Severe Weather Ingredients

**Material by Tom Galarneau Andrew Lyons,
Rich Thompson and Harry Weinman**

Ingredients for
Organized Severe Thunderstorms

- Instability (Lapse Rates)
- Lift (QG, mesoscale, convective scale)
- Moisture (return flow, soil moisture, evapotranspiration)
- Vertical wind shear

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This lecture

- Vertical wind shear

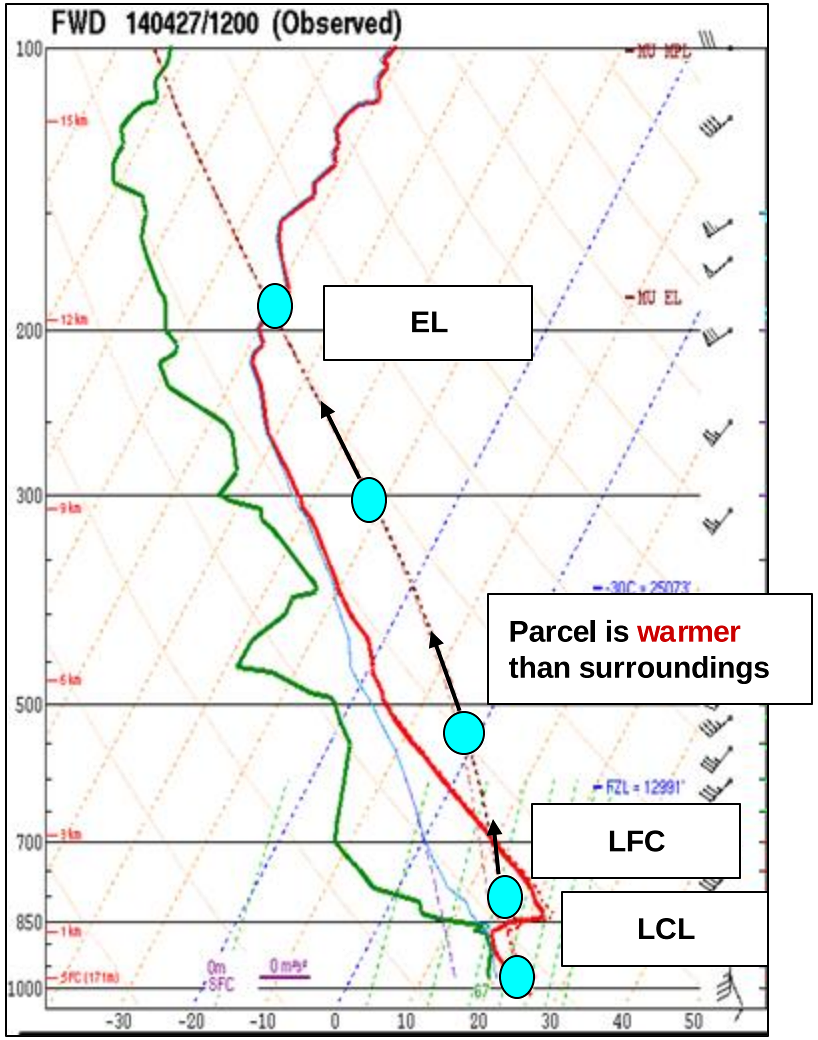
- a separate lecture

Key ingredient for
organized severe storms

Instability: The Basics

- **Give a parcel a nudge and see what happens!**

- **We determine an environments stability by its lapse rate (Change of environmental temperature with height)**

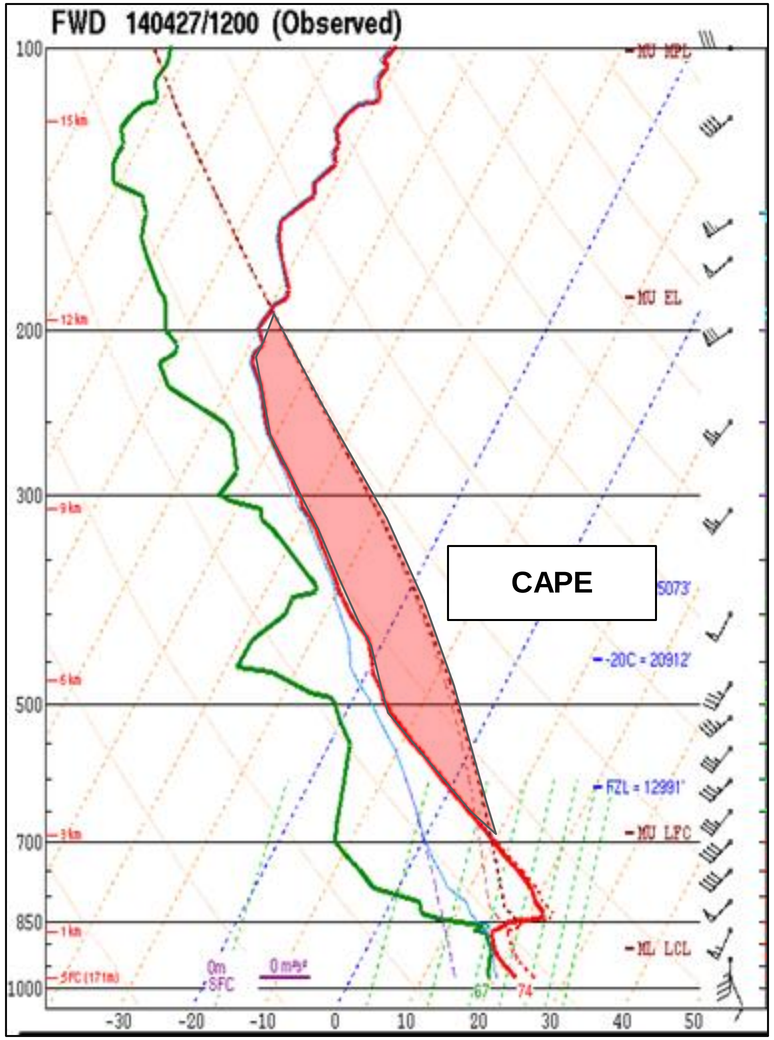


Instability: The Basics

- **Integrate the depth where parcel is warmer/less dense than its surrounding**
- **CAPE (Convective Available Potential Energy)**

$$CAPE = \int_{LFC}^{EL} g \frac{T_{v\_p} - T_{v\_env}}{T_{v\_env}} dz = \left[\frac{kg\, m^2}{s^2} \frac{1}{kg}\right] = \left[\frac{m^2}{s^2}\right]$$

$$= \left[\frac{J}{kg}\right]$$

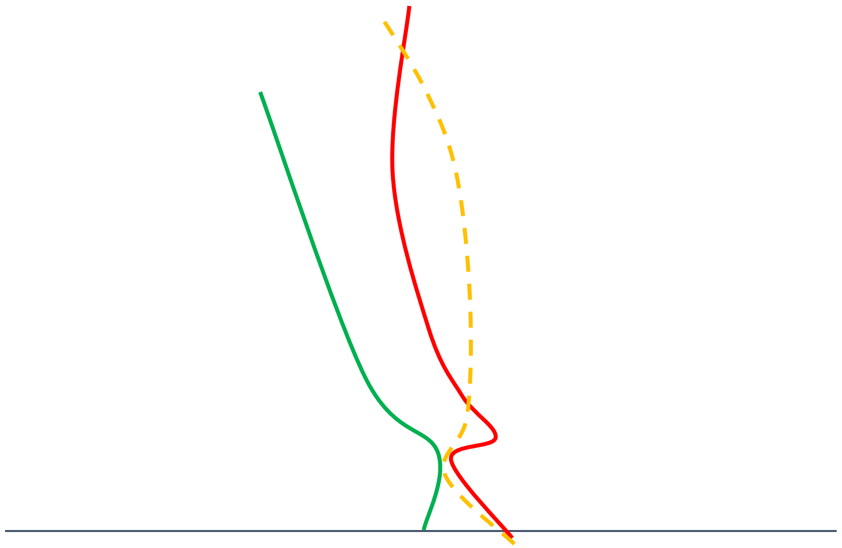


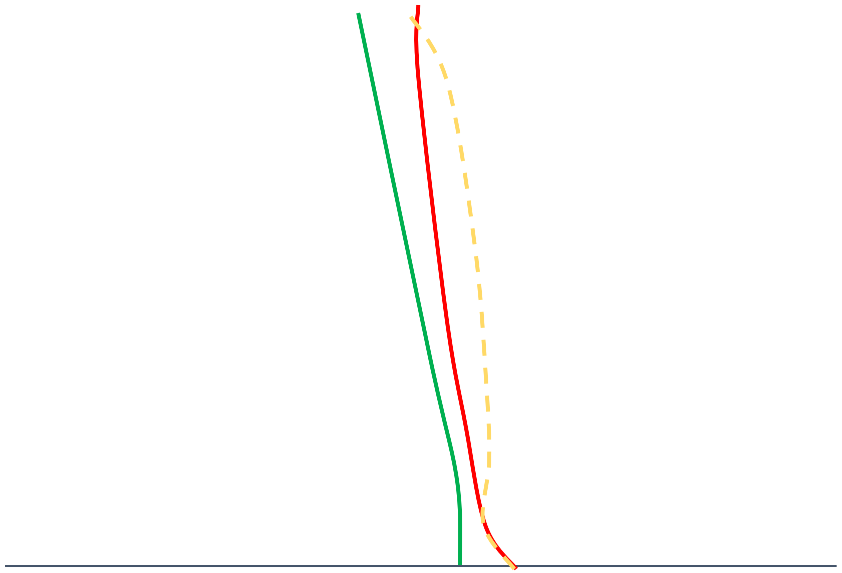
Instability: The Basics

Take a small finite layer depth within CAPE profile

$$\frac{CAPE}{\Delta Z} = \left[\frac{m^2}{s^2}\right]\left[\frac{1}{m}\right] = \left[\frac{m}{s^2}\right] \longrightarrow$$

Upward Acceleration!





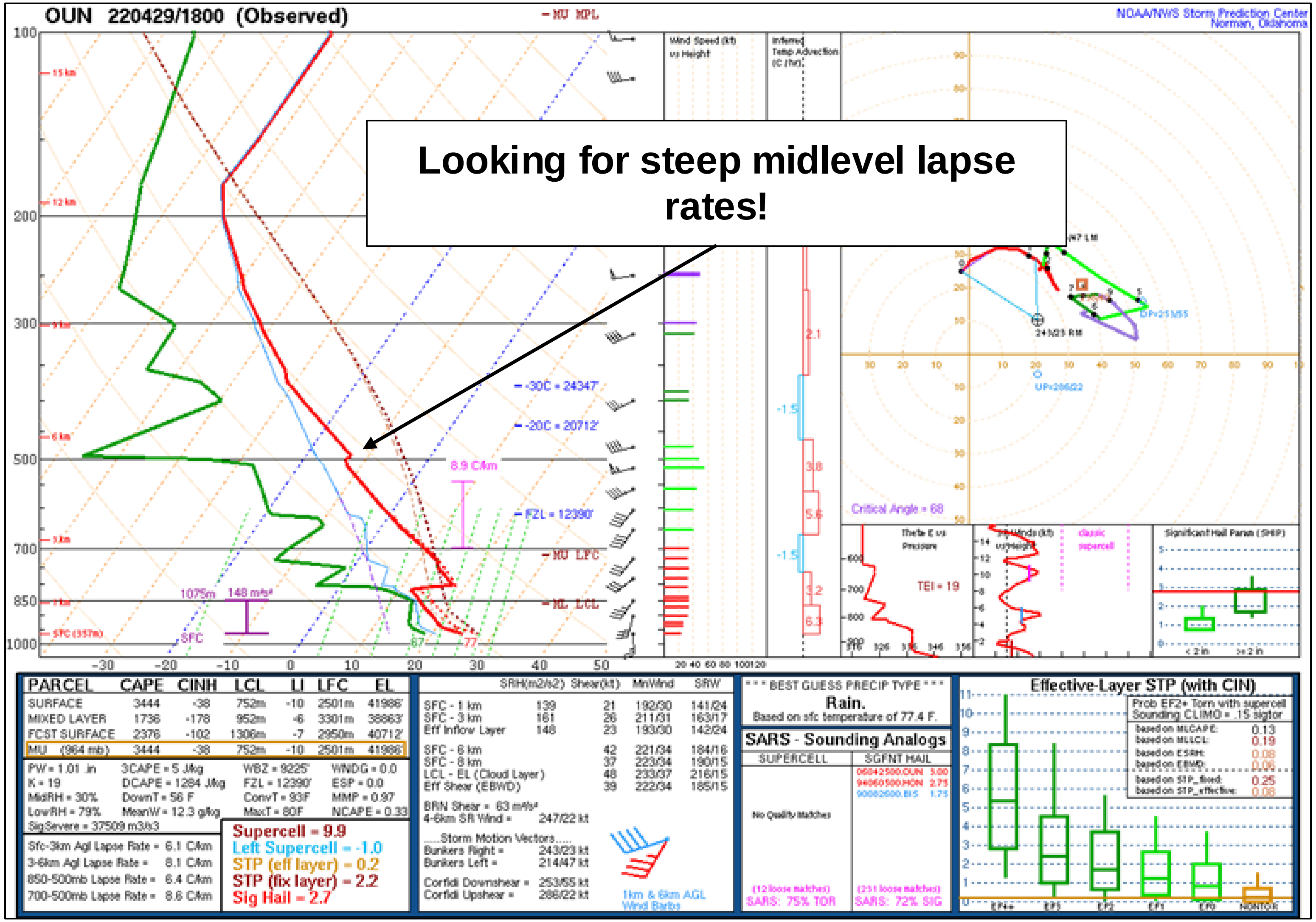
<u>Short/thick CAPE</u>:
Drives larger upward acceleration

1. Offsets negative effects of dry air entrainment into updraft
2. Mitigates effects of precipitation drag on updraft

<u>Tall/narrow CAPE</u>:
Smaller upward acceleration

Water loading and entrainment more substantially weaken updraft

So, how do we get wider CAPE?

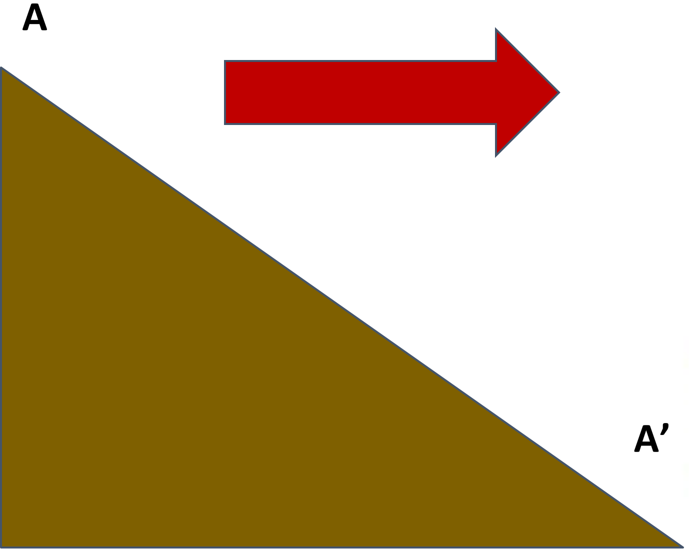


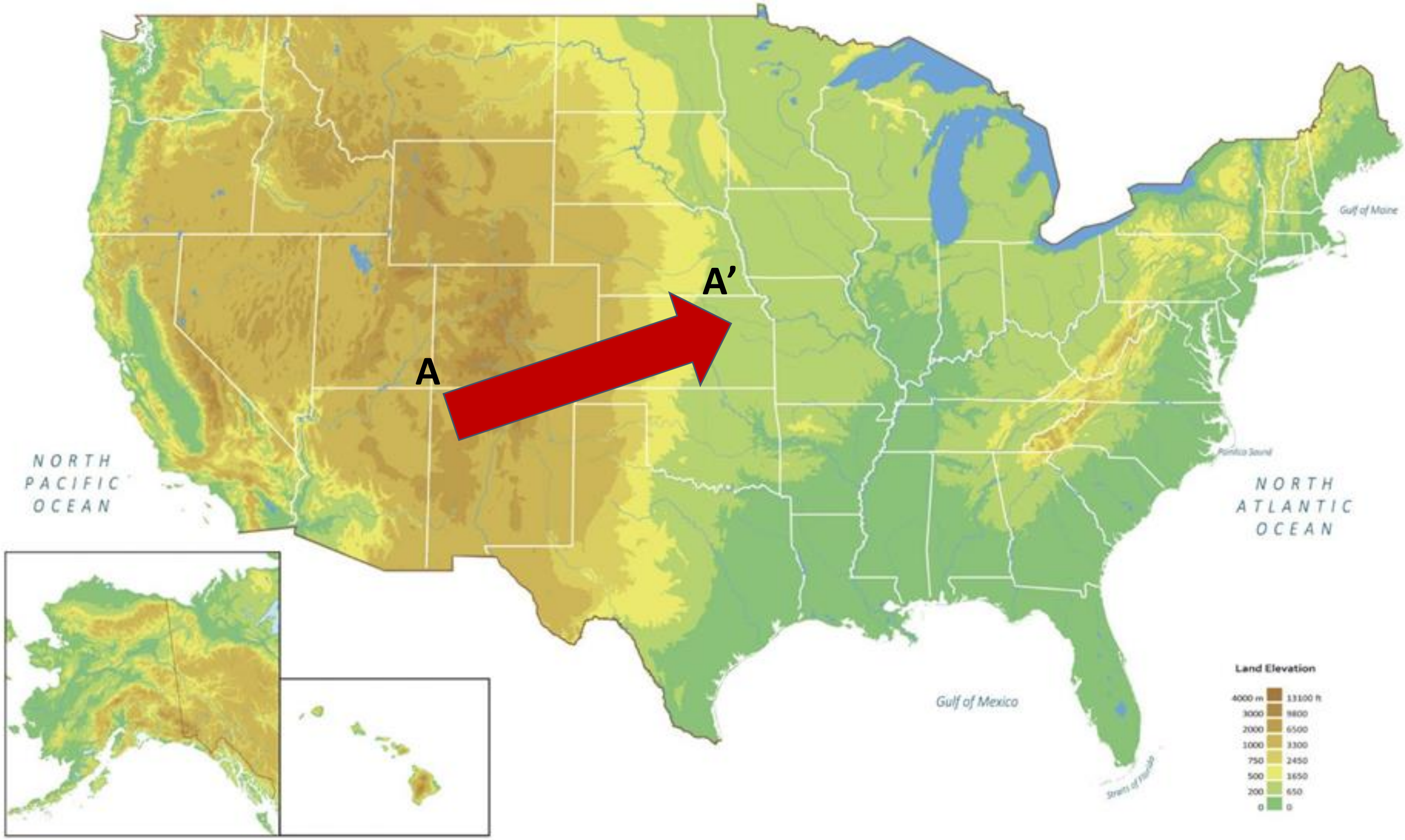
Looking for steep midlevel lapse rates!

Instability: Elevated Mixed Layer (EML)

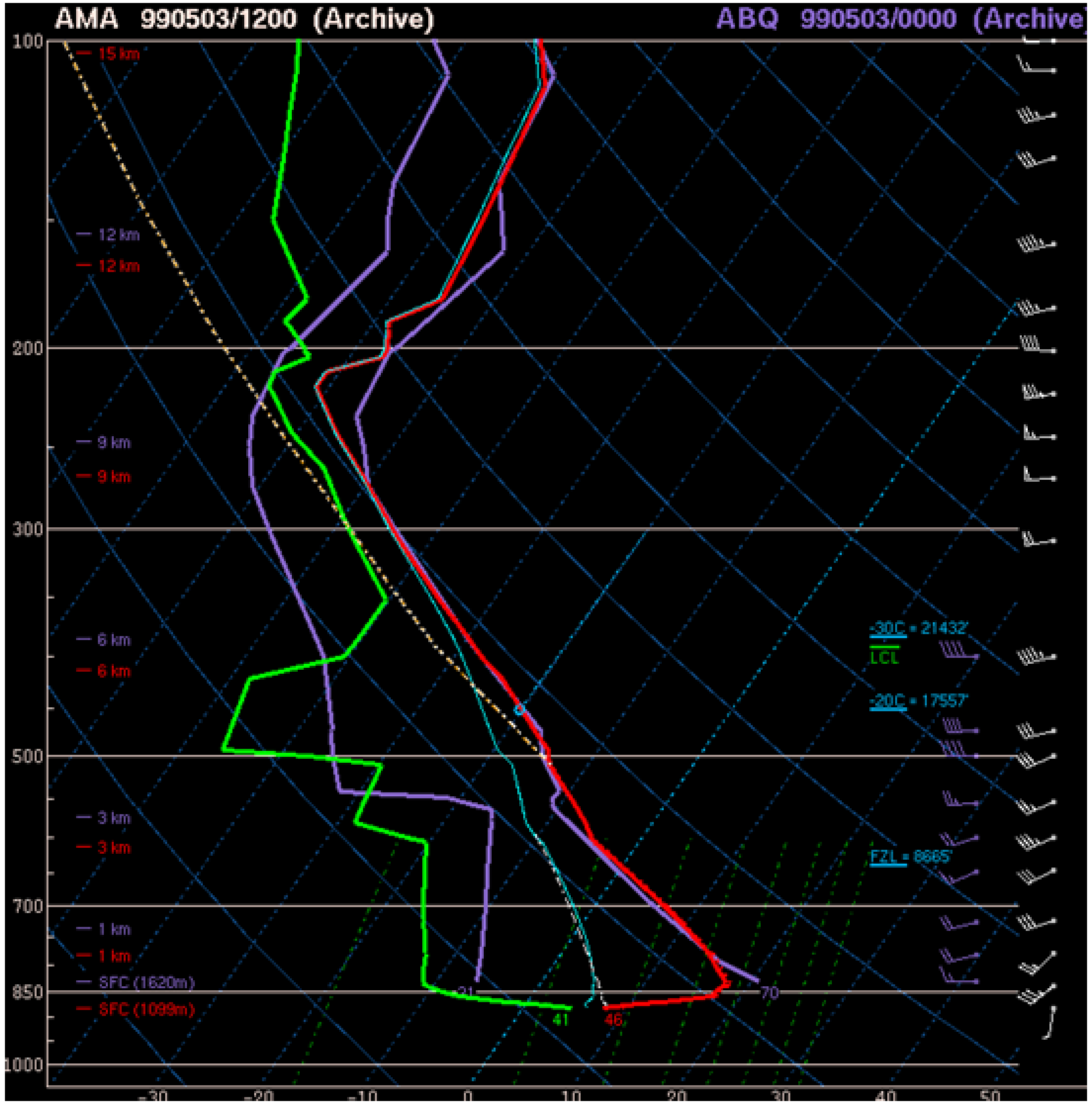
- Deep mixed layer forms over Rockies and Sierra Madre in response to surface heating
- Stronger heating and/or cooler temperatures aloft results in deeper mixed layer
- Mixed layer is advected eastward and becomes elevated east of the Rockies and Sierra Madre (really, east of the dryline)
- Differential advection (eastward advection of EML above northward advection of moisture from GoM) created "loaded gun" profile

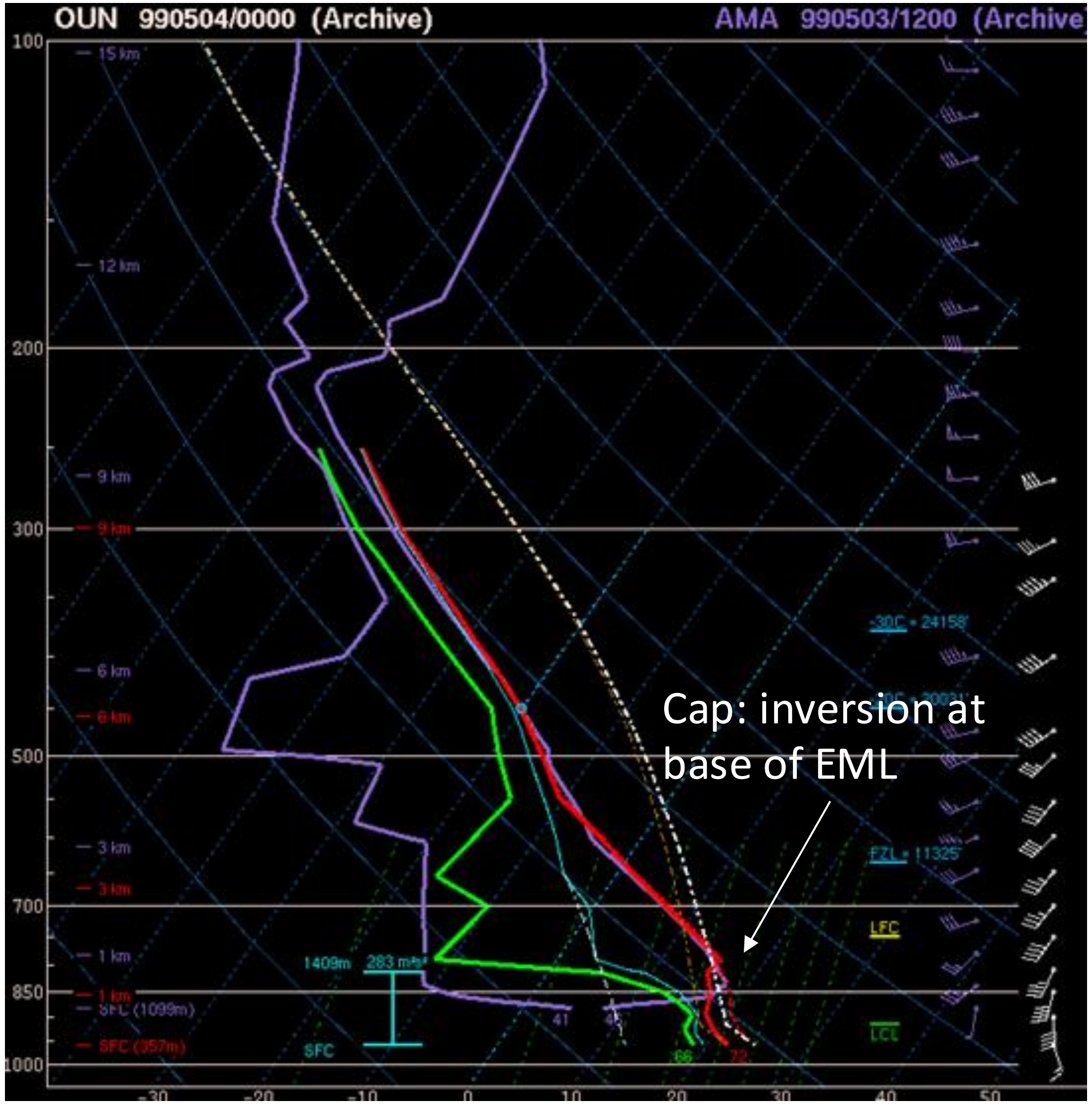
Elevated Mixed Layer (EML) Differential Advection

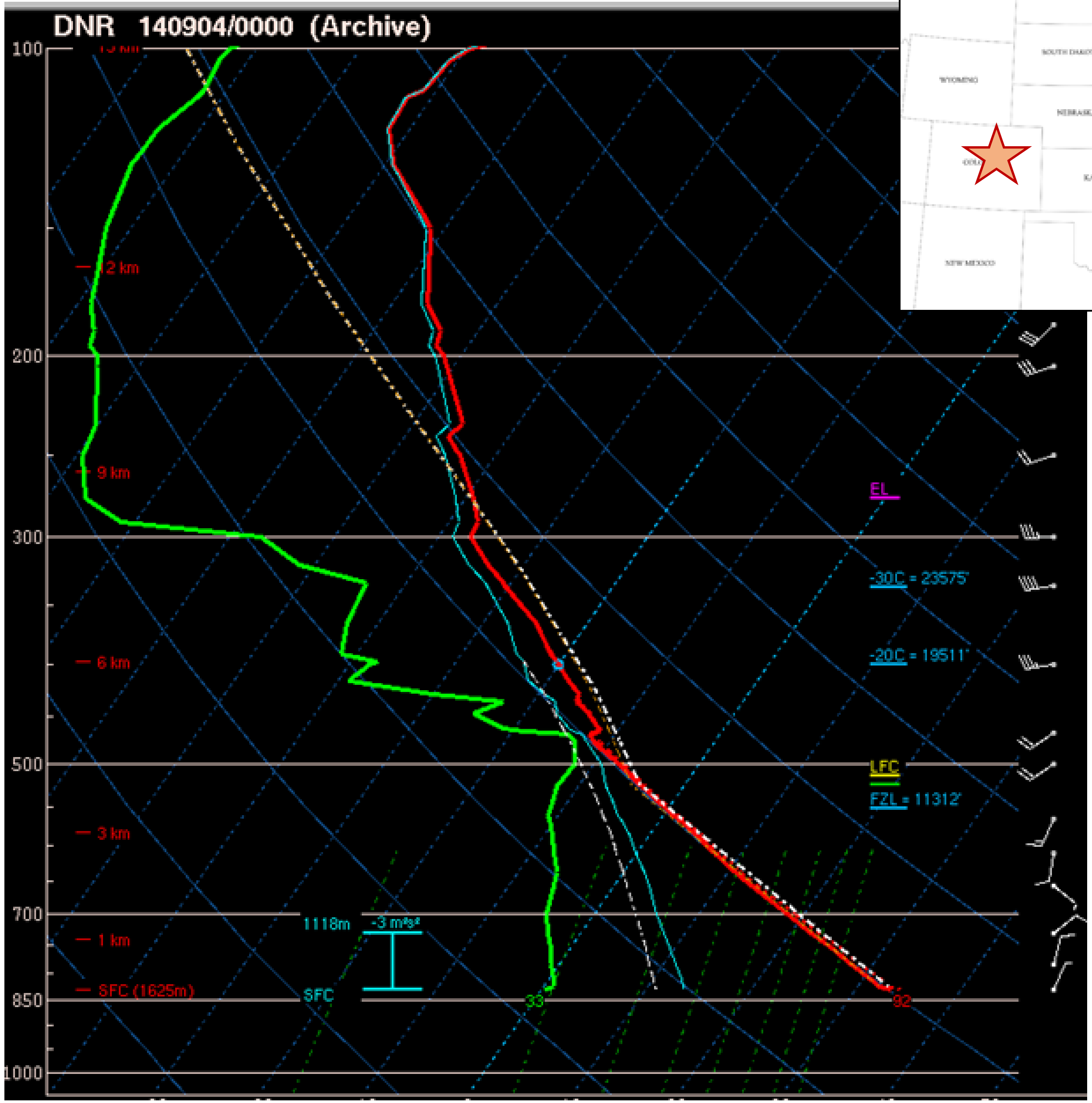




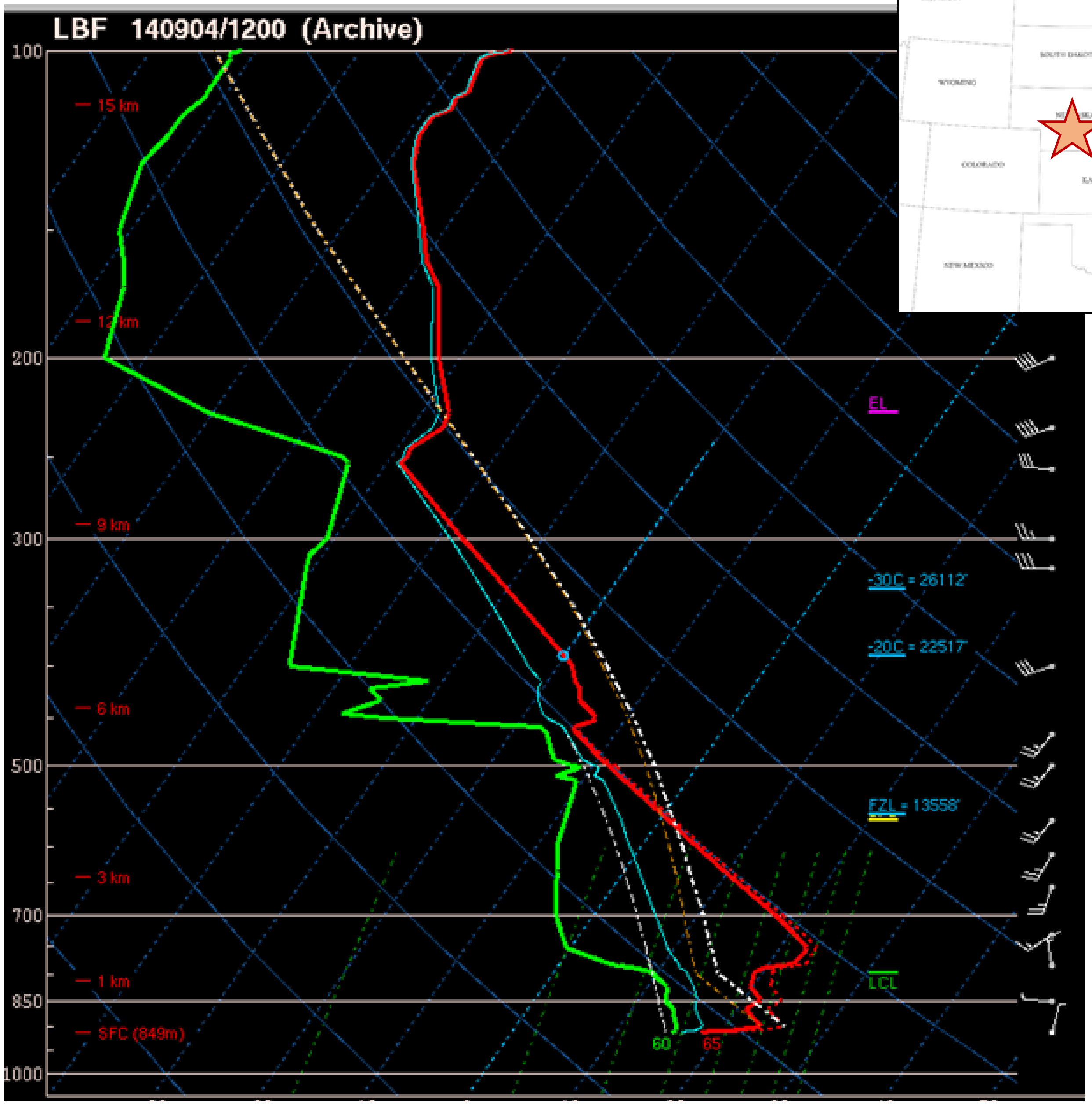
EML at OUN (0000 UTC 4 May 1999)





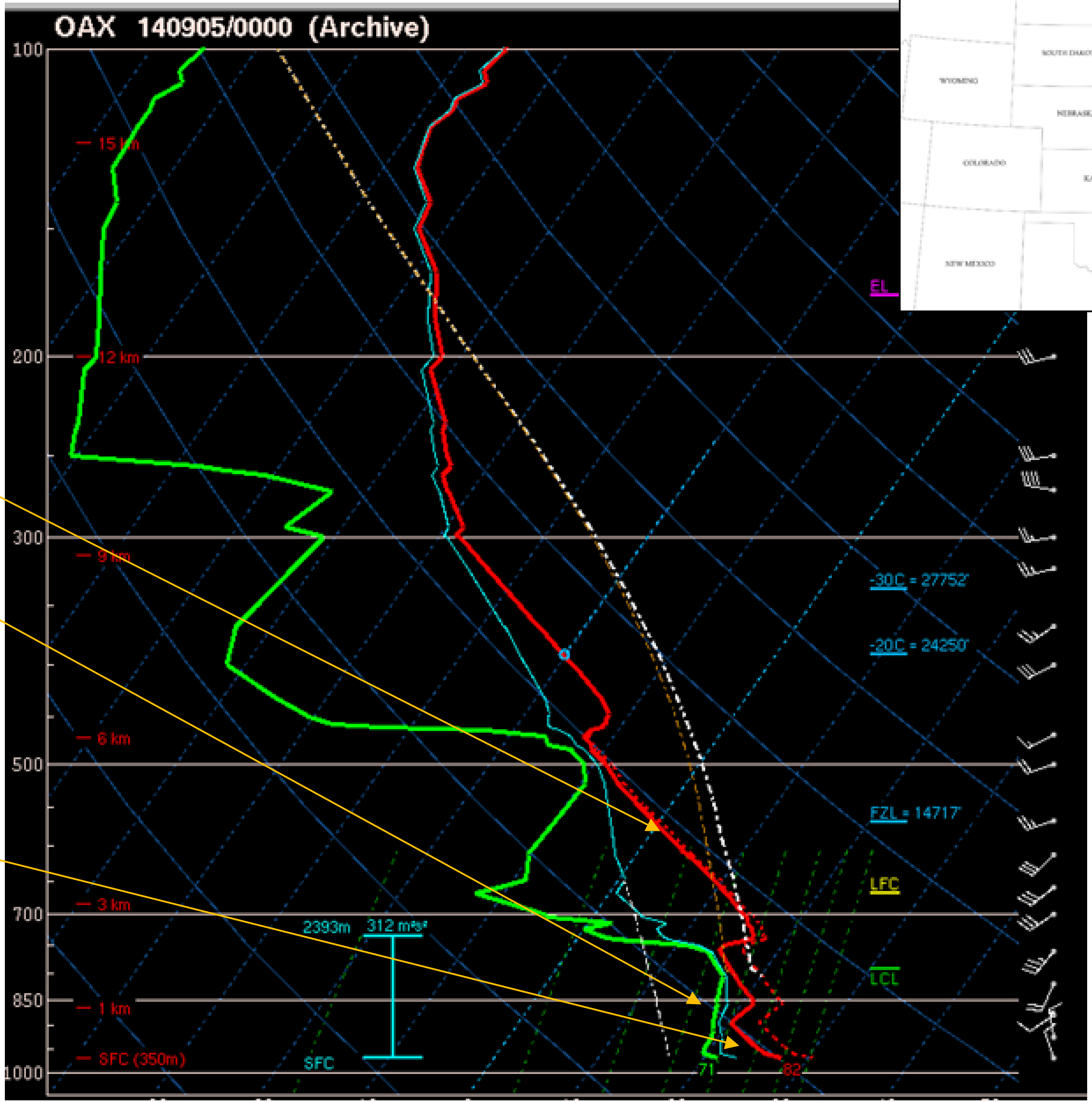

DNR 140904/0000 (Archive)
100
200
300
500
700
850
1000
12 km
9 km
6 km
3 km
1 km
SFC (1625m)
1118m
-3 m²s²
SFC
33
92
EL
-30C = 23575'
-20C = 19511'
LFC
FZL = 11312'

MONTANA
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WISCONSIN
WYOMING
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
KANSAS
MISSOURI
KENTUCKY
TENNESSEE
OKLAHOMA
ARKANSAS
NEW MEXICO
MISSISSIPPI
ALABAMA


LBF 140904/1200 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (849m)
EL
-30C = 26112'
-20C = 22517'
FZL = 13558'
LCL
60
65

Cap strength is related to:

- EML θ
- Depth/quality of moisture
- Surface heating and mixing in moist sector



Lift

- **Synoptic-scale lift**
  - 1-10 cm/s for many hours (6 hours ~2 km ascent (SFC-800 hPa))
  - 6 hours to reach LFC
  - Conditions environment for deep, moist convection over broad area
    - Lapse rate stretching
    - Removal of inhibition
  - Layered clouds in regions of isentropic lift; some elevated storms can form

- **Mesoscale lift**
  - 1 m/s for minutes to hours (1 hour ~3.6 km ascent (SFC-650 hPa))
  - < 1 hour to reach LFC
  - Narrow zones of ascent along boundaries and terrain features
  - Direct initiation of thunderstorms

- **Storm-scale lift**
  - 10 m/s for minutes (15 mins ~9 km of ascent (SFC-300 hPa))
  - 5 minutes to reach LFC
  - Storm maintenance and propagation (supercells, MCSs, squall lines, etc.)

Synoptic-Scale Lift

- **QG sources**
  - **Warm advection/isentropic lift and differential vorticity advection**

- **Jet streaks (also QG)**
  - **Straight jet: ascent in right entrance and left exit regions**
  - **Curved jet: ascent downstream and along jet core**

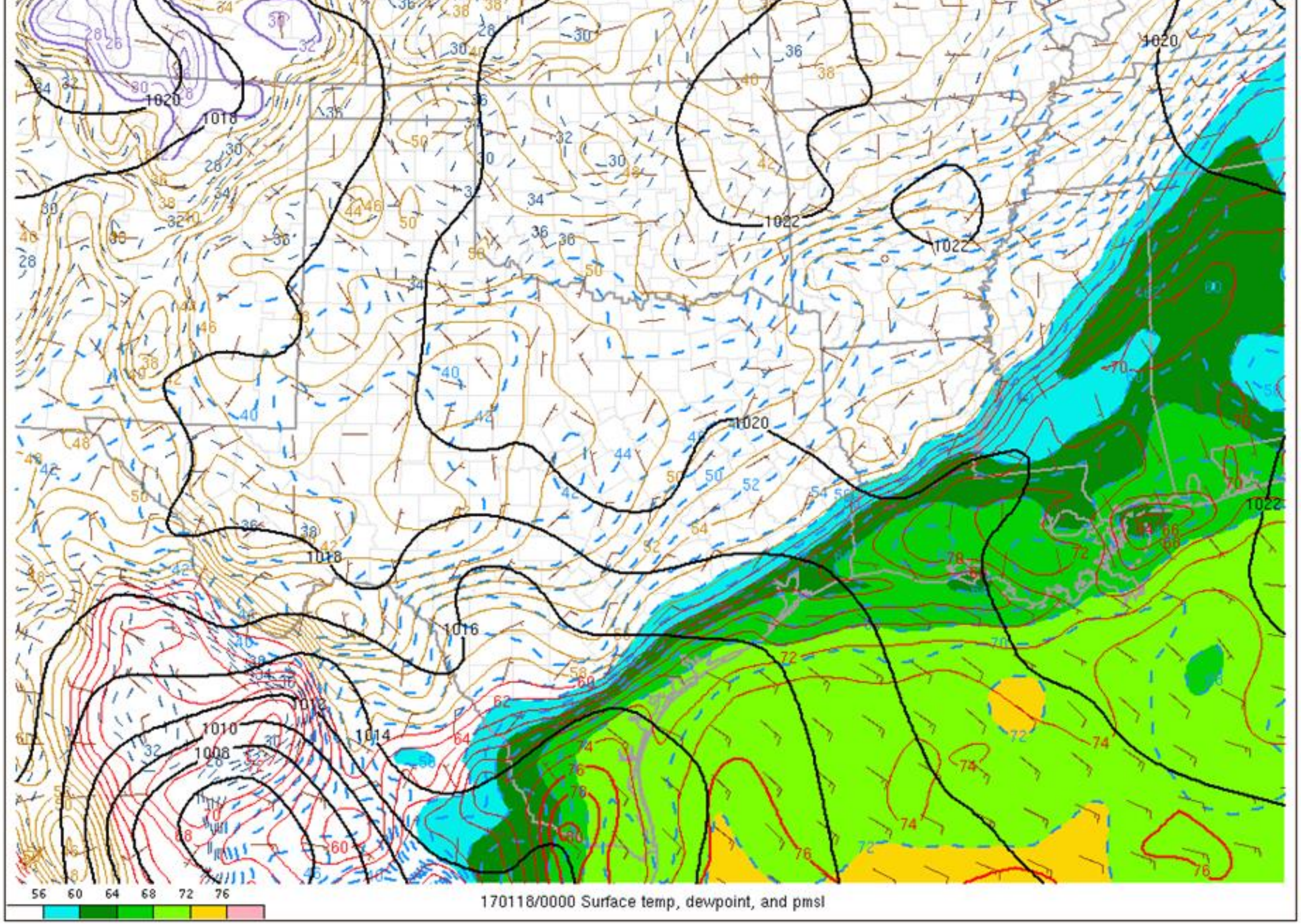
- SfcOA Diag - | - RAP

Image overlays:

- ☑ County Boundaries
- ☐ County Warning Area
- ☐ Hiways & Cities
- ☐ ARTCC Regions
- ☐ NWS Watches & Warn
- ☐ SPC Day1 Outlook

Image underlays:

- ◉ None
- ○ Radar
- ○ Terrain
- ○ Population
- ○ Surface Obs



170118/0000 Surface temp, dewpoint, and pmsl

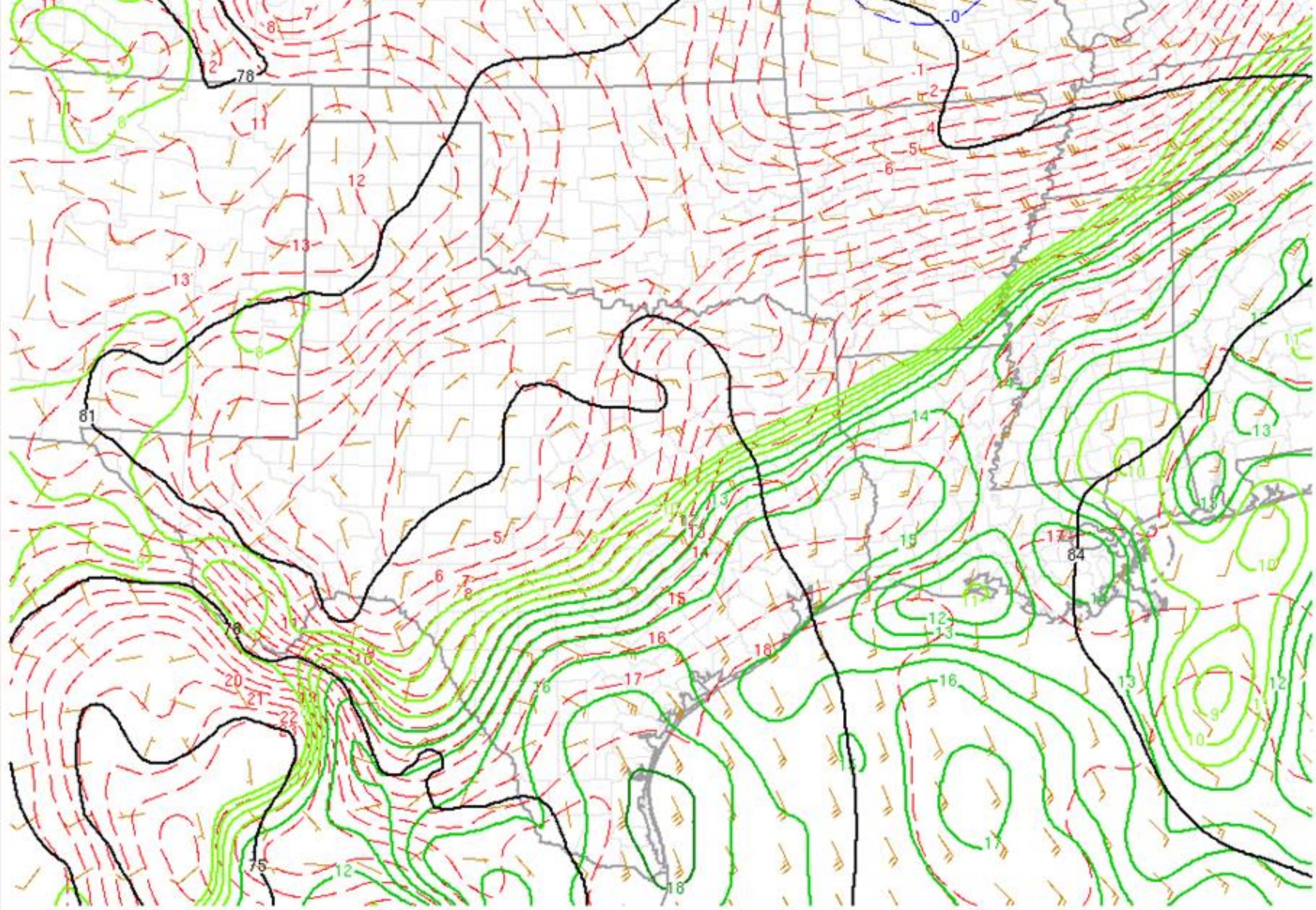
Current SPC Produ

Show popup images? ☑

Day1 Convective Outl
Issued at 1957 UTC
Probabilities: To

Day1 National Fire Ou
Issued at 1619 UTC

This list updates automatically



170118/0000V001 925mb hght/temp/dwpt/wind

- SfcOA Diag -

Image overlays:

- [x] County Boundaries
- [ ] County Warning Area
- [ ] Hiways & Cities
- [ ] ARTCC Regions
- [ ] NWS Watches & Warn
- [ ] SPC Day1 Outlook

Image underlays:

- (•) None
- ( ) Radar
- ( ) Terrain
- ( ) Population
- ( ) Surface Obs

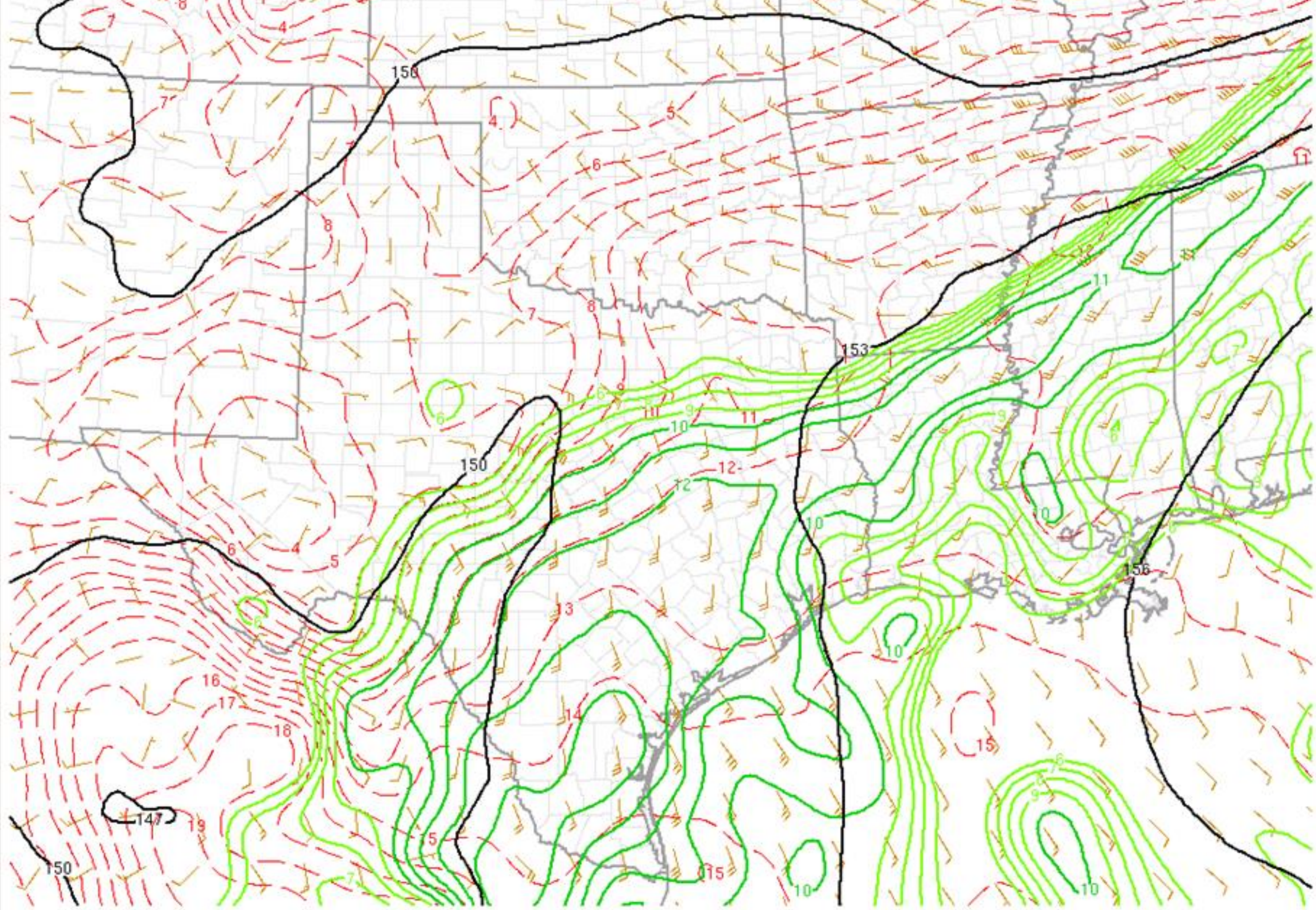
Current SPC Produ

Show popup images? [x]

Day1 Convective Outl
Issued at 1957 UTC
Probabilities: To

Day1 National Fire Ou
Issued at 1619 UTC

This list updates automatically



170118/0000V001 850mb hght/temp/dwpt/wind

- SfcOA Diag -

Image overlays:

- [x] County Boundaries
- [ ] County Warning Area
- [ ] Hiways & Cities
- [ ] ARTCC Regions
- [ ] NWS Watches & Warn
- [ ] SPC Day1 Outlook

Image underlays:

- (•) None
- ( ) Radar
- ( ) Terrain
- ( ) Population
- ( ) Surface Obs

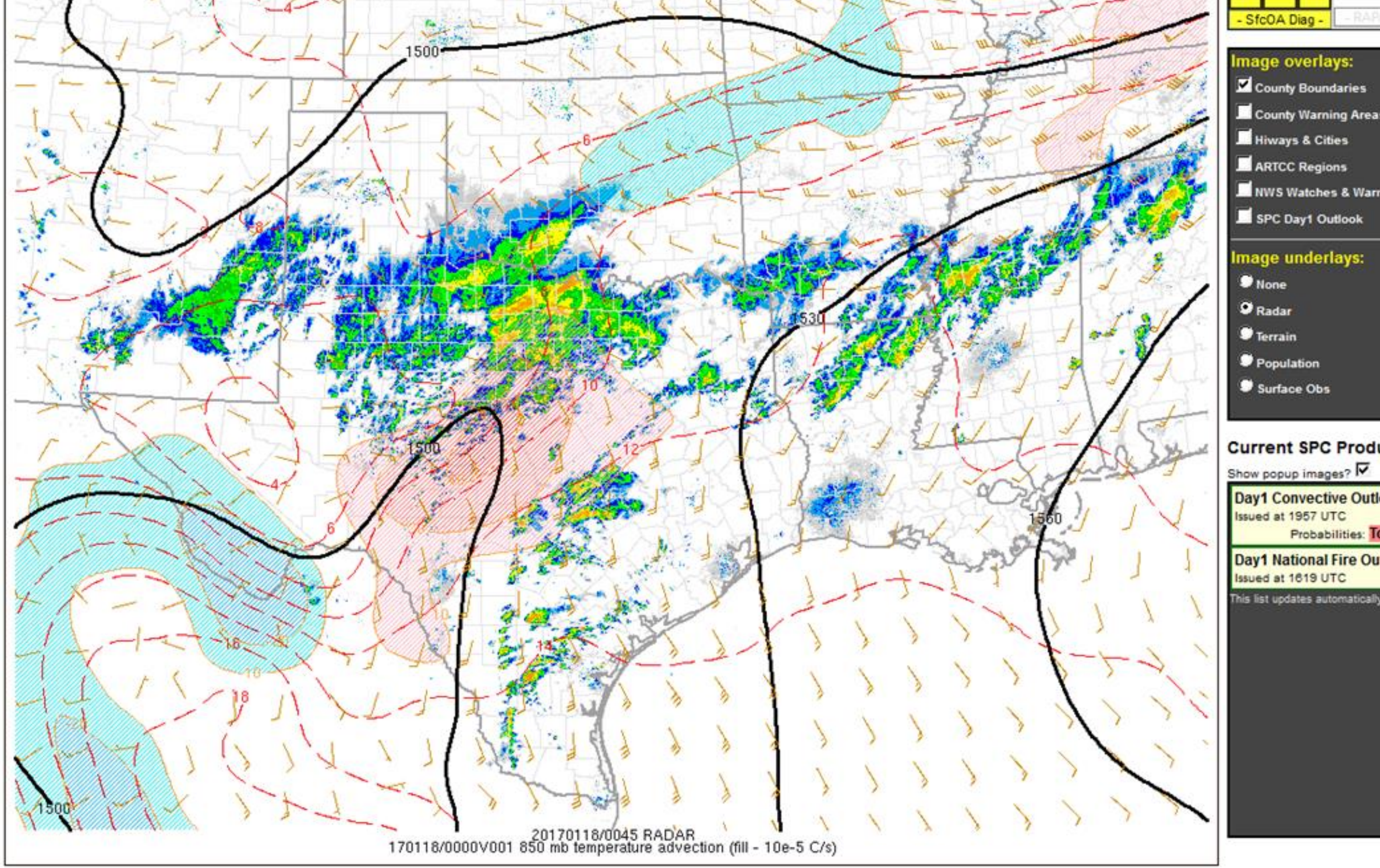
Current SPC Produ

Show popup images? [x]

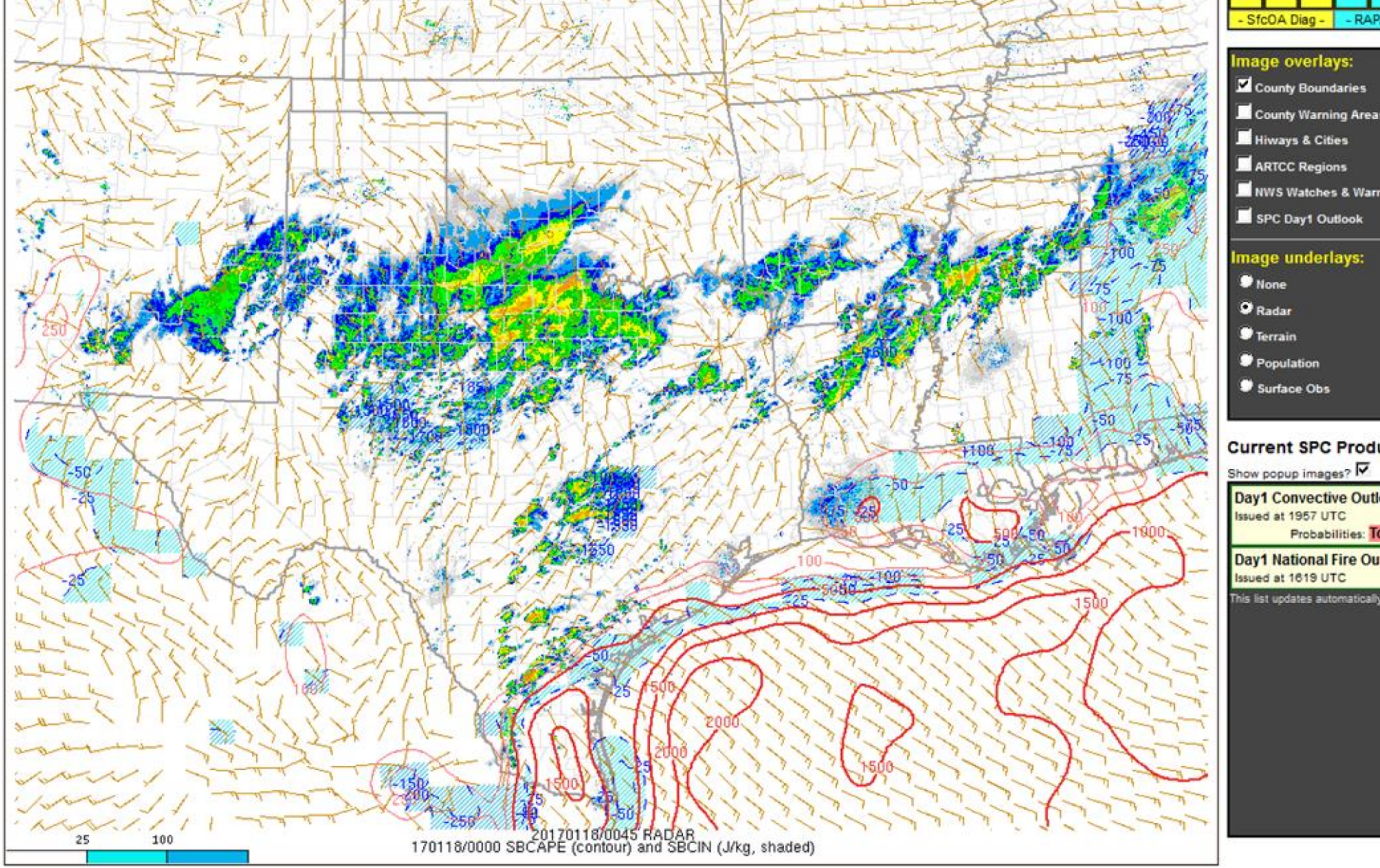
Day1 Convective Outl
Issued at 1957 UTC
Probabilities: To

Day1 National Fire Ou
Issued at 1619 UTC

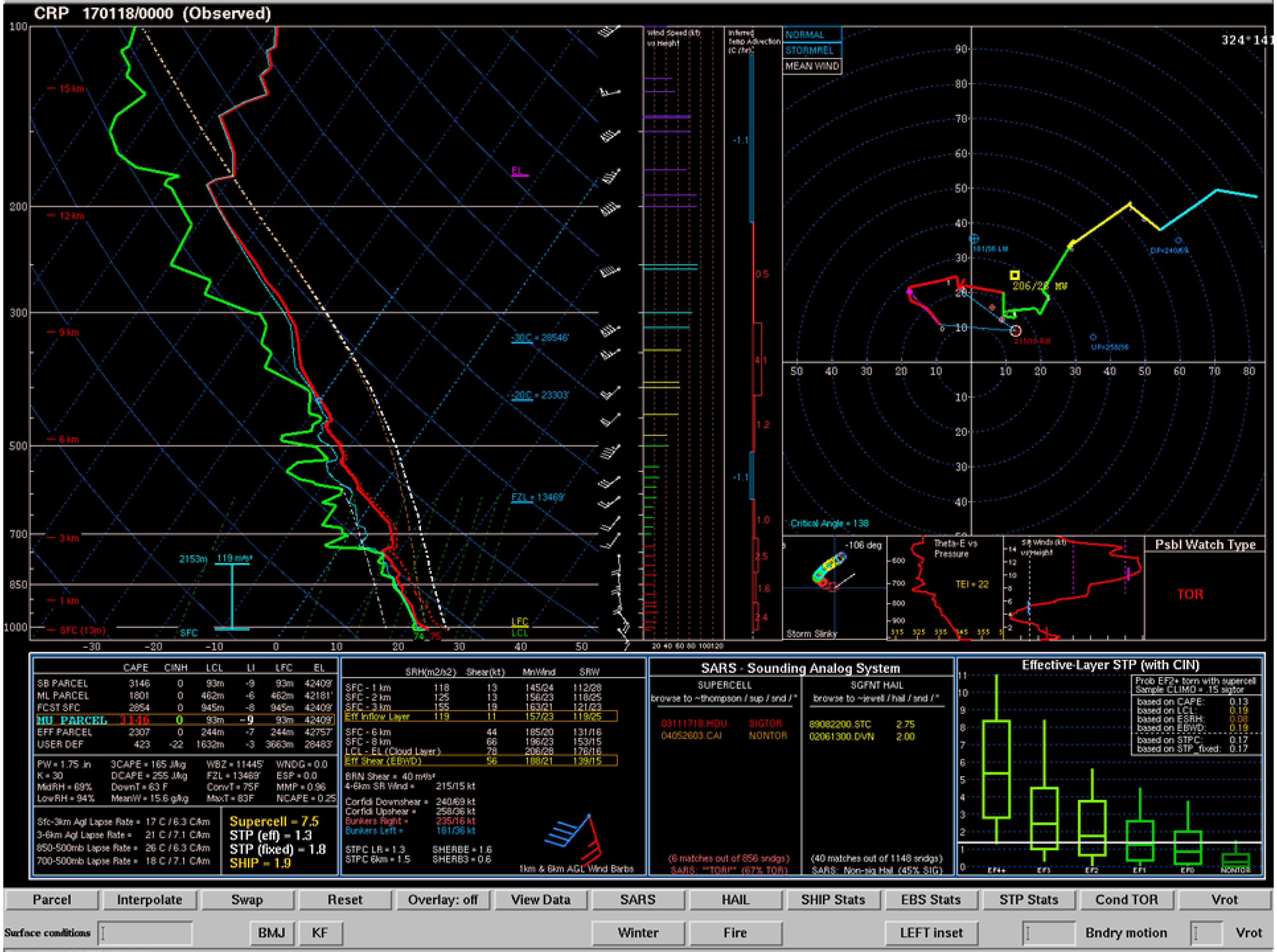
This list updates automatically



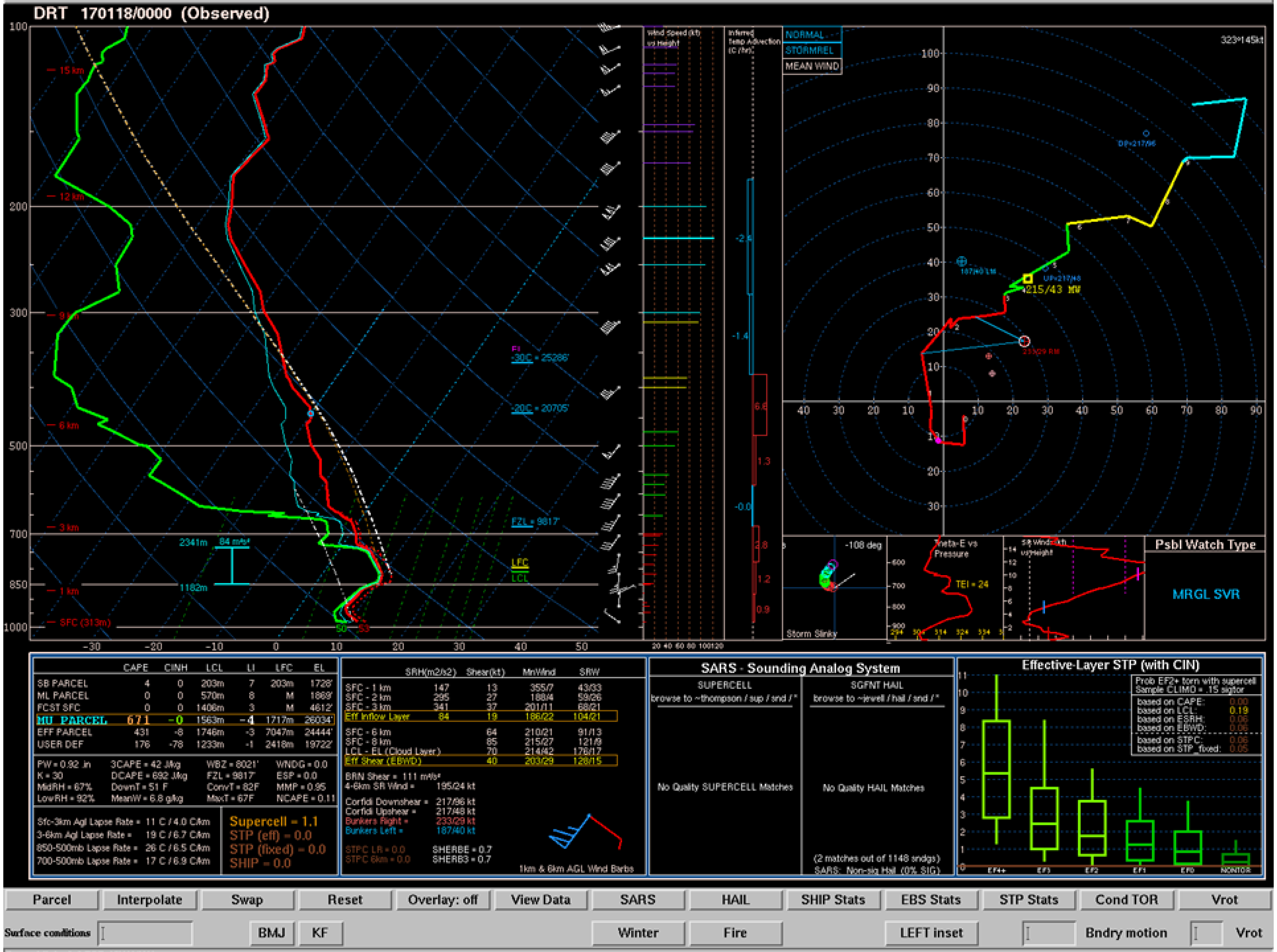
- SfcOA Diag -
Image overlays:
County Boundaries
County Warning Area
Hiways & Cities
ARTCC Regions
NWS Watches & Warn
SPC Day1 Outlook
Image underlays:
None
Radar
Terrain
Population
Surface Obs
Current SPC Produ
Show popup images?
Day1 Convective Outl
Issued at 1957 UTC
Probabilities:
Day1 National Fire Ou
Issued at 1619 UTC
This list updates automatically
1500
1530
1560
20170118/0045 RADAR
170118/0000V001 850 mb temperature advection (fill - 10e-5 C/s)



- SfcOA Diag -
- RAP
Image overlays:
County Boundaries
County Warning Area
Hiways & Cities
ARTCC Regions
NWS Watches & Warn
SPC Day1 Outlook
Image underlays:
None
Radar
Terrain
Population
Surface Obs
Current SPC Produ
Show popup images?
Day1 Convective Outl
Issued at 1957 UTC
Probabilities:
Day1 National Fire Ou
Issued at 1619 UTC
This list updates automatically
25
100
20170118/0045 RADAR
170118/0000 SBCAPE (contour) and SBCIN (J/kg, shaded)



CRP 170118/0000 (Observed)
NORMAL
STORMREL
MEAN WIND
324°141
206/28 MW
Critical Angle = 138
Storm Slinky
-106 deg
Theta-E vs Pressure
TEI = 22
SR Winds (kt) vs Height
Psbl Watch Type
TOR
EL
-30C = 28546'
-20C = 23303'
FZL = 13469'
2153m 119 m²/s²
SFC (13m)
SFC
LFC
LCL
CAPE CINH LCL LI LFC EL
SB PARCEL 3146 0 93m -9 93m 42409'
ML PARCEL 1801 0 462m -6 462m 42181'
FCST SFC 2854 0 945m -8 945m 42409'
MU PARCEL 3146 0 93m -9 93m 42409'
EFF PARCEL 2307 0 244m -7 244m 42757'
USER DEF 423 -22 1632m -3 3863m 28483'
PW = 1.75 in 3CAPE = 165 J/kg WBZ = 11445' WNDG = 0.0
K = 30 DCAPE = 255 J/kg FZL = 13469' ESP = 0.0
MidRH = 69% DownT = 63 F ConvT = 75F MMP = 0.96
LowRH = 94% MeanW = 15.6 g/kg MaxT = 83F NCAPE = 0.25
Sfc-3km Agl Lapse Rate = 17 C / 6.3 C/km
3-6km Agl Lapse Rate = 21 C / 7.1 C/km
850-500mb Lapse Rate = 26 C / 6.3 C/km
700-500mb Lapse Rate = 18 C / 7.1 C/km
Supercell = 7.5
STP (eff) = 1.3
STP (fixed) = 1.8
SHIP = 1.9
SRH(m2/s2) Shear(kt) MnWind SRW
SFC - 1 km 118 13 145/24 112/28
SFC - 2 km 125 13 156/23 118/25
SFC - 3 km 155 19 163/21 121/23
Eff Inflow Layer 119 11 157/23 119/25
SFC - 6 km 44 185/20 131/16
SFC - 8 km 66 196/23 153/15
LCL - EL (Cloud Layer) 78 206/28 176/16
Eff Shear (EBWD) 56 188/21 139/15
BRN Shear = 40 m²/s²
4-6km SR Wind = 215/15 kt
Corfidi Downshear = 240/69 kt
Corfidi Upshear = 258/36 kt
Bunkers Right = 235/16 kt
Bunkers Left = 181/36 kt
STPC LR = 1.3 SHERBE = 1.6
STPC 6km = 1.5 SHERB3 = 0.6
1km & 6km AGL Wind Barbs
SARS - Sounding Analog System
SUPERCELL
browse to ~thompson / sup / snd / *
03111718.HOU SIGTOR
04052603.CAI NONTOR
(6 matches out of 856 sndgs)
SARS: **TOR!** (67% TOR)
SGFNT HAIL
browse to ~jewell / hail / snd / *
89082200.STC 2.75
02061300.DVN 2.00
(40 matches out of 1148 sndgs)
SARS: Non-sig Hail (45% SIG)
Effective-Layer STP (with CIN)
Prob EF2+ torn with supercell
Sample CLIMO = .15 sigtor
based on CAPE: 0.13
based on LCL: 0.19
based on ESRH: 0.08
based on EBWD: 0.19
based on STPC: 0.17
based on STP_fixed: 0.17
EF4+ EF3 EF2 EF1 EF0 NONTOR
Parcel Interpolate Swap Reset Overlay: off View Data SARS HAIL SHIP Stats EBS Stats STP Stats Cond TOR Vrot
Surface conditions BMJ KF Winter Fire LEFT inset Bndry motion Vrot



DRT 170118/0000 (Observed)
SB PARCEL 4 0 203m 7 203m 1728'
ML PARCEL 0 0 570m 8 M 1869'
FCST SFC 0 0 1406m 3 M 4612'
MU PARCEL 671 -0 1563m -4 1717m 26034'
EFF PARCEL 431 -8 1746m -3 7047m 24444'
USER DEF 176 -78 1233m -1 2418m 19722'
PW = 0.92 in 3CAPE = 42 J/kg WBZ = 8021' WNDG = 0.0
K = 30 DCAPE = 692 J/kg FZL = 9817' ESP = 0.0
MidRH = 67% DownT = 51 F ConvT = 82F MMP = 0.95
LowRH = 92% MeanW = 6.8 g/kg MaxT = 67F NCAPE = 0.11
Sfc-3km Agl Lapse Rate = 11 C / 4.0 C/km
3-6km Agl Lapse Rate = 19 C / 6.7 C/km
850-500mb Lapse Rate = 26 C / 6.5 C/km
700-500mb Lapse Rate = 17 C / 6.9 C/km
Supercell = 1.1
STP (eff) = 0.0
STP (fixed) = 0.0
SHIP = 0.0
SFC - 1 km 147 13 355/7 43/33
SFC - 2 km 295 27 188/4 59/26
SFC - 3 km 341 37 201/11 68/21
Eff Inflow Layer 84 19 186/22 104/21
SFC - 6 km 64 210/21 91/13
SFC - 8 km 85 215/27 121/9
LCL - EL (Cloud Layer) 70 214/42 176/17
Eff Shear (EBWD) 40 203/29 128/15
BRN Shear = 111 m²/s²
4-6km SR Wind = 195/24 kt
Corfidi Downshear = 217/96 kt
Corfidi Upshear = 217/48 kt
Bunkers Right = 233/29 kt
Bunkers Left = 187/40 kt
STPC LR = 0.0 SHERBE = 0.7
STPC 6km = 0.0 SHERB3 = 0.7
1km & 6km AGL Wind Barbs
SARS - Sounding Analog System
SUPERCELL
No Quality SUPERCELL Matches
SGFNT HAIL
No Quality HAIL Matches
(2 matches out of 1148 sndgs)
SARS: Non-sig Hail (0% SIG)
Effective-Layer STP (with CIN)
EF4+ EF3 EF2 EF1 EF0 NONTOR
Psbl Watch Type
MRGL SVR
215/43 MW
TEI = 24
-108 deg
Storm Slinky
FZL = 9817'
-20C = 20705'
-30C = 25286'
LFC
LCL
2341m 84 m²/s²
1182m
SFC (313m)
NORMAL
STORMREL
MEAN WIND
Parcel
Interpolate
Swap
Reset
Overlay: off
View Data
SARS
HAIL
SHIP Stats
EBS Stats
STP Stats
Cond TOR
Vrot
Surface conditions
BMJ
KF
Winter
Fire
LEFT inset
Bndry motion
Vrot

Synoptic-Scale Lift Summary

- **Gradual ascent over many hours**
  - **Warm advection and differential vorticity advection are primary drivers**

- **Primary role of QG ascent is to precondition environment for convection**
  - **Can also initiate elevated storms in regions of warm advection**
  - **Most surface-based storms are triggered by mesoscale ascent**

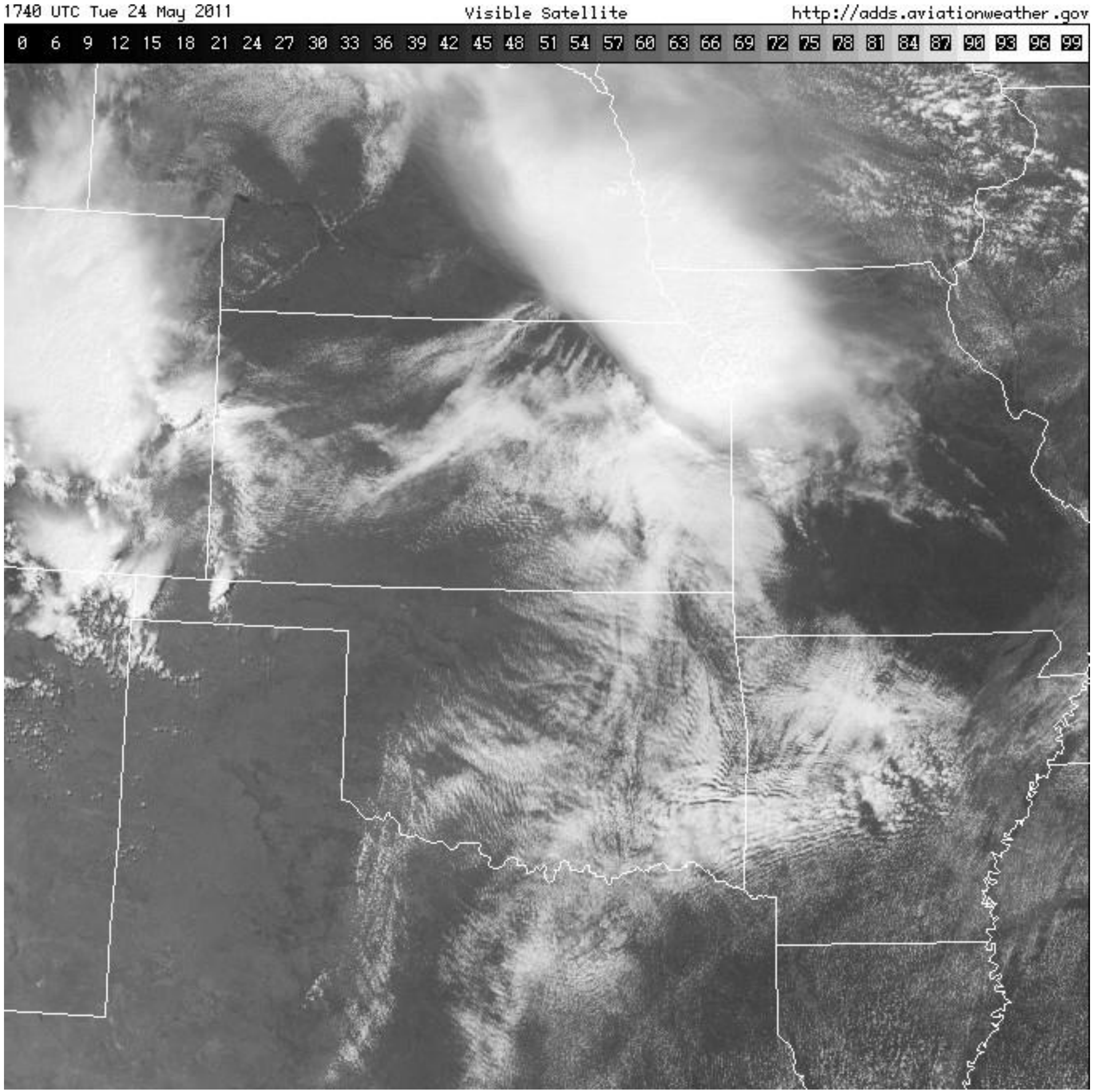
Mesoscale Lift

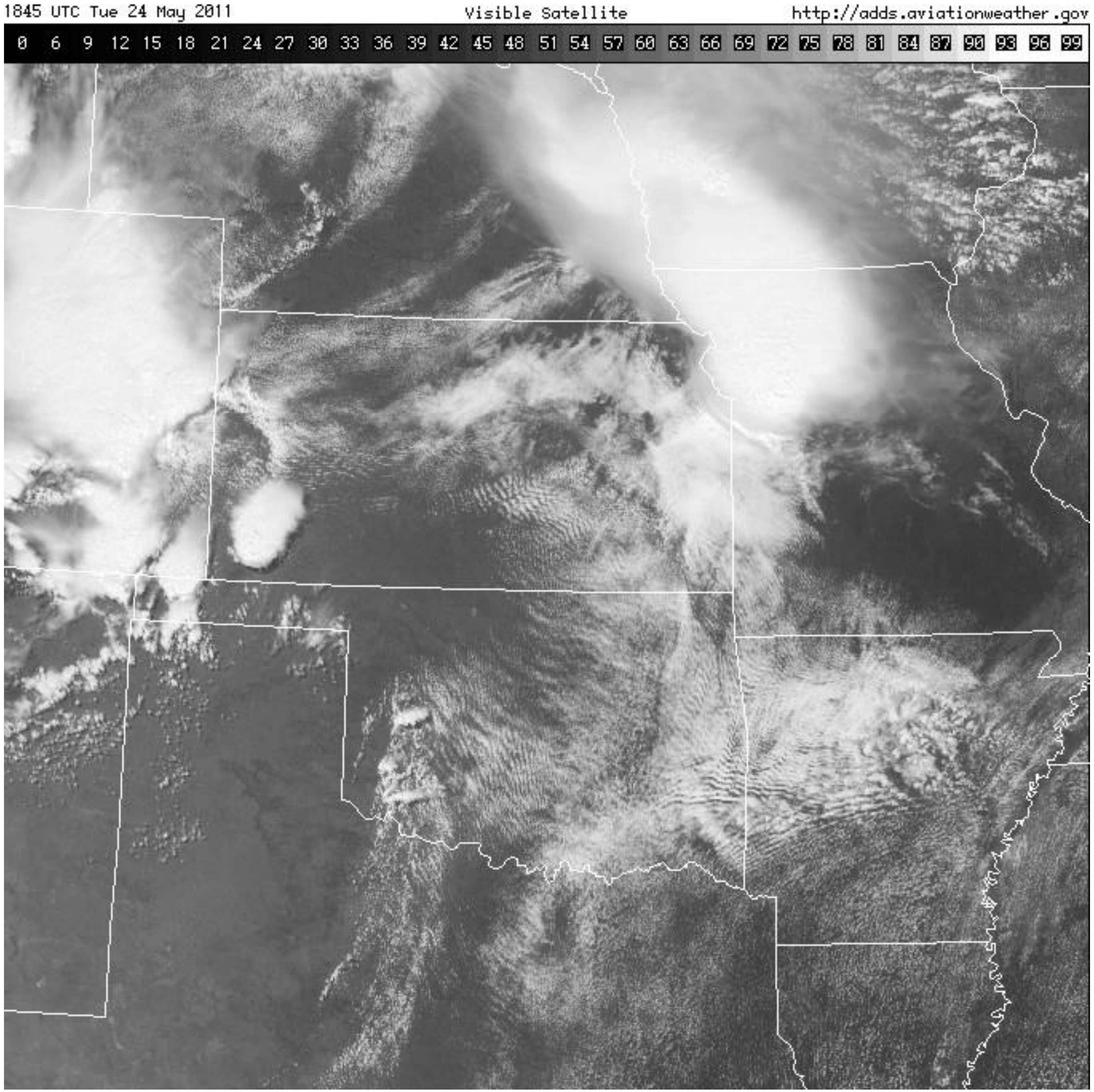
- **Focused and narrow zones of lift for minutes to hours**

- **Fronts**
  - Rising on warm side with frontogenesis
  - Isentropic ascent on sloped warm front

- **Outflow boundary**
  - Lift is governed by depth/strength of cold pool and low-level vertical wind shear [Rotunno-Klemp-Weisman (RKW) Theory]

- **Dryline**
  - Lift on dry/hot side (lower density air)
  - Lift governed by depth of mixing west of dryline and depth of moist layer east of dryline


1740 UTC Tue 24 May 2011
Visible Satellite
http://adds.aviationweather.gov
0 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96 99

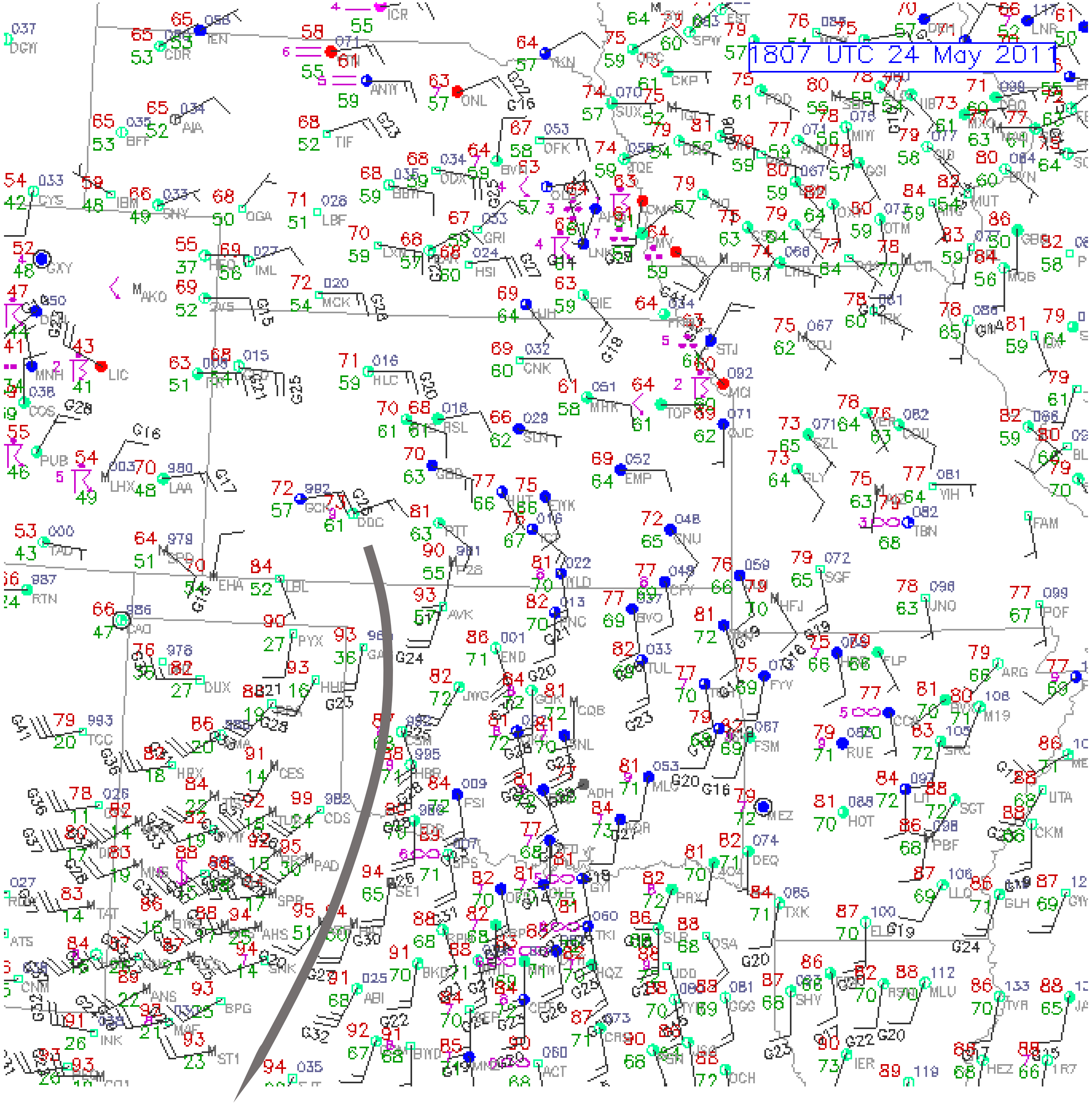

1845 UTC Tue 24 May 2011
Visible Satellite
http://adds.aviationweather.gov
0 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96 99

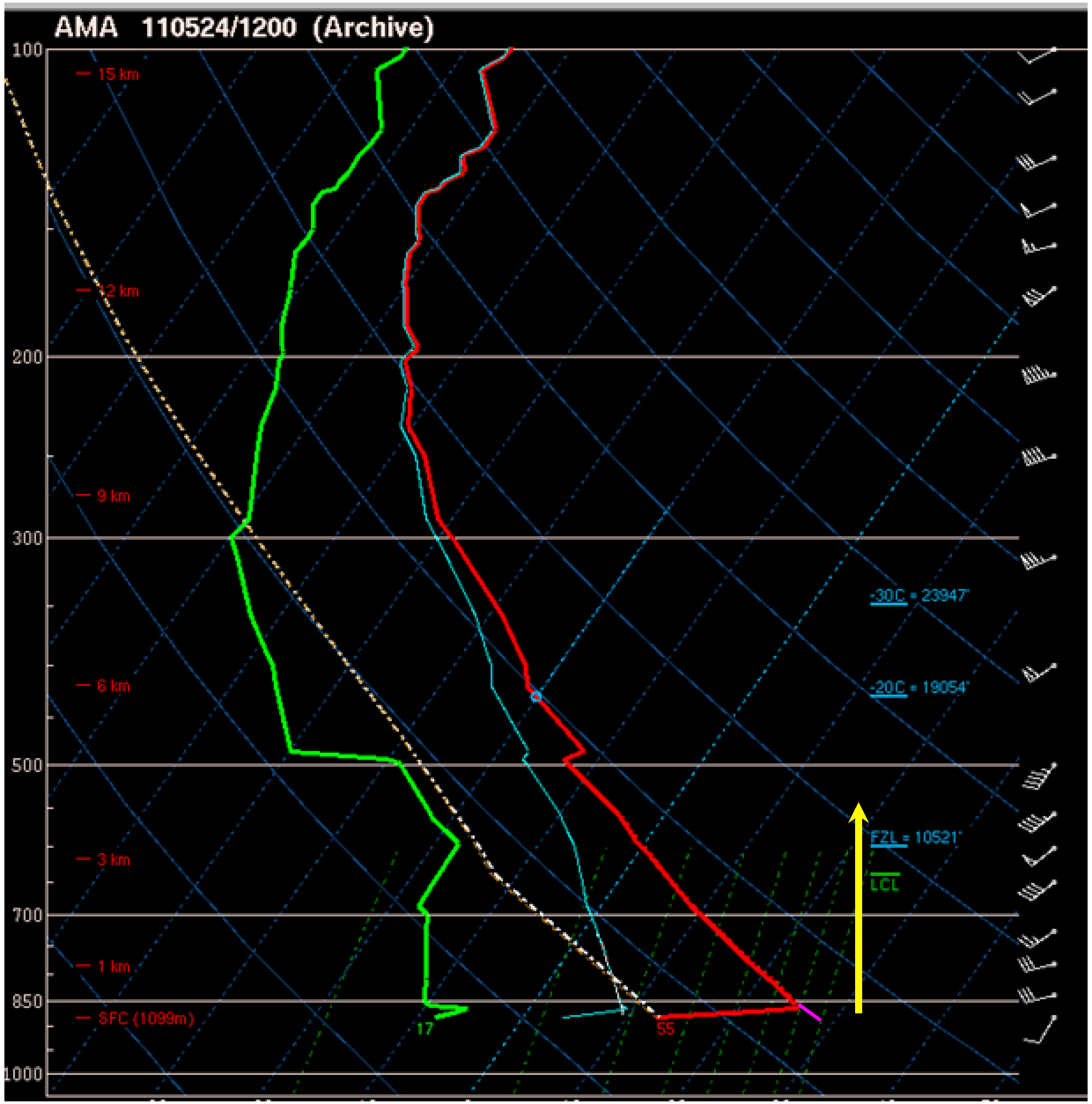
Dryline

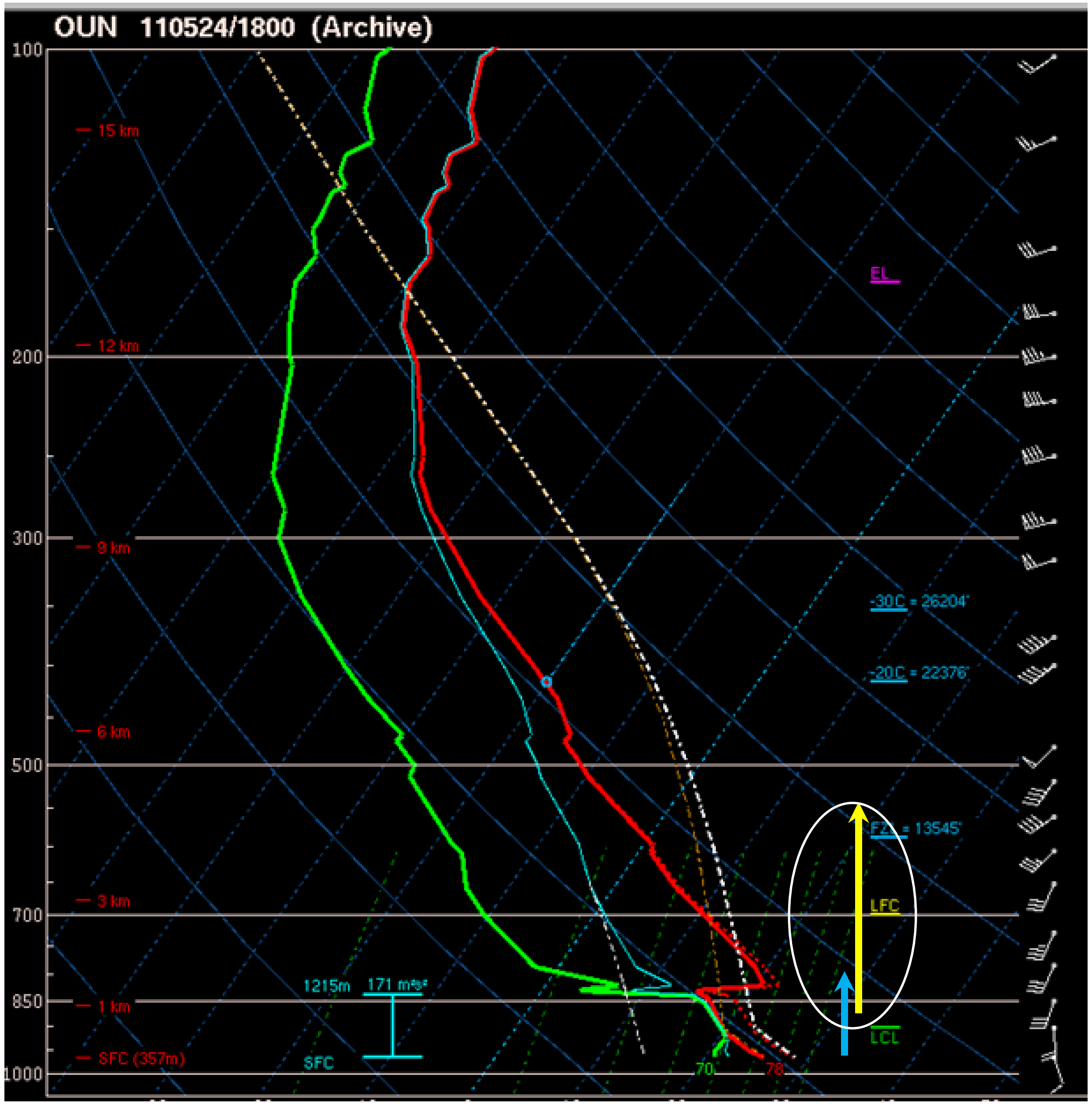
- Focused ascent along dryline can be ~1 m/s (~1 hour to reach LFC)
  - Lift depends on depth of mixing west of dryline and depth of moist layer ahead of dryline
  - Maximum vertical motion along dryline scales with height of moist layer

- Convection initiation linked to the residence time of air in the zone of ascent
  - Winds above the surface parallel to dryline keeps air in zone of lift longer

- Convection will initiate in points or bands
  - Usually the mode of initiation for surface-based supercells in central/southern Plains

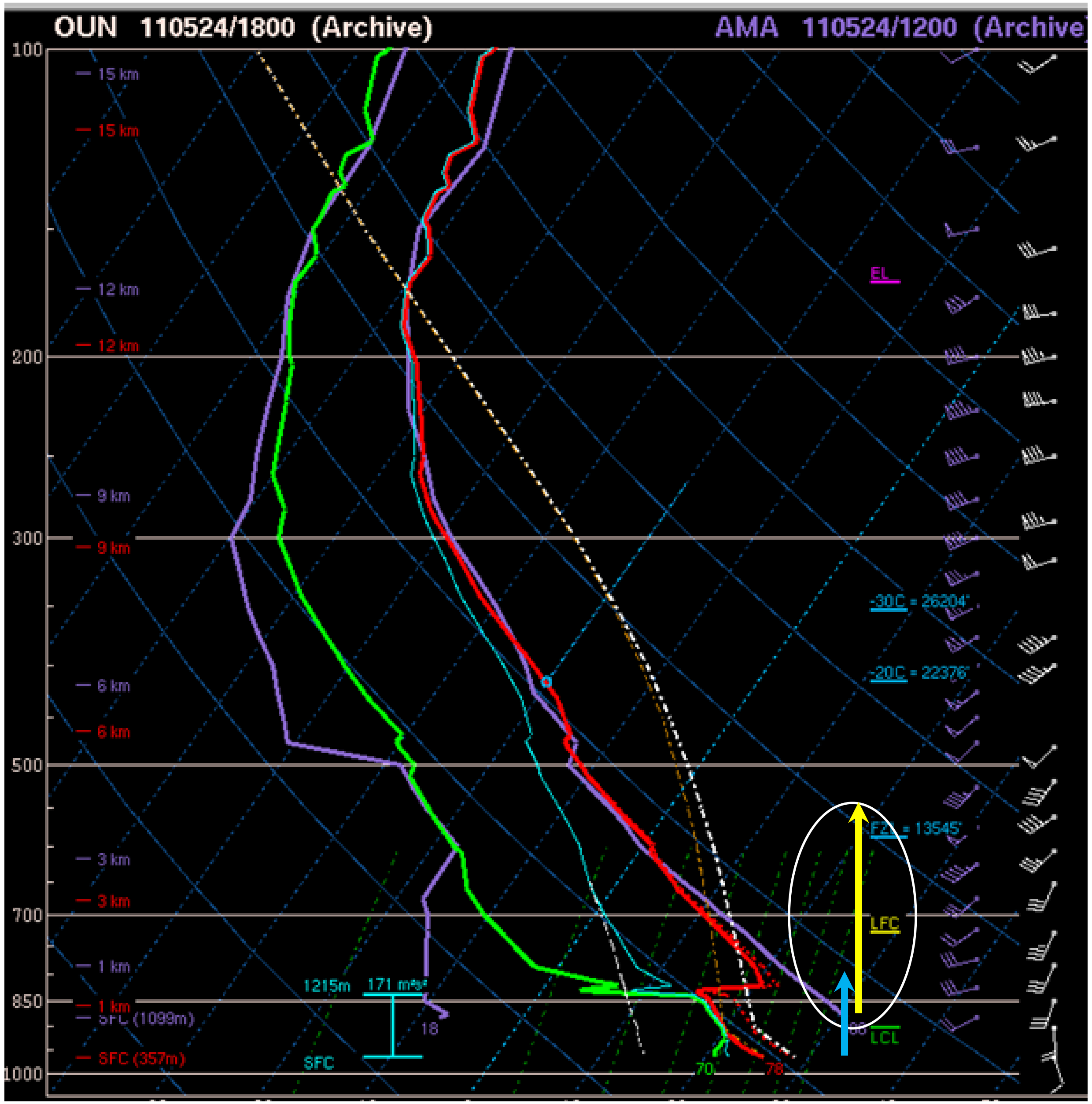

1807 UTC 24 May 2011


AMA 110524/1200 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (1099m)
17
55
-30C = 23947'
-20C = 19054'
FZL = 10521'
LCL

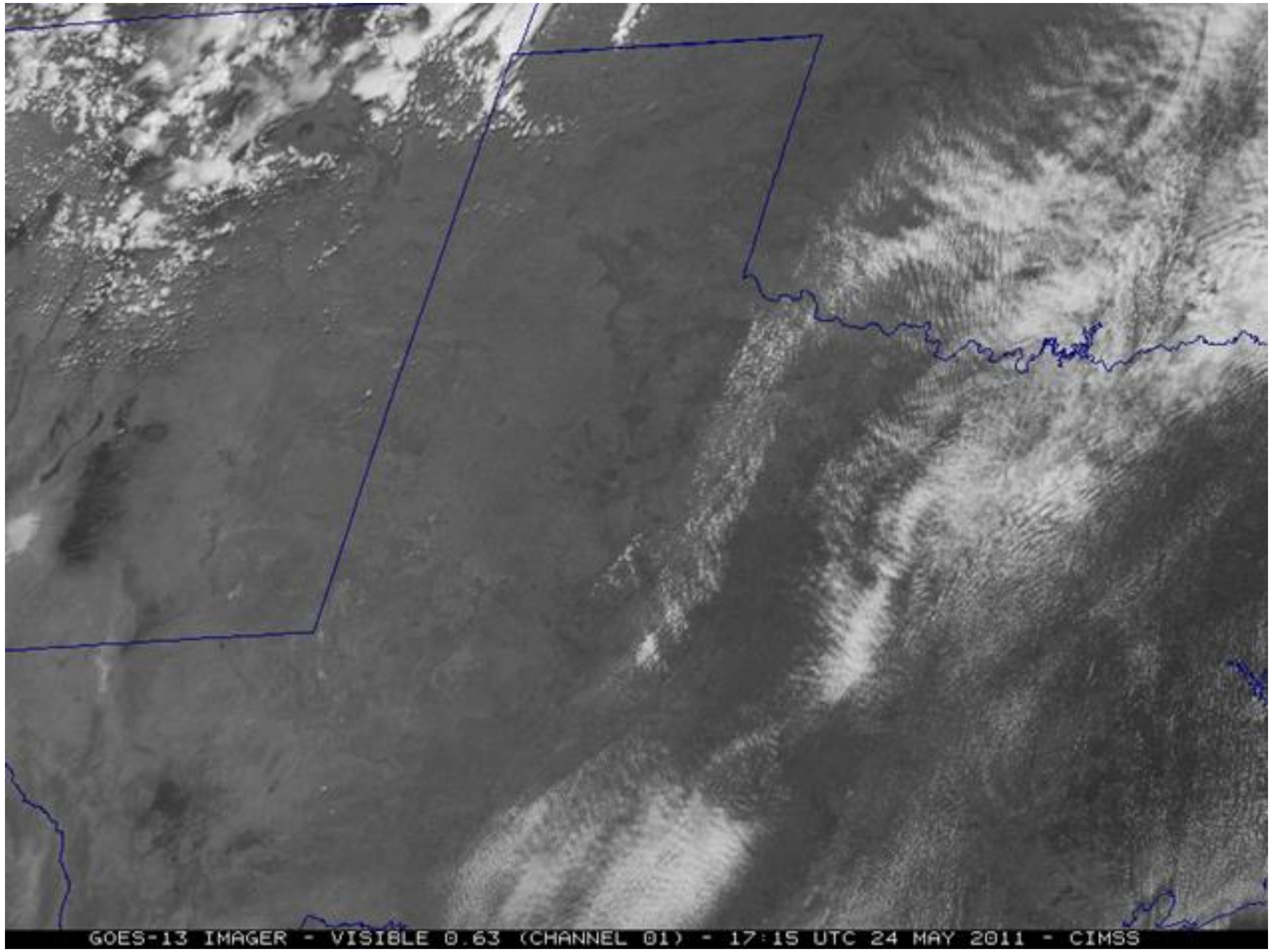


LFC is within the deep dryline circulation

Keep parcels in the zone of ascent – winds within circulation SSW (parallel to dryline)



OUN 110524/1800 (Archive)
AMA 110524/1200 (Archive)
100
200
300
500
700
850
1000
15 km
15 km
12 km
12 km
9 km
9 km
6 km
6 km
3 km
3 km
1 km
1 km
SFC (1099m)
SFC (357m)
EL
-30C = 26204'
-20C = 22376'
FZL = 13545'
LFC
LCL
1215m
171 m²/s²
18
SFC
70
78


GOES-13 IMAGER - VISIBLE 0.63 (CHANNEL 01) - 17:15 UTC 24 MAY 2011 - CIMSS

Moisture

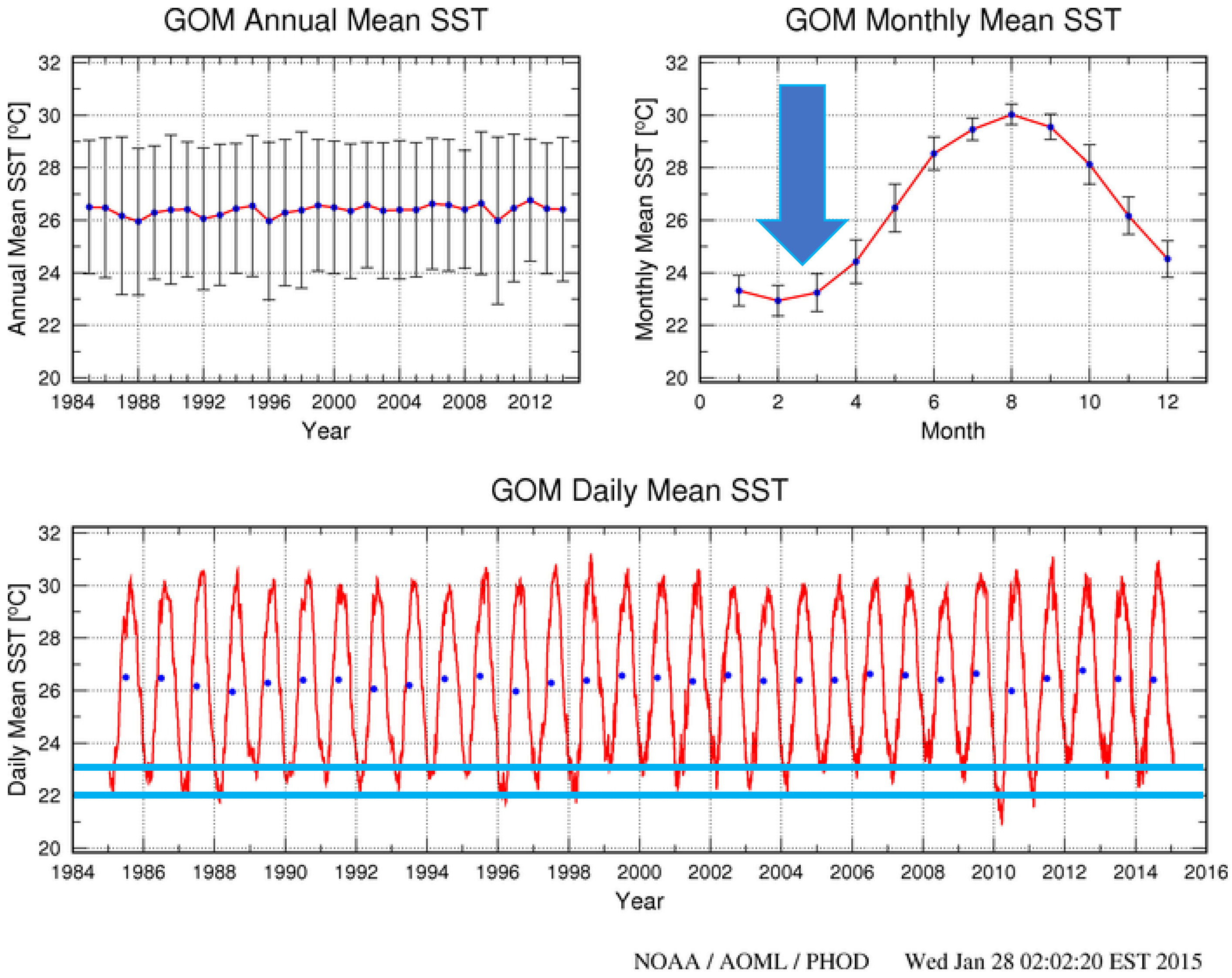
- Moisture in PBL needs to be large and deep enough for convection
- Return flow
- Inland vertical mixing/diurnal processes
- Evapotranspiration

Low-level Moisture Return Flow

- Key elements include air mass modifications over warmer water and return flow trajectories

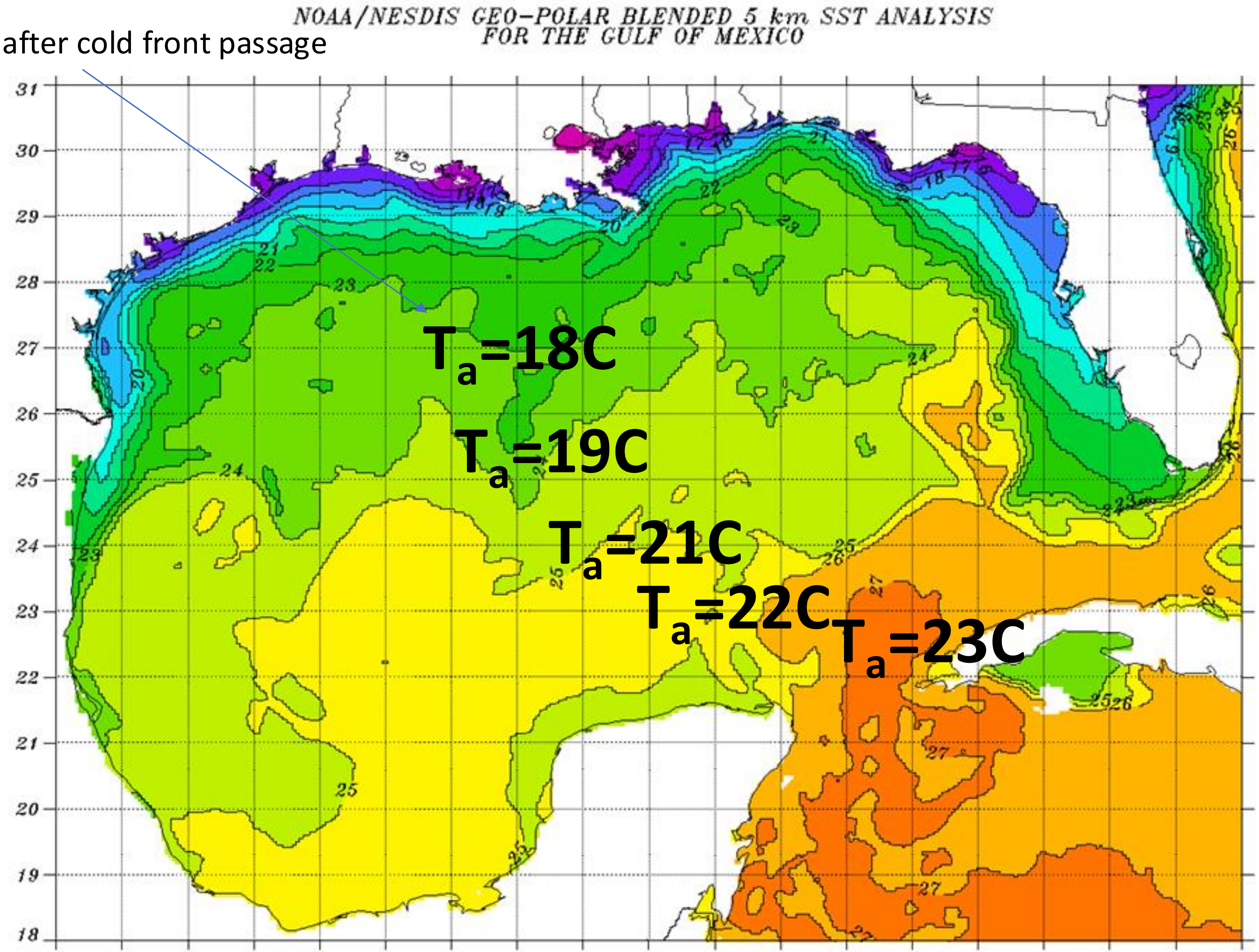
- Air mass modification is a multi-date process

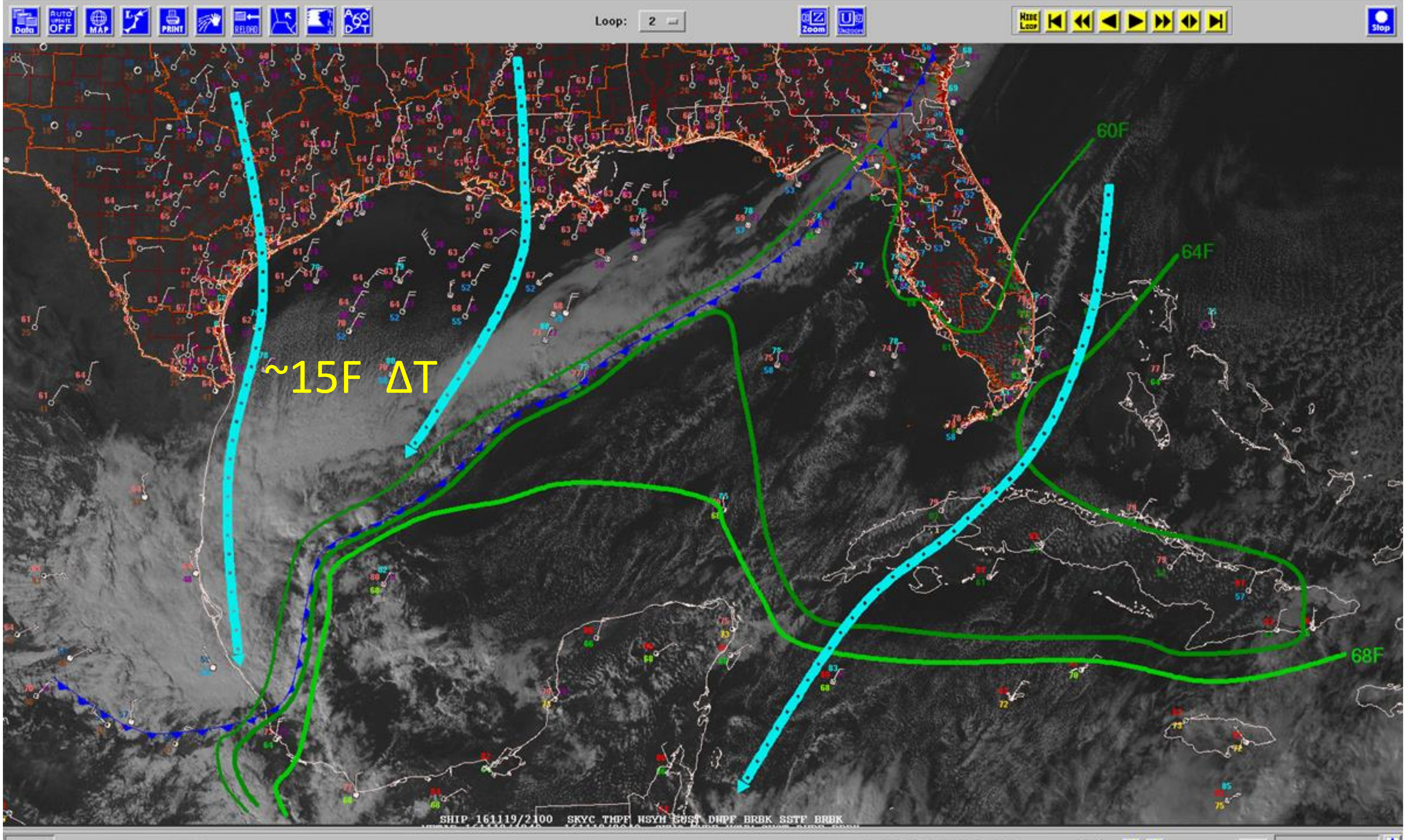
- Ask yourself the following:
  - Where is the air coming from?
  - What are the underlying ocean characteristics?
  - What is the character of the returning moist layer?

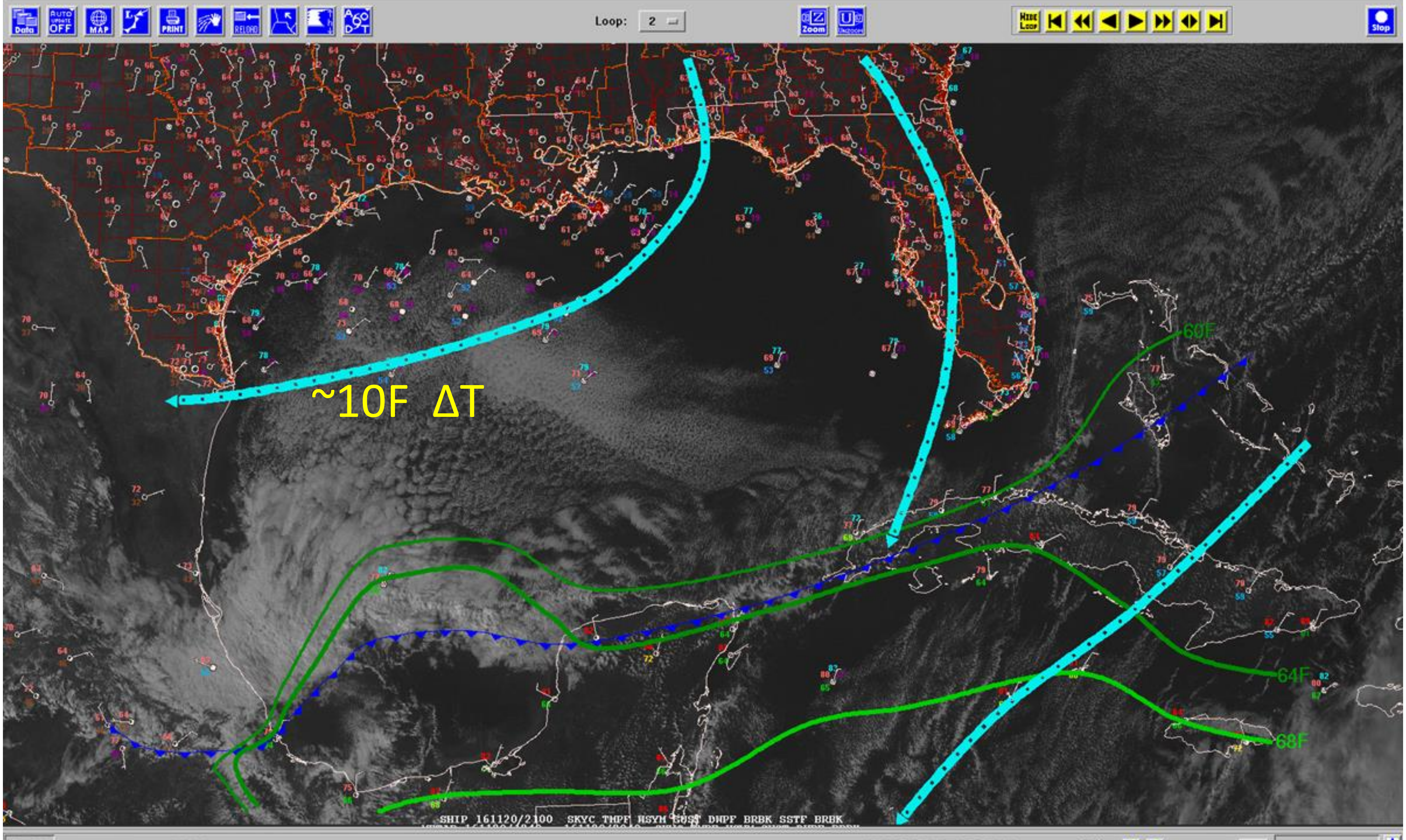


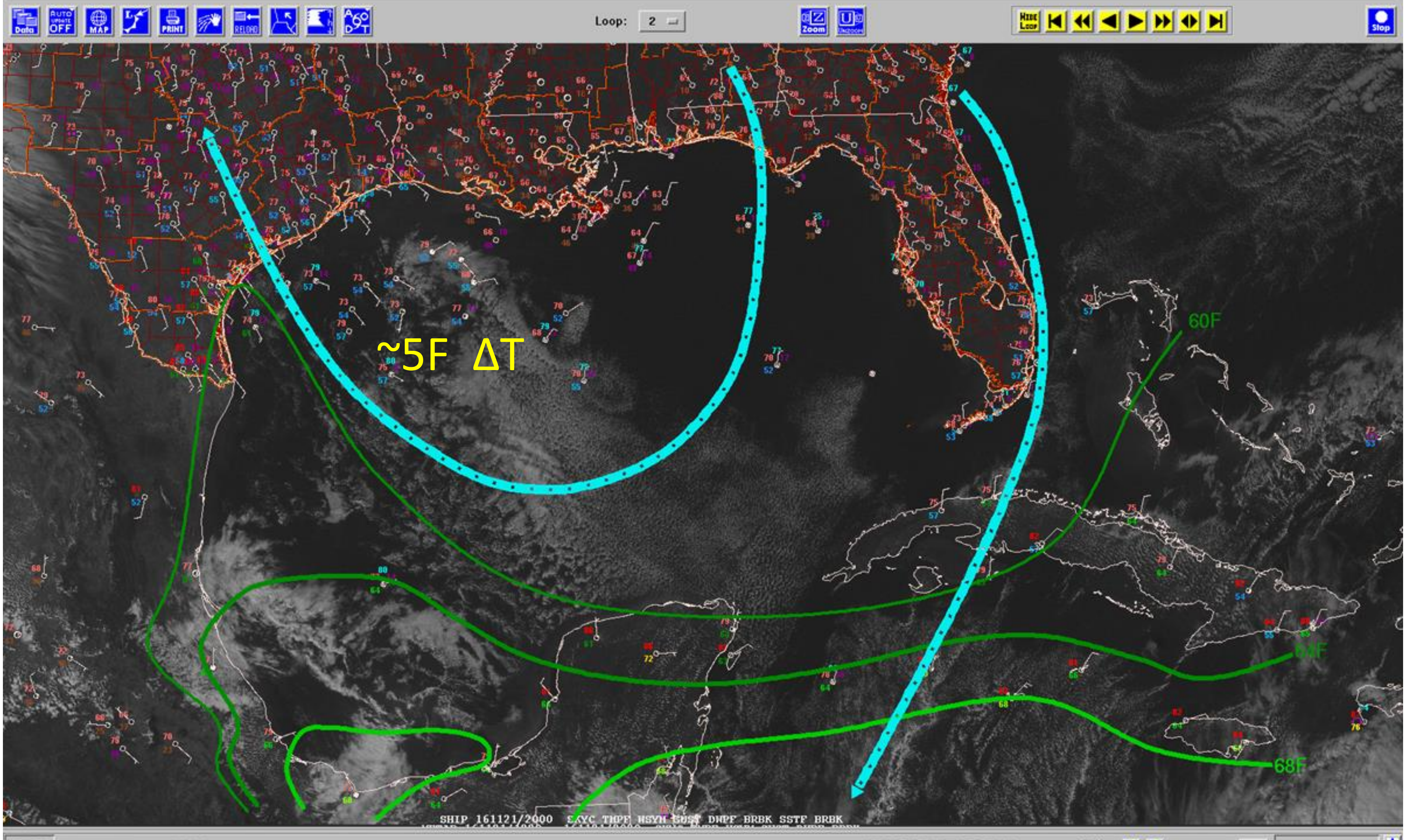
GOM Annual Mean SST
Annual Mean SST [ºC]
Year
GOM Monthly Mean SST
Monthly Mean SST [ºC]
Month
GOM Daily Mean SST
Daily Mean SST [ºC]
Year
NOAA / AOML / PHOD
Wed Jan 28 02:02:20 EST 2015

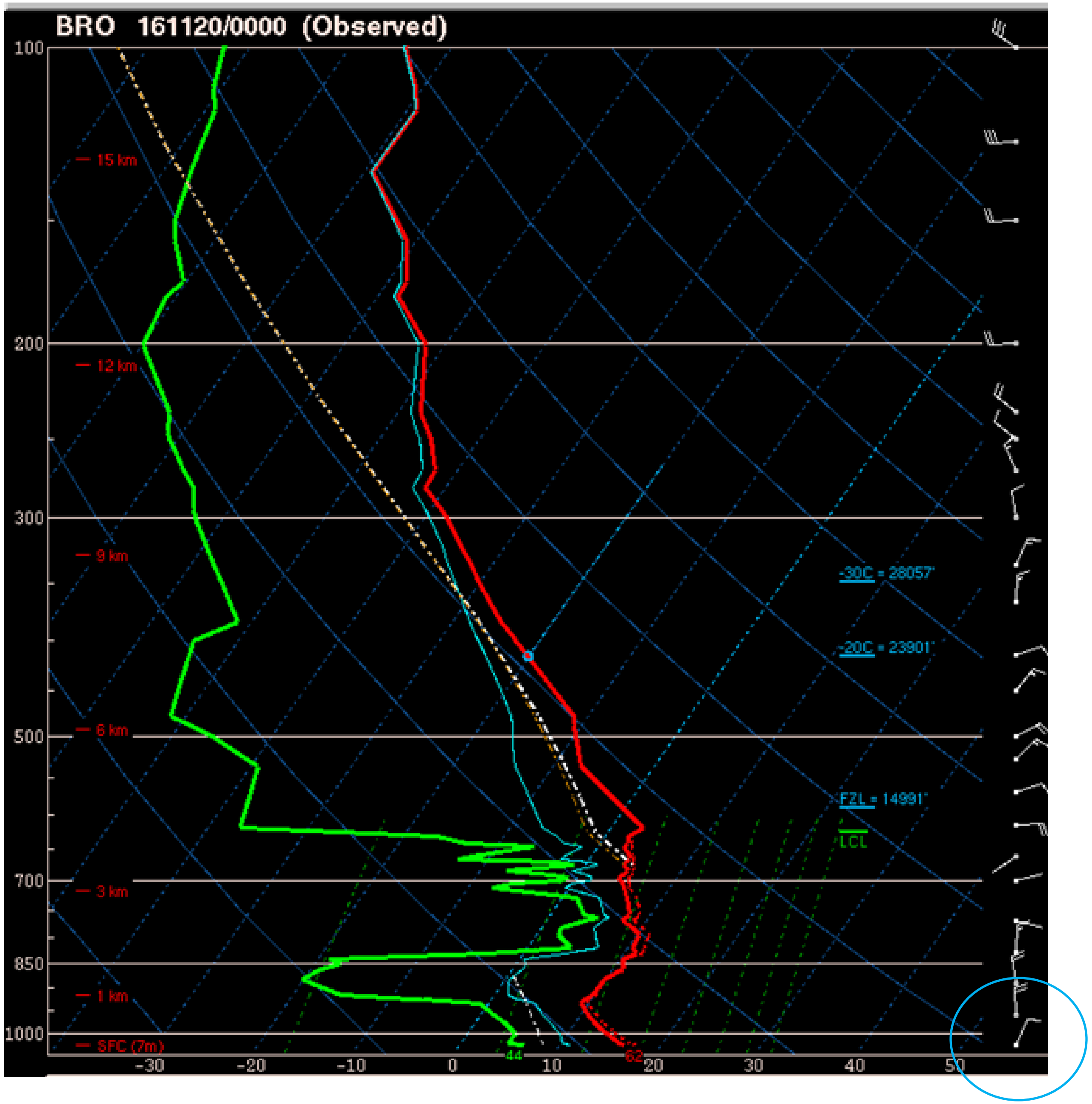
Air temperature after cold front passage

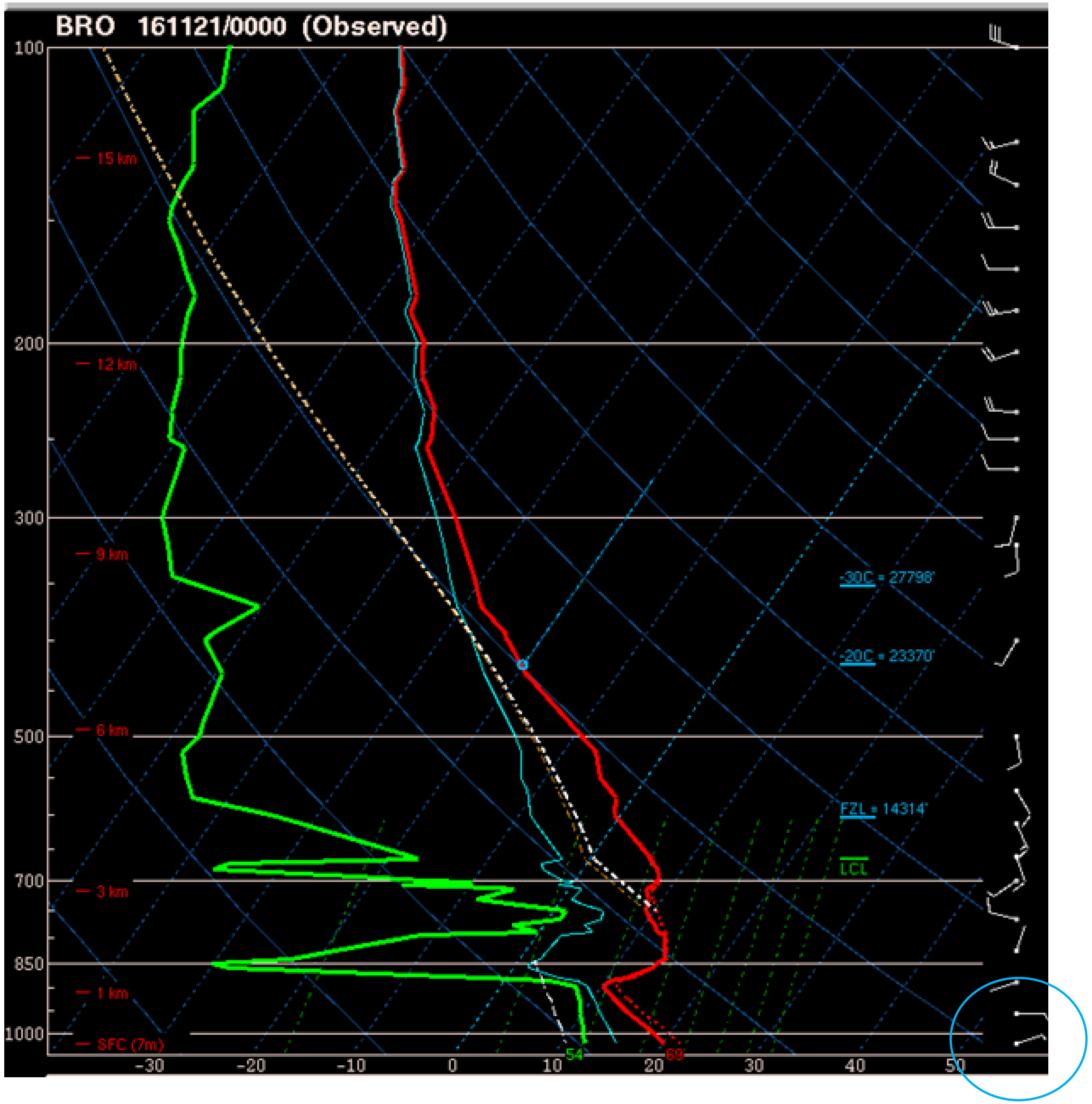



Loop: 2
60F
64F
68F
~15F ΔT

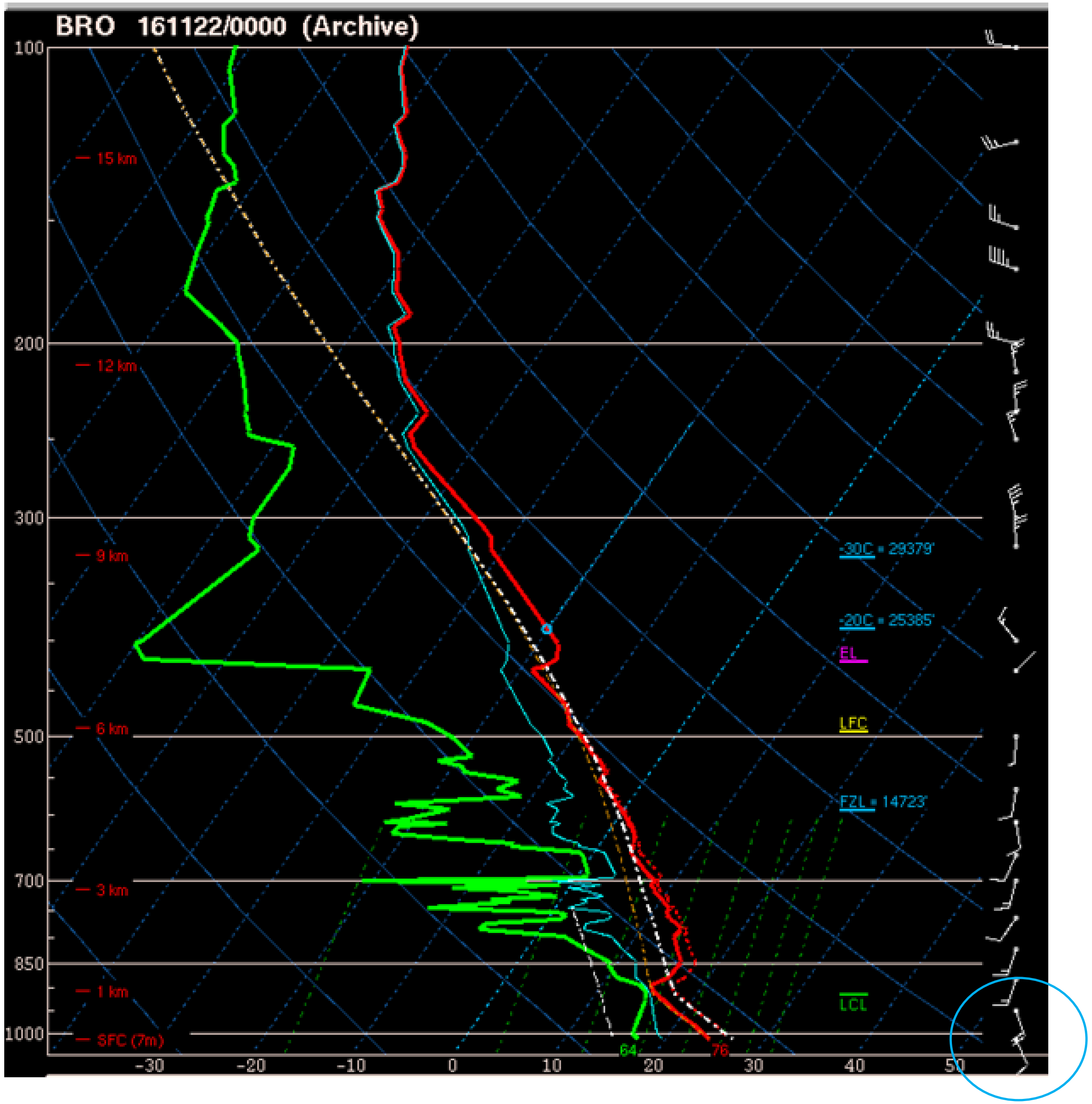

Loop: 2
~10F ΔT
60F
64F
68F
SHIP 161120/2100 SKYC THPF HSYM GUST DNPF BRBK SSTF BRBK


Loop: 2
~5F ΔT
60F
64F
68F
SHIP 161121/2000 SKYC THPF HSYM GUST DNPF BRBK SSTF BRBK

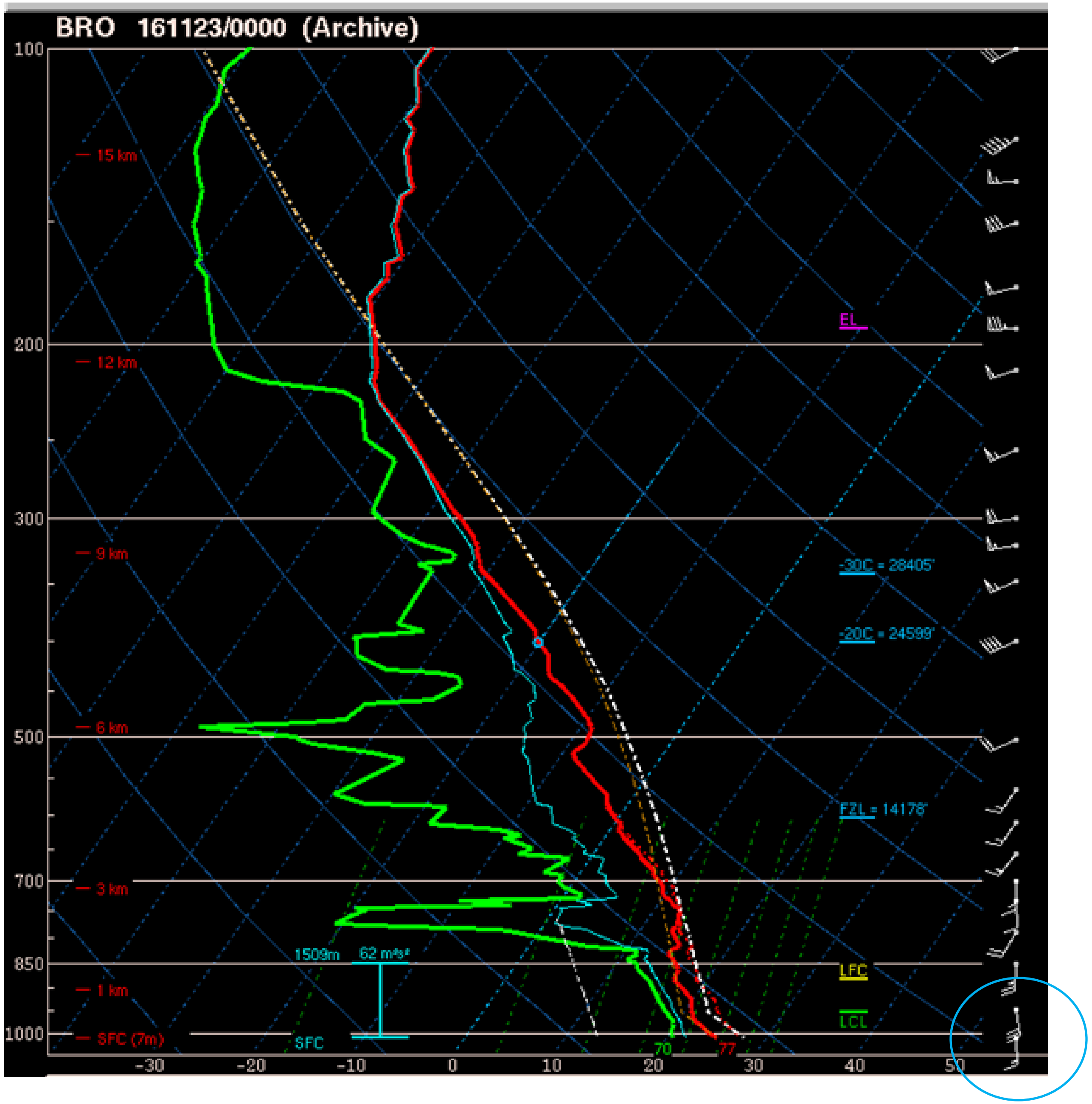

BRO 161120/0000 (Observed)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (7m)
-30C = 28057'
-20C = 23901'
FZL = 14991'
LCL
44
62
-30
-20
-10
0
10
20
30
40
50



BRO 161121/0000 (Observed)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (7m)
-30C = 27798'
-20C = 23370'
FZL = 14314'
LCL
-30
-20
-10
0
10
20
30
40
50
54
69



BRO 161122/0000 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (7m)
-30C = 29379'
-20C = 25385'
EL
LFC
FZL = 14723'
LCL
64
76
-30
-20
-10
0
10
20
30
40
50

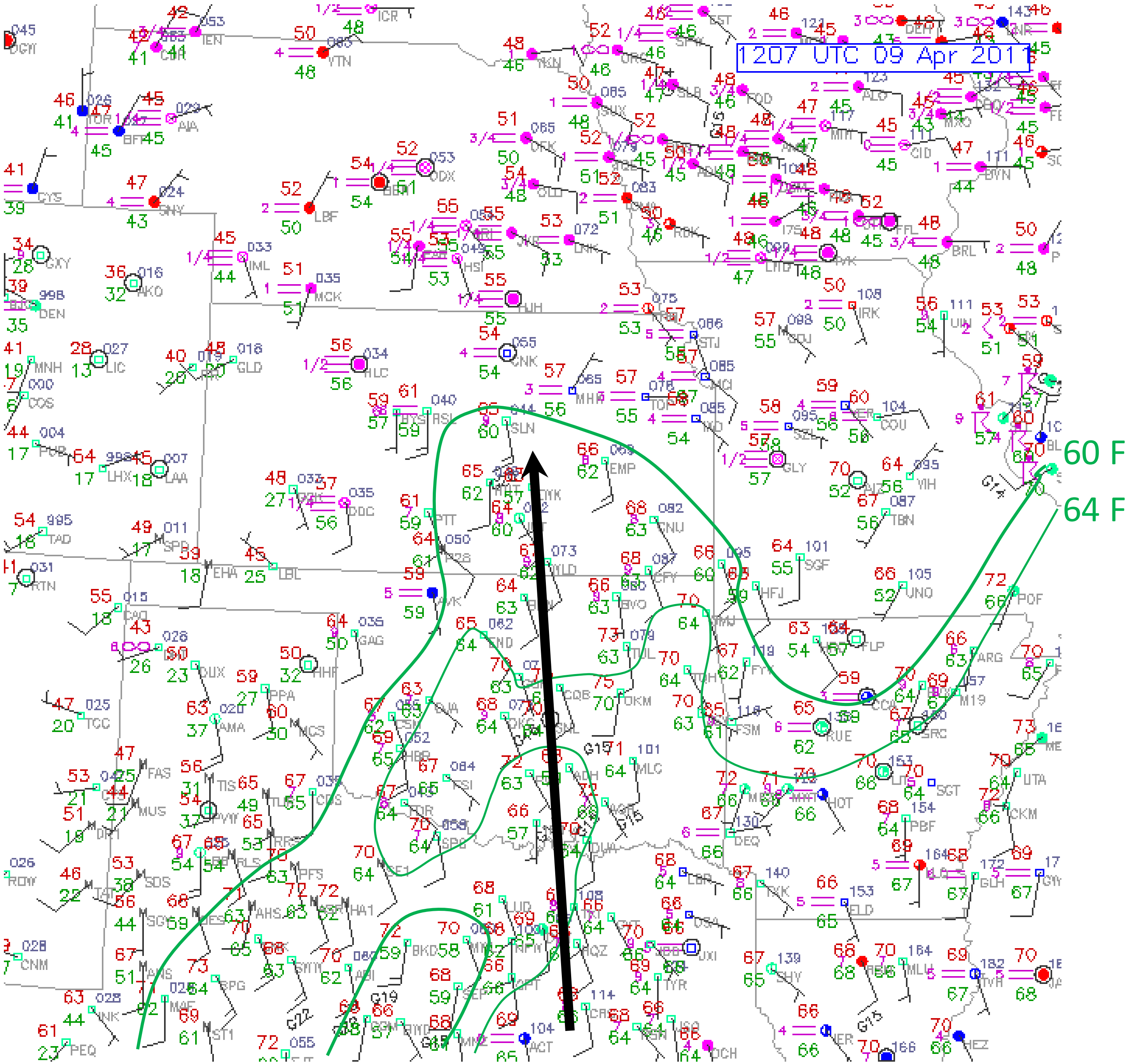


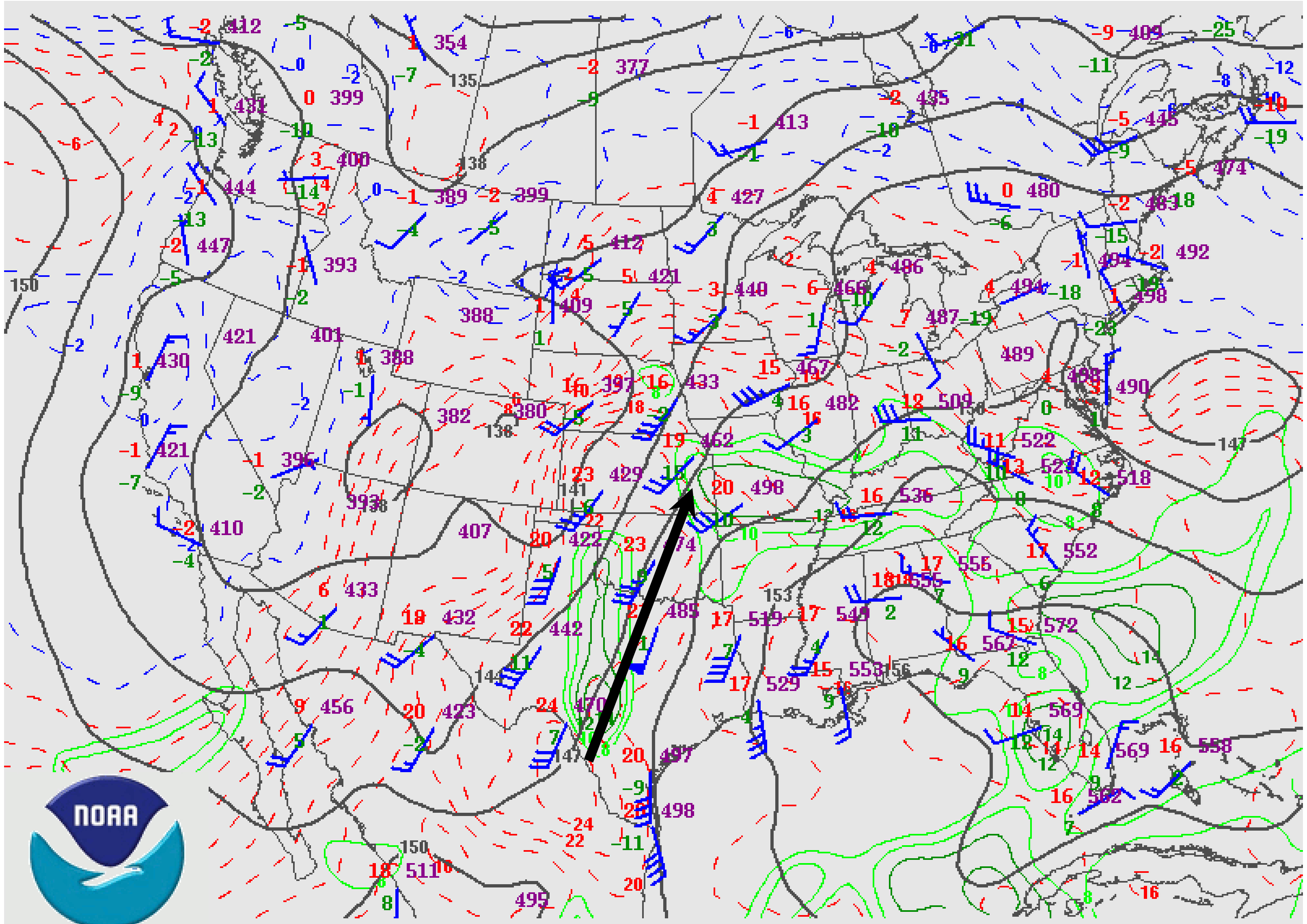
BRO 161123/0000 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (7m)
EL
-30C = 28405'
-20C = 24599'
FZL = 14178'
LFC
LCL
1509m
62 m²s²
SFC
70
77
-30
-20
-10
0
10
20
30
40
50

Inland Vertical Mixing

- **Surface moisture can decrease during the daytime when:**
  - Daytime heating/mixing extends deeper than original moist layer depth
  - Moisture advection is not enough to offset mixing
  - Compounded by dry soil, little green vegetation, and ongoing drought

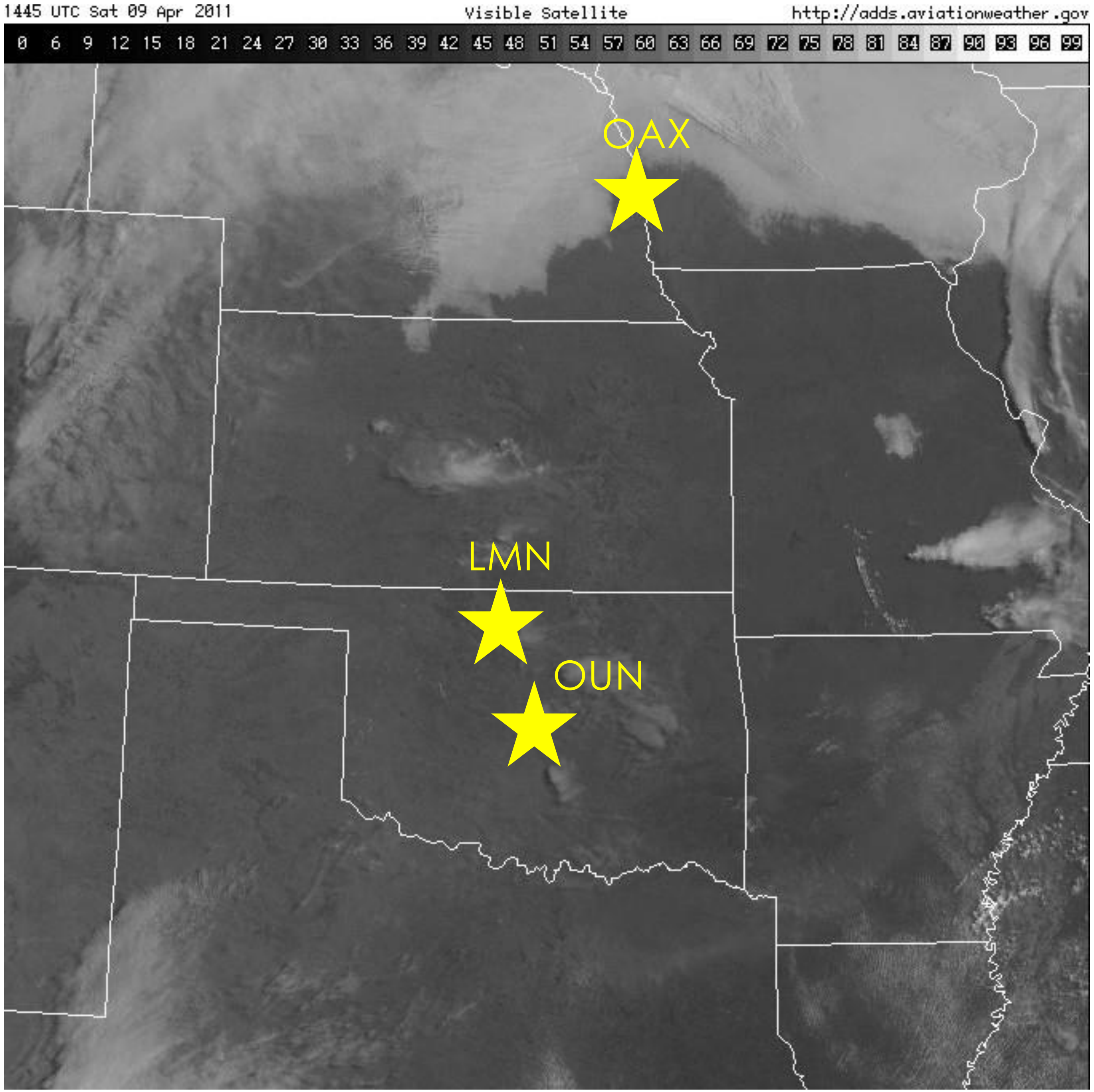
- **Daytime mixing is governed by:**
  - Vertical moisture structure
  - Height and strength of lid/cap
  - Upstream moisture sources
  - Local moisture sources


1207 UTC 09 Apr 2011
60 F
64 F



110409/1200 850 MB UA OBS, HGHTS, TEMPS, Td>=8

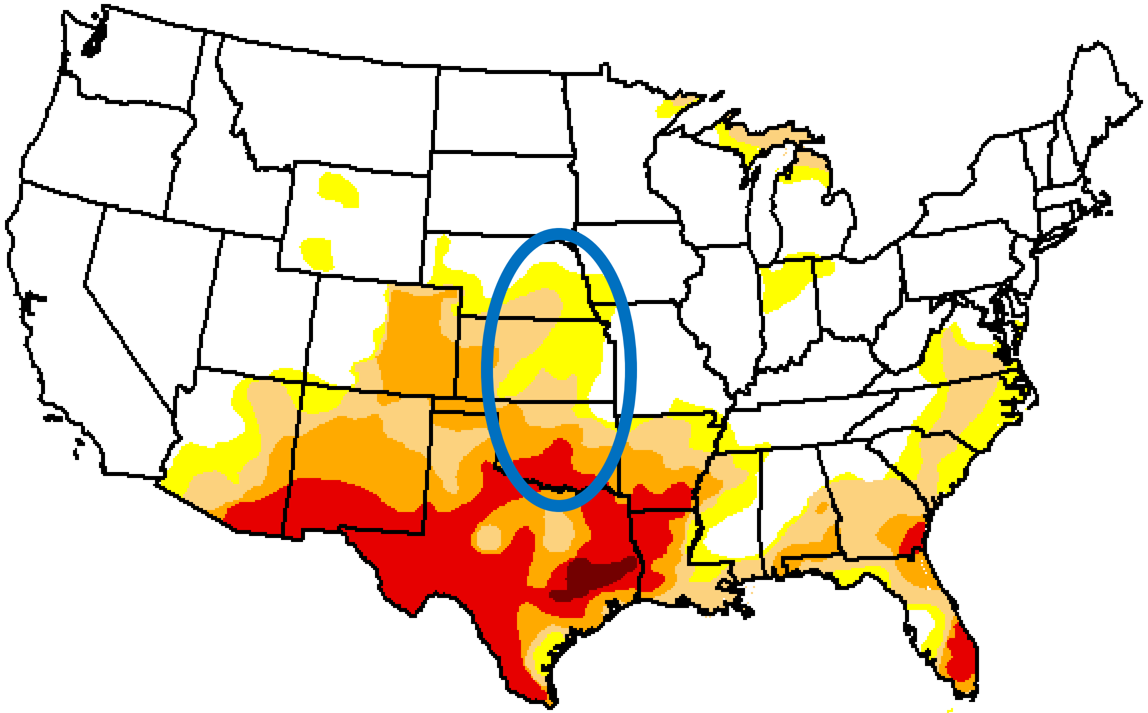
National Weather Service
Storm Prediction Center



1445 UTC Sat 09 Apr 2011
Visible Satellite
http://adds.aviationweather.gov
0 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96 99
OAX
LMN
OUN

U.S. Drought Monitor

CONUS



April 5, 2011

(Released Thursday, Apr. 7, 2011)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	62.46	37.54	28.75	18.17	8.75	0.42
Last Week *3/29/2011*	61.76	38.24	28.14	18.22	6.41	0.00
3 Months Ago *1/4/2011*	60.50	39.50	21.74	8.50	2.60	0.00
Start of Calendar Year *1/4/2011*	60.50	39.50	21.74	8.50	2.60	0.00
Start of Water Year *9/28/2010*	60.05	39.95	13.16	3.09	0.30	0.00
One Year Ago *4/6/2010*	71.57	28.43	9.10	2.00	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

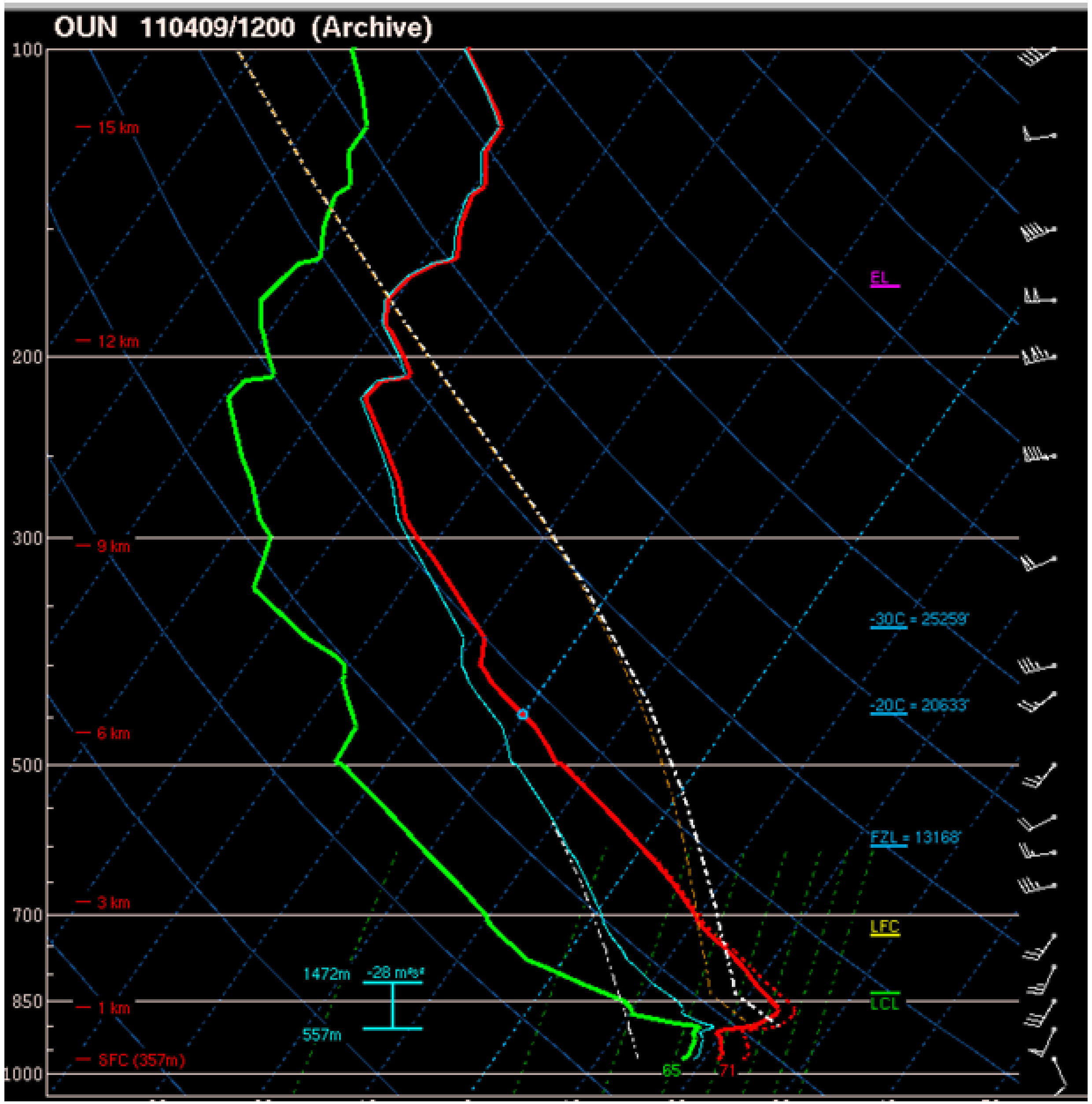
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author(s):

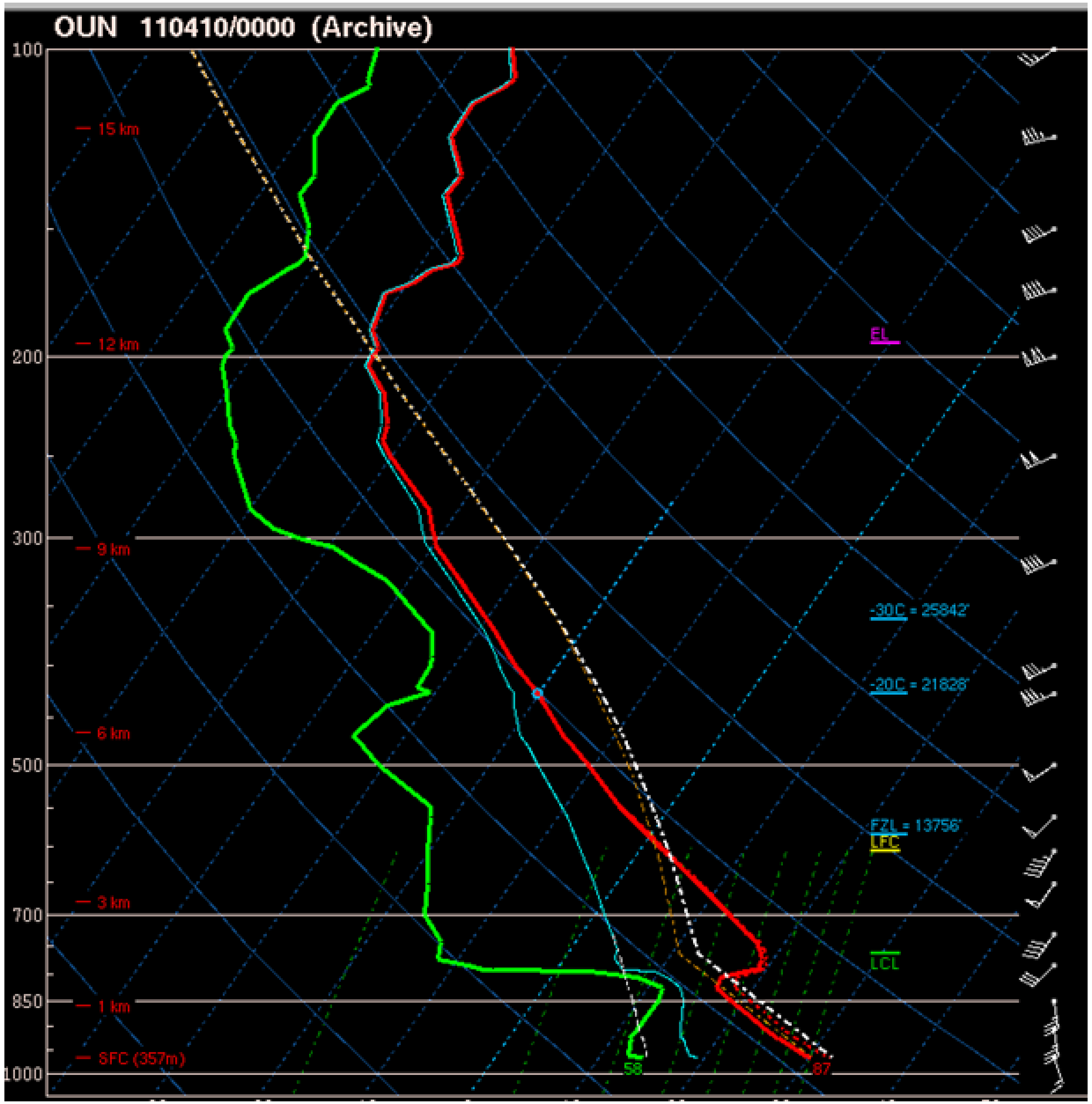
Mark Svoboda

National Drought Mitigation Center

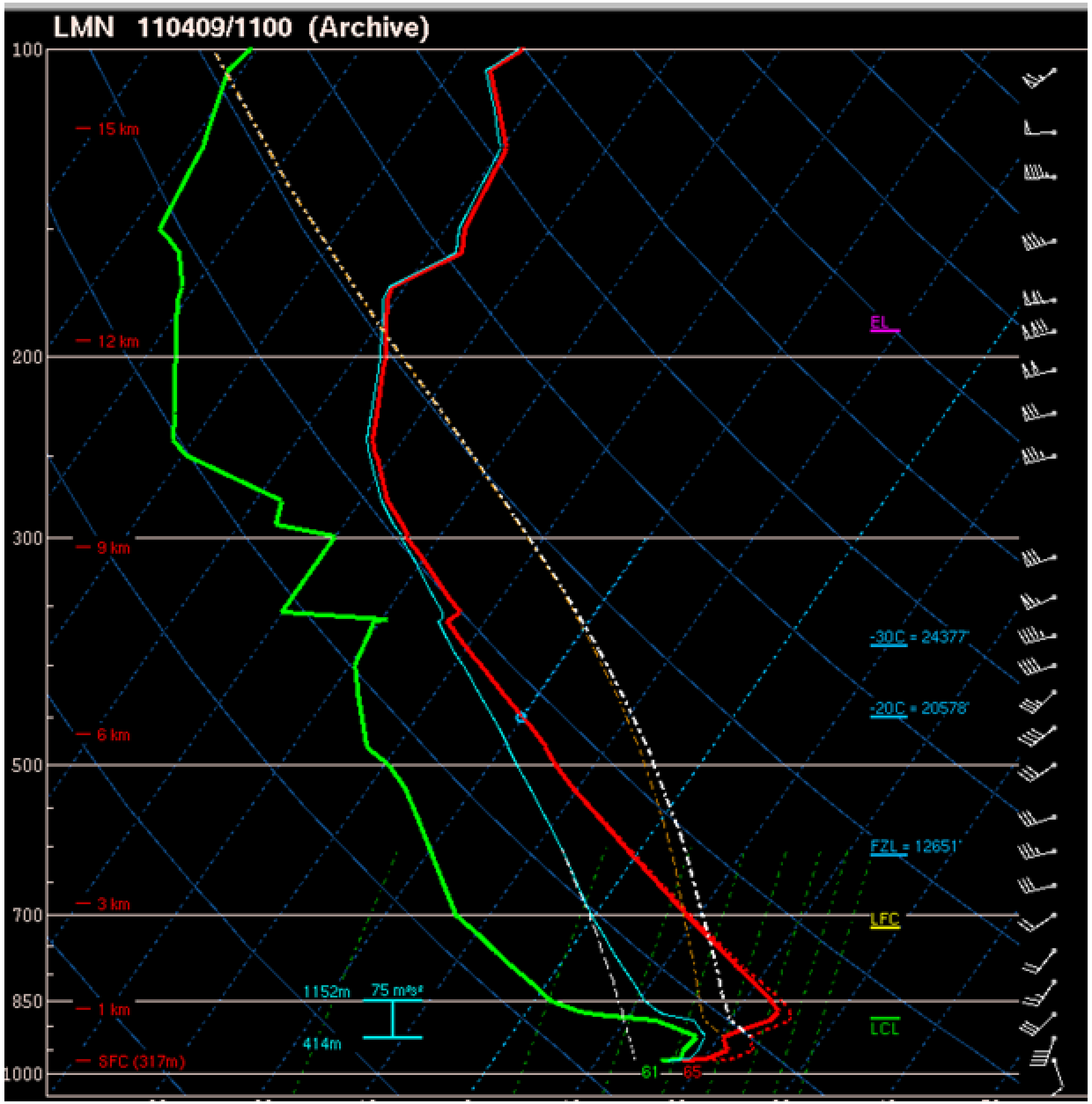
USDA



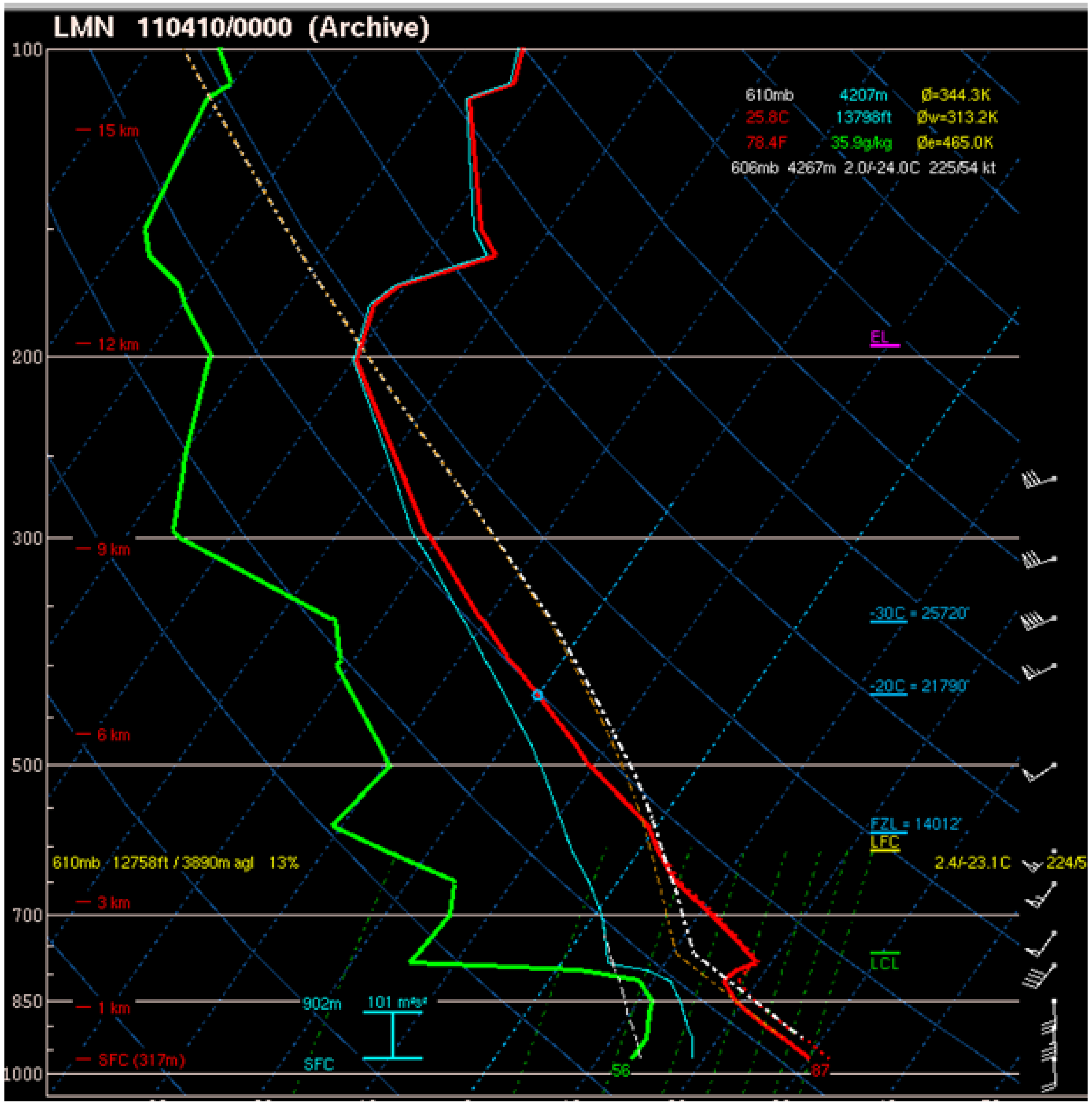
OUN 110409/1200 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (357m)
EL
-30C = 25259'
-20C = 20633'
FZL = 13168'
LFC
LCL
1472m
-28 m²s²
557m
65
71



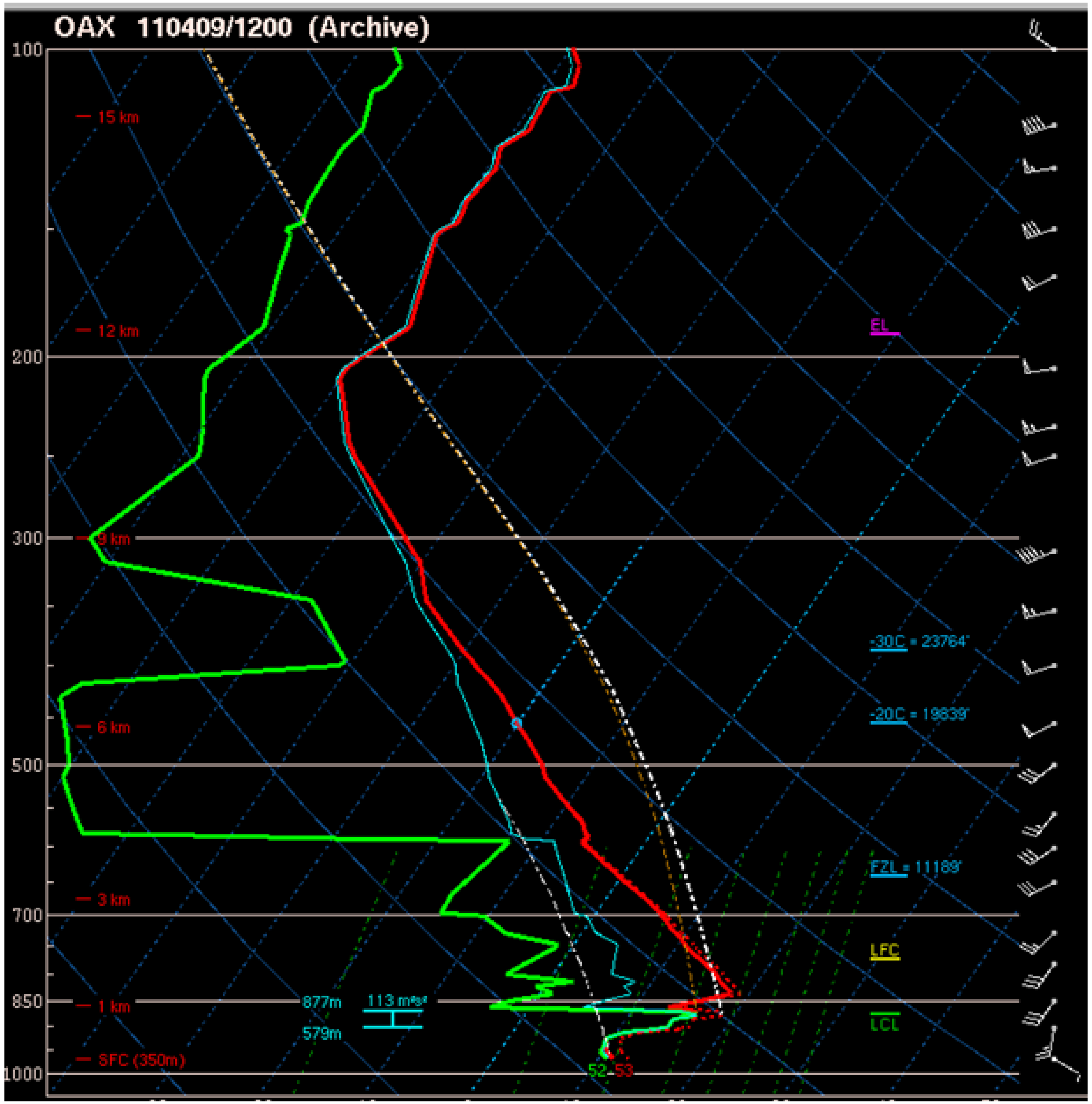
OUN 110410/0000 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (357m)
EL
-30C = 25842'
-20C = 21828'
FZL = 13756'
LFC
LCL
58
87



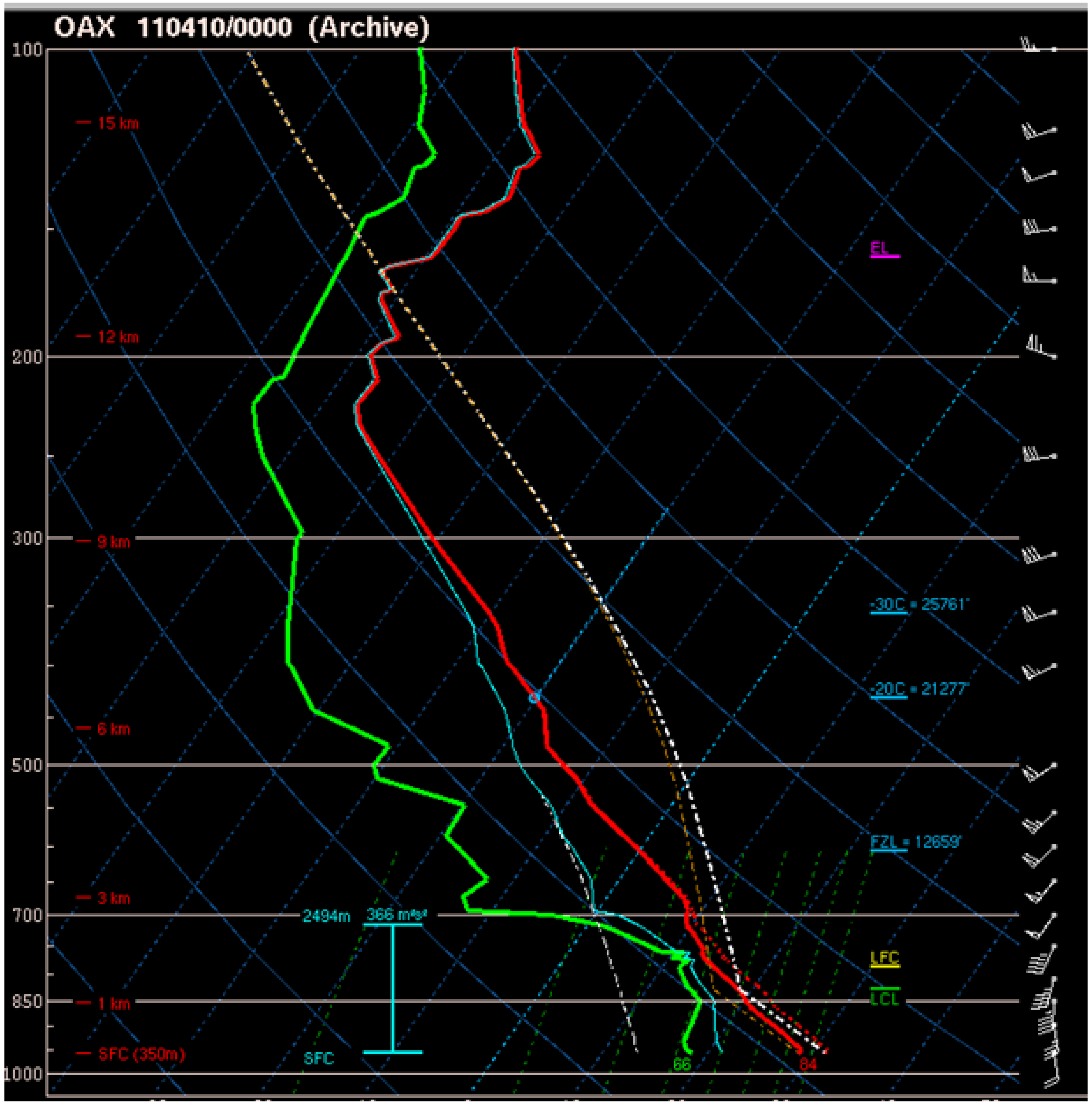
LMN 110409/1100 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (317m)
EL
-30C = 24377'
-20C = 20578'
FZL = 12651'
LFC
LCL
1152m
75 m²/s²
414m
61
65



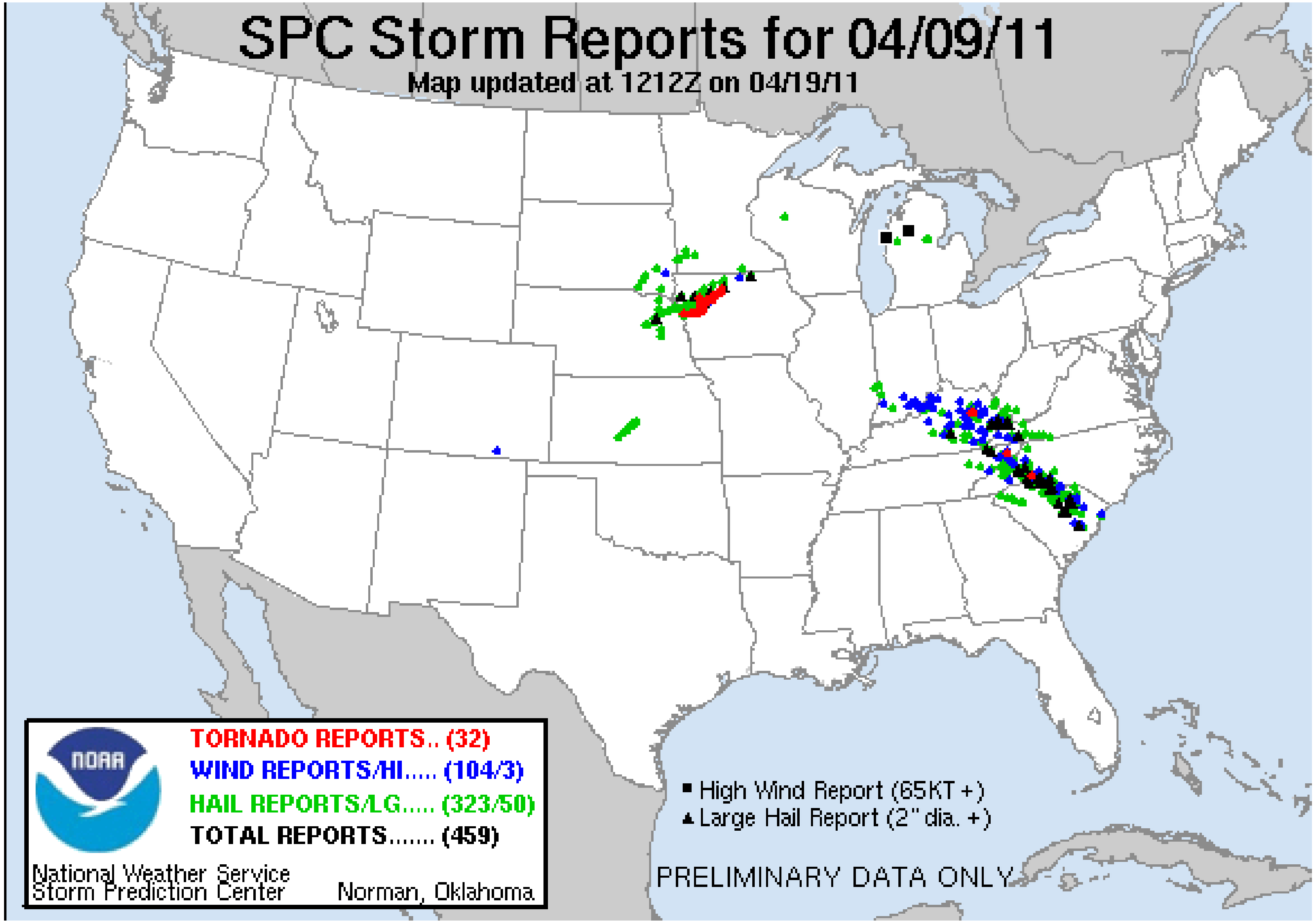
LMN 110410/0000 (Archive)
610mb 4207m Ø=344.3K
25.8C 13798ft Øw=313.2K
78.4F 35.9g/kg Øe=465.0K
606mb 4267m 2.0/-24.0C 225/54 kt
100
15 km
12 km
200
EL
300
9 km
-30C = 25720'
-20C = 21790'
6 km
500
FZL = 14012'
LFC
610mb 12758ft / 3890m agl 13%
2.4/-23.1C 224/5
3 km
700
LCL
850
1 km
902m
SFC (317m)
SFC
1000
56
87



OAX 110409/1200 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (350m)
EL
-30C = 23764'
-20C = 19839'
FZL = 11189'
LFC
LCL
877m
579m
113 m²/s²
52
53



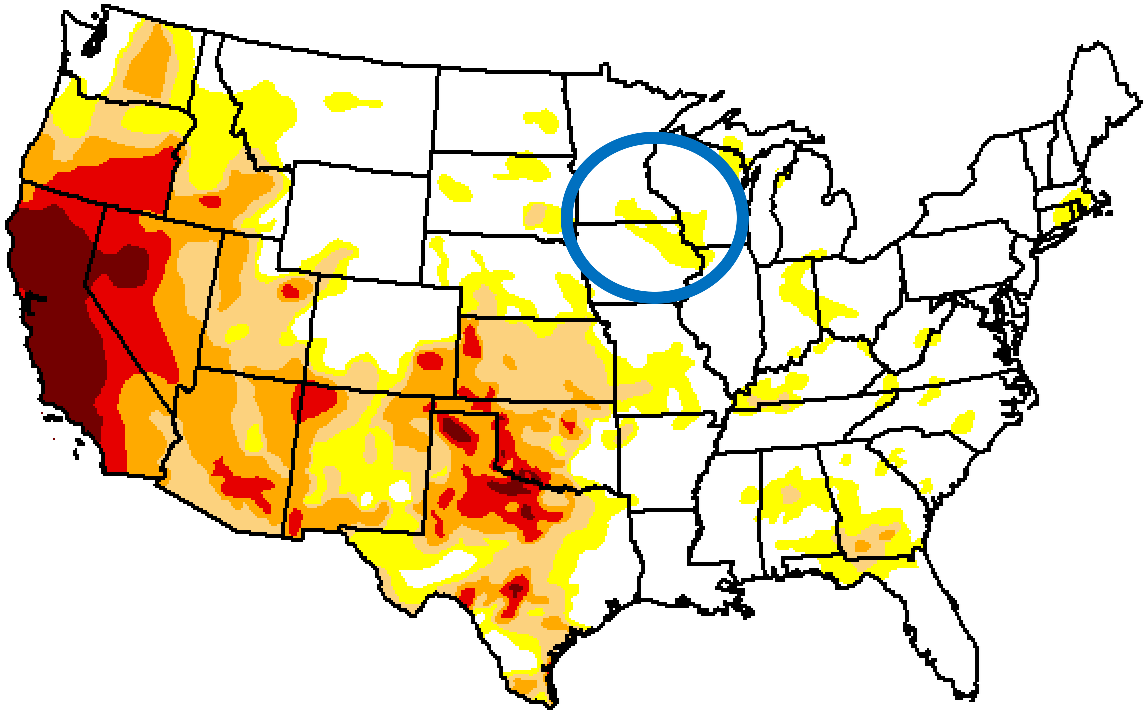
OAX 110410/0000 (Archive)
100
15 km
12 km
200
300
9 km
6 km
500
3 km
700
850
1 km
SFC (350m)
1000
2494m
366 m²s²
SFC
66
84
EL
-30C = 25761'
-20C = 21277'
FZL = 12659'
LFC
LCL


SPC Storm Reports for 04/09/11
Map updated at 1212Z on 04/19/11
TORNADO REPORTS.. (32)
WIND REPORTS/HI..... (104/3)
HAIL REPORTS/LG..... (323/50)
TOTAL REPORTS....... (459)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
High Wind Report (65KT +)
Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

Evapotranspiration

- Need moist soil and growing vegetation
- Plentiful rain previous 1-2 weeks
- Maturing crops (wheat, corn, or canola)
- Capped boundary layer to trap moisture; relatively weak winds
- Almost always a significant return flow contribution (in addition)

U.S. Drought Monitor
CONUS



August 19, 2014

(Released Thursday, Aug. 21, 2014)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	51.93	48.07	33.56	21.62	10.12	3.80
Last Week 8/12/2014	52.81	47.19	33.61	22.03	10.24	3.79
3 Months Ago 5/20/2014	52.36	47.64	38.12	28.30	14.47	4.99
Start of Calendar Year 12/31/2013	48.24	51.76	30.95	16.67	3.96	0.37
Start of Water Year 10/1/2013	39.57	60.43	41.21	20.70	3.06	0.29
One Year Ago 8/20/2013	40.02	59.98	45.61	32.23	10.54	1.32

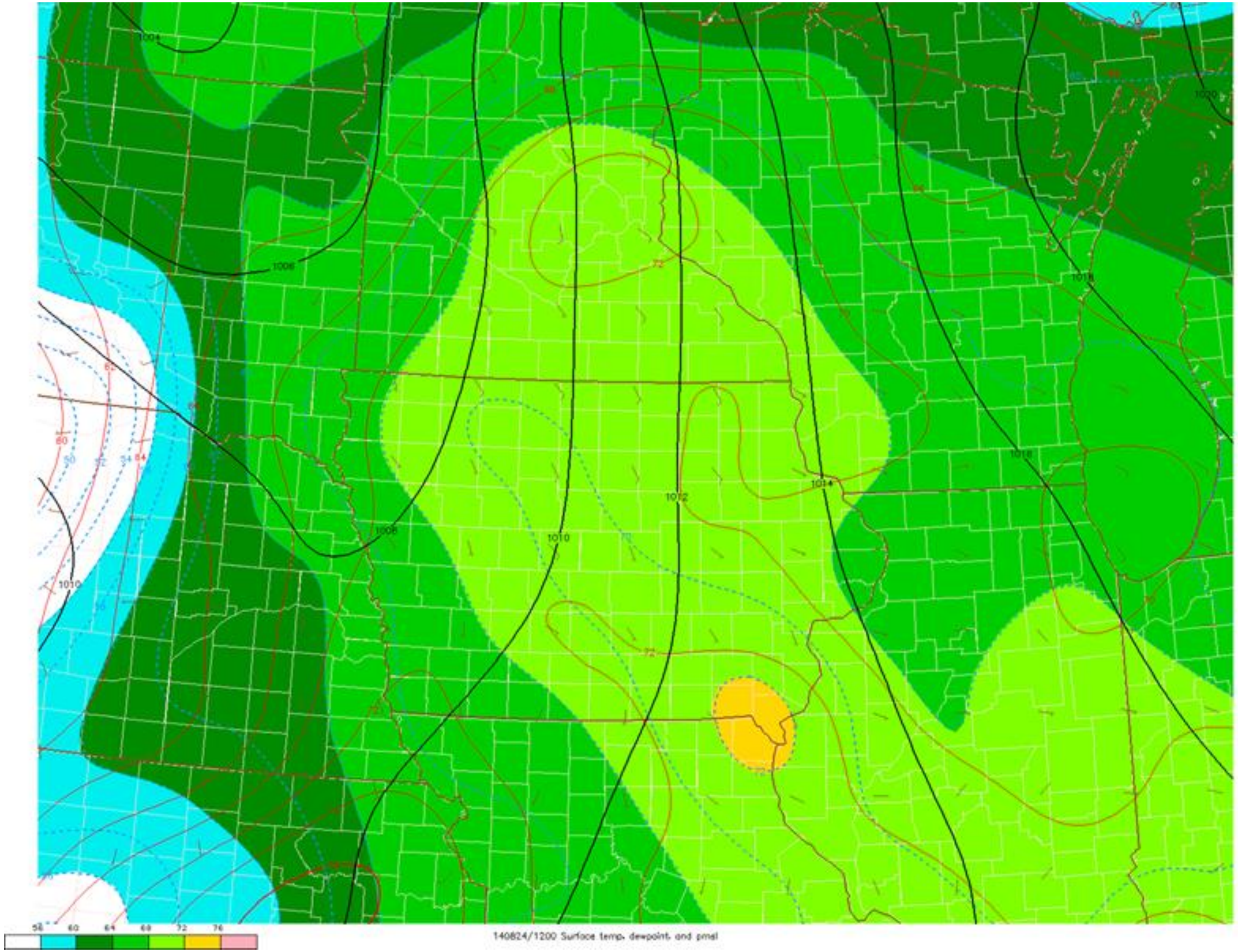
Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

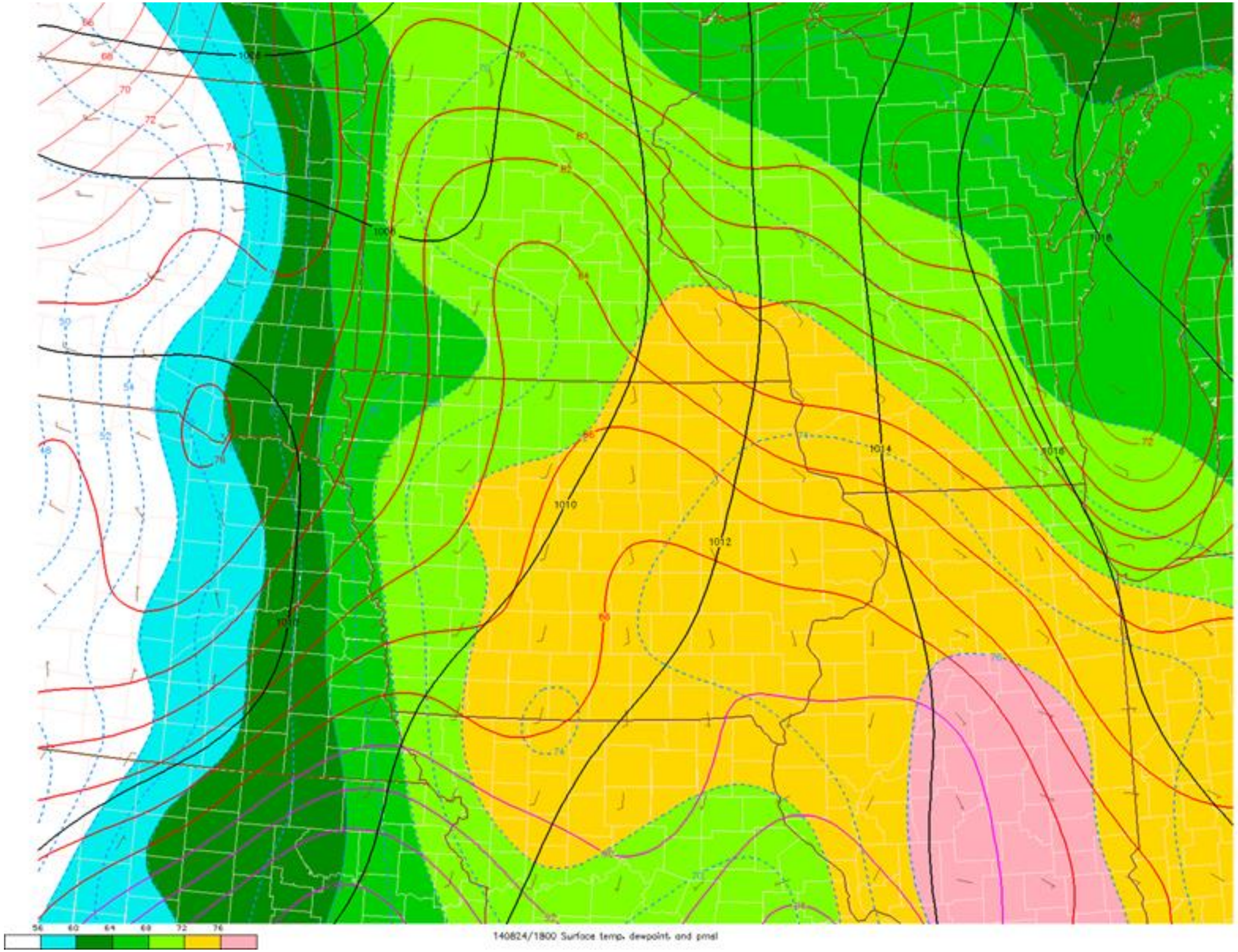
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author(s):
Richard Tinker
CPC/NOAA/NWS/NCEP

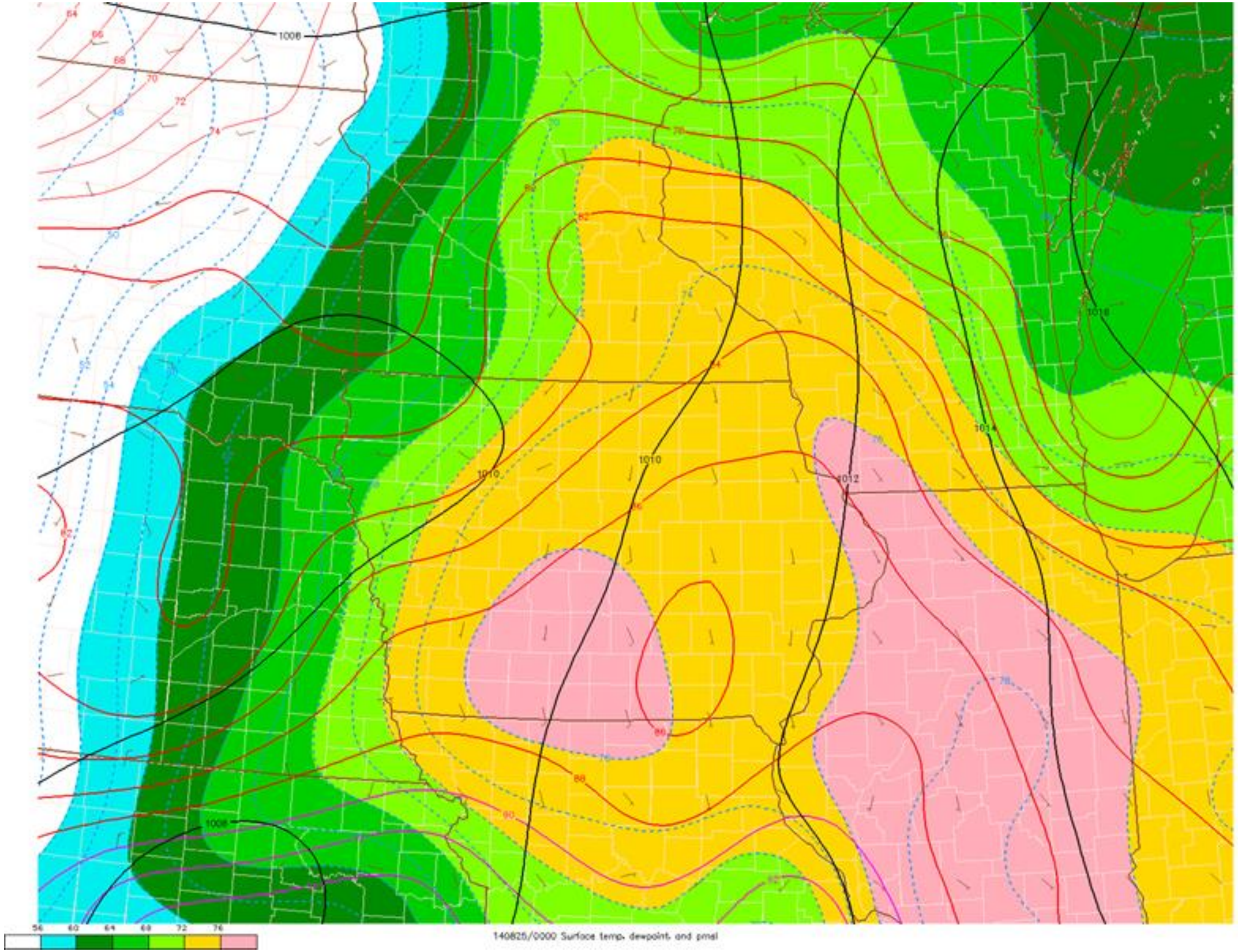
USDA

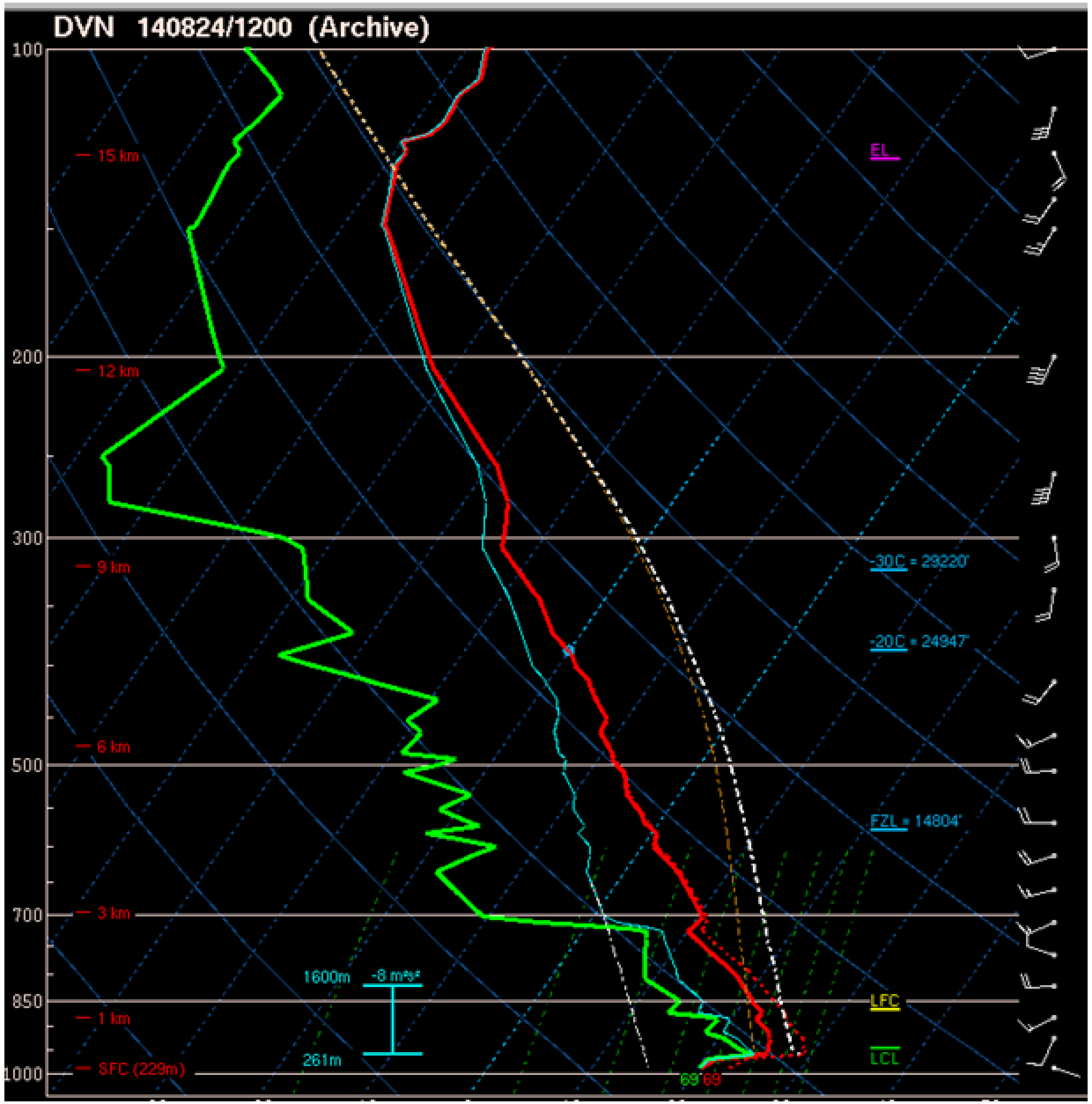


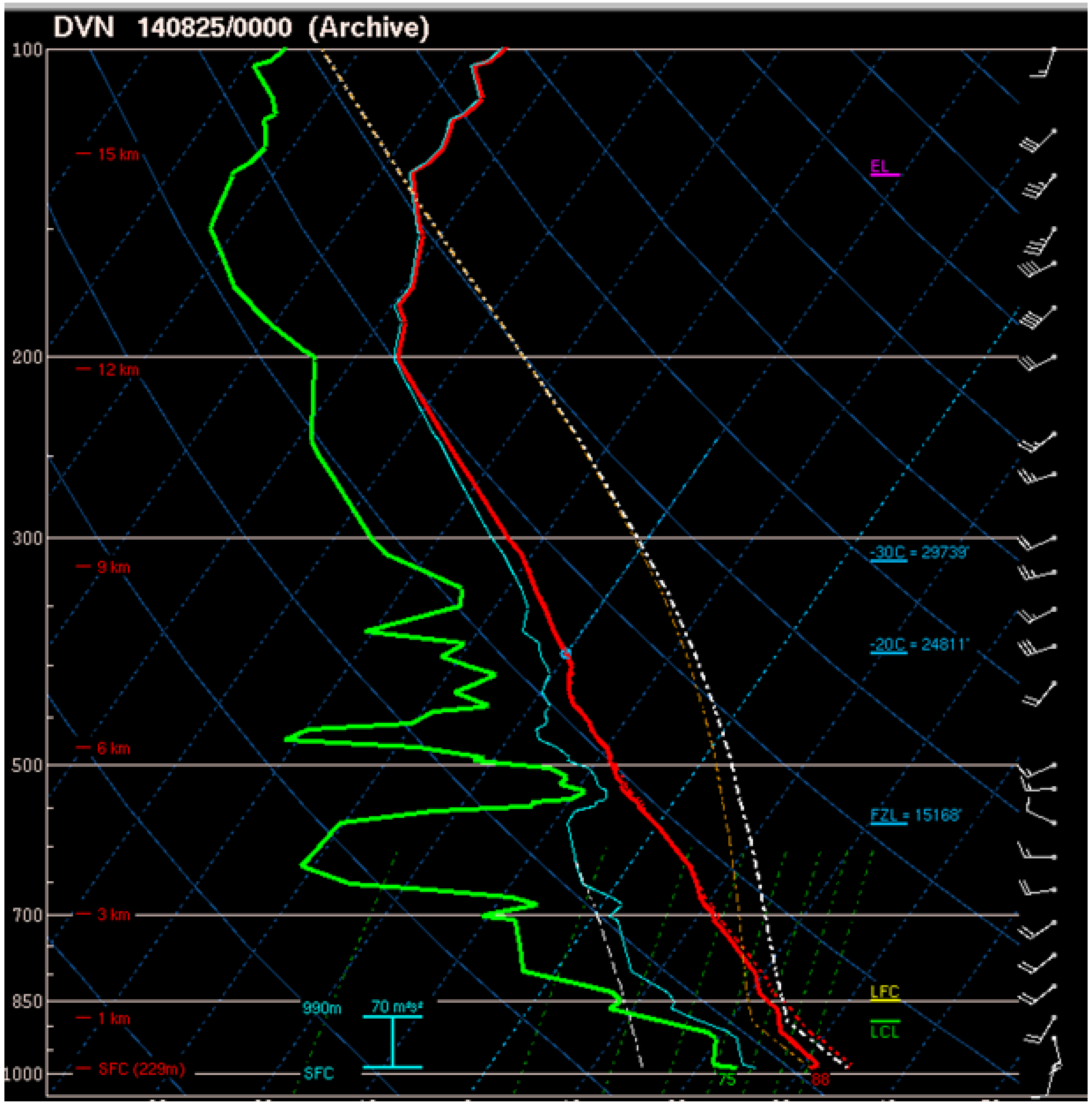
140824/1200 Surface temp, dewpoint, and pmsl



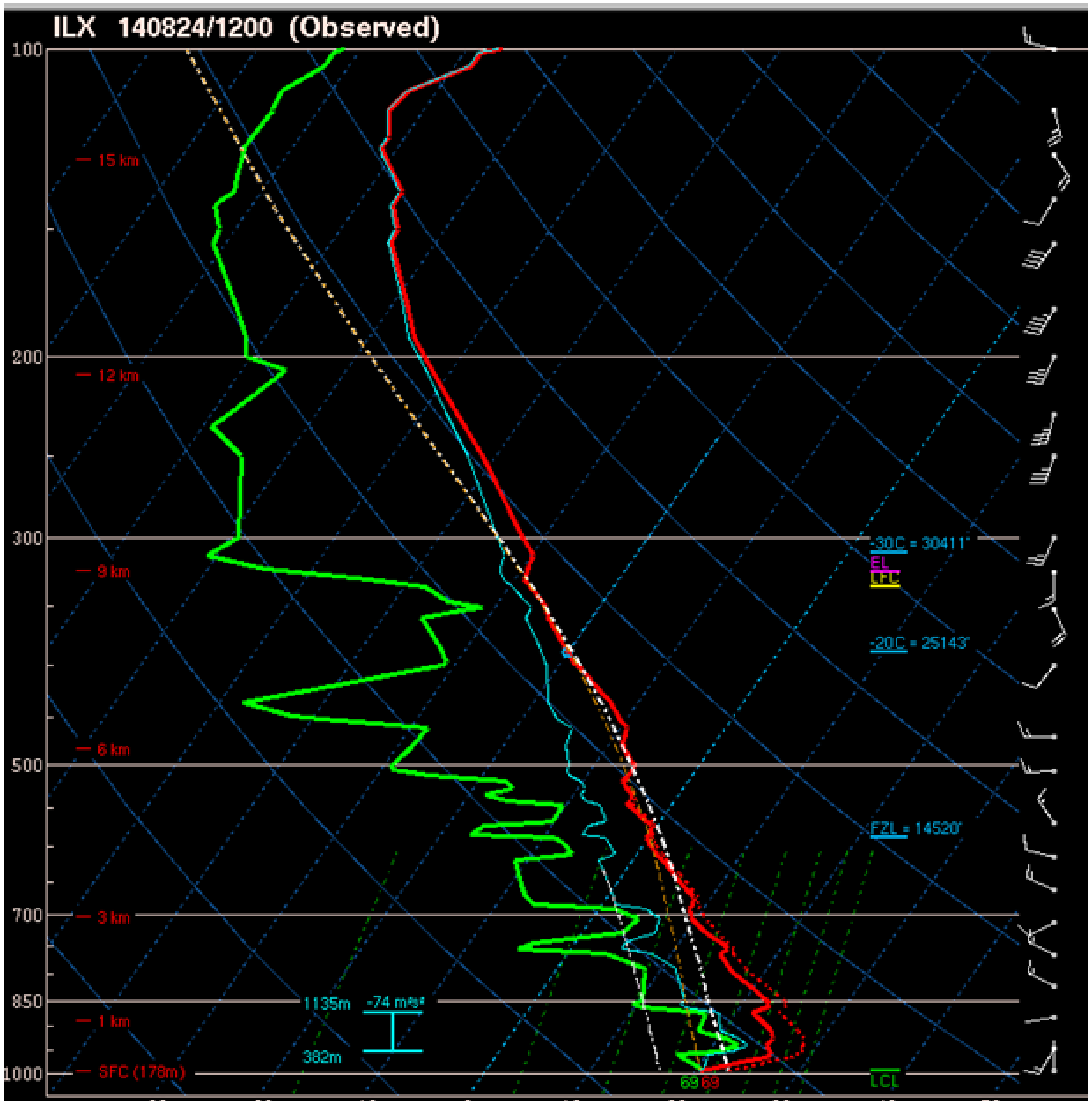
140824/1800 Surface temp, dewpoint, and pmsl


1008
1010
1010
1012
1014
1016
1008
56
60
64
68
72
76
140825/0000 Surface temp, dewpoint, and pmsl

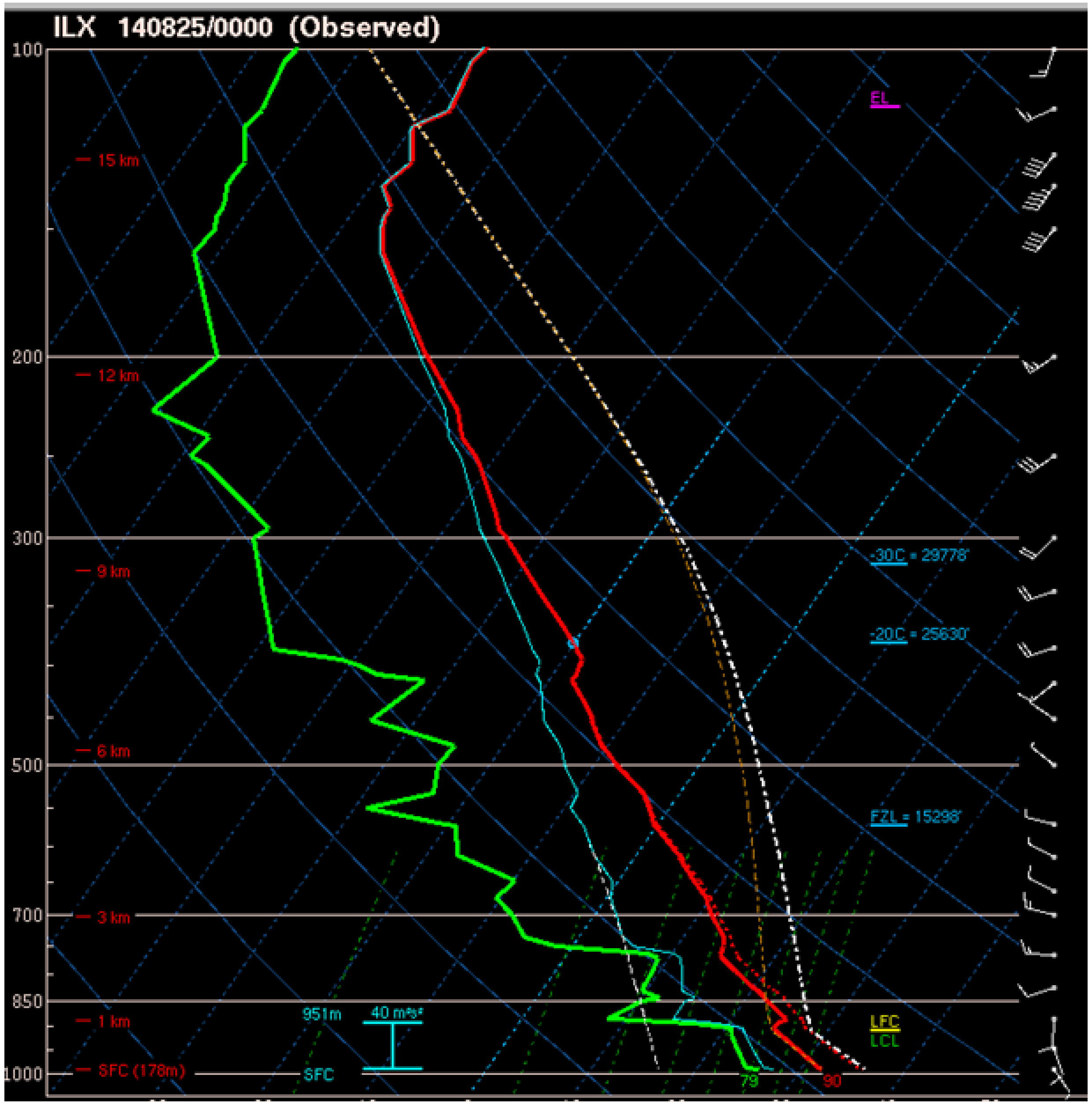

DVN 140824/1200 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (229m)
EL
-30C = 29220'
-20C = 24947'
FZL = 14804'
LFC
LCL
1600m
-8 m²s²
261m
69 69



DVN 140825/0000 (Archive)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (229m)
EL
-30C = 29739'
-20C = 24811'
FZL = 15168'
LFC
LCL
990m
70 m²/s²
SFC
75
88



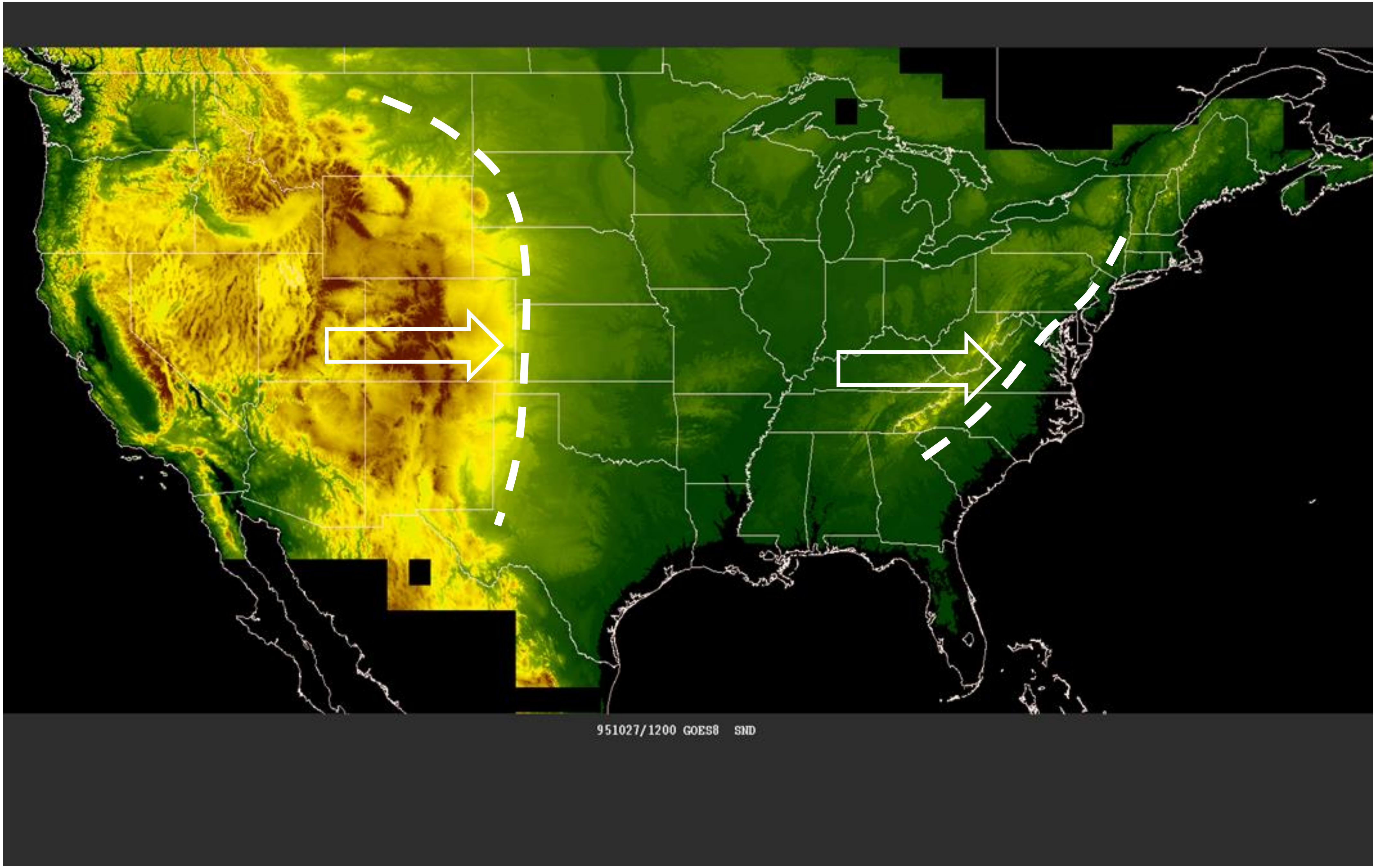
ILX 140824/1200 (Observed)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (178m)
-30C = 30411'
EL
LFC
-20C = 25143'
FZL = 14520'
1135m
-74 m²/s²
382m
69
69
LCL

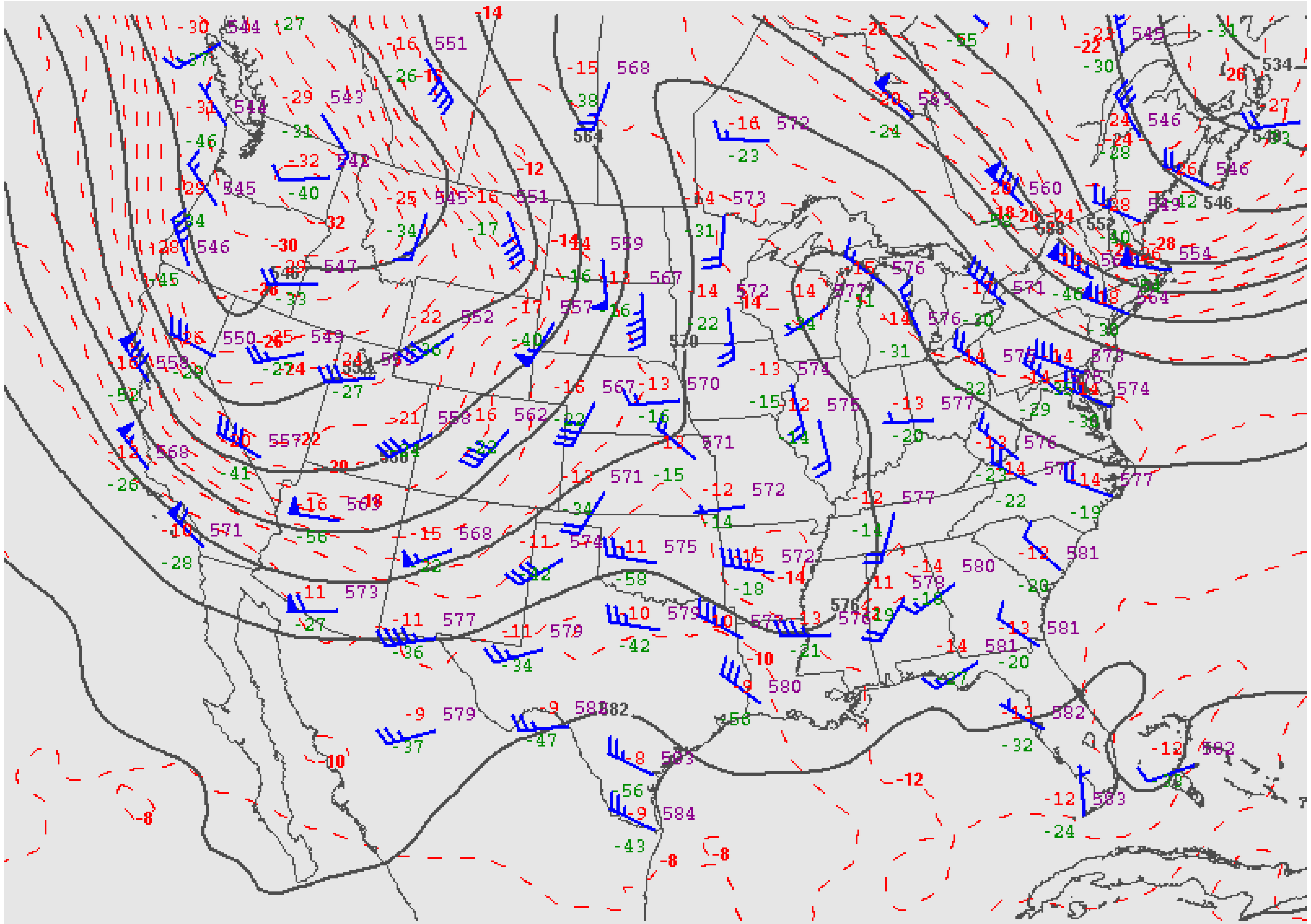

ILX 140825/0000 (Observed)
100
200
300
500
700
850
1000
15 km
12 km
9 km
6 km
3 km
1 km
SFC (178m)
EL
-30C = 29778'
-20C = 25630'
FZL = 15298'
LFC
LCL
951m
40 m²/s²
SFC
79
90

Lee Cyclogenesis

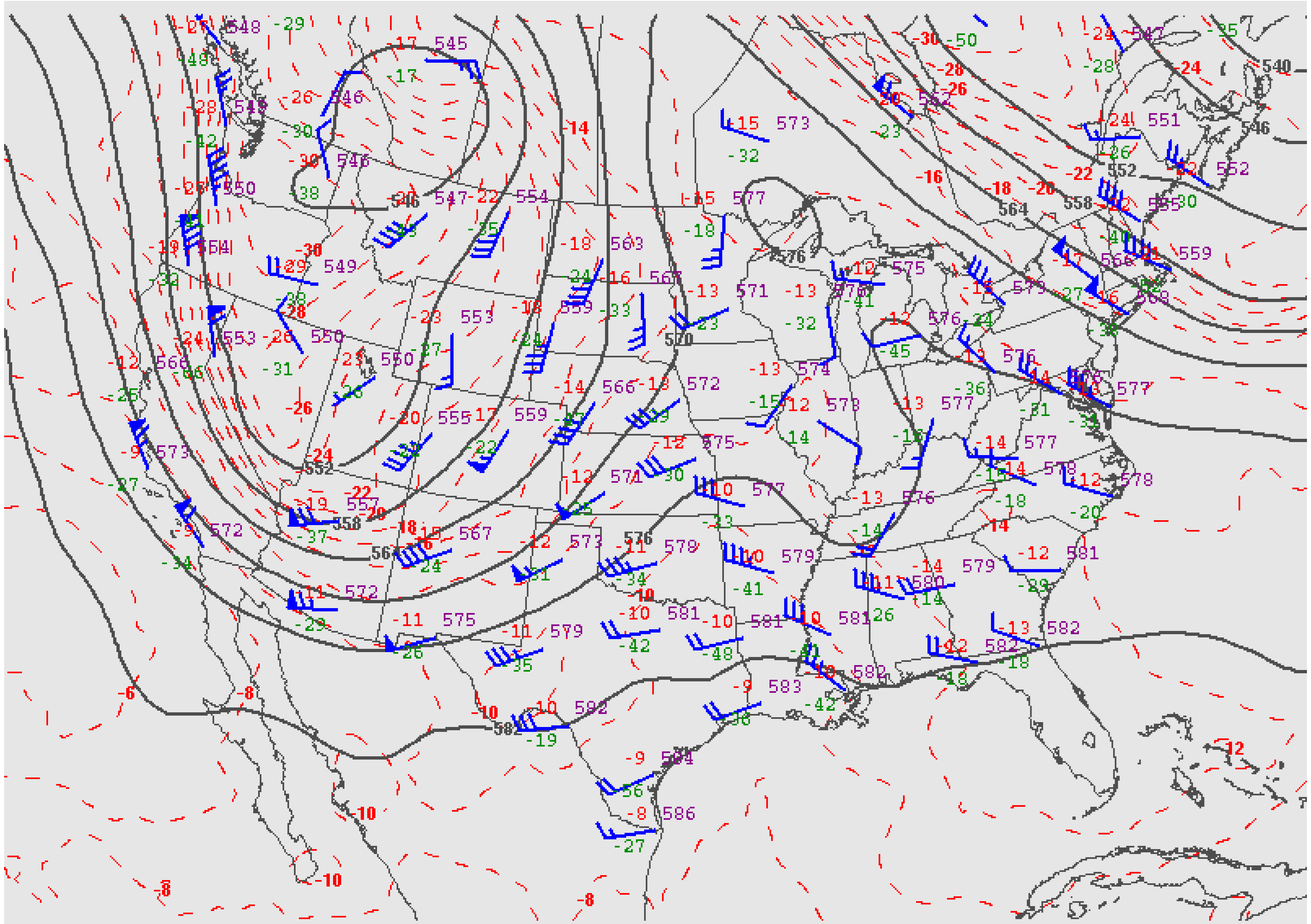
- **Midlevel flow crosses high terrain:**
  - Subsidence and warming E of mountains
  - Warming of column leads to "warm core" low formation
  - Strongest pressure falls with strongest flow crosses highest terrain

- **The lee trough/cyclone deepens before arrival of strongest Q-G forcing for ascent:**
  - Head start on differential advection, "loaded gun" sounding, and veering winds with height

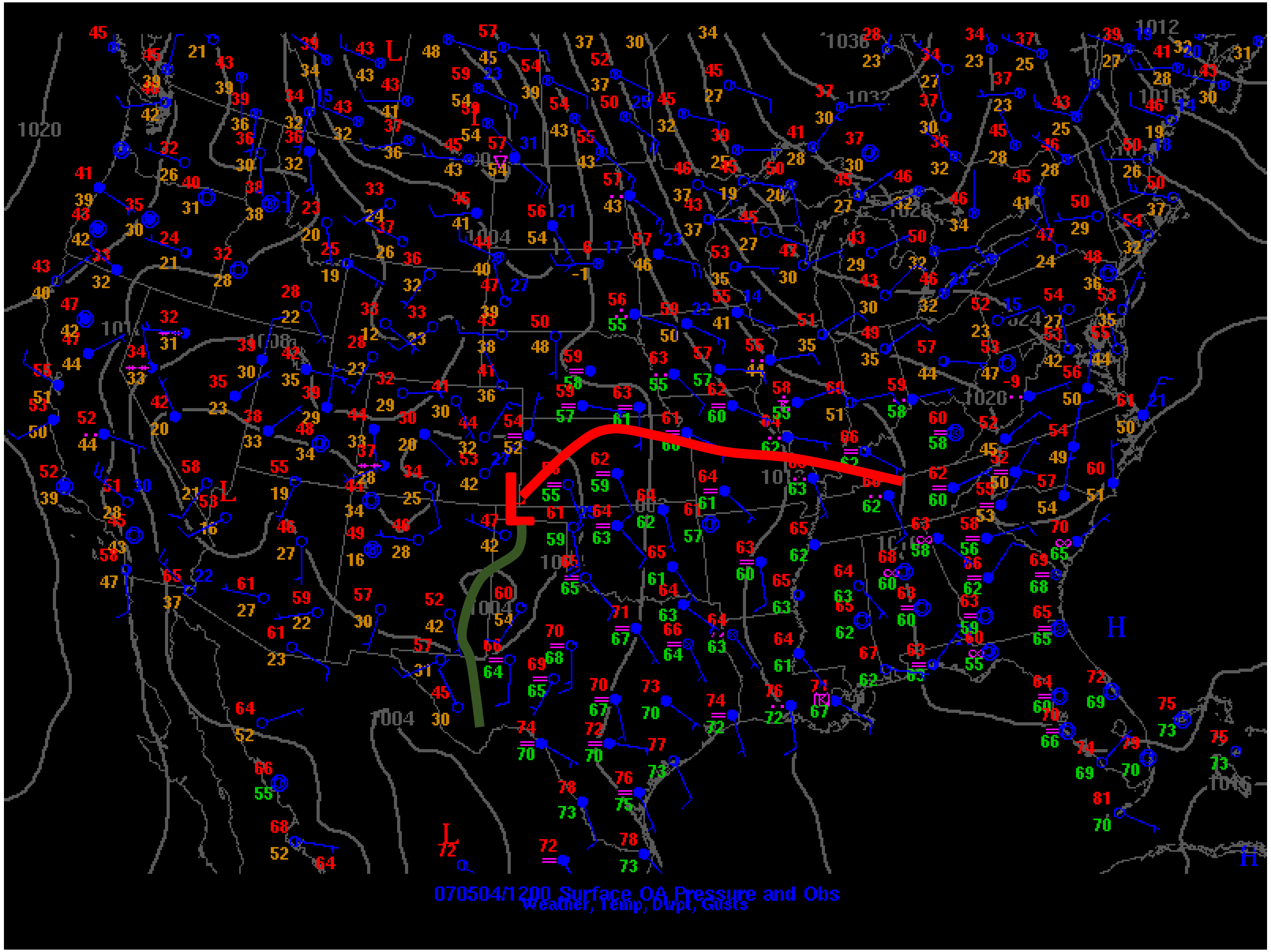

951027/1200 GOES8 SND

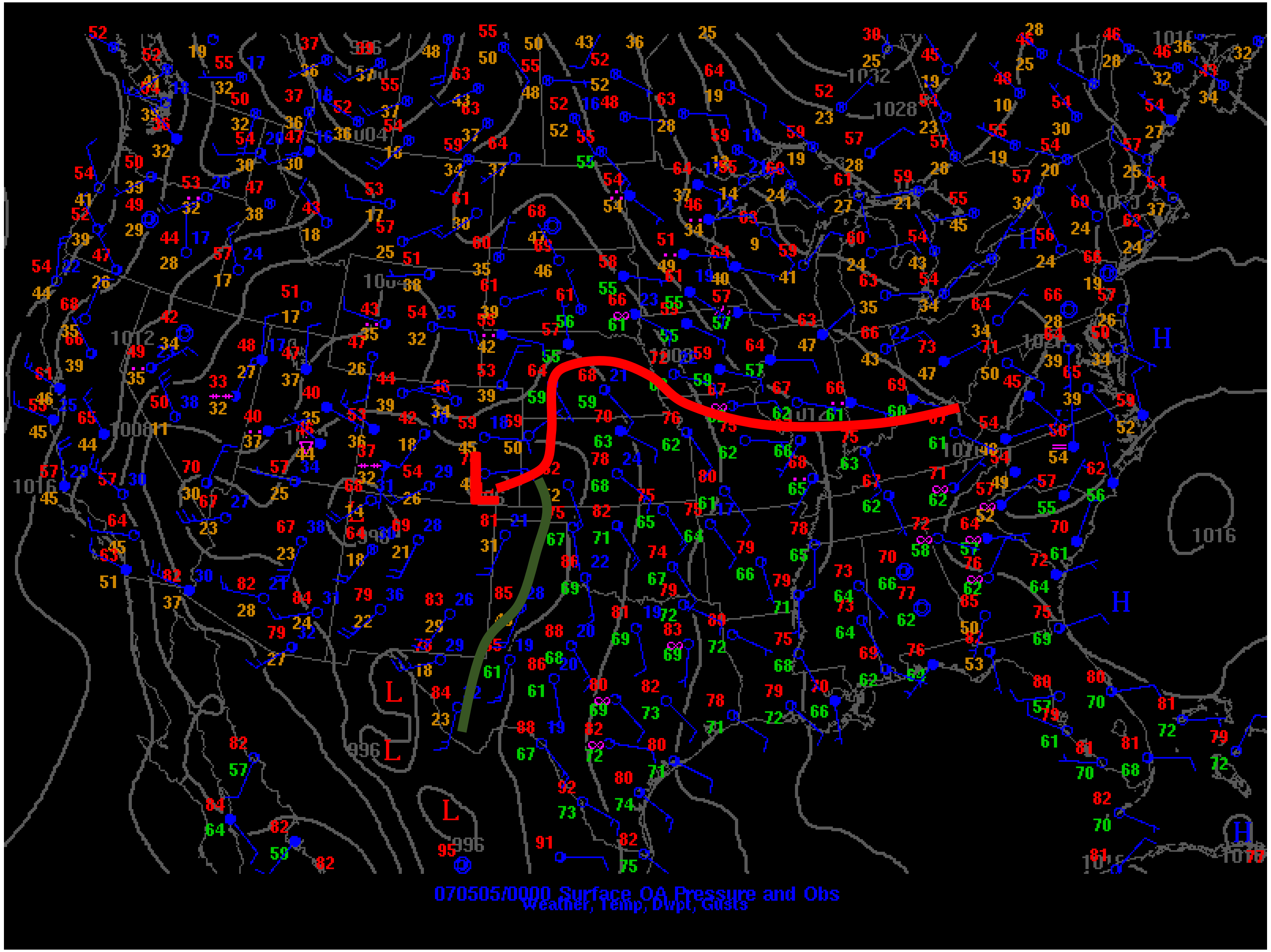


070504/1200 500 MB UA OBS, HGHTS, and TEMPS



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


070504/1200 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts

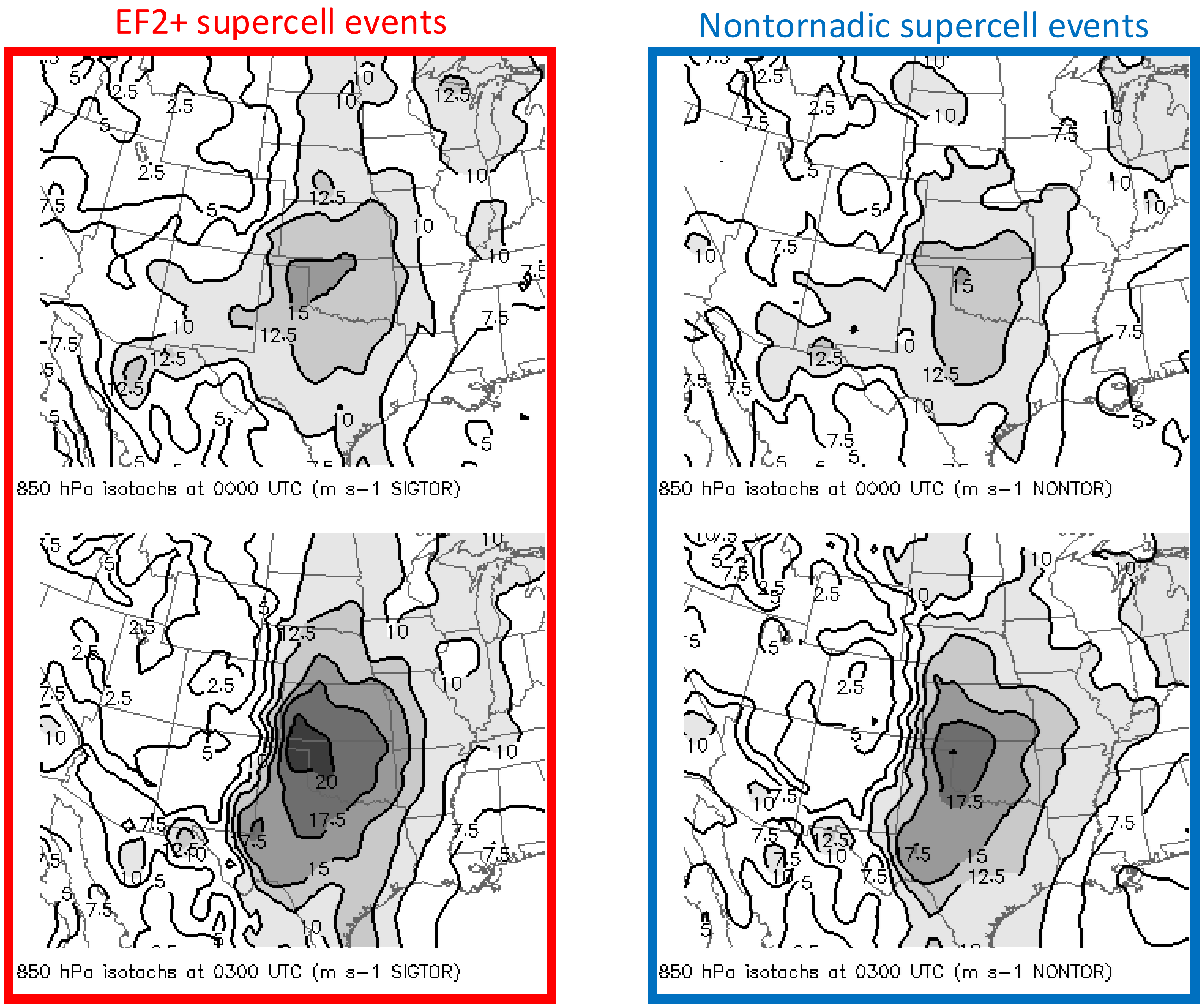

070505/0000 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts

Nocturnal Low-Level Jet (LLJ)

- **Plains often see early nocturnal low-level jet (LLJ) ramp up with lee cyclogenesis**

- **Related to two primary factors:**
  - **Boundary-layer decoupling and loss of surface friction (“inertial oscillation”)**
  - **Diurnal temperature variations over sloped terrain (thermal wind)**

- **Part of the process that can favor late evening/early overnight tornadoes (with favorable moisture/CAPE)**


EF2+ supercell events
Nontornadic supercell events
850 hPa isotachs at 0000 UTC (m s−1 SIGTOR)
850 hPa isotachs at 0300 UTC (m s−1 SIGTOR)
850 hPa isotachs at 0000 UTC (m s−1 NONTOR)
850 hPa isotachs at 0300 UTC (m s−1 NONTOR)

Lee Cyclogenesis Summary

- **Lee cyclogenesis occurs where upper-level flow is perpendicular to terrain features (westerly flow for Rockies)**
- **Lee cyclogenesis more robust with lower static stability**
- **Lee cyclone helps drive low-level moisture return**
- **Nocturnal low-level jet associated with lee cyclone is driven by inertial oscillation and thermal wind → increased low-level shear and tornado threat in evening and after dark if adequate CAPE**