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Modelling global peatlands from LGM to Anthropocene

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Peatlands play an important role in the global carbon cycle. While natural wetlands are the largest natural source of methane, peatlands have accumulated substantial amounts of carbon, with estimates of peat accumulated during the Holocene reaching 600 PgC. On longer timescales the carbon uptake by peatlands therefore becomes a cumulative flux of substantial magnitude.

In order to mechanistically model interglacial carbon cycle dynamics, we have developed a dynamical model of wetland extent and peat accumulation, which we have integrated in the coupled climate carbon cycle model of intermediate complexity CLIMBER2-LPJ. This model consists of the climate model of intermediate complexity CLIMBER2, containing dynamic models of atmosphere and ocean, as well as sea ice and land surface modules. Its coarse spatial resolution leads to a high computational speed, which allows long-term transient integrations of the coupled model.
Land carbon dynamics are computed using the dynamic global vegetation model LPJ. LPJ is run at a high spatial resolution of 0.5° and coupled to CLIMBER2 using the climate anomalies approach. Changes in land carbon storage as a response to changes in climate or atmospheric CO_2 are therefore taken into account interactively at high spatial resolution.

Within this model, we have implemented a module that dynamically determines the extent of a grid cell that is inunated, based on the TOPMODEL approach, incorporating sub-gridcell information on hydrological properties of the land surface. Within the permanent wetlands determined, peat is accumulated since the slow anaerobic decomposition in wetlands leads to a large excess of biomass production over organic matter decomposition. In addition, methane emissions from the decomposition of soil organic matter are determined, both for permanent, and for seasonal natural wetlands.

While we have previously published results for boreal peatlands, we have now extended our approach to include tropical peatlands. We have performed experiments covering the climatic range from the last glacial maximum to future climate states and will present selected results from these experiments, discussing Holocene carbon uptake by peatlands, as well as possible future carbon cycle impacts.