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Modelling of an extreme dust event in the Eastern Mediterranean with ICON-ART – Impact on local circulation systems in the Dead-Sea region

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Mineral dust is influencing meteorology, air quality, energy production and transport. The modelling system ICON-ART (ICOsahedral Nonhydrostatic – Aerosols and Reactive Trace gases; Rieger et al., 2015) was extended by the treatment of mineral dust and its interaction with radiation, allowing for a seamless simulation of dust transport from the global to the local scale. As a part of this work a new parametrization was developed to account for the influence of mineral dust on radiation. This extension allows investigating the radiative effect of the local mineral dust concentration and its feedback on meteorology.

Mineral dust optical properties are calculated at each grid point based on detailed Mie-calculations giving extinction coefficients, single scattering albedo and asymmetry parameters. Feedback on meteorology is obtained by modifying radiative fluxes and cooling rates for 30 longwave and shortwave bands used by the RRTM (Rapid Radiative Transfer Model; Mlawer et al., 1997). For the first time varying median diameters during transport are taken into account, significantly influencing the radiation interaction of the coarse mode particles. Simulations show that a strong night-time warming due to mineral dust can only be seen in dust source regions. However, surface day-time cooling is prominent in all dust-affected regions becoming more pronounced with increasing dust-layer elevation.

Simulations of a severe dust event in the Eastern Mediterranean reveal the feedback processes of the mineral dust-radiation interaction with the state of the atmosphere. An extensive comparison of the simulation results with ground as well as satellite observations illustrates the modelling capabilities. It is shown that the reduction in diurnal surface temperature variation, due to reduced incoming solar radiation as well as outgoing net-longwave radiation, leads to increased atmospheric stability, which in turn leads to an effective weakening of local circulation patterns.