Observational Needs for Climate Intervention via Stratospheric Aerosol Injection

David Verbart, Corey Pedersen, Yaowei Li, John Dykema, ***Frank Keutsch*** and David Keith
(Harvard University, Cambridge, MA, USA)
Sandro Vattioni, Rahel Weber, Gabriel Chiodo, and Thomas Peter
(ETH Zurich, Zurich, Switzerland)

Background/Objectives. Model studies of the impacts of climate intervention via stratospheric aerosol injection (SAI) benefit greatly from comparison with observations from different types of perturbations. Specifically, observations that span the length scale from potential point source injection via aircraft to the size of a grid box of climate models are useful to evaluate how realistic the representation of the aerosol size distribution in the models is. Models can be compared with measurements of solid rocket motor plumes, wake sampling of high-altitude aircraft, convective overshooting events, and volcanic eruptions to provide valuable information on the evolution of an injected plume over a large part of the relevant length scales. Although these observational analogs are valuable, they are inadequate for some critical aspects because they exclude relevant (small) scales of atmospheric transport and particle microphysics as well as the study of alternate SAI materials that may reduce risk compared to sulfuric acid, the material usually considered for SAI.

Approach/Activities. The existing data sets will be reviewed within the context of their utility for comparing with models of SAI. A proposed small-scale stratospheric experiment involving intentional formation of a particle plume to compare the near-field evolution with fluid dynamics and large eddy simulations will be discussed as well as experimental approaches to evaluate the short and long-term ageing of alternate aerosol materials such as calcium carbonate, alumina and diamond. These proposed experiments will help improve confidence in how aerosol size distributions from SAI are represented in models and whether predictions of the ageing of chemical and optical properties of alternate SAI materials based on laboratory studies are reliable.

Results/Lessons Learned. Results of laboratory studies of the physical (optical) and chemical properties of alternate SAI materials will be presented. The results are integrated into a model to evaluate how materials properties affects risk such as ozone loss, dynamical response to stratospheric heating and the changes in surface diffuse versus direct solar radiation. In addition, uncertainties will be discussed which are significantly larger for chemical impacts than those depending on optical properties, which can be explained by the fact that the latter depend on a bulk property while the chemical impacts primarily result from surface processes.