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UAV measurements of aerosol properties at the Cyprus institute

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Unmanned Aerial Vehicles (UAVs) provide a cost-effective and easy-to-use method to document the vertical profiles of aerosol particles and their physical and optical properties, within and above the boundary layer. These observations combined with satellite and ground data together can provide important information and model constrains regarding the impact of aerosols on the air quality and regional climate. Cyprus is a unique place to observe long-range transported pollution and dust originating from different areas (Europe, Africa, Turkey, and Middle East) and perform such aerosol profiling.
The USRL team at the Cyprus Institute has recently started weekly routine flights with a newly developed UAV fleet to build a unique dataset of vertical profile observations. Instrumentation on the UAVs includes miniature Scanning Aerosol Sun Photometer (miniSASP, Murphy et al., 2015), Printed Optical Particle Spectrometer (POPS, Gao et al., 2016), Ice nuclei sampler (IN) and Dual Wavelength absorption Prototype (DWP) together with the measured meteorological parameters (P, T and RH). The UAV fleet is still expanding, as well as the instrumentation, and preliminary test flights have led to very promising results.
The UAV ascend up to approximately the middle of the boundary layer, defined by LIDAR measurements at Limassol, where the UAV will fly on one altitude for several minutes ensuring stable data collection. After flying on one altitude, the UAV will continue ascending above the boundary layer, where another level flight will take place for data gathering, before descending for safe landing.
The miniSASP measures the sun irradiance and sky radiance at four wavelengths (460, 550, 670 and 680nm) by doing continuous almucantar scans every 30 s. The instrument installation compensates for the pitch and roll of the UAV with 4 Hz frequency. For this reason, the flights are designed to maintain level flight conditions, to ensure proper data acquisition, and to obtain data from discrete altitudes and not only during the ascend and descend periods. The POPS measures the particle size distribution in the range of 140-3000 nm diameter within 14 size channels. The POPS was successfully compared to another OPC (MetOne, model 212 profiler) on separate flights during the same day with coinciding results.
The routine flights will continue for a year, once or twice a week, targeting different air mass origins and synoptic conditions. The aim is to build a comprehensive dataset by merging atmospheric data measured both by UAVs and ground-based in situ observations obtained 1) at the Agia Marina Xyliatou remote station (500m asl) and 2) at the free troposphere Troodos altitude station (1800m asl).

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