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Influence of gross versus net land-use transitions on the carbon cycle, land use emissions and fire regime in the Max-Planck-Institute Earth System Model

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Since thousands of years mankind has altered the surface of the Earth by clearing forests for agricultural purposes and logging of wood for fuel and construction works. In total about half of the global land surface have at some point in history been altered by humans. Land use and land use changes (LULCC) have not only changed the physical surface properties of the Earth (albedo, roughness length) but also results in a release of carbon to the atmosphere (land use emissions, LUE). These fluxes have exceeded those from fossil fuel well into the 20th century and still amount to more than 10% of present day fossil fuel emissions. Thus quantification of the LUE is important for understanding the past and the prediction of the future climate. Therefore the last generation of Earth System Models (ESMs) used for the model intercomparison studies for the IPCC 5th assessment report include LULCC and LUE, but the implementation details and thus results are diverse. One important difference is whether sub-grid scale LULCC practices such as shifting cultivation (that is: clearing land, cultivating it for a few years then abandoning it again while clearing a new land piece), which is very important in certain regions of the world, is accounted for (gross transitions) or not (net transitions).
The difference between the two approaches has been quantified using the ESM of the Max-Planck-Institute (MPI-ESM) by reducing the LULCC information which include shifting cultivation (gross transitions) to include net transitions only. Accumulated over the period 1850-2005 the LUE were about 85GtC (almost 40%) lower when accounting for net transitions only. Through differences in fuel availability also fire occurrence was changed, though only regionally important. Using the RCP-senarios, the results were projected until year 2100. The differences between the two transition implementations diminishes at different speed in the different RCPs but has (almost) vanished in 2100 in all projections.
This study highlights that model implementation details of LUC severely influences the estimate of LUE and thus the role of LULCC in climate change.