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The potential impact of unmanned aircraft systems on storm-scale numerical weather prediction of supercells: Results from ensemble sensitivity analysis and observing system simulation experiments

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Targeted observation of supercells by unmanned aircraft systems (UAS) has the potential to improve the accuracy and lead times of storm-scale forecasts. Ensemble sensitivity analysis (ESA) can identify the storm regions in which variations to the initial state of a numerical weather prediction (NWP) model are most likely to affect predictions of storm strength and severity. Observing system simulation experiments (OSSEs) can complement ESA-based findings by testing the impact of assimilated synthetic observations "collected" by a simulated UAS in storm regions identified through ESA. Results will be presented from both approaches.

ESA was performed to relate perturbations in state variables (temperature, moisture, pressure, and the three-dimensional wind) to proxies for storm strength and severity. Several coherent regions of strong sensitivity were identified at both short lead times (5-20 min) and long lead times (>40 min). These results suggest that regions near the mesocyclone and upstream along the forward flank both ahead of a behind the forward-flank outflow boundary may be preferred regions for targeted observations.

UAS OSSEs require a high-resolution simulation (the "nature run") that represents the true atmospheric state, an aircraft model that "collects" (synthetic) observations within the nature run, and a numerical weather prediction model into which data from the nature run are assimilated. The nature run was developed using the First-Generation Pennsylvania State University/National Center for Atmospheric Research Cloud Model (CM1), and was initialized in an environment consisting of open-cell boundary layer convection and deep-layer vertical wind shear sufficient to support a supercell. An aircraft model was developed to collect synthetic data from the nature run in a manner consistent with a fixed-wing UAS. The impact on forecasts achieved through assimilation of these synthetic data into coarse-resolution idealized Weather Research and Forecasting model (WRF) simulations will be discussed. This comparison of the nature run predictions (truth) to the coarse-run predictions allow for evaluation of the impact UAS data could have on real time convection allowing models.