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Simulation of particle aging during the Eyjafjallajökull and the Pinatubo eruption

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Aerosols of volcanic origin, such as ash and sulfate particles, can impose a severe hazard on aircrafts as well as they can influence weather and climate. Hence, having an exact representation of these particles in numerical weather and climate models is of great interest not only for weather forecasters and climate modelers, but also for air traffic safety. For this purpose, in addition to a transport scheme for the aerosol particles and reactive trace gases, the emission of volcanic ash and gases has to be parametrized correctly as well as aerosol dynamic processes have to be considered, such as the formation of secondary particles, particle-particle interaction, and removal processes. The global modeling system ICON-ART has been used before to simulate the distribution of volcanic ash and its radiative feedback after volcanic eruptions. In this connection, the emission of volcanic ash has been parametrized. However, during these studies the chemical properties of volcanic ash particles could not have been altered.

With the current work, the global modeling system ICON-ART is extended towards a comprehensive representation of aerosol dynamic processes, which allows the simulation of aging processes for volcanic ash aerosol. The improved aerosol module AERODYN (AEROsol DYNamic) includes a scheme for particle-particle interaction through coagulation and particle growth due to condensation of gaseous matter onto the particle. Furthermore, Weimer et al. (2017) implemented a simplified OH chemistry scheme into ICON-ART that enables the conversion of volcanic SO_2 into sulfuric acid, which, in a second step, can nucleate into sulfate particles or condensate onto already existing aerosol particles.

First studies with the improved aerosol module AERODYN in ICON-ART have been conducted for the Eyjafjallajökull eruption in May 2010 and the Pinatubo eruption of 1991. It is shown that the transformation of SO_2 into secondary volcanic aerosol (sulfate particles) as well as the aging of ash particles due to condensation of sulfate, nitrate, ammonium and water onto them alters the chemical composition of the ash plume, modifies the SO_2 budget, and changes the sedimentation velocity and, therefore, the removal of internally mixed aerosol particles.