11.1 Status Report on the NATIONAL WEATHER RADAR TESTBED (PHASED-ARRAY)

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1. INTRODUCTION

An exciting new research tool is now operational in Norman, Oklahoma. The National Weather Radar Testbed (NWRT) is a 10-cm phased array radar 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), the NWRT was developed by a government/university/ industry team consisting of the National Oceanic and Atmospheric Administration's National Severe Storms Laboratory (NSSL), the Tri-Agencies' (Department of Commerce, Defense & Transportation) Radar Operations Center (ROC), the United States Navy's Office of Naval Research, Lockheed Martin Corporation, the University of Oklahoma's Electrical and Computer Engineering Department and School of Meteorology, the Oklahoma State Regents for Higher Education, the Federal Aviation Administration's William J. Hughes Technical Center and Basic Commerce and Industries, Inc.. The NWRT became operational in September 2003, and the first data were collected in May 2004. Several data sets have been collected during the limited 2005 storm season. Current efforts are concentrated on improving the scanning speed through beam-multiplexing (Orescanin, et.al. 2005), implementing dual weather and aircraft tracking capability, and preparing the system for remote operations. In this paper, we will describe the present status, research progress, and plans on how to exploit the unique capabilities of electronic beam steering on the NWRT.

2. CURRENT STATUS

We have now completed the Engineering Phase of getting the NWRT operationally stable and providing good estimates of reflectivity, velocity and spectrum width. The early velocity errors have been corrected and subjective and objective comparisons to the WSR-88D look good. The hardware system has been very stable with only minor problems with the air handling and chiller components. We have recently learned that the manufacture of the Environmental Processor (EP) hardware will no longer supply that hardware, so we have started a parallel development using a Matrix PC system to handle the EP functions.

3. DATA COLLECTION

Data collection with the NWRT has been episodic. We have collected a total of 30 hours of data for engineering tests, weather observations and system checks. We have archived both I&Q (raw) and moment (Universal Format (UF)) data. See Table 1. for a summary of our significant data collections in 2005. We had hoped to collect several tornadic cases, but the Spring season in Oklahoma was very quiet.

Date	Radar Status	# UF's	H:M:S	# I/Q's	H:M	Weather / Comments
03/21/05	Test Beam Mult, Wx collection OPS	270	2:15:00	20	1:50	Weak TVS in SVR WX
04/10/05	Data collection	150	1:15:00			No TVS, turned into routine storm
05/08/05	Data collection	141	1:10:30			No TVS, routine storms
05/13/05	Data Collection	93	0:46:30	6	1:55	Strong Storms
05/14/05	Data Collection	146	1:13:00			
05/26/05	Dr. Palmer collection, W2 upgrade, tour	122	1:01:00			ground clutter collection
06/04/05	Data Collection	237	1:58:30	1	:15	Post TVS with RTC problems
06/09/05	Data Collection, tour	145	1:12:30	7	1:24	Weak Meso
06/10/05	Data Collection, tour	165	1:22:30			
06/12/05	Weekend, data collection	278	2:19:00	19	2:03	Straight Line Gust Front
06/13/05	Data Collection	291	2:25:30	3	1:02	Shear
06/16/05	Data Collection, system problems	161	1:20:30	3	:33	High cape, strong winds,
06/22/05	BCI Operations, W2 collection	16	0:08:00	2	:10	Tim Maese testing
06/23/05	Data Collection			1	:10	beam mult collection
06/24/05	Data Collection	20	0:10:00	2	:10	ground clutter
06/29/05	Data Collection for BCI, tour	11	0:05:30			
09/07/05	Data collection	68	0:34:00			Boundary Layer Experiment
09/16/05	Data collection			9	:45	BCI Balloon1,
09/19/05	Data collection			7	:35	BCI Balloon2, 1
09/28/05	Data Collection	11	0:05:30			ground clutter
09/30/05	Data Collection, tour	83	0:41:30	4	1:00	Boundary Layer, Lightning tracking

Table 1. Summary of Data Collection for 2005. UF is Universal Format data files containing Moment data (Reflectivity, Mean Velocity, and Spectrum Width). I/Q data are raw data collected before moments are calculated. (TVS=Tornadic Vortex Signature, RTC=Real Time Controller, Meso= Mesocyclone)

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4. RESEARCH PROGRESS and PLANS

Now that we have determined that the data quality is comparable to the operational radars, we are proceeding with some initial research. One topic involves increasing the data collection speed by the use of beam multiplexing. The idea is described by Orescanin, et.al. (2005). In addition, we have concentrated on implementing a remote operational capability (Priegnitz and Forsyth, 2006). This is needed not only to make the NWRT a truly national facility, but to allow NSSL to operate the NWRT from its new facility at the National Weather Center. The NSSL plans to move to this new facility sometime in April 2006.

Another area of improvement is to add the capability to process the data radial by radial. Currently, the system collects a pseudo volume scan (defined by the user) and the data is processed when the end of volume is obtained. The radial-by-radial processing will allow more flexibility in displaying and processing the data with algorithms.

BCI, in support of the FAA has installed and tested an aircraft tracking processor that runs independently from the NWRT using the same I/Q stream supplied to the EP. Thus, we have started to test the multi-function capabilities of the NWRT.

We continue to investigate improved display methods for phased array data and to modify current radar algorithms to process the NWRT data stream. One new product is the rotation tracker (Smith and Elmore, 2004). This particular product allows the users to see the increase and decrease in shear over time.

We are also pursuing an automated method to keep the NWRT calibrated, along with implementation of ground clutter canceling and range and velocity unfolding.

Finally, we continue to investigate the possibility to implement a dual polarized sub-array (Katz, et.al., 2006) in order to determine the feasibility of using dual polarized active arrays for design of the multi-function Phased Array (MPAR) system.

5. ELECTRONIC BEAM STEERING (EBS)

Some of the advantages in using electronic beam steering include the ability to share any given scan with any given task and to quickly change the scan strategies to accommodate the needs of various tasks, i.e. aircraft tracking, weather phenomena identification, wind profiling, etc..

The EBS also allows the beam to follow the terrain to minimize ground clutter. The beam can also notch out various buildings/structures to minimize RF exposure where required.

One can easily make a quick surveillance scan and then return to the targets that are most important to obtain fine scale data with improved space and time resolution.

One could also design scans that concentrate on various phenomena such as precipitation measurements and wind measurements.

These are but a few of the advantages envisioned for EBS. We are certain there are many more uses that have not been detailed in this paper. We do plan to test the EBS ideas presented above.

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