

# Sensitivity of a Simulated Derecho Event to Model Initial Conditions

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EGU 2014, Vienna, Austria

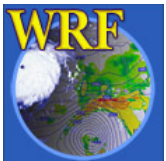


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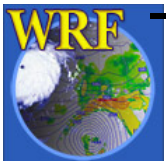
# Real-Time Forecasting Experiments

- Since 2003, MMM/NCAR has been testing and evaluating WRF-ARW model in real-time forecasts at 3 or 4 km for early spring and summer severe weather over US
  - Model physics, initial conditions (Weisman et al. 2008)
- In 2012 season, the modeling system captured one of the most destructive Derecho event on record on June 29
  - WRF-DART, 6-h cycled analysis, 50 members, 15 km



# What's a Derecho?

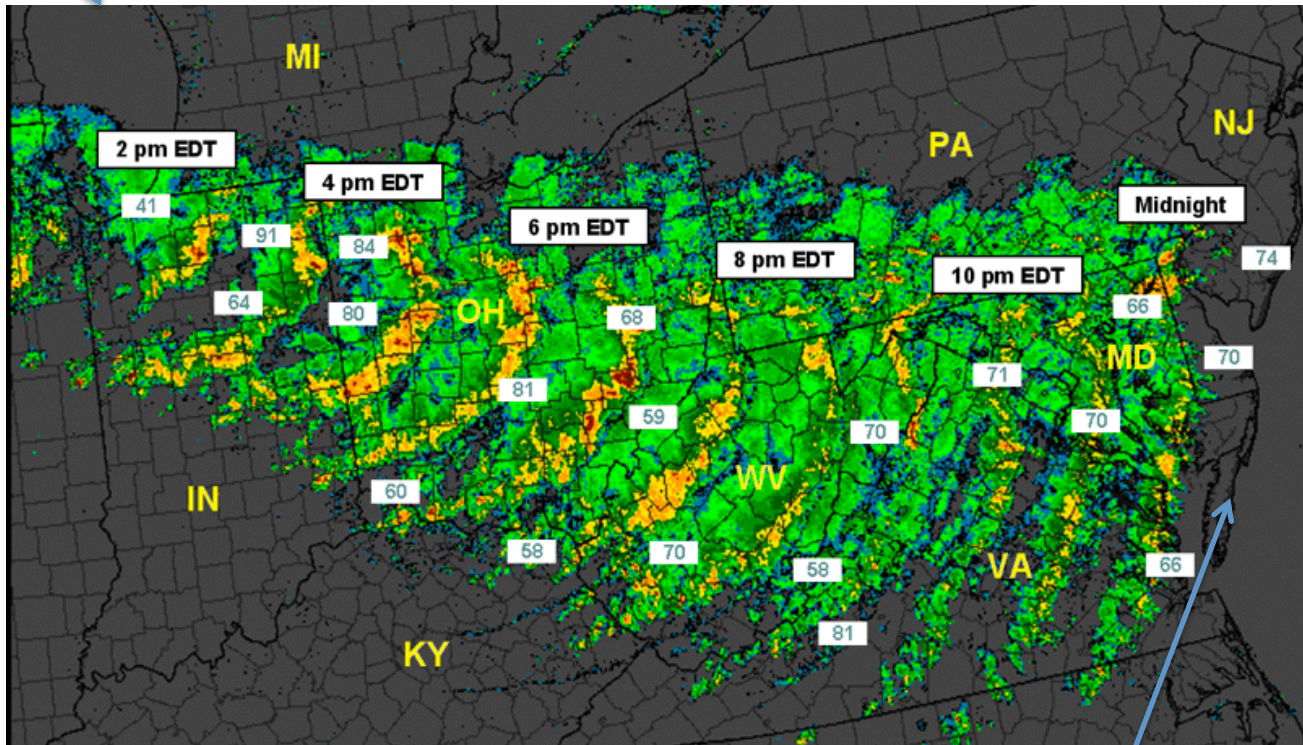
- A Derecho is a widespread, long-lived, straight-line wind storm associated with severe thunderstorms.
  - Definition: 250 miles (400 km) wide, with wind gusts exceeding 50 knots (58 mph, 25 m/s), and last at least 6 hours.
- The June 29 2012 Derecho had wind gusts up to 80 kts, and lasted 14 hours.
  - Traveled over 1100 km, affected 10 states



# Derecho Event of June 29, 2012

Lake Michigan

Observed radar composite from NWS/SPC



(G. Carbin of SPC)

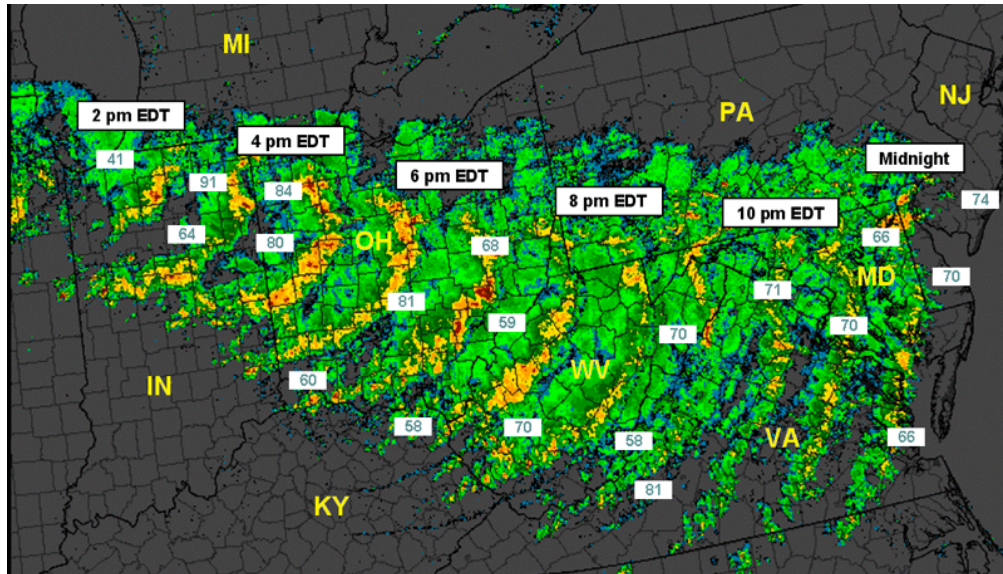


East Coast of US



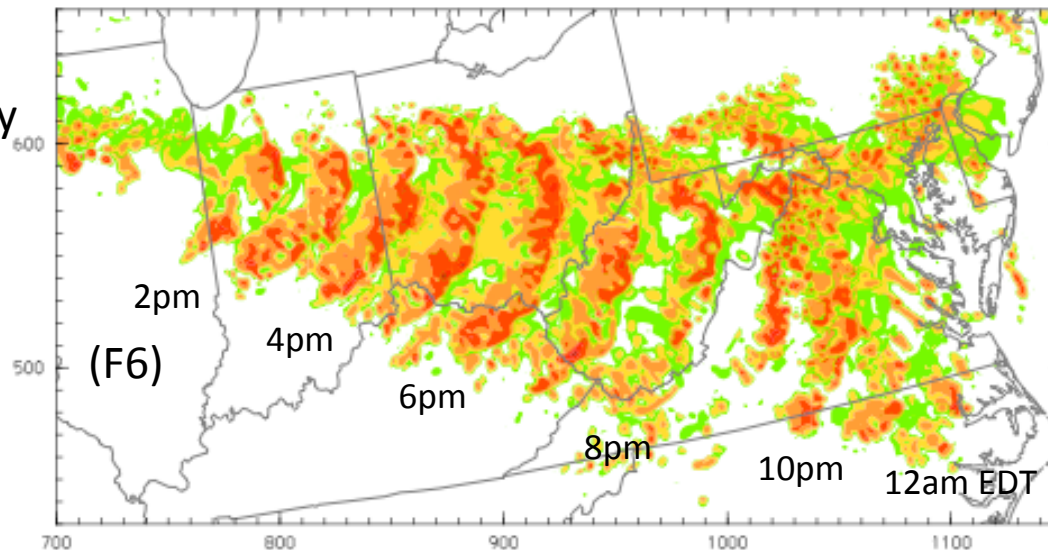
# Derecho forecast from NCAR's 2012 RT

Observed radar composite

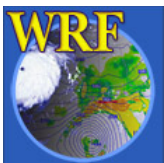


(from NOAA/SPC)

Forecast max-column reflectivity at 3 km, starting from 1200 UTC June 29

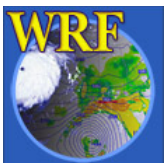
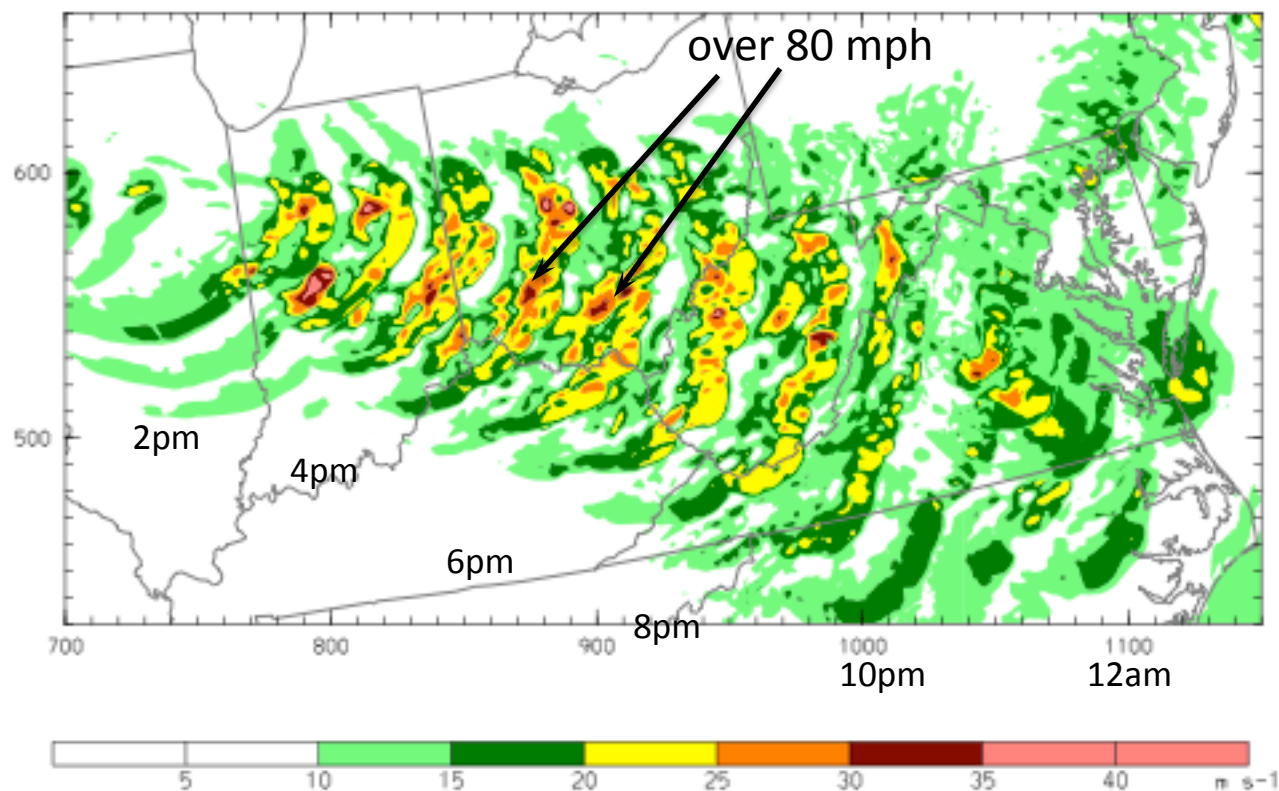


IC: Fully cycled analysis starting from late April using WRF-DART

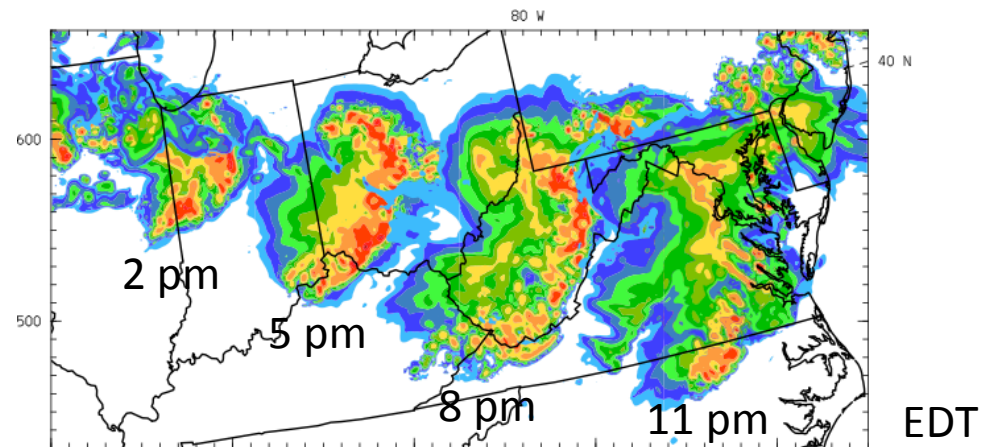


# Derecho forecast from NCAR's 2012 RT

Hourly max wind from 2 pm to 12 am EDT, June 29

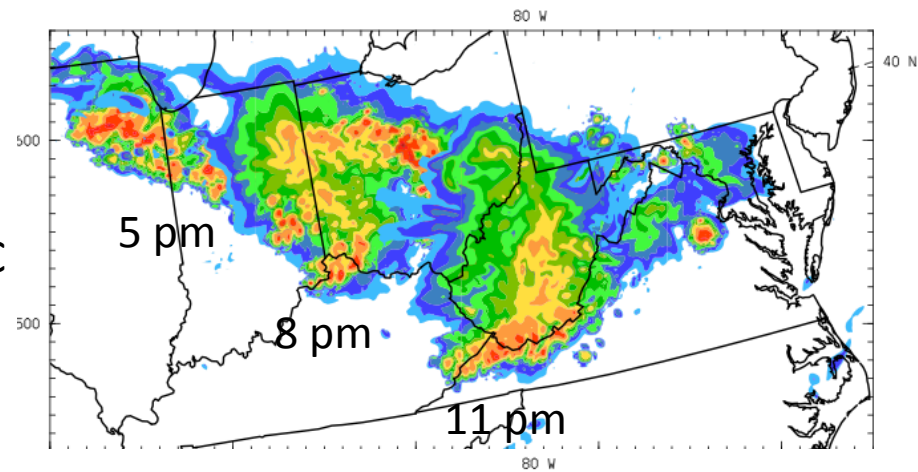


EnKF IC

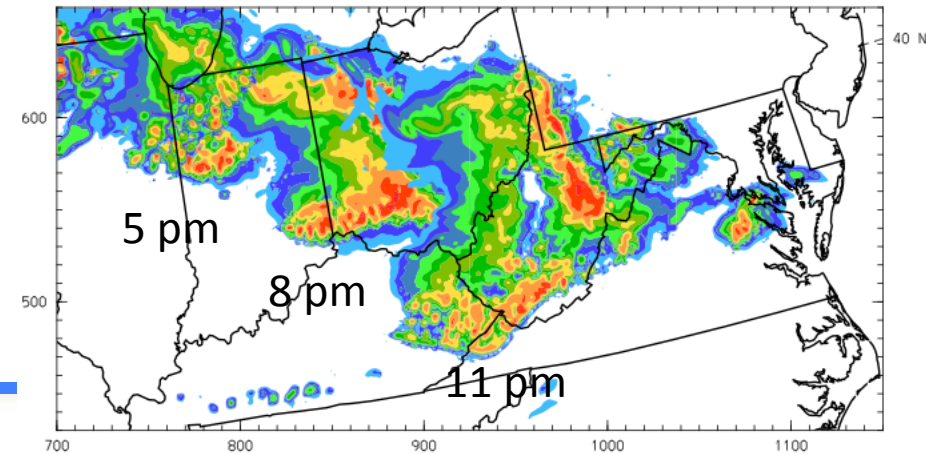


EDT

NAM IC



GFS IC





IC

F06

F09

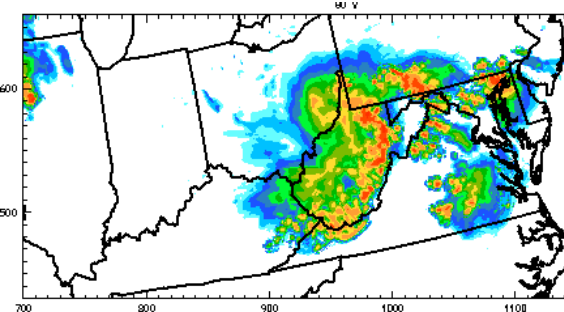
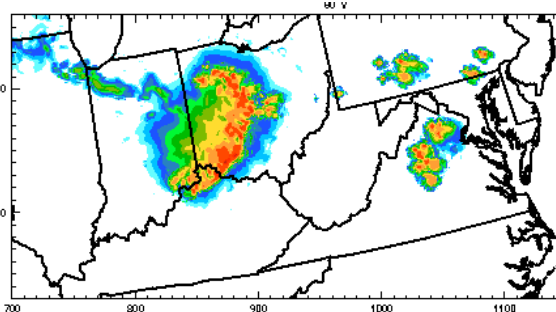
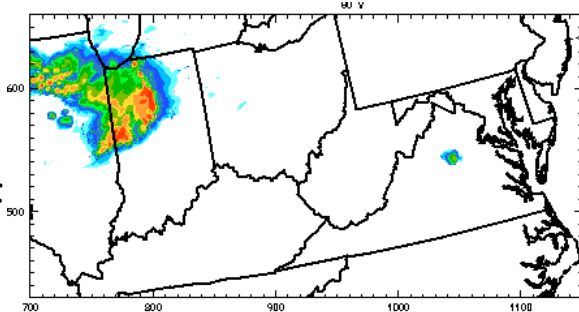
F12

1800 UTC, 2 pm EDT

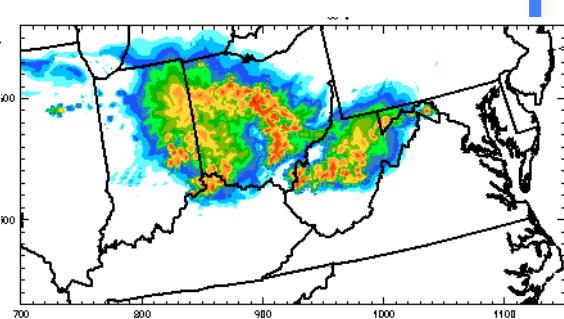
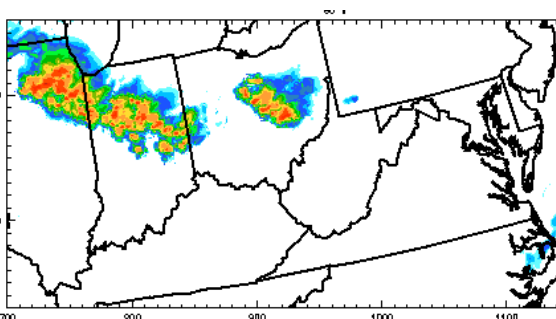
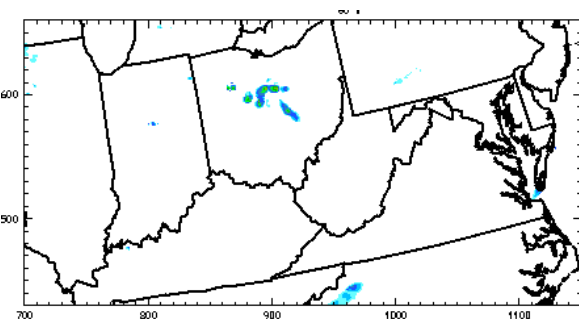
2100 UTC, 5 pm EDT

0000 UTC, 8 pm EDT

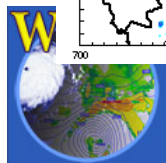
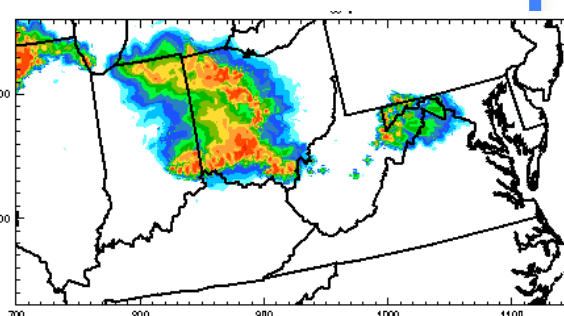
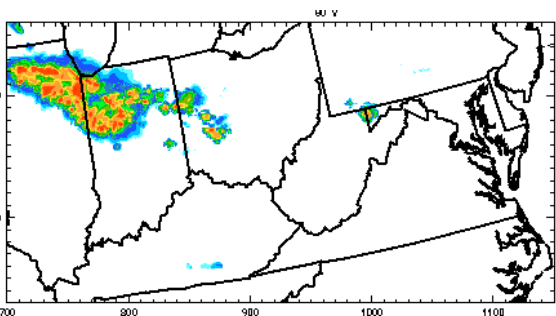
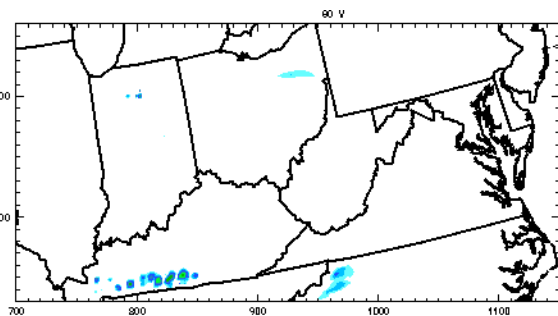
EnKF



NAM



GFS



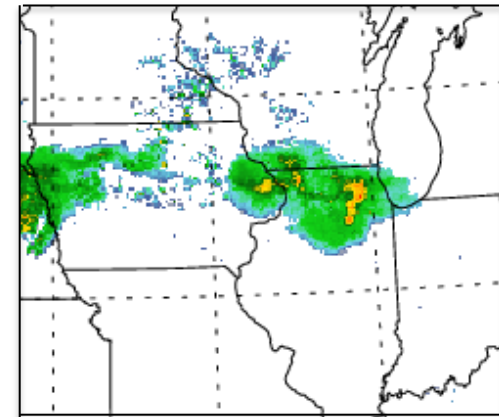
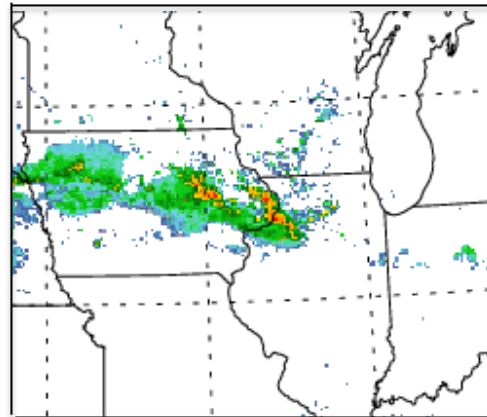
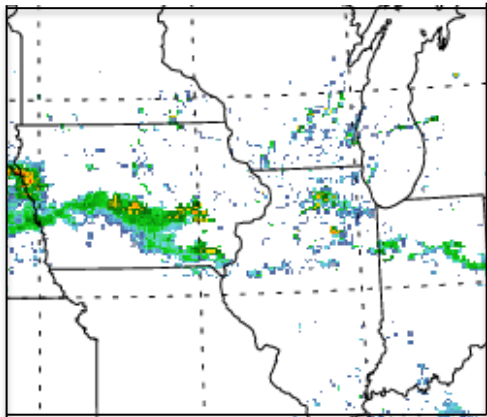


1200 UTC, 8 am EDT

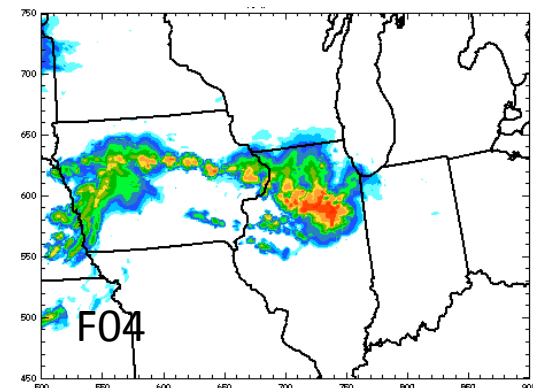
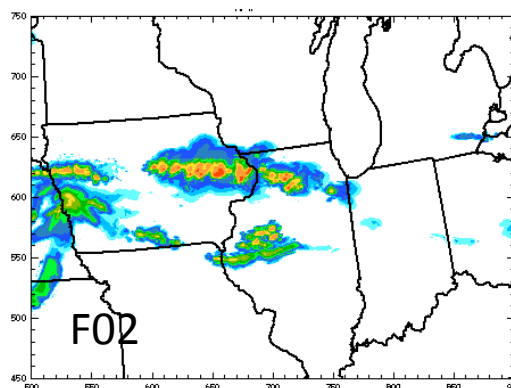
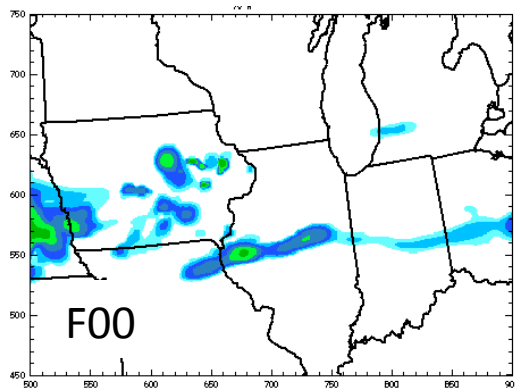
1400 UTC, 10 am EDT

1600 UTC, 12 am EDT

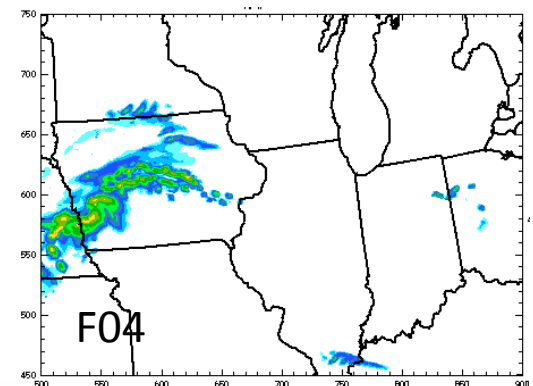
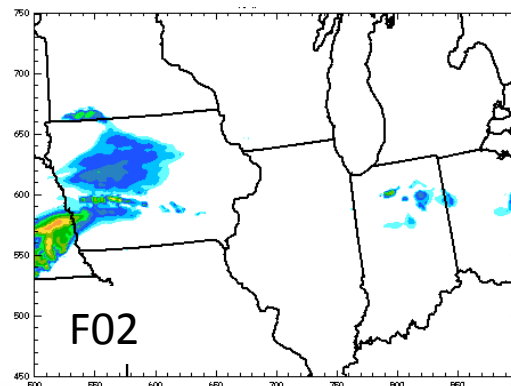
Obs



EnKF IC



NAM IC

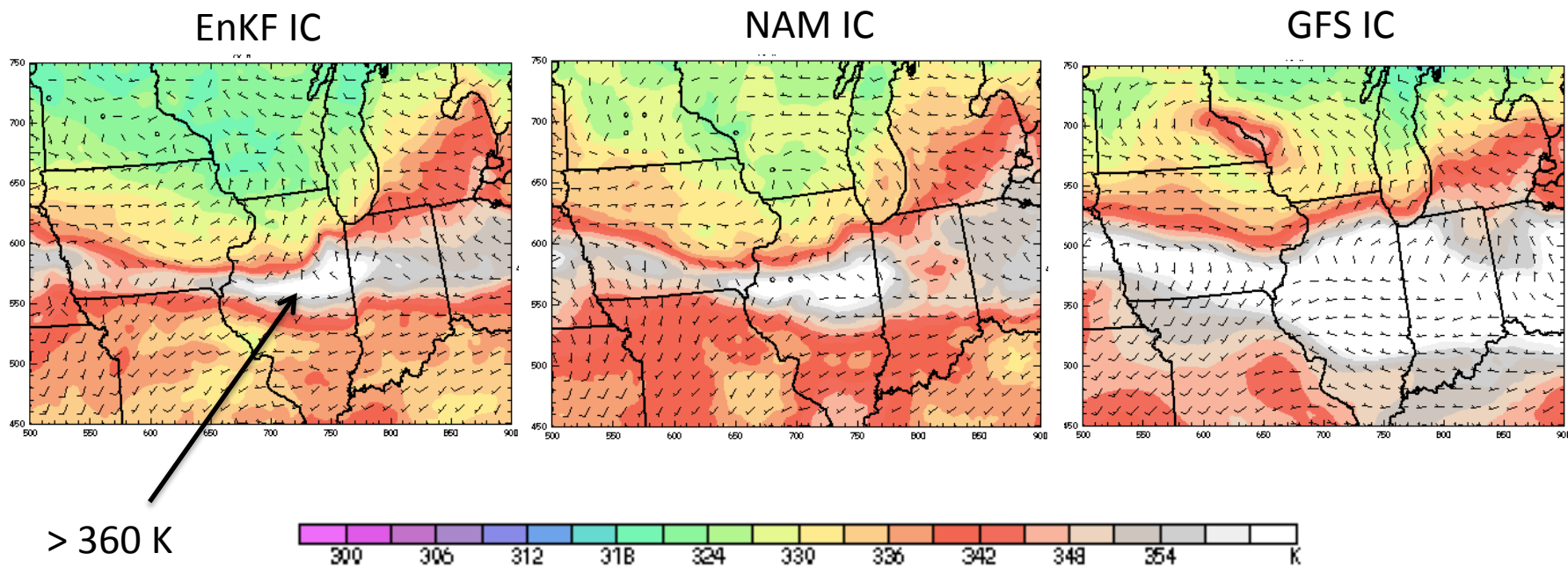


# Strong Sensitivity to IC ...

- Not all IC are the same:
  - No convection until 2100 UTC from NAM/GFS IC
  - Simulated convection doesn't have the right characteristics
- What're missing in the NAM and GFS initial conditions?

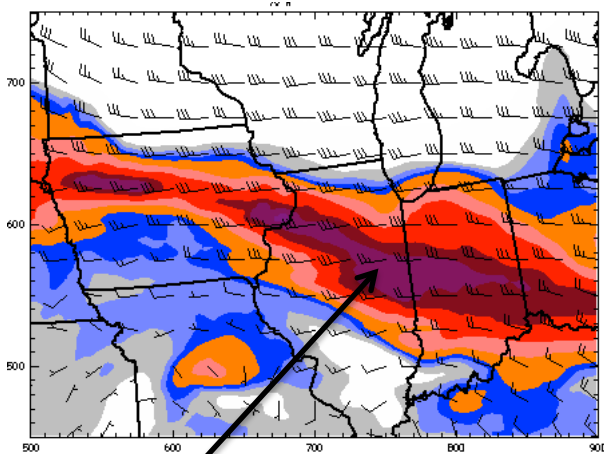


# Surface Condition at Initial Time: equivalent potential temp and wind

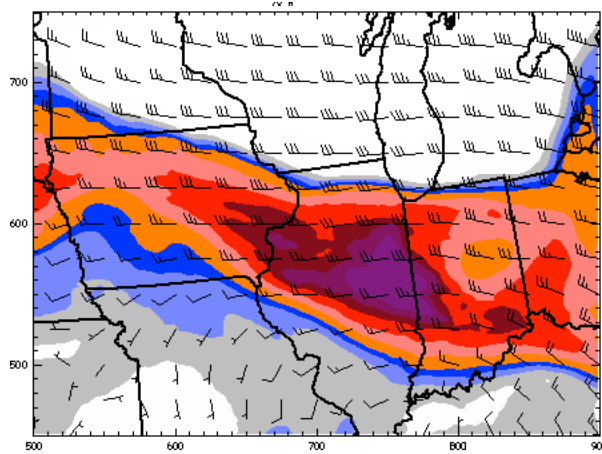


# CAPE at Initial Time

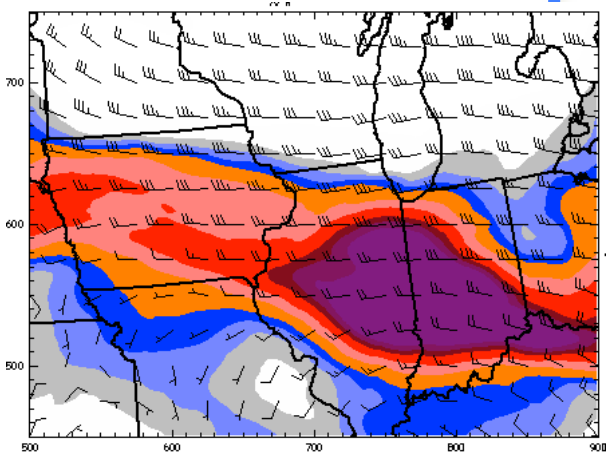
EnKF IC



NAM IC



GFS IC



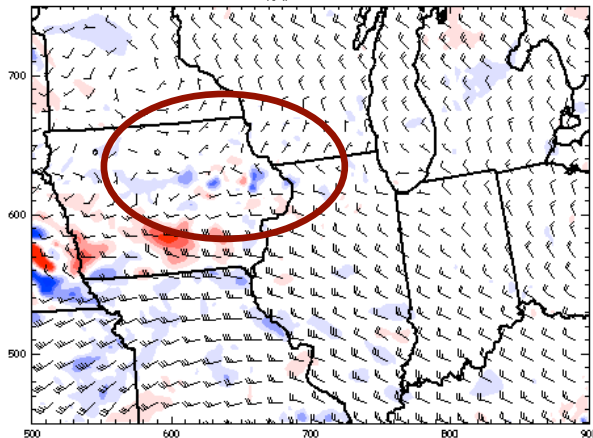
$> 5000 \text{ J / kg}$



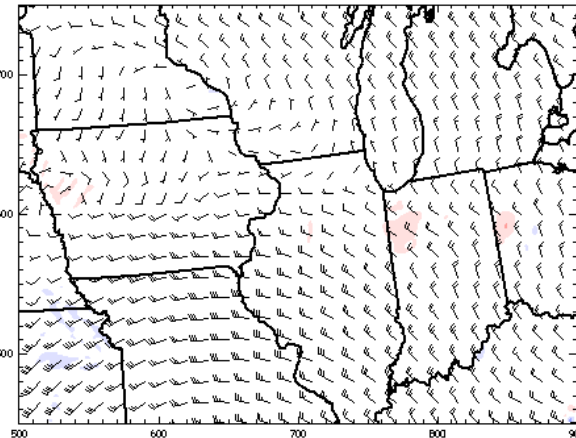


# 900 mb Convergence at Initial Time

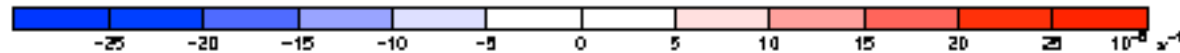
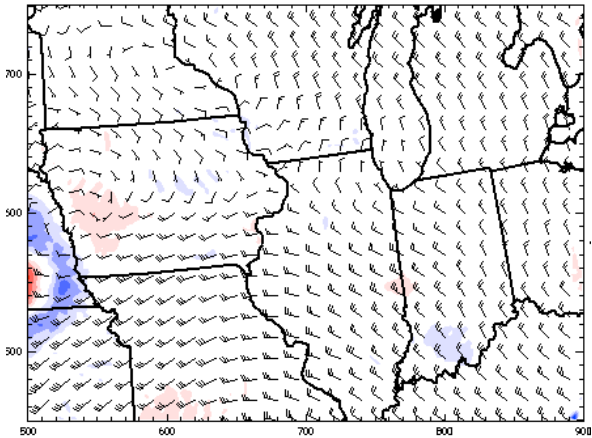
EnKF IC



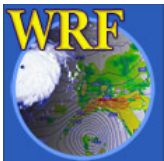
NAM IC



GFS IC



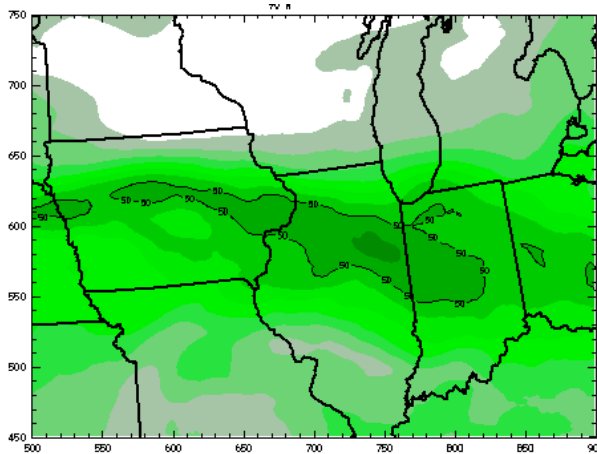
Blue: convergence



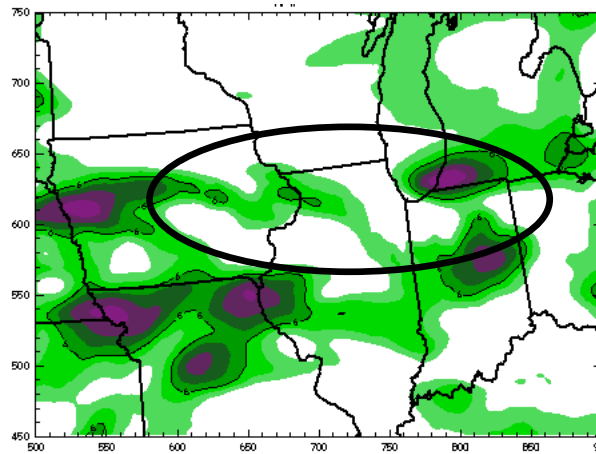
# Precipitable Water at Initial Time

Difference in PCPWV

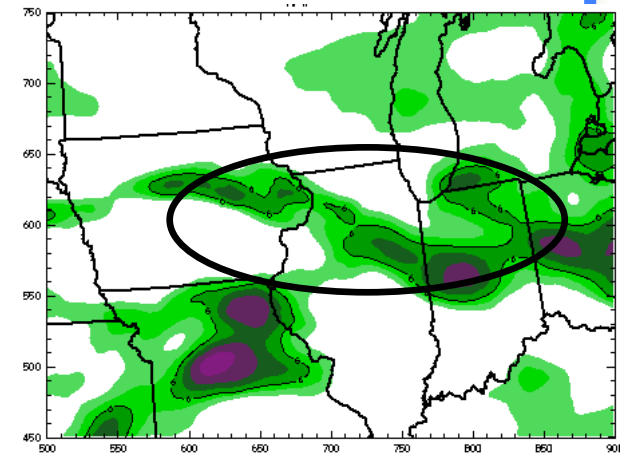
EnKF IC



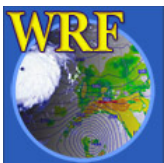
EnKF-NAM IC



EnKF-GFS IC

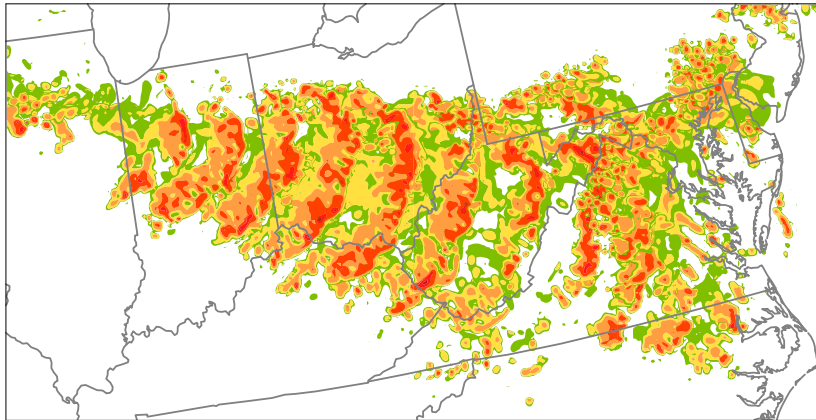


Color: more precipitable water in EnKF IC

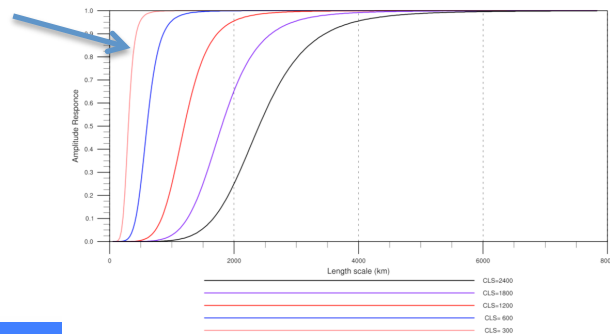
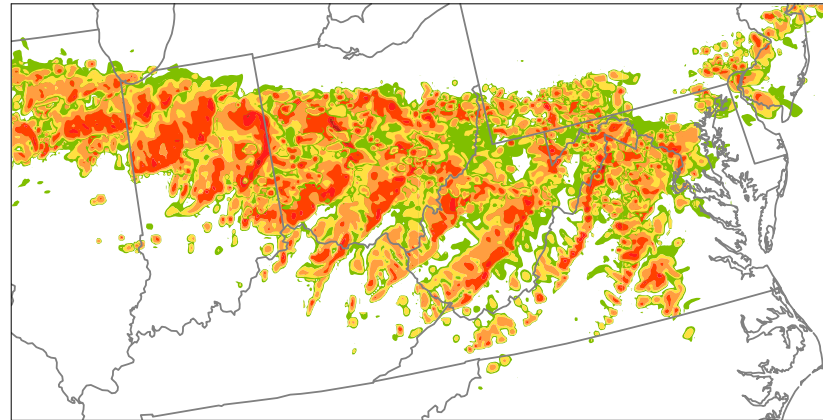


# Question: Are the small scale features in the ICs that critical?

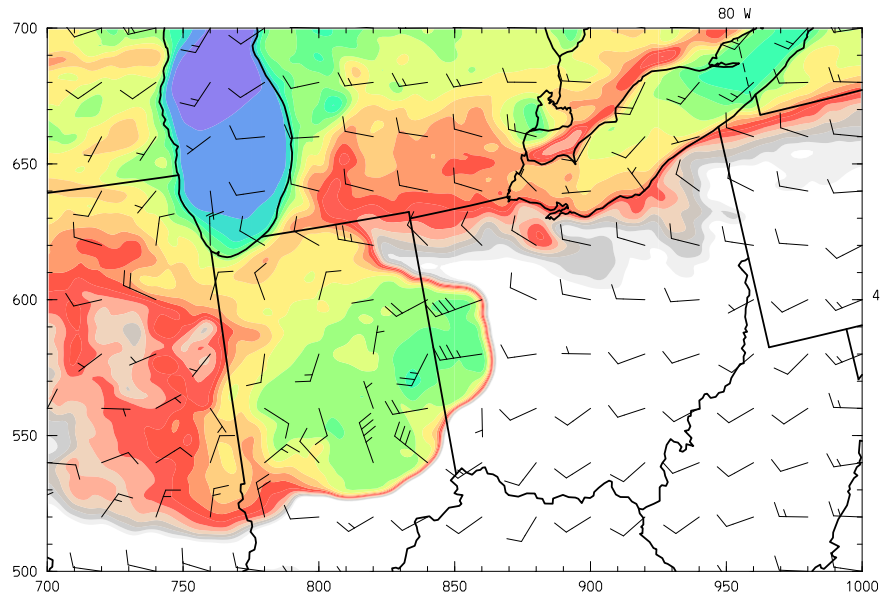
Original IC Run



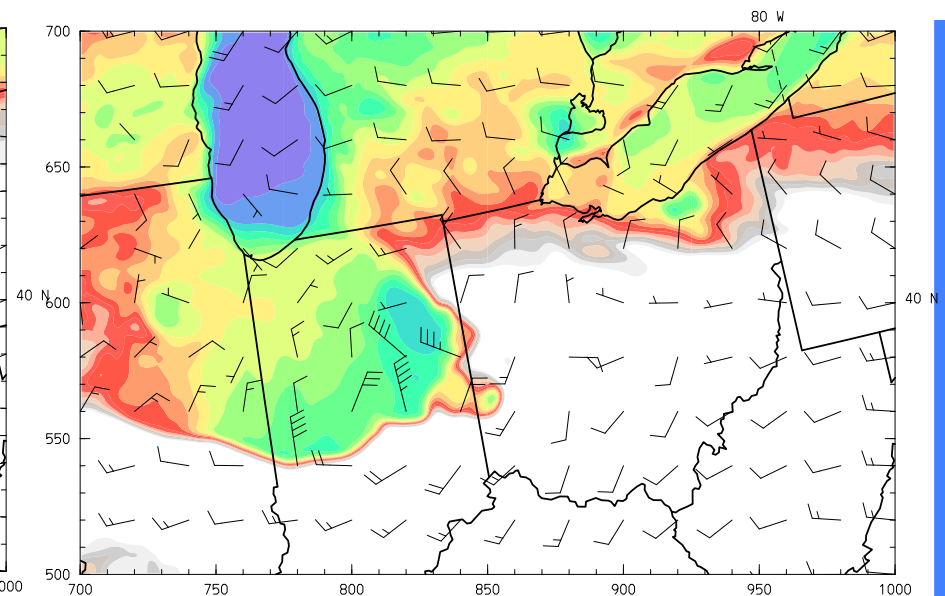
Altered IC Experiment  
Filtered IC with SL at 300km



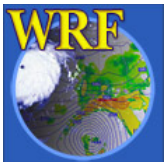
Original IC at 2000 UTC



F300km at 2200 UTC – 2 hours late

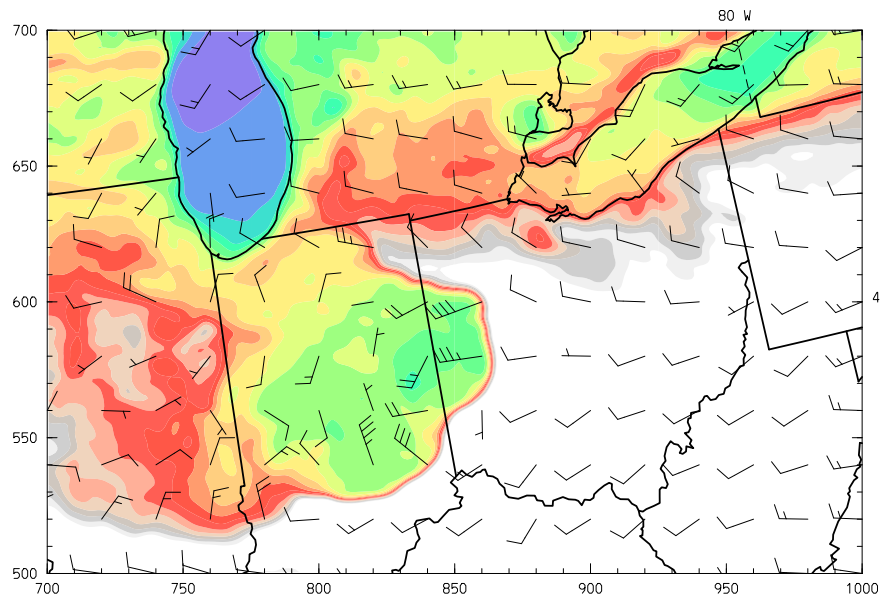


Depiction of surface cold pool: surface equivalent potential temp

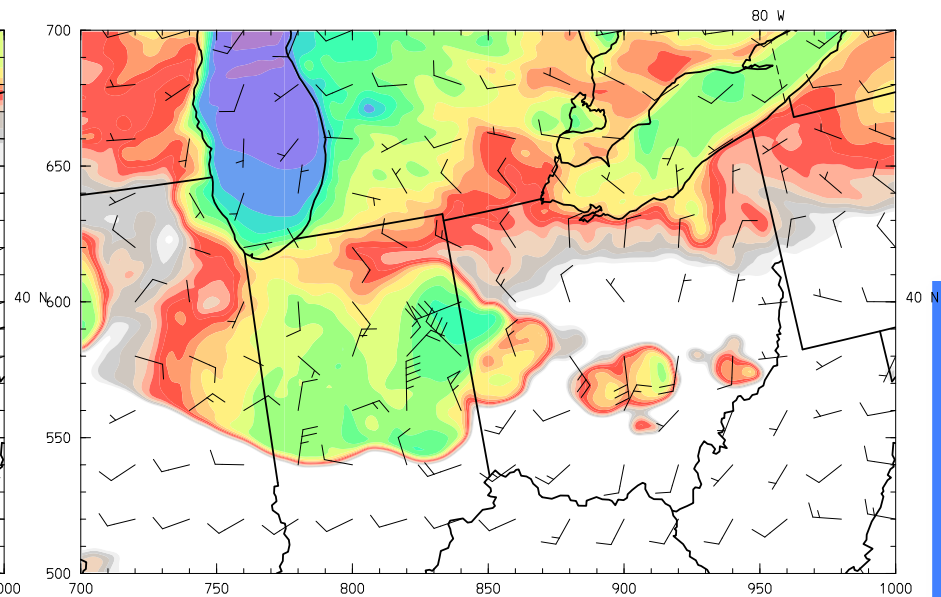




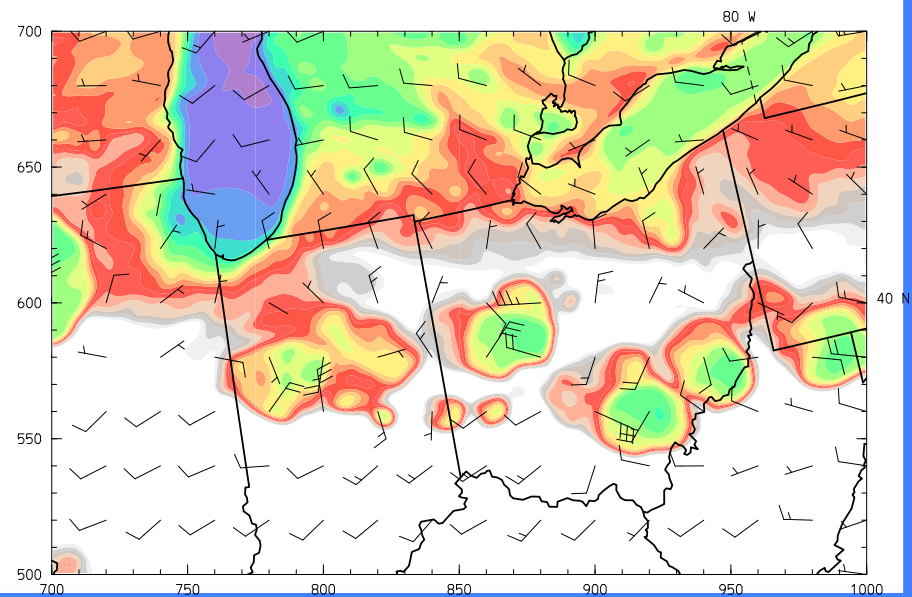
Original IC at 2000 UTC



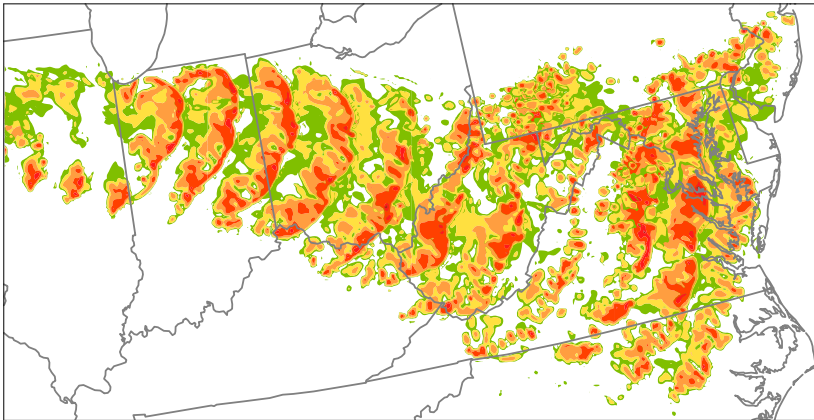
F600km at 0000 UTC – 4 hours late



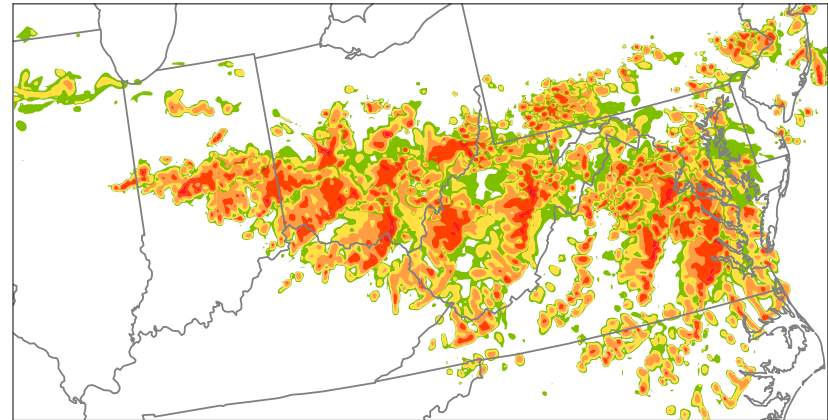
F600km Q  
at 0000 UTC



IC2906



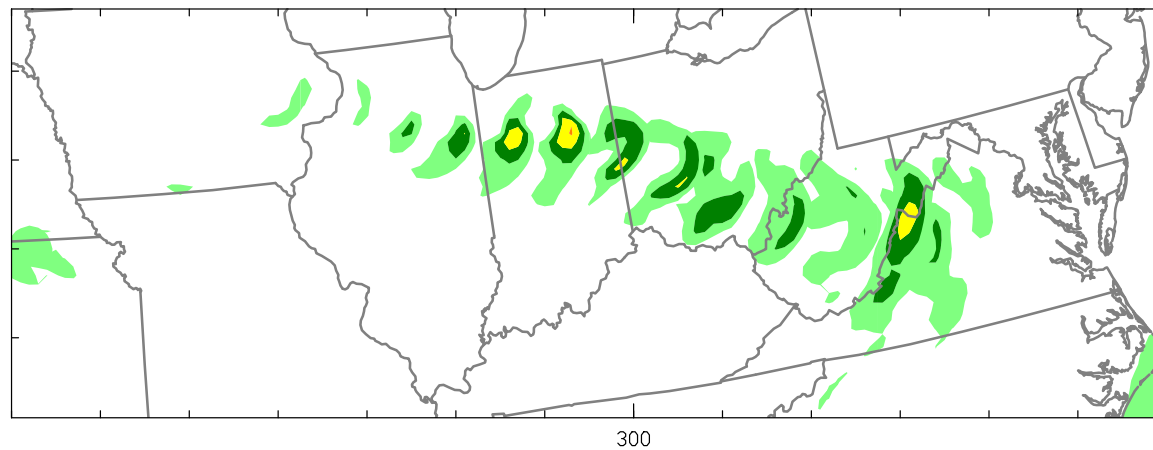
IC2918



\* Other members of EnKF IC also forecast the systems.



## 15 km forecast: composite surface max wind



# Summary So Far...

- The WRF model at 3 km grid-size was able to capture the destructive Derecho event accurately: formation and propagation
- The success is largely hinged on the initial condition. Initial conditions from GFS and NAM failed to produce the event: small scale and coherent disturbances matter as shown by the filtered IC experiments
- Analysis shows that several features in the initial conditions may play a critical role in the success:
  - Pre-existing convection
  - More accurate representation of low-level moisture, stability and shear
- Cycled analysis was important.





Thank you for your attention!

Acknowledgement: Glen Romine,  
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Hans Huang



Mesoscale & Microscale Meteorological Division / NCAR

