Impact of Assimilating CASA X-Band Radar Data for 24 May 2011 Tornadic Storms Using Various Microphysics Schemes at 1-km Grid Spacing

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Introduction
- On 24 May 2011, Western and Central Oklahoma experienced an outbreak of tornadoes, including one rated EF-5 (S1) and two rated EF-4 (S2 and S3).
- The extensive observation network across Oklahoma during the 2011 Spring makes this an ideal case to explore model forecast capabilities applicable to the Warn-on-Forecast (WoF) concept (Stensrud et al. 2009, 2013).
- The Center for Analysis and Prediction of Storms (CAPS) real-time forecasting system had good success in simulating these storms, but the impact of assimilating CASA X-band radar data on various microphysics schemes' abilities to simulate the storms and their structure has not previously been examined.
- This study's aim is to examine the effect of assimilating CASA radar data using five different microphysics parameterization schemes on the genesis and evolution of simulated mesocyclones via the updraft helicity (UH) field as compared to each other and reality (i.e., estimated tornado point locations).

Observational Data
- NWS METAR and Oklahoma Mesonet data
- WSR-88D radar data (KTLX, KFDR, KVNX, KICT, KDDC, KFKW, and KINK)
- Collaborative Adaptive Sensing of the Atmosphere (CASA) IP-1 radar data (KCYR, KSAO, KW3, and KRPX)
- Tornado tracks estimated from National Weather Service damage surveys

Model Details
- Advanced Regional Prediction System (ARPS) with IAU assimilation, developed at CAPS
- 323x353-km domain with 53 vertical levels
- 1-km horizontal grid spacing
- Minimum vertical grid spacing of 20 m
- dtdy = 2.0 s and dtdx = 0.5 s
- 4th order momentum advection
- 12-km North American Mesoscale (NAM) model output used for background fields and lateral boundary conditions

Modeling Process
- 5-min IAU with increments every 20 sec
- 120-min ARPS Simulation

Microphysics Scheme
<table>
<thead>
<tr>
<th>ID</th>
<th>UH-3 microphysics</th>
<th>WSM4 Weather Research and Forecasting single-moment 6-class microphysics</th>
<th>MyBM Mitriband and Yau’s (MY) single-moment bulk microphysics</th>
<th>MYDM MYD-double-moment bulk microphysics</th>
<th>MYTM MYT-triple-moment bulk microphysics</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARPS 1902 Z</td>
<td>1902</td>
<td>1902</td>
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<td>2000</td>
<td>1902</td>
<td>1902</td>
<td>1902</td>
<td>1902</td>
</tr>
</tbody>
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Verification Technique
- A search radius of 10 km is used to isolate 1–6 km (0–14 km) UH maxima that are greater than or equal to 400 m s^-1 (20 m s^-1) and their surrounding grid point values.
- A max UH value is considered a UH-center candidate if 4 out of 8 (3 out of 8) of the adjacent grid point values equals or exceeds 200 m s^-1 (10 m s^-1).
- Once the UH-center candidates are determined, the UH-weighted center is computed using a radius of 5 km extending from the grid point with the max UH value.

Conclusions and Future Work
- The impact of assimilating CASA X-band radar data proved to be largely variable run-to-run and between microphysics schemes, especially for Storm 2 and Storm 3.
- Not surprisingly, the impacts likely were small for Storm 1 due to the storm being located well to the north of the CASA radar network.
- The low-levels (<2 km AGL) of storms within the CASA radar network initially exhibit stronger horizontal and vertical circulations with the inclusion of CASA radar data (not shown), but this seemingly-important benefit has less impact on forecasts than anticipated.
- Future: Look at the differences between the Control, No-CASA, No-KTLX, and Neither simulations for the other simulation times and additional case studies.