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Atmospheric Impacts of Biofuels

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With concerns over CO2 emissions and climate change mounting, many national governments are now committed to the development and use of biomass-based fuels. While net CO2 emissions from their use may be lower than from fossil fuel combustion when accounting over growth, processing and combustion of plant material, detrimental impacts on atmospheric composition and climate remain large. For example, the changes in land-use required to generate sufficient quantities of biofuels will lead to significant changes in biogenic emissions of volatile organic compounds (VOCs), altering the tropospheric abundance of ozone and secondary organic aerosols and influencing both air quality and climate. Furthermore, tropospheric composition has a direct impact on the biosphere, affecting both primary productivity and VOC emission rates, and the resultant feedbacks between the biosphere and atmosphere have the potential to mitigate or exacerbate the the effects of these land use changes on local and global scales.

This study uses the HadGEM2 Earth system model to explore the response of surface ozone and aerosol concentrations to land use change arising from the cultivation of biofuel feedstock crops to meet projected global biofuel demands in the near future. The land use change scenarios have been designed to reflect realistic levels of low density replanting of current vegetation with either oil palm or short-rotation coppices (fast-growing tree species such as poplar, willow or eucalyptus) based on current government targets and initiatives. Both scenarios result in increased emissions of isoprene (in the tropics in the case of oil palm, and the mid- to high- latitudes for the SRCs), leading to increases in surface ozone and aerosols around the re-planted areas. While the effects are mostly local in extent, they are sufficiently large to impact both plant and human health, and to lead to feedbacks between the biosphere and atmosphere as a direct result of the change in land cover.