Atmospheric Chemistry
Observations & Modeling

ACOM Seminar

Risks and benefits of climate intervention via stratospheric aerosol injection of solid particles

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ABSTRACT

Recent studies have suggested that injection of solid particles such as alumina and calcite instead of SO2 for climate intervention via stratospheric aerosol injection (SAI) could reduce some of the adverse side effects of SAI such as ozone depletion and stratospheric heating. However, the expected improvements are subject to large uncertainties. We constrain some of these uncertainties by experimental work on calcite particles using elastic recoil detection analysis and in-situ X-ray photoelectron spectroscopy. Subsequently, we use a global aerosol-chemistry-climate model that, for the first time, interactively couples microphysical and chemical processes of solid particles as well as sulfuric acid aerosols with model radiation and transport. Notably, SAI by solid particles only leads to more effective radiative forcing per aerosol burden compared to sulfur-based SAI, not per injected mass. However, reduced stratospheric warming remains a major advantage of solid particles. Furthermore, different assumptions on the heterogeneous chemistry of solid particles, based on the available experimental data, result in drastically different impacts on stratospheric ozone layer. For alumina particles, which are thought to not undergo chemical aging in the stratosphere we present a sensitivity analysis of the ozone response to quantify uncertainty. For the alkaline calcite particles, which are thought to undergo chemical aging in the stratosphere via reaction with acids we find even larger uncertainties due to unknown reaction pathways and highly uncertain rates under stratospheric conditions. Uncertainty in predicted stratospheric ozone changes can only be reduced via additional laboratory experiments under stratospheric conditions.

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