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Studying the feedback processes 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. BOLCHEM (Mircea M. et al, 2008) is a regional coupled meteorology-chemistry model which uses the BOLAM meteorology. The meteorological model BOLAM is based on the hydrostatic primitive equations, with wind components u and v, potential temperature, specific humidity q, surface pressure ps, as dependent variables. The vertical coordinate is terrain-following with variables distributed on a non-uniformly spaced staggered Lorentz grid. As gas chemistry scheme BOLCHEM uses saprc90 (Carter W., 1990) and as aerosol model it implements the scheme AERO3 (Binkowski S. et al, 1995) which includes 3 different aerosol modes (Aitken, Accumulation and Coarse) with several chemical composition (sulfate, black carbon, organic, sea salt, etc.) BOLCHEM is currently involved in multi-year validation activities within the project CITYZEN.
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 order to study the feedback of the aerosols on the radiation, the aerosol optical depth needs to be calculated starting from the modeled aerosol concentrations. In a previous experiment conducted with BOLCHEM we used an approximate Mie formulation for the aerosol optical depth 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. 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. Recently the global version of BOLAM has been equipped with a new cloud microphysics model, and we plan on implement it in BOLCHEM so that the aerosol indirect effect on meteorology can be studied.