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Modelling the response of soil carbon to climate and land cover change in an Earth System Model

Daniel Goll (1,2), Victor Brovkin (1), and Jari Liski (3)

(1) Max Planck Institute for Meteorology, Hamburg, Germany (daniel.goll@zmaw.de), (2) KlimaCampus, Hamburg, Germany, (3) Finnish Environment Institute (SYKE), Helsinki, Finland

The response of soils to climate change is a major uncertainty in the trajectory of atmospheric carbon dioxide concentrations. Soils contribute to the land carbon balance directly via soil respiration and indirectly by constraining plant productivity via nutrient availability. The modelling of these processes on global scale is hampered by gaps in process understanding and insufficient data for parameterization. Thus, the current generation of Earth System Models has severe difficulties in simulating soil carbon balance (Todd-Brown et al., 2012, 2013) and most of these models do not account for nutrient cycles and thus are prone to overestimate plant growth (Goll et al., 2012).

Additionally, the representation of soils in Earth System Models influences other processes, like indirect emissions due to land cover changes, the emissions of greenhouse gases like methane and nitrous oxide, or the effect of nitrogen deposition on plant growth. A realistic representation of soils in such a model is therefore crucial to reduce uncertainties in a variety of processes analyzed with such models.

We exchanged the soil carbon component of an Earth System Model with a decomposition model based on litter bag experiments and quantified the consequences of the exchange on a variety of components of the land carbon balance.

Todd-Brown et al. “Causes of variation in soil carbon predictions from CMIP5 Earth system models and comparison with observations”. Biogeosciences, 2012.
Todd-Brown et al. “Changes in soil organic carbon storage predicted by Earth system models during the 21st century”. Biogeosciences Discussions. 2013
Goll et al. “Nutrient limitation reduces land carbon uptake in simulations with a model of combined carbon, nitrogen and phosphorus cycling”. Biogeosciences. 2012