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Secondary organic aerosols from projected future large-scale vegetation changes in low-emission scenarios

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Changes to vegetation and land-use affect the climate through emissions of chemically reactive biogenic volatile organic compound (BVOCs), in addition to modifying carbon fluxes and surface albedo. Previous studies have found that the resulting changes to production of secondary organic aerosols (SOA) have contributed to the net climate impact of historical land-use change and deforestation. Here, we investigate the climate impact of increased and decreased SOA concentrations resulting from land use and vegetation changes likely associated with low global warming targets.

Most scenarios for limiting global warming to 1.5-2°C rely on negative emission technologies, including large-scale deployment of bioenergy with carbon capture and storage (BECCS), as well as reforestation and afforestation. This in turn entails significant changes to the vegetation and land surface, such as increased expansion of energy crops. Once in the atmosphere, SOAs formed from BVOCs affect the energy balance, posing a cooling climate impact through interaction with radiation and clouds. However, the full consequences of changes to BVOC emissions following land-use perturbations in such scenarios are not well quantified.

Building on existing literature and data about land-use change in the Shared Socio-economic Pathways (SSPs), we construct time-slice scenarios for future vegetation composition, focusing on the pathways with high assumptions for BECCS. The consequent BVOC emissions and concentrations of SOA are simulated using the detailed global chemistry-transport model OsloCTM3, separating the impact of vegetation changes alone and the combined effects of vegetation and climate change. Finally, we quantify the radiative forcing relative to the baseline, present-day vegetation case, thereby providing a broader picture of the climate impact of possible future land-use change beyond the carbon-only impacts.