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Biogeophysical Effects of Anthropogenic Land Cover Change during the last Millennium

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Humans have actively managed and transformed the world's landscapes for millennia already, but the effects of pre-industrial human activity on global and regional climate are still highly uncertain. The wide range of climate responses to land surface forcings in recent modeling studies highlights the need for further research in this area. A major obstacle has also been the lack of quantitative data on historical land use activity prior to AD 1700. The study presented here applies a high-resolution land cover reconstruction for the last millennium that we have recently published.

In a first step, we quantify changes in radiative forcing from surface albedo changes throughout the last millennium. Our results are in line with previous studies for the recent centuries that are covered by former land use data. For pre-industrial times, our results show that energy balance was significantly influenced by human activity already a millennium ago. Regional monthly values of radiative forcing are as low as -2.5 $\mathrm{W/m^2}$ in AD 800. Strong regional dynamics are observed as a result of political and social changes, and events such as the Black Death epidemics in Europe leave a distinct fingerprint in forcing history.

In a second step, we estimate the climate impact of anthropogenic land cover change by biogeophysical effects. Two 100-year equilibrium simulations are performed with the high-resolution GCM ECHAM5/JSBACH for present-day and potential land cover. They show an overall cooling effect by agricultural expansion, which is consistent with previous studies where the surface albedo change is the dominating force.

However, the interaction of changes in albedo and the hydrological cycle result in climate signals that are highly heterogeneous and variable between individual months.