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Impact of geoengineering on cirrus clouds

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Inspite of the framework convention agreement, climate warming is still an actual and very important issue society has to deal with. This has motivated some scientist to start thinking about implementation of artificial methods that could change the climate and weather patterns in order to stop or reverse the global warming effects. Nowadays, there is a consortium of politicians, scientists and engineers interested in evaluating different geoengineering schemes as a way to mitigate global warming, discount rates, and risk aversion (Polborn S. and Tintelnot F., 2009).

The geoengineering proposal attracting the most attention and having considerably lower expected deployment costs than conventional emissions abatement approaches (Nordhaus, 2007) is stratospheric aerosol injection. This method, proposed by Budyko (1977) and Crutzen (2006), relies on the fact that large amounts of sulphur aerosols injected into the lower stratosphere enhance the Earth's albedo and lead to cooling of the globe. This proposal is currently discussed in the climate community and possible side effects are investigated. However, the investigations concentrate almost exclusively on the impact on chemistry and stratospheric circulation, whereas the impact on cirrus clouds in the underlying tropopause and upper troposphere region was not taken into account up to now.

In this contribution we investigated the impact of artificially produced sulphate aerosol concentrations, modeled with the AER 2D aerosol model (Weisenstein et al., 2007), on the formation and evolution of cirrus clouds in the mid-latitudes. For large injections of SO_2 some sulphate aerosol particles grow to large sizes that they can sediment to lower altitudes and eventually reach the troposphere, where they can influence ice crystal formation. Investigations are carried out using a bulk microphysical box model (Spichtinger and Gierens, 2009, Spichtinger and Cziczo, 2009), concentrating on moderate constant updrafts with different background aerosol mass and number concentrations in response to geoengineering measures. In order to obtain qualitative and quantitative estimations of troposphere-stratosphere air mixing (intrusions, tropopause folds etc.) trajectory studies are done using ECMWF data.

The results of this conceptual study suggest that an enhancement of sulphuric acid in the tropopause and upper troposphere region may impact the ice crystal number concentrations in cirrus clouds formed via homogeneous nucleation. The global impact can not be estimated, but on the local level, this could lead to change of cloud lifetime and thickness. It would further influence the albedo and radiative properties of cirrus clouds, i.e. modifying the net warming impact of cirrus clouds.

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