Dust observations at ERATOSTHENES Research Centre: Cyprus in the middle of African-Asian Dust belt

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The deserts in northern Africa and in the Middle East are major dust sources and have a strong impact on air quality and aerosol conditions in southern and eastern Europe. Emissions from arid (non-desert) and semi-arid regions and areas with strong agricultural activities also contribute to the dust load over Europe. For a proper consideration of mineral dust in climate modeling and air quality monitoring efforts, vertical profiling of dust with the potential to distinguish between fine-mode and coarse-mode dust is required. Fine and coarse dust particles influence the Earth's radiation budget, cloud processes, and environmental conditions in different ways. The optical properties and radiative impact are widely controlled by coarse-mode dust particles. However, 20–40% of the dust-related optical depth is caused by fine-mode dust according to Aerosol Robotic Network (AERONET) sun/sky photometer observations. Regarding the influence on cloud processes, coarse dust particles belong to the most favorable cloud condensation and ice nuclei. Fine-mode dust particles, on the other hand, can significantly impact air quality, defined in PM (particulate matter) aerosol levels, and may even sometimes dominate PM1.0 (particles with diameters less than 1.0 μm) observations at sites close to deserts, such as Cyprus.

Cyprus as an island in the Eastern Mediterranean and more specifically Limassol is an ideal natural laboratory for advanced and comprehensive field studies of dust properties and weather-precipitation-dryness complex, representative for typical Mediterranean and even Middle East meteorological conditions and for coastal areas in the EMME region.

Modern efforts of atmospheric research and environmental and weather prediction are based on sophisticated atmospheric modeling in close connection with state-of-the-art observations (for validation, for observational data assimilation into the model to improve prediction quailty) ([1], [2]).

Lidars are a key instrument for the characterization of aerosols as they are able to provide vertically resolved information of aerosols. Several new dust profiling methods built on existing AERONET and EARLINET (European Aerosol Research Lidar Network) measurements in Europe. The development of a new method for the separation of the fine and coarse dust components [3], based on the well-established Polarization Lidar Photometer Networking (POLIPHON) approach [4] was motivated by observations of enhanced free tropospheric depolarization ratios of 10–20% with the EARLINET polarization lidar over Limassol, Cyprus - the values indicate the presence of dust- and at the same time, AERONET sun/sky photometer measurements indicated the absence of coarse-mode dust particles. These enhanced depolarization ratios were thus most likely exclusively caused by fine-mode dust particles.

From the eight years (2010-2018) dataset, aerosol optical properties during the dust intrusions were measured by a polarization lidar (CUT-EARLINET station) and a 8 channels sun-photometer (CUT-TEPAK AERONET station) both located in Limassol, Cyprus. Backward trajectories calculated by the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model at several altitudes, were used in order to identify the origin of the observed aerosol layers. The main objective of the current study is to present the dust vertical distribution in the Eastern Mediterranean basin from both deserts.

Furthermore to the EARLINET and AERONET eight years database of ERATOSTHENES Research Centre stations, the dataset of the Cy-CARE (Cyprus – Clouds Aerosol and Rain Experiment) -18 months continuous observations with LACROS -state-of-the-art mobile active remote sensing facility of TROPOS in Limassol, Cyprus nicely demonstrate the importance of a permanent super site in the EMME (Esastern Medditerranean Middle East) region. For selected cases, from the long-term observations of dust over Limassol, dust optical properties as well as dust relevant parameters will be presented to highlight the intensity of the dust intrusions in the area and the importance of the synergistic use of passive and active remote sensing techniques.

The ERATOSTHENES Research Centre (ERC) with the vision to become a Centre of Excellence for Earth Surveillance and Space-Based Monitoring of the Environment (EXCELSIOR H2020: Teaming project) in close collaboration with the German Leibniz Institute for Tropospheric Research (TROPOS), will design and implement a Remote Sensing supersite in Cyprus that focuses on producing high-quality

observations and to be included to the map of ESFRI (European Strategy Forum on Research Infrastructures) as a lighthouse of atmospheric research in the EMME.

The EXCELSIOR is a team effort between CUT (acting as the coordinator), the German Aerospace Centre (DLR), the Institute for Astronomy and Astrophysics Space Applications and Remote Sensing of the National Observatory of Athens (NOA), the TROPOS and the Cyprus' Department of Electronic Communications of the Ministry of Transport, Communications and Works (DEC-MTCW) who will work together to improve the network structures significantly, resulting in Cyprus being regarded as a cornerstone of a European Network of active remote sensing of the atmosphere. A modern observational super site at Cyprus is of fundamental importance to understand the atmospheric system in the fast growing and developing EMME region.

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