Multi-functional Airborne External Hazard Monitoring Radar with Antenna Diversity

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250-words abstract for review

Under the support of NASA Langley Research Center and other Federal Agencies, the University of Oklahoma is developing airborne radar sensing technology with the goal of simultaneous detection and monitoring of multiple types of external hazards with a single radar platform. This development effort is inspired and motivated by the ground-based Multi-Mission Phased Array program and the National Weather Radar Testbed (NWRT), and has made significant progress toward applying signal processing technologies developed for ground-based array radar systems to airborne sensors. Innovative achievements fall into the following three areas: (1) System development: X or higher-frequency band, light-weight, dual-polarized, dual-frequency antenna array elements are being designed and fabricated, the unified radar receive channels are being tested, low-cost digital receivers are being tested, and in-lab radar emulation tests are being performed. Also, realistic radar signal simulations based on the output from the Advanced Regional Prediction System (ARPS) are extended to airborne radar scenarios to verify high-resolution, short-range airborne sensing concepts; (2) Radar signal processing based on antenna spatial diversity, or array architectures, are achieved through a space-time joint-processing approach. This approach is not only able to measure three-dimensional wind hazards and associated F-factors, but also able to identify multiple types of external hazards based on a joint space-Doppler spectrum; (3) Algorithm development for utilizing polarimetric radar data such as dual-polarization WSR-88d data for hazard detection. The capability to retrieve and display microphysical characteristics including the hydrometeor classification and quantification in near real-time is demonstrated. With such a capability, the sensor is able to conduct more intelligent weather hazard classifications, e.g., discriminating ice content from mixed hydrometer hazards. To support this capability, a polarimetric hydrometeor knowledge base is being constructed on the basis of precision lab-measurements.

100-words on-line abstract

An airborne radar sensing technology for detecting and monitoring of multiple types of external hazards is introduced. Antennas with spatial and polarimetry diversity are adopted in the radar sensor to support the comprehensive hazard monitoring requirements. A knowledge-aided joint space-time processing approach is developed for monitoring wind hazard as well as estimating target direction and Doppler spectrum simultaneously. The hazard microphysics information can be retrieved through polarimetric data processing. In addition to the intelligent processing algorithms, the system design is generated and the tradeoffs are considered, the dual-polarized patched antenna array for airborne radar is fabricated and tested. In-door scattering measurements are performed for hydrometeor knowledge development.