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Effects of Land Cover Changes over the Last Glacial-interglacial cycle

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Modern land cover changes are dominated by land use change, and globally the carbon cycle is generally considered to be the dominant aspect. However, past changes in climate show that changes of atmospheric carbon dioxide concentration on the scale of some future projections have a significant effect on 'natural' vegetation. This longer-term Climate Induced Land Cover Change (CILCC) affects the biogeophysics and biogeochemistry differently, and the carbon emissions become less important. Here we use a fully-coupled dynamic atmosphere-ocean-vegetation General Circulation Model (GCM) to generate a set of 62 equilibrium simulations spanning the last 120 ka. The analysis of these simulations elucidates the relative importance of the biogeophysical versus biogeochemical terrestrial biosphere interactions with climate. We find that the biogeophysical effects of vegetation account for up to an additional -0.91°C global mean cooling, with regional cooling as large as -5°C, but with considerable variability across the glacial-interglacial cycle. By comparison, while opposite in sign, our model estimates of the biogeochemical impacts are substantially smaller in magnitude. Offline simulations show a maximum of +0.33°C warming. In contrast to shorter (century) time-scale projections of future terrestrial biosphere response where direct and indirect responses may at times cancel out, the biogeophysical effects consistently and strongly dominate the biogeochemical effect over the inter-glacial cycle. On average across the period, the global net biogeophysical and biogeochemical effect of CILCC is a -0.26°C effect on temperature, with -0.58°C at the last glacial maximum.