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Exploring the limits of knowledge on boreal peatland development using a new model: the Holocene Peatland Model

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The Holocene Peatland Model (HPM) (Frolking et al. 2009, Frolking et al. in prep.) is a recently developed tool integrating up-to-date knowledge on peatland dynamics that explores peatland development and carbon dynamics on a millennial timescale. HPM combines the water and carbon cycles with net primary production and peat decomposition and takes the multiple feedbacks into account. The model remains simple and few site-specific inputs are needed. HPM simulates the transient development of the peatland and delivers peat age, peat depth, peat composition, carbon accumulation and water table depth for each simulated year.

Evaluating the ability of the model to reproduce peatland development can be achieved in several manners. Commonly one could choose to compare simulations results with observations from field data. However, we argue that the overall response of the model does not give much information about the value of the model design. Modelling of peatlands dynamics requires a lot of information regarding the behaviour of a peatland system within its environment (including allogenic changes in climate, hydrological conditions, nutrient availability or autogenic processes such as microtopographical effects). The actual state of knowledge does not cover all processes, interactions or feedbacks and a lot of peatland properties are neither well defined nor measured yet, so that estimates have been needed to build the model.

The work presented here aims at analyzing the role of the model parameterization on the simulation results. To do so, a sensitivity analysis is performed with a Monte-Carlo analysis and with help of the GUI-HDMR software (Ziehn and Tomlin, 2009). This method ranks the parameters and combinations of them according to their influence on simulation results.

The results will emphasize how the simulation is sensitive to the parameter values. First, the distribution of outputs gives insight into the possible responses of the simulation to HPM's assemblage of current knowledge. Second, the importance of some parameters on simulation results points out certain gaps in the current understanding of peatland dynamics. Thus, this study helps determine some avenues that should be explored in future in order to improve peatlands dynamics understanding.

Frolking S, NT Roulet, A Quillet, E Tuittila, JL Bubier. 2009. Simulating long-term carbon and water dynamics in northern peatlands Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract PP12B-05.

Frolking S, NT Roulet, E Tuittila, JL Bubier, A Quillet. XXXX. A new model of Holocene peatland net primary production, decomposition, and peat accumulation. in prep.

Ziehn T, AS Tomlin. 2009. GUI-HDMR – A software tool for global sensitivity analysis of complex models. Environmental Modelling & Software, 24, 775-785.