Red Sea Research Center Symposium

Session Topic: Modeling & Analyzing the Red Sea Physical & Biological Environments
Session Leaders: Prof. Georgiy Stenchikov and Prof. Ibrahim Hoteit

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Title: The Role of Natural and Anthropogenic Particles on Radiation-Cloud-Precipitation Cycle in Arid and semi-Arid Areas

Abstract: Airborne particles of anthropogenic and/or natural origin have certain direct and indirect effects in the atmosphere. Aerosols interact strongly with solar and terrestrial radiation in several ways. By absorbing and scattering the solar radiation aerosols reduce the amount of energy reaching the surface. Aerosols enhance the greenhouse effect by absorbing and emitting outgoing longwave radiation. However, forcing by dust and other natural aerosols exhibit large regional and temporal variations due to their short lifetime and diverse optical properties. Aerosols can serve as cloud condensation nuclei (CCN) and ice nuclei (IN). The amount of particles that will nucleate and form cloud droplets depends on number concentration, size distribution and chemical composition. Changes in the partitioning between hygroscopic and non-hygroscopic particles can affect the cloud cover, radiative properties and precipitation. Moreover, several other environmental parameters such as atmospheric conditions and surface properties play an important role on cloud processes. Modeling such processes and interactions require explicit resolving physical, chemical and dynamical processes at very high resolution. A new modeling tool with such properties has been developed at the University of Athens. This is the Integrated Community Limited Area Modeling System – ICLAMS - an extended version of the RAMS model. The model has been applied in the Mediterranean Region to study the impacts of aerosols on radiation transfer, cloud and precipitation. As it was found, increased concentrations of particles delayed the initiation of precipitation and limited the rainfall heights. The size distribution of the particles was also found to be important. Adding GCCN to polluted clouds promoted early-stage rain while adding GCCN to pristine clouds had no significant effect on precipitation. The role of dust and soot as IN and the competition between homogeneous and heterogeneous ice formation mechanisms has been also investigated for various types of clouds. Comparison of model results with surface observations of precipitation indicated a strong link between dust concentrations and rainfall amounts. Despite these advances in understanding these processes intense combined modeling and observational surveys are needed to reduce the uncertainty on these mechanisms and to improve our knowledge on atmospheric chemistry and meteorology interactions.