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Record dust outbreaks towards Eastern Mediterranean: Space-borne and ground-based remote sensing observations

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MODIS products are used to describe the dust load in the Eastern Mediterranean and Cyprus region. We calculated the mean AOT at 550 nm wavelength and the mean Ångström exponent (for the 510–670 nm spectral range) from the available set of AOT data in areas within a 50 km radius around selected cities. Twelve extreme dust outbreaks reached Limassol in southern Cyprus within the 2001–2015 period. The strongest dust outbreaks were observed on 1 April 2013 (AOT > 4.0, Saharan dust storm) and 8 September 2015 (AOT > 5.0, Middle East desert dust storm). Extreme dust events, characterized by an AOT exceeding the climatological mean AOT by four standard deviations, occur, on average, 1–2 times per year for the given site in the Mediterranean. The AOT is most frequently lower than 1.5 during these events. Surprisingly, dust transport models widely failed to predict the record-breaking dust storm in September 2015, which advected huge amounts of dust from the Middle East desert region towards Cyprus. This fact motivated us to investigate the underlying weather conditions that caused this huge dust outbreak. Extreme dust events provide a unique opportunity to learn more about known and established dust mobilizing mechanisms and to identify and explore new or not-well-parameterized dust emission processes.
In this study, we present final results based on space-borne and ground-based remote sensing, taken from 7-11 September 2015 We discuss the major outbreak in terms of particle extinction profiles (measured with lidar from space, CALIPSO, and from ground, with EARLINET lidar), dust particle optical depth, profiles of the extinction-to-backscatter ratio and dust-to-total-aerosol mass fractions. Complementary, we used satellite imaginary in our data analysis and photos taken from a high building over Limassol to accurately derive the actual visibility during the peak dust event and to estimate the true dust mass load. The dust plume was confined to the lowermost 3 km of the troposphere and occurred in two layers below and above 1500 m height. Extinction coefficients of the order of 5000-8000 Mm-1 close to the ground were estimated. Lidar ratio of 40sr clearly indicated the presence of dust particles originating from Middle East deserts, and the maximum depolarization ratios close to 30% indicate the dominance of dust over several days.

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