Project Summary

Intellectual merit

We seek to add polarization diversity and make major upgrades to the signal processing, antenna control, and data processing capabilities of an existing C-band mobile Doppler radar to extend the fundamental understanding of frequency dependent back-scattered signal from precipitating cloud systems and to advance scientific knowledge in the areas of cloud microphysics, cloud electrification, storm dynamics, rainfall estimation, and numerical weather prediction. The C-band system will help extend the application of dual-polarimetric observations beyond the Rayleigh scattering regime by utilizing a multi-radar multi-frequency test bed to determine how to exploit or, if necessary, mitigate resonance effects found at C-band. The mobile nature of the platform will provide greater opportunities for sampling a diverse range of atmospheric phenomena than would be afforded by a fixed site instrument. The platform will be based on the existing Shared Mobile Atmospheric Research and Teaching (SMART) radar design that have been successfully deployed in a variety of studies including land-falling hurricanes, desert microbursts, tornadic supercell thunderstorms, and mountain snow storms.

The most significant addition to the SMART radar will be an antenna-mounted receiver (AMR) with a four port dual-position waveguide switch that routes the transmitted pulse through a magic-T to provide a dual-polarimetric simultaneous transmit and receive (STaR) capability. To ensure high signal quality at C-band on a mobile platform, the existing 2.4 m diameter reflector will be replaced with a new reflector that has high cross-polarimetric isolation and low sidelobe characteristics. Given the increased weight and wind loading, a newly rebuilt SCR-584 pedestal with higher torque motors than those on the existing SMART radar will be required. When completed, the polarimetric C-band radar will measure differential radar reflectivity (ZDR), differential phase (Φ_{DP}), and cross-correlation (ρ_{hv}) in addition to the normal spectral moments. We will also be able to record time series (inphase and quadrature components) to generate raw power spectra for each of the range bins in each beam.

Broader impacts

We plan to make use of the new polarimetric radar for research related to: quantitative rainfall estimation in land-falling hurricanes; hydrometeor classification in mesoscale convective systems and supercell thunderstorms; the relationships between cloud dynamics, microphysics, and electrification (making use of the complimentary 3-D lightning mapping system in central Oklahoma); the impact of assimilating polarimetric data in numerical weather prediction; and fundamental interpretation of polarimetric signatures at frequencies that are affected by resonance. The Fifth (Tenth) Prospectus Development Team of the US Weather Research Program identified rainfall estimation during land-falling hurricanes (lighting activity in the urban zone) as a major concern. Both lightning and floods, especially those during hurricanes, yield significant loss of life and represent a profound hazard to the US economy. The radar developed here will help improve rainfall estimates from these storms and others and help provide a transfer standard for the upcoming polarimetric upgrade of the WSR-88D network. With the polarimetric diversity of the upgraded radar and the dual-Doppler afforded with the other SMART radar, we will be able to better define the relationship between cloud dynamics, microphysics, and electrification.

In keeping with the collaborative nature of the SMART radar program, the new polarimetric radar will be made available to other users. Thus, this system will continue to serve as part of the national infrastructure for atmospheric science research and education.