Lightning Initiation Forecasting: An Operational Dual-Polarimetric Radar Technique

Crystal J. Woodard, University of Alabama Huntsville, Huntsville, AL; and L. D. Carey, W. A. Petersen, and W. P. Roeder

The objective of this NASA MSFC and NOAA CSTAR funded study is to develop and test operational forecast algorithms for the prediction of lightning initiation utilizing the C-band dual-polarimetric radar, UAHuntsville's Advanced Radar for Meteorological and Operational Research (ARMOR). Although there is a rich research history of radar signatures associated with lightning initiation, few studies have utilized dual-polarimetric radar signatures (e.g., Z_{dr} columns) and capabilities (e.g., fuzzy-logic particle identification [PID] of precipitation ice) in an operational algorithm for first flash forecasting. The specific goal of this study is to develop and test polarimetric techniques that enhance the performance of current operational radar reflectivity based first flash algorithms. Improving lightning watch and warning performance will positively impact personnel safety in both work and leisure environments. Advanced warnings can provide space shuttle launch managers time to respond appropriately to secure equipment and personnel, while they can also provide appropriate warnings for spectators and players of leisure sporting events to seek safe shelter. Through the analysis of eight case dates, consisting of 35 pulse-type thunderstorms and 20 non-thunderstorm case studies, lightning initiation forecast techniques were developed and tested. The hypothesis is that the additional dual-polarimetric information could potentially reduce false alarms while maintaining high probability of detection and increasing lead-time for the prediction of the first lightning flash relative to reflectivity-only based techniques. To test the hypothesis, various physically-based techniques using polarimetric variables and/or PID categories, which are strongly correlated to initial storm electrification (e.g., large precipitation ice production via drop freezing), were benchmarked against the operational reflectivity-only based approaches to find the best compromise between forecast skill and lead-time. Forecast skill is determined by statistical analysis of probability of detection (POD), false alarm ratio (FAR), Operational Utility Index (OUI), and critical success index (CSI).