Optimization of a drone based miniature mass spectrometer system (Drone-MS) for in situ gas plume measurements

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In the 2017 HEMS workshop, we presented the results of the first flight testing of a miniature mass spectrometer prototype system integrated to an octocopter drone flown over Solfatara Volcano, Italy to demonstrate the capabilities of an autonomous airborne system for measuring volcanic gas emissions.

The 8 kg Drone-MS prototype included a modified XPR3 miniature quadrupole mass spectrometer from Inficon Inc. (1-100amu, 10^{-3} torr range operating pressure), together with a miniature turbo pump (either from CREARE LLC or Pfeiffer Inc.) two diaphragm pumps (rough pump and sample bypass), an embedded PC, a Lipo battery and telemetry integrated to an ITALDRONE octocopter with 10kg payload capabilities, 1km range and 20 min of endurance. Since the publication of the first results, there has been an increasing interest from researchers, volcanic observatories and other in situ surveying companies for introducing drones and unmanned aerial vehicles (UAV) with gas sensing capabilities for routine in situ gas monitoring in different applications.

The prototype flight testing was successful but showed areas of optimization needed to provide a ready to fly UAV-MS system to conduct routine in-situ gas measurements and 3D area surveys. Therefore, the original Drone-MS system has been progressively modified to decrease its weight by 25%, improve the vacuum system, fine tune the miniature quadrupole mass spectrometer's parameters to the target gases, and increase its endurance to drone vibration and high turns. The talk covers most of the optimizations to make the system flight ready for an Etna Volcano deployment scheduled for late October 2018.

The long term goal is to develop UAV payloads to conduct systematic in-situ measurements in a variety of applications, for example calibration and validation of remote sensing data using volcanic plume measurements, characterization of volcanic emissions and determination of chemical composition ratios that are used as precursor to bigger eruptions without the need of risking human lives, oil/gas pipe and landfill or chemical exposed area surveys and other application that requires systematic unmanned in-situ airborne measurements.