Physical and Chemical Properties of Aerosols in the Mediterranean: Patterns and Impacts

George Kallos, with contribution from

Platon Patlakas, Christos Spyrou, Marika Koukoula, Nikolaos Bartsotas

National & Kapodistrian University of Athens, Department of Physics, Atmospheric Modeling and Weather Forecasting Group, 15784, Athens, Greece

kallos@mg.uoa.gr, http://forecast.uoa.gr

The Mediterranean region and Middle East are well known places for high aerosol and ozone concentrations. There three categories of sources of aerosols: desert dust, sea salt and anthropogenic. The characteristic paths and scales of transport was the subject of several studies in the past. Changes in the physical and chemical properties of the aerosols occur along the followed paths. Aerosol levels have several impacts on other gaseous pollutants but the most important are associated with radiation, clouds and precipitation (Direct and indirect effects).

In this presentation we discuss the complex direct, semi-direct and indirect links and feedbacks between natural aerosols, radiation budget and the meteorological and chemical state of the atmosphere. The results of a fully coupled atmospheric modeling system (RAMS/ICLAMS) are discussed. The capabilities of this modeling system include the online coupling between chemical and meteorological processes, as well as the explicit treatment of cloud condensation, giant and ice nuclei (CCN, GCCN, IN), and size and humidity dependent optical properties for aerosols. The results from this work show that the presence of mineral dust leads to a linear reduction in solar radiation and nonlinear increase in net downward longwave radiation that is larger during daytime than nighttime. The magnitude of change in the radiation budget is determined by the vertical structure of the dust cloud and mainly its height. The perturbations in the radiation budget affect the air temperature and moisture vertical profile, leading to a cloud base lifting and redistribution of condensates.

Sea spraying is a procedure that creates considerable amount of sea salt that acts later as CCN and GCCN with the formation of characteristic cloud formations. The explicit activation of aerosols as CCN and IN causes changes in the spatiotemporal patterns of the precipitation field during and after the event. These influences are caused more by the indirect rather than the direct and semi-direct effects. The changes in the diffuse and direct components of the radiation budget lead to a net negative effect on the photolysis rates that, in turn, alter the pollutants distribution. Ozone concentration, in particular, is affected by dust in a non-monotonous way determined by the availability of ozone precursors.

Finally, the anthropogenic aerosols and sea salt are two key contributing factors for near-ground condensation and fog formation in coastal areas.