

Nowcasting and Short-term Forecasting of Thunderstorms and Severe Weather Using OSCER

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Oklahoma Supercomputing Symposium
October 12, 2011



CASA & NEXRAD Radars

- CASA NetRad

NSF ERC: Collaborative Adaptive Sensing of the Atmosphere

- X-Band Dual-Pol Radars
- 40 km nominal range
- Collaborative, Adaptive Scanning
- Fill-in below coverage of NEXRAD
- Toward phased-array panels – low-cost!

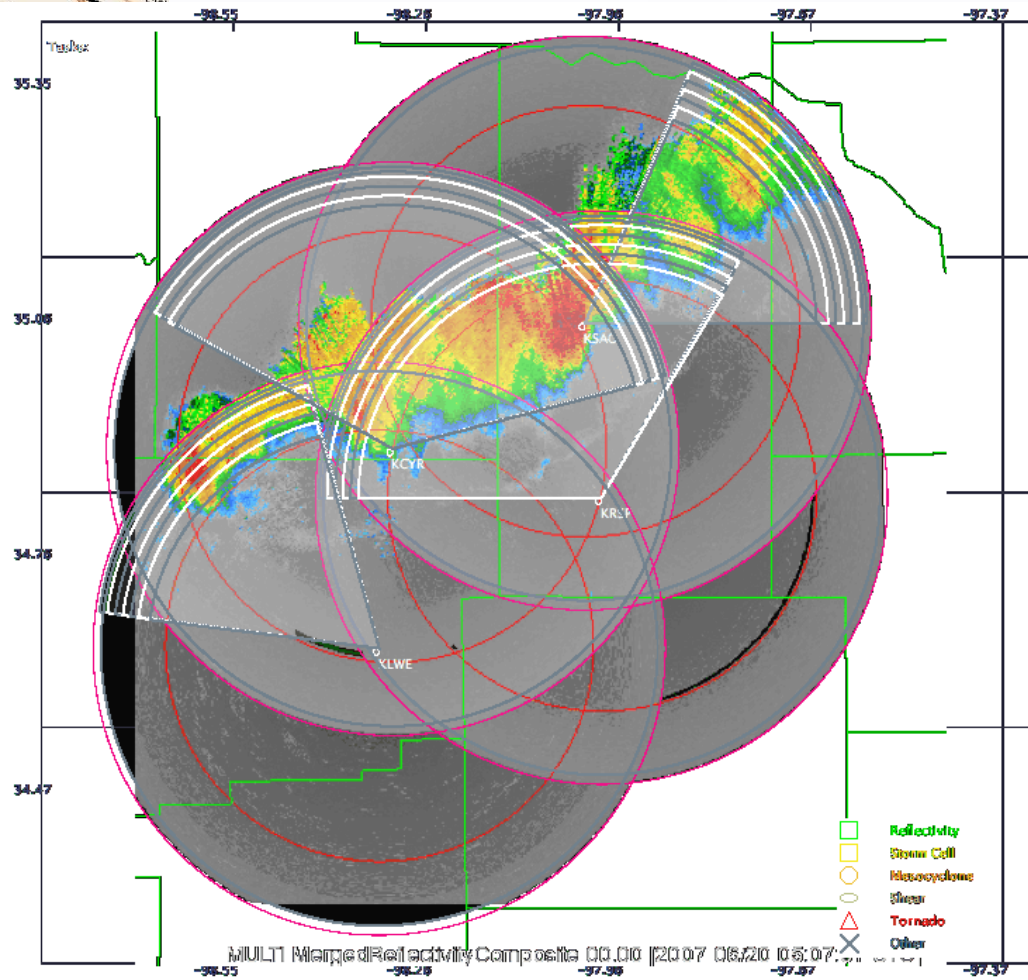
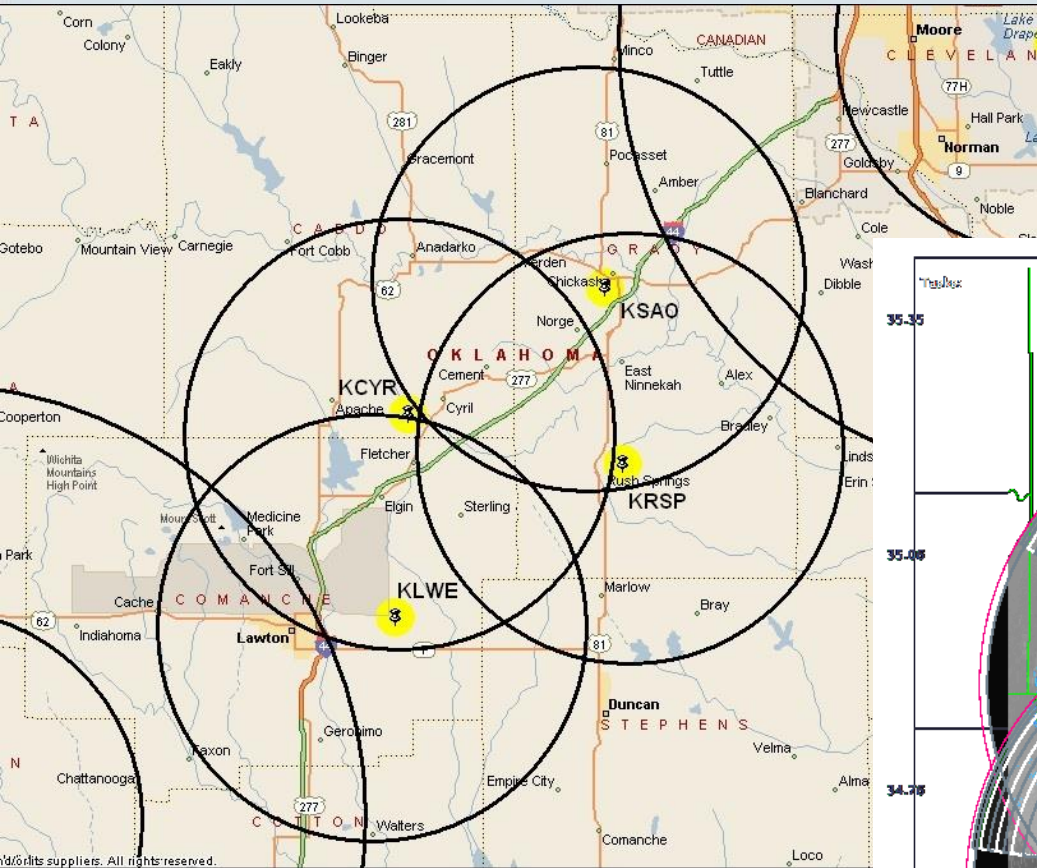


- NEXRAD

- S-Band Radars
- 14 covering domain
- Data used out to 230 km



CASA NetRad Network

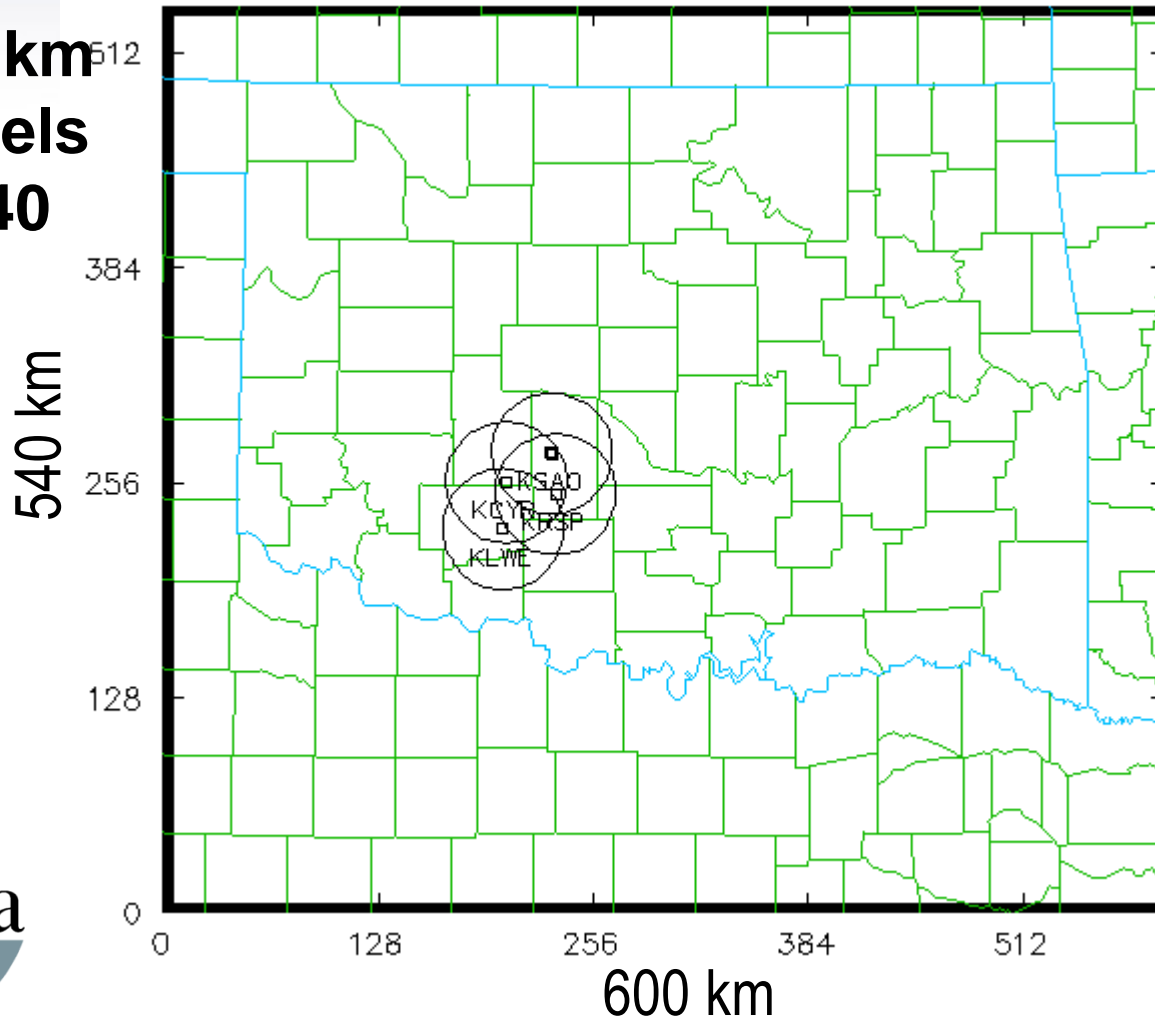


Southwest Oklahoma



Spring 2007-2009 Near-Real Time Forecast Domain

$\Delta x = 1 \text{ km}$
53 Levels
600x540

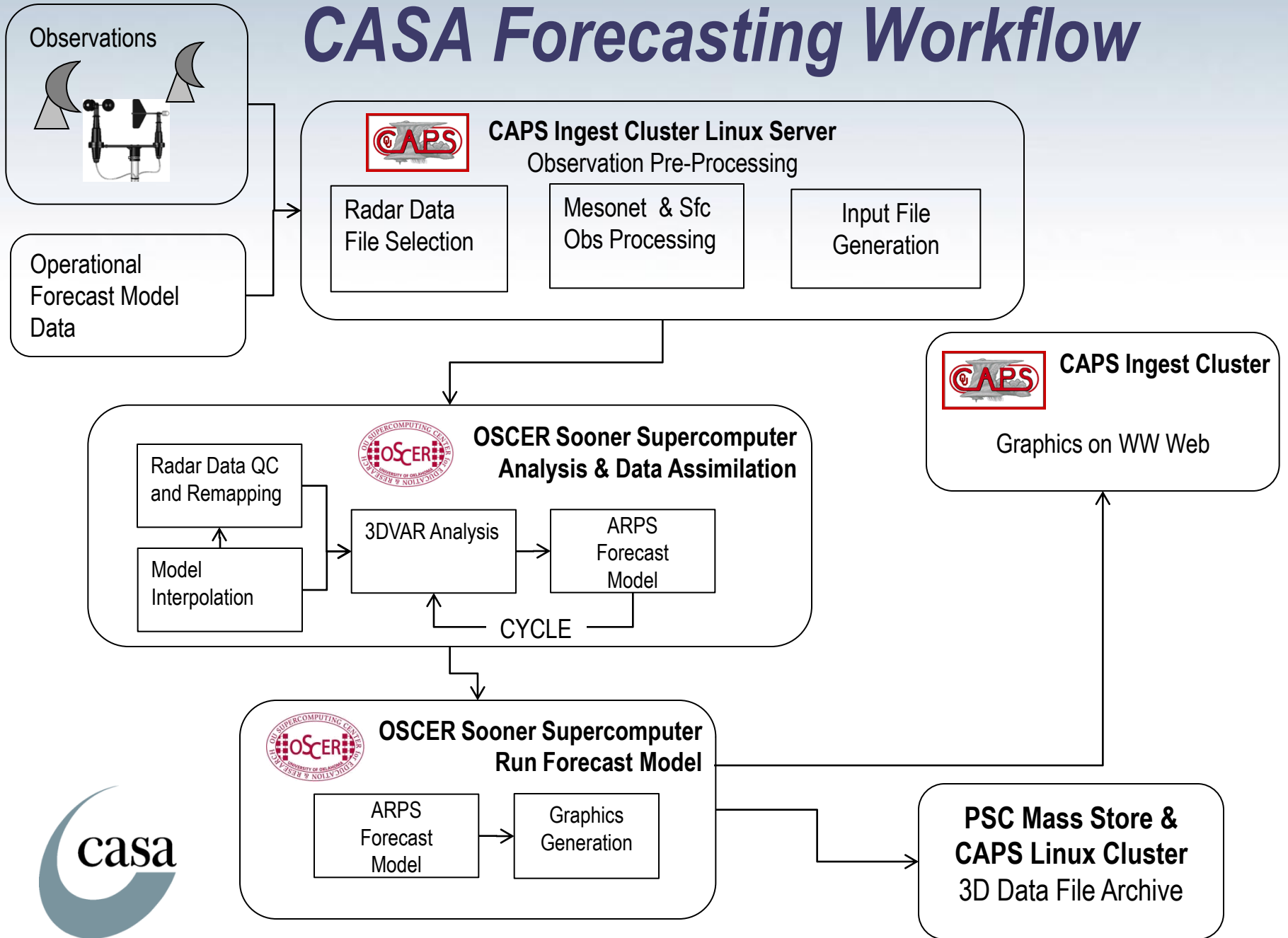


Radars Used:
4 CASA
14 NEXRAD

Plus
Satellite &
Surface Data



CASA Forecasting Workflow



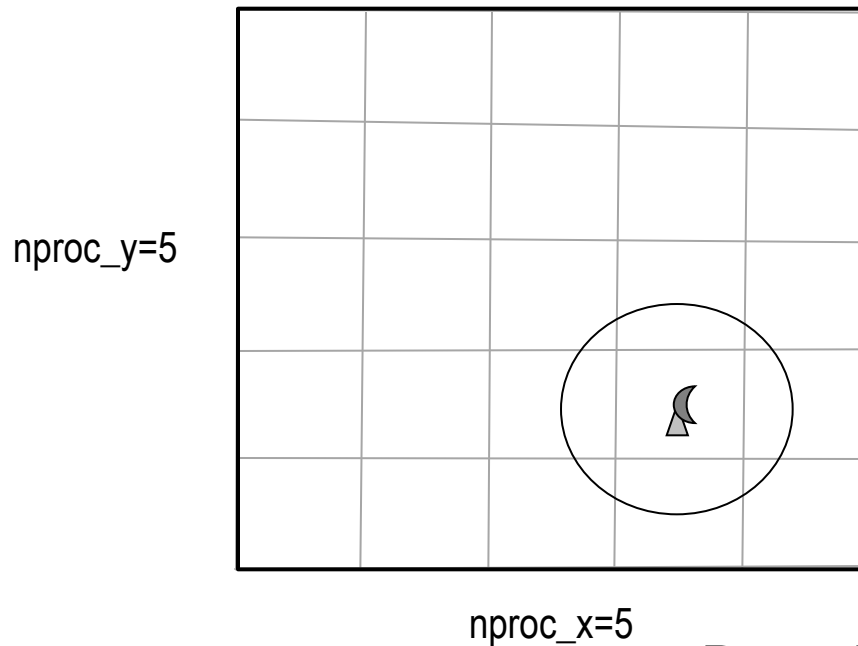
Improving the MPI Efficiency of Radar Remapper

Radar data are converted from 3-D polar to 3-D Cartesian coordinates.

Original Strategy:

Horizontal Domain Decomposition

Each processor finds solution on columns within its domain

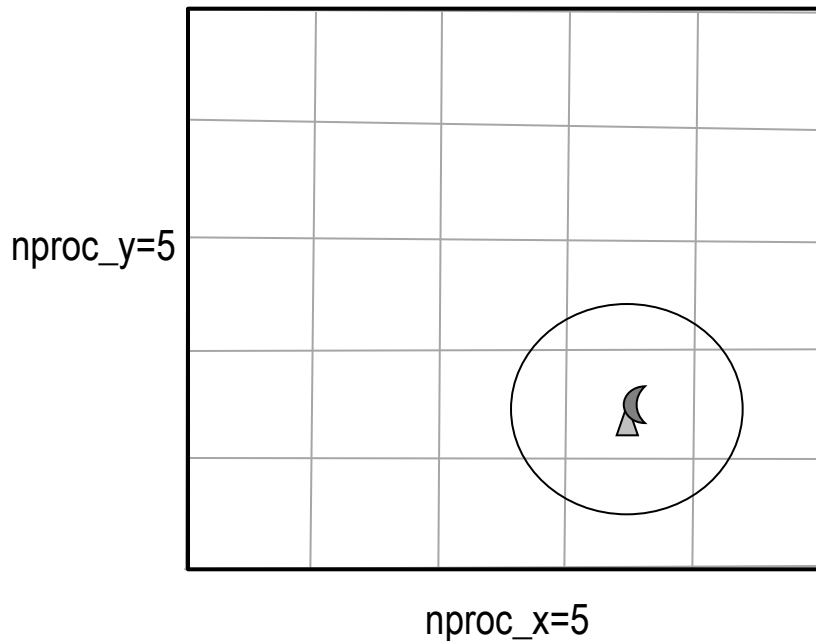


Potentially uneven workload



Improving the MPI Efficiency of Radar Remapper

Radar data are converted from polar to Cartesian coordinates of model grid.



Improved Algorithm

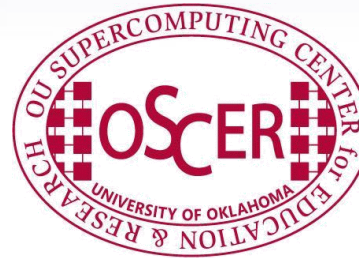
For each radar

1. Within domain decomposition, determine columns having valid data
2. Collect columns with valid data in 1-D array
3. Distribute work for these columns uniformly among processors
4. Execute remapping algorithm MPI
5. Distribute results to original home processor for output.

Real-Time NWP Runs 2009

- 9 Weeks in Spring Season
- 6-hour 1-km resolution forecasts
- Use Radar Reflectivity & Radial Velocity
- 3DVAR wind with ADAS cloud analysis
- ARPS Model
- Runs posted to Web in real-time
<http://www.caps.ou.edu/wx/casa/>

- Run on Parallel Linux Boxes



OU OSCER

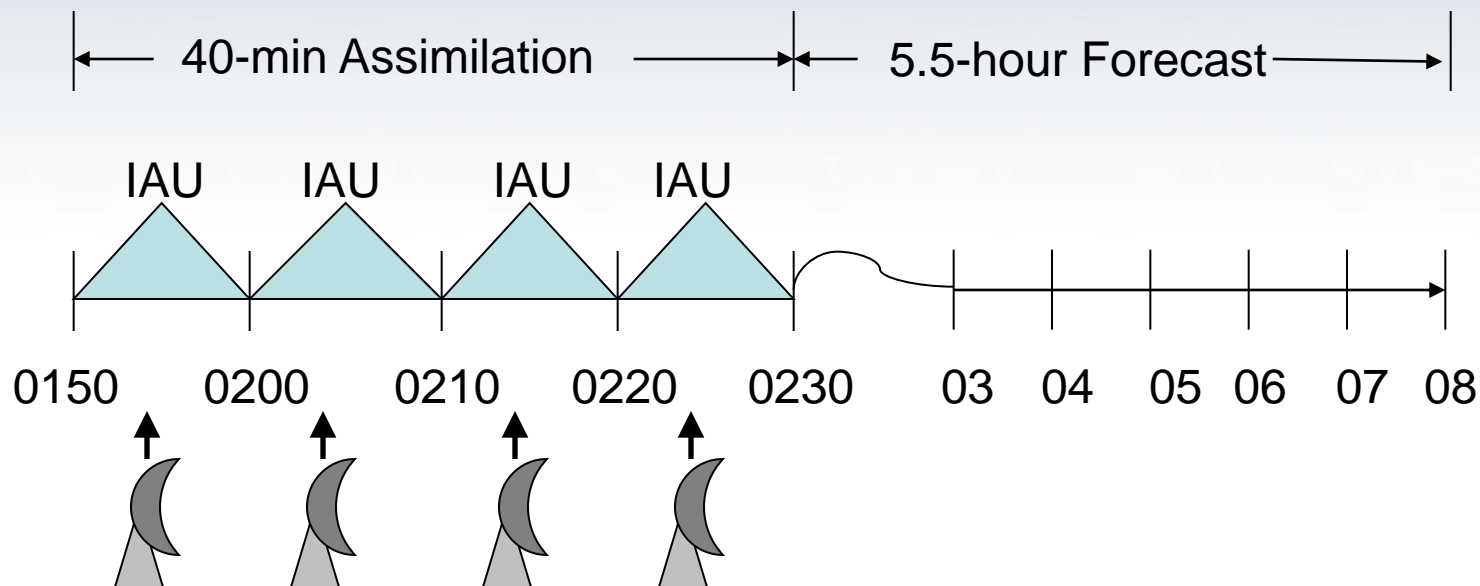
600 processors/2 runs at a time

- Total Run Time 1.5 hours
- Two Runs in Near Real-time

CASA & NEXRAD	No CASA Data
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2007-2009 Assimilation Strategy



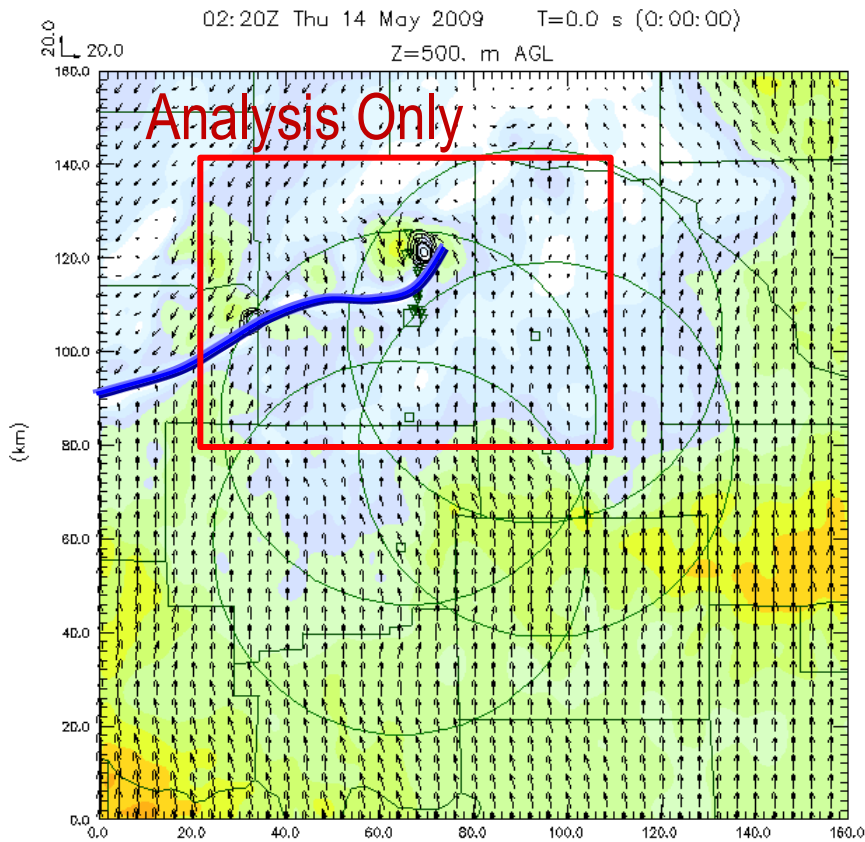
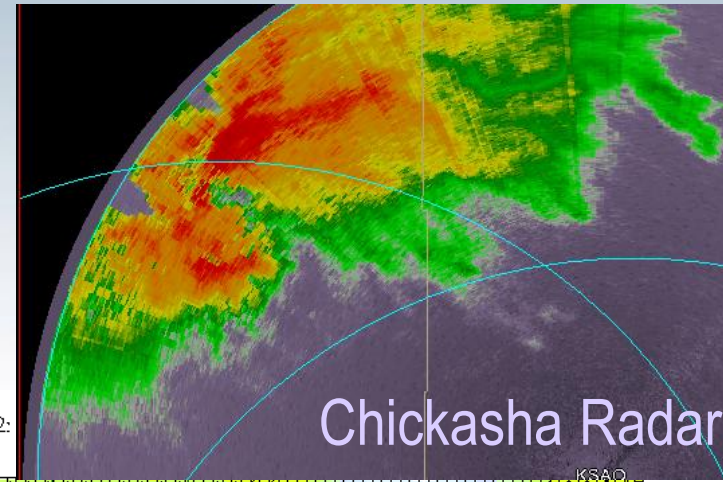
Manual on-demand model start-up for storms in the network.



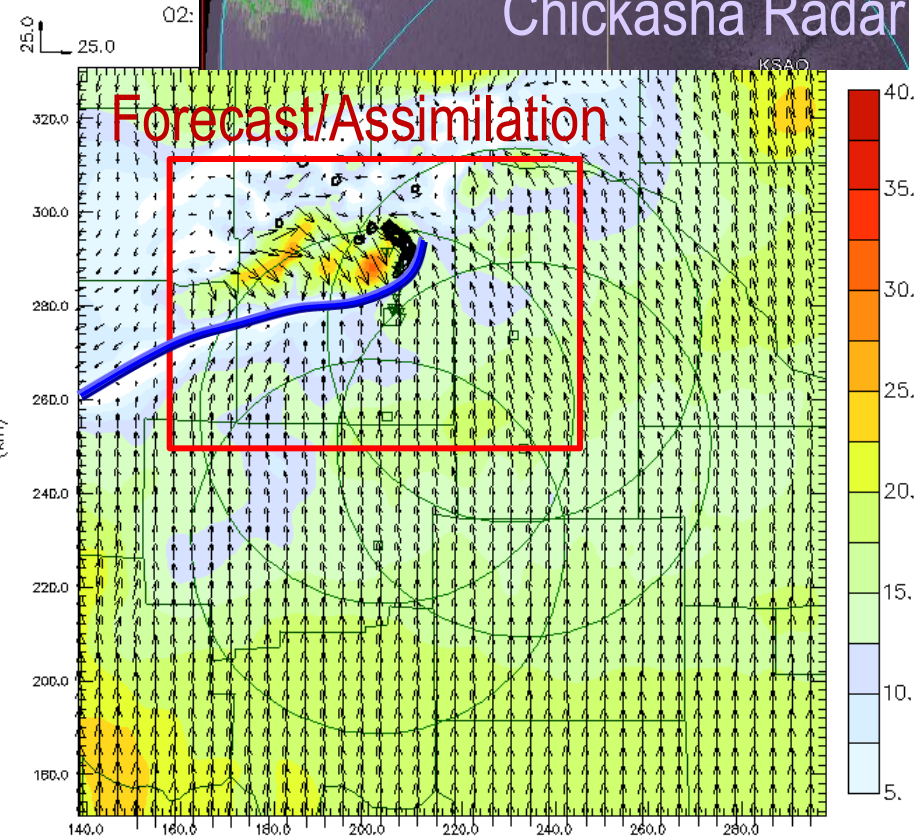
Assimilation vs. Analysis

Wind Speed/Vectors 500m AGL

0220 UTC

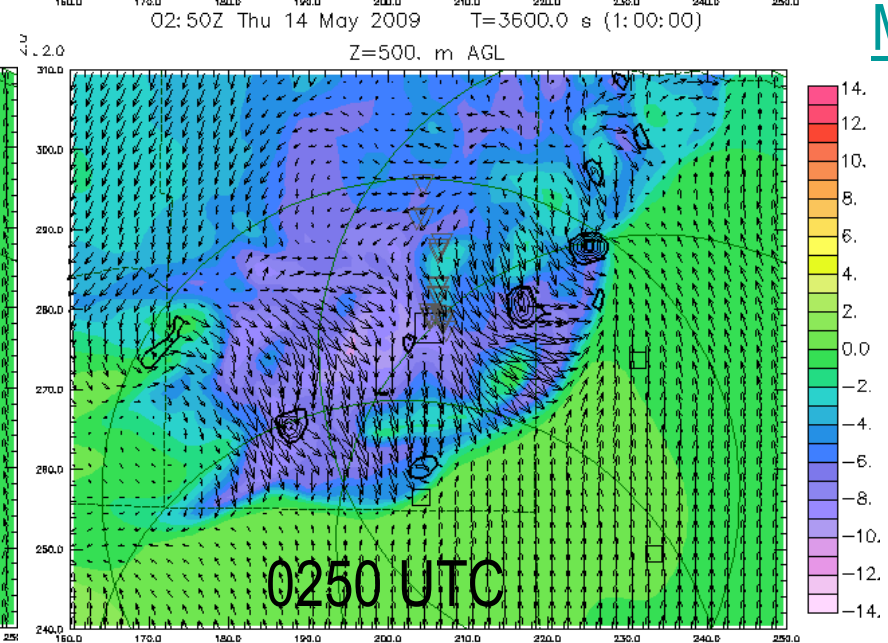
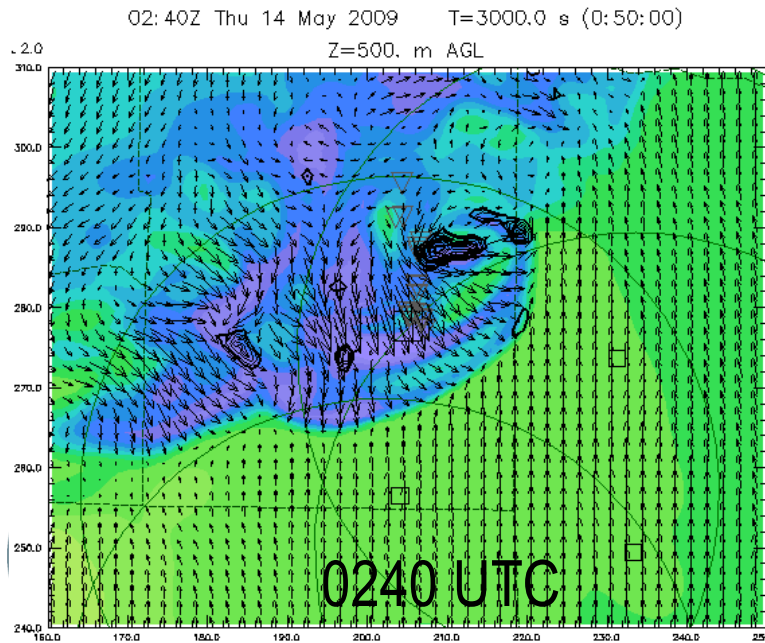
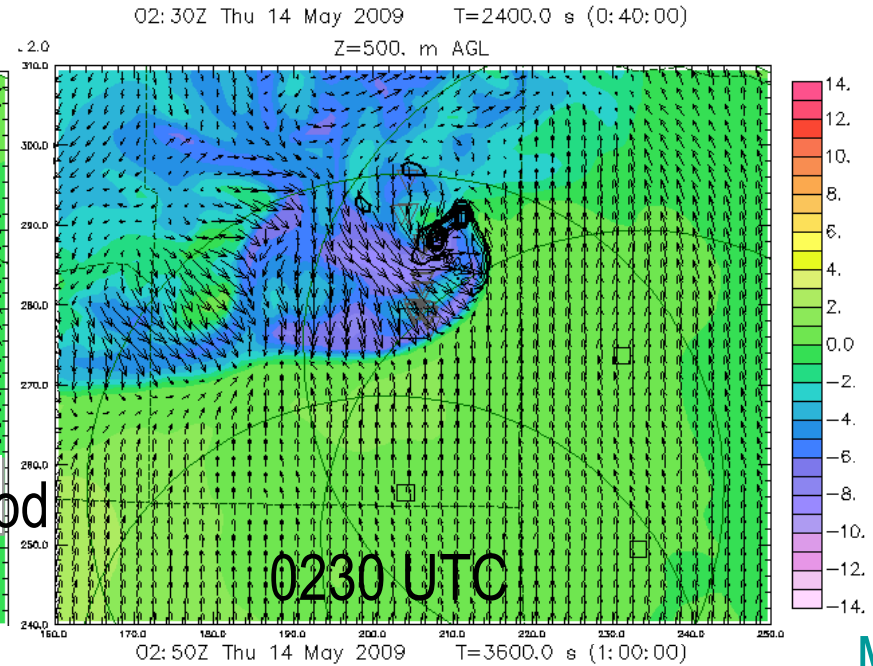
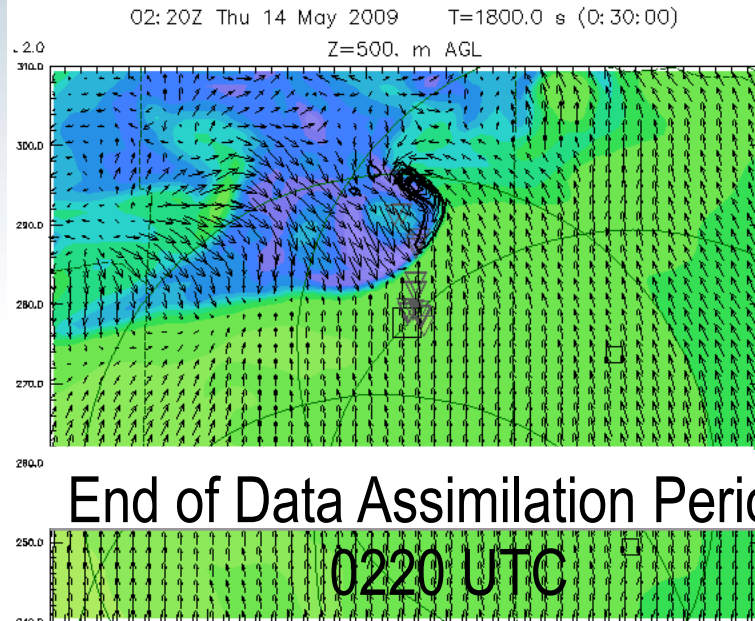


Horiz. wind (m/s, Shaded) (km) Min=0.417 Max=26.0
 U-V (m/s, Vector) Umin=-13.27 Umax=9.61 Vmin=-20.41 Vmax=25.73
 Vort*10⁵ (1/s, contour) Min=-474.6 Max=934.6 inc=100.0



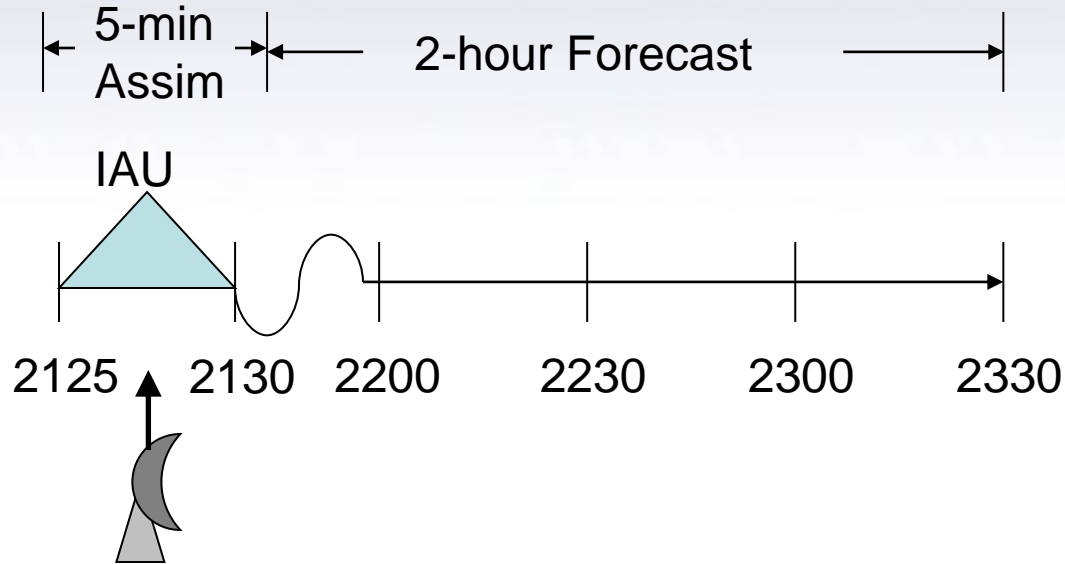
Horiz. wind (m/s, Shaded) (km) Min=0.860 Max=30.5
 U-V (m/s, Vector) Umin=-23.61 Umax=25.75 Vmin=-27.42 Vmax=23.97
 Vort*10⁵ (1/s, contour) Min=-724.6 Max=2622. inc=100.0

Forecast temperature perturbation + Vort. at z =500m AGL



[Movie](#)

2010 Nowcast Strategy

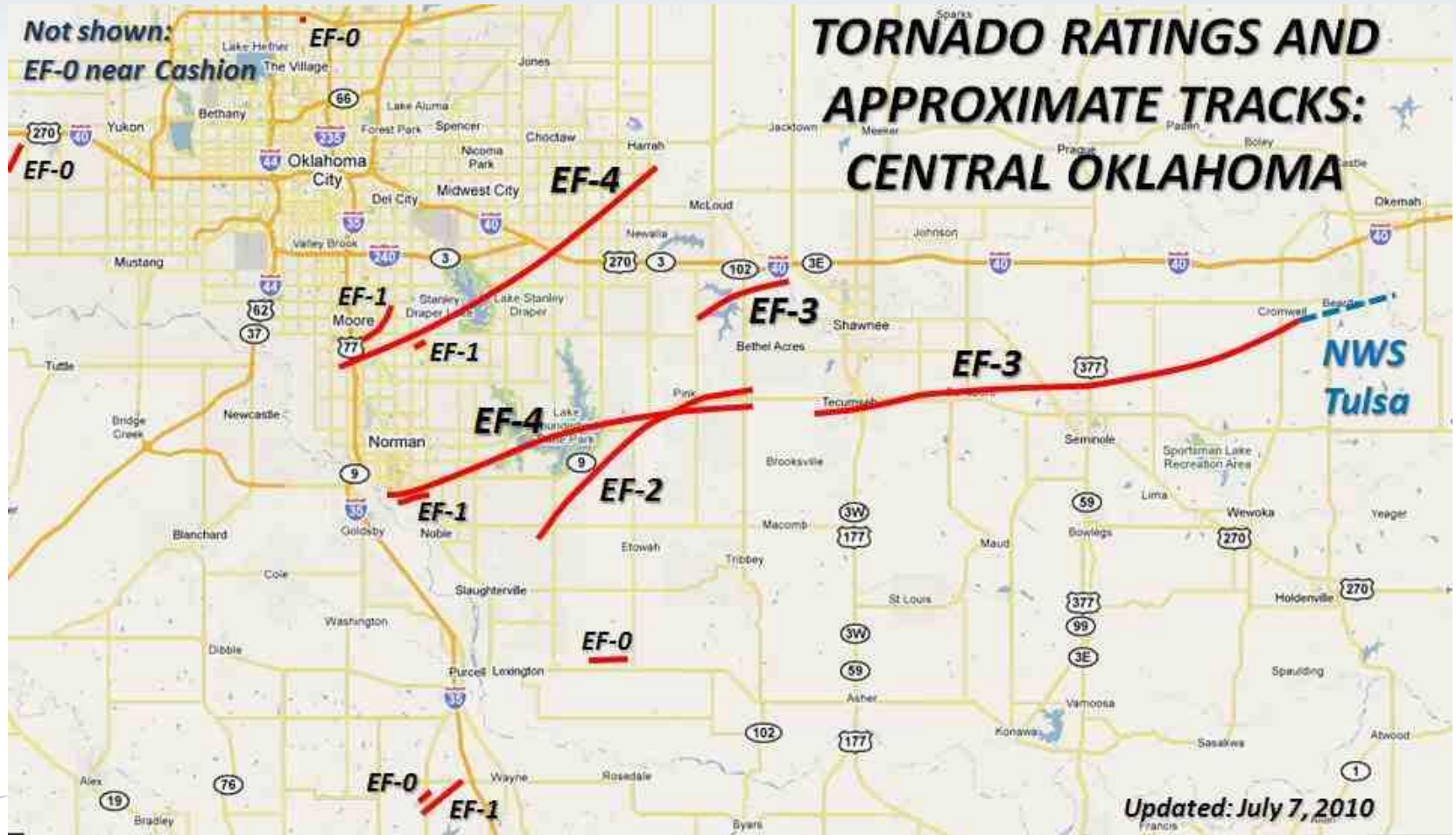


Domain size: 350 x 320 x 53. **Total Run Time < 10 min**
800 cores (100 dual-quad-core servers)

Forecast model run every 10-min whenever the radars
were operating (during precipitation).



Sample: 10 May 2010 21:40



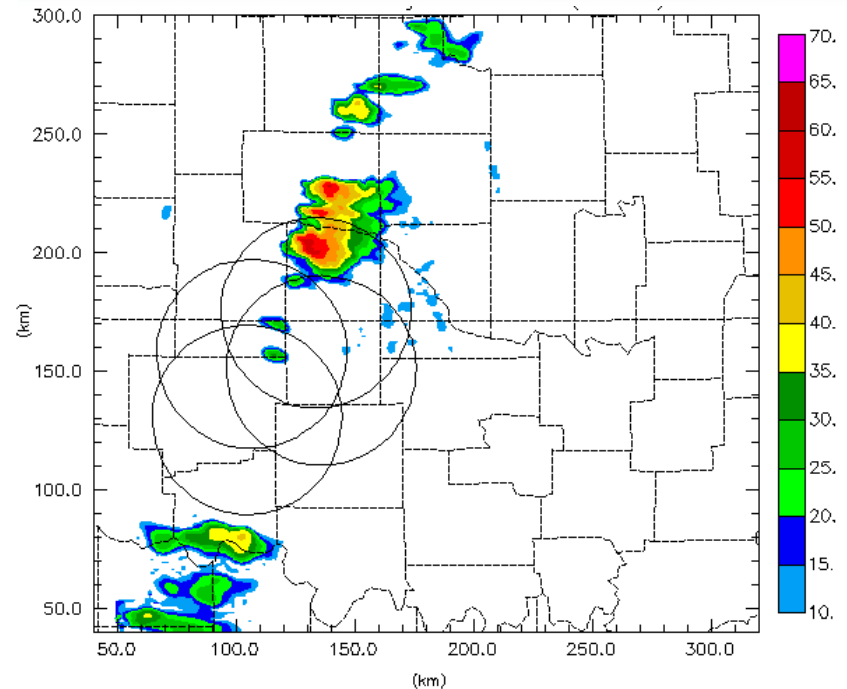
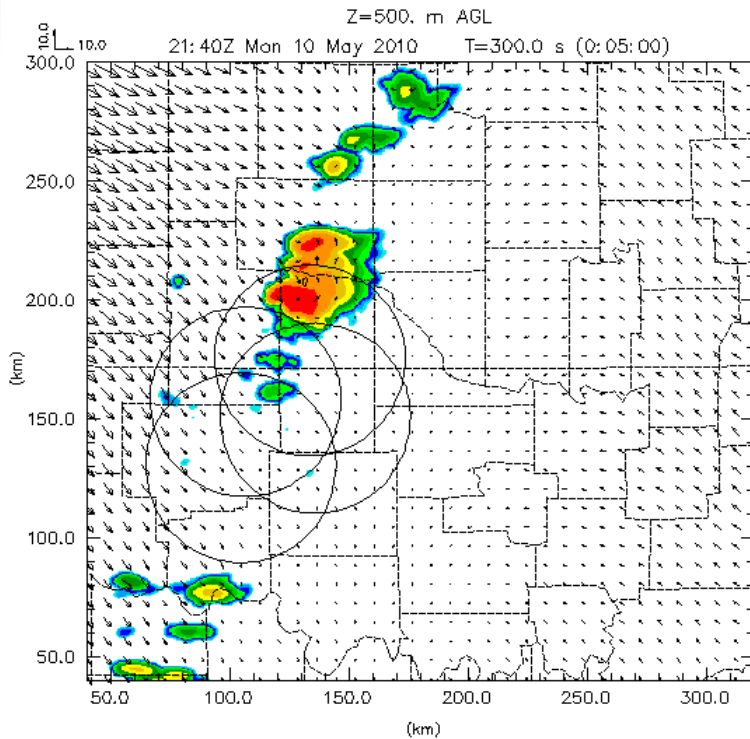
casa

From NWS Norman

2140 UTC Nowcast/Forecast

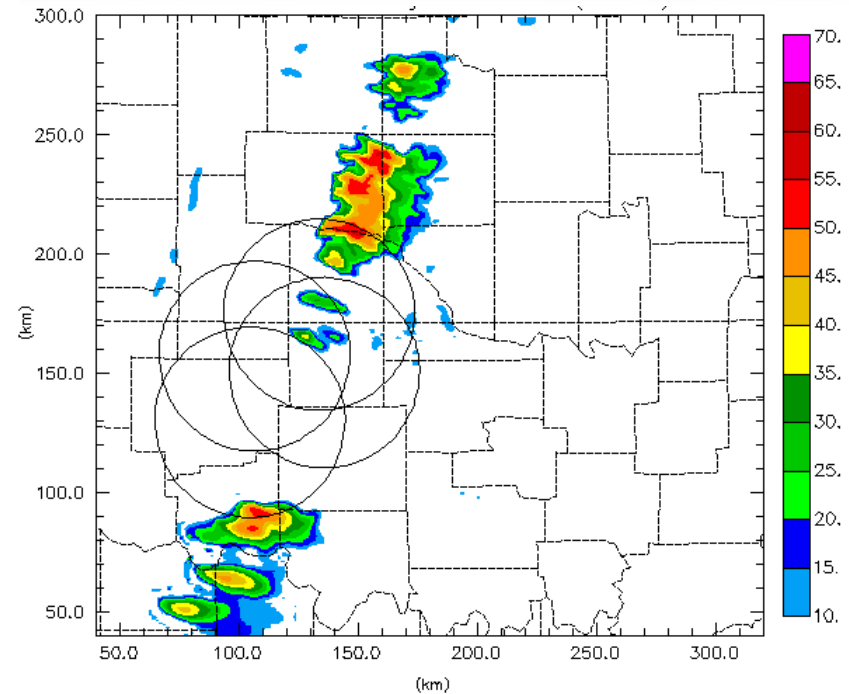
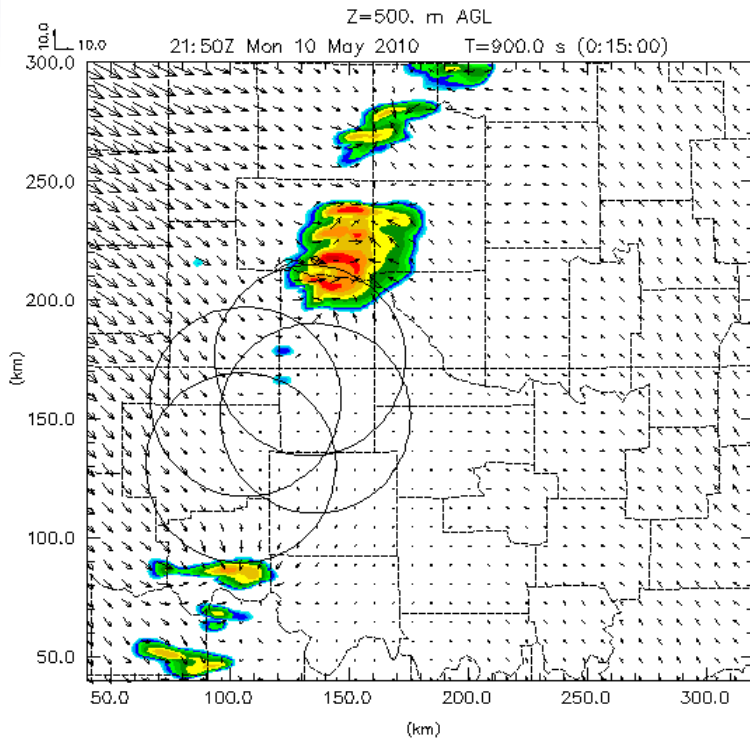
T=05 min (assimilated state)

2140



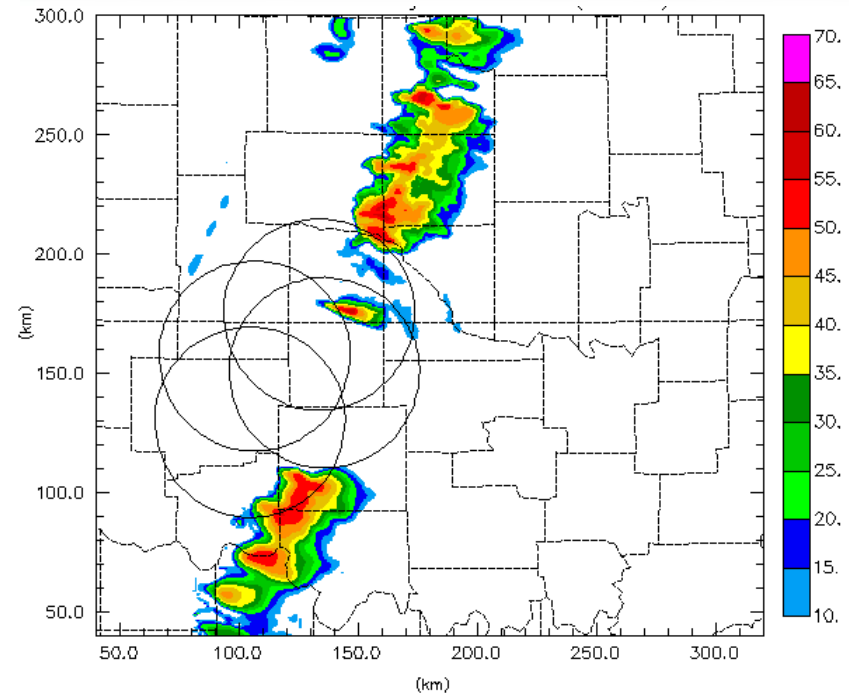
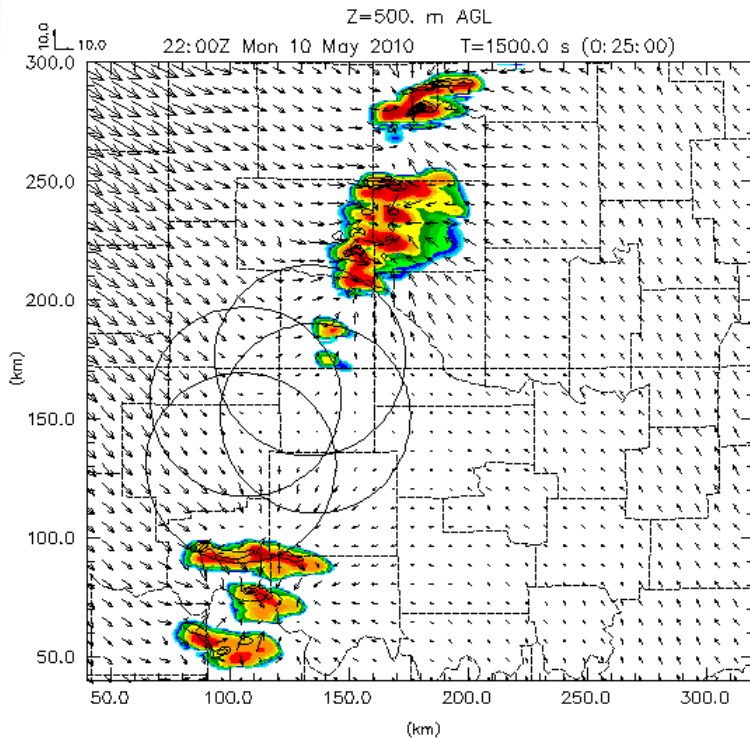
2140 UTC Nowcast/Forecast

T=15 min 2150



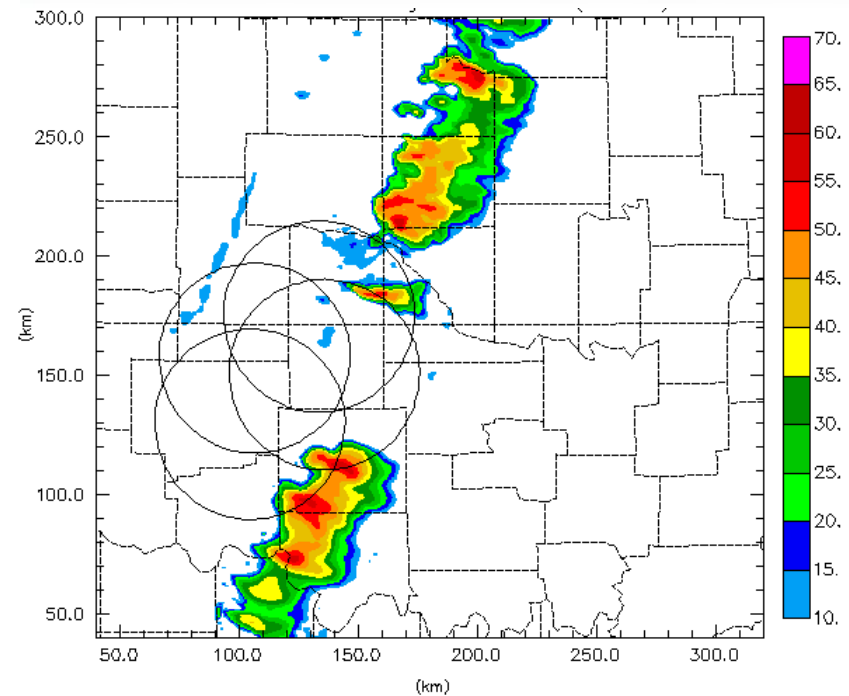
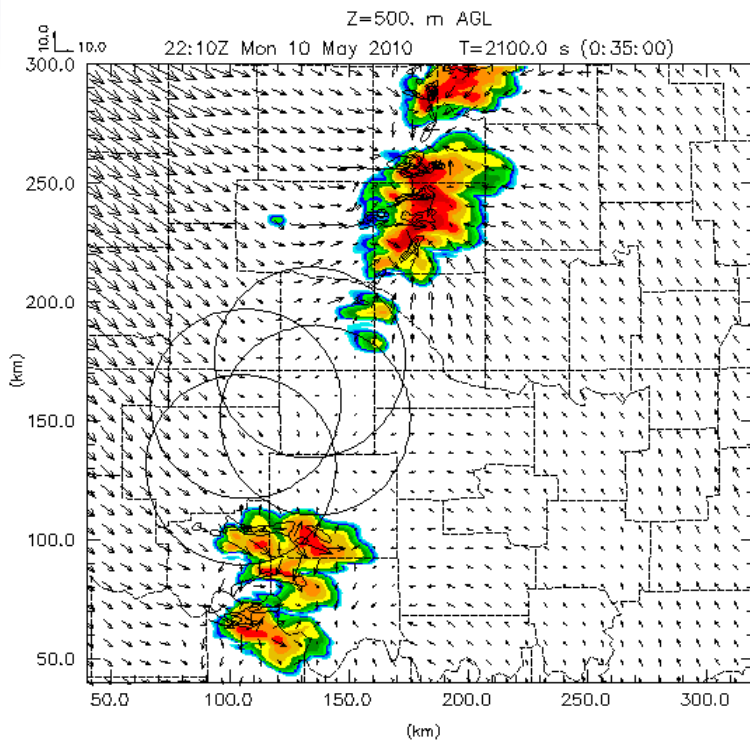
2140 UTC Nowcast/Forecast

T=25 min 2200



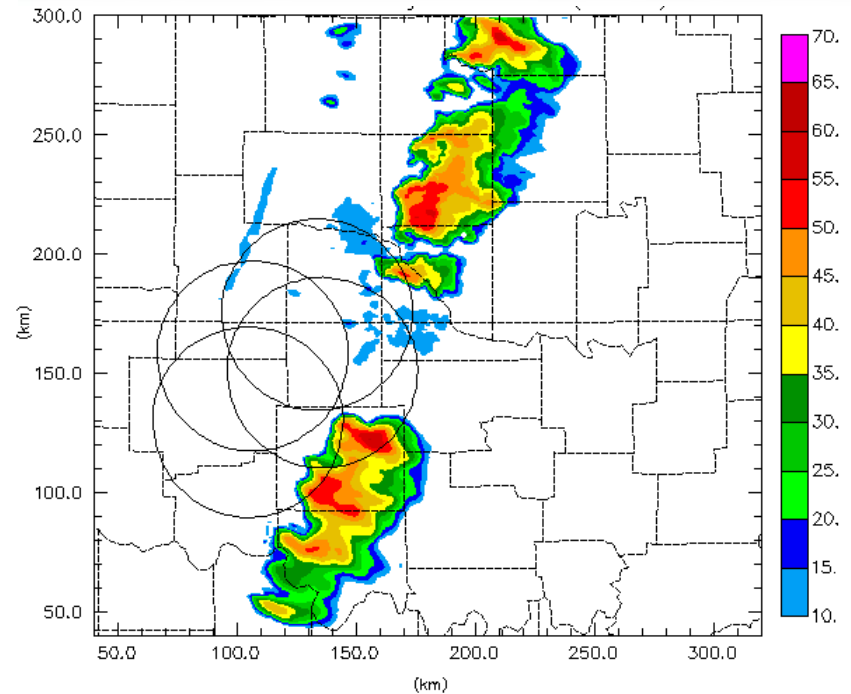
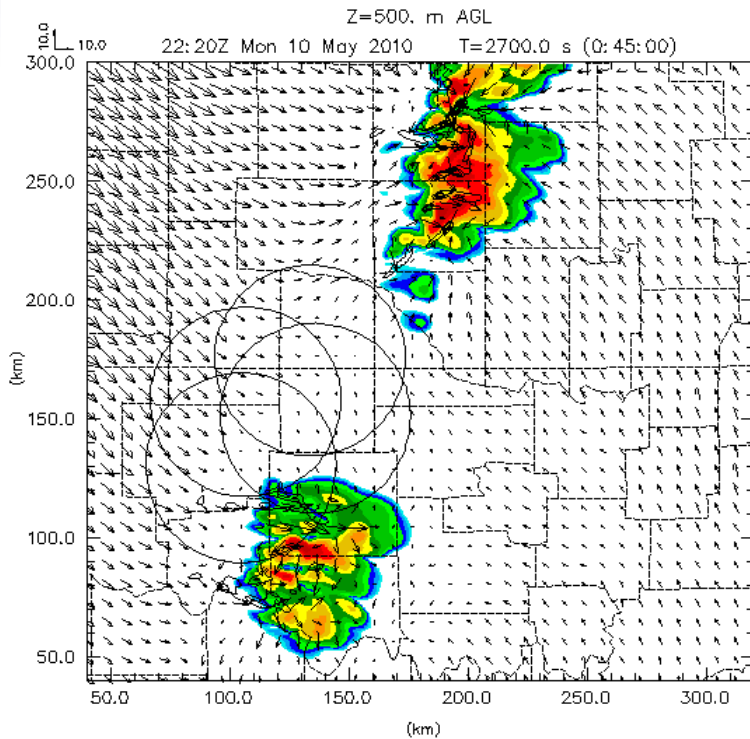
2140 UTC Nowcast/Forecast

T=35 min 2210



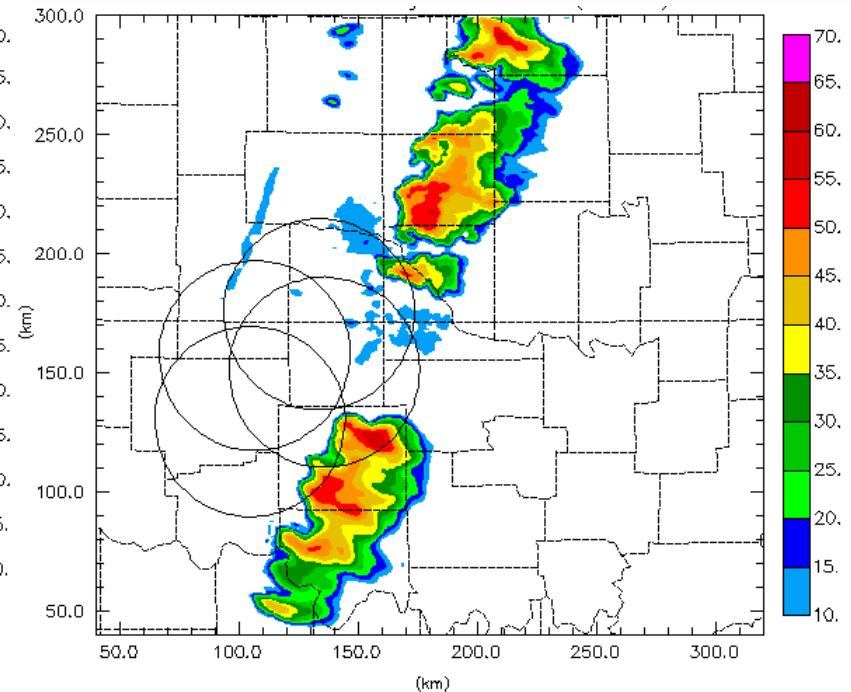
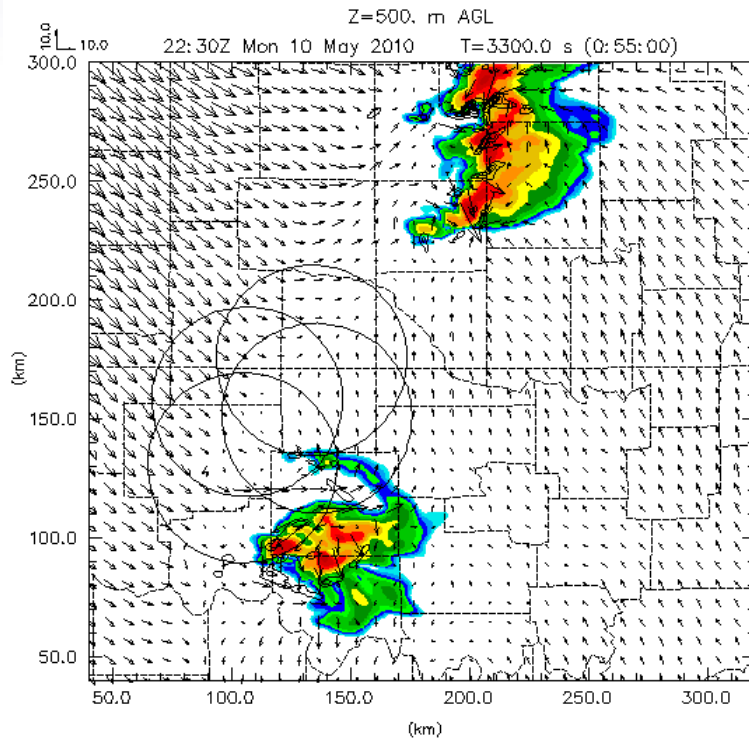
2140 UTC Nowcast/Forecast

T=45 min 2220



2140 UTC Nowcast/Forecast

T=55 min 2230



Data Assimilation Accomplishments

- Developed a very efficient real-time data assimilation, nowcasting and forecasting system
- Demonstrated initial impacts of CASA data on cloud-scale analysis and forecasting
- Advanced *real-time* storm-scale assimilation to where we can directly compare forecasted small-scale vorticity features to radar signatures
 - Major step towards “warn on forecast”

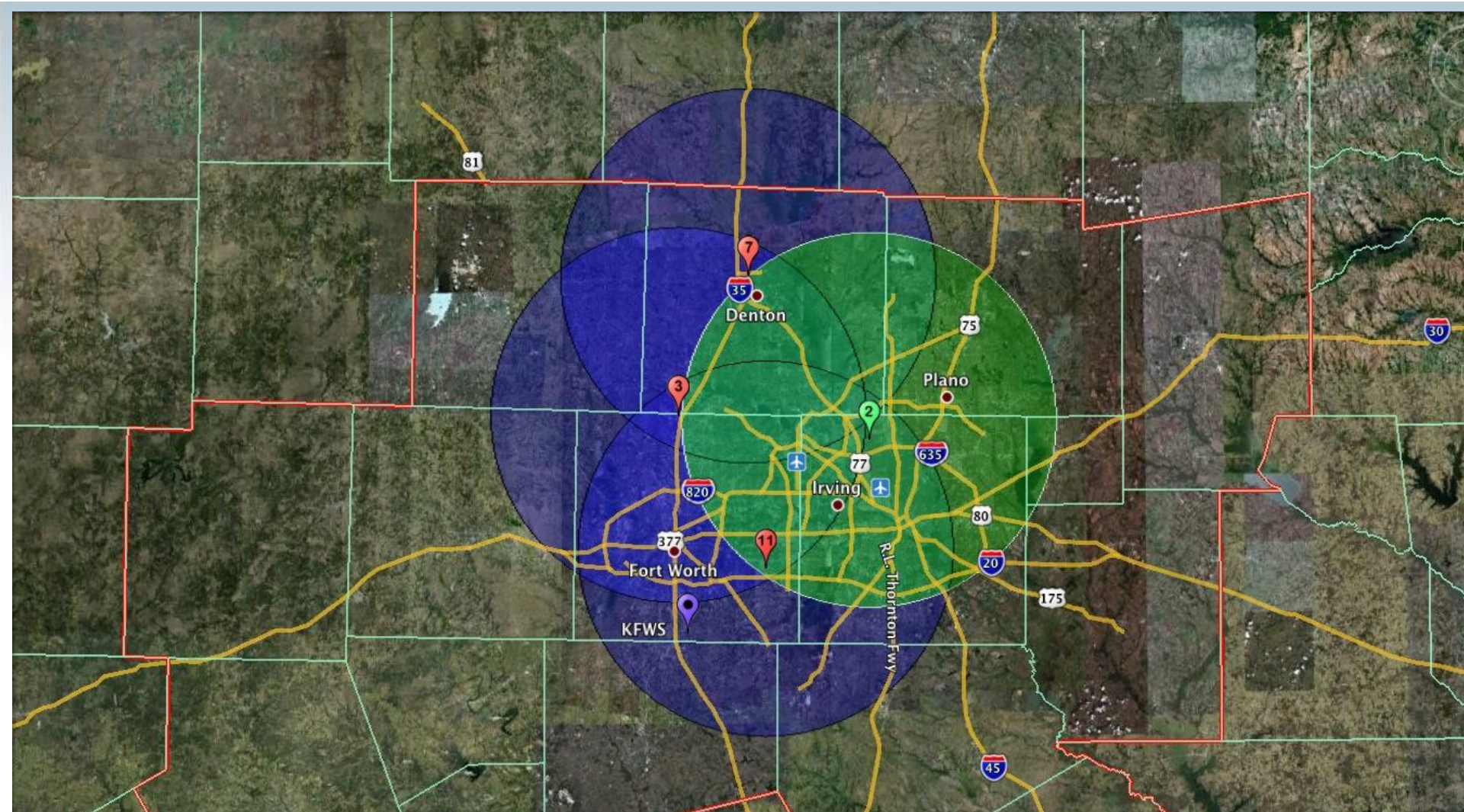


Ongoing Work Using CASA Data

- Objective Verification of recent forecasts, to also include object-based methods.
 - Rainfall (using QPE field from NSSL)
 - Vorticity Centers
- Methods to improve data assimilation
 - Improvements to current algorithms
 - More sophisticated, but expensive, algorithms



Acknowledgments: NSF Sponsors CASA ERC
Computing: OU OSCER



In 2012 moving the radars to the Dallas/Ft Worth Metro

65 km

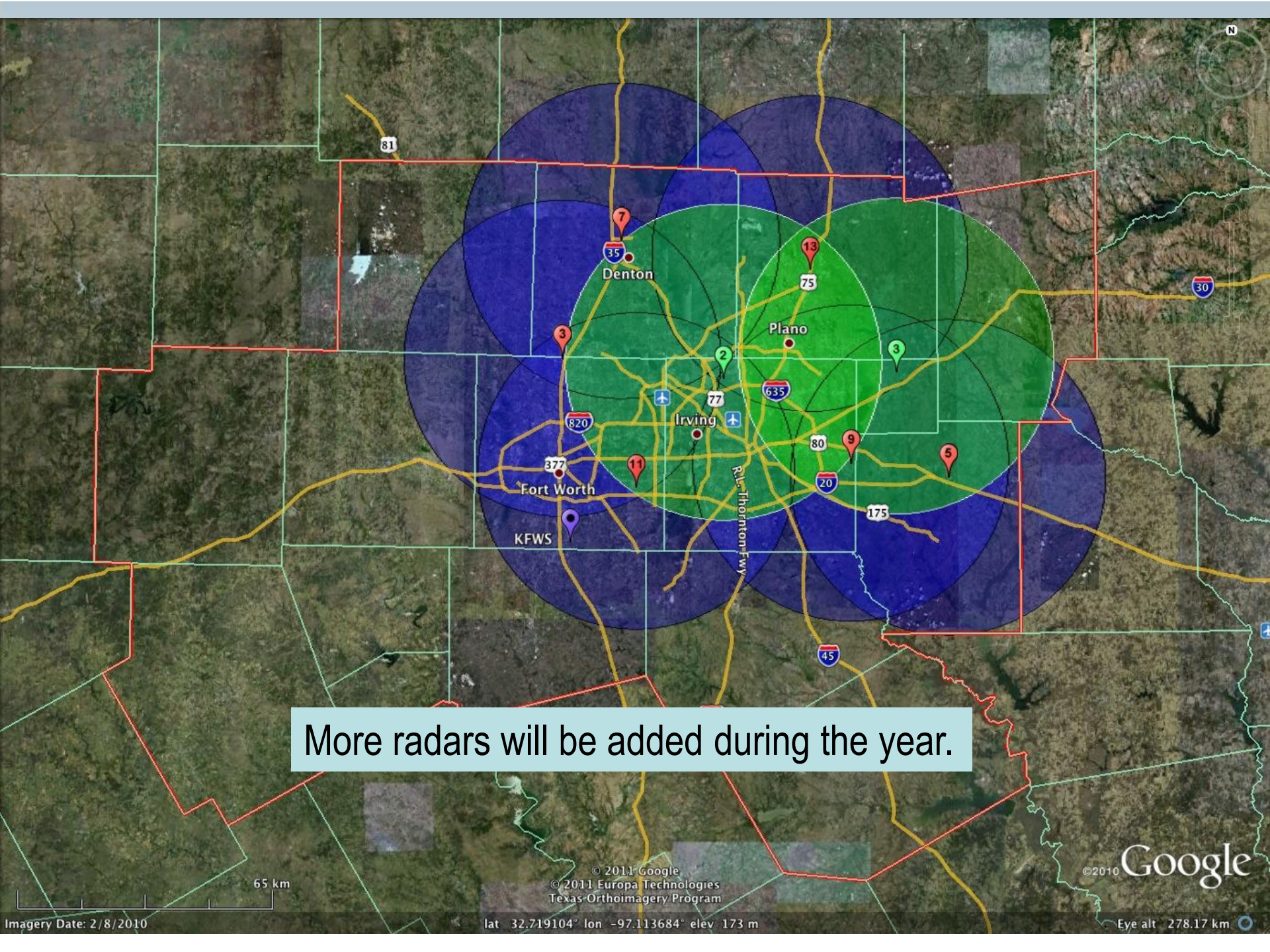
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Imagery Date: 2/8/2010

lat 32.719104° lon -97.113684° elev 173 m

Eye alt 278.17 km



More radars will be added during the year.