

# P.54: Comparison of 24 May 2011 Genesis and Evolution of Simulated Tornado-Like Vortices Using Various Microphysics Schemes with 1-km Grid Resolution

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## Introduction

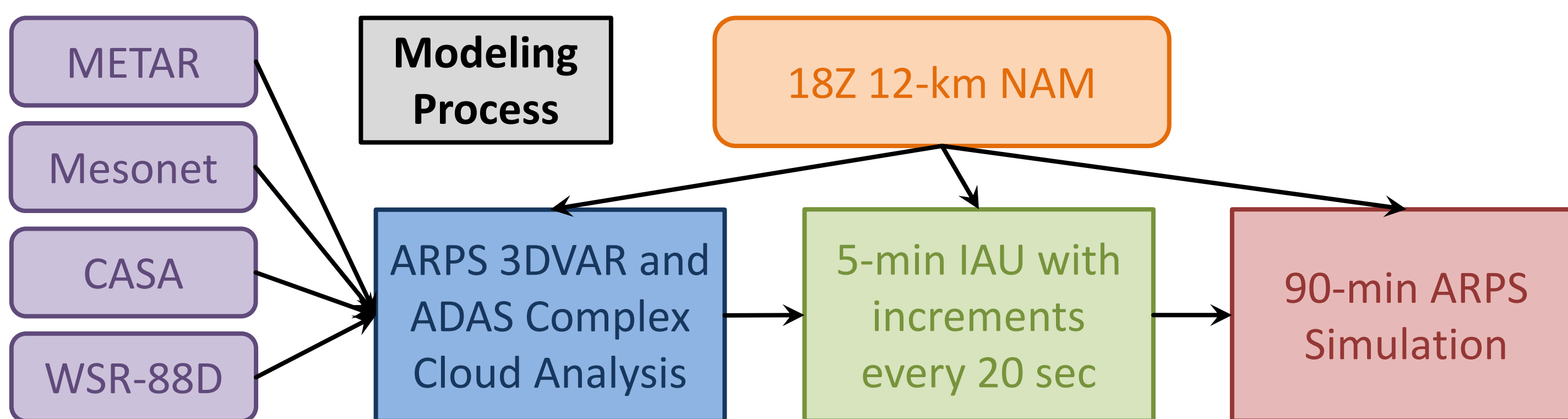
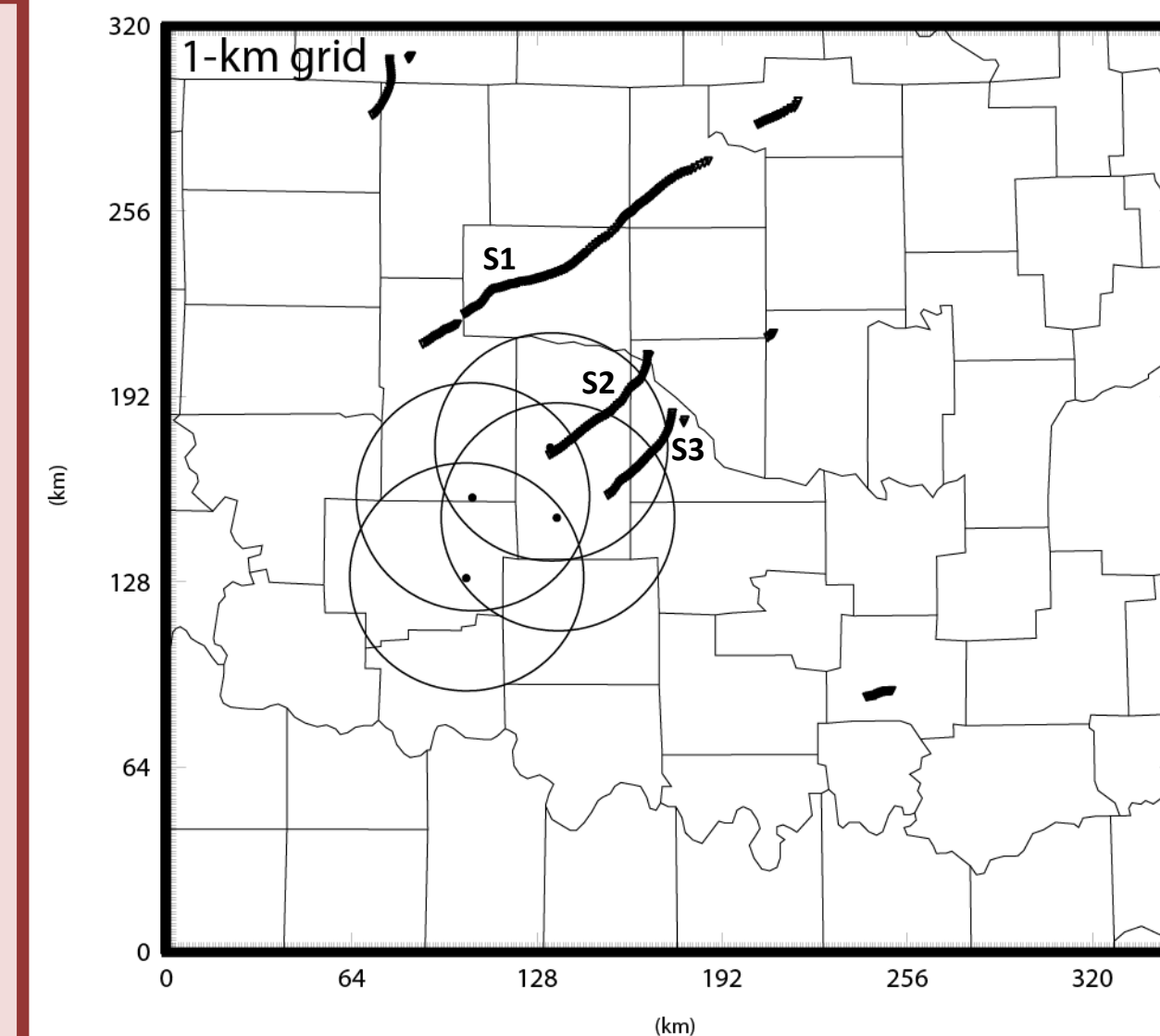
- On 24 May 2011, Western and Central Oklahoma experienced an outbreak of tornadoes, including one rated EF-5 (S1) and two rated EF-4 (S2 and S3).
- The extensive observation network across Oklahoma during the 2011 Spring makes this an ideal case to explore model forecast capabilities applicable to the 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 improvements might be expected using more sophisticated microphysics schemes or an ensemble of models with microphysics diversity.
- The aim of this study is to examine the impact of using four different microphysics parameterization schemes on the genesis and evolution of simulated tornado-like vortices (TLVs) via the updraft helicity (UH) field as compared to each other and reality.
- Similar to hurricane track errors (e.g., Xue et al. 2013), UH track errors are computed to assess model performance.

## Observational Data

- NWS METAR and Oklahoma Mesonet data
- WSR-88D radar data (KTLX, KFDR, KVNK, KICT, KDDC, KFWS, and KINX)
- Collaborative Adaptive Sensing of the Atmosphere (CASA) radar data (KCYR, KSAO, KWE, and KRSP)
- Tornado tracks estimated from National Weather Service damage surveys

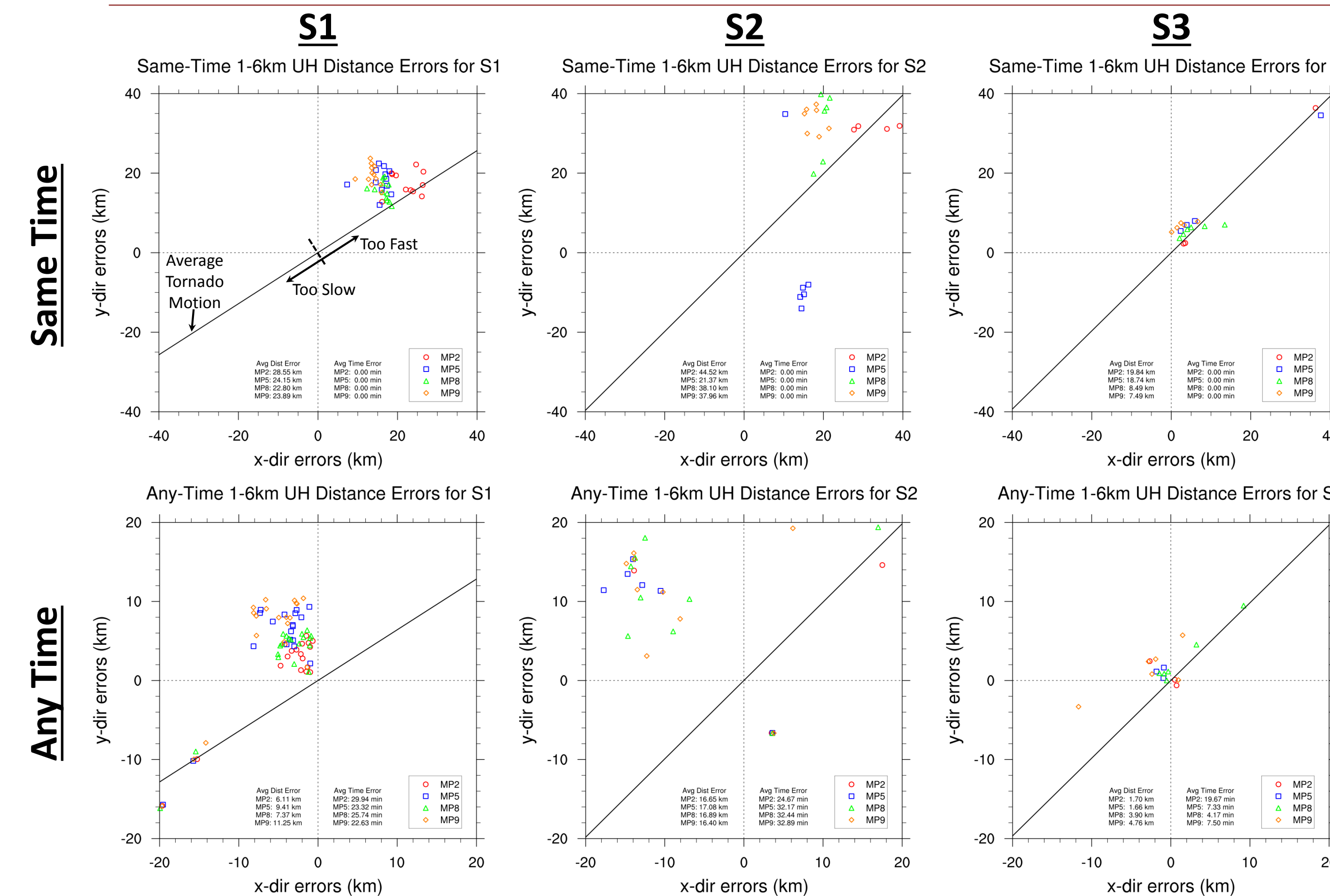
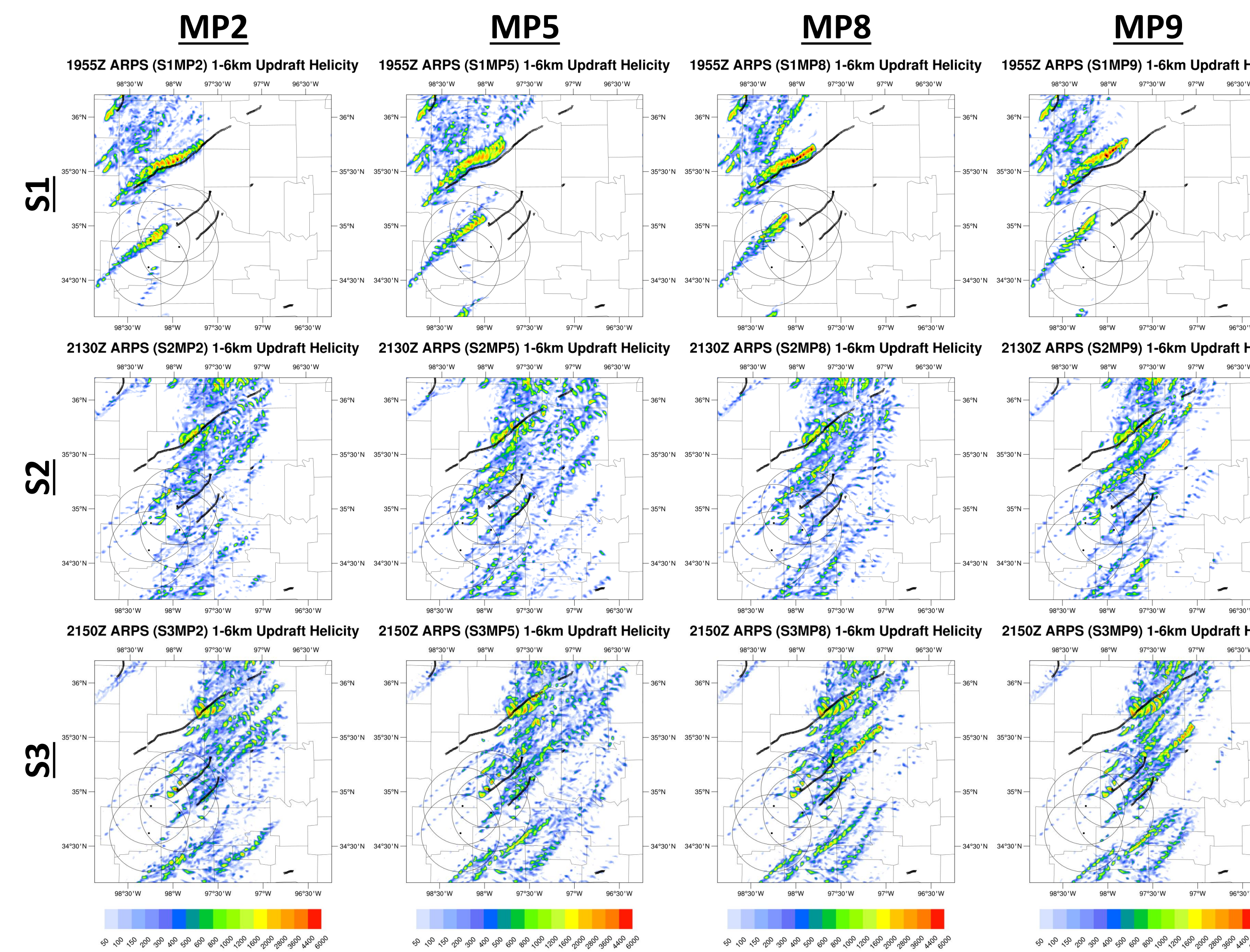
## Model Details

- Advanced Regional Prediction System (ARPS) developed at CAPS
- 323x353x53-km domain
- 1-km horizontal grid spacing
- Minimum vertical grid spacing of 20 m
- $dt_{big} = 2.0$  s and  $dt_{small} = 0.5$  s
- 4<sup>th</sup> order momentum advection
- 12-km North American Mesoscale (NAM) model output used for background fields and lateral boundary conditions



ID	Microphysics Scheme	Storm ID	Tornado Begin - End	ARPS Begin - End
MP2	Lin 3-ice microphysics	S1	2031 Z - 2046 Z 2050 Z - 2235 Z	1955 Z - 2130 Z
MP5	Weather Research and Forecasting single-moment 6-class microphysics	S2	2206 Z - 2301 Z	2130 Z - 2305 Z
MP8	Milbrandt and Yau (MY) single-moment bulk microphysics	S3	2226 Z - 2305 Z	2150 Z - 2325 Z
MP9	MY double-moment bulk microphysics		2302 Z - 2303 Z	

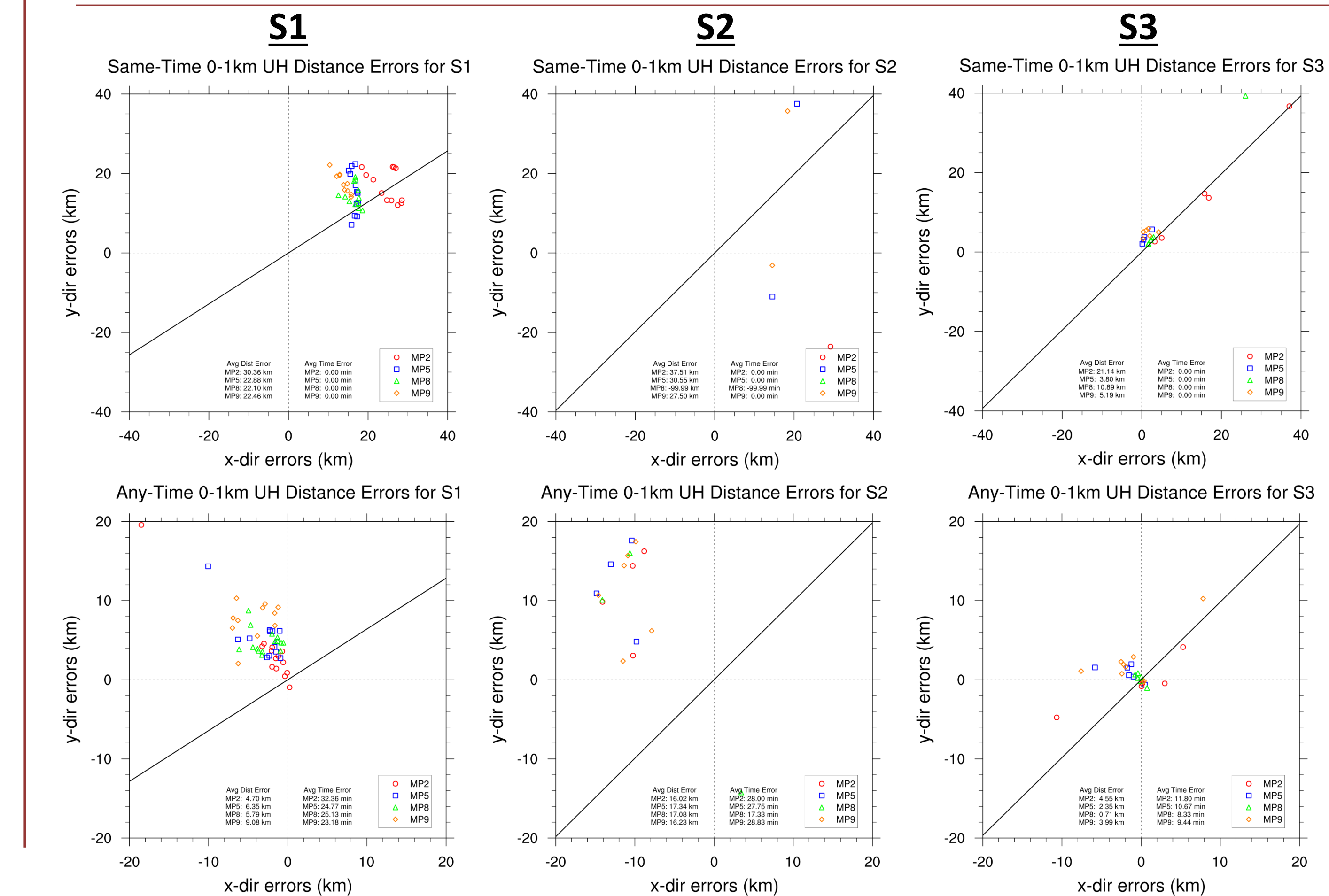
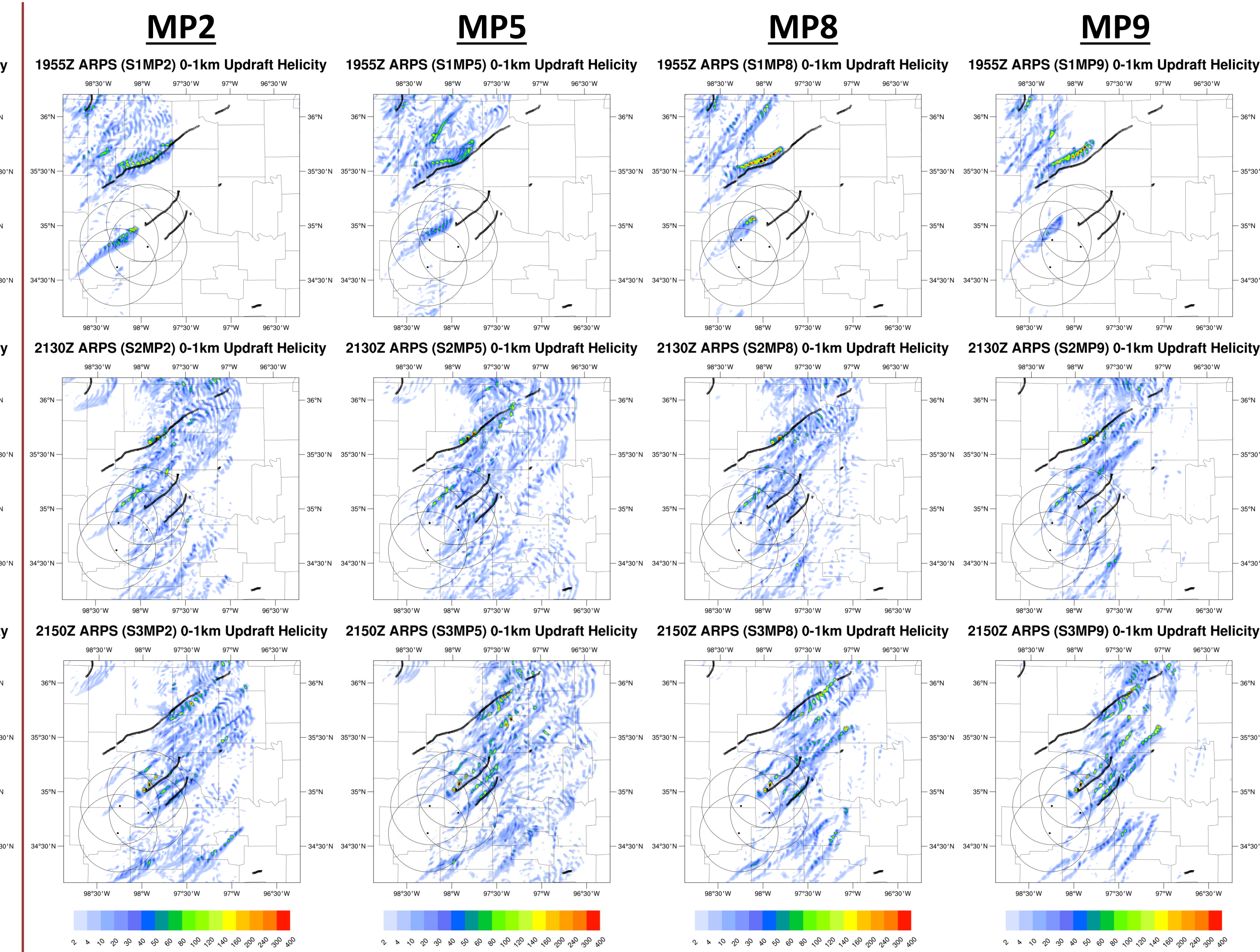
## 1 – 6-km UH



## Results

- 1 – 6-km UH**
- For S1, MP2 is fastest, but closest to tornado tracks at any time.
- For S1, MP8 is nearest to tornado tracks at same time.
- For S2, all simulations produce a UH track > 10 km to the NW.
- For S3, MP5, MP8, and MP9 emulate the tornado track well.
- 0 – 1-km UH**
- For S1, similar to 1 – 6-km UH's results, but UH centers are now closer to tornado tracks.
- For S2, not much in range of interest at same time, but at any time, some UH centers exist > 10 km to the NW.
- For S3, MP8 is best, but all simulations perform well.

## 0 – 1-km UH



## Summary and Future Work

- Evaluating simulated TLVs via the UH field with respect to estimated real tornado points from the 24 May 2011 tornado outbreak has proven to be an effective measure of model successes and failures.
- This study helps define expected error bounds for WoF ensemble concept.
- Explore other variables (e.g., vorticity, w-wind, etc.) for center tracking.
- Investigate the possibility of using 3DVAR/IAU analysis instead of tornado points for verification.
- Apply this verification technique to the Storm Prediction Center's storm reports database.

1. David J. Stensrud, Louis J. Wicker, Kevin E. Kelleher, Ming Xue, Michael P. Foster, Joseph T. Schaefer, Russell S. Schneider, Stanley G. Benjamin, Stephen S. Weygandt, John T. Ferree, and Jason P. Tuell, 2009: Convective-Scale Warn-on-Forecast System. *Bull. Amer. Meteor. Soc.*, **90**, 1487–1499.  
 2. David J. Stensrud, Louis J. Wicker, Ming Xue, Daniel T. Dawson, Nusrat Yussouf, Dustan M. Wheatley, Therese E. Thompson, Nathan A. Snook, Travis M. Smith, Alexander D. Schenkman, Corey K. Potvin, Edward R. Mansell, Ting Lei, Kristin M. Kuhlman, Youngsun Jung, Thomas A. Jones, Jidong Gao, Michael C. Coniglio, Harold E. Brooks, Keith A. Brewster, 2013: Progress and challenges with Warn-on-Forecast. *Atmospheric Research*, **123**, 2–16.  
 3. Ming Xue, Jordan Schleit, Fanyou Kong, Kevin W. Thomas, Yunheng Wang, and Kefeng Zhu, 2013: Track and Intensity Forecasting of Hurricanes: Impact of Convection-Permitting Resolution and Global Ensemble Kalman Filter Analysis on 2010 Atlantic Season Forecasts. *Wea. Forecasting*, **28**, 1366–1384.