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Revealing the aerosol radiative impact of volcanic ash on synoptic time scales

Carolin Walter (1), Daniel Rieger (1), Philipp Gasch (1), Jochen Förstner (2), and Bernhard Vogel (1)

(1) Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany (carolin.walter@kit.edu), (2) Deutscher Wetterdienst, Offenbach, Germany

Including the interactions of aerosols with radiation in weather forecast models often leads to perturbations of the temperature field even at locations not directly influenced by the regarded aerosols. They arise out of signals propagating with the speed of sound leading to abrupt changes in cloud cover. The temperature perturbations due to these changes hamper the quantification of the aerosol radiative impact as they can appear in the same order of magnitude. In order to reveal the aerosol radiative impact on synoptic time scales we introduce a new method to separate the aerosol induced temperature effect from atmospheric perturbations.

We simulated the impact of volcanic ash aerosol on radiation with the new global to regional scale modelling system ICON-ART (ICOsahedral Nonhydrostatic – Aerosols and Reactive Trace gases; Rieger et al., 2015). Within ICON-ART the radiative fluxes and cooling rates are calculated with the RRTM (Rapid Radiative Transfer Model; Mlawer et al., 1997) for 30 longwave and shortwave bands. To determine the optical properties of the prognostic ash aerosol, Mie calculations were conducted for a compilation of ash refractive indices.

We obtain a significant change in 2 m temperature of up to several Kelvin for the Puyehue-Cordon Caulle eruption in 2011. In addition to the temperature effect the atmospheric stability is modified and as a consequence the ash concentrations. The temperature effect during the Eyjafjallajökull eruption in 2010 over Europe is much less pronounced. Nevertheless, we are able to show the impact of volcanic ash on the state of the atmosphere by this eruption.