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Intense dust episodes in the Mediterranean and possible effects on atmospheric lapse rates

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Dust aerosols are major contributor to the atmospheric particulate matter, having significant effects on climate and weather patterns as well as on human health, not to mention others like agriculture or ocean chlorophyll. Moreover, these effects are maximized under conditions of massive dust concentration in the atmosphere, namely dust episodes or events. Such events are caused by uplifting and transport of dust from arid and semi-arid areas under favorable synoptic conditions. The Mediterranean basin, nearby to the greatest world deserts of North Africa and Middle East, frequently undergoes dust episodes. During such Mediterranean episodes, the number and mass concentration of dust is high, due to the proximity of its source areas. The dust episodes, through the direct interaction of dust primarily withthe shortwave but also with longwave radiation can lead to strong local warming in the atmosphere, possibly causing temperature inversion during daytime. The existence of such temperature inversions, associated with intense dust episodes in the Mediterranean, is the focus in this study.

The methodology followed to achieve the scientific goal of the study consists in the use of a synergy of different data. This synergy enables: (i) the determination of intense dust episodes over the Mediterranean, (ii) the investigation and specification of temperature lapse rates and inversions during the days of dust episodes and (iii) the identification of vertical distribution of aerosols in the atmosphere over specific locations during the days of the episodes. These objectives are achieved through the use of data from: (i) the AERosol Robotic NETwork (AERONET) network, (ii) the Upper Air Observations (radiosondes) database of the University of Wyoming (UoW) and (iii) the European Aerosol Research Lidar Network (EARLINET) database. The study period spans the years from 2000 to 2013, constrained by the data availability of the databases. A key element of the methodology is the simultaneous availability of data from all these three databases for a specific Mediterranean location and day. Here, results are presented for two stations, Lecce (Italy) and Thessaloniki (Greece).

For each station, using long-term AERONET daily aerosol retrievals, including optical depth (AOD), and applying a specific methodology aiming to find out days in which aerosol burden is unusually high, dust episodes are determined for specific days. Subsequently, for these days, a search is made for simultaneously available UoW radiosonde and EARLINET aerosol profiles (vertically distributed aerosol backscatter and extinction coefficients). This procedure led in a number of study case dust episodes, which were further confirmed by back-trajectories of air masses obtained with the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) Model. Our study reveals that during the investigated episodes, in the daytime, high dust atmospheric loadings induce temperature inversions in heights ranging from the surface to the top of boundary, but also through to the lower free tropospheric layer.