Increasing Observing Capabilities of the NWS with Agile-Beam Polarimetric Phased Array Radar

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Nonconventional application of the polarimetric phased array weather radar is suggested. Namely retrieving environmental winds in the vicinity of storms, profiling winds in the clear atmosphere, and estimating water vapor content in the planetary boundary layer. This is because beam agility enables a high sensitivity mode to be selectively applied in areas of weak reflectivities. The mode has a long dwell time (few seconds) and a high compression-ratio waveform followed by spectral analysis and spatial averaging. The high efficiency (power and pulse compression) is achievable with GaN power amplifiers having ~50 W peak power per element and 10% duty cycles. Therefore, a WSR-88D sized aperture could radiate roughly two orders of magnitude more power than the average on the WSR-88D. In this mode it should be possible to retrieve signals with SNRs of about -30 dB. Use of polarimetry and polarimetric spectral analysis can separate returns from passive wind tracers (insects, or turbulence-induced fluctuations in refractive index) from returns caused by birds and other flying biota. If winds are locally uniform (over several km) the retrieved Doppler velocities can be combined to produce horizontal winds.

Vertical profiles of winds in clear air and cloudy conditions may also be estimated in this high-sensitivity mode. Polarimetric information can be used to censor Doppler winds caused by strong non-passive scatterers. Scanning techniques developed for UHF/VHF wind profiling radars can then be applied to retrieve vertical profiles of winds. The beam agility makes possible rapid switching between the wind profiling mode and the storm surveillance mode.

The proposed high-sensitivity mode may detect Bragg scattering and the associated refractive index structure parameter (C_n^2) profile with height. A bistatic mode for this application offers significant enhancement of detectability because it samples larger size eddies than the monostatic mode.

Technical issues and challenges to make the proposed measurements are addressed.

Keywords: Increasing detectability, Processing, Measurements in clear air