

Does Range Oversampling Help or Hurt NEXRAD's Ability to Detect Tornadoes?

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The NEXRAD network routinely produces super-resolution data at the lowest elevation angles of precipitation-mode scan strategies. Super resolution entails finer sampling in range (250 m vs. 1 km) and azimuth (0.5° vs. 1°) and improved azimuthal resolution due to a narrower effective beamwidth ($\sim 1^\circ$ vs. $\sim 1.4^\circ$). The reduced effective beamwidth and the finer spatial sampling of super-resolution data afford improved detection of tornadoes since tornado-vortex signatures get stronger as the ratio between the circulation diameter and the effective beamwidth increases. Because of this, National Weather Service forecasters routinely use super-resolution data as a major input into their warning decision process, especially for tornado warnings.

Because super-resolution's reduced effective beamwidth is achieved by applying a tapered data window to the samples in a dwell, it comes at the expense of increased variances for all meteorological-variable estimates. In fact, super-resolution data do not meet NEXRAD's data-quality requirements; so it is only displayed to forecasters and not used by algorithms, which ingest a "recombined" data stream with legacy-like resolution and quality.

Range-oversampling techniques have the potential to reduce the variance of super-resolution data to match that of legacy-resolution data without increasing the acquisition time. This would enable not only forecasters but also algorithms to benefit from the finer sampling grid and improved azimuthal resolution of super-resolution data. However, range-oversampling processing typically changes the radar range weighting function and could degrade the range resolution.

In this work, we use simulated time-series data for vortex-like fields to quantify the effects of range-oversampling processing on tornado vortex detection using super-resolution data. The results are then analyzed to determine whether super-resolution data produced with range-oversampling techniques help or hurt NEXRAD's ability to detect tornadoes.