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The 3D Mesonet Concept: Extending Networked Surface Meteorological Tower Observations Through Unmanned Aircraft Systems

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Fixed monitoring sites, such as those in the US National Weather Service Automated Surface Observing System (ASOS) and the Oklahoma Mesonet provide valuable, high temporal resolution information about the atmosphere to forecasters and the general public. The Oklahoma Mesonet is comprised of a network of 120 surface sites providing a wide array of atmospheric measurements up to a height of 10 m with an update time of five minutes. The deployment of small unmanned aircraft to collect in-situ vertical measurements of the atmospheric state in conjunction with surface conditions has potential to significantly expand weather observation capabilities. This concept can enhance the safety of individuals and support commerce through improved observations and short-term forecasts of the weather and other environmental variables in the lower atmosphere. We report on a concept of adding the capability of collecting vertical atmospheric measurements (profiles) through the use of unmanned aerial systems (UAS) at remote Oklahoma sites deemed suitable for this application. While there are a number of other technologies currently available that can provide measurements of one or a few variables, the proposed UAS concept will be expandable and modular to accommodate several different sensor packages and provide accurate in-situ measurements in virtually all weather conditions. Such a system would facilitate off-site maintenance and calibration and would provide the ability to add new sensors as they are developed or as new requirements are identified. The small UAS must be capable of accommodating the weight of all sensor packages and have lighting, communication, and aircraft avoidance systems necessary to meet existing or future FAA regulations. The system must be able to operate unattended, which necessitates the inclusion of risk mitigation measures such as a detect and avoid radar and the ability to transmit and receive transponder signals. Moreover, the system should be able to assess local weather conditions (visibility, surface winds, and cloud height) and the integrity of the vehicle (system diagnostics, fuel level) before takeoff. We provide a notional concept of operations for a 3D Mesonet being considered, describe the technical configuration for one station in the network, and discuss plans for future development.

Publication: American Geophysical Union, Fall Meeting 2017, abstract #A33I-2508

Pub Date: December 2017

Bibcode: 2017AGUFM.A33I2508C

Keywords: 0305 Aerosols and particles; ATMOSPHERIC COMPOSITION AND STRUCTURE;
0321 Cloud/radiation interaction; ATMOSPHERIC COMPOSITION AND STRUCTURE;
0350 Pressure; density; and temperature;
ATMOSPHERIC COMPOSITION AND STRUCTURE; 0394 Instruments and techniques;
ATMOSPHERIC COMPOSITION AND STRUCTURE

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