University: University of Oklahoma
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Project Title: Evaluation of Downscaled High-Resolution WRF Simulations For Use in Operational Forecasting
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SECTION 1: SUMMARY OF PROJECT OBJECTIVES

1.1 The scientific goal of the project was "to evaluate high resolution output from the WRF model for use in NWS operational forecasting via observations from several unique, real-time data sources within the Norman CWA including the Oklahoma Mesonet, the Fort Cobb Micronet, the Little Washita Micronet, and the Oklahoma City Micronet".

1.2 The operation forecasting goals of the project included:

- Provide forecasts that better account for local topography (land use) and its impact on temperature, wind, moisture, and stability.
- Provide more specific, accurate, and detailed fire weather and dispersion forecasts.
- Provide more specific forecasts of hazardous winter weather, including wind chill and locally extreme temperatures.

1.3 The educational goals of the project included the development case studies for use in the Norman WFO and, given the resources used in this project, those that can be easily transportable to other WFOs – i.e., the lessons learned from this project could be utilized to improve high-resolution forecasts throughout the NWS. In addition the results from this project will be (1) directly applicable to the content and supplemental training materials (lab exercises, modules, etc.) of COMAP Boundary Layer Symposium course and (2) will be incorporated in any future COMAP Boundary Layer Symposium course offering used to educate and train NWS personnel.

SECTION 2: PROJECT ACCOMPLISHMENTS AND FINDINGS

Overall, the project was a success and provided new insight into the utility of high-resolution operational forecasts developed from a downscaled version of the Weather Research and Forecast (WRF) model. Further, the results demonstrated the range of expected forecast error produced by the NDFD and downscaled WRF forecast systems across varying spatial and temporal domains. The key accomplishments and results of the work include:

- The final study period ranged from 10 August 2010 through 15 May 2011, and forecast data from a total of 212 non-continuous days were used in the analyses.

- The downscaled WRF showed improvement over the NDFD on many occasions for air temperature, especially when the domain of the downscaled WRF was located over the Wichita Mountains National Wildlife Refuge (WMNWR), which was an area with the greatest variability in elevation and overall terrain features.

- Almost none of the improvements of the downscaled WRF over the NDFD showed any statistical significance at a 90 percent confidence interval, with the possible exceptions being air temperature for the overall study period from forecast hour 0 to 4, and for air temperature when the downscaled WRF's domain was over the WMNWR for all forecast hours.

- There was no improvement in wind speed forecasts by the downscaled WRF compared to the NDFD.

While these accomplishments represent the bulk aspects of the study, many aspects of the research and secondary results were also noted. These include the finer aspects of the results from specific, local domains as well as case study analysis for fire weather conditions. As such, the full breadth of the work is included in the attached M.S. Thesis written by Mr. Aaron Gleason under the supervision of university project PI, Dr. Jeff Basara.

SECTION 3: BENEFITS AND LESSONS LEARNED: OPERATIONAL PARTNER PERSPECTIVE

3.1. An important benefit of the project for the NWS was the ability to quantitatively verify downscaled model forecasts at high spatial and temporal resolutions. To determine when the forecasts provide enhanced skill and when they do not is a critical step as such forecasts are implemented to support NWS Decision Support Services goals.

3.2. Results of the project provided insight into small-scale variability arising from topographic and vegetation differences that cannot be resolved by current products. As such, the increased understanding of small-scale variability will help forecasters interpret and apply high-resolution data sets in NWS operations.

SECTION 4: BENEFITS AND LESSONS LEARNED: UNIVERSITY PARTNER PERSPECTIVE

4.1. A main benefit of the project was the ability to assign Mr. Gleason to tasks that bridged the operations of the NWS along with the education and research missions of the University of Oklahoma. This allowed a unique opportunity to educate *and* train a student such that he would be prepared to take on the role within the NWS with not only a thorough background in meteorology, but also the application of science to operational forecasting. Given Mr. Gleason's

successful completion of his M.S. degree and his hire by the NWS WFO in Birmingham, AL, the experience provides a successful potential pathway for future students.

4.2. From a research perspective, the project provided new insight into the utility and limitations of the current downscaling techniques used by the Norman WFO. As such, while the forecast values of air temperature and dew point temperature show improvements overt the NDFD gridded values, the wind forecasts need significant improvement. Thus, a main component of potential future research includes new methodologies for improving the wind speed forecasts through the application of new boundary layer schemes.

4.3. Finally, it cannot be understated how the project demonstrates the vision of the National Weather Center (NWC) at the University of Oklahoma which is to integrate across academic, operational, and research aspects of the facilities represented by the various units housed within the NWC. This project represents that vision across all three phases, and as such, is a model for such activities in the future.

SECTION 5: PUBLICATIONS AND PRESENTATIONS

The Norman WFO Science and Operations Officer (David Andra) presented a brown bag seminar at the National Weather Center on the WFO's use of downscaled and a preliminary verification study. The study utilized data provided to the WFO by the Oklahoma Climate Survey, an organization within the University of Oklahoma. December 2009.

Aaron Gleason presented a seminar entitled *Evaluation of National Weather Service forecast products using in situ observations in Oklahoma* at the Boundary-Layer, Urban, Land-Atmosphere Interactions seminar series at the National Weather Center, April 2011.

Jeff Basara presented *Station Siting, Microclimates, and Their Impacts on the Urban Forecast Challenge* at the American Meteorological Society 39th Broadcast Meteorology Conference in Oklahoma City, June 2011.

An abstract was submitted to the 21st Conference on Probability and Statistics at the January 2012 Annual Meeting of the American Meteorological Society entitled *Evaluation of National Weather Service forecast products using in situ observations in Oklahoma.*

Gleason, A. M., 2011: Evaluation of National Weather Service forecast products using in situ observations in Oklahoma. M.S. Thesis. University of Oklahoma, Norman, Oklahoma.

SECTION 6: SUMMARY OF UNIVERSITY/OPERATIONAL PARTNER INTERACTIONS AND ROLES

The project represents an excellent collaboration between operational, academic, and research aspects at the NWC. During the project, there was excellent communication between the project partners and the work moved forward at all times. It was extremely helpful to have a diligent

student with the capabilities of Mr. Gleason serving as a liaison between the partners while accomplishing many of the tasks of the proposed work.

The most significant obstacles for the academic partners were twofold: (1) navigating the academic schedule (both Basara and Gleason) and (2) the weather itself which yielded a number of significant/extreme events that disrupted schedules. The greatest challenges to the NWS partners were data archival, IT security issues, and determining an optimal configuration for the local forecast model. Even so, an extensive dataset of forecasts for the downscaled WRF and NDFD were collected and robust conclusions were drawn from the work.