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Intercomparison of aerosol microphysics modules in the framework of the ECHAM5 climate model

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Aerosols in the atmosphere are an elementary constituent of the atmospheric composition and affect the global climate through a variety of physical and chemical interactions in the troposphere and stratosphere. Large volcanic eruptions alter the Earth's radiative balance and interfere with the catalytic cycles of ozone depletion mainly by the formation of micrometer size aerosol particles above the tropopause.

Recent experimental and numerical investigations of process oriented aerosol-climate interactions revealed that appropriate climate effects can only be modeled when informations about the aerosol size and number spectra are provided. Nevertheless in the majority of climate models volcanic perturbations of the stratosphere are either prescribed based on the aerosol parameters of interested (surface area, optical depth) or the aerosol microphysics is considered explicitly but with a heavily reduced number of degrees of freedom. This yields e.g. to underestimations of surface temperature effects in the fade of an eruption.

To overcome that weakness, we tested three aerosol modules currently available in the framework of the climate model ECHAM5 in environmental conditions assumed to be representative in the stratosphere after the injection of SO_2 from modest to large volcanic eruptions. The study focuses on the evolution of liquid H_2SO_4/H_2O aerosol.

The modal modal M7, currently the default aerosol scheme in ECHAM5, is compared with two sectional aerosol schemes: the moving centre sectional aerosol scheme SALSA, and the fixed sectional scheme SAM2. Since direct measurements of particle size informations during the initial stage of a volcanic injection in the stratosphere are not available, the detailed sectional aerosol model MAIA is used as a reference in this study.

It is shown that all modules are able to represent a "typical" stratospheric background aerosol distribution when the particles are formed via the oxidation pathway of SO_2. However, the modules differ strongly and their setup have to be changed to be applied in global model simulations capturing respective volcanic episodes.