WES Case Student Guide:
WFO FSD - July 5, 2022

Warning Operations Course: Severe Curriculum

NWS Warning Decision Training Division

Released August 2024

Overview:

This simulation focuses on threat assessment and warning methodologies for a derecho that traversed the Sioux Falls, SD weather forecast office (FSD) county warning area (CWA) between 1800 and 2300 UTC. The simulation is intended for students who are enrolled in the FY24 WOC Severe course but, this simulation also can be used for anyone who wishes to practice a severe weather event.

WES in the Cloud Case Instructions:

Contact your office's WES point of contact (SOO or WES focal point) to access the case via a WES in the Cloud instance.

Part 1: Hazard Assessment, Radar & Warning Strategies

Prerequisites

WOC Severe students, prior to taking the WES simulation, should complete all of the following:

1. Hand analysis homework (via the How to Hand Analyze Maps module)
2. WOC Severe Instructor-Led Webinar
3. Recommended modules:
    a. The I-SPIDA Warning Workflow
    b. Advanced Warning Methodology: Wind from Linear Storm Modes
    c. Anticipating Severe Winds
    d. Introduction to Derechos
    e. Derecho Warning Strategies and Operations

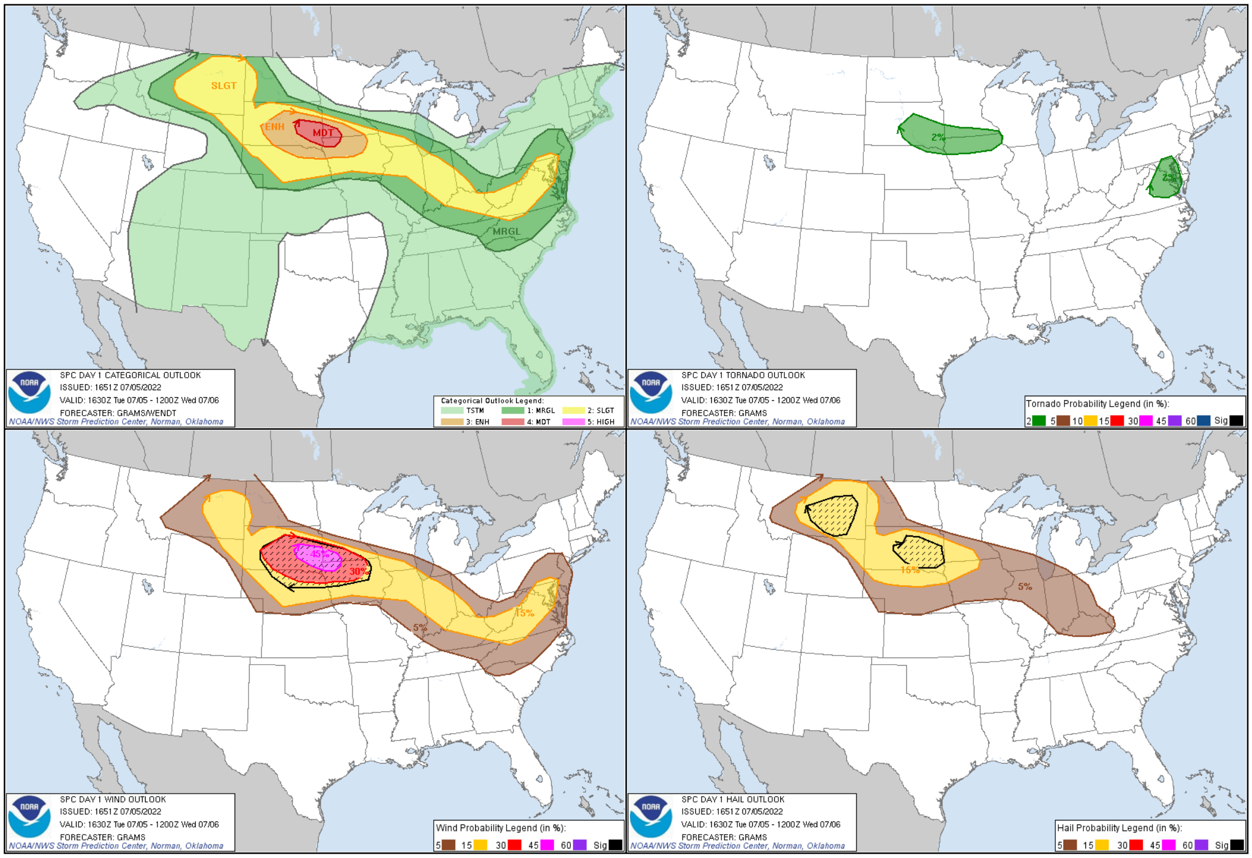
Non-WOC Severe students, prior to taking the WES simulation, should complete the following:

1. "Mesoanalysis Walk-Through Worksheet" at the back of this student guide.
2. Recommended modules:
    a. The I-SPIDA Warning Workflow
    b. Advanced Warning Methodology: Wind from Linear Storm Modes
    c. Anticipating Severe Winds
    d. Introduction to Derechos
    e. Derecho Warning Strategies and Operations

Then, all those taking the WES simulation should complete the following steps:

1. Take the introduction module, WES Case Introduction: FSD July 2022, which provides an overview of the case.
2. Based on your threat assessment and convective expectations, discuss your warning strategy with your facilitator. Include all facets of the I-SPIDA Warning Methodology in your discussion.

SPC Day 1 Convective Outlook 1630Z

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Day 1 Convective Outlook CORR 1
NWS Storm Prediction Center Norman OK
1151 AM CDT Tue Jul 05 2022

Valid 051630Z - 061200Z

...THERE IS A MODERATE RISK OF SEVERE THUNDERSTORMS SOUTHEAST SOUTH
DAKOTA...SOUTHWEST MINNESOTA...AND NORTHWEST IOWA...

CORRECTED FOR NDFD GRIDDED SIG HAIL

...SUMMARY...
A derecho with embedded significant severe wind gusts appears
probable from central to eastern South Dakota into southwest
Minnesota and northern Iowa into this evening.

...SD to IA and southern MN...
An intense cluster over central SD will likely persist
east-southeast across southeast SD. This should evolve into a
forward-propagating linear MCS, expanding in latitudinal extent as
MLCIN further diminishes ahead of it. A large MLCAPE reservoir in
excess of 3000 J/kg across southern SD/MN and northern IA will
support potential for embedded significant severe wind gusts
exceeding 75 kts. While the majority of CAM guidance appears to be
egregiously poor (especially the HRW-FV3) with handling the
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conceptual model for this event, the 12Z HRW-ARW and NSSL are in the ballpark and suggest bowing linear segments will be maintained into southern MN and northern IA before weakening this evening.

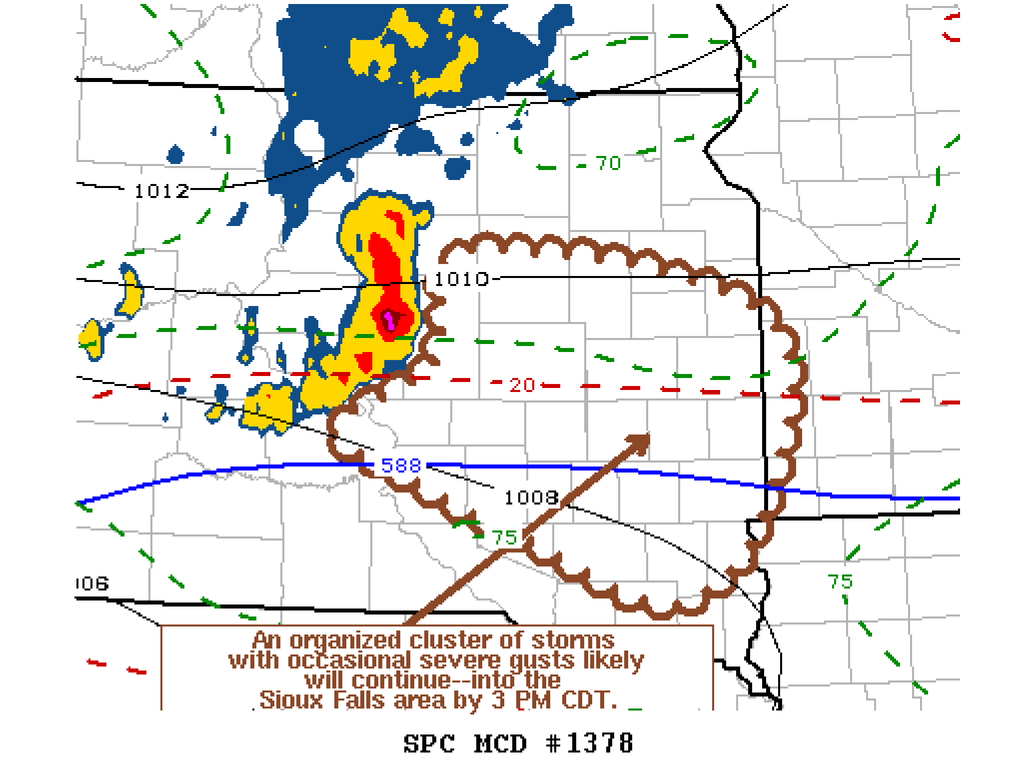
...Central/eastern MT to western ND...
Air mass recovery is underway across central to eastern MT in the wake of the intense MCS over northwest SD. Residual 50s to low 60s surface dew points in conjunction with pockets of pronounced boundary-layer heating will yield MLCAPE of 1000-1500 J/kg. With 45-55 kt effective bulk shear, at least a few supercells are expected from central to northeast MT during the late afternoon and evening with large hail and isolated severe wind gusts as the primary threats. Some of these cells should consolidate into a cluster that spreads into western ND during the evening. Overall intensity should decrease as activity impinges on the more stable air mass left in the wake of the SD MCS.

...Mid-Atlantic to Midwest...
Poor mid-level lapse rates were evident in 12Z observed soundings east of the Appalachians and this will be the main limiting factor to more intense convective development. An MCV over western PA will move east towards the NJ coast, with scattered thunderstorms near and to its south. With 30-40 kt 700-mb westerlies impinging on the region attendant to this MCV and the boundary-layer destabilizing from south to north, an increase in strong gust potential should occur from VA into the Lower DE Valley.

Arcing convective bands extend west of the lead MCV across WV and OH/IN. This activity will likely persist through the rest of the afternoon into this evening, building south-southwest in time towards large buoyancy centered on the Lower OH Valley. Moderate deep-layer shear will be further offset as this process occurs, suggesting that loosely organized clusters will dominate with strong to isolated severe gusts as the primary threat. Additional multicell clusters will probably form northwest along the baroclinic zone near the IA/IL/WI border area during the late afternoon into the evening. These will similarly pose a threat for scattered damaging winds and isolated severe hail, although the spatial extent of this threat will likely be limited by this morning's stabilization in OH.

..Grams/Wendt.. 07/05/2022

SPC Mesoscale Discussion 1378



Mesoscale Discussion 1378
NWS Storm Prediction Center Norman OK
1231 PM CDT Tue Jul 05 2022

Areas affected...central through southeastern South Dakota and adjacent southwestern Minnesota....northwestern Iowa

Concerning...Severe Thunderstorm Watch 436...

Valid 051731Z - 051930Z

The severe weather threat for Severe Thunderstorm Watch 436 continues.

SUMMARY...An organized cluster of severe storms appears likely to be maintained, and continue to be accompanied by severe wind gusts and hail while approaching the Sioux Falls area through 1-3 PM CDT. A new severe weather watch probably will be needed east-southeast of WW 436.

DISCUSSION...Despite considerable lingering inhibition for seasonably moist boundary-layer parcels (including surface dew points near 70F) within its inflow , forcing for ascent along the convectively generated cold pool continues to overcome mid-level capping and maintain intense convective development now southeast through east of the Pierre vicinity. Beneath very steep lower/mid tropospheric lapse rates, CAPE is increasing in excess of 3000 J/kg, and strongest convection continues to be accompanied by heavy rain, occasional severe hail and frequent lightning flash rates.

Heavy precipitation loading, and melting/evaporation of precipitation within the downdrafts, are aiding downward transfer of 30-50+ kt rear inflow, and contributing to occasional severe surface gusts. With continuing boundary-layer warming and at least some further erosion of inhibition near/ahead of activity, this all seems likely to be maintained across and north of the Interstate 90 corridor into the Sioux Falls area by around 20Z.

..Kerr.. 07/05/2022

...Please see www.spc.noaa.gov for graphic product...

ATTN...WFO...MPX...FSD...ABR...

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LAT...LON   45049877 44659642 43579646 43049717 43419830 43779928
            44039983 44399903 45049877
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Part 2: Simulation

Set-up: Simulation Paused at 1902 UTC

Take this time to load your warning procedures and do an environmental analysis. Then, while paused, work through your first I-SPIDA cycle.

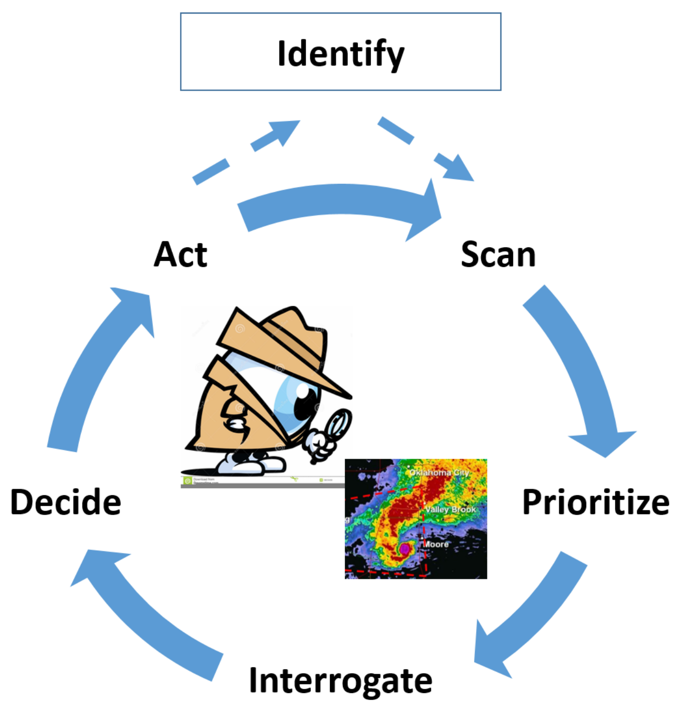
Warning Simulation Period: 1902 - 2135 UTC

As the warning forecaster[1], you are responsible for issuing warnings along the line of storms moving through the FSD CWA. As warning meteorologist, your goals include:

1. Follow the I-SPIDA warning workflow in your warning process.
2. In the “Act” step of the I-SPIDA warning workflow, follow the 10 Steps to Issue a Warning or Statement to issue timely warnings for the convective hazards associated with this event.

Warning Simulation Period (BONUS): 2135 - 2300 UTC

Those who wish to continue with the case can run it up to an hour longer, providing an opportunity to warn across a metro area and as the system moves through the FSD CWA.



[1] Note that WDTD is using the phrase “warning meteorologist” or “warning forecaster” to replace “radar operator,” as NWS meteorologists do so much more than “operate” a radar in their warning process!

10 Steps to Issue a Warning or Statement

1. Select the warning **product type**
2. Check the **duration**
3. Place the "drag me to a storm" **point or line** on the storm
4. Track and check **storm motion**
5. Create and/or trim the warning **polygon**
6. Select the **source** and **tag**
7. Select the **hazards/intensity** and **calls-to-action**
8. Create and **quality-control** the text, then **send**
9. Hit "**restart**" to clear the hatched outline area
10. Write down the warning info on your **Warning Tracking Sheet**

Part 3: Debrief

Watch the debriefing module, WES Case Summary: FSD July 2022, and take its quiz in the CLC module for course completion credit (mandatory for those in WOC Severe). If proctored, your SOO or facilitator will review the case with you, focusing on how you performed regarding the stated objectives.

Mesoanalysis Walk-Through Worksheet

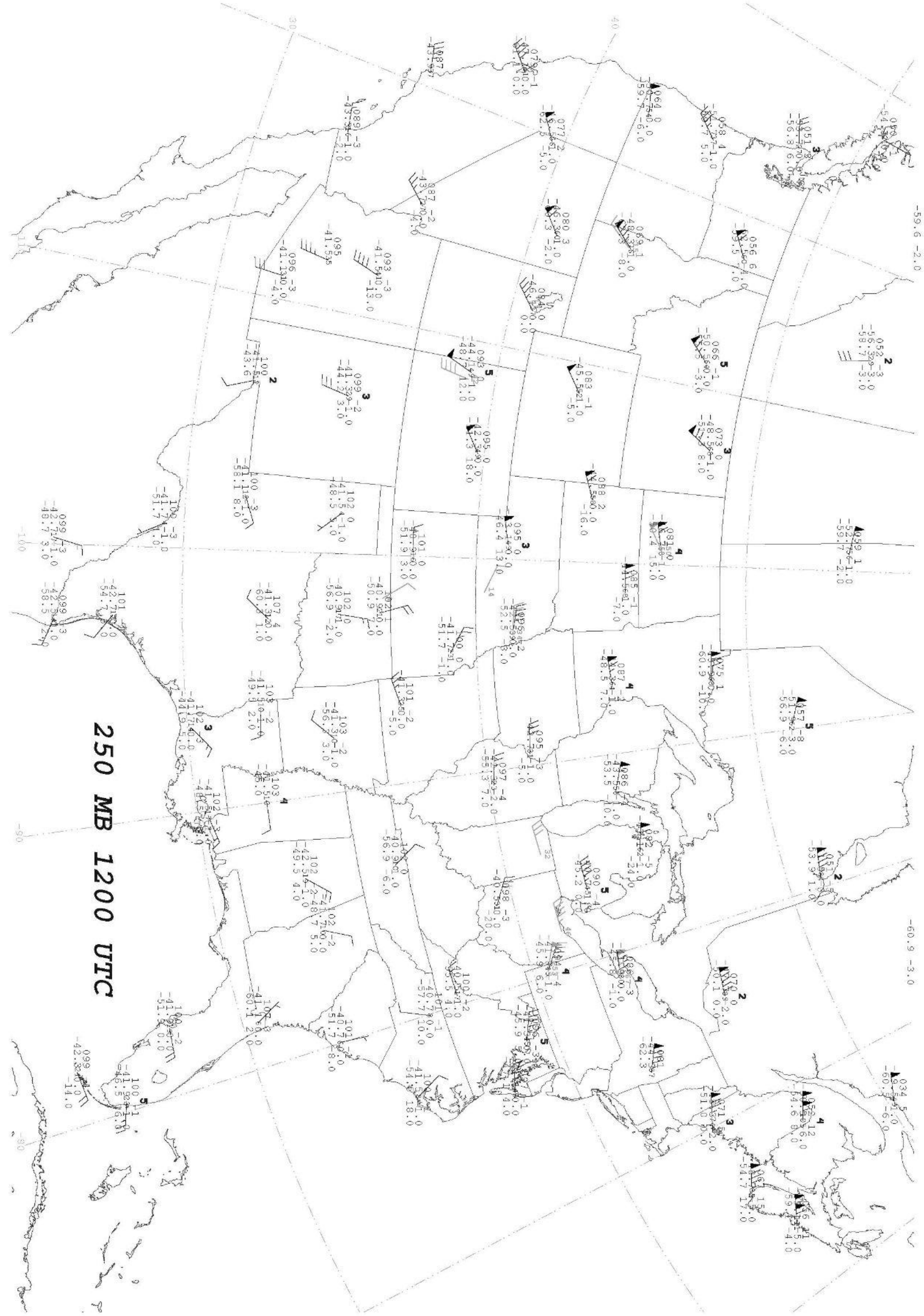
This section is for those who take the WES case but are not enrolled in WOC Severe in FY24. It provides guidance for investigating the mesoscale and near-storm environment prior to issuing the first warning and is a necessary component in the “Identify” step of the I-SPIDA Warning Workflow for this event.

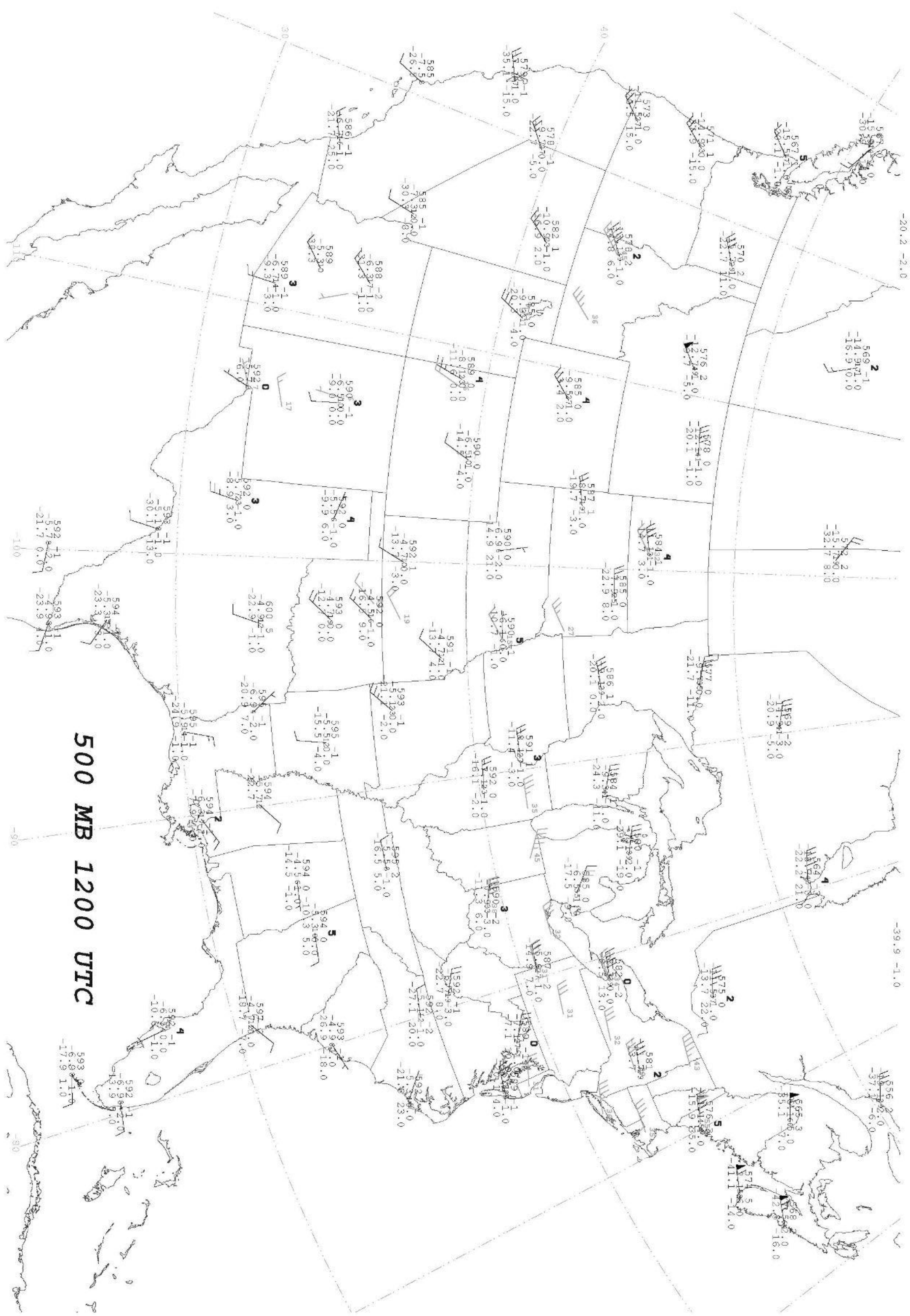
1. Open the case using the macro provided in the WES case instructions.
2. Review the content provided in the pages that follow in this guide.
3. Take a representative point forecast sounding using RAP13 in the airmass in the FSD CWA ahead of the line. Using that sounding, complete the tables that follow to assess the threats for tornadoes, hail, and damaging winds. For more context for these tables, please head to the WDTD RAC References VLab page and download the Warning Methodology Worksheet.
4. Review the SPC Mesoanalysis at 18Z (as seen in the case) to assess the spatial extent of the parameters assessed in the point sounding, as well as any other parameters of interest or note.
5. Write a one-paragraph mesoanalysis discussion and share it with your training facilitator. The discussion should be succinct and include supportive reasoning for the level of risk you have assigned to each convective hazard.
6. When your training officer has determined that you have completed the steps to their satisfaction, move on to Part 2.

Mesoanalysis Materials

12Z Surface and Upper-Air Maps for Hand Analysis

(Maps follow on next 5 pages. Please print full size and hand analyze!)


250 MB 1200 UTC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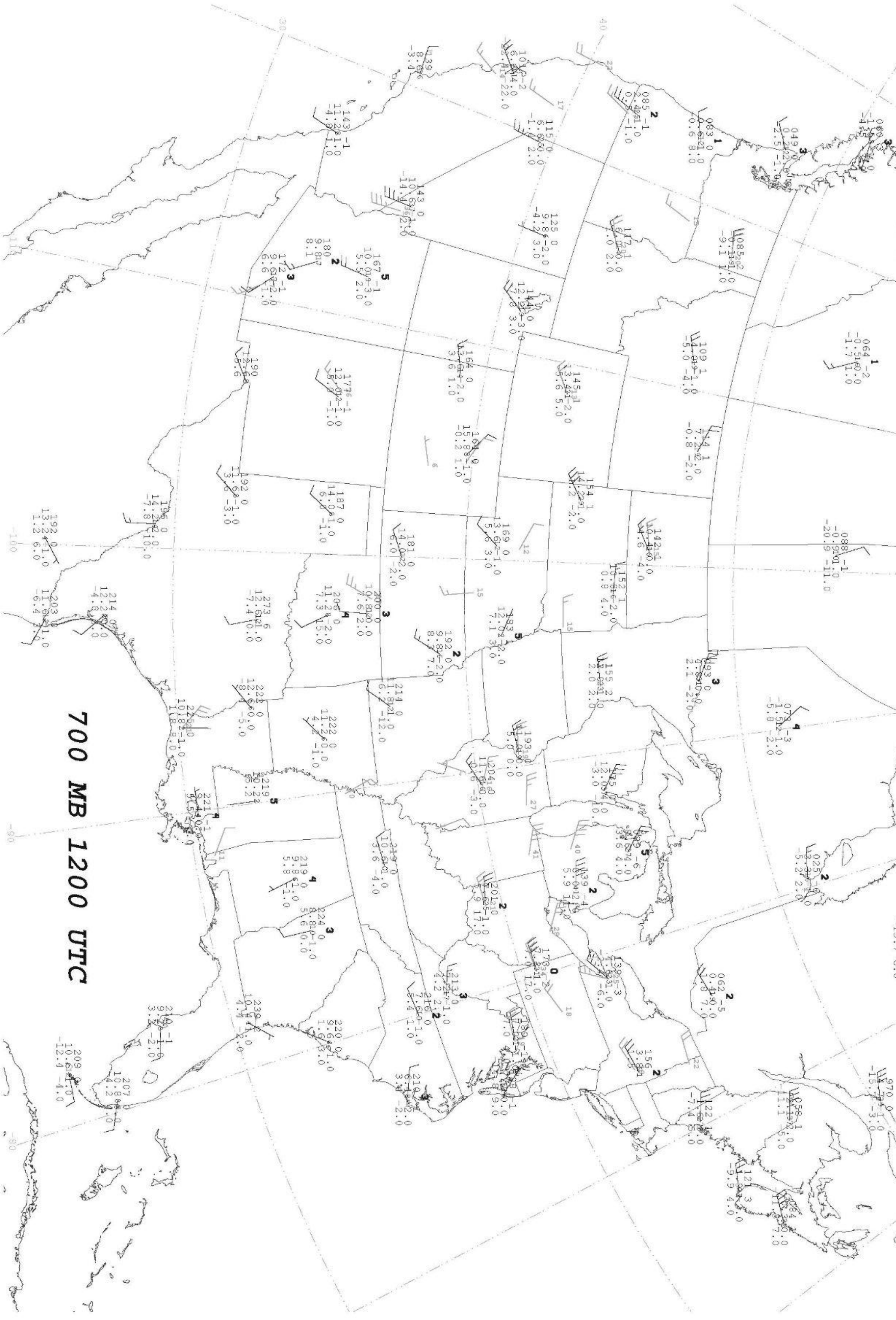
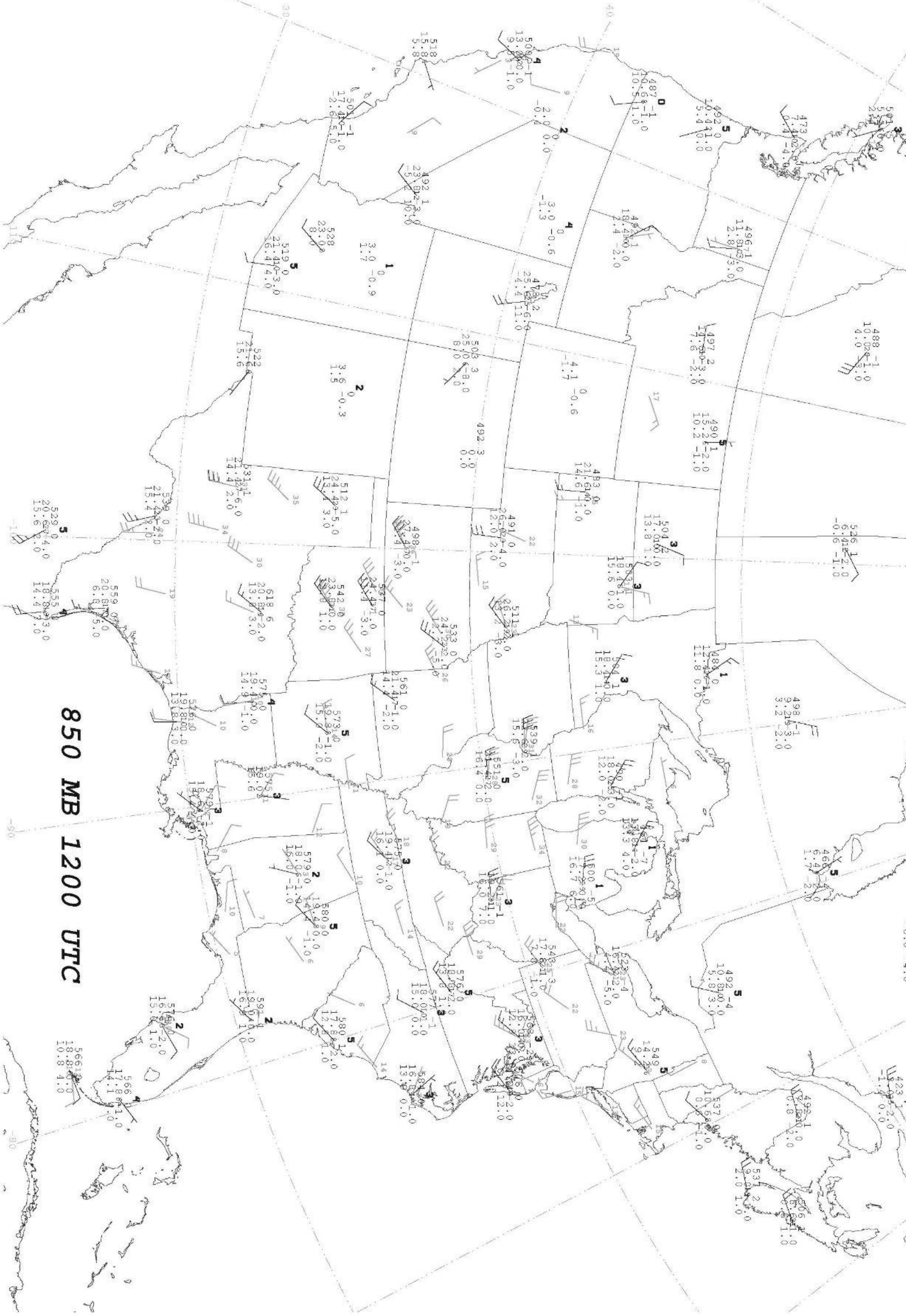
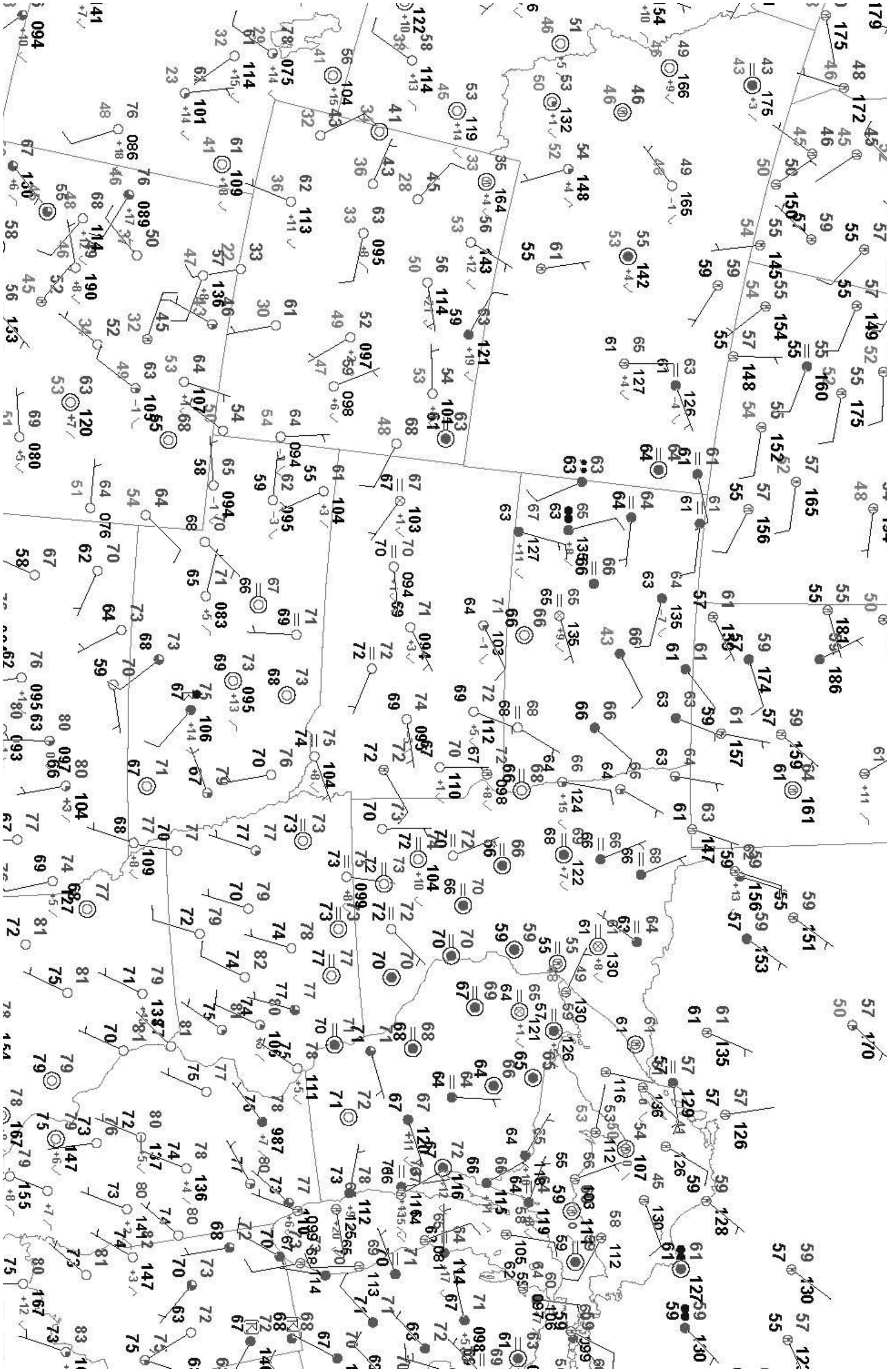


700 MB 1200 UTC



850 MB 1200 UTC



12Z

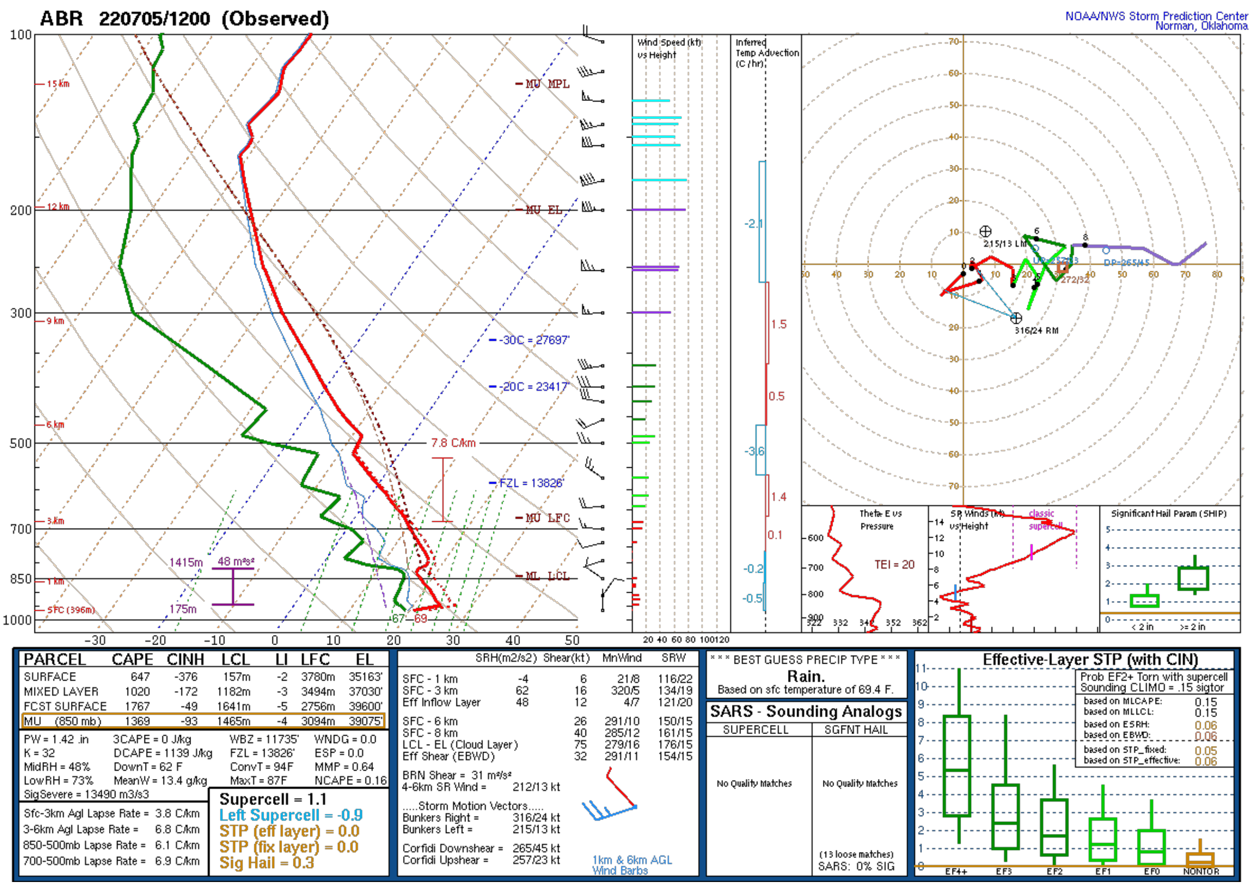


Fig. 1. SPC sounding from KABR at 1200 UTC on July 5th, 2022.

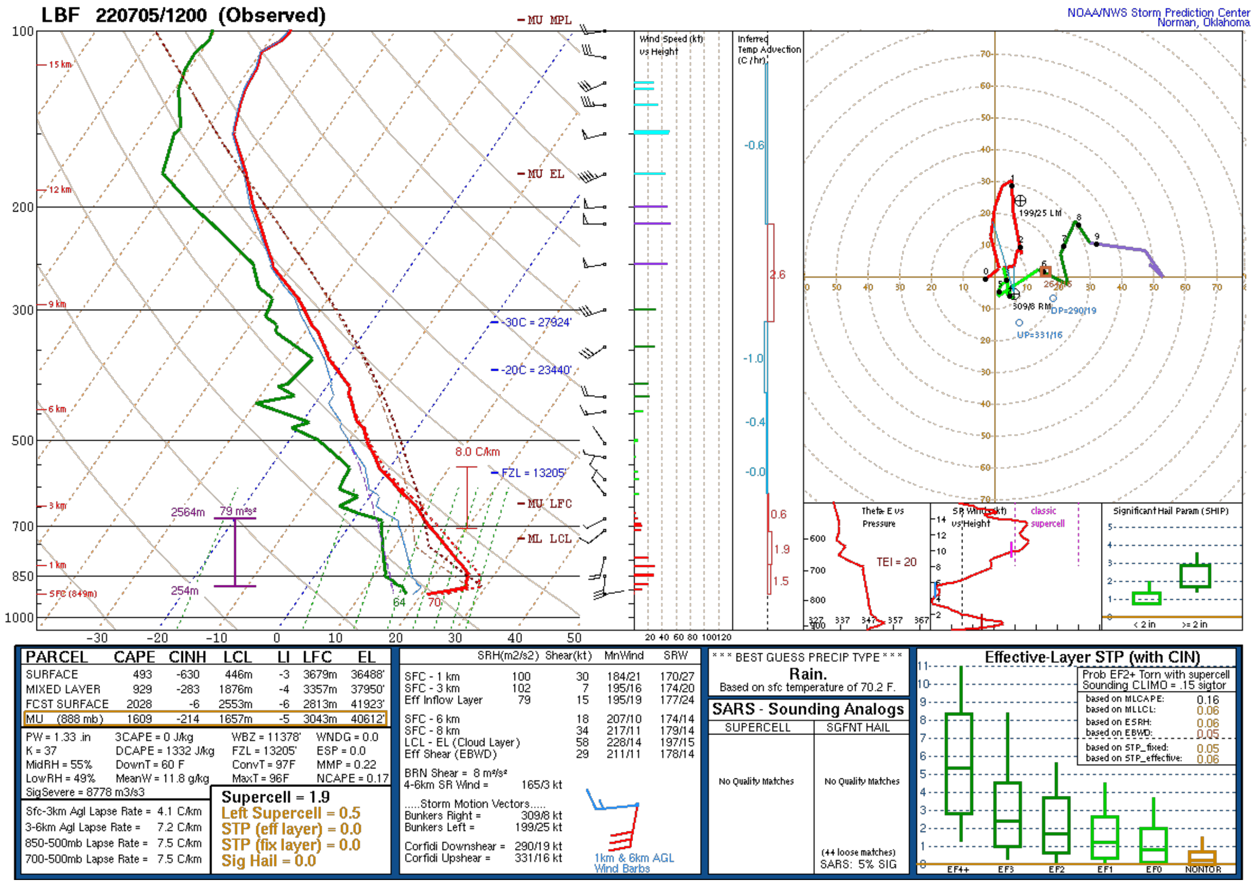


Fig. 2. SPC sounding from KLBF at 1200 UTC on July 5th, 2022.

15Z

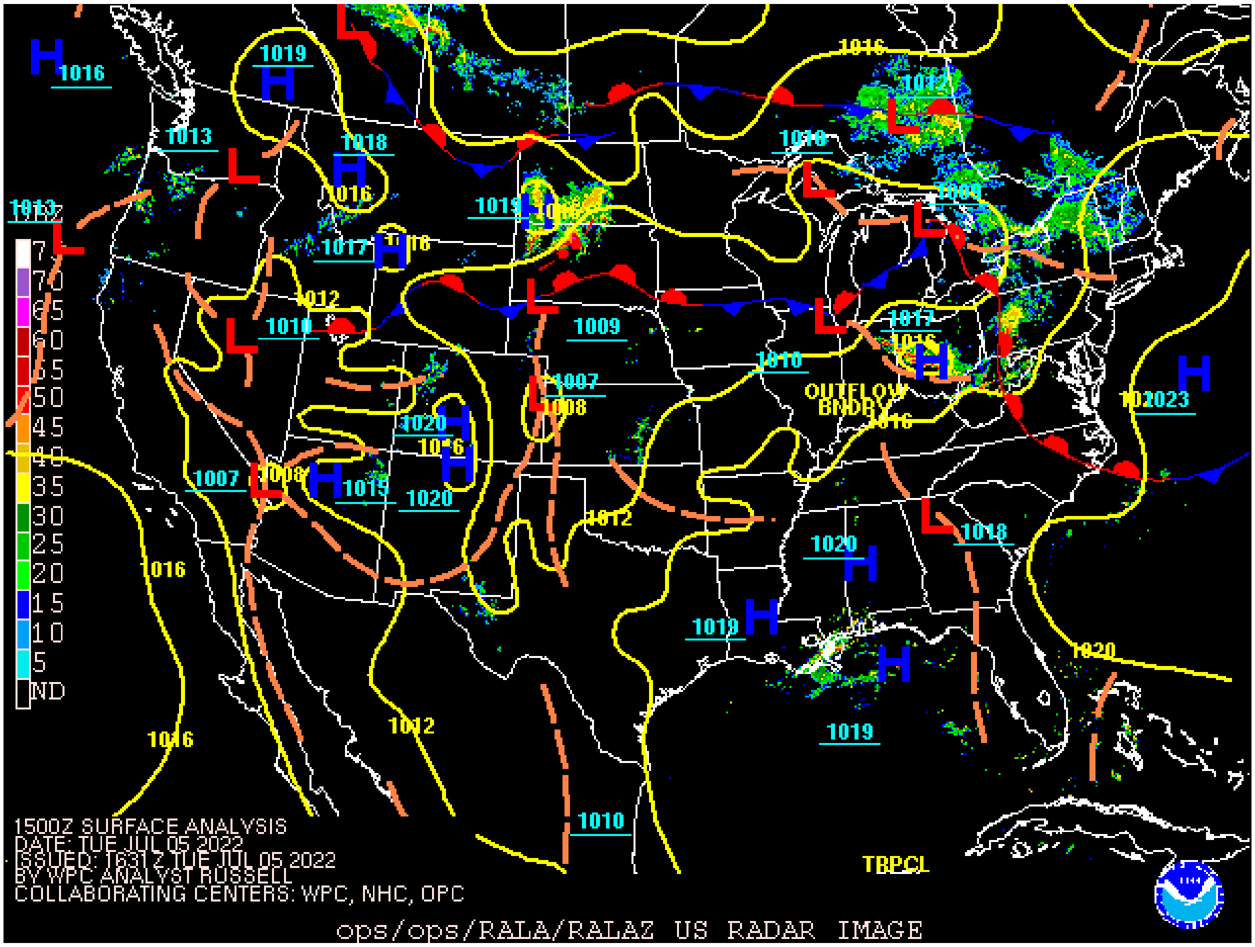


Fig. 3. WPC surface frontal analysis as of 1500 UTC on the morning of July 5th, 2022.

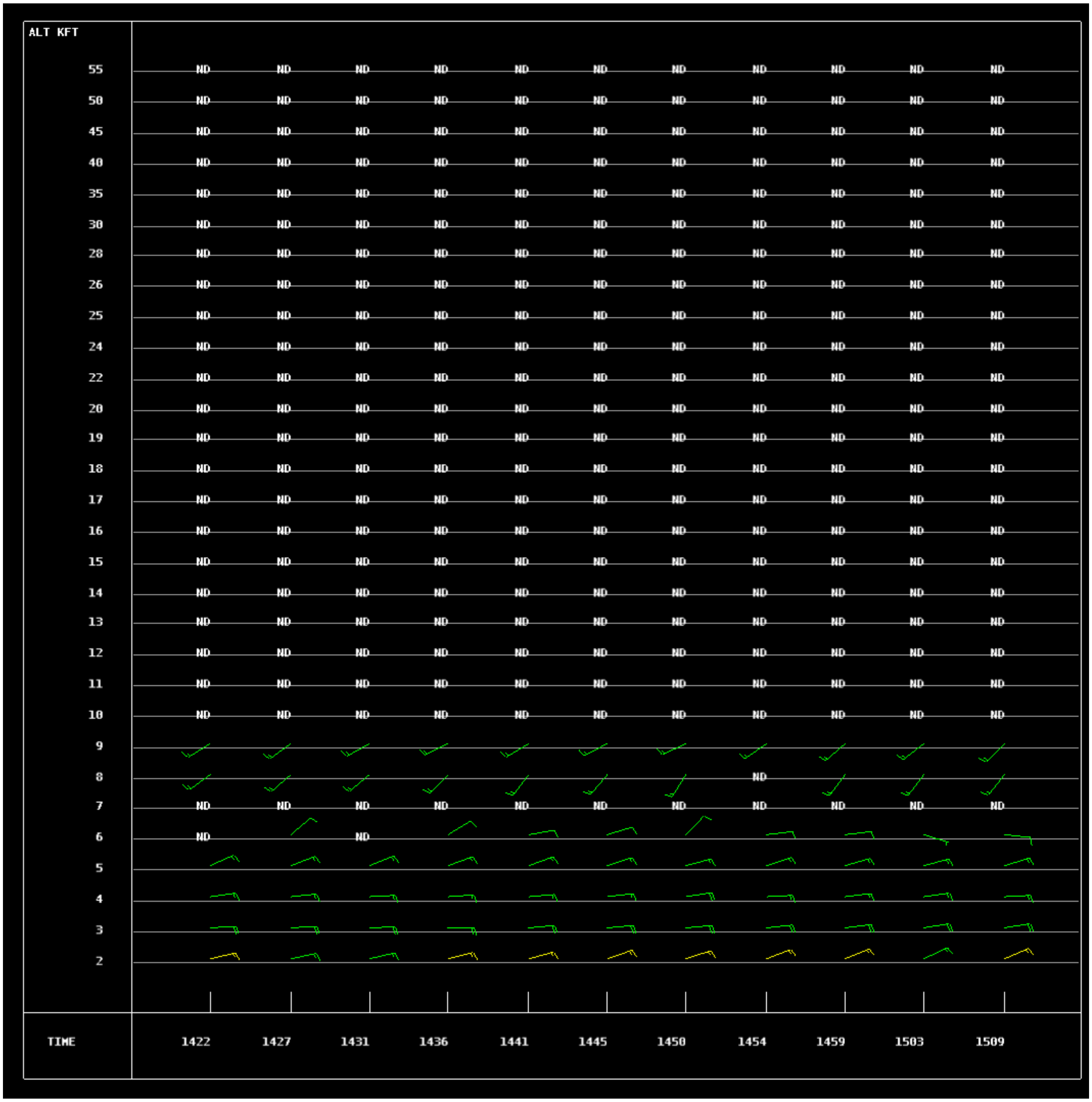


Fig. 4. KFSD vertical wind profile (VWP) valid at 1500 UTC.

18Z

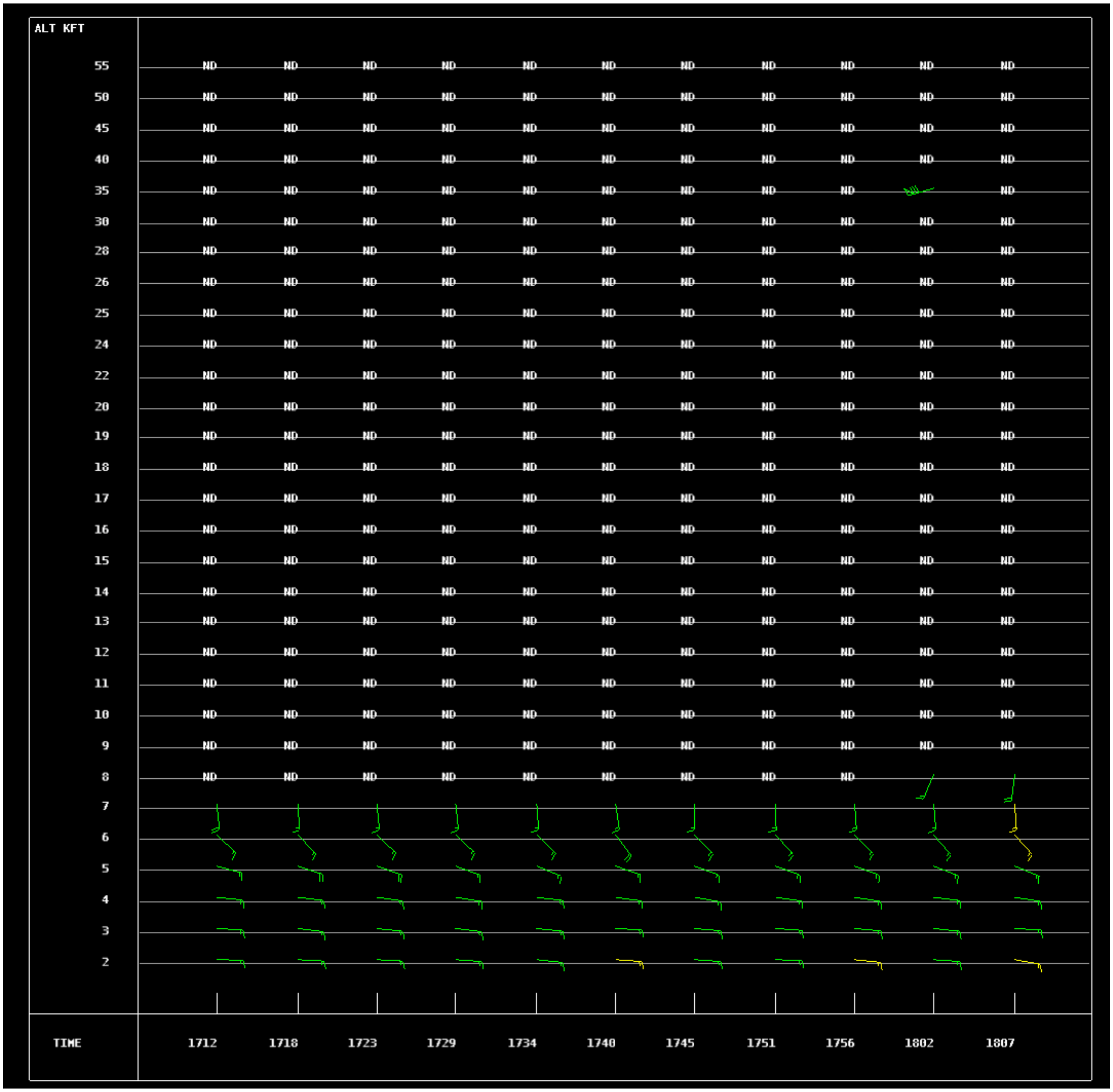


Fig. 5. KFSD VWP valid at 1800 UTC.

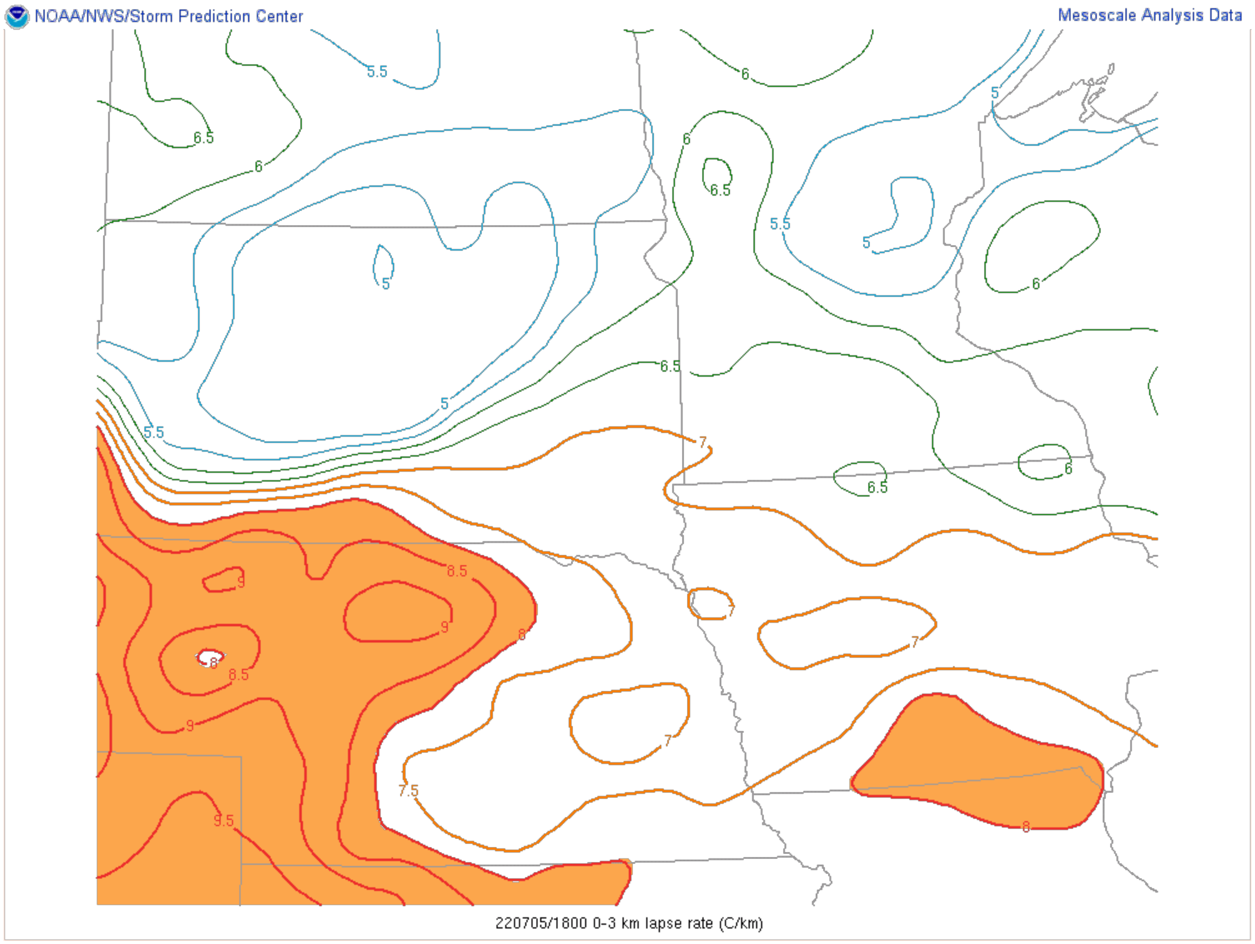


Fig. 6. SPC mesoanalysis of low level lapse rates valid at 1800 UTC.

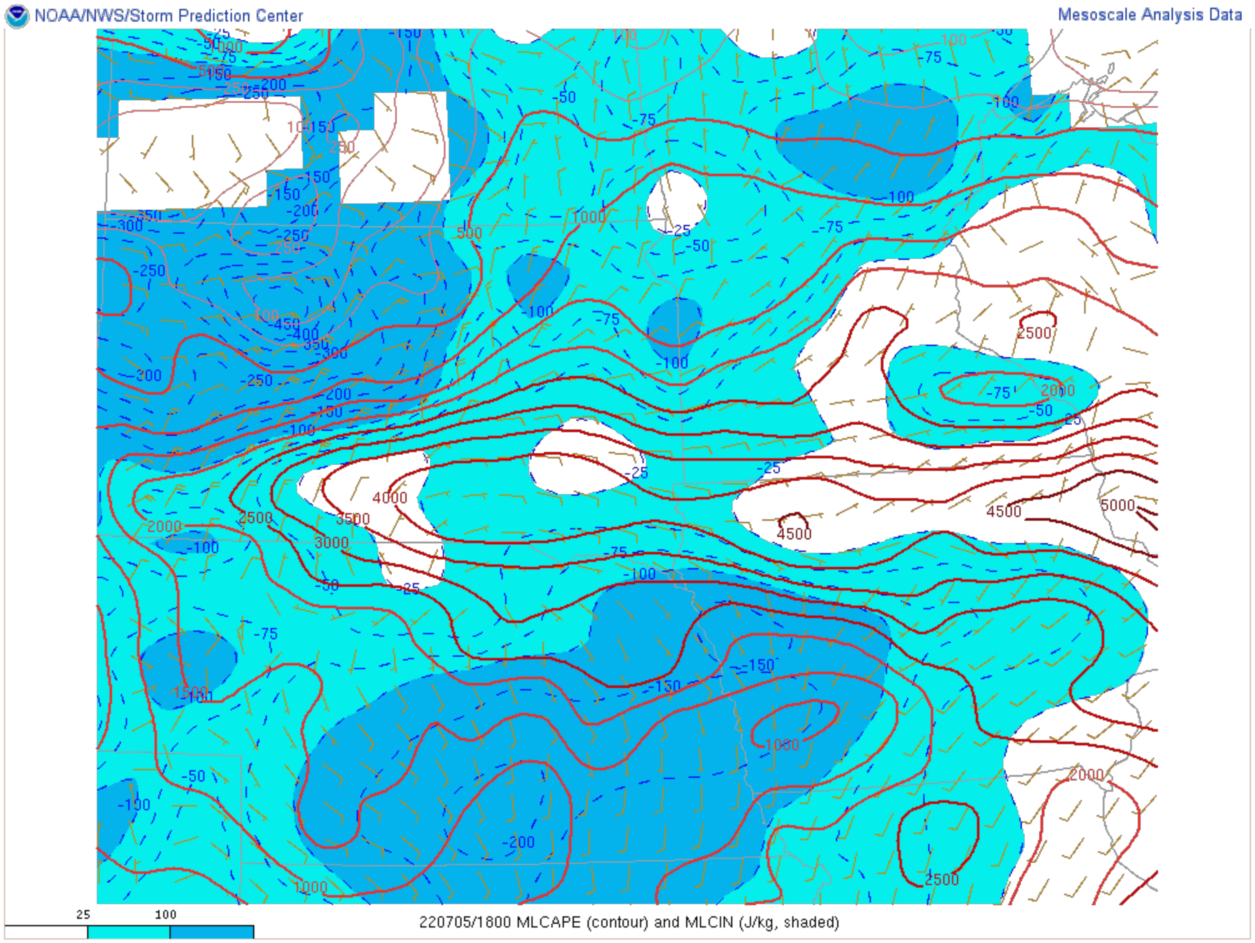


Fig. 7. SPC mesoanalysis of MLCAPE (red contours) and MLCINH (blue contours, shaded fill) valid at 1800 UTC.

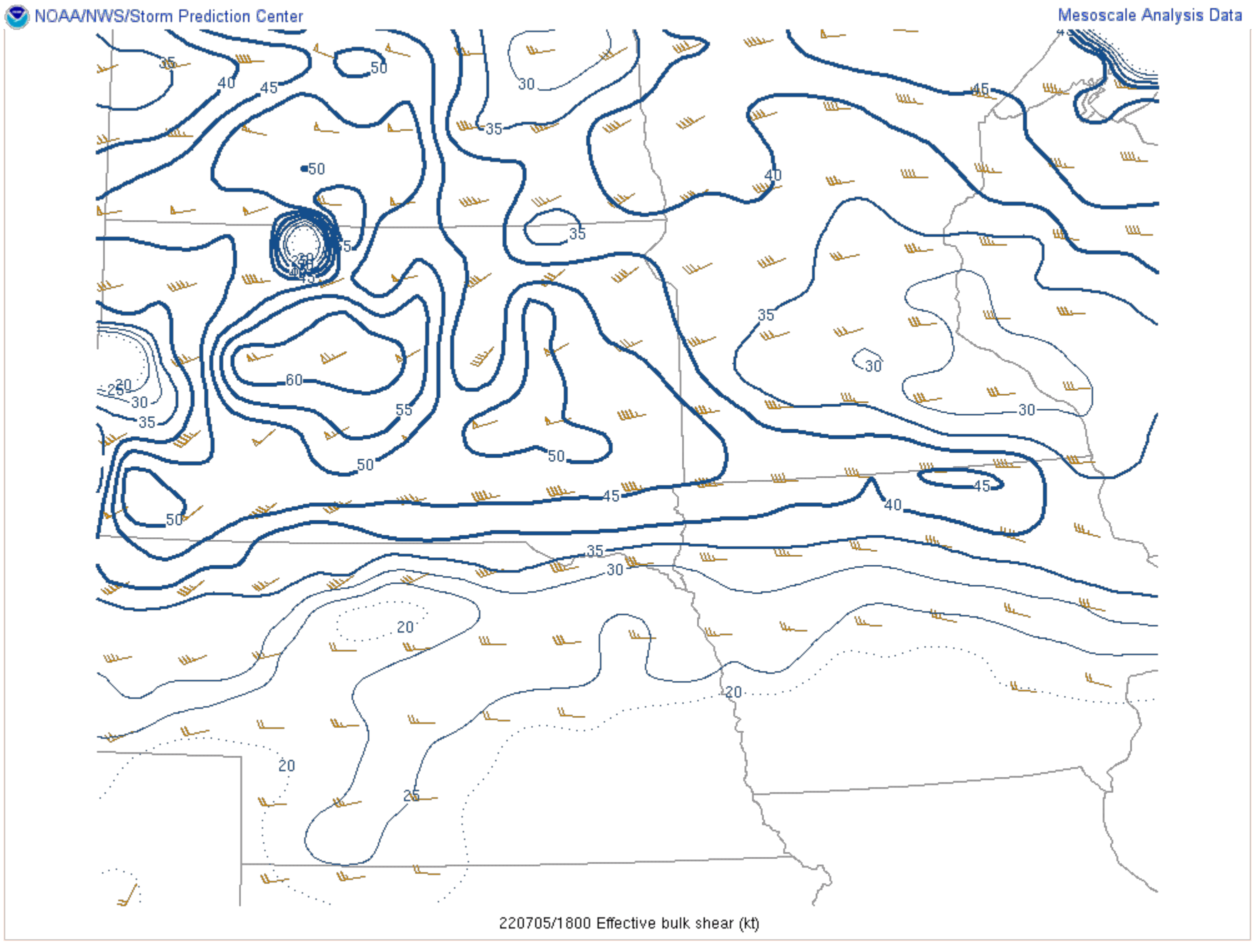


Fig. 8. SPC mesoanalysis of effective shear valid at 1800 UTC.

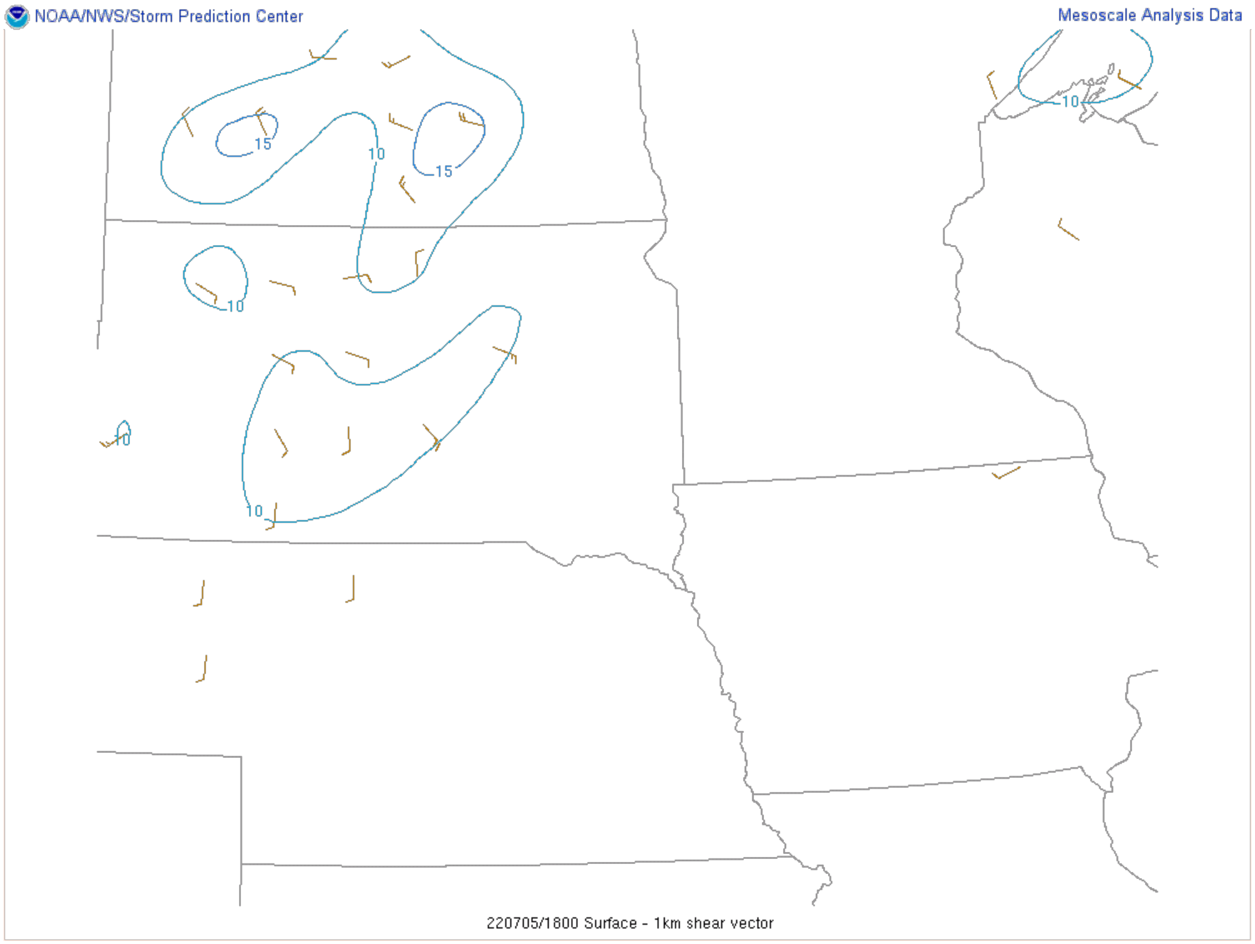


Fig. 9. SPC mesoanalysis of 0-1-km shear valid at 1800 UTC.

Near-Storm Environment Evaluation

Using a RAP13 model sounding at 18Z (mesoanalysis evaluation time)

Tornado

Mesocyclonic Parameters	**Necessary Value**	**Preferred Value**	**Value**
0-1 km shear	≥15 kt	≥20 kt	
Significant Tornado Parameter (Eff)	>0	>1	
100 mb mean parcel mixed layer CAPE (MLCAPE)	>0 J/kg	>1500 J/kg	
100 mb mean parcel mixed layer CIN (MLCIN)	>-200 J/kg	>-50 J/kg	
100 mb mean parcel LCL height (MLLCL)	<2000 m	<1000 m	
Effective storm relative helicity (*"eff inflow layer*" in NSHARP)	>0 m^2/s^2	>150 m^2/s^2	
Effective bulk wind difference (EBWD)	≥25 kt	≥40 kt	
Non-Mesocyclonic Parameters	**Necessary Value**	**Preferred Value**	**Value**
Non-Supercell Tornado Parameter (Eff)		>1	
0-3 km mixed layer CAPE (3CAPE)	>0 J/kg	>100 J/kg	
Mixed layer CIN (MLCIN)	>-225 J/kg	>-25 J/kg	
0-1 km lapse rate (LR_{0-1})		>9˚ C/km	
Surface relative vorticity		>8x10-5 s-1	
0-6 km bulk wind difference	≤35 kt	≤25 kt	
QLCS Parameters (Three Ingredients Method)	**Necessary Value**	**Preferred Value**	**Value**
0-3 km line normal bulk shear		≥30 kt	
Rear inflow jet or outflow caused surge in line		Yes	
0-3 km mixed layer CAPE (3CAPE)		≥40 J/kg	

Tornado Potential (circle one): No, Yes, Yes – Significant

Hail

Parameters	**Base Severe (≥1")**	**Significant (≥2")**	**Giant (≥4")**	**Value**
Freezing/melting (0 °C) level				
-20 °C level (ft AGL)				
Large Hail Parameter (LHP) (*LGHAIL" in NSHARP*)	≥4	≥5	≥8	
Most unstable CAPE (MUCAPE)	≥1600 J/kg	≥1850 J/kg	≥3000 J/kg	
Effective bulk wind difference (EBWD)	≥30 kt	≥40 kt	≥46 kt	
700-500 mb lapse rate ($LR_{700-500}$)		≥6.5 ˚C/km	≥7.0 ˚C/km	
Surface to equilibrium level bulk shear ($Shear_{EL}$) (*"LCL-EL (Cloud Layer)" in NSHARP*)		≥46 kt	≥60 kt	
Significant Hail Parameter (SHIP)		>1		

Hail Potential (circle one): No, Yes, Yes - Significant

Wind

Wet Microburst Parameters	**Necessary Value**	**Preferred Value**	**Value**
0-3 km maximum theta-e difference ($\Delta\theta_e$)		≥25 K	
Microburst Composite (MBCP)	**5-8**	**≥9**	
Surface-based CAPE (SBCAPE)	≥3100 J/kg	≥4000 J/kg	
0-3 km lapse rate (LR_{0-3})	>8.4 ˚C/km		
Downdraft CAPE (DCAPE)	≥900 J/kg	≥1100 J/kg	
Precipitable water	≥1.5"		
Dry Microburst Parameters	**Necessary Value**	**Preferred Value**	**Value**
Inverted-V sounding (apex based in midlevels)		Yes	
Most unstable CAPE (MUCAPE)	1-500 J/kg		
100-mb mean parcel LCL height (MLLCL)	>3 km AGL	Above Melting Layer	
0-3 km lapse rate (LR_{0-3})	≥Dry adiabatic		
Effective bulk wind difference (EBWD)		<30 kts	
QLCS/Derecho Parameters	**Necessary Value**	**Preferred Value**	**Value**
Derecho Composite Parameter (DCP)		**>2**	
Downdraft CAPE (DCAPE)	>0 J/kg	>980 J/kg	
0-6 km mean wind		>16 kt	
Most unstable CAPE (MUCAPE)	>0 J/kg	>2000 J/kg	
Effective bulk wind difference (EBWD)		>20 kt	

Wind potential (circle one): No, Yes, Yes - Significant