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# Evaluating the climate impacts of stratospheric Sulphate, Titania and Black-Carbon injection scenarios using HadGEM2-CCS

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Stratospheric Aerosol Injection (SAI) has emerged as a possible method for ameliorating future global warming. Although most SAI modelling studies have simulated Sulphate injection scenarios (in-line with the natural analogue of volcanic eruptions), various research has identified advantages of using alternative aerosols to sulphate (e.g. Tang et al 2014). In particular, minerals with optimal refractive indices (such as Titania) and sunlight-absorbing aerosols (such as Black-Carbon) have been identified as candidate particles.

In this talk, I will present the results of 80-year integrations of HadGEM2-CCS (N96L60) with injection of either sulphate, titania or black-carbon initiated in 2020 and continued until 2100. Aerosol is injected at such a rate as to balance top of the atmosphere (TOA) radiative fluxes in the RCP8.5 scenario, akin to the G3 design of the GeoMIP project. I will compare the climate changes in the baseline scenario (RCP8.5) with the geoengineering scenarios for the 2090s period, and attribute these changes to optical properties of the aerosol species used. Stratospheric dynamical and radiative changes impact the underlying tropical overturning circulation, affecting precipitation, with the magnitude and distribution of impacts dependent on the aerosol species used. Black carbon in particular causes stratospheric heating of >40K, impacting the hydrological cycle and reducing global mean annual precipitation by $\sim$0.25mm/day compared to a historical period. The efficiency of solar-absorption by black carbon means that the injection-rate required to balance TOA fluxes in RCP8.5 is shown to be approximately 1/20th of the mass needed of sulphate and 1/5th of the mass needed of titania. Despite similar global-mean temperature evolution in the geoengineering scenarios (a relative stabilisation), the distribution of high-latitude residual warming and tropical cooling in the sulphate and titania simulations is opposite to the high-latitude cooling and low-latitude warming due to black-carbon injection. The temperature changes in the black-carbon simulations are attributed to snow-albedo and cloud feedbacks. This work is the first to compare the results of long-term GCM integrations of geoengineering with different aerosol species.