Seasonal wind analysis in Limassol, Cyprus, using the ground-based Doppler LiDAR of the CARO National Facility

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Cyprus Atmospheric Remote-Sensing Observatory (CARO) is a ground-based station (GBS) located in the coastal city of Limassol, Cyprus, which offers complete insights for improving our understanding of the atmospheric dynamics, for the monitoring of the atmosphere, and advancing climate research as a whole. CARO is a National Facility for atmospheric research based on remote sensing techniques and since January 2023 it has been equipped with the HALO (Snoopy) Doppler LiDAR. This state-of-the-art active remote sensing instrument has the ability to provide high-resolution, both spatial and temporal, vertical and horizontal wind profiles and thus offers an unprecedented view of wind dynamics in the region. The research spans two full years of wind data, from February 2023 to January 2025, analyzing the variability of the horizontal wind across diurnal, seasonal, and synoptic scales. It focuses on identifying monthly and seasonal patterns of wind speed and direction, while simultaneously estimating the Mixing Layer Height (MLH) using advanced remote sensing techniques, such as calculations of the vertical wind variance, therefore providing valuable insights into the dynamics of the planetary boundary layer and its seasonal evolution.

The findings suggest the existence of seasonal patterns that reveal pronounced diurnal variations in wind speed and direction, with distinct characteristics detected between them, that get influenced by the regional meteorology, local topographical factors such as the Troodos Mountains, and the Mediterranean Sea. Additionally, some of the months and seasons exhibited some common patterns which led to their grouping and distinction into two periods; the warm one and the cold one. Similarly, diurnal and seasonal patterns were found for the case of the estimated extent of the mixing layer, showcasing the impact that the incoming solar radiation and the consequent heating of the Earth's surface have on atmosphere's dynamics. Overall, these findings highlight the complex interactions shaping the wind, contributing to the growing understanding of its climatology and intra-annual variability in the Eastern Mediterranean, while improving the weather models.

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