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The Next Generation of UAV-sensor Systems: New Perspectives for In-situ Profiling of Aerosol Properties

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Airborne in-situ and remote sensing measurements are integrative part of air quality, climate forcing, and atmospheric chemistry studies, enabling observations over large atmospheric domains, resolving vertical distributions, and offering the ability to characterize long-range transport, estimate fluxes, better infer atmospheric radiative properties of a large suite of chemical and meteorological parameters. The rapid development of Unmanned Aerial Vehicles (UAVs) together with the recent progress in developing low-cost sensing technology offers new perspectives - yet under exploited - for systematic airborne observations of the lower troposphere.
Ease in deployment and high manoeuvrability allow UAVs to cover areas otherwise inaccessible with conventional airborne platforms, particularly within the first kilometres of the troposphere. Even though small UAVs are subject to significant payload restrictions compared to larger manned aircrafts, they have distinct advantages over their manned counterparts, including: i) performing autonomous flight operations from take-off to landing; ii) allowing spatially dense data collection due to low speed operation; iii) flying closer to ground with greater spatial accuracy; iv) being less expensive to purchase and especially in operation widening access to this technology to small research groups; and v) causing much smaller disturbance to the atmospheric flow than large aircraft (this is crucial for turbulence and cloud studies).
Since its establishment in 2010, the Unmanned Systems Research Laboratory (USRL) of the Cyprus Institute has performed pioneering research in UAV-sensor systems in close collaboration with many international research teams and private partners developing lightweight aerosol sensors. Research infrastructure of USRL is unique and encompasses a private runway/airspace granted permanently by the civil aviation authorities and exclusively dedicated to a fleet of research UAVs. Supported by an instrumentation laboratory specialized in the development of lightweight miniaturized sensors, USRL is the first facility of its kind worldwide dedicated to analyse the vertical distribution of air pollutants in the lower 10 km of the atmosphere on a continuous (weekly) basis. This capability will help towards filling the gap between ground-based and satellite observations in a region (Eastern Mediterranean - Middle East) where air pollution is very high but still poorly characterized.
This presentation will provide a comprehensive overview of the recent technical developments of USRL in profiling key aerosol properties (multi-wavelength aerosol absorption, size-resolved number concentration, multi-wavelength aerosol optical depth, ice nuclei, etc.). Field deployment of these UAV-sensor systems will be presented for contrasting atmospheric environments ranging from heavily polluted regions (e.g. Arabian/Persian Gulf), large cities (e.g. Athens, Greece) to remote areas (e.g. Arctic, Mediterranean).

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