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Including the biogeochemical impacts of deforestation increases projected warming of climate

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Forests cover almost one third of the Earth's land area and their distribution is changing as a result of human activities. The presence, and removal, of forests affects the climate in many ways, with the net climate impact of deforestation dependent upon the relative strength of these effects (Betts, 2000; Bala *et al.*, 2007; Davin and de Noblet-Ducoudré, 2010). In addition to controlling the surface albedo and exchanging carbon dioxide (CO_2) and moisture with the atmosphere, vegetation emits biogenic volatile organic compounds (BVOCs), which lead to the formation of biogenic secondary organic aerosol (SOA) and alter the oxidative capacity of the atmosphere, affecting ozone (O_3) and methane (CH_4) concentrations.

In this work, we combine a land-surface model with a chemical transport model, a global aerosol model, and a radiative transfer model to compare several radiative impacts of idealised deforestation scenarios in the present day.

We find that the simulated reduction in biogenic SOA production, due to complete global deforestation, exerts a positive combined aerosol radiative forcing (RF) of between +308.0 and +362.7 mW m^{-2}; comprised of a direct radiative effect of between +116.5 and +165.0 mW m^{-2}, and a first aerosol indirect effect of between +191.5 and +197.7 mW m^{-2}. We find that the reduction in O_3 exerts a negative RF of -150.7 mW m^{-2} and the reduction in CH_4 results in a negative RF of -76.2 mWm^{-2}.

When the impacts on biogenic SOA, O_3 and CH_4 are combined, global deforestation exerts an overall positive RF of between +81.1 and +135.9 mW m^{-2} through changes to short-lived climate forcers (SLCF). Taking these additional biogeochemical impacts into account increases the net positive RF of complete global deforestation, due to changes in CO_2 and surface albedo, by 7-11%. Overall, our work suggests that deforestation has a stronger warming impact on climate than previously thought.

References:

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