An Analysis of the Devastating 28 July 1993 Convective Windstorm in Northeast Ohio

By

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Background on the Storm

- **Ravaged a three county swath through northeast Ohio**
- **Series of downbursts produced winds estimated to have reached or exceeded 100 mph**
- **Thousands of trees were destroyed, and roofs, windows, and vehicles were damaged resulting in $25 million in damage**
- **Power outages lasted up to 10 days-300 utility poles and 150 main electrical feeders were destroyed between Cleveland and the PA line**
- **Rural Geauga County residents lost water and resorted to ice and bottled water**
- **Geauga County also lost the screen at the Mayfield Road Drive-In**

Euclid Residents Know It As…"The Storm"

- **Euclid was hit the hardest (northeast Cuyahoga County)**
- **30 thousand trees were lost on public and private property**
- **A 10-ton monument to war veterans was toppled behind the library**
- **$15 million damage in Euclid alone, cleanup took 6 months!**
- **Denied help from FEMA: Former Mayor David Lynch met with President Clinton to create storm recovery funds**

Path of Destruction

Method of Study

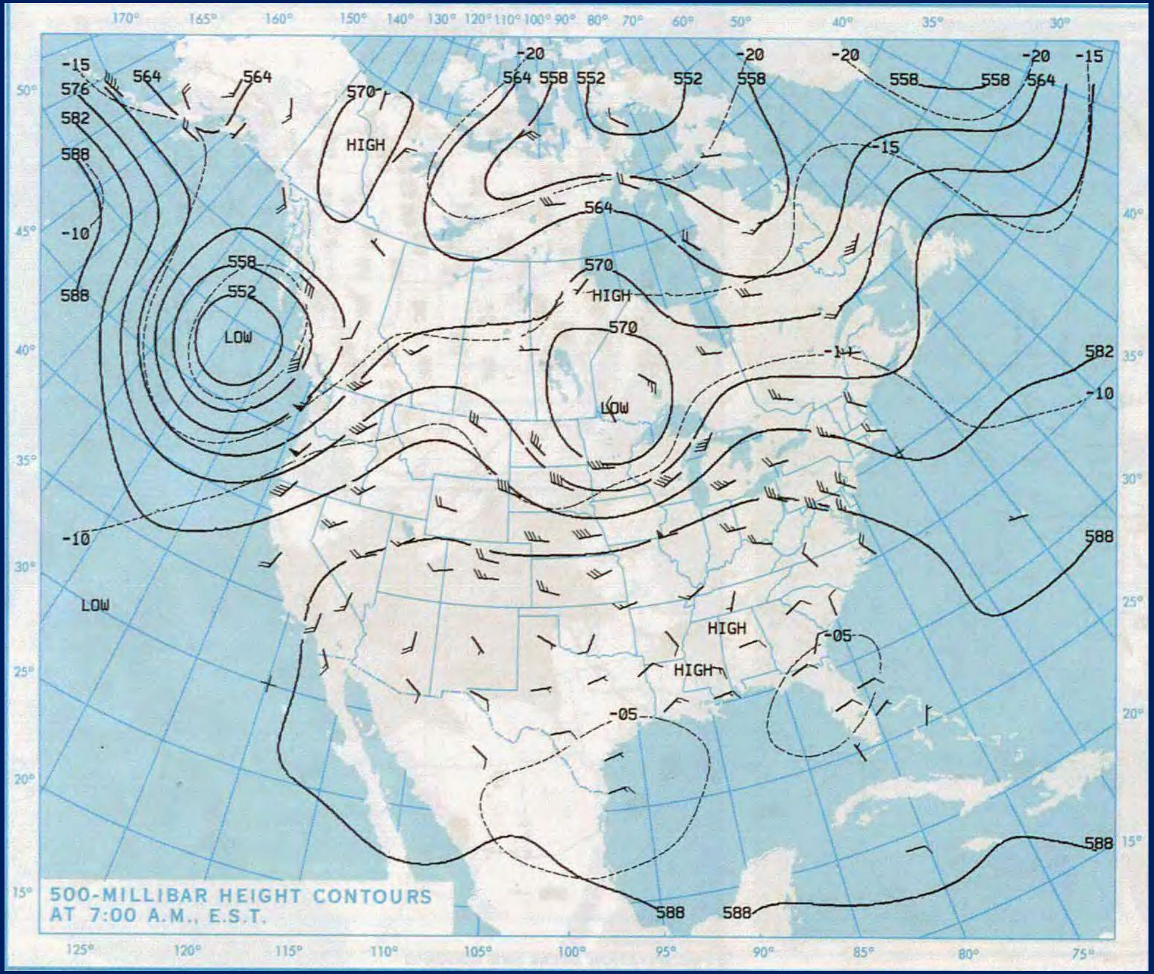
- Studied historical weather maps of the 500 mb pattern and surface features between 28 July and 29 July 1993 from the NOAA Central Library
- Examined regional surface data from the Iowa Mesonet GEMPAK archive displayed with IDV
- Looked at the Lake Erie water temperatures from the Great Lakes Environmental Research Laboratory (GLERL)
- Used North American Regional Reanalysis (NARR) data to view CAPE, 0-6 km wind shear, and precipitable water with IDV
- Viewed observed soundings with RAOB at Flint, Michigan and Dayton, Ohio from NOAA North American Soundings Radiosonde Database
- Analyzed the convection with infrared and visible satellite from the National Climatic Data Center (NCDC) and regional radar from WJW-TV 8 in Cleveland, Ohio

Method of Study Continued

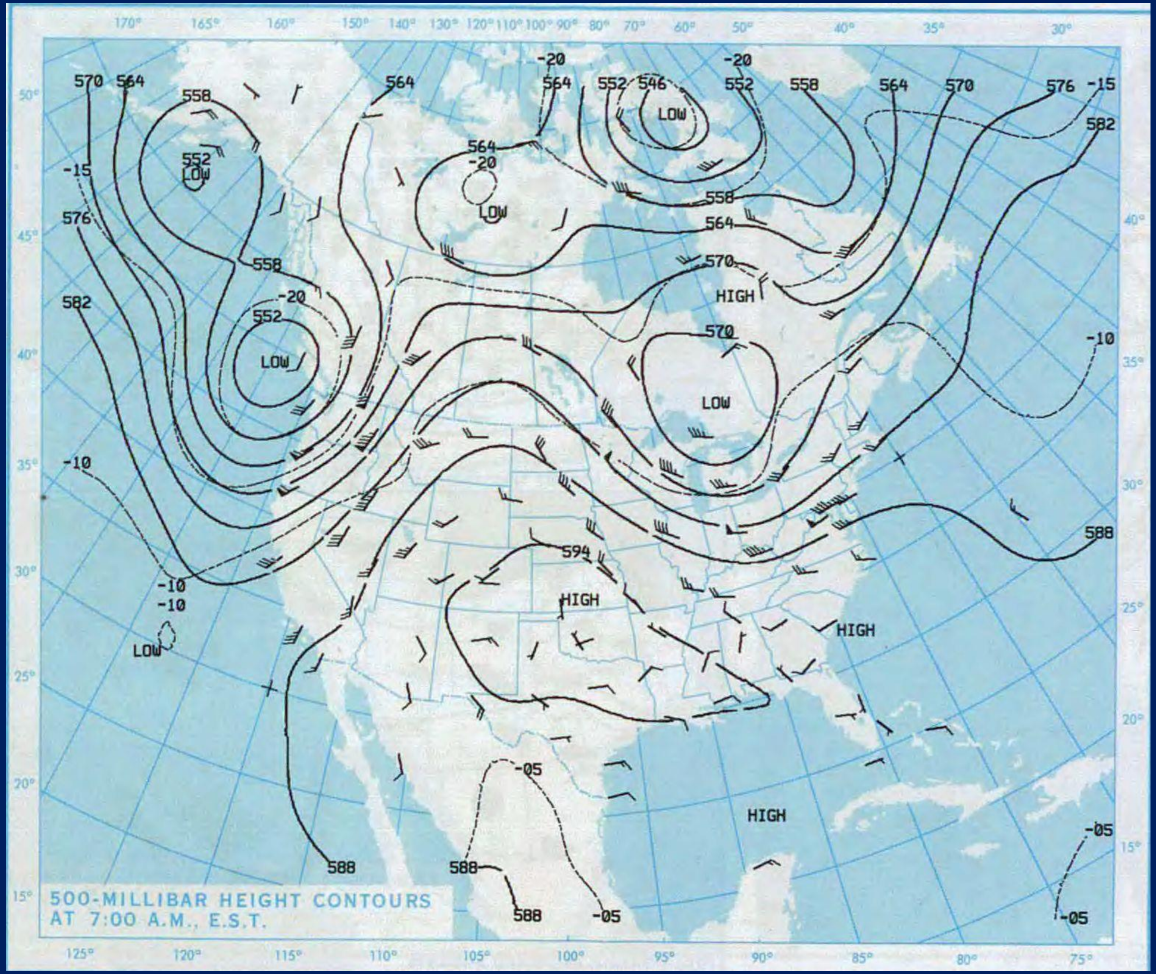
- **Ran the SUNY Oswego Weather Research and Forecast Model (WRF) at a 9-km outer and 3-km nested domain for the Ohio Valley/lower Great Lakes region using the NARR for initialization and boundary conditions every three hours**
- **Studied WRF simulated composite reflectivity, 10 meter simulated winds, and 950 mb simulated winds**
- **Compared storm reports for 28 July 1993 obtained from the Storm Prediction Center's Online Severe Plot with all of the significant convective wind reports that occurred in the region between 1984 and 2013**

Major Pattern Change

500 mb Pattern 28 July 1993

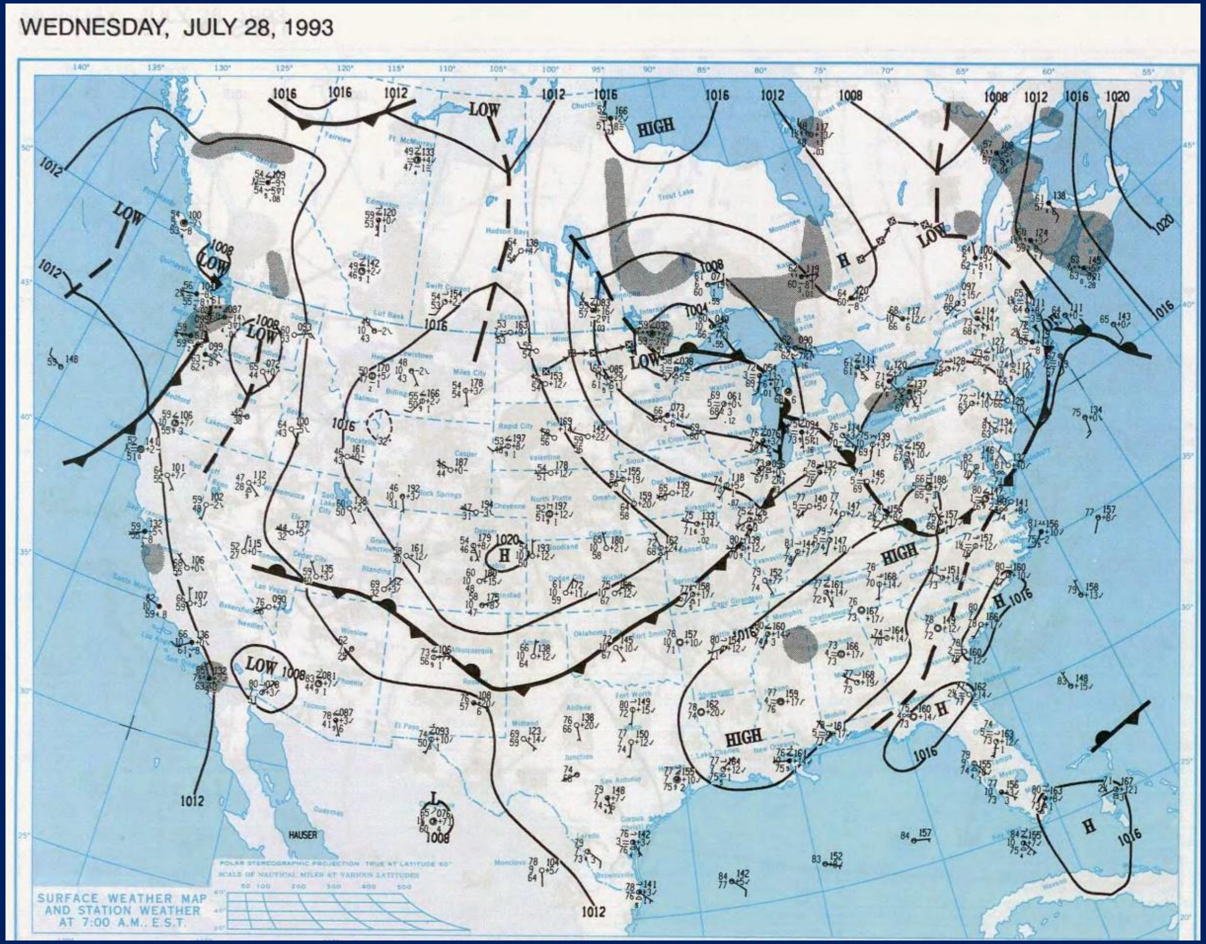


500 mb Pattern 29 July 1993

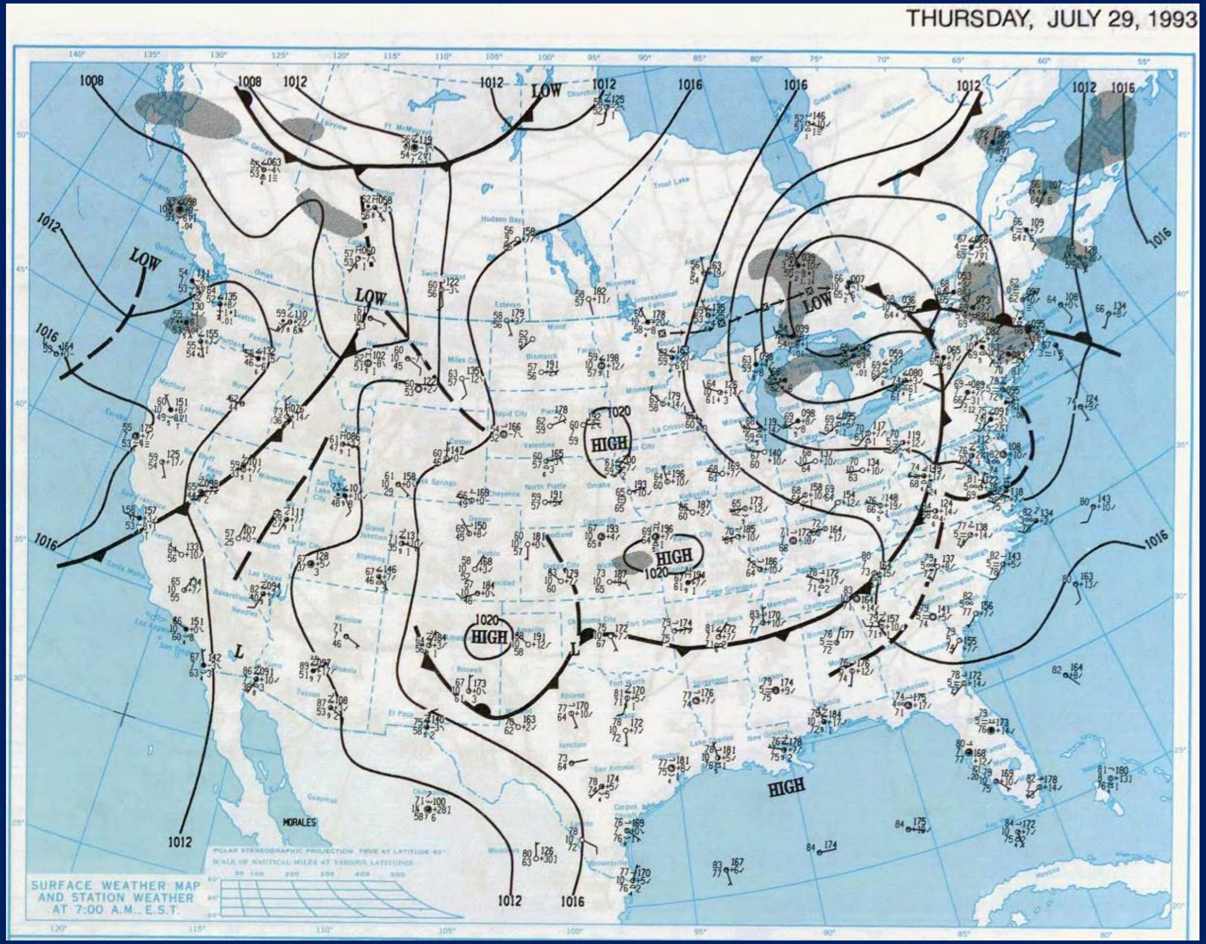


Major Pattern Change

Surface Features 28 July 1993

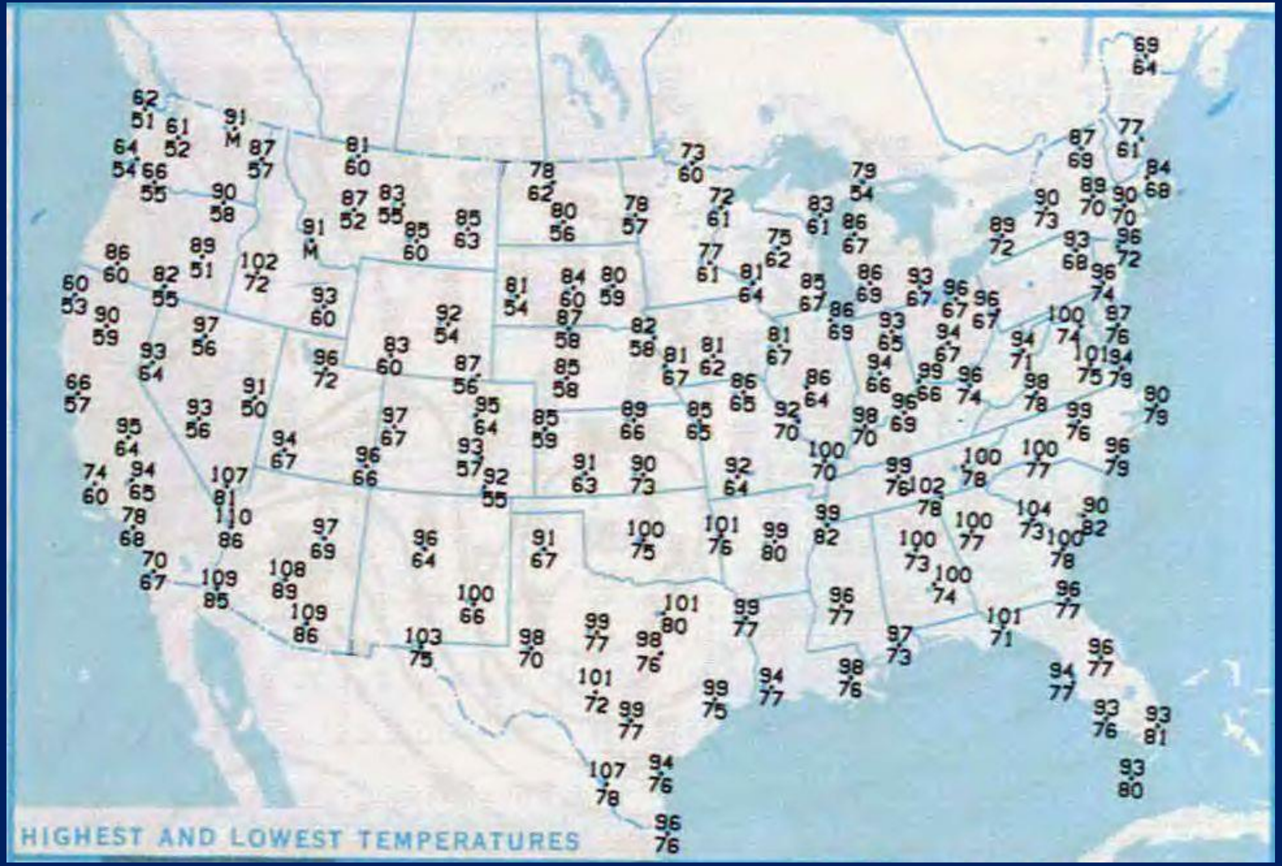


Surface Features 29 July 1993

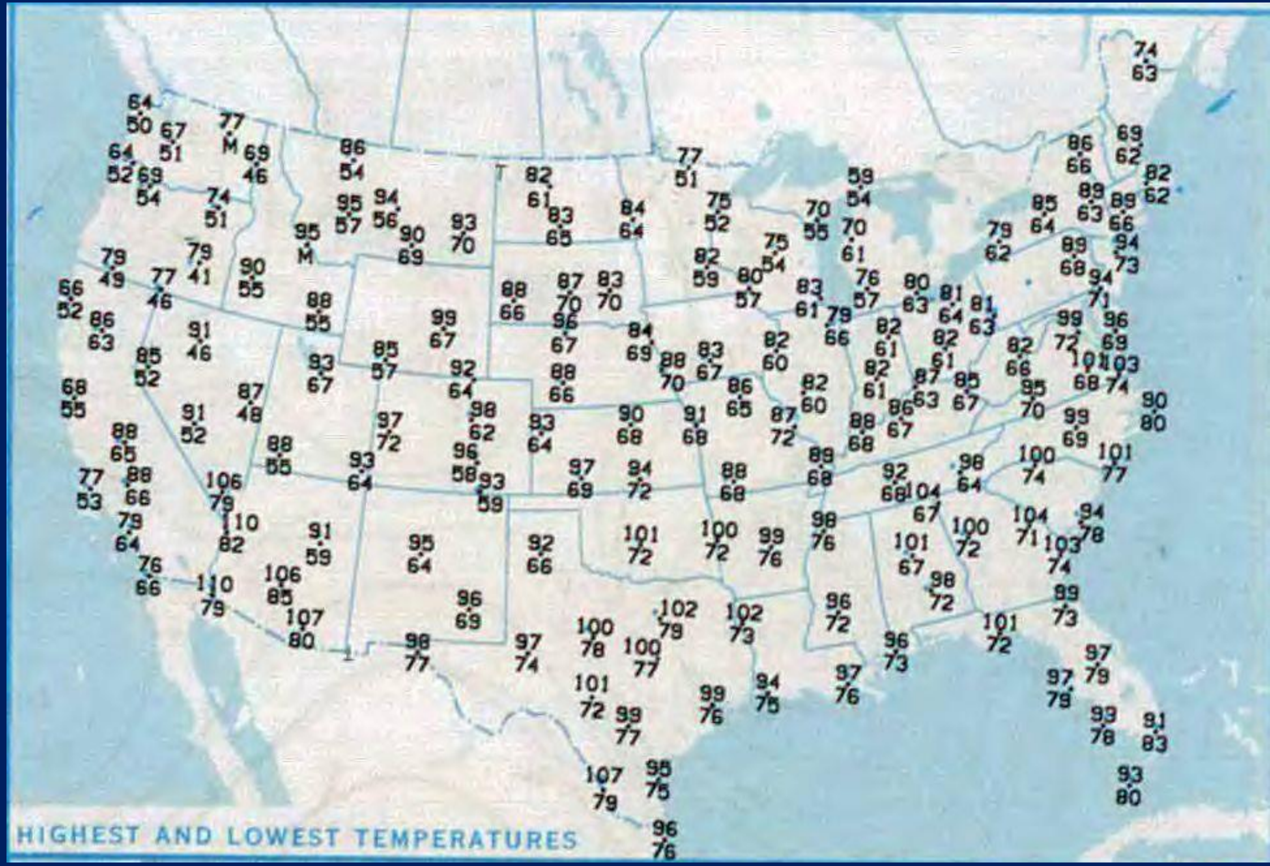


What a Difference in Temperatures!

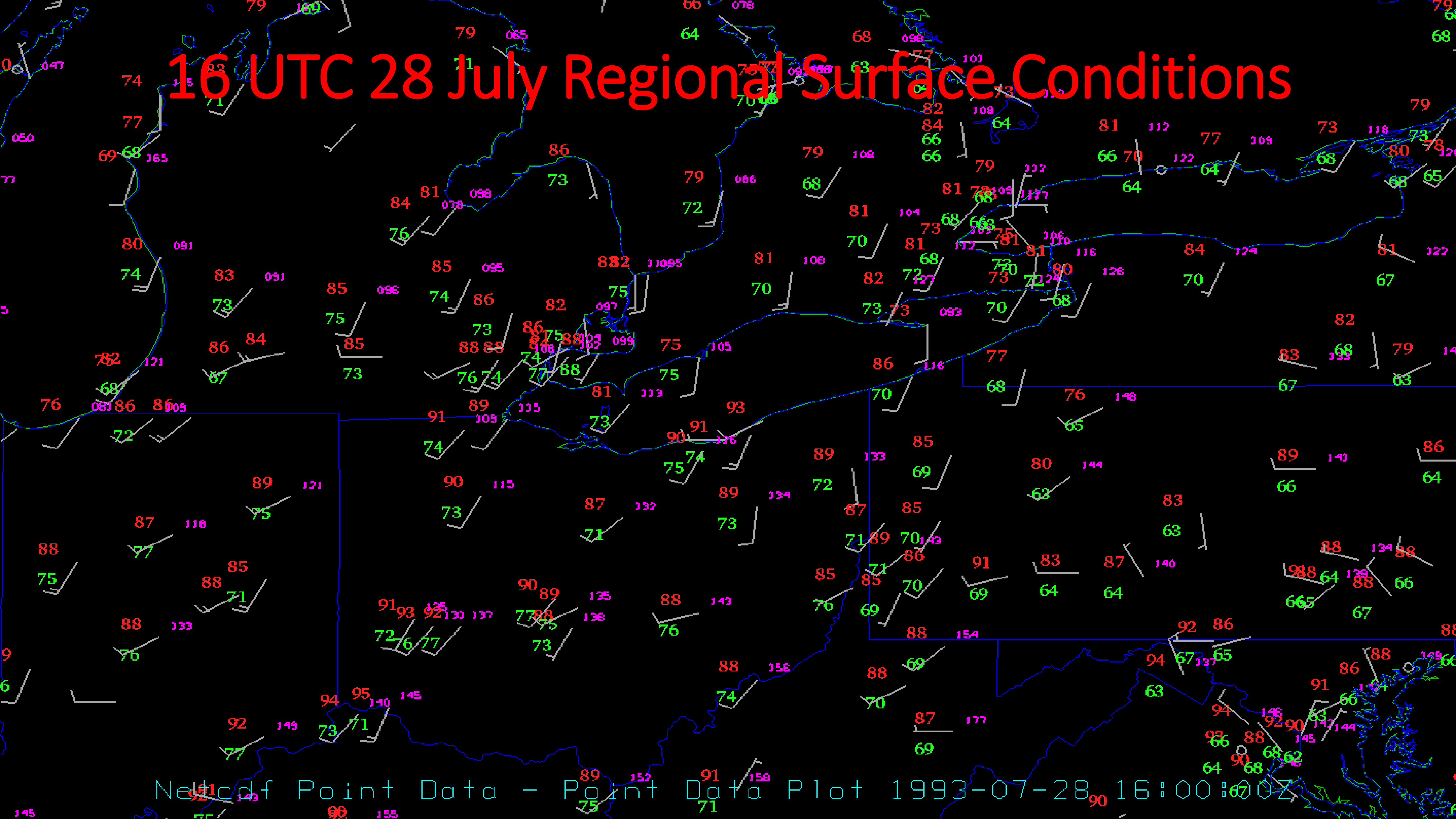
High and low temperatures 28 July 1993



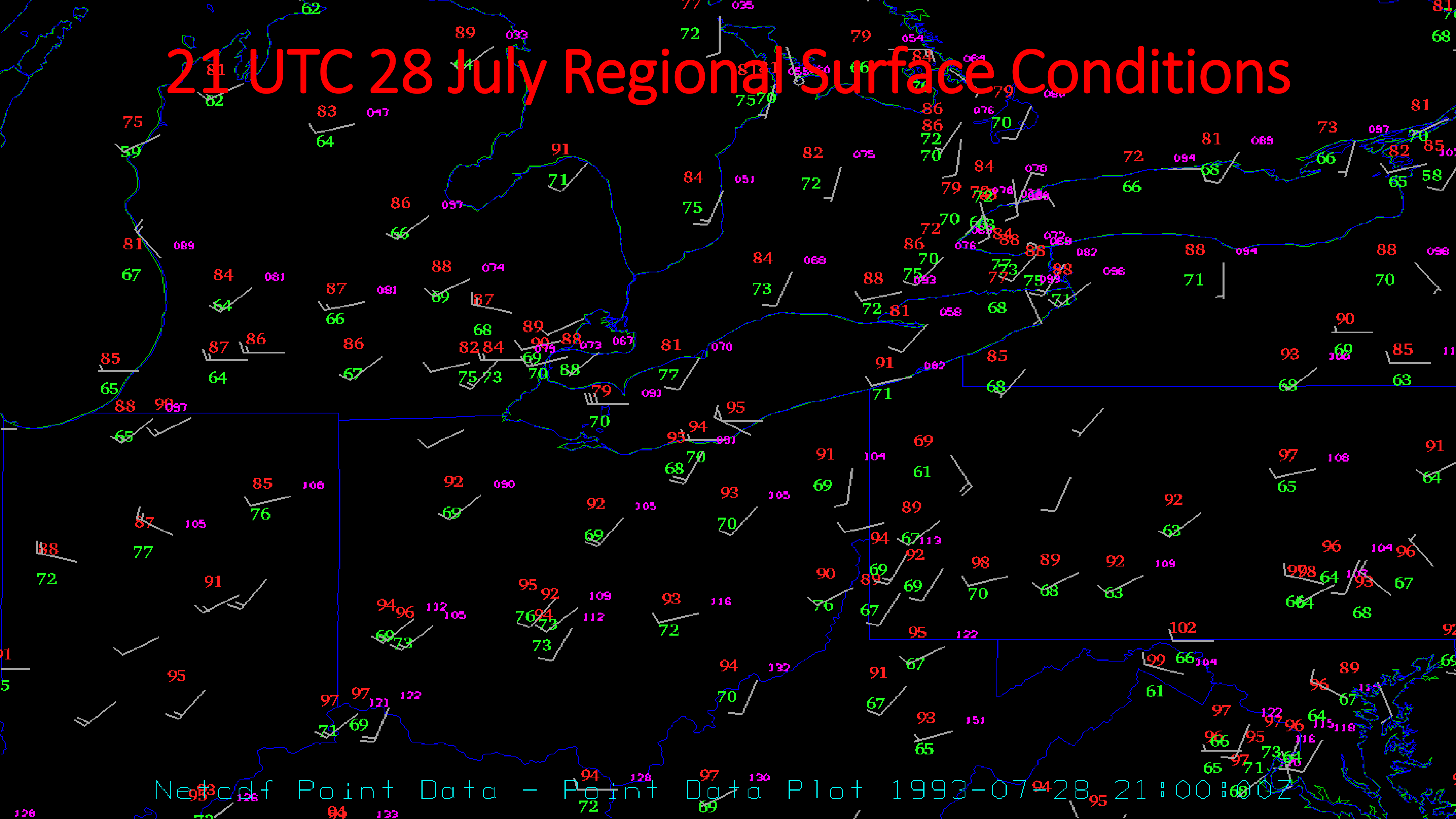
High and low temperatures 29 July 1993



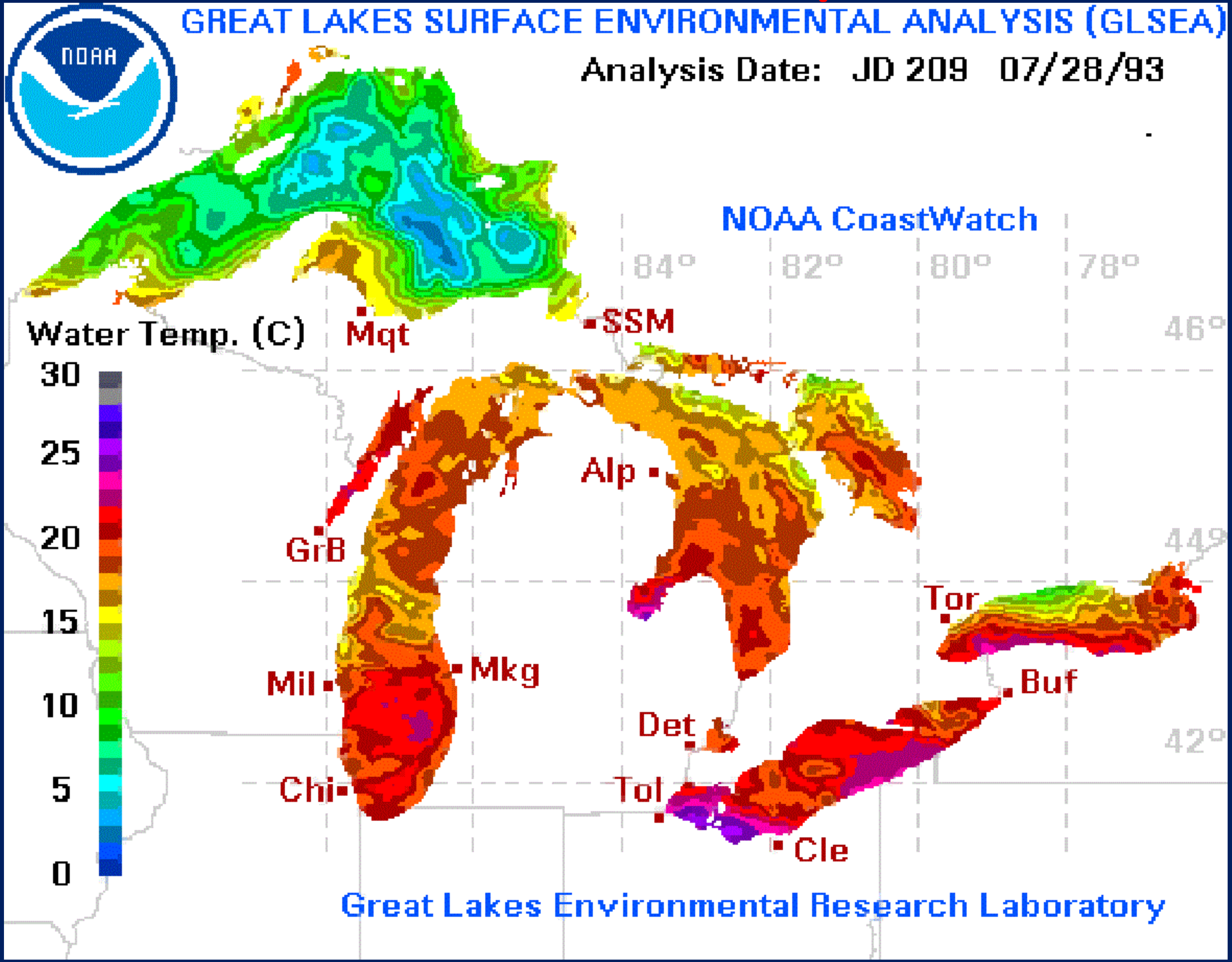
16 UTC 28 July Regional Surface Conditions



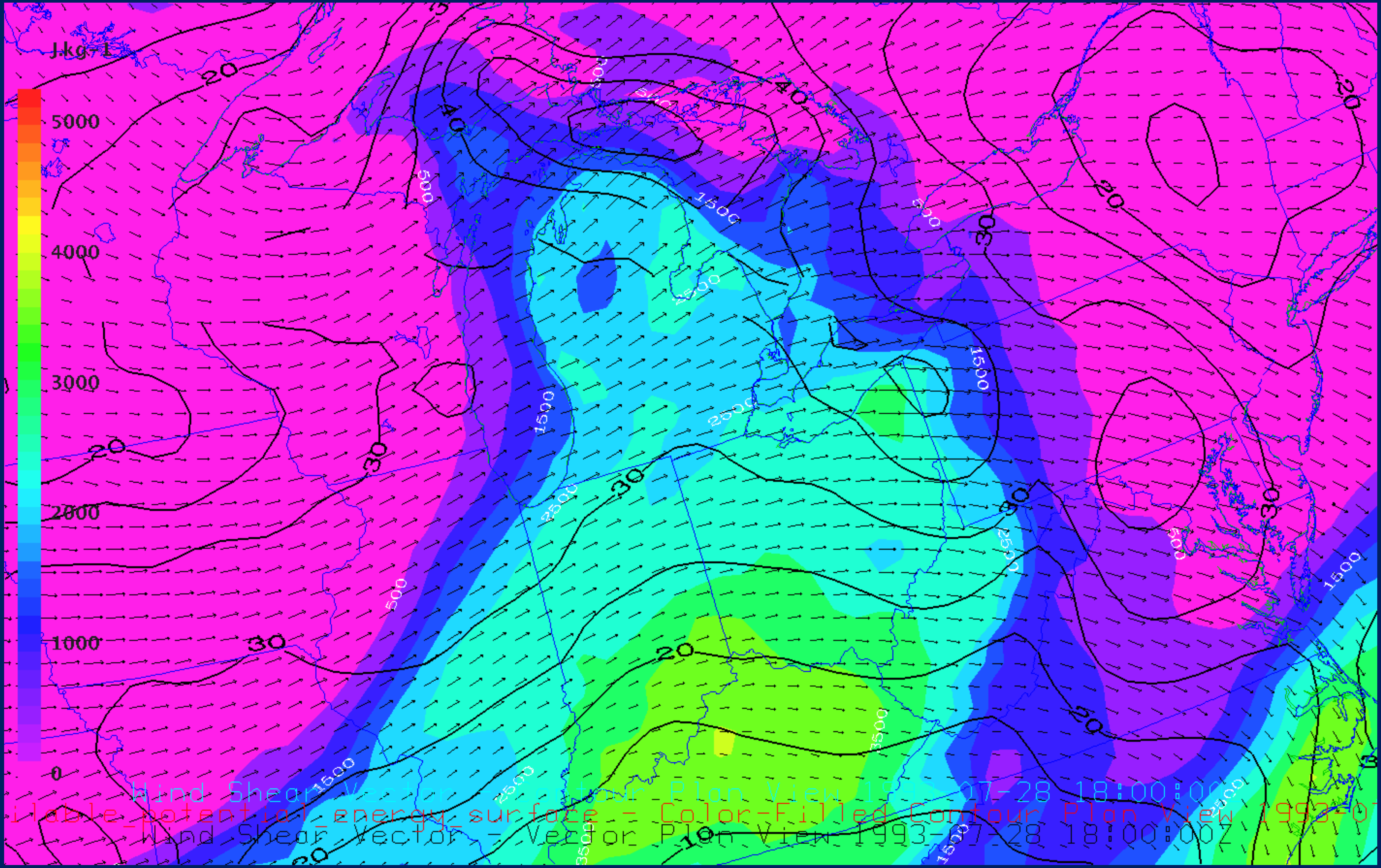
21 UTC 28 July Regional Surface Conditions



Lake Erie Water Temperatures



18 UTC 28 July CAPE and 0-6 km Shear



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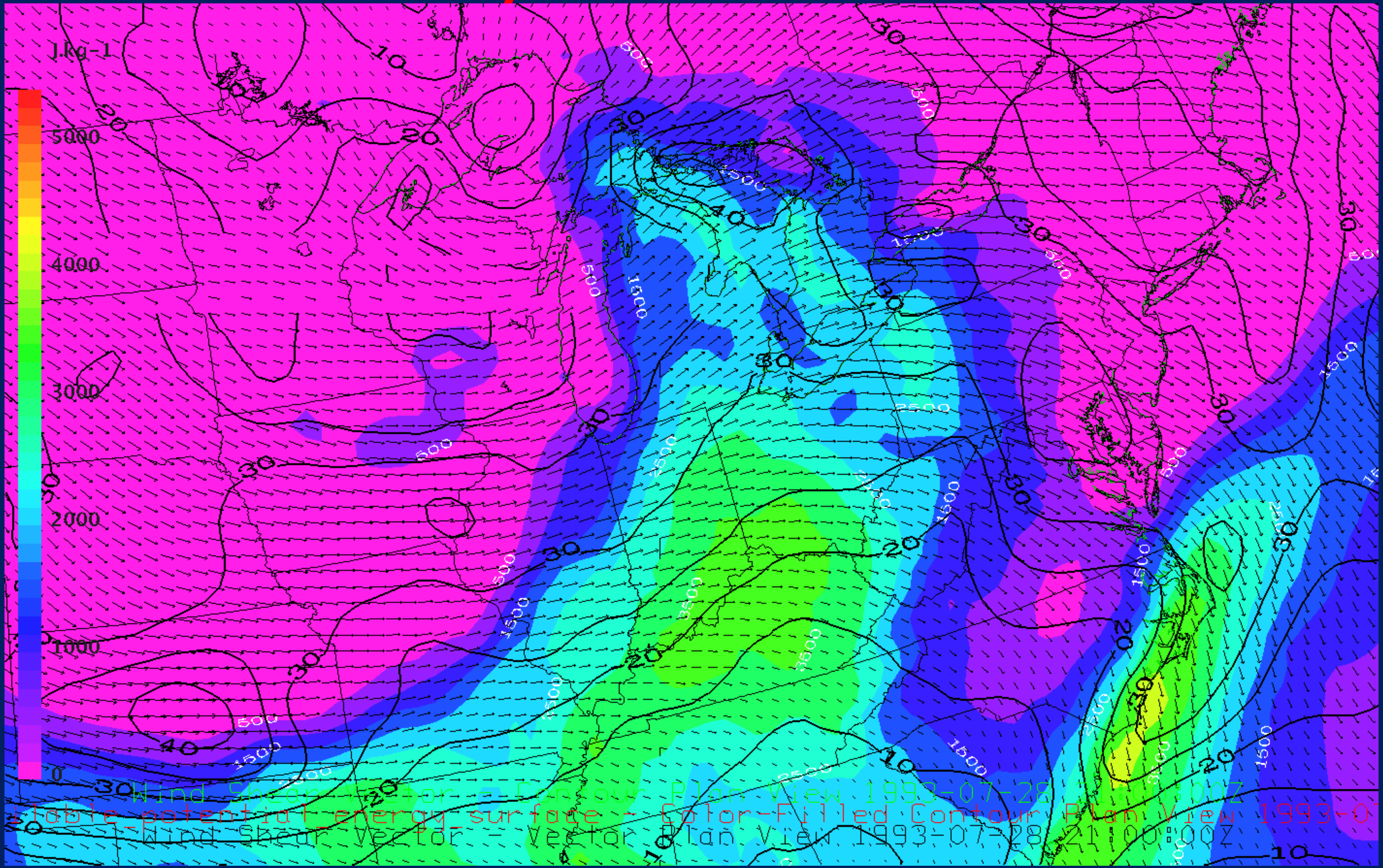
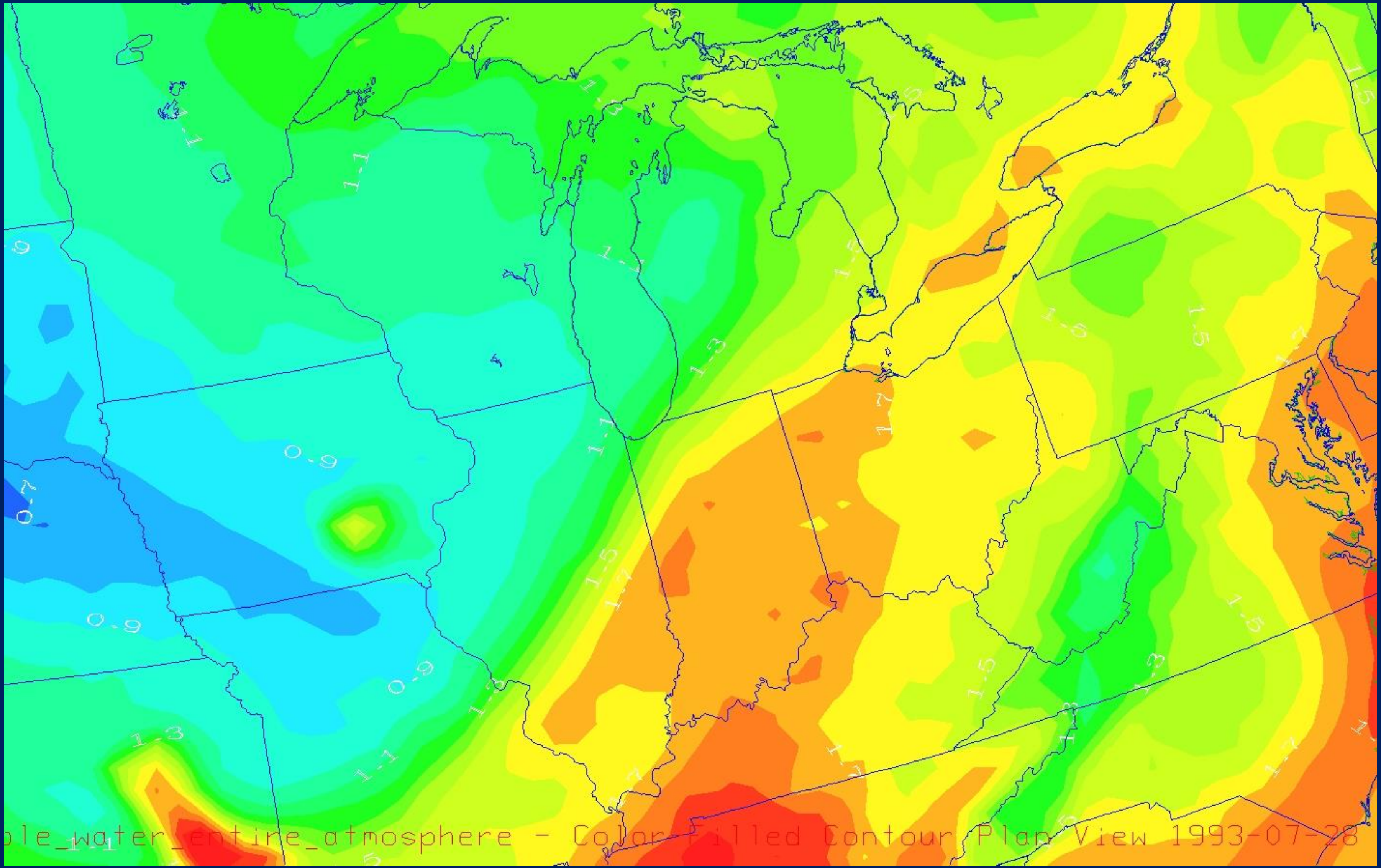


18 UTC 28 July Precipitable Water



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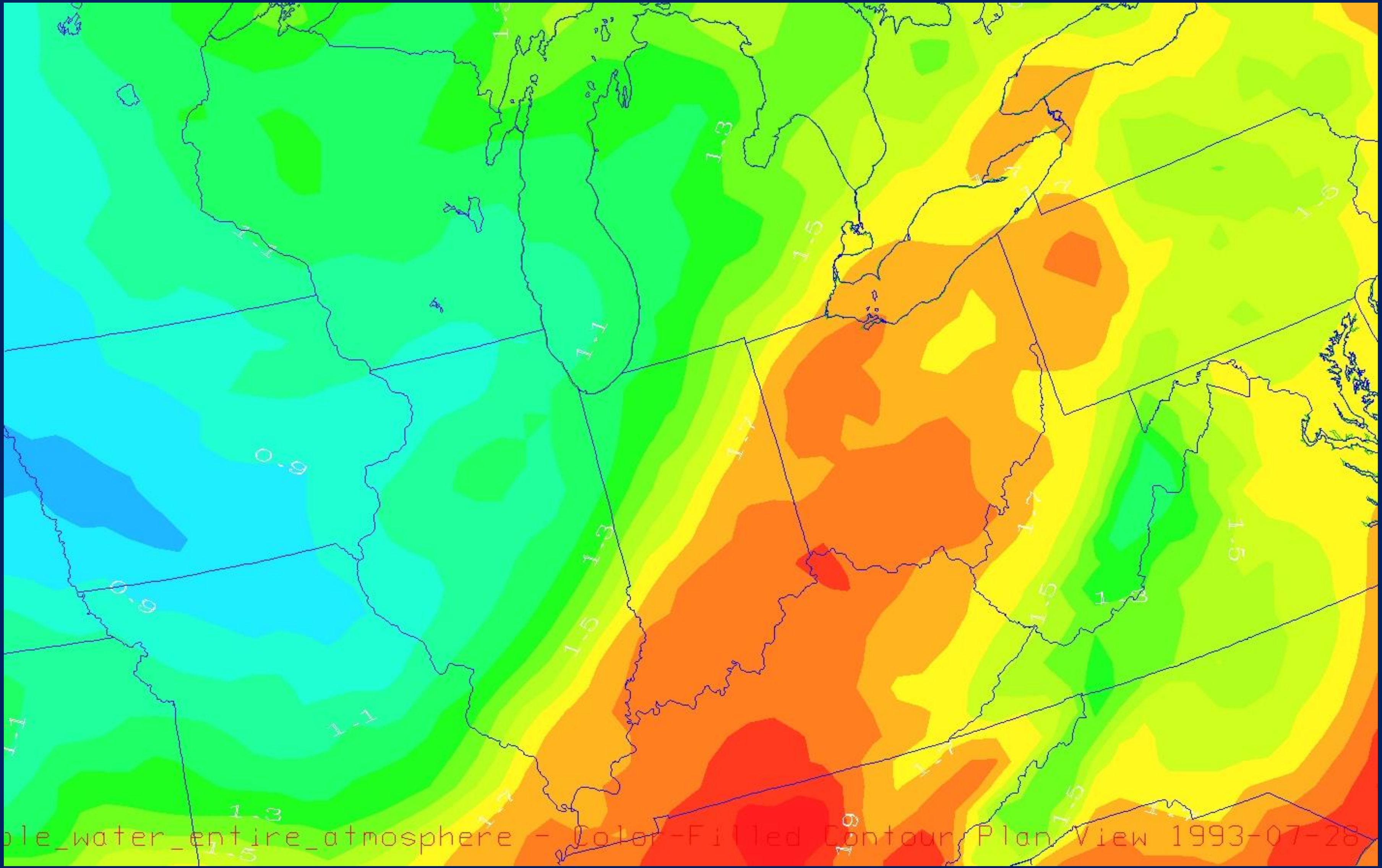
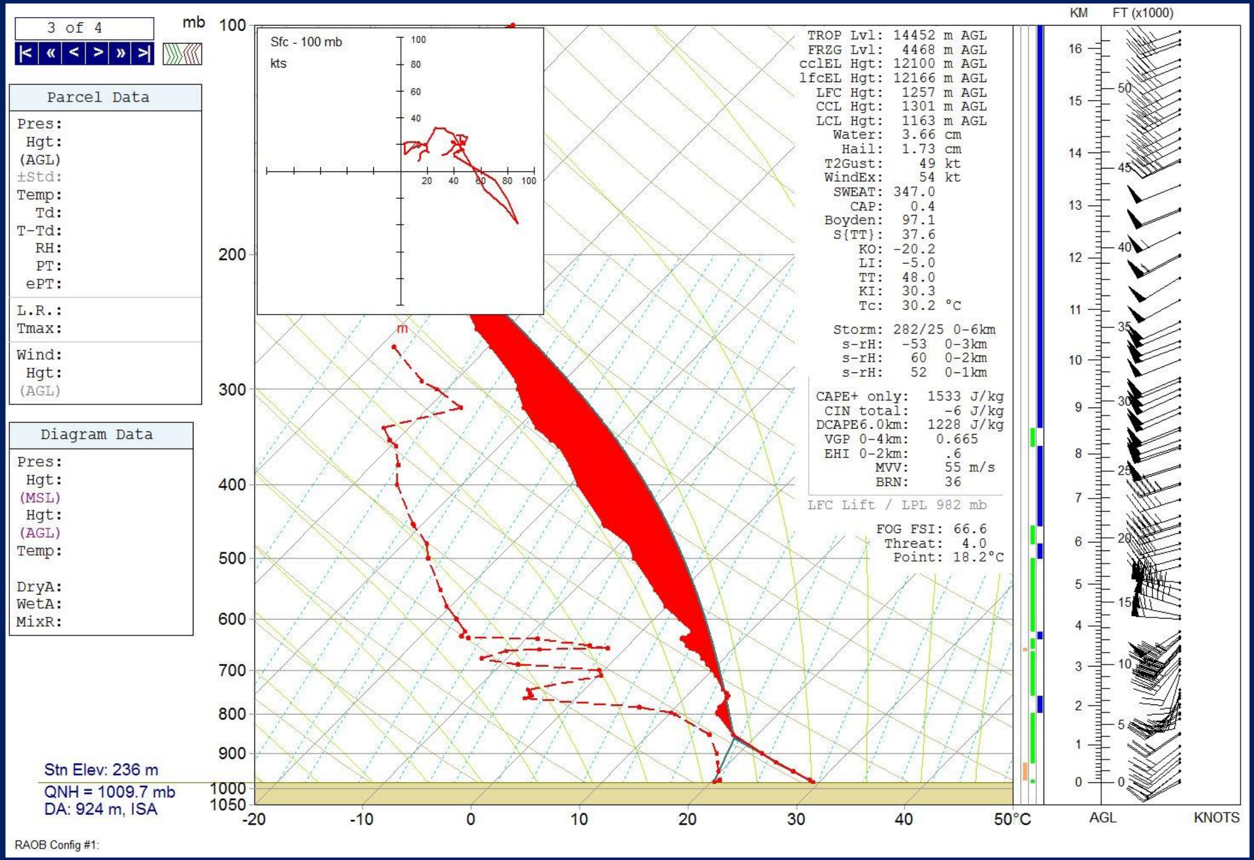
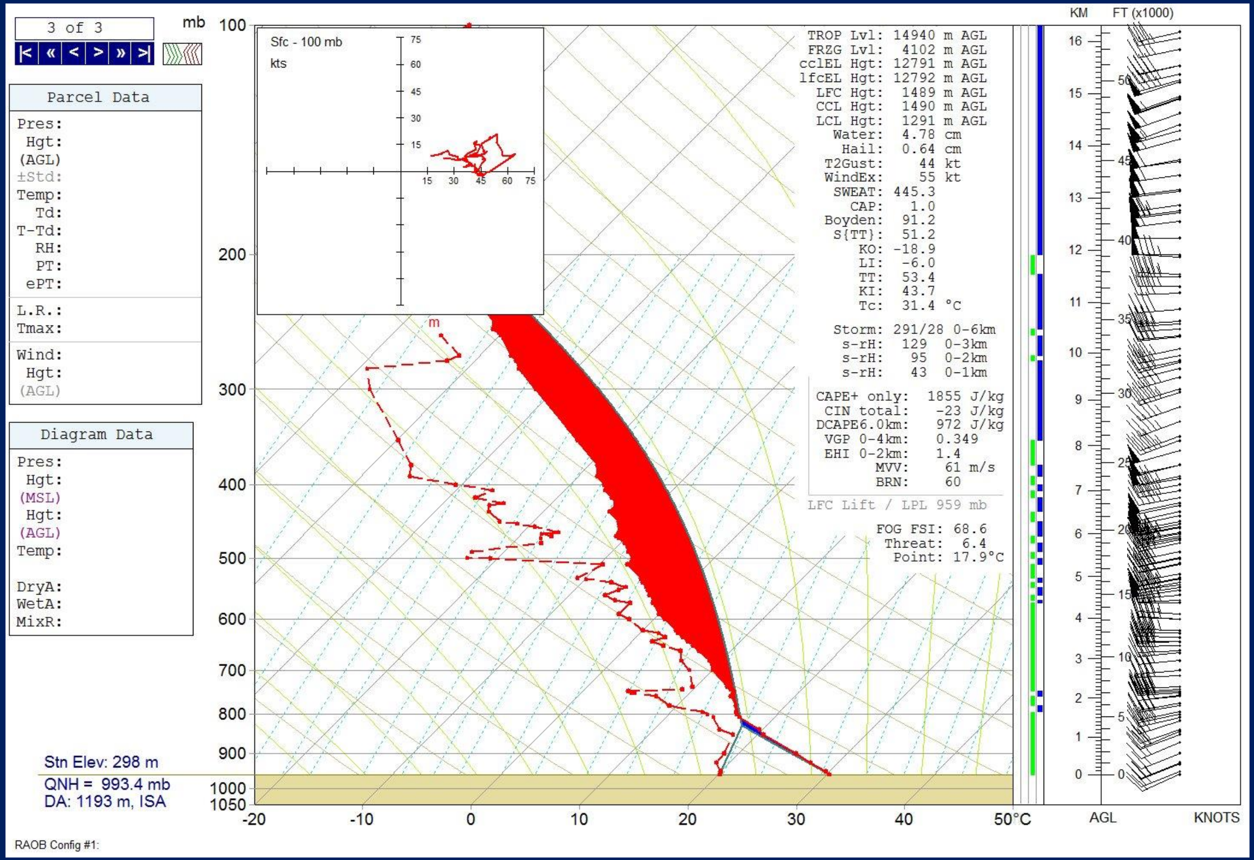


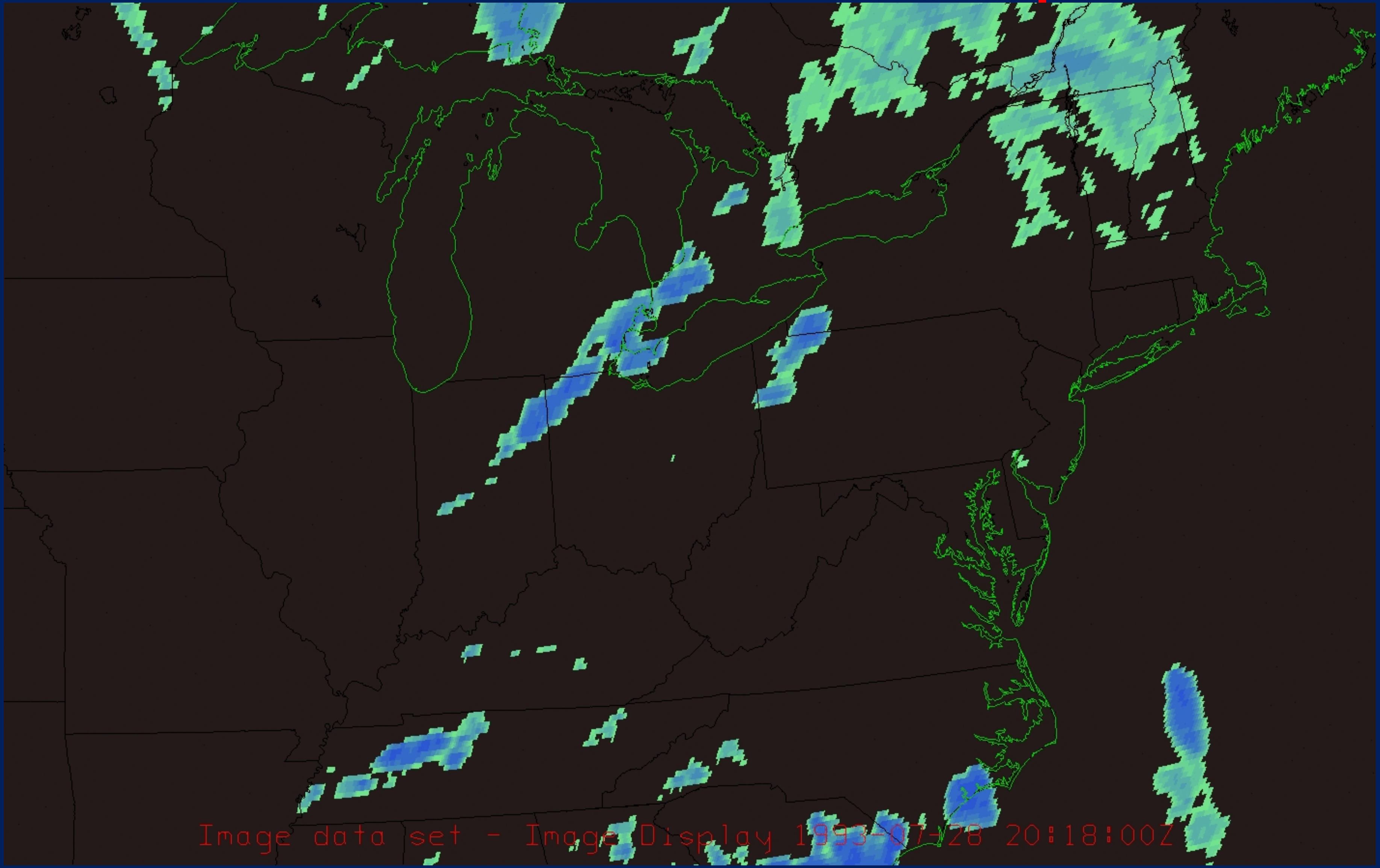
19 UTC 28 July Observed Sounding
Flint, MI



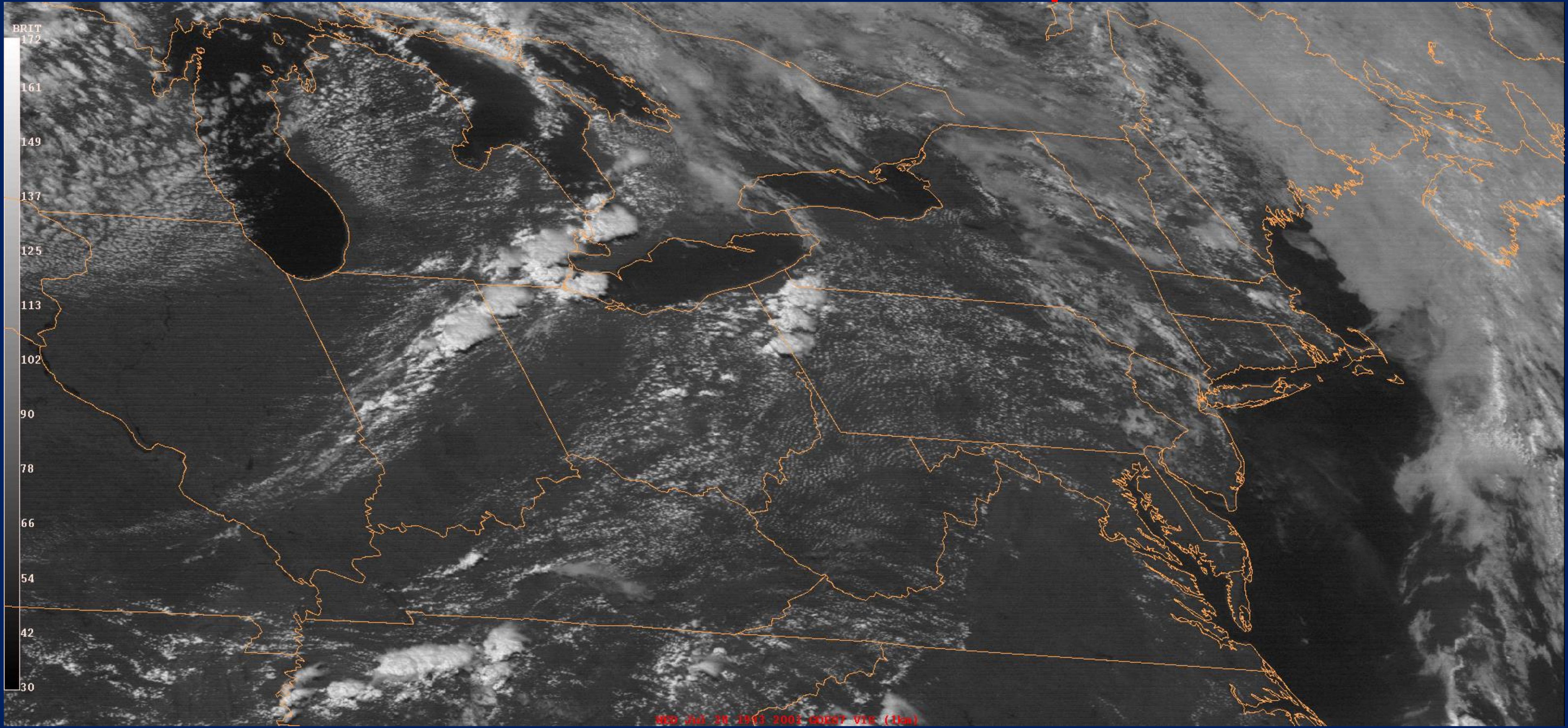
00 UTC 29 July Observed Sounding
Dayton, OH



Infrared Satellite Loop



Visible Satellite Loop



Regional Radar

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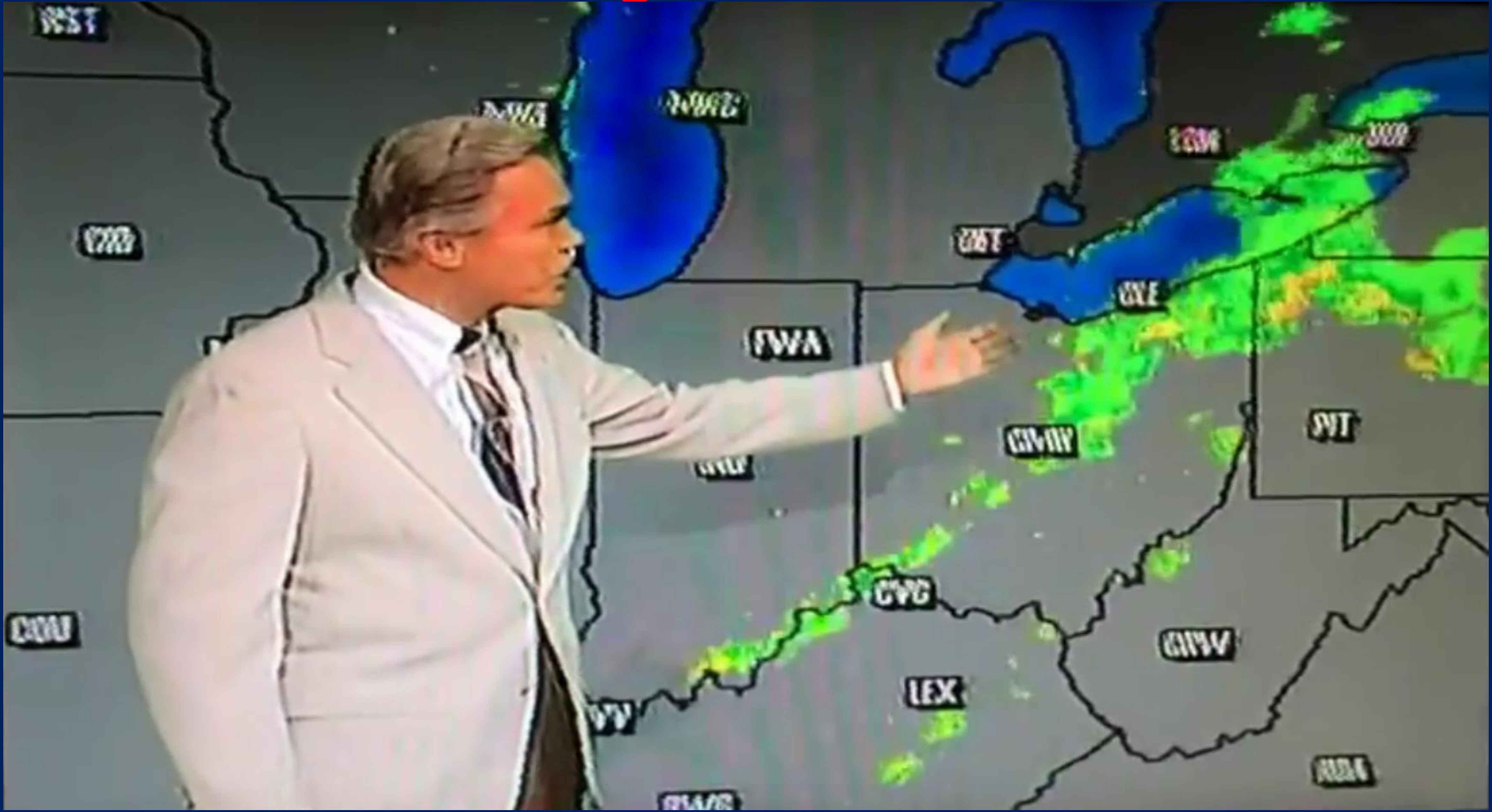
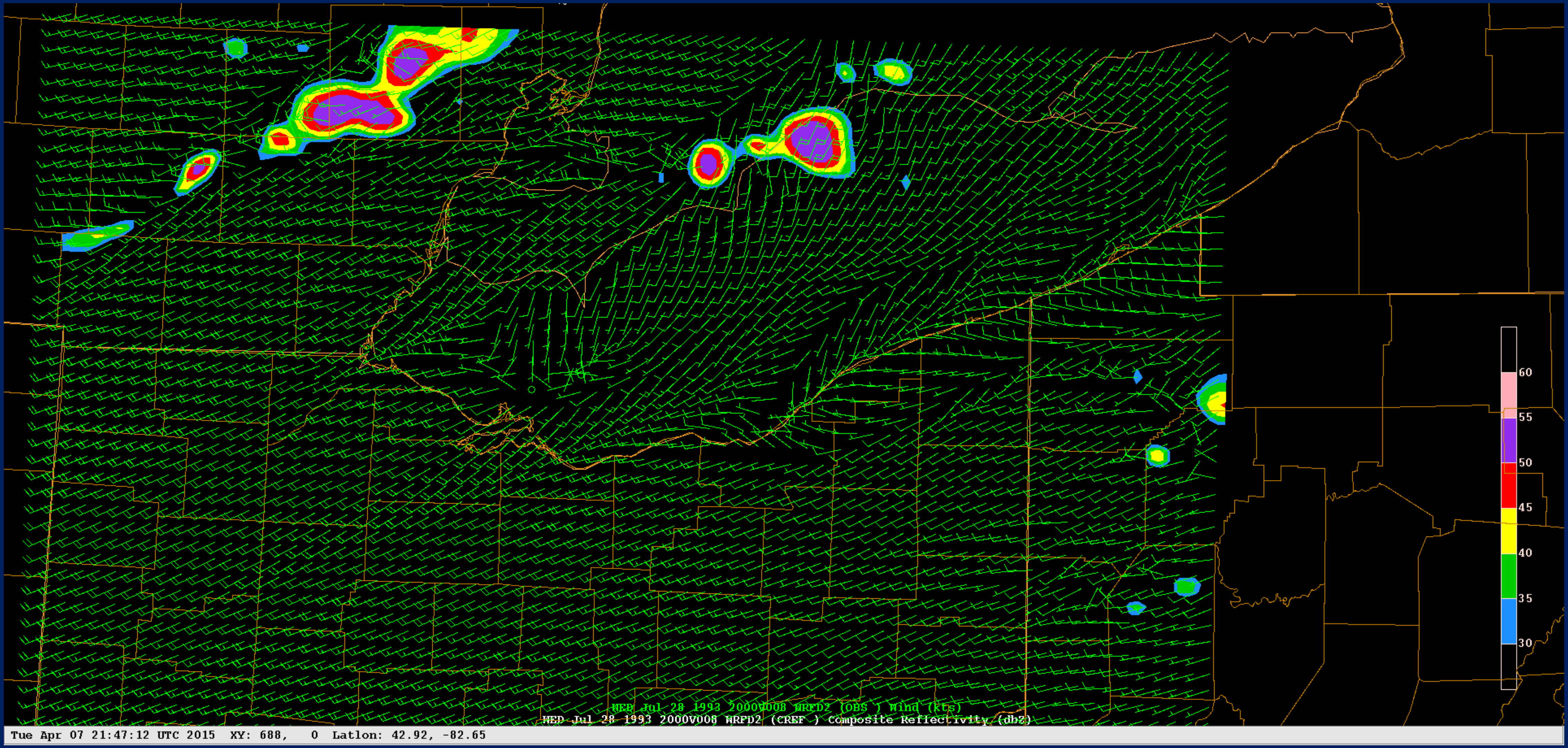
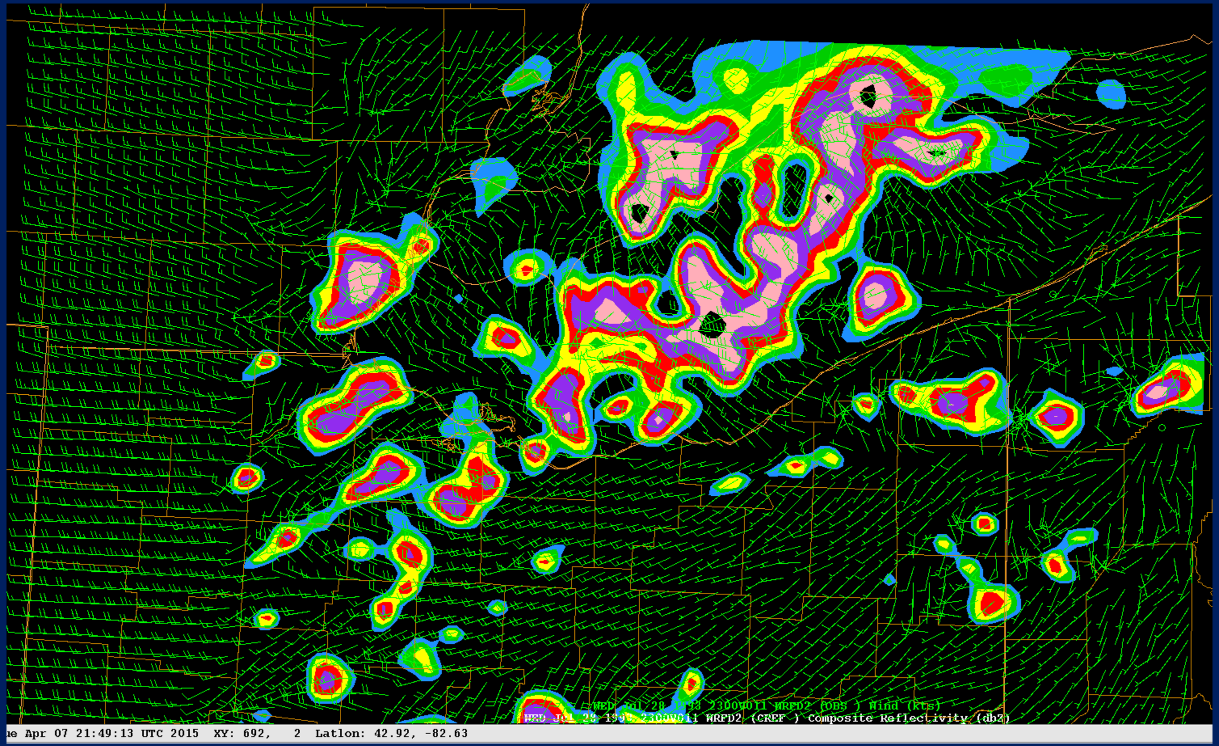


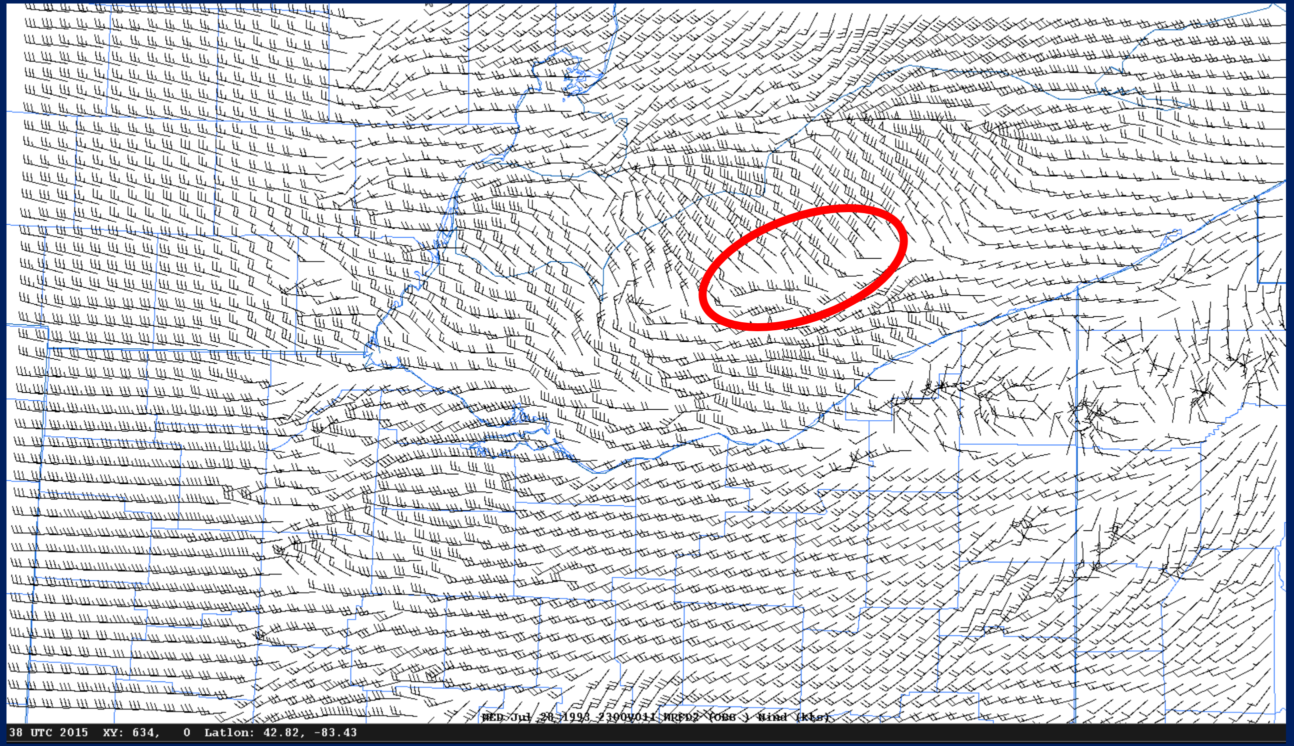
20 UTC 28 July WRF Simulated Composite Reflectivity and 10 meter Winds



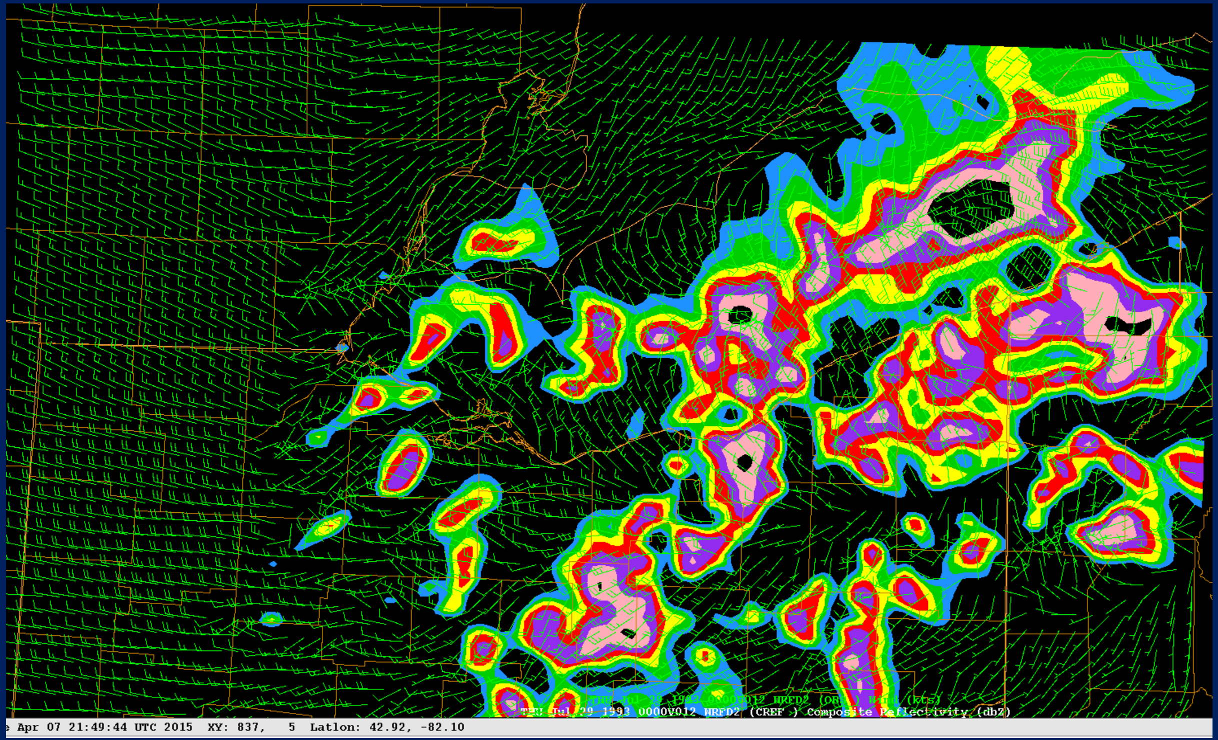
23 UTC 28 July WRF Simulated Composite Reflectivity & 10 meter Winds



23 UTC 28 July WRF Simulated 950 mb Winds



00 UTC 29 July WRF Simulated Composite Reflectivity & 10 meter Winds



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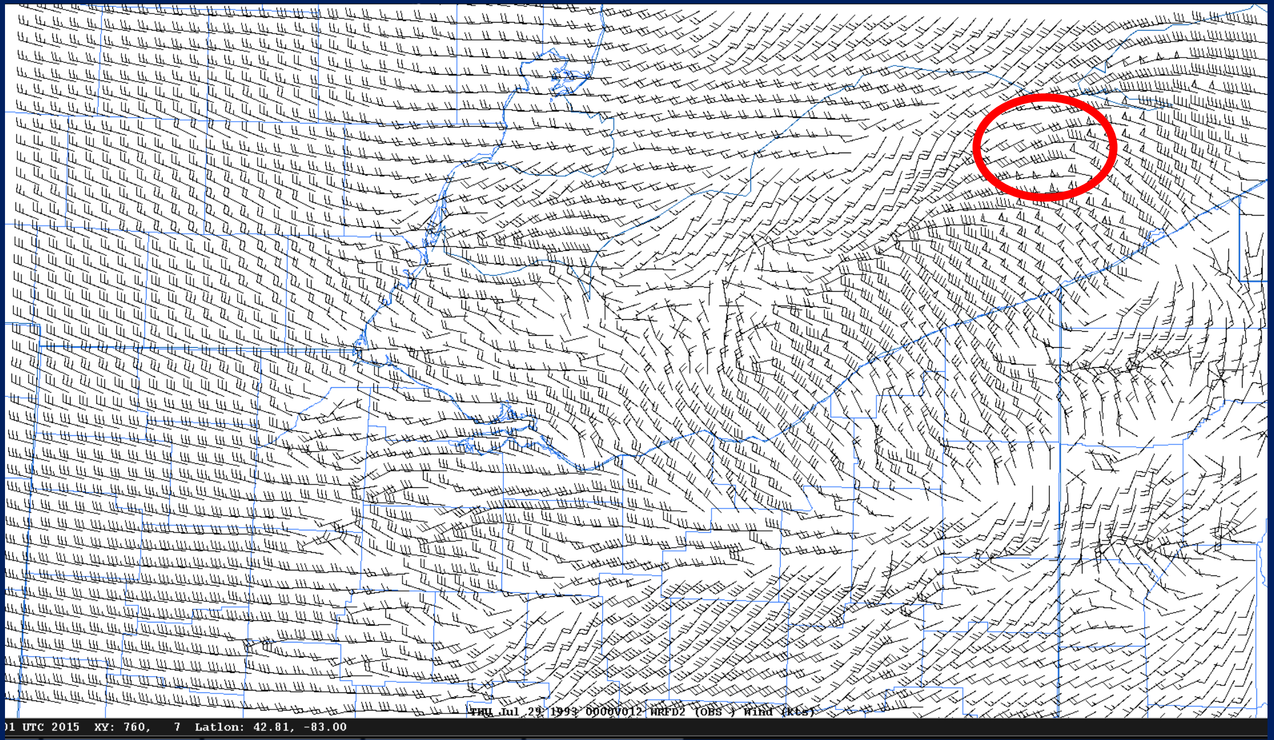
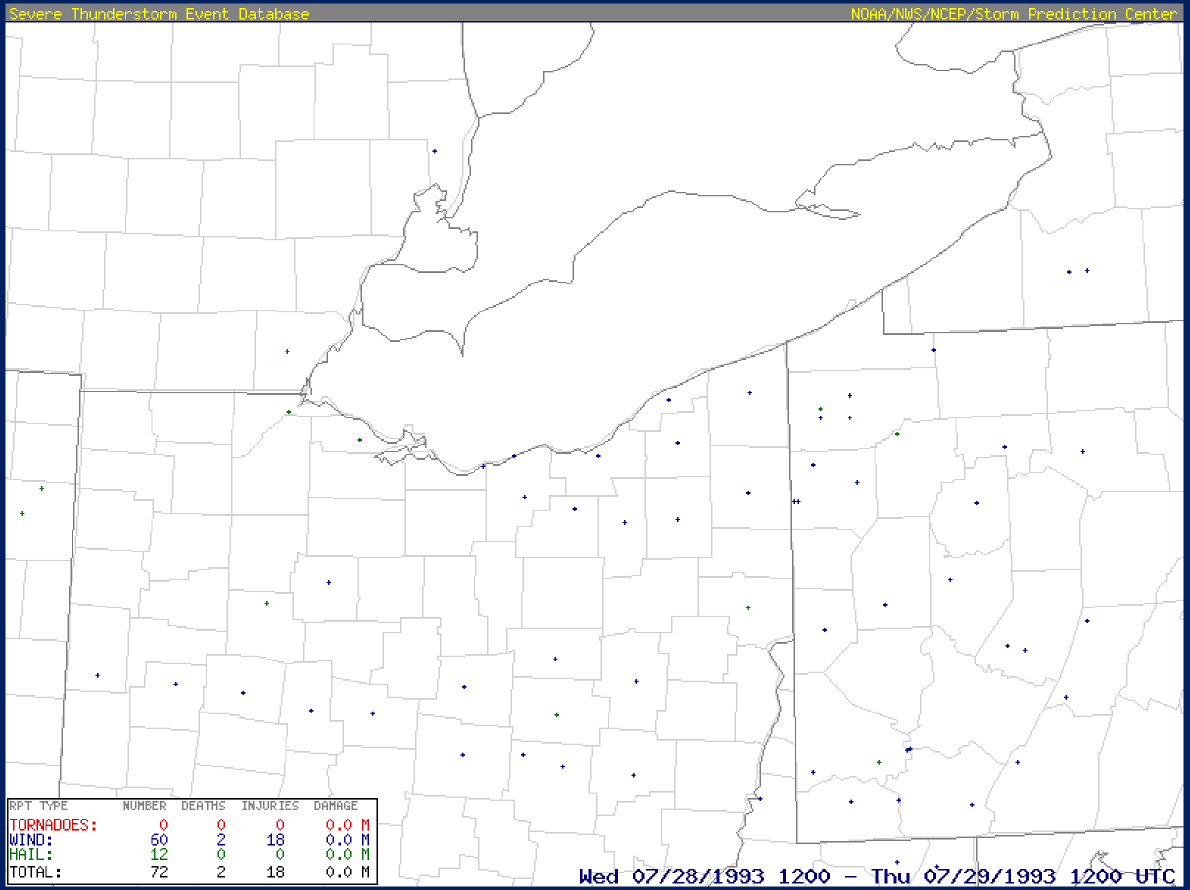
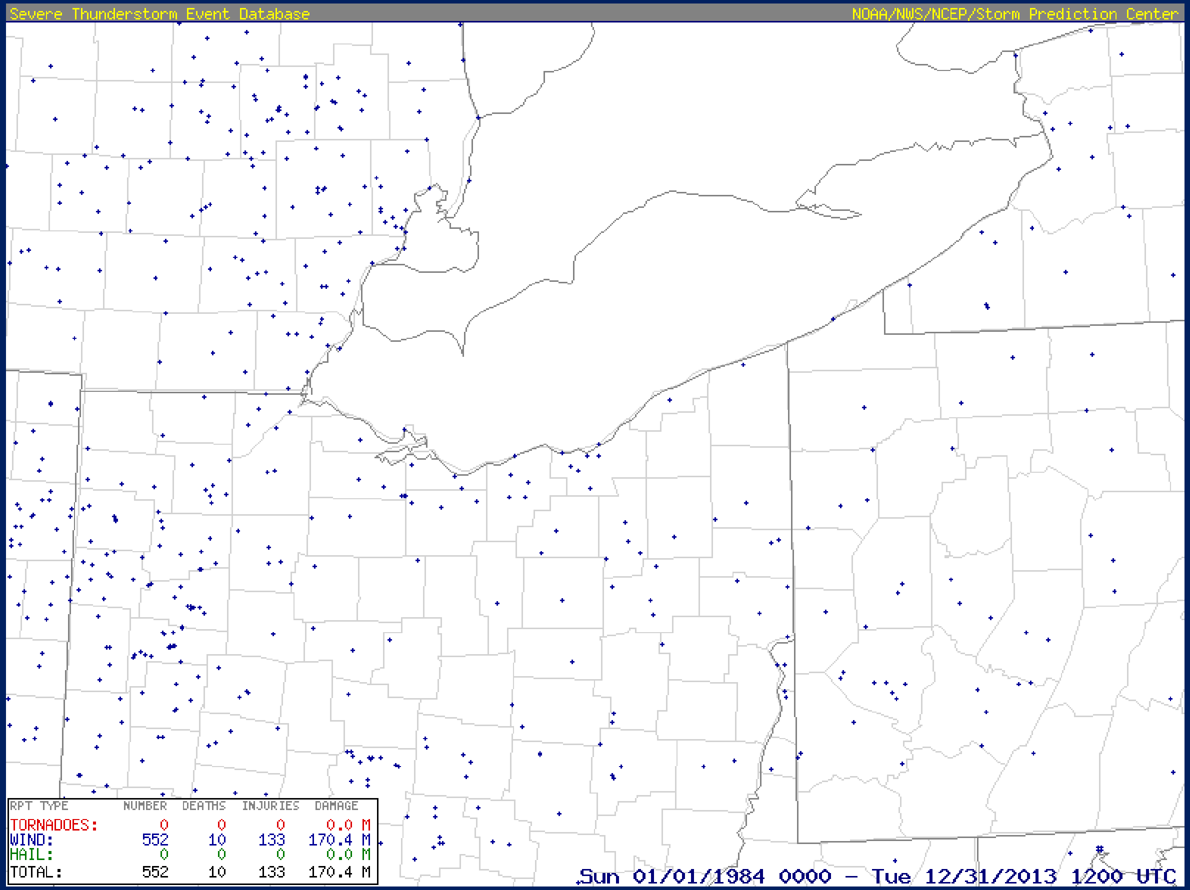


28 July 1993 Storm Reports



1984-2013 Significant Wind Reports



Conclusions

- **Favorable synoptic and mesoscale environment**
- **Approaching 500 mb trough placed northern Ohio in favorably fast westerly flow, and the strong cold front provided the trigger in the warm sector during peak heating**
- **The tongue of hot & humid air in the Ohio Valley contributed to favorably high CAPE, and the sufficient west-northwest shear allowed for east-southeast propagation and strong wind potential**
- **High precipitable water and sufficiently dry low-midlevels helped strong wind potential by aiding in evaporative cooling & strong downdrafts**
- **The persistent lake breeze boundary from western Lake Erie through the eastern suburbs of Cleveland acted as a focus for the convective cluster to intensify and propagate along, and the warm waters allowed the system to maintain intensity**

Conclusions Continued

- **WRF performed extremely well in the development and intensity of the convection, but was too slow on the timing and too far east with the strongest winds**
- **It may have even overproduced convection**
- **The simulated 65 knot winds at 950 mb north of Erie, PA were well east of where they actually occurred**
- **This devastating event occurred in a region that has not had many significant convective windstorms in the past 30 years, and it raises additional questions on the interactions of lake boundaries with convective environments**

Acknowledgements

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- Rich Thompson
- David Lynch
- The Petras Family
- My Family

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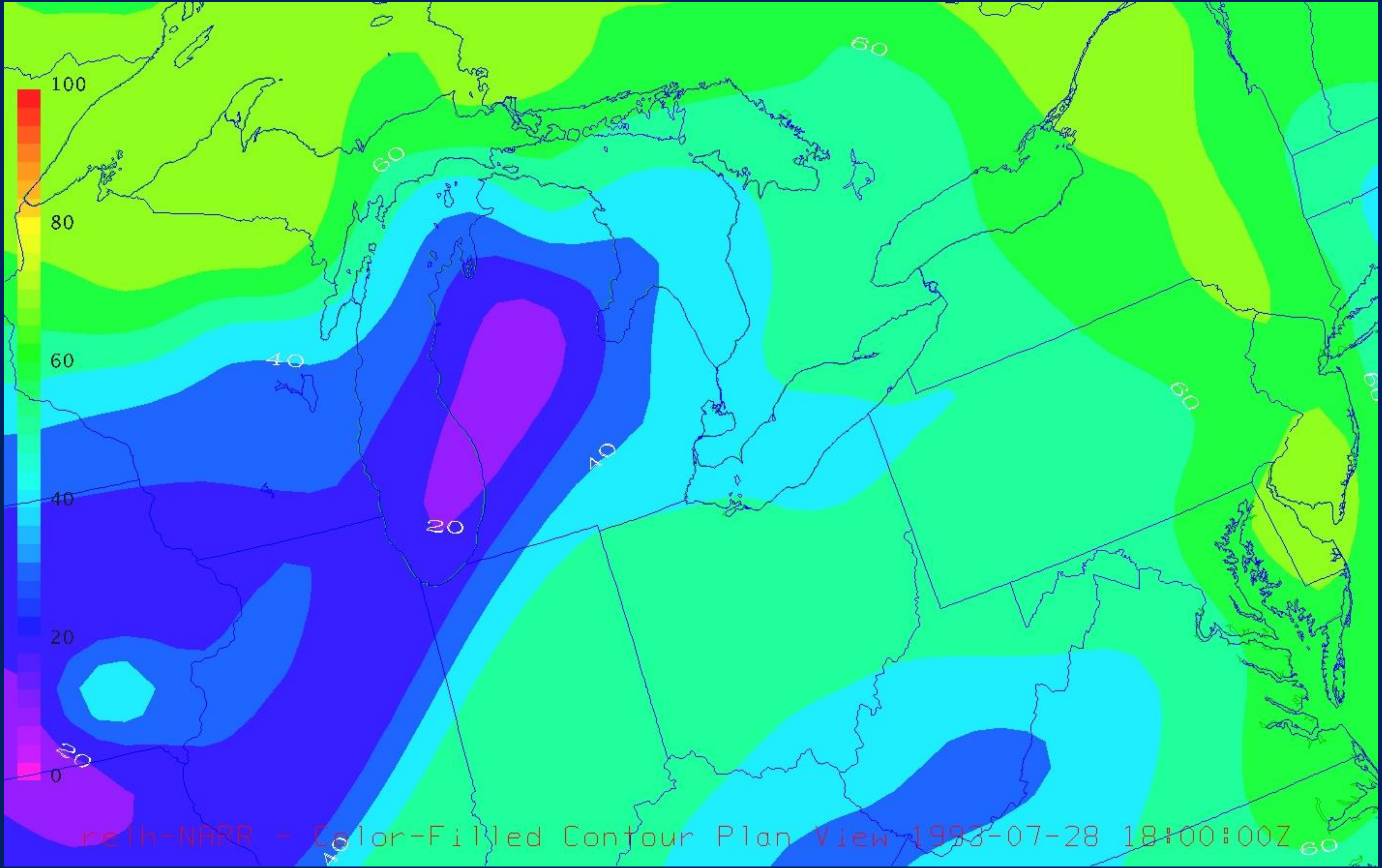
18 UTC 28 July 700 mb Relative Humidity



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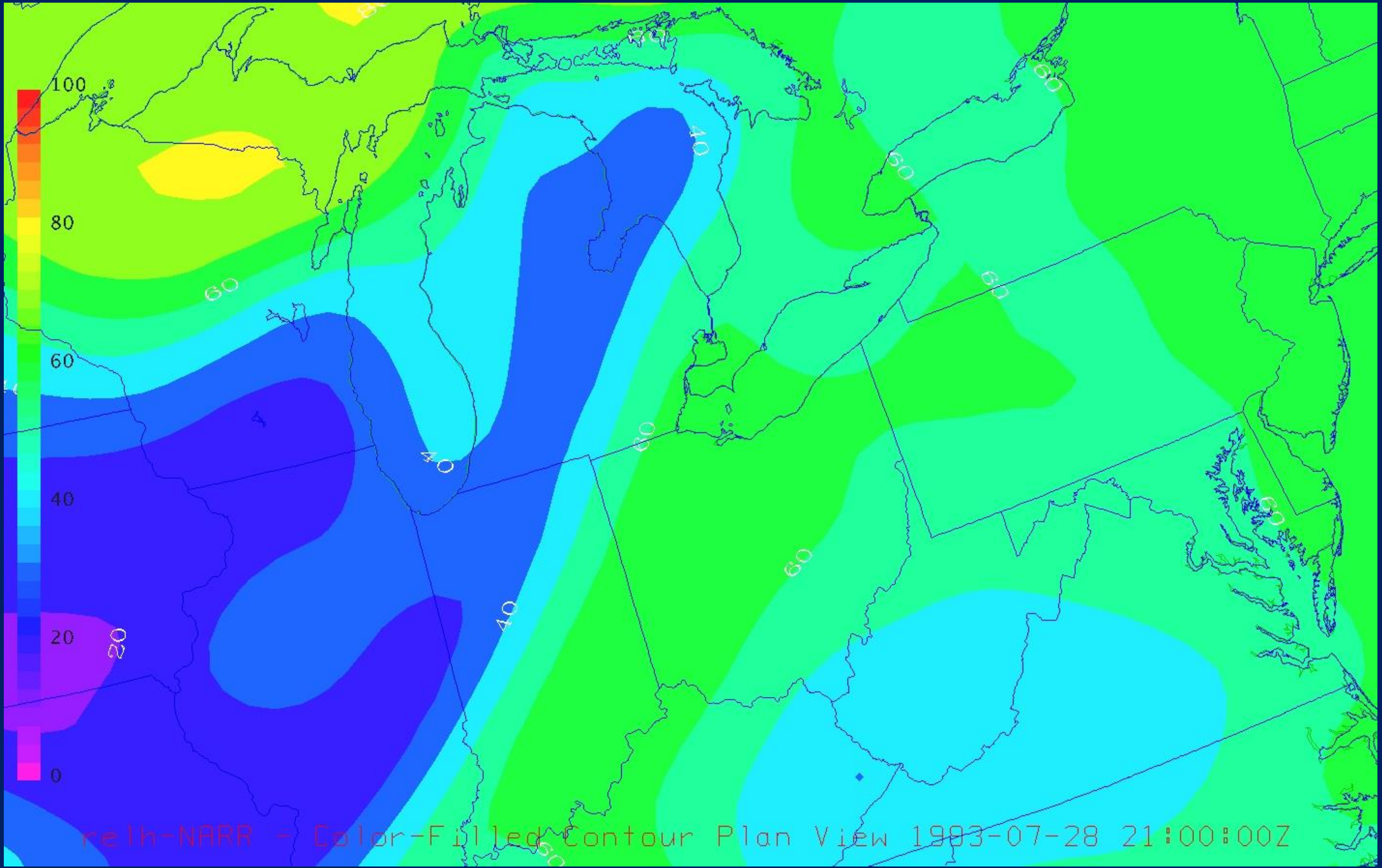
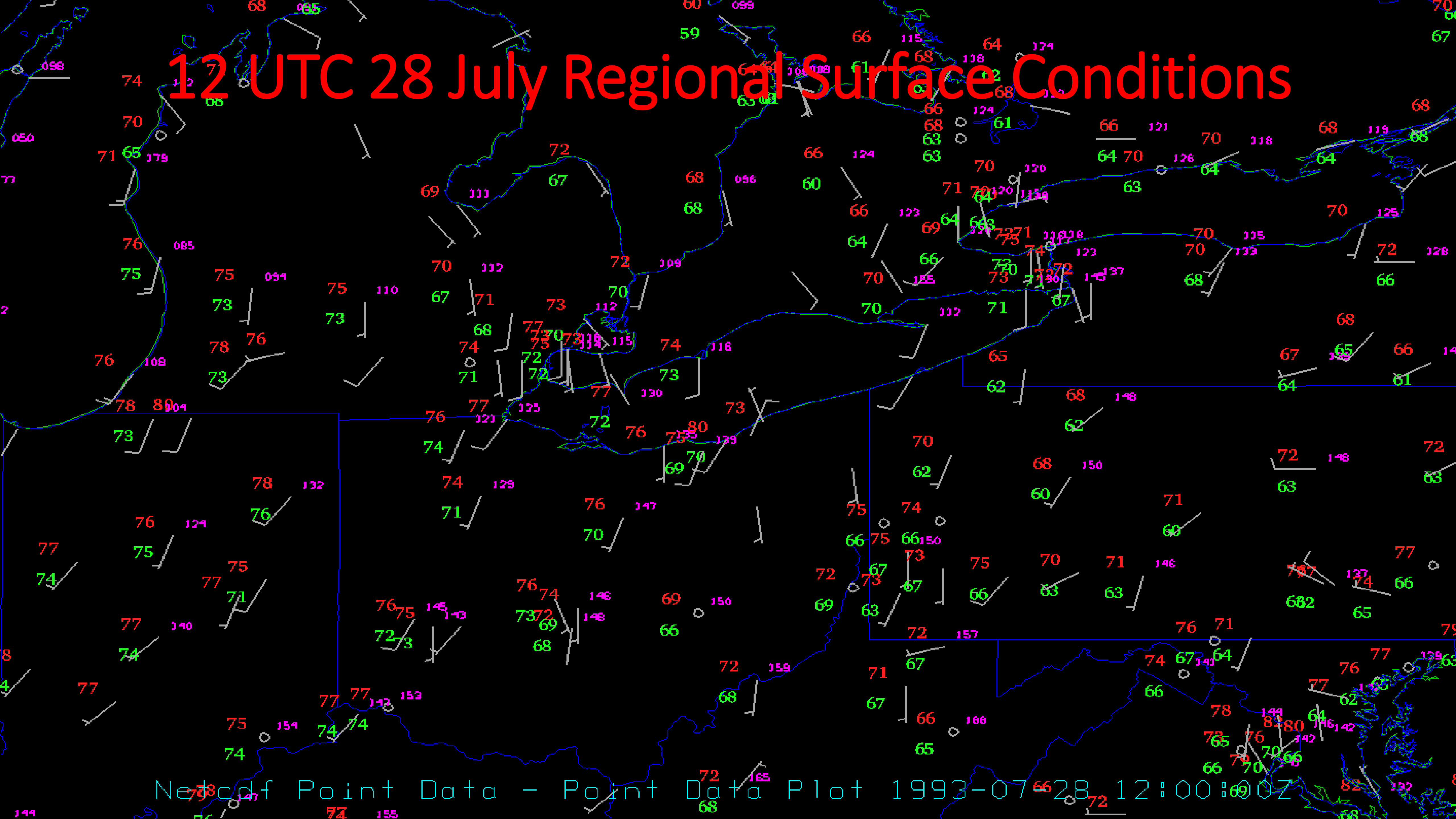
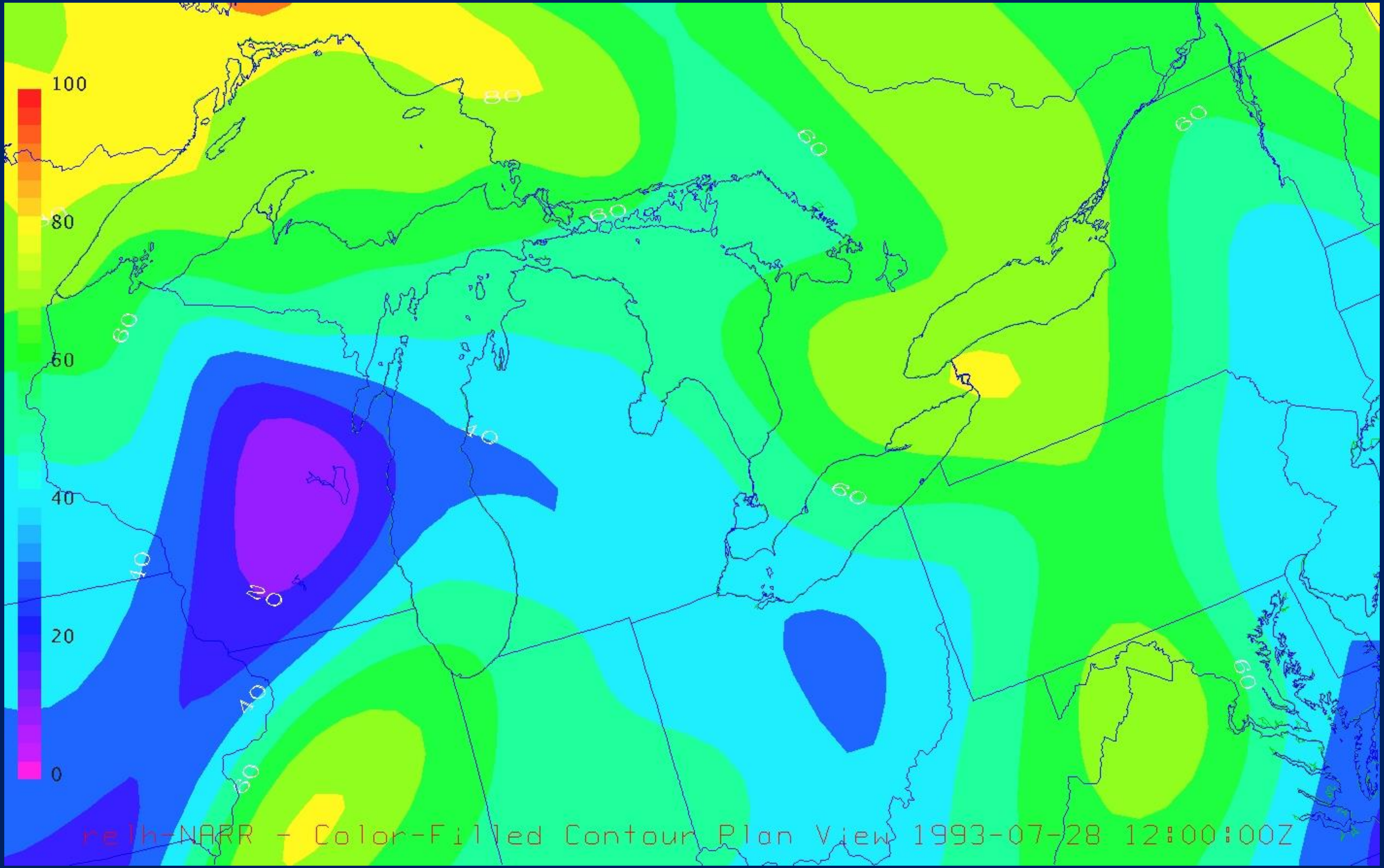


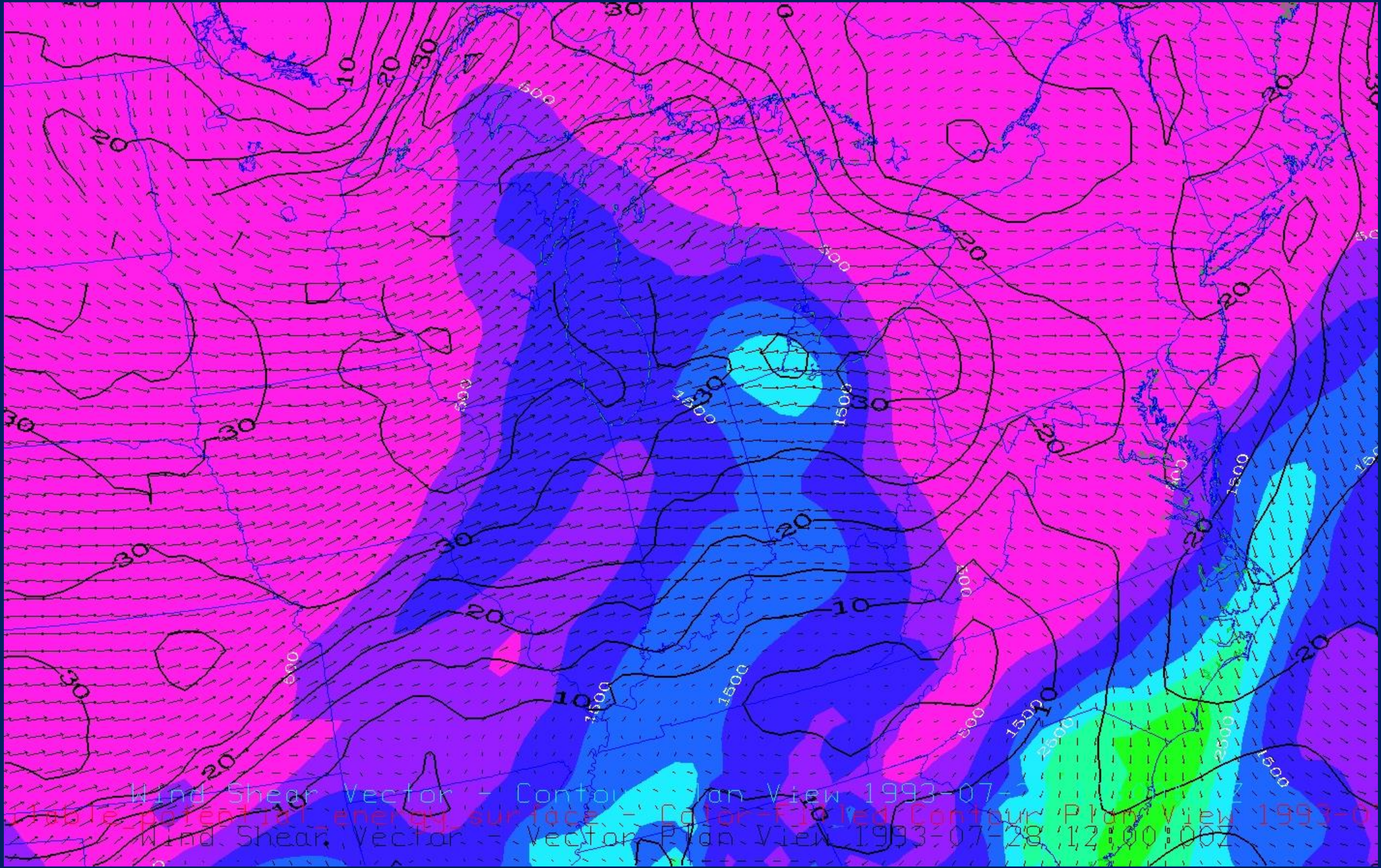
12 UTC 28 July Regional Surface Conditions



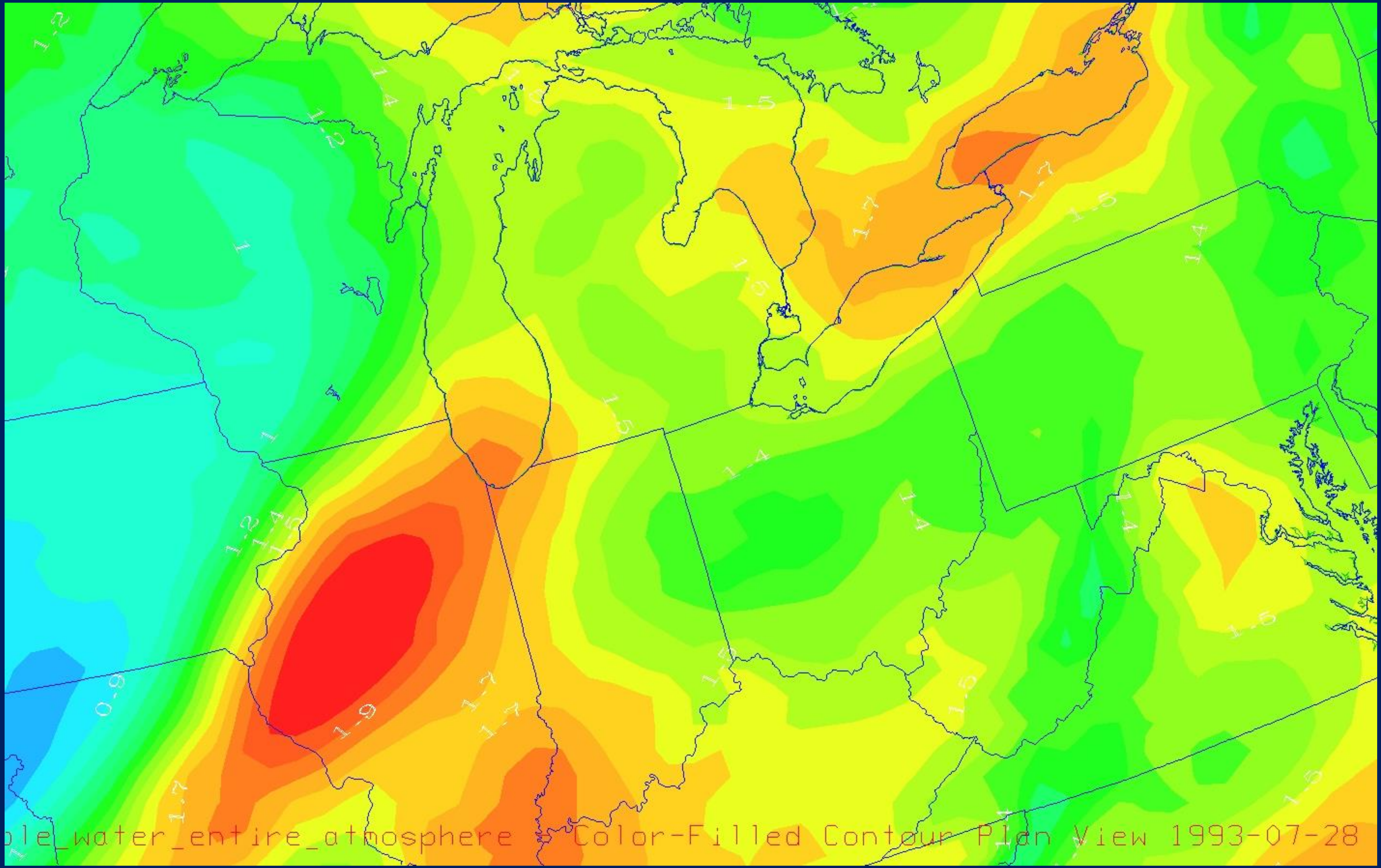
12 UTC 28 July 700 mb Relative Humidity



12 UTC 28 July CAPE and 0-6 km Shear



12 UTC 28 July Precipitable Water



Previous Work

- Fujita and Wakimoto (1981) studied damage patterns of a convective windstorm on 16 July 1980
- Determined the damage was caused by downbursts and microbursts containing multiple scales of airflow
- Developed a 5 scale system for classifying downbursts (maso-BETA, meso-ALPHA, meso-BETA, miso-ALPHA, miso-BETA)

Previous Work Continued

- **Johns and Hirt (1987) studied 70 cases of derechos over the United States during May-August between 1980 and 1983**
- **Majority of cases occur under westerly to northwesterly 500 mb flow with an average speed of 41 knots**
- **Average midlevel relative humidity values in derecho environments range from 25% to over 80% promoting strong downdrafts**
- **Johns (1993) found that average CAPE values associated with bow echo development exceeds 4500 Jkg^{-1}**

Previous Work Continued

- **Workoff *et al*. (2012) studied the influence of the Lake Erie overlake boundary layer on 111 episodes of convection crossing the lake between 2001 and 2009**
- **July showed a peak for convection crossing Lake Erie**
- **Linear and complex convective modes weakened less than isolated and cluster convective modes overall**
- **The strength of linear convective modes was more affected by the 3-km wind speeds than by the overlake boundary layer**