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A modelling study on the effects of air quality on cloud processes and precipitation

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Aerosol particles are well known climate and weather regulators since they alter the radiative properties of the atmosphere as well as the microphysical properties of clouds. In the Mediterranean area, desert dust, sea salt spray and particles of anthropogenic origin are the dominant components of the aerosol burden. The chemical composition of the aerosol particles is important for the nucleation of cloud droplets. This composition is determined from the corresponding mineralogy of their sources and their transportation pathways. Desert dust particles are usually slightly hygroscopic during the early steps after their mobilization. However, along their transportation paths, these particles may interact with other atmospheric components, thus producing sulfate or salt – coated dust particles which have been reported to be very effective cloud condensation nuclei (CCN). On the other hand, mineral dust particles are known to be effective ice nuclei (IN), thus contributing to the formation of high clouds.

The newly developed Integrated Community Limited Area Modeling system (ICLAMS) is used to investigate the possible links and feedbacks between aerosol concentration, chemical composition and rain formation processes. The new model is developed on the well established Regional Atmospheric Modeling System (RAMS) which has been used in the field of cloud research for several years. ICLAMS includes also soil dust, sea salt, gas, aqueous and aerosol phase chemistry, radiative transfer scheme with aerosols effects on longwave and shortwave bands, prognostic ozone radiation feedbacks and explicit cloud droplets nucleation scheme based on meteorology and aerosol properties.

Selected test cases are analyzed for the greater Mediterranean area and model results are compared to available observational data. Several scenarios for the type of aerosol are performed. The interaction between dust, sea salt and anthropogenic pollution may lead in the formation of mixed particles with unique characteristics. The amount, size distribution and chemical composition of airborne particles is important for the cloud droplets nucleation process. Proper handling of those quantities is expected to improve our understanding on cloud microphysical processes and on the links between air quality and precipitation. The sensitivity of cloud and rain fields on the aerosol properties is discussed in this presentation.