MULTI-BEAM EXPERIMENTS FOR THE PHASED ARRAY RADAR CALIBRATION AND SIDELOBE REDUCTION

Guifu Zhang[1], Yinguang Li[1], Richard J. Doviak[2], John Carter[2] and Dave Priegnitz[2]
1: University of Oklahoma, Norman, OK 73072
2: National Severe Storms Laboratory, NOAA, Norman, OK 73072

The Phased Array Radar (PAR) of the National Weather Radar Testbed (NWRT) provides opportunities to study and better utilize radar resources for weather surveillance, aviation control, and target detection/tracking. It has been demonstrated that faster data collection compared with dish-antenna weather radars can be achieved with its pulse-to-pulse beam steering capability. The NWRT/PAR has sum and difference channels that allow the study of spaced antenna interferometry for crossbeam wind measurement and sub-volume inhomogeneity/object detection. However, the variable gain and sidelobe levels have caused some concerns about using the phased array for weather sensing.

The NWRT/PAR dual-scan (mechanical and electrical) capability is a unique feature, allowing concurrent multi-beam measurements (i.e., with boresight and squinted beams). As these beams are mechanically scanned, echoes received through sidelobes are not as coherent as the echoes received through the respective mainlobes because sidelobe amplitude and phase patterns for these beams differ. Thus, by jointly processing the data recorded for various squinted beams (corresponding to different antenna patterns), we suggest that we can distinguish echoes received through the main and sidelobes.

In this study, we formulate the radar equation for PAR calibration and conduct multi-beam experiments. The PAR beam electronically points to five directions uniformly spaced or optimally chosen while mechanically scanning the antenna. Hence, five sets of radar data are collected with one mechanical scan, and then jointly processed. By calculating the standard deviation of the multi-beam measurements, the echoes contaminated by clutter through sidelobes are identified and filtered out. It is found that the multi-beam technique can reduce sidelobe contamination of not only ground clutter but also that of moving targets such as aircrafts. It is also shown that the experiment with optimally chosen beam directions is more effective in reducing the sidelobe effects than that of uniformly spaced beams.