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Simulating the attenuated backscatter of volcanic ash in ICON-ART modeling system

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Volcanic ash clouds pose significant threads to the aviation safety. Thus, there is a strong demand to locate these clouds in the atmosphere precisely. Attenuated backscatter obtained from Lidar and Ceiliometer instruments is one of the key parameters that is often used to determine the vertical distribution of the ash clouds in the atmosphere. Atmospheric models on the other hand do not predict the attenuated backscatter directly. This results in a gap between models and observation when it comes to comparisons and evaluations.

To fill this gap we develop a forward operator to predict the attenuated backscatter of volcanic ash within a multi-scale atmospheric modelling system ICON-ART (ICOsahedral Nonhydrostatic model with Aerosols and Reactive Trace gases). The operator is based on the backscatter coefficient of the ash particles, which is obtained from ash optical properties assuming non-spherical particles.

As a case study, we simulate the Eyjafjallajökull eruption in 2010 and investigate the effects of resolution (horizontal and vertical) as well as the particle shape on the simulated attenuated backscatter. The results show that the backscatter coefficient is reduced by factor of 2.3 by assuming spheroid particles with aspect ratio of 1.5. In this case, the simulated attenuated backscatter signal is in better agreement with the observations compared to that of the spherical particles. The particle concentrations are also satisfactorily simulated.