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Abstract #
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Title

Precision Meteorological Prediction Employing A Data-Driven, Adaptive, Real-Time (DART) Approach

Authors

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Abstract

Given the rapid growth of uncrewed aerial vehicles (UAV) shipments [1], and the emerging and projected use of UAVs in transportation and delivery [2], highly localized weather forecasts, or precision meteorological prediction, is needed for safe, efficient, and profitable operation UAV operations. Precision meteorology is also required in case of emergency operations associated with tracking a contaminant cloud due to an incident, which number about 300 annually for the United States [3]. To address this challenge, a data-driven, adaptive, real-time (DART) numerical model has been developed employing the Weather Research Forecast Large Eddy Simulation (WRF-LES) open-source code [4], which is maintained by the National Center for Atmospheric Research (NCAR). The WRF-LES code was augmented with a retrospective cost adaptation control (RCAC) algorithm [5,6], which was originally developed for active noise and vibration control [7]. The RCAC algorithm serves to adapt, or drive, the simulated horizontal velocity component values to observed values at specified locations that are gathered via the UAVs. The operational concept is that the numerical model not only receives real-time telemetry observation feeds from a swarm of UAVs, but also provides forecast updates to the swarm's guidance. The guidance system then uses the updated forecast to reposition the UAVs for collection of the next set of most beneficial observations. In short, UAVs would collect the data needed to provide precision weather forecasts for safe operation of other UAV flights. Representative, but arbitrary, observation data has been successfully utilized in the DART solution. The resulting output, for this continuous observation collection and weather model adaptation concept, is that the entire flow field in a relatively small geographic region is modified. Consequently, the fidelity and accuracy of the flow field in the small region is expected to improve when compared to a model run that is not adapted. Planning and development are underway to test, validate, and quantify the expected improvement in the WRF-LES model using a UAV swarm at the University of Kentucky's Flight Field. Once the promise of the DART approach is fully proven and operational, the ensuing forecasts would serve to greatly benefit the entire UAV community and first responders of contaminant incidents.

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