38th Conference on Environmental Information Processing Technologies

7B.6 - A Shared Mobile C-Band Polarimetric Atmospheric Imaging Radar (PAIR)

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Abstract

Fast updates of volumetric radar data have been demonstrated to enhance understanding of fast evolving weather phenomena such as tornadoes, hailstorms, and microbursts, which supports improved warning lead times of severe and hazardous weather events. To achieve fast update time while maintaining data quality, a fast-rotating pedestal accompanied with frequency hopping has been used for a reflector-based radar. For phased-array radar (PAR), a number of different approaches can be used depending on the system architecture and operation mode. For example, beam multiplexing can be used for pencil beam operation, which can provide 2-4 times of improved update time compared to standard pencil-beam operation. An imaging radar can further improve the update time through digital beamforming (DBF). Specifically, an imaging radar can transmit a much wider beam and simultaneously produce multiple narrow receive beams within the illumination of the transmit beam. Up-to-date polarimetric weather observations with imaging technique is limited because of the low number of imaging polarimetric PARs. In this presentation, we will discuss the design and development of a mobile C-band polarimetric atmospheric imaging radar (PAIR), sponsored by the National Science Foundation. PAIR will be available for a wide scientific community after it is commissioned.

The architecture of the PAIR offers unique flexibility of scanning modes resulting in an unprecedentedly fast update time of polarimetric observations. PAIR's electronic subsystems include RF front-end,

transceiver, and digital backend, while the mechanical subsystems include the truck, array enclosure, chiller, and pedestal. PAIR is capable of polarimetric operations in simultaneous transmit simultaneous receive (STSR) and alternating transmit simultaneous receive (ATSR) modes. Further, PAIR offers electronical beam steering in elevation with either pencil beam (highest sensitivity but slower update time) or imaging with different degree of spoiled transmitted beams (i.e., simultaneous RHI scan). It is estimated that using imaging beams in elevation, a 6-10 s update time of volumetric dual-polarization measurements (i.e., 360-degree in azimuth and 20-degree in elevation) can be obtained. Potential scientific applications include the observation of tornadic supercells, microbursts, hailstorms, cloud electrification, and radar aeroecology. Moreover, data from imaging technique can be negatively impacted by lower sensitivity and higher two-way sidelobes, but can be mitigated by using novel methods. For example, imaging techniques allow radar beams to be shaped adaptively for better suppression of ground clutter, interference, etc., and provides improved weather observations. An optimization framework for dual-polarization beam shaping and preliminary results will be presented and discussed.

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