3rd International Conference on Earth System Modelling
Vol. , 3ICESM-413, 2012
3rd International Conference on Earth System Modelling

Modelling Holocene and future carbon accumulation and methane emissions of boreal wetlands. An Earth System Model approach

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Since the Last Glacial Maximum, northern wetlands, in particular boreal peatlands, accumulated considerable amounts of carbon in form of peat and constitute a significant natural source of methane even though they cover only 3% of the global land surface. Observational studies suggest that the boreal peat carbon stocks are as large as 270 to 547 Pg and CH4 emissions ranges between 32 and 112 Tg/yr. By storing carbon and taking up carbon dioxide from the atmosphere, boreal peatlands have had a cooling effect on climate during the last millennial despite the methane emissions. These carbon pools might be destabilised in the future since they are sensitive to climate change. However, global biogeochemistry models used for simulations of carbon cycle dynamics in past and future usually neglect peatland processes.

To account for the biogeochemical processes in boreal wetlands, a generic model of peat accumulation and decay was developed and included in the land surface model JSBACH of the MPI-Earth System Model. We also implemented a methane emission model that represents the different pathways of methane to the surface including its oxidation. The model results compare favourably with observations. This allows addressing the question of changes of CH4 emissions from boreal regions and its contribution to the atmospheric concentration reconstructed from the ice cores. Model results from 6,000 years BP to the end of the 21st century will be presented.