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Simulation of a dust episode over Eastern Mediterranean using a high-resolution atmospheric chemistry general circulation model

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An extended episode of low visibility took place over the Eastern Mediterranean in late September 2011, caused by a strong increase in dust concentrations, analyzed from observations of PM10 (Particulate Matter with $<10\mu$m in diameter). A high-resolution version of the atmospheric chemistry general circulation model EMAC (ECHAM5/Messy2.41 Atmospheric Chemistry) was used to simulate the emissions, transport and deposition of airborne desert dust. The model configuration involves the spectral resolution of T255 (0.5°, $\sim$50Km) and 31 vertical levels in the troposphere and lower stratosphere. The model was nudged towards ERA40 reanalysis data to represent the actual meteorological conditions. The dust emissions were calculated online at each model time step and the aerosol microphysics using the GMXe submodel (Global Modal-aerosol eXtension). The model includes a sulphur chemistry mechanism to simulate the transformation of the dust particles from the insoluble (at emission) to soluble modes, which promotes dust removal by precipitation. The model successfully reproduces the dust distribution according to observations by the MODIS satellite instruments and ground-based AERONET stations. The PM10 concentration is also compared with in-situ measurements over Cyprus, resulting in good agreement.

The model results show two subsequent dust events originating from the Negev and Sahara deserts. The first dust event resulted from the transport of dust from the Sahara on the 21st of September and lasted only briefly (hours) as the dust particles were efficiently removed by precipitation simulated by the model and observed by the TRMM (Tropical Rainfall Measuring Mission) satellites. The second event resulted from dust transport from the Negev desert to the Eastern Mediterranean during the period 26th - 30th September with a peak concentration at 2500m elevation. This event lasted for four days and diminished due to dry deposition. The observed reduced visibility over Cyprus resulted from the sedimentation of dust originating from the Negev, followed by dry deposition at the surface. The dust particles were both pristine and polluted (sulphate coated), and we evaluate the role of mixing in the duration and extent of the episodes.