Strategic positioning of the 'ERATOSTHENES Research Centre' for atmospheric remote sensing research in the Eastern Mediterranean and Middle East region

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ABSTRACT

The aim of this article is to present the importance of a permanent state-of-the-art atmospheric remote sensing ground based station in the region of the Eastern Mediterranean and Middle East (EMME). 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) already operates (within Phase 1) a fully established EARLINETt-Cloudnet supersite at Limassol, Cyprus, for a period of 2 years, in close collaboration with the German Leibniz Institute for Tropospheric Research (TROPOS), The scientific aspects of this prototype-like field campaign Cy-CARE (Cyprus Cloud Aerosol and Rain Experiment) - a common initiative between the Cyprus University of Technology (CUT), Limassol and TROPOS- are presented in this paper. Cy-CARE has been designed by TROPOS and CUT to fill a gap in the understanding of aerosol-cloud interaction in one of the key regions of climate change and how precipitation formation is influenced by varying aerosol/pollution and meteorological conditions The guiding questions are: How may rain patterns change in future and what may be the consequences of climate change in arid regions such as EMME. 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), 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.

Keywords: Lidar, Aerosol, clouds, Remote sensing, Climate change

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1. INTRODUCTION

1.1 Region of Interest

The Mediterranean Basin is well recognized by the Intergovernmental Panel on Climate Change (IPCC) as a hot spot for climate change, the impacts of which are expected to amplify further in the years to come, adding one more uncertainty factor. There are very few locations on Earth which experience such high levels of anthropogenic pollution mixed with desert dust from the Middle East and the Sahara as well as complex meteorological patterns (as in the case of coastal areas in the Eastern Mediterranean).

The island of Cyprus, located in the Eastern Mediterranean, exhibits Middle East atmospheric and climate conditions, where dry and hot weather prevails. The climate conditions and air quality are strongly affected by a mixture of aerosols like urban haze, originating mainly from urban and industrial conglomerations in southeastern Europeas well as from the Middle East and North Africa, by biomass-burning smoke from the North (e.g. Black Sea countries), by mineral dust originating from arid regions in Turkey and Middle East deserts (often mixed with anthropogenic pollution), and by Saharan dust from North Africa [1-2]. Marine aerosols play an important role, too.

There are only few locations on Earth which experience such complex aerosol structures and vertical layering which may have a strong impact on cloud evolution, cloud lifetime, and precipitation processes. Additionally, Cyprus, as an EU member state, has difficulty complying with EU Air Quality regulation standards since the atmospheric environment in Cyprus is laden with particles originated by local atmospheric emissions as well as advected from natural (deserts) and unregulated pollution sources mainly from Turkey and the Middle East. These conditions make Cyprus an ideal natural laboratory for studies of atmospheric composition and air quality, climate change, aerosol-cloud interaction, and the weather-precipitation-dryness complex.

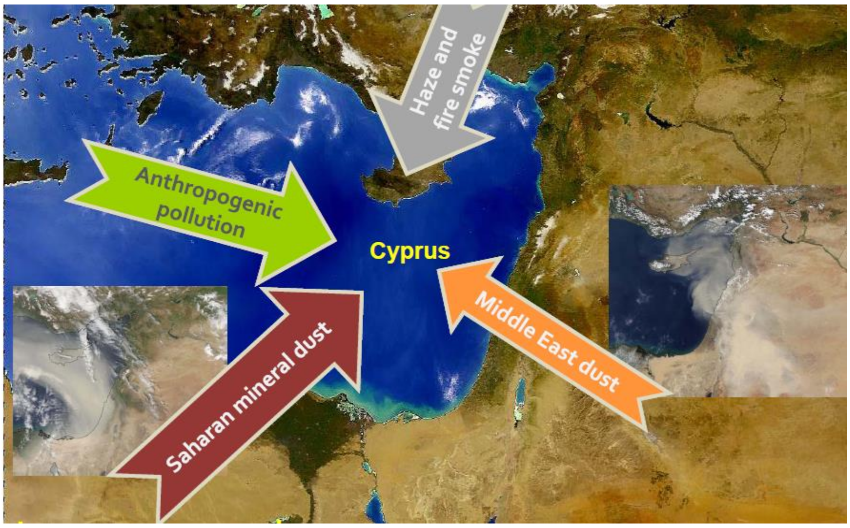

Figure 1: The strategic position of Cyprus for atmospheric research. A natural laboratory for the study of the impact of complex aerosol mixtures and layering on air quality, cloud and precipitation formation, and aerosol-related climate change aspects..

2. INFRASTRUCTURE

In contrast to the exciting atmospheric research conditions of Cyprus, the infrastructure for studying the respective processes is restricted. During the last decades, it became evident that a detailed insight into the basic atmospheric processes, is only possible by means of continuous vertical profiling (long-term monitoring with high vertical and temporal resolution) of aerosol and cloud parameters as well as of meteorological parameters which are relevant for cloud evolution processes. The following sections present the Cypriot facilities used since 2010 for remote sensing based atmospheric studies in Cyprus, as well as the ongoing Teaming activities using state-of-the-art German infrastructure.

2.1 CUT facilities

The remote sensing station of the Cyprus University of Technology (CUT) at Limassol (34.7^{o}N, 33^{o}E, 50 m above sea level (a.s.l)) is equipped with an EARLINET lidar [3] and AERONET sun/sky photometer (CUT–TEPAK site, Limassol, Cyprus, http://aeronet.gsfc.nasa.gov) [4] and is located about 150 km south of Turkey and 250 km west of Syria.

The laser transmits linearly polarized laser pulses at 532 and 1064 nm, and detects the parallel and cross-polarized signal components at 532 nm. Calibration of the polarization channels is performed by rotating the box with the polarization sensitive channels following the methodology given in [5]. Further measurement channels collect lidar return signals at 607 nm (nitrogen Raman channel) and 1064 nm (elastic backscatter). The full overlap of the laser beam with the receiver field of view of the 20 cm Cassegrain telescope is obtained at heights around 300 m a..s.l: and therefore in most cases within the shallow planetary boundary layer (PBL) reaching up to 350–500m height. The basic temporal and spatial signal resolution, with which the raw signals are stored, is 50 s and 7.5 m, respectively.

The lidar system started performing systematic measurements in May 2010 as a 532-nm elastic-backscatter lidar. A hardware upgrade was realized in mid-2012 by integrating a 607 nm Raman channel. Raman-lidar retrievals are only available at nighttime, typically for the EARLINET measurement times (Monday and Thursday evenings). The Raman-lidar observation used to validate the lidar-ratio approach in the case of the analysis of daytime measurements.

Further information on the lidar, the methods applied to analyze the data, the products, and basic retrieval uncertainties can be found in [3, 6]. Details of the determination of the basic volume depolarization ratio profile are given in [1].

The lidar is collocated with a sun/sky photometer of the Aerosol Robotic Network (AERONET, CUT-TEPAK site, Limassol, Cyprus; http://aeronet.gsfc.nasa.gov) [4]. The CUT AERONET photometer measures the aerosol optical thickness (AOT) at eight wavelengths from 339 to 1638 nm. AOT errors are of the order of 0.01–0.02 in the absence of unfiltered cloud contamination [7]. It also provides retrievals of column-integrated particle size distributions, complex refractive index, and the percentage of spherical particles to the total number of particles [8]. This is sufficient information to compute the column lidar ratio SA [9]. From the particle size distribution, the fine-mode volume fraction FVF is obtained. We further use the Ångström exponent AE [10], determined from the spectral AOT distribution, and the fine mode fraction FMF (fraction of fine–mode AOT to total AOT) [11]. During the yearly CIMEL calibration period and/or in case of technical problems, we performed measurements with a MICROTOPS II sun photometer (Solar Light Company, USA) to obtain aerosol optical properties at 440, 500, 675, 870, and 936 nm. To assure high accuracy, the sun photometer was mounted on a tripod.

In a cooperation with the Leibniz Institute for Tropospheric Research (TROPOS) Leipzig, Germany, CUT developed a new lidar/photometer data analysis method (POLIPHON: Polarization Lidar Photmeter Networking, [6,12]) that allows us to separate fine dust (dust particles with diameter $<1\mu$m), coarse dust, and non-dust aerosol components and to estimate the particle extinction coefficient and mass concentration of the dust components (fine, coarse), of marine aerosols, and of the anthropogenic non-dust aerosol (fire smoke, urban haze contributions). This is an essential step forward in environmental monitoring to quantify the impact of natural aerosols on the fine-mode ($PM_{1.0}$) aerosol pollution state, and to check how much of the aerosol is of local origin and imported from the surrounding continents (Europe, Africa, Asia).

2.2 Cy-CARE campaign

Based on the scientific need for performing high-level atmospheric research in the Eastern Mediterranean, CUT and TROPOS perform the cooperative Cy-CARE (Cyprus Cloud Aerosols and pRecipitation Experiment) measurement campaign in Limassol (http://lacros.rsd.tropos.de/cloudnet/limassol_ql.php).

TROPOS has deployed its state-of-the-art mobile active remote sensing facility LACROS (Leipzig Aerosol Cloud Remote Observation System) at Limassol, Cyprus, and has started the observations of the atmospheric vertical structure for the study of aerosol-cloud-precipitation interactions in October 2016 (before the begin of the rain season in the Eastern Mediterranean). The facility will run until late spring/summer of 2018.

The LACROS facility combines an advanced multi-wavelength depolarization aerosol lidar (PollyXT), a ceilometer, a Doppler lidar, a cloud radar, a microwave radiometer, and a rain-quantifying disdrometer and is thus an advanced Cloudnet station [13] There are many other Cloudnet stations, but only few of them are equipped with a Raman lidar and, hence, combine detailed aerosol and cloud observations. This state-of-the art active remote sensing facility is operating for the first time in Cyprus providing a unique opportunity for a high level atmospheric research in the region of the highly polluted and dust-laden Eastern Mediterranean. This is a unique opportunity for CUT to have direct access to the measurements of LACROS. In this way, unprecedented scientific undertakings are possible, since a comparable measurement system (combination of sophisticated multiwavelength polarization/Raman lidar, wind Doppler lidar, 35 GHz cloud radar, and microwave radiometer) has never been deployed in the Eastern Mediterranean area.

The unique two-year dataset, together with the sun-photometer observations of CUT-TEPAK AERONET station at CUT, provides, for the first time, the possibility of an in-depth and integrated study of atmospheric composition and air pollution in Cyprus by means of advanced remote sensing. The novel combined approaches and methodologies will lead to new knowledge that could improve the quality of life and contribute to the social progress of Cyprus. Numerical weather prediction and dust forecasts may benefit of the online profiling of meteorological, aerosol, and cloud properties. All these activities will provide the necessary knowledge to the ERATOSTHENES team for the implementation and the operation of a permanent remote sensing atmospheric station in future with the goal to fill a significant gap regarding atmospheric monitoring capabilities, climate and environmental research, and high-level and modern education of students in the field of atmospheric research in the Eastern Mediterranean..

3. ATMOSPHERIC ACTIVITIES AT CUT

3.1 What aerosol types we observe in the Eastern Mediterranean region?

Aerosols influence the Earth’s radiation budget. Depending on the aerosol type, particles can absorb or scatter the incoming and outgoing radiation, and thus can lead to a warming or cooling of the atmosphere. Aerosol types are mainly defined by their sources and can be categorized roughly as mineral dust, sea salt, volcanic, carbonaceous, or sulfate aerosols originating from various natural and anthropogenic origins. In the Eastern Mediterranean, the coastal region of Limassol in Cyprus is in a key geographical position where aerosols from different sources converge. Specifically, maritime aerosols from sea spray, mineral dust from North Africa and Middle East, anthropogenic aerosols from the highly populated urban centers and industrial areas of Europe, as well as biomass burning aerosols and solid dust from Turkey coexist [1-2]. Lidar measurements with high vertical and temporal resolution provide detailed information on aerosol composition, mixing state and vertical layering. The particle extinction-to-backscatter ratio (also known as the lidar ratio) and the particle depolarization ratio, obtained from polarization/raman lidar observations, contain information on the aerosol type since they depend on the index of refraction, the size and shape of particles.

We used the five years of observations (2010–2014) with the EARLINET polarization lidar and AERONET sun/sky photometer at Limassol, Cyprus, to study lofted aerosol layers over Limassol, Cyprus in terms of their optical and microphysical parameters. , A number of synergistic measurements and model estimations were used to identify the source of aerosol particles. Firstly, four-day backward trajectories were calculated for Limassol using the Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) to gather information about the origin of the observed aerosols and the synoptic patterns corresponding to the measurements. Based on backward trajectory cluster analysis, air masses from the north, east, south and west are investigated in terms of 532 nm particle depolarization ratios. The cluster analysis presented was applied for the full period of five years at 09:00 UT (corresponding to the lidar measurements) and for arrival air mass heights at 2000km (mean height of the center of the lofted aerosol layers over Limassol).

In Figure 2, the most representative clusters for Limassol, which are also representative for Cyprus, are given. The first cluster corresponds to southwestern flows (red line), indicating aerosol advection from West and Central Saharan regions. The second cluster corresponds to eastern flows (orange line) indicating particles from Middle East (Syria, Jordan, Israel, Iraq, and the Arabian Peninsula). Clean marine and polluted marine particles are represented by the third cluster (light blue line). The fourth cluster, flow from northwestern directions, indicates aerosol advection from Central Europe (grey line). Finally, the last two clusters represent northern flows during the burning (red line) and non-burning (blue line) activity season, indicating smoke and soil dust advection from biomass burning regions in Turkey agricultural area and urban haze, respectively.

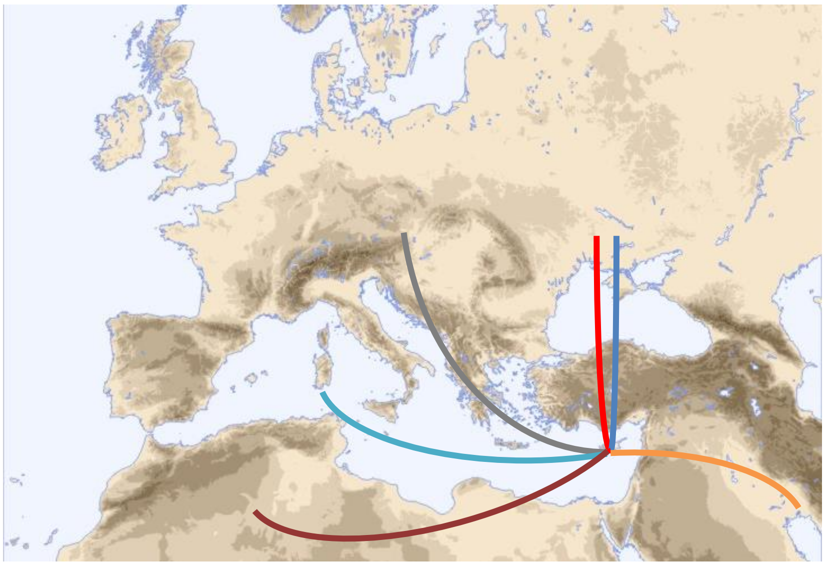

Figure 2: Main patterns of air mass flows for Cyprus. Eastern flows advect particles from the Middle East (orange), southwestern flows transport particles from the Saharan desert (wine red) to Cyprus, during western flows marine particles dominate (light blue). During northwestern and northern air mass transport, aged European haze (grey) and anthropogenic aerosol, fire smoke, and soil dust from Turkey (red, blue) reach Cyprus.

The total the available lidar and sunphotometer observations have been separating to the of six most representative clusters for Cyprus. In Figure 3, mean size distributions for the six different air mass clusters (and thus six different aerosol mixtures) for Limassol, Cyprus, as retrieved from the CUT-TEPAK AERONET observations are given. East (orange) and southwest (wine red) clusters, representing the Arabian Peninsula and Saharan origin desert particles, show mainly coarse-mode particles, according to the sun photometer observations. From the mean size distributions, one can conclude that the presence of fine mode particles is not negligible for each of the six aerosol mixtures showing an almost permanently occurring fine mode background in the region of Eastern Mediterranean.

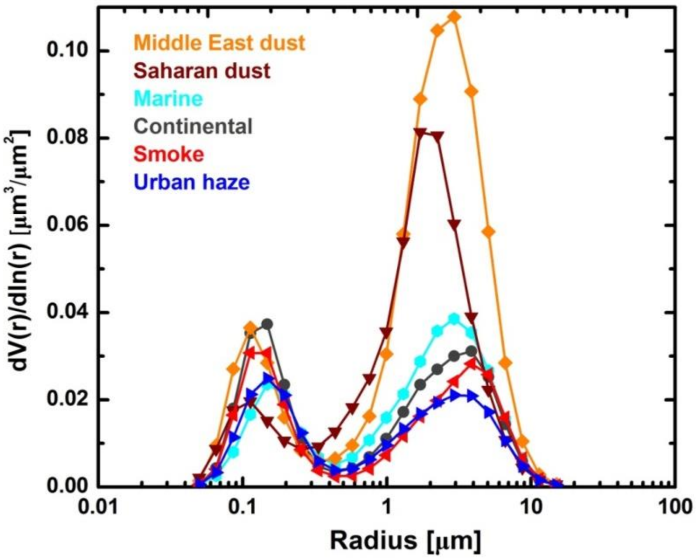

Figure 3: Mean size distribution for the six main aerosol mixtures (according to the six main air flow clusters) observed over Limassol, Cyprus as retrieved from the CUT-TEPAK AERONET observations.

Table 1 summarizes the mean values of the different aerosol mixture types optical properties as calculated from the five years of available lidar observations over Limassol. Most frequently, Saharan dust particles are observed over Limassol. In the case of dust and dust mixtures, depolarization values of 20-32% (disregarding the dust source, eastern and southwestern clusters, Arabian and Saharan deserts) are observed. In the case of northern air masses, a significantly lower depolarization ratio of 2-10% is observed during the low-fire activity periods. When high fire activity is noticed over Turkey (based on spaceborne observations of fires, [1]) heat-induced soil dust injection occurs and thus increased depolarization ratio values are observed. We assume that the mixture of Turkish fire smoke and soil dust mostly contains fineb mode smoke and dust. Fine-mode dust causes532 nm depolarization ratios of 15-20% [12].

Table 1: Optical properties of the six main aerosol mixtures (for the six air mass transport clusters). The mean values together with the standard deviation of aerosol optical thickness in the free troposphere (AOT-FT), lidar ratio (S) and particle depolarization ratio (δ) are given in the fourth, fifth and sixth columns, respectively. The third column gives the percentage of the occurrence of each aerosol mixture (cluster).

cluster	Aerosol type	Occurrence [%]	AOT-FT	S [sr]	δ [%]
North(fires)	Smoke+soil dust	20	0.12±0.04	41±10	12.1±2.1
North	Urban haze	19	0.17±0.12	34±10	6.7±3.2
North-west	Continental	10.5	0.14±0.05	40±13	8.3±2.1
West	Marine	15.5	0.14±0.07	26±9	3.2±1.1
South-west	Saharan dust	23	0.18±0.11	43±9	23.9±7.0
East	Middle East dust	12	0.32±0.19	41±4	23.7±4.9

The mean vertical profiles of the six clusters (and thus aerosol mixture types) of the backscatter coefficient and particle depolarization ratio are given in Figure 4. As can be seen, aerosol layers in the free troposphere (above 1 km height) frequently extent to 4-6 km height. Pure dust layer indicated by depolarization ratios around 30% and pure marine or pure urban haze aerosols with depolarization ratios clearly below 5% are not often observed. Most aerosol scenarios show mixtures of aerosols (marine aerosol with dust, urban haze with dust, fire smoke with soil dust, etc.).

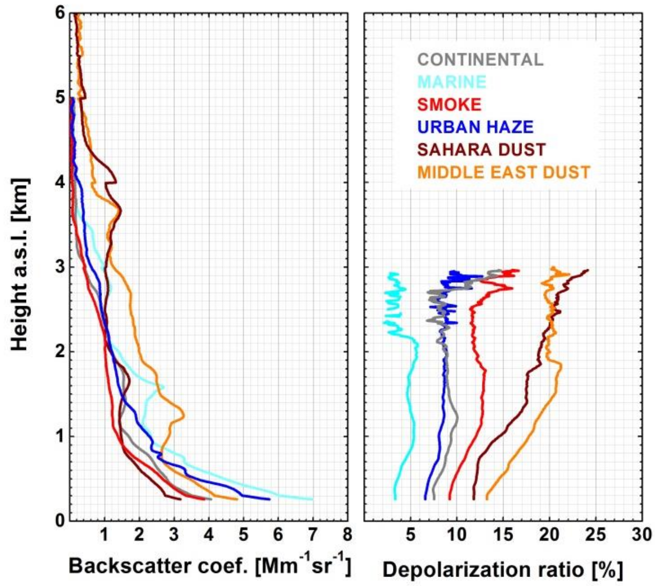

Figure 4: Mean backscatter coefficient and particle depolarization ratio vertical profiles for the six main aerosol types as observed by the CUT lidar over Limassol, Cyprus.

3.2 The importance of dust particles

As previously mentioned, two of the major dust sources (Africa and Middle East) are located near Cyprus and have a strong impact on air quality and aerosol conditions of the island.

A comprehensive overview of the aerosol conditions using satellite data for the definition of the typical strong and extremes aerosol loads over Cyprus have been presented in [14]. In that paper, Figure 1 (Figure 5 in the present paper) provides an overview of AOT observed with MODIS over Limassol, Cyprus, from 2001 to 2015. 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.

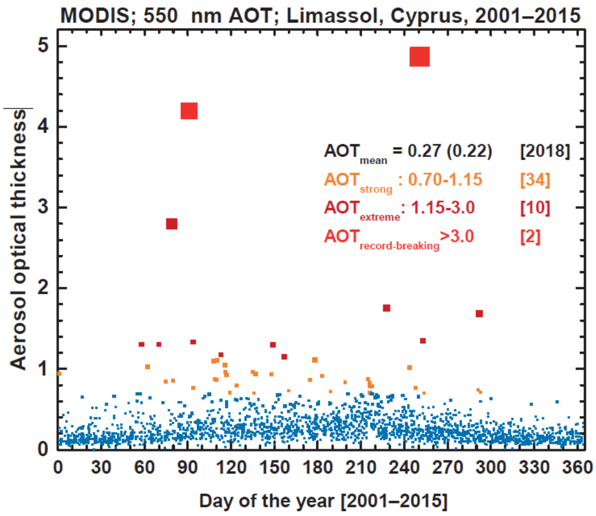

Figure 5: Seasonal distribution of 550 nm AOT at Limassol, based on 15 years of MODIS observations (http://lance-modis.eosdis. nasa.gov/, terra MODIS, 2001–2002, aqua MODIS, 2003–2015). Figure adapted from [14].

Such unique events where the AOT exceeds values of 3.0 may take place once in a decade or even less frequently and are thus obviously linked to unique meteorological conditions. The documentation of extremely rare dust storms with high vertical, horizontal, and temporal resolution in combination with advanced atmospheric modeling covering cloud evolution, development of thunderstorms, density currents, and associated strong dust mobilization can certainly lead to an improved understanding of the evolution of major dust storms under extreme meteorological conditions and to improved dust forecasts. A permanent and continuously running active remote sensing station in the Eastern Mediterranean (located at Cyprus) would be of great value to support dust transport modeling and dust forecasts. An important issue of the recently developed POLIPHON method is the potential to separate and estimate the fine dust and coarse dust contributions to the overall aerosol light extinction coefficient and particle mass concentration. Fine and coarse dust particles influence the Earth's radiation budget, cloud processes, and environmental conditions in different ways [15-16]. 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 AERONET sun/sky photometer observations. Regarding the influence on cloud processes, coarse dust particles belong to the most favorable cloud condensation and ice nuclei [17]. 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. Lidar plays an important role in dust monitoring efforts because it is the optimum aerosol profiling technique.

Figure 6 shows an example of the POLIPHON retrieval products. The basic separation of dust and non-dust (pollution in this example) is highlighted. Lidar observation of a strong dust outbreak from Middle East heat Cyprus on 7 September 2015 is presented. According to the air mass back trajectories, the air masses observed over Cyprus originated from Syria desert. As can be seen, the dust plumes contain (non-desert) aerosol in addition, probably originating from anthropogenic activities. The backscatter and extinction profiles and the lidar ratio information allow us to estimate the 532 nm AOT. We estimated the extinction values in the vertical range without extinction measurements (in the lowermost about 800 m) by multiplying the backscatter coefficients with a lidar ratio of 50 sr, which is higher than a pure-dust lidar ratio and takes the influence of anthropogenic pollution (lidar ratios of 60–80 sr) into account. On 7 September, the 532 nm AOT for the lower layer (0–1.7 km height) was 1.2 and 0.5 for the upper layer from 1.7 to 3.5 km, according to the evening lidar observations. In comparison with MODIS observations before and after noon is not possible on this day; however 0f the rapidly changing dust conditions, as seen in Figure 5, this can be characterized as a strong dust event,

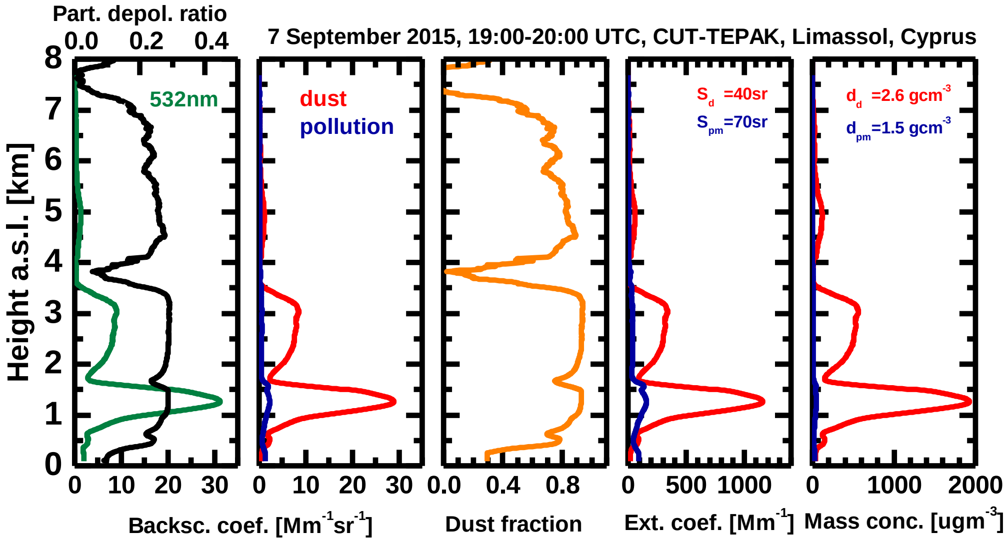

Figure 6: Example of the vertical profiles of aerosol parameters using the POLIPHON method.

3.3 Holistic approach of Aerosol-cloud-atmospheric dynamics studies

Field studies of aerosol–cloud-dynamics interaction are presently in the focus of atmospheric research. Large uncertainties in weather and future-climate predictions (IPCC, 2013) arise from gaps in our knowledge of the detailed impact of the aerosols on the evolution of liquid-water, mixed-phase and cirrus clouds. This unsatisfactory situation motivates the strong efforts presently undertaken to investigate formation and evolution of cloud layers and associated aerosol–cloud interactions. Aerosol particles influence cloud evolution, lifetime, and cloud microphysical properties in two ways. Aerosol particles can serve as cloud condensation nuclei (CCN) in liquid droplet nucleation processes and/or as ice-nucleating particles (INP) in ice nucleation processes, which include the conversion of liquid droplets into ice crystals (immersion freezing). Ground-based active remote sensing (lidar and radar observations) can be used to continuously monitor the evolution of clouds in their natural environment, at given meteorological conditions with high vertical and temporal resolution [13, 21-24]. Lidar is the most prominent tool for aerosol profiling in terms of particle optical properties. However, besides a detailed dust profiling, the POLIPHON method has the potential to estimated cloud-formation-relevant parameters such as cloud condensation nucleus (CCN) and ice-nucleating particle (INP) concentrations as well [18-19].

During the last decades, it became evident that a detailed insight into the basic processes of cloud formation and a full understanding of cloud evolution processes, is only possible by means of continuous vertical profiling (long-term monitoring with high vertical and temporal resolution) of aerosol layering and cloud parameters, characterizing the evolution of pure-liquid and mixed-phase clouds in the aerosol-laden environments. However, vertically resolved atmospheric observations, especially for simultaneous profiling of aerosol and cloud layers are rare especially in Cyprus. ERATOSTHENES Research Centre vision is to address and to fulfill this gap by providing valuable information and new knowledge on regional and international levels in the field of aerosol-cloud-precipitation through a permanent state-of-the-art remote sensing atmospheric ground based station in Cyprus.

This station, as a continuation of the CyCARE prototype activity, will provide for the first time continuously, synchronized and complementary datasets in such a complex environment, characterized by typical Mediterranean meteorological conditions. This state-of-the art constellation will provide a unique opportunity to perform sophisticated research on aerosols, clouds, precipitation, and atmospheric dynamics in Limassol, and will significantly contribute in this way to a very important field of atmospheric and climate science.

Figure7 shows an example of the combined observation with a polarization lidar for aerosol and cirrus profiling and a vertically pointing Doppler lidar providing information on vertical winds and terminal velocities of falling ice crystals. Fall speeds of ice crystals and backscatter strength (lidar) and reflectivity information (from cloud radar observations) permit the estimation of the ice crystal (IC) number concentration. The combination of cloud radar, Doppler lidar and polarization lidar of the LACROS station thus allows us to investigate the relationship of occurring INP concentration and their impact on the formation of ice clouds.

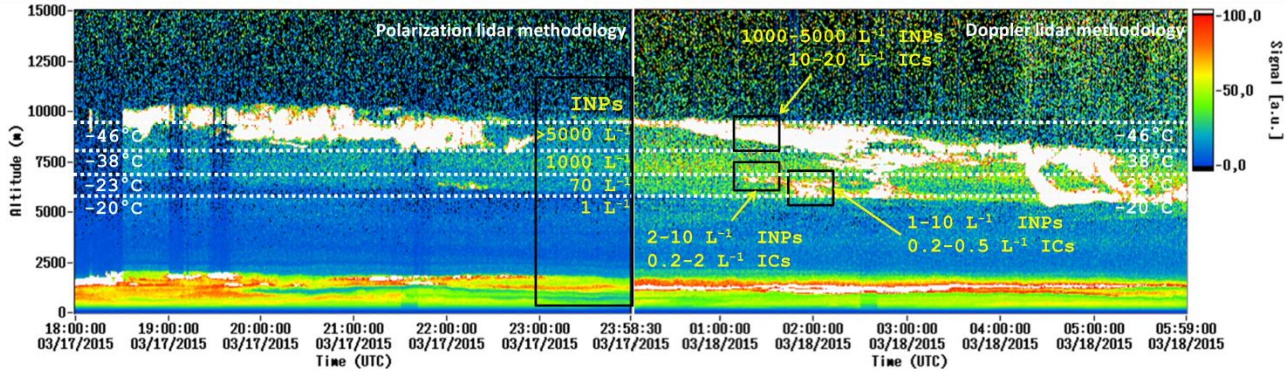

Figure 7: Typical example of clouds evolution within an aerosol layer in Cyprus. INP is referring to the ice nuclei particles as estimated by polarization-lidar observations and IC the number of Ice crystals as estimated by the Doppler lidar observations. The Limassol LACROS remote sensing facility samples such data sets since October 2016 and will continue the observations until spring/summer 2018.

4. CONCLUSIONS

It is evident that Cyprus and more specifically Limassol is an ideal natural laboratory for advanced and comprehensive studies of climate change, aerosol-cloud-dynamics-precipitation interaction, and the weather-precipitation-dryness complex, representative for typical Mediterranean meteorological conditions and coastal areas, in general.

Field studies of dust outbreaks (causing severe environmental problems) and aerosol–cloud-dynamics interaction are presently in the focus of atmospheric research. Large uncertainties in weather and future-climate predictions arise from gaps in our knowledge of the detailed impact of aerosols on the evolution of liquid-water, mixed phase and cirrus clouds. This unsatisfactory situation motivates the strong efforts presently undertaken to investigate formation and evolution of cloud layers and associated aerosol–cloud interactions.

Regarding the forecasts of severe dust storms, a dust lidar network with stations close to the main desert areas, e.g., in the Europe–Africa–Asia region around the Sahara, over the Middle East deserts to the desert regions in central, southern, and eastern Asia would be an ideal supplement to dust forecast model efforts, with the potential future goal to assimilate these lidar products into the forecast models. As demonstrated in this overview article, modern polarization lidars allow us to separate dust and non-dust optical properties and to quantify the dust-related particle extinction coefficient and mass concentration in the vertical profile, and even separate fine dust and coarse dust contributions to the observed aerosol profiles.

Furthermore, complementary to the ongoing NASA-CALIPSO mission, with a polarization lidar as one of the central instruments, the ADM (Atmospheric Dynamics mission; operating a wind Doppler lidar [25]) and EarthCARE (Earth Clouds and Aerosol and Radiation Explorer; operating a polarization lidar and a cloud radarl [13]) satellites are going to be launched by ESA (European Space Agency). In both ESA missions, lidars are involved with the potential to monitor aerosol and cloud parameters on a global scale. The POLIPHON method can be applied to the CALIPSO and EarthCARE lidar profiles. Ground truth activities are needed as a basic requirement to guarantee high quality in the space-borne observations of aerosols, clouds, and winds. A new state-of-the-art active remote sensing facility in the island of Cyprus can play an important role in these required ground truth activities and in the subsequent efforts to link ground-based remote sensing network (EARLINET, Cloudnet) and space-borne activities in one of the most polluted and, from the view point of climate change, most interesting region in the world.

Cyprus can be regarded as a cornerstone of a European Network of active remote sensing of the atmosphere especially now that the government announced as a priority the participation of Cyprus in the ACTRIS ESFRI project. EXCELSIOR project would directly improve the network structures in that field. A fully established supersite within ERATOSTHENES Research Centre (with continuous observational data flow into existing network data bases) is clearly an added value for the European community dealing with atmospheric and environmental research.

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