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Study of the radiative effects of desert dust on weather and climate

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Mineral dust produced from arid and semi-arid areas of the world is injected into the atmosphere under favorable meteorological conditions. Aerosols interact strongly with solar and terrestrial radiation in several ways (Haywood et al., 2003; Heinold et al., 2008; IPCC 2007; Kallos et al., 2009; Spyrou et al., 2010). By absorbing and scattering the solar radiation aerosols reduce the amount of energy reaching the surface (Kaufman et al., 2002; Tegen 2003; Kallos et al., 2009). Also aerosols enhance the greenhouse effect by absorbing and emitting outgoing longwave radiation (Dufrense 2001; Tegen 2003). However forcing by dust and other natural aerosols exhibit large regional and temporal variations due to their short lifetime (Tegen 2003; Miller 2004) and diverse optical properties (Tegen 2003; Kalashnikova et al., 2005; Kim and Ramanathan 2008) Modeling the impacts on radiation and cloud is a complicated task that is either oversimplified or absent in most of the dust models.
To this end the RRTM radiative module (Mlawer et al., 1997; Iacono et al., 2003; Iacono et al., 2008) has been incorporated into the framework of the SKIRON model (Mesinger 1984; Janjic 1994; Kallos et al., 1997; Kallos et al., 2006; Spyrou et al., 2010). This updated system was used to perform a 6 – year long simulation over the Mediterranean region in order to evaluate the magnitude of the Direct Radiative Effect of desert dust particles over a long period of time. The optical properties of dust particles were calculated using the OPAC (Optical Properties of Aerosols and Clouds; Hess et al., 1998) software package, along with the Wiscombe Mie algorithm (Wiscombe, 1980, Mishchenko et al., 2002).
As it was found, the most profound effect dust clouds have is the surface cooling through the “shading” effect. However the long wave radiation forcing below and above the dust cloud is considerable and results in mid and low tropospheric warming. We also examine how aerosols change atmospheric absorption and energy distribution and the effects on precipitation amounts. This has a profound application in big renewable energy projects planned in North Africa and Sahara.