Advancing flash flood early warnings using a proxy of polarimetric PAR observations

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Accurate quantitative precipitation estimates at high spatiotemporal resolution is essential for flash flood forecasting, especially in urban environments and headwater areas where basins are small and streamflow gauges are typically sparse. The advent of dual-polarization capabilities for weather radars has resulted in better rainfall rate estimation, as well as improved skill for hydrologic simulations of stream discharge. Conventional WSR-88D radars, however, provide rainfall intensities at approximately five minute intervals that may miss peak rainfall in severe-weather events that develop and evolve very rapidly. On the other hand, phased-array radar (PAR) technology, a potential next-generation weather radar, can provide updates that are at least 4-5 times faster than the conventional WSR-88D scanning rate.

To explore the ability of high-frequency polarimetric PAR observations to provide early flash flood warnings, hydrologic simulations have been conducted using data collected by the polarimetric KOUN WSR-88D radar, which was operated in sector-scan mode in order to collect high temporal resolution data that can be used as a proxy for a polarimetric PAR. The results show that the streamflow generated by rapid-scan KOUN QPE at 1-min temporal resolution better matches stream gauge observations than that generated by traditional WSR-88D 5-min QPE. The unit streamflow from the rapid-scan simulations also produced higher maximum values, indicating that the rapid-scan data’s improved capability to capture flash flooding events. These results highlight the benefit of PAR’s rapid-scan capability to provide early flash flood warnings. In order to evaluate whether polarimetric radar observations improve discharge simulation, the hydrologic simulations forced by a variety of advanced polarimetric rainfall estimators are also compared in this study to observed streamflow and simulations forced by reflectivity-based R(Z) relation.

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