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The Role of Solar Geoengineering in a Comparative Integrated Assessment of Temperature Targets: How Much Does 0.5°C Make Difference?

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Following the Paris Agreement highlighting the pursuit of efforts to limit the atmospheric temperature rise to 1.5°C above its pre-industrial level, the research question has been raised that what the role of climate engineering in compliance with 1.5°C-temperature target would be. Although there is no clear indication of solar geoengineering (SGE) in this context, it is not explicitly ruled out too. Comparing target-based decision frameworks for 1.5°C- and 2°C- temperature targets, here we ask for the optimal mix of SGE and traditional greenhouse gas emissions mitigation when precipitation changes are taken into account as a side effect of SGE. Employing the integrated assessment model MIND, we run our simulations in both global and 'Grorgi'-regional scales and consider global and regional temperature anomalies as well as global and regional precipitation changes. We firstly conduct a deterministic cost-effectiveness analysis (CEA) for climate sensitivity (CS) of 3°C when both temperature and precipitation targets are activated. Then, we apply cost-risk analysis (CRA) with probabilistic information on CS ranging between 1.01°C and 7.17°C for three different scenarios: temperature-risk-only, precipitation-risk-only, and equally-weighted both-risks scenarios.

Using CEA, our simulations find no feasible solution to comply with 1.5°C-temperature target by only mitigation in both global and regional settings, which emphasizes the significant role of SGE in reaching this target. Our simulations highlight that by altering the temperature target from 2°C to 1.5°C under CEA, when no transgression of temperature and precipitation targets are allowed, SGE usage either does not change in the regional analysis or decreases in the global analysis, that is, the need for more mitigation. Also, regardless of 2°C or 1.5°C temperature target, SGE usage is restricted by regionalizing the model.

Applying CRA, our findings show infeasibility when the conventional calibration process is used. As a solution, we circumvent the calibration process by distinguishing between the concept of risk in calibration phase and decision making phase. The cooling effect of SGE will increase by 0.4°C for median CS of 3°C while switching from a regional setting to a global setting as well as reducing the temperature target from 2°C to 1.5°C. SGE can save approximately 2/3 to 3/4 of the welfare-loss in the mitigation-only portfolio in the regional setting of 1.5°C-temperature target analysis, respectively in precipitation-risk-only and both-risks scenarios.