Phased Array Radar Technology

National Severe Storms Laboratory
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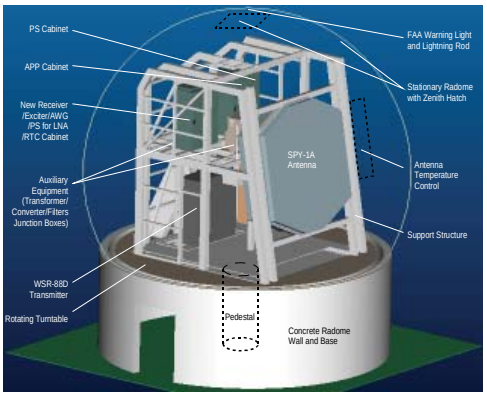
The future of weather radar

NSSL is leading the development of the future generation of weather radars. NSSL and their research partners have adapted Lockheed Martin SPY-1 military surveillance radar technology used on Navy ships to weather detection. NSSL's phased array research radar, the NOAA National Weather Radar Testbed (NWRT) in Norman, OK, has been operational since 2003. NSSL researchers believe the way the NWRT collects data is better for detecting weather hazards.

The NOAA National Weather Radar Testbed

Fast scans and power steering

A phased array radar (PAR) has a unique antenna that collects the same weather information as a WSR-88D radar, but in about one-sixth the time. The PAR antenna has clusters of thousands of transmitters on a flat panel all sending and receiving pulses of energy at one time. This creates a beam that can scan the sky in 30 seconds, producing fast updates of weather data. The PAR can also be directed to re-scan areas of weather as storms develop severe features or as severe weather shows signs of ending. This capability will increase forecasters' warning lead-times and confidence.



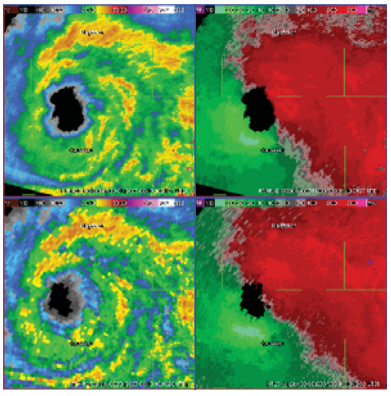
Phased array radar components and configuration

Early detection of hazards

NSSL researchers have confirmed PAR can detect rotation, hail, microbursts and gust fronts well ahead of other radars because it can scan areas so quickly. During the summer of 2006 the NWRT, WSR-88D, and Terminal Doppler Weather Radar scanned four thunderstorms in central Oklahoma. NSSL researchers compared the data from all three radars and found the NWRT detected severe weather hazards several minutes ahead of the other radars. During 2007 and 2008 NWS forecasters evaluated the PAR data for threats of large hail, high winds, and tornadoes, and provided feedback on the operational utility of rapid scan data. Earlier detection of hazardous severe weather using PAR has strong potential to aid forecasters in the forecast and warning decision process, helping to protect the public.

NWRT catches a landfalling tropical cyclone

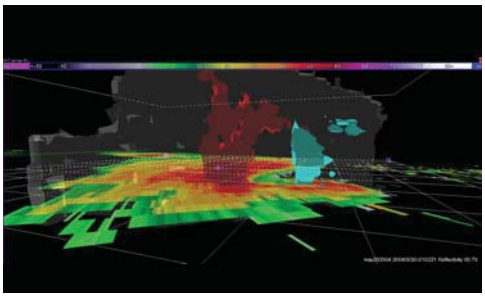
The NWRT had an unusual opportunity in August, 2007 to gather data on a tropical storm, even though the radar is hundreds of miles from a coast. Tropical Storm Erin made landfall on the Gulf Coast of Texas, tracked north, and regained strength in central Oklahoma, well within range of the NWRT. Comparison of data from the NWRT and the Norman WSR-88D nearby revealed the power of PAR's rapid scanning. Using its ability to re-scan areas, NWRT captured the rapid spin-off of tornadoes, and detected these severe weather signatures earlier than the WSR-88D.



T.S. Erin rain bands and "eye" as captured by the NWRT (top) and WSR-88D (bottom)

Forecasters evaluate the new radar data

Visiting forecasters from across the nation have had several opportunities to evaluate PAR data in real-time. Their goal was to to investigate the potential operational benefits of PAR technology. Forecasters evaluated NWRT data for threats of large hail, high winds, and tornadoes, and provided feedback on the usefulness of the more detailed and faster data. Partipating forecasters said PAR technology provided critical data to help determine whether or not to issue severe weather warnings. These evaluations will continue as PAR technology is targeted to replace the WSR-88D radar network.



Phased array radar isosurface image. 3-D contour surface with red indicating the hail core of the storm, blue showing the area of rotation, and grey/black showing the entire thunderstorm structure

Multi-mission capability

As our nation's radars age, NSSL scientists and engineers are looking to the future to address current and anticipated radar needs. NSSL is collaborating with other federal agencies to explore ways to transition from maintaining a number of single-function radar systems, used for aircraft surveillance and weather observations, to a single multi-mission, phased array radar network. MPAR would expand our current weather surveillance network, replace the nation's aging air traffic surveillance radars, and meet homeland security and defense requirements for identifying and tracking non-cooperative aircraft over the U.S. One network of MPAR units, each capable of performing multiple functions, could theoretically replace seven single-function conventional radar networks.

A visualization of the possible multi-mission capability of phased array radar technology

Research Partnerships

A unique federal, private, state and academic partnership is developing the phased array radar technology. Participants include NOAA's National Severe Storms Laboratory and National Weather Service Radar Operations Center, Lockheed Martin, Department of Defense including U.S. Navy and U.S. Air Force, University of Oklahoma's School of Meteorology, School of Electrical and Computer Engineering, and Atmospheric Radar Research Center, Oklahoma State Regents for Higher Education, the Federal Aviation Administration, Department of Homeland Security, Basic Commerce and Industries, and the Office of the Federal Coordinator for Meteorology. The project – from research and development to technology transfer and deployment throughout the U.S. – is expected to take 10 to 15 years.

Payoff: Phased array radar technology has the potential to increase the average lead time for tornado warnings well beyond the current average of 15 minutes to 18-22 minutes. Other technology being developed at NSSL will extend lead times even farther.

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3/2009