



Preindustrial agriculture and the carbon cycle - a GCM study on the beginning of the Anthropocene

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From the current state of knowledge, it is still undecided whether humankind had a significant impact on the carbon cycle and the climate already in preindustrial times. We address this question with state-of-the-art GCM simulations of the last millennium, coupling the atmosphere, ocean, and the land surface including a closed carbon cycle. This setup also applies a spatially explicit, population-based reconstruction of anthropogenic land cover change (ALCC) and quantifies the carbon source and sink terms associated with ALCC.

Primary emissions until the industrialization (AD 1850) sum up to 53 Gt C. Nearly half of these emissions are, however, stored back in the terrestrial biosphere due to land-atmosphere coupling. After ocean uptake, this leaves an airborne fraction of only 21%. Despite the low airborne fraction, atmospheric CO₂ rises above natural variability by late medieval times. This suggests that human influence on CO₂ began prior to industrialization. Global mean temperatures, however, are not significantly altered until the strong population growth in the 19th century.

We further investigate the effects of historic events such as epidemics and warfare on the carbon budgets. Only long-lasting events such as the Mongol invasion are found to lead to carbon sequestration. The reasons for this are indirect emissions from past ALCC that compensate carbon uptake in regrowing vegetation for several decades. Concurrent emissions from other parts of the world further contribute to atmospheric CO₂. Drops in CO₂ that have been reconstructed from ice core records are thus unlikely to be attributable to human action. Our results indicate that climate-carbon cycle studies for present and future centuries, which usually start from an equilibrium state around 1850, start from a significantly disturbed state of the carbon cycle.