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Natural aerosols and atmospheric radiation: Impacts and consequent feedbacks on meteorology and photochemistry

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The aim of this work is to study the complex direct, semi-direct and indirect links and feedbacks between natural aerosols, radiation budget and the meteorological and chemical state of the atmosphere. This is realized with the implementation of an integrated modeling system (RAMS/ICLAMS) for a ten day test period that includes an intense dust event over the Eastern Mediterranean region. The capabilities of this modeling system include the online coupling between chemical and meteorological processes, as well as the explicit treatment of cloud condensation, giant and ice nuclei (CCN, GCCN, IN), and size and humidity dependent optical properties for aerosols. The results from this work show that the presence of mineral dust leads to a linear reduction in solar radiation and nonlinear increase in net downward longwave radiation that is larger during daytime than nighttime. The magnitude of change in the radiation budget is determined by the vertical structure of the dust cloud and mainly its height. The perturbations in the radiation budget affect the air temperature and moisture vertical profile, leading to a cloud base lifting and redistribution of condensates. The explicit activation of aerosols as CCN and IN causes changes in the spatiotemporal patterns of the precipitation field during and after the event. Those influences are caused more by the indirect rather than the direct and semi-direct effects. The changes in the diffuse and direct components of the radiation budget lead to a net negative effect on the photolysis rates that, in turn, alter the pollutants distribution. Ozone concentration, in particular, is affected by dust in a non-monotonous way determined by the availability of ozone precursors.