Examining the Sensitivity of Horizontal and Vertical Grid Spacing on Simulations of Cool Season Severe Thunderstorms in the Southeast United States

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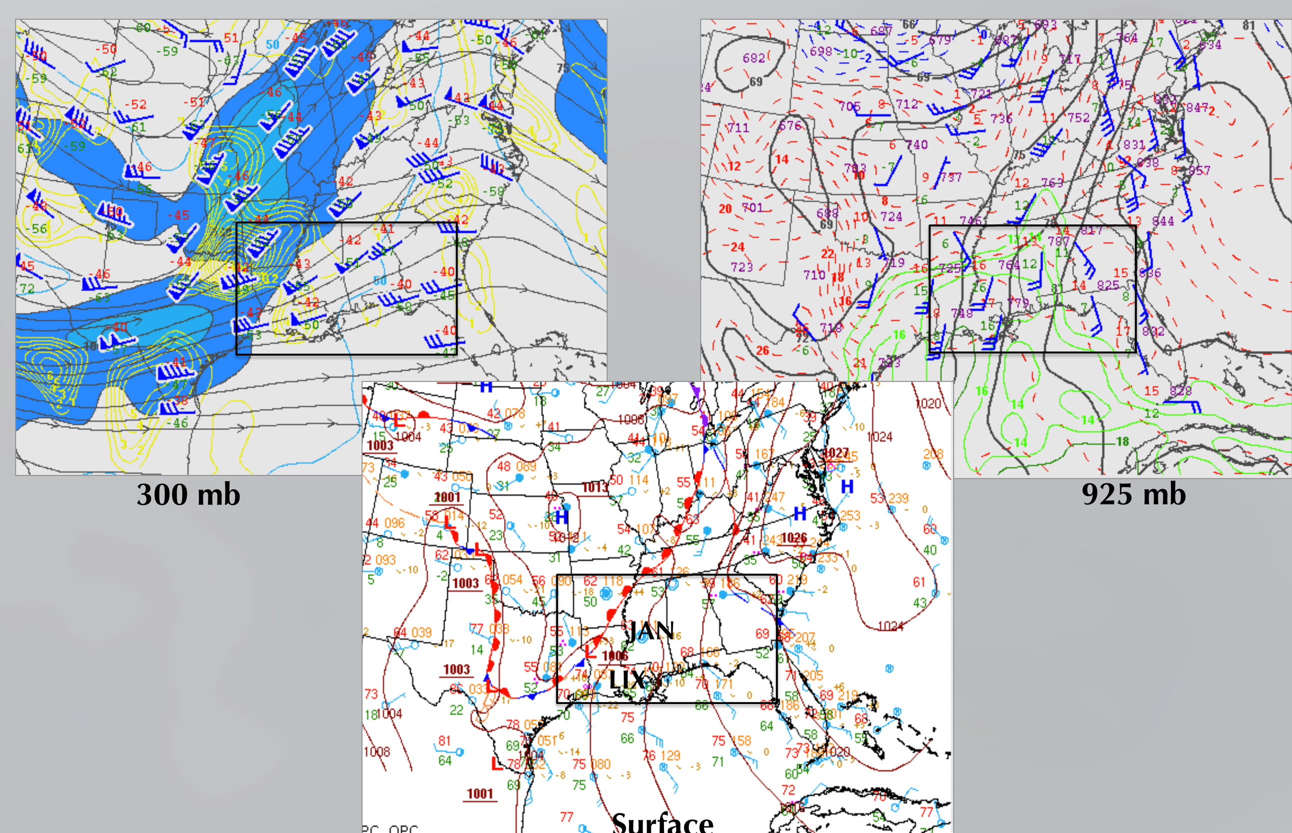
High-Shear, Low CAPE Environments

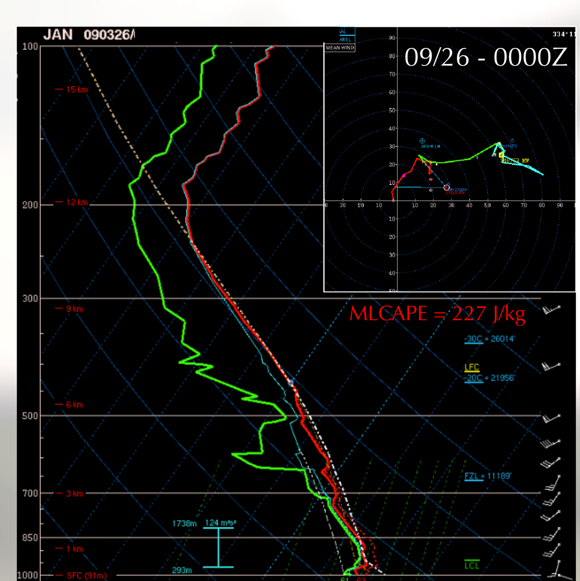
Magee, MS – March 26, 2009



Weak CAPE, strong shear environments are prevalent during Southeast cool season severe outbreaks (Guyer et al. 2006) and can prime local environments for tornadic activity. Due to these atypical conditions and their tendency to form overnight, storms in these environments pose an **enhanced societal threat and forecasting challenge** (Guyer et al. 2006, 2010; Evans et al. 2006). This was the case on March 25, 2009, when a supercell spawned an EF3 tornado that ripped through central Mississippi around 1:30 a.m. local time.

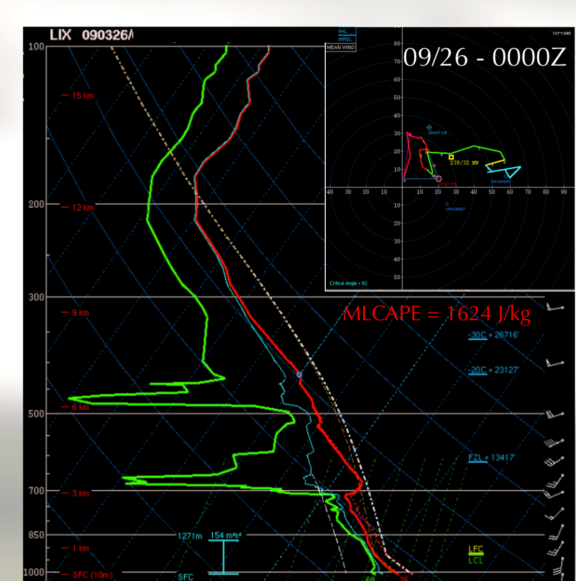
This study examines simulations of this event at varying horizontal (4, 2, and 1 km) and vertical (30, 40, and 50 levels) grid spacings. Recent studies have shown the influence of different grid spacings on simulated convective development, but limited emphasis has been placed on **high-resolution modeling of storms forming in weak CAPE, strong shear environments**.

By examining the effects of varying grid spacings on simulated storms in these environments, our results **expand our understanding and predictive ability of cool season severe weather in the southeast United States.**



Jackson, MS (JAN)

Marginal MLCAPE

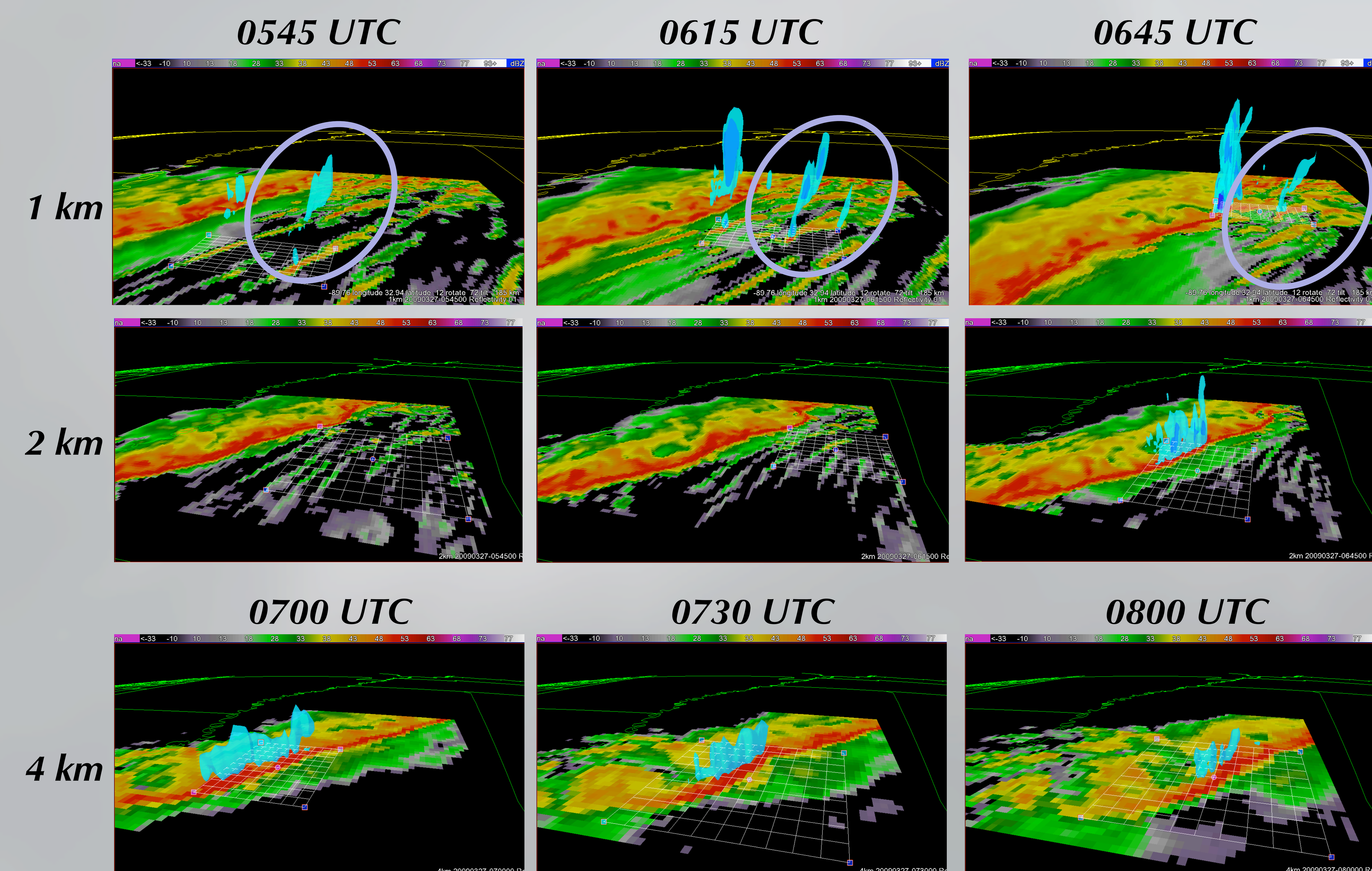


Slidell, LA (LIX)

Moderate low-level jet

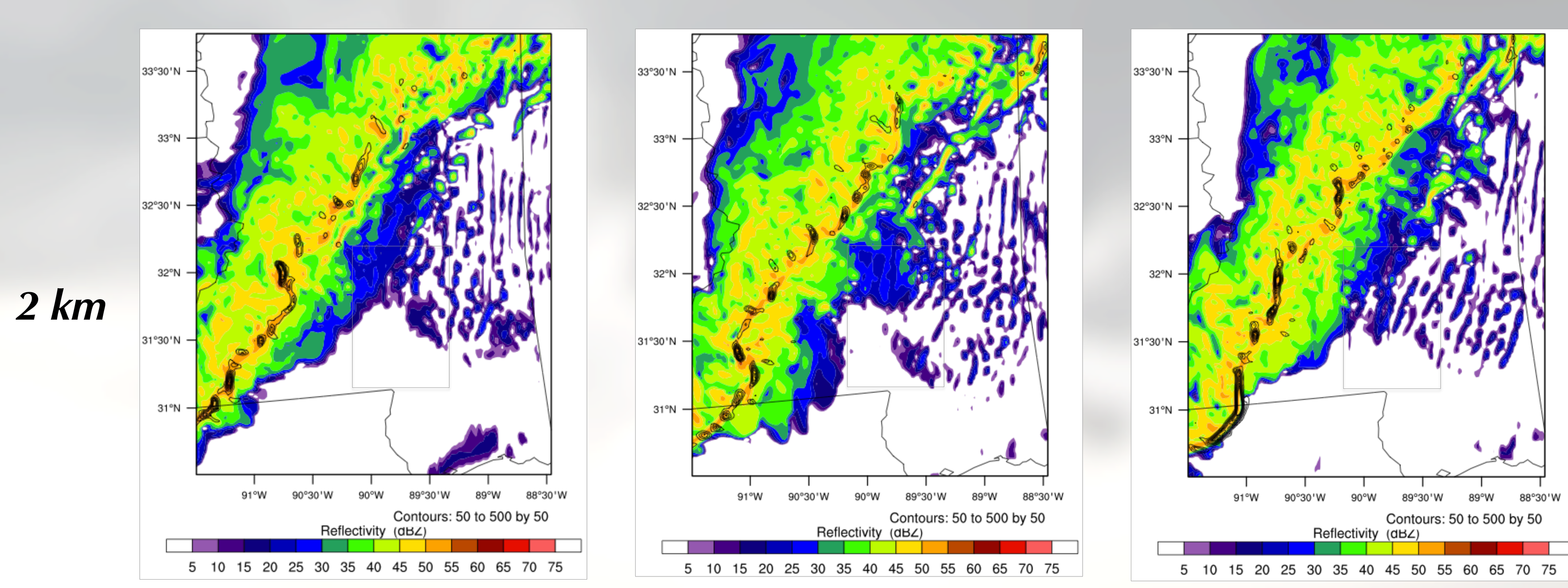
Simulation Sensitivity to Horizontal Resolution

Low-level Reflectivity and Updraft Rotation



Simulation Sensitivity to Vertical Resolution

Low-level Reflectivity and Updraft Rotation



30 Vertical Levels ***40 Vertical Levels*** ***50 Vertical Levels***

References

Evans, J. S., and J. L. Guyer, 2006: The Relationship of Cool Season Significant Tornado Events and Buoy Data in the Western Gulf of Mexico. Preprints, *23rd Conf. Severe Local Storms*, St. Louis MO.

Guyer, J. L., D. A. Imy, A. Kis, and K. Venable, 2006: Cool season significant (F2-F5) tornadoes in the Gulf Coast states. Preprints, *23rd Conf. Severe Local Storms*, St. Louis MO, Amer. Meteor. Soc., CD-ROM.

Guyer, J. L., and A. R. Dean, 2010: Tornadoes within Weak CAPE Environments across the Continental United States. Preprints, *25th Conf. Severe Local Storms*, Denver CO.

Simulation Observations and Conclusions

Horizontal Resolution Sensitivity

1 km

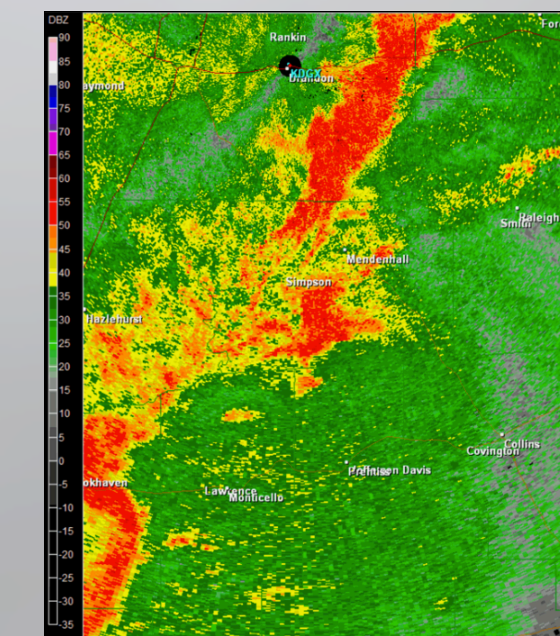
- Meridional, along-flow rain bands ahead of line
- **Strengthening updraft rotation** within two of the bands (circled in purple)
- Relative, **low-level (<1 km) updraft rotation** maxima

2 km

- Relatively weak, along-flow rain bands
- **No strong updraft rotation** in the leading bands
- Strong updraft rotation in the main line near Magee

4 km

- **No rain bands or strong updraft rotation** ahead of the line
- Weak, localized updraft rotation in the main line



0630 UTC

Decreasing horizontal grid spacing ultimately yields localized reflectivity and updraft rotation maxima ahead of the line. While both the 4 km and 2 km runs failed to reproduce the supercell, **the 1 km simulation showed the development of a supercellular feature with strong, low-level updraft rotation indicative of the potential for tornadogenesis**. These experiments show that the operational use of storm-scale models with 1 km horizontal grid spacing would be extremely beneficial **in distinguishing between potentially tornadic and non-tornadic storms in low CAPE, high shear environments**.

Vertical Resolution Sensitivity

30 Levels: Horizontal convective rolls and unorganized convection ahead of the line unassociated with updraft rotation.

40 Levels: More organized, large reflectivity maxima ahead of the line associated with convective roll development.

50 Levels: Horizontal convective rolls and semi-discrete reflectivity and updraft helicity maxima ahead of the line.

Decreasing vertical grid spacing yields slightly more organized reflectivity and updraft rotation maxima ahead of the line. While the run with 30 vertical levels only reproduced horizontal convective rolls, the **simulations with 40 and 50 vertical levels both showed strong, discrete cells** developing from the rolls. None of these runs were able to reproduce a reflectivity and updraft rotation signature characteristic of a tornadic supercell, but **the simulation with 40 vertical levels did resolve a particularly strong, rotating storm** two counties north of the actual supercell at that time. This suggests that, while decreasing vertical grid spacing may not be as critical for resolving discrete supercells as decreasing horizontal grid spacing, **increasing the number of vertical levels in storm-scale models results in more accurate simulations of wintertime thunderstorms**. This is currently being investigated by examining simulations of other tornadic events associated with low CAPE, high shear environments in the southeast U.S.

Photo by Kelly DeLay