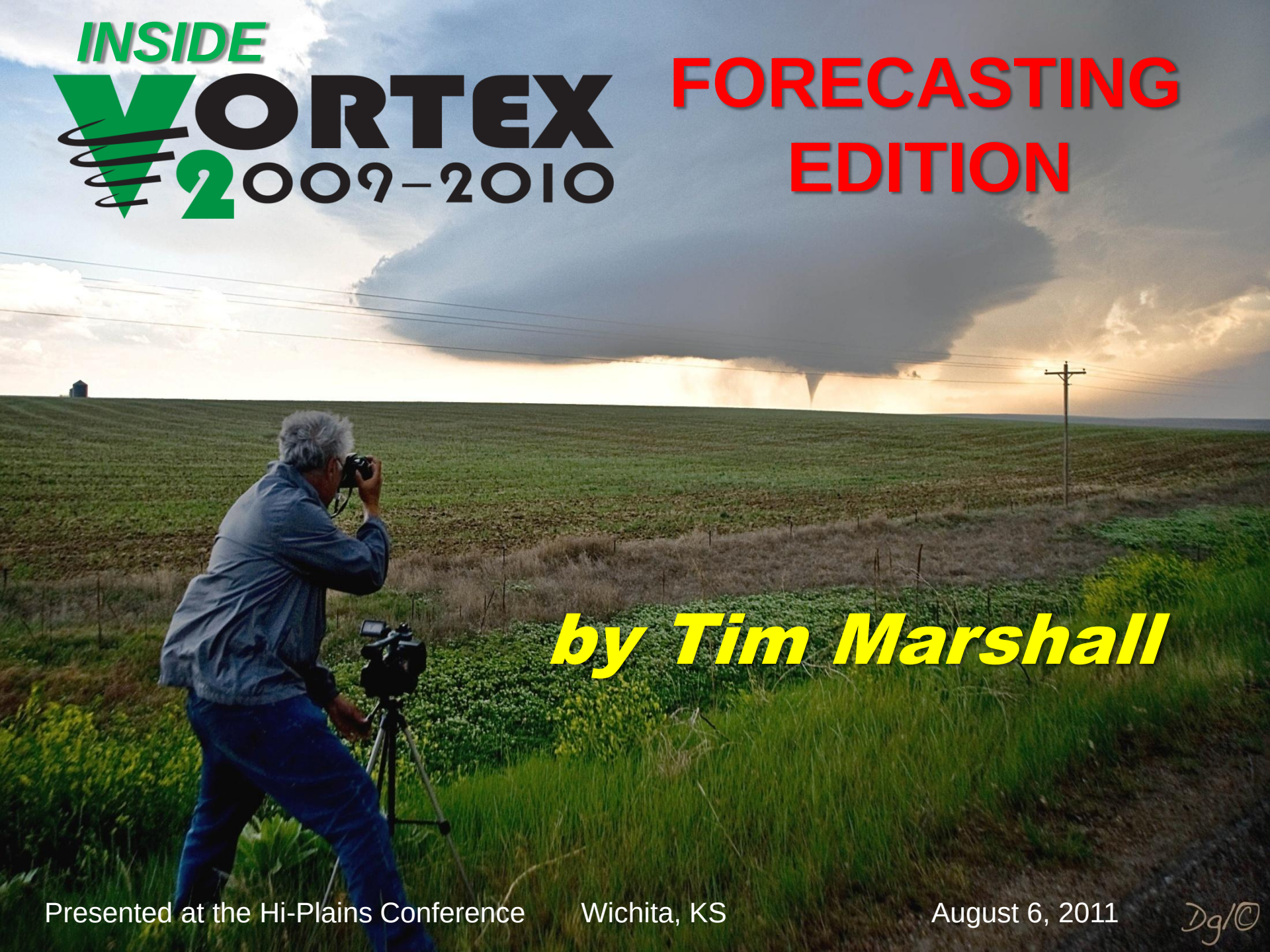
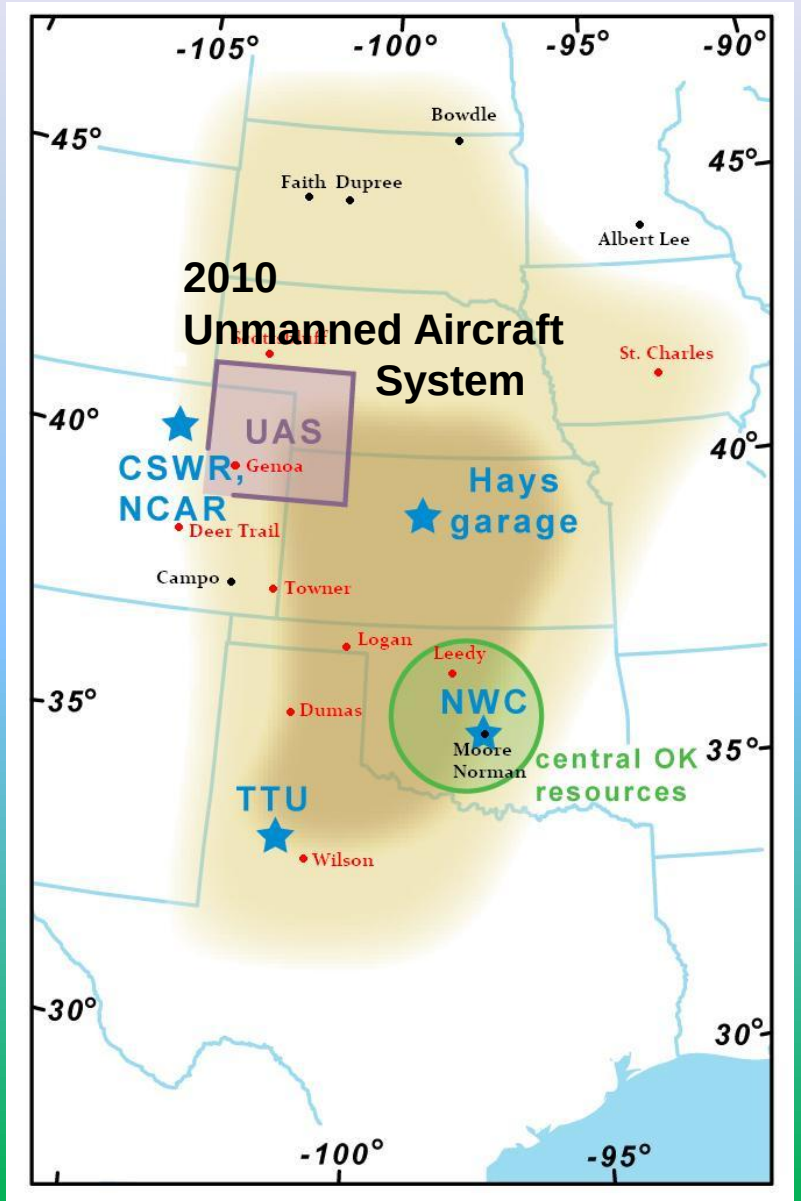

INSIDE
VORTEX
2009-2010
FORECASTING
EDITION
by Tim Marshall
Presented at the Hi-Plains Conference
Wichita, KS
August 6, 2011

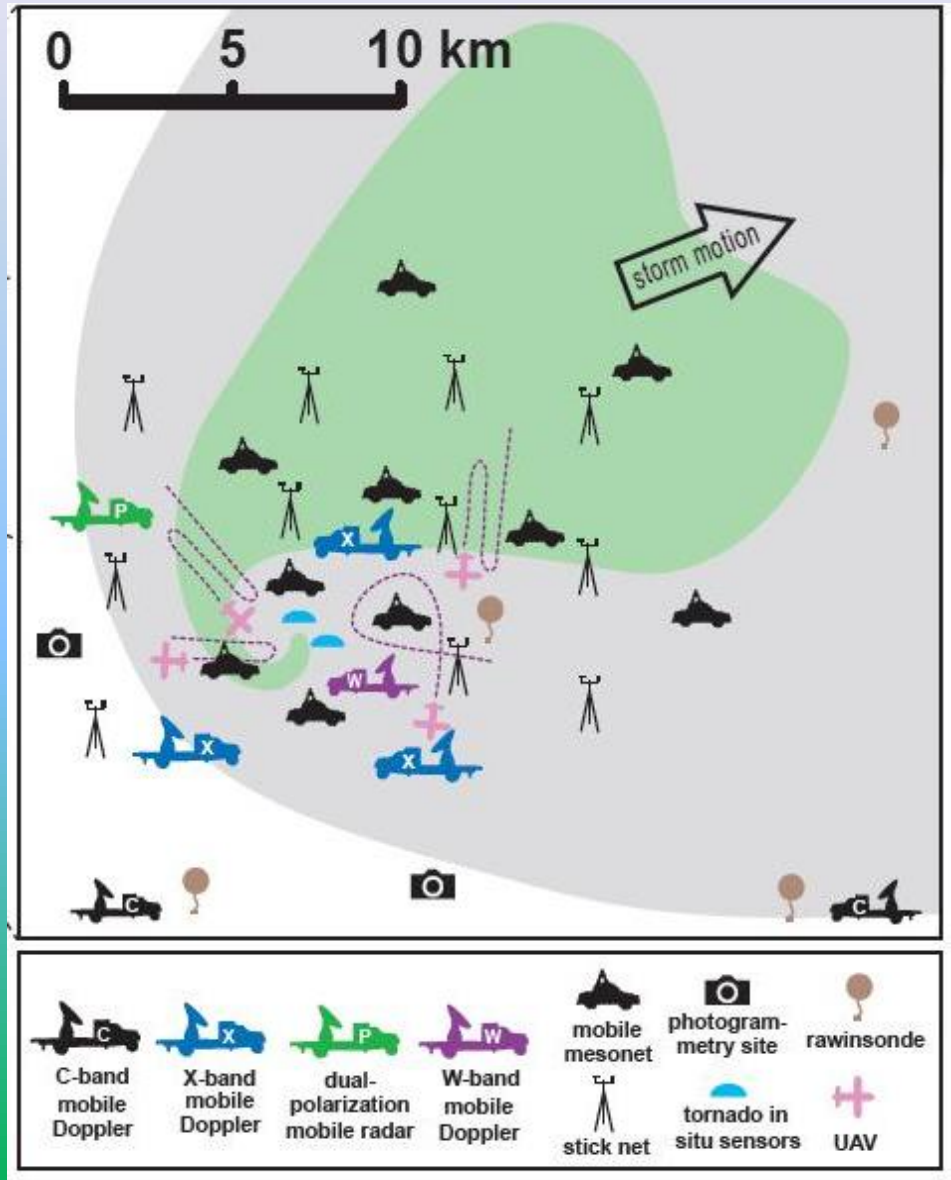
VORTEX 2 PURPOSE:

- Explore the mechanisms of tornadogenesis, maintenance, and demise.
- Determine the wind field near the ground in tornadoes.
- Study the relationship between tornadoes and their parent storms and the larger scale environment.
- Improve numerical weather prediction and forecasting of severe storms and tornadoes.

From Wurman et al., 2010

THE DOMAIN and PLAN





The V2 Armada

In 2009, GM donated a Hummer

So, I volunteered my truck in 2010

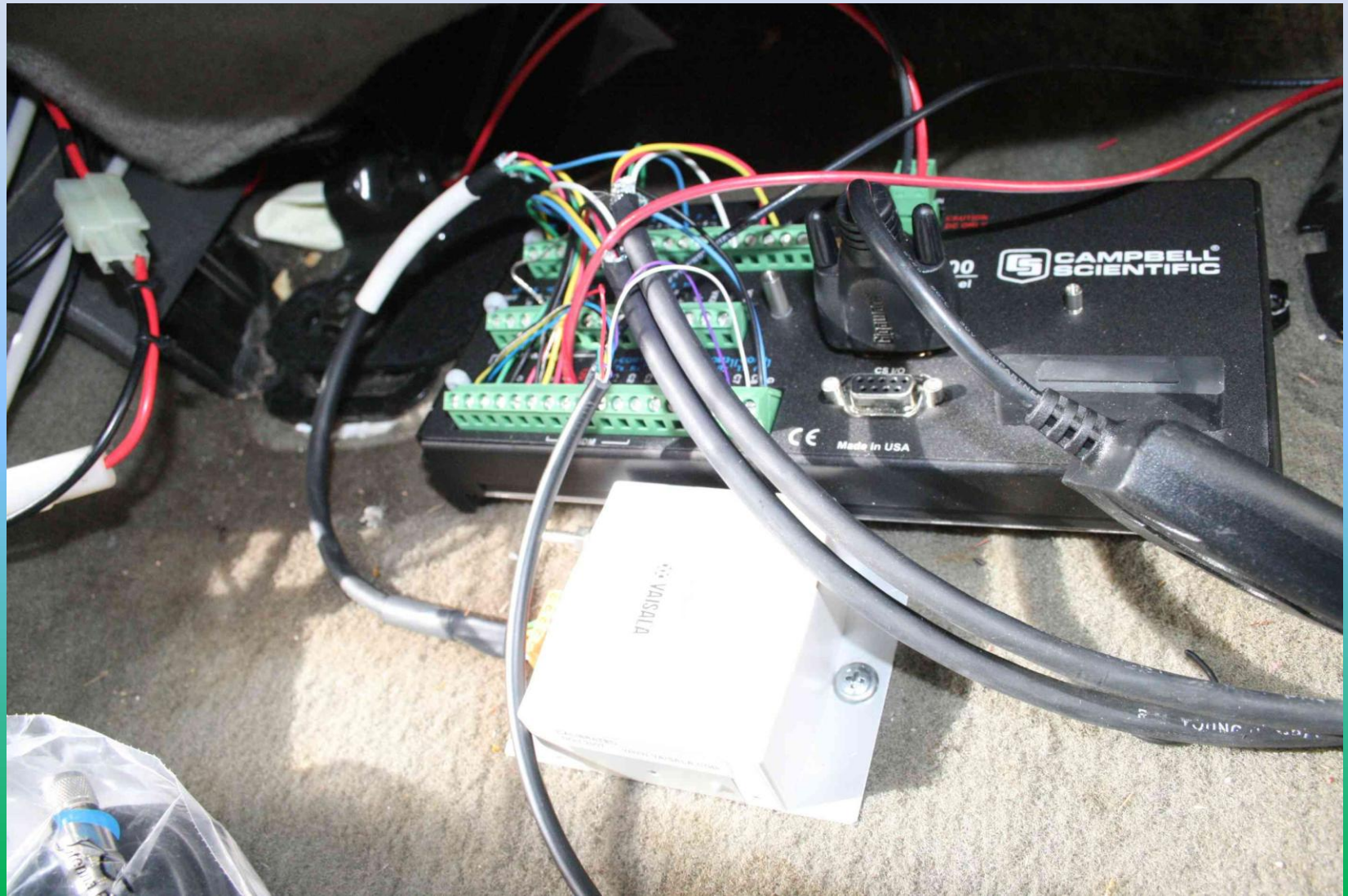
Dr. Wurman please…

My pimped up Chevy Colorado

13’ mast contained wind, T, H sensors

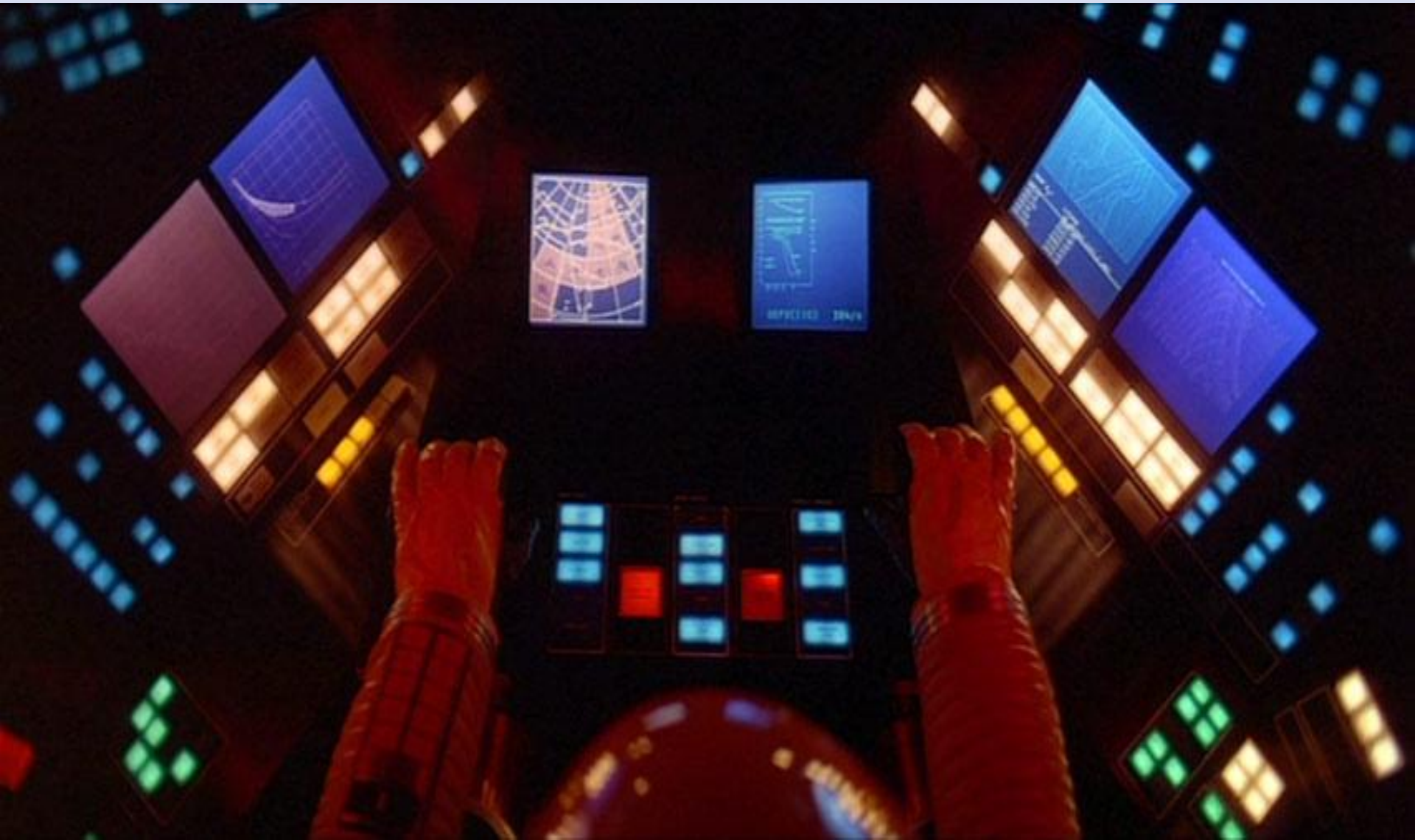
Base of mast was welded to frame

Mesonet datalogger recorded parameters once per second



Inverters to power computer systems

Front seat of my vehicle



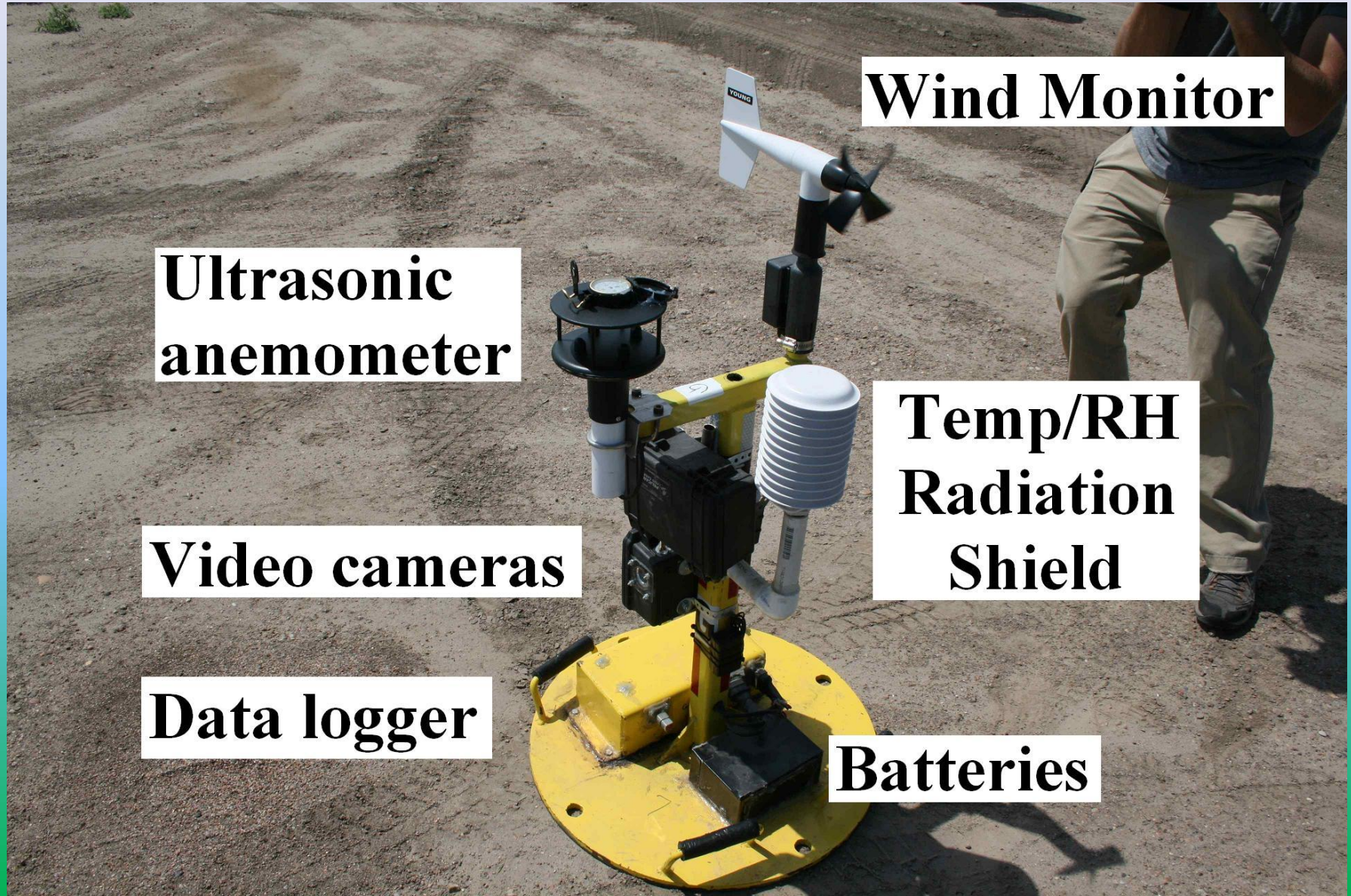
Actual front seat in my vehicle

Custom camper top
Truck bed contained 3 pods

Name of my vehicle:

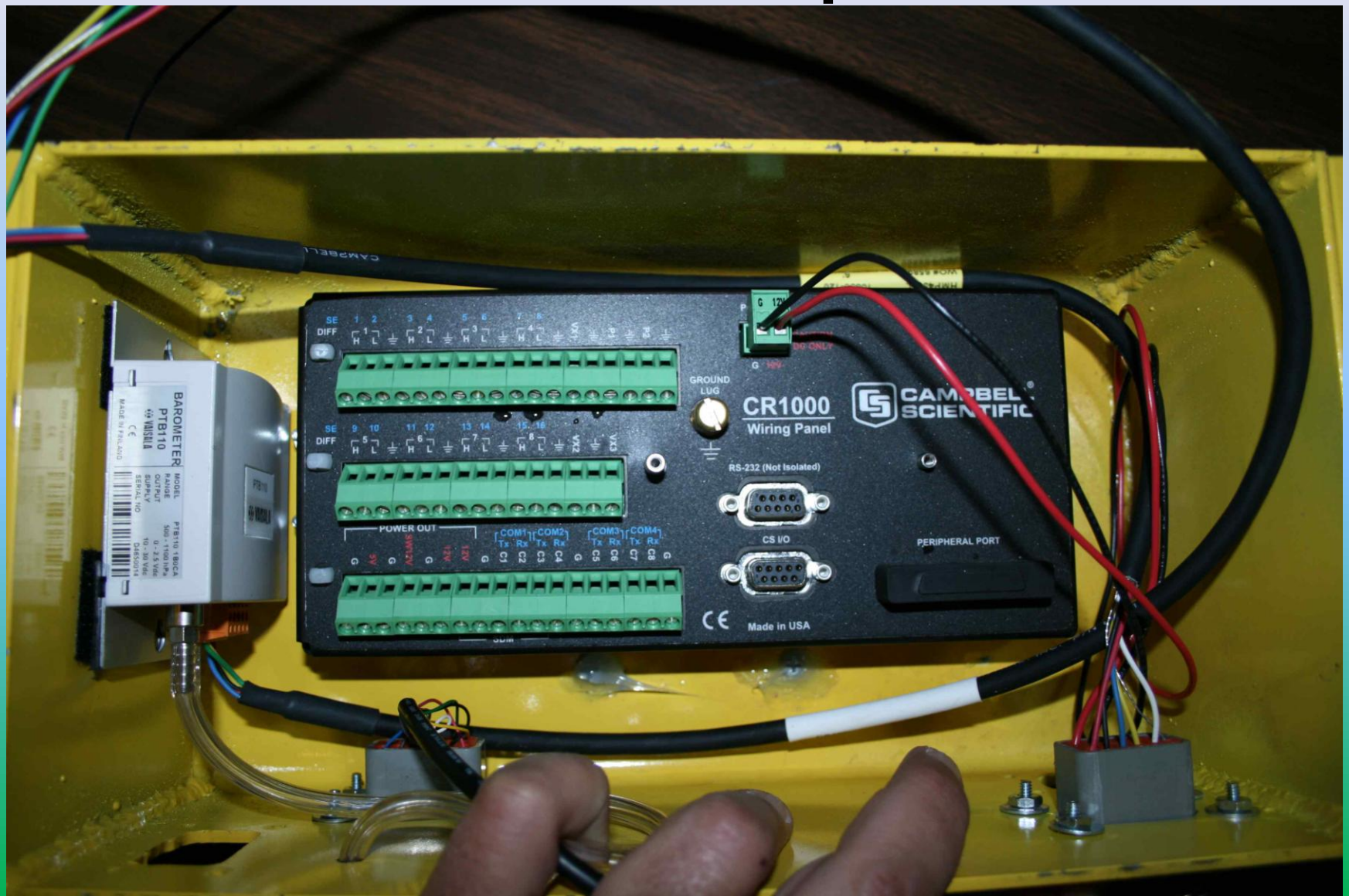
WHITE LIGHTNING

The instrumented pod – cost 5K each



Hardened steel case holds data logger

Datalogger recorded pod/mesonet observations once per second

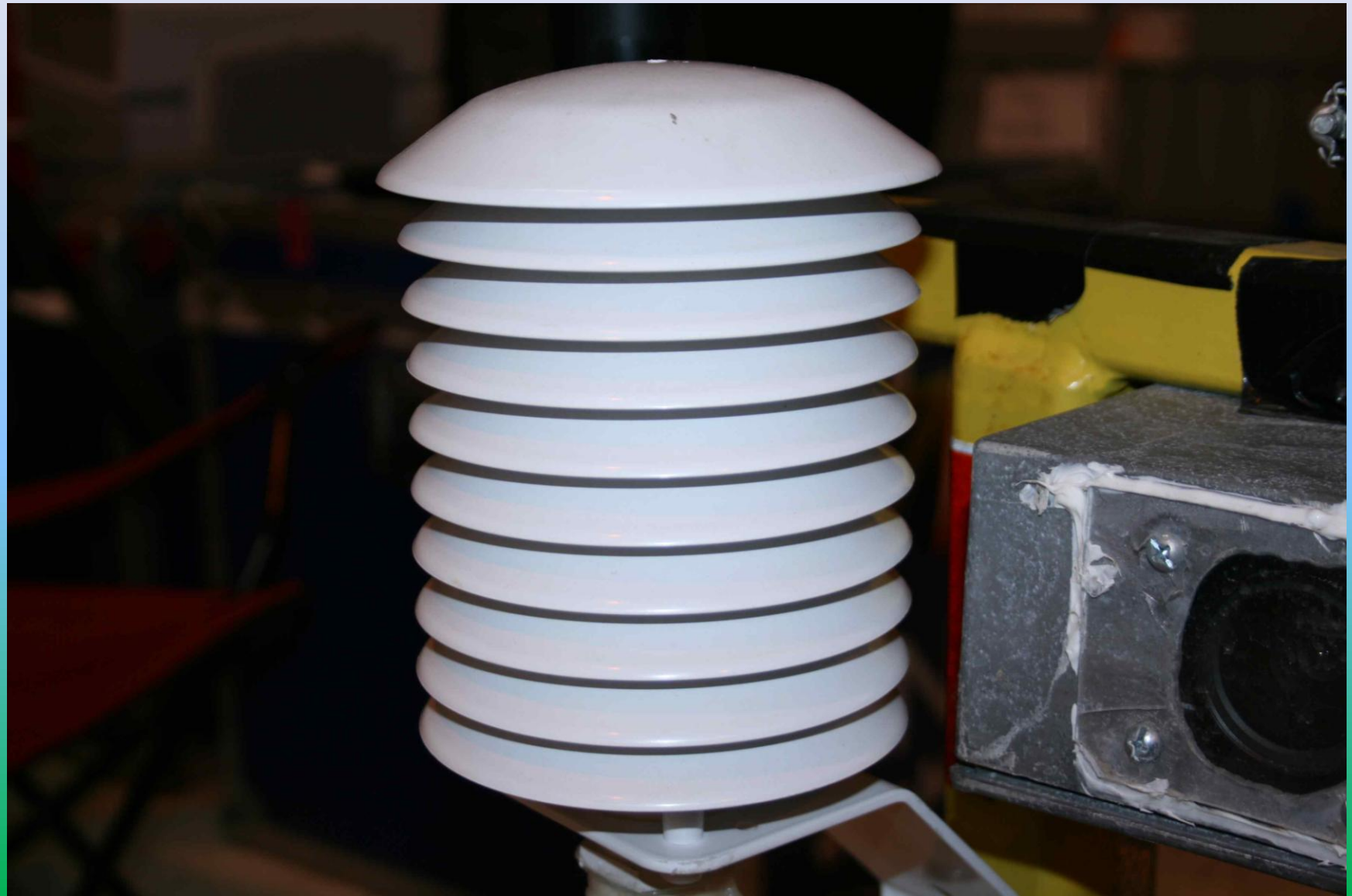


Battery that powered pod

Wind Monitor – rated to 224 mph

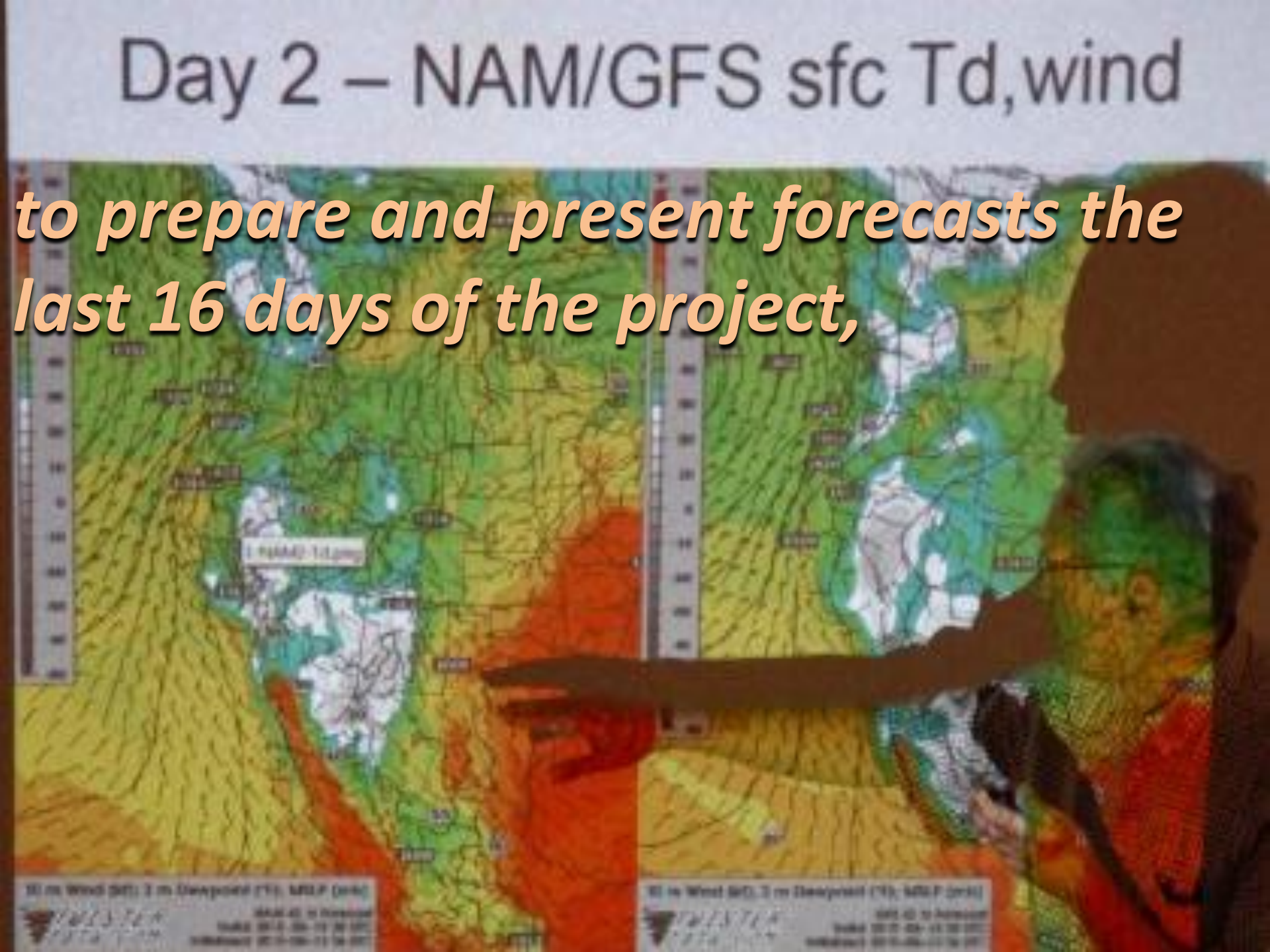
Ultrasonic anemometer

Radiation shield for T and RH



HD Cameras provided by NHK


My tasks were to drop instrumented pods in front of tornadoes,


Day 2 – NAM/GFS sfc Td,wind
to prepare and present forecasts the last 16 days of the project,


...to obtain mesonet data of storm environments,

...and to assist in surveying damage, if needed.

Sampled 9 Tornadic storms

15 tornadoes – 77 days of operations - $860K/tornado

- June 5, 2009 – Goshen, WY (best storm)
- May 18, 2010 – Dumas, TX (2)
- May 19, 2010 – Kingfisher, OK (2)
- May 25, 2010 – Tribune, KS (2)
- June 7, 2010 – Scottsbluff, NE
- June 10, 2010 – Deer Trail, CO (2)
- June 11, 2010 – Genoa, CO (2)
- June 13, 2010 – Booker, TX (2)
- June 14, 2010 – Wilson, TX

Vortex 2 forecasting

My typical day – 6am-8:30am

- Download yesterdays storm reports (verification)
- Plot a surface weather map
- Obtain satellite images(VIS, IR, WV)
- Study 12z soundings
- Analyze 12z upper air maps
- Peruse model forecasts
- Prepare a PowerPoint presentation
- Present forecast to principal investigators(PIs) at 9:30am central time
- Chase – then do it all over AGAIN !


BEFORE V2
AFTER V2

The PI's debated the target town

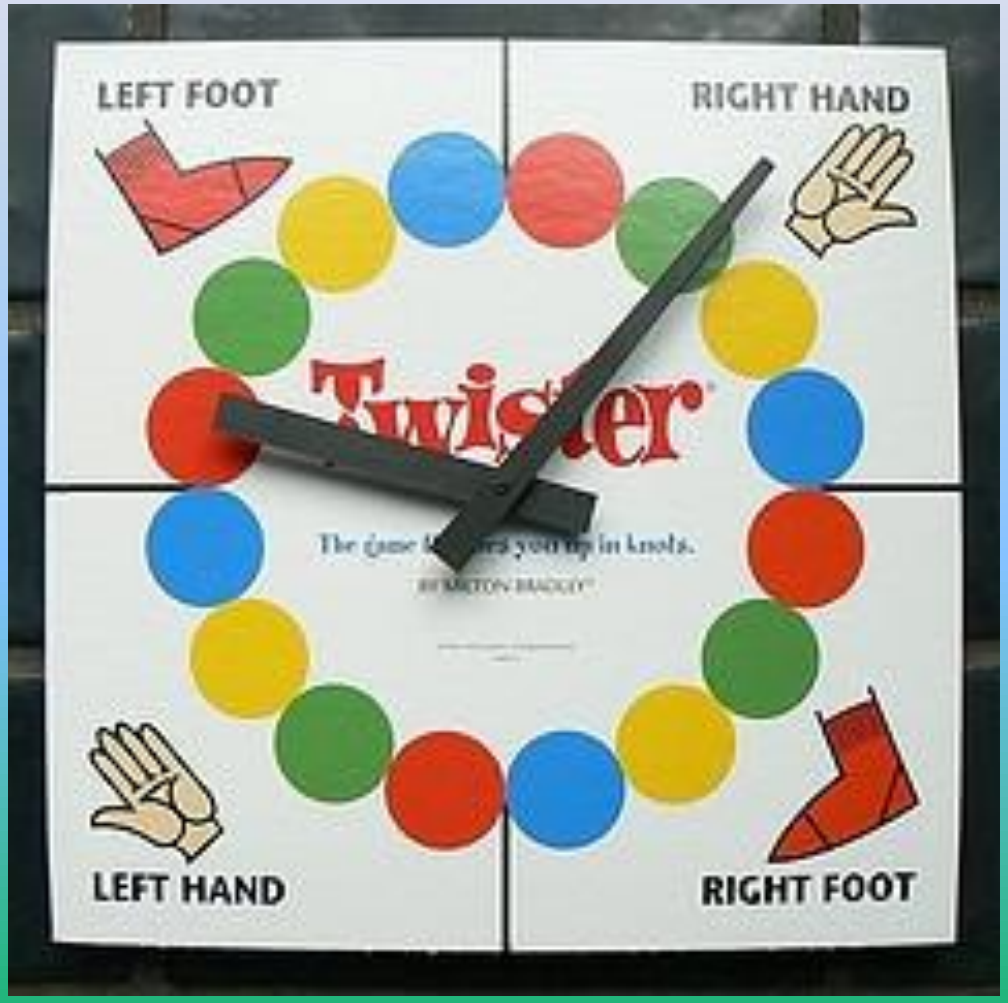
The mission scientist decided the ultimate target town and time of arrival

En route the Field Commander provided the latest weather update/target info.

Inside the Field Commander vehicle

Forecast questions

- Will supercells form today?
- Will they be tornadic?
- If so, where?
- What time will storms initiate?
- How about tomorrow?



2010 Vortex 2 Forecasters

- Keith Brewster (CAPS)
- Mike Coniglio (NOAA/NSSL)
- Mike Foster (NOAA/NWS)
- Gabe Garfield (OU-Meteorology)
- Jim Ladue (NOAA-WDTB)
- Tim Marshall (Haag Engineering) May 30-June 15

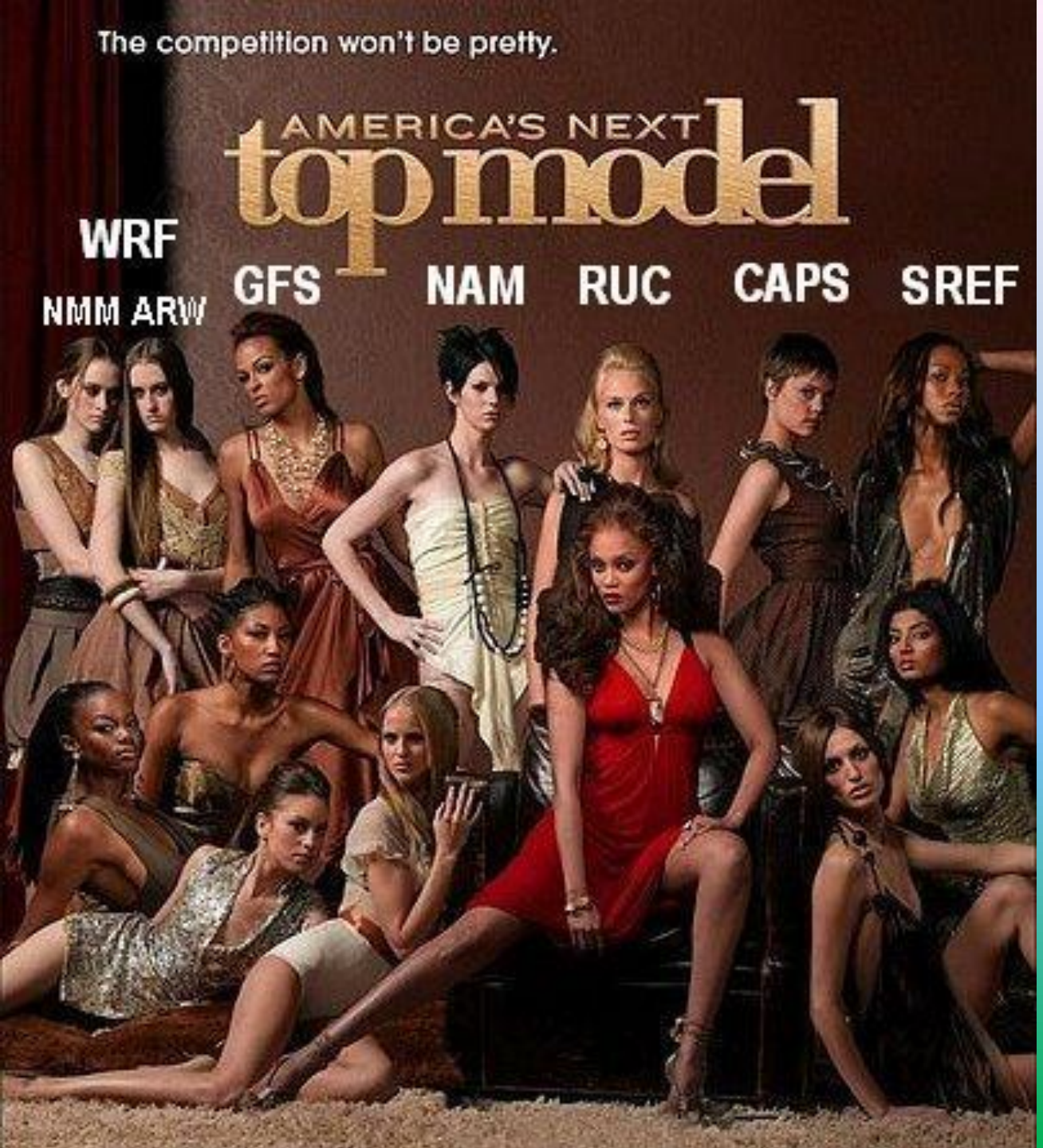
Forecasting supercell storms:

Our paper is available online at:

http://ams.confex.com/ams/pdfpapers/176186.pdf

Popular models used during Vortex 2

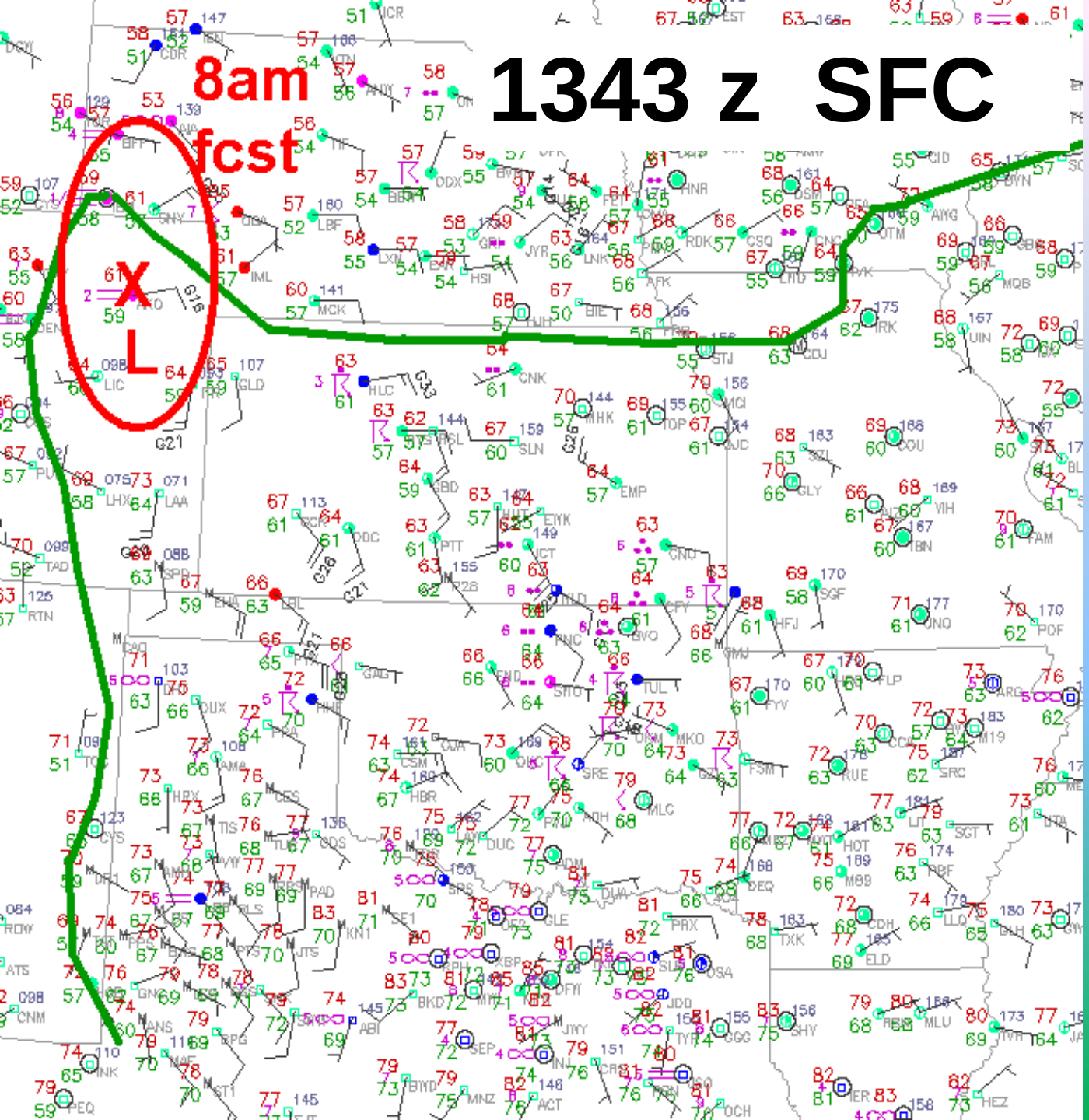
- NAM – North American (Mesoscale) Model
- GFS – Global Forecast System Model
- RUC – Rapid Update Cycle Model
- HRRR – High Resolution Rapid Refresh Model
- WRF – Weather Research and Forecasting Model (NCEP, NCAR, NSSL) NMM – non-hydrostatic mesoscale model
  ARW –Advanced Research Weather
- SREF – Short Range Ensemble Forecasts (SPC)
- CAPS – (4km ensemble, 1 km CONUS and V2 runs)



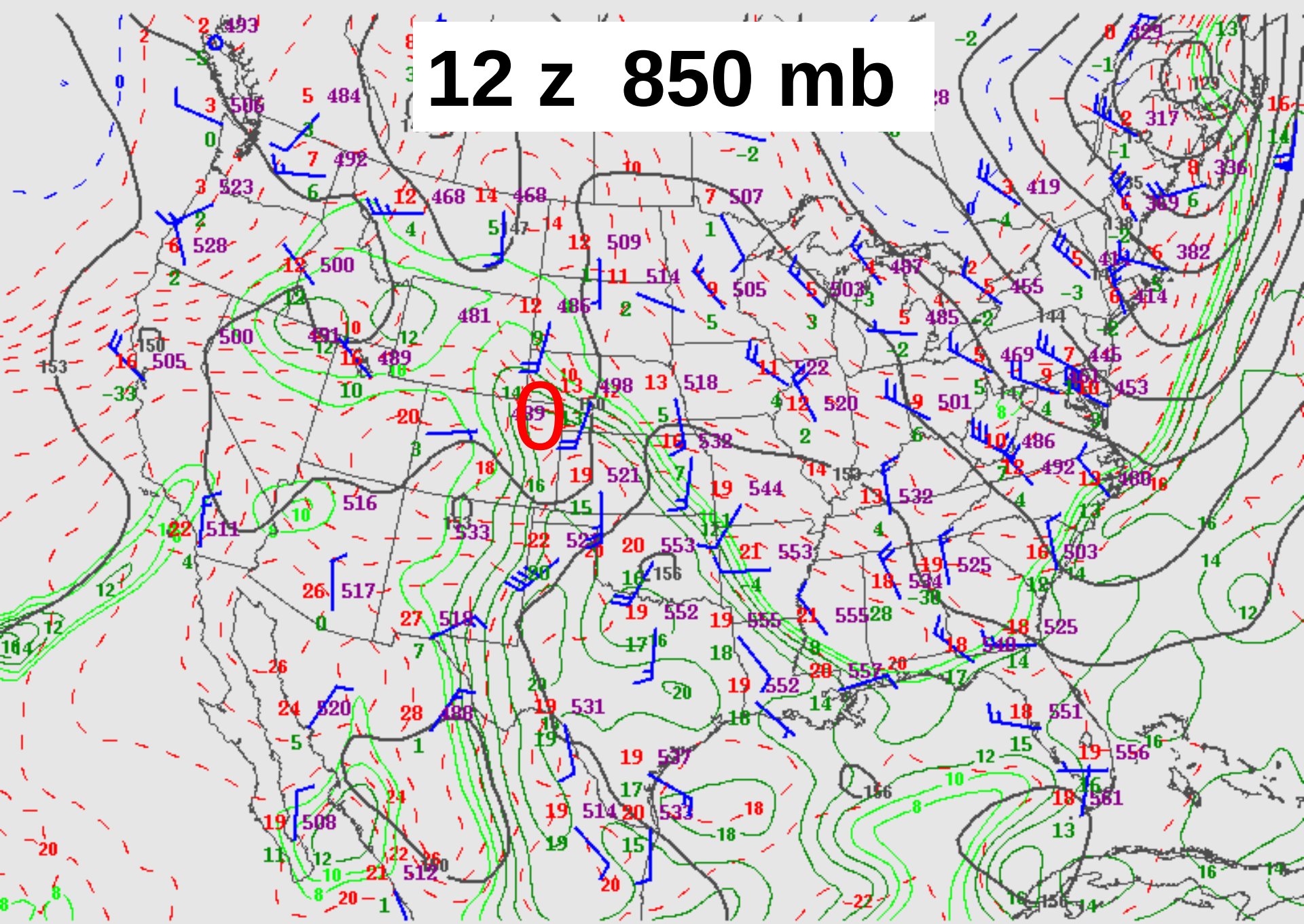
What was Vortex 2's favorite top model?

June 7, 2010 Weather

Upslope Case



6/7/10
8 am
Forecast
Target
Sterling, CO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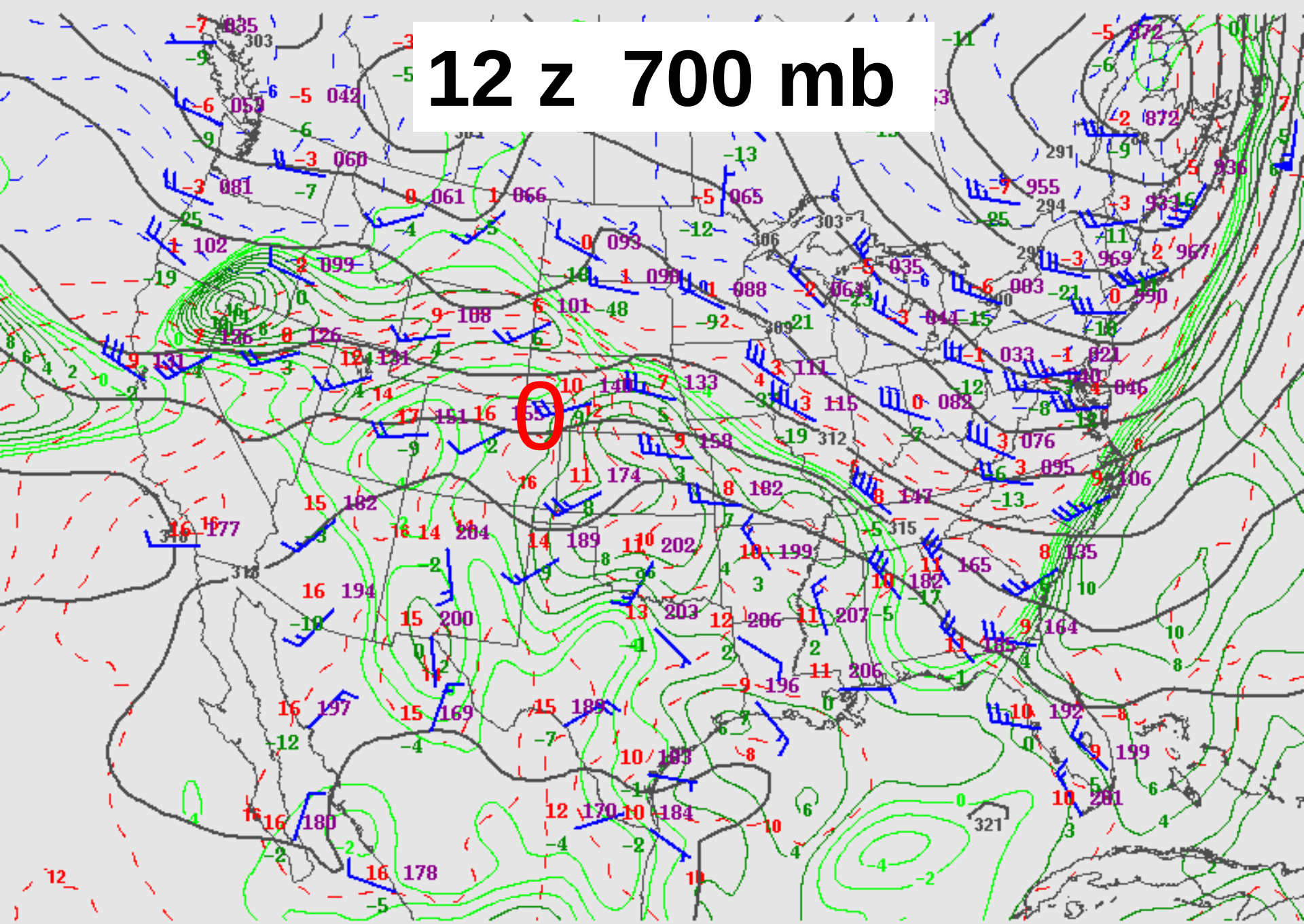
100607/1200 850 MB UA OBS, HGHTS, TEMPS, Td>=8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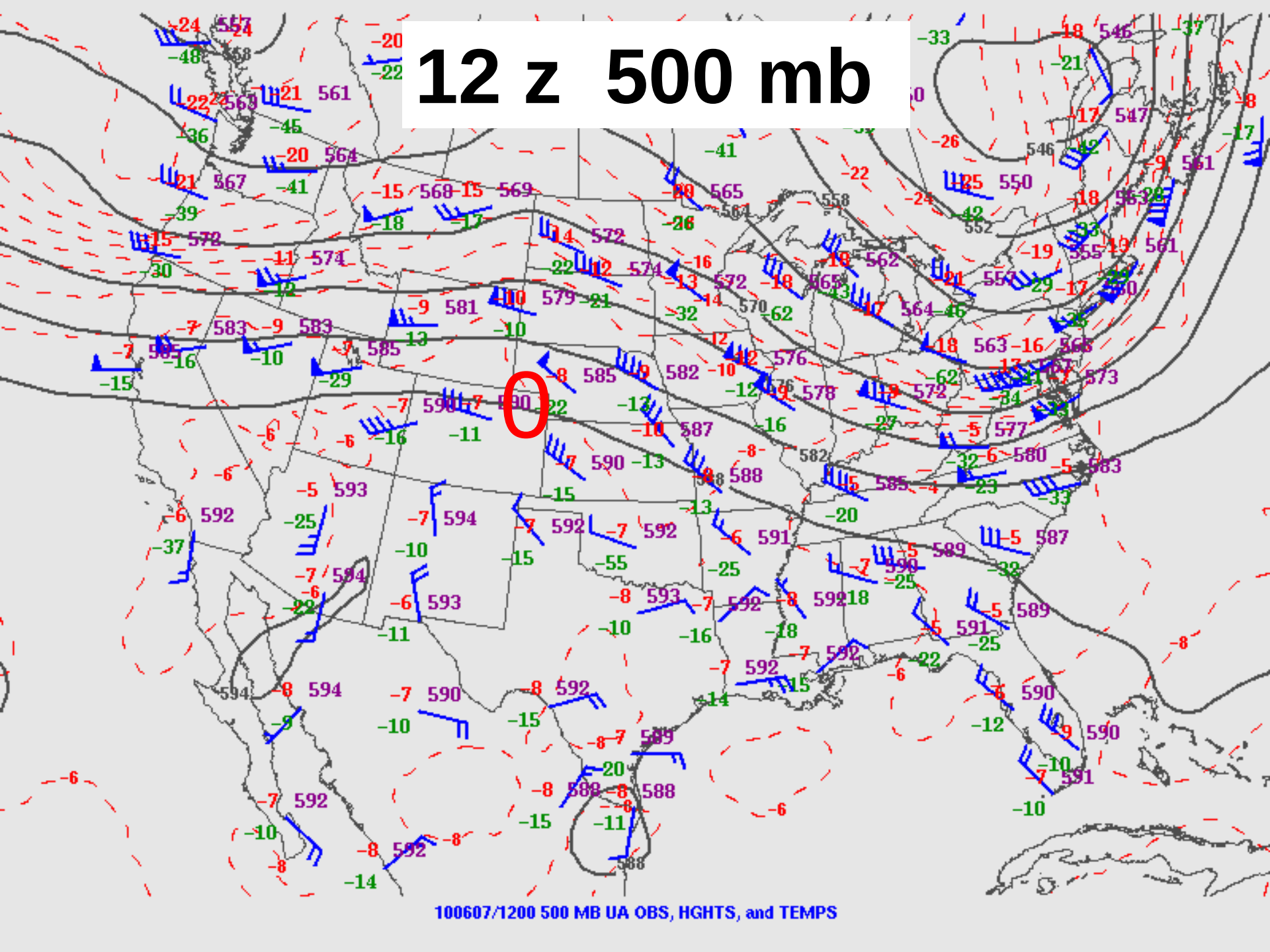
100607/1200 700 MB UA OBS, HGHTS, TEMPS, Td>=-4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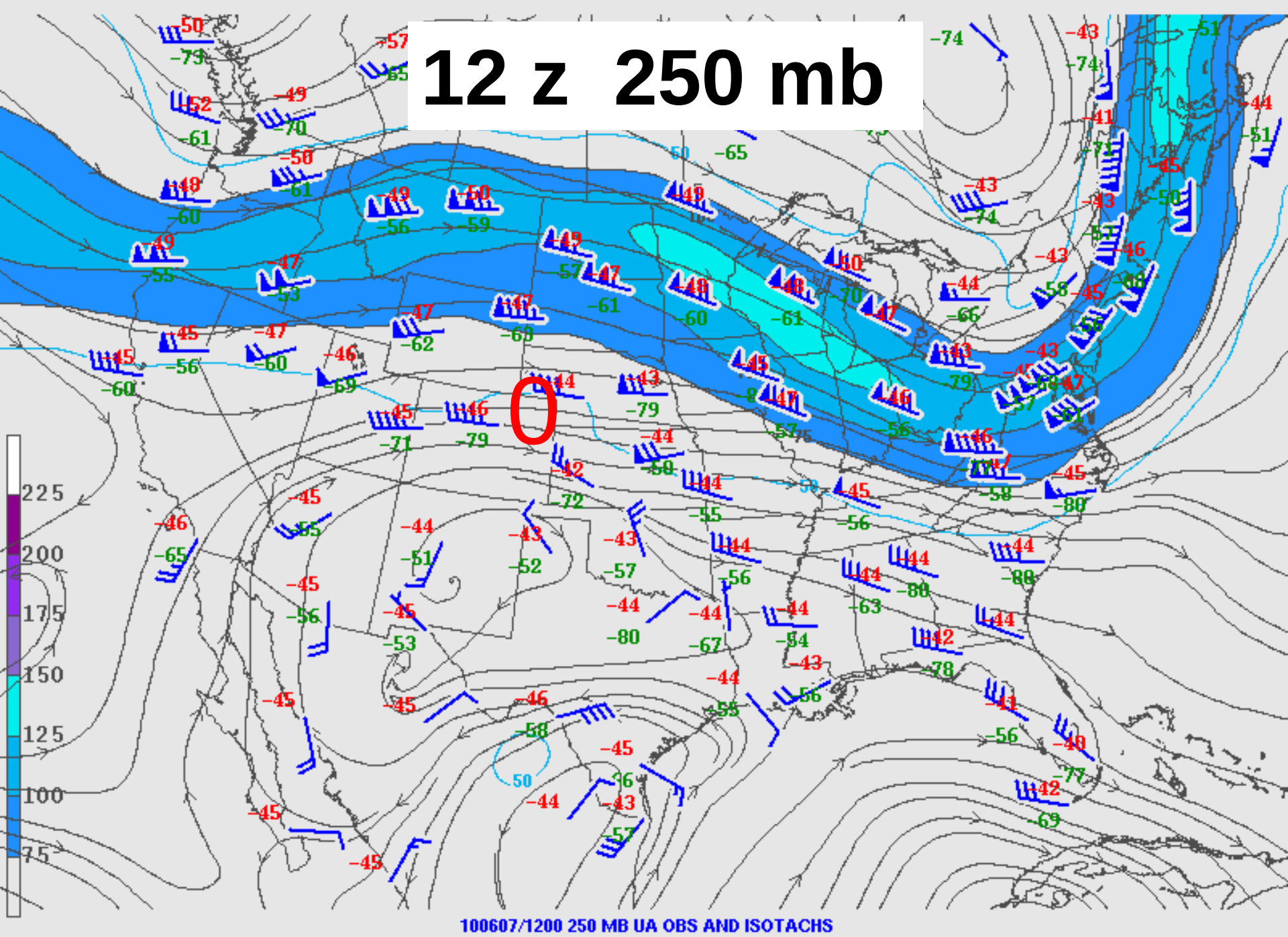
100607/1200 500 MB UA OBS, HGHTS, and TEMPS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225
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175
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125
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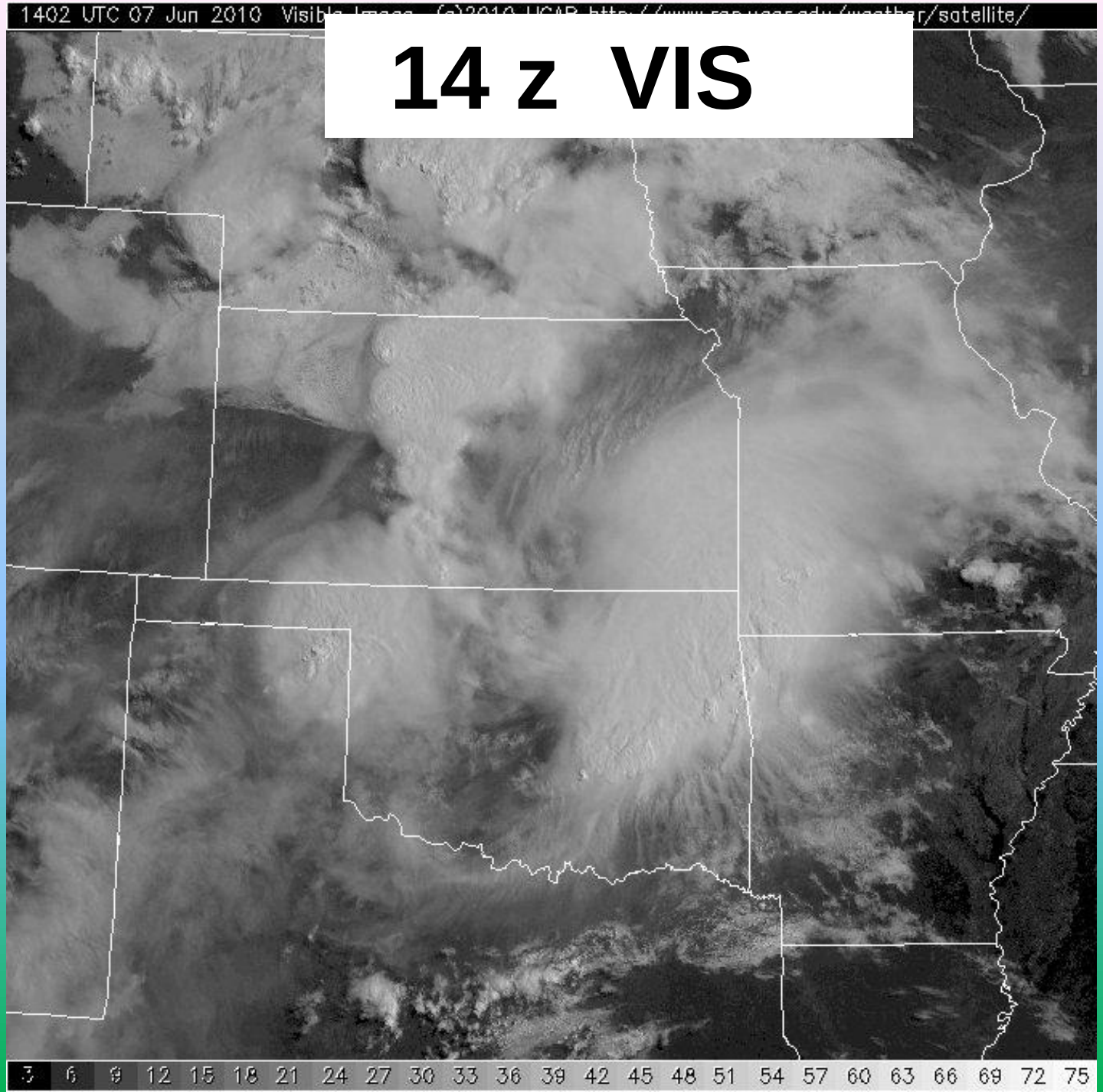
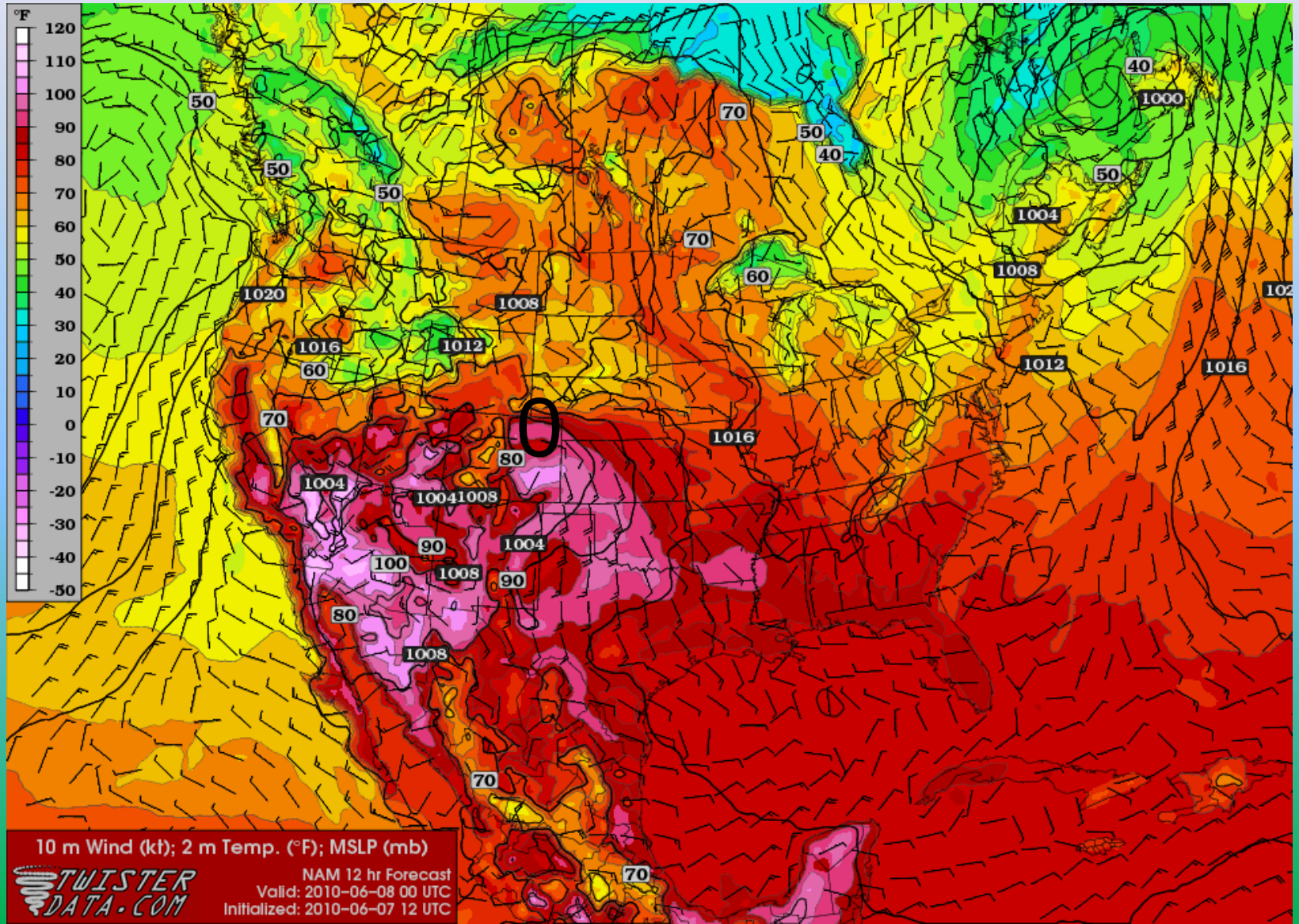
100607/1200 250 MB UA OBS AND ISOTACHS


1402 UTC 07 Jun 2010
14 z VIS
3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75

12z NAM – Surface T valid 0z



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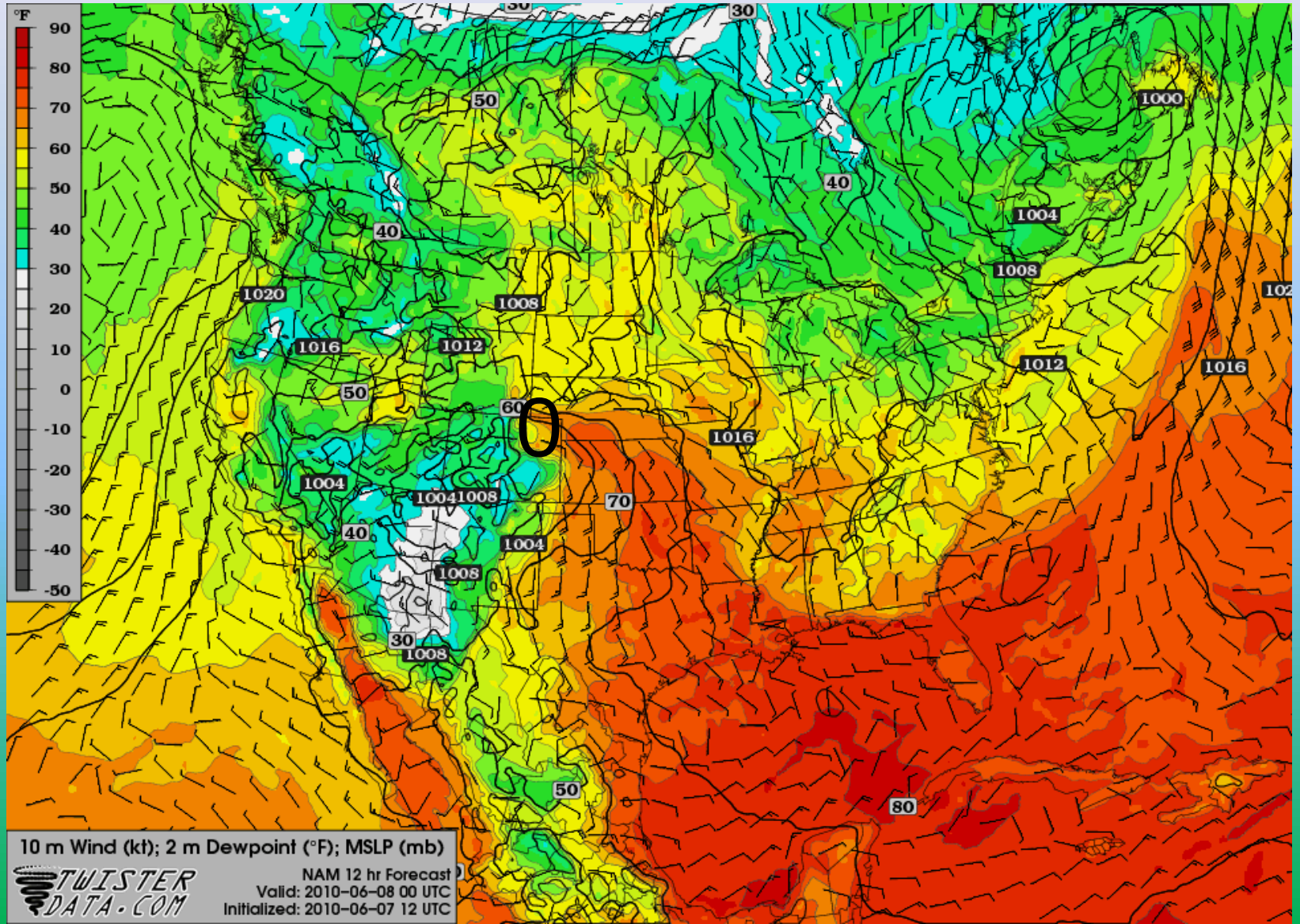
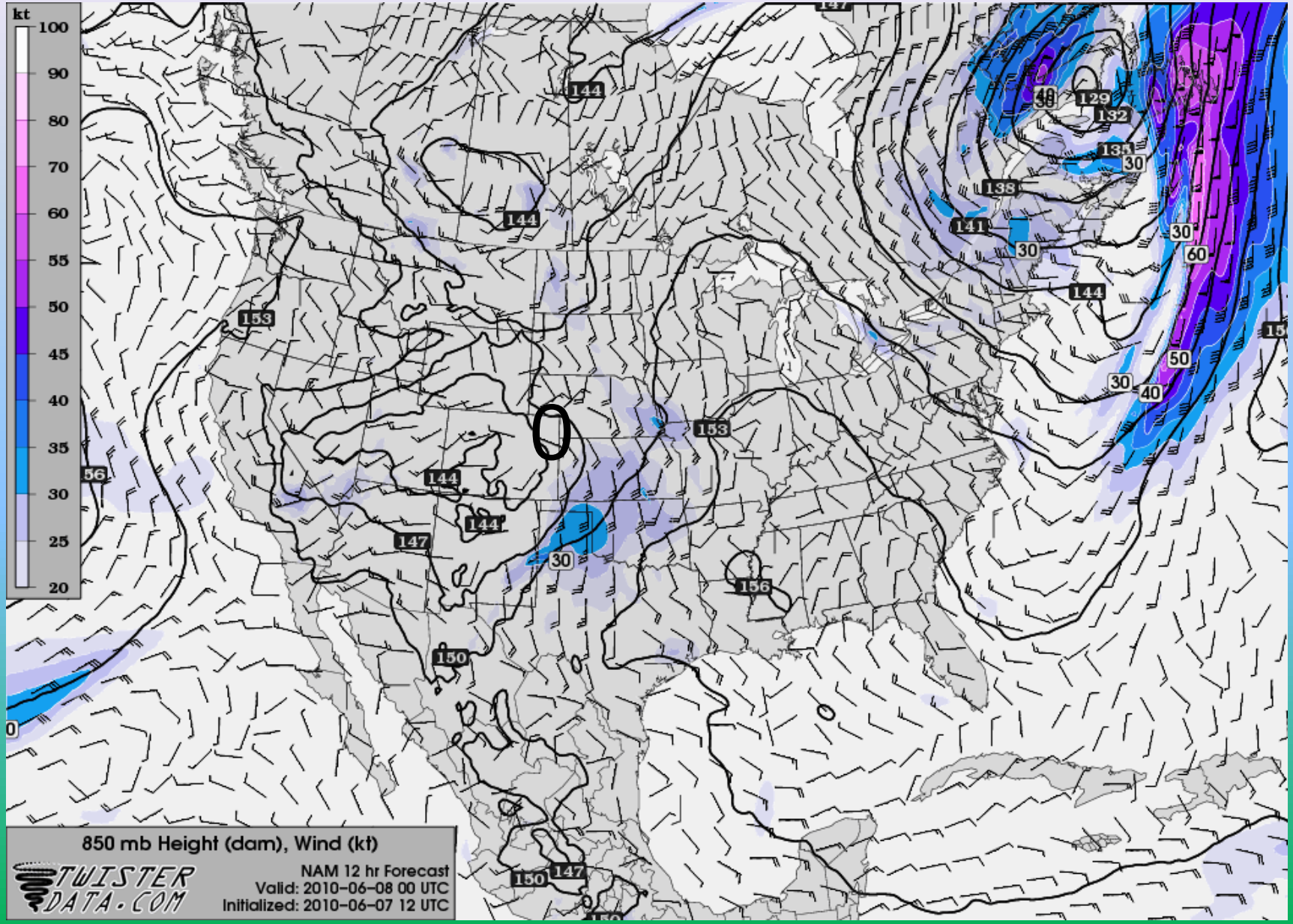
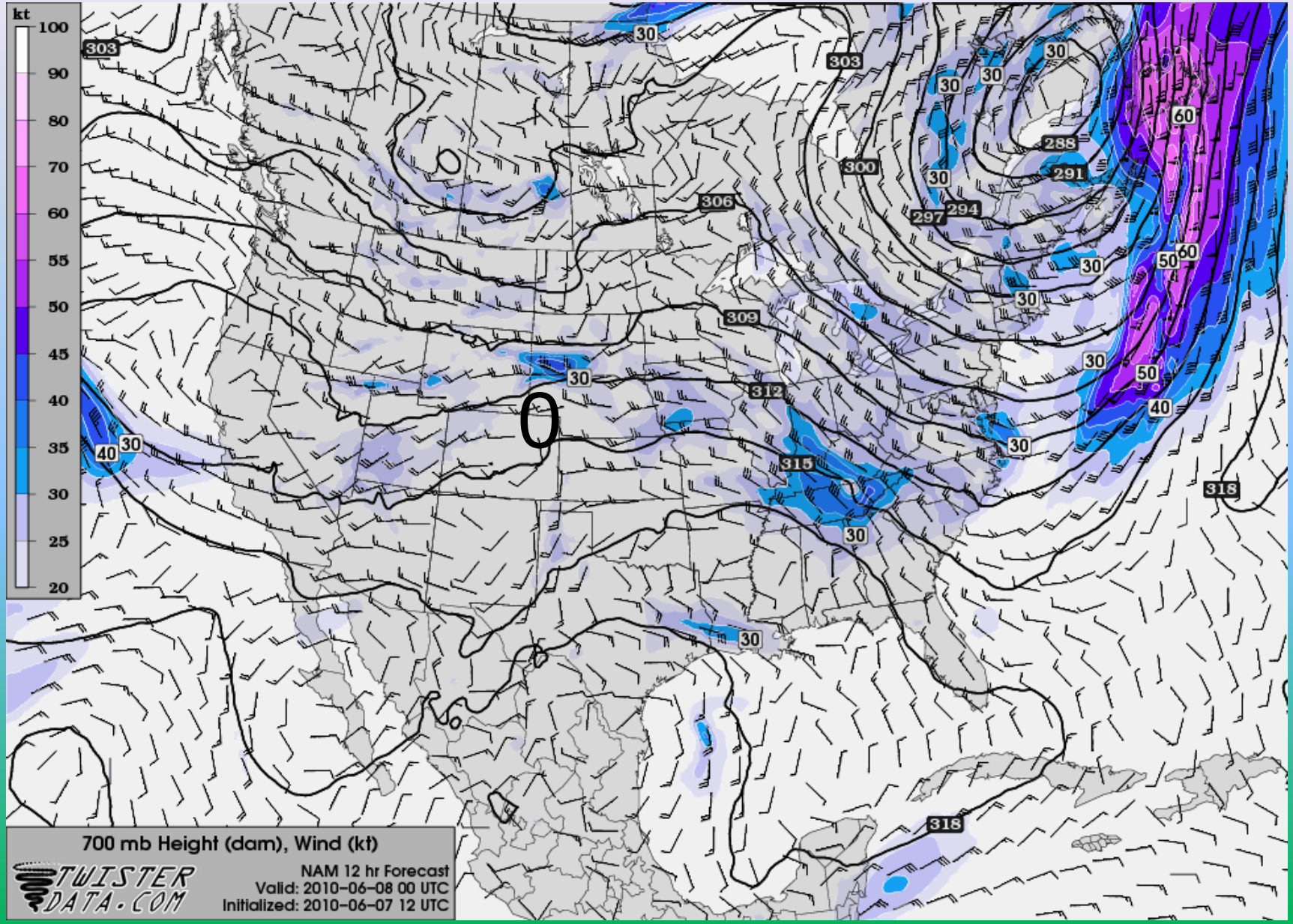


12z NAM 850mb valid 00z



12z NAM 700mb valid 00z



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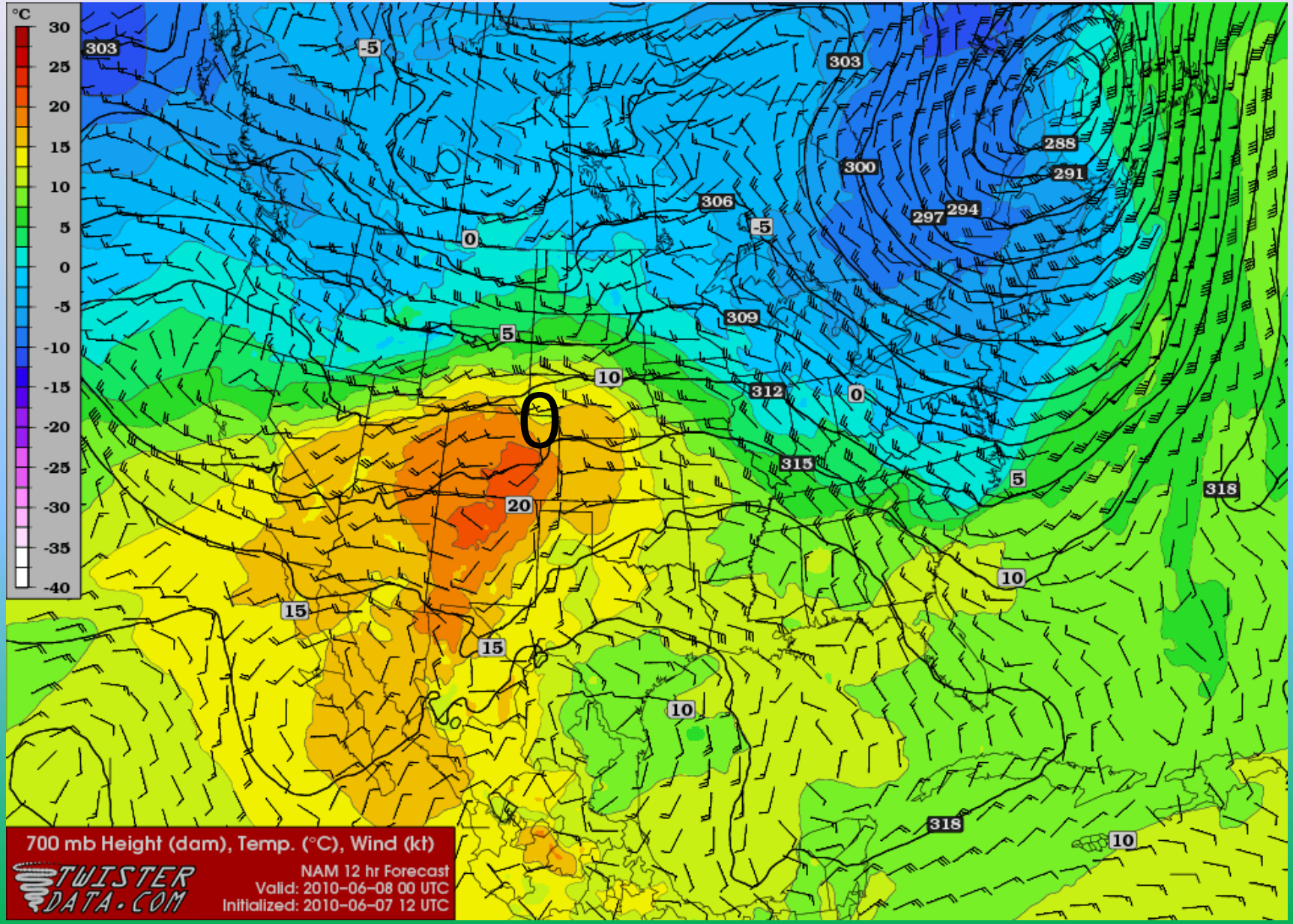
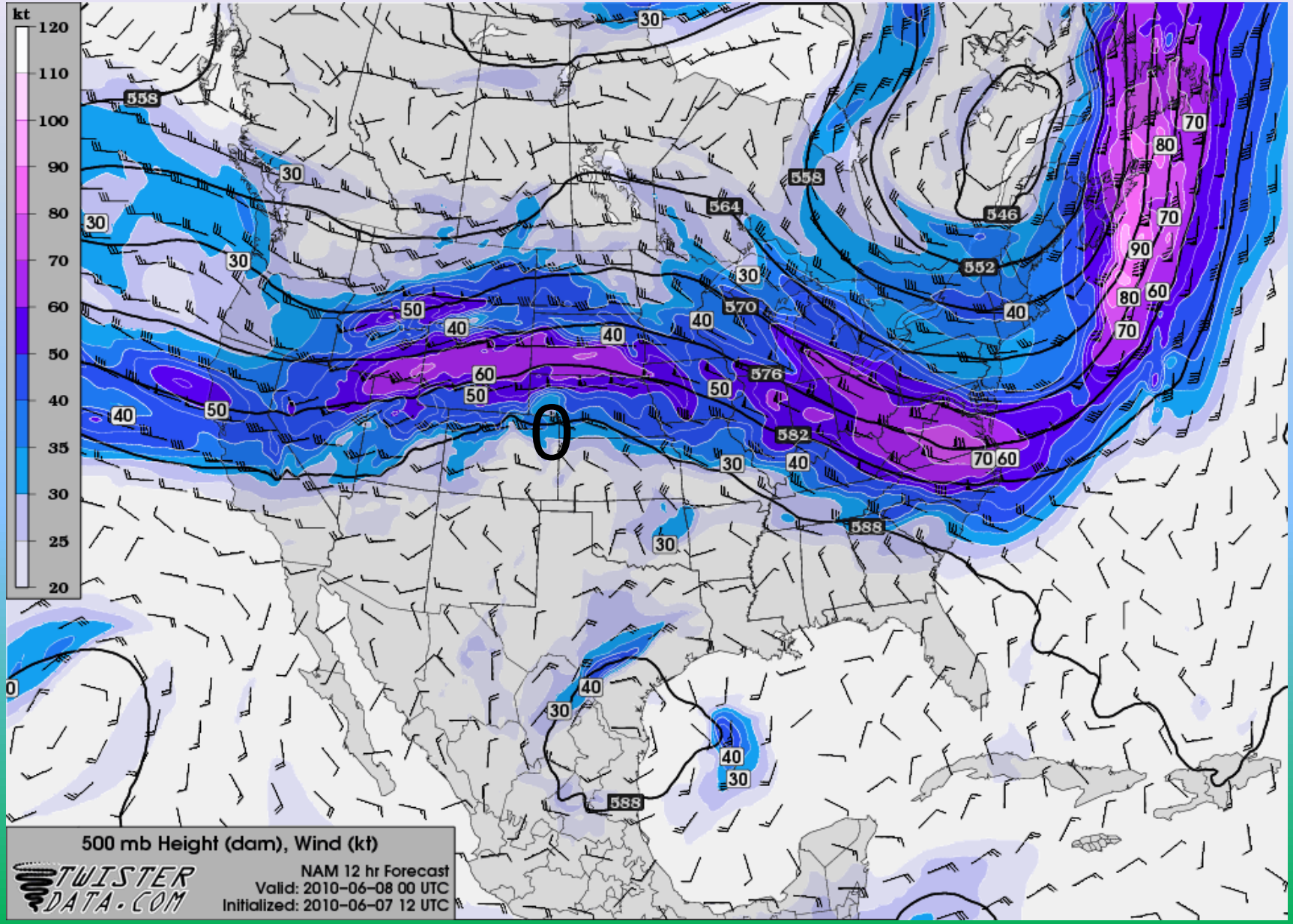
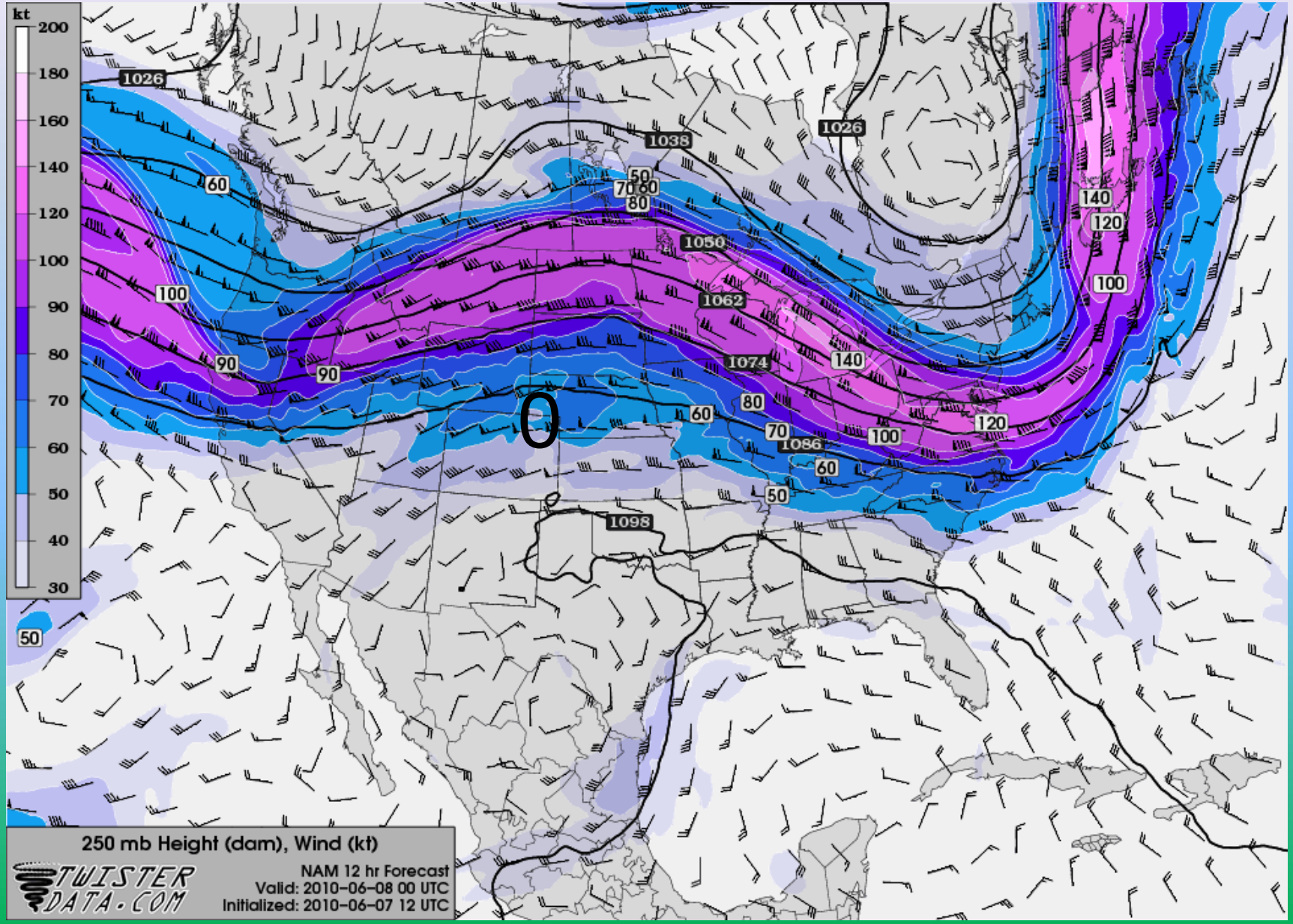


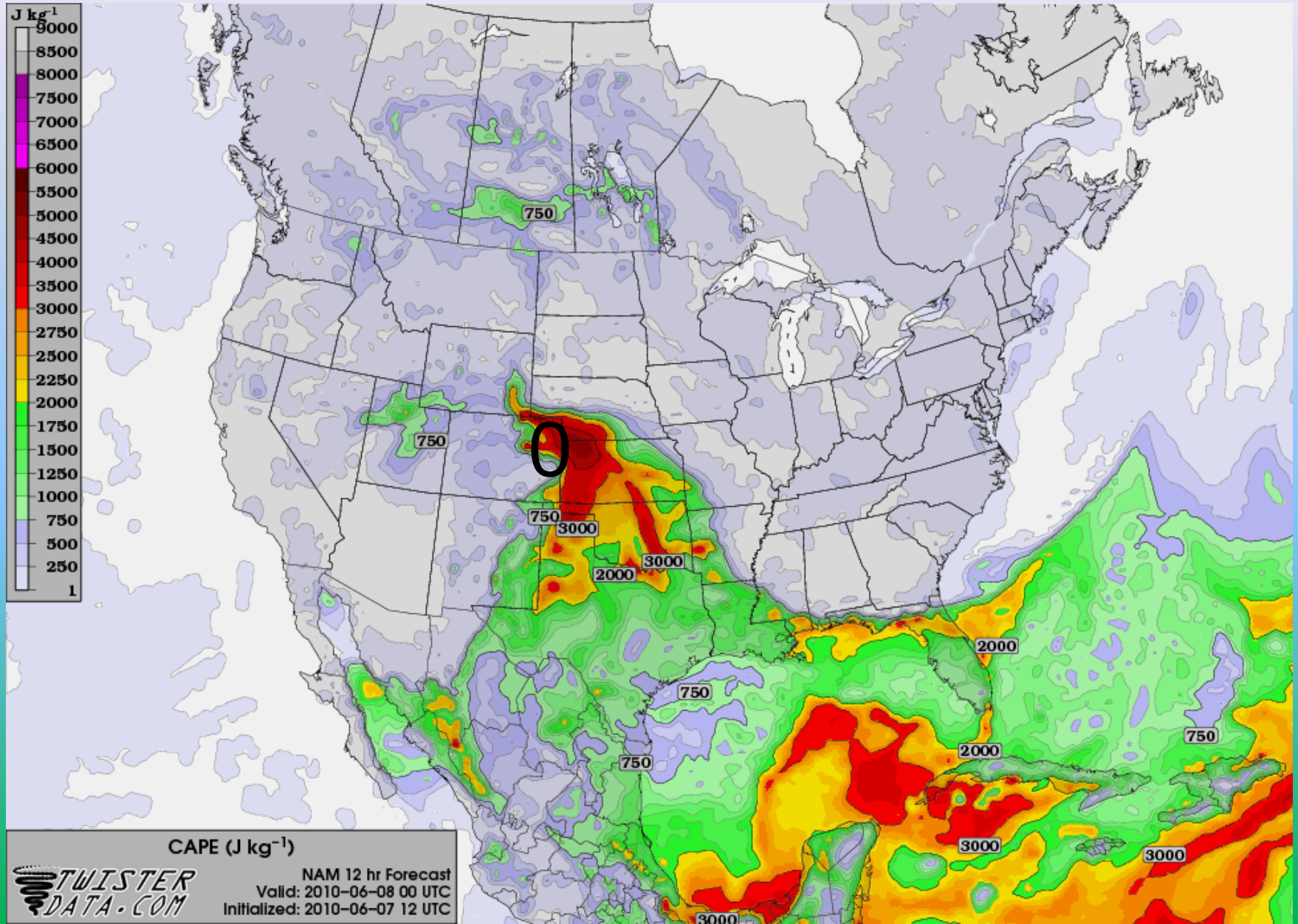
12z NAM 500mb valid 00Z



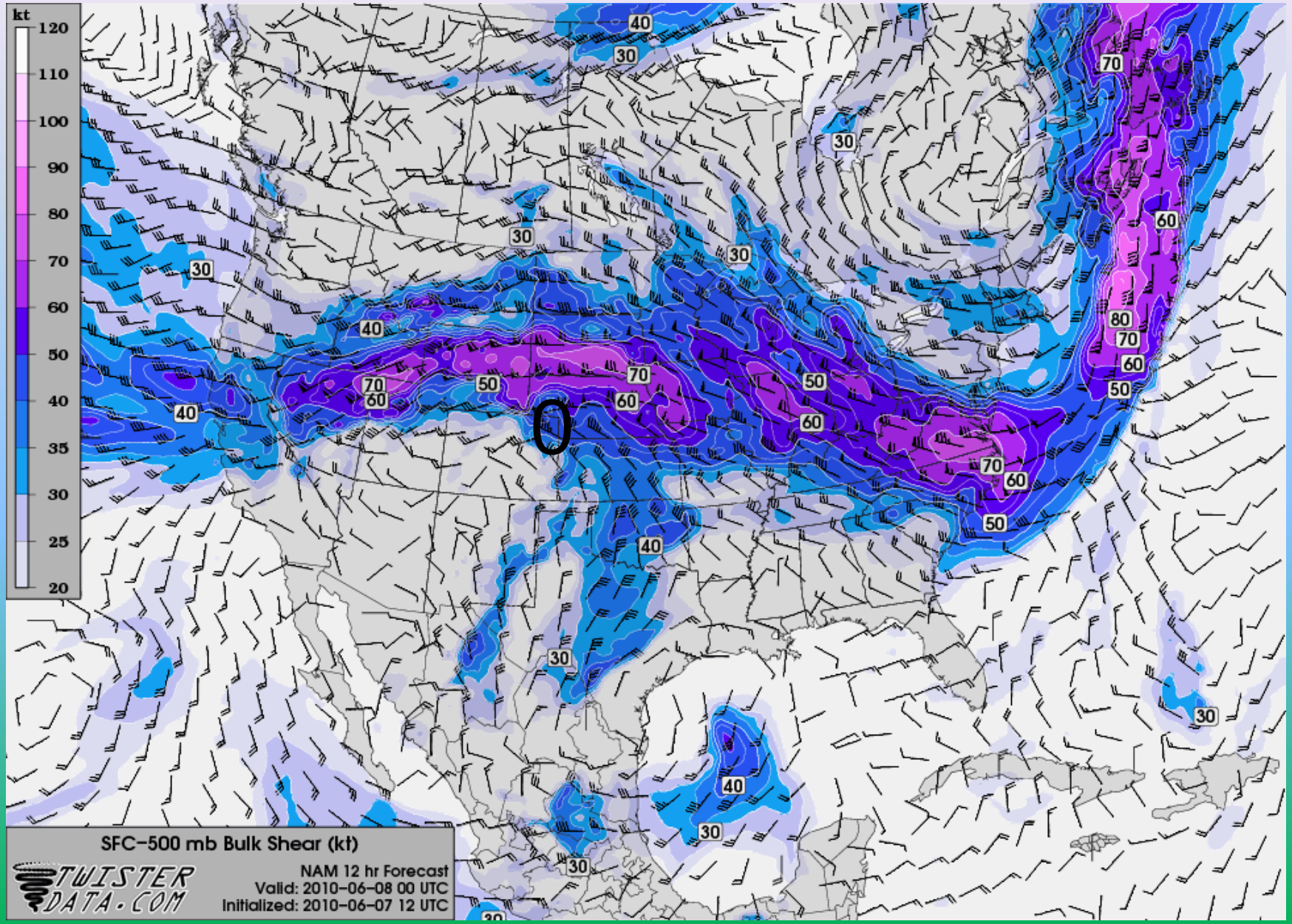
12z NAM 250mb valid 00Z



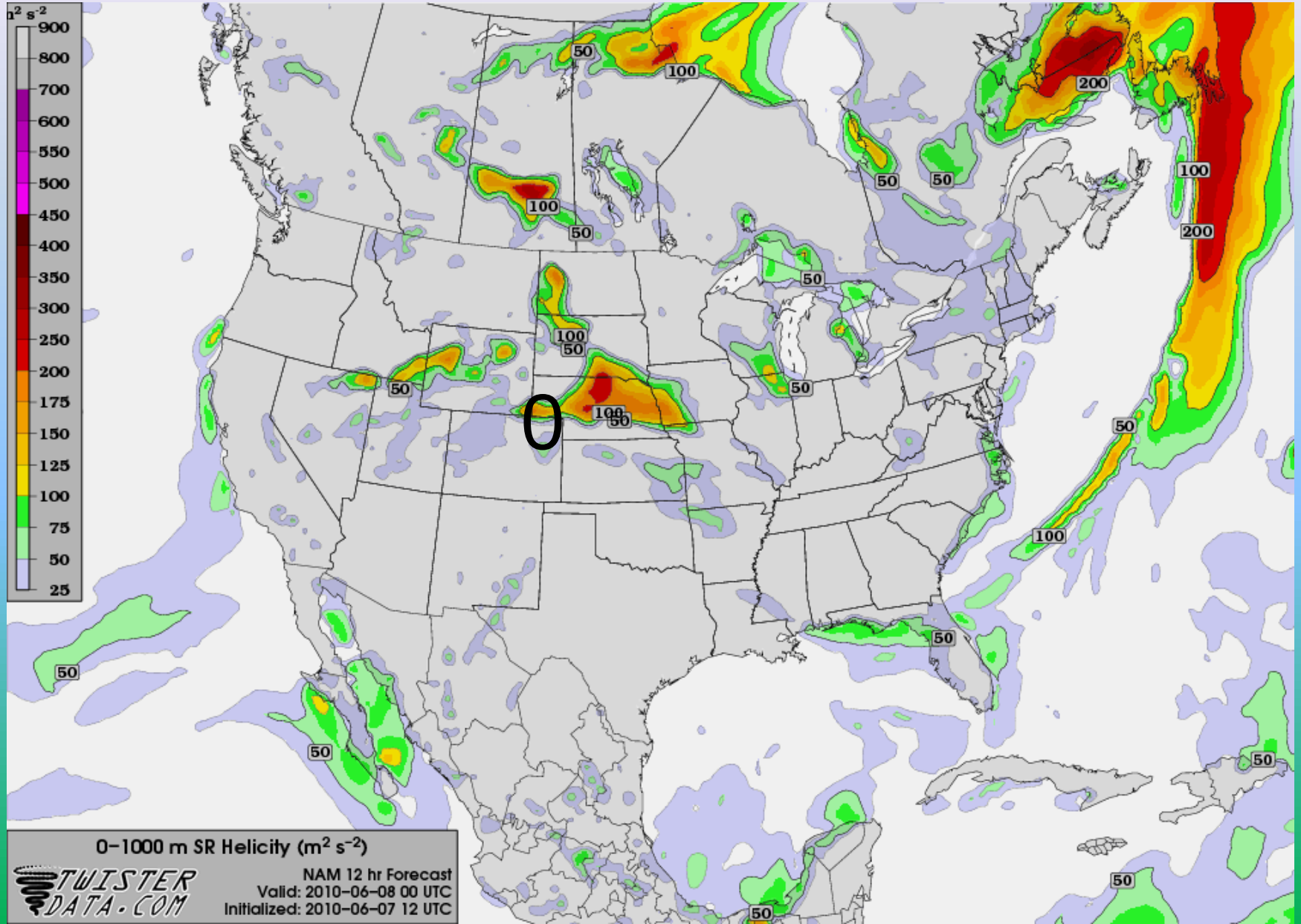
12z NAM- CAPE – valid 0z



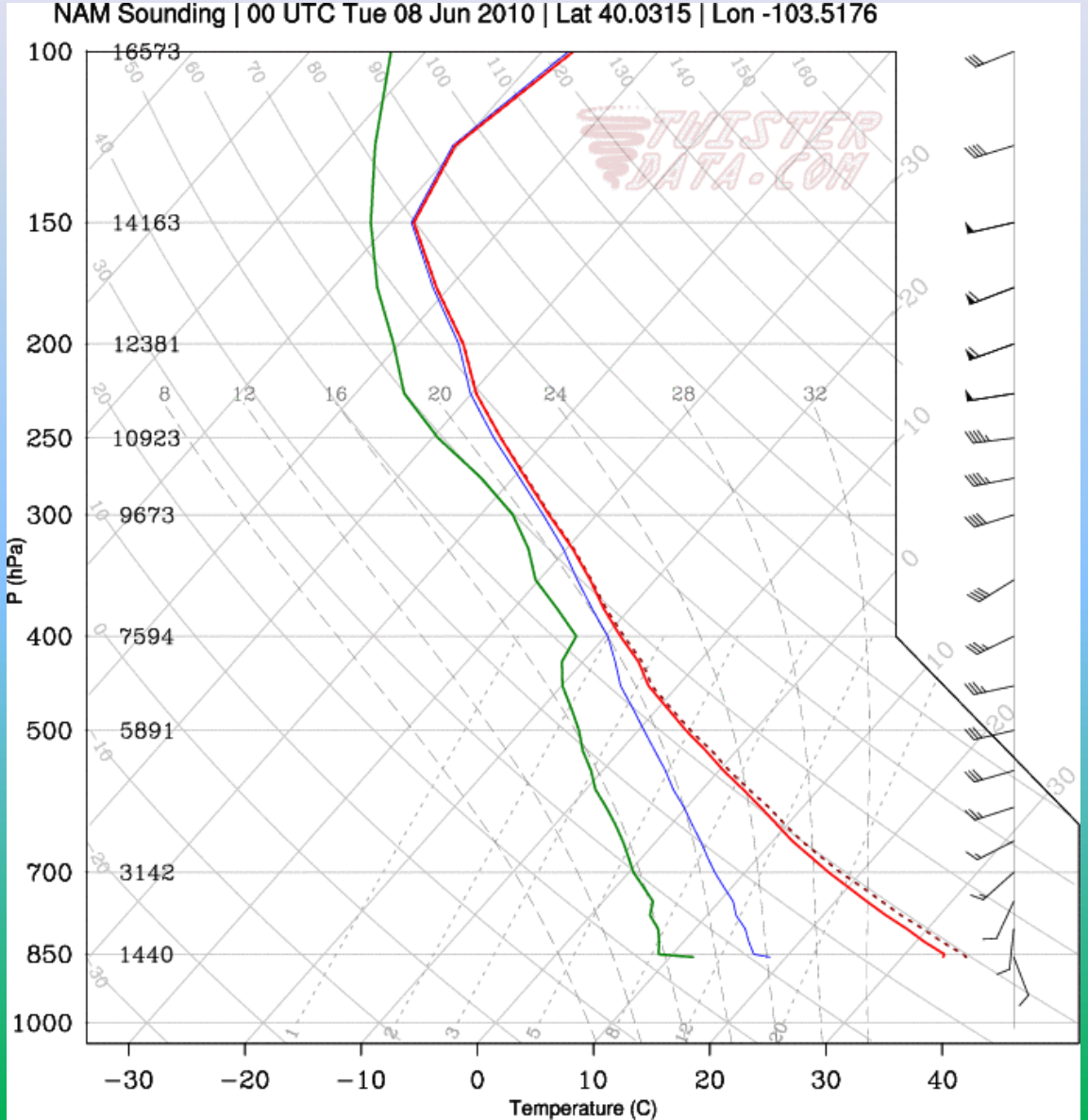
12z NAM sfc-500mb shear valid 00Z

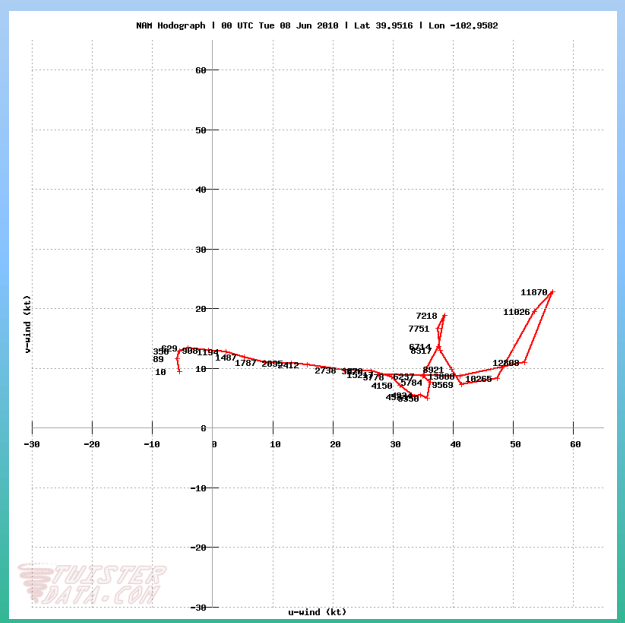


12z NAM 0-1 SRH valid 00Z

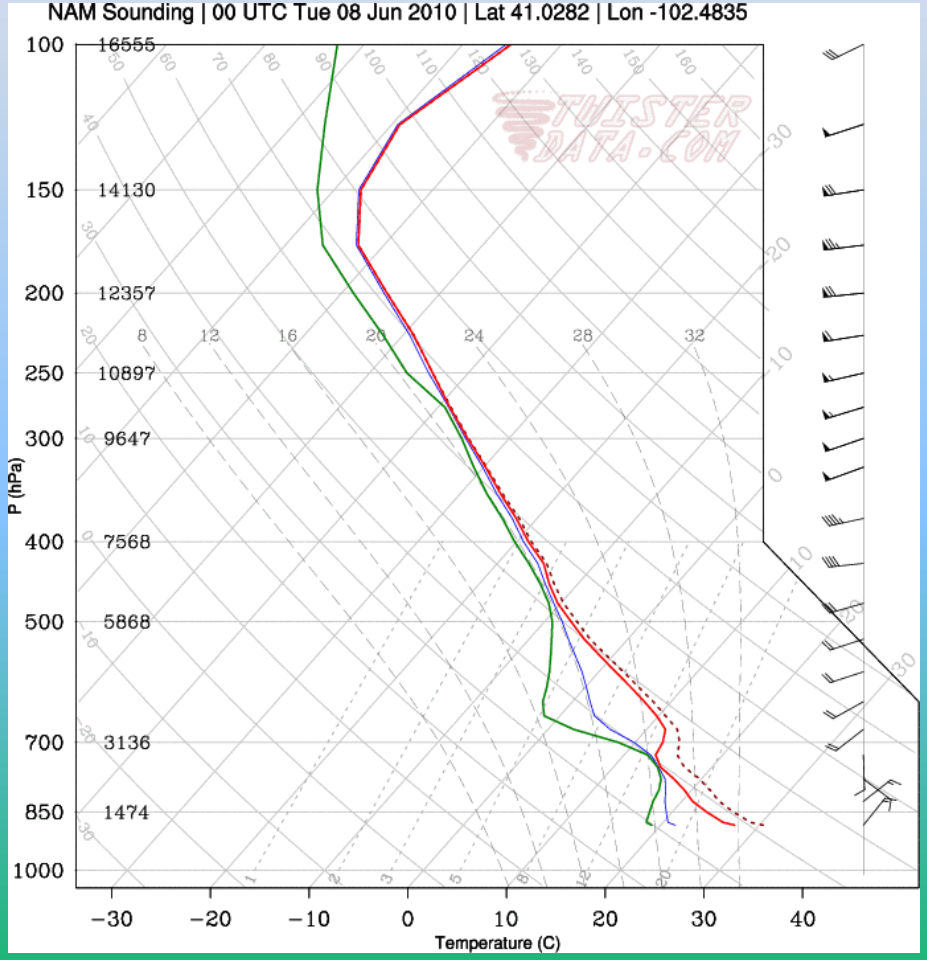


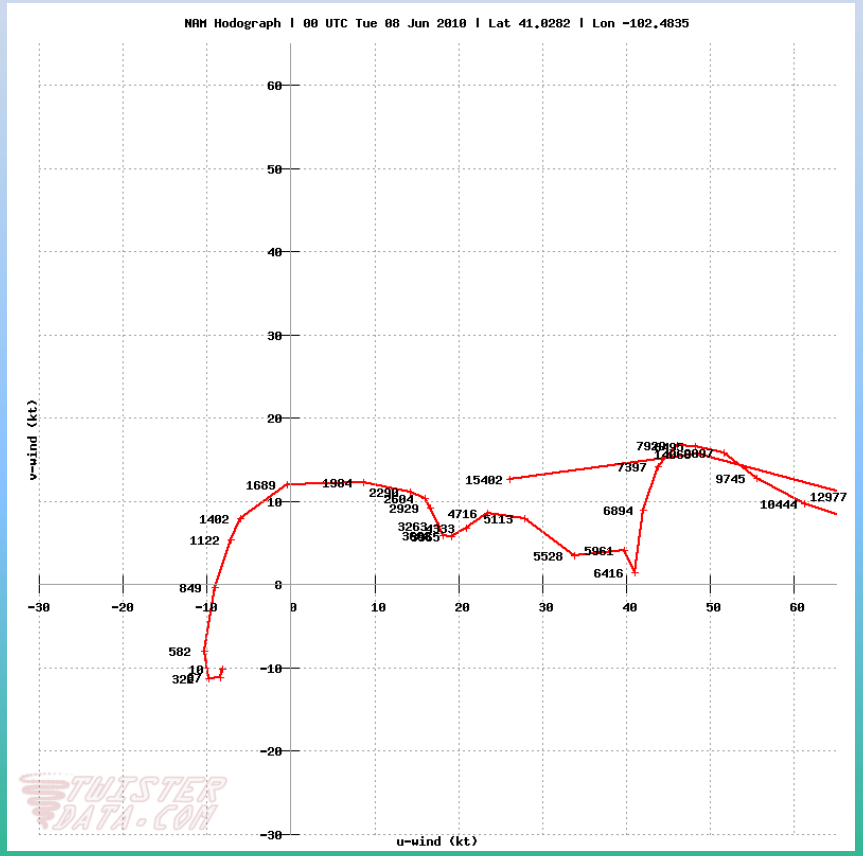
Akron, CO NAM fcst 0z



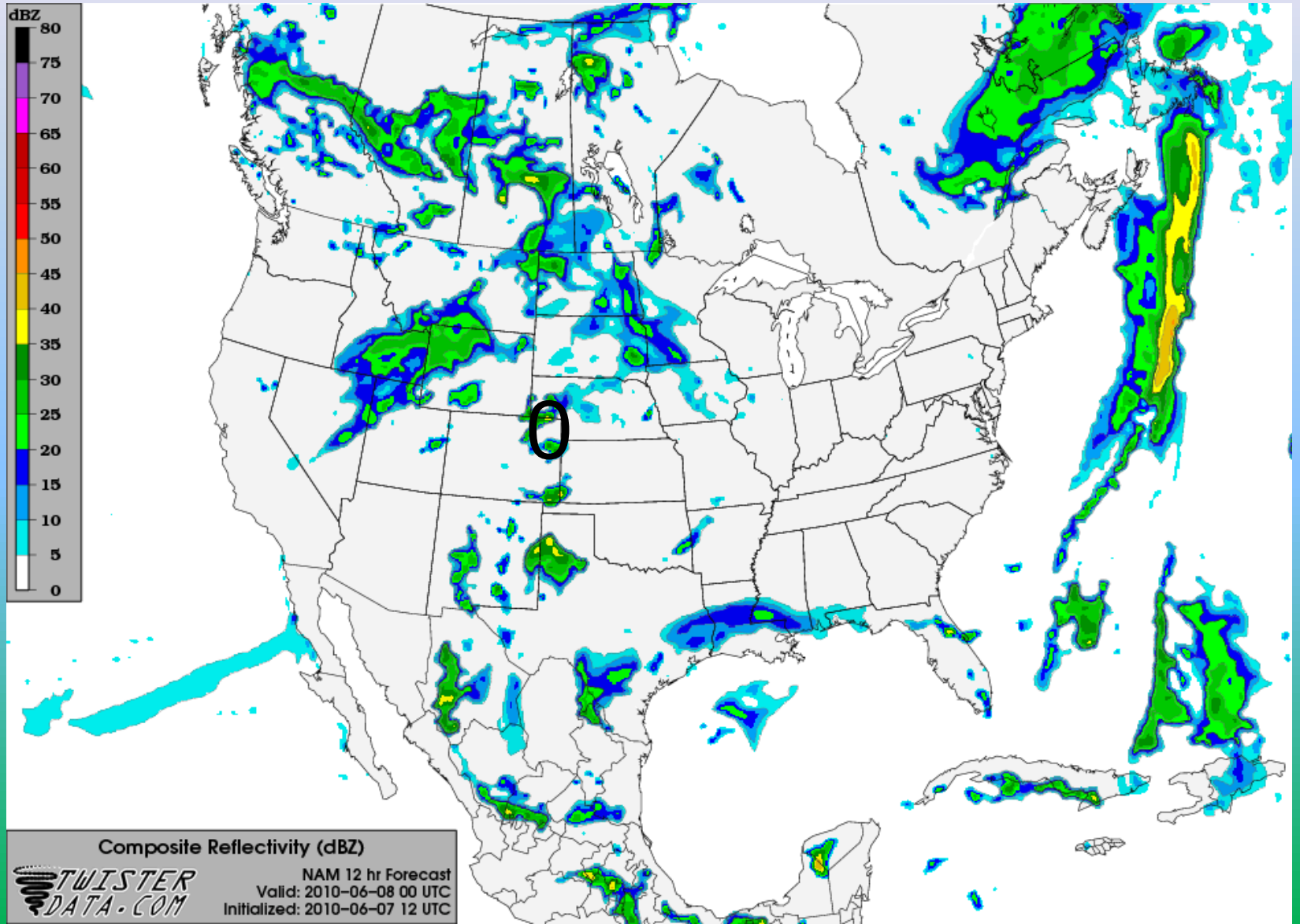


Julesburg, CO NAM fcst 0z

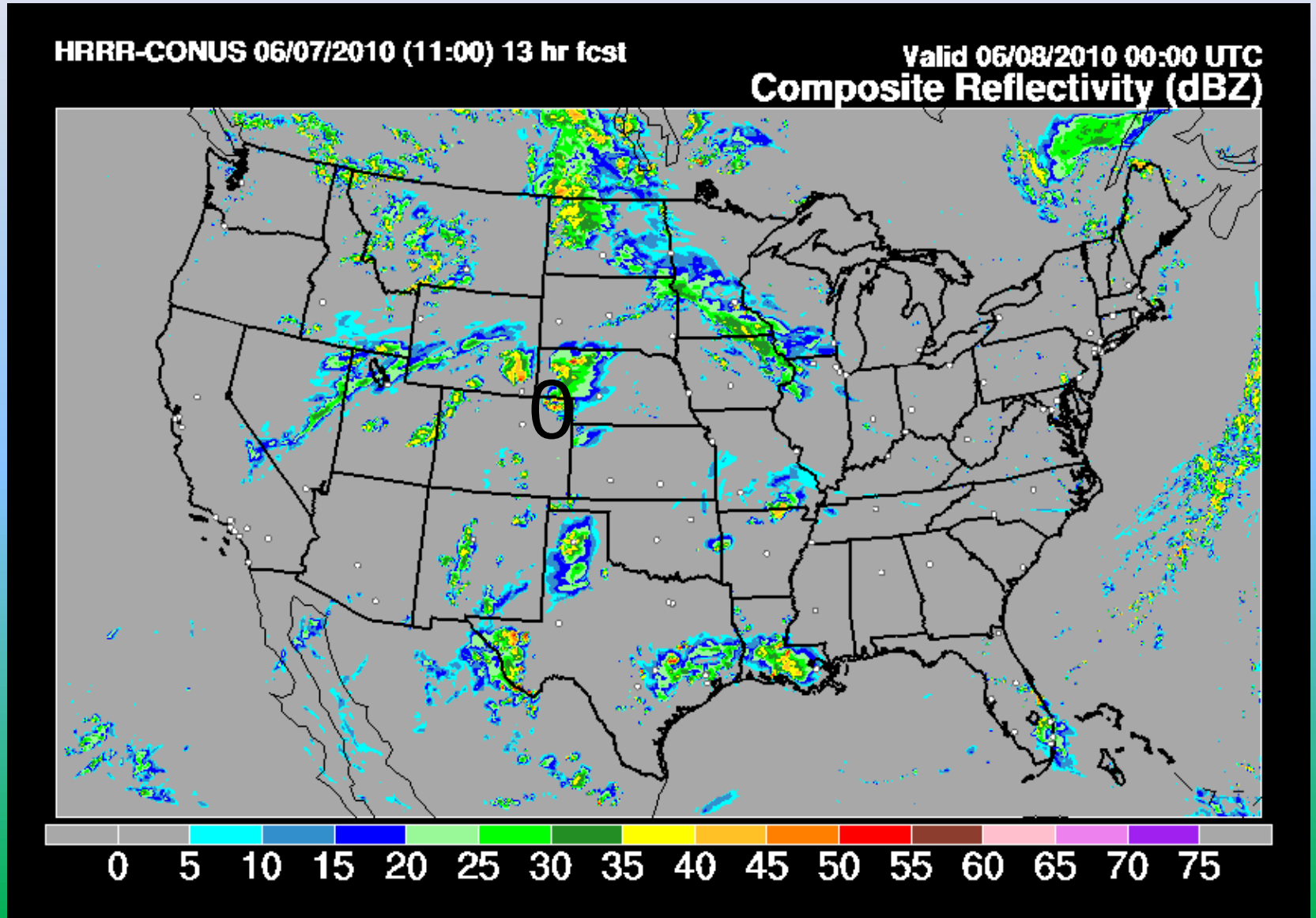




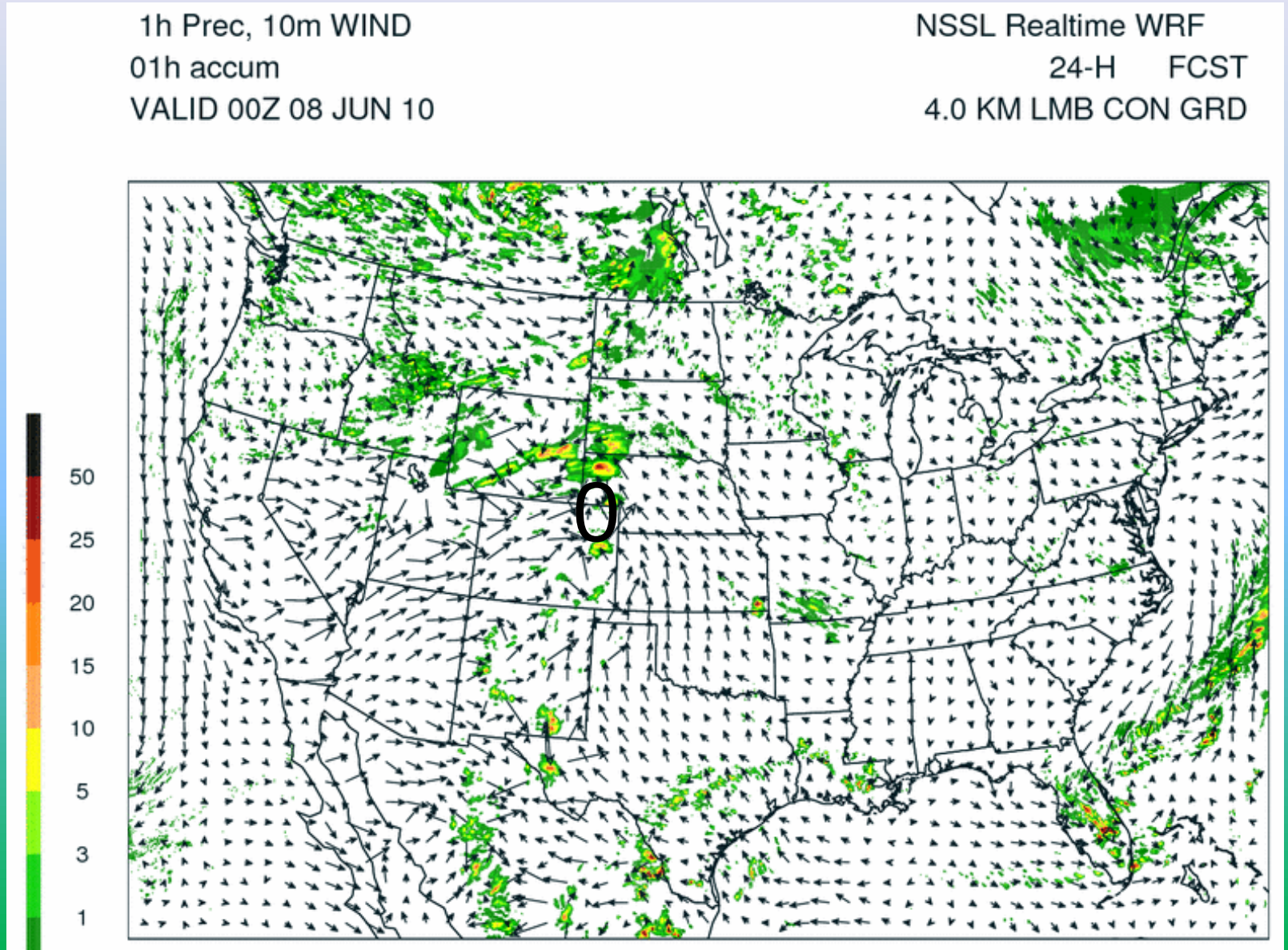
12z NAM comp refl valid 00z



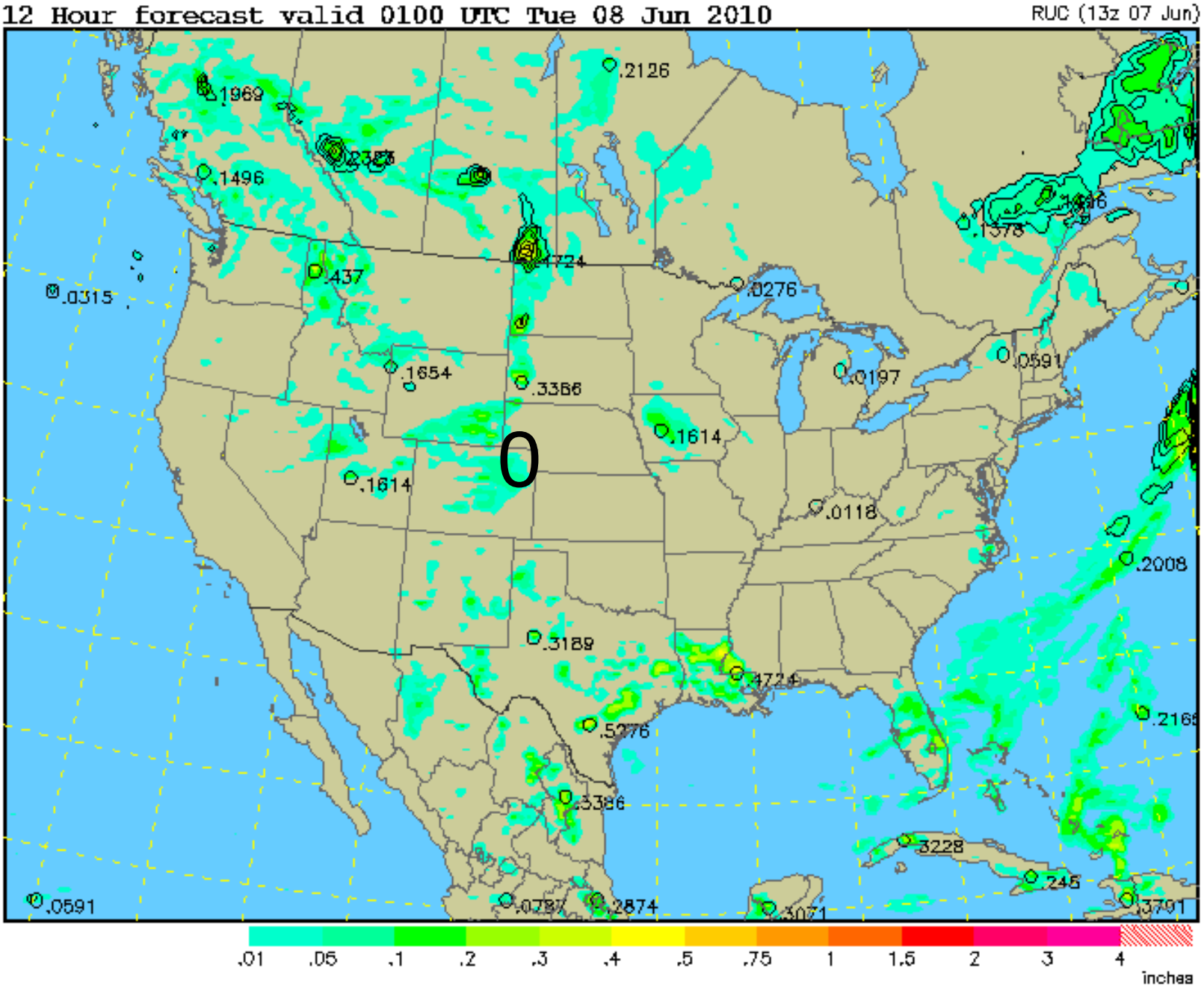
11z HRRR Comp. Ref valid 00z

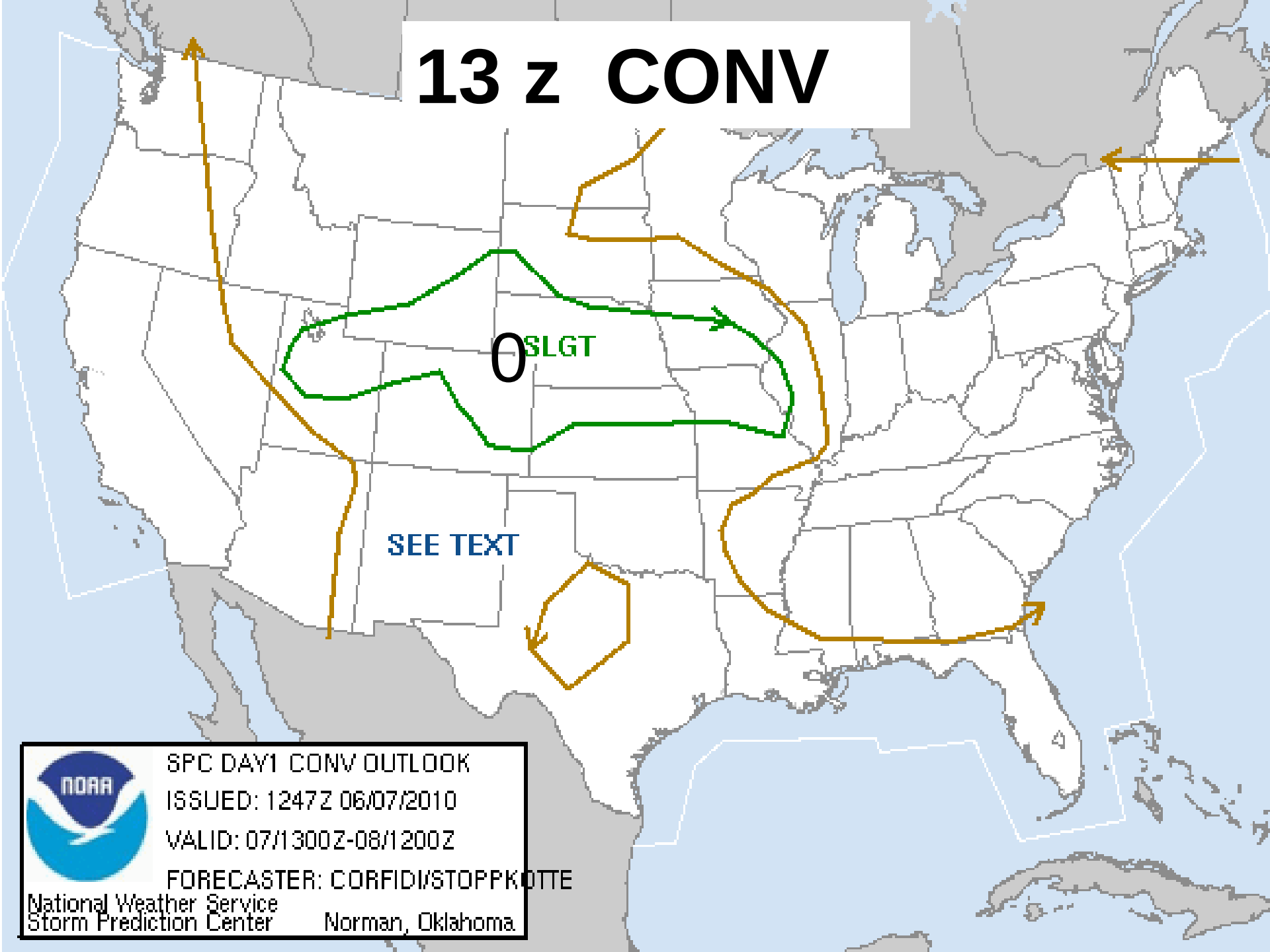


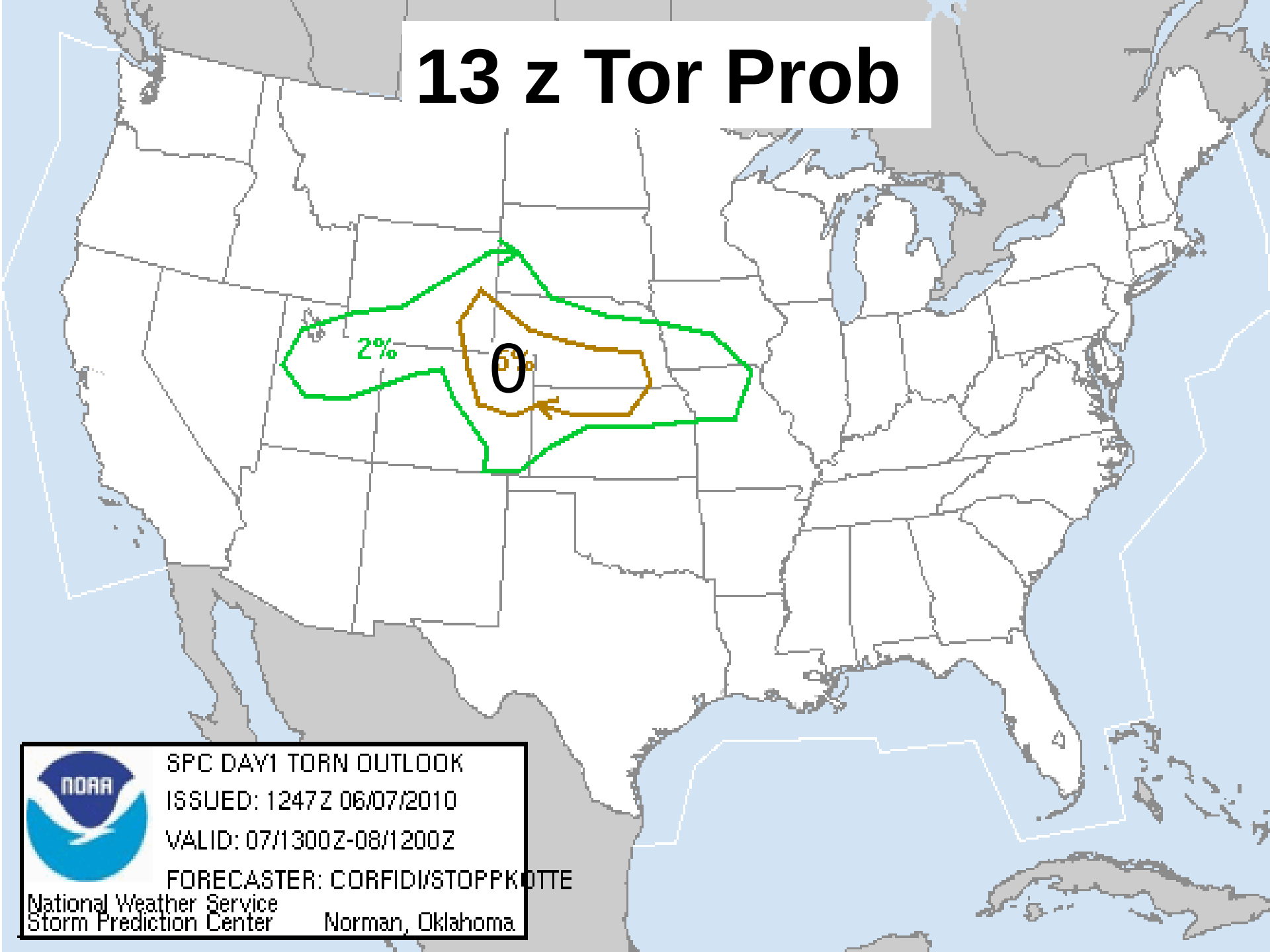
24 hr NSSL WRF precip valid 0z



3-hr accum precip (total-shaded; nonconvect-solid)




13 z CONV
0
SLGT
SEE TEXT
SPC DAY1 CONV OUTLOOK
ISSUED: 1247Z 06/07/2010
VALID: 07/1300Z-08/1200Z
FORECASTER: CORFIDI/STOPPKOTTE
National Weather Service
Storm Prediction Center
Norman, Oklahoma

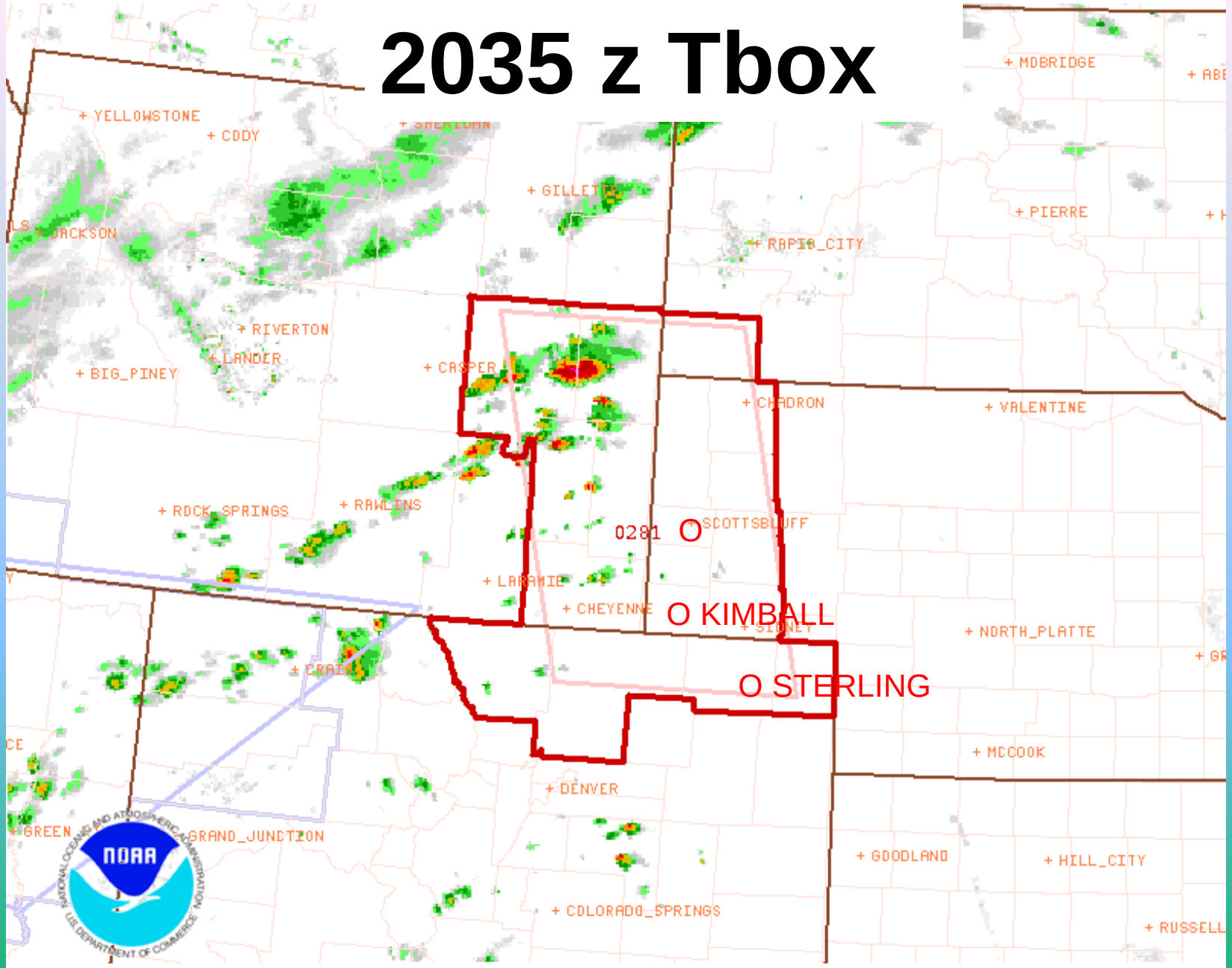

13 z Tor Prob
2%
0
SPC DAY1 TORN OUTLOOK
ISSUED: 1247Z 06/07/2010
VALID: 07/1300Z-08/1200Z
FORECASTER: CORFIDI/STOPPKOTTE
National Weather Service
Storm Prediction Center
Norman, Oklahoma

6/7/10 – My 8am Forecast

- UPSLOPE supercells are likely initiating in the higher terrain of SE WY and CO.
- Recommended target town: Sterling, CO
- Storms will be rotating but have a tough time with cold air outflow –like yesterday.
- A few storms could produce tornadoes.

PI target at 9:30 AM – Kimball, NE by 3 pm.
Later updated to Scottsbluff, NE

2035 z Tbox



Tornado Watch # 281 - Valid from 335 PM until 1100 PM MDT

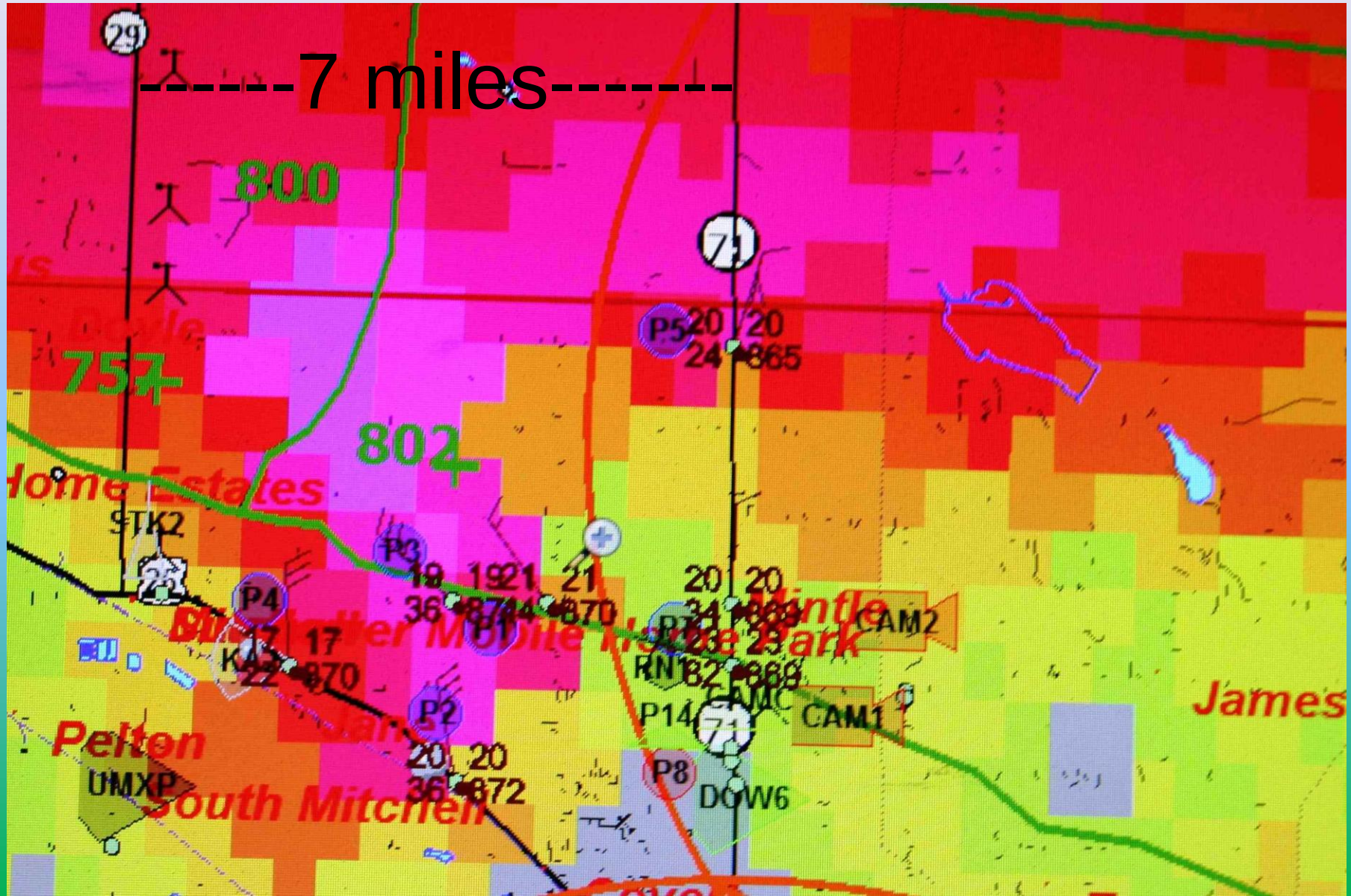
NOAA/NWS/Storm Prediction Center

Updated: 20100607/2148 UTC

Supercell near Scottsbluff, NE

Wall cloud west

P14 location at tip of hook echo

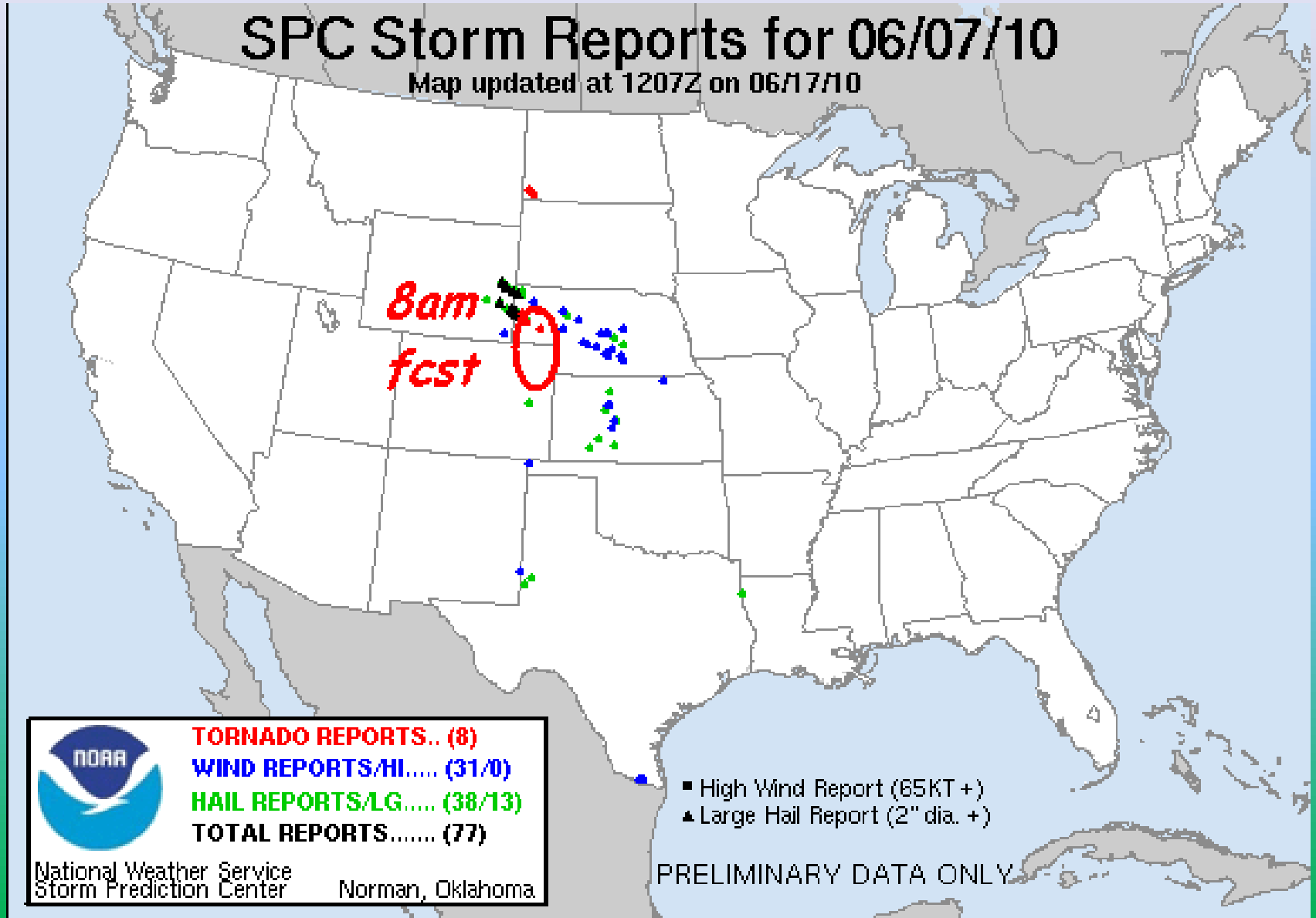


Scottsbluff, NE Tornado

Photograph by Roger Hill

Scottsbluff, NE Tornado

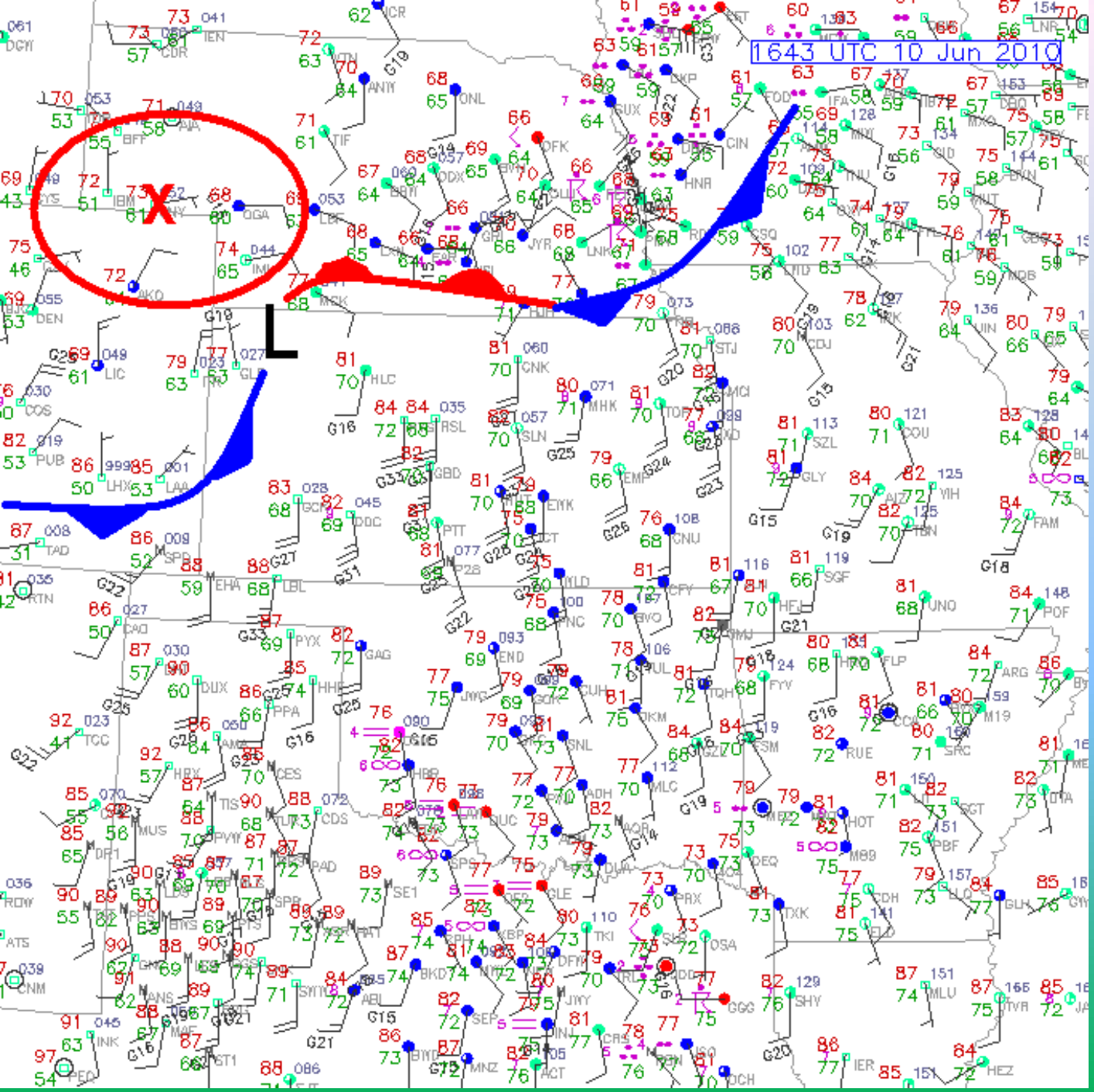
Tornadoes near Scottsbluff, NE



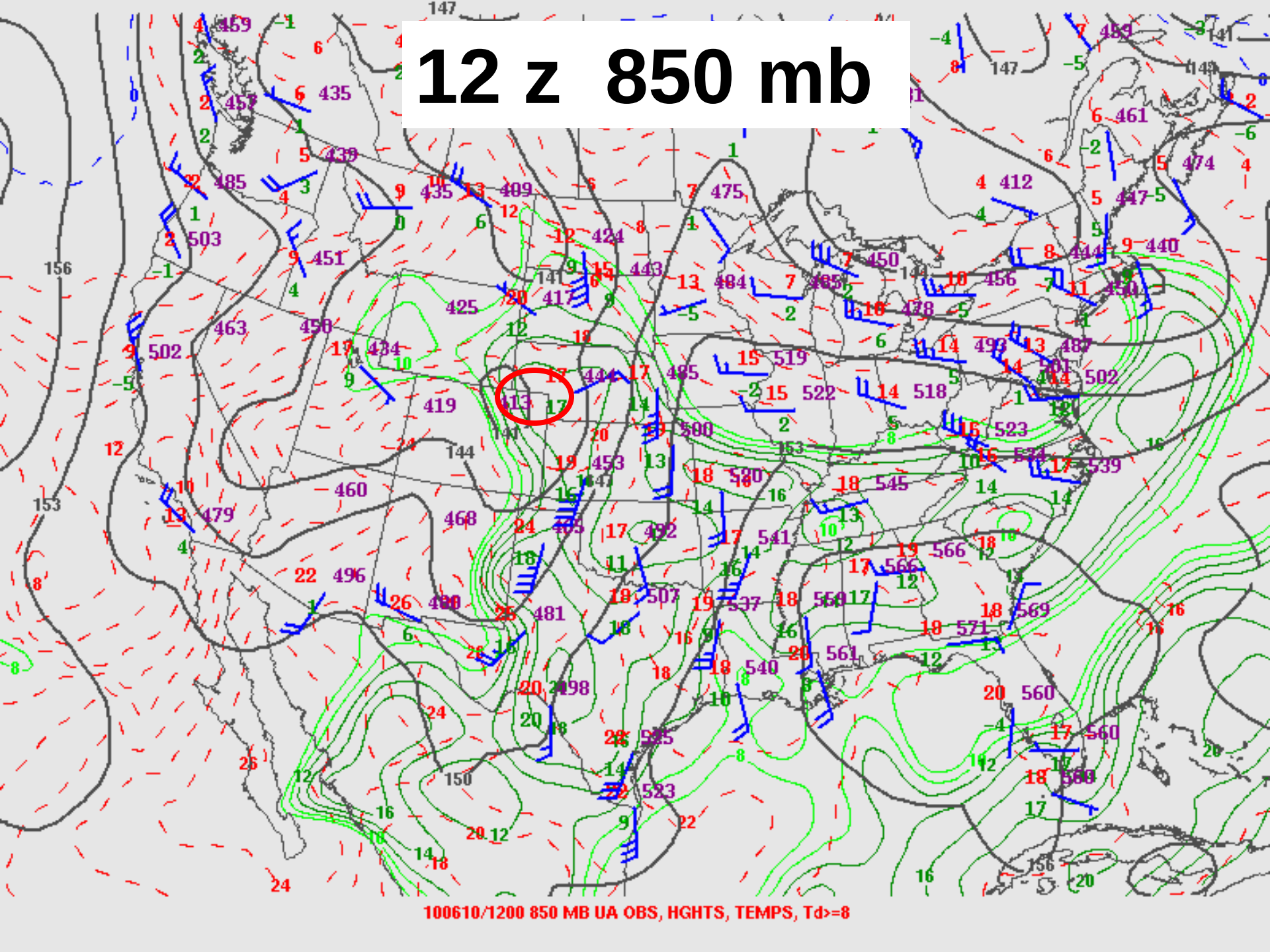
June 10, 2010 Weather

Upslope Case

14 Highs vs 4 Lows = Highs win!



6/10/10 8 am Forecast Sidney, NE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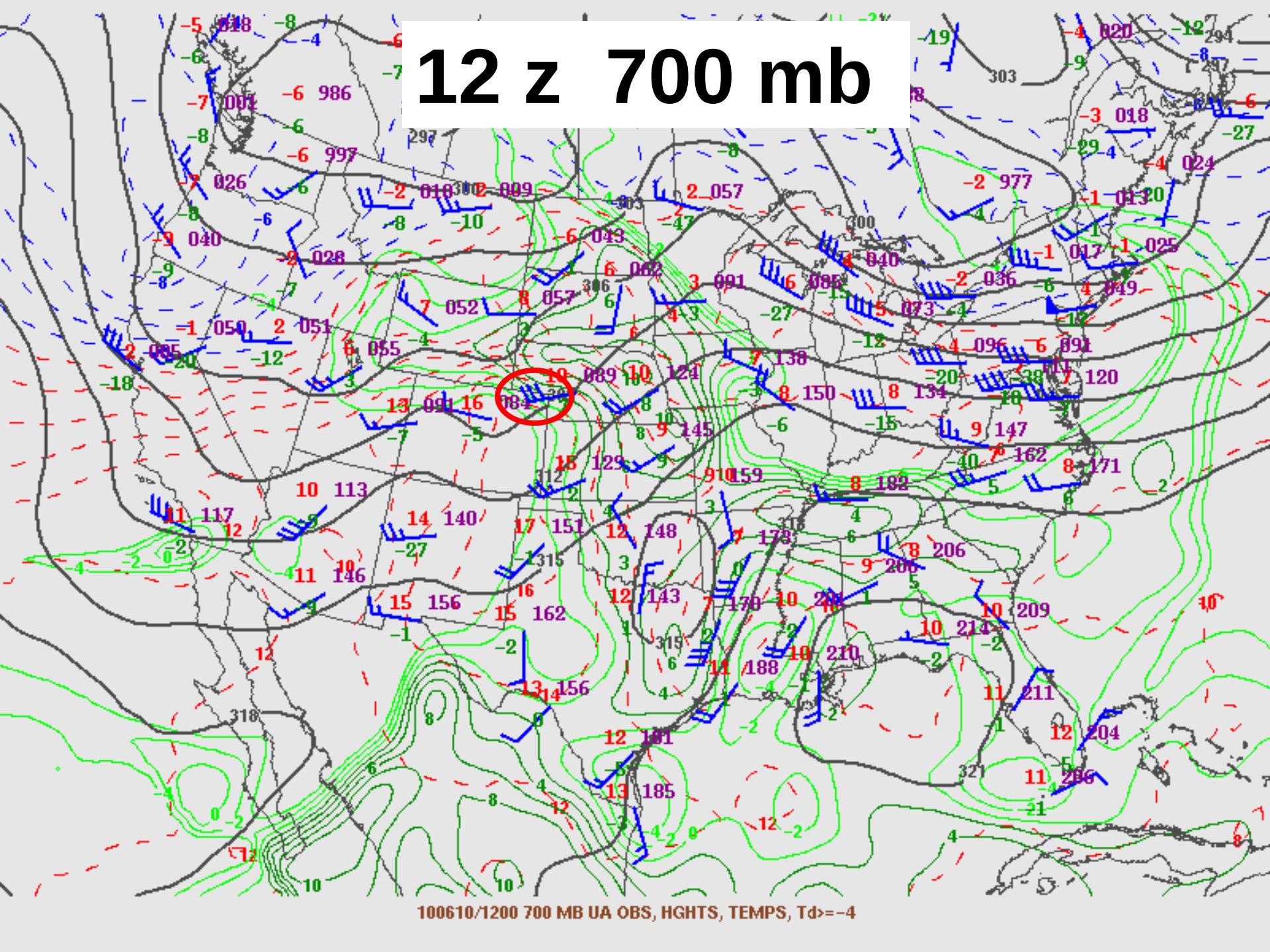
100610/1200 850 MB UA OBS, HGHTS, TEMPS, Td>=8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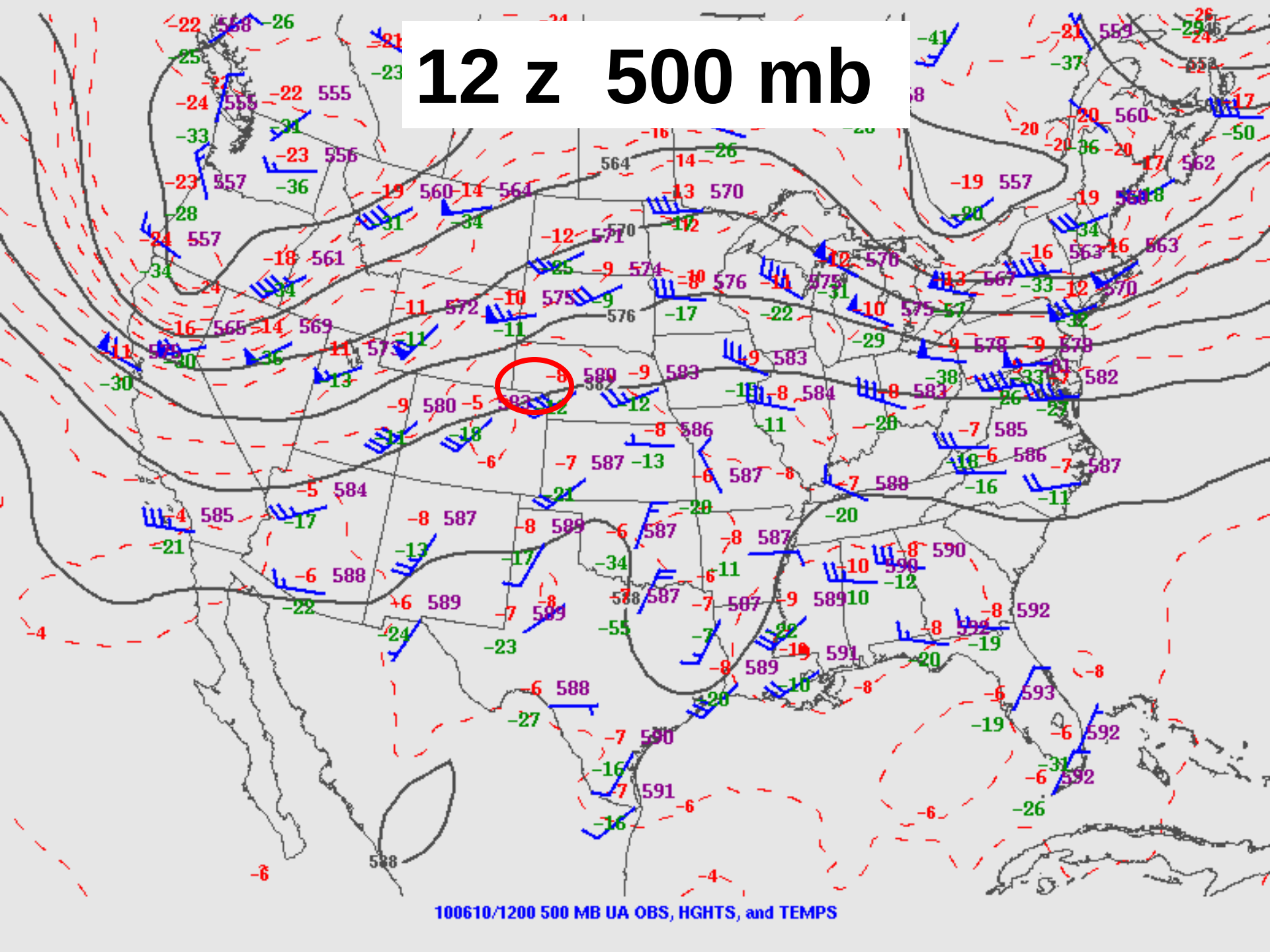
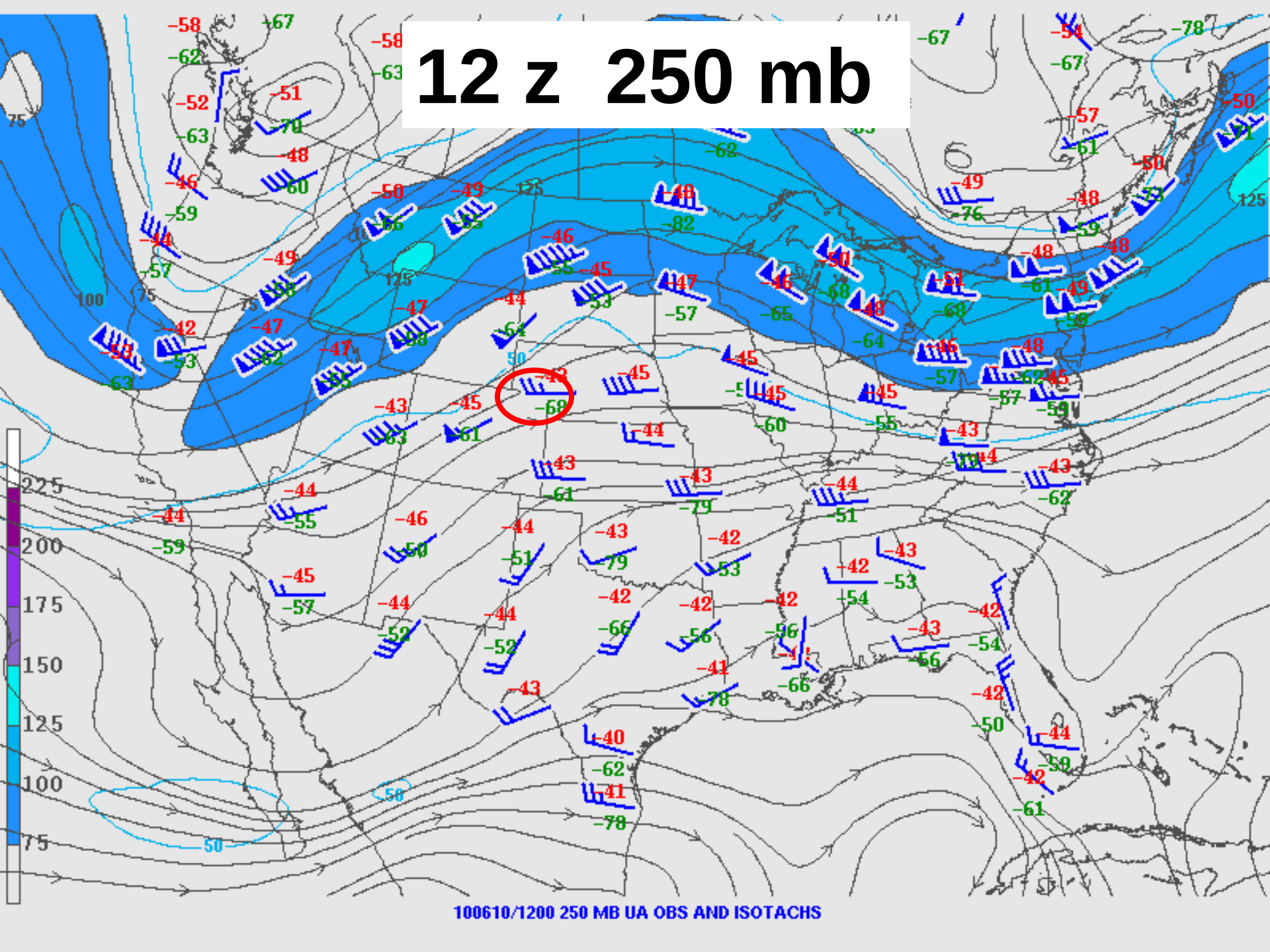

12 z 500 mb
100610/1200 500 MB UA OBS, HGHTS, and TEMPS


12 z 250 mb
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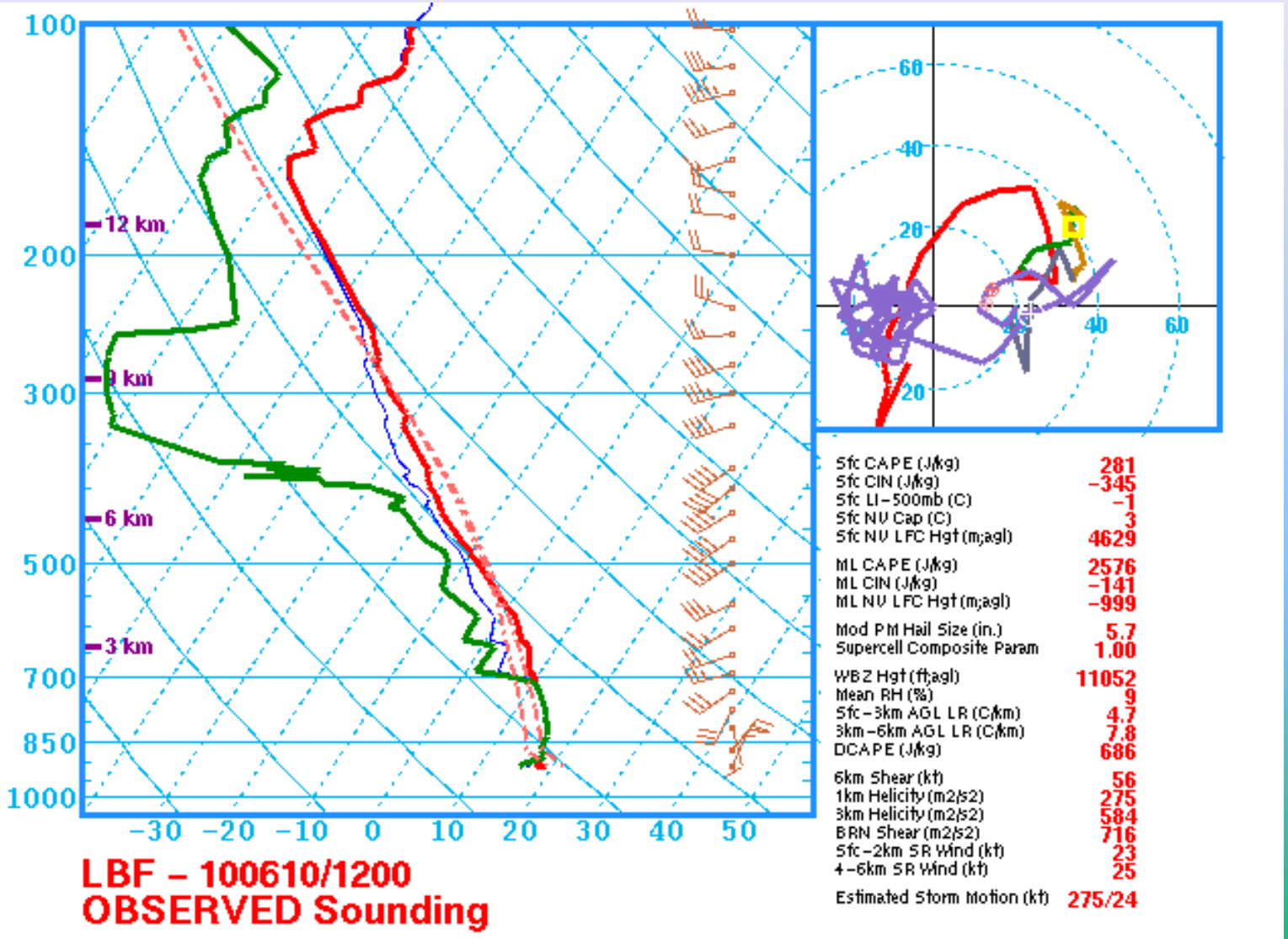
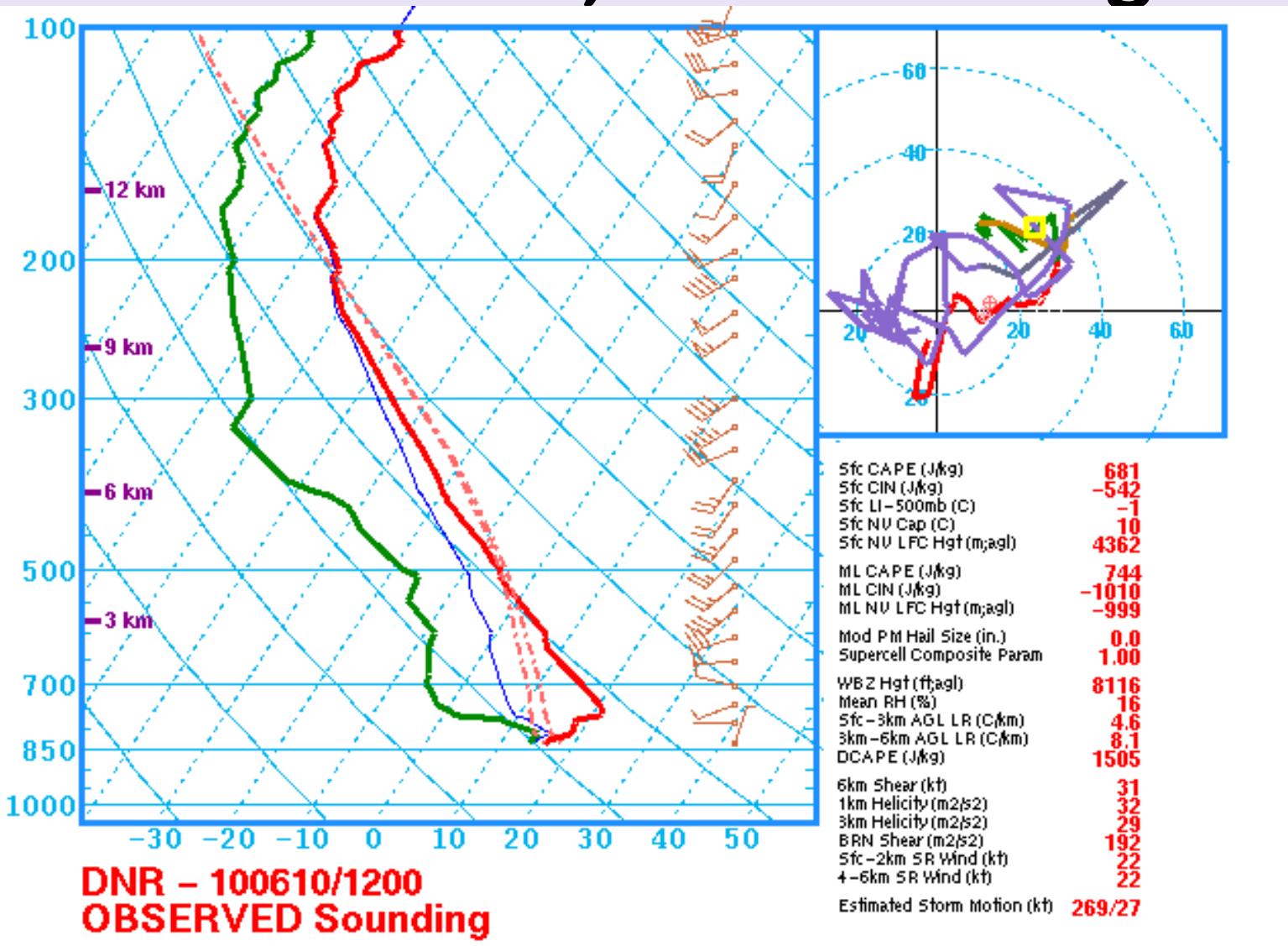
100610/1200 250 MB UA OBS AND ISOTACHS

12z North Platte, NE Sounding

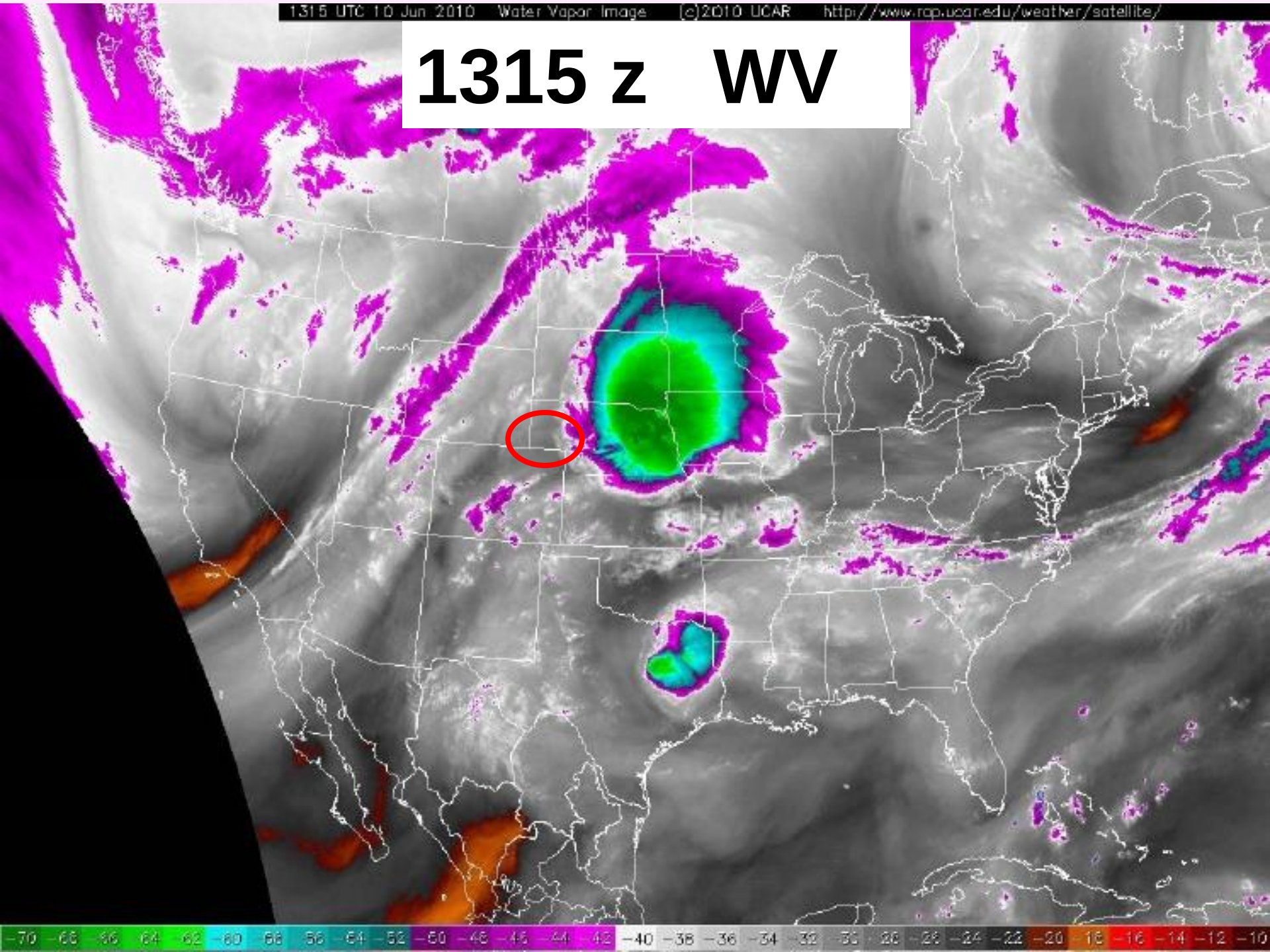


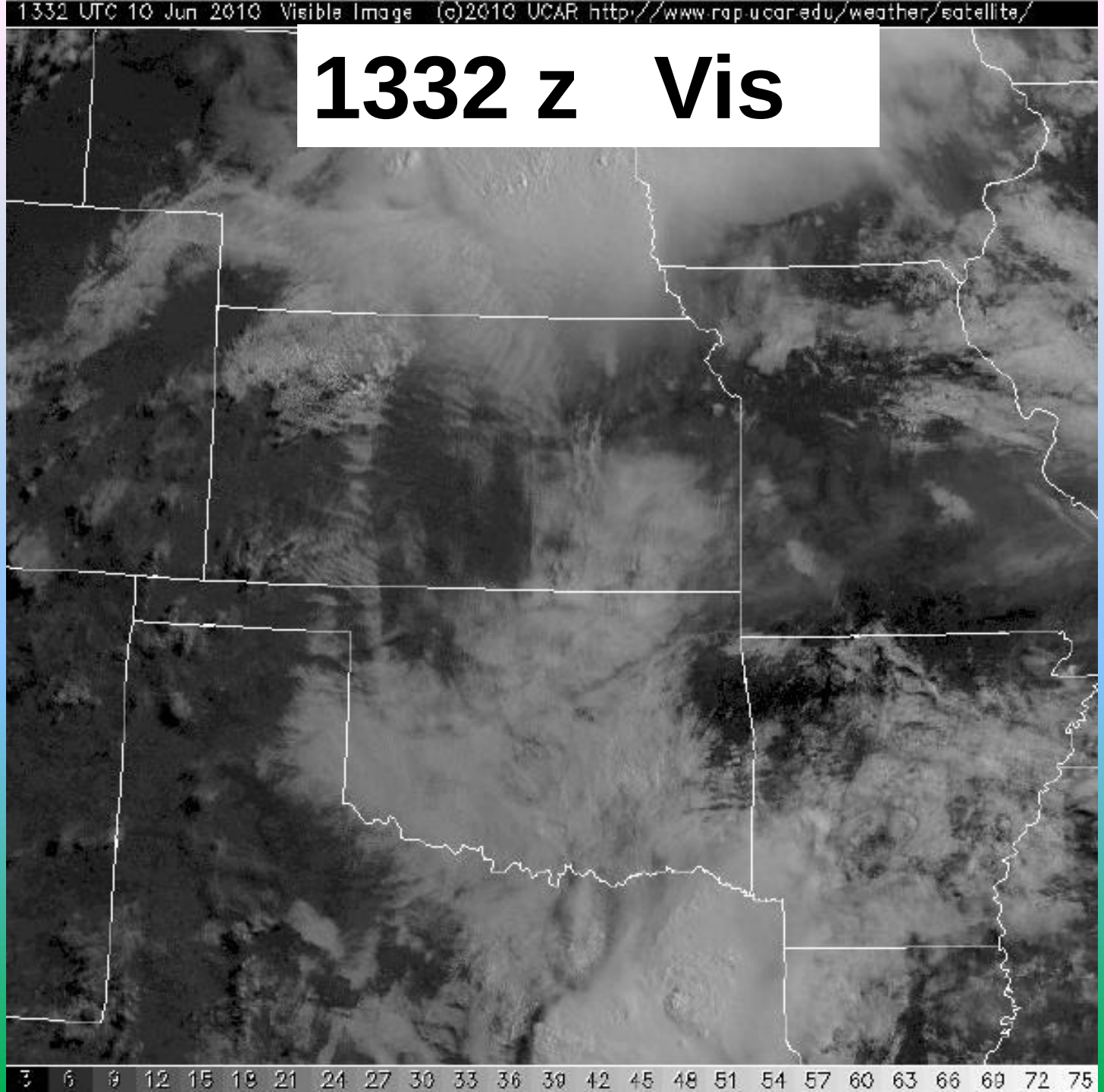
NWS/NCEP/SPC

12z Denver, CO Sounding

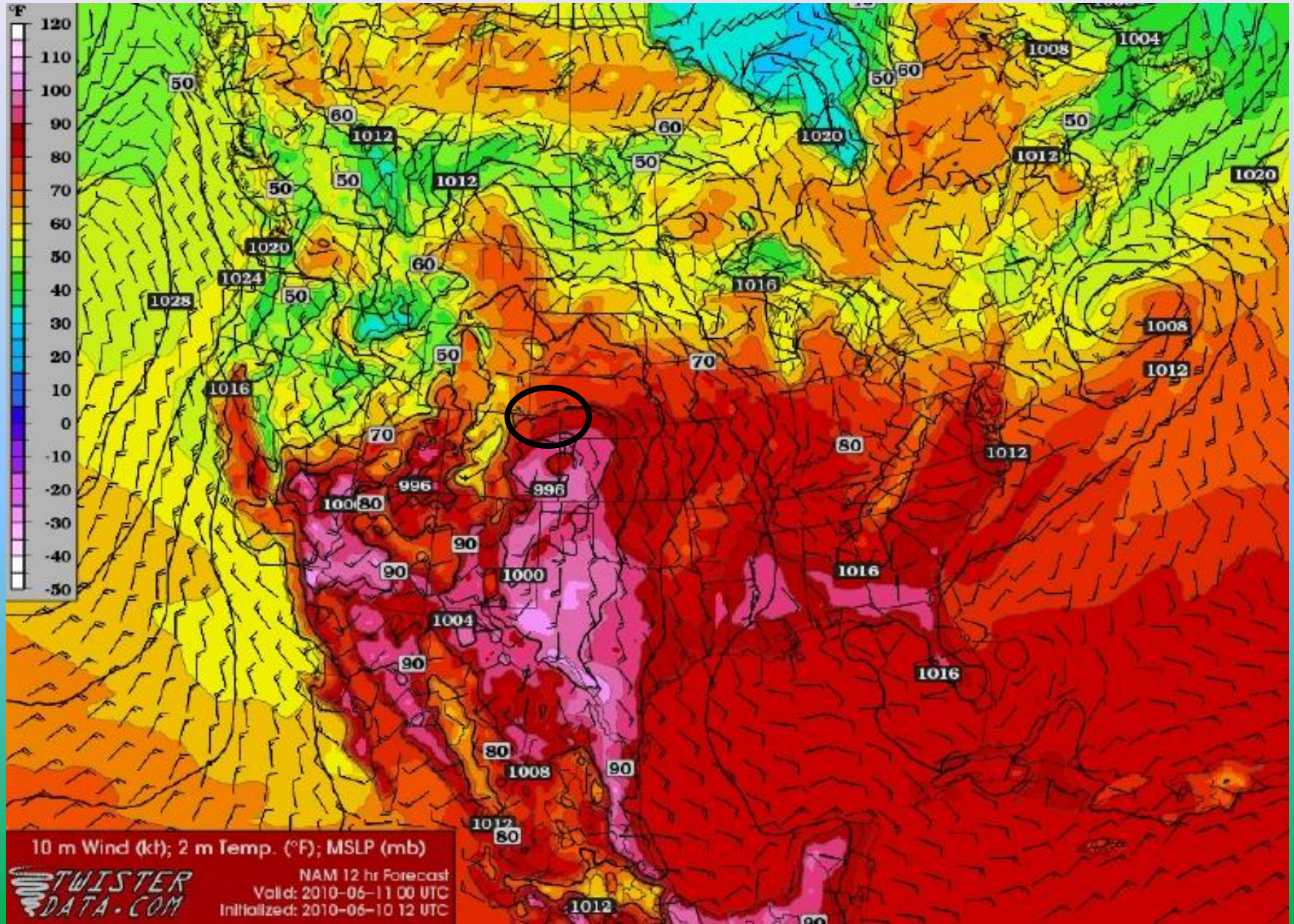


NWS/NCEP/SPC

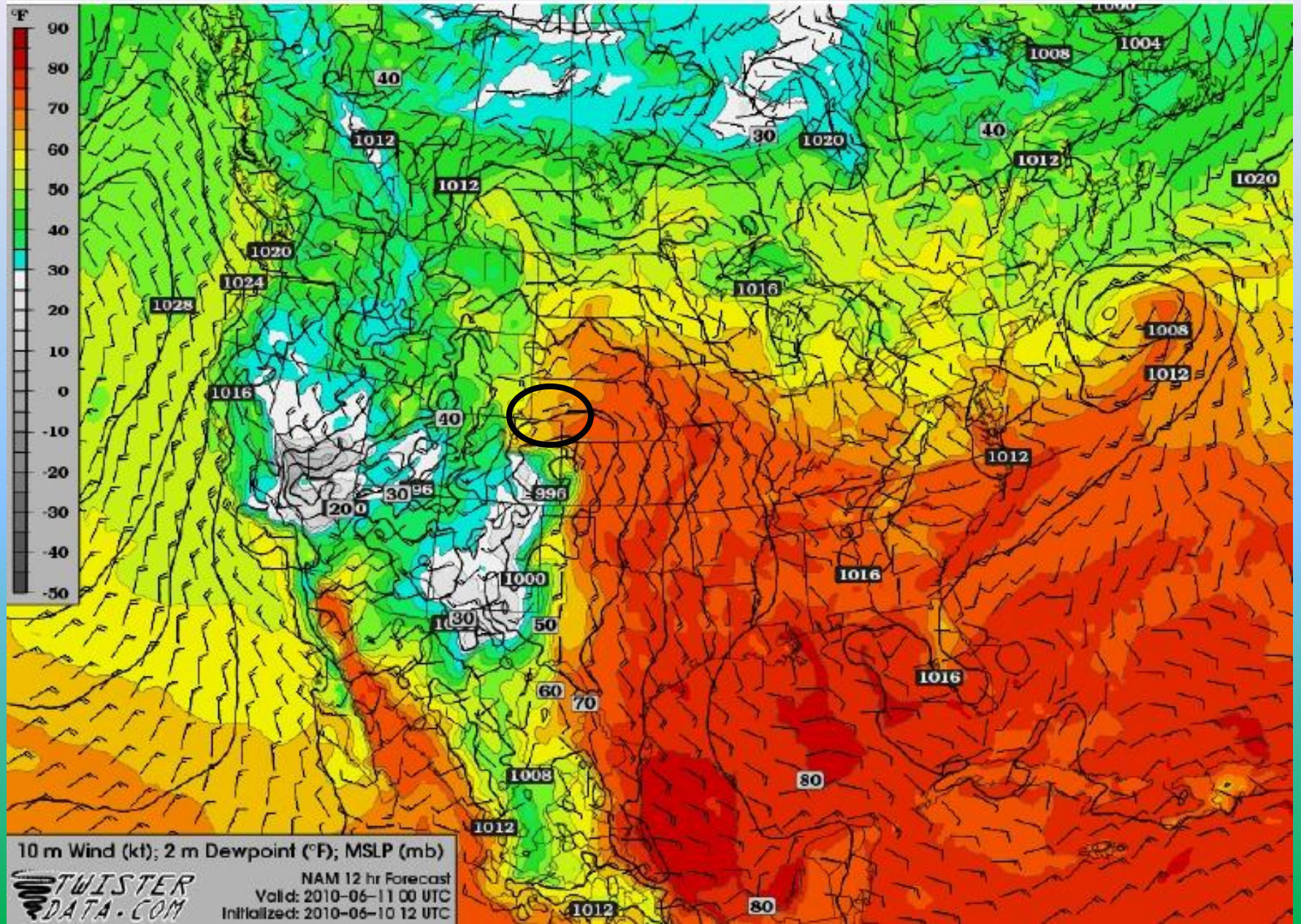

1315 UTC 10 Jun 2010 Water Vapor Image (c)2010 UCAR http://www.rap.ucar.edu/weather/satellite/
1315 z WV
-70 -68 -66 -64 -62 -60 -58 -56 -54 -52 -50 -48 -46 -44 -42 -40 -38 -36 -34 -32 -30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10


1332 UTC 10 Jun 2010 Visible Image (c)2010 UCAR http://www.rap.ucar.edu/weather/satellite/
1332 z Vis
3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75

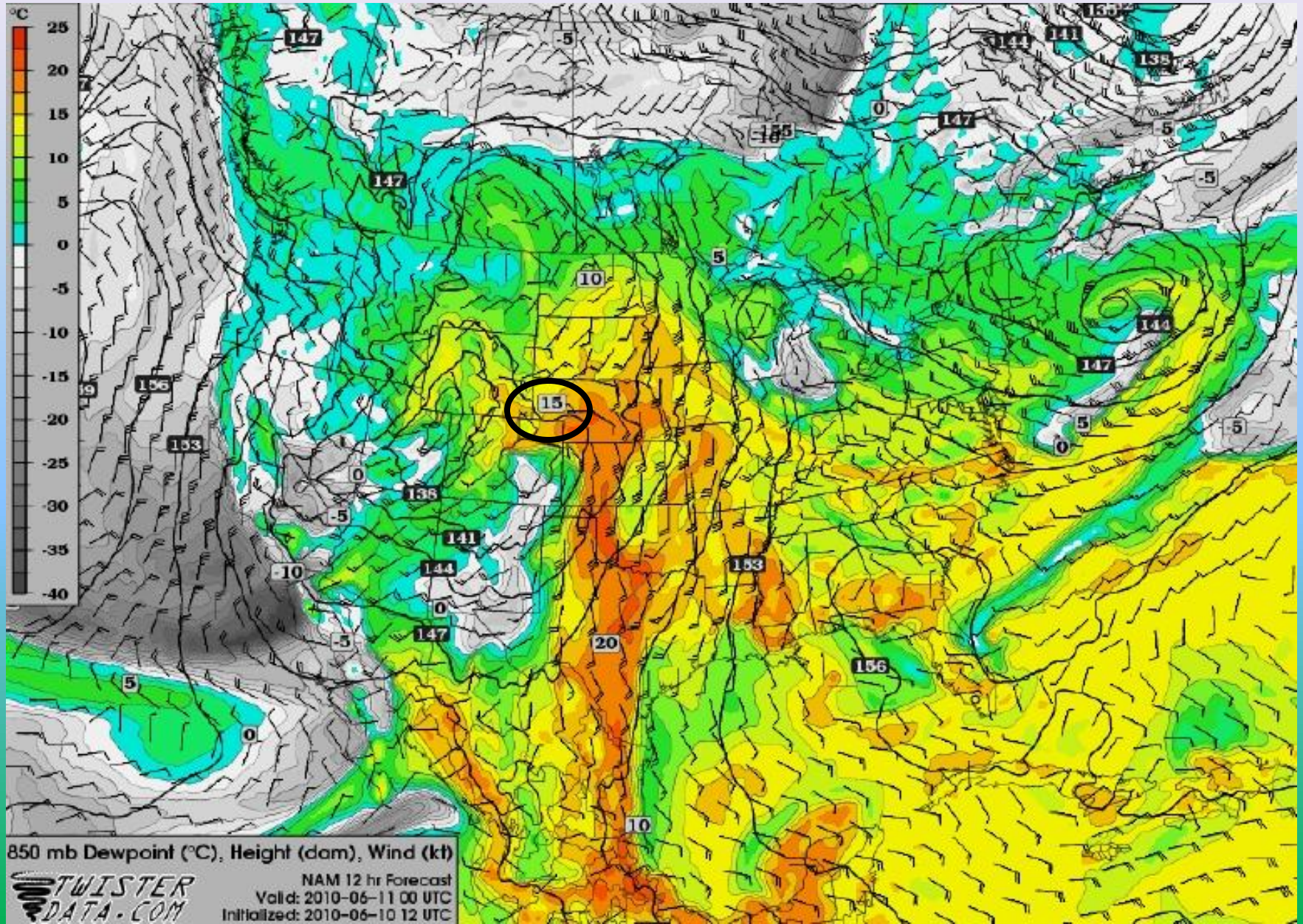
12z NAM – Surface T valid 0z



12z NAM – Surface Td valid 0z



12z NAM – 850mb valid 00z



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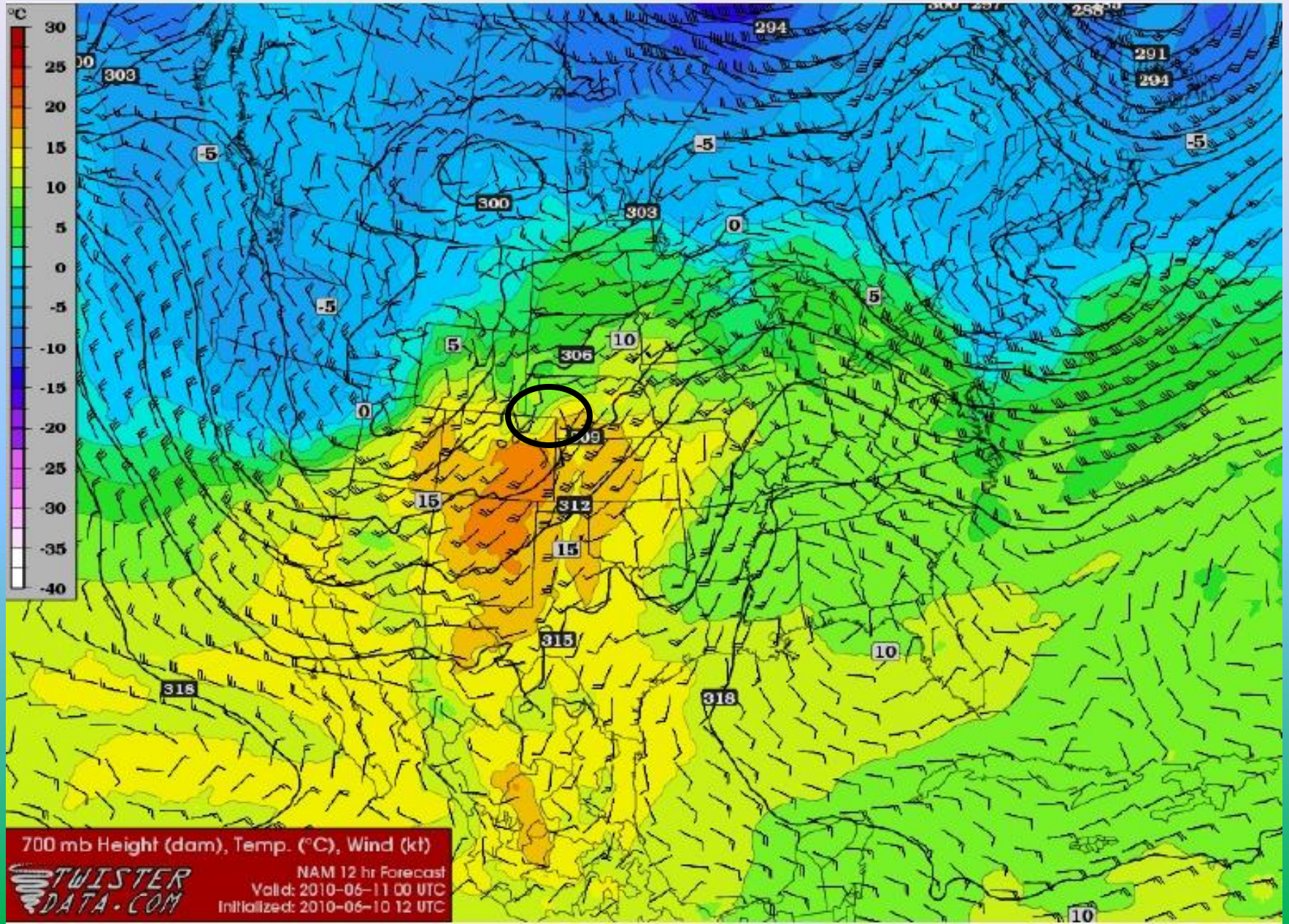
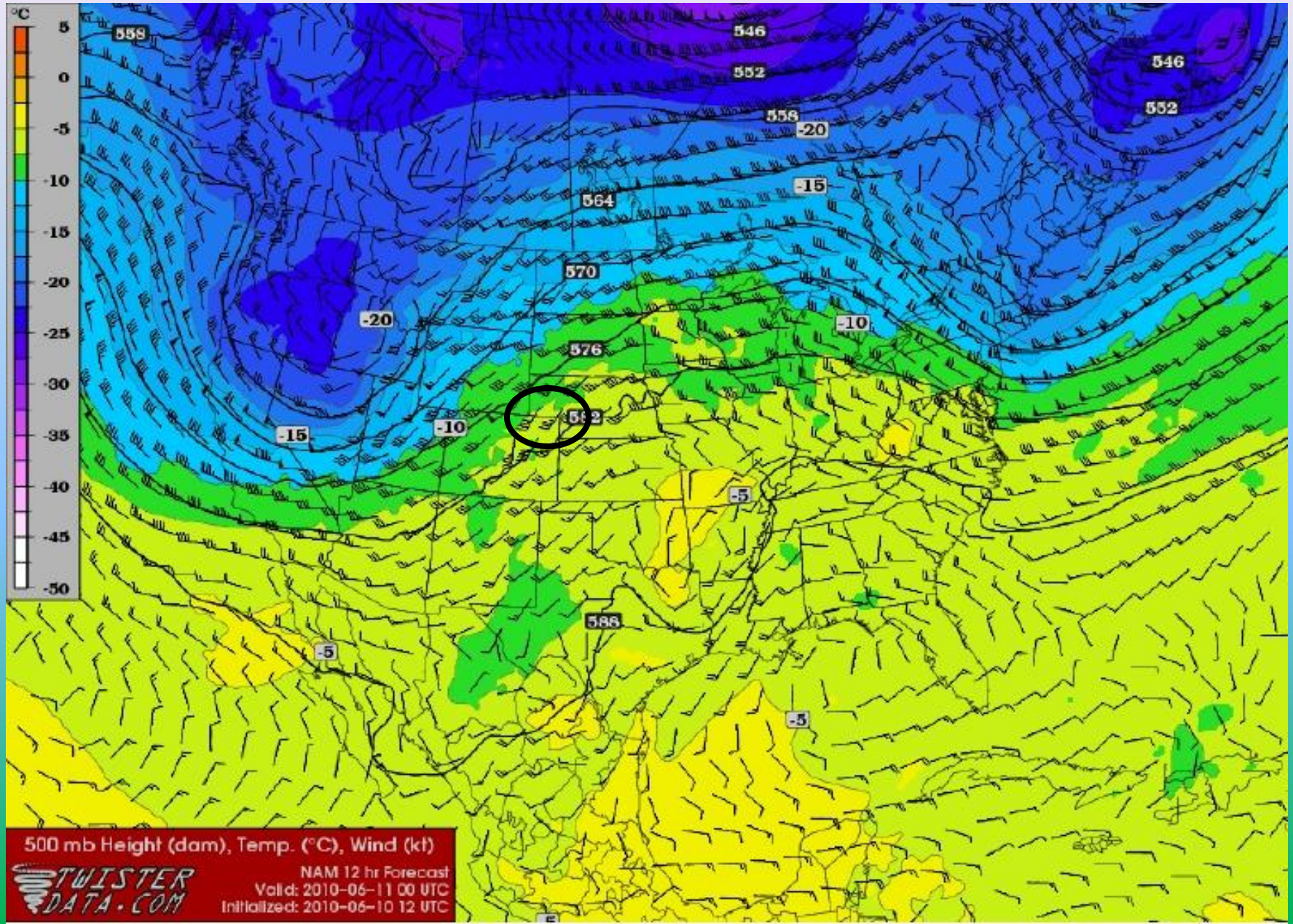
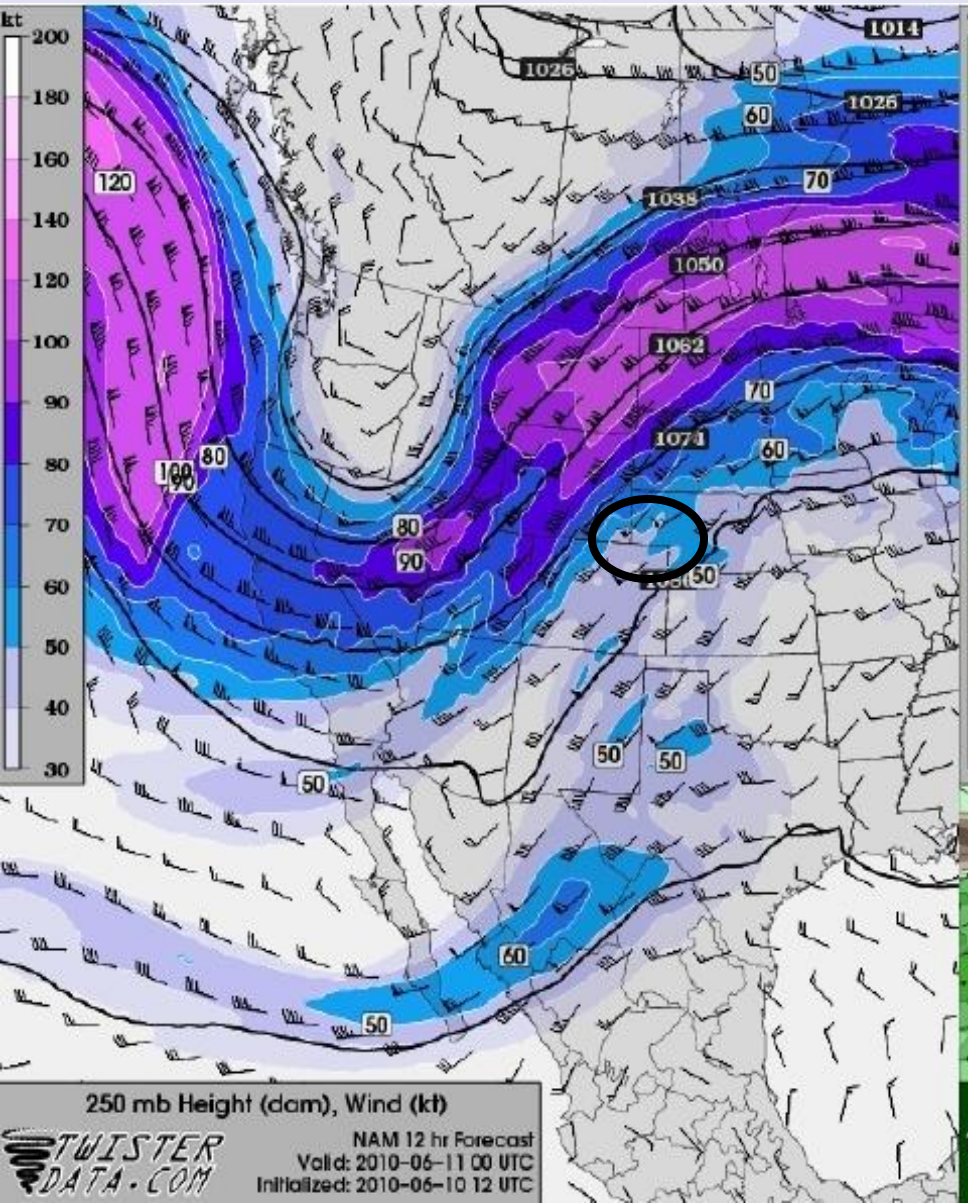
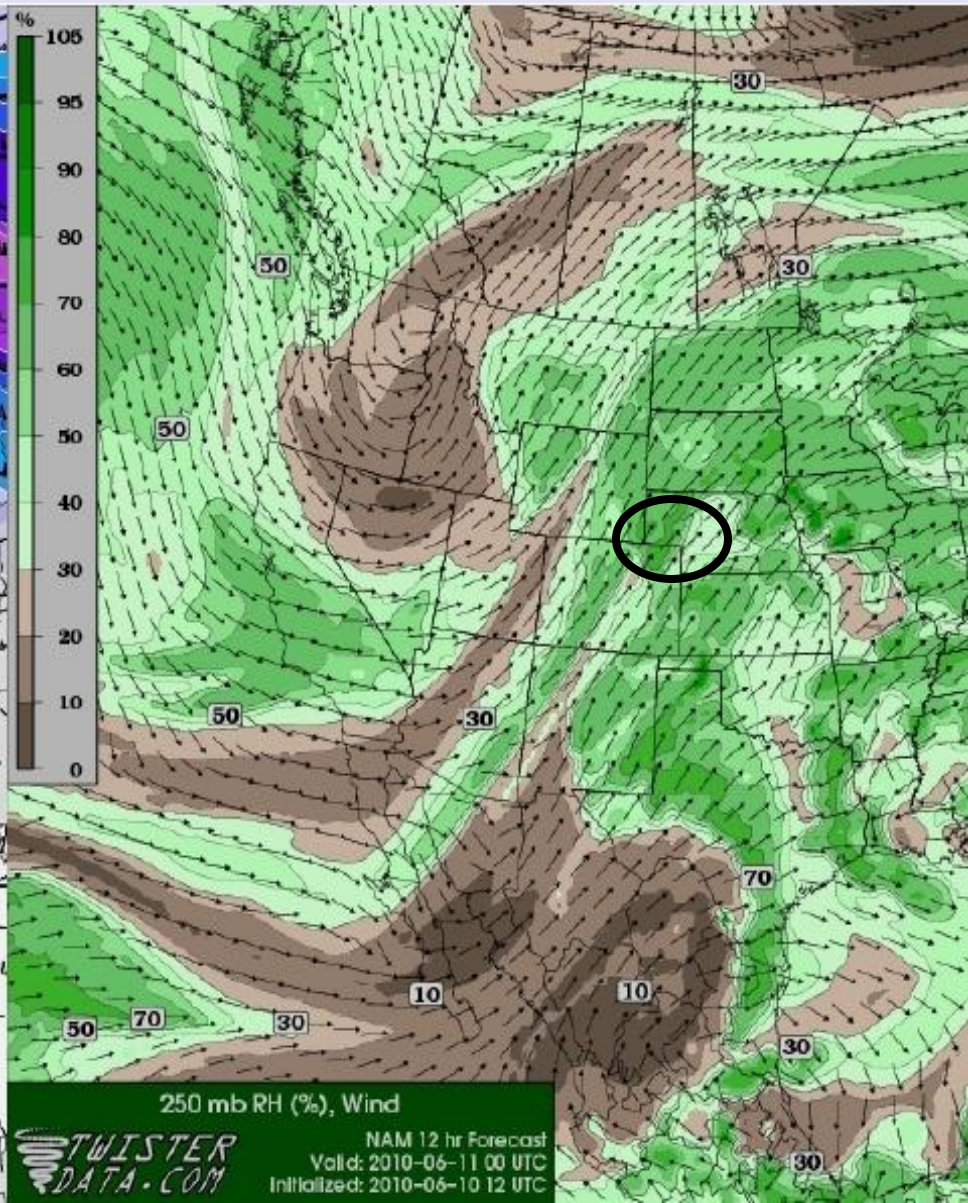


12zNAM – 500mb valid 00z

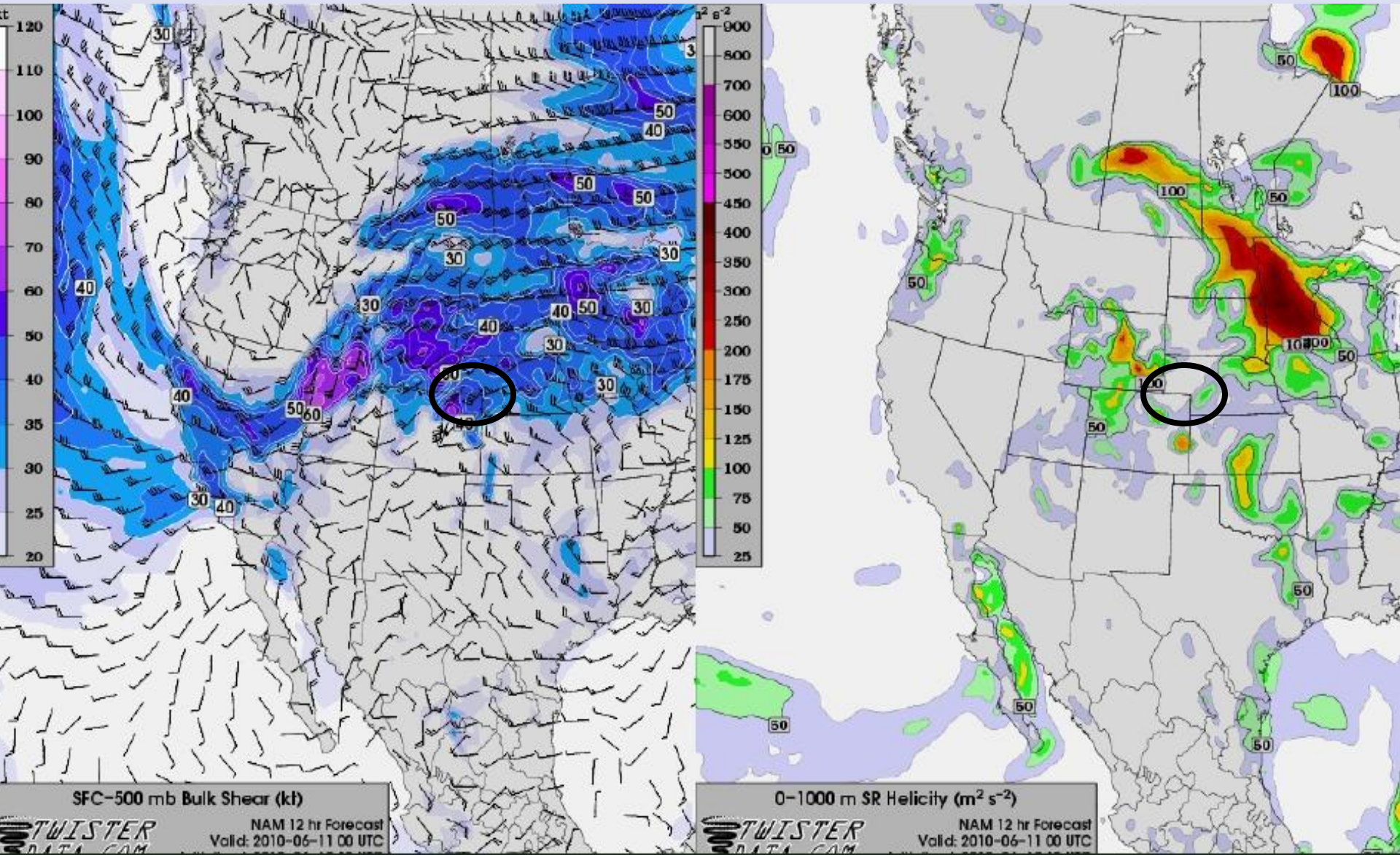


12z NAM – 250mb valid 00z

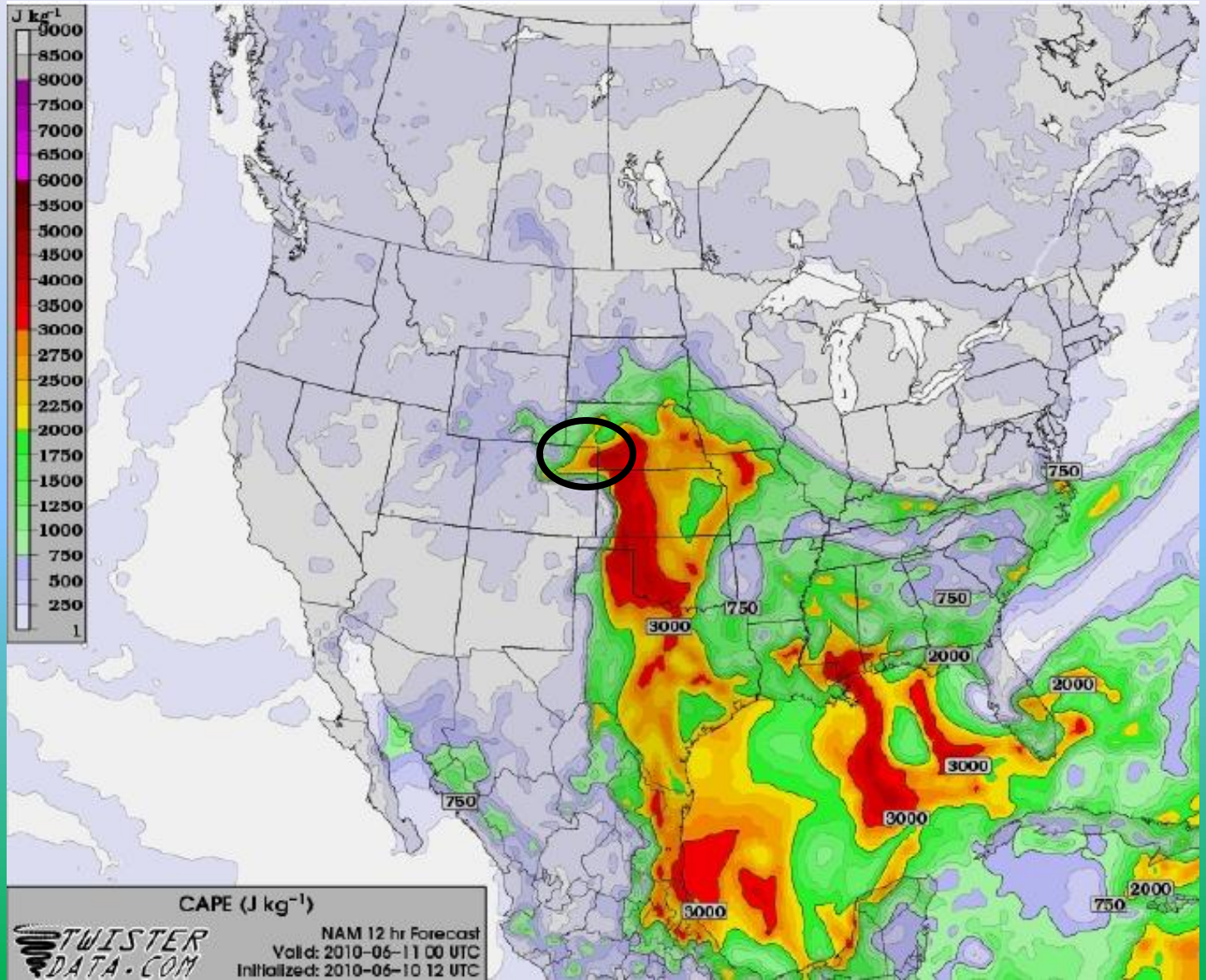




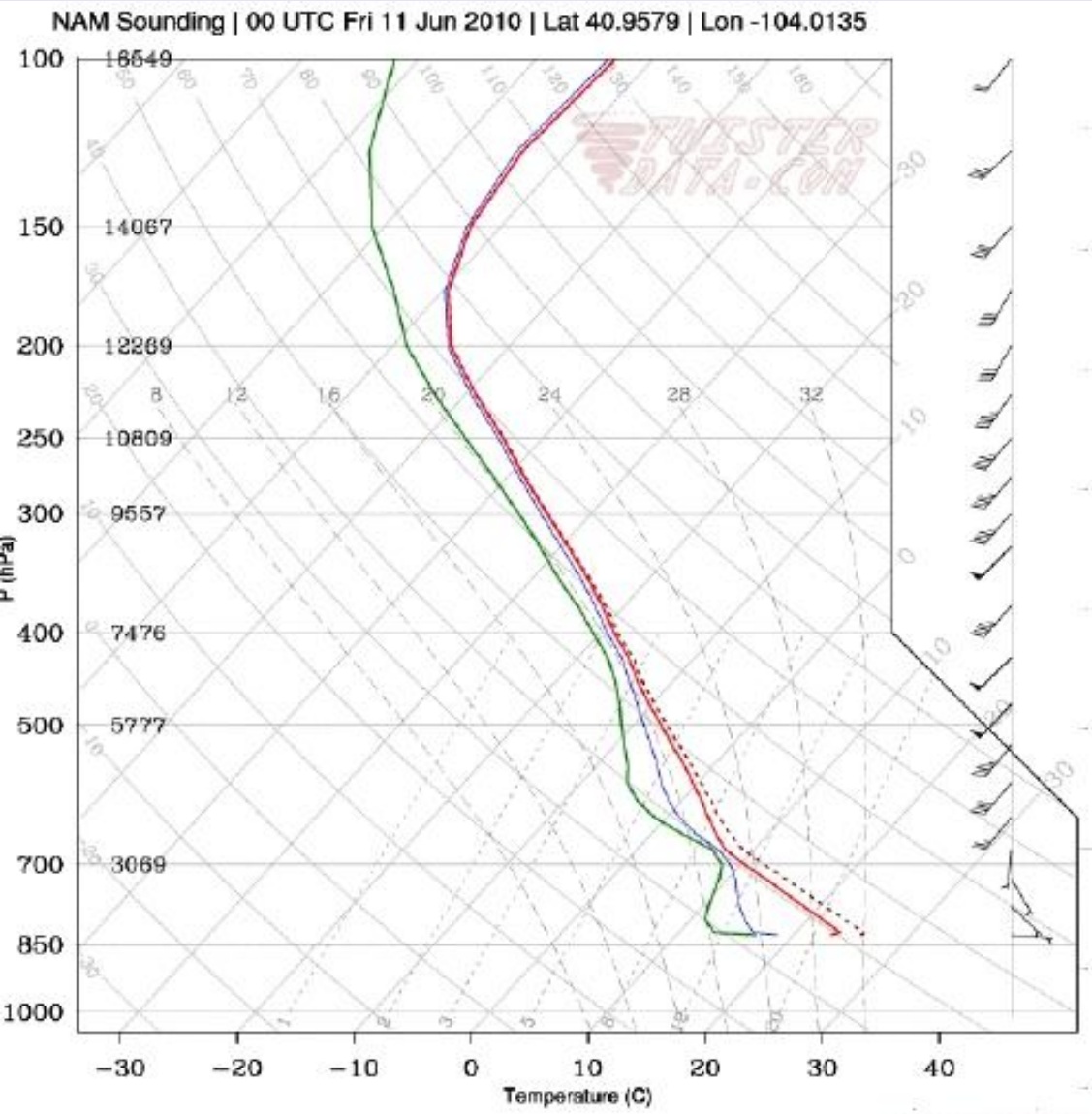
12zNAM – Bulk Shear/Helicity valid 00z

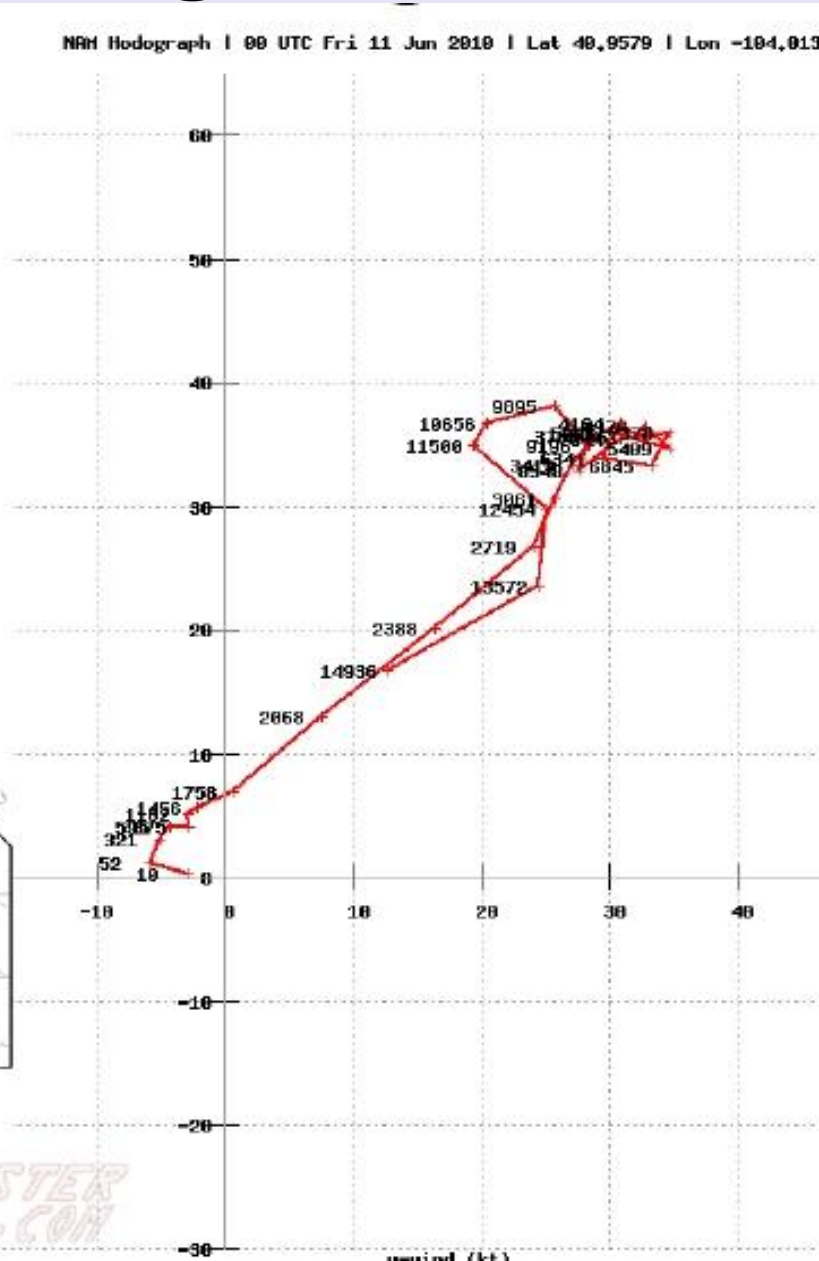


12z NAM – CAPE – valid 00z

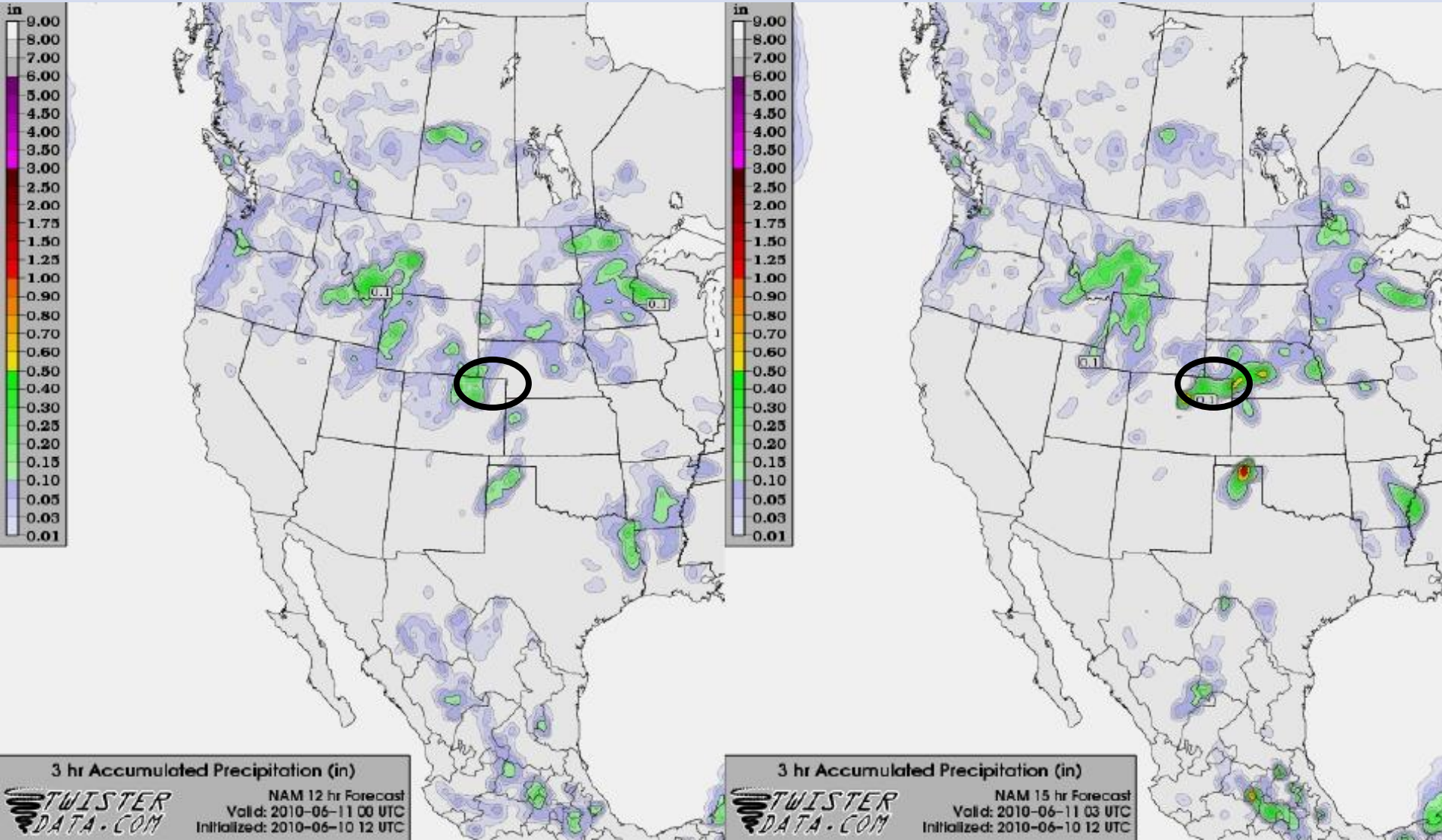


12zNAM – CYS sounding valid 00z

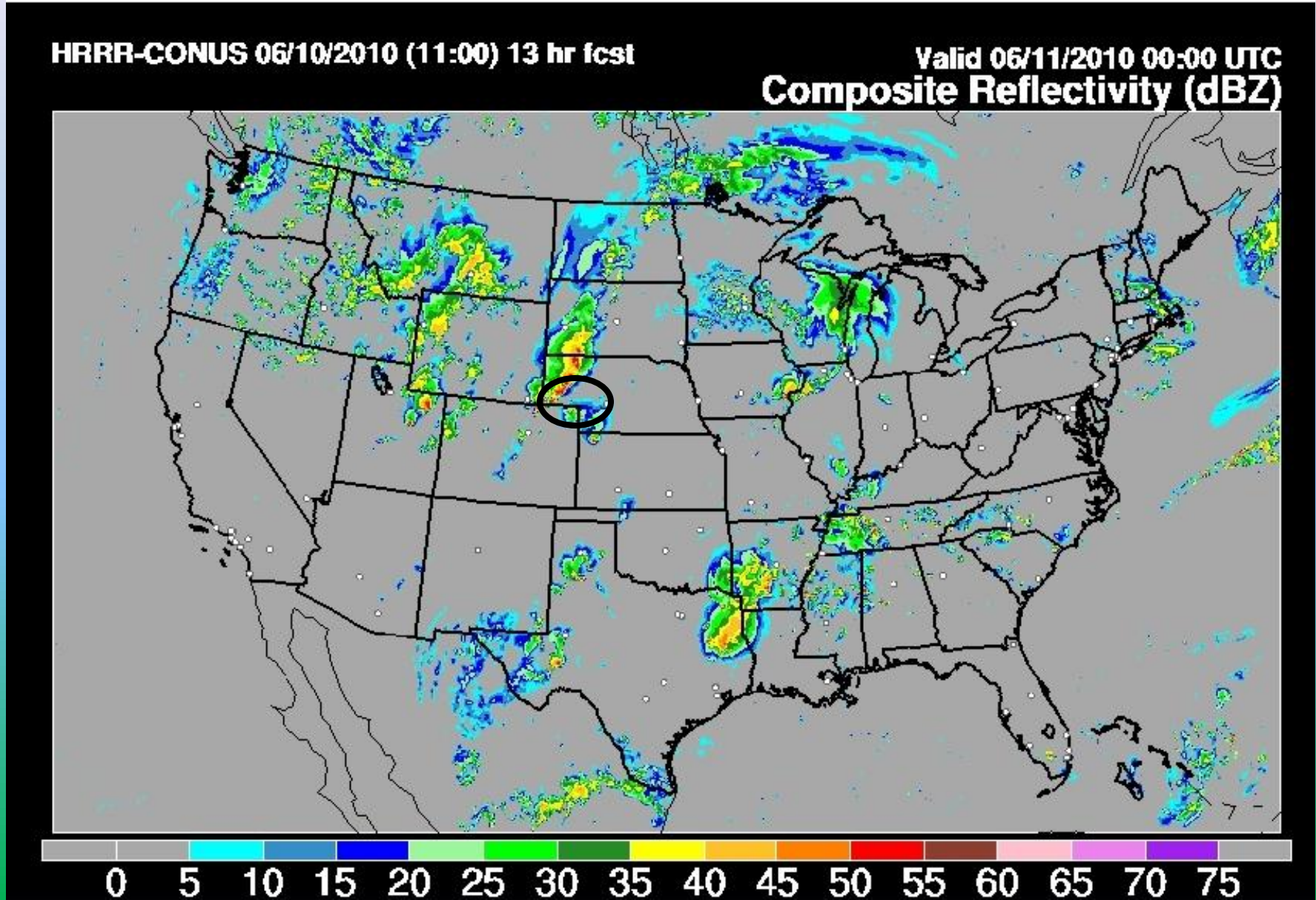


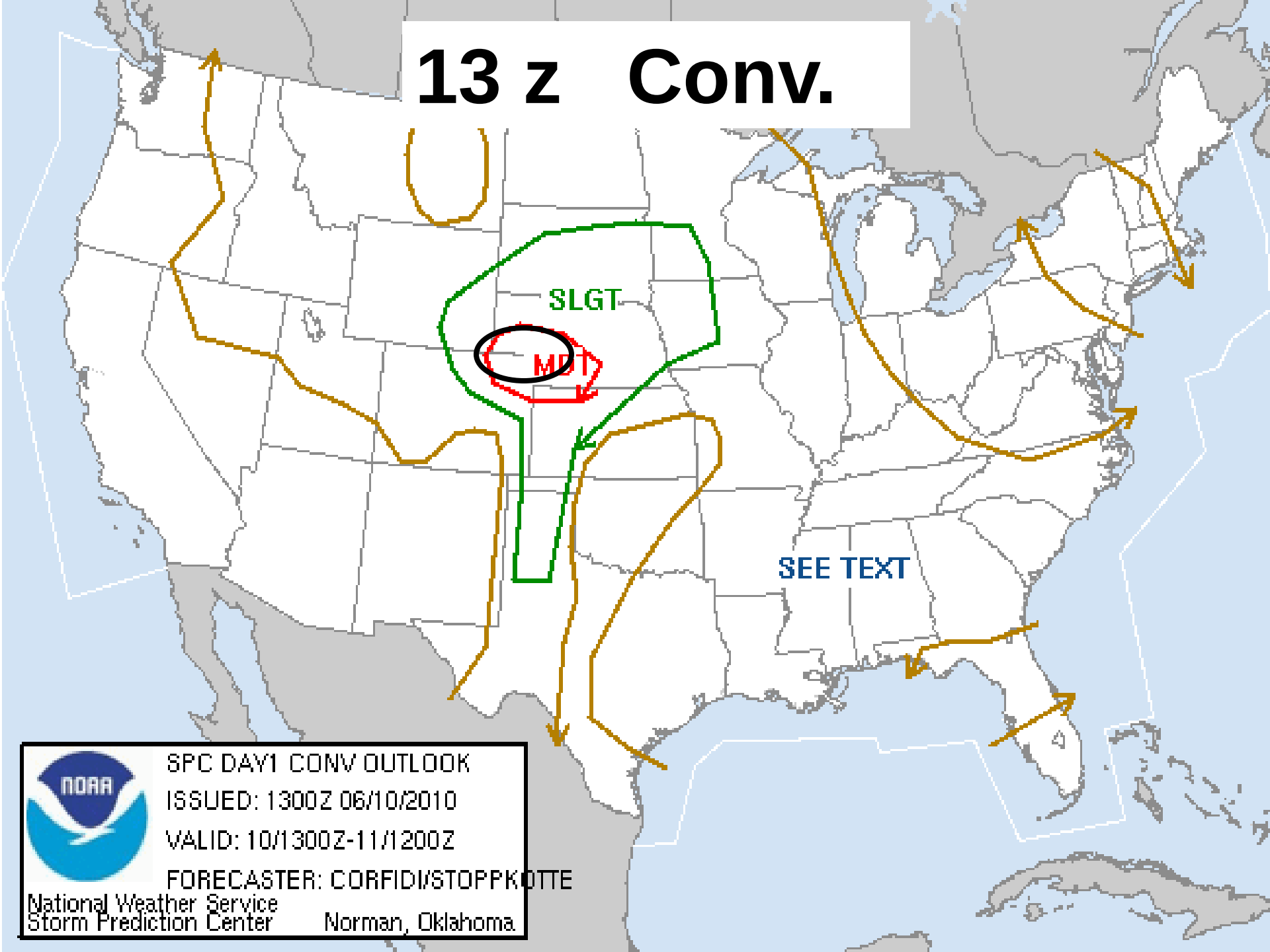


12z NAM – 3 hr precipitation valid 00z and 03z

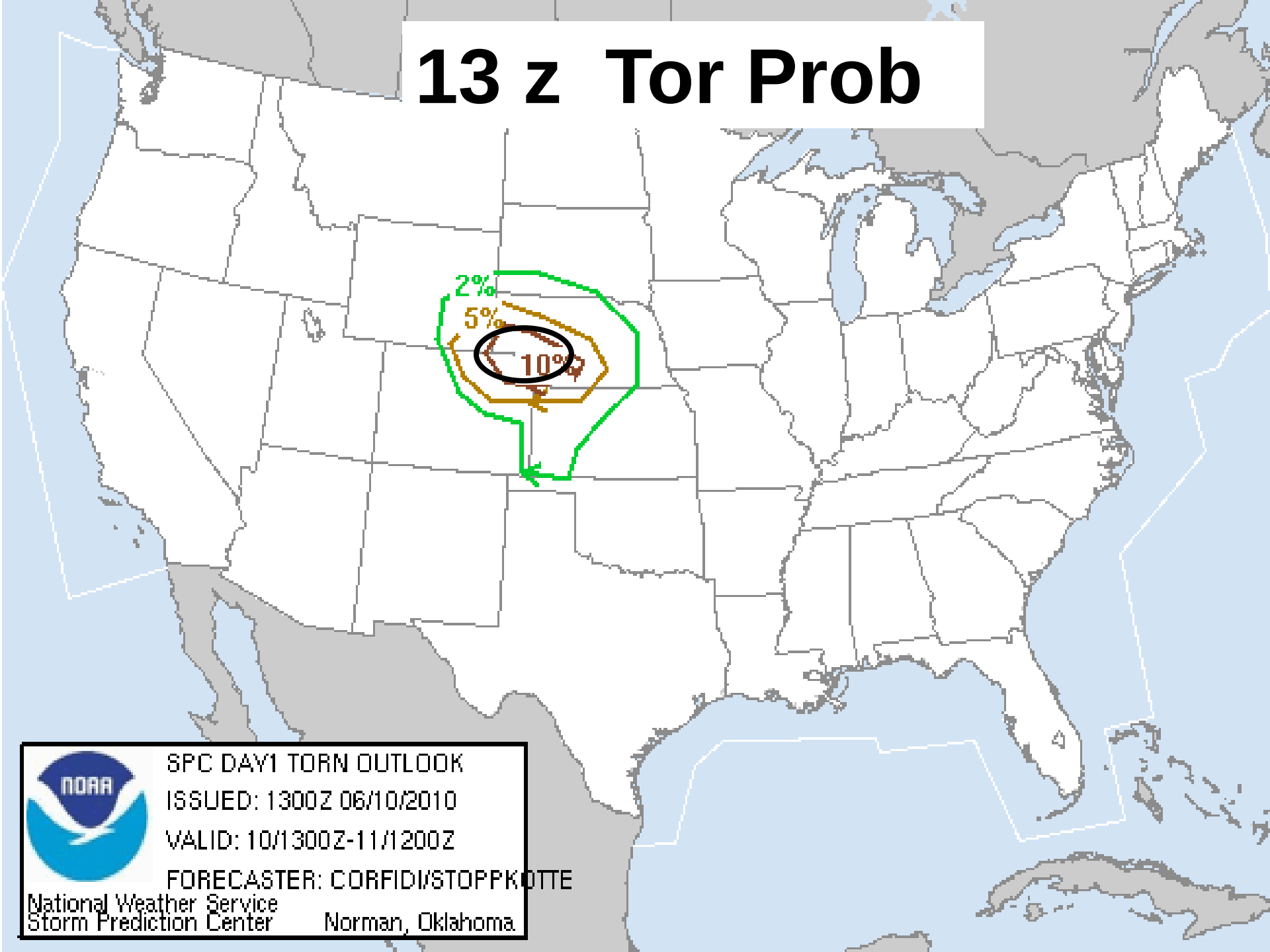


HRRR composite reflectivity valid 00z




13 z Conv.
SLGT
MDT
SEE TEXT
SPC DAY1 CONV OUTLOOK
ISSUED: 1300Z 06/10/2010
VALID: 10/1300Z-11/1200Z
FORECASTER: CORFIDI/STOPPKOTTE
National Weather Service
Storm Prediction Center
Norman, Oklahoma

13 z Tor Prob

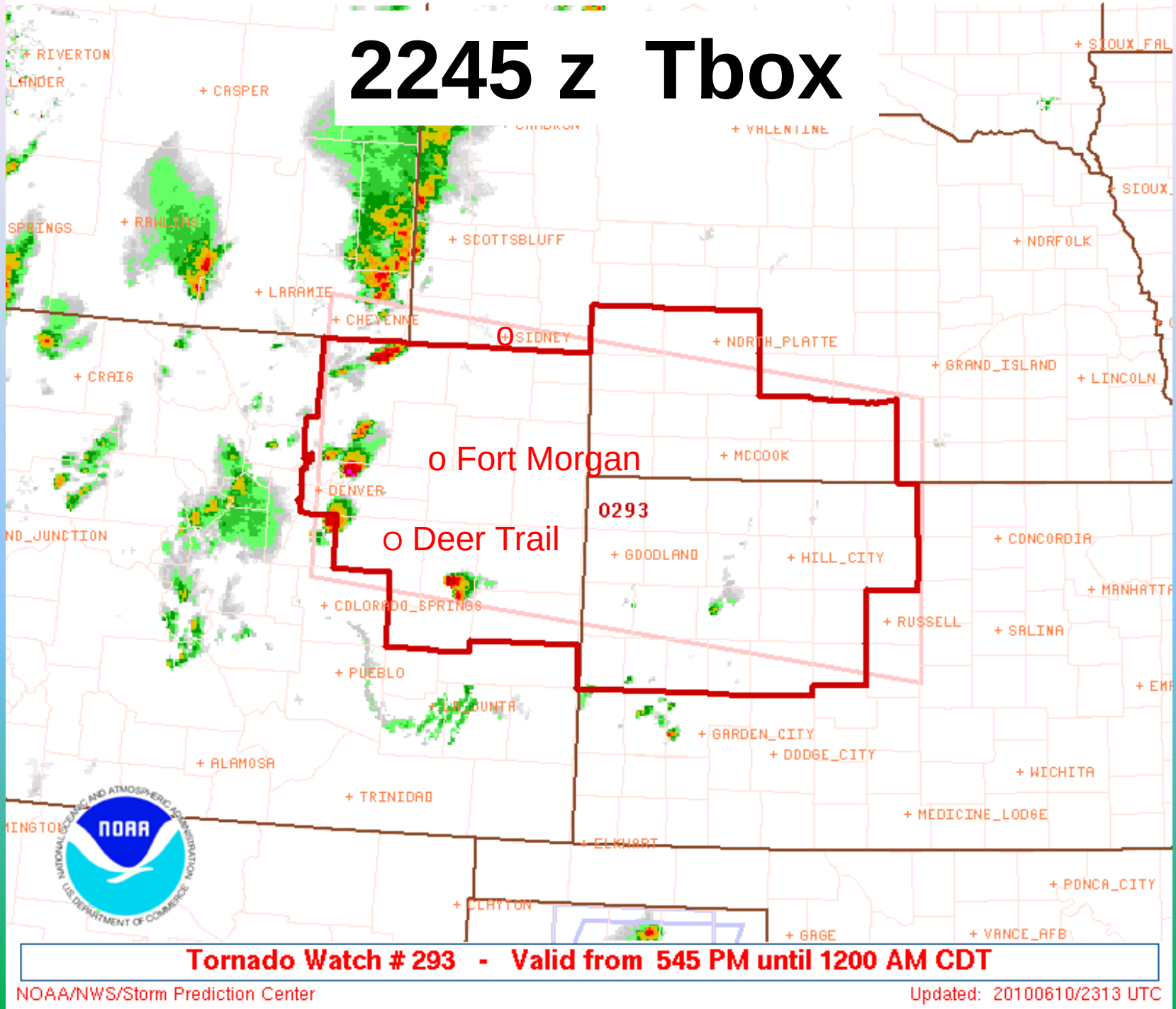

2%
5%
10%
SPC DAY1 TORN OUTLOOK
ISSUED: 1300Z 06/10/2010
VALID: 10/1300Z-11/1200Z
FORECASTER: CORFIDI/STOPPKOTTE
National Weather Service
Storm Prediction Center
Norman, Oklahoma

6/10/10 - My 8am Forecast

- UPSLOPE supercells are likely initiating in the higher terrain of SE WY and CO.
- Forecast target town: Sidney, NE
- Storms will be rotating but outflow will soon undercut them.
- A few storms could produce tornadoes.

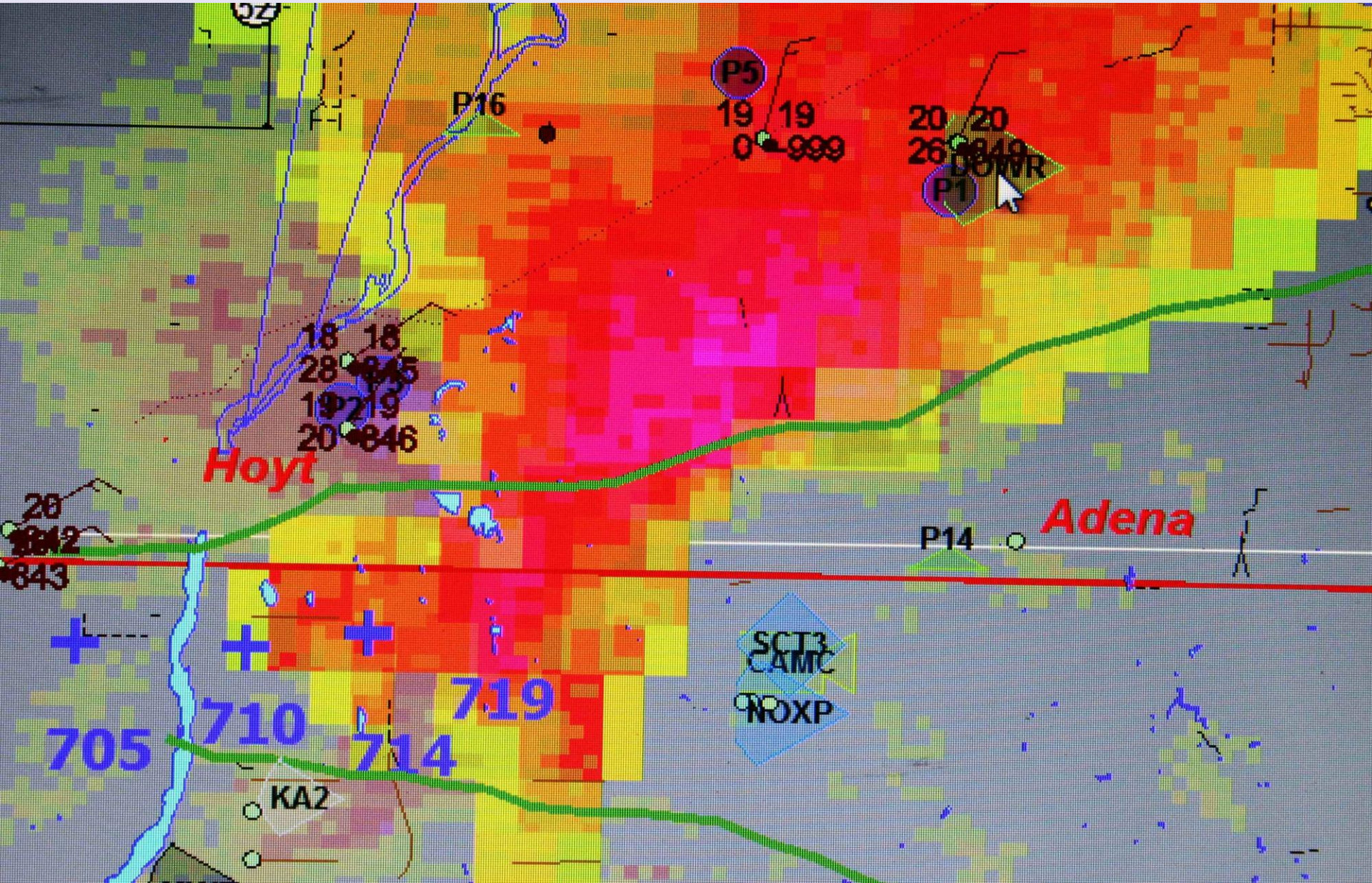
PI target – Sidney, NE by 1:30 pm.

Later changed to Fort Morgan, then down to Deer Trail


2245 z Tbox
RIVERTON
LANDER
CASPER
SPRINGS
RAWLINS
SCOTTSBLUFF
LARAMIE
CHEYENNE
SIDNEY
CRAIG
NORTH_PLATTE
GRAND_ISLAND
LINCOLN
Fort Morgan
MCCOOK
DENVER
0293
Deer Trail
GOODLAND
HILL_CITY
CONCORDIA
COLORADO_SPRINGS
RUSSELL
SALINA
PUEBLO
GARDEN_CITY
DODGE_CITY
WICHITA
ALAMOSA
TRINIDAD
MEDICINE_LODGE
ELKHART
PONCA_CITY
CLAYTON
GAGE
VANCE_AFB
NOAA
Tornado Watch # 293 - Valid from 545 PM until 1200 AM CDT
NOAA/NWS/Storm Prediction Center
Updated: 20100610/2313 UTC

Rotating LP supercell SW near Deer Trail, CO

Probe 14 closing in on the hook



Tornado SW

Tornado SW

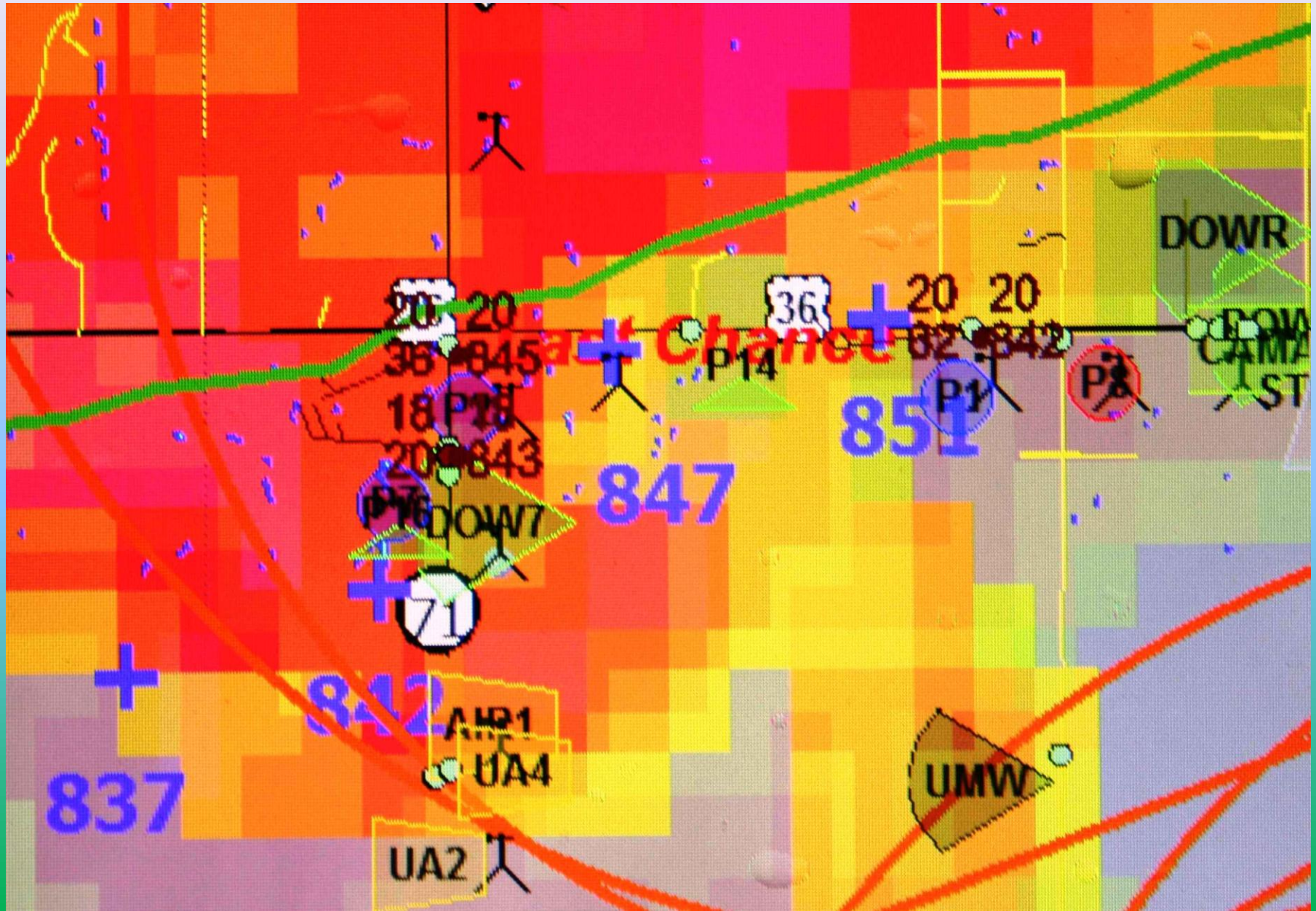
Tornado lasted 8 minutes

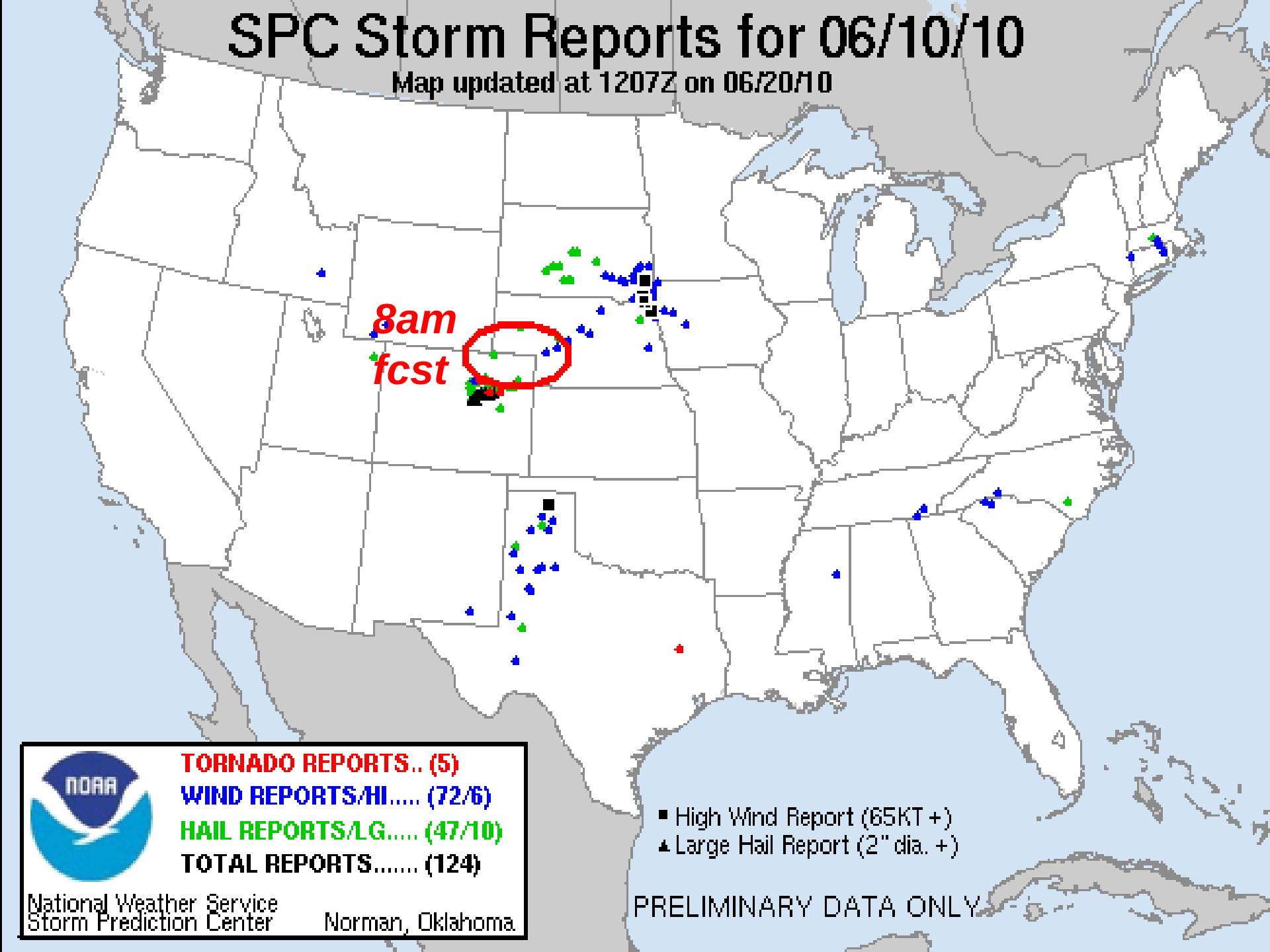
Large rotating base SW w/ funnel

Second tornado W-SW

Second tornado lasted 6 minutes

Probe 14 in the hook

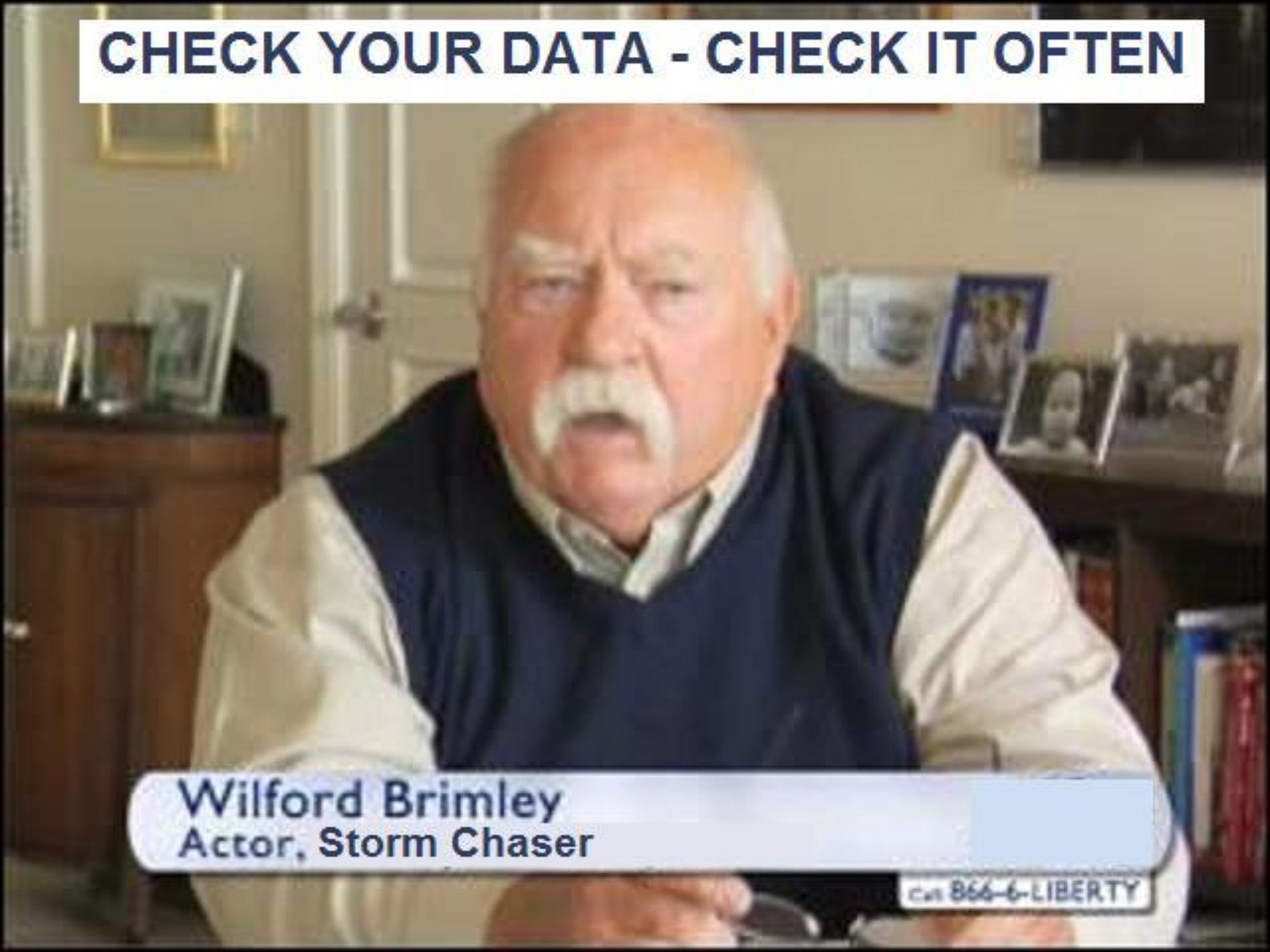


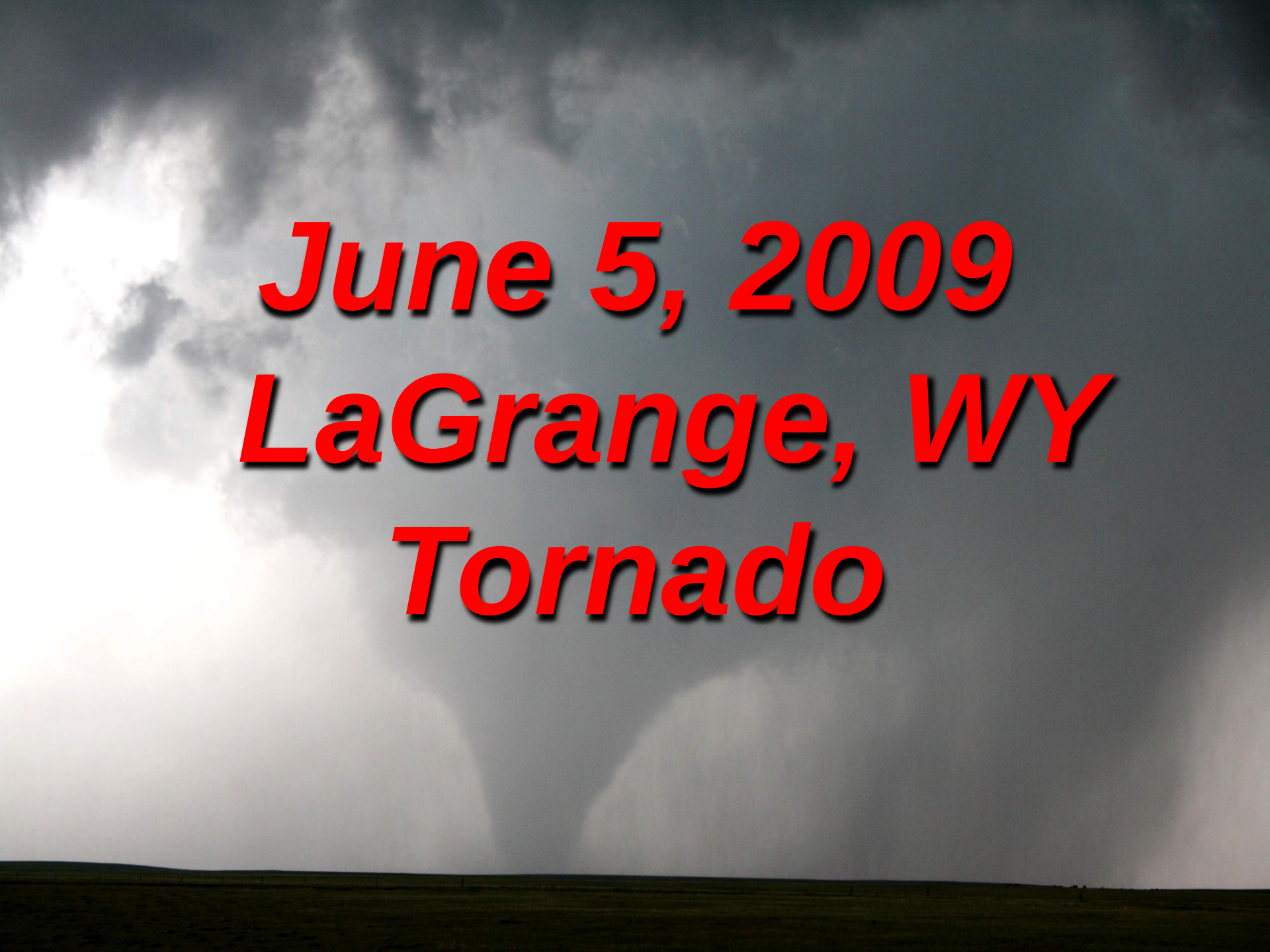

SPC Storm Reports for 06/10/10
Map updated at 1207Z on 06/20/10
8am
fcst
TORNADO REPORTS.. (5)
WIND REPORTS/HI..... (72/6)
HAIL REPORTS/LG..... (47/10)
TOTAL REPORTS..... (124)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
■ High Wind Report (65KT +)
▲ Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

Forecasting Lessons Learned

- Storms usually did not form where forecasted at 8am.
- Upslope conditions provided best low-level shear on the most marginal days.
- Needed to monitor and review new data throughout the day, especially radar (fine lines) and satellite (Tcu).
- Had to be able to move target area.
- Don’t rely too heavily on model forecasts (i.e. HRRR)
- Mesoscale accidents will occur (storm/boundary interactions) and change the target.

CHECK YOUR DATA - CHECK IT OFTEN

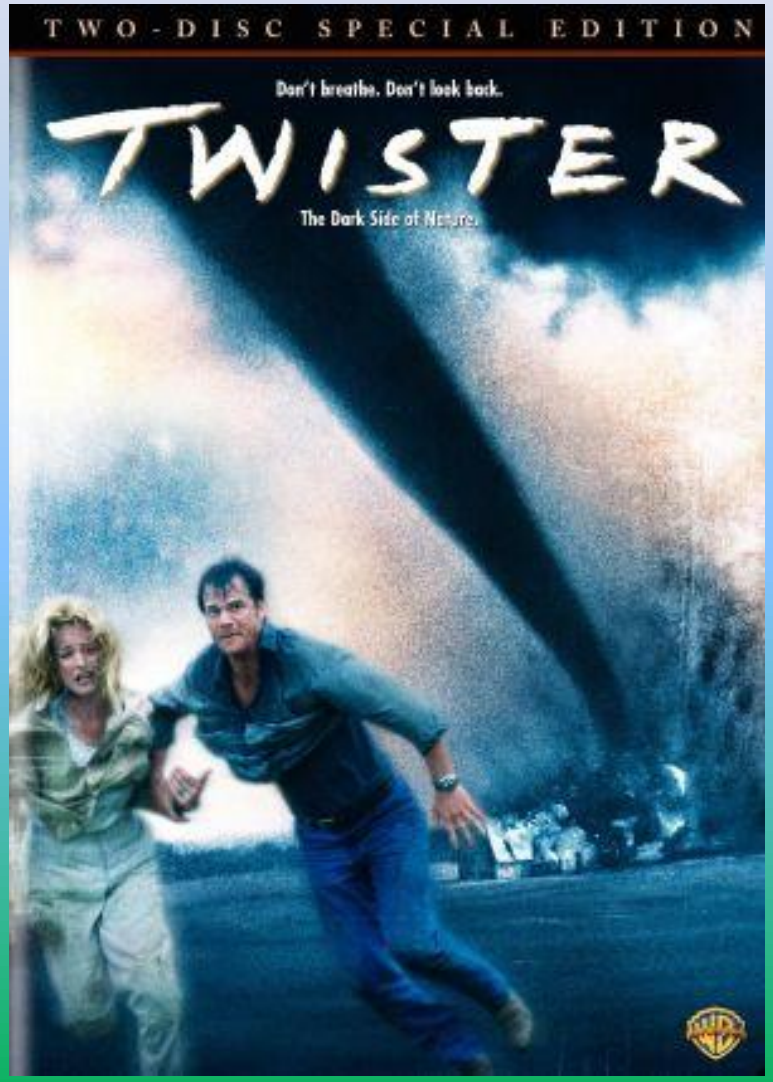



June 5, 2009
LaGrange, WY
Tornado

Deploying pod

Second pod deployed at 4:15 pm

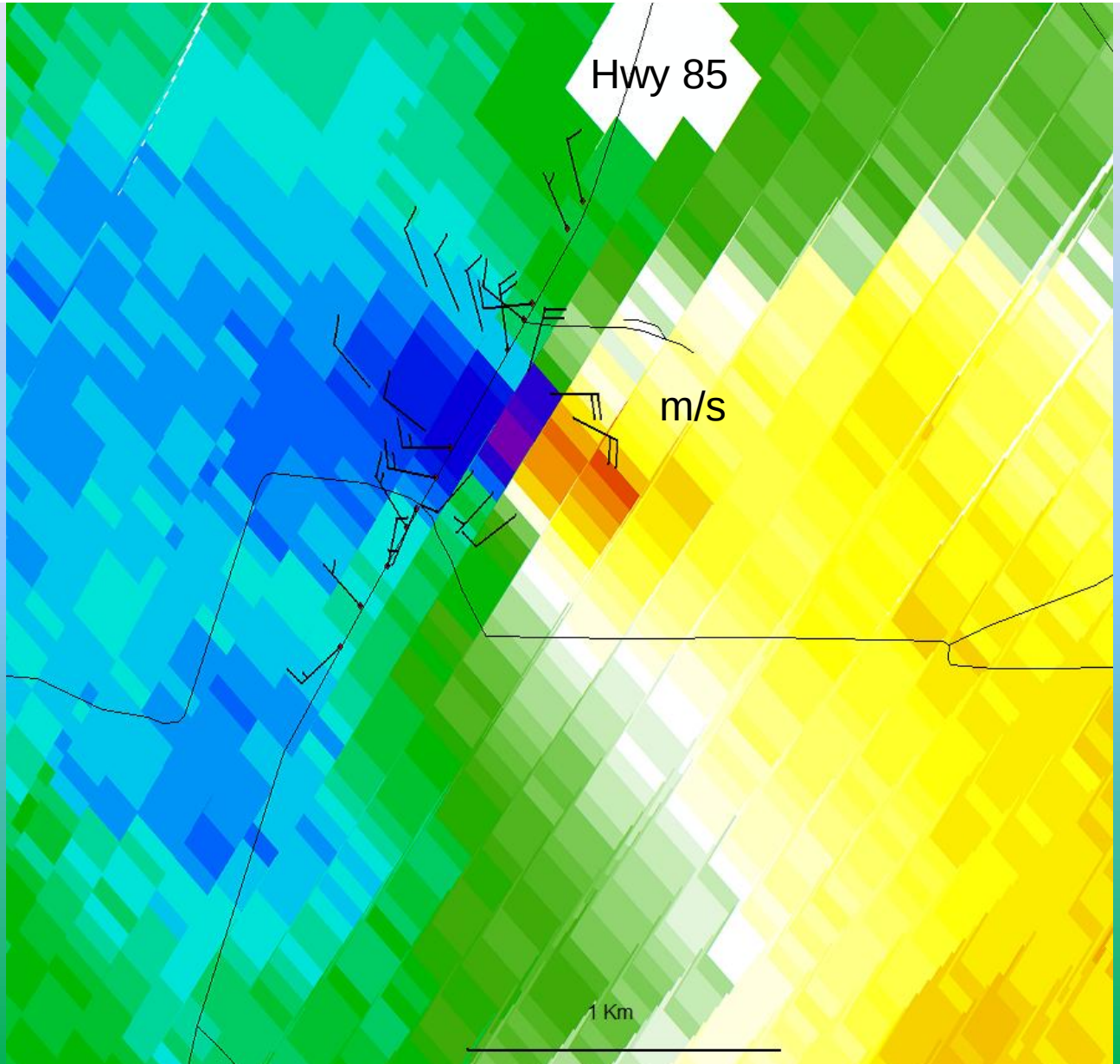
Reality duplicates Hollywood



Pod view of tornado at 4:18 pm

TORNADO WENT BETWEEN MY PODS (E, F, & G)!

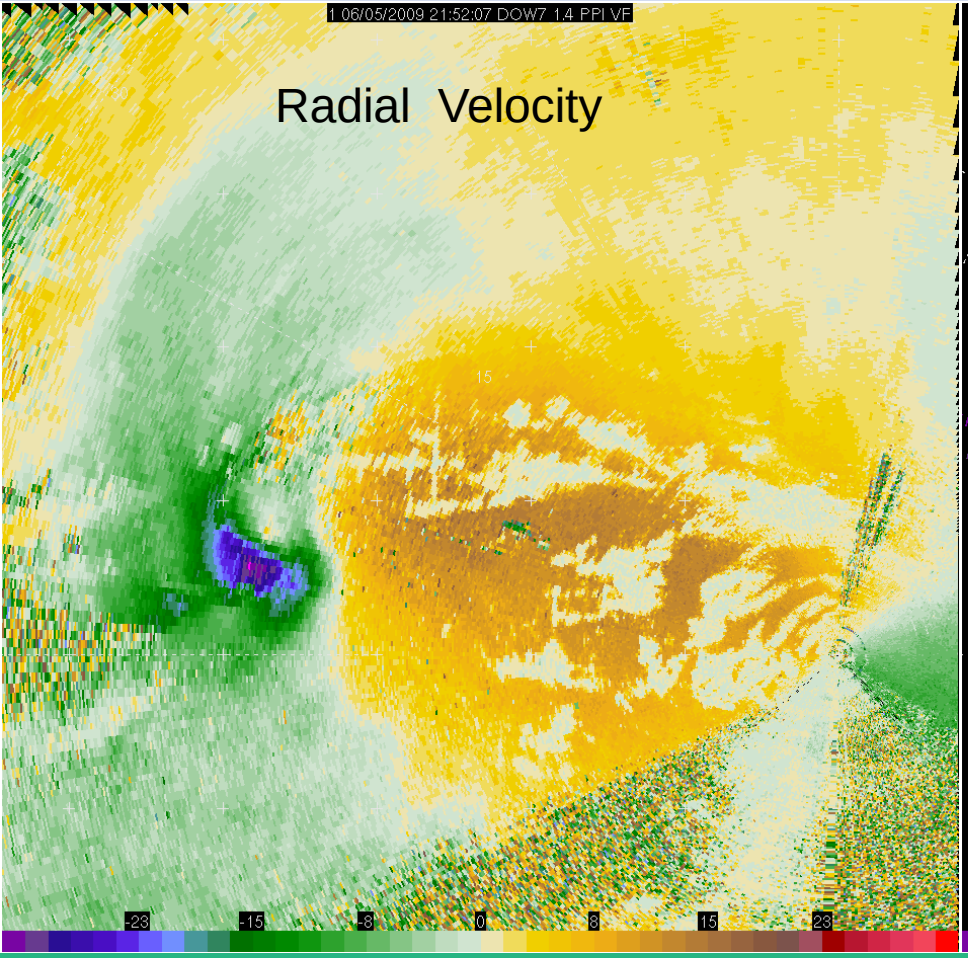
RESULTS - Overlay of DOW 6 and POD data

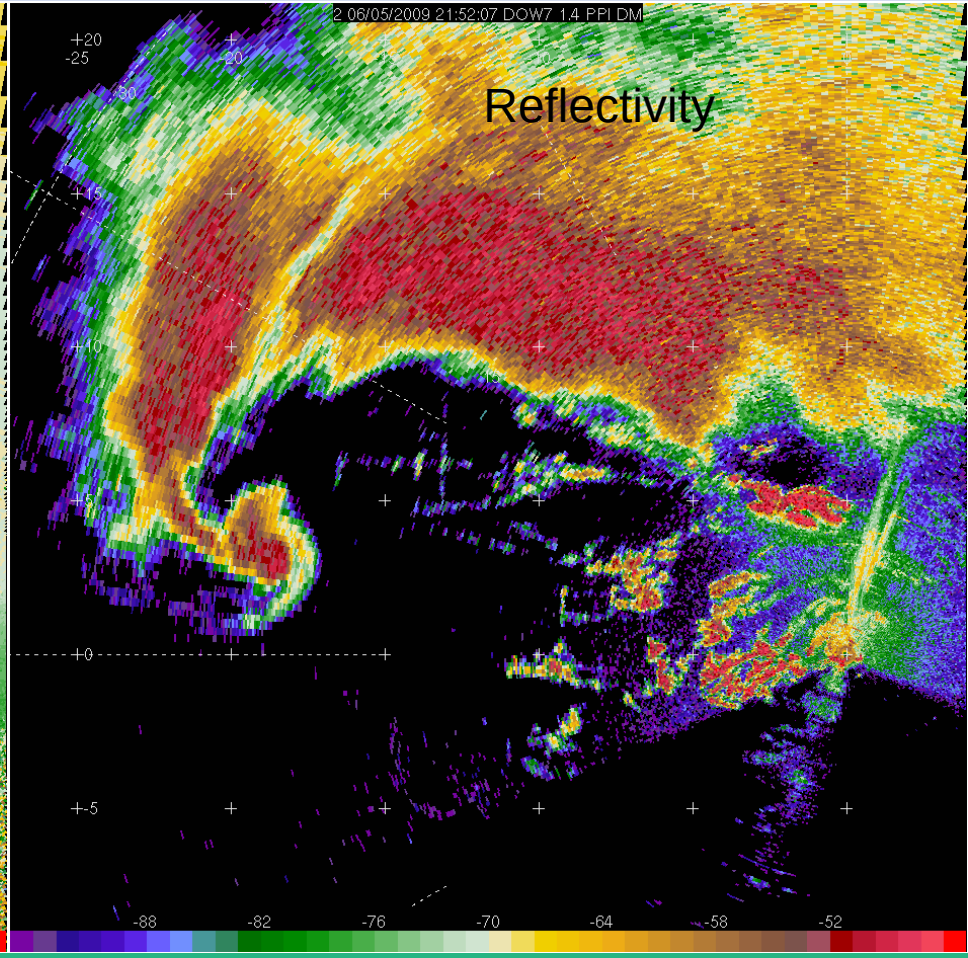


Scientists were very pleased with the data

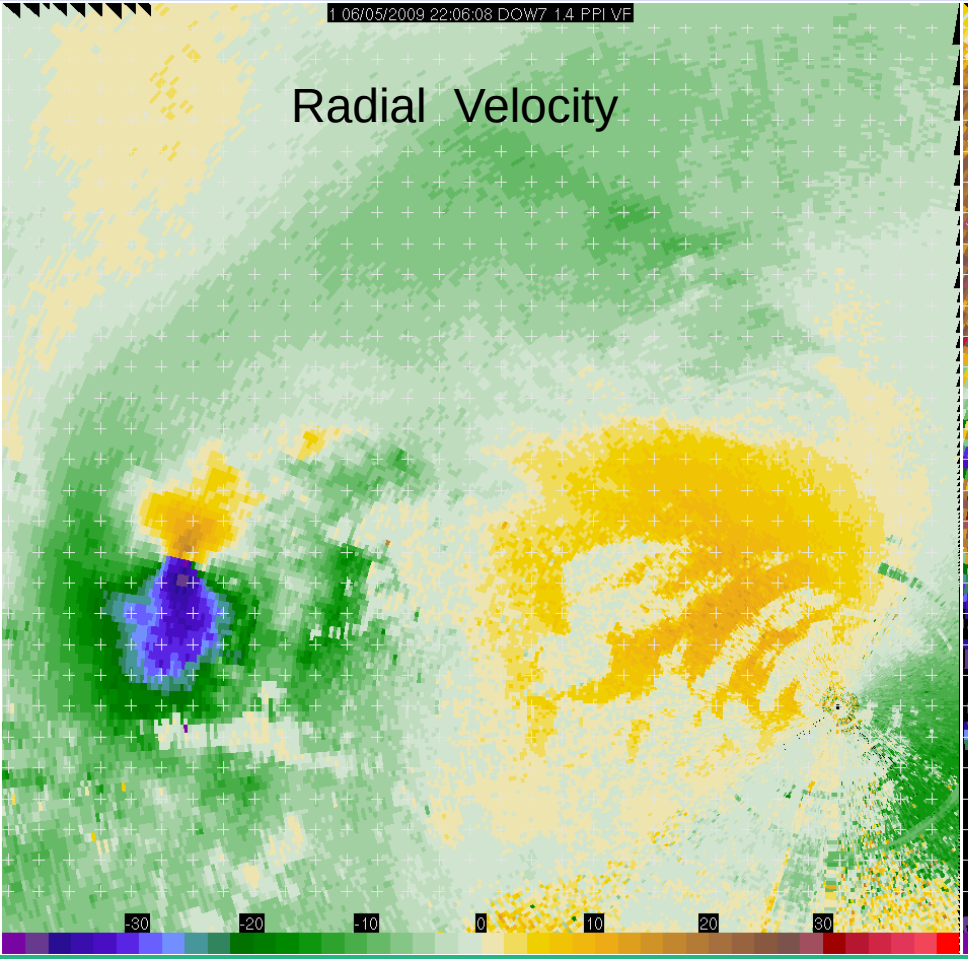
DOW image of hook echo – 3:52 PM

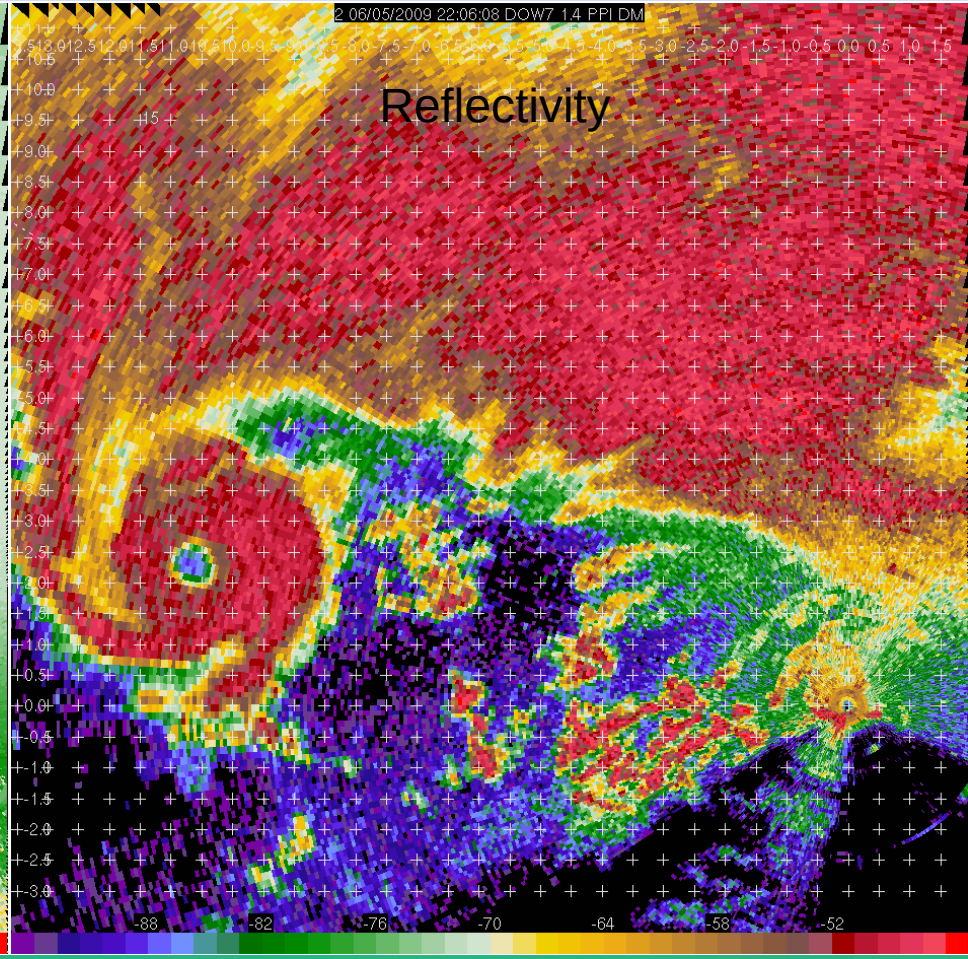
(9 minutes before visual confirmation of tornado)



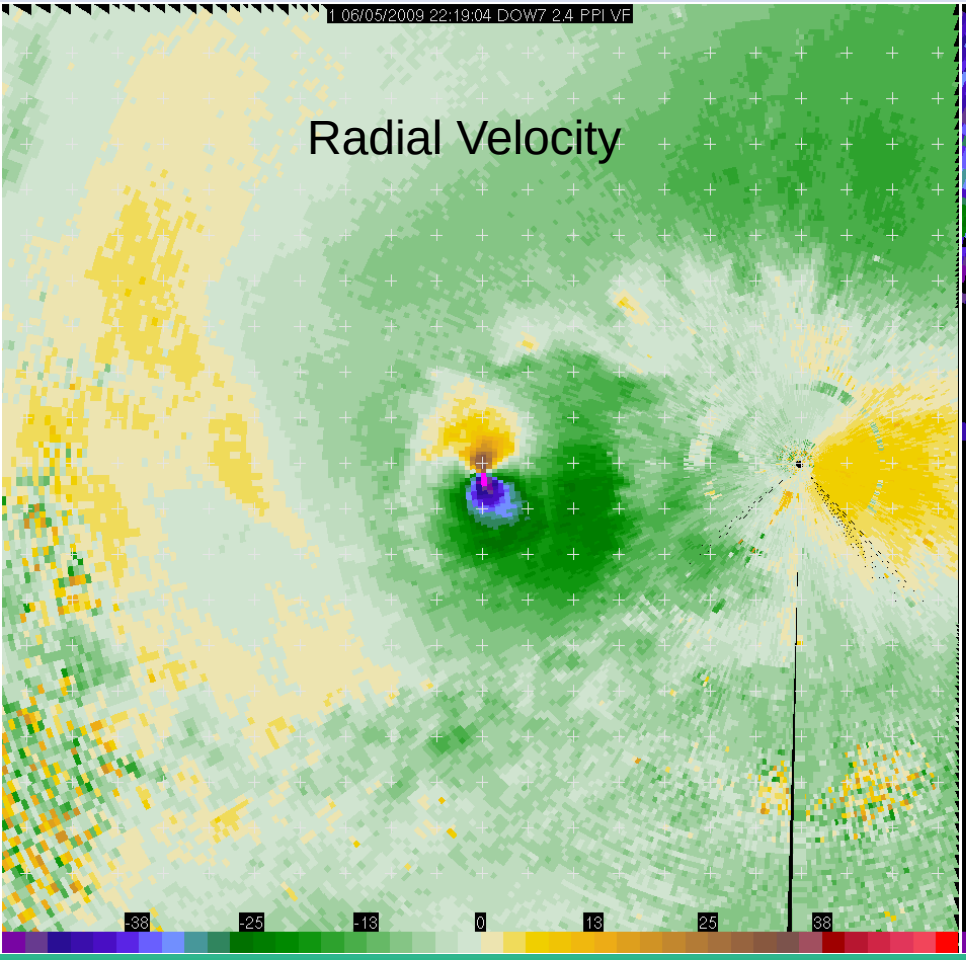


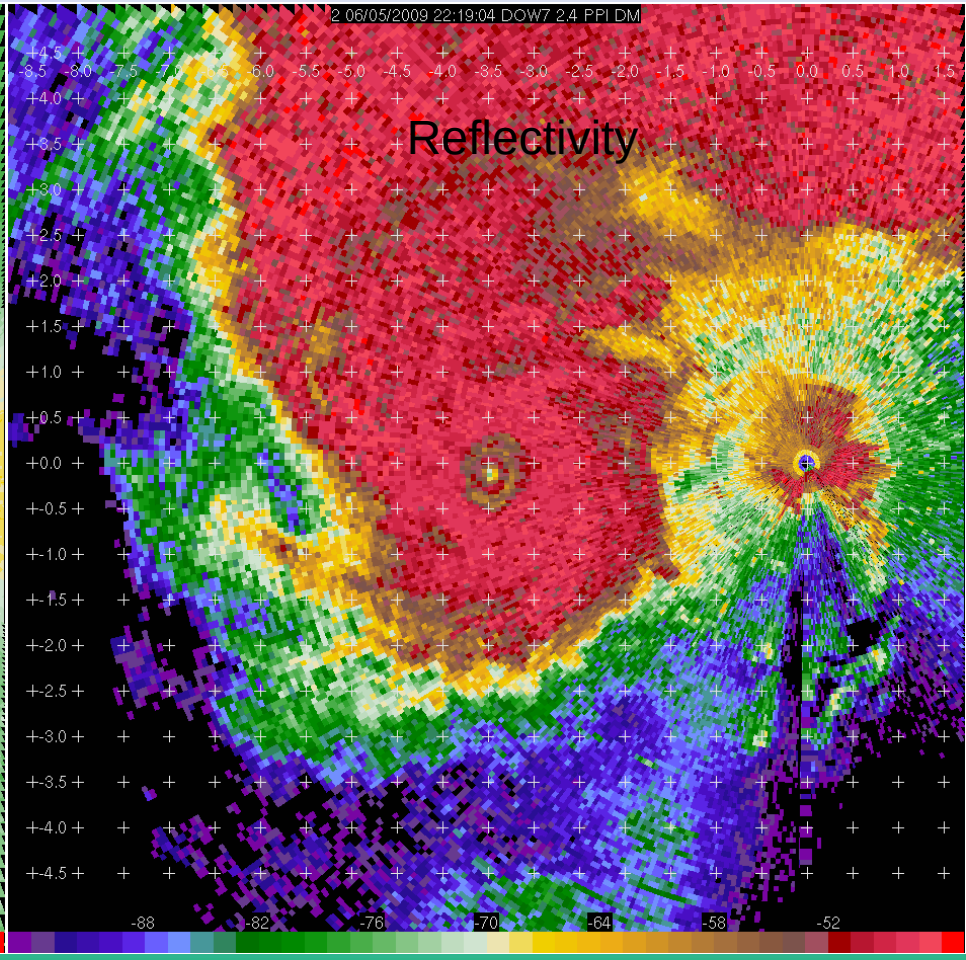
DOW image of tornado – 4:06 PM





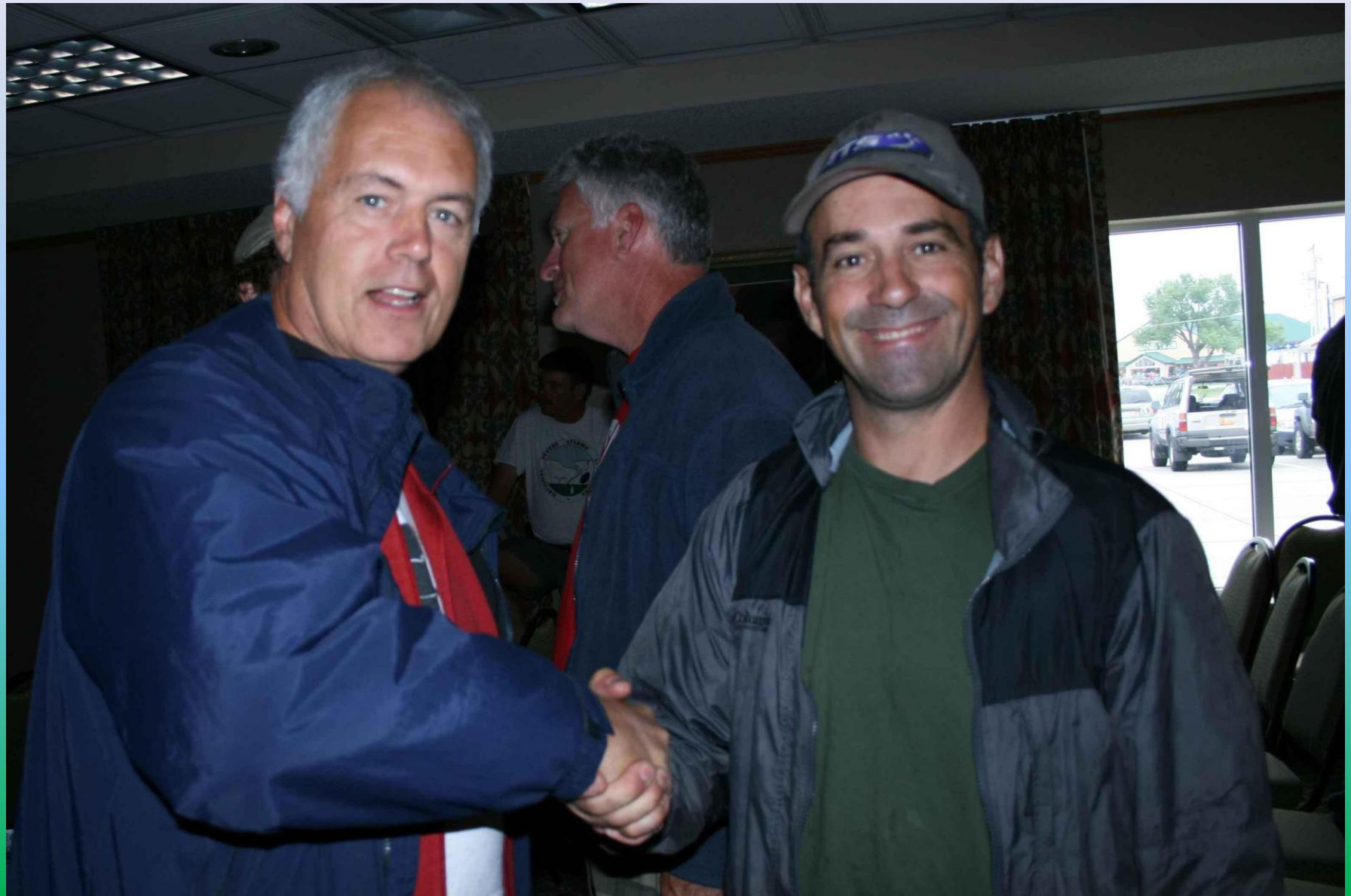
DOW image of tornado – 4:19 PM



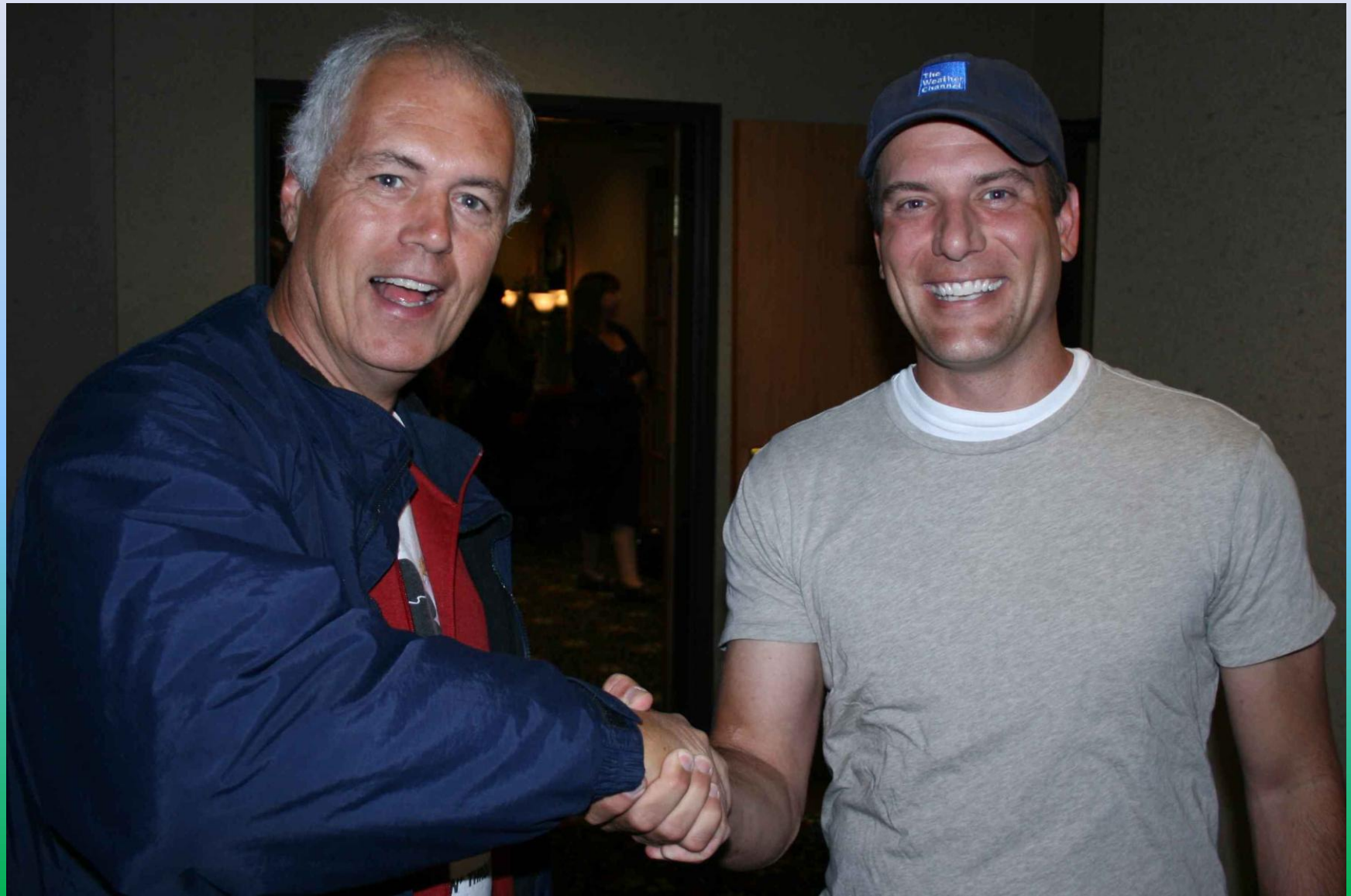


Dr. Josh Wurman was happy

Sean Casey (TIV2) was happy



Mike Bettes (TWC) was happy



Don Burgess (the forecaster) was happy

Wyoming cows were happy

Mesonet group was not happy

Inside mobile mesonet vehicle

Acknowledgements

- All principal investigators, NSF, and NOAA.
- Drs. Josh Wurman and Karen Kosiba (CSWR)
- Dr. Lindsay Bennett and Matt Rydzig (2009 drivers)
- Shawn McQuinn and Carrie Cunningham (2010 drivers)
- Brian Pollack (videographer for TWC)
- Gino Degrandis, Ryan McGinnis, and Chris Hill (freelance photographers)
- NHK TV – Japan, Wakana Nakimoto
- Roger Hill, Vern Carlson (photos)