission model based on temperate and Arctic wetland sites" *by* J. van Huissteden et al.

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1. Section 4.1. Not being an expert on this kind of statistical methods, I would like to see clearly mentioned what is the difference between a Monte Carlo simulation and running the model with a multitude of different random parameter sets. Or is there a difference?

Reply. Monte Carlo simulations rely on repeated random sampling of parameters in model simulations of physical systems. They are applied specifically when there is parameter uncertainty, to assess to what extent random variations of the parameters affect model output. So, a Monte Carlo simulation not just one model simulation, but a large set of simulations. In this set, each individual model simulation has been run with a fixed subset of parameters, with randomly chosen parameter values. We will adapt the description in section 4.1. to make this more clear.

2. Equation (5). Please define σ_t.

Reply. σ_t is the standard error of the individual flux measurements at time t. This will be added to the text.

3. Conclusions page 9108, row 26 (and other places, e.g. page 9102 row 25). You say the model could not follow short-term temporal variation of the fluxes. How much could ebullition affect this and which parameters are significant in determining ebullition events?

Reply. In the model, ebulliton depends on excess CH_4 concentration above the threshold concentration at which CH_4 bubbles are formed, which depends on the solubility of CH_4 in water. The ebullition is modelled as the difference between the actual CH_4 concentration and the threshold concentration, multiplied by a rate factor, set to 1.0 (Walter, 2000). This approach for calculating ebullition in the model is very simple and does not account for air pressure effects (review by Whalen, 2005) or for resistance to bubble movement within the soil (e.g. Granberg et al., 2001).

Ebullition events may have contributed, in particular at the Horstermeer Wet, Ruwiel and Kytalyk sites where water level is at the surface. Therefore, ebullition may indeed have contributed to the short term variability. However, also for the Horstermeer dry sites, where the water table is below the surface and the effect of ebullition is supposed to be small, the short-term temporal variability is not simulated very well. Moreover, Hendriks (2009) did not find a significant relation of air pressure (that may affect ebullition) and CH_4 flux measured by eddy covariance at Horstermeer. We therefore expect that ebullition is not an important factor in improvement of model fit. Furthermore, although the model could be improved here, ebullition probably will remain difficult to quantify, in particular the timing of ebullition events.

Next to ebullition there are other possible causes for the mismatch in the short-term temporal variation of the fluxes. Recent eddy covariance measurements on several site indicate that near-surface air turbulence may be an important factor, e.g. Sachs et al., 2008; Wille et al., 2008 for wetlands in the Lena delta, Parmentier (pers. comm., paper in prep. for the Kytalyk site). The resulting air pressure variation may enhance plant transport, and is not included in the model. However, in theory higher fluxes by short-term turbulance should not be recorded by the static chambers as they shield the soil surface from turbulence.

We will add a short paragraph to the discussion section on the possible effect of ebullition.

4. Conclusions page 9109, row 28. You mention that the parameter sensitivity and the parameter values resulting from the GLUE optimalisation agree well with a priori knowledge on the parameters. You do not, however, present the ‘real’ parameter values anywhere. Are the ranges in Table 1 realistic, taken from observations from arctic and temperate wetland sites, or do they include unrealistic values? If there also were values lower than/exceeding the realistic range, did they result in behavioral runs?

Reply. As discussed in section 4.3, the parameter ranges are based on Walter (2000) and Van Huissteden et al. (2006). Walter discusses the parameter ranges extensively in her paper, and these are considered to be realistic values taken from literature on measurements. If appropriate (e.g. for the R_0 parameter), we used the range denoted by Walter as the usual range for northern/temperate wetlands. We did not include values that should be considered as unrealistic. It should be noted that for some parameters, for instance plant transport rate V_{transp} or the amount of CH_4 oxidized during plant transport P_{ox} only a very few measurements are available on a few plant species, from which a realistic parameter value range is difficult to deduce for a multi-species wetland vegetation.

In the case of Kytalyk, we have a priori knowledge on some of the parameters although exact measurements are unavailable. Rather, it consists of an expected range of values. The floodplain site has a vegetation that is composed of plants that transport CH_4 readily (Cyperaceae and grasses) as is known from literature. The terrace/tundra sites are dominated by Sphagnum which is a non-vascular plant lacking arenchyma for gas transport, and moreover has symbiosis with methanogenic bacteria. Consequently, the plant transport factor should a priori be high for the floodplain and low for the tundra, while for the tundra also the plant CH_4 oxidation factor should be high.

References

Sachs, T., Wille, C., Boike, J., Kutzbach, L. 2008. Environmental controls on ecosystem-scale CH4 emission from polygonal tundra in the Lena River Delta, Siberia. J. Geophys. Res. 113, G00A03, doi:10.1029/2007JG000505, 2008.

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