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The climate of a "Sunshade Geoengineered World"

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Several schemes have been proposed with the explicit aim of modifying the future climate of the planet as a mitigation strategy in a response to anthropogenic global warming. A selection of these, including the placing of mirrors at the Lagrange point between the Earth and the Sun, and the injection of aerosols into the stratosphere, have at their heart the goal of effectively reducing the incoming solar radiation near the top of the atmosphere, to 'balance' increased surface warming due to increased greenhouse gas concentrations.

However, it is likely that an exact balance of the radiative forcing would be very difficult to obtain, due to differing spatial characteristics of the solar forcing applied (greatest at the equator and least at the poles) and that of long wave absorption (more equal over all latitudes), as well as differing temporal characteristics of the radiative forcings. In this study, we model the different climate expected in a 'Sunshade Geoengineered World', compared to the 'Preindustrial World', if both have the same global annual mean surface temperature.

We use the UK Met Office GCM, HadCM3L, and carry out 3 simulations: Preindustrial, Quadrupled CO_2, and a simulation in which the increased CO_2 is balanced in the global annual mean by a reduction in incoming solar radiation. The 'strength' of mirror required is calculated using an iterative procedure, until balance is obtained.

Our results indicate significant differences between the Sunshade Geoengineered World and the Preindustrial World, despite near-identical global annual mean surface temperatures. In particular, we obtain relatively large differences in surface temperature over the Arctic, including a reduction in seaice, and equatorial cooling including

significant changes in upwelling on the West African tropical coast. We analyse the response of ENSO in the modified climate, and find a reduction in the intensity of El Nino and La Nina events. There is a reduction in global precipitation, and a northward shift of the ITCZ. We also analyse the response of the biosphere - the high CO_2 leads to a shift towards C_3 vegetation in the tropics, compared to more C_4 in the modern.