Improving Tornado Warnings: from *Observation* to *Forecast*

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Hazards Caucus Alliance Briefing

Tornadoes: Understanding how they develop and providing early warning

10:30 am – 11:30 am, Wednesday, 21 July 2010

Senate Capitol Visitors Center 212

Each Year:

~***1,500 tornadoes*** touch down in the United States, causing over ***80 deaths, 100s of injuries*****,** and an estimated ***$1.1 billion in damages***

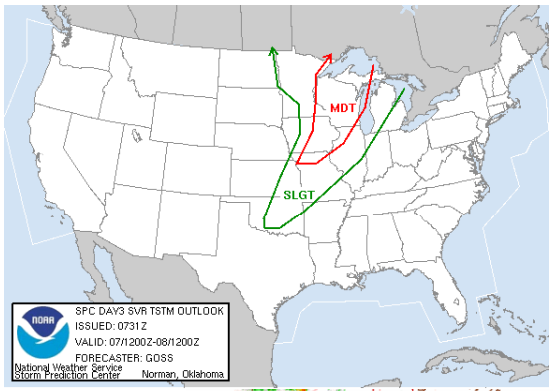
Statistics from NOAA Storm Prediction Center

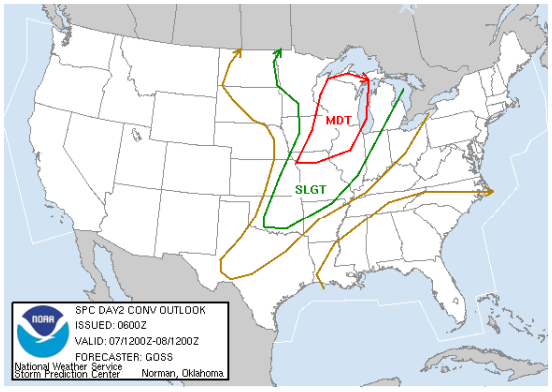
Supercell – A long-lived rotating thunderstorm

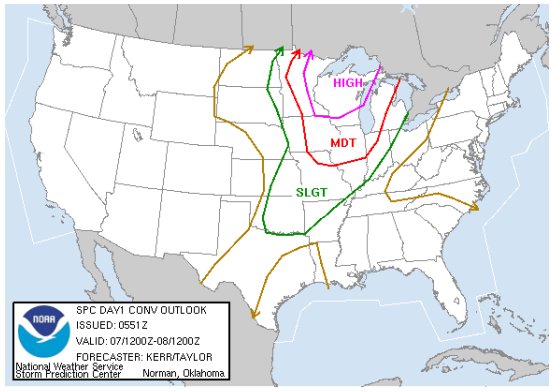
*the primary type of thunderstorm producing **strong** and **violent** tornadoes*

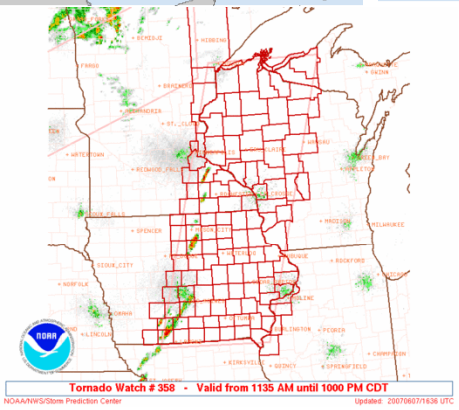
Present Warning System: Warn on Detection

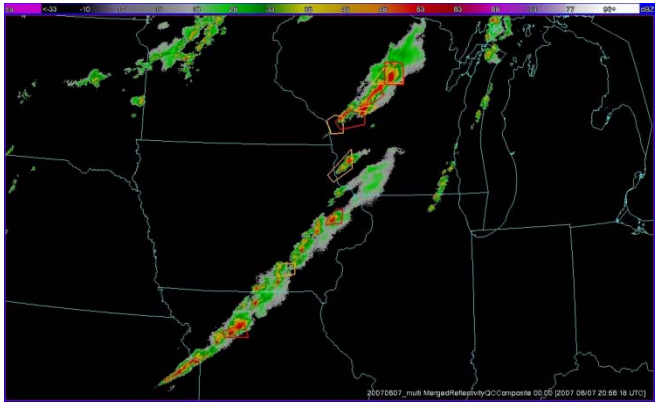
- A Warning is the culmination of information developed and distributed over the preceding days → sequence of day-by-day forecasts identifies an area of high threat
- On the day, storm spotters deployed; radars monitor formation, growth of thunderstorms
- Appearance of distinct cloud or radar echo features → tornado has formed or is about to do so → Warning is generated, distributed







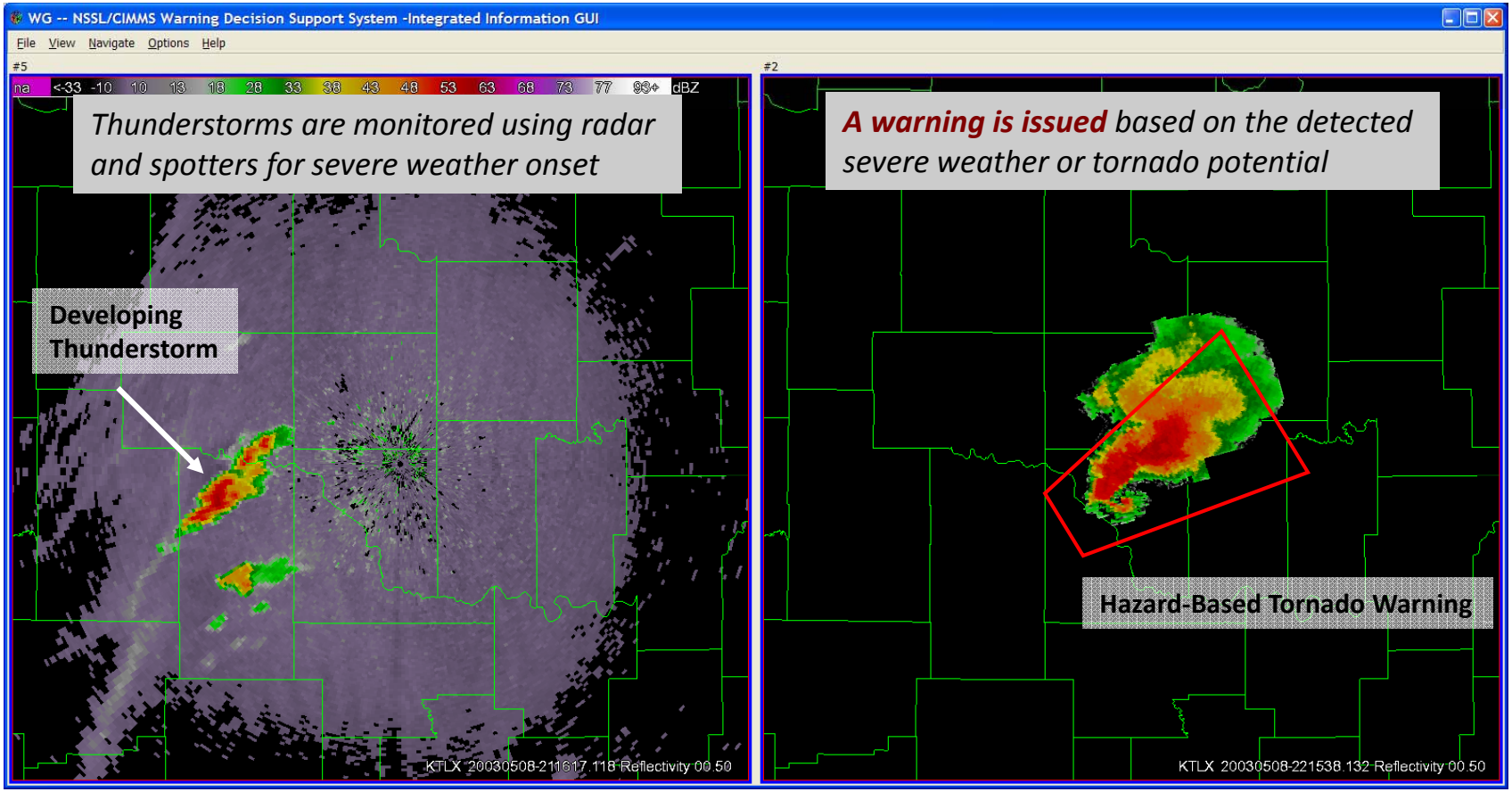




Present Warning System: *Warn on Detection*

Radar at 2100 CST

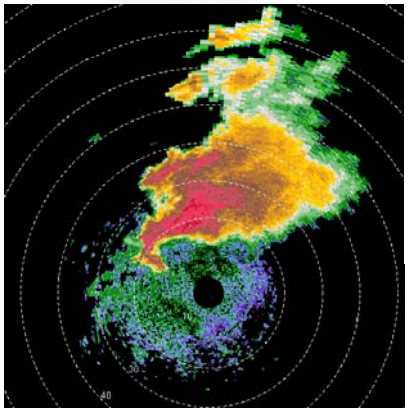
Radar at 2130 CST with Warning



- ***Reactive; responds to what nature is doing***
- **Tornado Warning lead times average 14 minutes**
- **Warnings allow individual response**

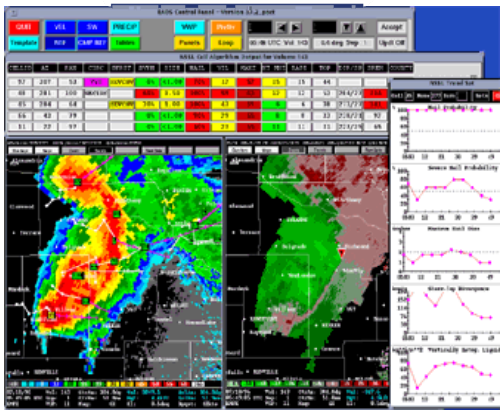
The Future: *Radar information* assimilated to *initialize* an *ensemble* of *mesoscale numerical weather prediction* models running on *high performance computing systems* → likelihood, location, and characteristics of a severe thunderstorm/tornado is forecasted well in advance of touchdown, maybe even before storm forms.

RADAR, OTHER DATA

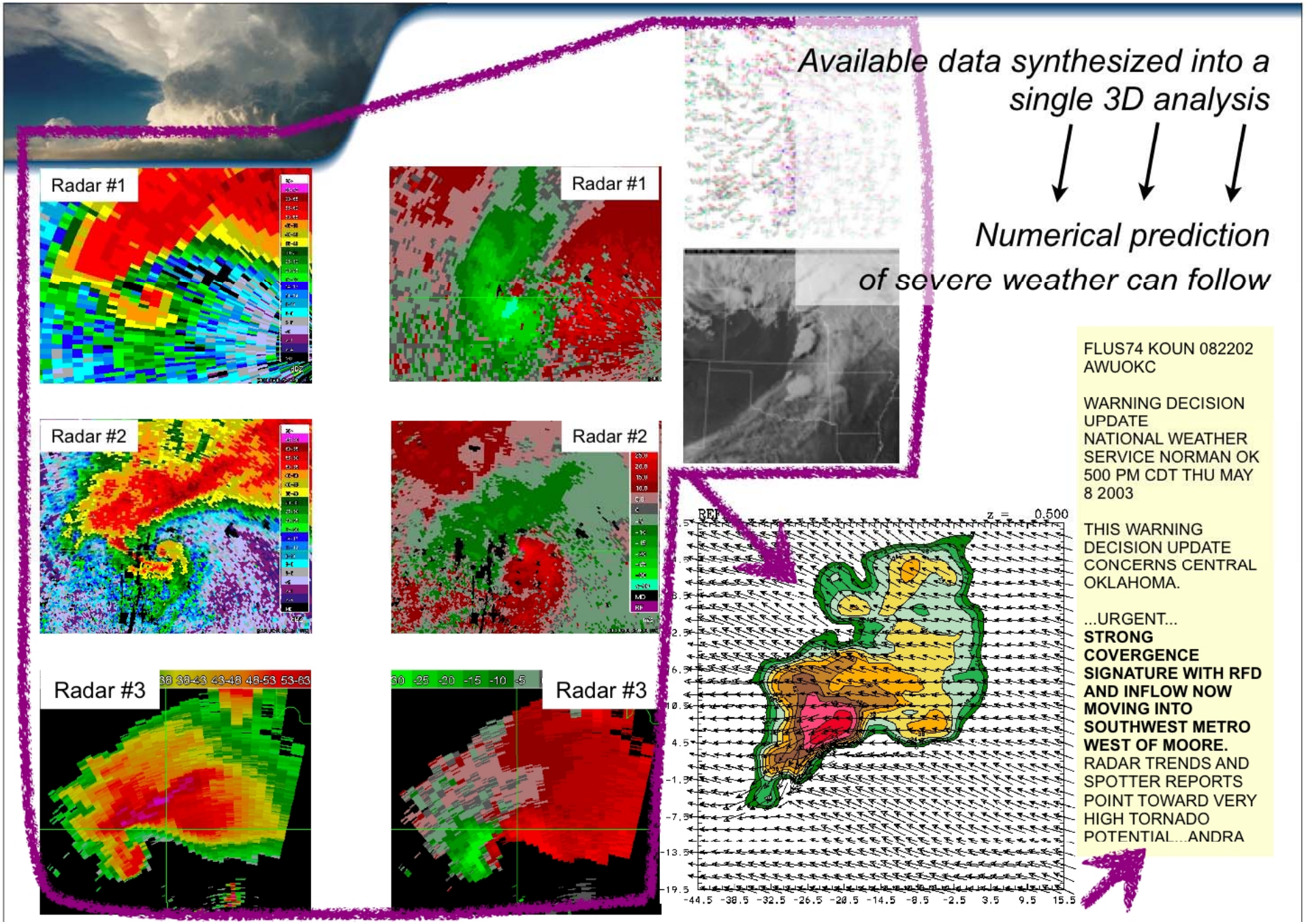


MESO NWP MODEL ON HPC SYSTEM

FORECAST→ WARNING

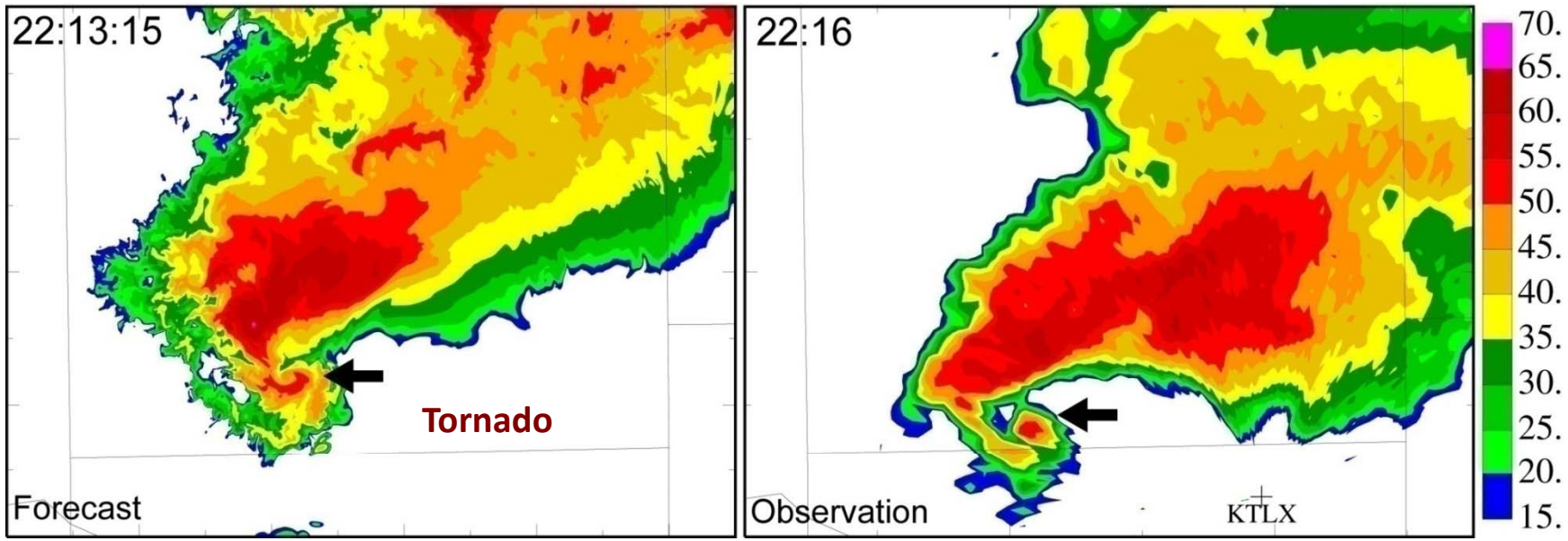


Radar information is ***essential*** but other observations are very valuable



Courtesy Lou Wicker

Clear Potential for Improved Severe Weather Forecasts & Subsequent Warnings



43 minute forecast

Actual event as observed with radar

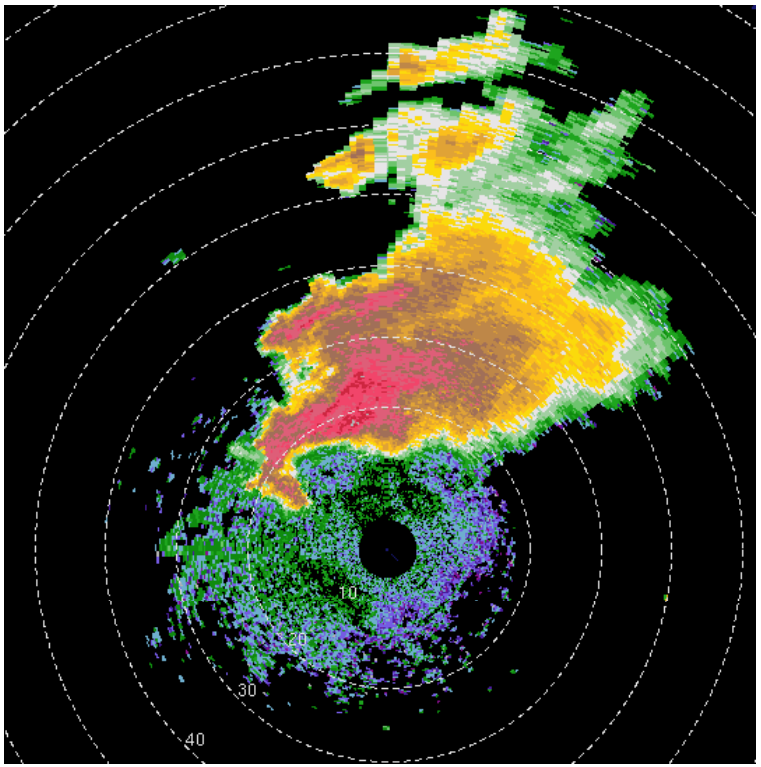
This sophisticated research simulation (50 m grid spacing) illustrates the potential for extended alerts for severe/tornadic thunderstorms

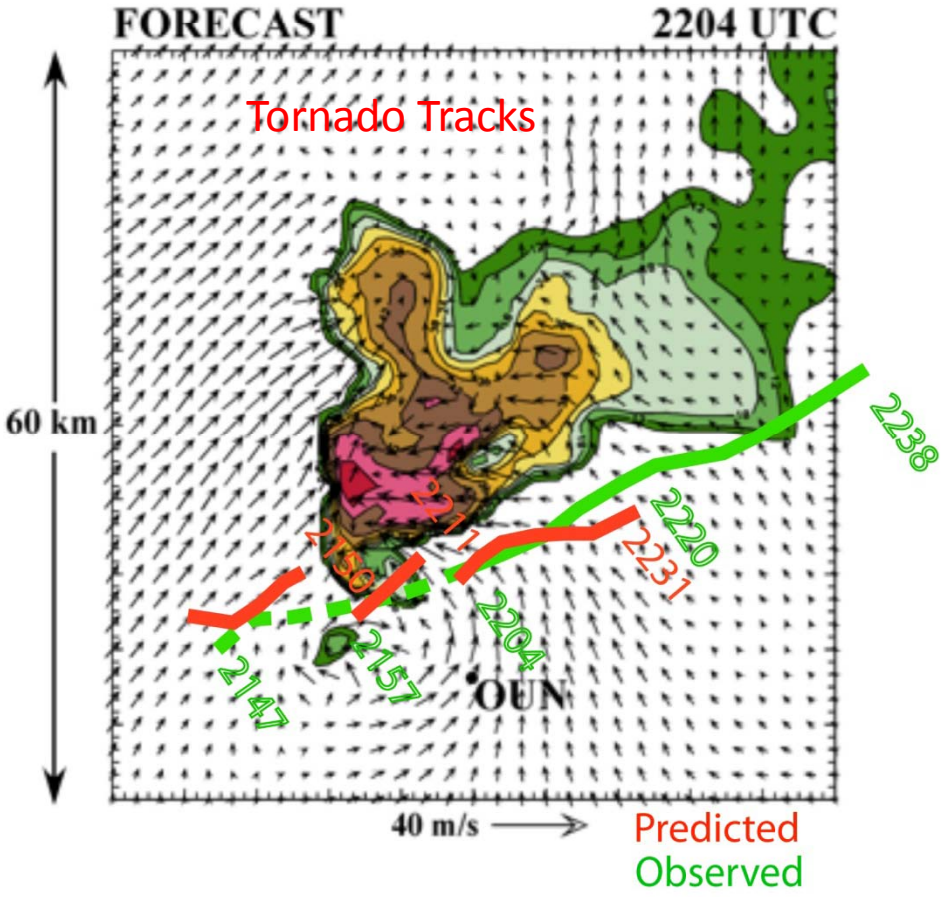
Xue, Droegemeier, and Weber 2007

Clear Potential for Improved

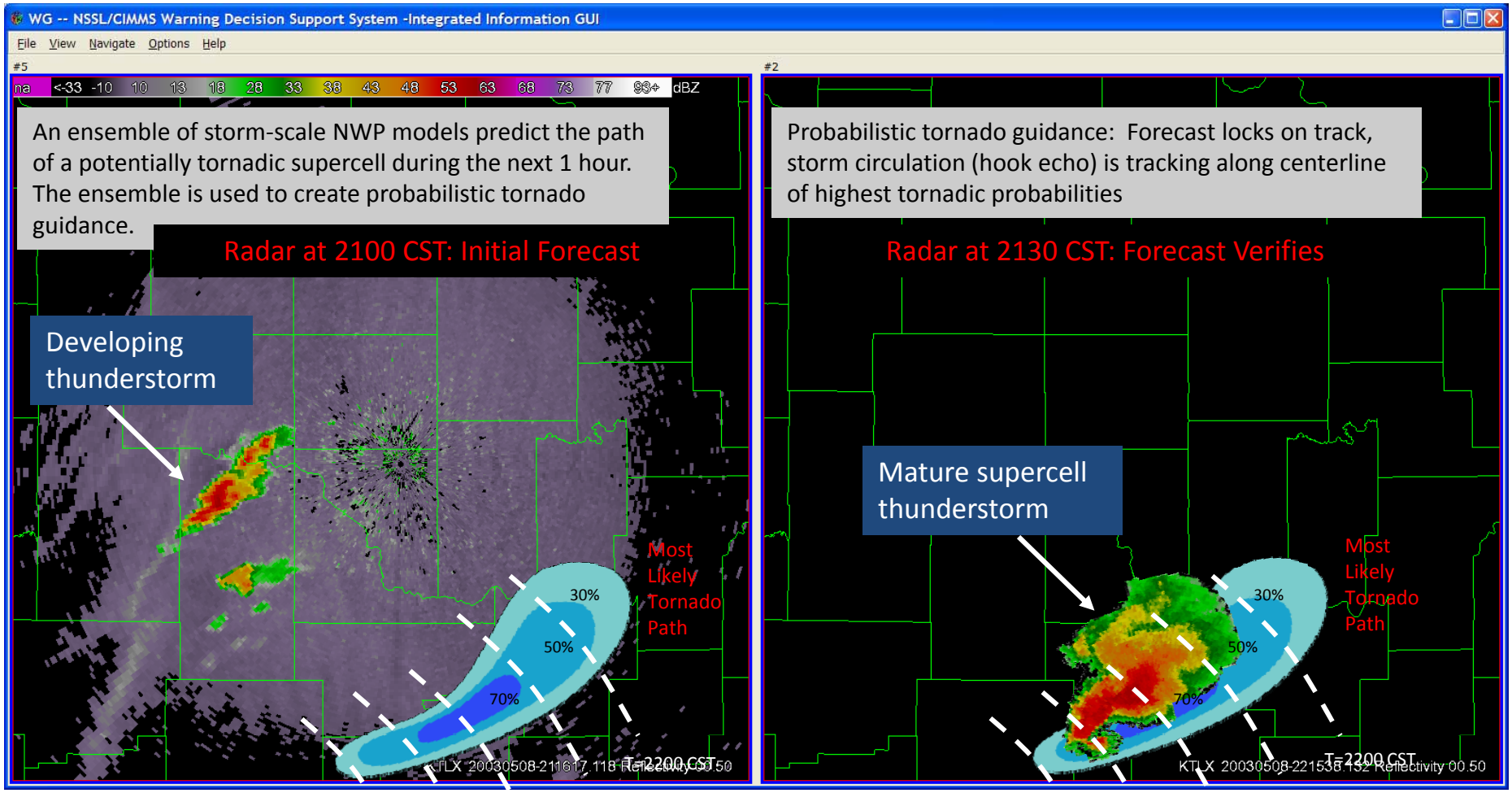
Severe Weather Forecasts & Subsequent Warnings

Dowell and Wicker (2009)





The Goal: Convective-scale Warnings Based On Forecasts



Stensrud et al. 2009 (October *BAMS*)

- **Proactive: anticipates what nature will do**
- **More than triple current Tornado Warning lead times**
- **Improved warnings allow enhanced <u>community</u> response**

Challenges to Achieving Warn-on-Forecast

- **Many Science Challenges and Questions Remain**
  - **Improved Observations and Prediction Models → VORTEX2**
- **High Performance Computing Capacity**
  - **Research**
    - Next generation approaches to storm scale prediction
      - » develop, test, and evaluate at the Hazardous Weather Testbed
    - Explore high resolution ensembles & adaptive computing strategies
    - Requires petaflop machines
  - **Operational Forecasts**
    - Essential to realize societal benefits of the research
      - » Severe Storms, Aviation, Energy
      - » An ensemble of 20+ forecasts critical to success (cost multiplier)
      - » Competing national requirements
    - Dedicated 365x24x7 HPC services → every day, every hour
      - » Must be timely and reliable
  - **Educate, prepare public to utilize this new type of warning**