



## Geo-engineering for Mitigation of Global Warming

**Shaw-Chen Liu**

Environment and Climate Institute, Jinan University

Research Center for Environmental Changes, Academia Sinica

---

Geo-engineering offers an important option for mitigation of global warming. Specific methods of geo-engineering generally rely on two principles: increasing sinks of carbon dioxide and reducing solar heating. Reforestation can increase the carbon dioxide sink. To make it work, substantial agricultural lands need to be returned to forests, particularly the large areas used for meat production. Unless global consumption of meat is reduced significantly, reforestation could not be effective in increasing the carbon dioxide sink. Ocean enrichment is another method for increasing the carbon sink. The method usually involves enriching the ocean by adding rate-limiting nutrients to enhance the fixation of carbon dioxide. However this method is expensive and has not been proven on a large scale. Furthermore ocean enrichment may inflict large adverse environmental impacts on the ocean ecosystem. Reflecting sunlight using reflectors on the ground or in the space obviously can reduce global warming. This method is also expensive and can cause significant perturbations in regional meteorology and circulation. Currently the most promising geo-engineering method is injection of aerosols into the stratosphere. Once entering the stratosphere, aerosols tend to stay for about two years (residence time of a trace species in the stratosphere against transport to the troposphere is about two years) and spread over the globe. Aerosols in the stratosphere can scatter sunlight back to the space, thus cool the Earth. This method has been proven effective and relatively safe by naturally occurring volcanic eruptions. For instance Pinatubo volcano erupted in 1991. Global temperature decreased by about 0.2 – 0.3°C in 1992 and 1993 following the eruption, and there was no report of any definitive adverse effect on the environment. Technically it is feasible and reasonably inexpensive to transport and release significant amount of sulfur containing compounds (precursors of aerosols) into the stratosphere. There have been some proposals to the United Nations in recent years to conduct a small scale experiment of injecting aerosols into the stratosphere. But environmental impact considerations have prevented the approval of such experiments.