

## **Volcanic eruptions as an analog for geoengineering**

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In response to the global warming problem, there has been a recent renewed interest in geoengineering "solutions" involving "solar radiation management" by injecting particles into the stratosphere, brightening clouds or the surface, or blocking sunlight with satellites between the Sun and Earth. This talk addresses stratospheric geoengineering, the topic that has produced the most discussion. While volcanic eruptions have been suggested as innocuous examples of stratospheric aerosols cooling the planet, the volcano analog also argues against geoengineering because of ozone depletion, regional hydrologic responses, and other negative consequences. I will show climate model calculations that evaluate stratospheric geoengineering, and then give volcanic examples that can inform us about their validity. Volcanic eruptions are an imperfect analog, since solar radiation management proposals involve the production of a permanent stratospheric aerosol layer, while volcanic layers are episodic. Nonetheless, we can learn much from the volcanic example about the microphysics of stratospheric sulfate aerosol particles; changes in atmospheric circulation, producing regional climate responses, such as changes to the summer monsoon; atmospheric chemistry; changes of the partitioning of direct and diffuse insolation; effects on satellite remote sensing and terrestrial-based astronomy; and impacts on the carbon cycle. By the way, I now have 26 reasons why geoengineering may be a bad idea, and nine reasons why it might be a good idea. Much more research is needed before we can quantify each of these, so that policymakers in the future can make informed decisions about whether to ever implement stratospheric geoengineering. This research needs to develop additional observational programs to take advantage of future volcanic eruptions to inform us about the potential impacts of geoengineering. Given what we know today, global efforts to reduce anthropogenic emissions and to adapt to climate change are a much better way to address anthropogenic global warming.