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The Fully Online Integrated Model System COSMO-ART to Simulate Interactions of Aerosols, Clouds, and Radiation on the Regional to the Continental Scale

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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, Bangert et al., 2010). The operational weather forecast model of the Deutscher Wetterdienst was extended to treat secondary aerosols as well as directly emitted components like soot, mineral dust, sea salt and biological material. Secondary aerosol particles are formed from the gas phase. Therefore, a complete gas phase mechanism (RADMKA) is included in COSMO-ART. New methods to calculate efficiently the photolysis frequencies and the radiative fluxes based on the actual aerosol load were developed based on the GRAALS radiation scheme (Geleyn and Ritter, 1992). Modules for the emissions of biogenic precursors of aerosols, mineral dust, sea salt, biomass burning aerosol and pollen grains are included. Processes as coagulation, condensation (including the explicit treatment of the soot aging; Riemer et al., 2004), deposition, sedimentation, and washout are taken into account. To simulate the impact of aerosol particles on cloud formation and precipitation the two moment scheme of Seifert and Beheng (2001) is used. The activation of aerosol particles is based on Koehler theory using the parameterization of Abdul-Razzak and Ghan (2000). Recently, the treatment of the interaction of aerosol particles and cloud microphysics was extended (Bangert et al., 2010). The activation parameterization considers the CCN adsorption activation of dust particles (Kumar et al. 2009, Barahona et al. 2010) and the competition for water with the activation of soluble particles and in addition the ice nucleation parameterization of Barahona and Nenes 2009. The latter includes the competition effects of heterogeneous freezing involving dust and BC with homogenous freezing of aerosol.

In May 2008 a strong Saharan dust outbreak covered large areas over Europe. During this time period the operational weather forecast models over predicted the observed 2 m temperature. Applications of COSMO-ART demonstrate that the treatment of the two way interactions improves the weather forecast. Sensitivity runs will show the contribution of direct and indirect effects to these improvements.