3.3 THE ROLE OF LOCAL HIGH RESOLUTION MODELS IN THE EVOLVING NATIONAL WEATHER SERVICE: DECISION SUPPORT AND SITUATIONAL AWARENESS

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1. INTRODUCTION

Weather forecasters have a number of tools at their disposal, including an expansive network of near real-time meteorological observations, satellite, and radar data to depict the current state of the atmosphere -- and global and regional numerical forecast models to depict the future state of the atmosphere. Advances in computer and network technologies in recent decades have facilitated rapid growth in the field of meteorological modeling. These advancements have yielded numerous benefits to operational meteorologists. Of these, the capability to develop and implement high-resolution models has become a vital asset. Models with grid-spacing less than 4 km and update latency less than 3 hr have become a cornerstone of short-range forecasting in National Weather Service (NWS) field offices. These models have been particularly helpful in developing heightened situational awareness (SA), resulting in enhanced decision support services (DSS) to end users, particularly during high-impact weather events.

Over the last decade, the role of NWS meteorologists has evolved from primarily composing short and long-term forecasts to providing time-sensitive and detailed short-fuse forecast updates during high impact weather events. These updates require knowledge of both the current and expected future state of the atmosphere. High-resolution models have allowed forecasters to go beyond the observed, predicting the evolution of critical weather features out to several hours, in time intervals of 15 min or less. This degree of detail is essential in developing robust decision-making aids intended for dissemination to primary partners during life-threatening events.

Selected cases have been analyzed to showcase the effectiveness of high-resolution model data in depicting the timing, evolution, and mode of convectionduring high impact severe weather events. Model output was interpreted and used to develop Graphicasts, Web briefings, social media entries, and other products to relay to the primary partners in the NWS Weather Forecast Office in Norman, Oklahoma (WFO OUN) county warning area (CWA). This study will show the effectiveness of using high-resolution model data in enhancing SA and providing DSS to primary partners that havea common goal of protecting life and property fromthreateningweather.

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2. CASE DATES AND MODEL DATA

The following three case dates, 10 May 2010, 14 April 2011, and 24 May 2011, were chosen for this study since significant tornadoes (EF-2 or greater on the Enhanced Fujita Scale) occurred on these dates in the WFO OUN CWA (Fig. 1). Two high-resolution models were used for comparison including a local Weather Research and Forecasting (WRF) model from WFO OUN known as the OUNWRF model and the NWS Earth System Research Laboratory's High-Resolution Rapid Refresh (HRRR). The OUNWRF was implemented in 2007, has 4 km grid spacing, and runs every hour with 15 min intervals out to 8 hr. The HRRR has 3 km grid spacing and runs every hour with a time resolution of 15 min to 1 hr. Both models allow for convection and are capable of depicting derived reflectivity, updraft helicity, maximum wind speed, and many other useful fields for assessing the potential for severe convective weather. During active severe weather outbreaks, these data have proved essential -- in enhancing both SA and DSS at WFO OUN.

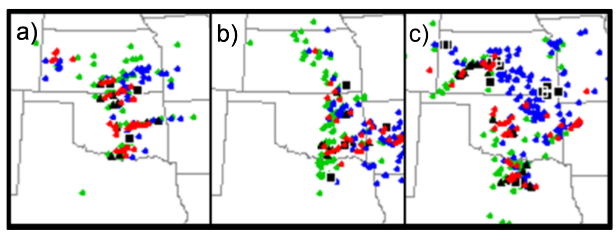

Figure 1. NWS Storm Prediction Center Storm Reports for a) 10 May 2010, b) 14 April 2011, and c) 24 May 2011 indicating observed tornado reports, severe wind reports of 25.7 ms^{-1} (50 kt) or greater, and severe hail reports of 2.5 cm (1 in) or greater.

3. 10 MAY 2010 CASE

On 10 May 2010, an outbreak of severe thunderstorms including tornadoes occurred in the WFO OUN CWA (Fig 1a). The forecast times of thunderstorm initiation by the OUNWRF and HRRR runs 2-6 hr prior to storm initiation were within 1-3 hr of the actual time of thunderstorm initiation (Fig. 2). In addition, the forecast times when thunderstorms located along the Interstate Highway 35 (I-35) corridor including Oklahoma City (OKC) by these model runs were within 1-2 hr of the actual times thunderstorms were near these locations (Fig 2 and 3). Not to mention, these model runs accurately depicted that the primary storm mode would be supercell thunderstorms (Fig 2).

	OUNWRF	HRRR	Actual
Time of Storm Initiation	1830-1945 UTC	1900-2100 UTC	1838 UTC
Time Storms Near I-35/OKC	2100-2200 UTC	2100-2400 UTC	2130-2400 UTC
Storm Mode	Supercell	Supercell	Supercell

Figure 2. Comparison of OUNWRF and HRRR output to actual radar observations in Oklahoma on 10 May 2010.

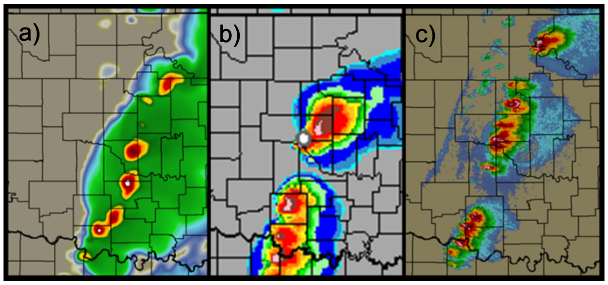

Figure 3. Comparison of 17 UTC runs for 22 UTC on 10 May 2010 of the a) OUNWRF derived composite reflectivity and b) HRRR derived composite reflectivity to the c) actual observed composite reflectivity.

WFO OUN provided numerous DSS prior to and during this event on 10 May 2010. An e-mail was sent encouraging emergency managers to prepare for a significant severe weather event three days before the event. Graphicasts highlighting the severe weather risks including the possibility of strong tornadoes were issued with 184 Graphicasts issued on 10 May 2010 alone (Fig 4). Individual and group telephone and multimedia briefings were utilized to communicate the potential for a tornado outbreak as well.

4. 14 APRIL 2011 CASE

On 14 April 2011, another outbreak of severe thunderstorms with tornadoes occurred in the WFO OUN CWA (Fig 1b). The forecast times of thunderstorm initiation by the OUNWRF and HRRR runs 2-6 hr prior to storm initiation were generally 1-3 hr slower than the actual time of thunderstorm initiation (Fig 5). Also, the forecast times when thunderstorms were located near Atoka, Oklahoma by these model runs were within 1-2 hr of actual times thunderstorms were near this location (Fig 5), which is significant because an EF-3 tornado was confirmed in this area. The OUNWRF accurately predicted that the primary storm mode would transition from supercell thunderstorms to a line of thunderstorms, whereas the HRRR predicted that only supercell thunderstorms would occur in the WFO OUN CWA (Fig 5).

In this case, it is noted that slightly weaker forcing and stronger capping may have not been handled well by the OUNWRF and HRRR. Archived DSS provided by WFO OUN during this event were limited, but included Graphicasts and morning multimedia briefings.

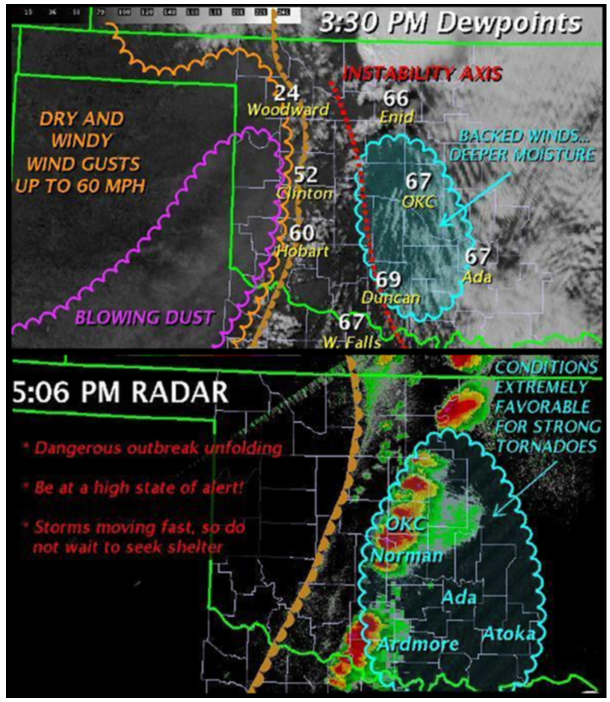

Figure 4. Two examples of Graphicasts issued by WFO OUN on 10 May 2010.

	OUNWRF	HRRR	Actual
Time of Storm Initiation	2030-2100 UTC	2200-2300 UTC	1951 UTC
Time Storms Near Atoka	2245-2400 UTC	2300-0200 UTC	2330-0100 UTC
Storm Mode	Supercell/ Linear	Supercell	Supercell/ Linear

Figure 5. Comparison of OUNWRF and HRRR output to actual radar observations in Oklahoma on 14 April 2011.

5. 24 MAY 2011 CASE

Twelve tornadoes occurred in the WFO OUN CWA including an EF-5, two EF-4s, and two EF-3s on 24 May 2011. The forecast times of thunderstorm initiation by the OUNWRF and HRRR runs 2-6 hr prior to storm initiation were within 1 hr of the actual time of thunderstorm initiation (Fig. 6). Similarly to 10 May 2010, the forecast times when thunderstorms located along the I-35/OKC corridor by these model runs were within 1-2 hr of actual times thunderstorms were near these locations, and the storm mode of supercell thunderstorms was correctly depicted.

WFO OUN provided enhanced DSS before and during this event (Fig 7). This was the first event in which Facebook and Twitter social media accounts were utilized to communicate messages that dangerous thunderstorms were to be expected. E-mail messages were sent to government officials urging individuals to plan ahead and prepare, especially as the OKC area,

	OUNWRF	HRRR	Actual
Time of Storm Initiation	1900-1945 UTC	1945 UTC	1924 UTC
Time Storms Near I-35/OKC	2100-2300 UTC	2145-2245 UTC	2000-2230 UTC
Storm Mode	Supercells	Supercells	Supercells

Figure 6. Comparison of OUNWRF and HRRR output to actual radar observations in Oklahoma on 24 MAY 2011.

the most densely populated part of the WFO OUN CWA, would be most affected by the thunderstorms near evening rush hour, 2100-2400 UTC. School districts and organizations in Oklahoma cancelled and postponed events to prepare for tornadic thunderstorms. Multimedia briefings to emergency managers and government officials were held prior to the event. Graphicasts were issued as well.

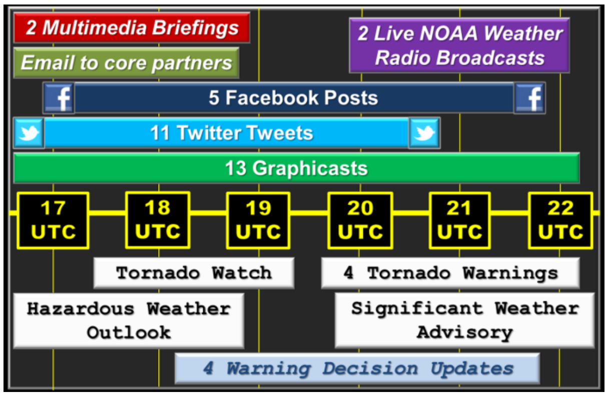

Figure 7. DSS timeline at WFO OUN on 24 May 2011.

6. SUMMARY AND CONCLUSIONS

High-resolution models proved critical in providing accurate and timely information during the10 May 2010, 14 April 2011, and 24 May 2011 tornado outbreaks in the WFO OUN CWA. They increased confidence in short-term forecasts and allowed for enhanced information for graphical and textual products.Also, they improved interactive DSS via Facebook, Twitter, webinars, and NWSChat. These high-resolution mesoscale models enabled forecasters at WFO OUN to include life-saving information in their products and services, resulting in fewer fatalities and injuries. As high resolution models continue to evolve, with improving spatial and temporal resolution, so too will the role of the NWS meteorologist as a decision support specialist and forecaster.