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Impact of Geo-Engineered Aerosols on Stratospheric Ozone Chemistry

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The deliberate injection of aerosol into the stratosphere has been suggested as a solar radiation management scheme, which would cool the Earth's surface reflecting solar radiation back to space. Such a scheme is believed to be both affordable and have a high effectiveness when compared to other geo-engineering schemes for mitigation of global warming (1). The lower stratosphere already contains a sulphate aerosol layer which is produced from both biogenic and volcanic sources. Recently, most research has focused on the deliberate injection of sulphate aerosol (or precursors) into the stratosphere. However, aerosols other than sulphate could be cheaper to produce and be more effective at scattering radiation by virtue of having a greater refractive index.

In addition to containing a sulphate aerosol layer, the lower stratosphere also contains the ozone layer which is crucial for protecting the Earth's biosphere from harmful UV radiation. The ozone layer also is a key component of the coupled atmospheric chemistry system, impacting temperatures and dynamics. International regulations are already in place to protect the ozone layer from depletion by man-made halocarbons. Therefore the deliberate injection of aerosols into the stratosphere must be assessed with respect to the possible interactions between the geo-engineered aerosol and the ozone layer.

We will present a review of the possible effects of aerosols upon stratospheric ozone. We consider both sulphate aerosol and other aerosols that offer different possibilities of cheap and effective solar radiation management. In particular, the direct destruction of ozone upon the aerosol surface and the activation of ozone destroying catalytic species will be considered (e.g. activation of ClONO2 to ClO, and HCl to Cl). The interaction of aerosols with stratospheric water vapour will be assessed. The possibility of using aerosol coatings to provide an inert aerosol surface to reduce the ozone depletion potential will also be presented. This review will provide a solid framework with which to assess the suitability of different aerosol candidates for use in geo-engineering.

(1) J. Shepherd, Geoengineering the climate; science governance and uncertainty, The Royal Society, 2009.