Volcanic and Solar Forcing of Climate Change in the Preindustrial era

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The Goddard Institute for Space Studies (GISS) climate-middle atmosphere model has been used to study the impacts of volcanic eruptions and solar variability, the primary natural climate forcings during the preindustrial era.

We examine both the radiative and dynamical impacts of these forcings in an ensemble of numerical experiments. In the case of volcanos, the radiative effect of stratospheric aerosols leads to global cooling, while their effect on dynamics results in wintertime continental warming. Decreased solar output leads to radiatively induced surface cooling as well, but in contrast to the volcanic case, favors dynamically induced wintertime continental cooling. Both dynamical responses occur mainly through biasing of the Arctic Oscillation-North Atlantic Oscillation pattern. The opposing behavior of the radiative and dynamical response of the climate system to these external perturbations leads to distinct differences in their overall impacts.

Volcanos seem to play a large role in short-term (1-3 year) dynamical forcing of regional change, and in longer-term global change. Solar variability contributes to long-term global change as well, but is most important in long term dynamically forced regional climate change, where volcanic eruptions exert less influence.