

A.01.09 Atmospheric 3D Winds for Weather and Climate

Monitoring Atmospheric 3D Winds with the HALO Doppler Wind Lidar at the CARO National Facility in Limassol, Cyprus

Constantinos Chrysostomou^{1,2}, George Kotsias¹, Argyro Nisantzi^{1,2} and Rodanthi-Elisavet Mamouri^{1,2}

1. *Eratosthenes Centre of Excellence, Limassol, Cyprus*
2. *Cyprus University of Technology, Faculty of Engineering and Technology, Cyprus*
3. *Leibniz Institut für Troposphärenforschung, Leipzig, Germany;*

Abstract The study of atmospheric 3D wind fields is vital for both monitoring the atmospheric dynamics as well as advancing weather prediction and climate research. Since January 2023, the Cyprus Atmospheric Remote Sensing Observatory (CARO) Ground-Based Station (GBS) located in coastal Limassol, has been hosting the HALO (Snoopy) Doppler wind lidar, providing continuous and detailed vertical and horizontal wind profiles. This ongoing dataset provides a high-resolution view of wind dynamics over the region, contributing to a deeper understanding of atmospheric processes and their variability. The present research utilizes the HALO lidar to extract 3D wind fields and assess their variability across diurnal, seasonal, and synoptic scales. The analysis extends for almost two years (from February 2023 to December 2024) and focuses on monthly and seasonal variations of wind speed and direction. Also, by integrating advanced remote sensing techniques, including the calculation of vertical velocity variance, the study estimates the Mixing Layer Height (MLH) across the seasons, offering insights into atmospheric dynamics over the region. Furthermore, the ongoing data collection at CARO provides a valuable opportunity for calibration and validation activities supporting satellite-based observations. As a consequence, in the present study the validation of ESA's Aeolus satellite mission's Level 2B Rayleigh-Clear and Mie-Cloudy data against ground-based LiDAR measurements is performed, aiming to assess their accuracy and applicability in regional wind profiling. In general, the findings of this work highlight distinct seasonal wind patterns, with notable differences in wind speeds and directions between daytime and nighttime, as well as the influence of regional meteorology, such as local topographical features, and the influence of the Mediterranean Sea. These results contribute to the understanding of wind climatology patterns and intra-annual variability in the Eastern Mediterranean, emphasizing the importance of integrated satellite and ground-based observations for climate studies and weather forecasting.

Acknowledgements

The authors acknowledge the 'EXCELSIOR': ERATOSTHENES: EXcellence Research Centre for Earth Surveillance and Space-Based Monitoring of the Environment H2020 Widespread Teaming project (www.excelsior2020.eu). The 'EXCELSIOR' project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 857510, from the Government of the Republic of Cyprus through the Directorate General for the European Programmes, Coordination and Development and the Cyprus University of Technology. This study was supported by the ATARRI Horizon Europe Widespread Twinning Project. ATARRI receives funding from the European Union's Horizon Europe Twinning Call (HORIZON-WIDERA-2023-ACCESS-02) under the grant agreement No 101160258.