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The impact of geoengineering on vegetation in experiment G1 of the Geoengineering Model Intercomparison Project

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Solar Radiation Management (SRM) has been proposed as a means to partly counteract global warming. The Geoengineering Model Intercomparison Project (GeoMIP) simulated the climate consequences of a number of SRM techniques, but the effects on vegetation have not yet been thoroughly studied. Here, the vegetation response to the idealized GeoMIP G1 experiment is analyzed, in which a reduction of the solar constant counterbalances the radiative effects of quadrupled atmospheric CO_2 concentrations; the results from eight fully coupled earth system models (ESMs) are included. For most models and regions, changes in net primary productivity (NPP) are dominated by the increase in CO_2, via the CO_2 fertilization effect. As SRM will lower temperatures, in high latitudes this will reverse gains in NPP from the lifting of temperature limitations. In low latitudes this cooling relative to the $4xCO_2$ simulation decreases plant respiration whilst having little effect on gross primary productivity, increasing NPP. Despite reductions in precipitation in most regions in response to SRM, runoff and NPP increase in many regions including those previously highlighted as potentially being at risk of drought under SRM. This is due to simultaneous reductions in evaporation and increases in water use efficiency by plants due to higher CO_2 concentrations. The relative differences between models in the vegetation response are substantially larger than the differences in their climate responses. The largest differences between models are for those with and without a nitrogen-cycle, with a much smaller CO_2 fertilization effect for the former. These results suggest that until key vegetation processes are integrated into ESM predictions, the vegetation response to SRM will remain highly uncertain.