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Modelling the role of volcanoes in the stratospheric aerosol layer from Pinatubo to the early 21st century

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Volcanic activity is one of the major natural climate forcings and its influence on climate was recognized long ago, however the magnitude and evolution of this climate forcing is still full of uncertainties. The debate has continued surrounding the emission magnitude of the Mt. Pinatubo eruption in 1991, the largest directly observed volcanic eruption, because of instrumental problems and uncertainties. Although there are more reliable observations in the beginning of the 21st century, this time period did not include any very powerful eruptions with volcanic explosivity index of more than 4. This study aims to discuss the existing uncertainties in the modelling of recent observed aerosol changes and to clarify the contribution of volcanic activity.

We use the newly upgraded version of the aerosol-chemistry-climate model SOCOL-AER. The model includes comprehensive radiatively-coupled chemistry and sulfate aerosol microphysics with the particle size distribution represented by 40 size bins spanning dry sulfate radii from 0.39 nm to 3.2 μm. Interactive wet and dry deposition schemes were added to SOCOL-AER, provoking changes in the distribution of sulfate deposition and the tropospheric sulfur budget. In a series of sensitivity runs and emission scenarios we present the model's uncertainty related to the large Pinatubo eruption, the full atmospheric sulfur budget for volcanically quiescent conditions, as well as the contribution of different sulfur sources to the aerosol evolution during the early 21st century.

Key words: Stratosphere, Sulfate aerosols, Ozone, Climate modeling, Volcanic eruptions.