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Biogeochemical effects of land cover and land management

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Land cover and land management (LCLM) changes are important sources of anthropogenic CO_2 emissions, constituting about 10% of current annual CO2 emissions, or about one third of cumulative emissions over the industrial era. However, simulations with Earth system models (ESMs) show a large range of CO_2 emissions from LCLM. Several reasons for the divergence in estimates have been identified, in particular differences in simulated biomass and soil carbon stocks, and if and which land management practices are included in models. The divergence of model estimates is particularly worrisome since LCLM practices are discussed as key mitigation tools or “negative emission technologies” to reach the temperature goals of Paris Agreement. In the LAMACLIMA project (land management for climate mitigation and adaptation) we therefore conduct a detailed analysis of several LCLM practices across three ESMs to improve our understanding about model uncertainties. The present study aims to quantify the effects of forest cover changes and wood harvesting on the global carbon cycle, globally important LCLM practices with relevance also for physical climate and economic production.

We conduct idealized global experiments of deforestation, afforestation and wood harvesting over a 150-year simulation period under present climate. All forcings (solar, trace gases, aerosols) are held constant at present-day levels to isolate the climatic effects from different LCLM scenarios on the carbon cycle. All experiments are conducted by three different Earth system models (MPI-ESM, EC-EARTH and CESM) to quantify inter-model uncertainty and potentially uncover specific model biases. The analysis focuses on the transient response of carbon fluxes after the LCLM practice is in order to unravel model differences concerning temporal dynamics of LCLM effects and to show how quickly signals emerge that could potentially mitigate climate change.

With this research, we will provide a deeper understanding about simulated LCLM effects on the carbon cycle and also report model uncertainties. Together with parallel efforts to quantify biogeophysical effects of LCLM, our study will also lead to assess the overall potential of LCLM as a

means for land-based climate mitigation.