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Observation Denial and Performance of a Local Mesoscale Model

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Forecasters at the 45th Weather Squadron (45 WS) use observations from the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS) wind tower network and the CCAFS (XMR) daily rawinsonde observations (RAOB) to issue and verify wind advisories and warnings for operations. These observations are also used by the Spaceflight Meteorology Group (SMG) in Houston, Texas and the Melbourne, Florida National Weather Service office to initialize their locally run mesoscale models. SMG also uses the observations to support shuttle landings at the KSC Shuttle Landing Facility. Due to impending budget cuts, some or all of the KSC/CCAFS wind towers on the east-central Florida mainland and the XMR RAOBs may be eliminated. The loss of these data may impact the forecast capability of the 45 WS and SMG.

The Applied Meteorology Unit (AMU) was tasked to conduct a modeling study to determine how important these observations are to the accuracy of the model output used by the forecasters as input to their forecasts. To accomplish this, the AMU performed a sensitivity study using the Weather Research and Forecasting (WRF) model initialized with and without KSC/CCAFS wind tower and XMR RAOB observations. The AMU assessed the accuracy of model output by comparing peak wind forecasts with operationally significant wind advisory and warning criteria forecast by the 45 WS. To assess model performance when initialized with and without some of the wind tower and XMR RAOB observations, the AMU conducted a subjective analysis by displaying model wind forecasts graphically with the observations overlaid for comparison and they conducted an objective analysis by comparing the maximum peak wind forecast to the maximum peak wind observed within the KSC/CCAFS wind tower network.

Data were collected for twelve warm season cases and eight cool season cases from June – September 2007 and November – January 2008, respectively. For each case chosen, the 45 WS must have issued a wind advisory or warning for the KSC/CCAFS area and the KSC/CCAFS wind towers must have recorded significant wind events, or winds greater than 18 kt.

The model configuration used a "hot-start" initialization of the WRF model using the Local Analysis and Prediction System (LAPS). Each run started at 0900 UTC and was integrated 12 hours with a 1.3 km horizontal grid spacing and 40 irregularly spaced, vertical sigma levels. LAPS was initialized with Level II Weather Surveillance Radar-1988 Doppler (WSR-88D) data from the Melbourne, Florida radar, Geostationary Operational Environmental Satellites (GOES) visible and infrared satellite imagery, Meteorological Assimilation Data Ingest System (MADIS) data, and KSC/CCAFS wind tower data and the XMR RAOB. The AMU initialized LAPS under four different scenarios of withholding local data:

- With the mainland towers and without the 1015 UTC XMR RAOB,
- With the mainland towers and with the 1015 UTC XMR RAOB,
- Without the mainland towers and without the 1015 UTC XMR RAOB, and
- Without the mainland towers and with the 1015 UTC XMR RAOB.

The AMU completed a subjective analysis of the WRF forecasts by comparing model output to observations at the time of the maximum peak wind corresponding to the 45 WS advisories and warnings for that day to determine if any of the four scenarios produced better results than the others. They compared the model output to the observations to determine if any of the four scenarios produced better results than the others. For the AMU objective analysis, they identified model-domain maximum peak wind speeds for each forecast output time and compared them to the observed maximum peak wind speed in the domain. They then conducted an overall evaluation of how well the four model scenarios performed against each other.

During the warm season, the four scenarios of withholding data were within 2 kt of each other through the 7-hr forecast and then diverged to over 3 kt at the 11-hr forecast. The cool season results indicate the four scenarios tracked better after the 4-hr forecast than before, remaining within 1.4 kt of each other. The average difference among the four WRF scenarios for the entire 12-hr forecast period was 1.91 kt for the warm season and 1.38 kt for the cool season. This indicates the data-denial scenarios performed comparably to the data-rich scenarios. The AMU also computed the root mean square error (RMSE) for the four scenarios. During the warm season, the WRF RMSE decreased from 4.7 kt at the 0-hr forecast to 2.3 kt at the 3-hr forecast, a reduction of just over 2 kt. It then generally increased throughout the remaining 12-hr forecast period to a maximum RMSE of 13.87 kt at the 11-hr forecast. During the cool season, the WRF RMSE was consistent throughout most of the forecast intervals at about 5-7 kt, with a maximum RMSE of 7.77 kt at the 2-hr forecast. These data indicate WRF performance is worse in the warm season.

The subjective and objective analyses indicate denying the wind tower and XMR RAOB data had minimal impact on the model forecasts.

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14. ABSTRACT

Forecasters at the 45th Weather Squadron (45 WS) use observations from the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS) wind tower network and daily rawinsonde observations (RAOB) to issue and verify wind advisories, watches, and warnings for operations. They are also used by the Spaceflight Meteorology Group and Melbourne, Florida National Weather Service to initialize locally run mesoscale models. Due to impending budget cuts, some or all of the mainland wind towers and RAOBs may be eliminated. The loss of these data may significantly impact the forecast capability of the 45 WS and SMG. The Applied Meteorology Unit (AMU) was tasked to conduct an objective independent modeling study to determine how important these observations are to the accuracy of the model output used by the forecasters as input to their forecasts. To accomplish this, the AMU performed a sensitivity study using the Weather Research and Forecasting (WRF) model run with and without KSC/CCAFS wind tower and CCAFS RAOB observations and assessed the accuracy of model forecasts by comparing them to the observations.

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