9A.1 Another update on the NATIONAL WEATHER RADAR TESTBED (PHASED-ARRAY)

Douglas E. Forsyth[1]*, James F. Kimpel[1], Dusan S. Zrnic[1], Ron Ferek[2], John F. Heimmer[7], Tom McNellis[3], Jerry E. Crain[4], Alan M. Shapiro[4], Richard J. Vogt[5] and William Benner[6]

[1]National Severe Storms Laboratory (NSSL), [2]Office of Naval Research (ONR), [3]Lockheed Martin Corporation, [4]University of Oklahoma (OU), [5]Tri-Agencies' (Dept. of Commerce, Defense & Transportations) Radar Operations Center, [6]Federal Aviation Administration (FAA), [7]Basic Commerce & Industries, Inc (BCI).

1. INTRODUCTION

We have finished our third year of testing of a new research radar called the National Weather Radar Testbed (NWRT). Located in Norman, OK, this 10-cm phased array radar is designed for use in studying and developing a multifunction radar with the capability to perform aircraft tracking, wind profiling and weather detection at the same time. As reported at several Interactive Information Processing Systems (IIPS) conferences, (Forsyth, 2002, 2003, 2005, 2006, 2007), the NWRT was developed by a government/university/ industry team represented by the co-authors plus the Oklahoma State Regents for Higher Education. The NWRT became operational in September 2003, and the first data were collected in May 2004. Engineering tests were completed in 2004. Several data sets have been collected during the 2007 storm season. Current efforts are concentrating on analysis of recently gathered fast scan data, improved signal processing and investigating changes to algorithms in order to run on fast scan data. In this paper, we will describe the present status and research progress, and structure of the NWRT Facility Advisory Panel.

2. CURRENT STATUS

With the completion of the Engineering Phase in 2004, and after two very limited spring data collections, we ran several experiments using the NWRT during the Spring 2007. A summary of those experiments follow (Forsyth, 2007):

a. Adaptive scanning and Radar Client Interface (RCI). Using phased array technology, a user has the capability to rapidly scan targets of interest as well as perform the traditional volume scan. The RCI and Real Time Controller software can be modified to satisfy these capabilities, but currently this is done in a manual mode. In the future, we would like this to be automated to the point that an algorithm could decide its own optimum scan strategy.

* Corresponding author address: Douglas E. Forsyth, Chief, Radar Research & Development Division, National Severe Storms Laboratory, 120 David L. Boren Blvd, Norman, OK, 73072;
email: Douglas.Forsyth@noaa.gov

b. Data Collection. We are continuing to collect data on targets of opportunity and have a goal of collecting at least one event for each weather phenomena for comparison purposes and further development.

c. Techniques Development. Collect data to support research on staggered PRT, beam multiplexing and ground clutter cancellation.

d. Oversampling and Whitening. Collect snapshots of weather and clear-air data to support testing of signal processing techniques under development.

e. Severe weather warning decision making R&D. Support the Hazardous Weather Testbed warning scale activities and provide information to NWS HQ.

f. NWS pre-proof-of-concept experiment. On potentially high-impact severe weather days, provide data to NWS by running the NWRT and displaying data in the Hazardous Weather Testbed.

g. Algorithm work. Develop storm interrogation and warning guidance applications that take advantage of high temporal sampling of potentially severe storms.

h. Refractivity Fields. Retrieve refractivity fields (~moisture) using rapid update of NWRT. Implement real-time version using average I&Q and WDSS-II (Cheong, 2007) and compare to refractivity fields from KTLX.

i. Transverse wind. Implement and test the concept of weather radar interferometry (Zhang and Doviak, 2007) using a switched receiver to alternately sample sum and difference signals.

j. Tracking Aircraft. Using the NWRT to detect aircraft.

k. SMART-R validation & assimilation. Use both SMART-Rs to collect coordinated data sets with MPAR setting up two dual-Doppler networks in OKC area. Coordinate SMART radars to collect data to be used for verification of NWRT data in assimilation experiments and NWRT cross-beam winds

l. Multiple projects. Compare NWRT to WSR-88D baseline, experimental data and mobile radar data.

m. Collect data for comparison to Lidar and X-band radar system. In addition, collect data for comparison to the mobile X-Band phased array system.

3. DATA COLLECTION (NOV 06 – MAY 07)

Date	Radar Status	Moment	IQ	Weather / Comments
11/30/06	Snow Collection	4 hrs	6.6 gbs	via Laptop at home
12/01/06	Snow Collection			Archive
1/12/07	Ice Storm/ Thunder Sleet			
1/13/07	Ice Storm			
1/20/07	Ice Storm			
1/27/07	Snow			
1/29/07	Antenna Pattern Collection			
1/30/07	Antenna Pattern Collection			
1/31/07	Snow			
2/01/07	Snow & Ice			
2/15/07	Snow			
2/20/07	Azimuth Difference Collect		4.9 gbs	
2/21/07	Elevation Difference Collect		4.9 gbs	
2/23/07	Thunderstorms			
3/11/07	Thunderstorms			
3/12/07	Fog			
3/14/07	Wind Field Collection		20 gbs	With Chris Curtis
3/15/07	Wind Field Collection		40 gbs	With Chris Curtis
3/26/07	Rain			
3/27/07	Rain			
3/29/07	Thunderstorms & TVS	2 hrs		
3/30/07	Thunderstorms & TVS	4 hrs	61.4 gbs	
4/10/07	Hail & TVS	2 hrs		
4/13/07	Thunderstorms South		6 gbs	
4/17/07	Rain			
4/24/07	Thunderstorms & Hail	108 mbs	2.2 gbs	
4/30/07	Thunderstorms & Hail			
5/01/07	Thunderstorms	68 mbs	1 gbs	
5/02/07	Thunderstorms			
5/03/07	Thunderstorms	3.321 gbs		
5/04/07	Thunderstorms & TVS	17 mbs	600 mbs	Split cells NW
5/05/07	Hail & TVS			Out of range
5/06/07	Thunderstorms & TVS		20 gbs	Red River & Seminole
5/07/07	Thunderstorms	5 hrs	10 gbs	
5/08/07	Thunderstorms & TVS		115 gbs	El Reno
5/09/07	Thunderstorms		48 gbs	Funnel Cloud recorded
5/10/07	Thunderstorms			
5/11/07	Thunderstorms			
5/15/07	DARE Deployment	5 hrs	60 gbs	Cells to West with SMART-Rs
5/21/07	DARE Deployment	5.5 hrs		Cells NW moving SE
5/24/07	DARE & Balloon Deployment	5 hrs	224 gbs	Squall line WSW
5/30/07	DARE & Balloon Deployment	2.5 hrs	53 gbs	Squall line W mvg rapidly SE
6/01/07	DARE & Balloon Deployment	3 hrs	41 gbs	MCS NW mvg SE

Table 1. Summary of Data Collection for 2007. Moment data (Reflectivity, Mean Velocity, and Spectrum Width). I/Q data are raw data collected before moments are calculated. (DARE = Data Assimilation Resolution Experiment, gbs = giga-bytes, mbs = Mega-bytes, MCS = Mesoscale Convective System, mvg = moving, TVS = Tornadic Vortex Signature)

4. RESEARCH PROGRESS and PLANS

We now have a new and improved version of the Matrix PC. The system consists of 6 nodes using dual 3 GHz processors with a 10 gigabyte/sec Ethernet backbone. This version runs over 150 times faster then our previous version. This increased capability allows us to implement oversampling and whitening algorithms on the system with excess capacity available for many other improvements.

In addition, we are looking at building a dual polarized sub-array to investigate the dual polarization characteristics of such an array We are also working on modifying the Real Time Controller (RTC) in order to implement adaptive scanning (Priegnitz, 2007). Adaptive scanning will allow analysis algorithms to control the scanning functions of the radar and thus increase the efficiency in identifying severe weather.

An additional hardware upgrade will include an Uninterruptible Power Source for the NWRT. This will allow power transfers from commercial to generator and back without human intervention. Also, this will smooth out many of the power clichés that requires a reset of the power converter (Converts 240 volts, 60 Hz to 400 volts, 450 Hz).

An additional hardware upgrade is being led by the University of Oklahoma (Yeary, 2008) with a grant from the National Science Foundation for developing a multi-channel receiver suite to process monopulse and auxiliary antenna signals for tracking and cancellation algorithms. Implementation should be completed in 2009.

In addition to hardware upgrades, we are continually improving our ability to display the fast scan data (Lakshmanan, 2007) and process it with various detection algorithms. An additional area of research is the use of decision aids that will be required when using the fast scan data received from the phased array radar systems.

We continue to run comparisons between the WSR-88D and NWRT. In addition, we have started the analysis of the May 29, 2004 tornadic storm and other low-altitude circulations obtained with the NWRT (Heinselman, 2008). We are using our Visualization Lab to display the data in four-dimensions using Unidata's Integrated Data Viewer and Geowall technology (Figures 1 and 2).

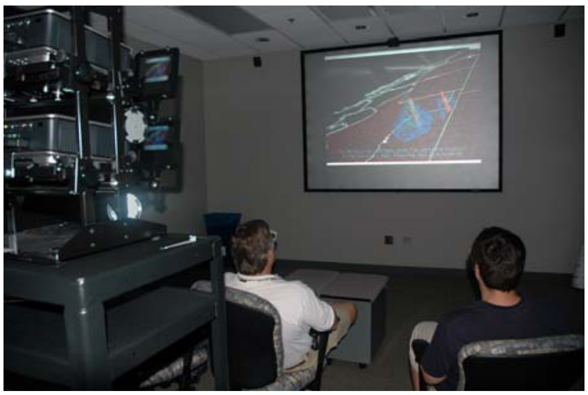

Figure 1. Picture of Visualization Laboratory using Geo Wall technology.

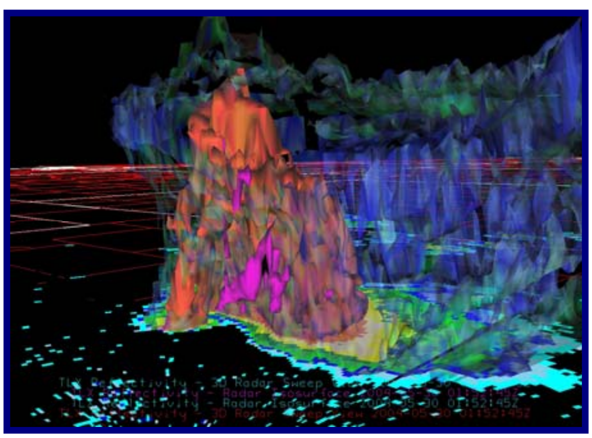

Figure 2. Three dimensional representation of a Supercell near Oklahoma City on 20040530-015245Z using Unidata's Integrated Data Viewer and KTLX Level II data. Blue transparent iso-surface = 15 dbz indicating the threshold of precipitation, red – 50 dbz and highlights areas likely to contain hail, magenta represents areas of azimuthal shear.

With the proliferation of wind farms, a study is ongoing on how to mitigate the interference with the WSR-88D (Vogt, 2008). A new study will look at how the phased array radar might further help mitigate this interference.

5. NATIONAL FACILITY

As part of a Memorandum of Understanding between NOAA, Navy, FAA and OU, the NWRT is now a national facility allowing access to the broader research community for use in testing and advancing our understanding using phased array radar. To implement this national facility, a new user interface was developed to allow the operation of the NWRT from anywhere there is a network connection. Also, a NWRT Assessment Panel has been formed to evaluate and regulate the use of the NWRT. Current members are Jeff Kimpel and Doug Forsyth (NOAA), Jim Williams and Bill Benner (FAA), Ron Ferek and Scott Sandgathe (Navy) and Mark Yeary and Robert Palmer (OU). Details on how to apply for use of the NWRT are located on our web site: http://www.nssl.noaa.gov/research/radar/nwrt_use.php
The intent is to charge only for costs exceeding basic NWRT support costs.

6. ACKNOWLEDGMENTS

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