14A.2 National Weather Radar Testbed (Phased-Array): An outstanding platform for research and development

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1. INTRODUCTION

The National Weather Radar Testbed (NWRT) (Forsyth, 2009, 2010, 2011) has continued its research and development role as the multi-function phased array radar testbed in Norman, Oklahoma. Developed as a result of a 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 (FAA) Technical Center and Basic Commerce and Industries (BCI), Inc., the NWRT continues to provide both meteorological and aircraft data for testing the concept of a multifunction phased array radar system. In addition, the NWRT has become a testbed for signal processing advancements and continues as an important component in the education of the forthcoming generation of radar meteorologists and engineers.

The testbed continues to provide important data on severe weather events and to demonstrate the advantages of using phased array technology (Zrnic, 2007). Participation by National Weather Service forecasters has expanded our knowledge concerning the benefits of fast scanning radars. New scanning strategies are being tested every year. In addition, our work on risk reduction continues on dual polarized phased array radars. In this paper, we will elaborate on our accomplishments and describe future work using the NWRT.

2. CURRENT STATUS

We have continued to make improvements to the NWRT since first collecting data in 2004. The improvements have allowed us to make more "apples to apples" comparisons with the current WSR-88D system and to improve our research capabilities.

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We have continued to make improvements in the areas of data acquisition, data archive and error reporting and handling. In addition, the hardware was seamlessly upgraded to expand the computational power from 8 to 16 processors.

Various techniques including staggered PRT (Warde, 2009), CLEAN-AP (Warde, 2010) (an automated algorithm for eliminating anomalous propagation) and noise estimates at each radial have been tested in real time using the increased processing capacity of the NWRT.

The system now uses a scan table (Torres, 2011) instead of super-STIMS to control the radar. With the super-STIMS, only a single scan strategy could be active and the stimulus stack had to be prebuilt and stored in files and was not modifiable in real-time. With the scan table, up to 10 scan strategies can be loaded and scan properties can be modified in real-time. The actual stimulus stack is built in real-time by the Real-Time Controller (RTC). To aid the operator in changing the scan properties, a range/height tool was added to the Radar Control Interface (RCI) (Fig. 1).

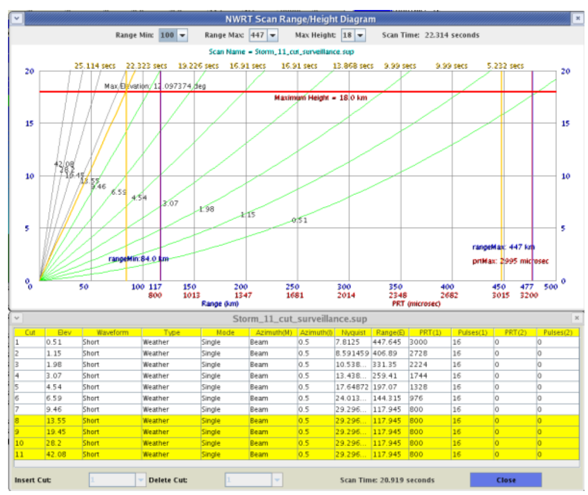

Fig 1. Range Height Table showing the effect of setting the minimum range to 84 km.

These improvements have allowed the radar operator to test various adaptive scan ideas and to modify the scanning strategies in real-time. These new adaptive scanning capabilities were used in the Phased Array Radar Innovative Sensing Experiment (PARISE).

The MATLAB signal processing environment was developed and has been maintained to allow for fast implementation, testing and validation of new techniques. These improvements include ground clutter filtering, adaptive oversampling techniques and automating the noise power calibration.

The original range oversampling (Curtis, 2011) processing mode using fixed transformations was upgraded to a true adaptive pseudo-whitening implementation. This improvement has led to scans with significantly faster update rates because of the decreased errors achieved. (Fig 2.)

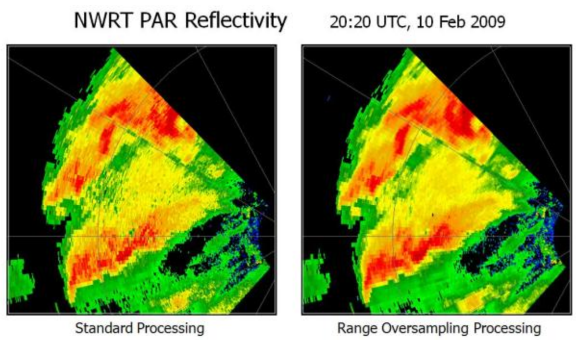

Fig 2. Comparison of Range oversampling with standard processing

Through PARISE, analyses have continued on the impacts of update time on the warning decision making process (Heinselman, 2011) and the strength and limitations of current radar systems (LaDue, 2010)

Studies have included "Lightning Activity in a Hail-Producing Storm observed with Phased-Array Radar" by Emersic, et.al, 2011.. and a study of the April 2, 2010 storm by Newman, et.al., 2011.

An innovative approach to the removal of moving clutter (birds, insects, etc) was proposed (Zhang, 2011) by using the multi-patterns generated through adaptive scanning of the phased array radar.

3. RESEARCH PROGRESS and PLANS

Our work through BCI has continued with tasking them to build and test a 12 by 12 element dual polarized phased array panel with cross-polarization isolation greater than a -40 db. In addition, we are following closely the FAA funded work at MIT Lincoln Laboratories along with the cylindrical array at the University of Oklahoma (OU) and the digital radar work at Purdue and OU.

We continue to work closely with the FAA on risk reduction activities and have been involved in reviewing the FAA Antenna Maturation and Engineering Plan and Backend Analysis and Engineering Plan as part of the FAA's Service Analysis and Concept and Requirements Definition (CRD) leading to an Investment Analysis Readiness Decision (IARD) in 2014

The work on implementing a faster Motorola CPU board for the Real Time Controller (RTC) was completed, but did not solve our digital receiver failures during quick changes of the Pulse Repetition Time (PRT) as hoped. An error in the code that controls the DMA transfers was corrected, but we have encountered another problem with system "slow down" that appears to be network related. We are continuing to trouble shoot this problem.

Additional plans include implementation and testing a surveillance function to run in conjunction with the adaptive scanning algorithm (ADAPTS). The surveillance and tracking function will handle data collection for the ADAPTS based inactive and active beam position respectively. A new processing mode will be added to the Digital Signal Processor (DSP) cluster to handle the surveillance data processing. The scan processing functionality is being migrated from the RTC to the DSP cluster. This will allow for better real-time control of scanning strategies driven by an automatic scheduling algorithm and will lead to more advanced adaptive scanning schemes.

4. ACKNOWLEDGMENTS

We acknowledge the support of our various organizations in funding the NWRT. We especially acknowledge the dedicated work of Bob Staples, Allen Zahrai, Mark Benner, Sebastian Torres, Chris Curtis, David Priegnitz, Ric Adams, John Thompson, Eddie Forren, Igor Ivic, David Warde, and Kurt Hondl for their continued efforts to improve the system. We thank Pam Heinselman, who organized the Spring data collection efforts and collected numerous hours of data. Thanks also to Dan Suppes for maintaining the NWRT data archives. Thanks to all those who helped collect data during 2010 and 2011. Mark Benner, with the help of Mike Schmidt and Richard Wahkinney, continued to maintain the system and we thank Mark, Ric, and Allen for also conducting numerous tours of the NWRT.

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