3rd International Conference on Earth System Modelling
Vol. , 3ICESM-52, 2012
3rd International Conference on Earth System Modelling

Modelling peatlands as part of the global carbon cycle

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Natural wetlands and 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 wetland extent, based on the TOPMODEL approach. Since wetland 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 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.
Besides a description of the modelling approach, we will present model results for the climate of the last 8000 years, during which modelled CO_2 concentration closely resembles reconstructions from ice cores. We will compare these experiments to model results for past interglacials and show the future evolution of the wetland carbon cycle during the present century, as well as future millennia.