Costs and benefits of geo-engineering in the Stratosphere

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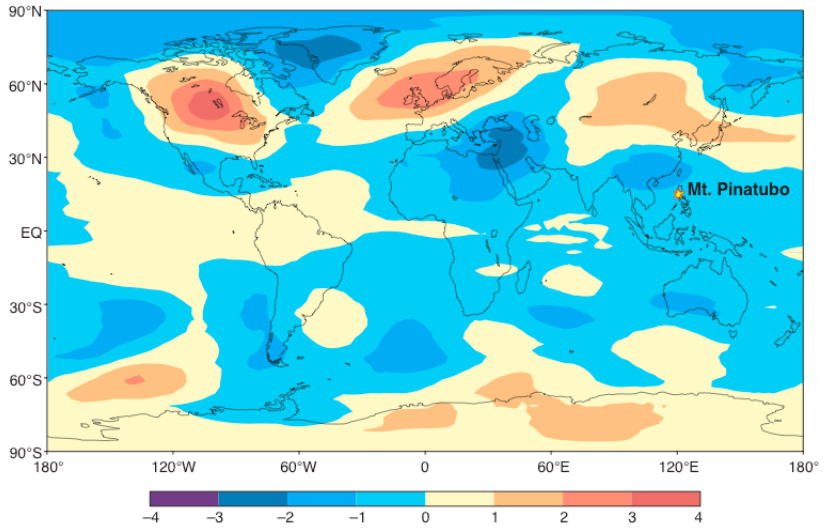
Anthropogenic climate change is widely regarded as one of the most important global health and security issues of this century. Many ways to mitigate or solve the problem have been proposed, mostly involving large reductions in the production of greenhouse gases by industrial societies. Since progress in curbing greenhouse gas emissions has been slow, there have been calls for artificial modification, or geo-engineering, of the climate system to counteract greenhouse gas increases.



Lower tropospheric temperature anomalies during winter 1991/2 following Mt Pinatubo erruption during summer 1991. Taken from Robock, Science (2002).

In this project we will investigate geo-engineering of the incoming solar radiation by adding sulphate aerosol to the stratosphere. This idea has its roots in our understanding of the global climate effects of large tropical volcanic erruptions. Following the last such erruption of Mount Pinatubo in the Phillipines in 1992, global climate was observed to cool during the following 1-2 years (see figure). Large volcanic eruptions of this kind deposit sulphur dioxide into the stratosphere, which ultimately becomes sulphate aerosol. The global cooling is the result of reflection and absorption of incoming solar radiation by the additional aerosol layer.

There is a small and growing literature on the study of stratospheric geo-engineering. However, a major unexplored part of the problem is the impact that the introduction of a dense, permanent layer of sulphate aerosols would have on the stratospheric climate and variability. This is an important missing piece in the discussion of the costs and benefits of geo-engineering because changes to the stratospheric circulation can have large impacts on both stratospheric ozone concentrations and on tropospheric dynamics through induced tropospheric circulation changes.

In this project, we will assess the impact of geo-engineering on stratospheric circulation and variability. The student will use a range of GCM tools to investigate the impact of geo-engineering on stratospheric variability. During the first year, the student will use simple models to investigate the impact of a permanent aerosol cloud in the stratosphere on the radiative and dynamical state. For the second and third years, the student will use a new complex chemistry-aerosol-climate model to quantify the impact of stratospheric geo-engineering in a more realistic context.

Student profile:
This project would be suitable for students with a degree in mathematics, physics or a closely related physical or environmental science. Someone with a broad knowledge and interest in the climate system and climate change topics would be particularly suitable.