Project: **1147**
Project title: **LAnd MAnagement for CLImate Mitigation and Adaptation**
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1. Introduction

The objective of the LAMACLIMA project is to advance the scientific and public understanding of the coupled effects between the climate system and changed land cover and land management as well as to elaborate sustainable land-based adaptation and mitigation measures.

There is now strong evidence that anthropogenic changes in land cover and land management are substantially affecting the climate through the emission and uptake of CO_2 to the atmosphere (biogeochemical effects), the alteration of local energy and water fluxes at the land surface, and their interaction with large-scale atmospheric dynamics (local and remote biogeophysical effects). Accounting for these coupled effects is thus one of the major tasks for future climate mitigation and adaptation efforts.

However, the coupled nature of these effects overall receives limited consideration in land-use decision making processes. This is not only due to uncertainties on the full implications of changes in land cover and management for climate and ecosystem services but also to a lack of dialogue between the relevant science, stakeholders, and practice communities.

Thus, within this project, we will first investigate the local and remote biogeophysical and biogeochemical effects of three key changes in land cover and management (re-/afforestation, wood harvest, irrigation) on climate. To do so, we use a fully coupled MPI-ESM-1.2 setup to conduct sensitivity studies with idealized simulations of (i) deforestation in 100% crop world, (ii) irrigation of a 100% crop world, (iii) re-/afforestation to a 100% forest world , and (iv) wood harvest of a 100% forest world. The results will be used by simulations with socio-economic models to identify their implications for the sectors of agriculture, water availability, forestry, and economic productivity. Finally, we are planning to design new land cover and management scenarios in order to complement the existing shared socioeconomic pathways.

2. The impact of extreme deforestation on global terrestrial carbon pools

Preliminary results of raw model output from simulations under present-day climate and constant current land cover and management (a so-called control simulation, CTL) in comparison to a 100% crop world (CROP) seem to indicate that the global terrestrial carbon pool (cLand) decreases due to a loss in total plant biomass (cVeg) and soil carbon (cSoil) (see Fig. 1). This idealized simulation of global deforestation also reveals that the response time of these global C pools to the drastic land cover change lies within a period of 160 years since only very small changes can be detected at the end of the simulation period. From these very first analyses with MPI-ESM simulations, we can calculate a decrease of total terrestrial C of about -420 GtC, with vegetation accounting for 57% and soil C 21% of that loss. The remaining 22% might be associated to a decrease in simulated litter C pools.

The C fluxes of the CROP simulation show an increase of gross primary productivity GPP but a decrease of net primary productivity NPP compared to the CTL simulation (see Fig. 2) which could also explain the overall loss in vegetation biomass.

While the general direction of changes is expected, we will perform further plausibility checks against existing simulation and observational data and via comparison to the LAMACLIMA partner models CESM and EC-EARTH. Detailed analyses of timescales and regionally varying sensitivities of the Earth system response to drastic deforestation will follow.

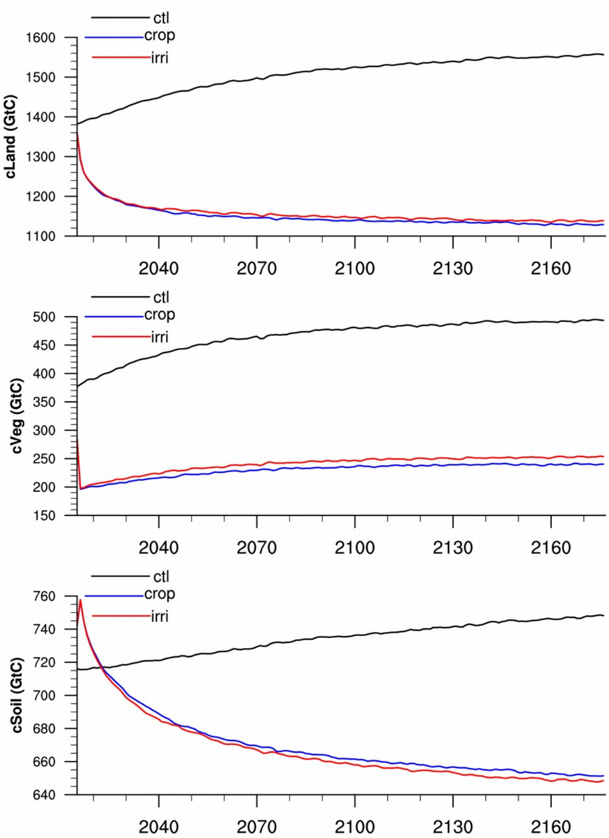

Figure 1: Global terrestrial pools of total C (top), vegetation C (middle) and C stored in the soil (bottom) simulated with MPI-ESM1.2 for 160 years under current climate and current land cover and management (ctl), a 100% crop world (crop), and a irrigated 100% crop world (irri).

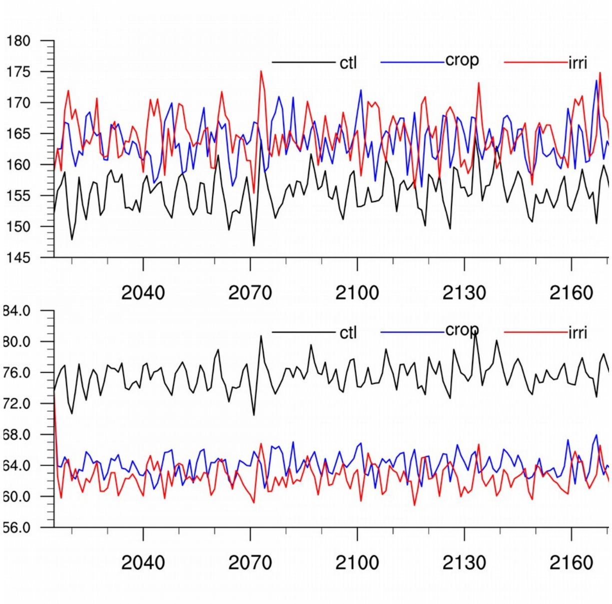

Figure 2: Global C fluxes of gross primary productivity (GPP, top) and net primary productivtiy (NPP, bottom) simulated with MPI-ESM1.2 for 160 years under current climate and current land cover and management (ctl), a 100 % crop world (crop), and an irrigated 100 % crop world (irri).

3. The impact of global crop irrigation on terrestrial carbon pools

A simulated change in land management from a rainfed crop world to an irrigation crop world leads to much smaller changes of the terrestrial C pools and C fluxes compared to the drastic deforestation scenario. However, we can yet show an irrigation induced increase of vegetation C pool and decrease soil C pool within our simulation results.

4. Outlook

An extensive and spatially explicit analysis divided into different global regions of other biogeochemical effects as well as a separation into local and remote biogeophysical effects will be done as a next step. Additionally, two simulations of a 100% forest world with and without harvest will be finished soon and analyzed in a similar way to the latter model results in order to compare all of the planned land cover and management scenarios with each other