METR 4403/5403
Synoptic Exercise
2/9/2022

Material gathered by Rich Thompson

To answer in-class questions go to: pollev.com/severeclass641

GOALS

1) Construct a scientifically reasoned forecast from limited basic data.

1) Develop a reproducible forecast process.

How do we do this?

Using concepts such as:

- QG reasoning
- PV reasoning
- Jet Streak Dynamics
- etc...

Keep in mind pt 1...

Right now we're focusing on the evolution of synoptic scale features associated with severe weather events.

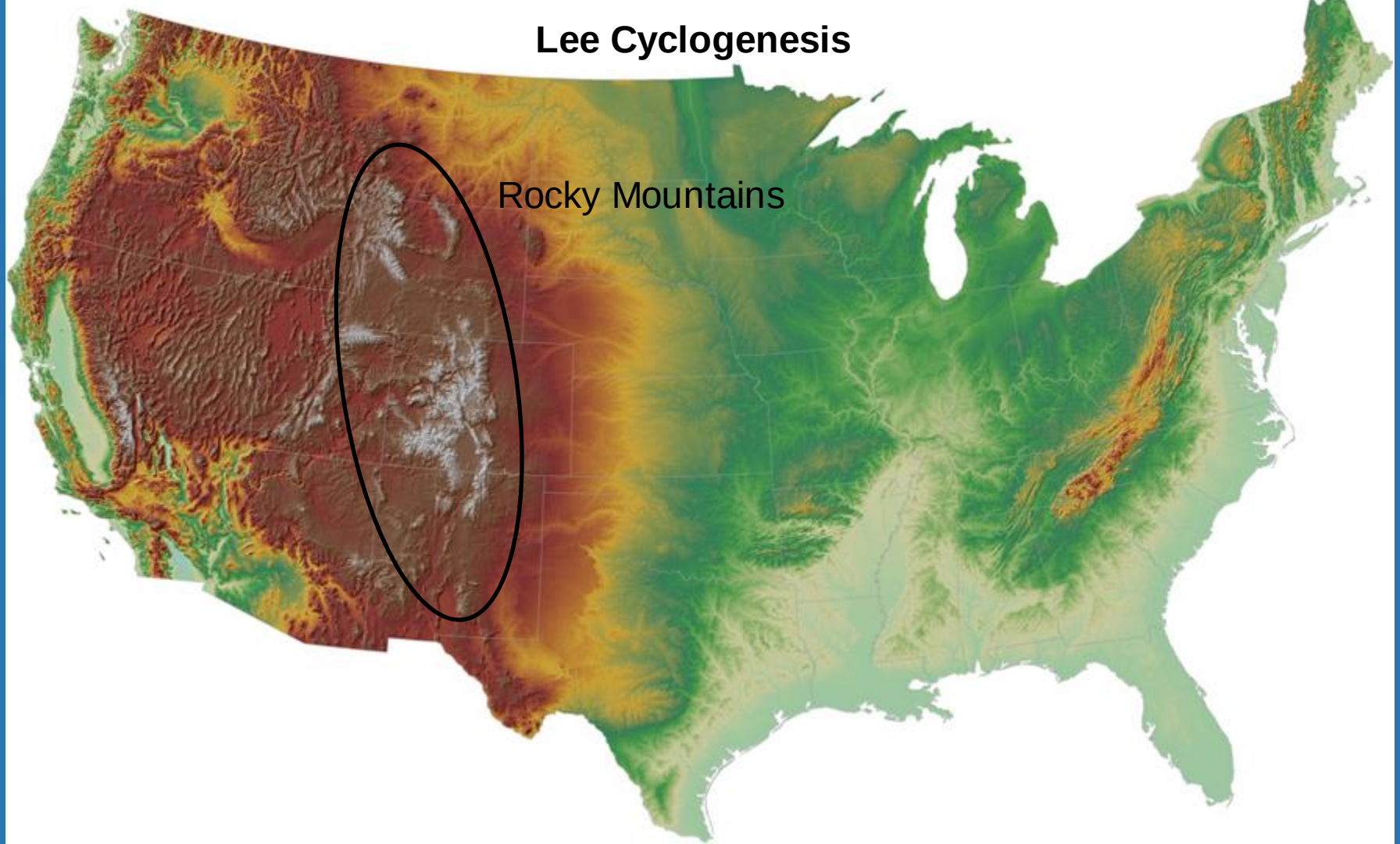
Details regarding the thunderstorm environments, mesoscale and storm-scale influences will be covered later.

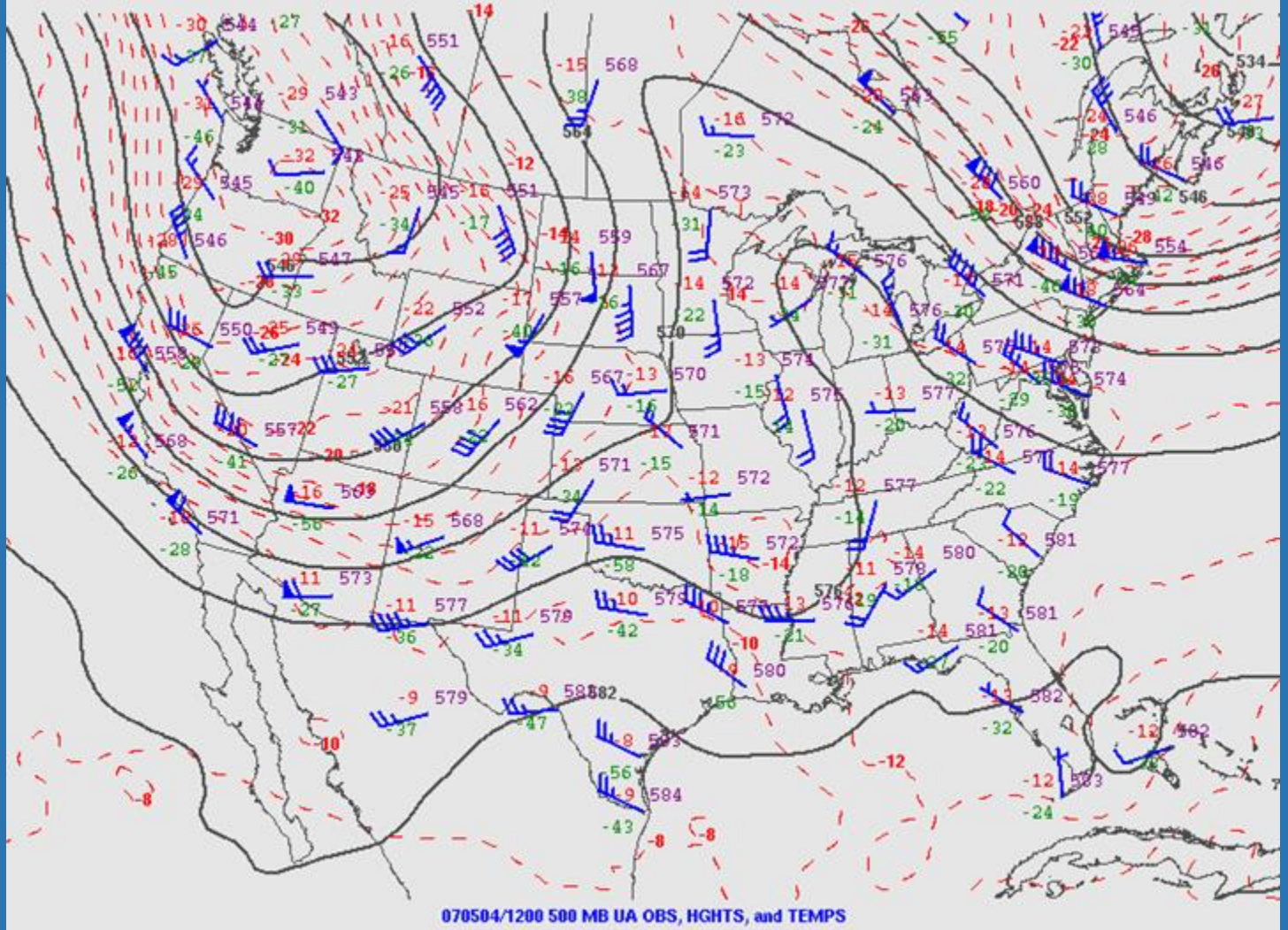
Keep in mind pt 2...

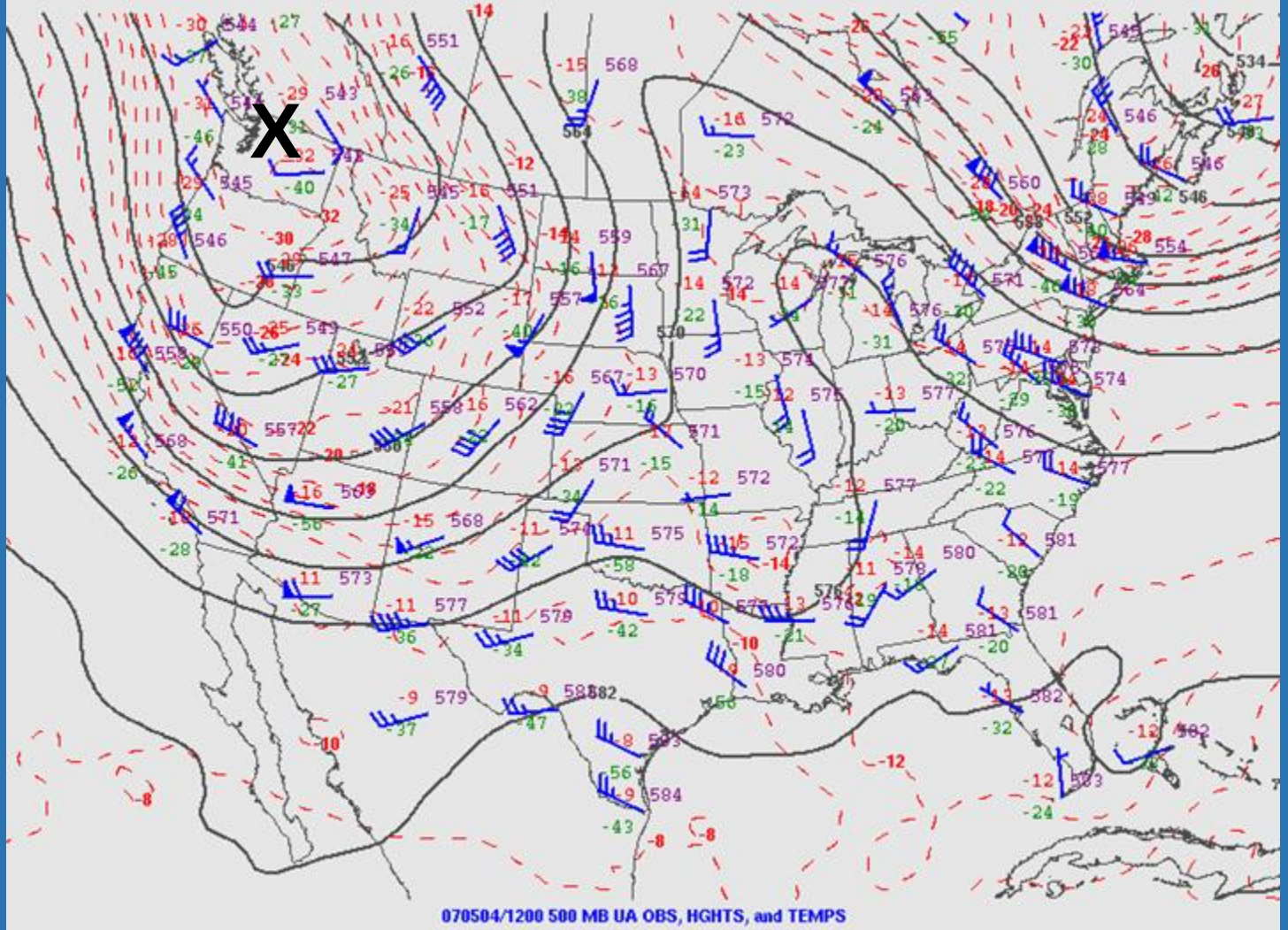
There are several different forcing mechanisms for ascent/descent in the atmosphere.
Be sure to consider:

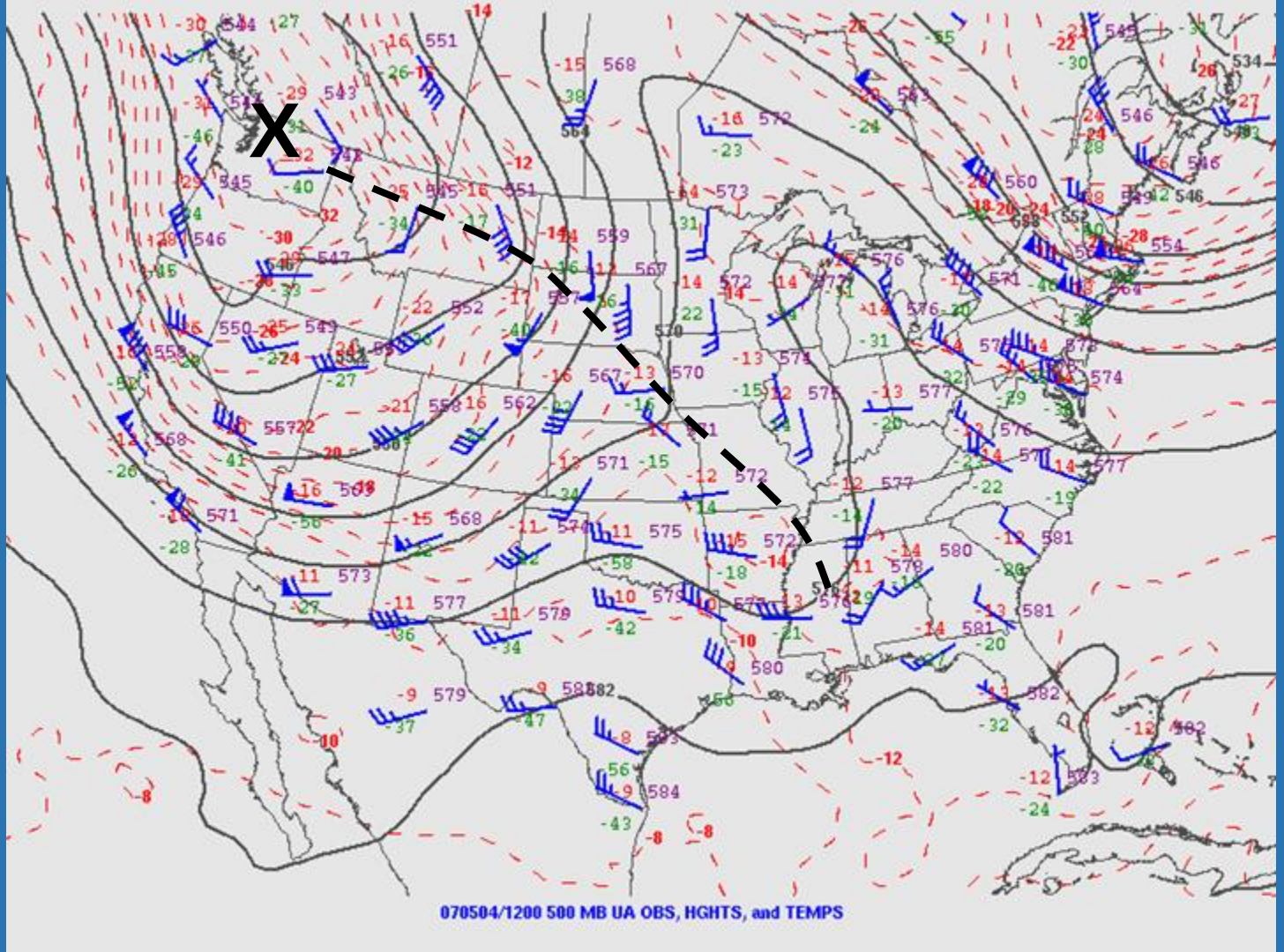
- Which mechanisms are the strongest?
- Where is there overlap of multiple mechanisms?
- What influence will these mechanisms have?

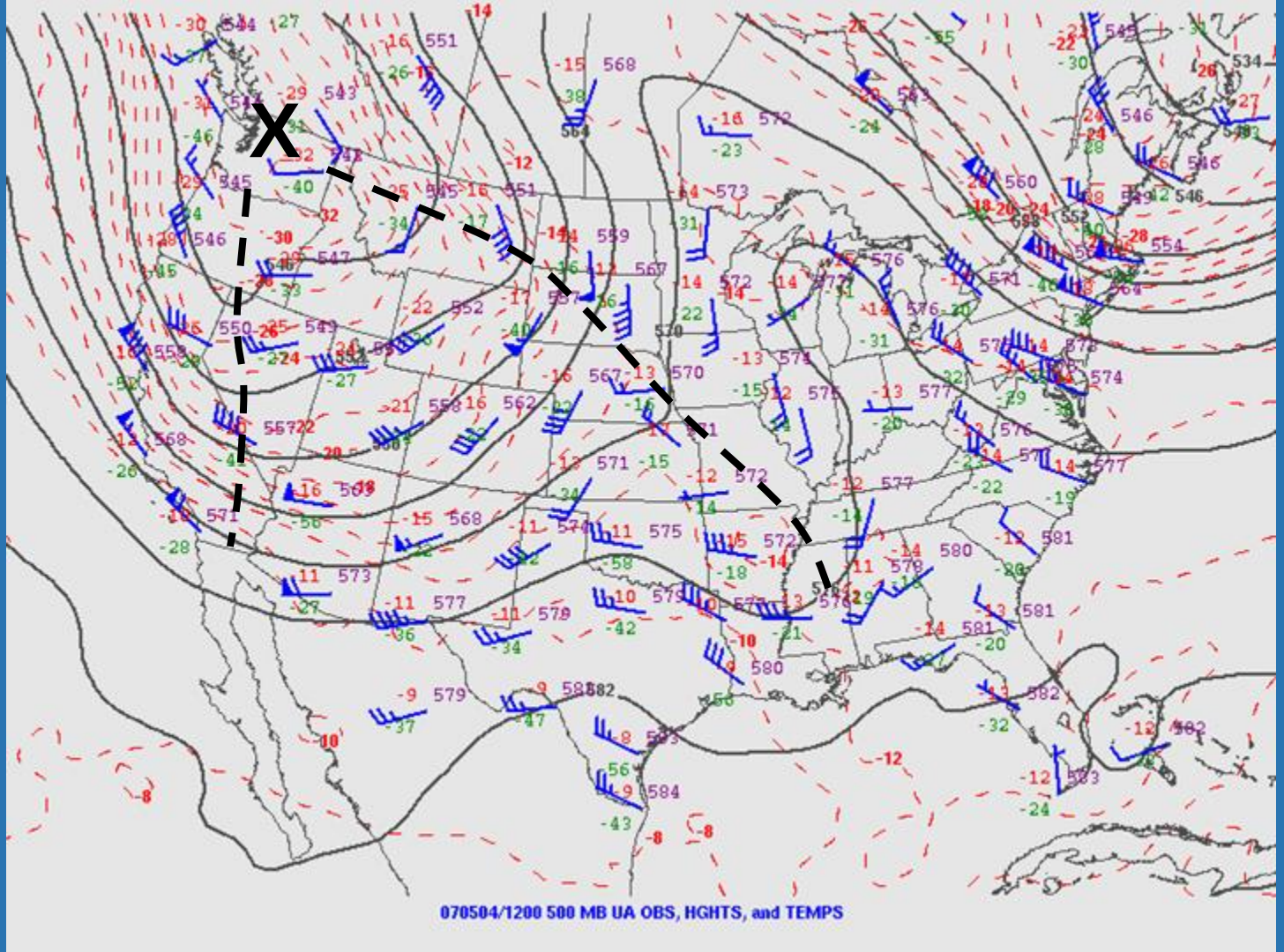
Lee Cyclogenesis

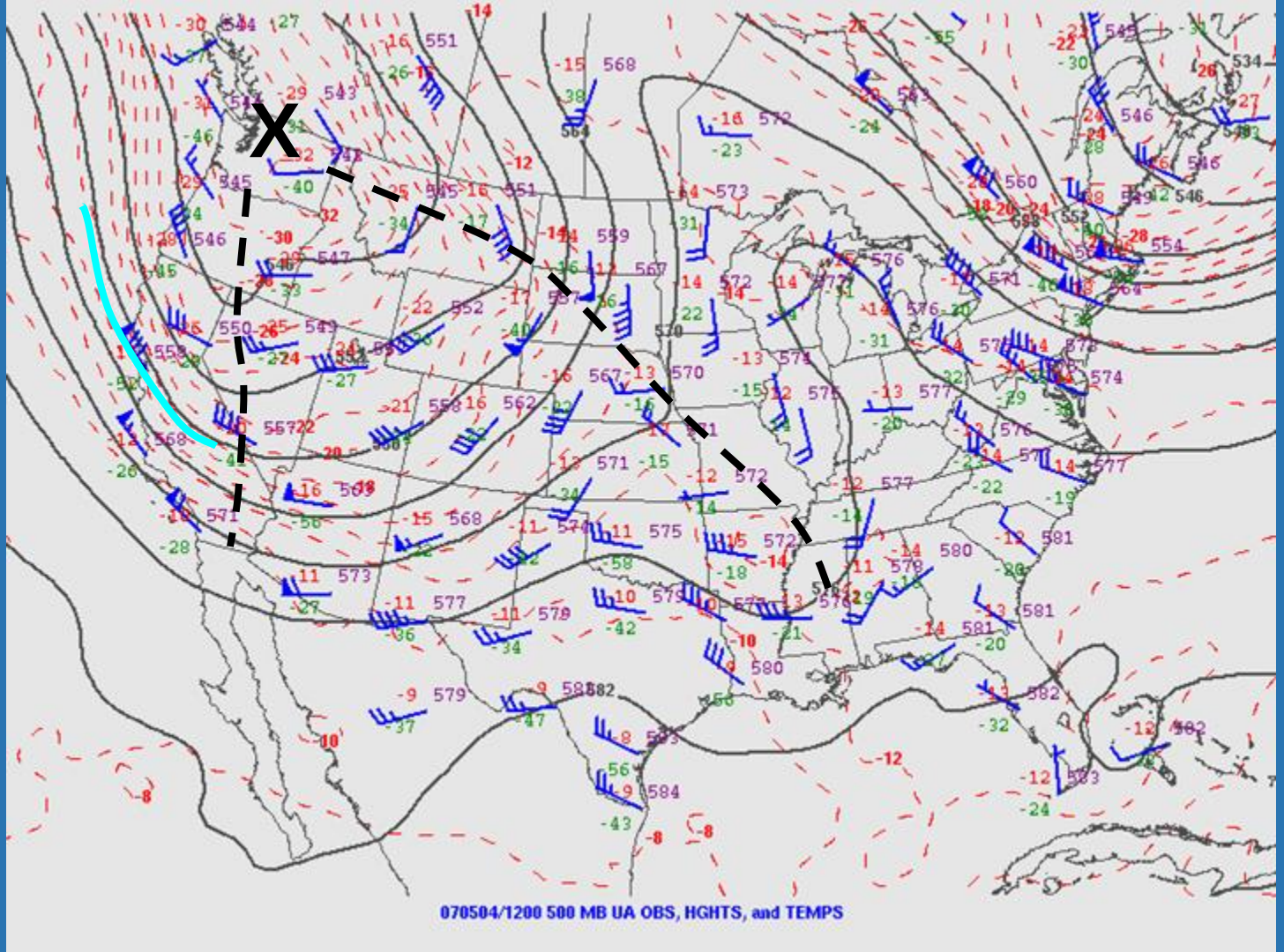


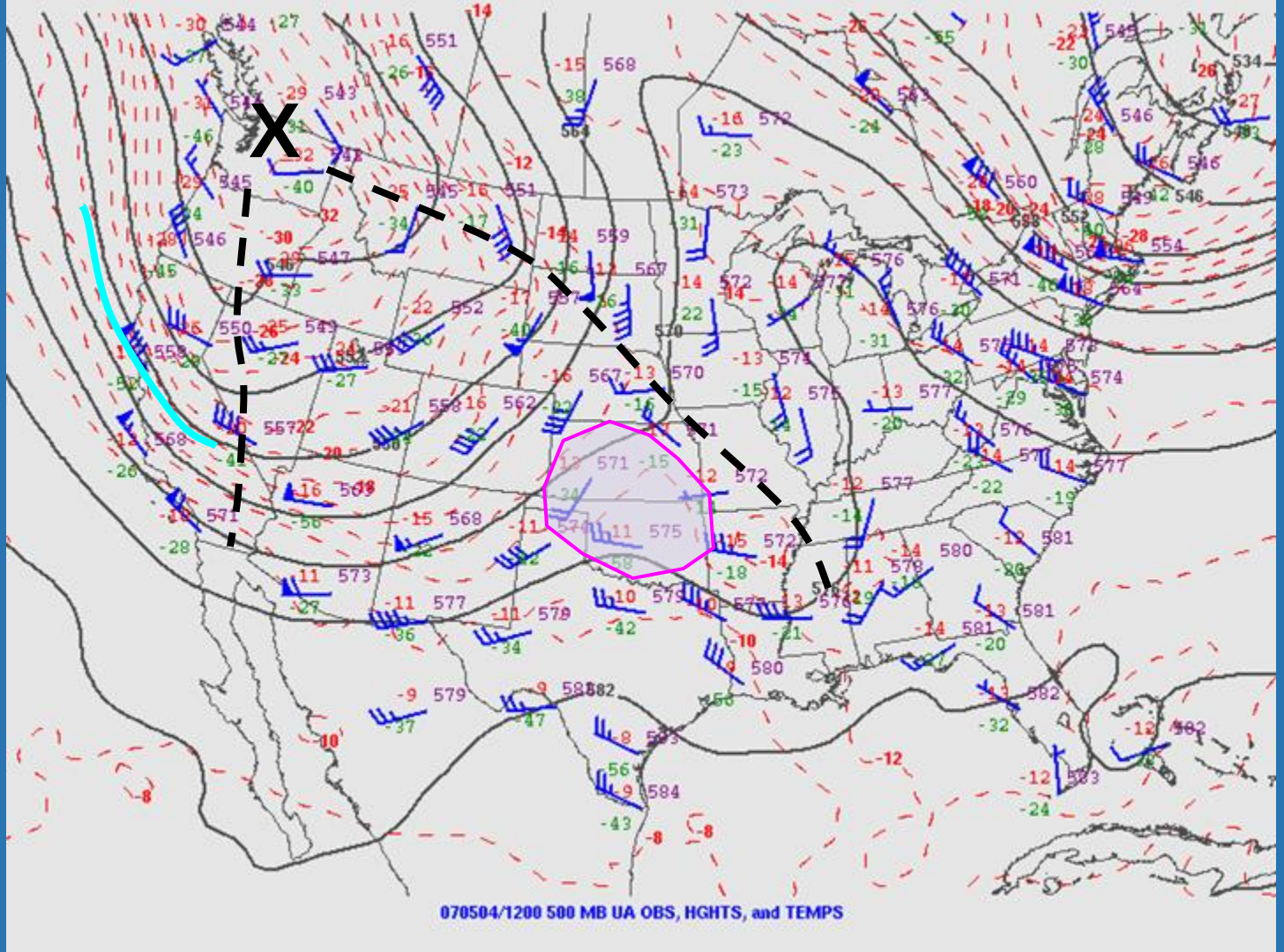

070504/1200 500 MB UA OBS, HGHTS, and TEMPS

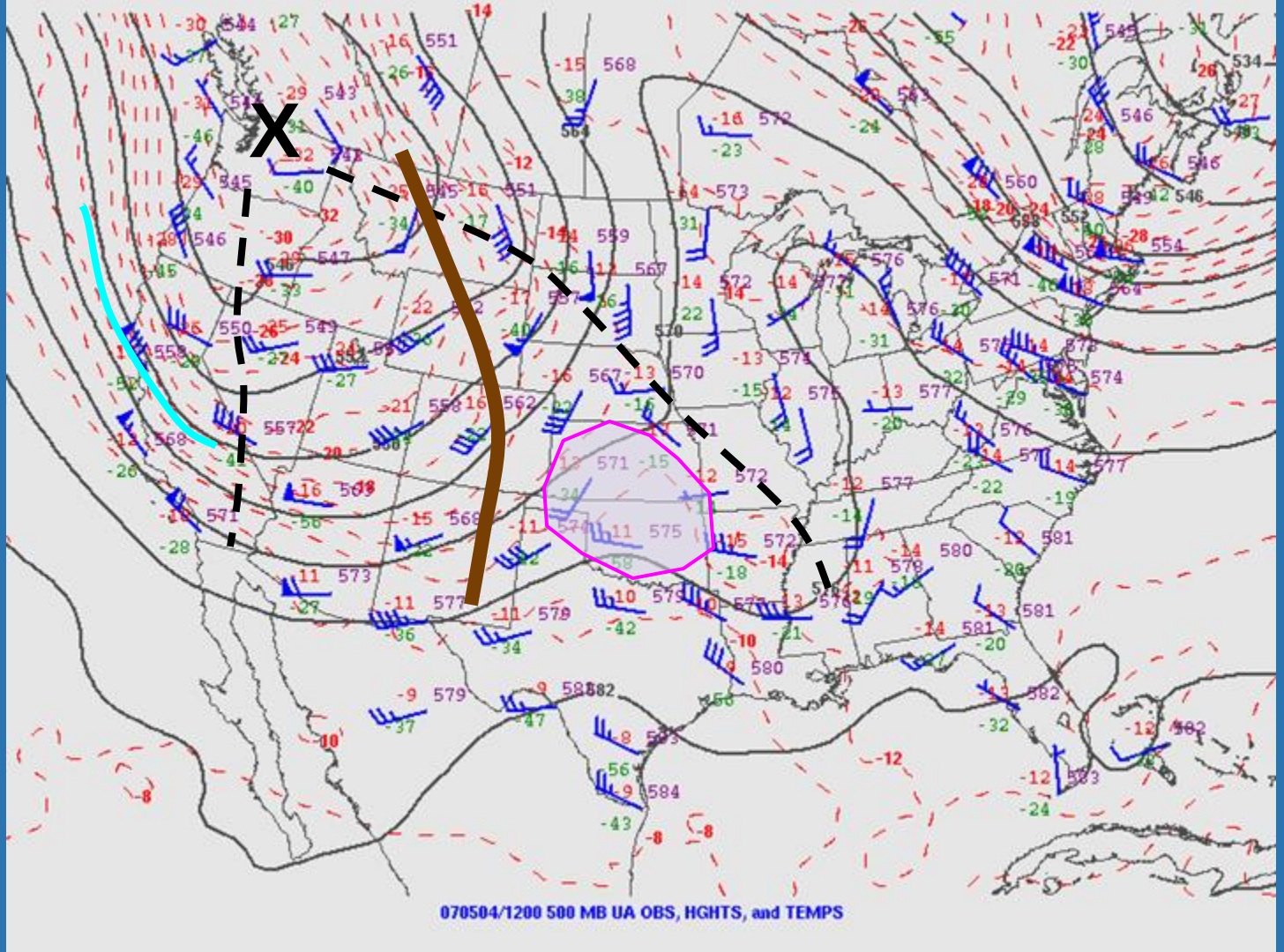

X
070504/1200 500 MB UA OBS, HGHTS, and TEMPS

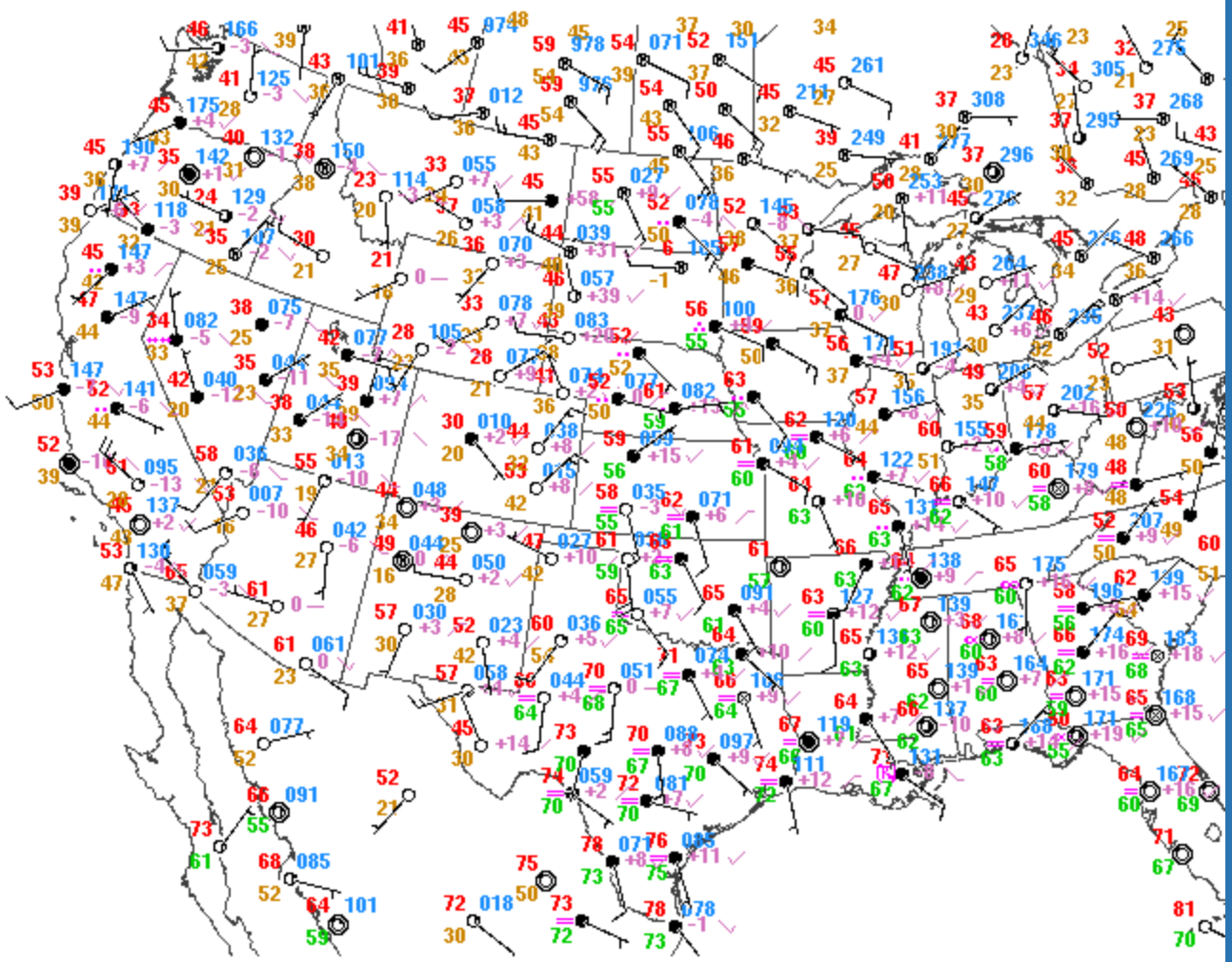

070504/1200 500 MB UA OBS, HGHTS, and TEMPS

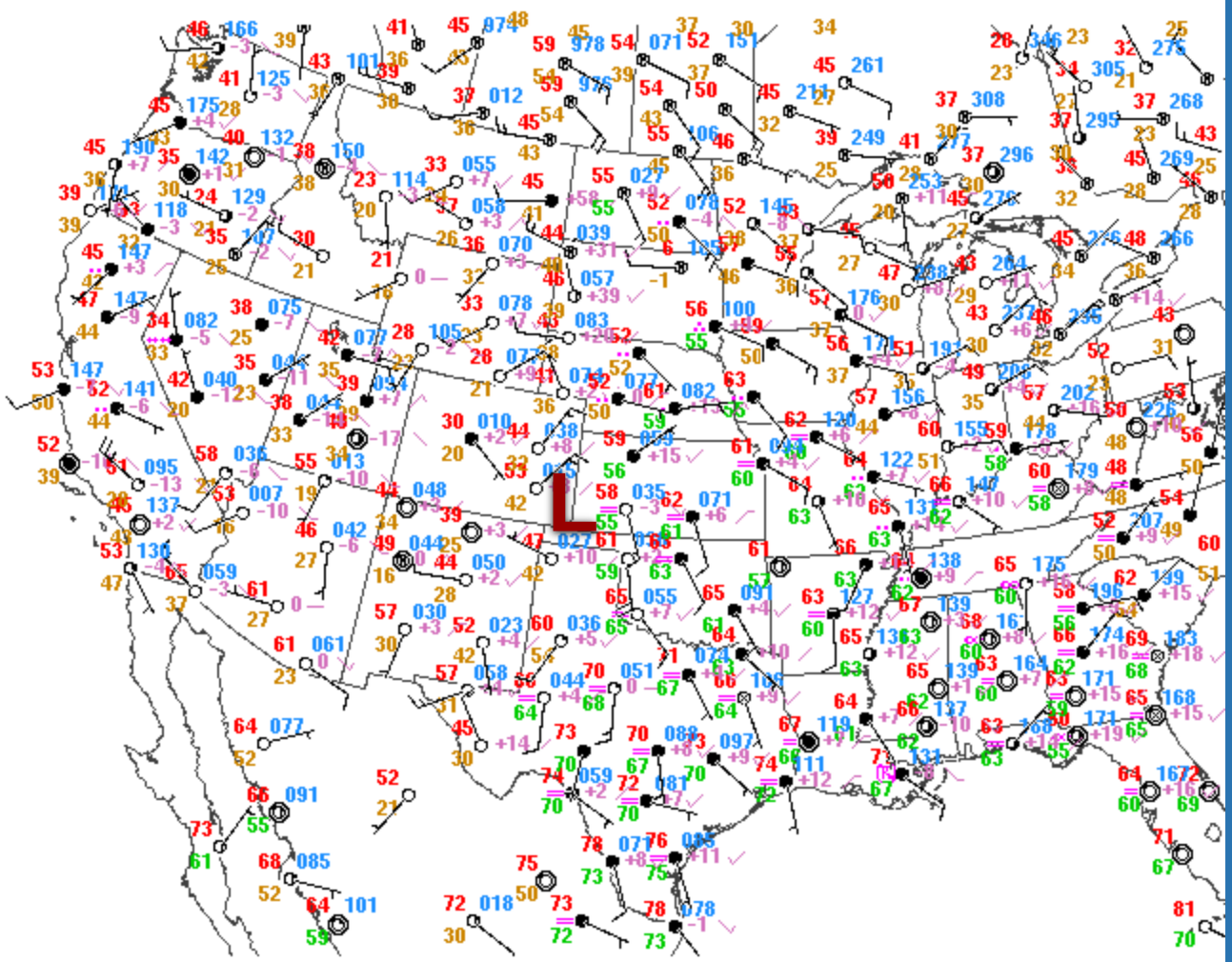

070504/1200 500 MB UA OBS, HGHTS, and TEMPS

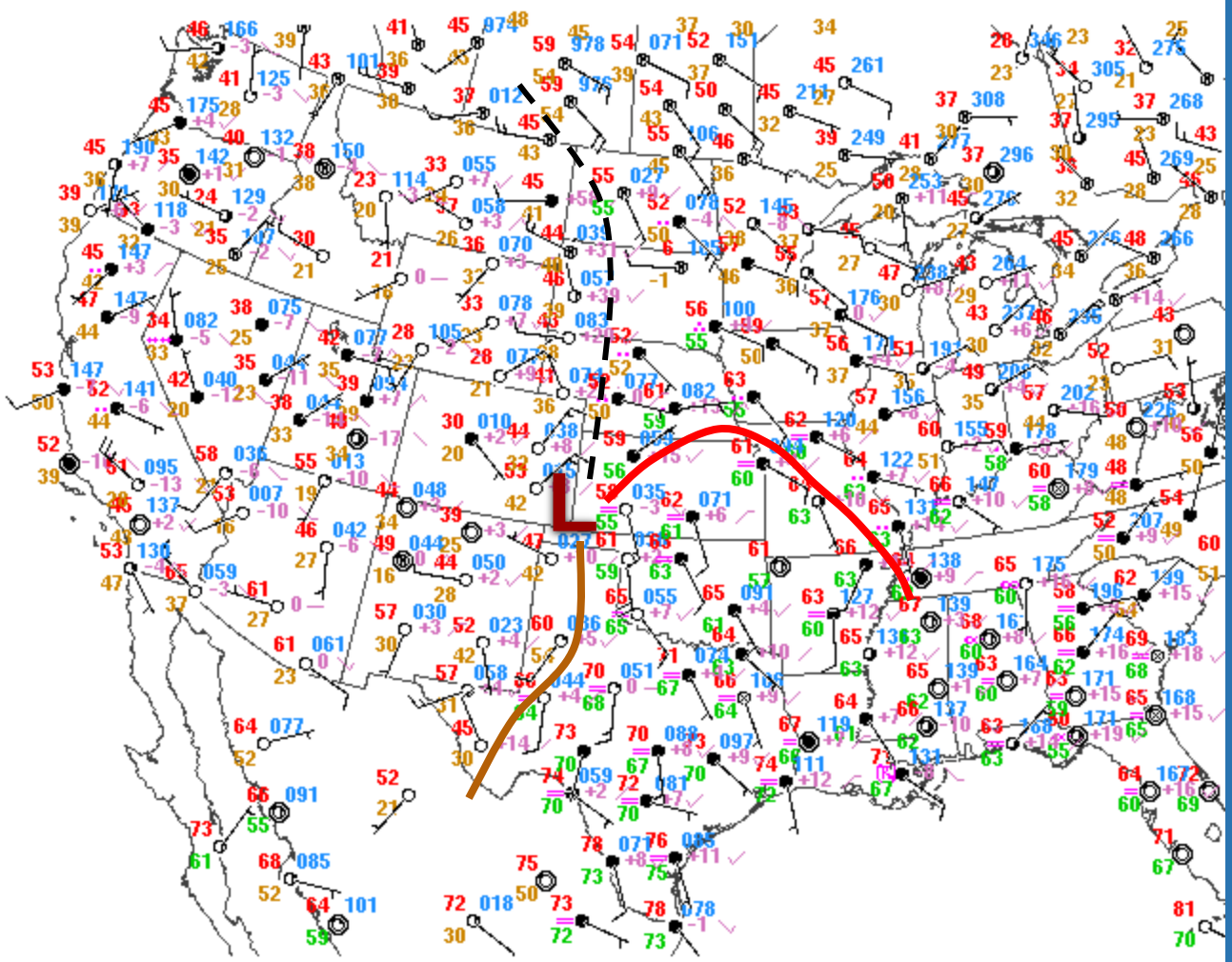

070504/1200 500 MB UA OBS, HGHTS, and TEMPS


070504/1200 500 MB UA OBS, HGHTS, and TEMPS


070504/1200 500 MB UA OBS, HGHTS, and TEMPS

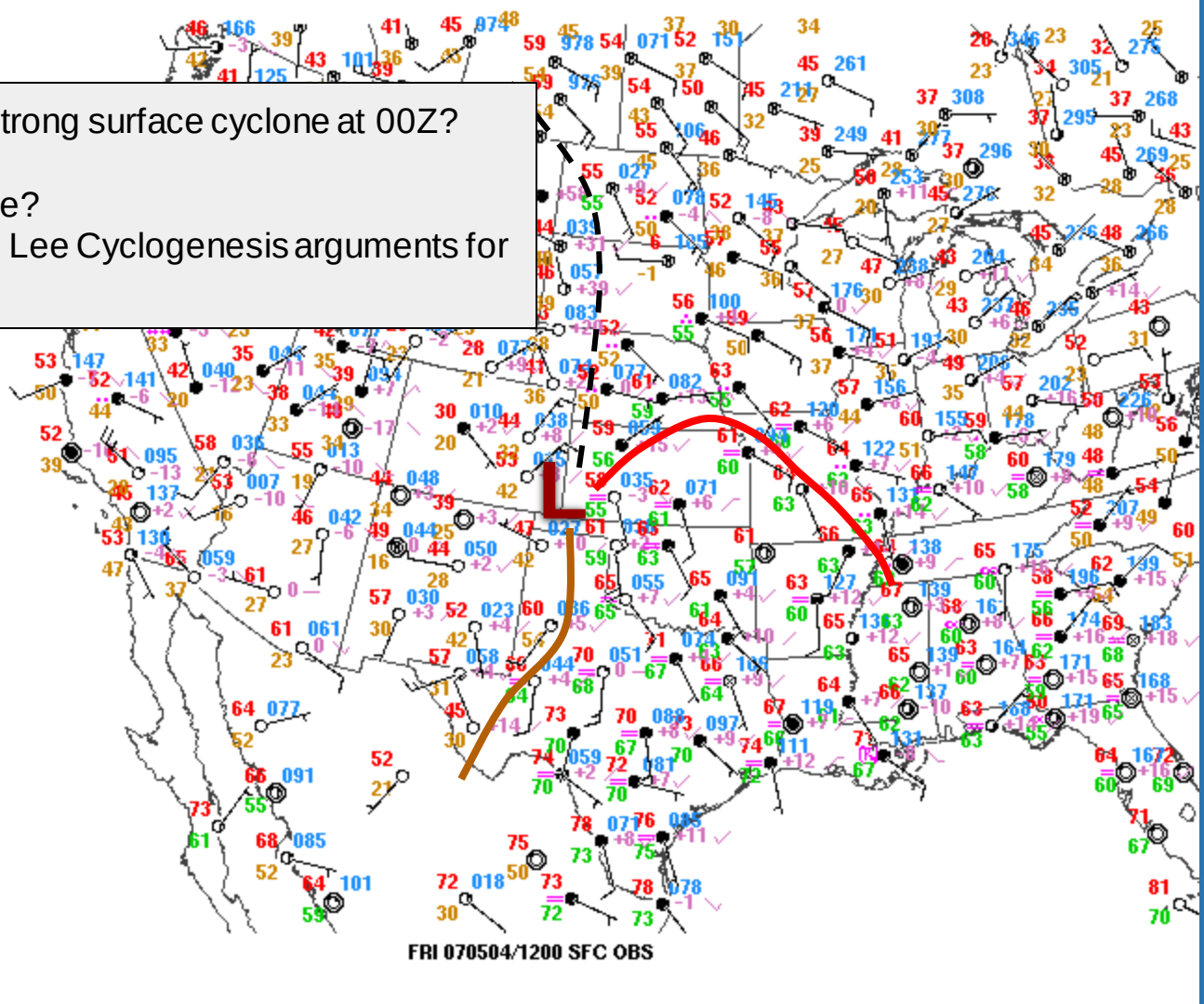

FRI 070504/1200 SFC OBS

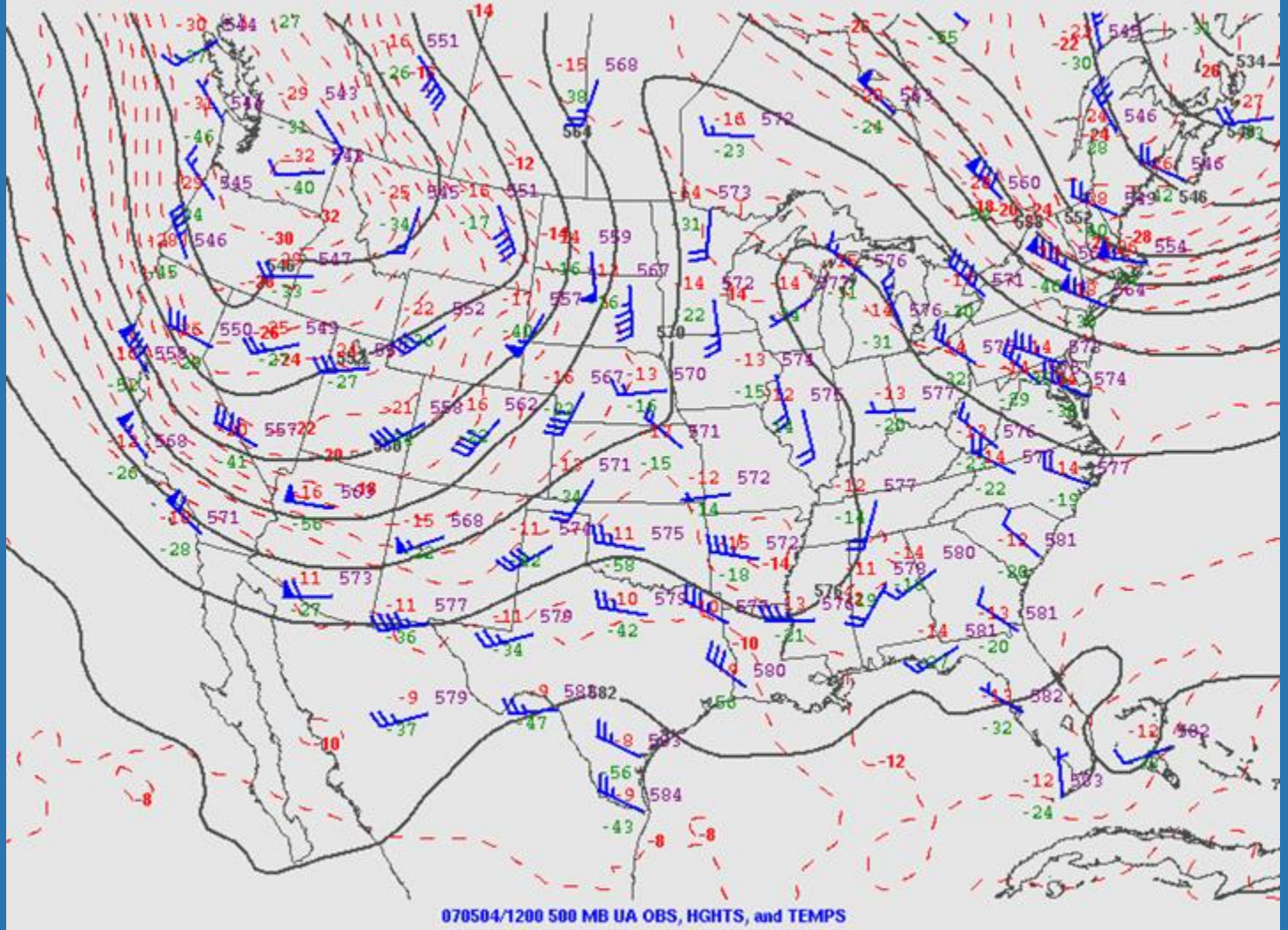

FRI 070504/1200 SFC OBS

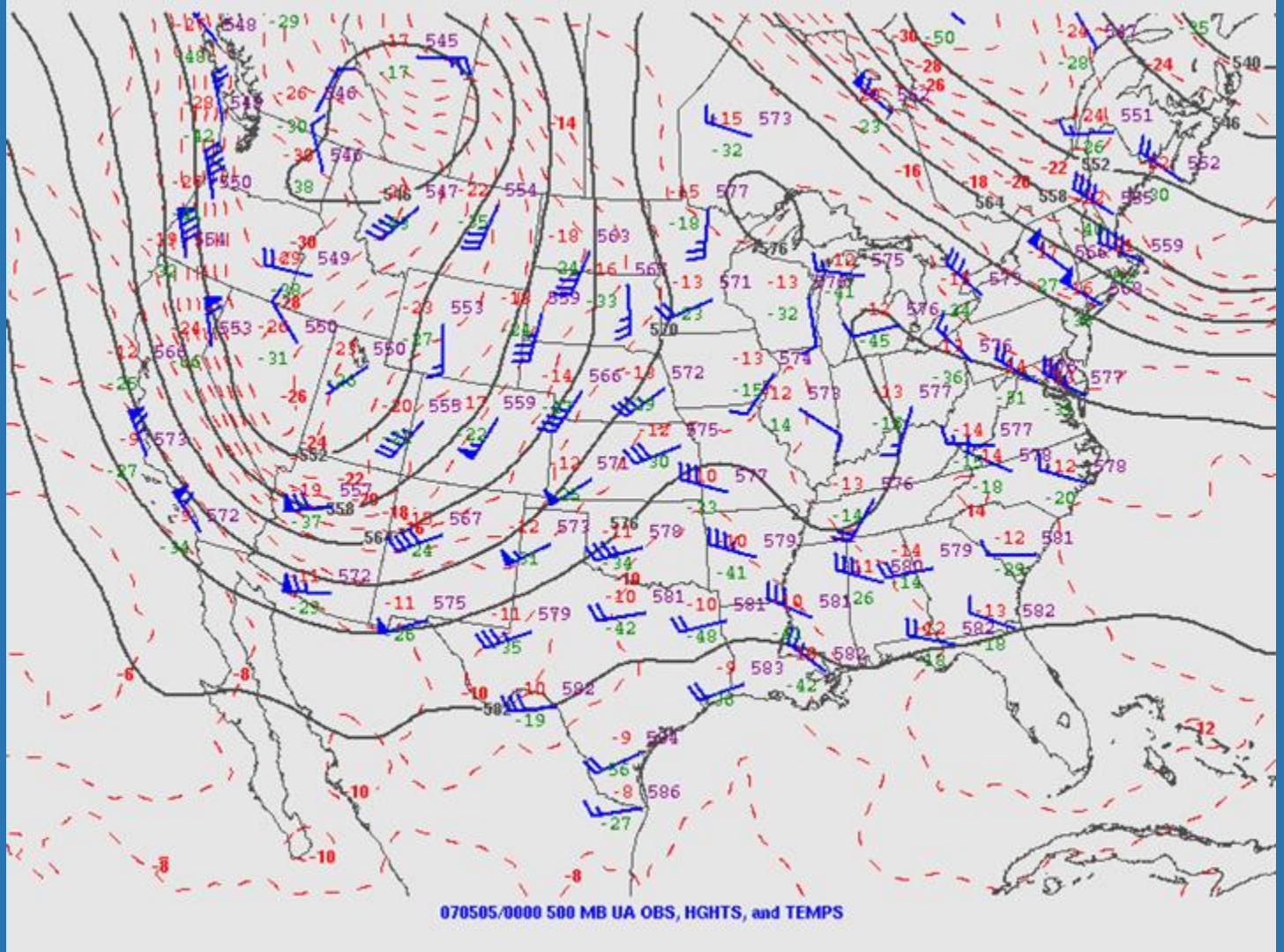

FRI 070504/1200 SFC OBS

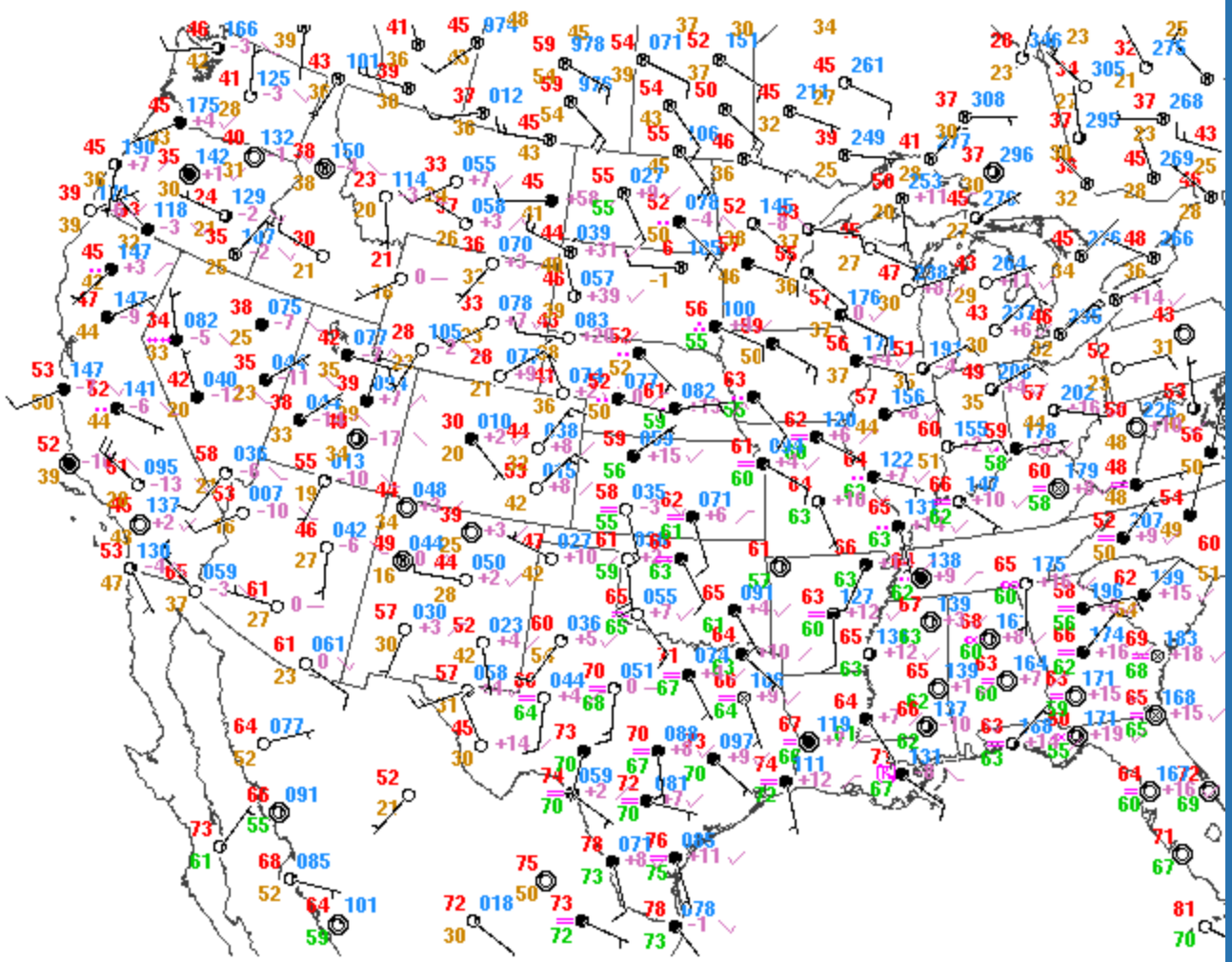
Will there be a strong surface cyclone at 00Z?

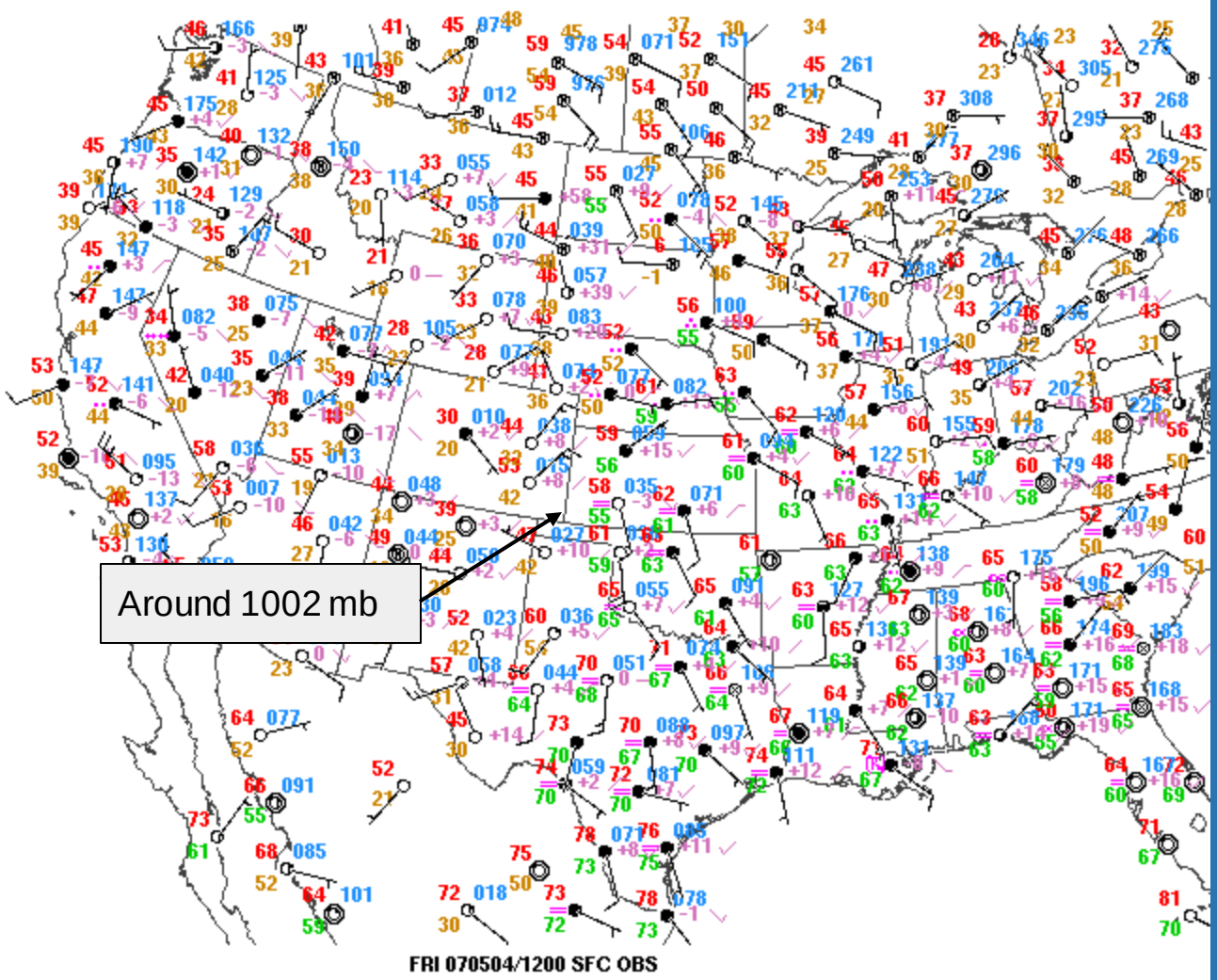
- If so, where?
- Use QG & Lee Cyclogenesis arguments for or against

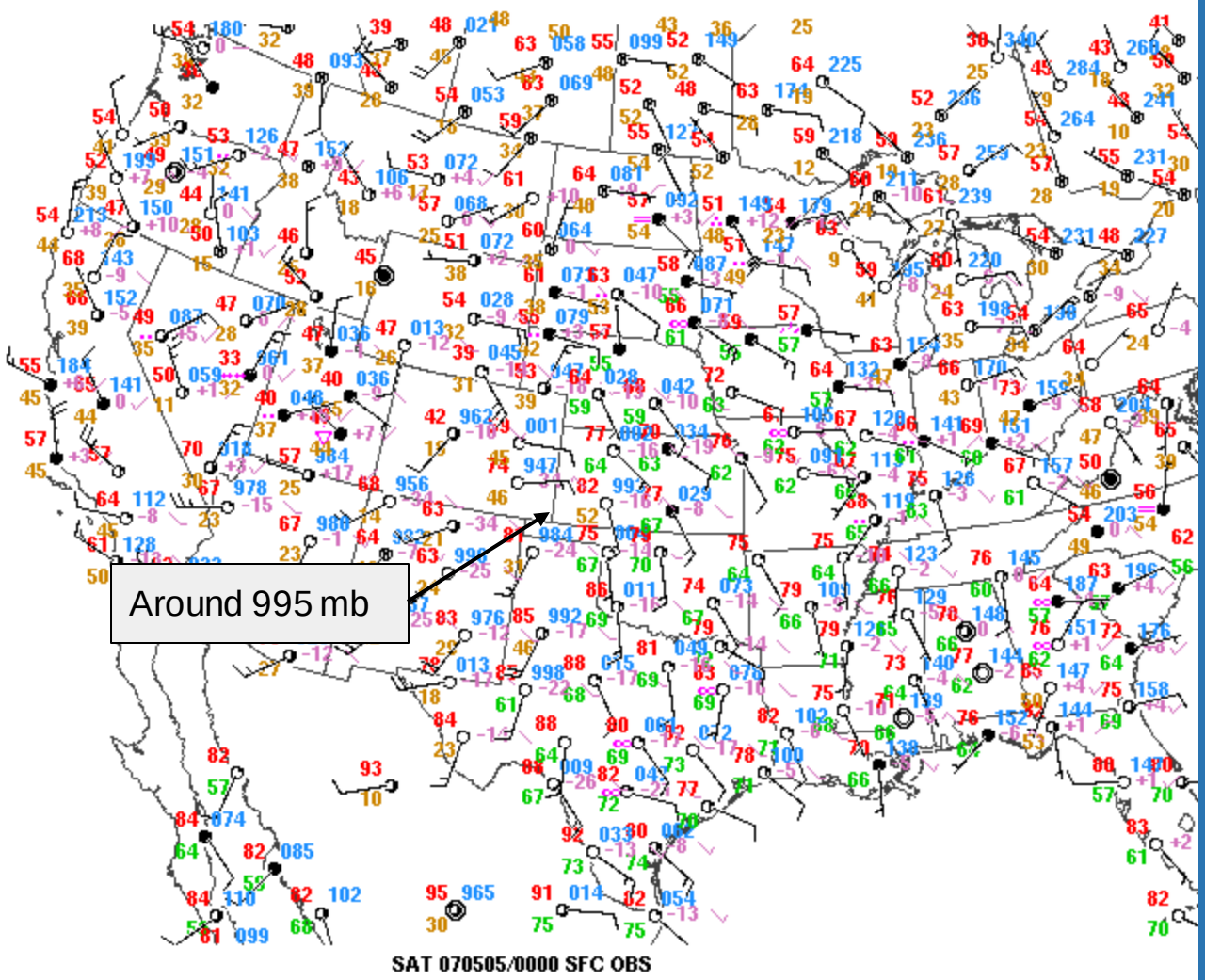



070504/1200 500 MB UA OBS, HGHTS, and TEMPS


070505/0000 500 MB UA OBS, HGHTS, and TEMPS


FRI 070504/1200 SFC OBS


Around 1002 mb
FRI 070504/1200 SFC OBS

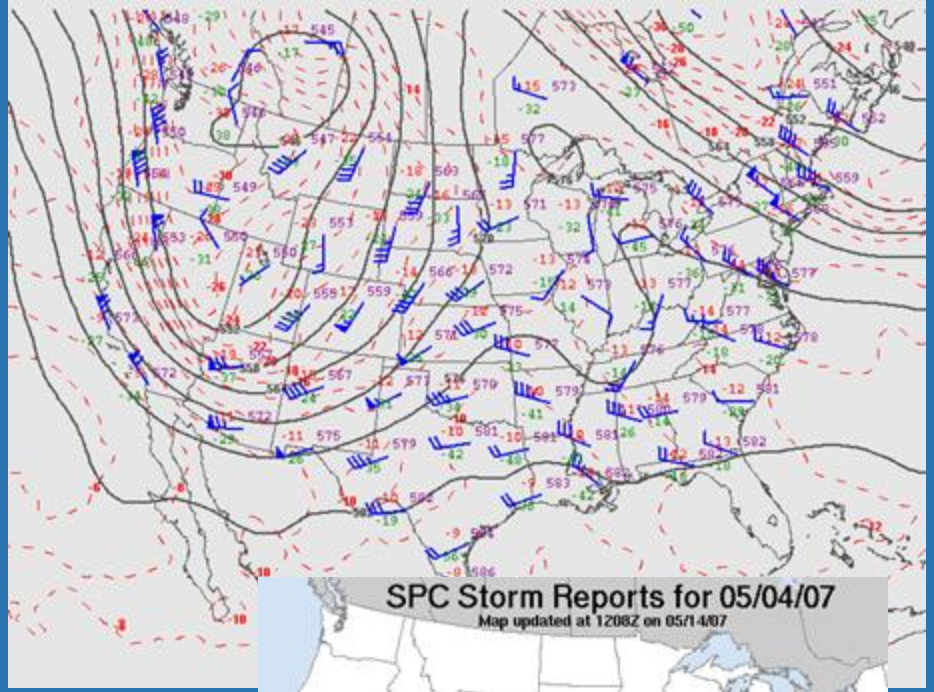

Around 995 mb
SAT 070505/0000 SFC OBS

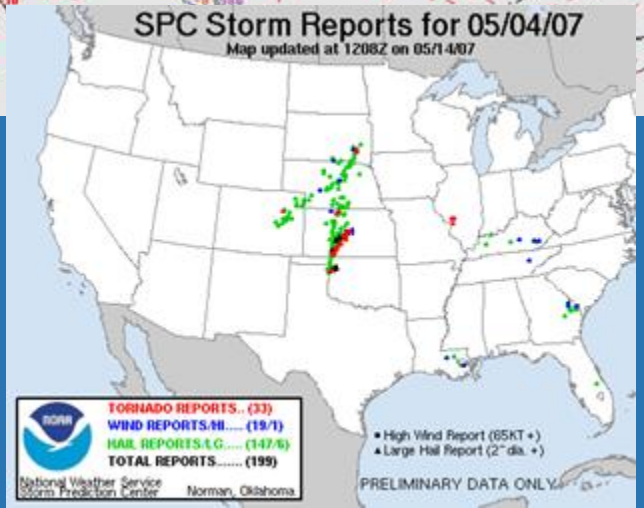
Contributing Factors

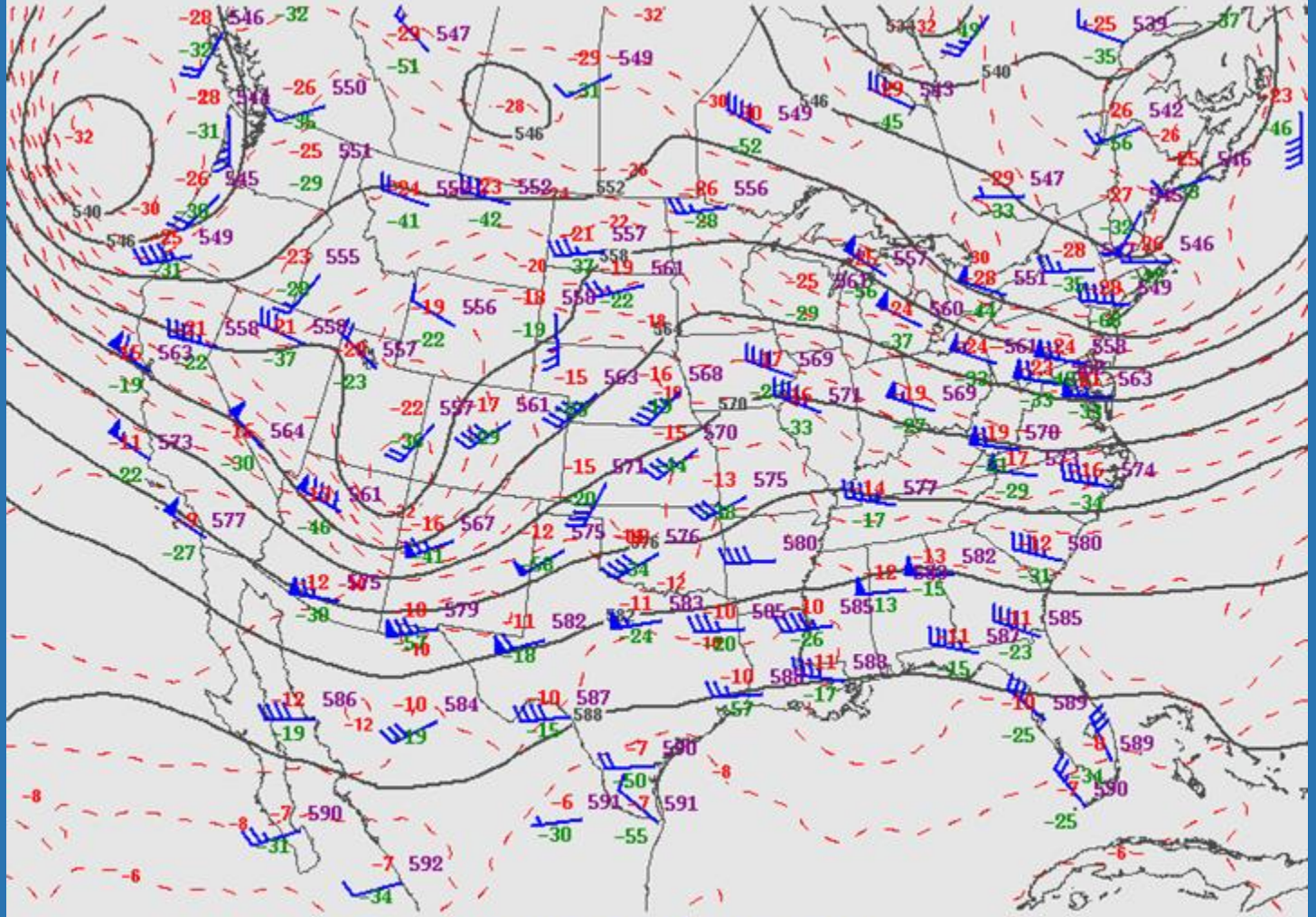
- Mid-level shortwave trough west/northwest of the Four Corners (stronger QG influences west of the Plains)

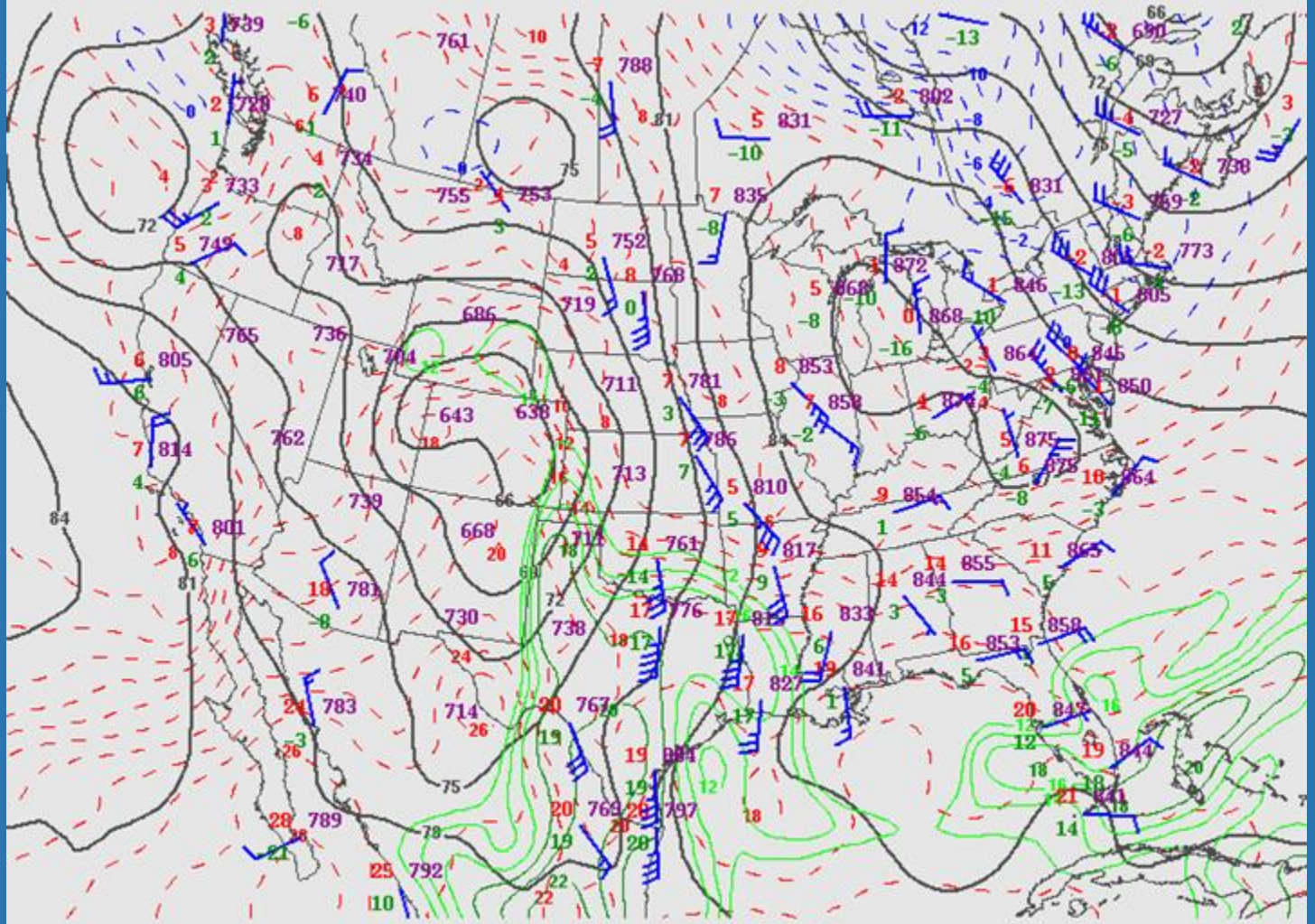
- Strongest mid-level flow over and across the higher terrain of NM (vs. weaker and more parallel flow along the terrain to the north).

- Result = deepening lee cyclone in southeast CO region.






100510/1200 500 MB UA OBS, HGHTS, and TEMPS

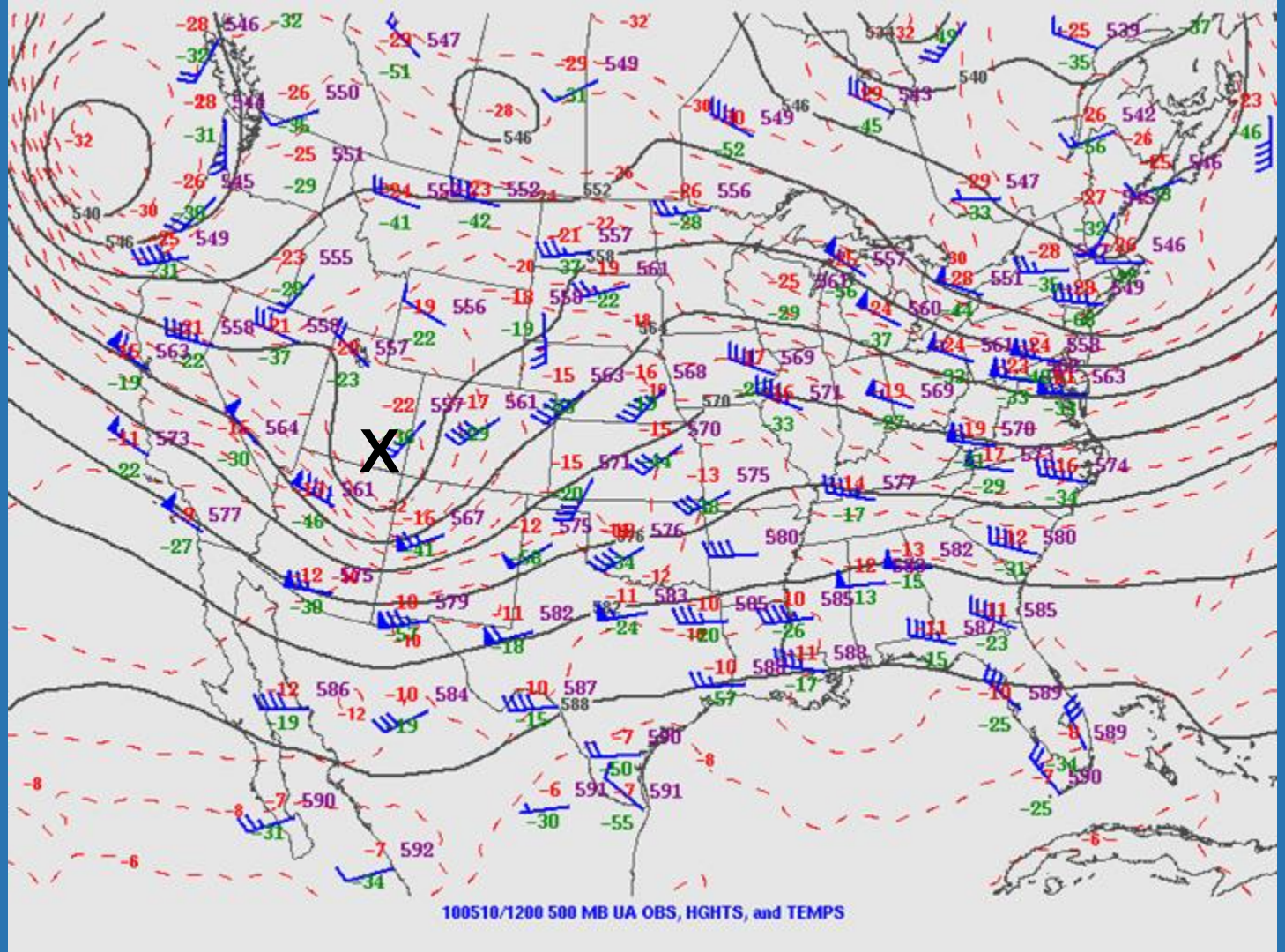

100510/1200 925 MB UA OBS, HGHTS, TEMPS, Td>=12

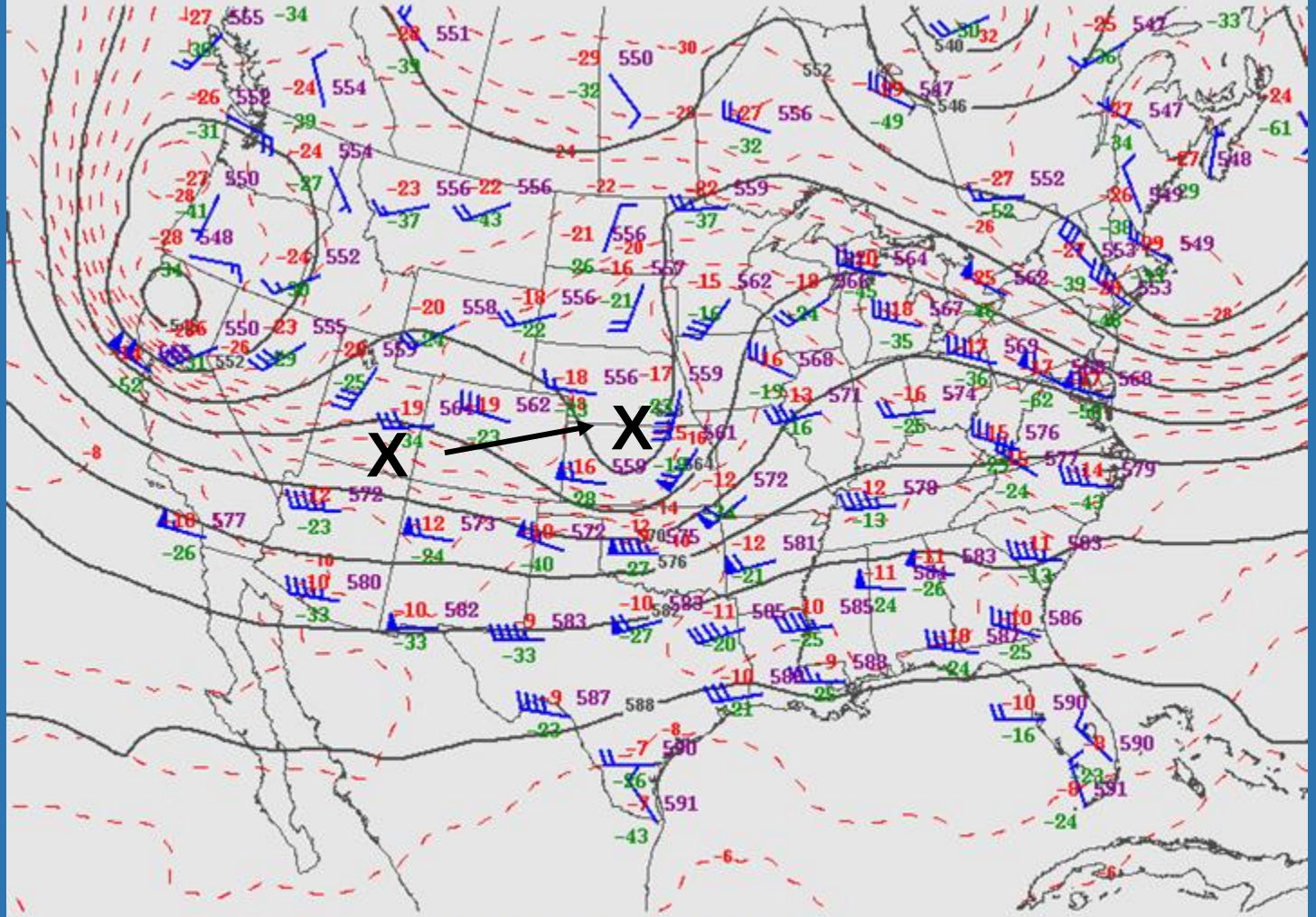
Forecast the 925 mb cyclone at 00 Z

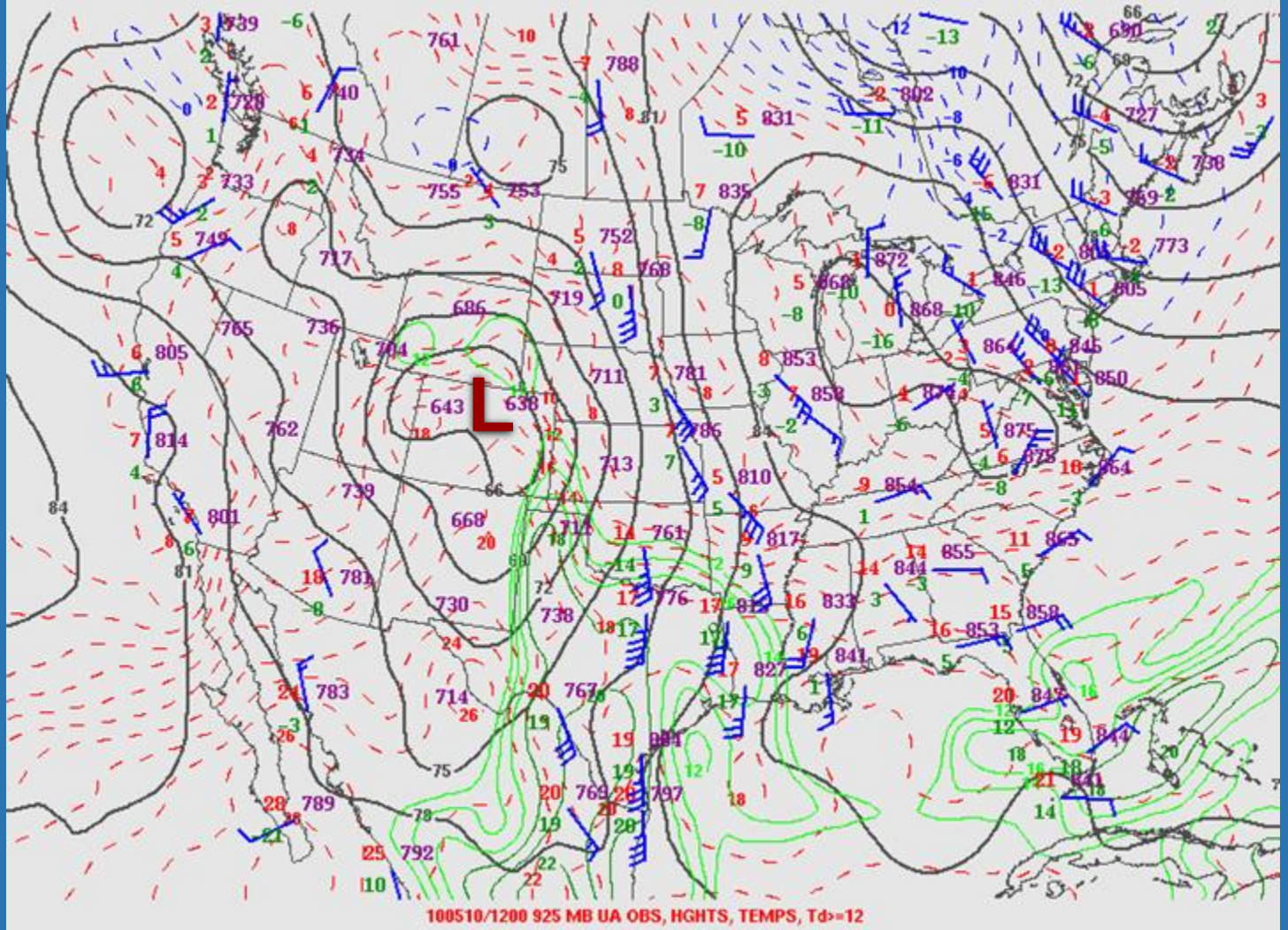
Where will it be located?

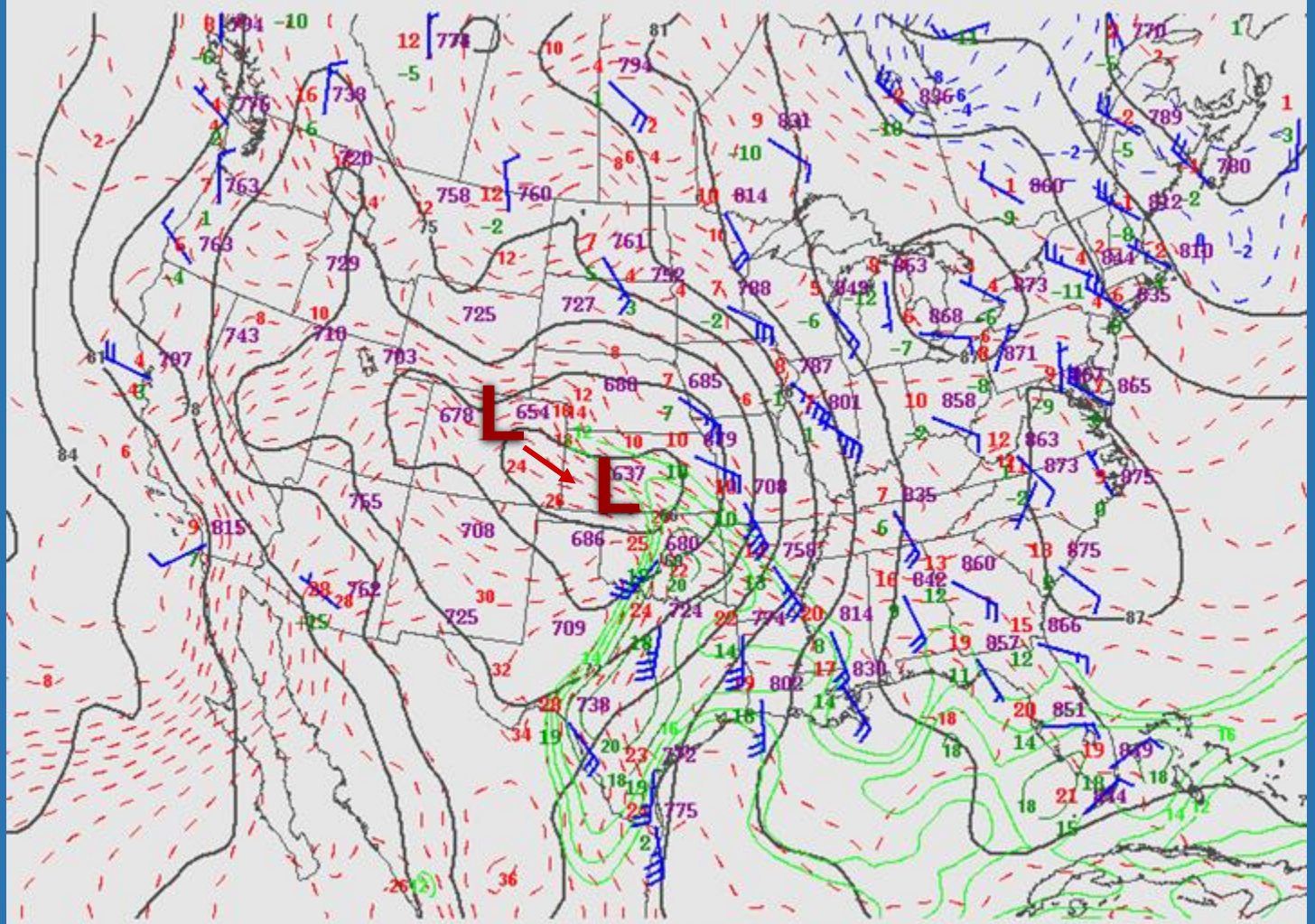
Will it deepen?

- Use QG arguments to support your answer!


X
100510/1200 500 MB UA OBS, HGHTS, and TEMPS


X
X
100511/0000 500 MB UA OBS, HGHTS, and TEMPS


L
100510/1200 925 MB UA OBS, HGHTS, TEMPS, Td>=12


L
L
100511/0000 925 MB UA OBS, HGHTS, TEMPS, Td>=12

Contributing Factors

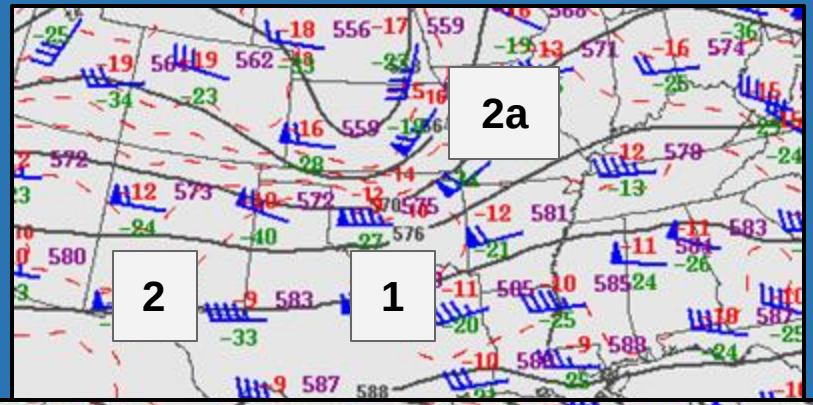
1) Strongest mid-level flow is moving over the higher terrain in the morning, but is exiting by the afternoon.

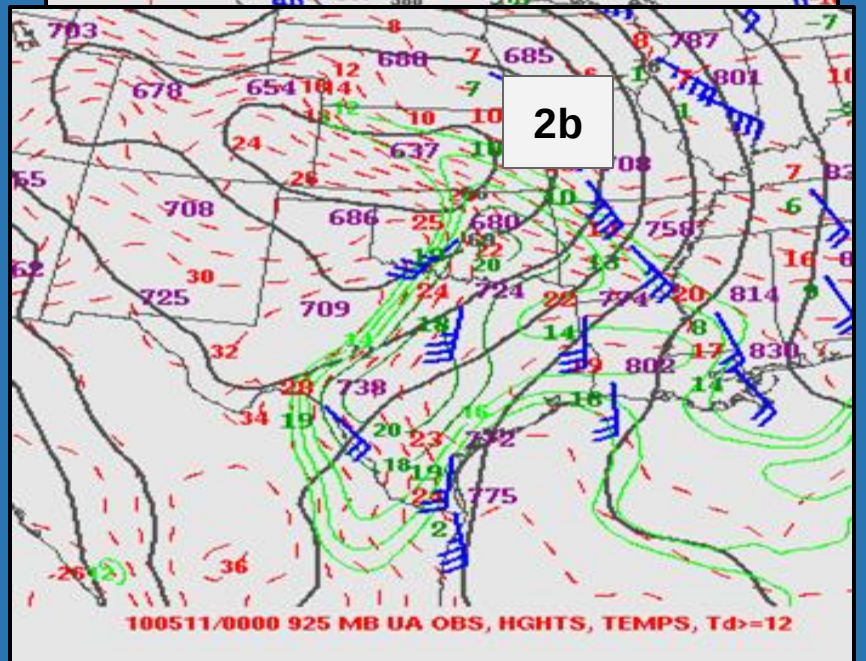
1) Lee cyclogenesis/troughing continues (due to persistent zonal flow over the S. Rockies), but becomes secondary to:

   2a) Low-level warm advection over OK

   2b) Inferred DCVA over KS/OK

- Net result = non-deepening low that shifts east/southeast.





Contributing Factors

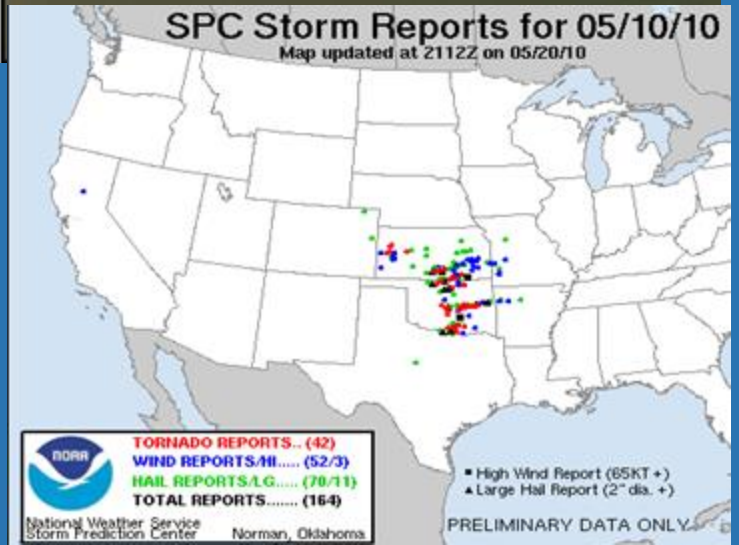
1) Strongest mid-level flow is moving over the higher terrain in the morning, but is exiting by the afternoon.

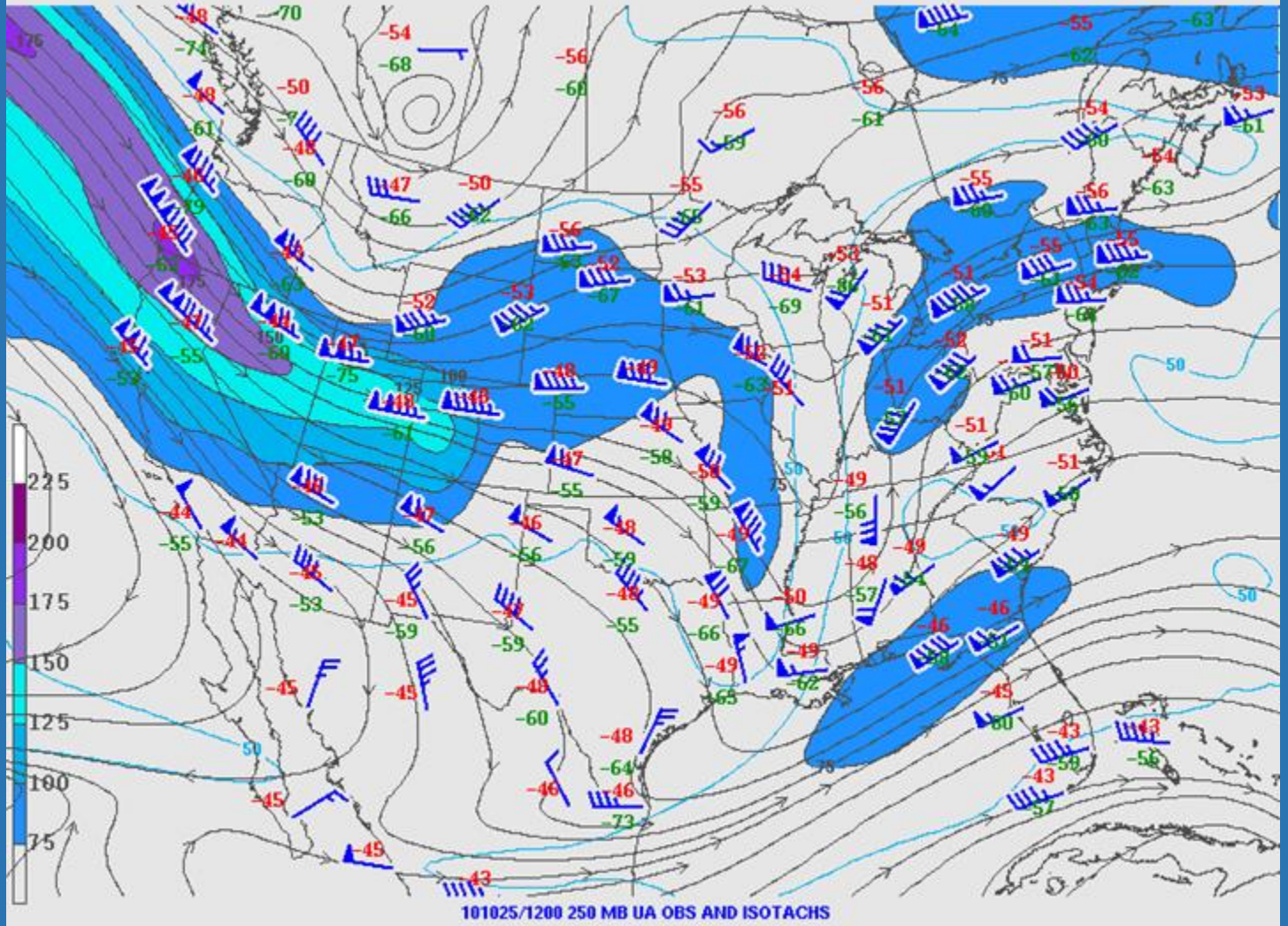
1) Lee cyclogenesis/troughing continues (due to persistent zonal flow over the S. Rockies), but becomes secondary to:

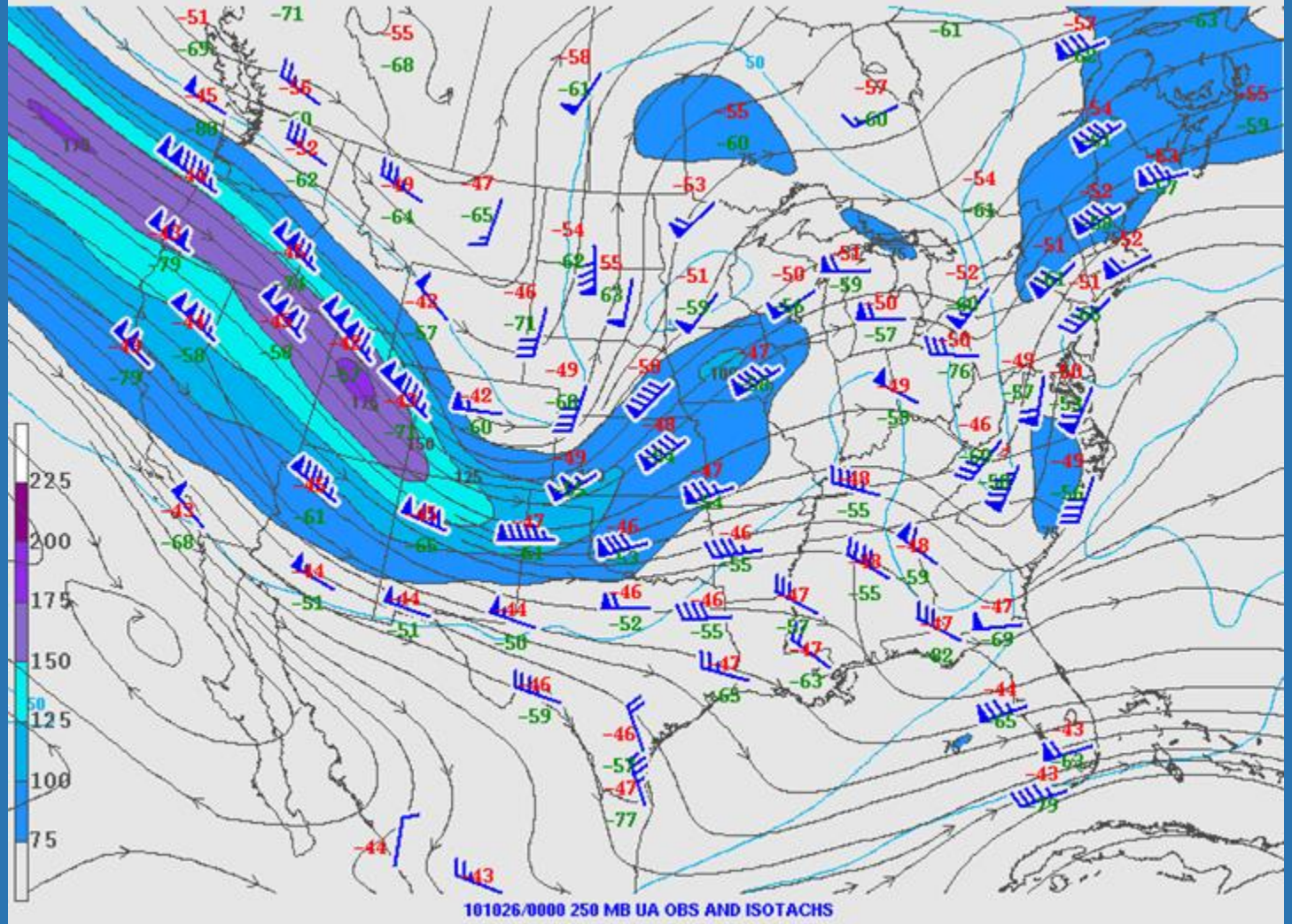
   2a) Low-level warm advection over OK

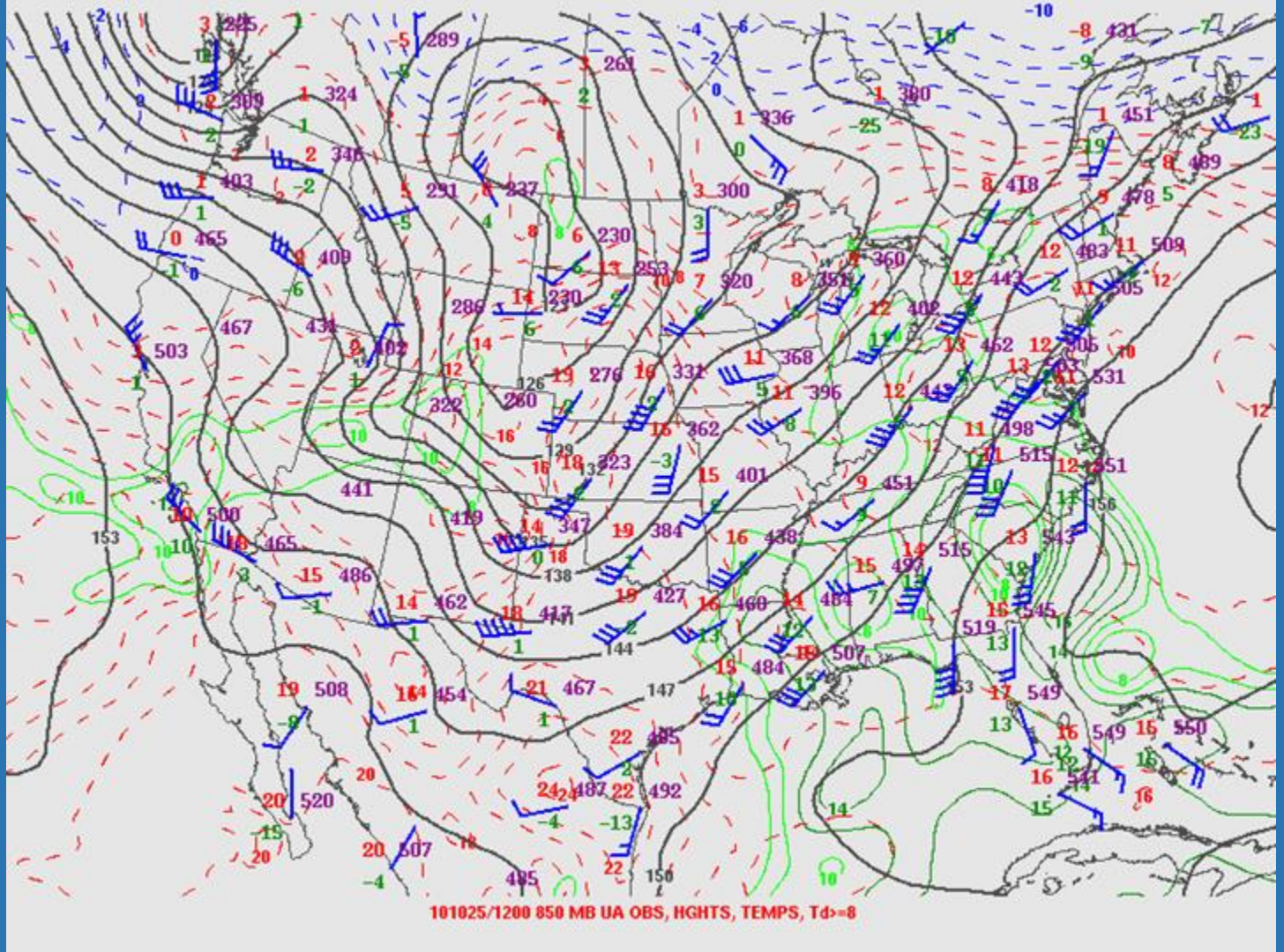
   2b) Inferred DCVA over KS/OK

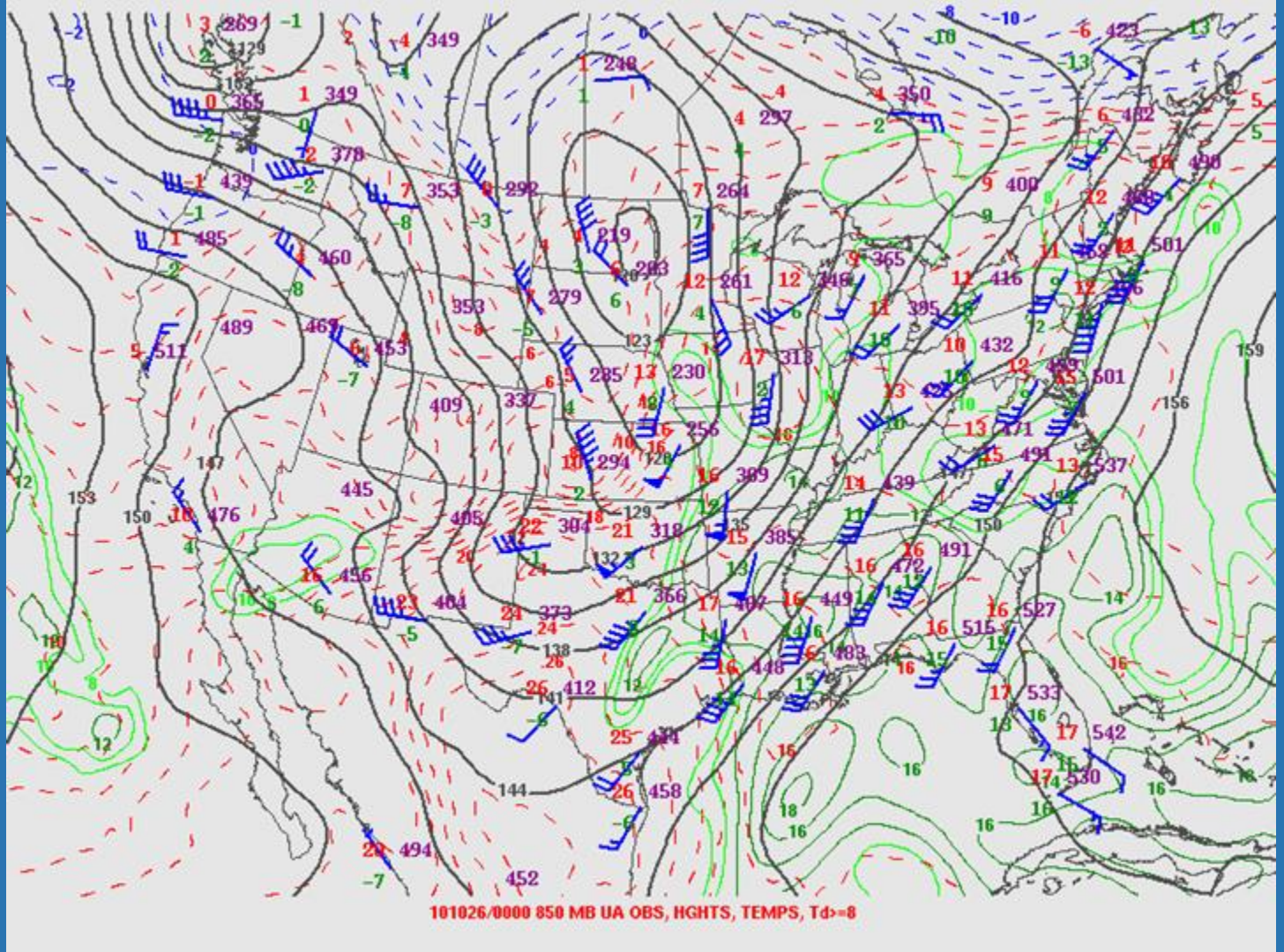
- Net result = non-deepening low that shifts east/southeast.




225
200
175
150
125
100
75
101025/1200 250 MB UA OBS AND ISOTACHS


225
200
175
150
125
100
75
101026/0000 250 MB UA OBS AND ISOTACHS


101025/1200 850 MB UA OBS, HGHTS, TEMPS, Td>=8

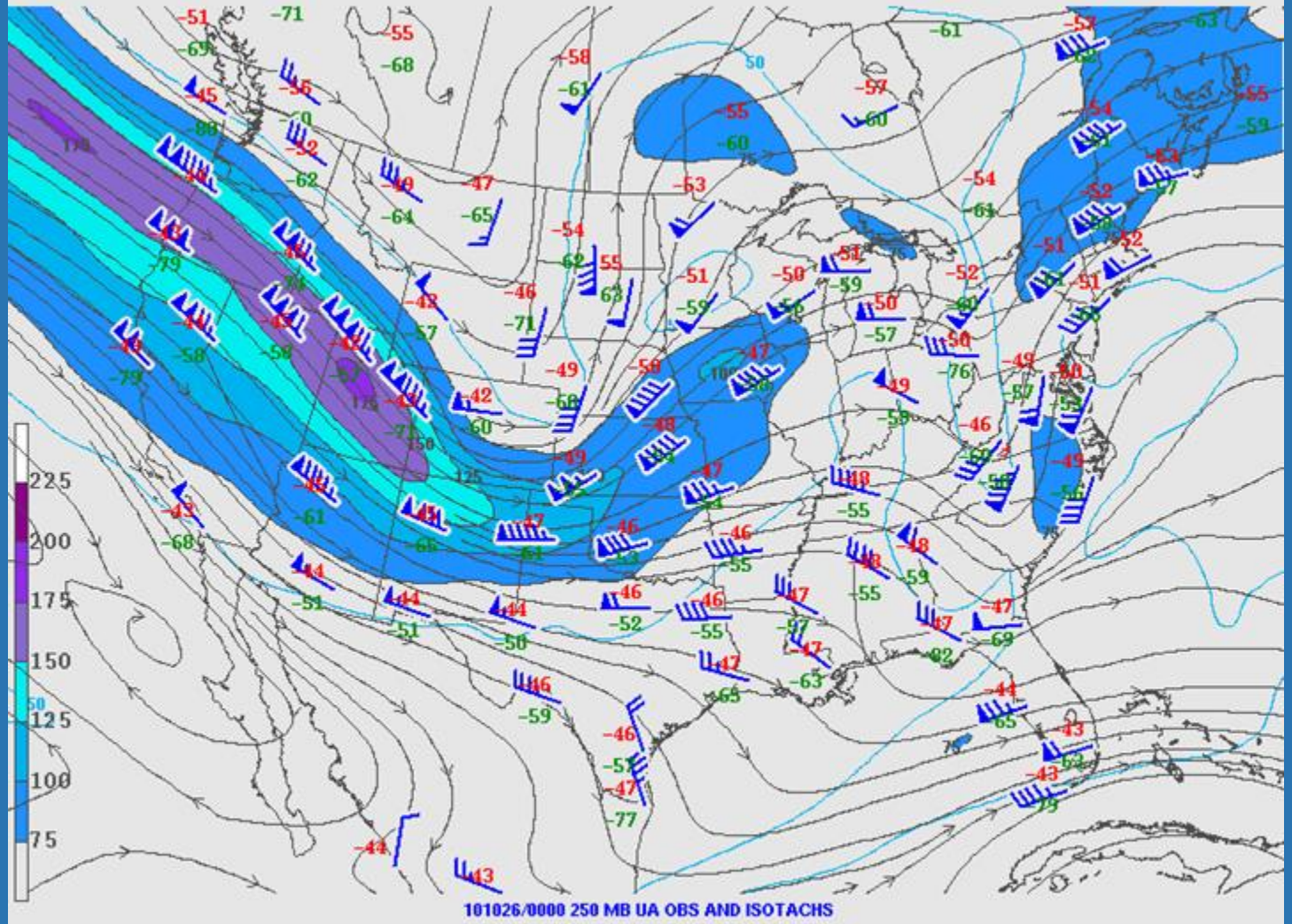

101026/0000 850 MB UA OBS, HGHTS, TEMPS, Td>=8

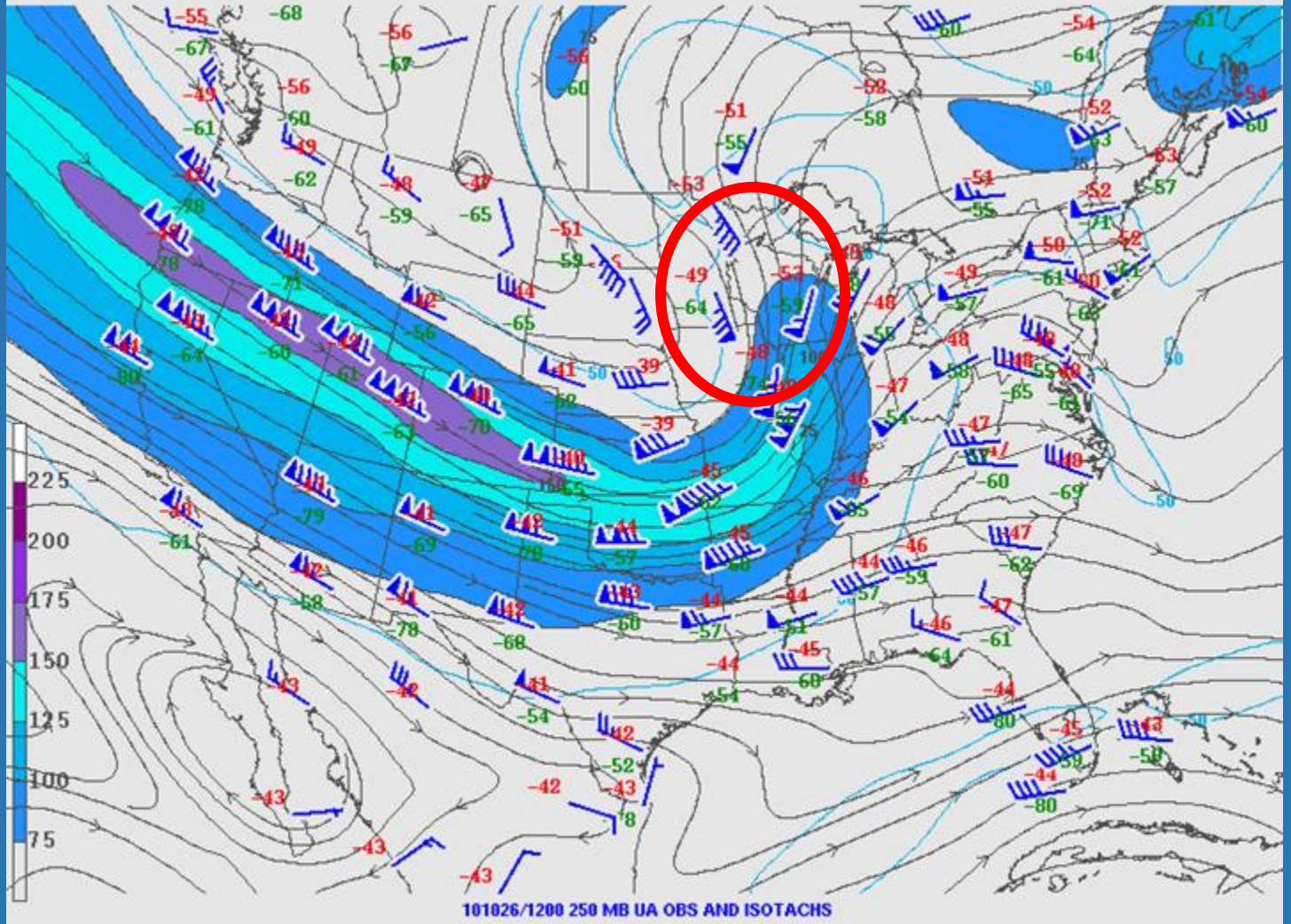
Forecast the 850 mb cyclone at 12 Z

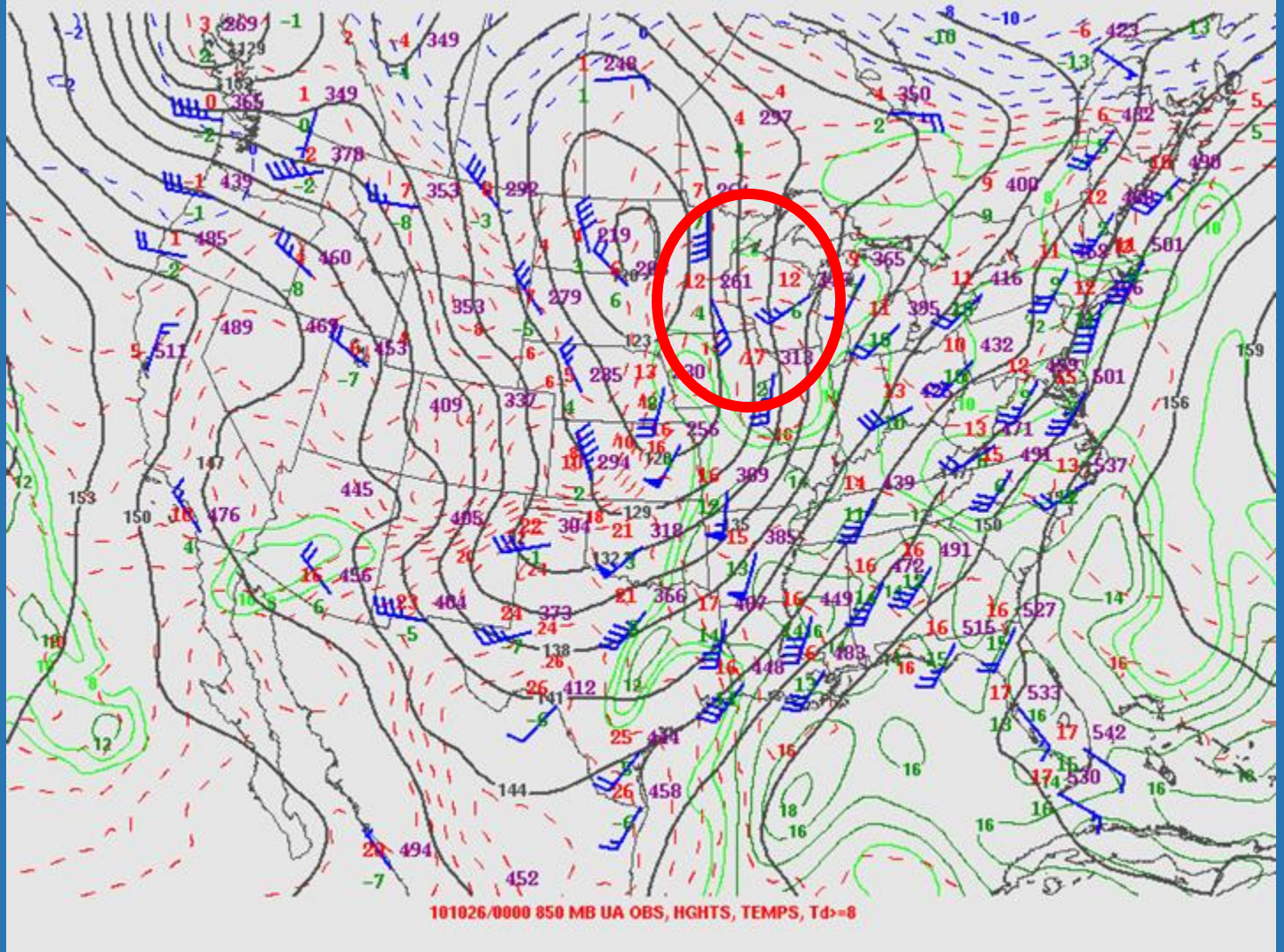
Where will it be located?

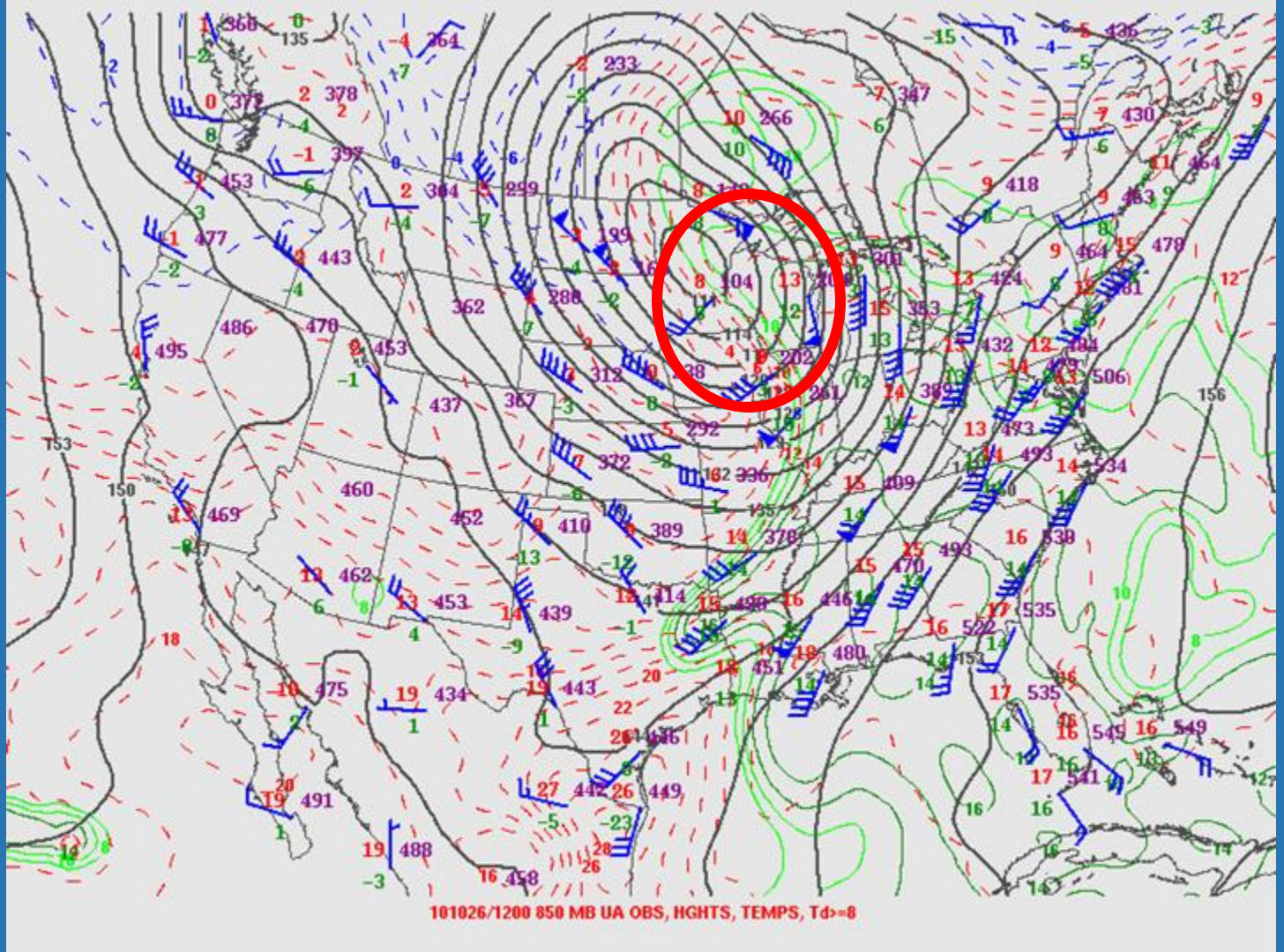
Will it deepen?

- Use QG arguments to support your answer!


225
200
175
150
125
100
75
101026/0000 250 MB UA OBS AND ISOTACHS

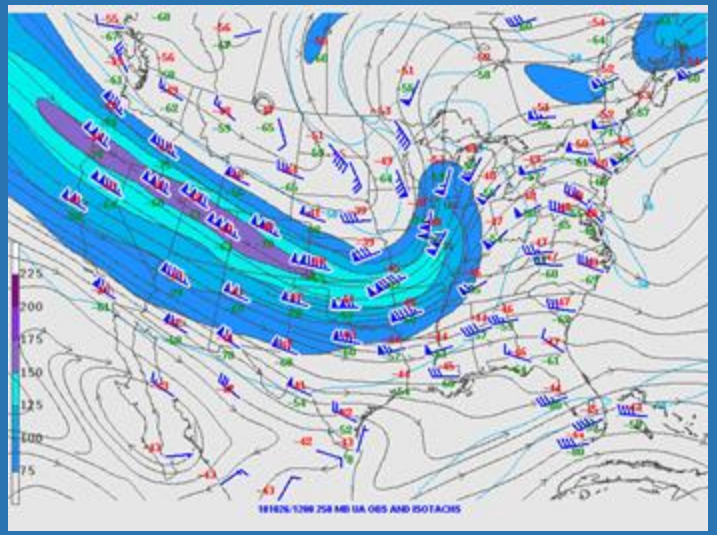

225
200
175
150
125
100
75
101026/1200 250 MB UA OBS AND ISOTACHS

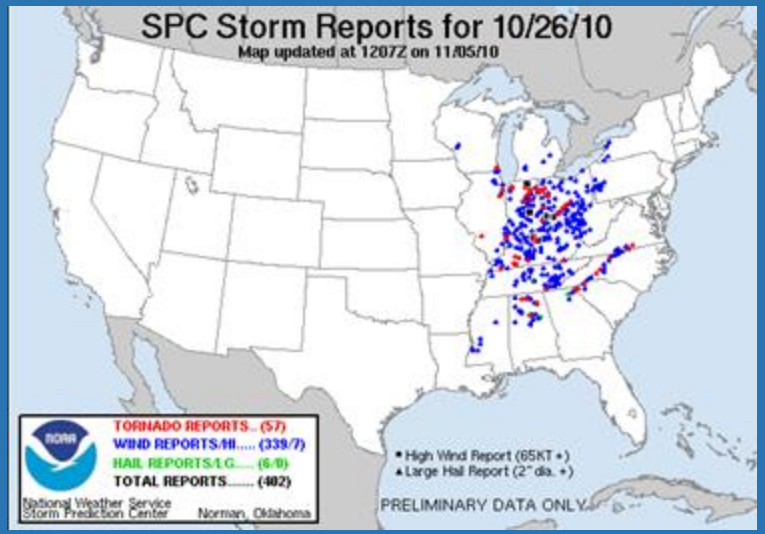

101026/0000 850 MB UA OBS, HGHTS, TEMPS, Td>=8

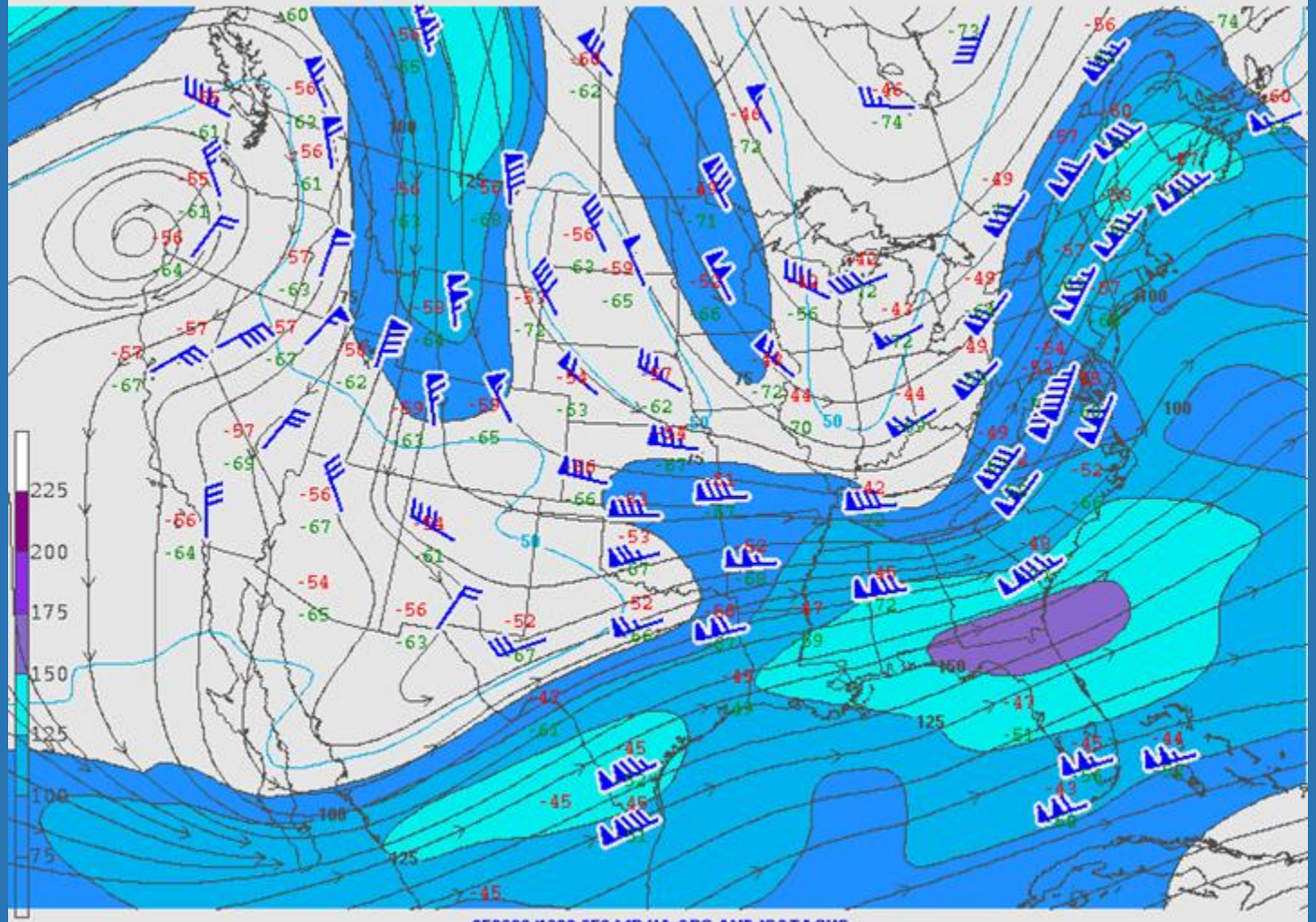

101026/1200 850 MB UA OBS, HGHTS, TEMPS, Td>=8

Contributing Factors

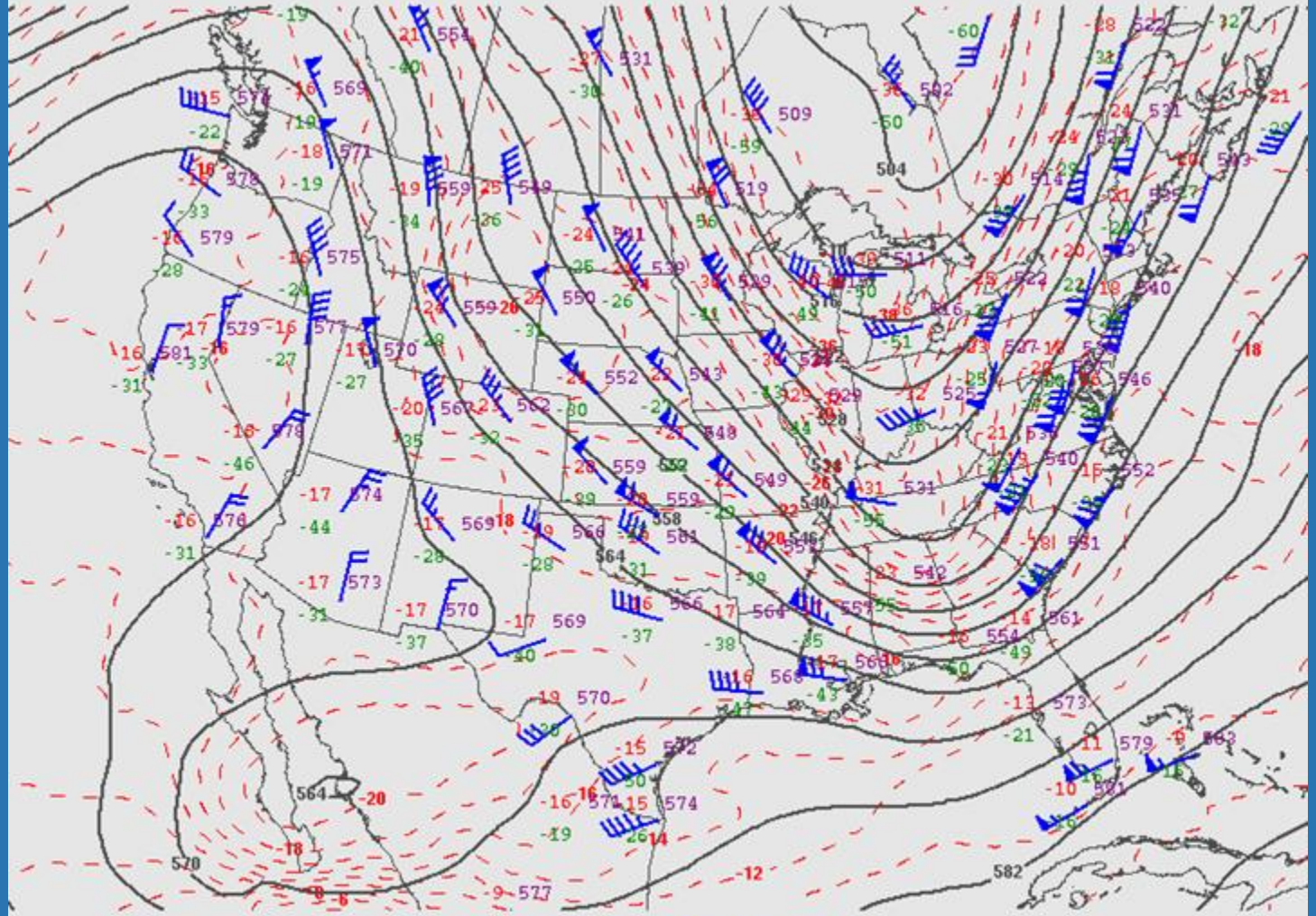
- Began with large cyclone in the lee of the northern Rockies.
- Intense jet streak aloft moves into the northern Plains.
  - Lift from left exit region.
  - Inferred lift via DCVA
- Result = deepening low over Dakotas/West MN.

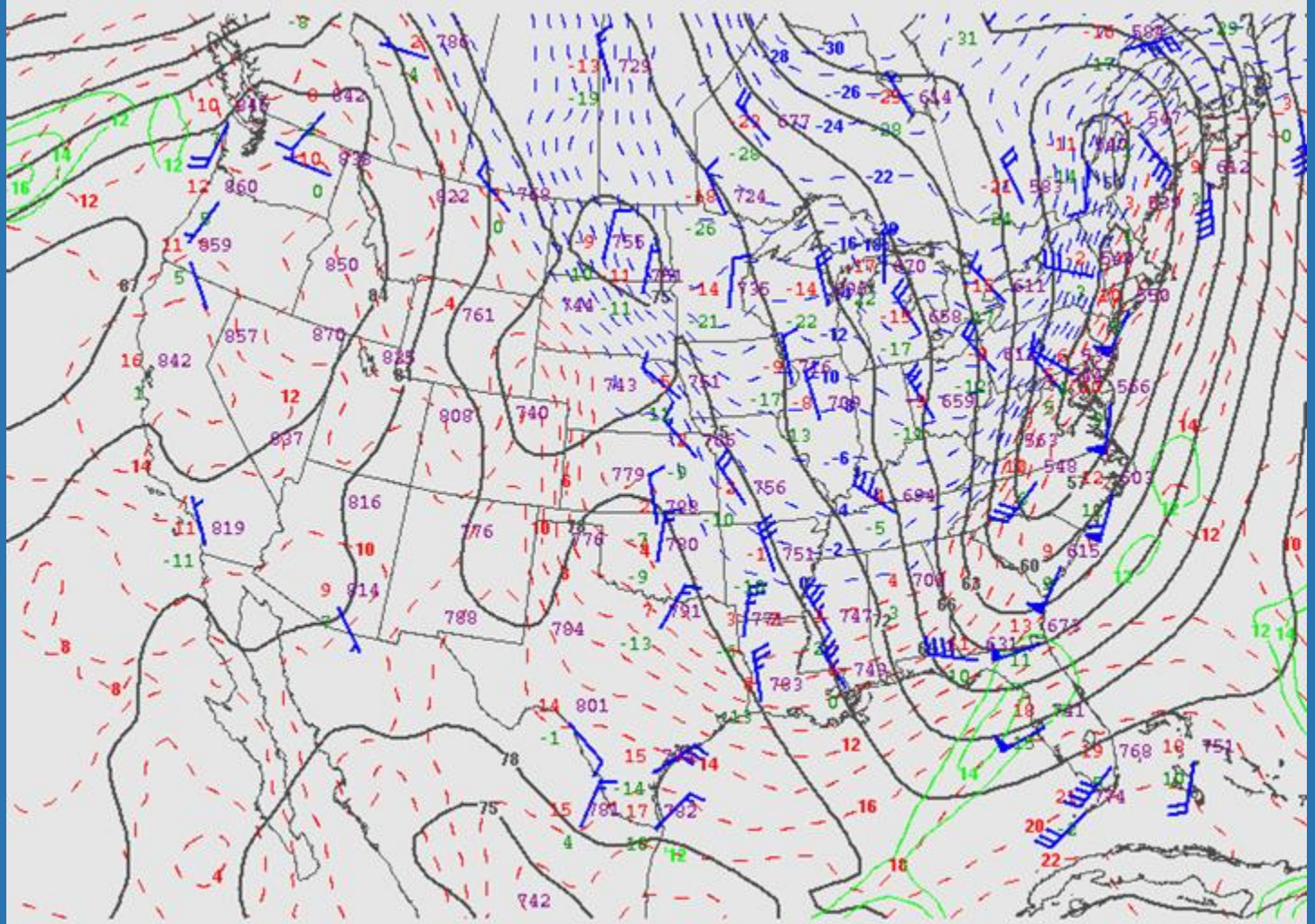






050308/1200 250 MB UA OBS AND ISOTACHS


050308/1200 500 MB UA OBS, HGHTS, and TEMPS

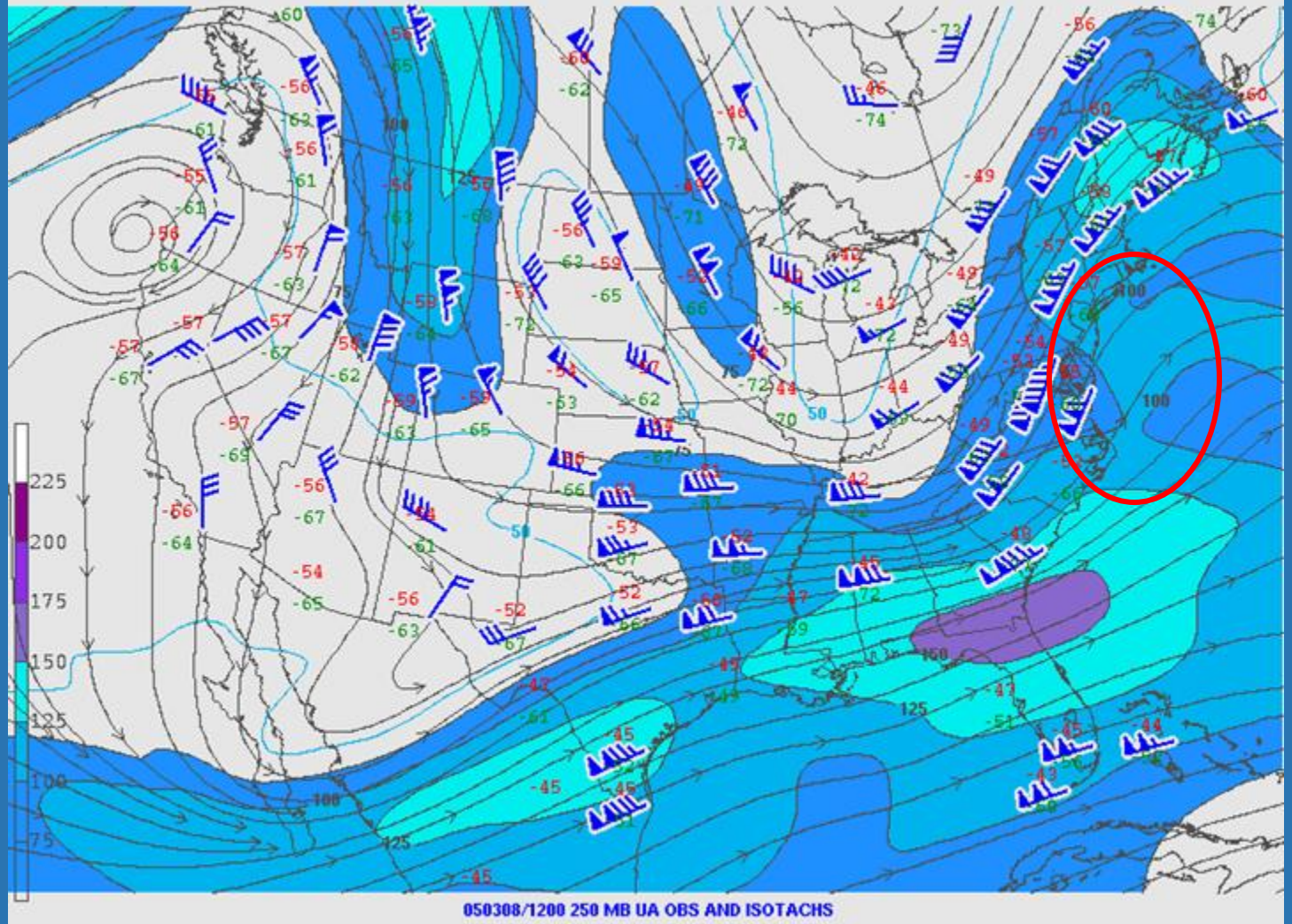

050308/1200 925 MB UA OBS, HGHTS, TEMPS, Td>=12

Forecast the 925 mb cyclone at 00 Z

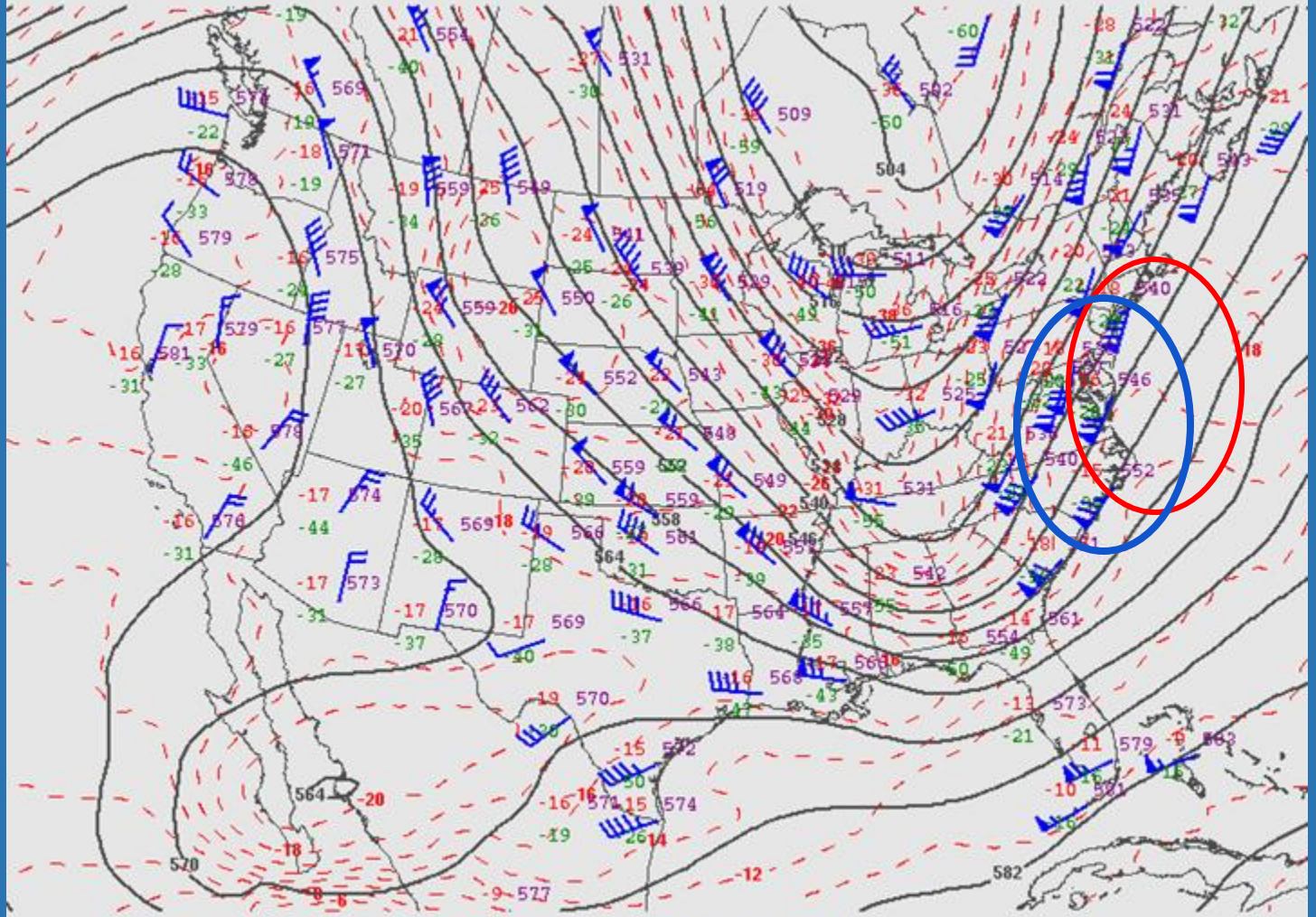
Where will it be located?

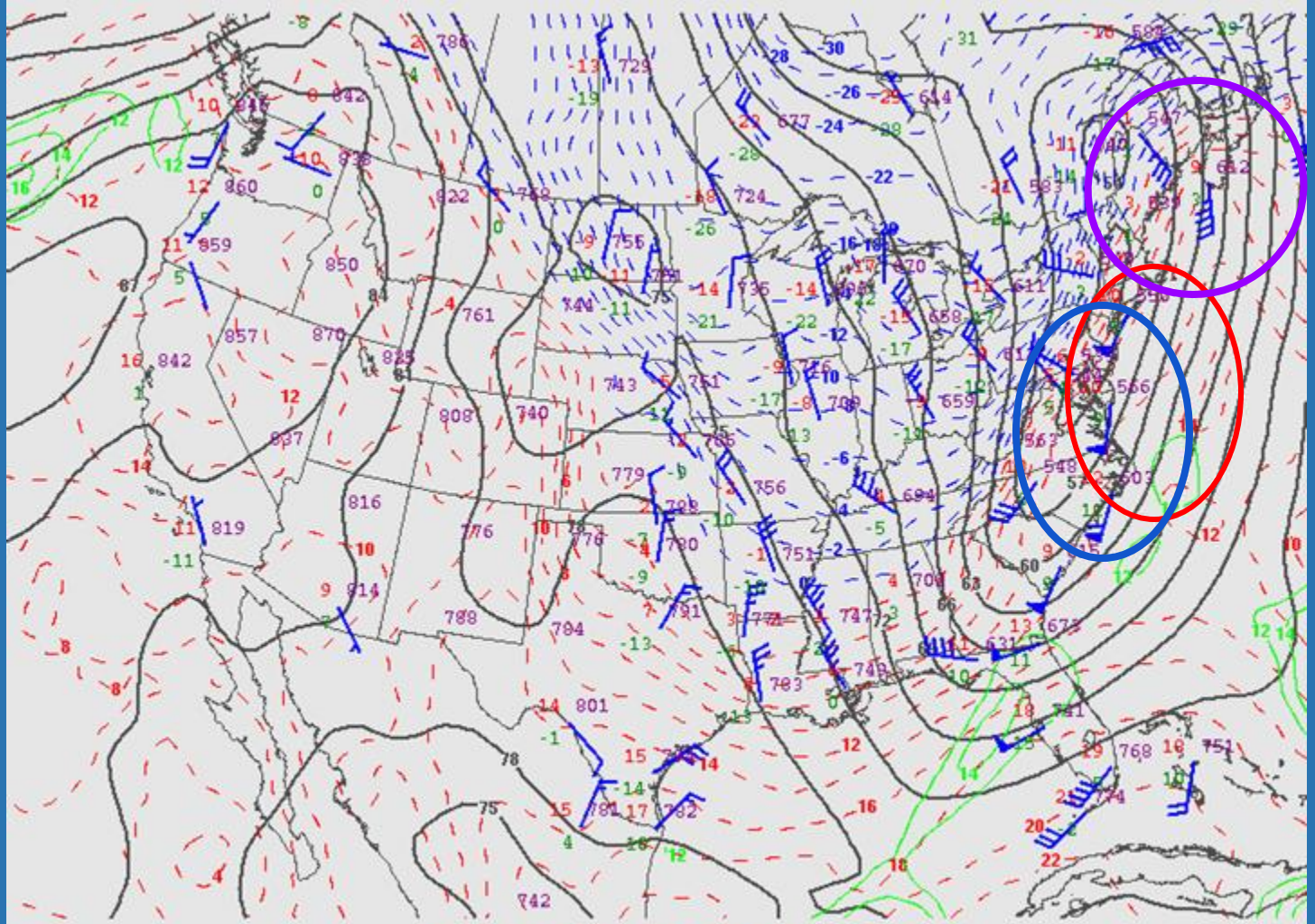
Will it deepen?

- Use QG arguments to support your answer!



050308/1200 250 MB UA OBS AND ISOTACHS


050308/1200 500 MB UA OBS, HGHTS, and TEMPS

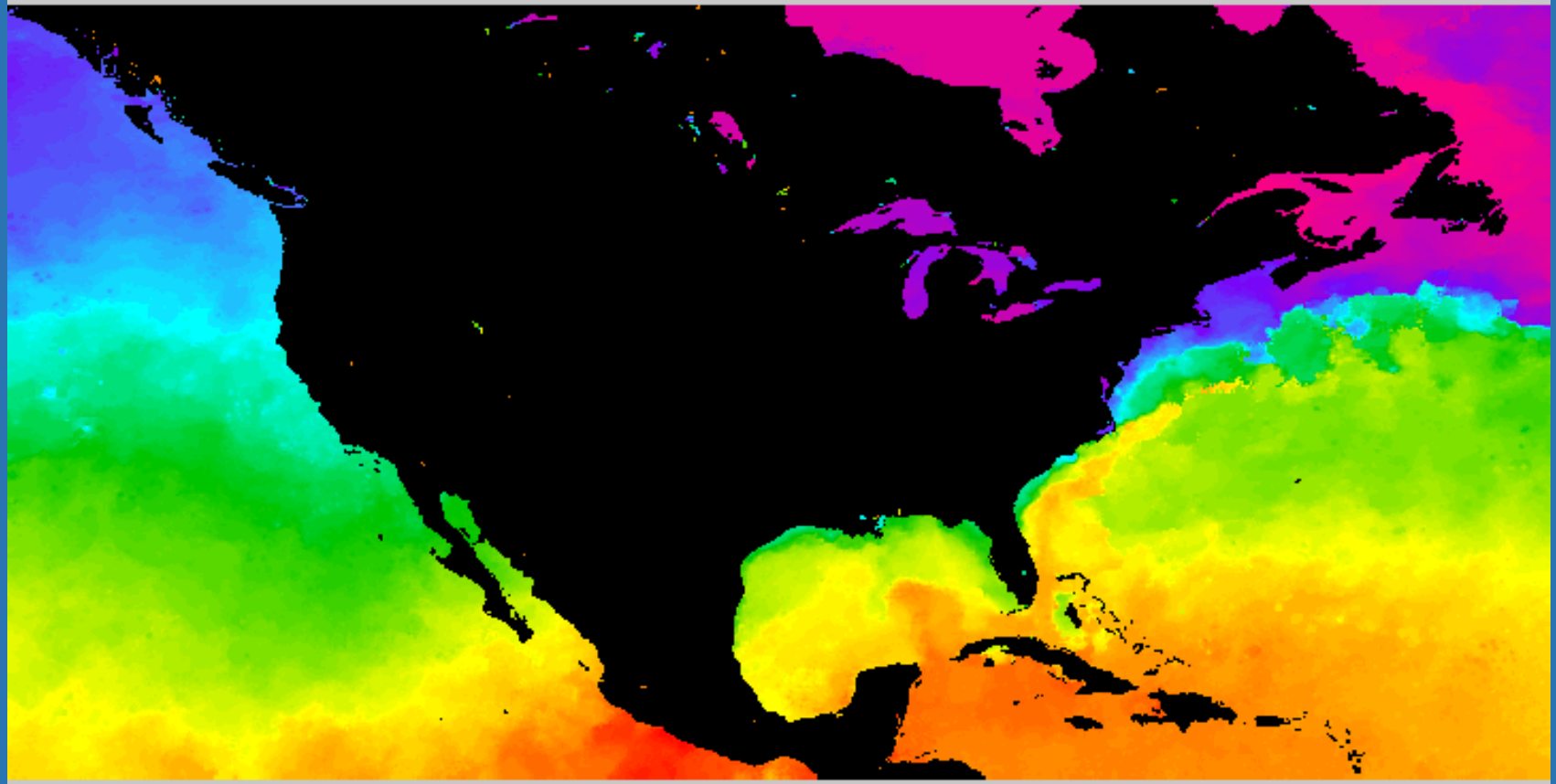

050308/1200 925 MB UA OBS, HGHTS, TEMPS, Td>=12

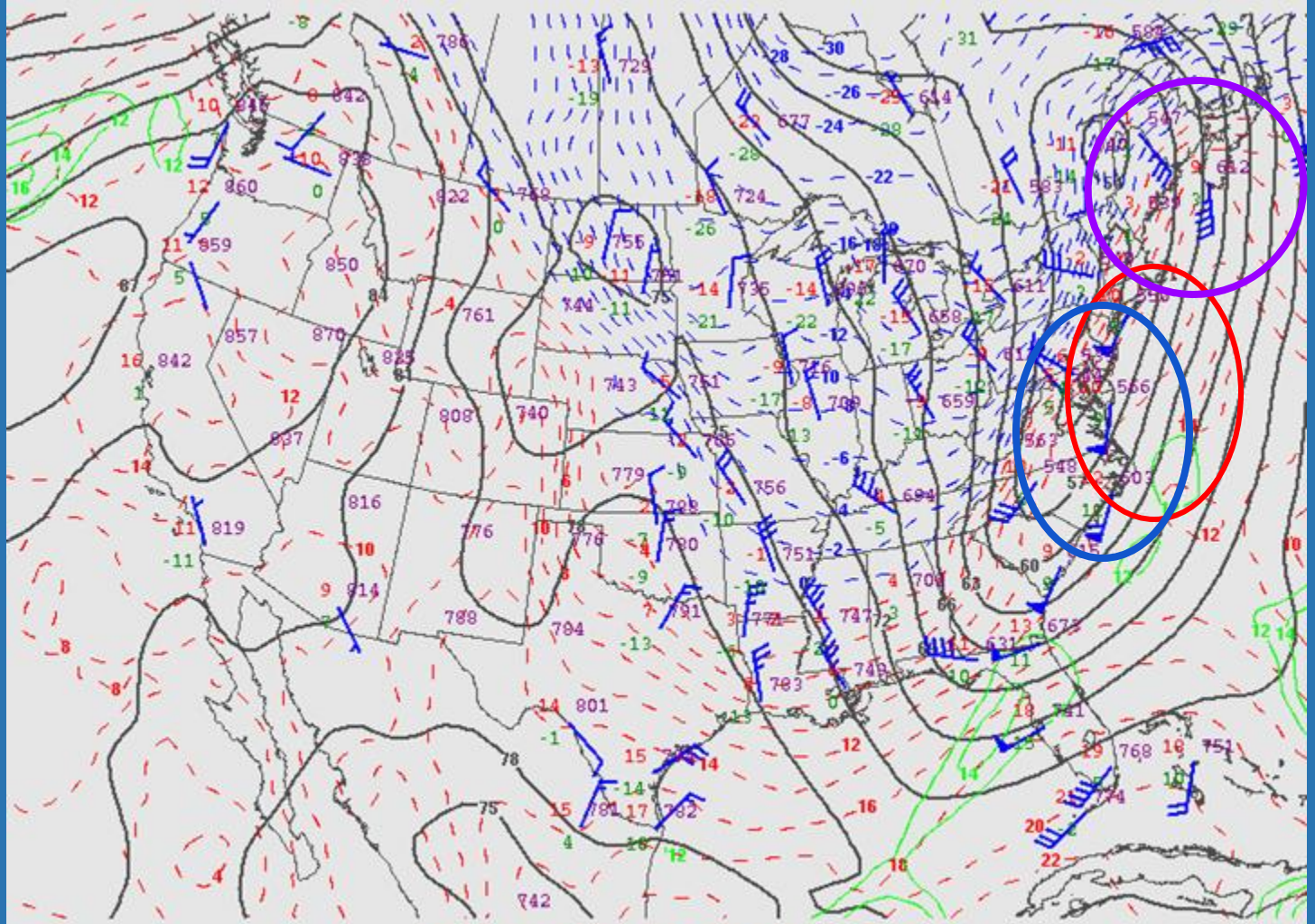
NOAA/NESDIS EDGE IMAGE DISPLAY

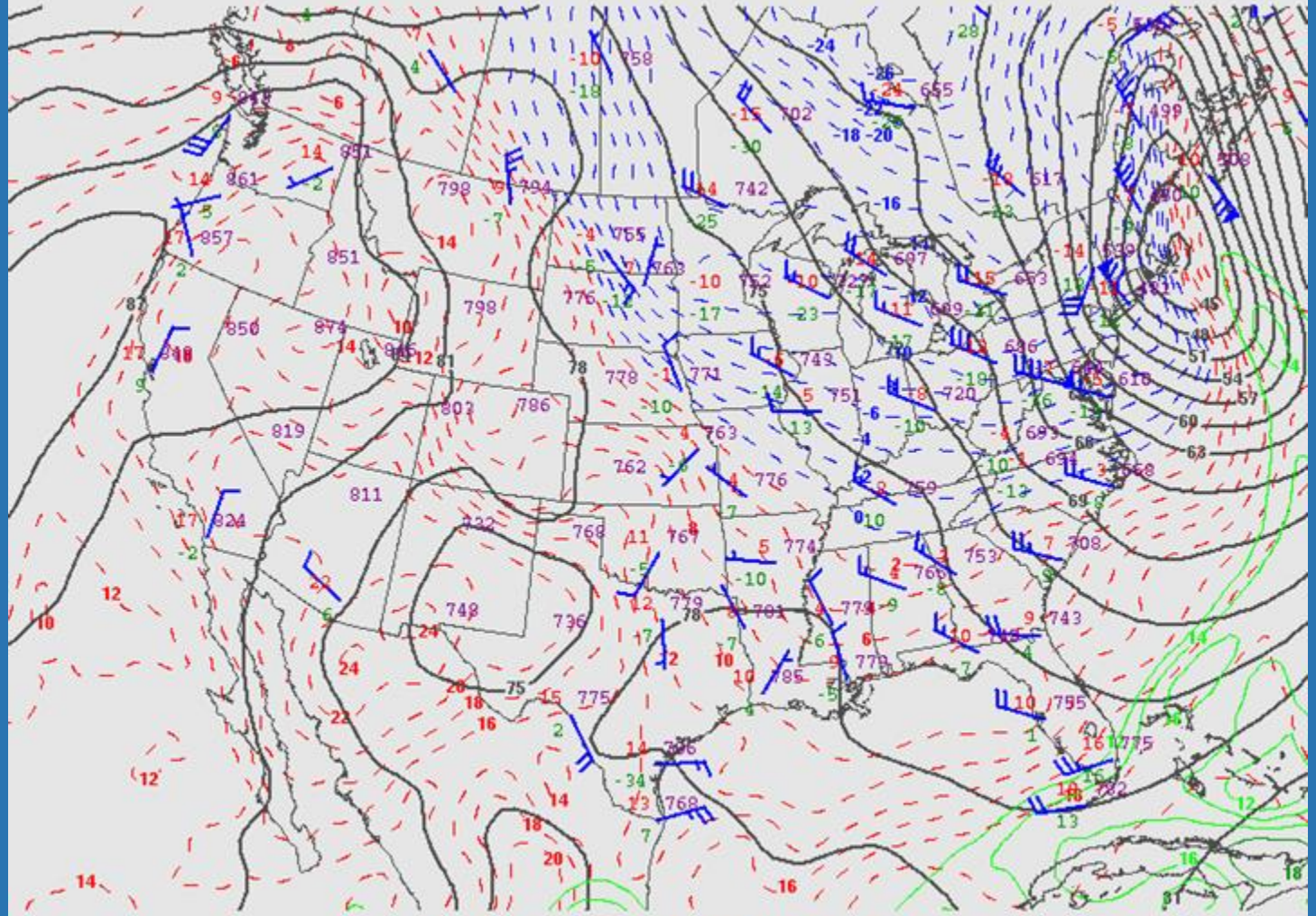
SST
14KM ANAL NORTH AMERICA
1/31/2016 23 – 2/1/2016 23

NOAA-19 OPERATION DAY/NITE

15.0000 TO 60.0000 LAT
-140.000 TO -50.0000 LON
24 HOURS




050308/1200 925 MB UA OBS, HGHTS, TEMPS, Td>=12


050309/0000 925 MB UA OBS, HGHTS, TEMPS, Td>=12

Contributing Factors

- Coupled upper-level jet structure.
- Inferred lift from DCVA ahead of the approaching shortwave trough.
- Strong low-level warm air advection across Maine.
- Warm ocean waters from the Gulf Stream allow for reduced low-level static stability/steepening low-level lapse rates, which allow for easier/efficient deepening of the low.

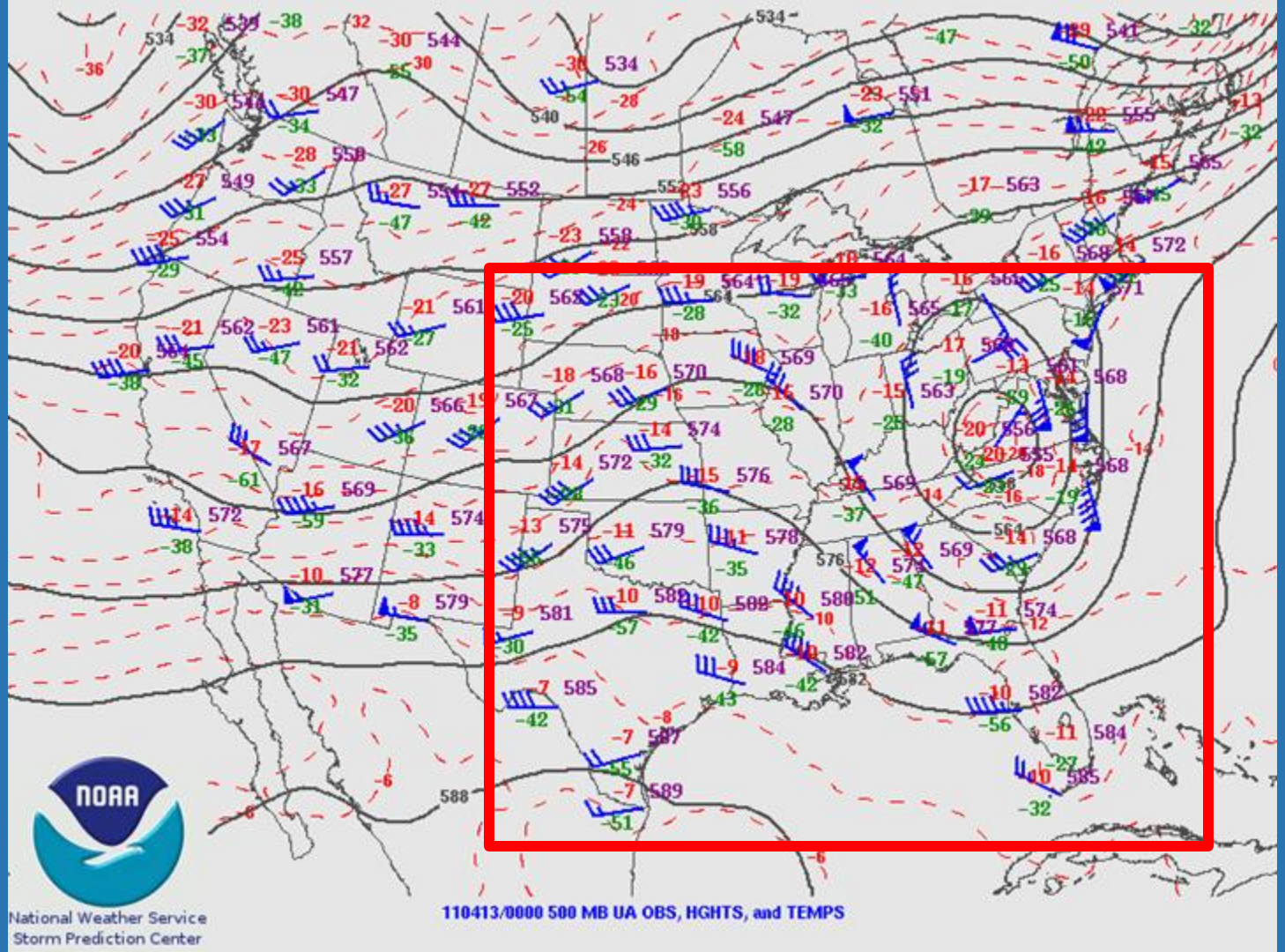
Deducing Surface Flow Patterns

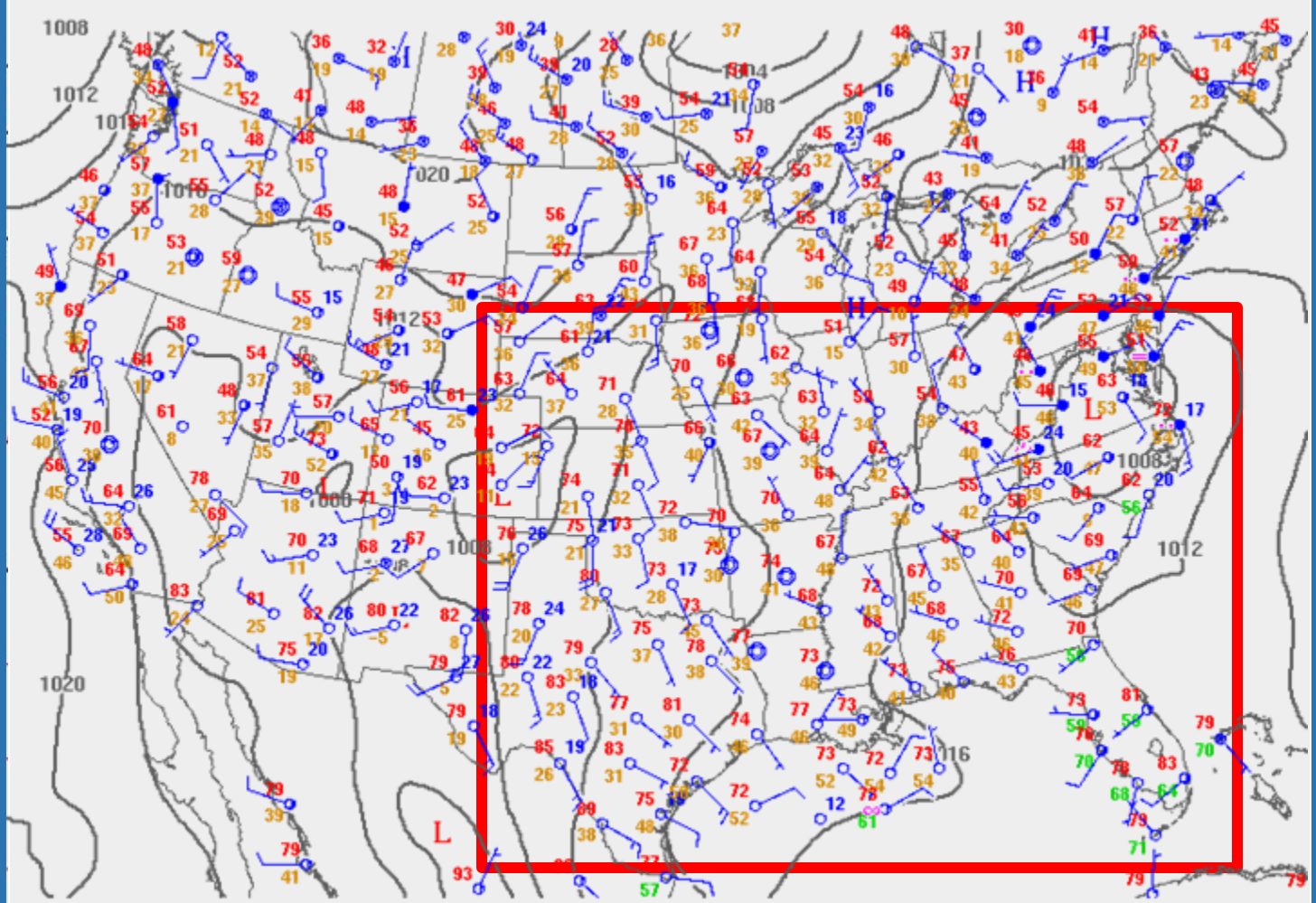
We'll see the progression of the pattern over several days.

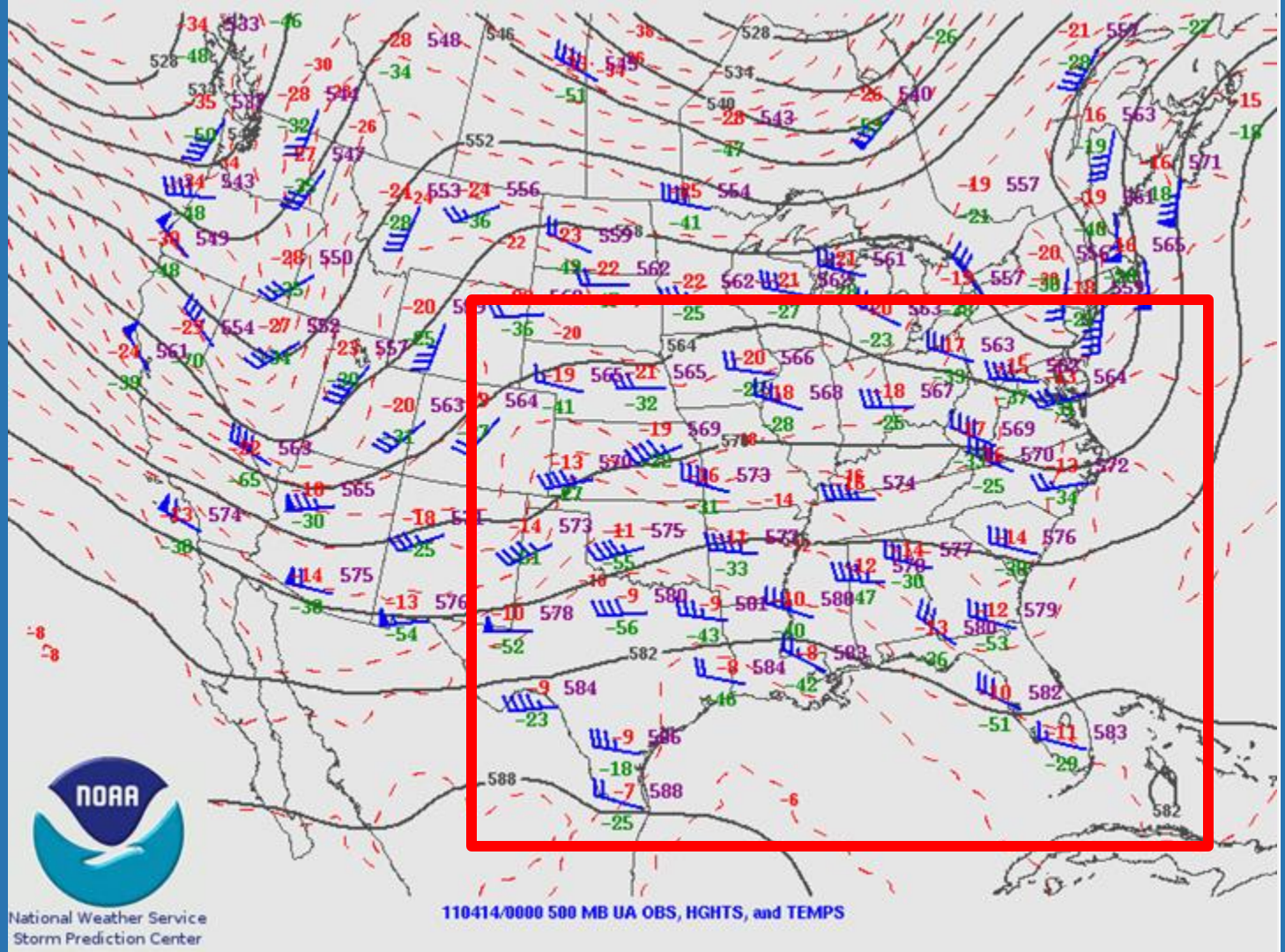
Given a single 500 mb chart, try to anticipate:

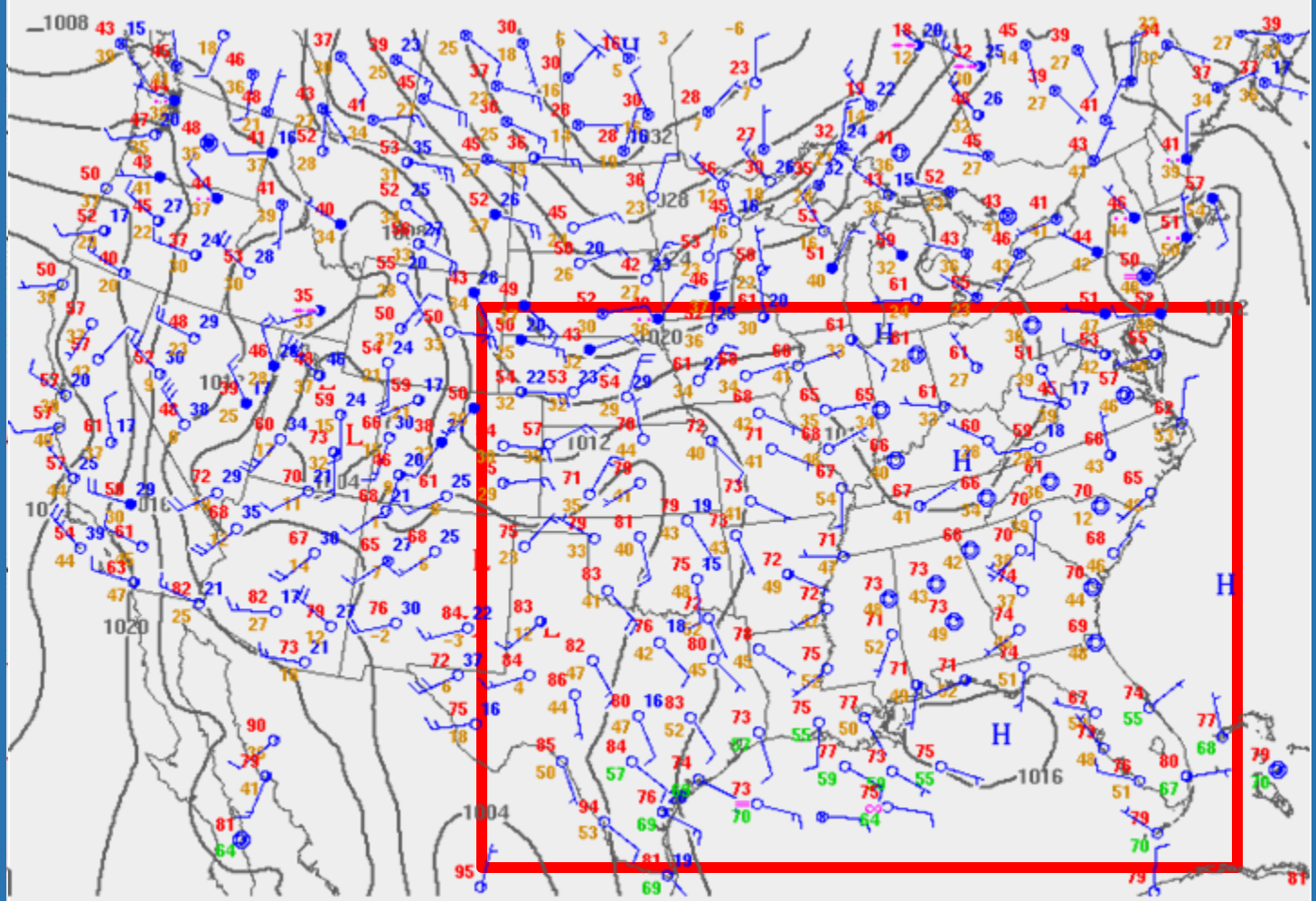
1) The expected surface pressure pattern

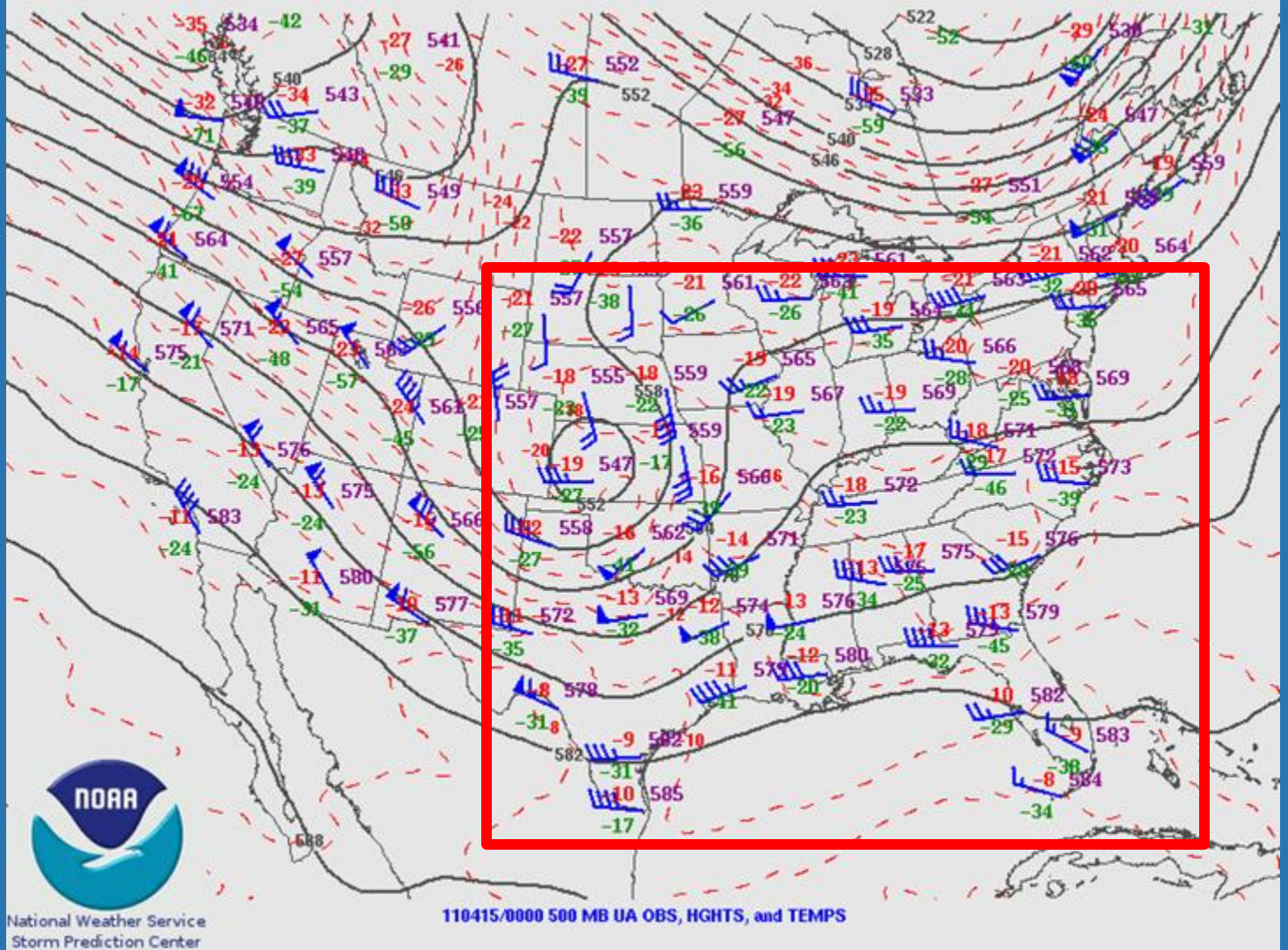
1) The resulting low-level moisture return pattern from the Gulf of Mexico into the southern Plains

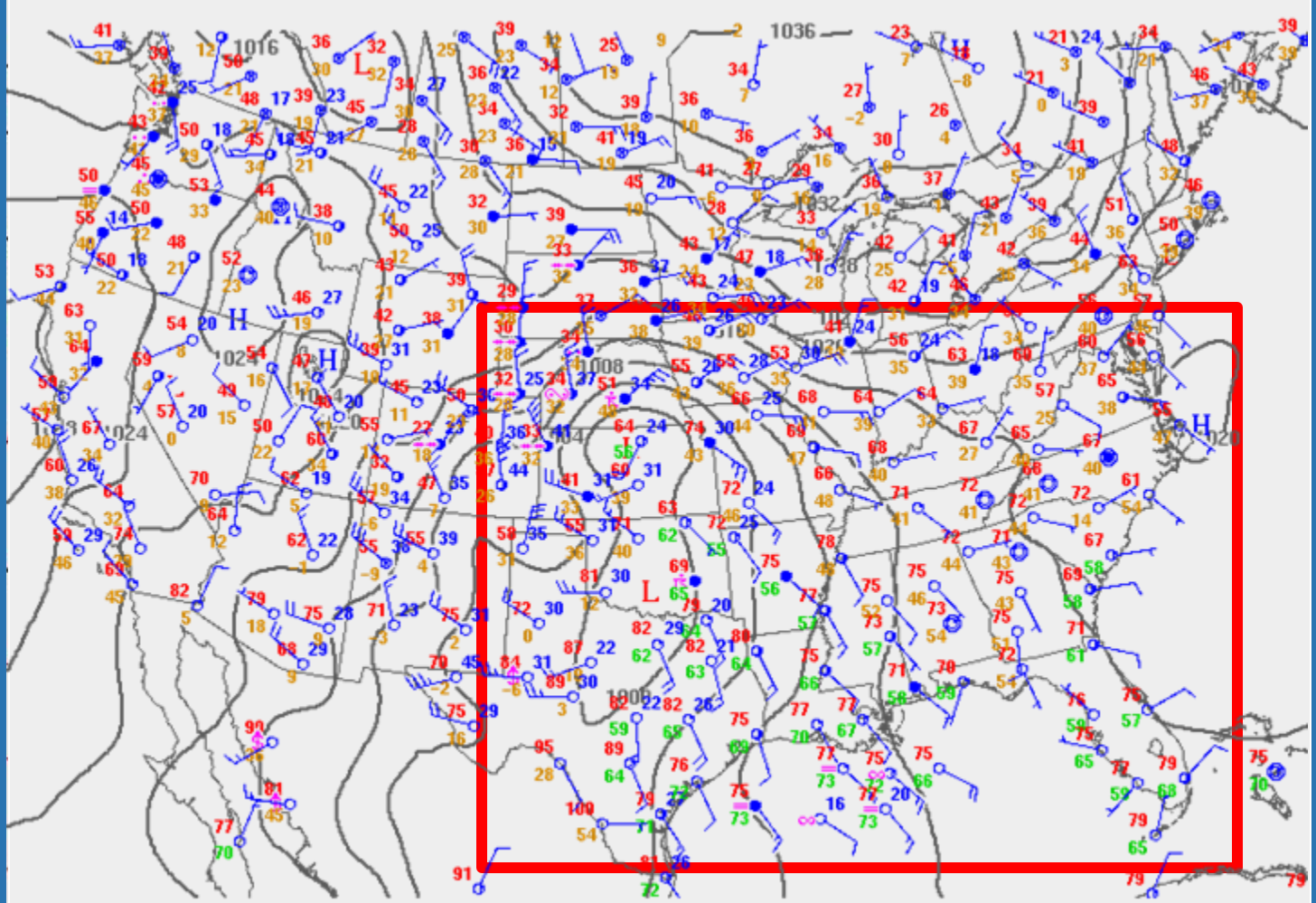

NOAA
National Weather Service
Storm Prediction Center
110413/0000 500 MB UA OBS, HGHTS, and TEMPS


110413/0000 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts


NOAA
National Weather Service
Storm Prediction Center
110414/0000 500 MB UA OBS, HGHTS, and TEMPS


110414/0000 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts

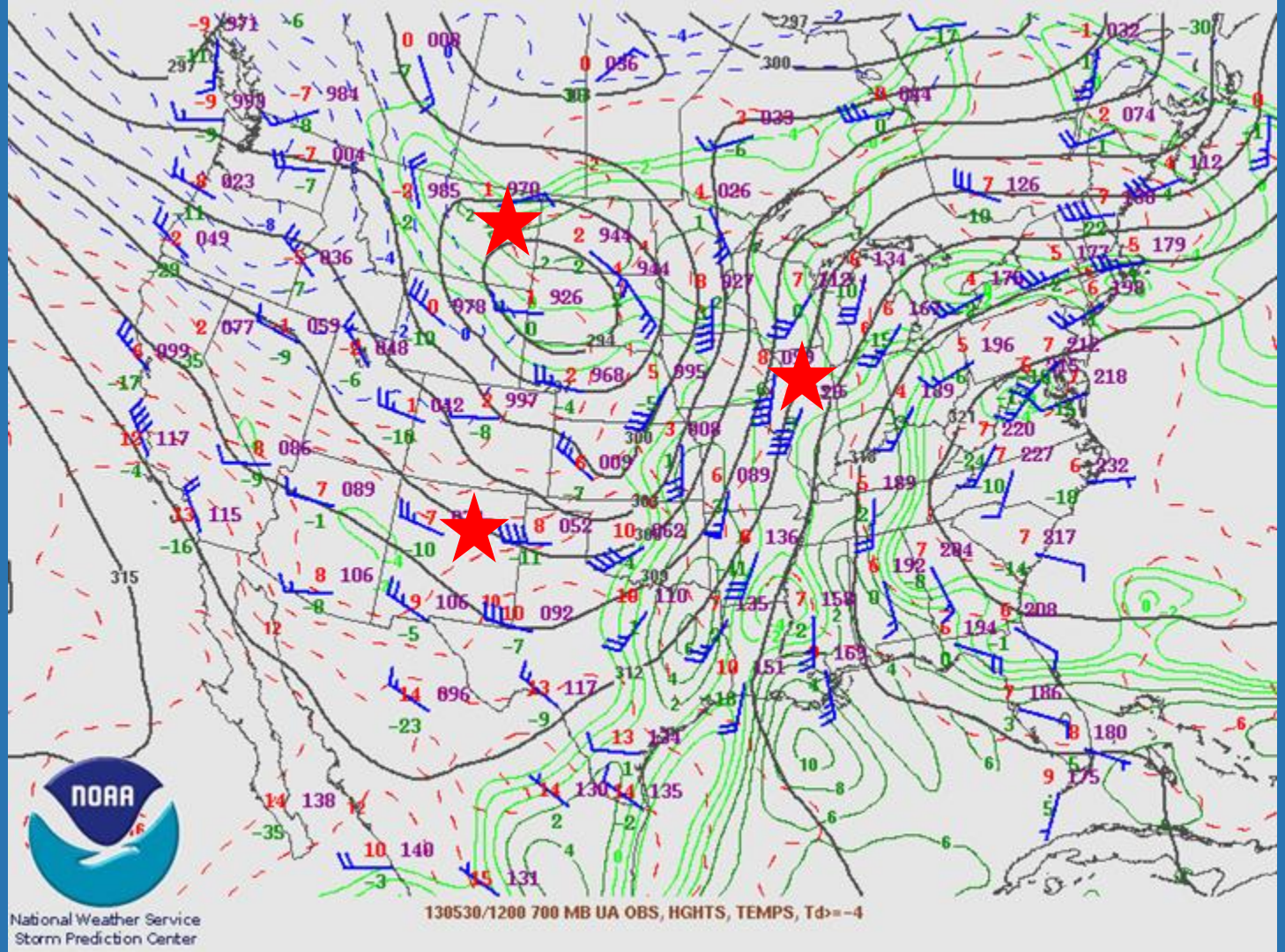

NOAA
National Weather Service
Storm Prediction Center
110415/0000 500 MB UA OBS, HGHTS, and TEMPS

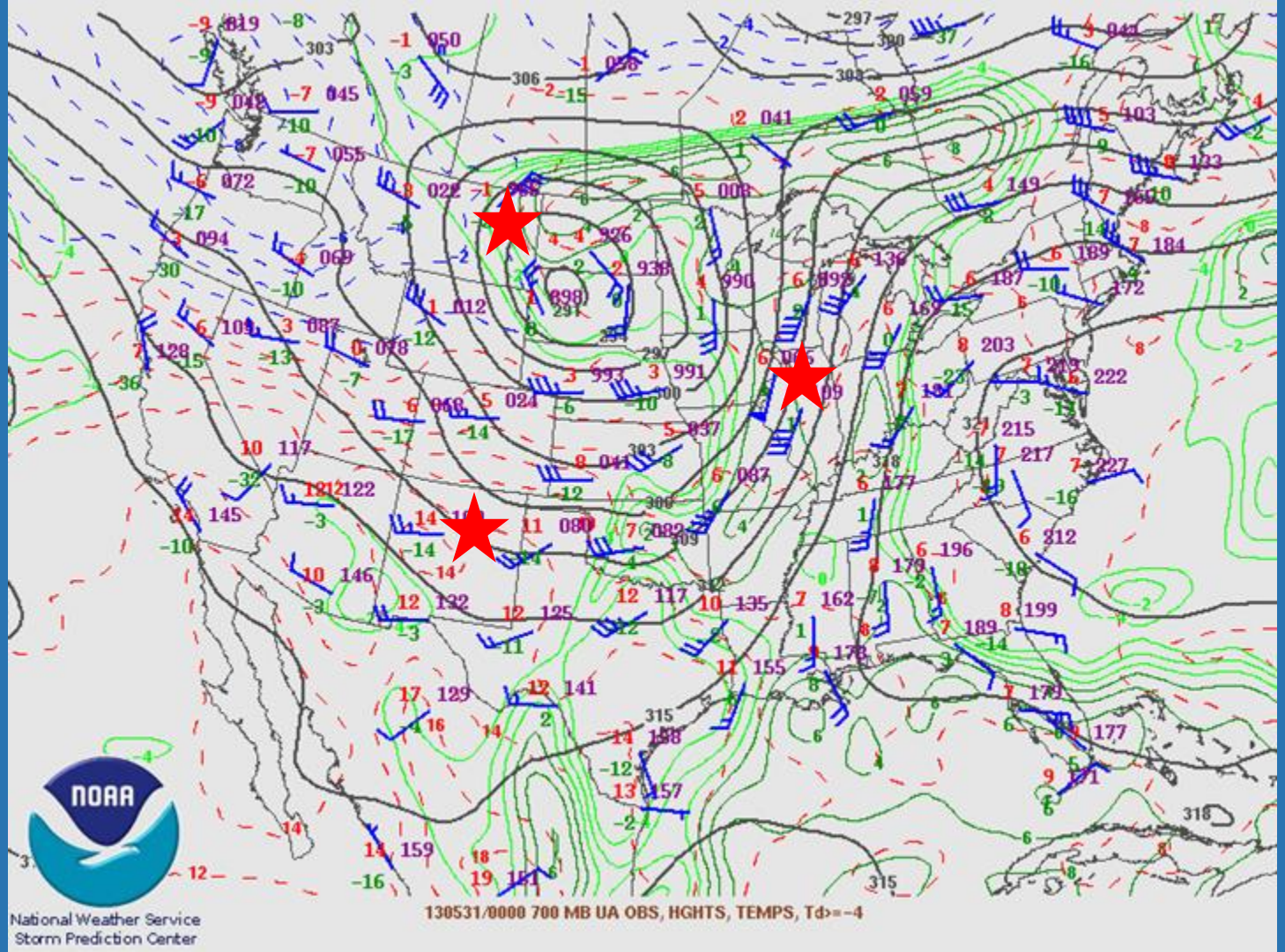

110415/0000 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts

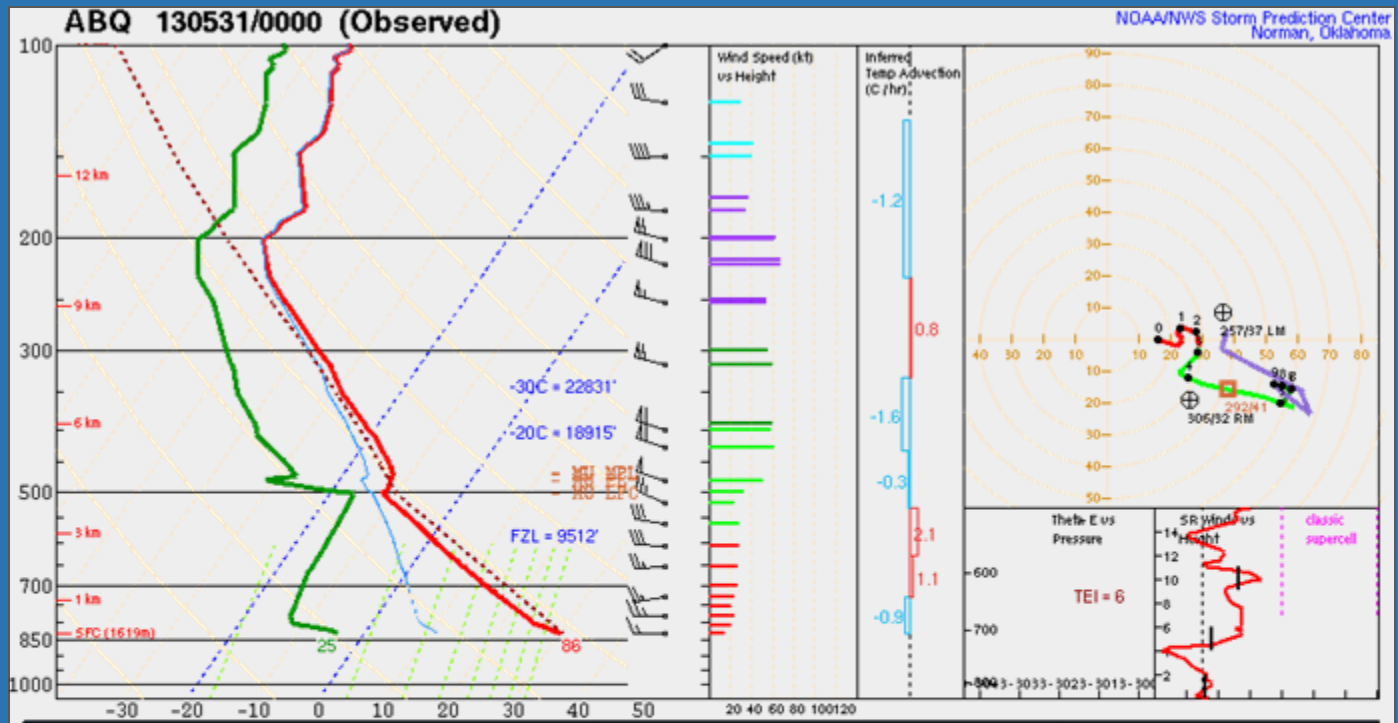
Deducing Lapse Rates

Given:
12 Z and 00 Z 700 mb charts

Predict:
Which location will see the steepest 700-500 mb lapse rates?


NOAA
National Weather Service
Storm Prediction Center
130530/1200 700 MB UA OBS, HGHTS, TEMPS, Td>=-4


NOAA
National Weather Service
Storm Prediction Center
130531/0000 700 MB UA OBS, HGHTS, TEMPS, Td>=-4



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	10	0	4130m	-2	4130m	14684'
MIXED LAYER	0	0	4669m	2	M	15313'
FCST SURFACE	0	0	4853m	1	M	15916'
MU (831 mb)	10	0	4130m	-2	4130m	14684'

PW = 0.29 in	3CAPE = 0 J/kg	WBZ = 5956'	WNDG = 0.0
K = M	DCAPE = 864 J/kg	FZL = 9512'	ESP = 0.0
MidRH = 33%	DownT = 48 F	ConvT = 97F	MMP = 0.74
LowRH = 9%	MeanW = 2.2 g/kg	MaxT = 86F	
SigSevere = 0 m3/s3			

Sfc-3km Agl Lapse Rate =	10.5 C/km
3-6km Agl Lapse Rate =	7.1 C/km
850-500mb Lapse Rate =	M
700-500mb Lapse Rate =	9.5 C/km

Supercell = 0.0
Left Supercell = 0.0
Sig Tor (CIN) = 0.0
Sig Tor (fixed) = 0.0
Sig Hail = 0.0

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	34	8	269/22	167/20
SFC - 3 km	71	13	268/25	176/20
SFC - 6 km		45	277/29	192/15
SFC - 8 km		42	279/33	206/15
Cloud Bearing Layer		21	292/41	253/12

BRN Shear = 10 m²/s²
4-6km SR Wind = 268/23 kt

.....Storm Motion Vectors.....
Bunkers Right = 306/32 kt
Bunkers Left = 257/37 kt

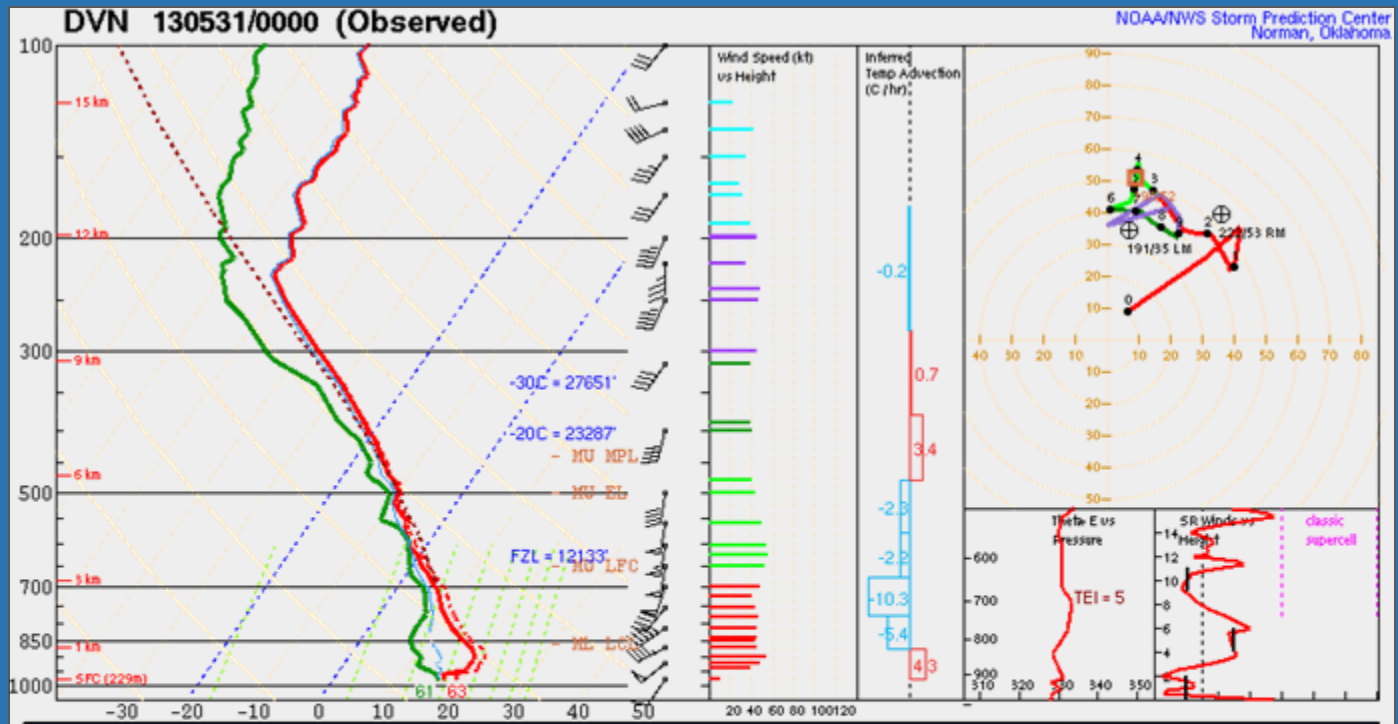
Corfidi Downshear = 43/1325 kt
Corfidi Upshear = 44/671 kt

1km & 6km AGL Wind Barbs

*** BEST GUESS PRECIP TYPE ***
Rain.
Based on sfc temperature of 86.4 F.

SARS - Sounding Analogs

SUPERCELL	SGFNT HAIL
No Quality Matches	No Quality Matches



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	0	0	167m	3	M	549'
MIXED LAYER	0	0	1093m	2	M	3584'
FCST SURFACE	458	0	1943m	-2	1943m	35688'
MU (703 mb)	43	-5	3054m	0	3429m	18024'

PW = 1.47 in	3CAPE = 0 J/kg	WBZ = 11751'	WNDG = 0.0
K = 32	DCAPE = 206 J/kg	FZL = 12133'	ESP = 0.0
MidRH = 82%	DownT = 62 F	ConvT = 84F	MMP = 0.41
LowRH = 66%	MeanW = 10.3 g/kg	MaxT = 85F	
SigSevere = 0 m3/s3			

Sfc-3km Agl Lapse Rate =	4.5 C/km
3-6km Agl Lapse Rate =	6.2 C/km
850-500mb Lapse Rate =	6.2 C/km
700-500mb Lapse Rate =	6.1 C/km

Supercell = 0.0
Left Supercell = 0.0
Sig Tor (CIN) = 0.0
Sig Tor (fixed) = -0.0
Sig Hail = 0.0

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	-70	36	231/39	20/16
SFC - 3 km	17	39	228/41	24/13
SFC - 6 km		32	214/42	70/13
SFC - 8 km		28	211/41	74/15
Cloud Bearing Layer		7	191/51	113/28

BRN Shear = 30 m²/s²
4-6km SR Wind = 107/30 kt

.....Storm Motion Vectors.....
Bunkers Right = 222/53 kt
Bunkers Left = 191/35 kt

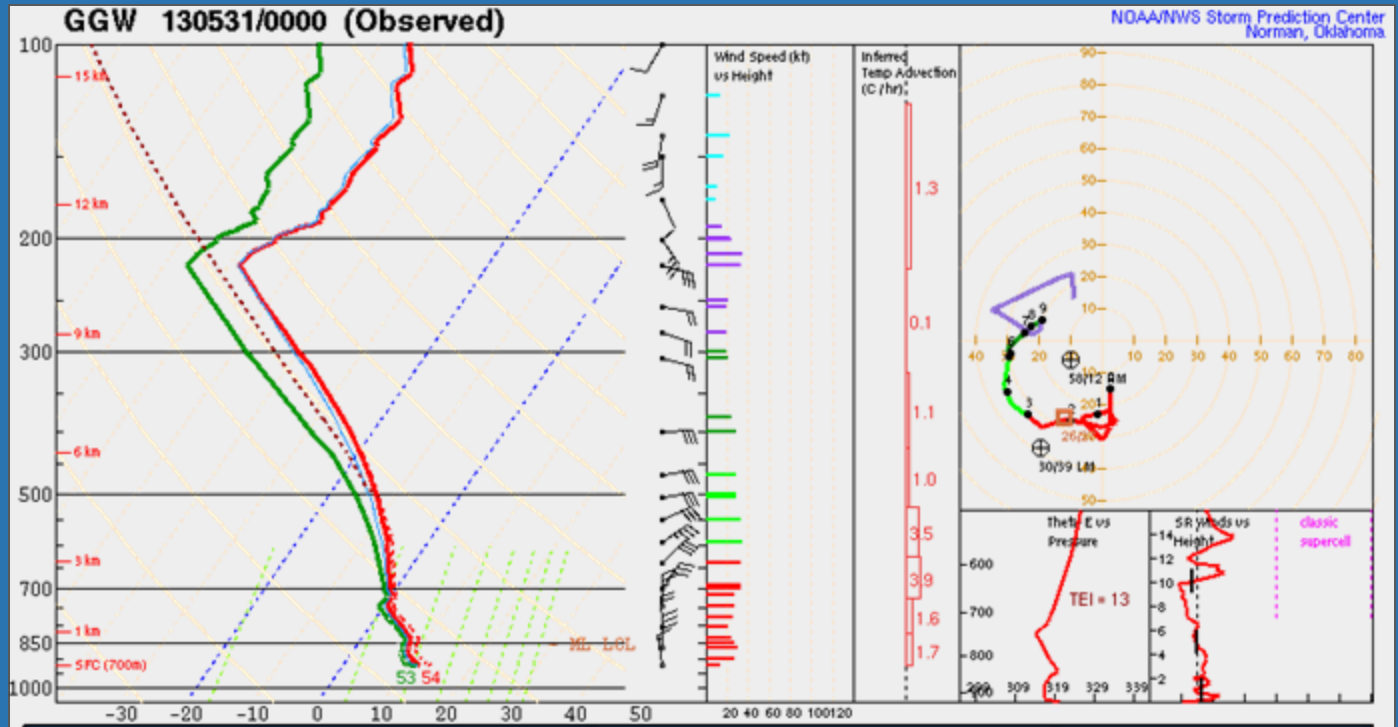
Corfidi Downshear = 181/57 kt
Corfidi Upshear = 136/23 kt

1km & 6km AGL Wind Barbs

*** BEST GUESS PRECIP TYPE ***
Rain.
Based on sfc temperature of 63.3 F.

SARS - Sounding Analogs

SUPERCELL	SGFNT HAIL
No Quality Matches	No Quality Matches



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	71	-0	75m	4	873m	8462'
MIXED LAYER	13	-12	613m	6	1283m	6578'
FCST SURFACE	126	0	1138m	3	1138m	10734'
MU (924 mb)	71	-0	75m	4	873m	8462'

PW = 0.94 in	3CAPE = 13 J/kg	WBZ = 6650'	WNDG = 0.0
K = 27	DCAPE = 85 J/kg	FZL = 6887'	ESP = 0.0
MidRH = 91%	DownT = 50 F	ConvT = 60F	MMP = 0.09
LowRH = 93%	MeanW = 7.8 g/kg	MaxT = 65F	
SigSevere = 228 m3/s3			

Sfc-3km Agl Lapse Rate =	5.6 C/km
3-6km Agl Lapse Rate =	5.4 C/km
850-500mb Lapse Rate =	5.2 C/km
700-500mb Lapse Rate =	4.8 C/km

Supercell = 0.0
Left Supercell = 0.0
Sig Tor (CIN) = 0.0
Sig Tor (fixed) = 0.0
Sig Hail = 0.0

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	69	9	2/25	334/21
SFC - 3 km	208	28	12/25	346/19
SFC - 6 km		34	30/24	8/15
SFC - 8 km		32	37/23	18/13

BRN Shear = 28 m²/s²
4-6km SR Wind = 85/20 kt

.....Storm Motion Vectors.....

Bunkers Right =	58/12 kt
Bunkers Left =	30/39 kt
Corfidi Downshear =	87/40 kt
Corfidi Upshear =	119/23 kt

1km & 6km AGL Wind Barbs

*** BEST GUESS PRECIP TYPE ***
Rain.
Based on sfc temperature of 54.0 F.

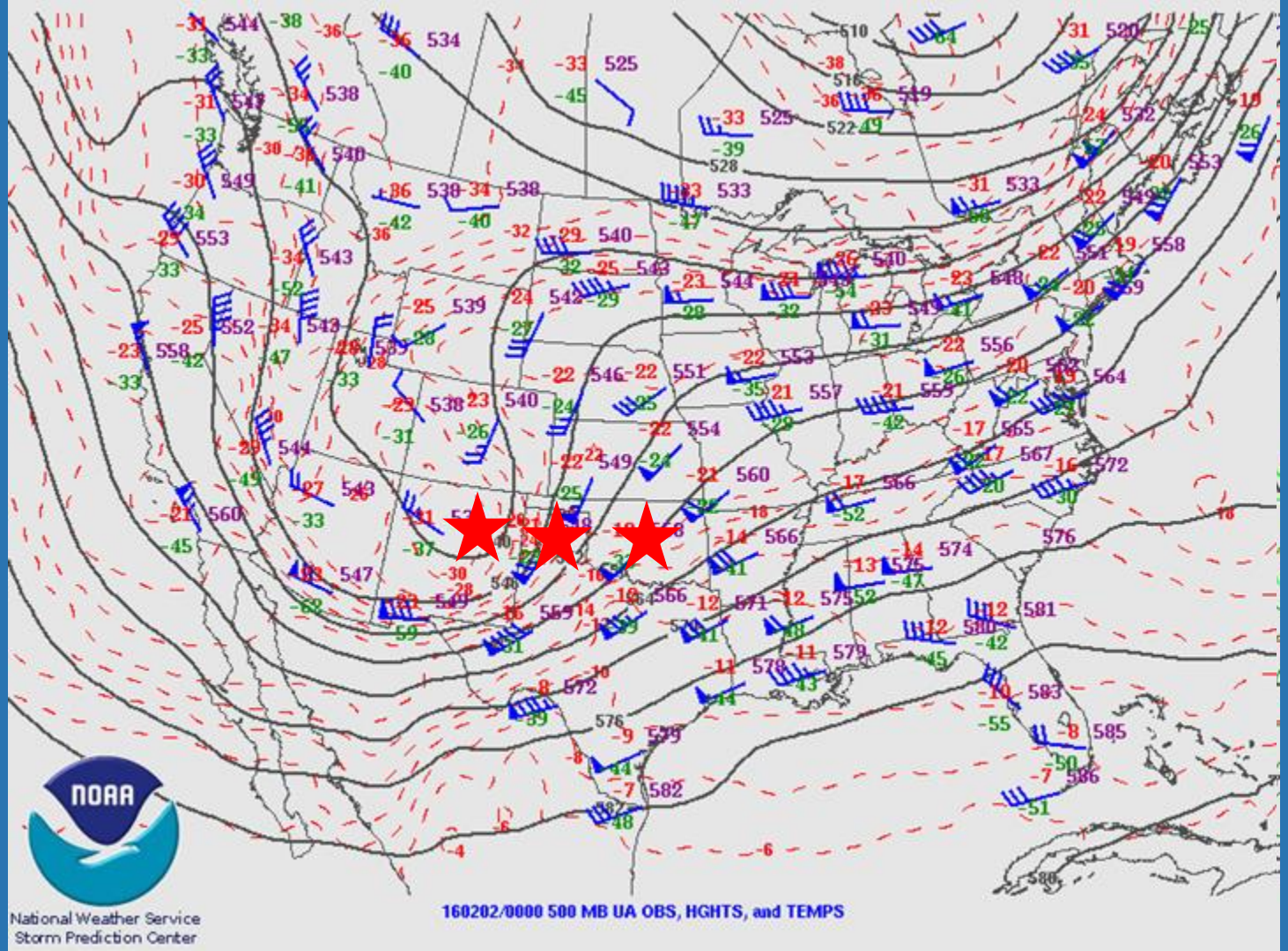
SARS - Sounding Analogs

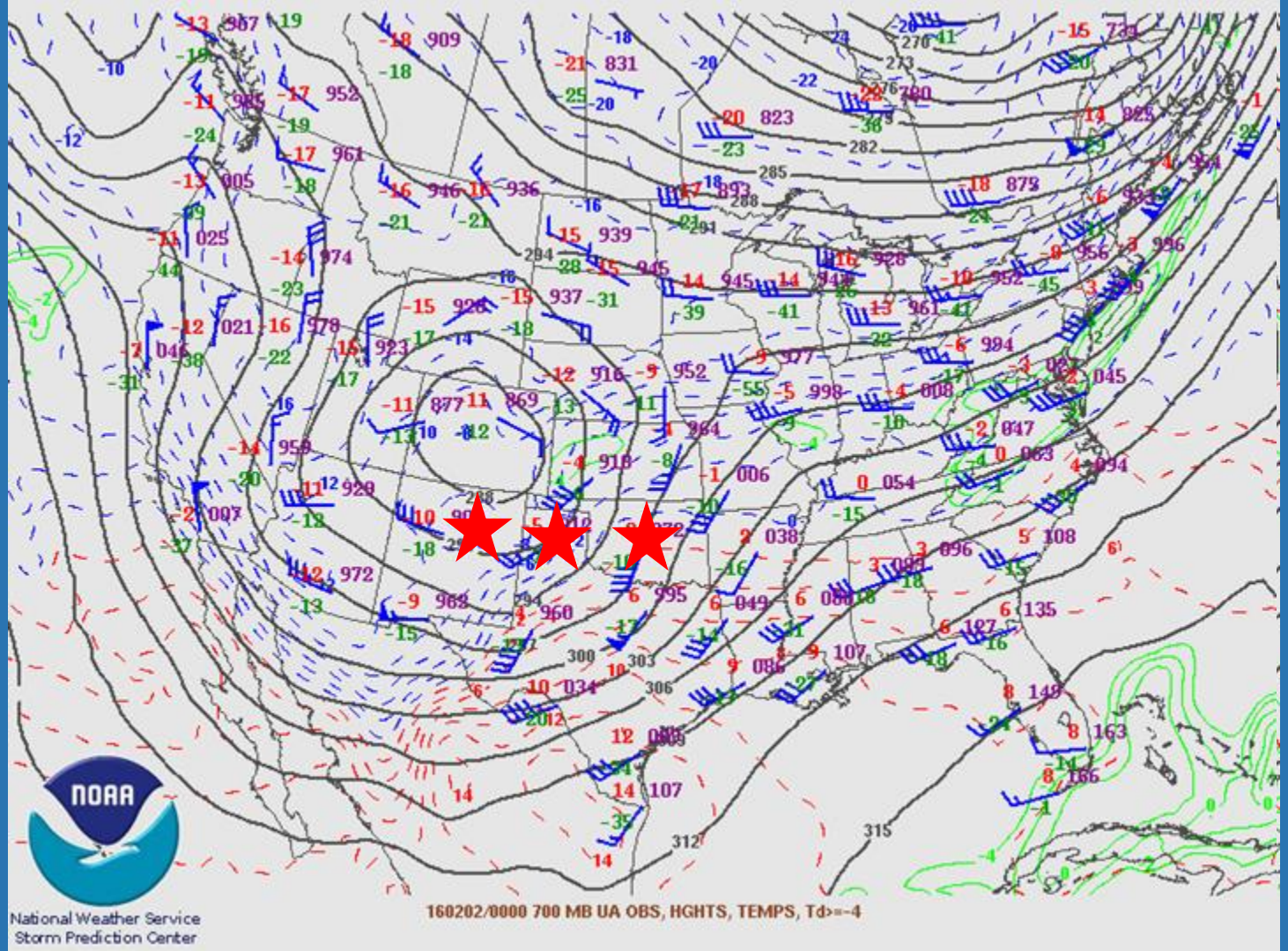
SUPERCELL	SGFNT HAIL
No Quality Matches	No Quality Matches

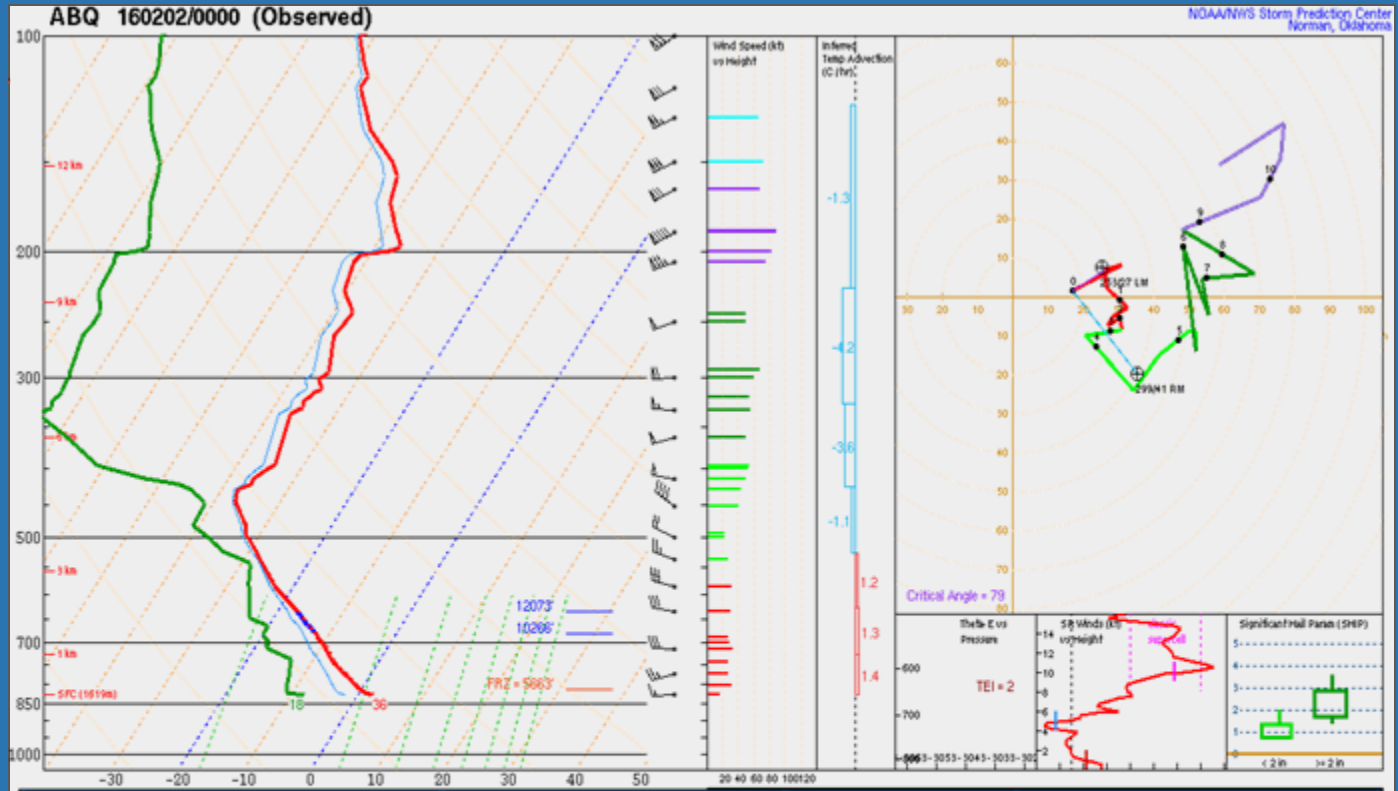
Deducing Lapse Rates

Given:
00Z 700 mb and 500 mb charts

Predict:
Which location will see the steepest 700-500 mb lapse rates?


NOAA
National Weather Service
Storm Prediction Center
160202/0000 500 MB UA OBS, HGHTS, and TEMPS


NOAA
National Weather Service
Storm Prediction Center
160202/0000 700 MB UA OBS, HGHTS, TEMPS, Td>=-4



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	149	0	1225m	-1	1225m	14684'
MIXED LAYER	6	-36	1531m	0	2648m	10906'
FCST SURFACE	154	0	1817m	-2	1817m	14939'
MU (825 mb)	149	0	1225m	-1	1225m	14684'

PW = 0.17 in | 3CAPE = 4 J/kg | WBZ = 0' | WNDG = 0.0
K = M | DCAPE = 231 J/kg | FZL = 353' | ESP = 0.0
MidRH = 60% | DownT = 25 F | ConvT = 37F | MMP = 0.01
LowRH = 50% | MeanW = 2.0 g/kg | MaxT = 39F | NCAPE = 0.00
SigSevere = 101 m3/s3

Sfc-3km Agl Lapse Rate = 9.3 C/km
3-6km Agl Lapse Rate = 3.4 C/km
850-500mb Lapse Rate = M
700-500mb Lapse Rate = 8.6 C/km

Supercell = 0.0
Left Supercell = 0.0
STP (eff layer) = 0.0
STP (fix layer) = 0.0
Sig Hail = 0.0

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	83	14	260/27	160/26
SFC - 3 km	64	15	273/28	158/20
Eff Inflow Layer	0	0	265/17	139/28
SFC - 6 km		33	278/30	158/16
SFC - 8 km		44	276/33	169/17
LCL - EL (Cloud Layer)		20	287/30	146/13

BRN Shear = 17 m²/s²
4-6km SR Wind = 216/9 kt

.....Storm Motion Vectors.....
Bunkers Right = 299/41 kt
Bunkers Left = 253/27 kt

Corfidi Downshear = 44/1327 kt
Corfidi Upshear = 44/674 kt

1km & 6km AGL Wind Barbs

*** BEST GUESS PRECIP TYPE ***
Snow.
Based on sfc temperature of 36.0 F.

SARS - Sounding Analogs

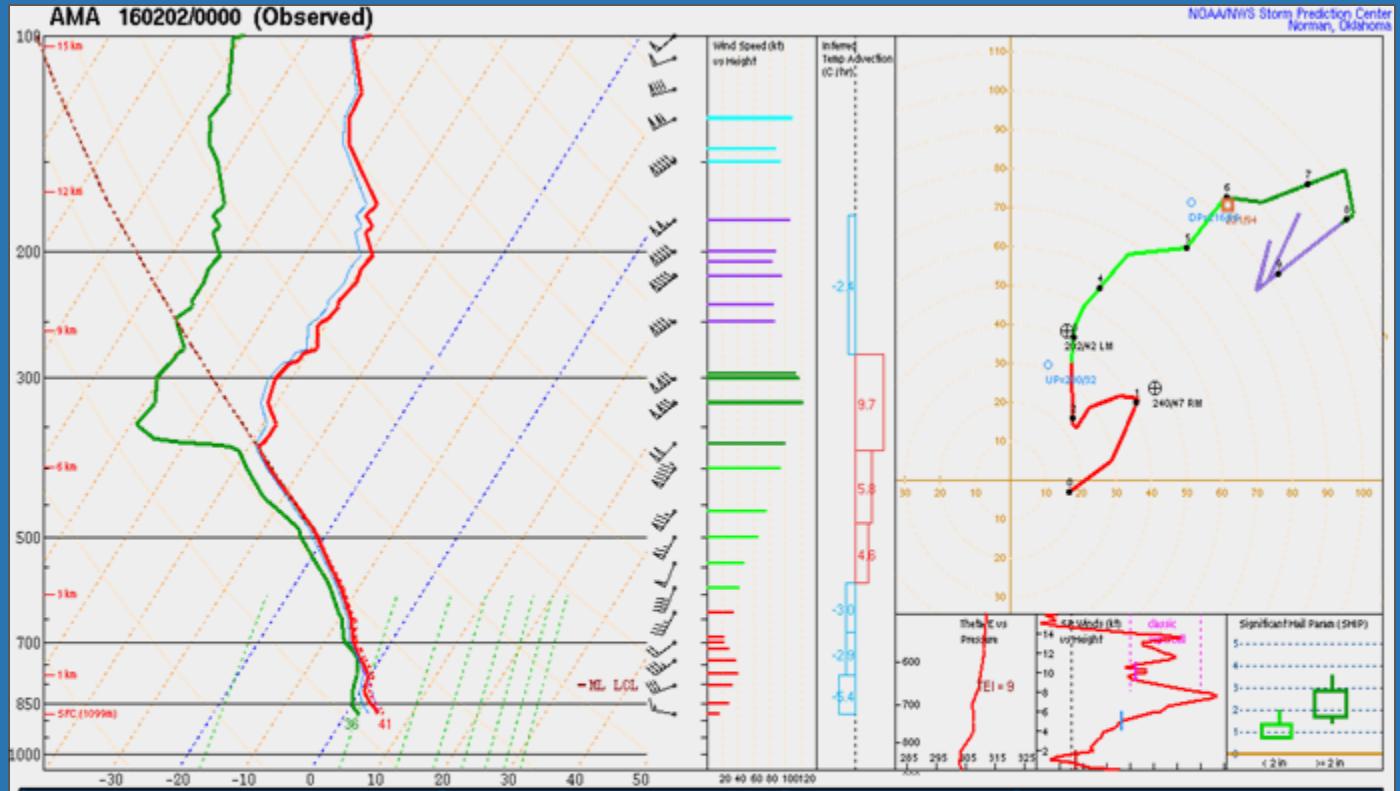
SUPERCELL	SGFNT HAIL
No Quality Matches	No Quality Matches

SARS: 0% TOR

Effective-Layer STP (with CIN)

Prob EF2+ Torn with supercell
Sounding CLIMO = .15 sigtor
based on MLCAPE: 0.12
based on MLLCL: 0.06
based on ESRH: 0.06
based on EBWD: 0.03
based on STP_fixed: 0.05
based on STP_effective: 0.06

EF4+ EF3 EF2 EF1 EF0 NONTOR



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	0	0	324m	6	M	1063'
MIXED LAYER	0	0	715m	6	M	2345'
FCST SURFACE	22	0	1342m	2	1342m	7844'
MU (485 mb)	7	-1	4860m	0	5494m	21235'

PW = 0.52 in | 3CAPE = 29 J/kg | WBZ = 2052' | WNDG = 0.0
K = 23 | DCAPE = -11 J/kg | FZL = 3190' | ESP = 0.0
MidRH = 89% | DownT = 41 F | ConvT = 52F | MMP = 0.97
LowRH = 88% | MeanW = 4.6 g/kg | MaxT = 53F | NCAPE = 0.01
SigSevere = 0 m3/s3

Sfc-3km Agl Lapse Rate = 5.7 C/km
3-6km Agl Lapse Rate = 7.8 C/km
850-500mb Lapse Rate = 5.9 C/km
700-500mb Lapse Rate = 6.2 C/km

Supercell = 0.0
Left Supercell = 0.0
STP (eff layer) = 0.0
STP (fix layer) = -0.0
Sig Hail = 0.0

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	-19	30	254/30	38/20
SFC - 3 km	109	40	237/30	66/18
SFC - 6 km		88	225/40	103/14
SFC - 8 km		105	226/47	132/12

BRN Shear = 81 m²/s²
4-6km SR Wind = 185/37 kt

.....Storm Motion Vectors.....
Bunkers Right = 240/47 kt
Bunkers Left = 202/42 kt
Corfidi Downshear = 216/68 kt
Corfidi Upshear = 200/32 kt

1km & 6km AGL Wind Barbs

*** BEST GUESS PRECIP TYPE ***
Rain.
Based on sfc temperature of 41.0 F.

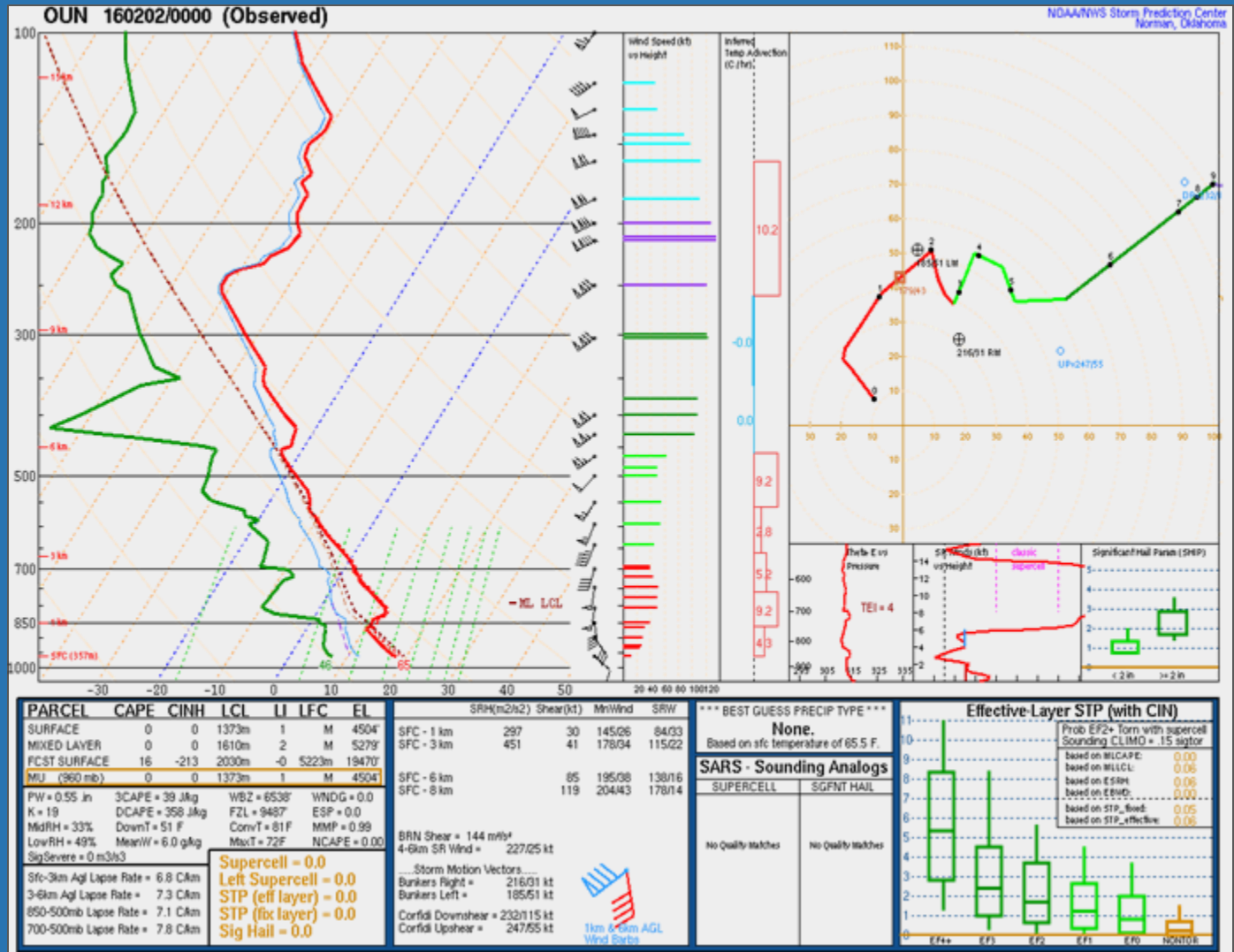
SARS - Sounding Analogs

SUPERCELL	SGFNT HAIL
No Quality Matches	No Quality Matches

Effective-Layer STP (with CIN)

Prob EF2+ Torn with supercell
Sounding CLIMO = .15 sigtor
based on MLCAPE: 0.00
based on MLLCL: 0.19
based on ESRH: 0.00
based on EBWD: 0.00
based on STP_fixed: 0.05
based on STP_effective: 0.06

EF4+ EF3 EF2 EF1 EF0 NONTOR


OUN 160202/0000 (Observed)
NOAA/NWS Storm Prediction Center
Norman, Oklahoma
Wind Speed (kt) vs Height
Inferred Temp Advection (C/hr)
Theta-E vs Pressure
Significant Hail Parms (SHIP)
EL
LCL
SFC (357m)
TEI = 4
PARCEL CAPE CINH LCL LI LFC EL
SURFACE 0 0 1373m 1 M 4504'
MIXED LAYER 0 0 1610m 2 M 5279'
FCST SURFACE 16 -213 2030m -0 5223m 19470'
MU (960 mb) 0 0 1373m 1 M 4504'
PW = 0.55 in 3CAPE = 39 J/kg WBZ = 6538' WNDG = 0.0
K = 19 DCAPE = 358 J/kg FZL = 9487' ESP = 0.0
MidRH = 33% DownT = 51 F ConvT = 81F MMP = 0.99
LowRH = 49% MeanW = 6.0 g/kg MaxT = 72F NCAPE = 0.00
SigSevere = 0 m3/s3
Sfc-3km Agl Lapse Rate = 6.8 C/km
3-6km Agl Lapse Rate = 7.3 C/km
850-500mb Lapse Rate = 7.1 C/km
700-500mb Lapse Rate = 7.8 C/km
Supercell = 0.0
Left Supercell = 0.0
STP (eff layer) = 0.0
STP (fix layer) = 0.0
Sig Hail = 0.0
SRH(m2/s2) Shear(kt) MnWind SRW
SFC - 1 km 297 30 145/26 84/33
SFC - 3 km 451 41 178/34 115/22
SFC - 6 km 85 195/38 138/16
SFC - 8 km 119 204/43 178/14
BRN Shear = 144 m²/s²
4-6km SR Wind = 227/25 kt
Storm Motion Vectors
Bunkers Right = 216/31 kt
Bunkers Left = 185/51 kt
Corfidi Downshear = 232/115 kt
Corfidi Upshear = 247/55 kt
1km & 6km AGL Wind Barbs
*** BEST GUESS PRECIP TYPE ***
None.
Based on sfc temperature of 65.5 F.
SARS - Sounding Analogs
SUPERCELL
SGFNT HAIL
No Quality Matches
No Quality Matches
Effective-Layer STP (with CIN)
Prob EF2+ Torn with supercell
Sounding CLIMO = .15 sigtor
based on MLCAPE: 0.00
based on MLLCL: 0.06
based on ESRH: 0.06
based on EBWD: 0.00
based on STP_fixed: 0.05
based on STP_effective: 0.06
EF4+
EF3
EF2
EF1
EF0
NONTOR

Congrats, you're done!

Key Takeaways:

- Even with limited data, you can use synoptic concepts to create a forecast.
- These analytical skills aid in interpreting model output.
- Always think about what you can observe and infer before jumping to conclusions!

Finally: Practice! Practice! Practice!