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Modeling cloud processes in a mixed-type aerosol environment

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The amounts, the distribution and the properties of airborne particles have significant implications on the microphysical cloud processes. Maritime clouds have significantly different properties than polluted ones and also the final amounts and types of precipitation are different. Mixed phase aerosols that contain soluble matter are efficient CCN and enhance the liquid condensates spectrum in warm and mixed phase clouds. Insoluble particles such as mineral dust and black carbon are also important because of their ability to act as efficient ice nuclei (IN) through heterogeneous ice nucleation mechanisms. Also, entrainment of particles at various cloud heights may either enhance cloud formation or invigorate cloud burn off due to radiation absorption. These types of processes are addressed within the framework of several integrated atmospheric and air pollution models. In this study the direct-coupled aerosol-cloud-radiation modeling system RAMS/ICLAMS has been used and various aerosol types are examined with regards to their effects on the microphysical and macrophysical cloud characteristics and on radiation. The concentration, chemical composition and the size distribution of the particles are explicitly treated in the model for the calculation of microphysics and radiative transfer. The two-way nesting capability of the system allows the simultaneous description of detailed in-cloud interactions - with the use of high resolution grid spacing - together with the feedbacks on the surrounding environment. Various model sensitivity tests have been performed to describe the physical processes at various stages of cloud development and also the description of the feedbacks on local and regional scale environment. Preliminary results suggest the efficiency of dust and black carbon in ice formation. The competition between homogeneous and heterogeneous ice formation mechanisms was also found to be significant for the development of the clouds and for the formation and types of precipitation. Also the optical properties of the particles are discussed for various atmospheric conditions. Hygroscopic growth of the particles and changes in their size distribution was found to be important for the estimation of visibility especially near coastal areas.