Geophysical Research Abstracts
Vol. 19, EGU2017-16006, 2017
EGU General Assembly 2017

Upper tropospheric ice sensitivity to sulfate geoengineering

Daniele Visioni (1,2), Giovanni Pitari (1), Eva Mancini (1,2)

(1) Department of Physical and Chemical Sciences, Universitá dell'Aquila, 67100 L'Aquila, Italy , (2) CETEMPS, Universitá dell'Aquila, 67100 L'Aquila, Italy

In light of the Paris Agreement which aims to keep global warming under 2 °C in the next century and considering the emission scenarios produced by the IPCC for the same time span, it is likely that to remain below that threshold some kind of geoengineering technique will have to be deployed. Amongst the different methods, the injection of sulfur into the stratosphere has received much attention considering its effectiveness and affordability. Aside from the rather well established surface cooling sulfate geoengineering (SG) would produce, the investigation on possible side-effects of this method is still ongoing. For instance, some recent studies have investigated the effect SG would have on upper tropospheric cirrus clouds, expecially on the homogenous freezing mechanisms that produces the ice particles (Kuebbeler et al., 2012).
The goal of the present study is to better understand the effect of thermal and dynamical anomalies caused by SG on the formation of ice crystals via homogeneous freezing by comparing a complete SG simulation with a RCP4.5 reference case and with a number of sensitivity studies where atmospheric temperature changes in the upper tropospheric region are specified in a schematic way as a function of the aerosol driven stratospheric warming and mid-lower tropospheric cooling.
These changes in the temperature profile tend to increase atmospheric stabilization, thus decreasing updraft and with it the amount of water vapor available for homogeneous freezing in the upper troposphere. However, what still needs to be assessed is the interaction between this dynamical effect and the thermal effects of tropospheric cooling (which would increase ice nucleation rates) and stratospheric warming (which would probably extend to the uppermost troposphere via SG aerosol gravitational settling, thus reducing ice nucleation rates), in order to understand how they combine together.
Changes in ice clouds coverage could be important for SG, because cirrus ice clouds scatter incoming shortwave and reflect outgoing infrared radiation, with the longwave absorption dominating. This means that a cirrus ice thinning would produce a negative radiative forcing, going in the same direction as the direct effect of incoming radiation scattering by the sulfate aerosol, thus influencing the amount of sulfur needed to counteract the positive RF due to the future increase in greenhouse gases.

References:
Kuebbeler, M., Lohmann, U., and Feichter, J.: Effects of stratospheric sulfate aerosol geo-engineering on cirrus clouds, Geophysical Research Letters, 39, doi:10.1029/2012GL053797, l23803, 2012.