SUMMARY OF A WORKSHOP ON INTEGRATING WEATHER INTO UNMANNED AERIAL SYSTEM TRAFFIC MANAGEMENT

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On 19–21 July 2016, the National Aeronautics and Space Administration (NASA) Ames Research Center and the National Center for Atmospheric Research (NCAR) organized and cosponsored a two-and-a-half-day workshop bringing aviation weather, Unmanned Aerial Systems (UAS) traffic management (UTM) researchers, and UAS operators together to discuss weather impacts and requirements to enable safe and efficient low-altitude UTM. The workshop, held at NASA Ames, Moffett Field, California, included two days of presentations covering the UTM system, the current aviation weather system, weather phenomena and their impact on UAS operations, and weather integration into UAS operations. The final half-day comprised two panel sessions: one panel discussed user experiences with weather in the field and the second discussed weather research needs for UAS operations. About 80 people attended the workshop representing industry, academia, government, and research organizations. The organizers will be using this workshop to engage a crosscutting group of users and weather researchers to inform weather product development and research to enable all-weather access for small UAS (sUAS) operations.

BACKGROUND. Weather and air traffic management researchers have a long and successful record in working with the traditional aviation community to develop and deploy decision support tools that have improved the safety and efficiency of the National Airspace System (NAS) for commercial air transportation. Entering a new era of aviation, in which both remotely piloted and fully autonomous small UASs are being used increasingly for commercial, military, and civilian applications, it can be seen that there...
are just as many similarities as differences between weather impacts on UAS operations and those impacting piloted aircraft. Therefore, there is a need for a coordinated effort to understand these challenges and requirements. As such, the workshop aimed to foster the discussion on the unique challenges associated with providing weather information for UASs and integrating this weather information into UTM.

**WORKSHOP.** To set the stage for the subsequent discussions, the first day of the workshop comprised presentations on NASA UTM research and development activities and the current aviation weather system. In the former session, NASA personnel described the overarching UTM concept and specifics related to ongoing prototype development and field demonstrations. In the latter session, presenters from the Federal Aviation Administration (FAA)’s Aviation Weather Research Program (AWRP), National Oceanic and Atmospheric Administration (NOAA)’s UAS program, the National Weather Service Aviation Weather Center, the Army Research Laboratory (ARL), and Massachusetts Institute of Technology Lincoln Laboratories (MIT/LL) described how weather is utilized in existing commercial transport, general aviation, and public sector UAS operations. The workshop’s second day began with talks on weather phenomena and their impact on UAS operations. Presenters from NCAR, MIT/LL, and KBRWyle discussed boundary layer meteorology, winds and turbulence, icing, and ceiling and visibility. The second day concluded with presentations focused on weather integration into UTM. Speakers from NCAR, NASA, and Sensurion Aerospace talked about weather needs for UAS operations, automation systems, access to weather products, and user requirements. The last half-day was devoted to panel discussions. The first session focused on user needs and experiences concerning weather and UAS operations. Panelists from the University of Oklahoma (OU), Sensurion Aerospace, and Skycatch gave brief presentations and then took questions from the audience. The second panel discussion centered on weather research needs for UAS operations. The panelists were from NCAR, FAA, OU, and ARL, and as with the first session, brief presentations were followed by audience participation and discussion.

**Outcomes.** From the presentations and discussions, it was clear that there will be a large variety of uses for small UASs, and their disparate missions and payloads will set different requirements for weather decision support tools. Based on the application, different missions will have different weather constraints—even when operating in the same environment. Because of the rapid growth of UAs there is a need for developing solutions for deconflicting UAS operations with traditional aviation. Any such solution will require decision support tools that integrate UAS flow structures and weather information.

The weather characteristics that impact UAS differ dramatically from those affecting larger manned aircraft. UAS decision-making will require weather information that is tailored specifically for much smaller vehicles. From the workshop participants, it was clear that wind and turbulence are key atmospheric phenomena that affect UAS operations. The impact of these two weather conditions vary from vehicle performance (e.g., head wind or battery drain due to control surface use in turbulence), to vehicle stability in turbulence, to the potential loss of a vehicle due to an unexpected wind gust. In addition, ceiling and visibility play an important role in determining the feasibility of line-of-sight operations. In addition to winds and turbulence, users also discussed the impact temperature has on both vehicle and battery performance. At high altitudes and temperatures, density altitude degrades rotorcraft performance and temperature affects battery performance.

![Fig. 1. Steve Abelman (FAA) speaking during the Weather Research Panel discussion on the last day, 21 Jul.](image-url)
resulting in reduced mission time. Furthermore, since the predictability of the atmosphere decreases with decreasing temporal scales, the observations and predictions required for supporting small UAS operations will need to be probabilistic in nature. UASs can also be part of the solution to more accurate weather prediction by providing atmospheric sensing capabilities in the lower regions of the planetary boundary layer that can be used to improve understanding and be assimilated into NWP.

One of the key results of the workshop was the agreement that a UAS Weather User’s Group is needed to help focus and direct research and development efforts regarding weather integration into UAS operations and UTM. To start this process, a smaller, more focused group is being assembled: the UTM Weather Integration Steering Group. It is intended that this group, comprising representatives from government, researchers, and industry, will provide guidance to UTM researchers, developers, operators, and decision-makers. This group will have a broad-based membership, reflecting the disparate aspects of UAS operations, and will be tasked with developing a plan that delineates the initial requirements, scope, and an implementation roadmap for weather-integrated UTM. This initial group will work closely with the larger, and more wide-ranging, UAS Weather Users Group.

For all the participants, this was an extremely informative and timely workshop, and it is envisioned that further meetings will be held to continue the discussions.