Strategic positioning of the 'ERATOSTHENES Research Centre' in the Eastern Mediterranean and Middle East region: ERATOSTHENES Remote Sensing Super Site

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1. Abstract

The vision of the ERATOSTHENES Research Centre (ERC) of the Cyprus University of Technology (CUT) is to become a Centre of Excellence for Earth Surveillance and Space-Based Monitoring of the Environment in the framework of the EU H2020 Teaming project EXCELSIOR. In this contribution we report on recent progress regarding the buildup of
a permanent, state-of-the-art atmospheric remote sensing station at Limassol, Cyprus, in the Eastern Mediterranean and Middle East (EMME) region. This effort is performed in close cooperation with the Leibniz Institute for Tropospheric Research (TROPOS), Leipzig Germany. We already operate the fully established PollyNet-CLOUDNET supersite LACROS in Cyprus for a period of 1 year as part of Phase 1 of the EXCELSIOR project. The Cy-CARE (Cyprus Cloud Aerosol and pRecipitation Experiment) has been designed by TROPOS and was implemented at CUT in October 2016 with main focus on the lidar/radar-based study of aerosol-cloud-precipitation processes in a region of high pollution, strong dust outbreaks, and expected strong changes in climate conditions during the next decades. The EXCELSIOR team consists of 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). This team will work together to significantly improve the research capabilities of CUT and the network infrastructure in Cyprus with respect to atmospheric, environmental and Earth science by means of active remote sensing from ground and passive remote sensing from space.

2. The region of interest

The Mediterranean Basin is well recognized by IPCC [1] as a hot spot for climate change. Severe consequences are expected for the future in EMME region. There are very few locations on Earth which experience such complex meteorological patterns and aerosol conditions (vertical profile structures, aerosol mixing) as given in the Eastern Mediterranean. Dust outbreaks and high pollution conditions occur frequently and presumably have a strong influence cloud formation and evolution, cloud lifetime, and precipitation processes. In Cyprus, ideal conditions for an in depth study of aerosol-cloud-dynamics-precipitation interaction by using ground-based active and passive remote sensing exist during the rain season (from November to March).

Climate conditions but also air quality are strongly affected by the complicated mixtures of urban haze, originating mainly from urban and industrial conglomerations in southeastern Europe, of biomass-burning smoke from the North (e.g. Black Sea countries), mineral dust originating from arid regions in Turkey and Middle East deserts (often mixed with anthropogenic pollution), Saharan dust from North Africa [2-3], and of marine aerosol components.

3. The super site

Guided by the scientific needs for high-level atmospheric profiling and research in the Eastern Mediterranean, CUT and TROPOS defined and realized the cooperative Cy-CARE measurement campaign in Limassol, Cyprus, from 21 October 2016 to 24 March 2018. The observations can be found at http://lacros.rsd.tropos.de/cloudnet/limassol_ql.php.

The Cy-CARE facility combines an advanced multiwavelength polarization/Raman lidar (PollyXT), a ceilometer, a wind Doppler lidar, a 35 GHz cloud radar, a microwave radiometer, and a rain-quantifying disdrometer and is thus an advanced CLOUDNET station [4]. These 17-month continuous field observations provide the unique opportunity for high-level atmospheric research on aerosols, clouds and aerosol-cloud interaction and also to highlight the unique location of Cyprus in this rather interesting region for climate-change-related research. The CUT/TROPOS initiative can be regarded as a pioneering step forward to establish modern atmospheric field research in the EMME region and to upgrade the position of Cyprus in the European atmospheric monitoring landscape and networking infrastructure. This initiative may trigger intensive cooperation with weather and environmental services and, the long term, may lead to the integration of the continuous observations into the forecasting system (weather prediction, pollution and dust forecasts, severe weather warning) and thus may lead to the improvement of the quality of life and to the social progress in Cyprus. All these research activities and field campaigns will transfer the knowledge to the ERATOSTHENES remote sensing team (in the framework of capacity building) to implement and operate a permanent atmospheric remote sensing station in the near future and to provide valuable observations and filling the gab of the missing aerosol and cloud profile data in the region of the Eastern Mediterranean.

4. Conclusions

It is evident that Cyprus and more specifically Limassol is an ideal natural laboratory for advanced and comprehensive field studies of climate change, aerosol-cloud-dynamics-precipitation interaction, and the weather-precipitation-dryness complex, representative for typical Mediterranean and even Middle East meteorological conditions and for coastal areas in the EMME region [5-6].

Incomplete coverage with ground monitoring stations is the main limitation to make fast and significant progress in understanding the complex climate-relevant atmospheric processes around the globe and thus to improve atmospheric models used for climate change predictions. Satellites can continuously monitor almost planet-wide, but they cannot resolve processes in detail. Satellite data must be 'ground-calibrated' as well as models need data for validation and even assimilation [7].

A modern observational super site at Cyprus is of fundamental importance to understand the atmospheric system in the fast growing and developing EMME region with increasing urbanization and pollution problems which cannot be separated from the climate-change issue. Field research is also needed in the EMME region to mitigate risks, to prepare for the future, and to adapt to changing conditions. 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 quality). But a modern supersite of atmospheric monitoring is totally missing in the Eastern Mediterranean, in one of the key regions of expected strong climate-change effects. The ERATOSTHENES super site will be fully in line with ACTRIS-RI (ESFRI) that focuses on producing high-quality observations of short-lived climate forcers (SLCFs) and knowledge about processes driving their atmospheric lifetime.

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