6B.2 Research and Development continues at the National Weather Radar Testbed (Phased-Array)

Douglas E. Forsyth[1], Dusan S. Zrnic[1], Ron Ferek[2], John F. Heimmer[7], Tom McNellis[3], Jerry E. Crain[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]PARTECH

1. INTRODUCTION

We continue research and development on the National Weather Radar Testbed (NWRT) in Norman, Oklahoma at the National Severe Storms Laboratory. Since 2003, we have been evaluating phased array technology for use as weather radar and multi-function radar (Zrnic, 2007). As a result of the partnership between the National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, the United States Navy's Office of Naval Research, Lockheed Martin Corporation, the University of Oklahoma's Electrical and Computing Engineering Department and School of Meteorology, the Oklahoma State Regents for Higher Education, the Tri-Agencies' (Department of Commerce, Defense and Transportation) Radar Operations Center, the Federal Aviation Administration's Technical Center and Basic Commerce and Industries, Inc, the National Weather Radar Testbed (NWRT) is providing both meteorological and aircraft surveillance data. In addition, the NWRT has become a testbed for signal processing advancements applicable to agile beam radars as well as classical systems. The system continues to play a role in the education of the forthcoming generation of radar meteorologists and engineers.

The testbed continues to provide valuable data on weather events and to demonstrate the advantages of using phased array technology (Forsyth, 2010, Forsyth, 2011, Forsyth, 2011). Participation by National Weather Service forecasters has expanded our knowledge concerning the benefits of fast scanning radars. The Digital Signal Processor (DSP) and Real Time Controller (RTC) have been modified in order to test advanced scanning strategies. Risk reduction activities in collaboration with the FAA are being pursued. In this paper, we provide further details on MPAR activities, an update of the 2011 data collection inventory and a brief summary of our future plans.

2. NWRT ACTIVITIES

It has been 12 years since the start of this activity and 8 years of constant improvements in capability and data quality. The NWRT has collected research data since May 29, 2004. The powerful DSP has allowed several new techniques to be tested in real-time including oversampling (Curtis, 2011), CLEAN-AP (Warde, 2010) and noise estimates at each radial (Ivic, 2011). The NWRT has become a radar for testing various scanning strategies including automated storm-based and has moved closer to fully automated adaptive scanning (Torres, 2011)

As new capabilities are implemented, new user interface capabilities are added to the RCI to facilitate data collection and operations. Some of the latest changes has included adaptive pedestal control and base-data display (Priegnitz, 2012) (Figure 1).

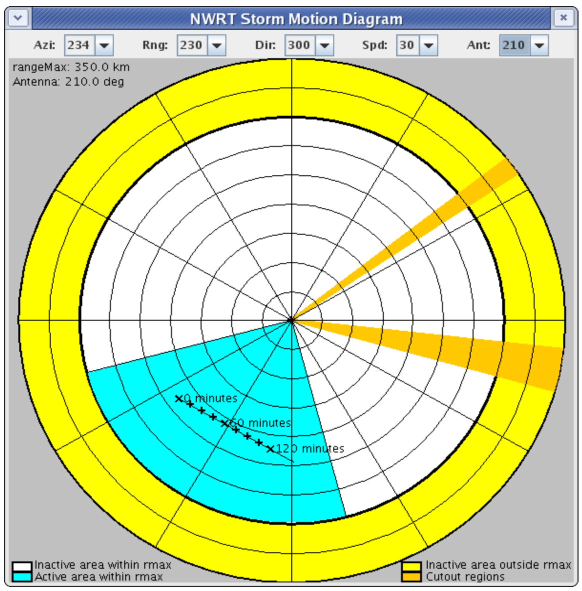

Fig 1. One of the new user interfaces supporting the adaptive scan functions on the NWRT.

Working with Lockheed Martin and the U.S. Navy, we obtained SPY-1A spare parts from the decommissioned Navy Ships York and Gates (Figure 2). The heavy lifting was accomplished by Mark Benner and Mike Schmidt.

* 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

Fig 2. Decommissioned York and Gates. Two closest to the Dock

Other improvements include adding Level-I data recording using Hierarchical Data Format (HDF-5) and additional metadata to facilitate playback of archived data with original processing settings.

Data Collection has continued on targets of opportunities with over 16 terabytes of data including 13+ terabytes of I&Q data being archived for research purposes. The archive now contains:

Supercells	31 -16 Tornadic
MCS	36 - 3 Tornadic, 8 severe winds
Pulse	24 - Microbursts, weak and strong
Scattered	15
Other (isolated or Linear, not MCS Scale	4 – 2 Severe

3. DATA COLLECTION (JAN 2011 – DEC 2011)

Date	Collection Type	Moment Archived	IQ	Weather / Comments
2/1/2011	Snow Blizzard	15G	306G	
2/9/2011	Snow Blizzard	16G	327G	Foot deep
2/24/2011	Segments QLCS	3.7G	77G	No Reports
2/27/2011	Isolated Supercell	4.7G	108G	TVS, Hail/Tornado
3/8/2011	Linear Thunderstorms	1.5G	35G	No Reports
4/14/2011	Supercells	5.2G	118G	TVSs/Hail
4/19/2011	Supercell	1.3G	33G	Distant TVS, Hail
4/22/2011	Tornadic Supercell	7.9G	175G	TVSs, weak tornado
4/23/2011	Severe Thunderstorms	700M	15G	Large Hail
4/24/2011	Parts of MCS	3.3G	71G	Hail
5/1/2011	Rain Showers	5.0G	114G	Rainfall est.
5/12/2011	Developing Line	4.4G	100G	Hail
5/19/2011	Tornadic Supercell	8.9G	106G	TVSs,Tornado & Wind
5/20/2011	Part of morning QLCS	3.5G	83G	Heavy Rainfall
5/22/2011	Isolated Supercells	1.9G	45G	Two TVS's; Tornado Byars, OK
5/23/2011	Onset Tor Outbreak	4.9G	109G	
5/24/2011	Tornado Outbreak	5.1G	117G	Long-track EF3-5
6/10/2011	Bowing segment	6.0G	143G	One wind report 2330 UTC Caddo County.
6/14/2011	Significant Microbursts	2.0G	55G	Reports came in within 20 min after radar went down.
6/16/2011	Isolated Severe Storm	4.9G	137G	Large Hail Altus
6/18/2011	Storms along bndry	2.5G	77G	Distant Storms
6/19/2011	Thunderstorms	1.2G	37G	Contains same images as 06/18/11 on webpage.
6/20/2011	QLCS	2.3G	47G	wind/hail
8/11/2011	Clear Air	3.0G	68G	Ops Check
8/12/2011	Severe Multicell Storms	5.8G	140G	Wind and hail
8/24/2011	Thunderstorms	769M	20G	Distant; some linear organization
10/8/2011	Squall Line	2.3G	49G	Transition to stratiform-only precipitation
10/9/2011	Rain Bands	2.2G	22G	Conv. Elements w/in MCS
10/22/2011	Severe Thunderstorms	5.5G	137G	Hail and wind. Scattered severe storms develop into organized QLCS
11/7/2011	Severe Thunderstorms	12G	71G	Tornado, wind, hail; Multiple supercells evolve into a QLCS

Table 1. Summary of Data Collection for 2011. Moment data (Reflectivity, Mean Velocity, and Spectrum Width). I/Q data are raw data collected before moments are calculated. (G = giga-bytes, M = Mega-bytes, TVS = Tornadic Vortex Signature)

4. MPAR ACITIVITES

Risk reduction activities continue in the MPAR program. Most of the current effort is concentrated on building dual-polarization phased array elements/panels (Figure 3). Several efforts are in progress including work funded by the FAA and Air Force at MIT LL, NOAA funded work at BCI and OU.

Within the next two years, we should have reduced this risk to a satisfactory level.

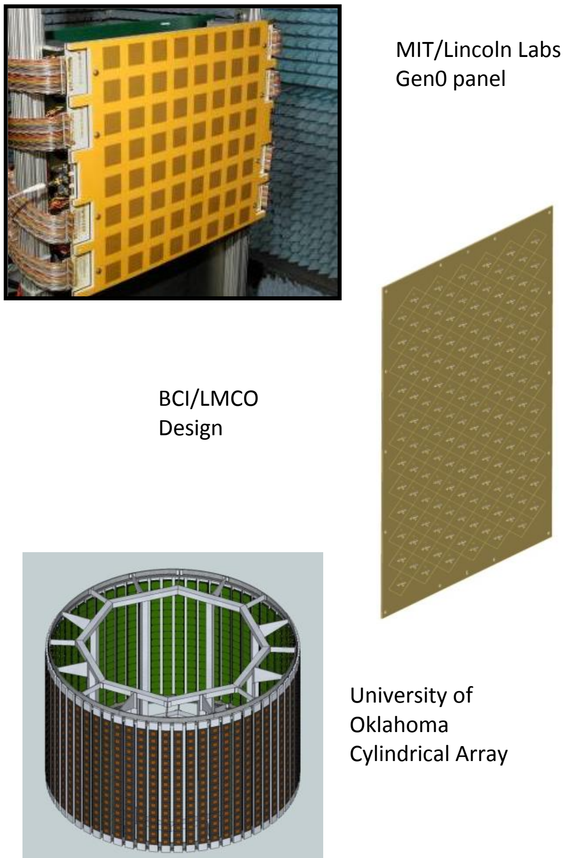

Fig 3. Examples of dual-polarized panels

Reduction in the projected cost of building an MPAR continues to diminish and has decreased at a faster rate than expected. An original estimate of having to use five watt elements has been exceeded 10 to 15 times with the development of 50-75 watt elements. Thus, concern for obtaining the required sensitivity of the radar has been eliminated.

The remaining risk reduction of the top three risks is the multi-function operation of the radar and thus proving that a single radar can do the job of multiple radars and meet the mission requirements of each agency still needs to be accomplished. This will require a prototype of some sort to fully reduce this risk.

5. SUMMARY OF FUTURE PLANS

We are coming closer to solving the fast PRT change problem on the NWRT that is limiting our ability to test some scanning strategies and to reduce the 10 Km blanking around the radar. Scanning strategies to be tested next year include very rapid surveillance scans followed by more comprehensive scans where weather is occurring. Work will continue on clutter mitigation and use of the multi-channel receiver. Work will also continue on the use of pulse compression and comparison and trade-offs of simultaneous transmission of H & V verses alternate transmission.

We will continue to collect data on targets of opportunities with some collection in support of scheduled field programs. The PARISE 2012 (Heinselman, 2011) is designed to identify key judgments and decision points of expert forecasters. Information collected will allow researchers and system designers to focus efforts in visualization and tools that support cognitive tasks of operational forecasters.

MPAR activities will include the testing of various dual-polarization phased array panels and risk reduction activities jointly identified with the FAA.

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