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Evaluating the climate sensitivity to human land use change using thermodynamics

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Land cover change can result in cooling or warming, depending on the associated, relative changes in radiative heating (mostly due to albedo changes) and evaporative cooling (mostly due to changes in canopy roughness and rooting depth). Hence, temperature alone does not serve well to characterize the climate sensitivity to land cover change. From a perspective of thermodynamics, differences in temperature and heating terms are only two of components of the first law of thermodynamics. The third term of the first law, the rate at which processes perform work, and the second law are conspicuously absent in the evaluation of climate sensitivity. Here I evaluate a series of climate-vegetation model simulations with different settings of land cover change. I implement different settings of land cover change by using the concept of human appropriation of net primary productivity (HANPP) and implement it into a simple vegetation model by removing a certain fraction of the simulated productivity, hence resulting in less biomass in the vegetation and associated climatic effects. These sensitivity simulations are then evaluated in terms of the components of the surface energy- and water balance and in terms of the different components of the first and second law of thermodynamics.