14.10 NEXRAD Product Improvement - Improving NWS Tornado Warnings

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1. INTRODUCTION

The NEXRAD system's fundamental mission requirement is to reduce loss of life, injuries, and property damage due to severe weather. Specifically, the radars were designed to improve over the legacy NWS weather radars by: increasing accuracy and resolution, providing Doppler wind information, and improving data distribution to users. As the NEXRAD capabilities continue to evolve through the NEXRAD Product Improvement (NPI) program [1], it is important to validate that system changes are providing improvements to this mission. While radar information is just one component, it is critical to a successful severe weather warning program. The NWS bases its programmatic justifications for NPI funding on the impact that NEXRAD improvements will have on accuracy and lead times for tornado, severe thunderstorm and flash flood warnings. Specific values for these NWS performance parameters are included in the Department of Commerce performance goals under the Government Performance and Results Act of 1993 (GPRA). The current NWS tornado warning GPRA goals are presented in Figure 1.

2. NWS TORNADO WARNINGS IMPROVEMENT TEAM

Figure 1 (next page) includes proposed modifications to the original goals, based on an NWS team's analysis of past years performance and planned improvements to the NEXRAD functionality under the NPI program. This team recommended that tornado warning improvement efforts in the near term (2002 - 2007):

- Focus on observational systems
- Enhance existing systems
- Optimize operations
- Increase MIC involvement
- Improve data assimilation and analysis

The team further stated that the most urgent technology improvements in the near term were:

- WSR-88D Upgrades
- AWIPS Upgrades to optimize performance
- WES upgrades to improve on-station training
- Integration of FAA radar data

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- Data density increase (temporal and spatial)
- Data assimilation/analysis improvements

The team's longer term recommendations included:

- Continuing enhancement of existing systems
- Integration into WFO operations of storm-scale models
- Integration of quantitative satellite
- Integration of total lightning mapping data
- Increased data resolution
- Phased array radar upgrade to WSR-88D

3. ADDRESSING NWS TEAM RECOMMENDATIONS

3.1 ORPG Functionality Enhancements

The Open Systems Radar Product Generator (ORPG) upgrade to the WSR-88D has been completed [2]. The NEXRAD agencies are now focused on implementing functionality enhancements that have been enabled by the ORPG [3]. The first enhancements (full resolution data array products for reflectivity and velocity, high speed communications link to AWIPS) were implemented in parallel with the final deployments of the initial ORPG units, finishing in July 2002. The full resolution velocity products paid off immediately in Iowa and Missouri with better detection of small tornadoes that might not have had positive lead time with previous products. Figures 2 and 3 depict full resolution velocity products for these two tornadoes.

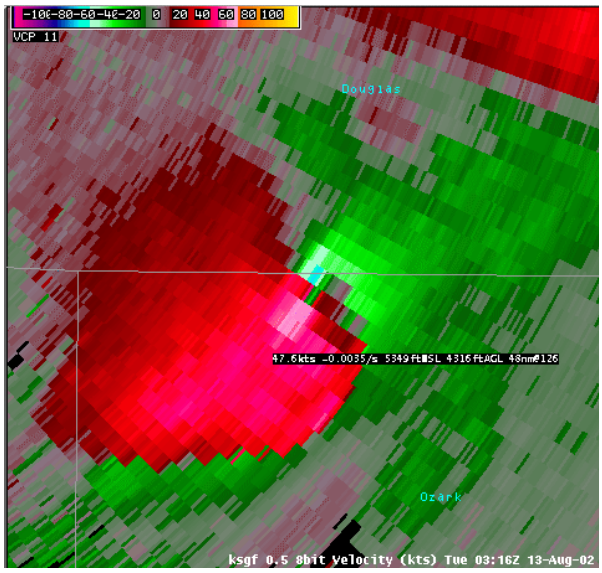

Figure 2. Wasola, MO, F1 Tornado. High Resolution Base Velocity Image Displayed on AWIPS

		98	99	00	01	02	03	04	05	06	07
Lead Time	Actual	11	12	10	10						
Minutes	Goal	12	11	12	13	13	13	14	14	14	15
	Proposed					11	11	12	13	13	14
False Alarm	Actual	80	73	76	72						
(FAR)	Goal		72	65	73	72	70	68	66	65	64
	Proposed					71	70	70	69	69	68
Accuracy	Actual	66	70	63	67						
(POD)	Goal	68	70	70	68	69	70	71	72	73	74
	Proposed					69	70	71	73	73	74

Figure 1. NWS GPRA goals, and proposed adjustments, for Tornado warnings.

Over the next two years, other ORPG enhancements will include:

- rapid updates of mesocyclone and tornadic vortex signature information at each elevation cut rather than waiting for the end of a volume scan
- user selectable layers of reflectivity to enable a forecaster to focus on particular altitudes in storms
- hodograph displays using VAD Wind Profile data, for storm relative helicity updates
- full resolution storm relative velocity displays
- incorporation of data from FAA radars (Figure 4) [4]
- improved mesocyclone detection algorithm
- high resolution VIL and Echo Tops
- boundary detection and projection algorithms
- a new VCP for faster updates of volume information, with increased vertical resolution for longer ranges (Figure 5)

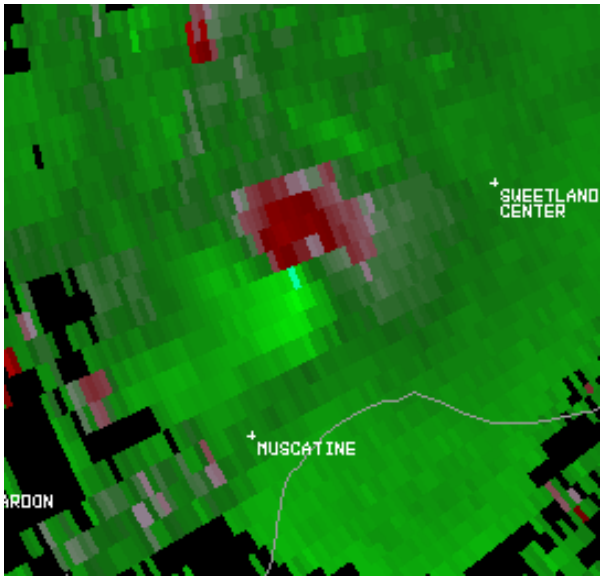

Figure 3. Muscatine, IA, F1 Tornado. High Resolution Base Velocity Image Displayed on AWIPS.

3.2 ORDA Functionality Enhancements

The Open Systems Radar Data Acquisition (ORDA) [6] module of the WSR-88D is in production development,

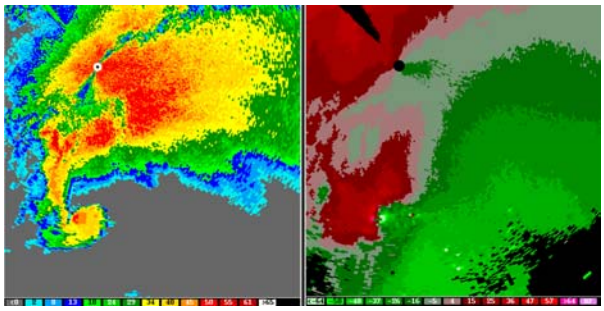

Figure 4. FAA TDWR data for May 3, 1999 tornado.

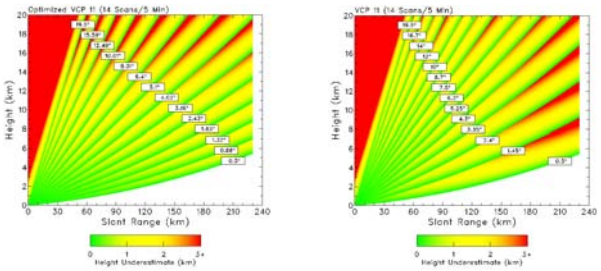

Figure 5. New VCP 77 versus current VCP 11.

and will be deployed in 2004 - 2005. The ORDA will bring state-of-the-technology digital signal processing capabilities to WSR-88D that will directly support improved tornado warnings through dramatic improvements in data resolution, data quality and volume update speeds. The planned ORDA functionality enhancements [5] will quickly follow the deployment of the initial ORDA units, and will include:

- ½° base data radials and 1/4 km reflectivity range resolution (Figure 6)
- range & velocity ambiguity mitigation to recover velocity information from areas which are currently obscured by range folding (Figure 7)
- over-sampling in range to enable faster scanning and/or increased angular resolution without degrading accuracy
- full power spectrum processing to recover within-beam velocity signatures and to better discriminate between weather and non-weather scatterers

- extension of Doppler processing to end of 2nd trip to utilize the velocity data between 230 km and 280 km that are currently lost

4. SUMMARY

The NWS is committed, along with its NEXRAD partners, to continually evolve the WSR-88D system to enhance its support to critical missions such as tornado warnings. The planned ORPG and ORDA functional enhancements will have a large impact on improving data quality and increasing tornado warning lead time. Future efforts for Dual Polarization and Phased Array Radar will continue to improve the WSR-88D data quality, scientific value and data timeliness.

REFERENCES

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[3] Near Term Planned Mission Enhancement for the WSR-88D Open Radar Product Generator, Simensky, J., R. Saffle, M. Istok, 18th IIPS, paper 5.4

[4] Analysis and Plans for Using FAA Radar Weather Data in the WSR-88D ORPG, Stern, A., P. Pickard, W. Blanchard, B. Bumgarner, M. Istok, 18th IIPS, paper 5.6

[5] Weather Surveillance Radar – 1988 Doppler (WSR-88D) Enhancements, Elvander, R., 17th IIPS, paper 3.4

[6] NEXRAD Product Improvement - Status of Open Radar Data Acquisition (ORDA) Program, Cate, G., R. Hall, M. Terry, 19th IIPS, paper 2.2

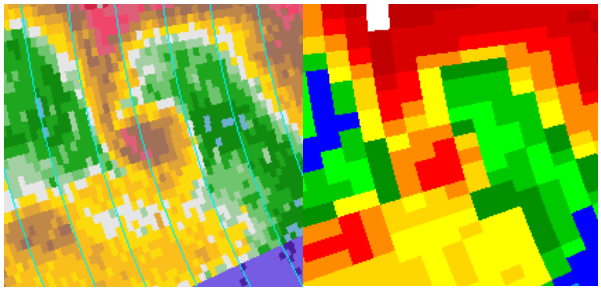

Figure 6. ORDA ½ ° by 1/4 km Reflectivity data versus current 1° by 1 km data for a May 3, 1999 tornado.

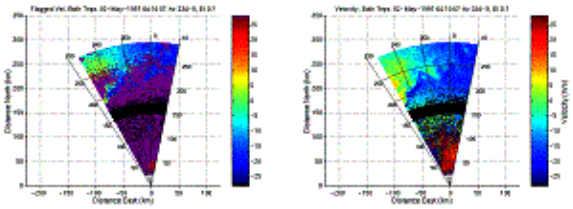

Figure 7. Current, range folded velocity data versus recovered velocity with ORDA range folding mitigation.