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A climatology of desert dust aerosols over the Mediterranean basin based on contemporary satellite data

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Desert dust (DD) aerosols are broadly studied during the last three decades since they play a significant role on the Earth's energy and radiation budget, by interacting both with shortwave and longwave radiation and thus affecting climate. DD also has weather implications, namely by modifying cloud physic-chemical, optical and radiative properties such as cloud lifetime and precipitation ability. Furthermore, dust aerosols also serve as surfaces for gaseous or aqueous reactions in the atmosphere, while affecting global oceans and carbon cycle. Finally, under episodic high-concentration conditions, DD is harmful for human health and hamper socio-economic activities like surface, sea and air transports. Although, DD originates from desert land surfaces, it undergoes medium or large scale transport, even inter-continental, under favorable synoptic systems. Variability in dust emissions, transport and removal processes result in a strong spatial and temporal variability of DD, which deserves to be studied especially in context of the ongoing climate change and in special world areas of interest. The Mediterranean basin (MB) is such an ideal study region for DD due to its location near to the world greatest deserts of North Africa and Middle-East from which it undergoes significant dust transport. Being one of the hot-spot global climate change regions, and already exhibiting signals of changing climate patterns, the Mediterranean basin's DD regime is worth to study on a climatological basis. In the past, there have been a large number of studies dealing with DD, but all of them only partly cover the needs of such a climatological DD study over MB, being limited either in spatial and or temporal terms. The rapid advent of satellite remote sensing and improved retrieval algorithms of DD during the last decade enables a holistic approach of such a DD climatological study over the MB, which is attempted in this study. The obtained DD climatology is useful for better understanding the various effects of dust and for use in various applications including climate and weather models.

The identification of DD over the broader MD is performed with an algorithm solely based on contemporary input satellite data enabling a complete spatial and an extended temporal coverage. The algorithm's input data are spectral Aerosol Optical Depth (AOD) and the Aerosol Index (AI). Using the spectral AOD information, the algorithm computes in a first step the aerosol Angstrom Exponent (AE), and in a second step it determines the presence of DD by setting threshold values (criteria) for AE and AI. The applied criteria ensure the presence of coarse mode and absorbing aerosols, which are characteristic features of DD. The spectral values of AOD and AI are taken from the MODIS-Aqua Collection-6.1 and OMI-Aura (Ozone Monitoring Instrument) datasets, respectively. The algorithm input data are daily at 1°x1° latitude-longitude resolution and cover the 14-year period 2005-2018. The algorithm output quantifies the frequency of occurrence and the loading of DD, namely its optical depth. Emphasis is given to the study of the seasonal and inter-annual variability and changes of the Mediterranean DD.