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Modelling carbon cycle in boreal wetlands with the Earth System Model ECHAM6/MPIOM

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Wetlands of the northern high latitudes provide excellent conditions for peat accumulation and methanogenesis. High moisture and low O_2 content in the soils lead to effective preservation of soil organic matter and methane emissions. Boreal Wetlands contain about 450 PgC and currently constitute a significant natural source of methane (CH_4) even though they cover only 3% of the global land surface.

While storing carbon and removing CO_2 from the atmosphere, boreal wetlands have contributed to global cooling on millennial timescales. Undisturbed boreal wetlands are likely to continue functioning as a net carbon sink. On the other hand these carbon pools might be destabilised in future since they are sensitive to climate change. Given that processes of peat accumulation and decay are closely dependent on hydrology and temperature, this balance may be altered significantly in the future. As a result, northern wetlands could have a large impact on carbon cycle-climate feedback mechanisms and therefore play an important role in global carbon cycle dynamics. However global biogeochemistry models used for simulations of CO_2 dynamics in past and future climates usually neglect carbon cycle in wetlands.

We investigate the potential for positive or negative feedbacks to the climate system through fluxes of greenhouse gases (CO_2 and CH_4) with the general circulation model ECHAM6/MPIOM. A generic model of peat accumulation and decay has been developed and implemented into the land surface module JSBACH. We consider anaerobic biogeochemical processes which lead to formation of thick organic soils. Furthermore we consider specific wetland plant functional types (PFTs) in our model such as vascular plants (sedges) which impact methane transport and oxidation processes and non vascular plants (sphagnum mosses) which are promoting peat growth.

As prototypes we use the modelling approaches by Frolking et al. (2001) as well as Walter & Heimann (2001) for the peat dynamics, and the wetland model by Wania (2008) for vegetation cover and methane emissions. An initial distribution of wetlands follows the GLWD-3 map by Lehner and Döll (2004). A dynamical wetlands hydrology scheme (T. Stacke) and a methane transport and emission model (M. Raivonen) are at the moment also under development at the MPI for Meteorology respectively in close cooperation with the University of Helsinki. First results of our modelling approach will be presented.

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