

Assessing the Benefits of a Rapid-Scanning Phased Array Weather Radar

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With NEXRAD now approaching the 30-year mark since its installation, intense study has been underway on designing a replacement national weather radar network in the United States. Because one of the major goals of such a system is to improve the temporal resolution compared to NEXRAD, it is important to understand the impact of rapid updates for a weather radar system, and methods by which rapid updates can be achieved in a phased array radar without sacrificing data quality. Here, we simulate the effects of beam multiplexing and radar imaging, and discuss their viability as scan speedup methods.

In this study, scanning strategies which meet or exceed notional performance requirements for a rapid-scan, operational weather radar system are developed and tested. During the development of these scanning strategies, careful attention has been paid to tradeoffs in spatial resolution, temporal sampling, and data quality. An assessment of the benefits of each scan speedup method is obtained via multiple all-digital phased array radar simulators, including SimRadar. The outputs of these radar simulators are analyzed in a quantitative fashion, by comparing latency times for tornado debris signature (TDS) appearance and comparing data quality estimates. Additionally, preliminary results from an adaptive scanning strategy using a cost function to maximize data quality are shown. This method utilizes estimates of radar moment errors to re-allocate pulses along each radar radial to maximize the number of locations with acceptable error estimates, similar in principle to an adaptive beam spoiling method outlined in Weber et al. (2017). These results are combined to assess feasibility and tradeoffs of various scanning strategies within an operational phased array radar framework.

Keywords: Phased array radar, Radar simulator, Data quality, Rapid-scan radar