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Introduction of the aerosol feedback process in the model BOLCHEM

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The effect of aerosols on the climate is still one of the least understood processes in the atmospheric science. The use of models to simulate the interaction between aerosols and climate can help understanding the physical processes that rule this interaction and hopefully predicting the future effects of anthropogenic aerosols on climate. In particular regional models can help study the effect of aerosols on the atmospheric dynamics on a local scale. In the work performed here we studied the feedback of aerosols in the radiative transfer calculation using the regional model BOLCHEM. The coupled meteorology-chemistry model BOLCHEM is based on the BOLAM meteorological model. The BOLAM dynamics is based on hydrostatic primitive equations, with wind components u and v, potential temperature θ, specific humidity q, surface pressure p_s, as dependent variables. The vertical coordinate σ is terrain-following with variables distributed on a non-uniformly spaced staggered Lorentz grid. In the standard configuration of the model a collection of climatological aerosol optical depth values for each aerosol species is used for the radiative transfer calculation. In the feedback exercise presented here the aerosol optical depth was calculated starting from the modeled aerosol concentrations using an approximate Mie formulation described by Evans and Fournier (Evans, B.T.N. and G.R. Fournier, Applied Optics, 29, 1990). The calculation was done separately for each species and aerosol size distribution. The refractive indexes for the different species were taken from P. Stier's work (P. Stier et al., Atmos. Chem. Phys., 5, 2005) and the aerosol extinction obtained by Mie calculation were compared with the results reported by OPAC (M. Hess et al., Bull. Am. Met. Soc., 79, 1998). Two model runs, with and without the aerosol feedback, were performed to study the effects of the feedback on meteorological parameters. As a first setup of the model runs we selected a domain over the Mediterranean sea including the Italian peninsula. The initial and lateral boundary conditions used were supplied by the European Centre for Medium-range Weather Forecasts (ECMWF) analysis available at $0.5^\circ \times 0.5^\circ$ resolution. The simulations were carried out for August 1st 2003, during one of the warmest summers ever recorded in Europe. The aerosol species that were considered for this feedback exercise were sulphates, primary organic compounds and black carbon. For the remaining aerosol species the climatological values were used. To study the effect of the aerosol feedback on the meteorology we studied the variation of both the radiative flux at the surface in the visible portion of the spectrum and the surface temperature. Preliminary results show that the largest differences corresponded to the land portion of the domain. In particular over the Po Valley region the application of the aerosol feedback corresponded to a maximum decrease in radiative flux of $40W/m^2$. This difference in radiative fluxes generated a maximum decrease in surface temperature of $0.4^\circ K$. These values were in general agreement with the values found by Vogel B. et al (Vogel B. et al, Atmos. Chem. Phys., 9, 2009) using the model system COSMO-ART.