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Solar radiation management – on feasibility, side effects, and reaching the 2 degree target

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Solar radiation management (SRM), i.e. artificially increasing the reflectivity of the Earth, has been suggested as a fast-response, low-cost method to mitigate the impacts of potential rapid future climate change. We have used 1) large eddy simulations as well as an aerosol-climate model and an earth system model to investigate the feasibility and side effects of two types of SRM (marine cloud brightening and stratospheric sulfur injections) and 2) a sequential decision-making approach to determine strategies that combine emission reductions and an uncertain SRM option to limit global mean temperature increase to 2 degree.

Regarding stratospheric injections, we find that a large explosive volcanic eruption taking place while SRM is in full force would result in overcooling of the planet, as expected; however, the radiative and climate effects would be clearly smaller than could be expected from the sum of the effects from volcanic eruption alone or SRM alone. In addition, the stratospheric sulphur load would recover from the eruption faster under SRM and natural conditions. If the eruption took place in the high latitudes, the resulting global forcing would be highly dependent on the season of the eruption. Furthermore, regarding marine cloud brightening we find that the spraying of sea water drops leads to cooling due to evaporation and leads to delay in particle dispersion. This delay enhances particle scavenging, and can influence the efficacy of cloud seeding.

In terms of combining emission reductions and SRM to reach the 2° C warming target, we find that before the termination risk for SRM can be completely excluded, the acceptable greenhouse gas emission pathways remain only slightly higher than in scenarios without SRM. More generally, the uncertainties in SRM start time, acceptable magnitude and sustainability mean that it can be only a limited substitute to greenhouse gas (GHG) emission reductions. If an additional constraint for CO_2 concentration to mitigate ocean acidification is included, the CO_2 emissions need to be rapidly reduced even if strong SRM will become available. However, in such scenarios the reductions for other greenhouse gases are not needed to reach the 2 degree target. Therefore, we conclude that the needs to simultaneously mitigate ocean acidification and temperature increase have important implications on how climatic targets and policies in the presence of uncertain SRM should be framed.