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Global simulations of BVOC-aerosol-climate feedbacks

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The terrestrial emission of biogenic volatile organic compounds (BVOCs) is modulated by several climate variables. Since the emitted BVOCs influence atmospheric aerosol formation and the respective aerosol forcing, there are several potential aerosol-climate feedback mechanisms which operate via BVOC emissions. Increased aerosol loading will increase the amount of diffuse radiation with respect to global radiation, leading to increased photosynthesis. On the other hand, an increase in BVOC emission could increase concentrations of cloud condensation nuclei (CCN), leading to changes in cloud albedo and cloud dynamics. We have developed the Norwegian Earth System Model (NorESM) to capture the necessary processes and interactions in order to describe BVOC-climate-feedbacks. BVOC emissions are calculated online by the MEGAN algorithm, and secondary organic aerosol formation from monoterpene and isoprene is accounted for. The developed coupled model is used to simulate the climate feedbacks with various idealized perturbations, including doubled/quadrupled CO_2 concentration and decreasing anthropogenic aerosol emission. Equilibrium simulations with doubled CO_2 show an increase of monoterpene emission by 20% globally, leading to increase in aerosol growth, aerosol loading and CCN concentration. Simulations indicate an overall negative BVOC-aerosol-climate feedback, which could act to reduce the future climate warming. However, the magnitude of the feedback is highly sensitive to the spatial distribution of the initial perturbation, applied BVOC emission parameters, and the underlying assumptions of SOA formation processes.