



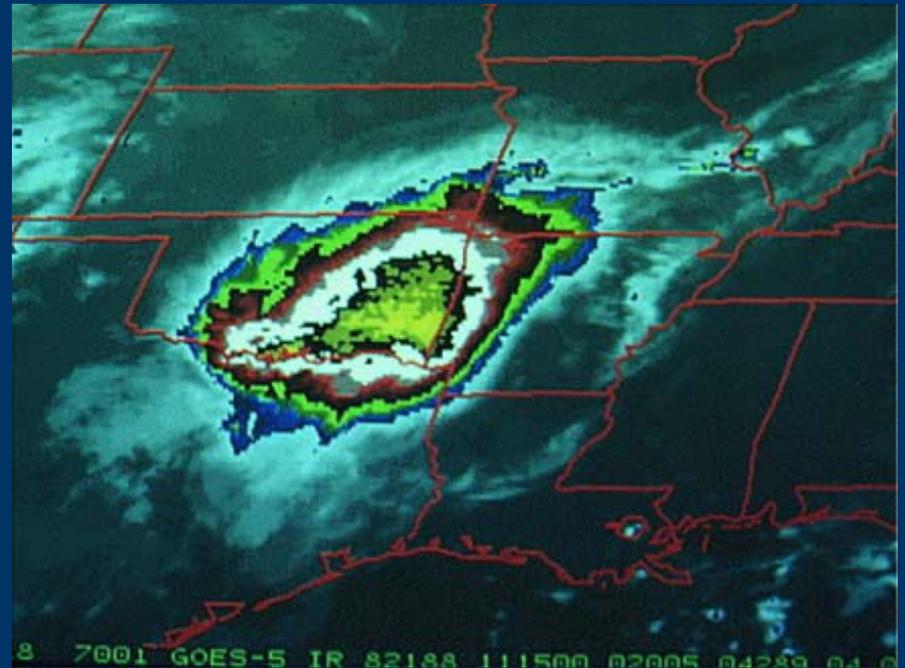
## SPC Mesoanalysis and Forecast Tools

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# Some 'mesoscale tools'

- Soundings
  - Model/Observed
- Profilers/VWP
- Analyses
  - Surface and Upper Air
- sfcOA
- ACARS/TAMDAR
- GOES derived fields



# What I'll focus on here:

- Sounding analysis and sfcOA parameters
  - Understand parcel choice and implications on:
    - CAPE
    - Effective shear/helicity
- Quick case using mesoscale 'tools' in making mesoscale discussion and watch decisions

# Model soundings/sfcOA

- One of biggest advancements in severe weather forecasting.
- Allows sounding analysis across entire country, at any time of day.
  - Directly infuse latest science into operations
  - Fine tunes severe weather forecasting down to the 'storm scale'



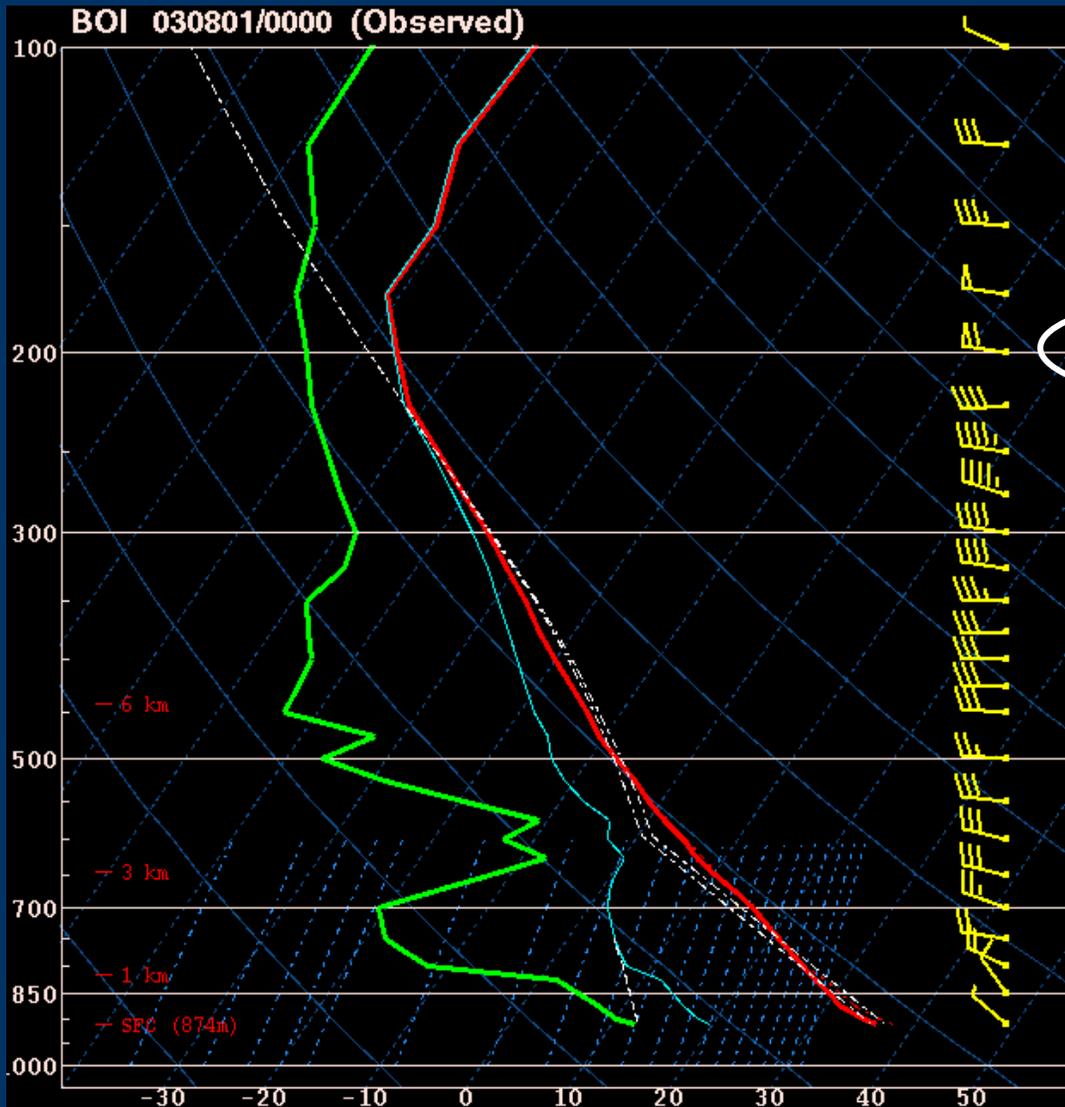
# CAPE definitions

*(<http://www.spc.noaa.gov/misc/acronyms.html>)*



- **MUCAPE**: Most unstable CAPE
  - Lifts most unstable parcel in lowest 300 mb.
  - Useful in non-surface based (elevated) CAPE.
  
- **SBCAPE**: Surface-based CAPE
  - Lift surface parcel.
  - Usually identical to MUCAPE in the afternoon.
  
- **MLCAPE**: Mean-mixed CAPE
  - Parcel lifted using mean temp/moisture (lowest 100mb).
  - Most representative for diurnal development when boundary layer is well mixed.

# Importance of parcel choice



CURSOR			SOUNDING	
91mb	17216m	$\theta=306.9K$	100mb	16670m
-118.2C	56465ft	$\theta_w=283.7K$	-63.3C	
-180.7F	0.0g/kg	$\theta_e=306.9K$	-79.3C	295/7 kt

**PARCEL DATA**

**\*\* 100mb MIXED LAYER PARCEL \*\*\***

LPL: 913mb 35C / 6C 96F / 43F

CAPE = 176 J/Kg      LI (500mb) = -0 C  
 Cape3km = 95 J/Kg      LImin = -2C / 400mb  
 CINH = -186 J/Kg      Cap = 2C / 575mb

LEVEL	PRES	HGT (AGL)	TEMP
LCL	596mb	11964ft	
LFC	510mb	16039ft	-6C
EL	265mb	31682ft	-42C
MPL	193mb	38469ft	

**THERMODYNAMIC DATA**

**----- AVAILABLE MOISTURE -----**

P. Water = 0.51 in      Mean RH = 14 %  
 Mean W = 6.6 g/Kg      Mean LRH = 14 %  
 Top of Moist Lyr =      M / M

**----- CONDITIONAL INSTABILITY -----**

700-500mb Lapse Rate = 24 C / 8.7 C/km  
 850-500mb Lapse Rate = 38 C / 8.6 C/km

**----- MISC PARAMETERS -----**

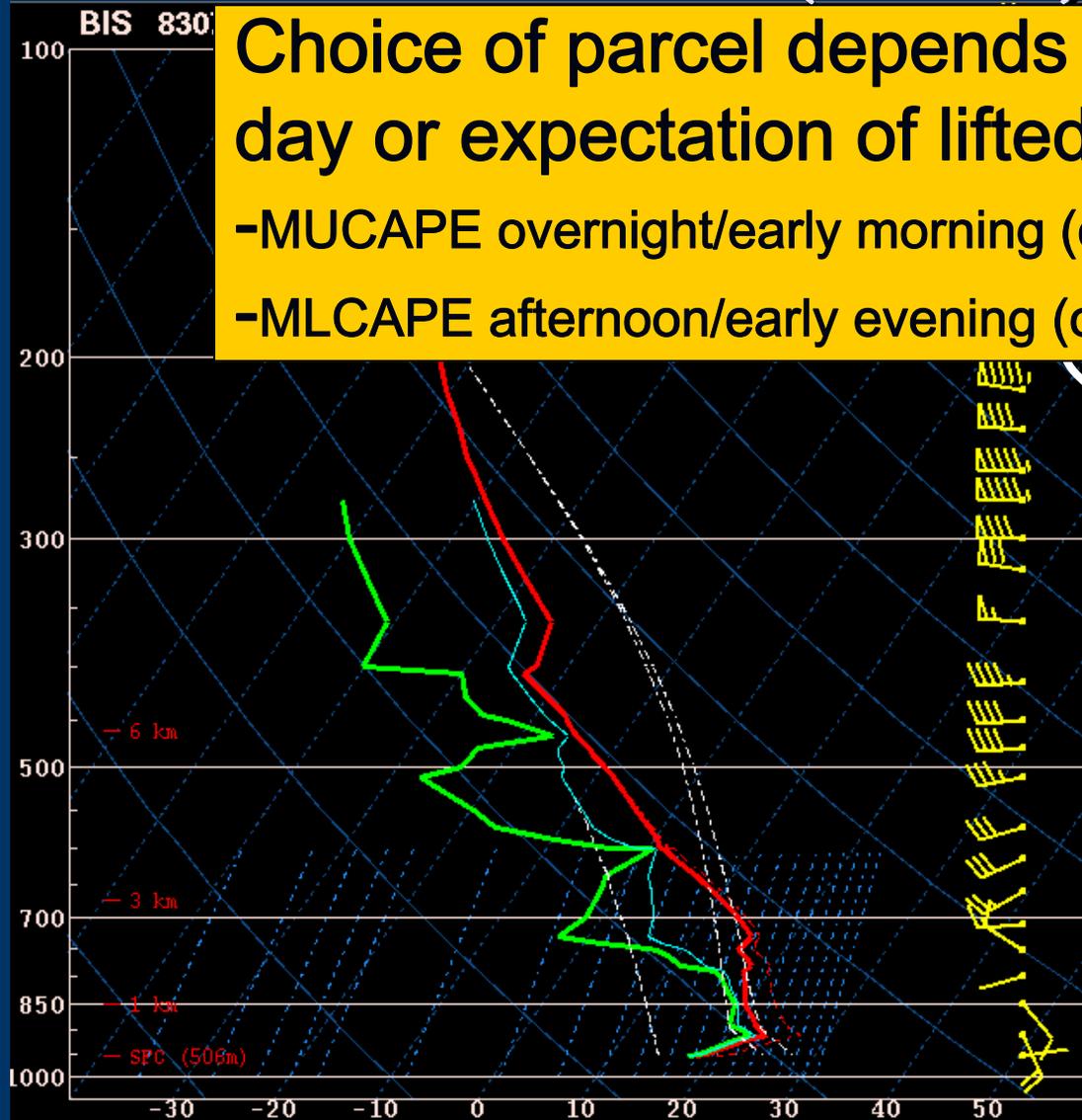
CB SigTor = 0.00      K-Index = 4  
 SigTorn = 0.0      Max Temp = 101F  
 Supercell = 0.0      Conv Temp = M  
 WBZ level = 10750ft      FGZ level = 13554ft

# Importance of parcel choice (cont.)

Choice of parcel depends on time of day or expectation of lifted parcel.

-MUCAPE overnight/early morning (or if not sfc based).

-MLCAPE afternoon/early evening (or if worry about sfc based).



CINH = -258 J/Kg      Cap = 3C / 889mb

LEVEL	PRES	HGT (AGL)	TEMP
LCL	899mb	1723ft	
LFC	661mb	10338ft	9C
EL	175mb	41630ft	-58C
MPL	M	M	

## THERMODYNAMIC DATA

### AVAILABLE MOISTURE

P. Water = 1.67 in      Mean RH = 54 %  
 Mean W = 16.5 g/Kg      Mean LRH = 91 %  
 Top of Moist Lyr = 911 mb / 1338 ft

### CONDITIONAL INSTABILITY

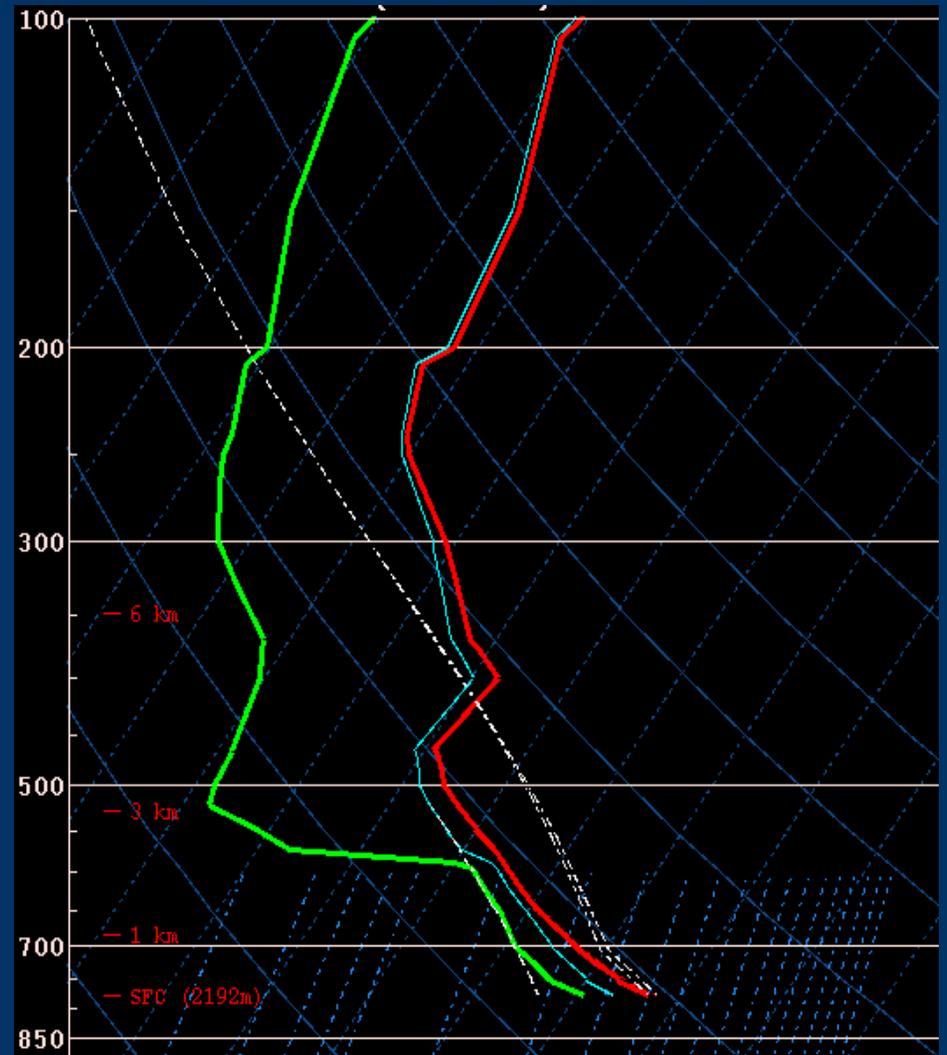
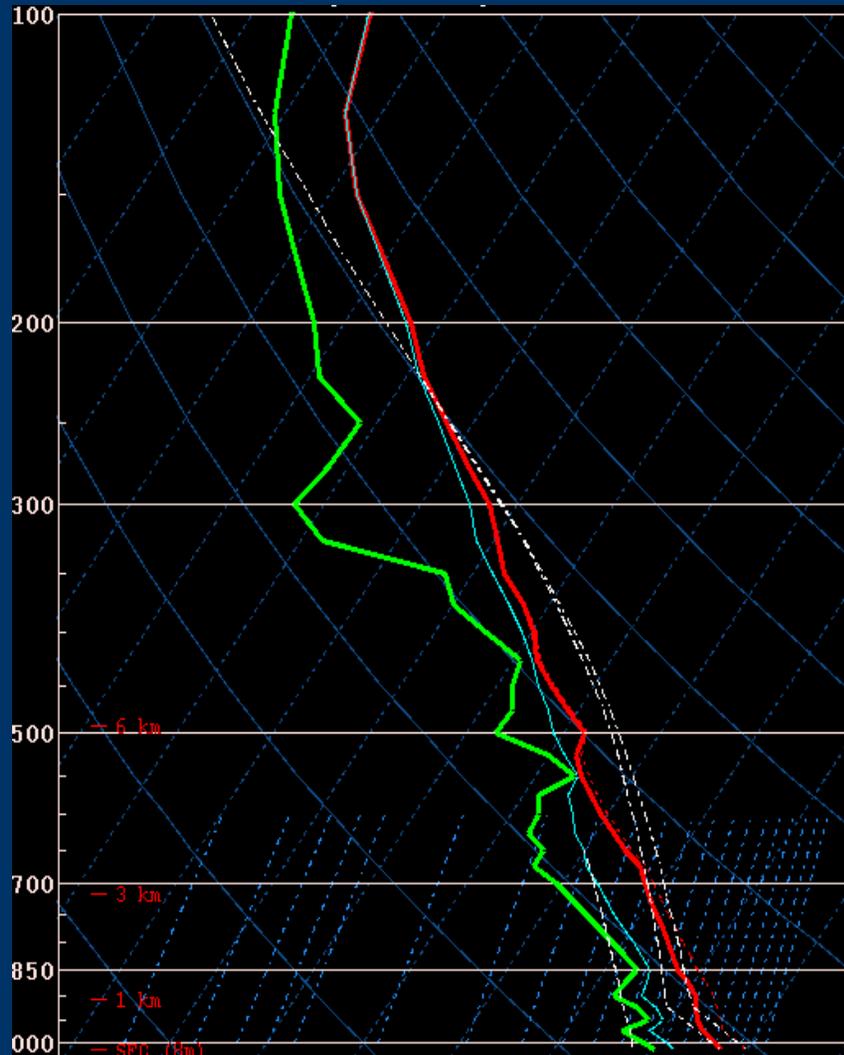
700-500mb Lapse Rate = 23 C / 8.8 C/km  
 850-500mb Lapse Rate = 32 C / 7.4 C/km

### MISC PARAMETERS

CB SigTor = 0.32      K-Index = 33  
 SigTorn = 1.5      Max Temp = 89F  
 Supercell = 1.3      Conv Temp = M  
 WBZ level = 12939ft      FGZ level = 13543ft

# All CAPE Not Created Equal

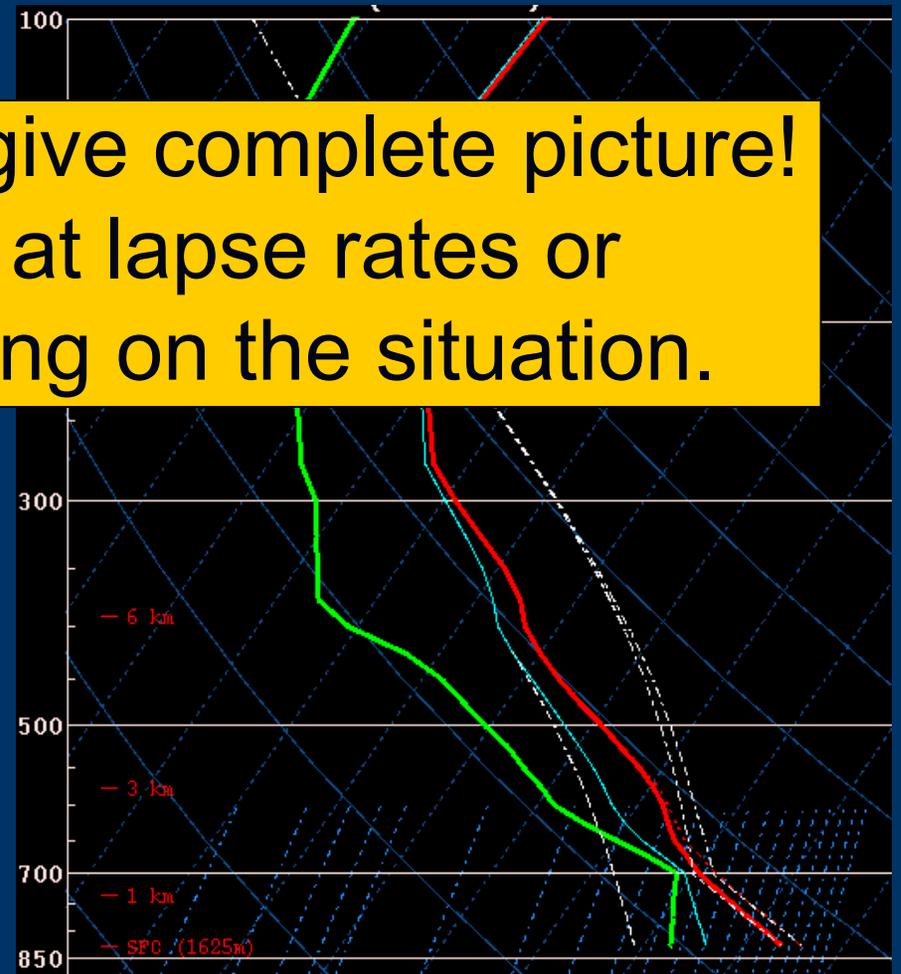
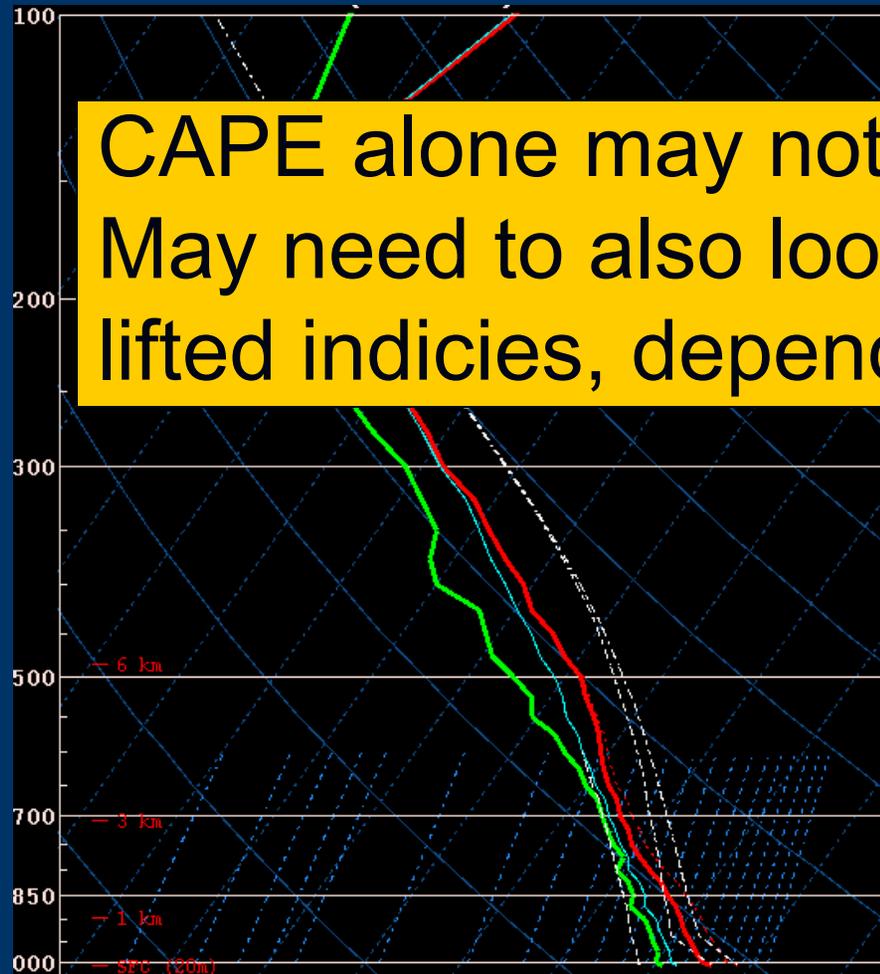
Same CAPE for both soundings



# All CAPE Not Created Equal

Same CAPE for both soundings

CAPE alone may not give complete picture!  
May need to also look at lapse rates or  
lifted indicies, depending on the situation.



# How about Kinematics/Shear?

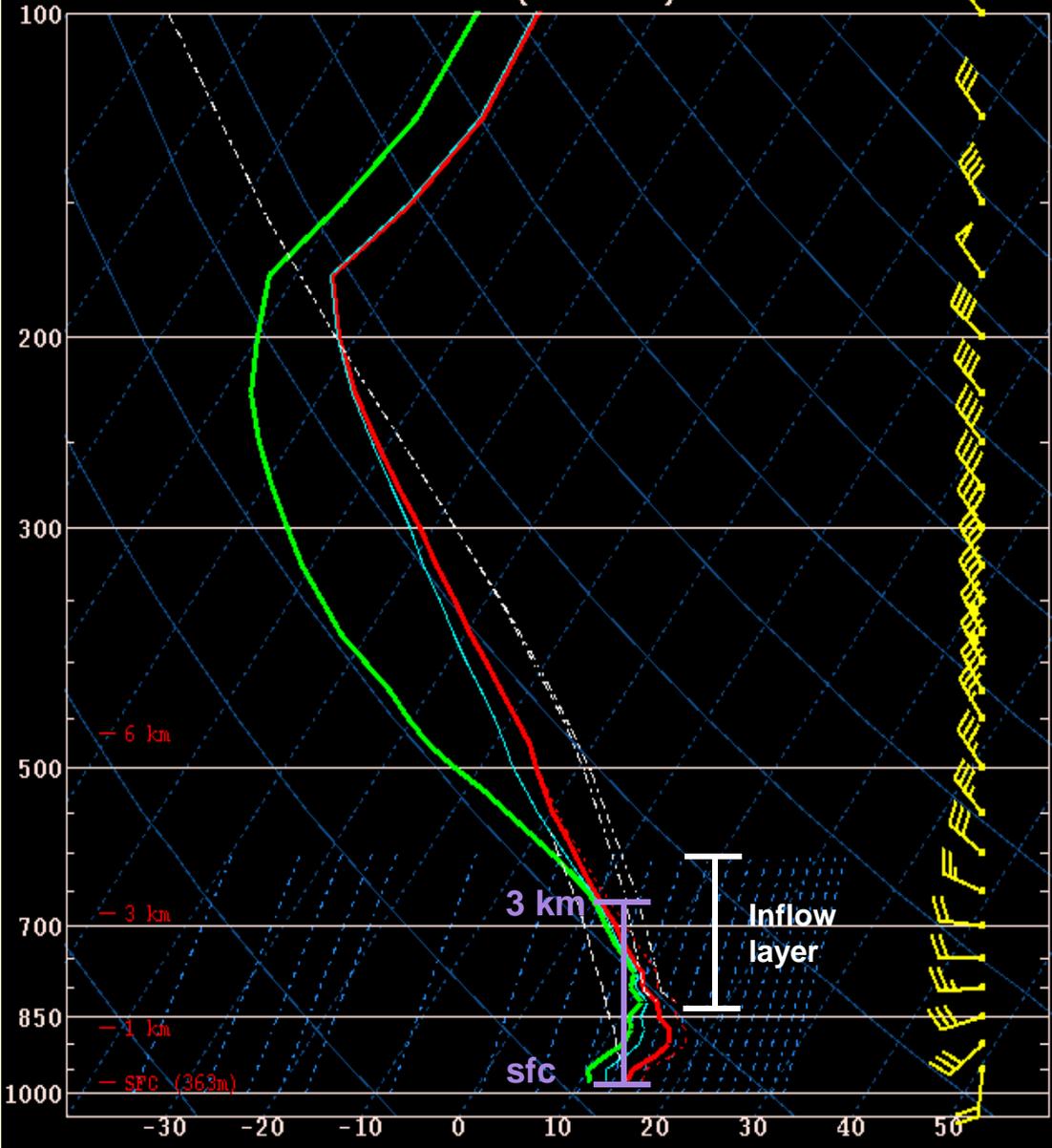
- Deep layer shear values more accurate in *forecasting* supercells versus other severe types.
  - Independent of accurate storm motion
  - Values greater than 35 kt favor supercells (*though not all the time!*)
- Helicity, though quite important, harder to use prior to storm development.
  - Needs accurate storm motion
  - Highly variable in time and space



# Effective Helicity/shear

- Traditionally, SRH and shear use fixed levels
  - (i.e. sfc-3 km, sfc-1 km, sfc-6 km).
  - Works fine in most situations
- What if storms elevated, or 'fixed' layer not sample of storm inflow?
- Effort by SPC forecasters (Thompson, Edwards, Mead, etc..) to automate identification of storm inflow.
- Developed 'parcel constraints' which are meant to confine the parameter calculations to where lifted parcels are buoyant, but not too strongly capped.

RUC 010513/1400F000 aio (GRID Eta)

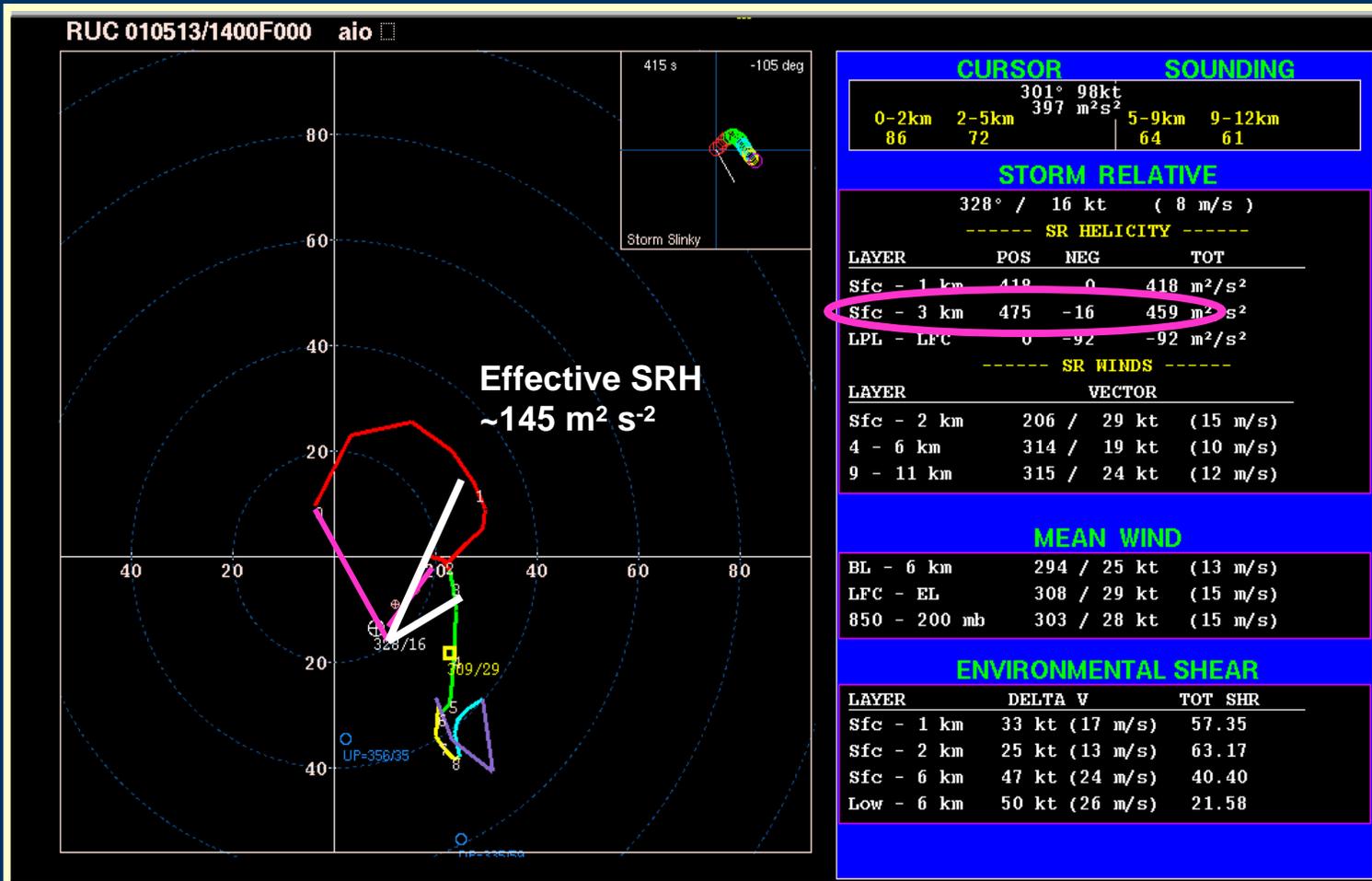


CURSOR			SOUNDING	
395mb	7553m	@=385.2K	400mb	7457m
22.2C	24773ft	@w=319.2K	-26.1C	
72.0F	45.4g/kg	@e=507.9K	-38.4C	329/41 kt

PARCEL DATA				
*** MU PARCEL IN LOWEST 300mb ***				
LPL:	825mb	12C / 11C	55F / 52F	
CAPE =	1355 J/Kg	LI (500mb) =	-5 C	
Cape3km =	43 J/Kg	LImin =	-5C / 500mb	
CINH =	0 J/Kg	Cap =	0C / 800mb	
LEVEL	PRES	HGT (AGL)	TEMP	
LCL	804mb	5415ft		
LFC	804mb	5415ft	11C	
EL	200mb	38492ft	-62C	
MPL	143mb	45221ft		

THERMODYNAMIC DATA		
----- AVAILABLE MOISTURE -----		
P. Water =	1.35 in	Mean RH = 58 %
Mean W =	9.0 g/Kg	Mean LRH = 77 %
Top of Moist Lyr =		M / M
----- CONDITIONAL INSTABILITY -----		
700-500mb Lapse Rate =	18 C / 7.2 C/km	
850-500mb Lapse Rate =	30 C / 7.0 C/km	
----- MISC PARAMETERS -----		
CB SigTor =	0.00	K-Index = 39
SigTorn =	1.5	Max Temp = 81F
Supercell =	7.3	Conv Temp = M
WBZ level =	10717ft	FGZ level = 10895ft

# Effective SRH versus 0-3 km SRH

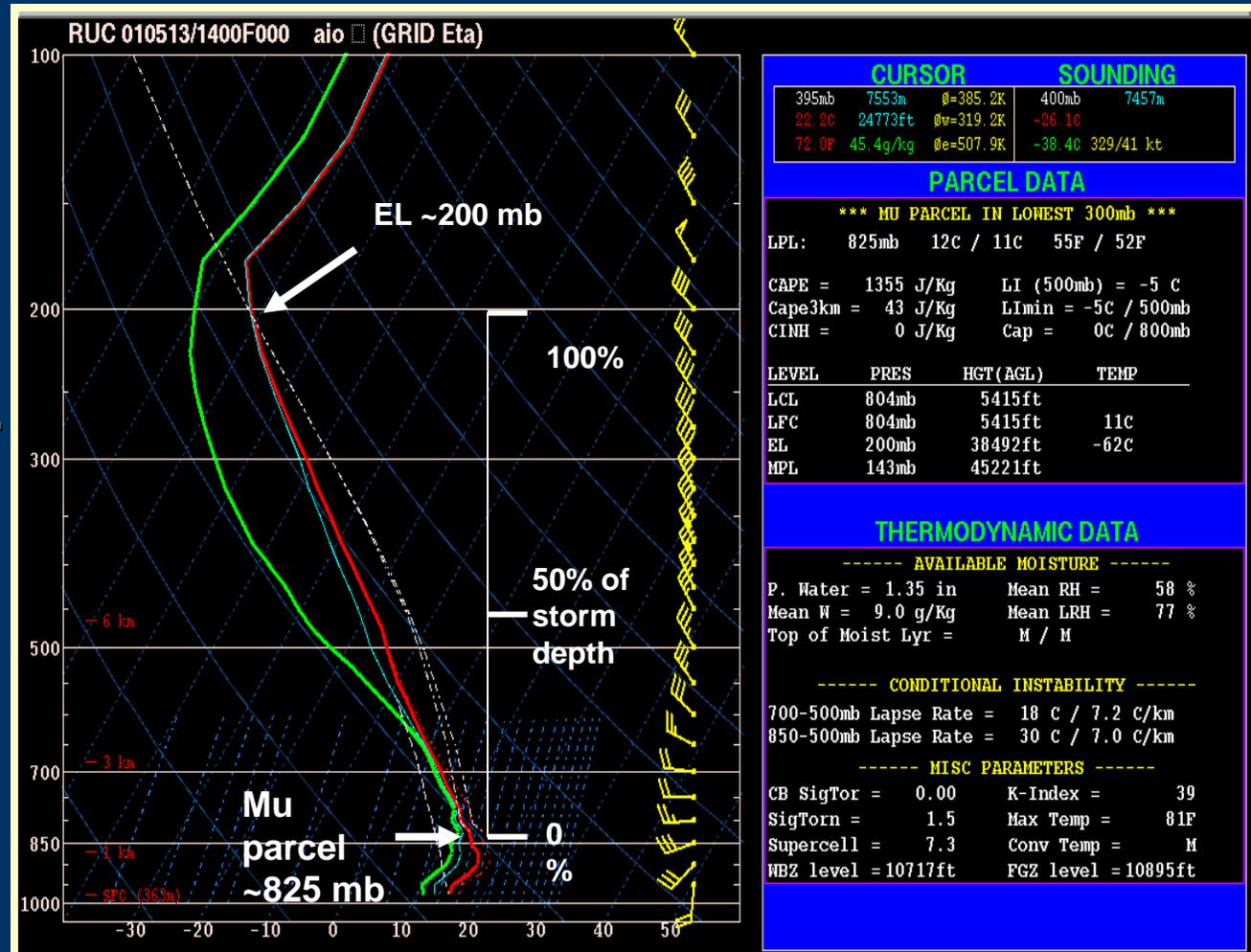


# Effective Shear

Instead of using sfc-6 km, use halfway between bottom of 'inflow layer' and EL.

Uses sounding to define levels; more event driven.

40-60% storm depth, best discriminator between supercells and non supercells



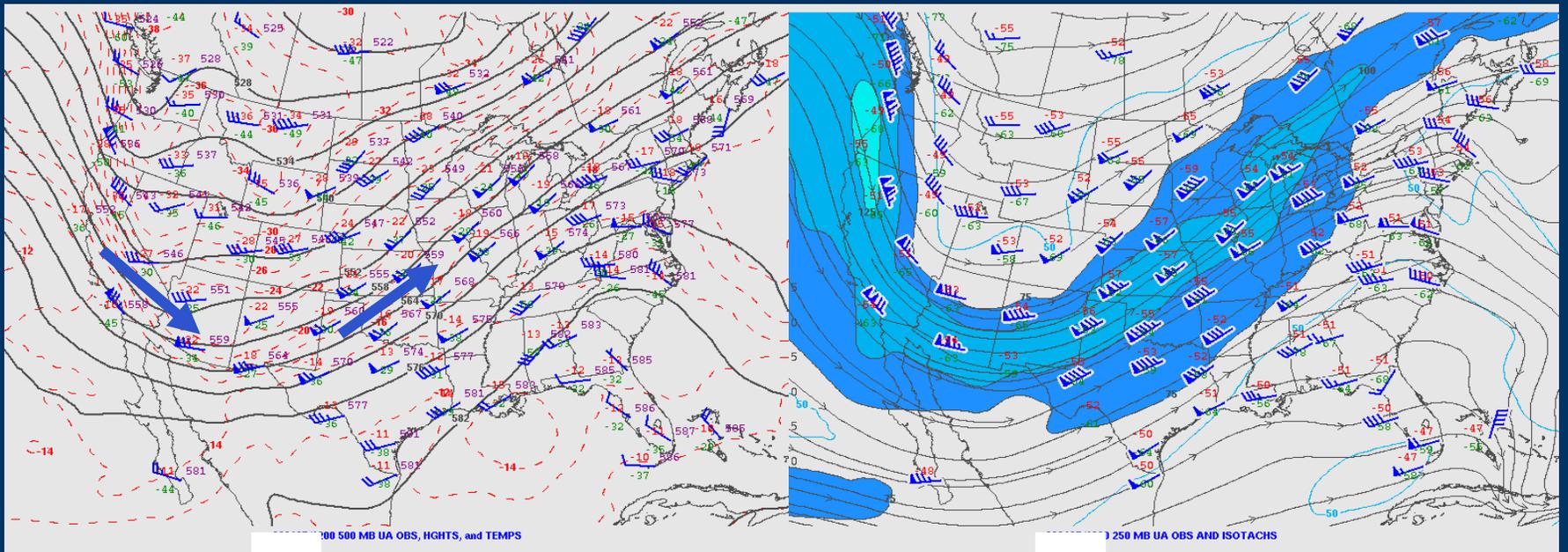
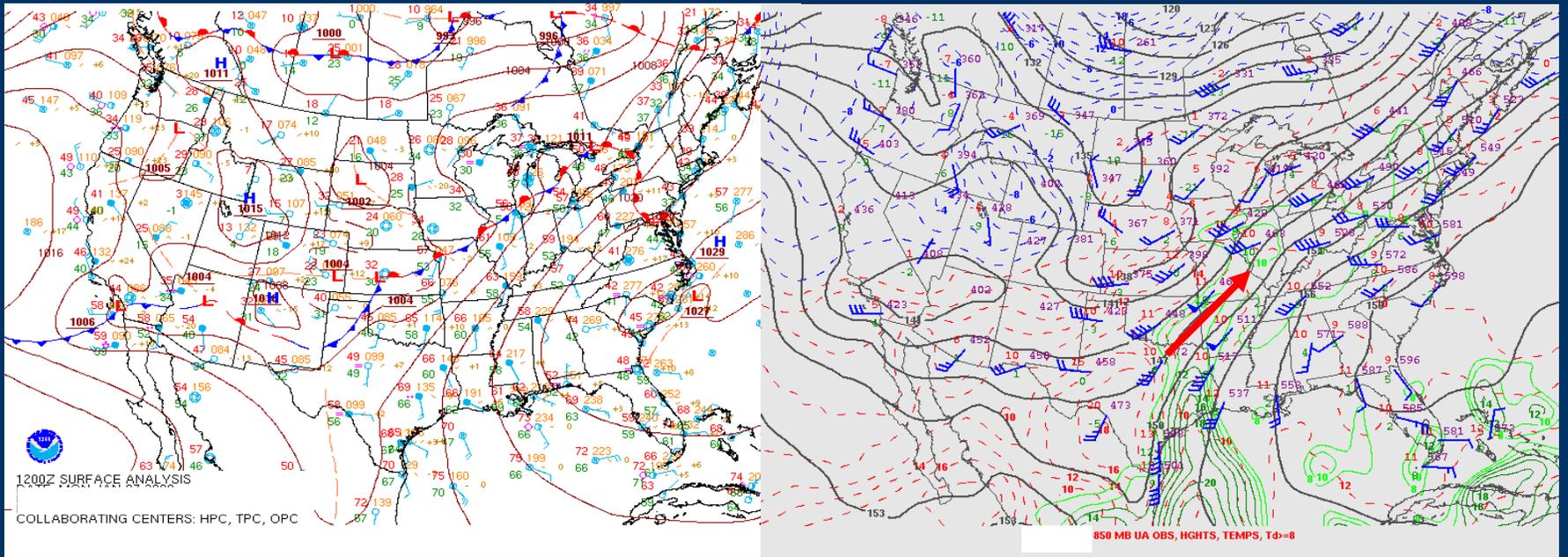
# Some points to consider

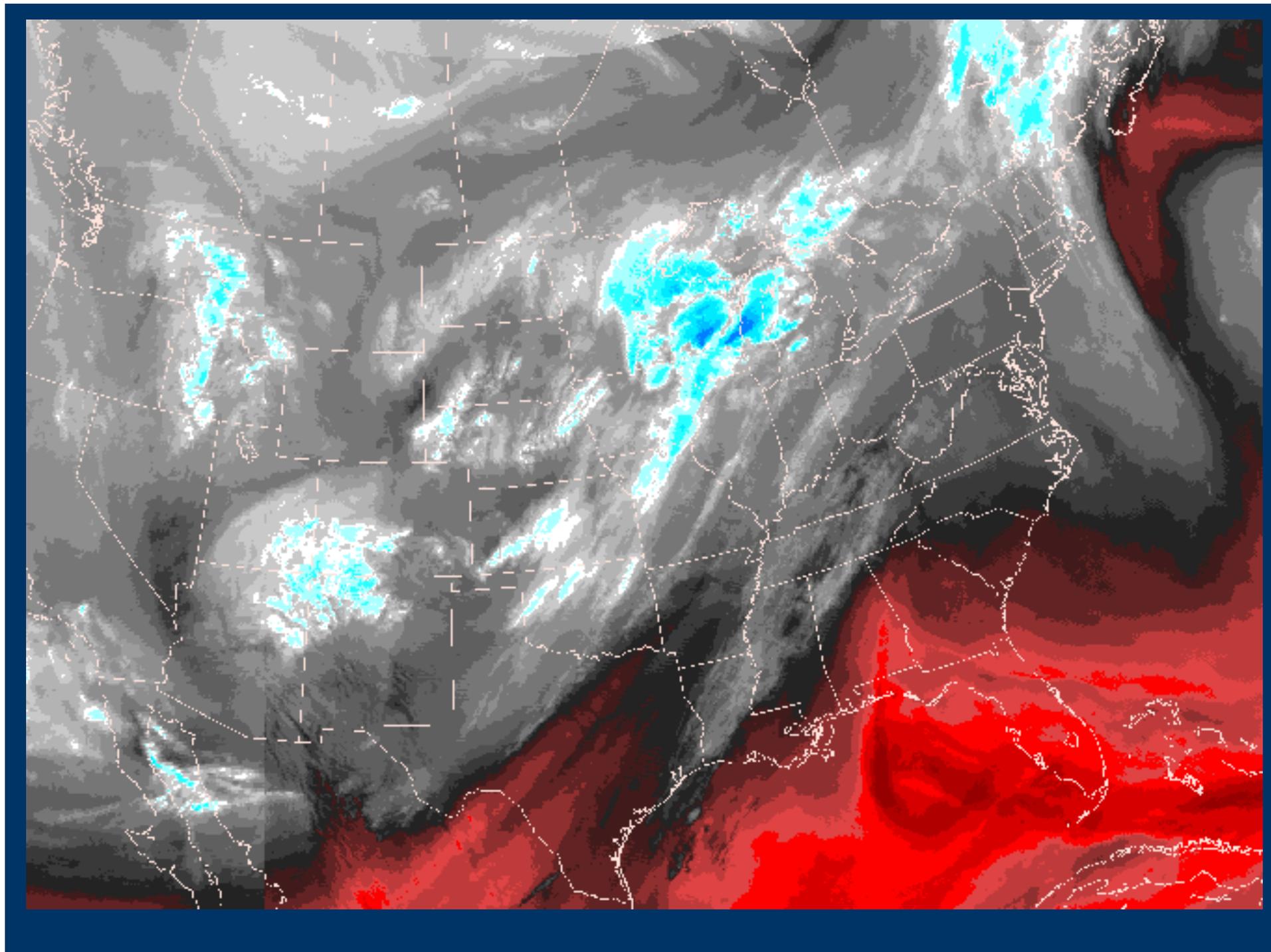
- Sounding parameters huge advancement in severe thunderstorm forecasting.
- However, this is just one tool.
- Must understand what your using.
- Parameters can be wrong!
  - Incomplete science?
  - RUC initialization must be accurate!
    - 'Effective' parameters most sensitive to RUC 'failures', especially if 'effective inflow' layer is not truly representative!
  - Fields for *previous* hour if towards top of next hour
    - Can change rapidly in dynamic patterns
- Forecasters seek observational data to support what mesoanalysis/RUC indicating.

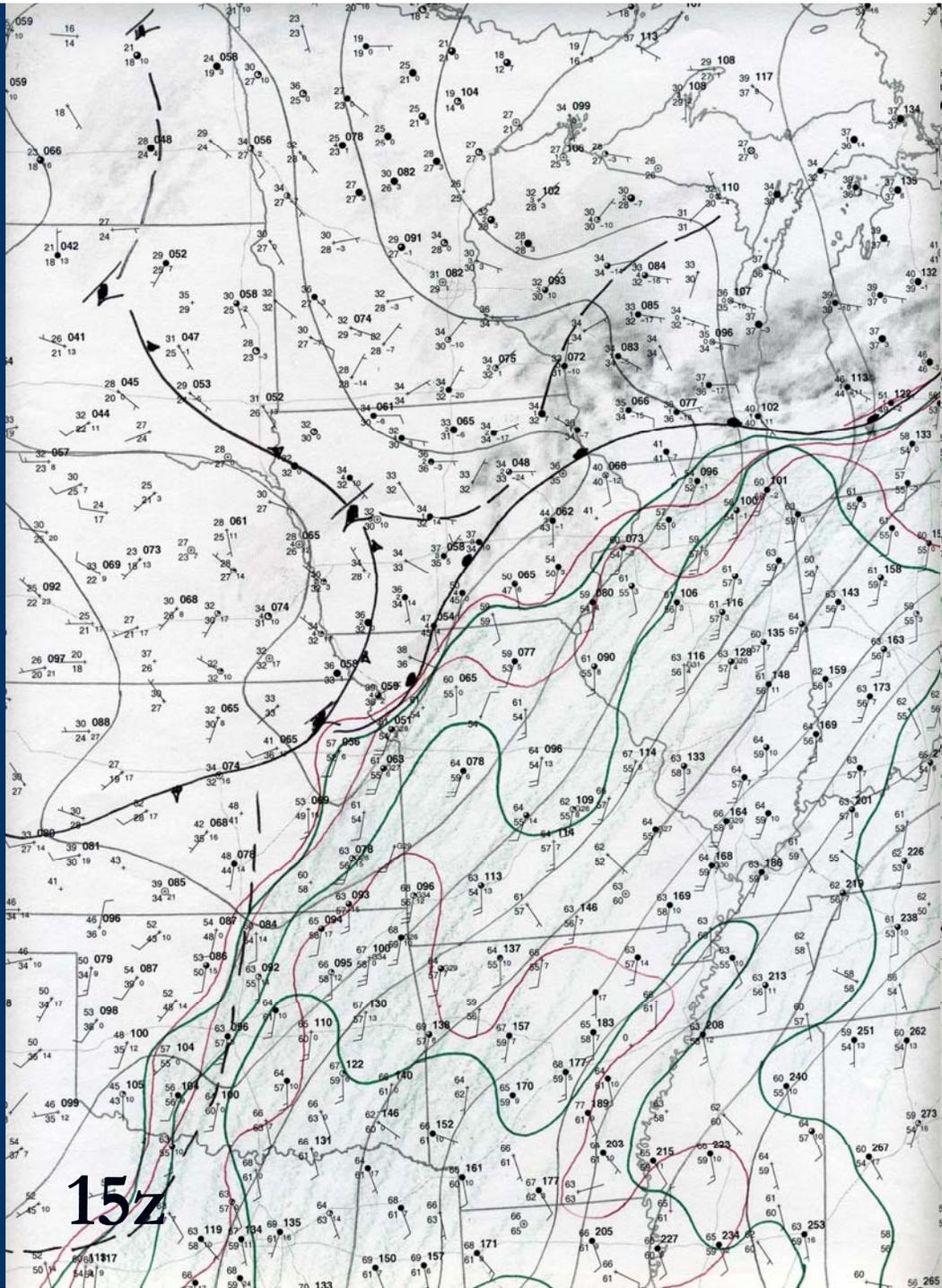


Lets look at quick case  
(day shift at SPC)

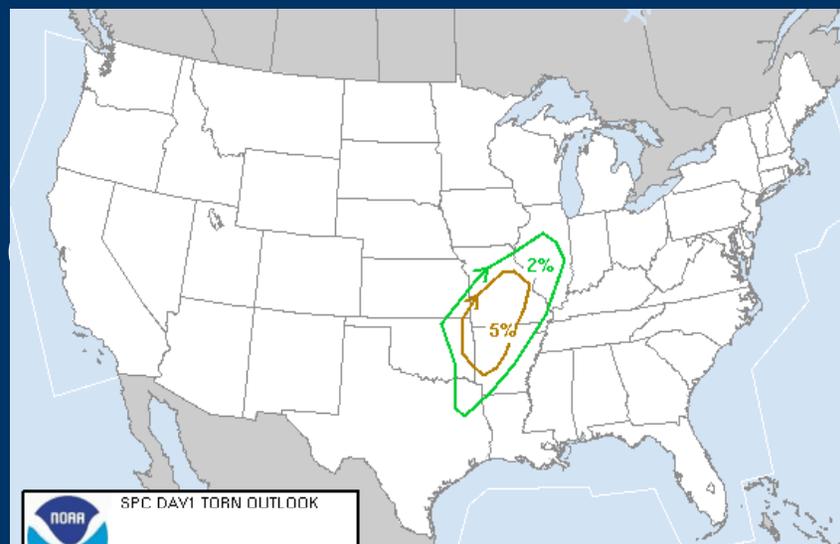
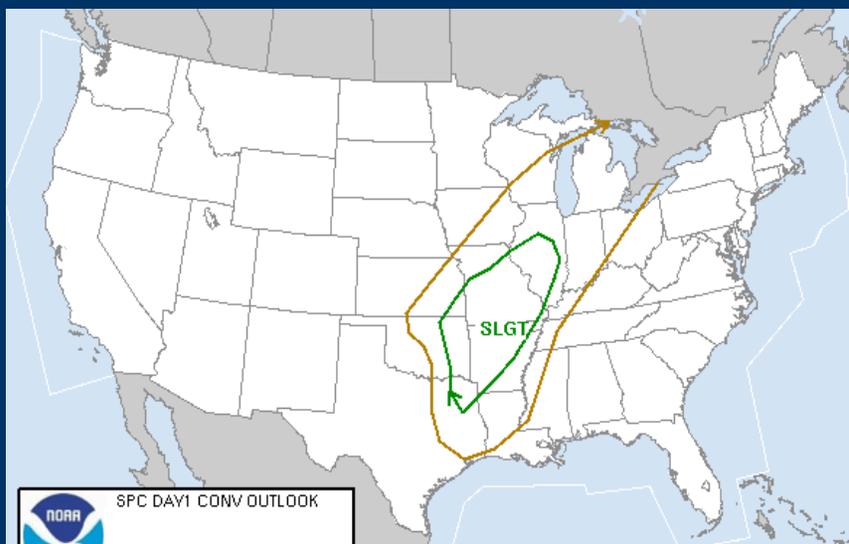
# Mid-Winter Severe Event



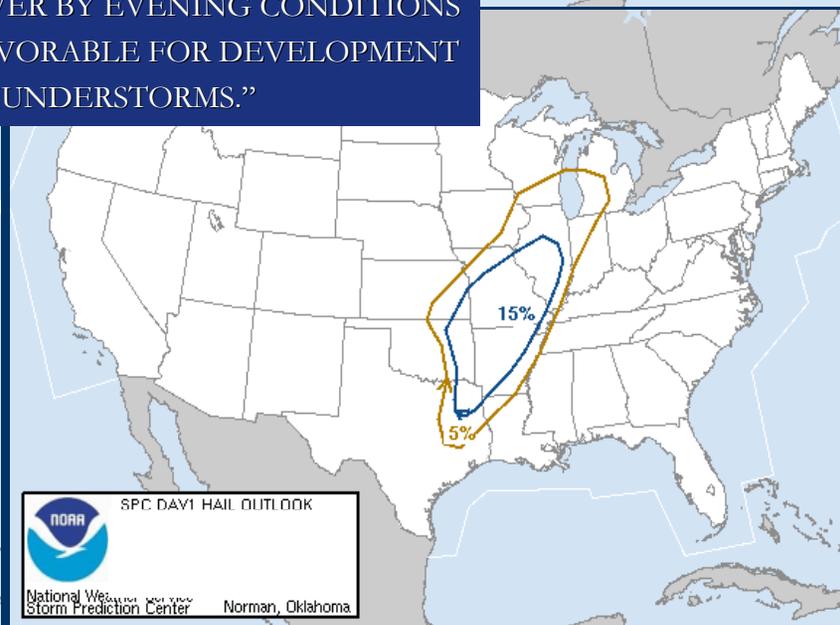
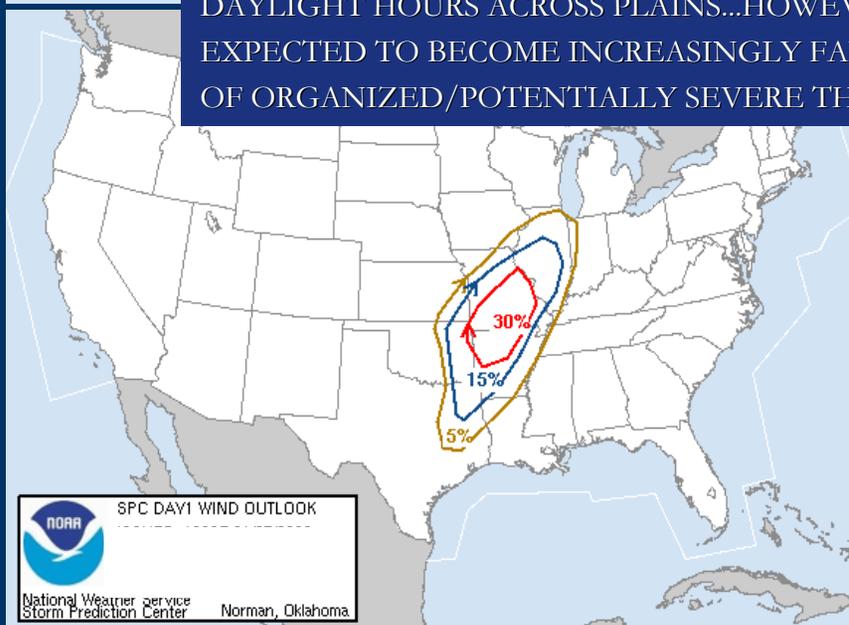




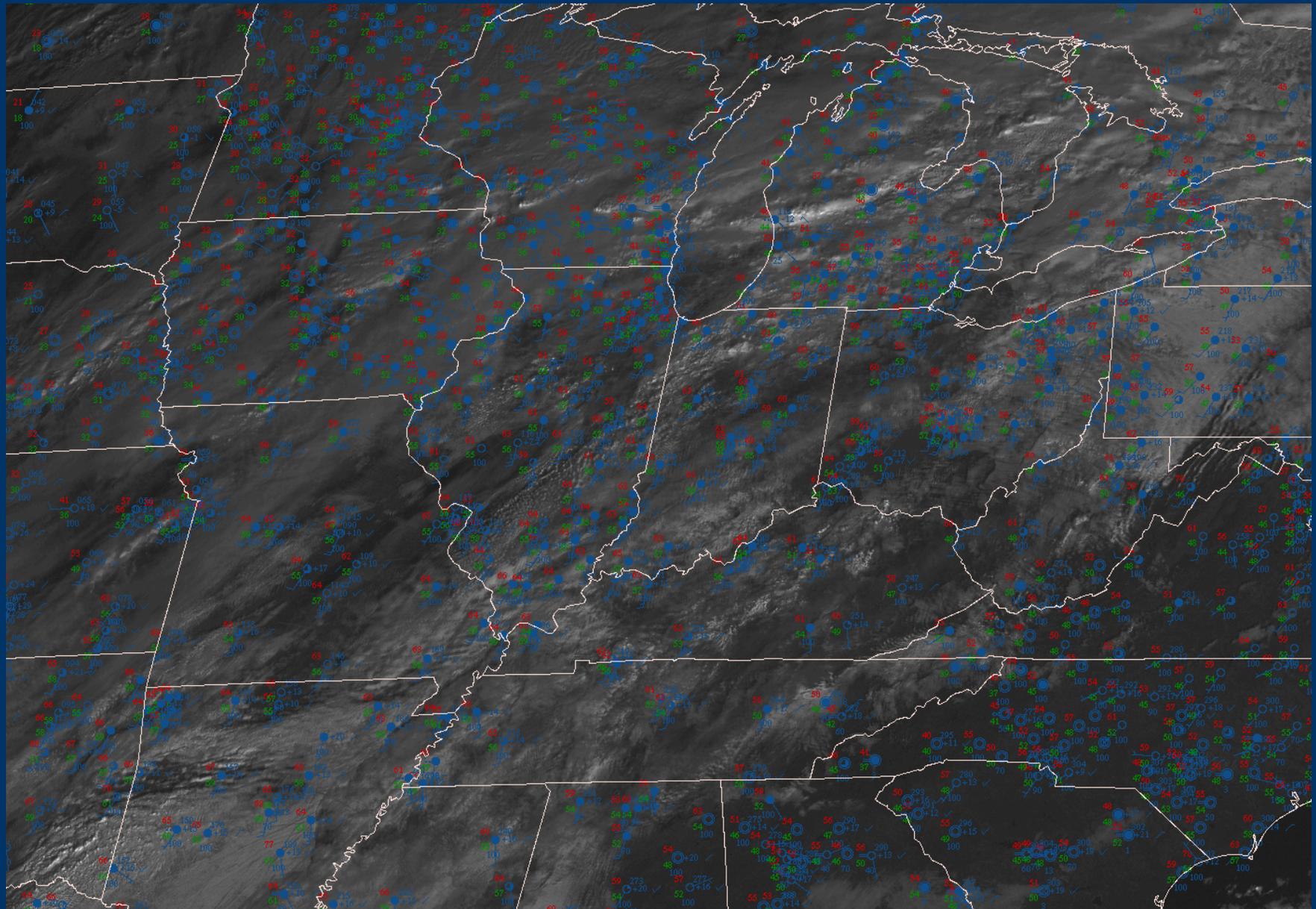
# Mid-Winter Severe Event



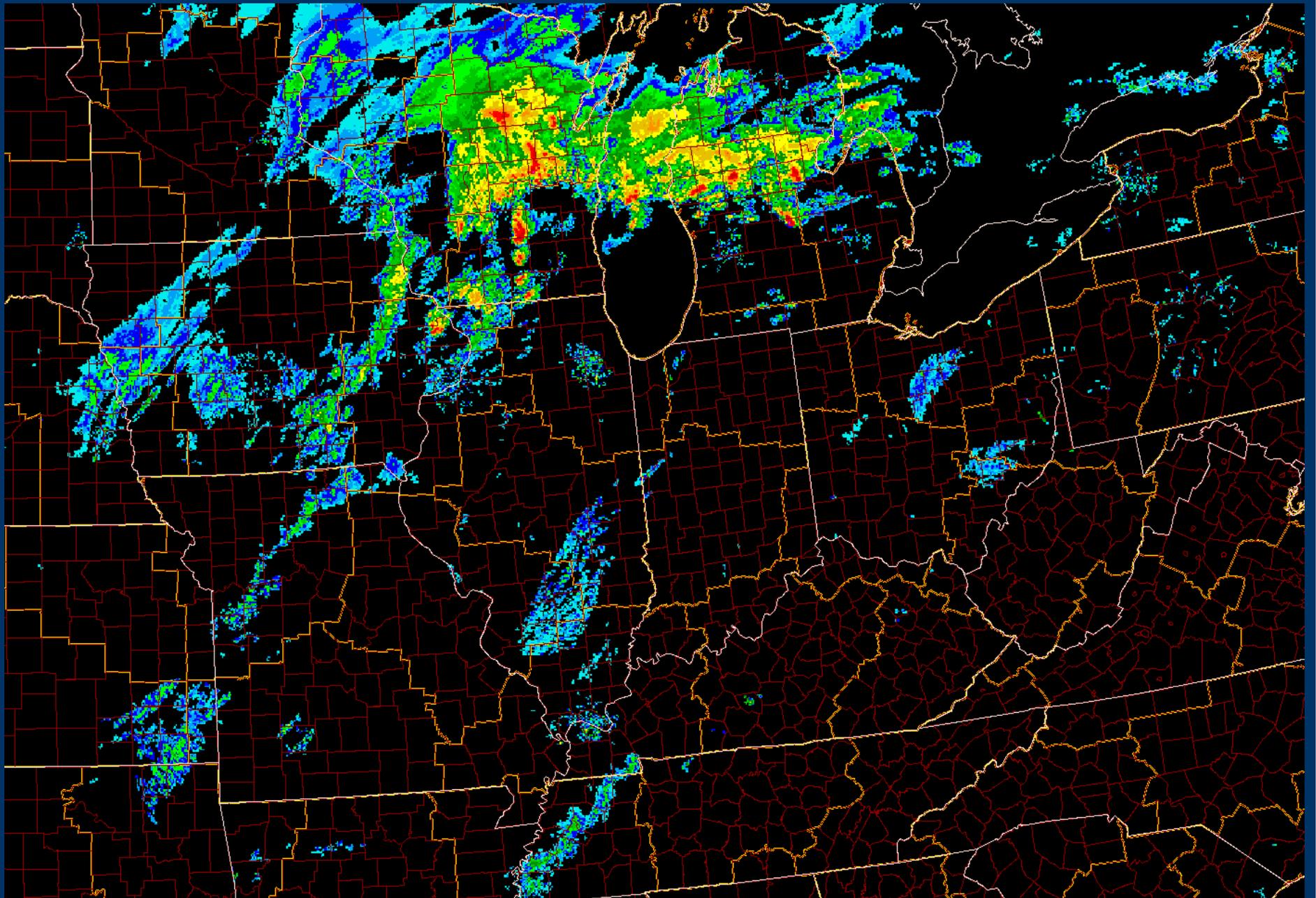
“THE WARM SECTOR EXPECTED TO REMAIN GENERALLY CAPPED THRU DAYLIGHT HOURS ACROSS PLAINS...HOWEVER BY EVENING CONDITIONS EXPECTED TO BECOME INCREASINGLY FAVORABLE FOR DEVELOPMENT OF ORGANIZED/POTENTIALLY SEVERE THUNDERSTORMS.”

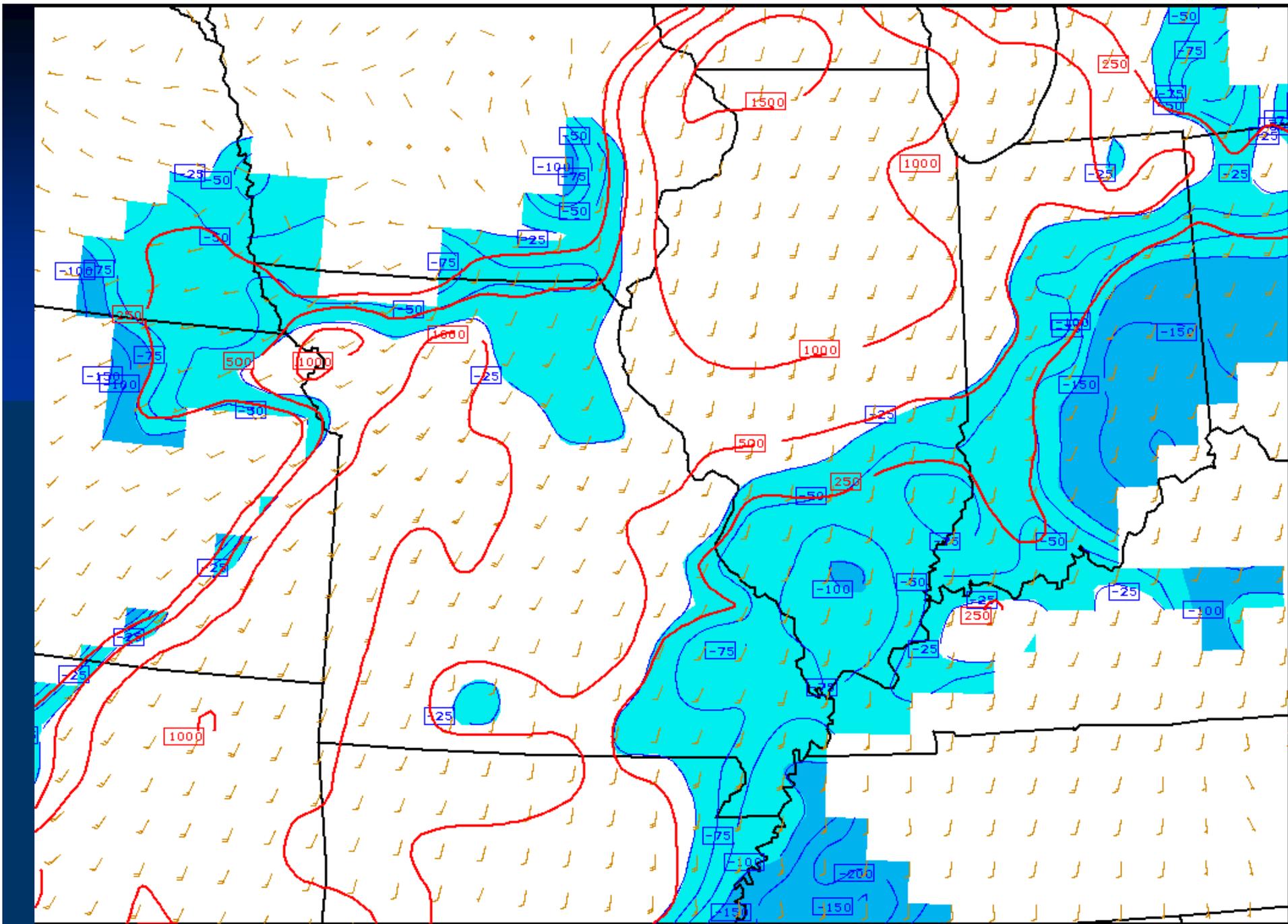


# VSBL thru 18z

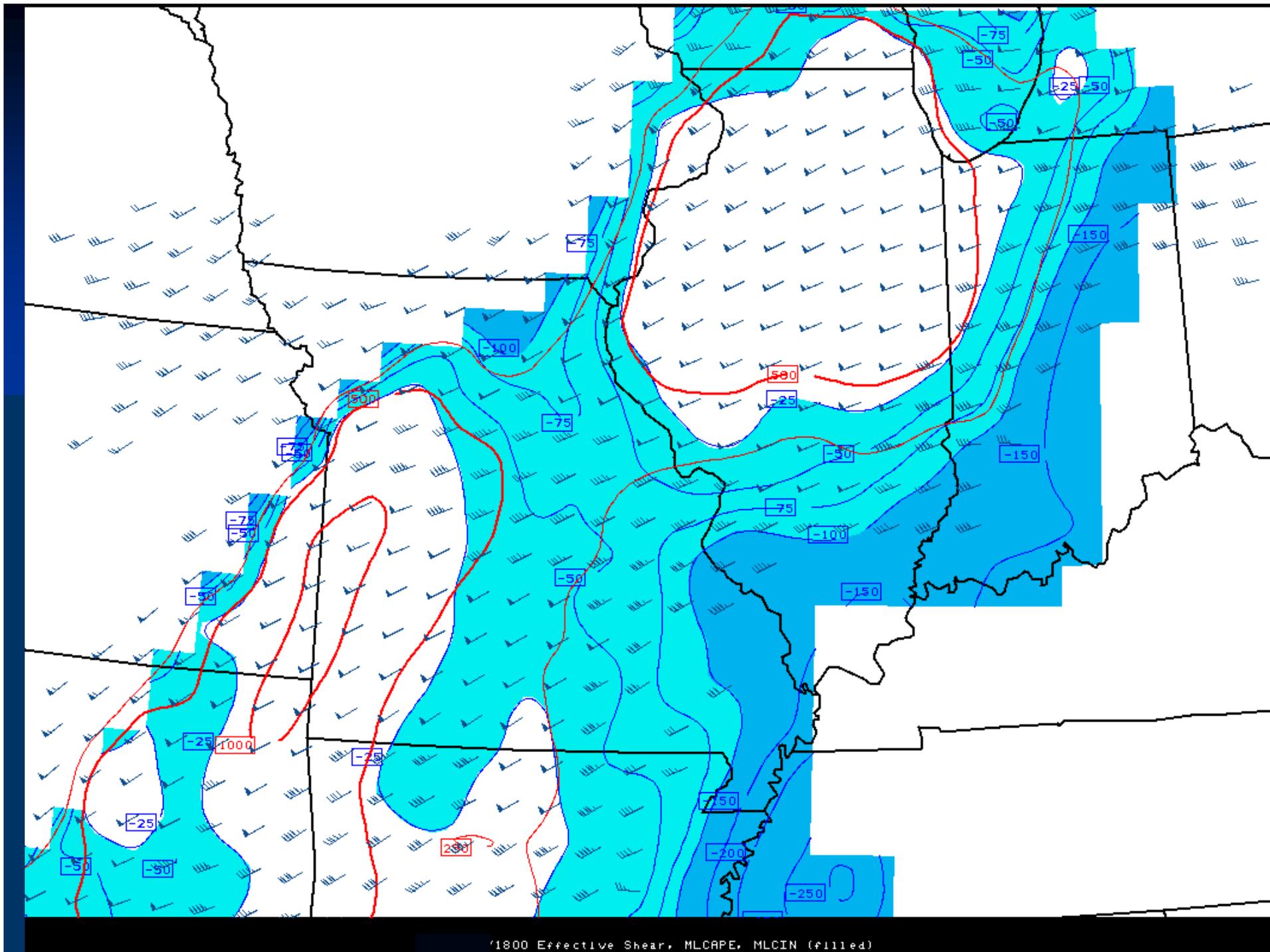


# BREF thru 18z

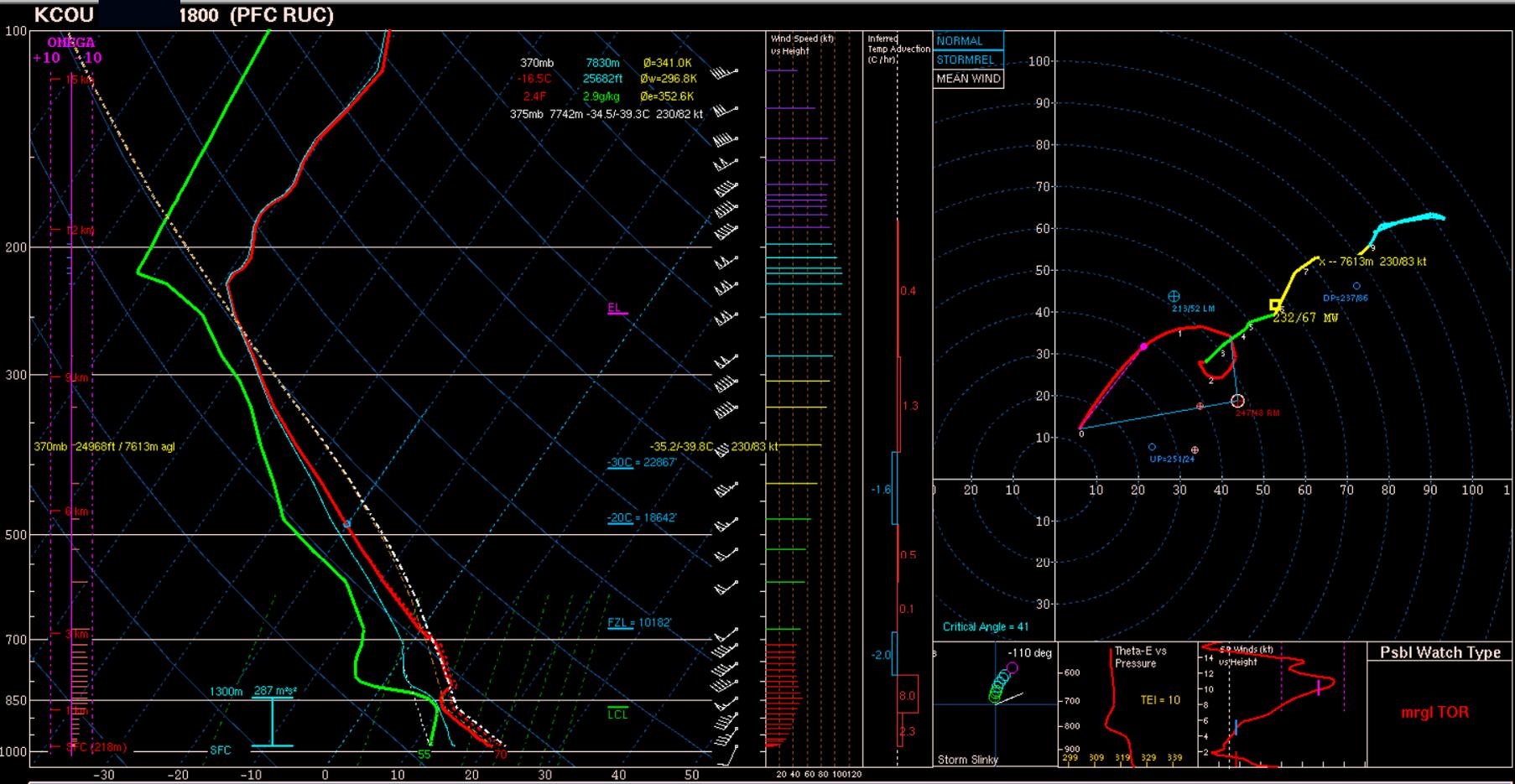




-----/1800 Most Unstable CAPE/CIN



'1800 Effective Shear, MLCAPE, MLCIN (filled)



	CAPE	CINH	LCL	LI	LFC	EL
SB PARCEL	811	-33	1048m	-4	3111m	33785'
ML PARCEL	593	-68	1033m	-3	3111m	31694'
FCST SFC	984	-15	1284m	-4	2797m	34209'
<b>MU PARCEL</b>	<b>811</b>	<b>-33</b>	1048m	<b>-4</b>	3111m	33785'
EFF PARCEL	551	-75	1077m	-3	3170m	31308'
USER DEF	309	-120	1413m	-2	3591m	29246'

PW = 0.95 in	3CAPE = 0 J/kg	WBZ = 8095'	WWDG = 0.0
K = 27	DCAPE = 372 J/kg	FZL = 10182'	ESP = 0.0
MidRH = 49%	DownT = 54 F	ConvT = 74F	MMP = 0.99
LowRH = 75%	MeanW = 9.2 g/kg	MaxT = 73F	NCAPE = 0.11

Sfc-3km Agl Lapse Rate = 20 C / 7.1 C/km	<b>Supercell = 4.7</b> <b>STP (CIN) = 0.8</b> <b>STP (fixed) = 1.1</b> <b>SHIP = 0.5</b>
3-6km Agl Lapse Rate = 23 C / 7.9 C/km	
850-500mb Lapse Rate = 28 C / 8.9 C/km	
700-500mb Lapse Rate = 21 C / 8.0 C/km	

	SRH(m2/82)	Shear(kt)	MnWind	SRW
SFC - 1 km	232	34	214/36	114/26
SFC - 2 km	277	34	224/40	123/19
SFC - 3 km	299	39	226/41	125/17
Eff Inflow Layer	287	43	216/38	118/24
SFC - 6 km	57	228/46	140/15	
SFC - 8 km	74	228/49	151/15	
LCL - EL (Cloud Layer)	65	232/58	187/18	
Lower Half Storm Depth	49	228/45	138/15	

BRN Shear = 49 m/s^2  
4-6km SR Wind = 191/19 kt  
Corfeli Downshear = 237/86 kt  
Corfeli Upshear = 251/24 kt  
Bunkers Right = 247/48 kt  
Bunkers Left = 213/52 kt

STPC (test) = 1.1

1km & 6km AGL Wind Bars

### SARS - Sounding Analog System

**SUPERCCELL**  
browse to ~thompson / sup / snd / \*

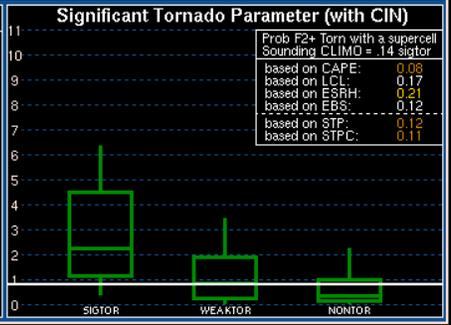
**SGFNT HAIL**  
browse to ~jewell / hail / snd / \*

96031600.FFC 2.75

No Quality SUPERCCELL Matches

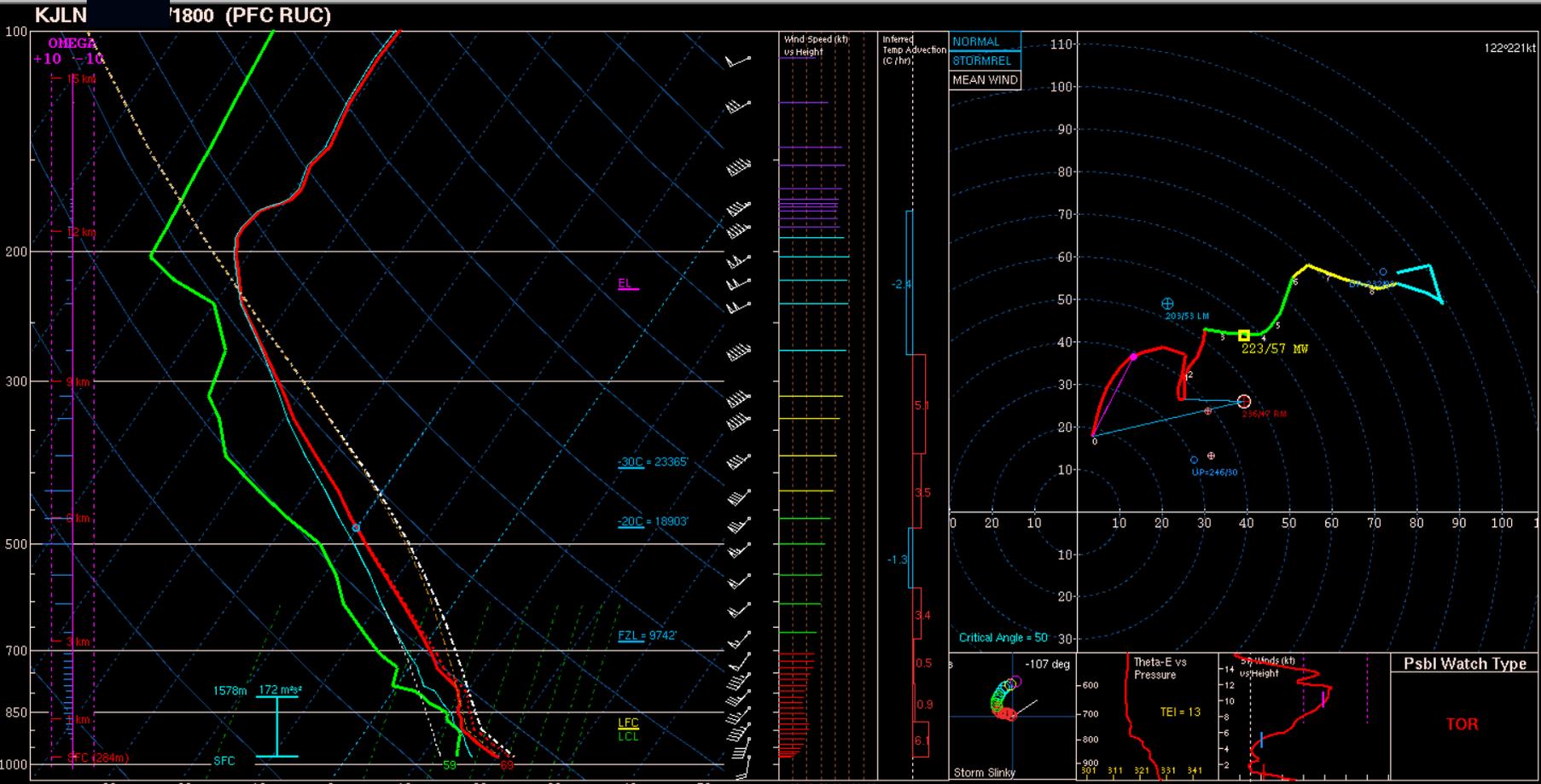
(7 matches out of 856 sndgs)  
SARS: "TOR" (100% TOR)

(3 matches out of 938 sndgs)  
SARS: Non-sig Hail (33% SIG)



Parcel Interpolate Swap Reset Overlay: off View Data SARS HAIL SHIP Stats STP Stats EBS Stats WINTER FIRE

Surface conditions BMJ KF LEFT inset Boundary motion



SB PARCEL	CAPE	CINH	LCL	LI	LFC	EL
1401	0	718m	-6	718m	35634'	
ML PARCEL	977	-6	740m	-5	1928m	34735'
FCST SFC	1704	0	1119m	-6	1119m	36259'
<b>MU PARCEL</b>	<b>1401</b>	<b>0</b>	<b>718m</b>	<b>-6</b>	<b>718m</b>	<b>35634'</b>
EFF PARCEL	762	-20	1005m	-4	2026m	32395'
USER DEF	524	-32	1383m	-3	2181m	31604'

PW = 1.05 in	3CAPE = 76 J/kg	WBZ = 8234'	WWDG = 0.7
K = 30	DCAPE = 569 J/kg	FZL = 9742'	ESP = 0.6
MidRH = 64%	DownT = 55 F	ConvT = 88F	MMP = 0.99
LowRH = 84%	MeanW = 10.5 g/kg	MaxT = 74F	NCAPE = 0.14

Sfc-3km Agl Lapse Rate = 21 C / 7.4 C/km	<b>Supercell = 4.8</b>
3-6km Agl Lapse Rate = 21 C / 7.3 C/km <th><b>STP (CIN) = 1.0</b></th>	<b>STP (CIN) = 1.0</b>
850-500mb Lapse Rate = 28 C / 7.0 C/km <th><b>STP (fixed) = 1.9</b></th>	<b>STP (fixed) = 1.9</b>
700-500mb Lapse Rate = 19 C / 7.3 C/km <th><b>SHIP = 1.3</b></th>	<b>SHIP = 1.3</b>

SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	198	26	202/36
SFC - 2 km	200	28	210/36
SFC - 3 km	251	39	212/39
<b>Eff Inflow Layer</b>	<b>172</b>	<b>23</b>	<b>208/36</b>
SFC - 6 km	60	217/46	131/15
SFC - 8 km	74	219/50	148/15
LCL - EL (Cloud Layer)	67	223/57	180/16
<b>Lower Half Storm Depth</b>	<b>54</b>	<b>217/45</b>	<b>130/15</b>

BRN Shear = 51 m/s/s
4-6km SR Wind = 200/21 kt
Cortelli Downshear = 232/92 kt
Cortelli Upshear = 246/30 kt
Bunkers Right = 236/47 kt
Bunkers Left = 203/53 kt

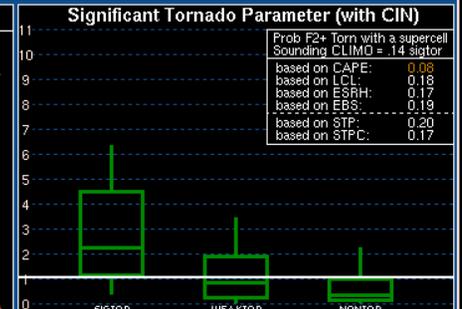
STPC (test) = 1.5

SARS - Sounding Analog System	
<b>SUPERCELL</b>	<b>SGFNT HAIL</b>
browse to ~thompson / sup / and / *	browse to ~jewell / hail / and / *
00010319.GWD	SIGTOR
04051923.GPK	SIGTOR
03040618.JAN	WEAKTOR
93040200.WAL	2.75

(21 matches out of 856 sndgs)  
SARS: \*\*TOR\*\* (76% TOR)

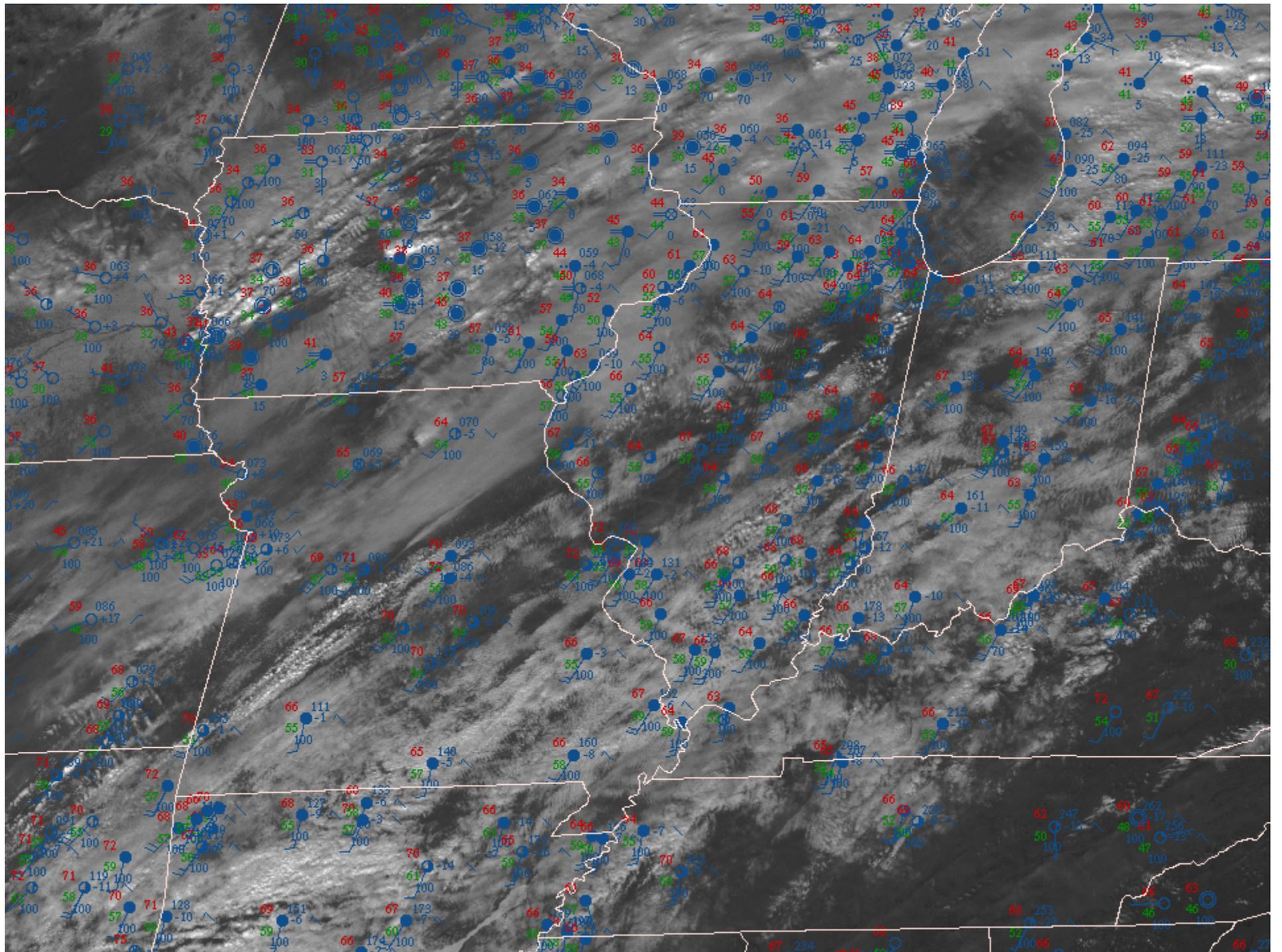
(11 matches out of 938 sndgs)  
SARS: \*\*SIG HAIL\*\* (64% SIG)



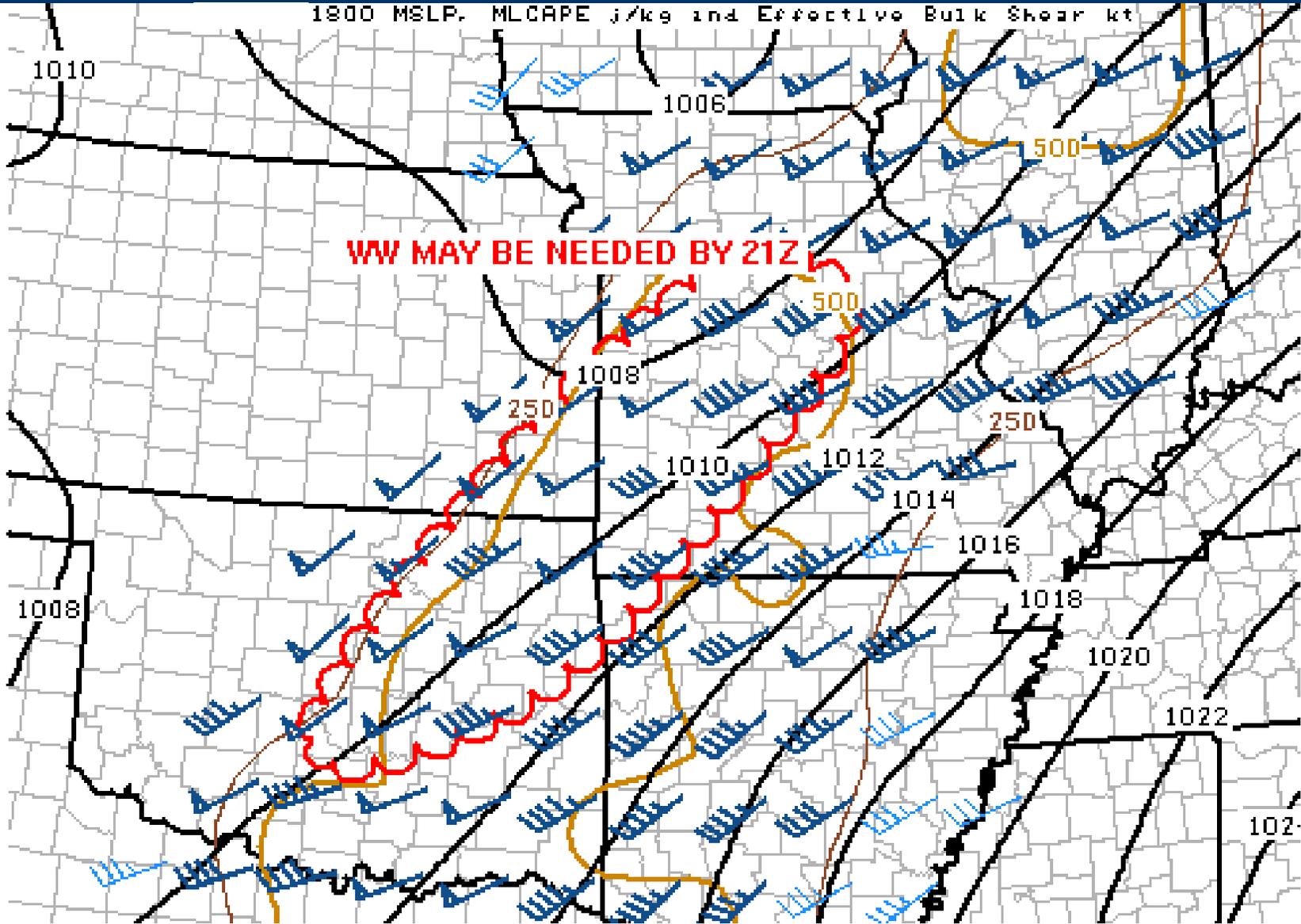
Parcel Interpolate Swap Reset Overlay: off View Data SARS HAIL SHIP Stats STP Stats EBS Stats WINTER FIRE

Surface conditions 66/57/195/15 B MJ K F LEFT inset Boundary motion

Successfully loaded KJLN 0501071900

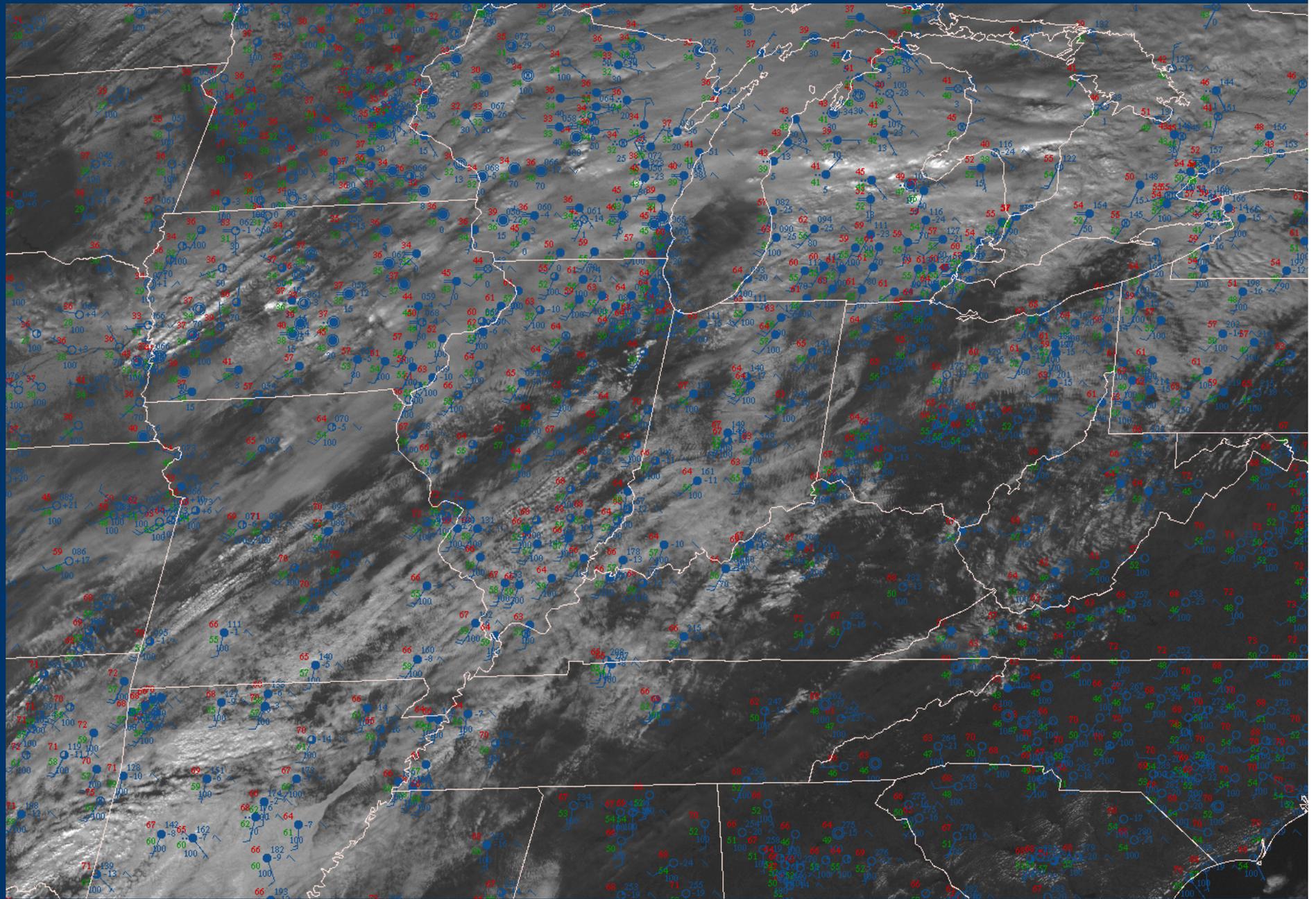


1800 MSLP, MLCAPE j/kg and Effective Bulk Shear kt

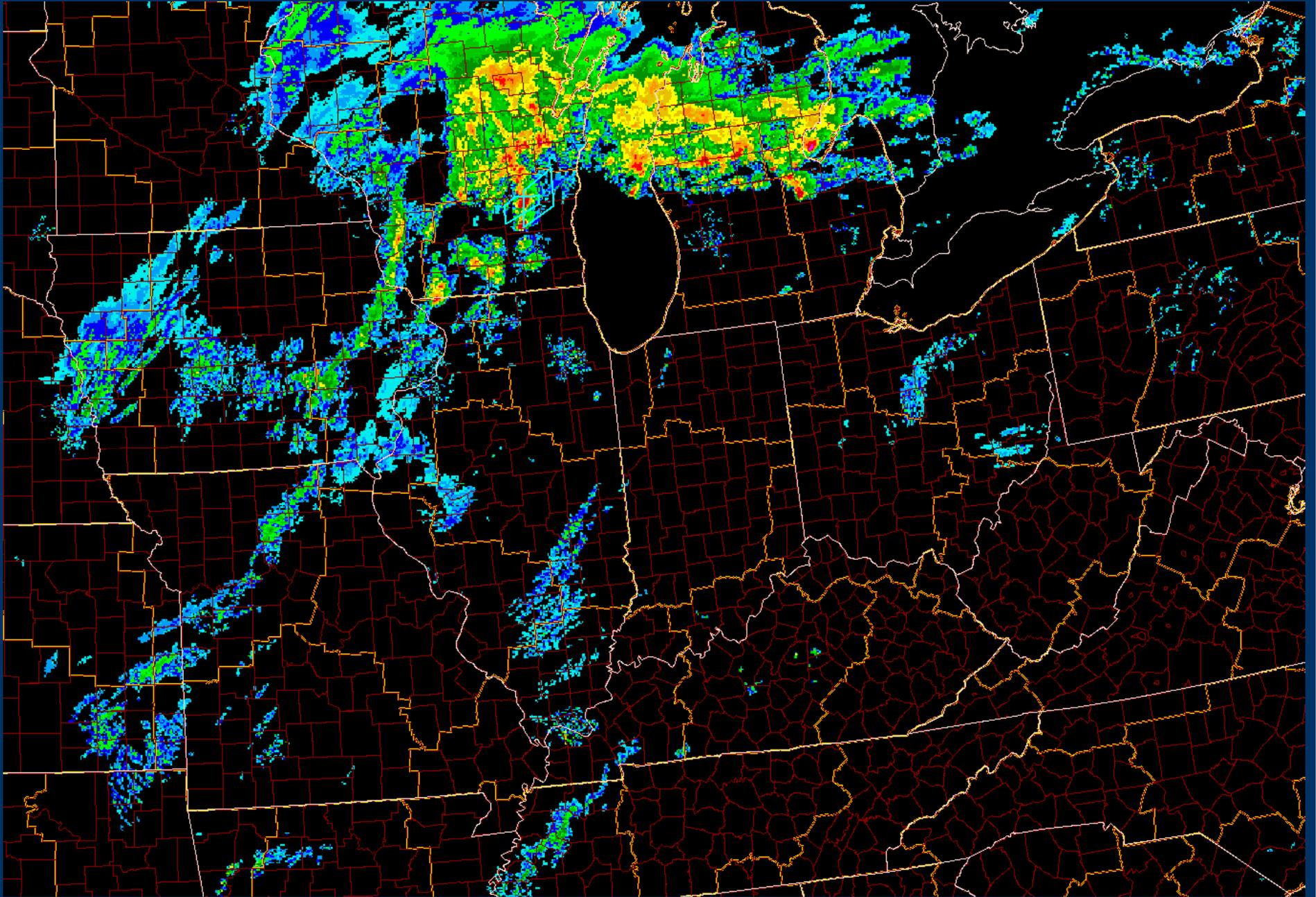


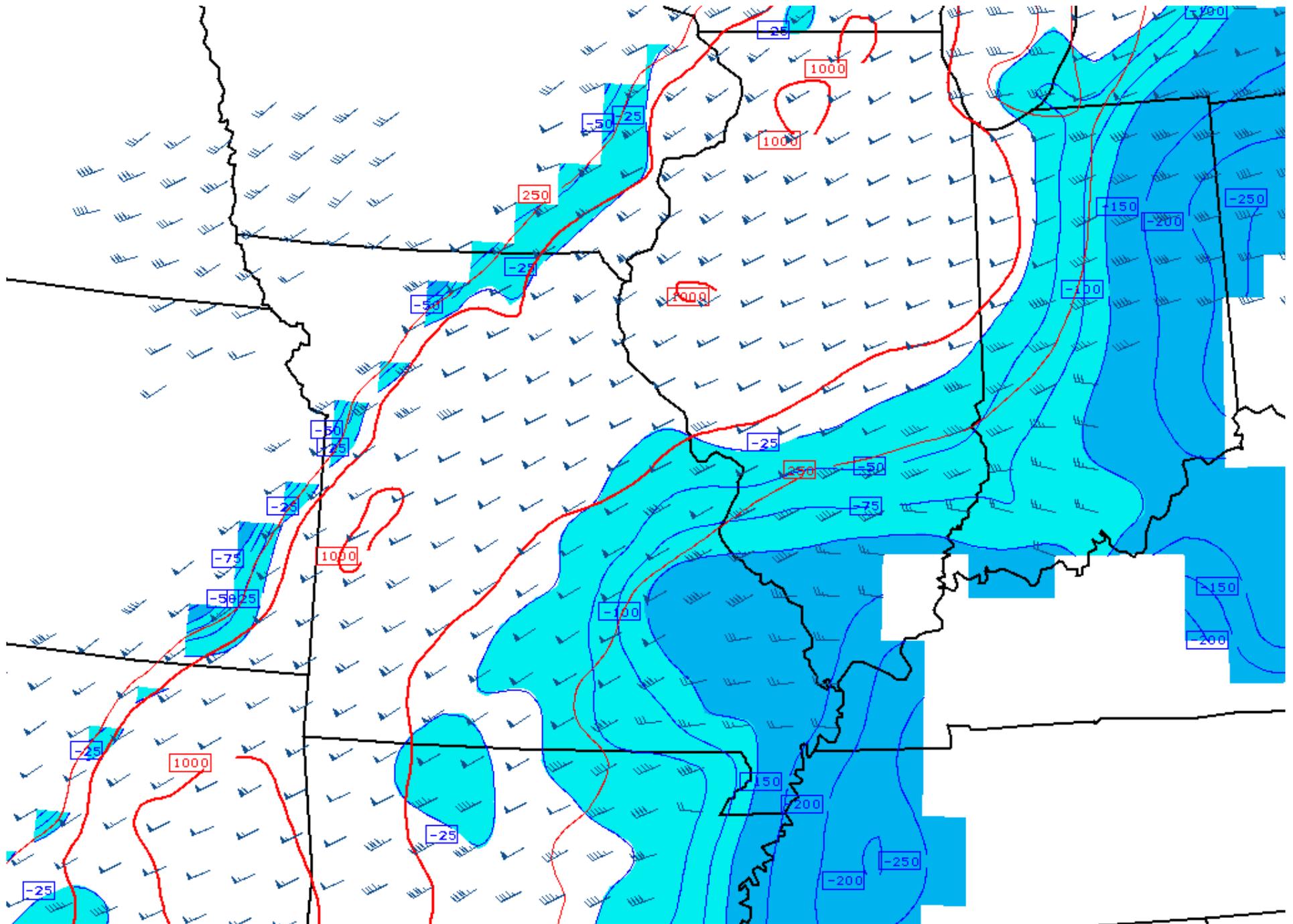
SPC MCD #

# 1730-1900z

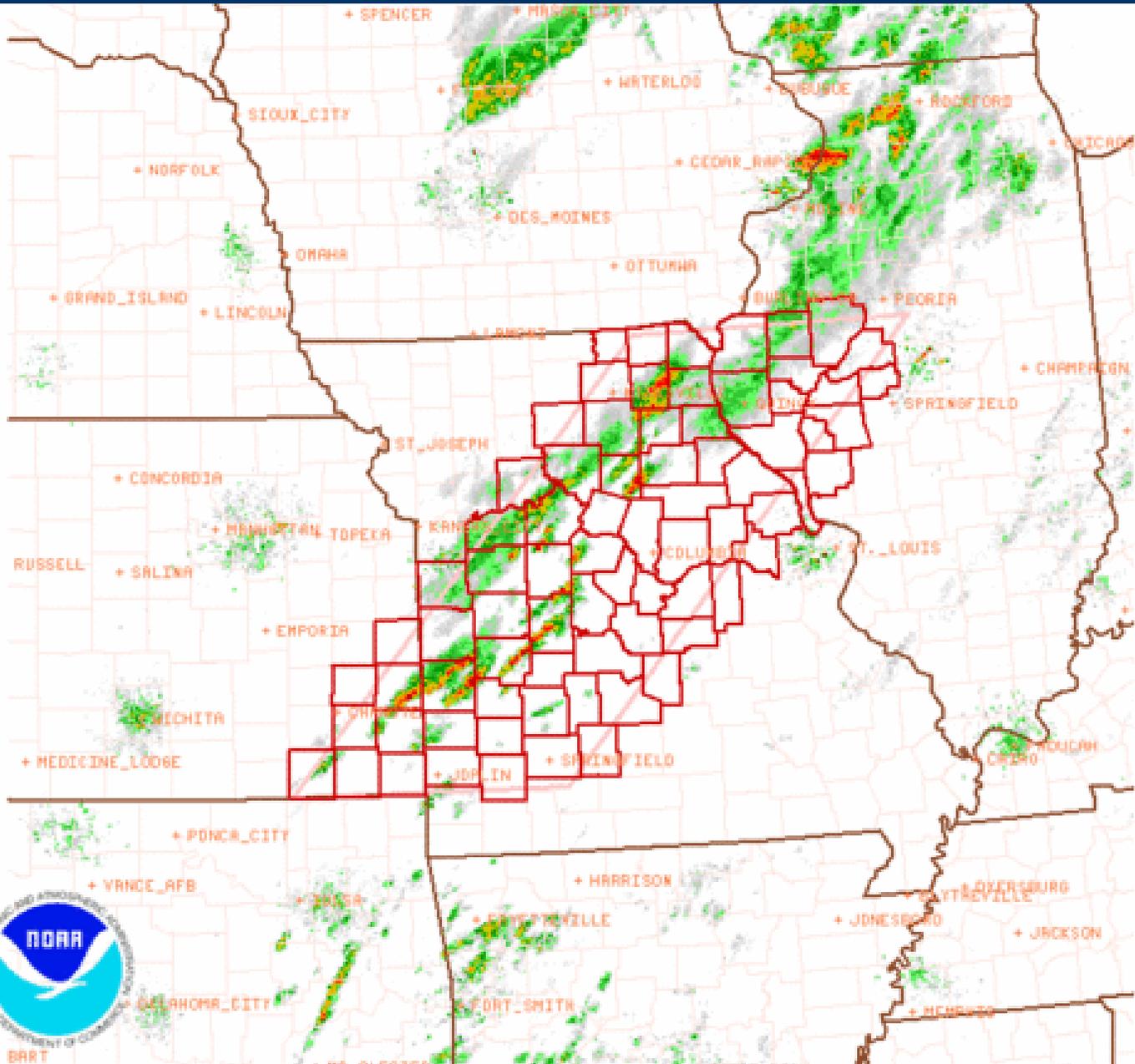


1730-1900z



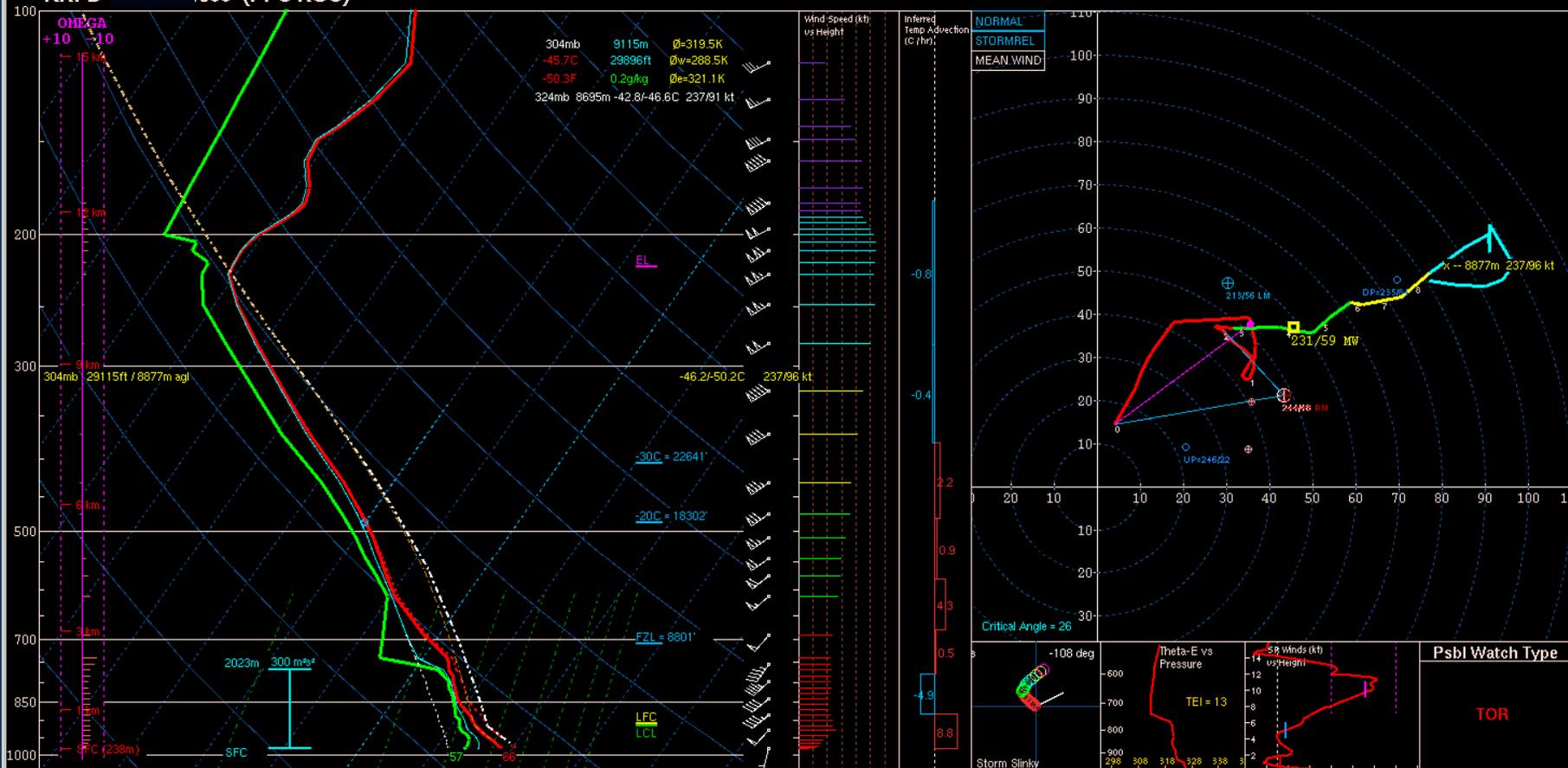


1900 Effective Shear, MLCAPE, MLCIN (filled)



**Tornado Watch # 1 - Valid from 155 PM until 900 PM CST**

### KRFD 1800 (PFC RUC)



	CAPE	CINH	LCL	LI	LFC	EL
SB PARCEL	1246	-1	631m	-4	781m	35408'
ML PARCEL	1047	-2	751m	-4	964m	35408'
FCST SFC	1812	0	1126m	-6	1126m	36153'
<b>MU PARCEL</b>	<b>1393</b>	<b>-0</b>	<b>567m</b>	<b>-5</b>	<b>646m</b>	<b>35885'</b>
EFF PARCEL	772	0	1108m	-3	1108m	33846'
USER DEF	466	-16	1292m	-2	2442m	31286'

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	289	33	220/41	120/20
SFC - 2 km	299	33	224/42	122/17
SFC - 3 km	317	37	222/43	126/18
<b>Eff Inflow Layer</b>	<b>300</b>	<b>33</b>	<b>224/42</b>	<b>122/17</b>
SFC - 6 km	62	226/48	144/15	
SFC - 8 km	77	228/51	155/14	
LCL - EL (Cloud Layer)	58	231/58	188/16	
<b>Lower Half Storm Depth</b>	<b>59</b>	<b>225/47</b>	<b>140/15</b>	

	3CAPE	91 J/kg	WBZ	7520'	WNDG	0.8
PW = 1.08 in	3CAPE = 91 J/kg		WBZ = 7520'		WNDG = 0.8	
K = 30	DCAPE = 411 J/kg		FZL = 8801'		ESP = 1.2	
MidRH = 82%	DownT = 53 F		ConvT = 67F		MMP = 0.99	
LowRH = 85%	MeanW = 9.8 g/kg		MaxT = 72F		NCAPE = 0.14	

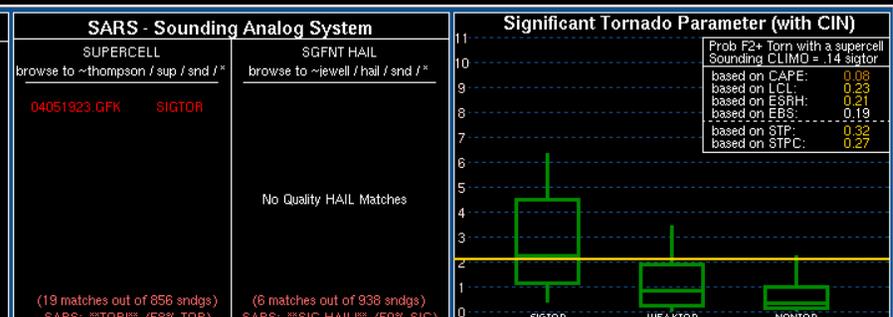
	SFC-3km Agl Lapse Rate	22 C / 7.7 C/km
3-6km Agl Lapse Rate	20 C / 6.8 C/km	
850-500mb Lapse Rate	28 C / 6.9 C/km	
700-500mb Lapse Rate	18 C / 6.9 C/km	

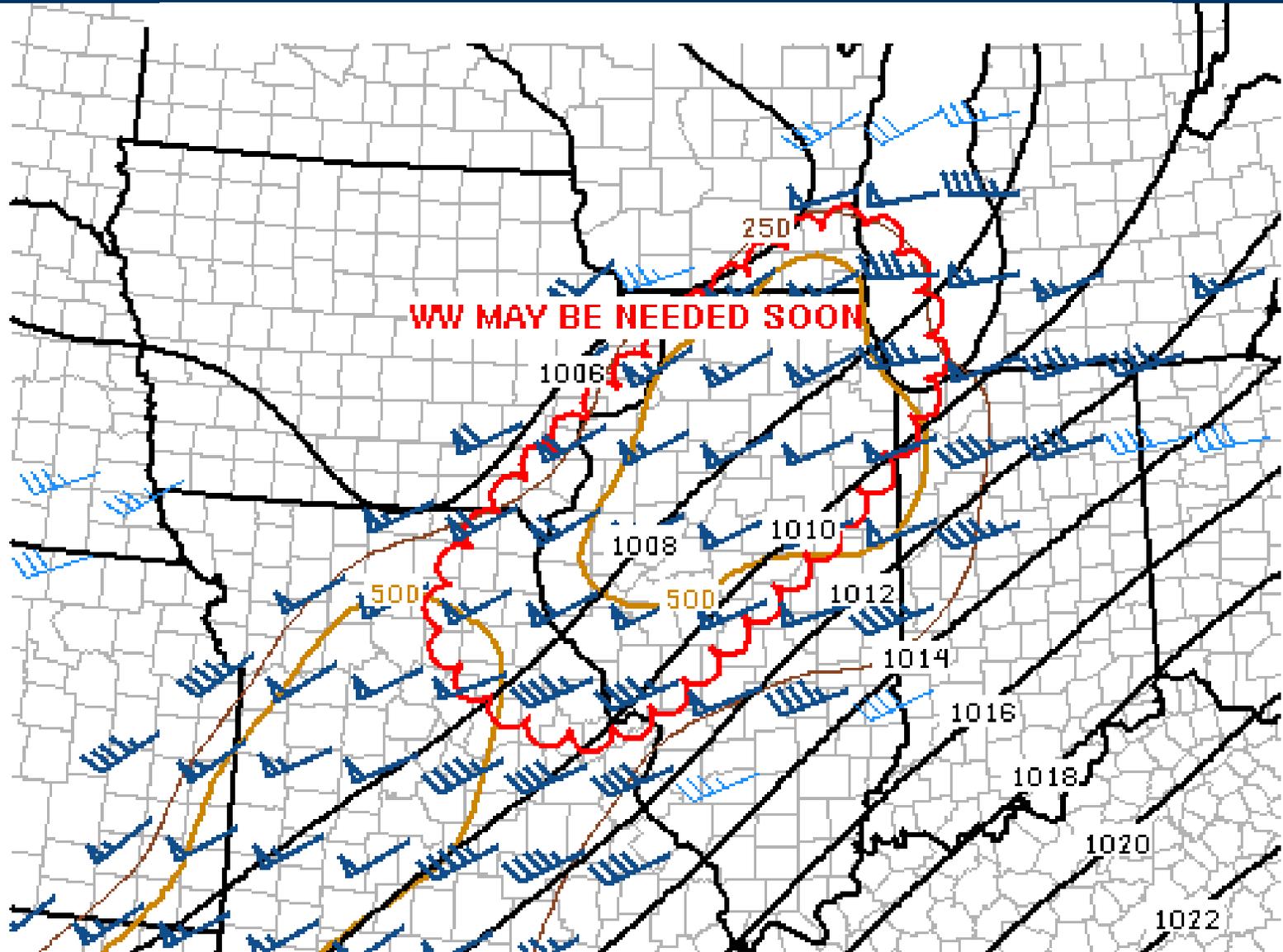
  

**Supercell = 8.3**  
**STP (CIN) = 2.1**  
**STP (fixed) = 2.4**  
**SHIP = 1.3**

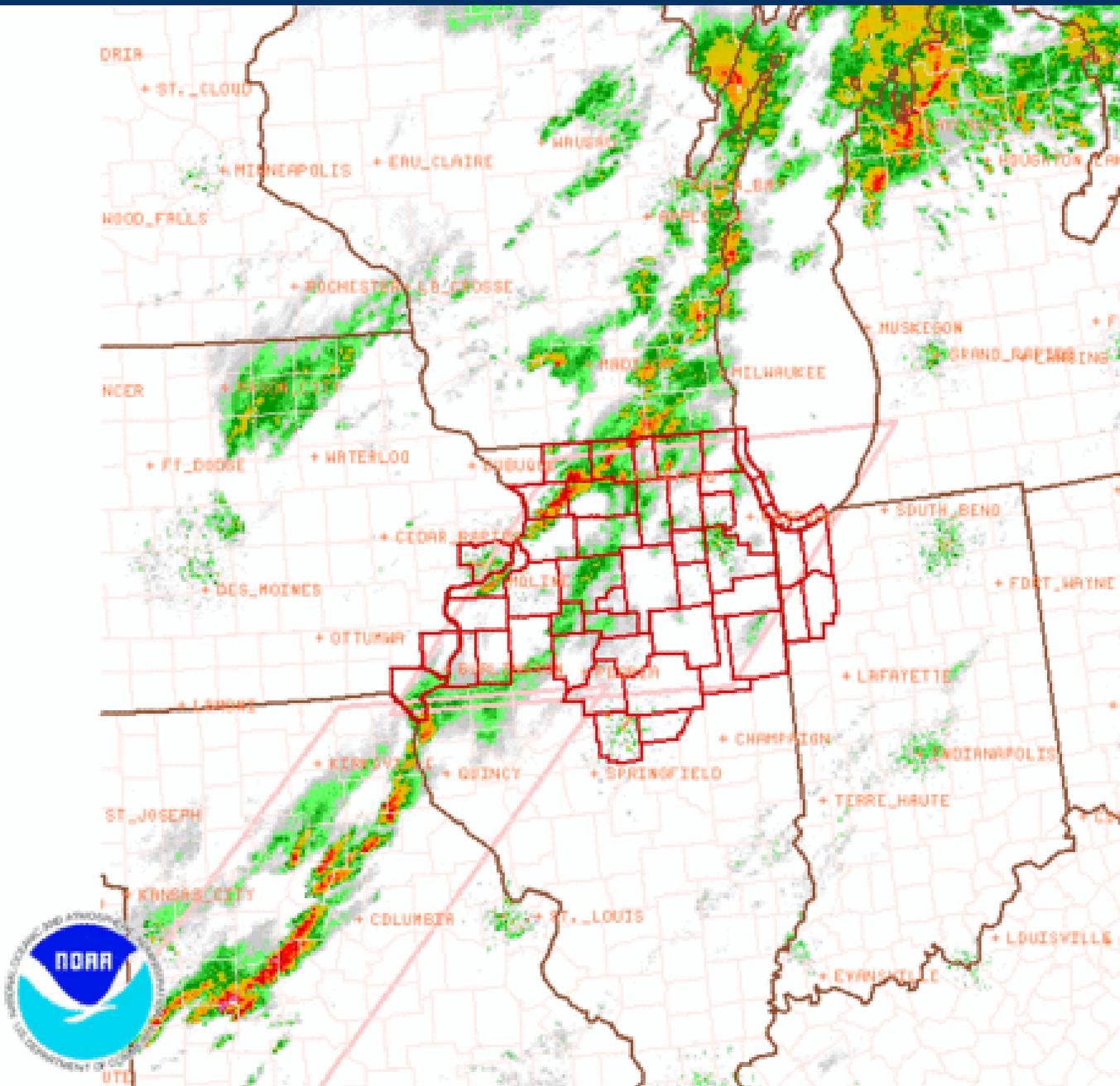
STPC (test) = 3.3

SARS - Sounding Analog System			
SUPERCELL	SGFNT HAIL		
browse to ~thompson / sup / and / *	browse to ~jewell / hail / and / *		
04051923.GFK SIGTOR	No Quality HAIL Matches		
(19 matches out of 856 sndgs)	(6 matches out of 938 sndgs)		
SARS: **TOR** (56% TOR)	SARS: **SIG HAIL** (50% SIG)		



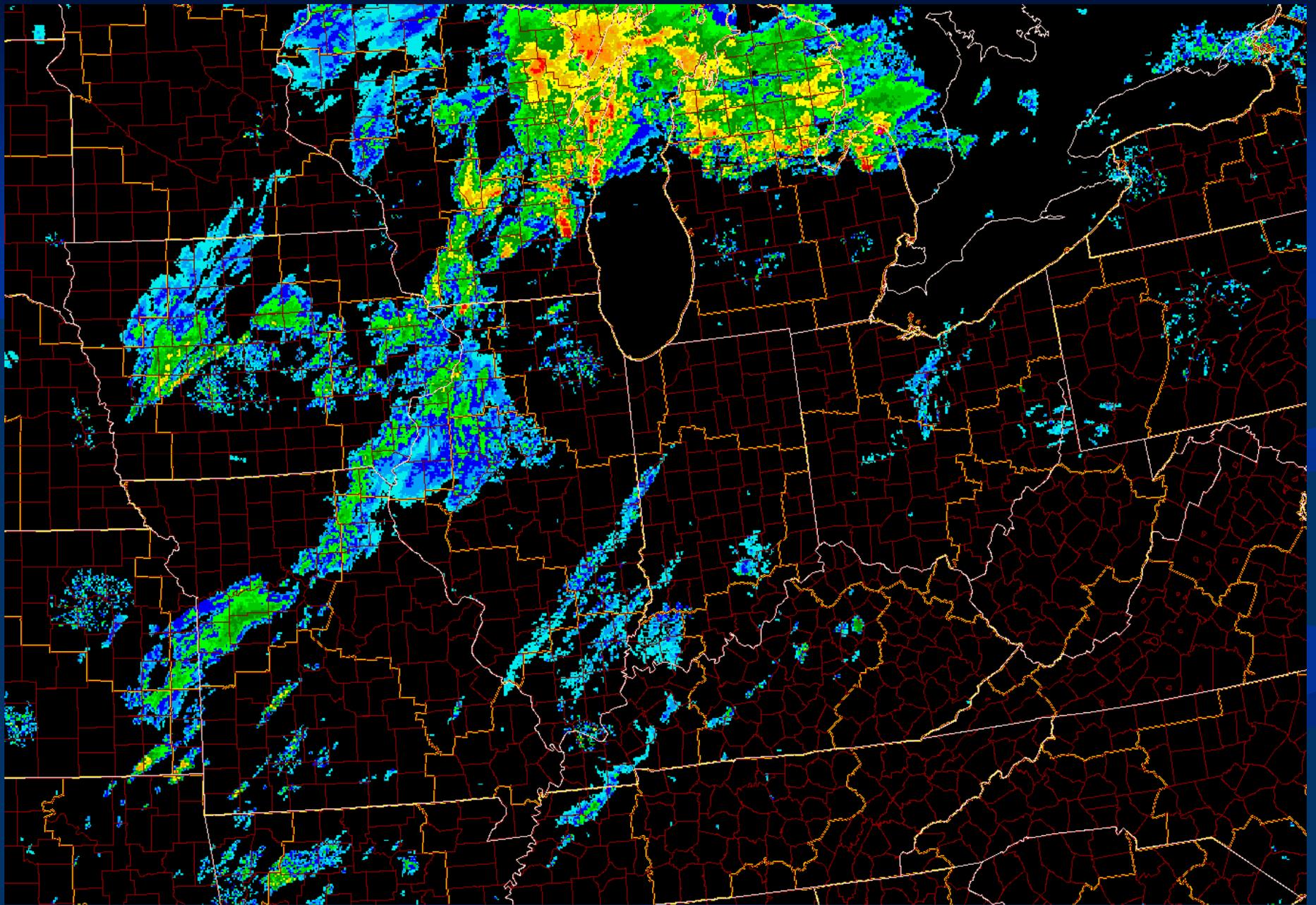


SPC MCD :



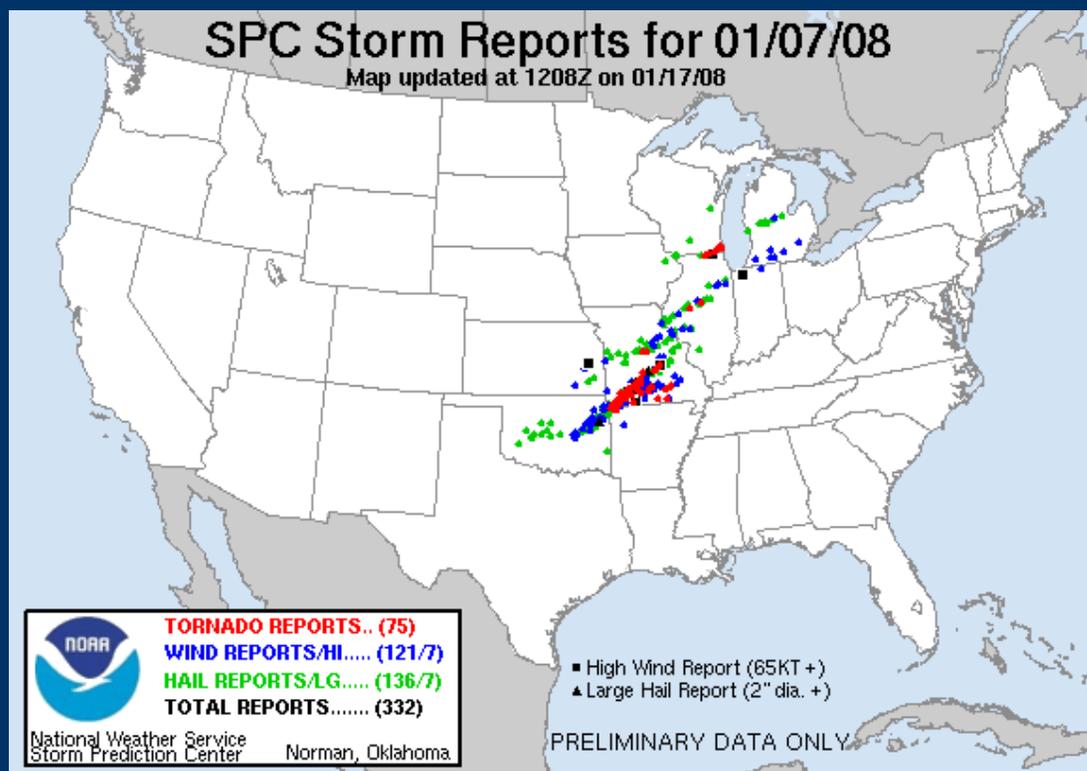
**Tornado Watch # 2 - Valid from 235 PM until 900 PM CST**

1830-2122z



# Jan. 07<sup>th</sup>, 2008

- Significant tornado outbreak across southern MO with EF3 tornado in far southeastern WI
- A total of 48 tornadoes surveyed by NWS for this tornado outbreak. Two fatalities and around 30 injuries were reported in MO.



# Quick conclusions

- Mesoscale tools enhanced short-term forecasting.
  - Allowed forecasters to forecast quicker beginning to the event.
  - Stay ahead of unfolding severe threat outside ongoing SLGT risk.

# The End!

