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Modelling peatlands as part of the global carbon cycle

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Arctic and Boreal peatlands cover just a small fraction of the Earth's land surface area, but they have accumulated substantial amounts of carbon. Estimates of peat accumulated during the Holocene reach up to 450 PgC. On longer timescales the carbon uptake by peatlands therefore becomes a cumulative flux of substantial magnitude, though it is rather small if one considers the short timescales only.

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 wetland extent, based on the TOPMODEL approach. Since wetland and therefore peatland size often is substantially smaller than the model grid cells, despite the rather high resolution of LPJ, the dynamic representation of wetland extent can only be accomplished by incorporating sub-gridcell information on hydrological properties of the land surface. Within the wetlands determined, peat is accumulated since the slow anaerobic decomposition in wetlands leads to a large excess of biomass production over organic matter decomposition.

Besides a description of the modelling approach, we will present model results for the last 8000 years, during which modelled CO_2 concentration closely resembles reconstructions from ice cores. During this time, wetland area changes slightly due to the changing climate, with wetlands expanding in eastern Canada, as well as northern Eurasia. Overall, peat accumulation resembles measured accumulation patters, and a total of 220 PgC is accumulated as catotelm peat during the last 8000 years.