5.4: Optimization of Rotary-Wing UAS as an Atmospheric Sensing Platform

Tuesday, 9 January 2018
11:15 AM - 11:30 AM
Austin, Texas - Room 13AB (ACC)

The capabilities of small unmanned aircraft systems (sUAS) to make atmospheric observations are rapidly being realized as a means to collect previously unobtainable observations in the lowest part of Earth's atmosphere. However, in order for these systems to provide meaningful kinematic and thermodynamic data, it is imperative to establish an understanding of the strengths and limitations of the sensors and retrieval algorithms implemented, as well as how they perform under various configurations and flight conditions. This initial objective is comprised of two experimental stages, the first of which is calibration of thermodynamic sensors against reference measurements from the Oklahoma Mesonet and the National Center for Atmospheric Research in order to understand response characteristics in quasi-ideal environments. Furthermore, efforts have been made to calculate horizontal wind fields using Euler angles derived from the rotary-wing's autopilot. The second stage is validation of these sensor performances once mounted onto a rotary-wing sUAS by comparing measurements with instrumented towers, radiosondes, and other sUAS. It appears that these measurements are robust provided that instrument packages are properly mounted in locations that provide adequate air flow and proper solar shielding. Moreover, experiments to locate this optimized location have been performed, which involved systematically displacing the sensors and a wind probe underneath the rotor wash in an isolated chamber using a linear actuator. Preliminary results indicate that sensors suffer from self-heating unless placed underneath the propellers close to the tips, where maximum airflow can be achieved, allowing the sensor to sample a representative environment. Differences in well vs. poorly aspirated sensors can see errors on the order of 0.5 degrees Celsius, implying careful consideration must be taken when deciding location of sensors on an sUAS. This presentation will provide a general evaluation of the sensors along with their performance characteristics, suggestions for sensor placements based on experience and experimental results, and an overview of the current wind retrieval algorithms as well as their uncertainties.

Once a platform's atmospheric sensing capabilities are optimized, its utility has been proven in applications from the diurnal boundary layer transition and turbulence to providing forecasters with quasi-real time profiles in convective environments deemed by the Storm Prediction Center (SPC) to be of highest risk for severe thunderstorms and tornadoes. After addressing the development of platforms by the Center for Autonomous Sensing and Sampling (CASS) at the University of Oklahoma (OU), results from the recent field campaigns, Collaboration Leading Operational UAS Development for Meteorology and Atmospheric Physics (CLOUD-MAP) and Environmental Profiling and Initiation of Convection (EPIC), will be discussed.

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