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Short and Long Wave Radiative Forcing from Desert Dust and Impacts on Weather and Climate

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The presence of desert dust in the atmosphere has considerable impacts on radiative transfer, clouds and precipitation. Desert dust is a considerable climate modifier. The impacts of desert dust to land and marine ecosystems are considerable as well in humans.

Modeling tools have been developed for studying the dust cycle in both global and regional scales. The uncertainties associated with the dust production, transport and deposition processes are still high for various reasons. Most of them are associated with the surface properties and dust production as well as with the radiative forcing parameterization. Modeling the impacts on radiation and cloud is a complicated task that is either oversimplified or absent in most of the dust models. Radiative transfer corrections due to the presence of dust particles for the incoming solar radiation can be applied (shading effects) by utilizing look up tables in the calculation of Aerosol Optical Depth (AOD). The impacts of dust on long wave radiation transfer are more complicated. A new version of the SKIRON/Dust modeling system incorporates the Rapid Radiative Transfer Model - RRTM for both short and long wave radiation. The new radiative transfer scheme has many properties that allow the partitioning of both short and long wave radiation according to the dust concentration and size distribution.

In this presentation we discuss the new model characteristics and especially the dust radiative properties as described by both: lookup tables and empirical formulation as well as the new approach by utilizing RRTM. Several cases with dust outbreaks in the Mediterranean and Europe have been analyzed. Heating rates of 2-10 degrees K/day (or even higher in cases of a strong episode) have been calulated within the dust layer. The model results are compared with soundings, lidar and AERONET observations. As it was found, the dust cloud has as a result the surface cooling of 50-80 Wm-2 in remote locations. Near the source areas is double or even triple to these amounts. The long wave radiation forcing below and above the dust cloud is considerable and results in mid and low tropospheric warming that has as impact the stabilization of the atmosphere and reduction of precipitation.