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Effects of solar radiation management on global crop yields

J. Pongratz (1), D.B. Lobell (2), L. Cao (3), and K. Caldeira (3)

(1) Max Planck Institute for Meteorology, Land in the Earth System, Hamburg, Germany (julia.pongratz@zmaw.de), (2) Department of Environmental Earth System Science and Program on Food Security and the Environment, Stanford University, Stanford, USA (dlobell@stanford.edu), (3) Department of Global Ecology, Carnegie Institution for Science, Stanford, USA (longcao@stanford.edu, kcaldeira@carnegie.stanford.edu)

Crop models predict that recent and future climate change may have adverse effects on crop yields. Climate models predict that intentional deflection of sunlight away from the Earth (solar radiation management, SRM) could diminish the amount of climate change in a high-CO_2 world. However, it has been suggested that this diminution would come at the cost of threatening the food and water supply for billions of people. In light of uncertainties about climate sensitivity and the existence of climate tipping points, it has been suggested by some members of the scientific and political communities that SRM may have the potential to reduce the risks associated with greenhouse gas emissions, with some going so far as to present SRM approaches as an alternative solution to emission reductions. These considerations make assessments of benefits and risks of geoengineering imperative, yet such assessments are only just beginning to emerge.

Here, for the first time, we perform high-CO_2, geoengineering, and control simulations using two climate models and combine these with an empirical crop model to predict effects on global crop yields. We find that in our models solar-radiation geoengineering in a high-CO_2 climate generally causes crop yields to increase. Our model results indicate that compared to the unmitigated 2xCO_2 scenario, SRM increases global yields of rice, maize, and wheat by 8-21%, and global production by 25-99 million tons. The reason is largely that temperature stresses are diminished while benefits of CO_2-fertilization are retained. Concerns about yield losses in the Asian monsoon region are not confirmed by our results: While the weakening of the monsoon precipitation under SRM is indeed found to have detrimental effects on crop yields, our crop model predicts that the positive effects of alleviation of temperature stress overcompensate these losses. As climate model results are less reliable on the local than on the global scale, large model ensembles of geoengineered climate as become available now have the potential to deliver more robust results on the regional level.

While yields increase on the large scale in our simulations, yield losses may occur on the local scale and may lead to local food insecurity in particular in regions where subsistence farming prevails. Further, geoengineering by SRM does not address a range of other detrimental consequences of climate change, such as ocean acidification, which could also affect food security through effects on marine food webs. Finally, SRM poses substantial anticipated and unanticipated risks by interfering with complex systems that are not fully understood. Therefore, the most certain way to reduce climate risks to food security is to reduce emissions of greenhouse gases.