Two-year wind observation in Limassol, Cyprus: Monthly and Seasonal analysis from Doppler LiDAR at the CARO National Facility

Chrysostomou C.[1,2*], Kotsias G.[1], Seifert P.[3], Bühl J.[4], Nisantzi A.[1,2], Hadjimitsis D.[1,2], Mamouri R.E.[1,2]

1 Eratosthenes Centre of Excellence, Limassol, 3012, Cyprus
2 Department of Civil Engineering and Geomatics, Cyprus University of Technology, Limassol, 3036, Cyprus
3 Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, 04318, Germany
4 Faculty of Automation and Computer Science, Harz University of Applied Sciences, Wernigerode, 38855, Germany

*Corresponding Author e-mail: constantinos.chrysostomou@eratosthenes.org.cy

Abstract

The National Facility of Cyprus Atmospheric Remote-Sensing Observatory (CARO) in Limassol, managed by the Eratosthenes Centre of Excellence, is a key ground-based station that offers complete insights into atmospheric dynamics, supports atmospheric monitoring, and advances climate research. Since January 2023, CARO is equipped with the HALO (Snoopy) Doppler LiDAR, a cutting-edge instrument that provides high-resolution vertical and horizontal wind profiles, offering an unprecedented view of wind dynamics in the region. This study analyzes two years of wind data (February 2023–January 2025) to investigate the diurnal, monthly, and seasonal variability of horizontal wind and to estimate the Mixing Layer Height (MLH) using vertical wind variance calculations. The results reveal distinct seasonal wind speed and direction patterns that are influenced by both the regional meteorology and the local topography, whereas the results also suggested that some of the months exhibited strongly similar trends, leading to their clustering into two main periods: the warm and the cold one. Moreover, MLH follows diurnal and seasonal cycles, driven by solar radiation and surface heating, showcasing their impact on boundary layer evolution. These findings provide a deeper understanding of the region's wind climatology and intra-annual variability, emphasizing the complex interactions between atmospheric dynamics, local geography, and seasonal meteorological conditions in the Eastern Mediterranean.

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Key Words: Wind, Mixing Layer, PBL, Atmosphere, Doppler LiDAR, Cyprus, EMMENA region