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Coupling the dynamic vegetation model LPJmL5.1 to an Earth system model – towards POEM1.0

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Feedbacks between biosphere and other components of the Earth system are challenging to model accurately and therefore are often omitted or oversimplified in Earth system models (ESMs). However, their importance is increasingly recognized as rapid disturbances due to anthropogenic (e.g., deforestation) or natural (e.g. regional increase in fires) drivers are already observed.

Here we couple the well established and comprehensively validated dynamic global vegetation model LPJmL5.1 (von Bloh et al., 2018) to an Earth System model CM2Mc (MOM5/AM2, Galbraith et al. 2011). We replace the simple static vegetation model LaD with LPJmL5.1 and couple the water- and energy cycle by using GFDL's Flexible Modeling System (FMS). In order to stabilize the model performance, several adjustments to LPJmL5.1 had to be done, including the introduction of a subdaily cycle for the energy and water calculations, the implementation of a conductance of the soil evaporation and plant interception, the calculation of a canopy layer humidity, and the surface energy balance in order to calculate the surface and canopy layer temperature within LPJmL5.1.

The coupled system allows us to answer questions regarding ecosystem stability with a complete energy and water cycle. For example, changes in the vegetation have a large impact on atmosphere dynamics, which in turn affects precipitation and feeds back into vegetation growth and mortality. To examine this feedback a simple experiment is performed by deforesting the whole Amazon basin and replacing it with grassland. Our results show decreasing precipitation and increasing canopy temperature which becomes a stable climate state in this treeless scenario. Future applications of the coupled model may include the investigation of tipping points in the biosphere, the impact of different atmospheric CO_2 concentrations or climate change and land-use change scenarios.