

# Impact of Rapid-Scan Radar Data on Vertical Velocity Retrievals from Dual-Doppler Analysis

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Accurate dual-Doppler retrievals of vertical velocity are more difficult than horizontal wind retrievals as radial velocities poorly capture the vertical component of the wind. Prior observational system simulation experiments (OSSEs) have found that a variational dual-Doppler technique that imposes both a mass conservation and vertical vorticity constraint produces superior vertical velocity estimates when the volume scan time is small (~30 secs). A short volume scan time is needed as vertical vorticity tendency needs to be estimated from consecutive volume scans. As advancements in radar technology have made 30-second volume scans a reality, the results from the prior OSSEs can now be explored using actual rapid scan radar data.

RaXPol, a rapid-scan X-band radar, and the Atmospheric Imaging Radar (AIR) were used to collect rapid-scan dual-Doppler observations of a thunderstorm on 4 September 2018 near Minco, Oklahoma. The AIR collected 20 elevation angles every 9 seconds, while RaXPol collected 13 elevation angles every 30 seconds. Additionally, the Shared Mobile Atmospheric Research and Teaching Radar-3 (SR-3) collected vertically pointing observations under the storm to provide a verification profile for the vertical velocity retrieved from the dual-Doppler analysis. Three different dual-Doppler techniques were applied to this dataset: a more-or-less traditional iterative integration technique, a variational technique without a vorticity constraint, and a variational technique with a vorticity constraint. The variational dual-Doppler analysis using a vorticity constraint subjectively and objectively produced the best vertical velocity estimates. The improvements came from a reduction of large magnitude errors at the upper levels of the analysis domain. These results suggest that future dual-Doppler studies should prioritize the use of rapid-scan radar observations so a vorticity constraint can be applied to the dual-Doppler analysis.

Keywords: Dual-Doppler, Rapid-Scan