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Development of Rotary-Wing UAS for Use in Atmospheric Sensing of Near-Storm Environments

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The capabilities of small unmanned aircraft systems (sUAS) to make atmospheric observations is 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 in both controlled and realistic conditions. This initial objective is comprised of two experimental stages, the first of which is calibration of thermodynamic sensors against references from the Oklahoma Mesonet and the National Center for Atmospheric Research in order to understand their quasi-ideal response characteristics. Furthermore, efforts have been made to calculate horizontal wind fields using Euler angles derived from the sUAS'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 mounted such that they receive adequate air flow and proper solar shielding. Moreover, experiments to locate this optimal location have been performed, and involved systematically displacing the sensors and wind probe underneath the rotor wash in an isolated chamber using a linear actuator. Once a platform's atmospheric sensing capabilities are optimized, its utility has been proven in applications from turbulence to providing forecasters with quasi-real time profiles in convective environments deemed by the Storm Prediction Center to be of highest risk for severe thunderstorms. After addressing the development of platforms operated by the University of Oklahoma, results from 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. These campaigns demonstrated the potential for sUAS to improve forecasting abilities and our understanding of the atmosphere, and provide a bright outlook on the future of sUAS applications.

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