EGU23-1720, updated on 27 Apr 2024
https://doi.org/10.5194/egusphere-egu23-1720
EGU General Assembly 2023

A Simple Model of Volcanic Aerosol Forcing Against an Idealized Climatological Background in Support of the DOE CLDERA Project

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This presentation describes the design and implementation of stratospheric aerosol injection (SAI) events in an idealized configuration of the Department of Energy's (DOE) Energy Exascale Earth System Model (E3SMv2). These aerosols are implemented as "tracers" within the framework of the climate model, i.e. dimensionless mixing-ratio quantities which are advected with the winds by the model's transport scheme. The spatio-temporal description of the injected tracer species, as well as their chemical interaction and evolution, are encoded as sub-grid parameterizations via a set of simple ODEs. The form of the equations are designed to mimic materials characteristic of stratospheric volcanic eruptions, specifically those chemical species which are known to perturb the Earth system's energy balance, and thus climate (e.g. sulfate aerosols). Here we employ highly-simplified expressions of these processes by coupling the scalar tracer fields directly to the atmosphere's temperature-- an effect that is normally either mediated by complex chemistry, aerosol, and radiation packages, or prescribed without true tracer transport. We impose this forcing in an idealized atmosphere that lacks almost all other diabatic forcings normally present in a coupled-climate model. In this way, the effect of specific atmospheric dynamics on the temperature response to the aerosols can be isolated. Output products from this model will be used as validation datasets for the climate source-impact attribution tools currently being developed by the United States Department of Energy's (DOE) CLDERA project.