Simulation of the Aerosol-Atmosphere Interaction in the Dead Sea Area with COSMO-ART

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The Dead Sea region and the ambient Eastern Mediterranean coastal zone provide a natural laboratory for studying atmospheric processes ranging from the smallest scale of cloud processes to regional weather and climate. The virtual institute DESERVE is designed as a cross-disciplinary and cooperative international project of the Helmholtz Centers KIT, GFZ, and UFZ with well-established partners in Israel, Jordan and Palestine. One main focus is the role of aerosols in modifying clouds and precipitation and in developing the Dead Sea haze layer as one of the most intriguing questions. The haze influences visibility, solar radiation, and evaporation and may even affect economy and health.

We carried out sensitivity runs for a three days period in May 2008 with 2.8 km horizontal resolution. Scenario A takes into account the complete feedback mechanisms between aerosols, clouds, and radiation. Scenario B gives the results for prescribed and constant background aerosol.

Direct emissions of soot and gaseous precursors of secondary aerosol particles in the Eastern Mediterranean are transported to the Dead Sea area by the westerly flow. Inside the Dead Sea Valley the westerly flow is superimposed by secondary flow systems as land sea breeze and upslope and down slope winds. The interaction of these flow systems finally leads to the formation of the two haze layers (white circles) similar to those measured by Levin et al. (2005).

During cloud free conditions especially mineral dust leads to an increase of the temperature close to the surface. During 18 May 2008 the fully interactive run simulates a temperature decrease of up to -2 K in the northern part of the model domain. This temperature decrease is caused by high ice clouds that are initiated by an elevated layer of mineral dust.

The model system COSMO-ART

In order to quantify the feedback processes between aerosols and the state of the atmosphere on the continental to regional scale the fully online integrated model system COSMO-ART with two-way interactions between different atmospheric processes was developed (Vogel et al., 2009; Knote et al., 2011; Bangert et al., 2012). The operational weather forecast model COSMO of the Deutscher Wetterdienst (Baldafu et al., 2011) was extended to treat secondary aerosols as well as directly emitted components like soot, mineral dust, sea salt and biological material and their feedback with radiation and clouds.

Gas phase chemistry

Treatment of aerosols

Treatment of clouds

Aerosol activation

Natural emissions

Anthropogenic emissions

Biogenic emissions

Biomass burning

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