Spring 2013 Graduate Spotter Class

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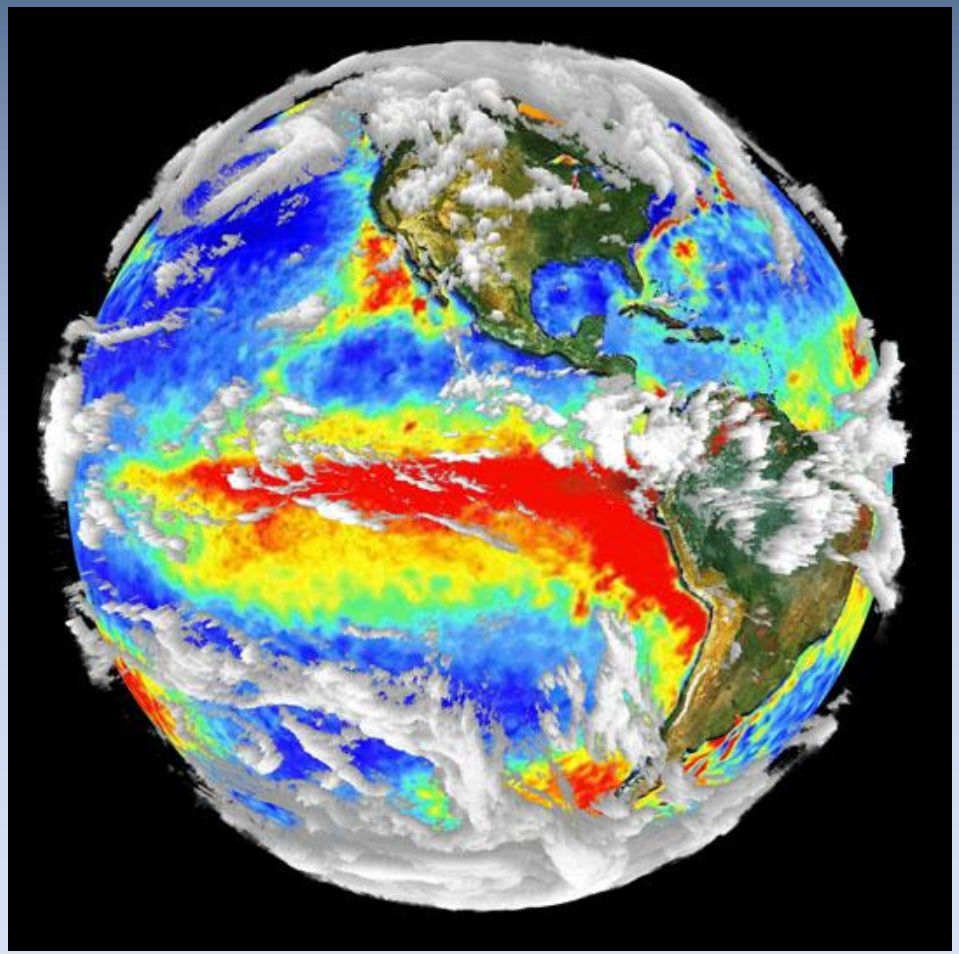
Welcome to the Graduate Spotter Class

What we will attempt to cover in this class:

- Advanced weather concepts including a 3-D look at the atmosphere.
- Instability versus Wind Shear – Finding the perfect balance. How do you arrive at the mode of convection in the forecast?
  - "The 'why' of what you observe when storm spotting"
- Dual Polarization Concepts

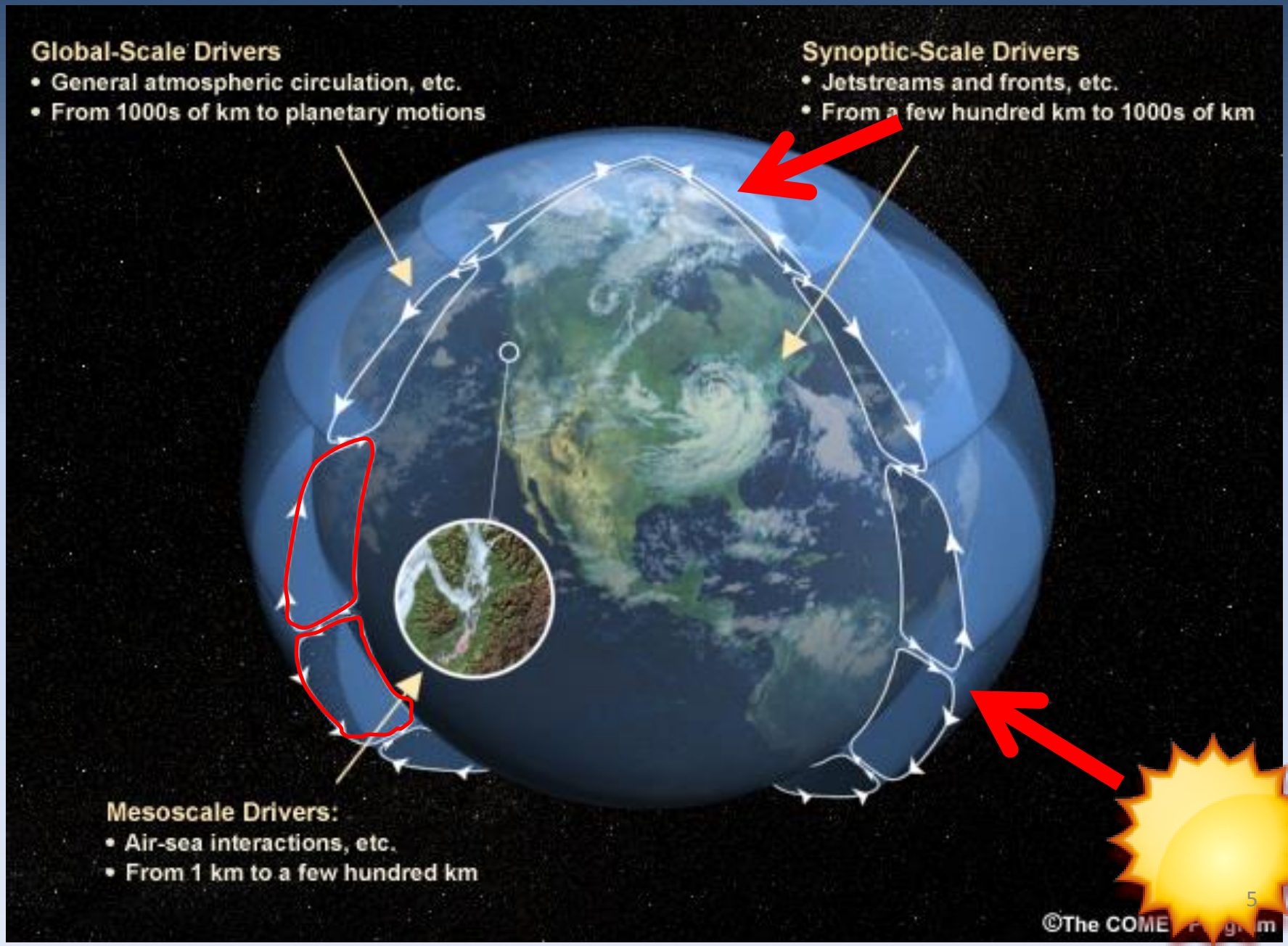
The Atmosphere



Large to Small Scale

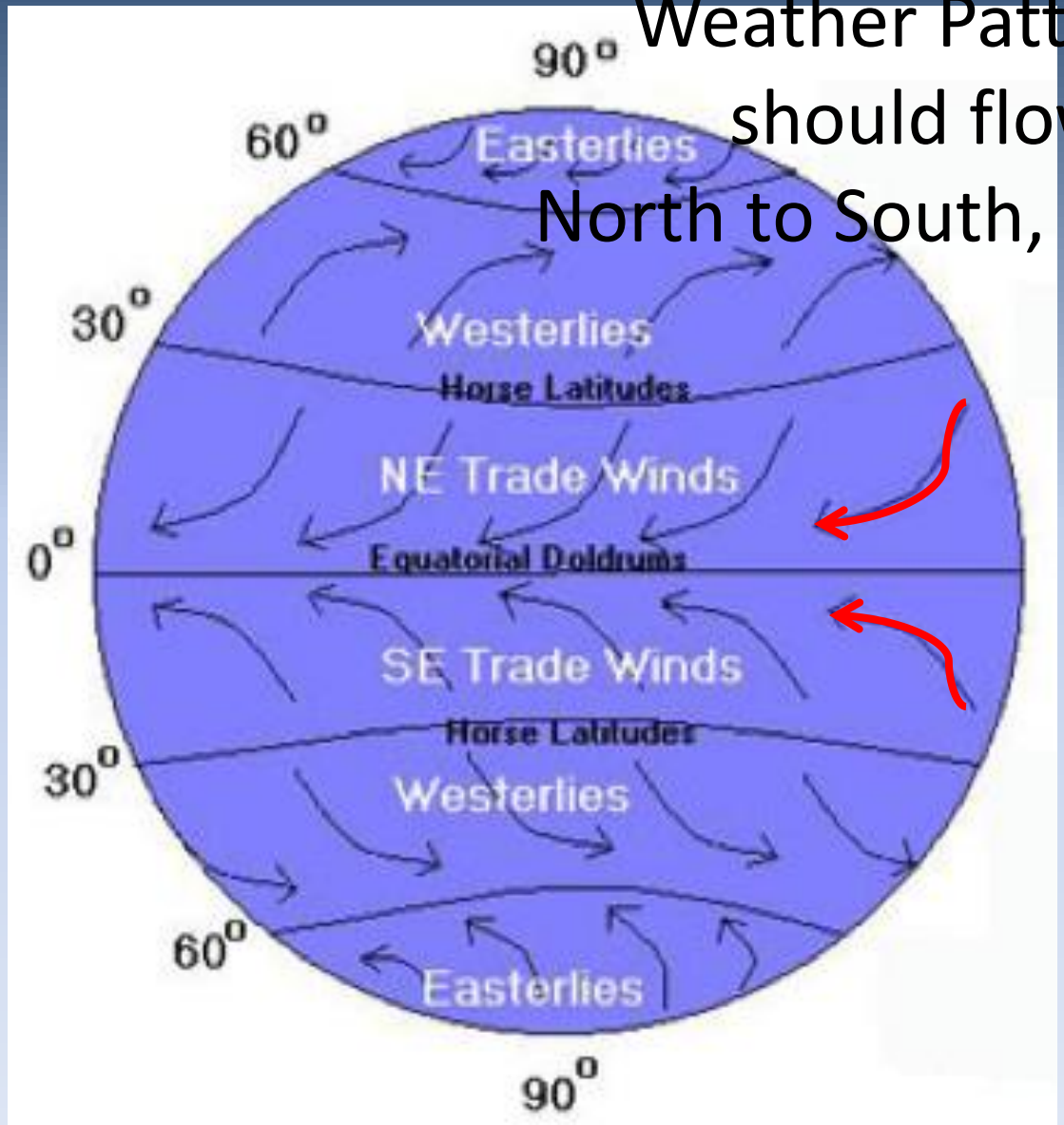
- Global (Largest)
- Synoptic (Large)
- Mesoscale (Small)

Global Weather Patterns



Global Weather Patterns

Weather Patterns should flow North to South, RIGHT?

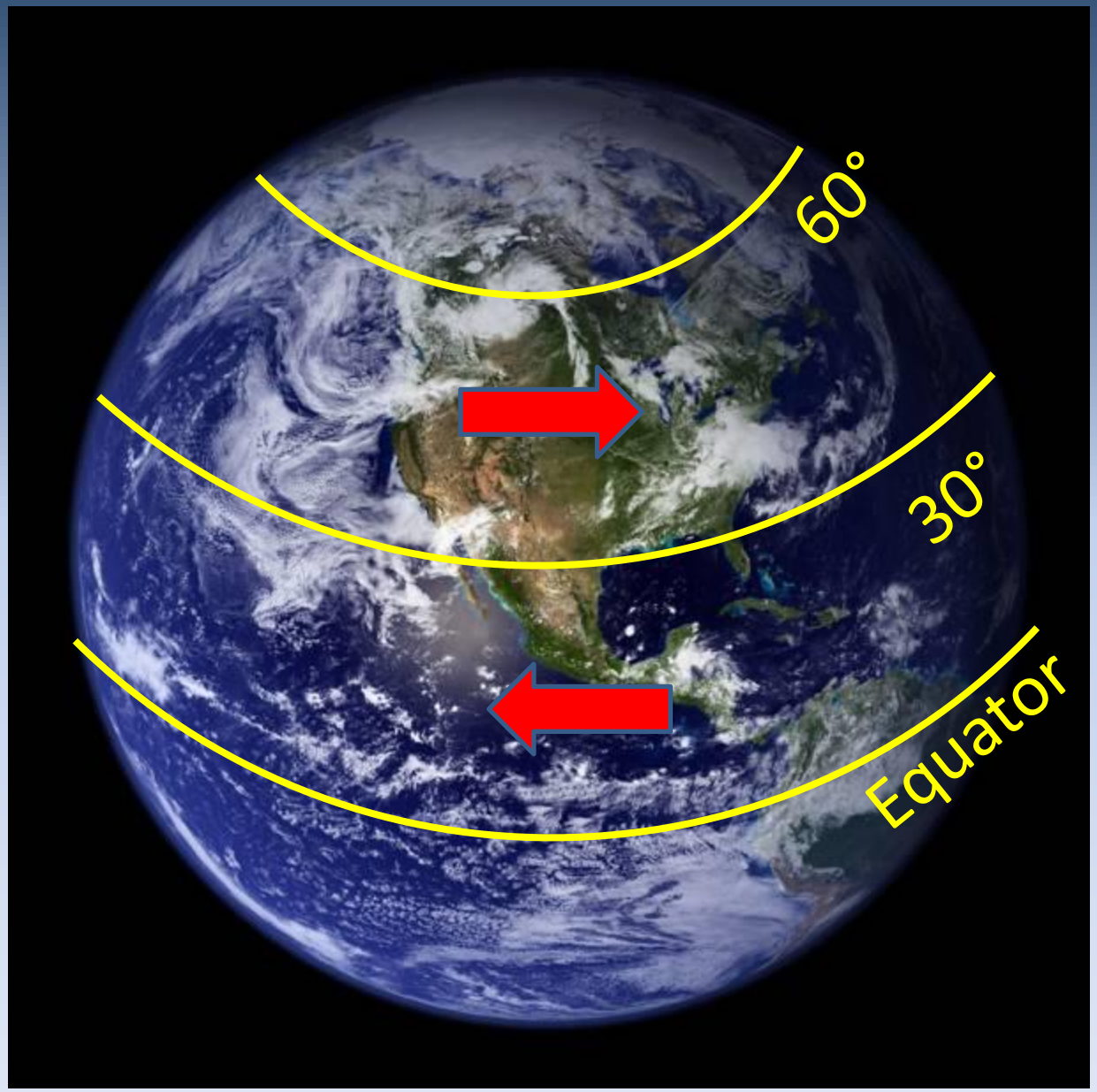


Two More Things to Factor in:

- Rotation of the Earth
- Gravity

Coriolis Effect

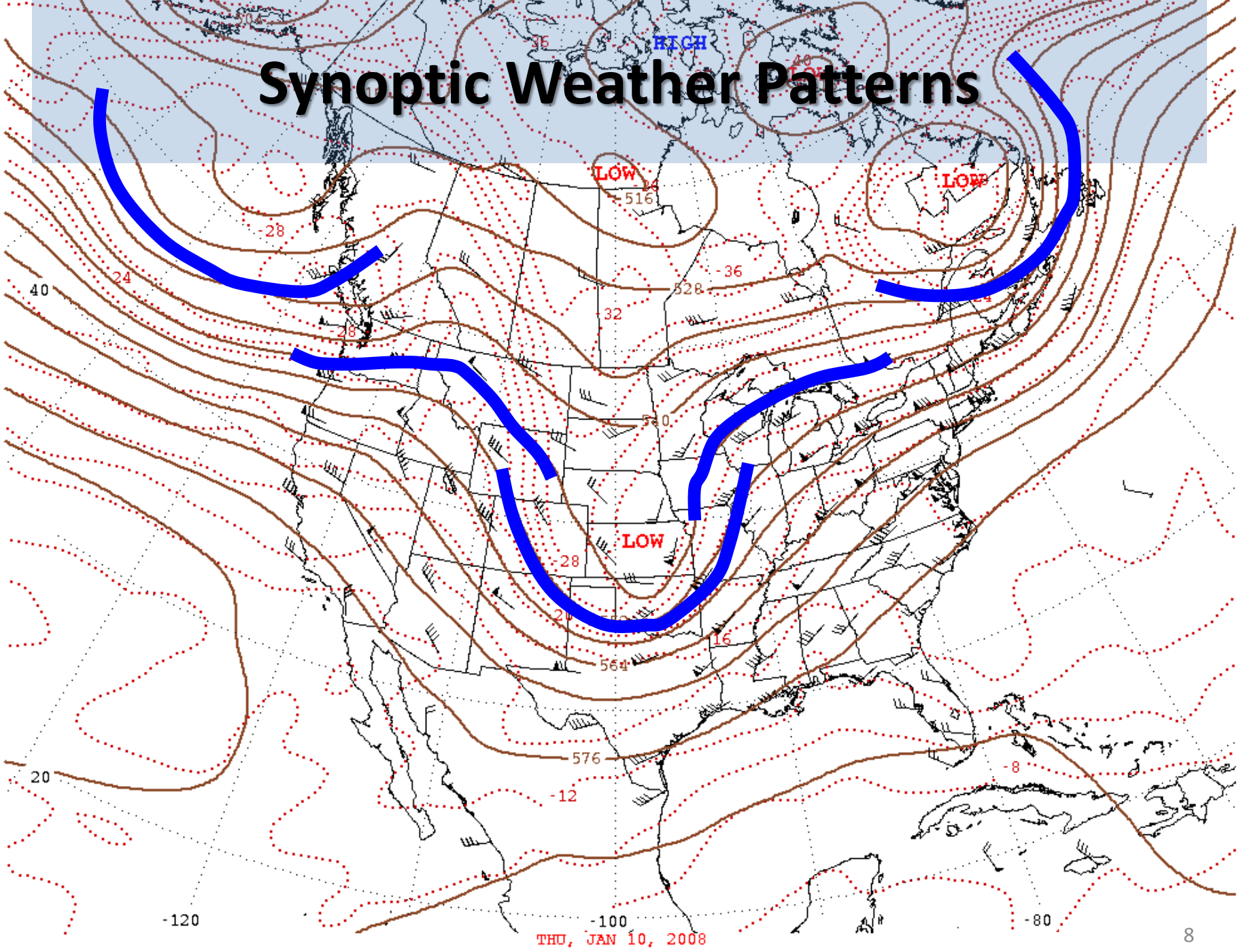
Global Weather Patterns



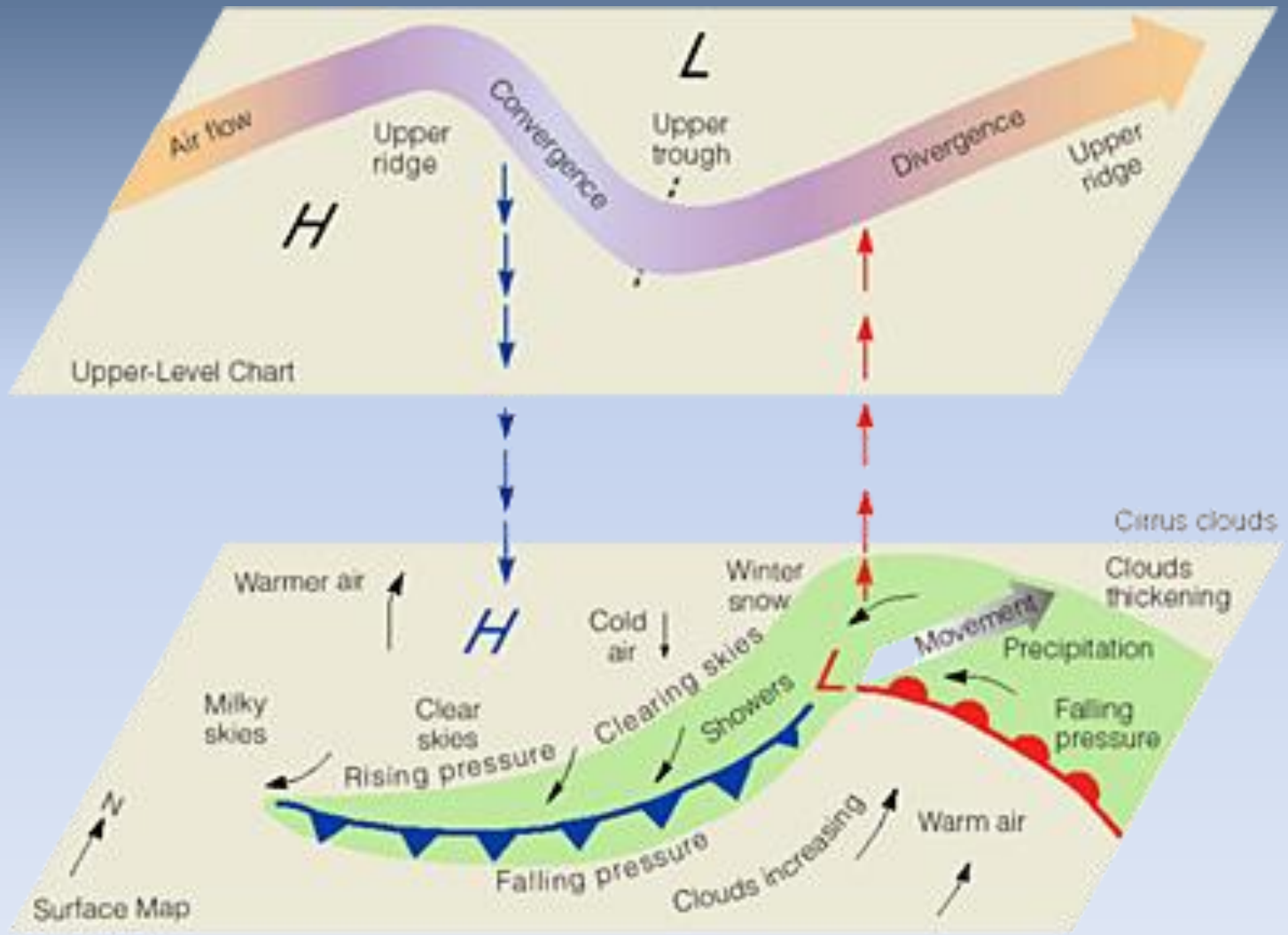
Westerlies vs. Easterlies

- Most of our weather comes from the west
- Hurricanes come from the east

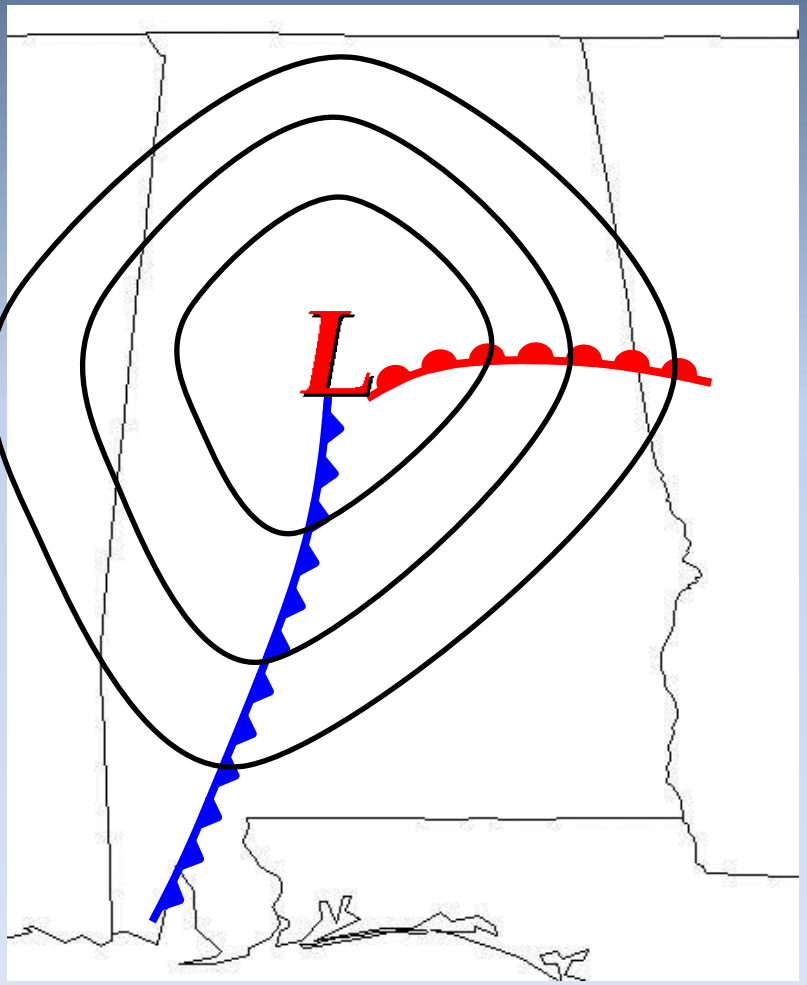
Synoptic Weather Patterns



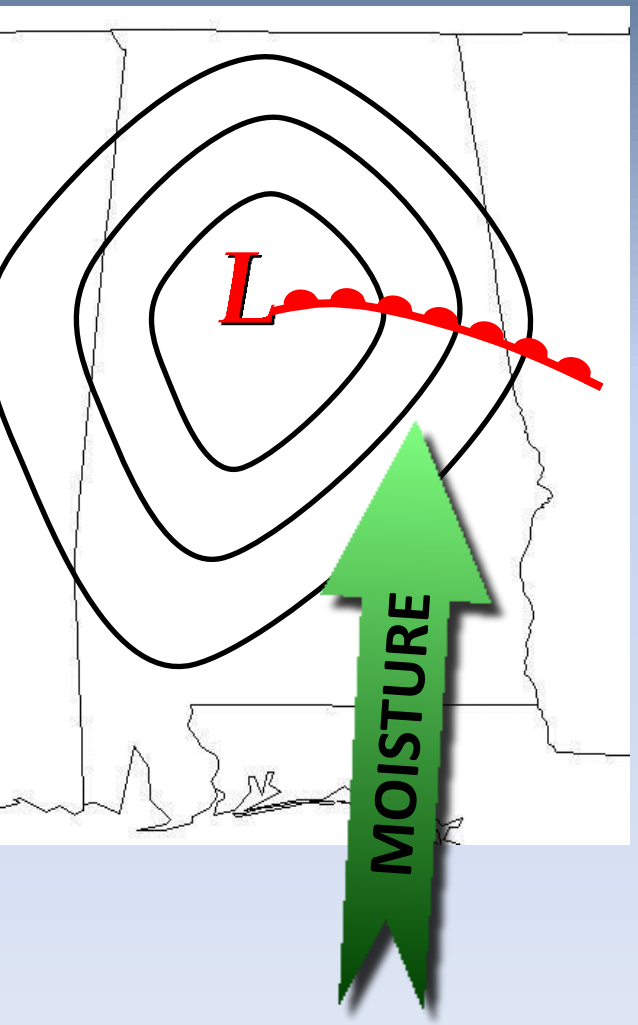
Synoptic Weather Patterns: Thinking in 3-D

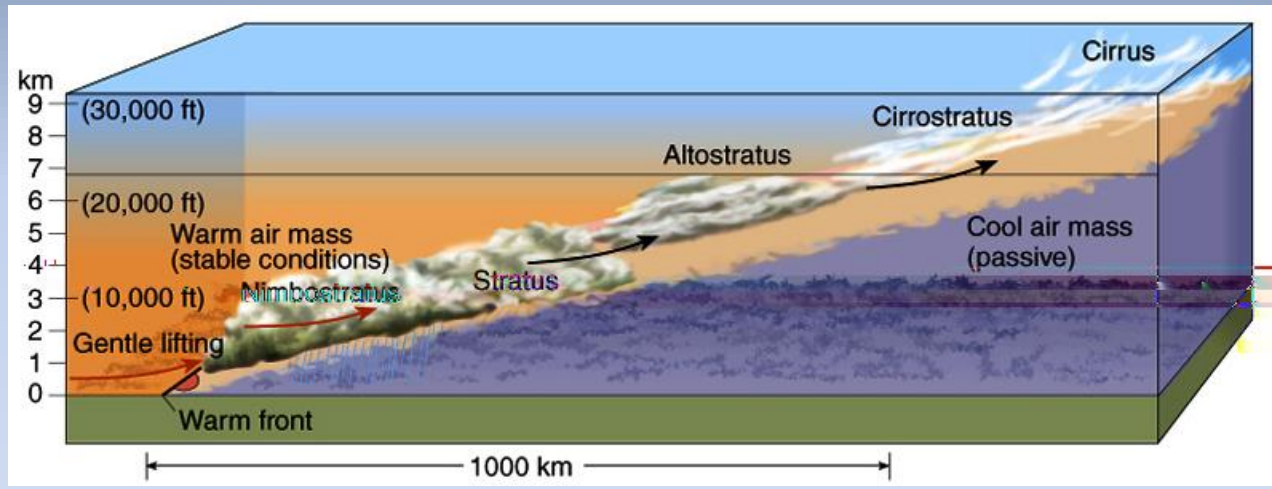


Synoptic Weather Patterns: Low Pressure System



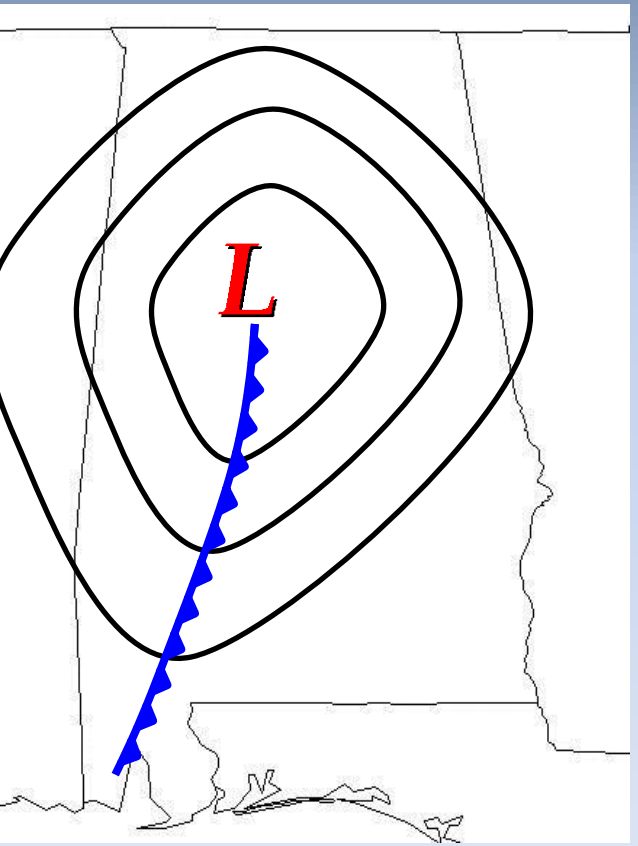
Synoptic Weather Patterns: The Low Pressure System

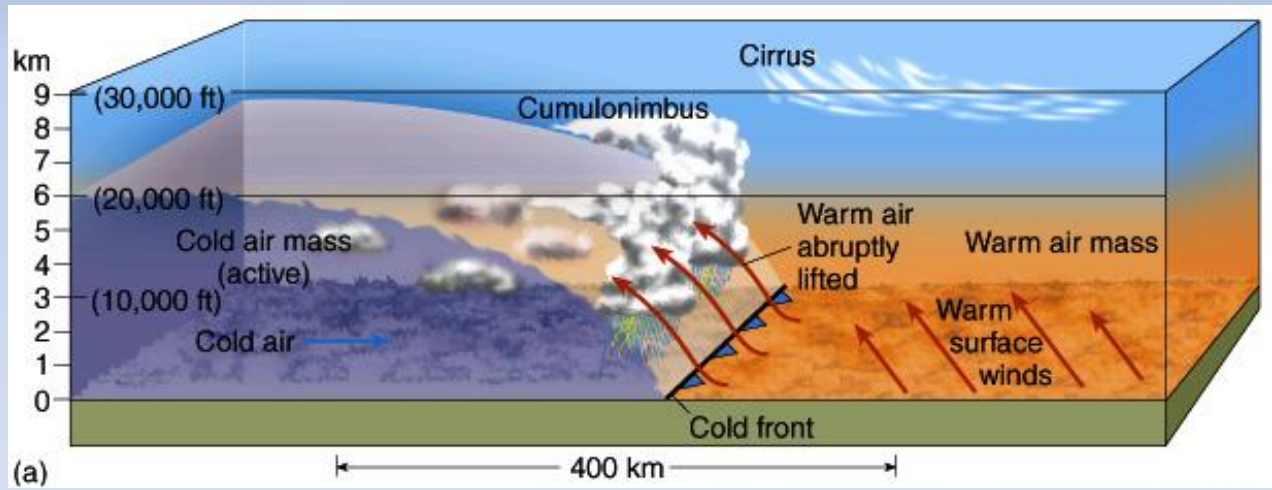




Warm Front

Synoptic Weather Patterns: The Low Pressure System

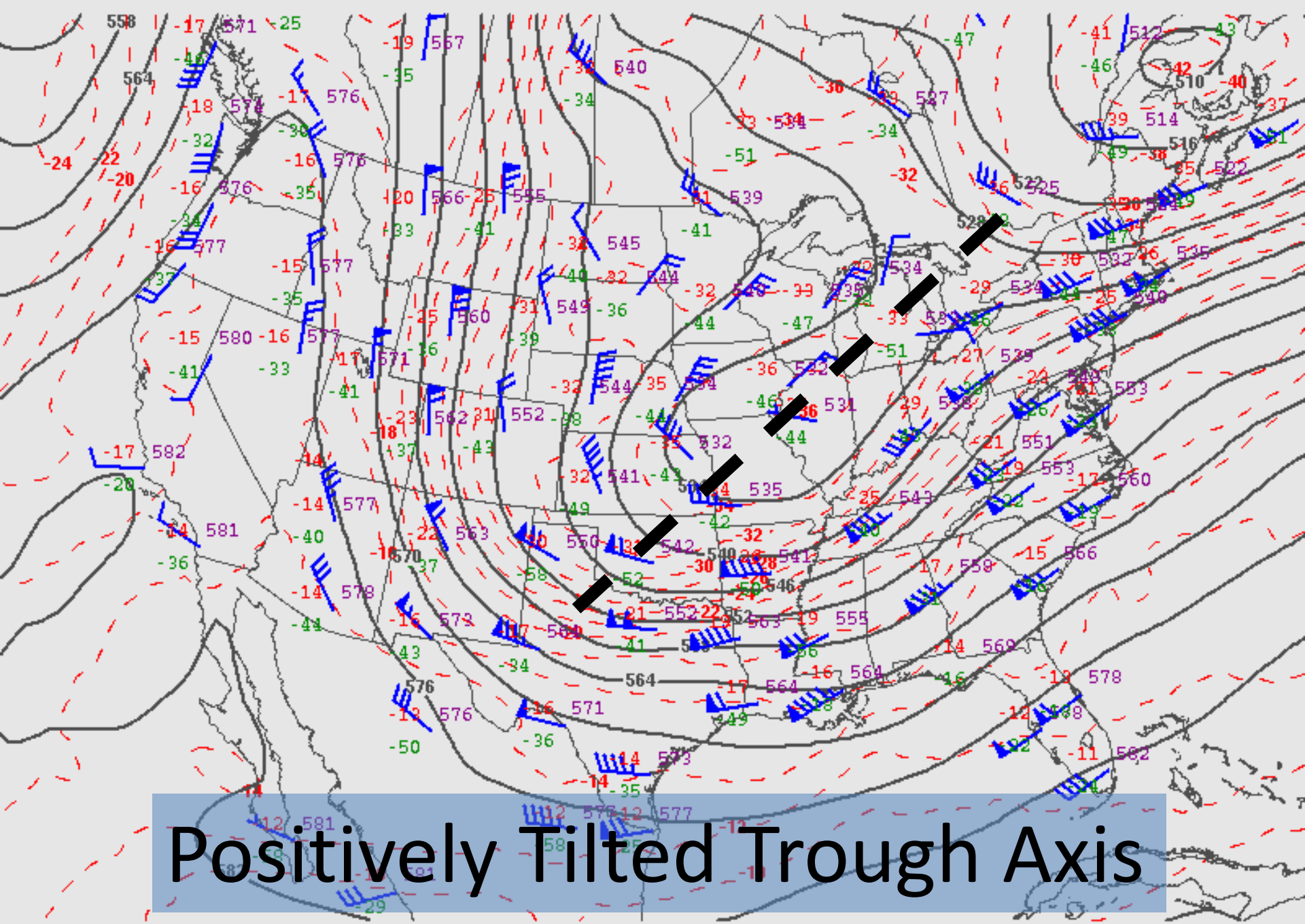




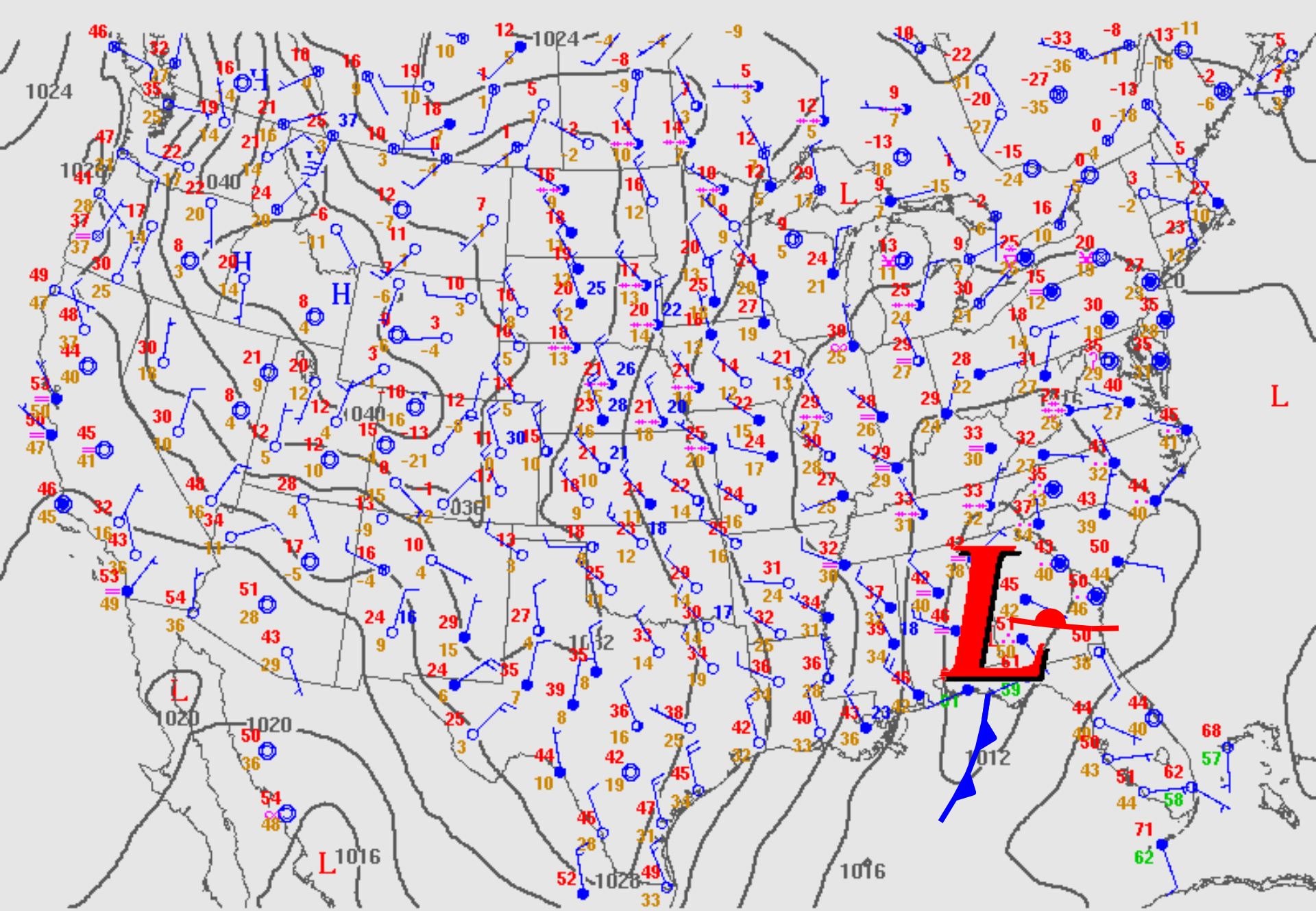
Cold Front

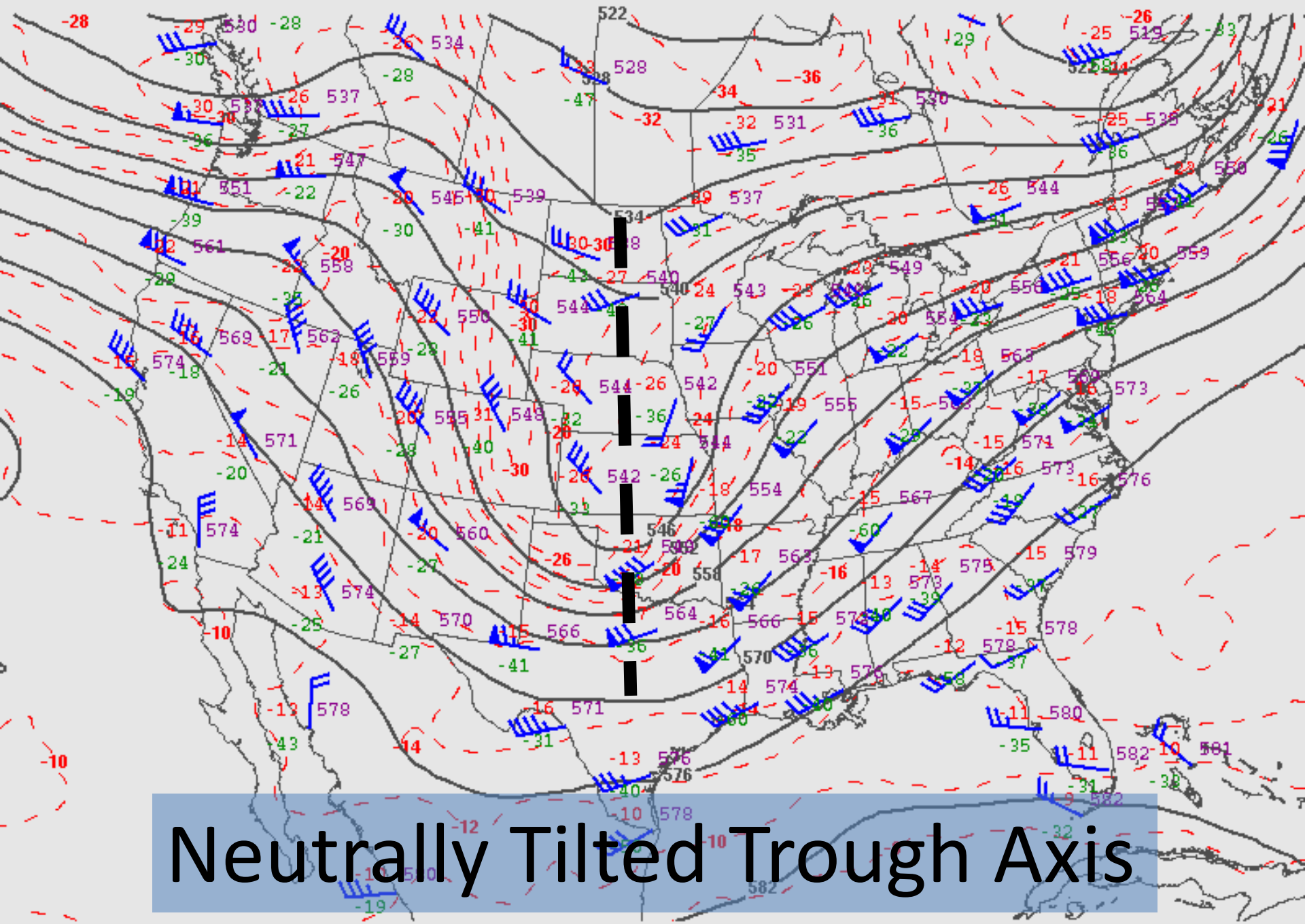
Synoptic Weather Patterns: The Low Pressure System

Why are some systems stronger than others?

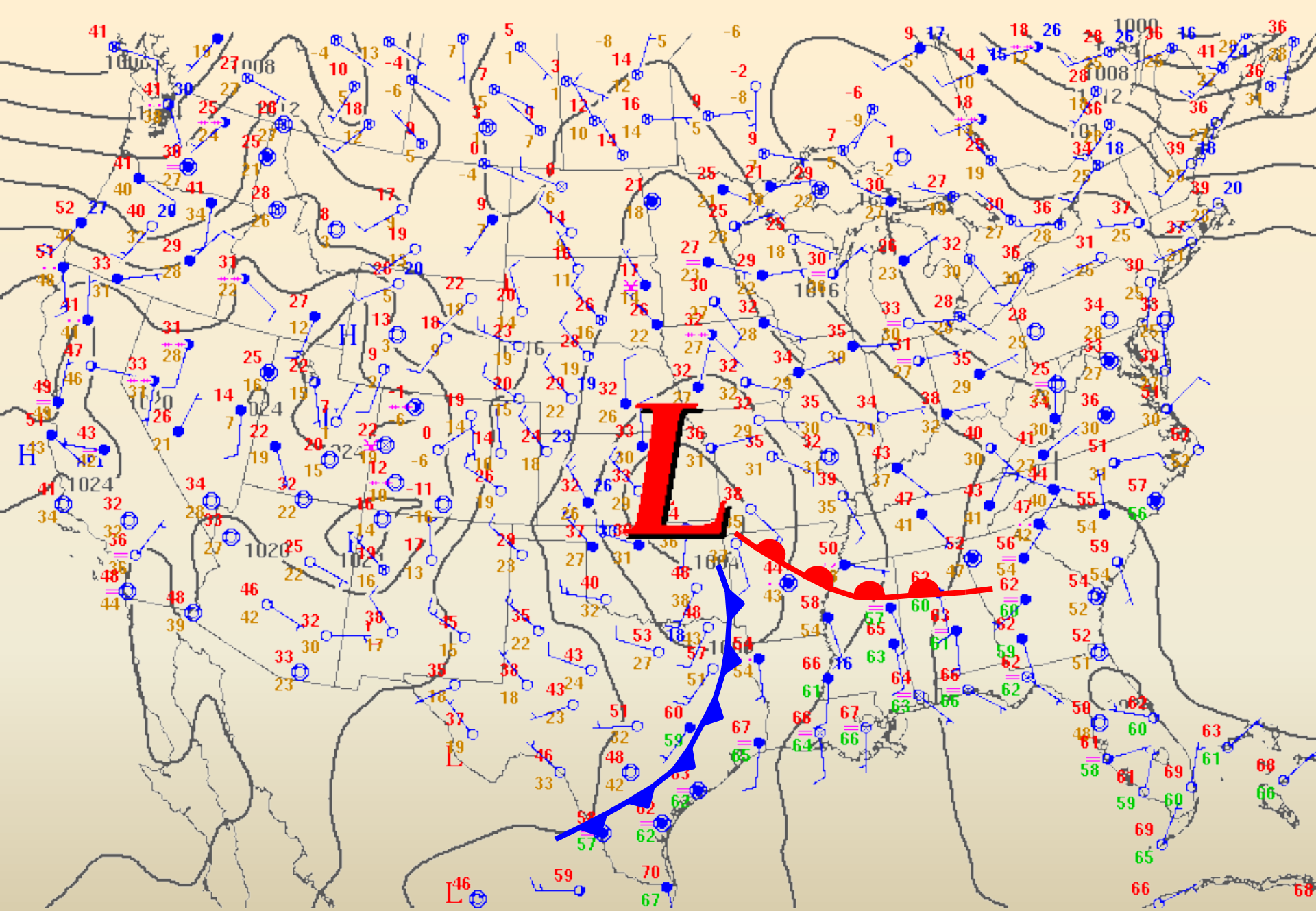


Positively Tilted Trough Axis


060211/1200 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts



Neutrally Tilted Trough Axis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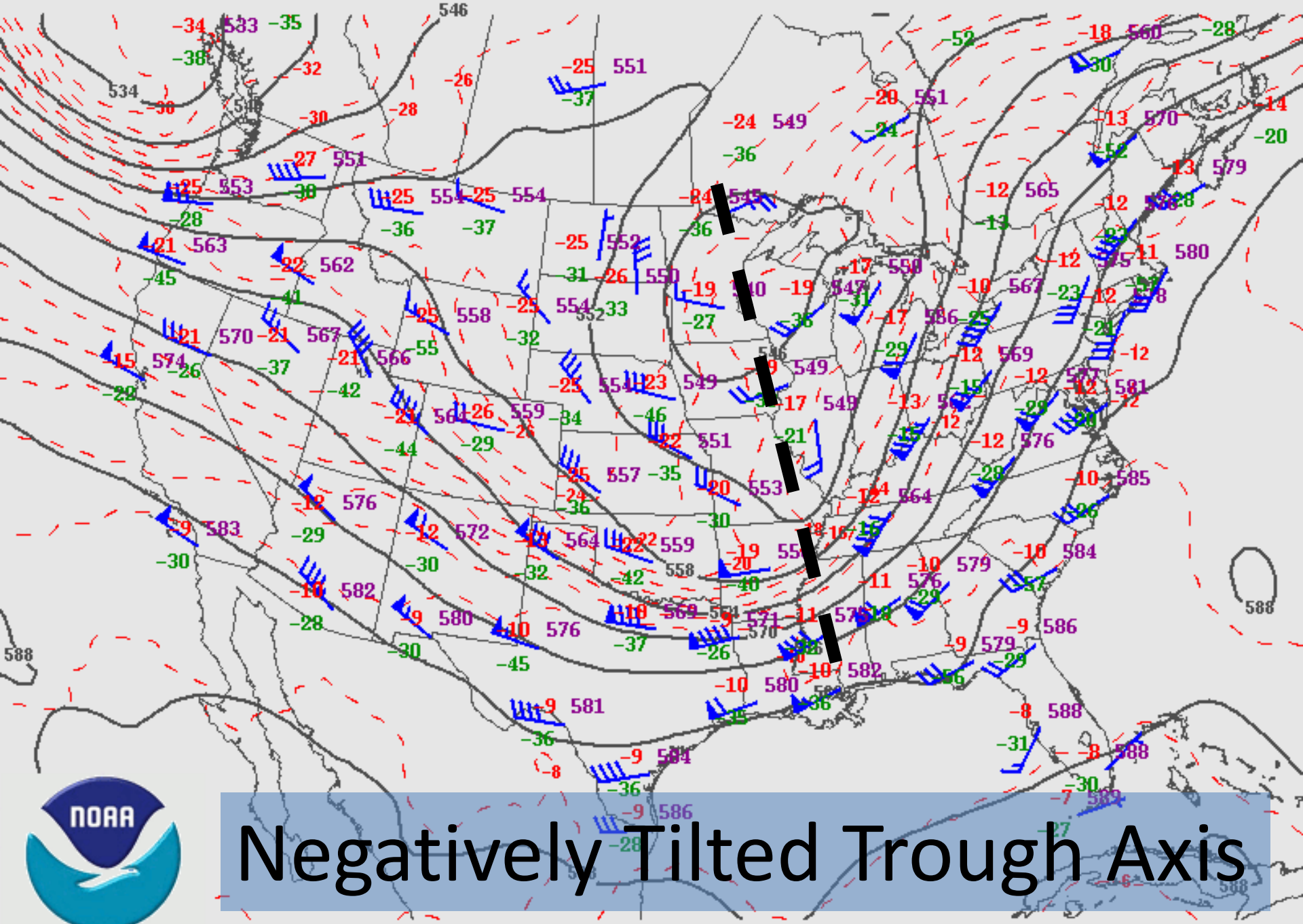
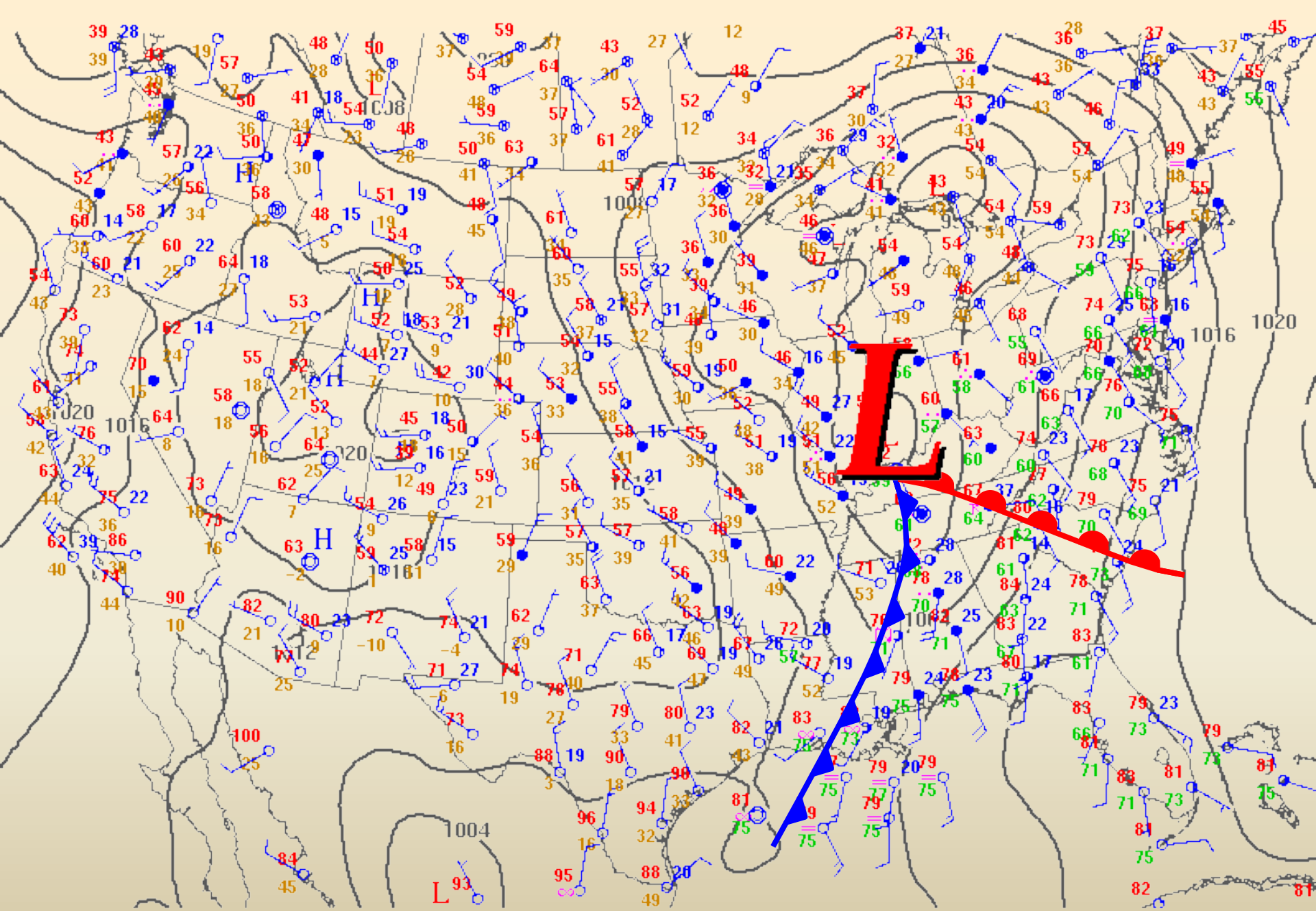
080110/1200 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts



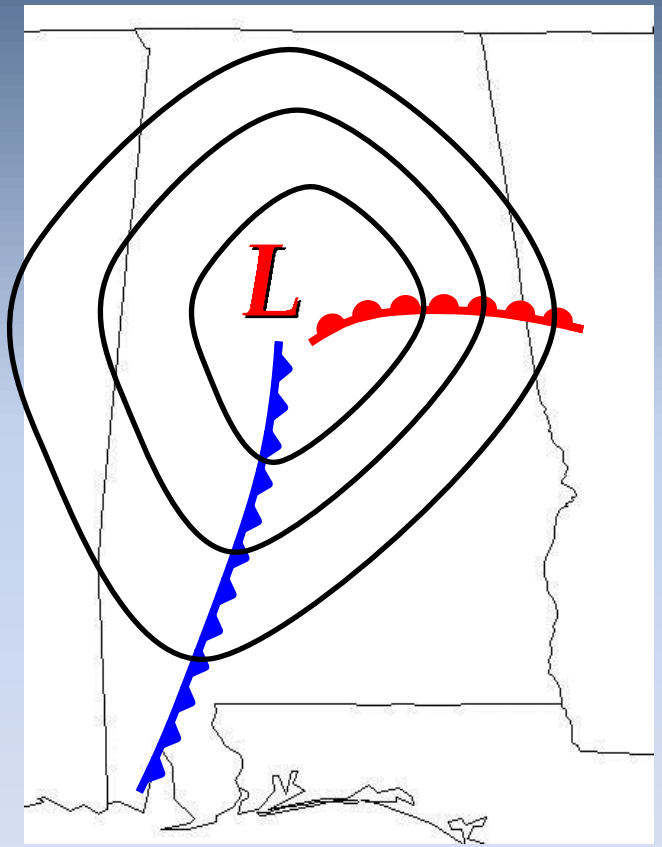
Negatively Tilted Trough Axis

National Weather Service
Storm Prediction Center



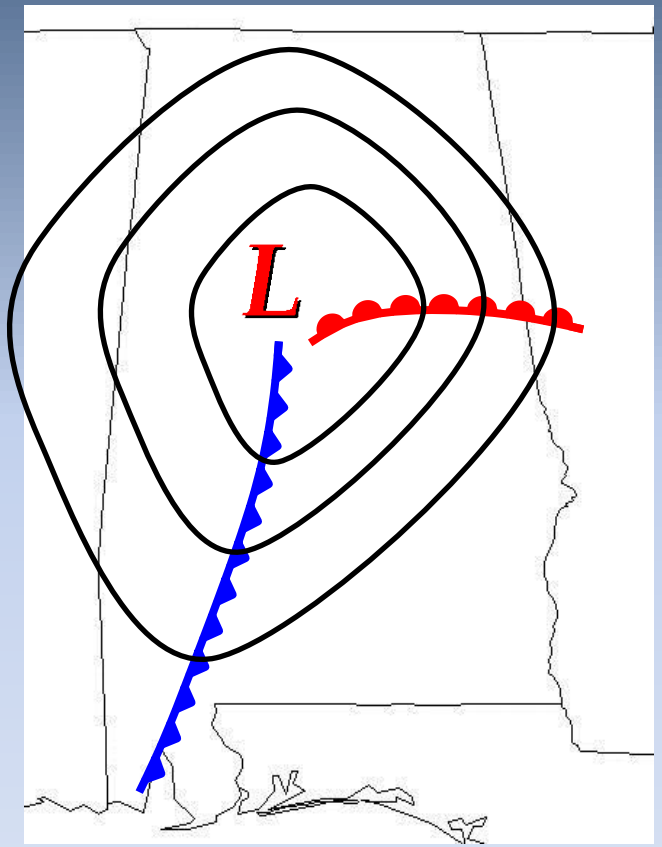
110428/0000 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts

Synoptic Weather Patterns: The Schematics to Getting Thunderstorms



3 Main Things to get thunderstorms fired up

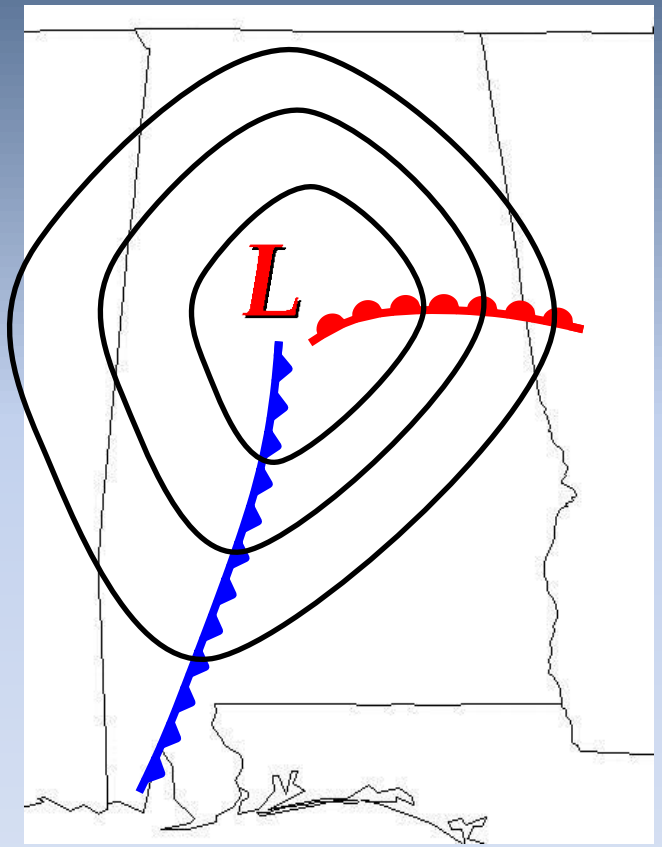
Synoptic Weather Patterns: The Schematics to Getting Thunderstorms



3 Main Things

- Moisture
  - Warm Front

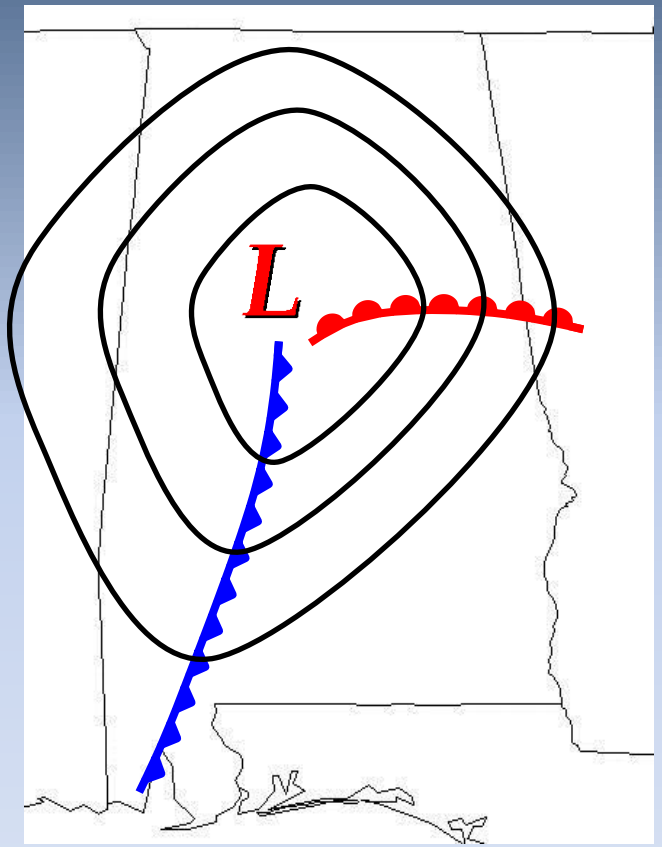
Synoptic Weather Patterns: The Schematics to Getting Thunderstorms



3 Main Things

- Moisture
  - – Warm Front
- Lift Mechanism
  - – Cold Front
  - –Warm Front

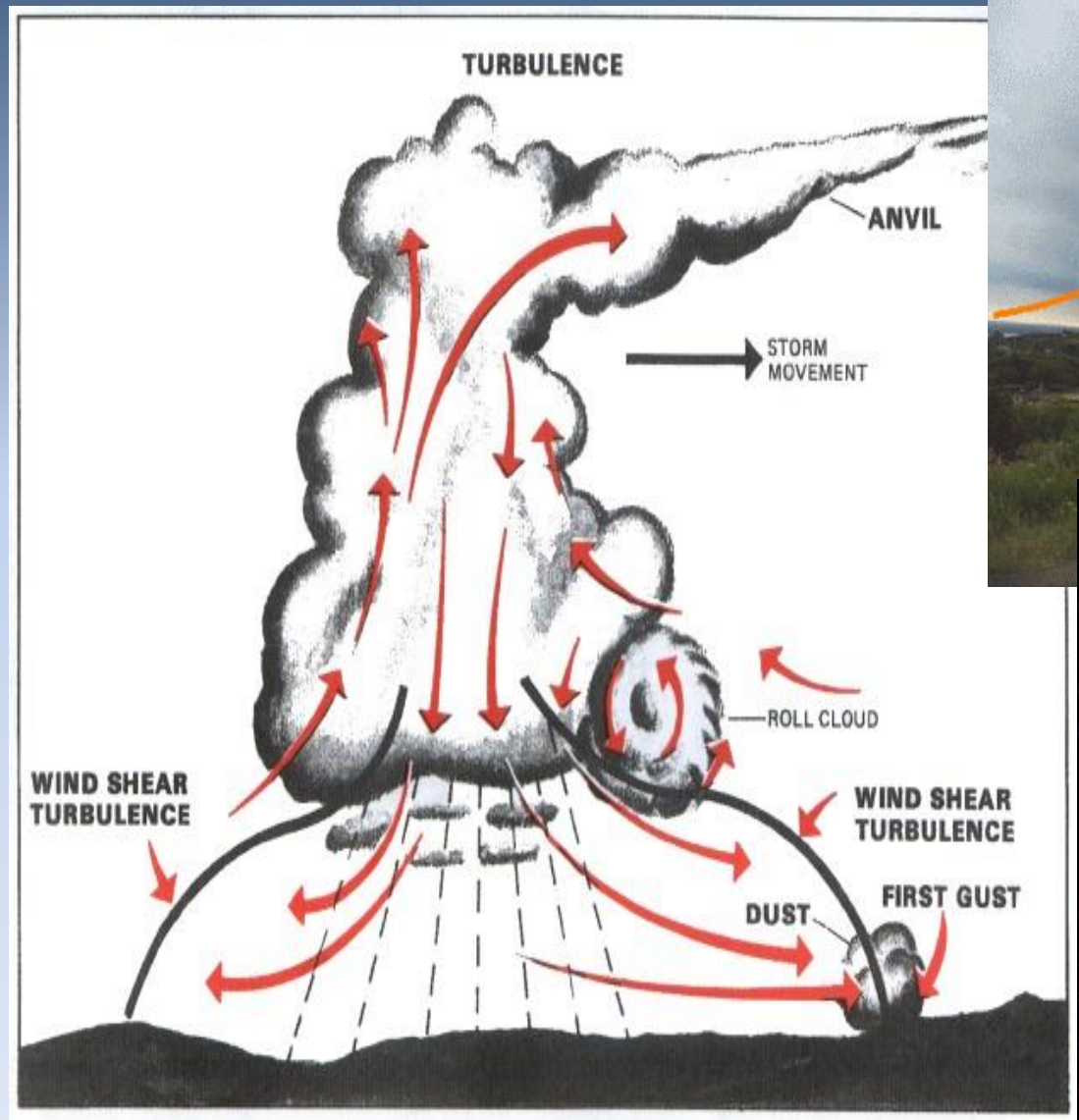
Synoptic Weather Patterns: The Schematics to Getting Thunderstorms

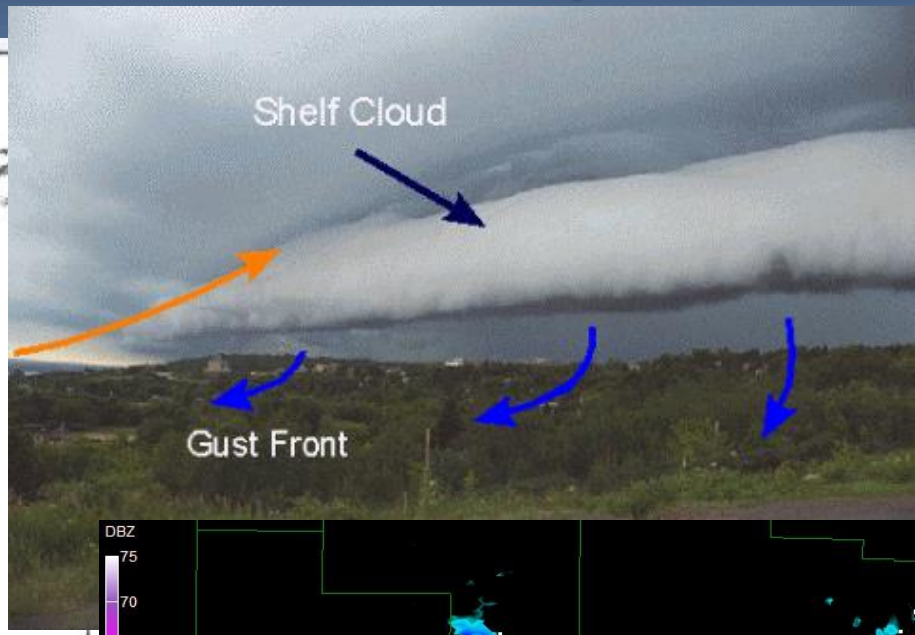


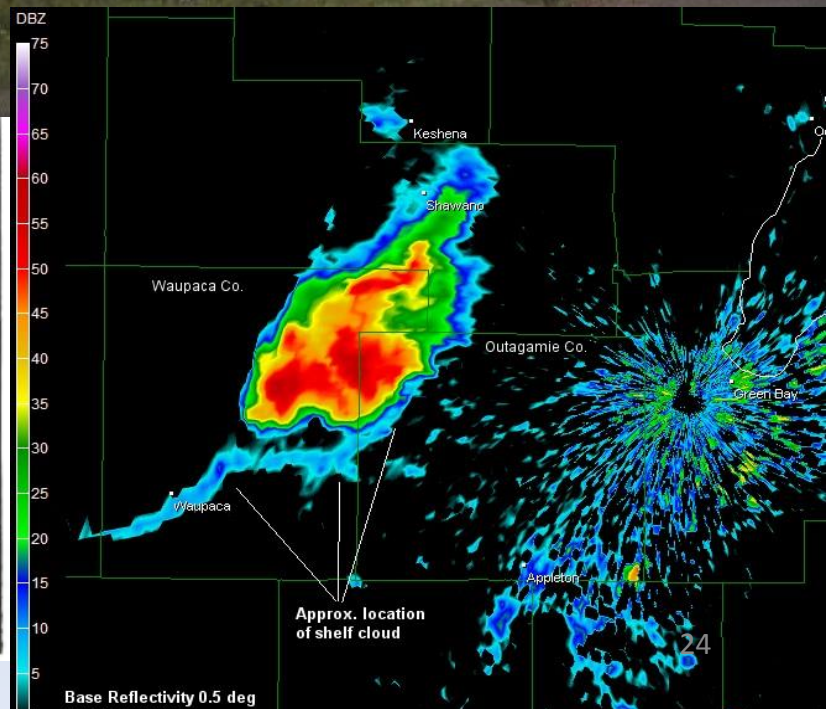
3 Main Things

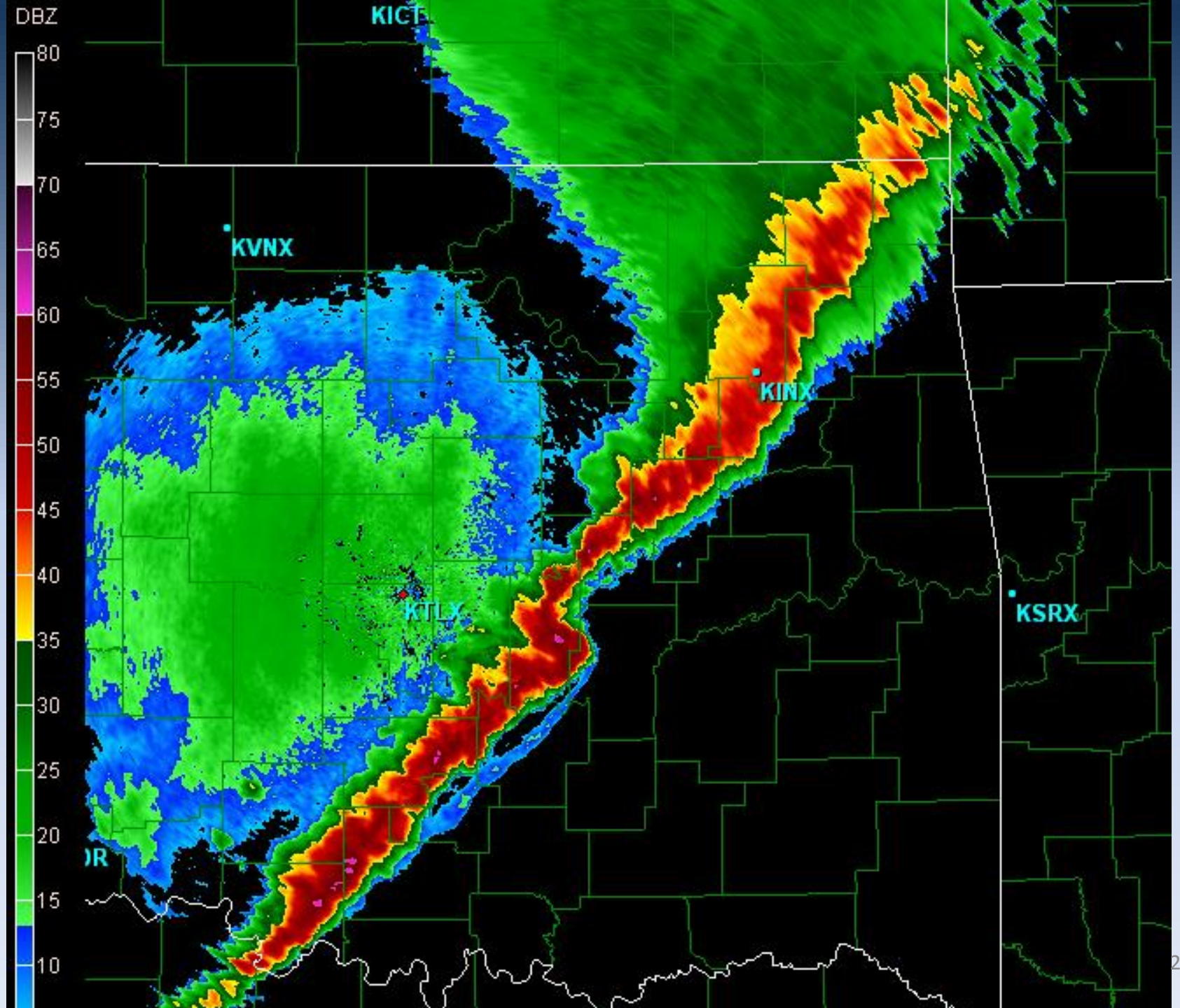
- Moisture
  - Warm Front
- Lift Mechanism
  - Other Types of Boundaries

The 3-Dimensional Atmosphere
Gust Front (other sources of lift)








DBZ
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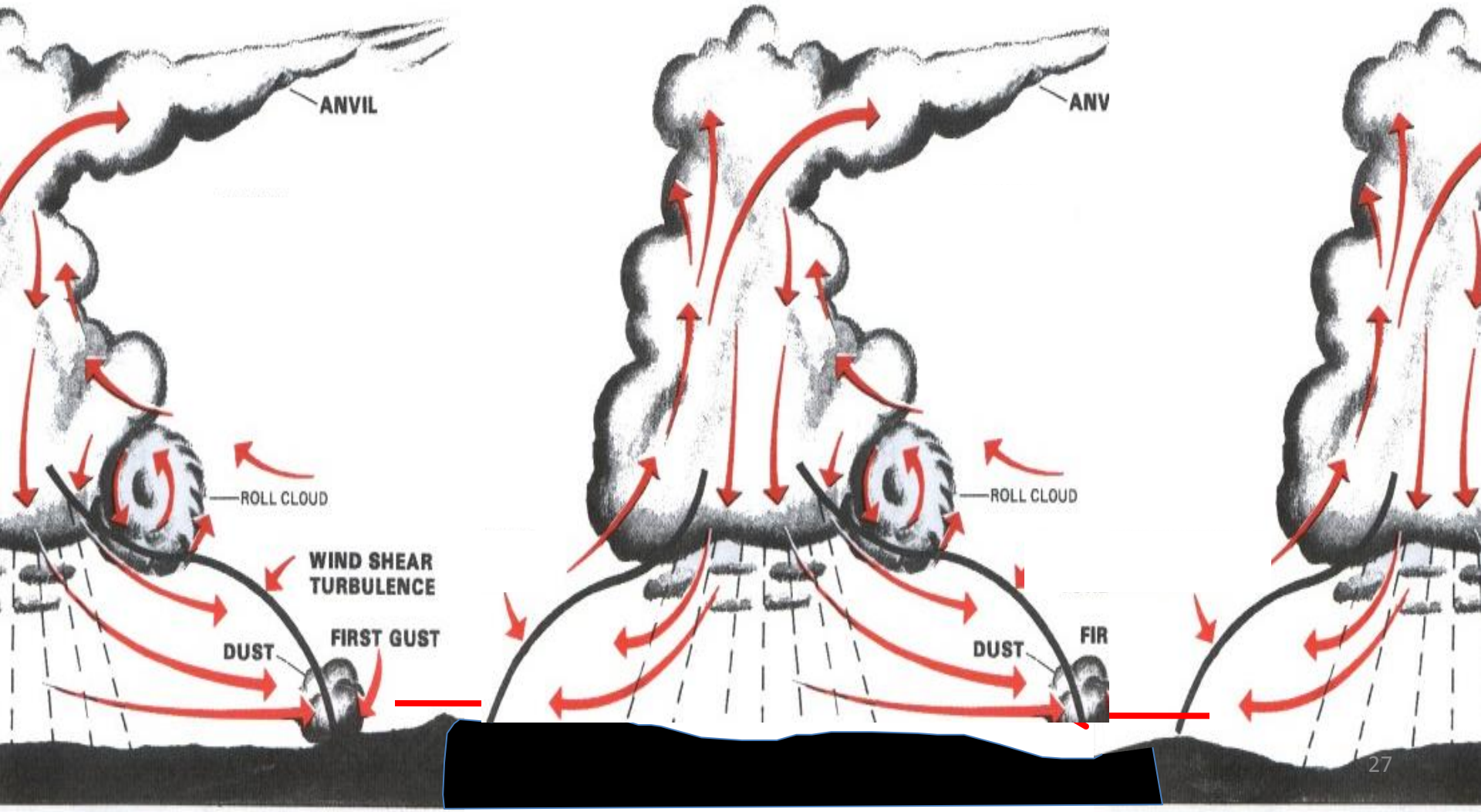
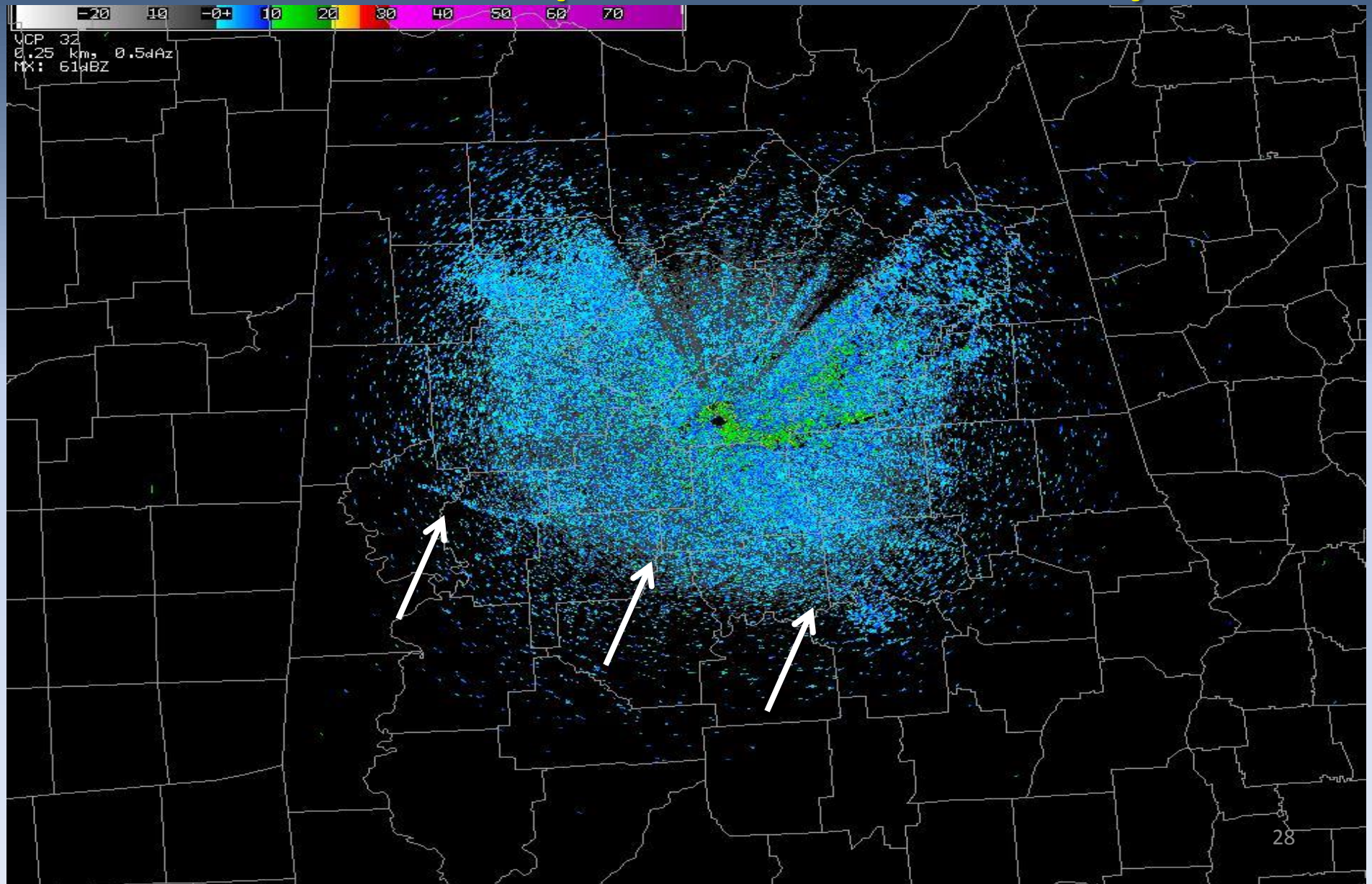
KICT
KVNX
KINX
KTLX
KSRX

Tornado Watch # 947 - Valid from 805 PM until 300 AM CST

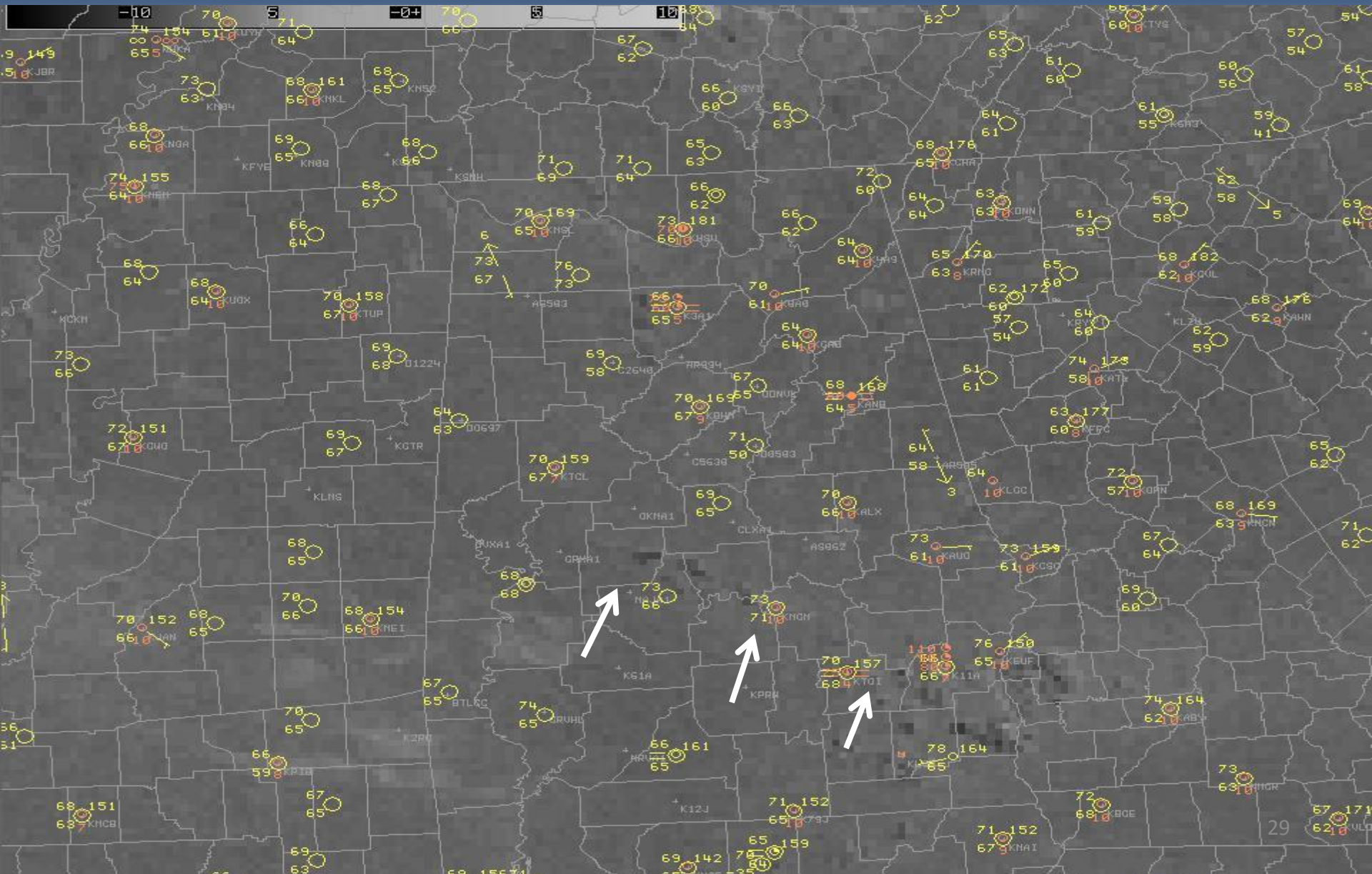
The 3-Dimensional Atmosphere
Gust Front (other sources of lift)



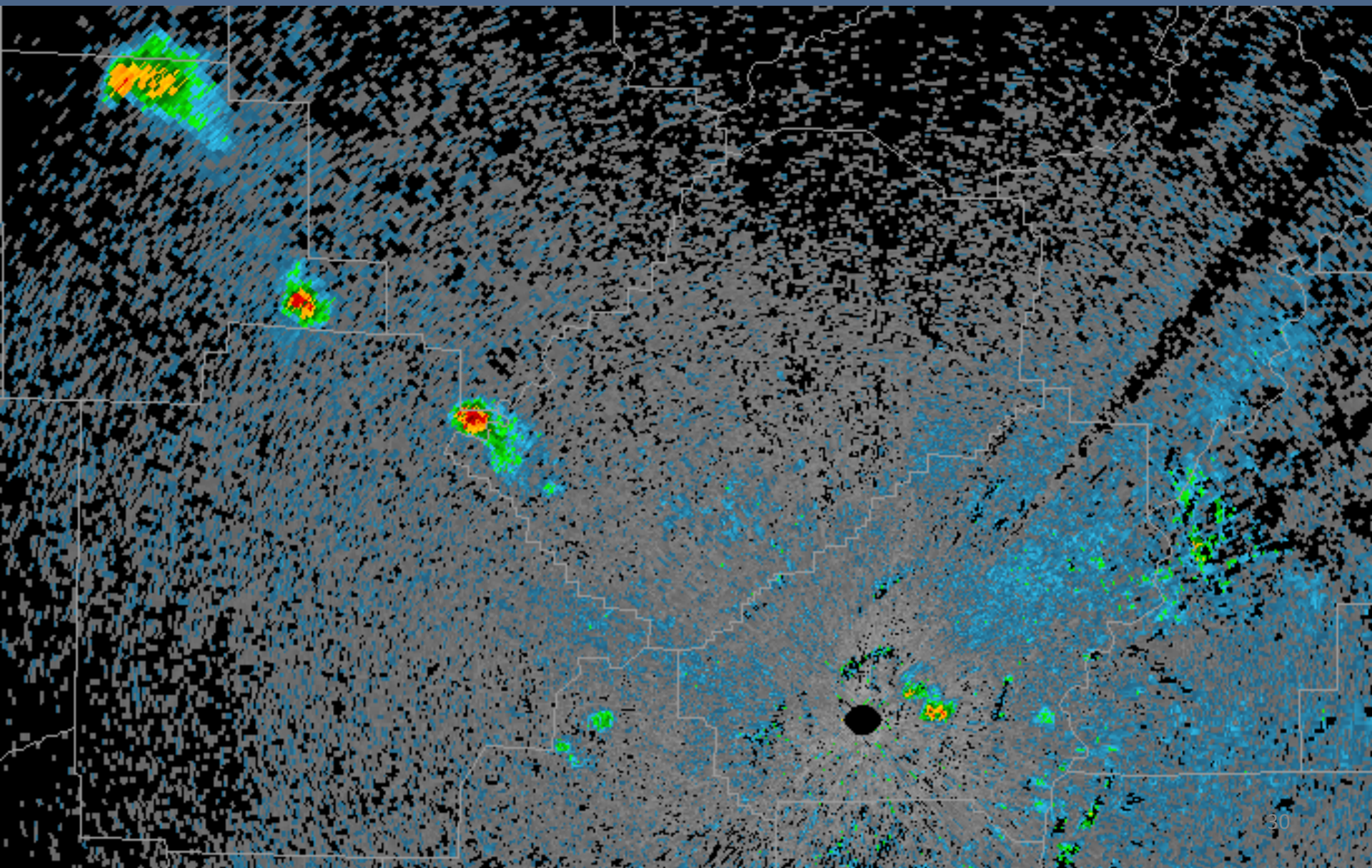
The 3-Dimensional Atmosphere
Sea Breeze (other sources of lift)



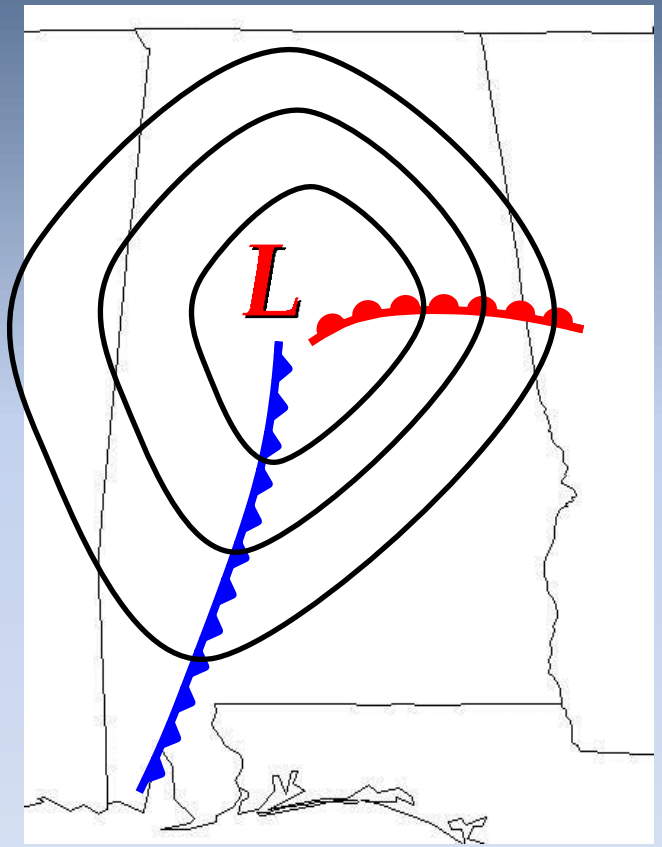
The 3-Dimensional Atmosphere
Sea Breeze



The 3-Dimensional Atmosphere
Thunderstorms caused by Sea Breeze



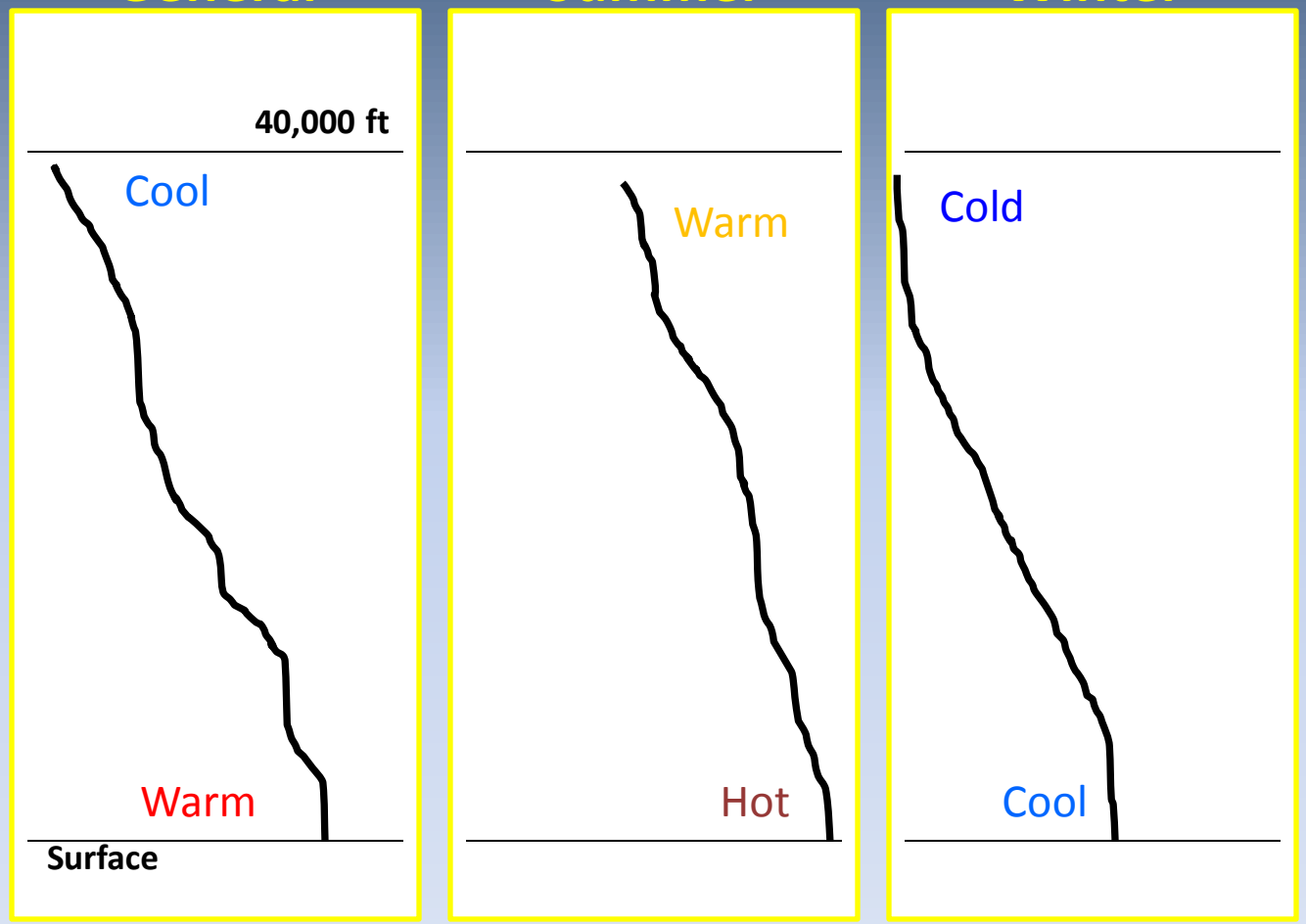
Synoptic Weather Patterns: The Schematics to Getting Thunderstorms



3 Main Things

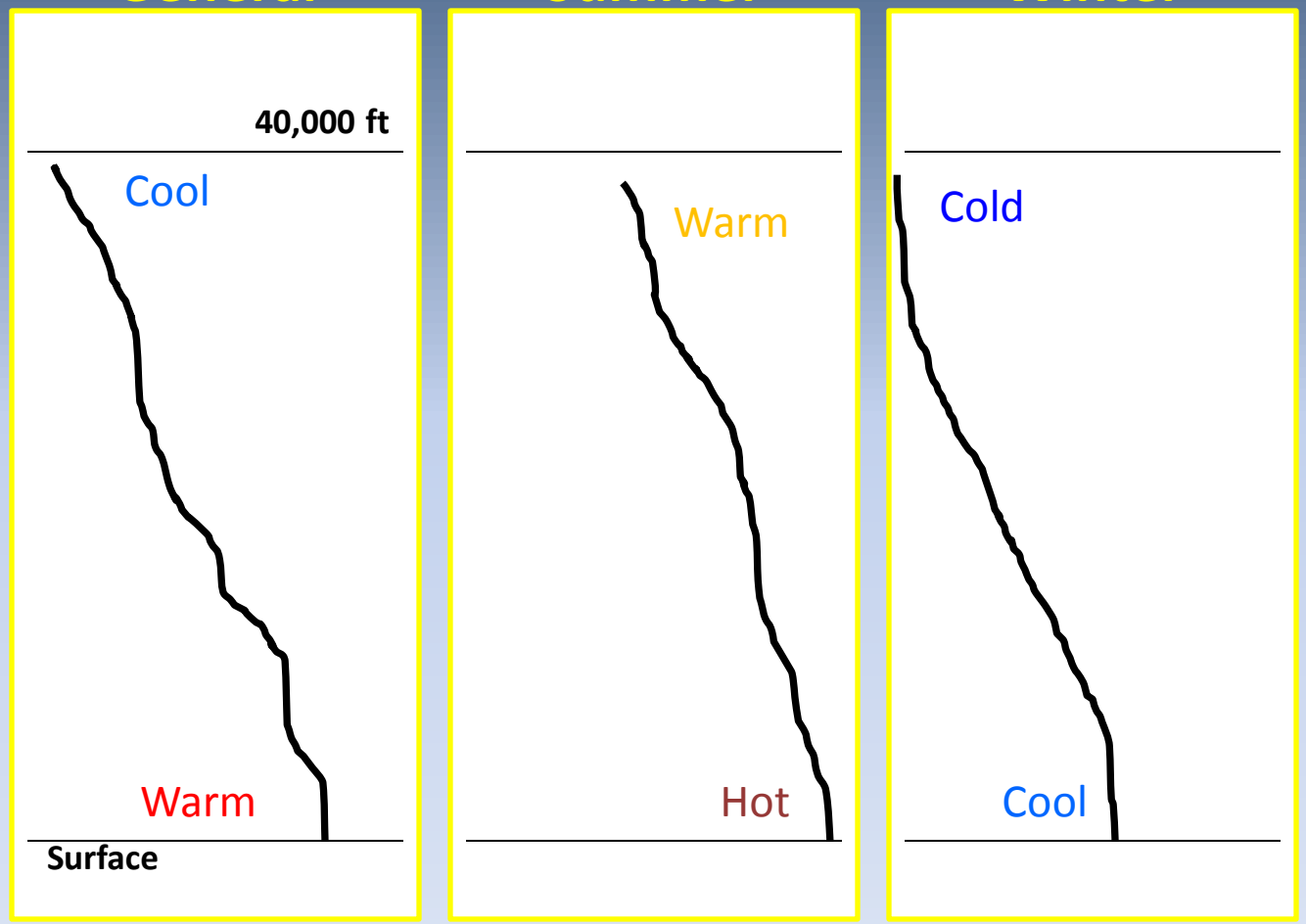
- Moisture
- Lift Mechanism
- Instability

The 3-Dimensional Atmosphere Instability



- In basic terms, the instability of the atmosphere is measured based upon how warm it is at the surface versus how cold it is aloft.
- In general, the atmosphere gets colder as you go up.
- During the summer, it is a lot hotter at the surface, but it also warm aloft
- In the winter it is colder at the surface, but it is also colder in the upper atmosphere, as well.

The 3-Dimensional Atmosphere Instability



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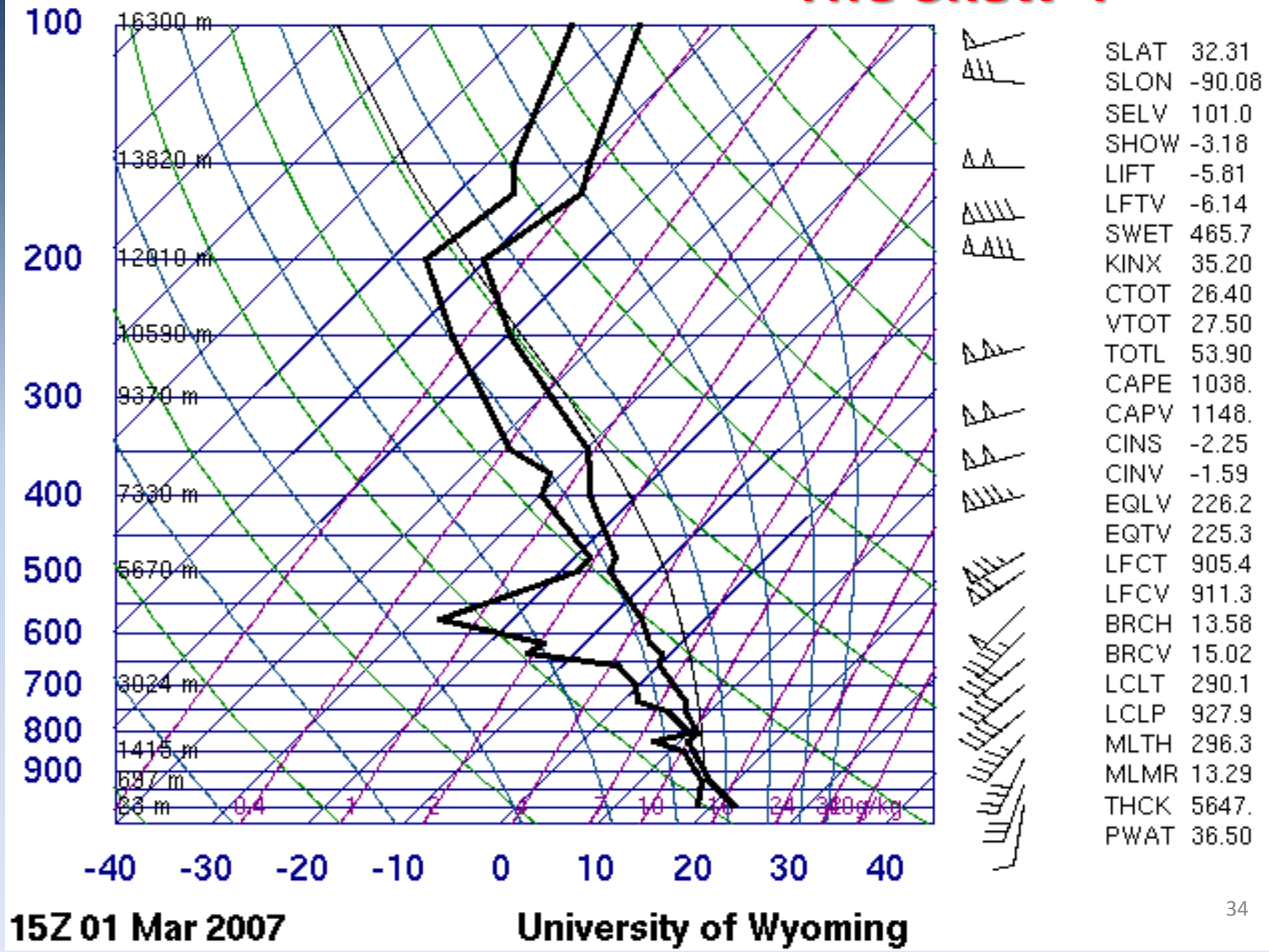
- During the summer, it is a lot hotter at the surface, but it also warm aloft
- In the winter it is colder at the surface, but it is also colder in the upper atmosphere, as well.
- How is the instability calculated?

The Skew-T


72235 JAN Jackson Thompson Fld
100
200
300
400
500
600
700
800
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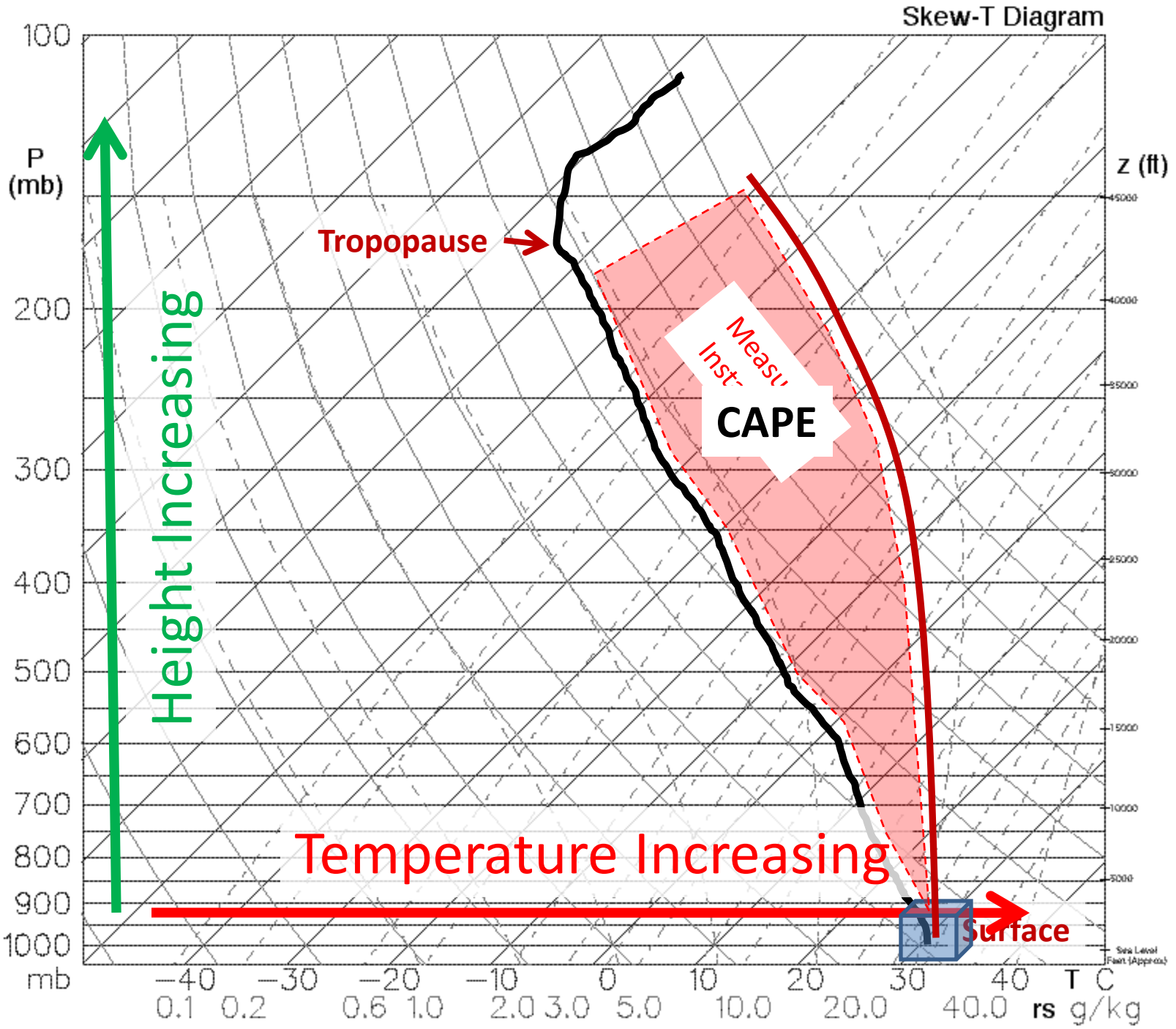
16300 m
13820 m
12010 m
10590 m
9370 m
7330 m
5670 m
3024 m
1415 m
697 m
23 m
-40
-30
-20
-10
0
10
20
30
40
15Z 01 Mar 2007
University of Wyoming
SLAT 32.31
SLON -90.08
SELV 101.0
SHOW -3.18
LIFT -5.81
LFTV -6.14
SWET 465.7
KINX 35.20
CTOT 26.40
VTOT 27.50
TOTL 53.90
CAPE 1038.
CAPV 1148.
CINS -2.25
CINV -1.59
EQLV 226.2
EQTV 225.3
LFCT 905.4
LFCV 911.3
BRCH 13.58
BRCV 15.02
LCLT 290.1
LCLP 927.9
MLTH 296.3
MLMR 13.29
THCK 5647.
PWAT 36.50

Multimedia Impact Briefing

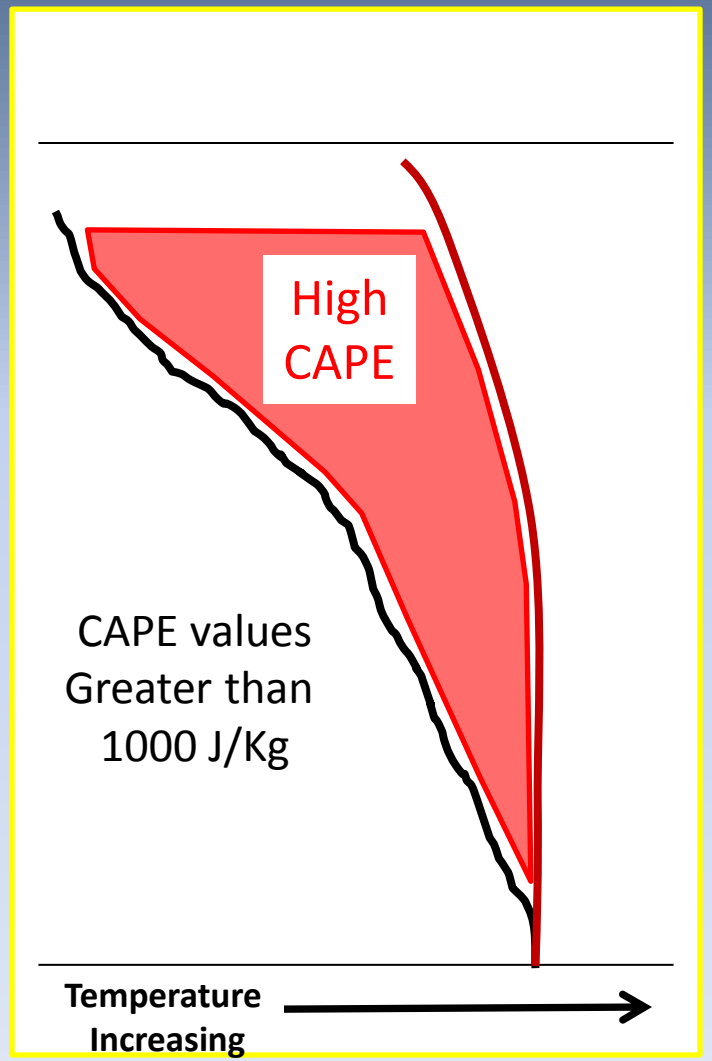
For Central Alabama

Morning Upper Air Balloon Launch

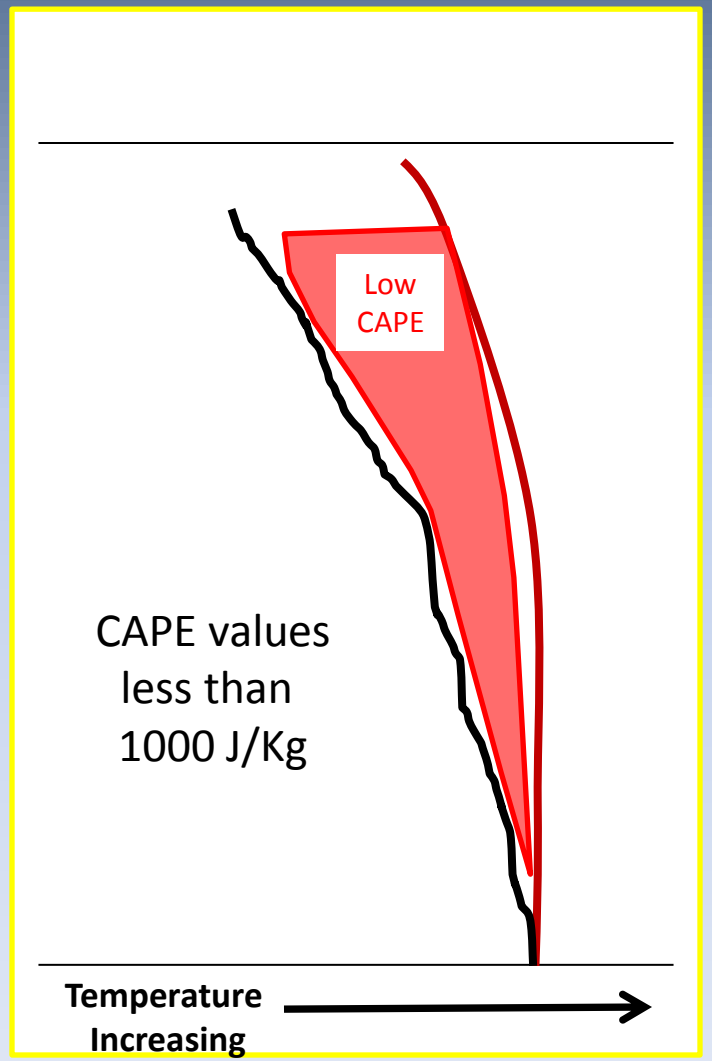

Skew-T Diagram
P (mb)
z (ft)
100
200
300
400
500
600
700
800
900
1000
mb
Tropopause
CAPE
Height Increasing
Temperature Increasing
Surface
−40 −30 −20 −10 0 10 20 30 40 T C
0.1 0.2 0.6 1.0 2.0 3.0 5.0 10.0 20.0 40.0 rs g/kg

The 3-Dimensional Atmosphere Instability

Hot Surface/Cold Aloft

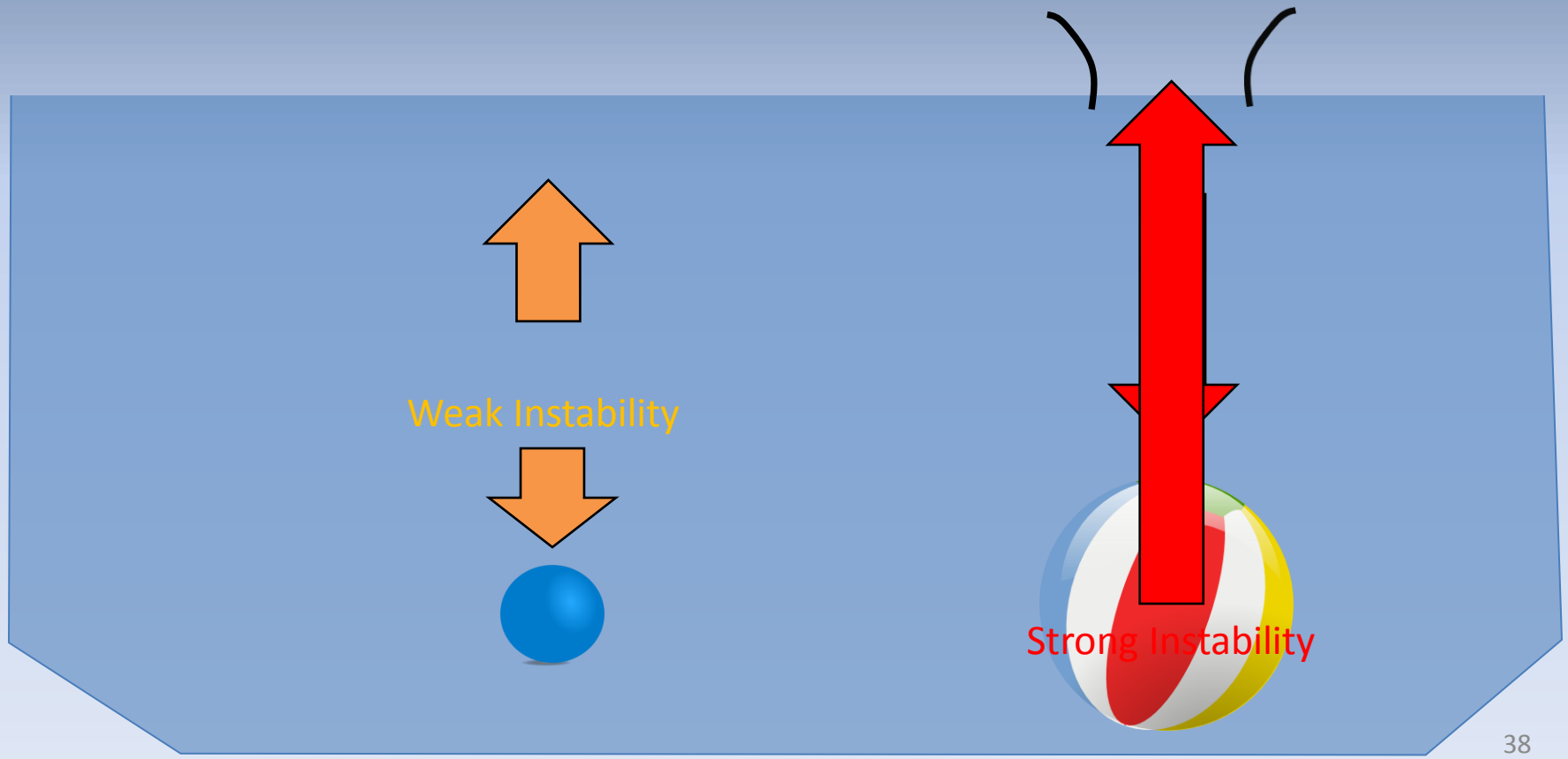


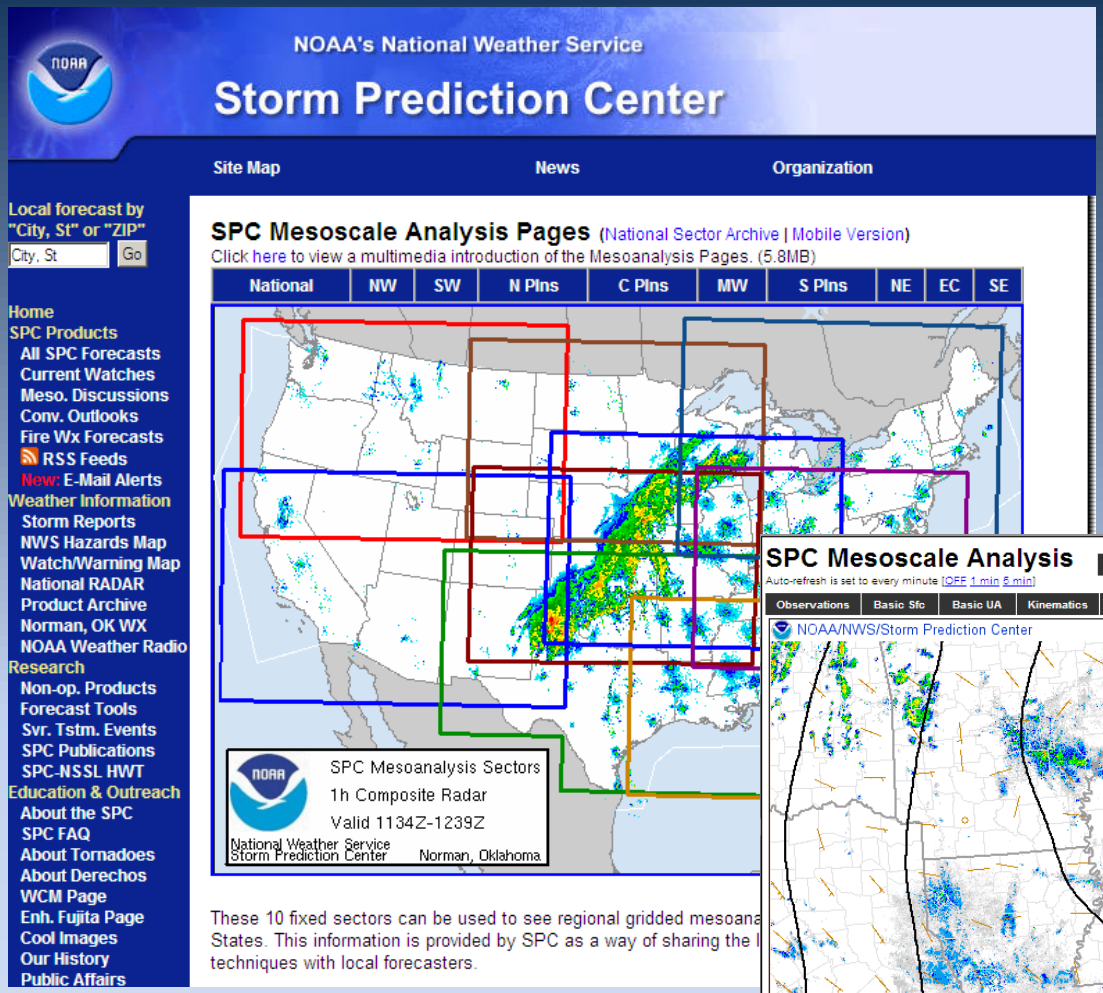
Hot Surface/Warm Aloft

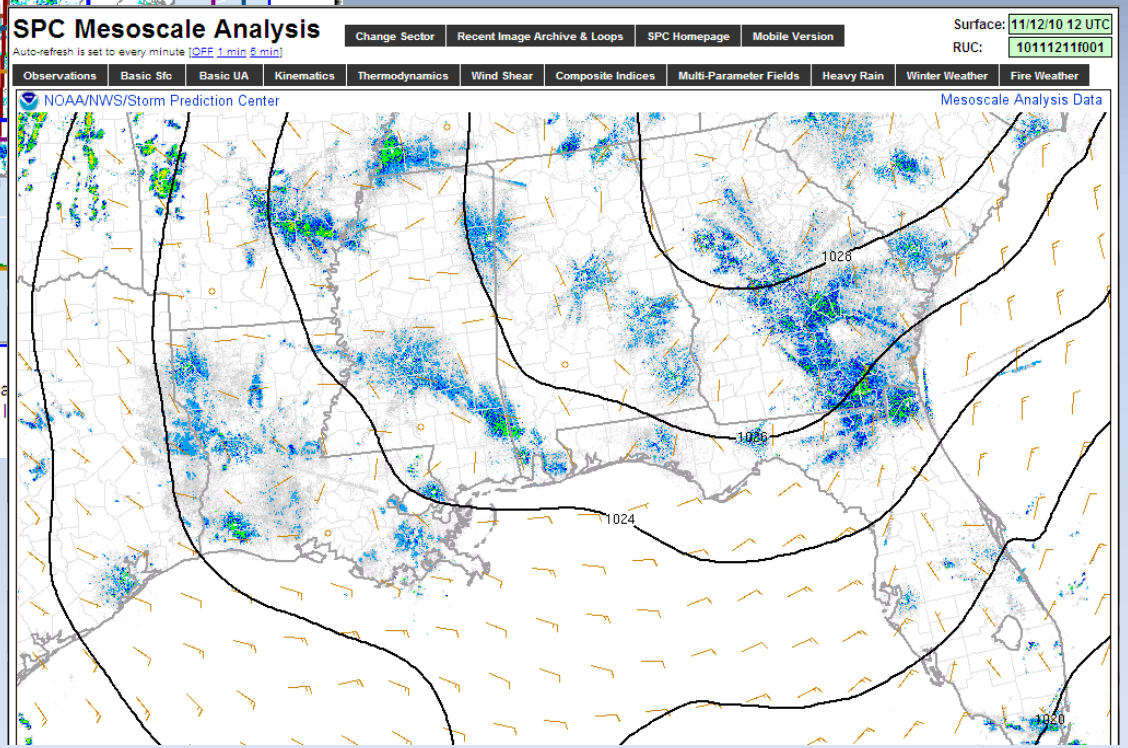


- CAPE stands for the Convective Available Potential Energy
- Depending on what type of CAPE exists (tall, short, skinny, fat) will determine the type and amount of thunderstorms that are possible (potential).

The 3-Dimensional Atmosphere Instability

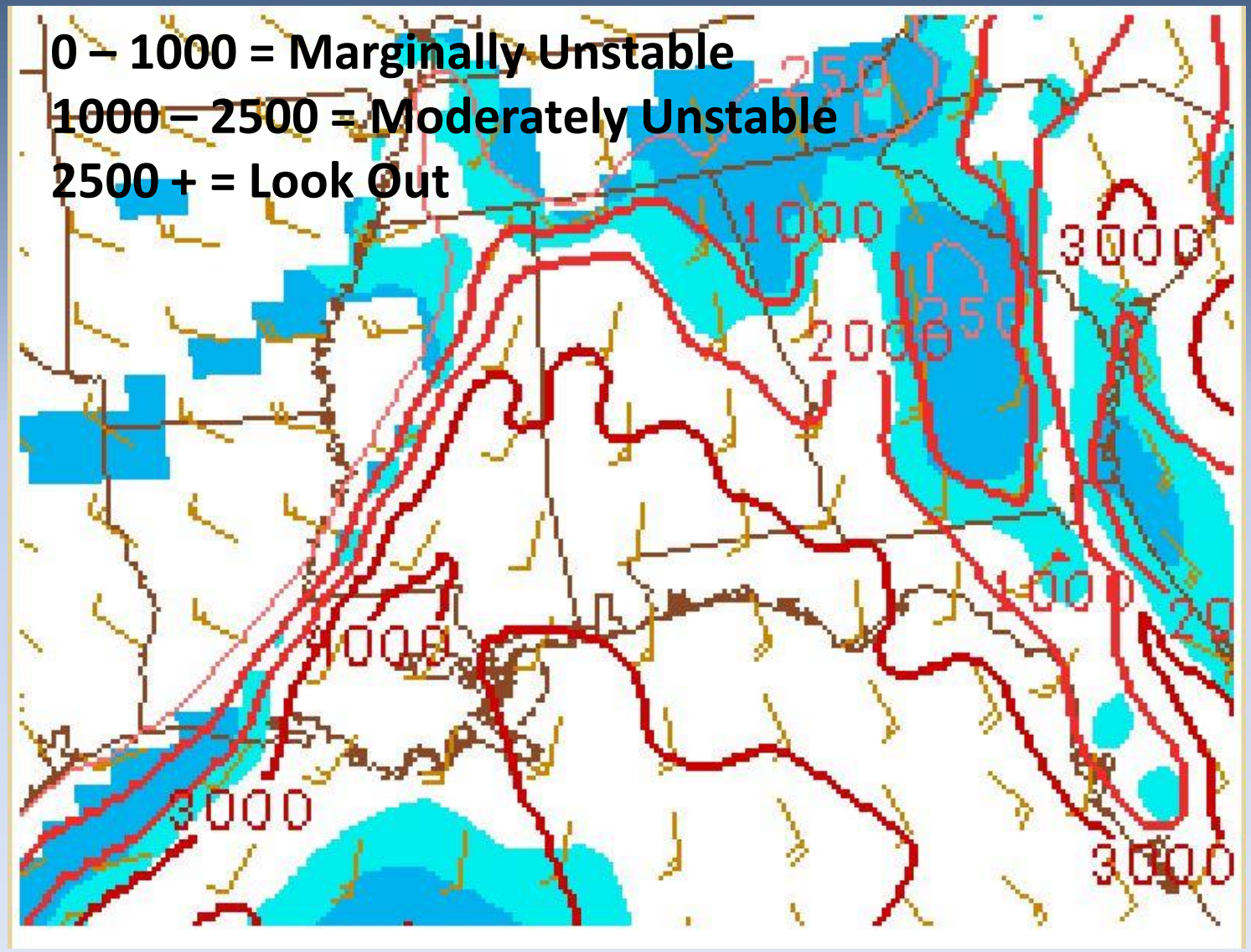


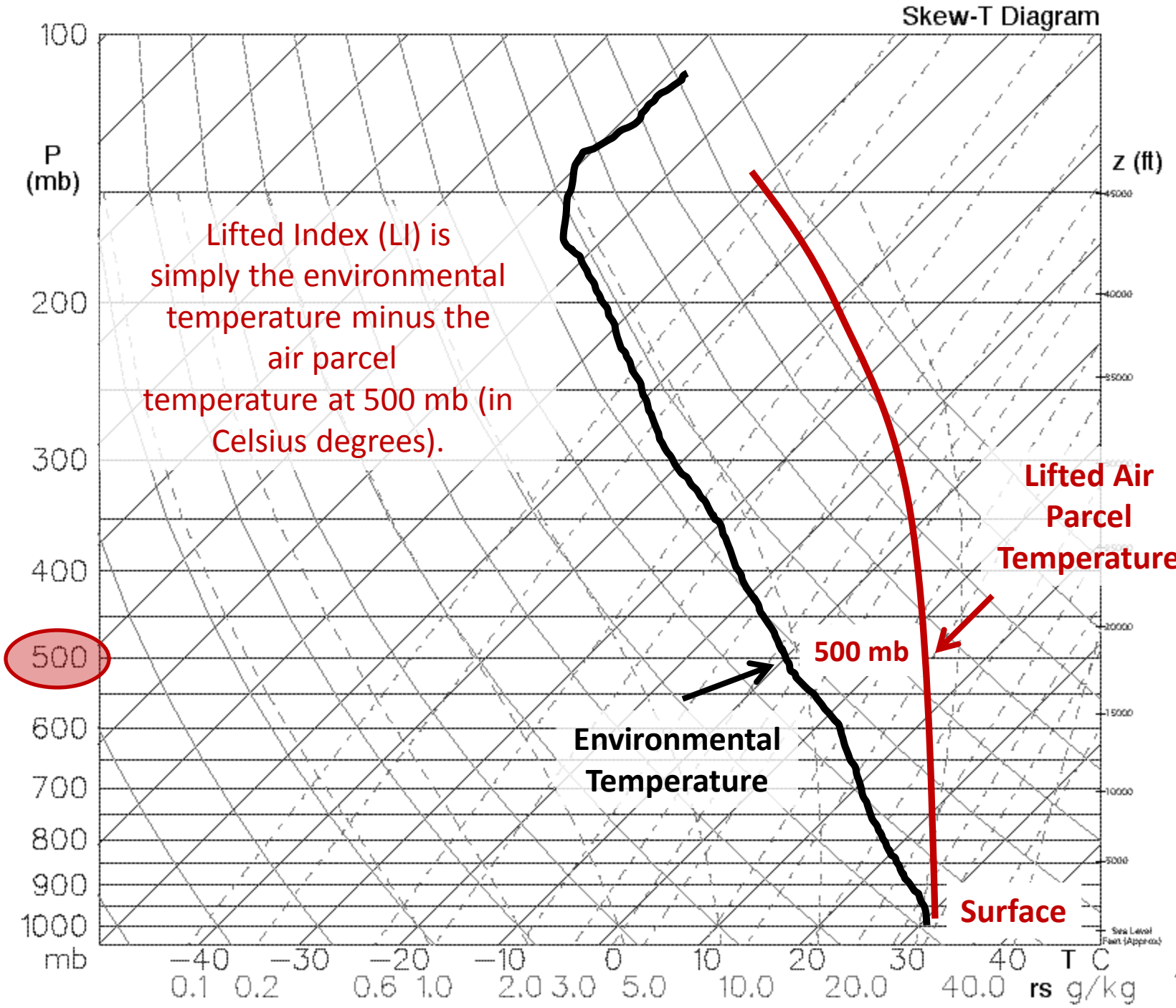




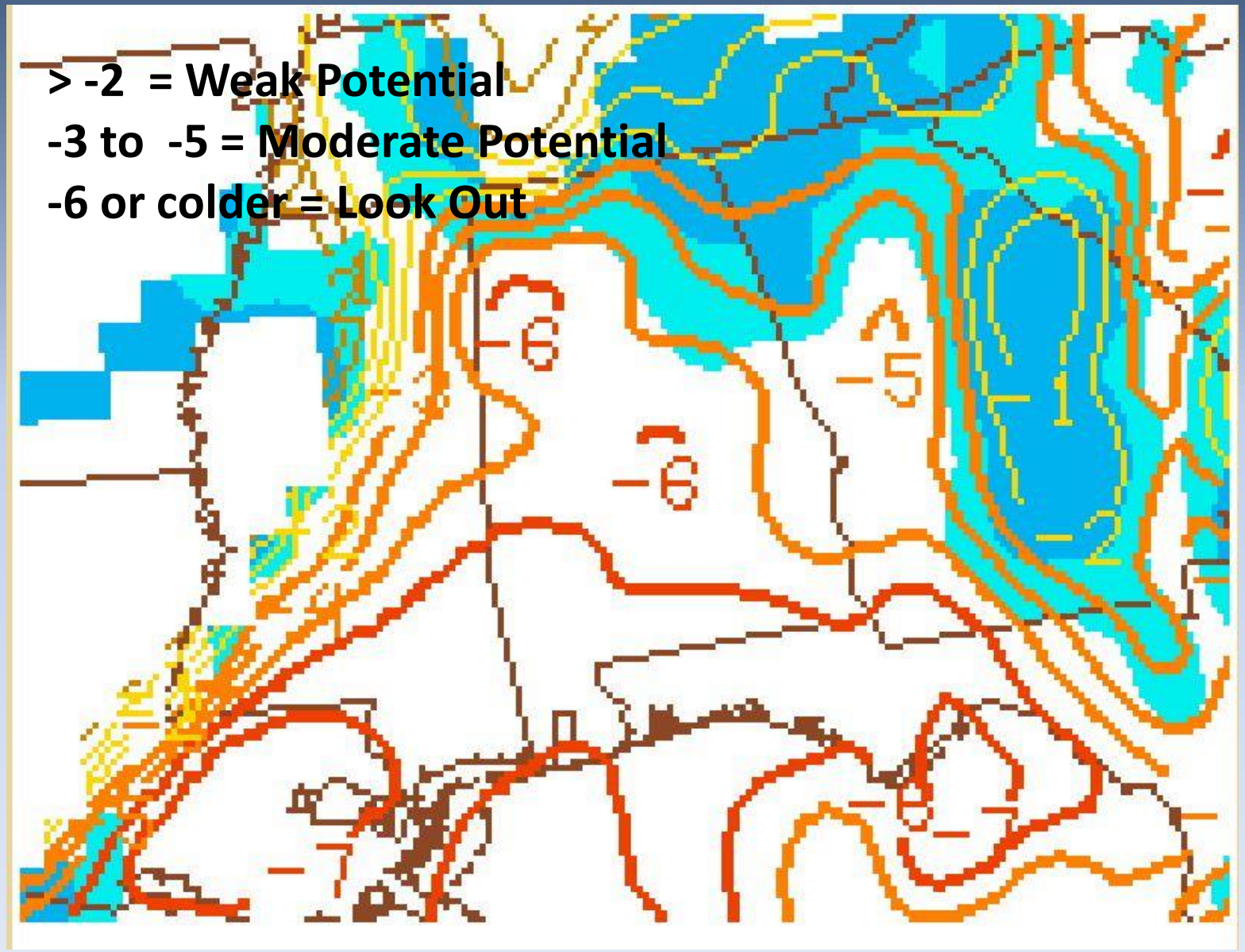
http://w1.spc.woc.noaa.gov/exper/mesoanalysis

The 3-Dimensional Atmosphere Instability

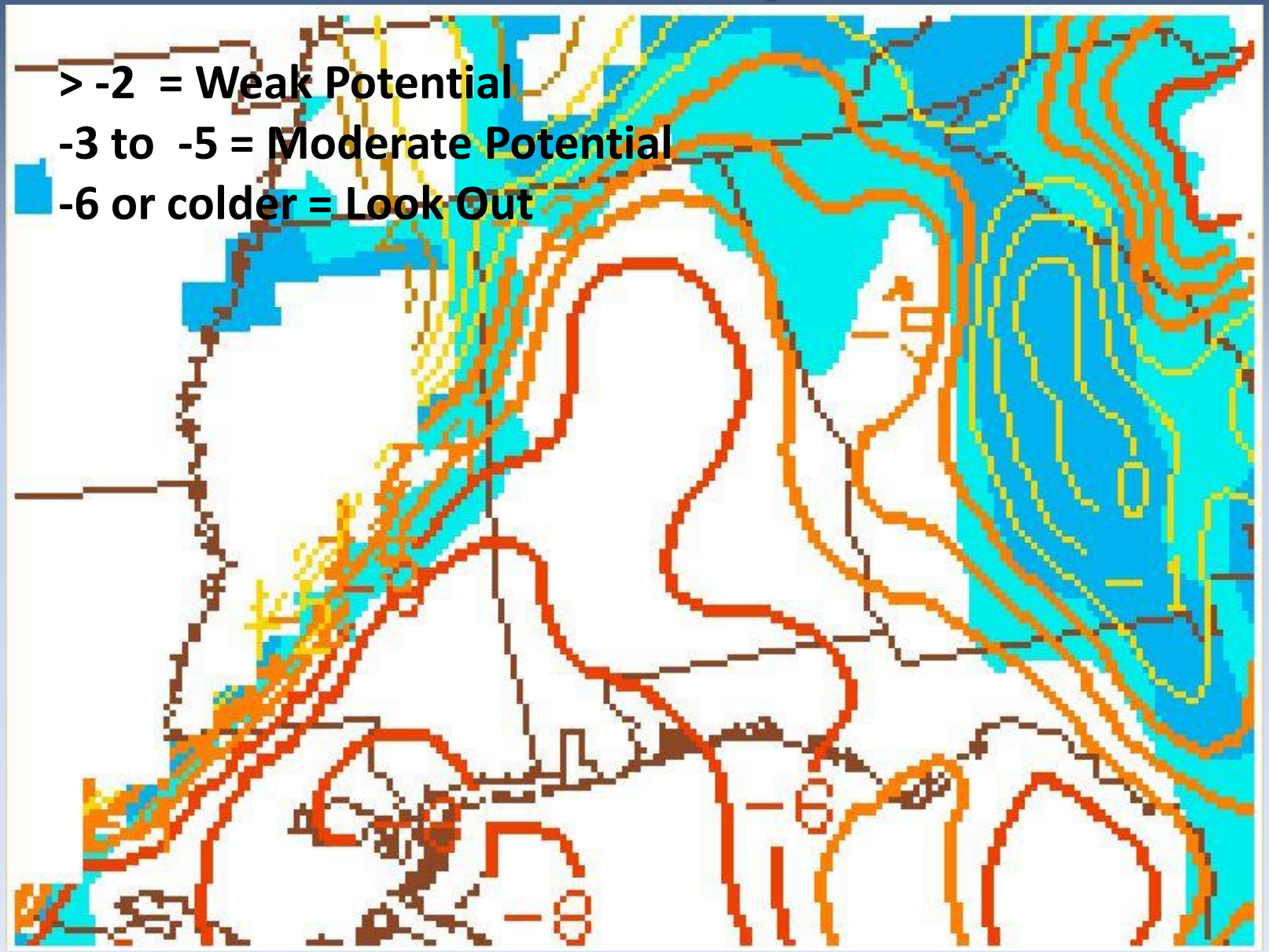



Skew-T Diagram
P (mb)
z (ft)
100
200
300
400
500
600
700
800
900
1000
mb
−40 −30 −20 −10 0 10 20 30 40 T C
0.1 0.2 0.6 1.0 2.0 3.0 5.0 10.0 20.0 40.0 rs g/kg
Lifted Index (LI) is simply the environmental temperature minus the air parcel temperature at 500 mb (in Celsius degrees).
Lifted Air Parcel Temperature
500 mb
Environmental Temperature
Surface

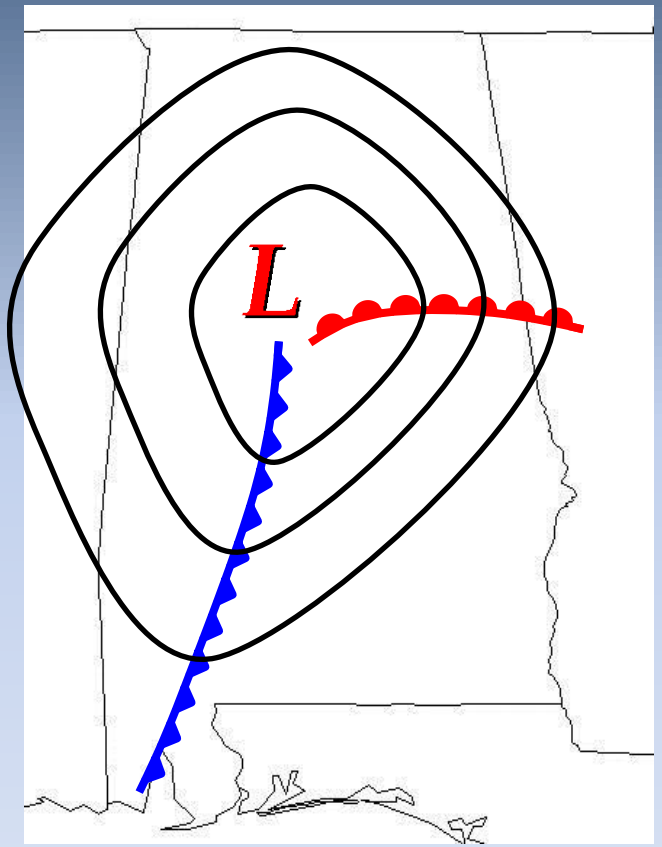
The 3-Dimensional Atmosphere Instability



The 3-Dimensional Atmosphere Instability



The Schematics to Getting Thunderstorms



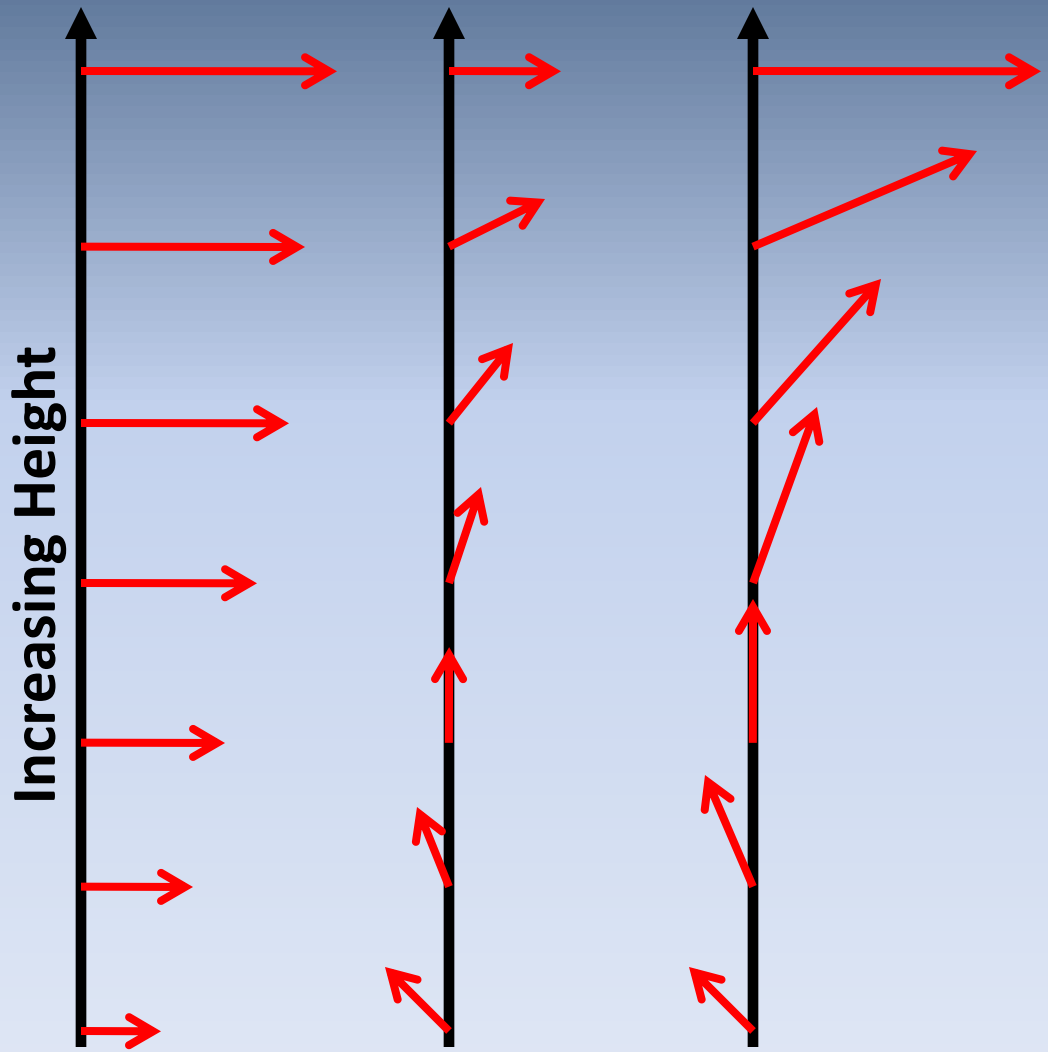
Thunderstorms

- Instability
- Moisture
- Lift Mechanism

Severe

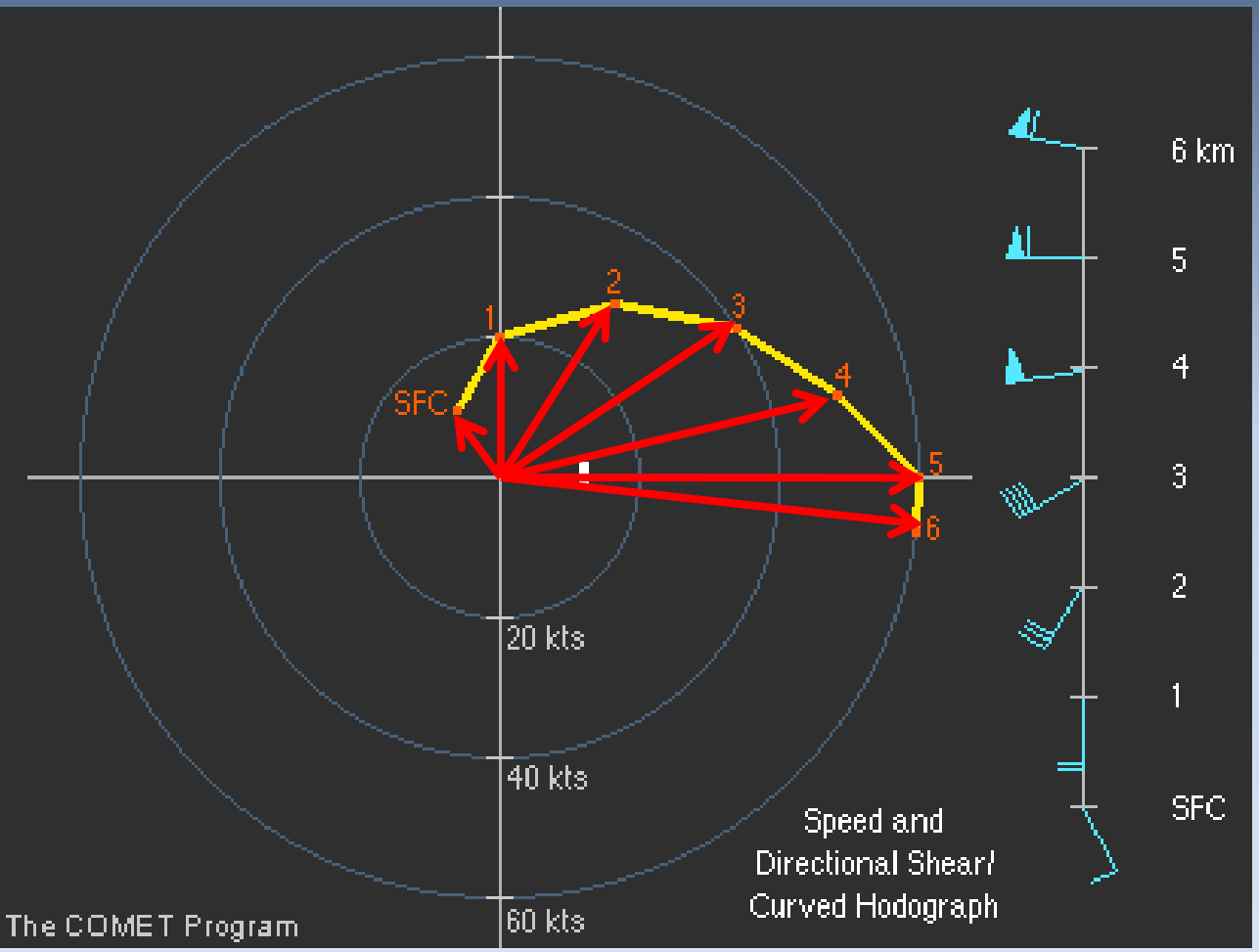
- Instability
- Wind Shear

The 3-Dimensional Atmosphere
Wind Shear

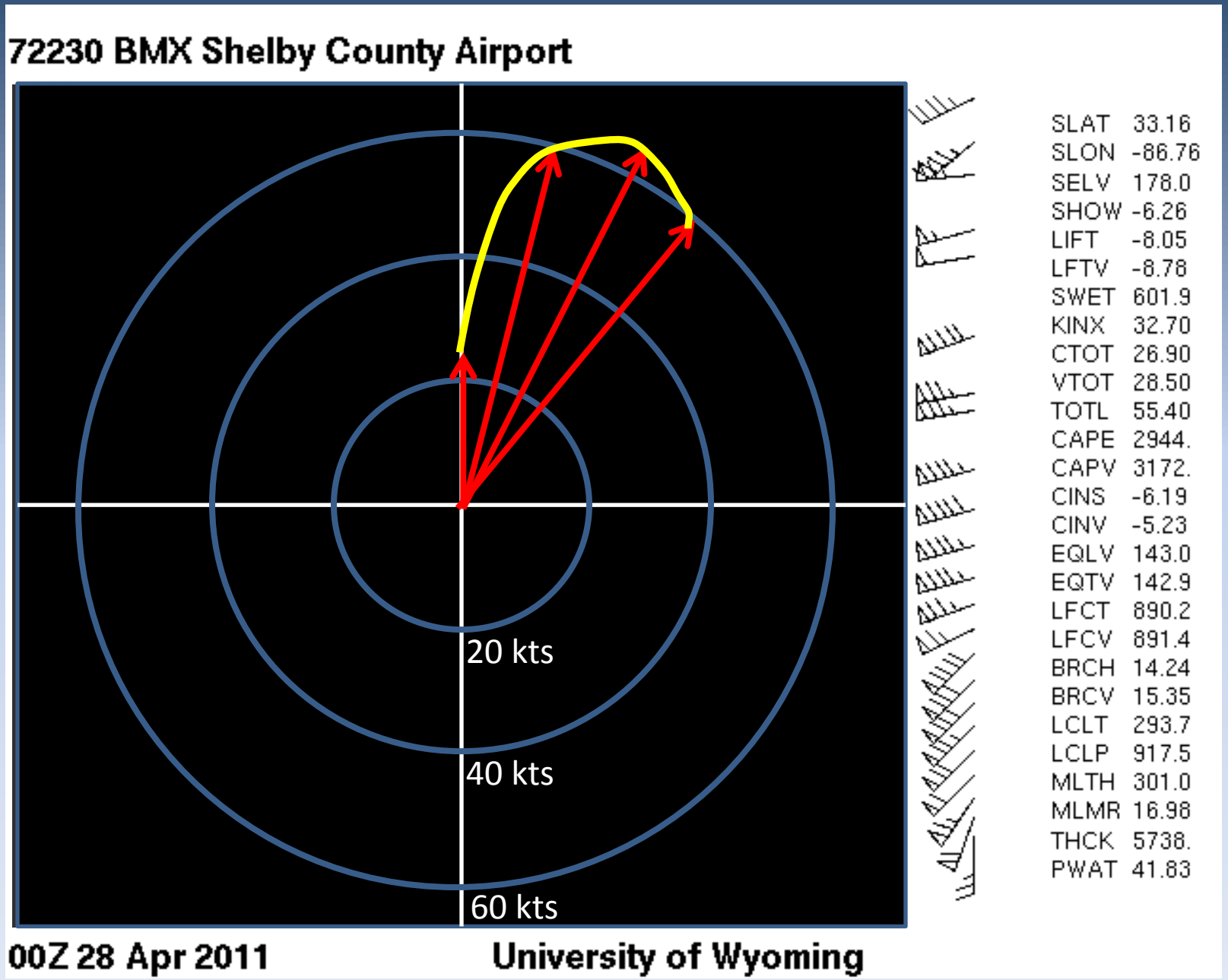


- Wind shear can be calculated in three ways
- Change in wind speed with height
- Change in wind direction with height
- Change in both speed and direction with height

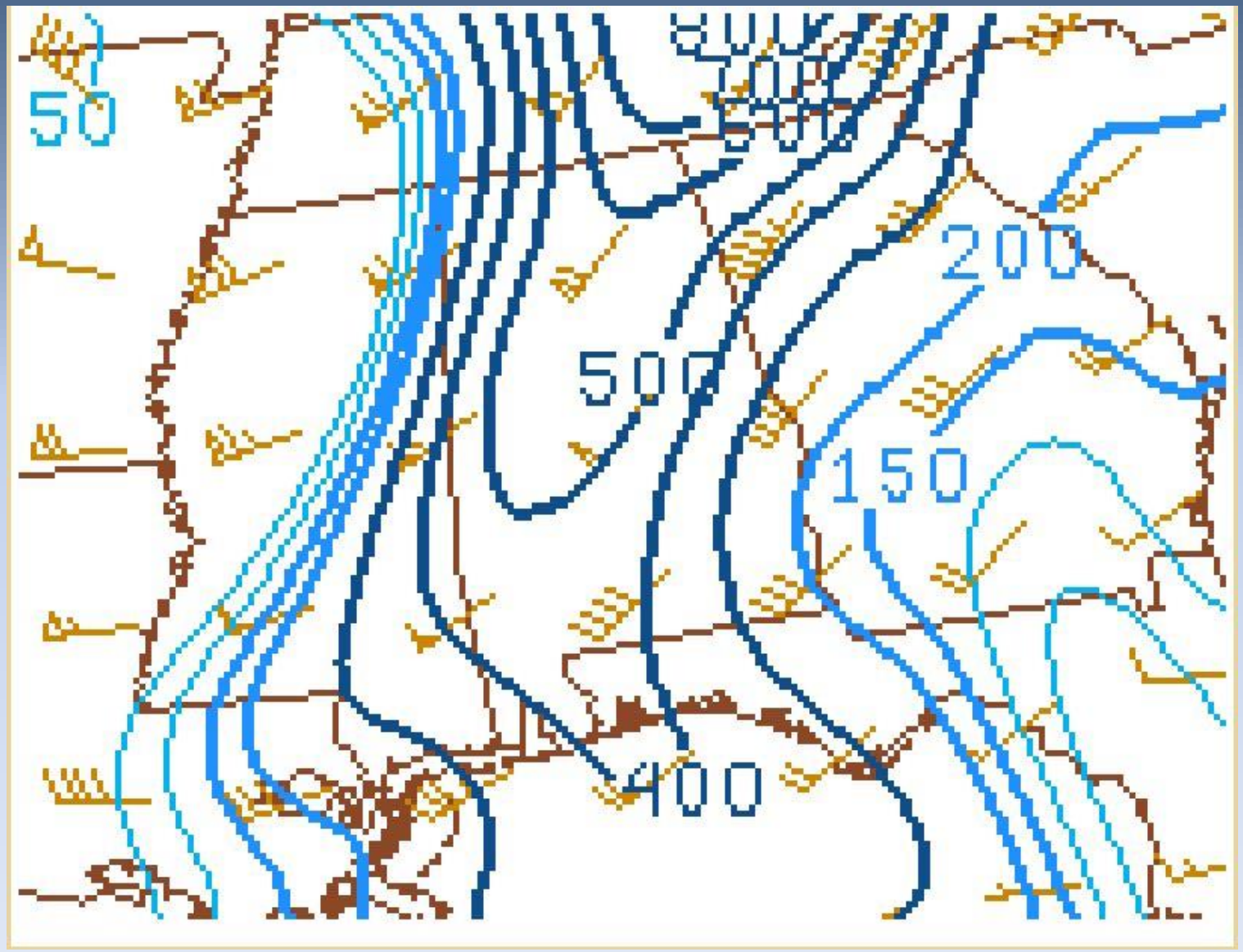
The 3-Dimensional Atmosphere
Wind Shear



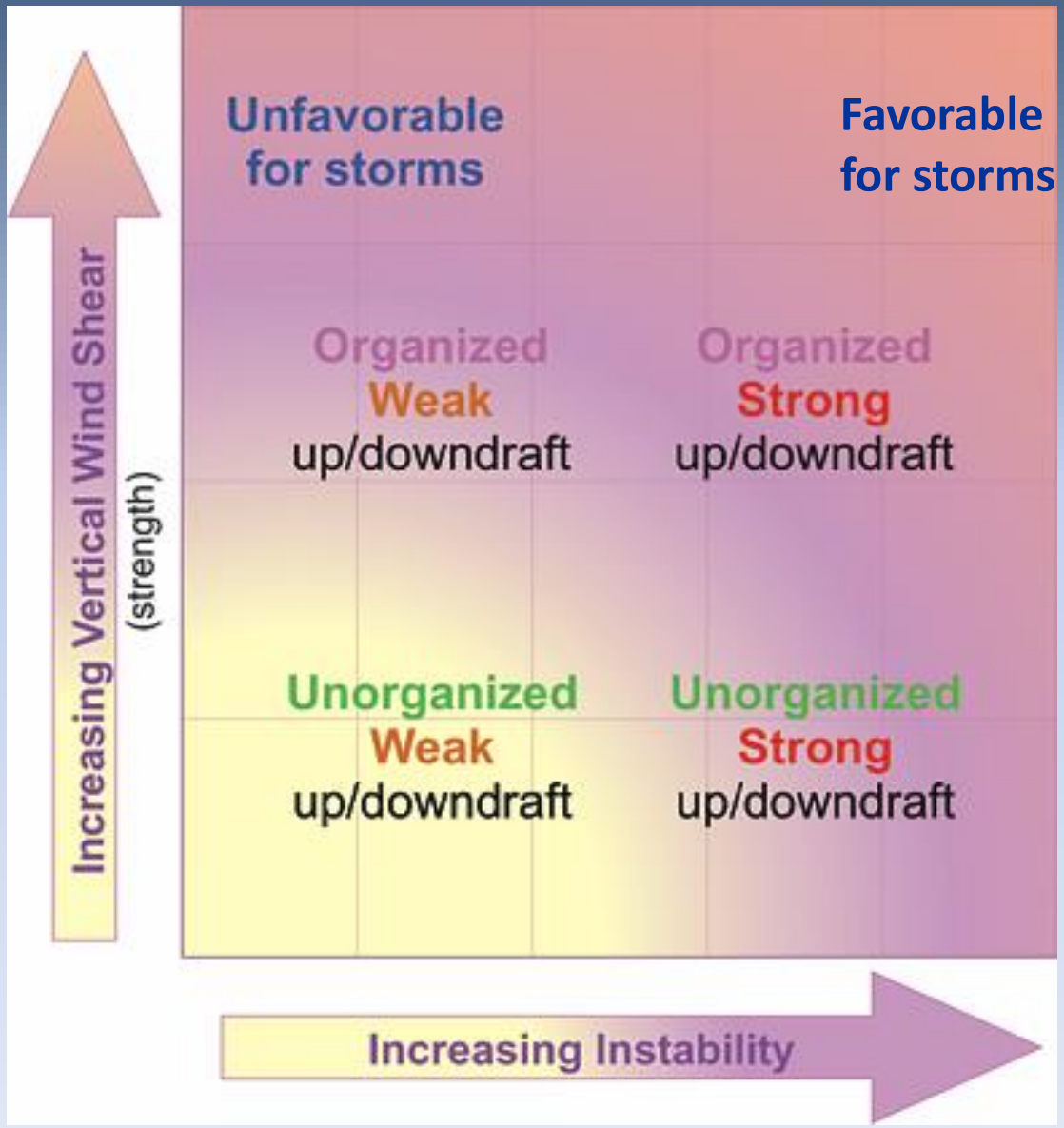
- Wind speed is typically calculated in terms of speed and direction. The change in these is known as Helicity or Storm Relative Helicity.
- Helicity is measured at several height levels, and that determines what type of storm is likely to form or what the mode of convection will be.
- 0 to 6 kilometers (storm motions)
- 0 to 3 km (supercells, multicell, or ordinary cell?)
- 0 to 1 km (tornadoes?)


72230 BMX Shelby County Airport
20 kts
40 kts
60 kts
SLAT 33.16
SLON -86.76
SELV 178.0
SHOW -6.26
LIFT -8.05
LFTV -8.78
SWET 601.9
KINX 32.70
CTOT 26.90
VTOT 28.50
TOTL 55.40
CAPE 2944.
CAPV 3172.
CINS -6.19
CINV -5.23
EQLV 143.0
EQTV 142.9
LFCT 890.2
LFCV 891.4
BRCH 14.24
BRCV 15.35
LCLT 293.7
LCLP 917.5
MLTH 301.0
MLMR 16.98
THCK 5738.
PWAT 41.83
00Z 28 Apr 2011
University of Wyoming

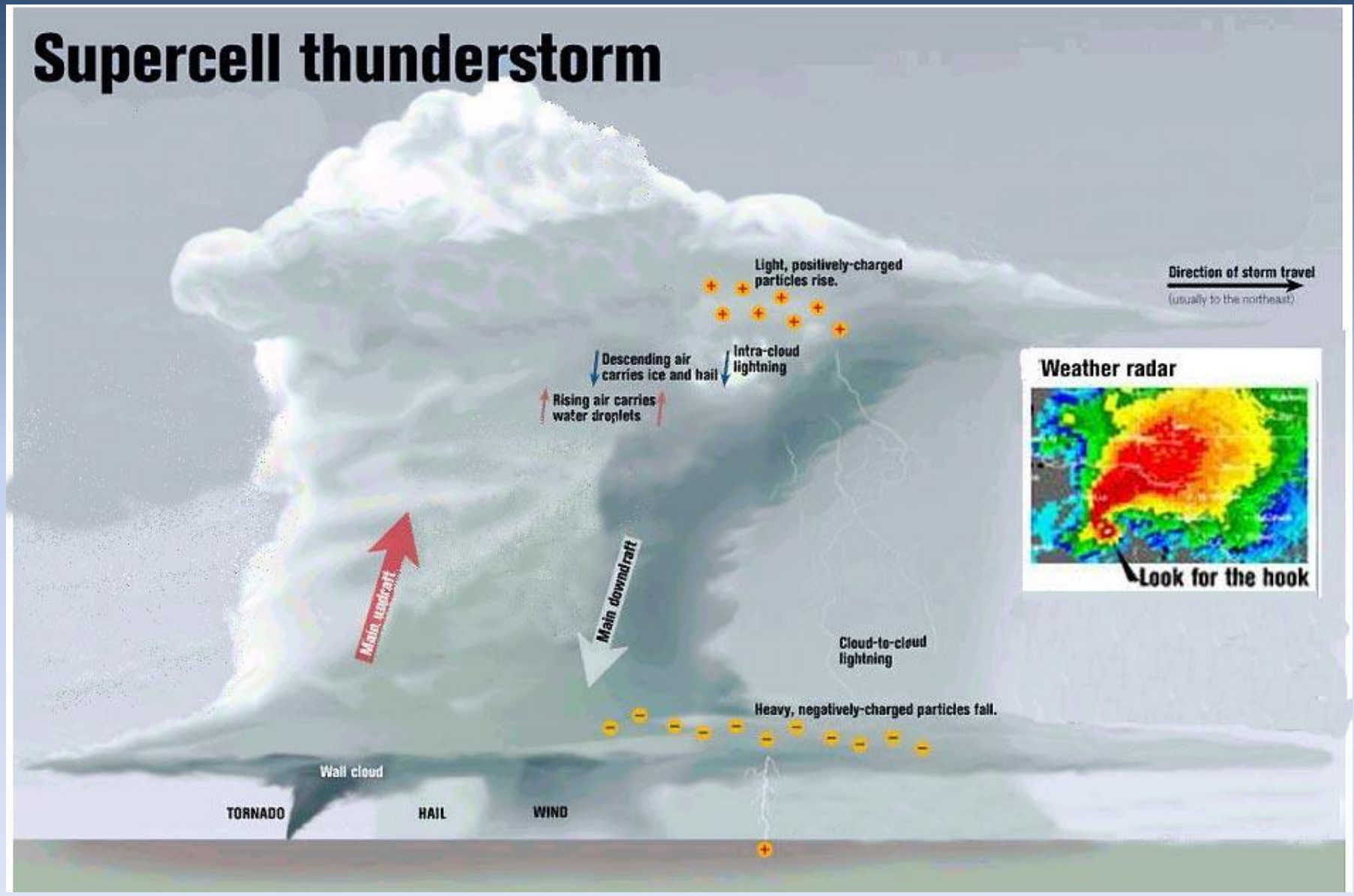
The 3-Dimensional Atmosphere
Wind Shear



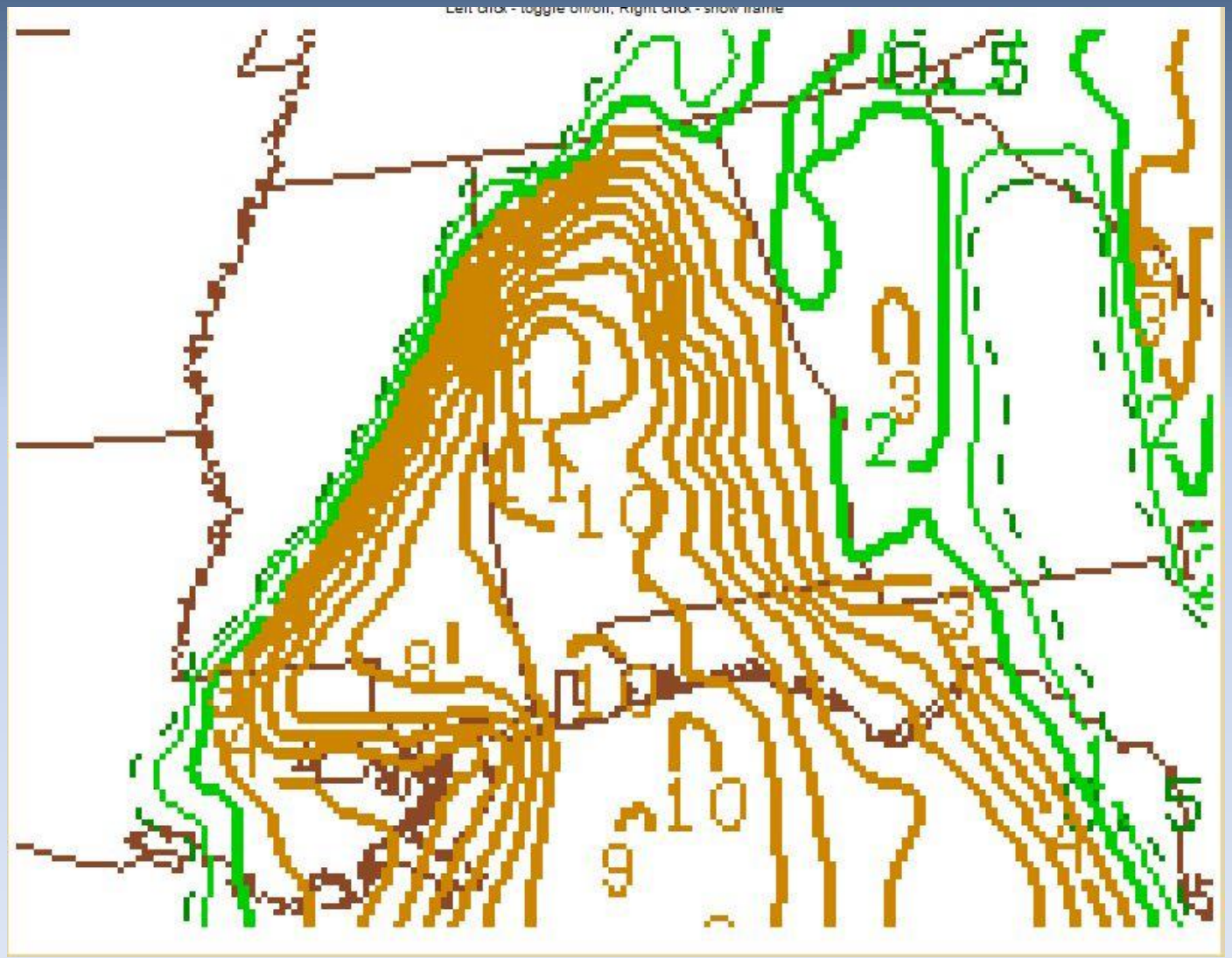
Finding the Perfect Balance Instability versus Wind Shear



- Finding the perfect balance between instability and wind shear remains a forecast challenge.
- All about the favorable mode of convection.

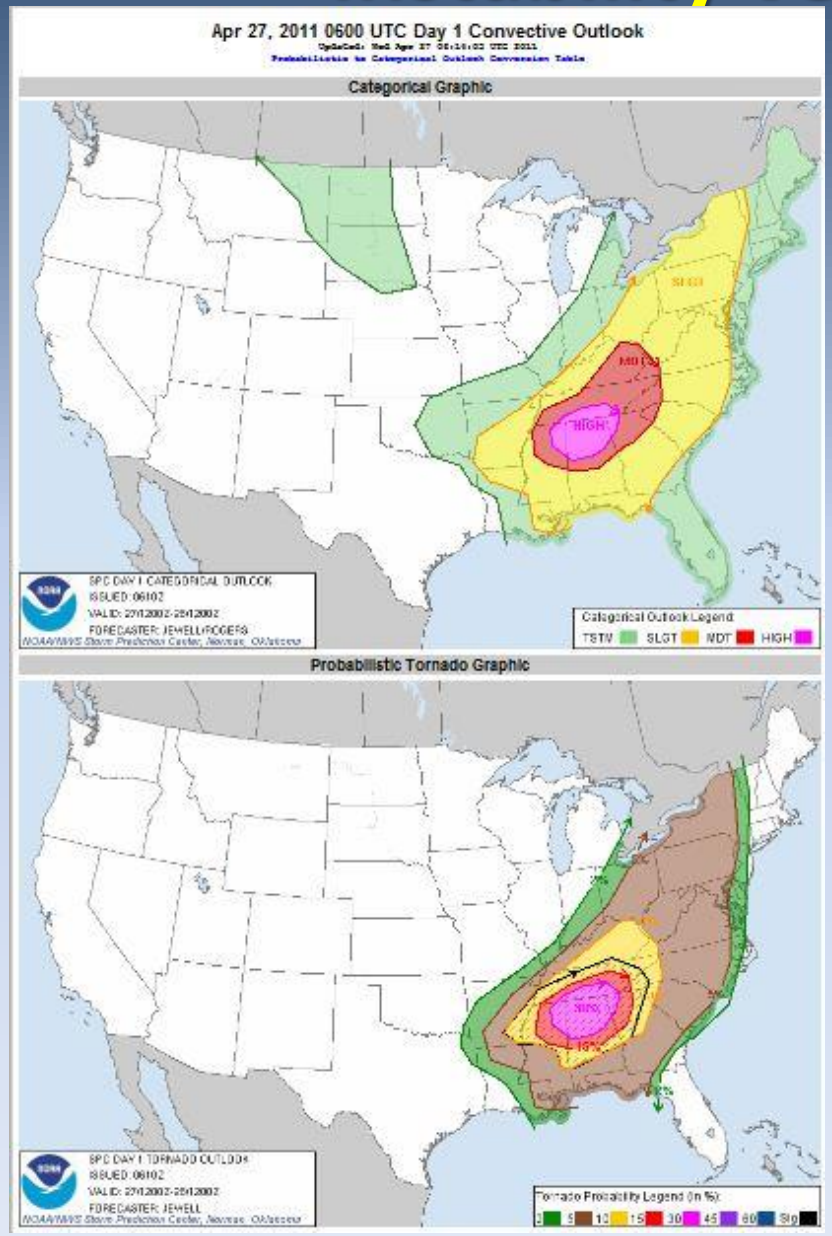

Supercell thunderstorm
Light, positively-charged particles rise.
Direction of storm travel
(usually to the northeast)
Descending air carries ice and hail
Intra-cloud lightning
Rising air carries water droplets
Weather radar
Look for the hook
Main updraft
Main downdraft
Cloud-to-cloud lightning
Heavy, negatively-charged particles fall.
Wall cloud
TORNADO
HAIL
WIND

Finding the Perfect Balance Instability versus Wind Shear



- Certain products like the Energy Helicity Index (EHI) can help you determine the mode of convection.
- EHI > 4 Watch Out!
- EHI 1 – 3 marginal
- EHI < 1 low

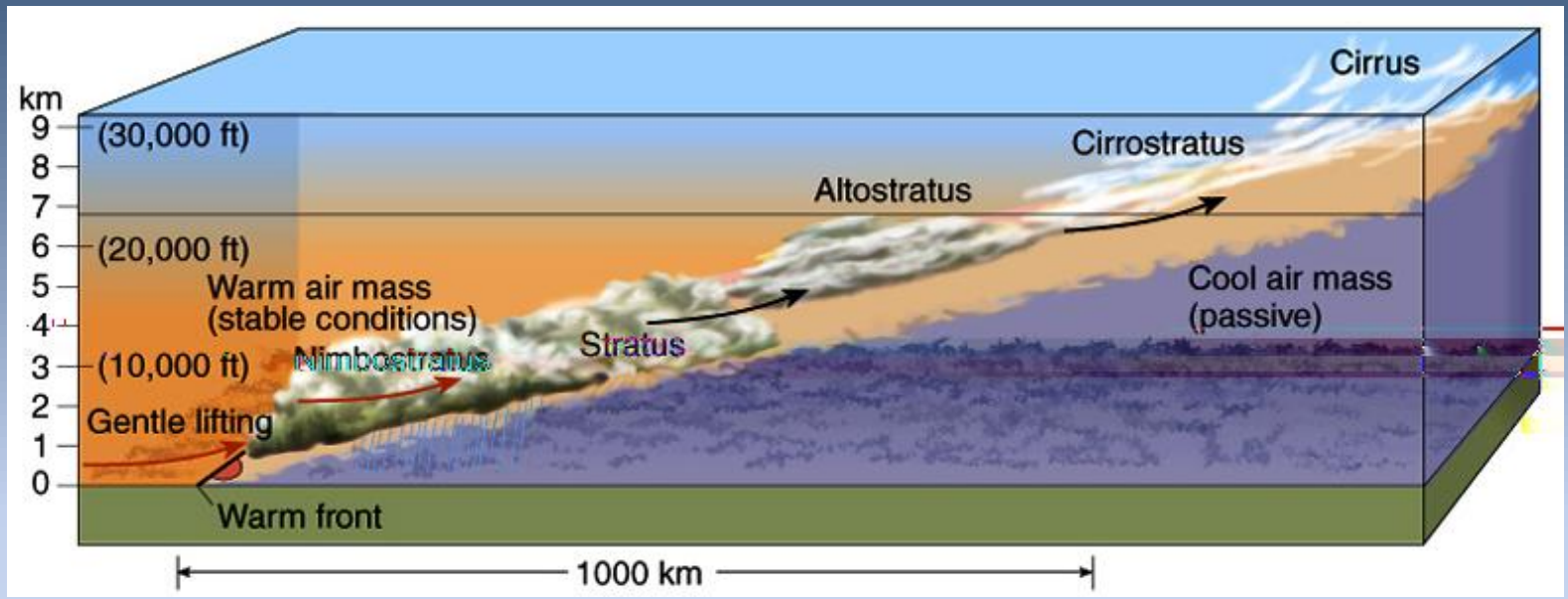
Finding the Perfect Balance Instability versus Wind Shear

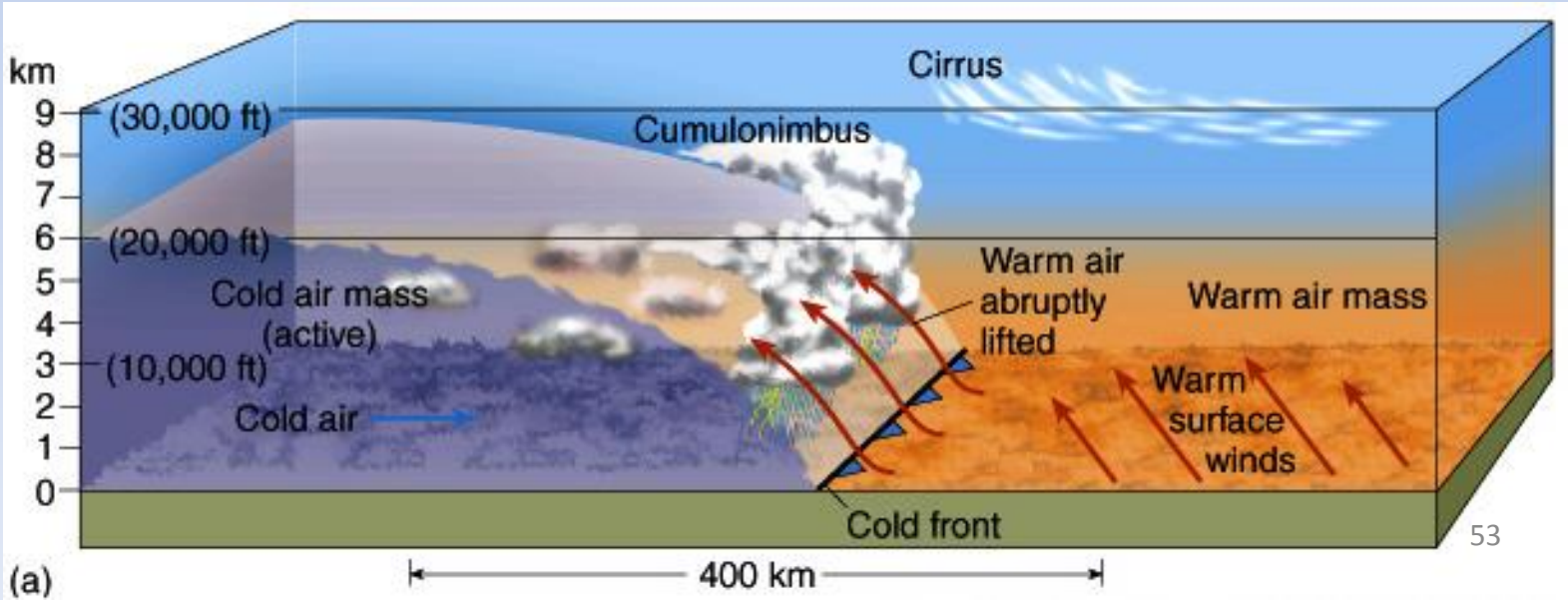


DAY 1 CONVECTIVE OUTLOOK NWS STORM PREDICTION CENTER NORMAN OK
0755 AM CDT WED APR 27 2011

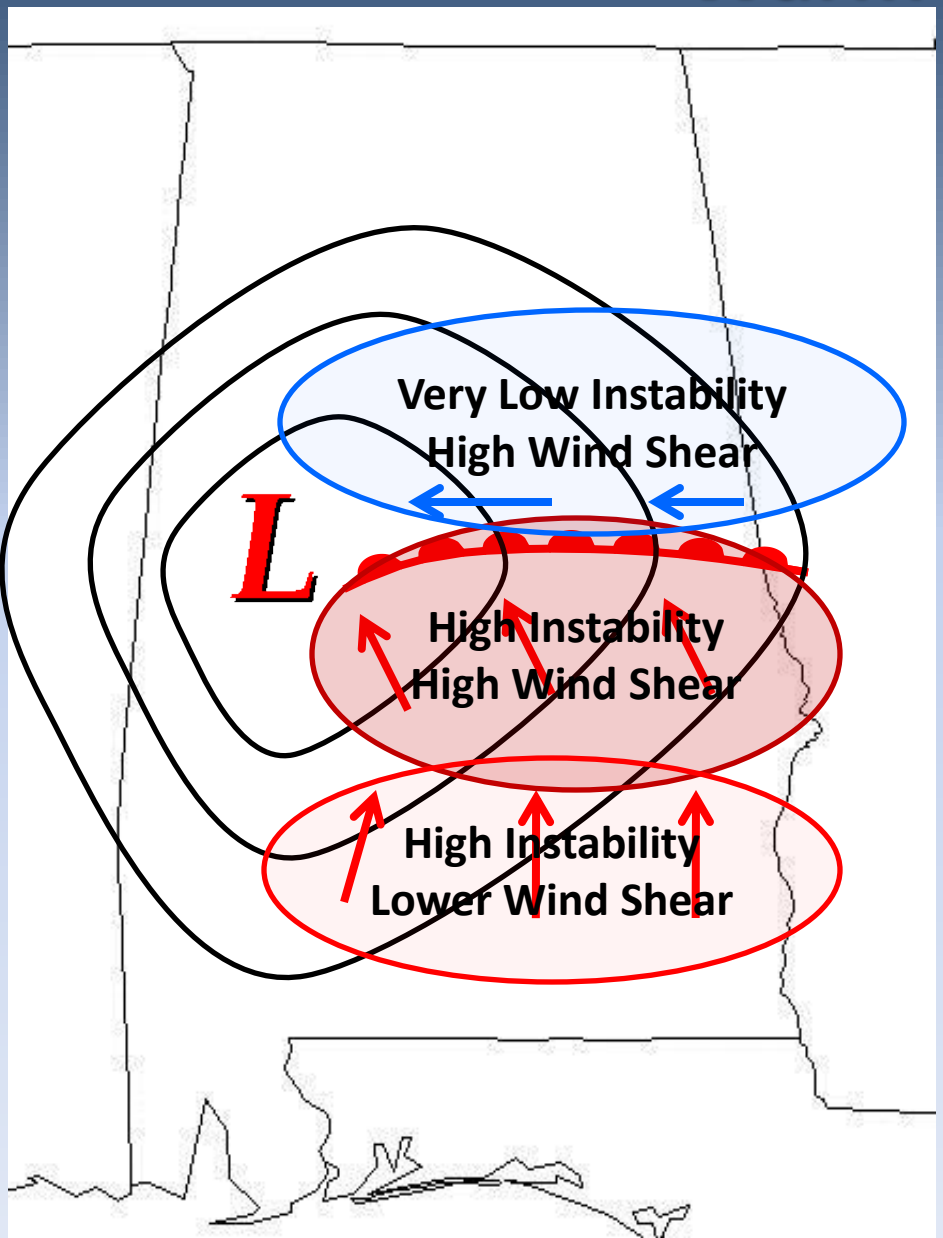
...MS/AL/TN/KY/GA AREA THROUGH TONIGHT... A RESERVOIR OF 70-72 F BOUNDARY LAYER DEWPOINTS FROM SRN LA TO SRN AL WILL SPREAD NWD IN THE WAKE OF THE MORNING STORMS...BENEATH THE REMNANTS OF STEEP MIDLEVEL LAPSE RATE PLUME SPREADING EWD FROM TX/LA. SURFACE HEATING WITHIN THE MOIST WARM SECTOR WILL BOOST MLCAPE VALUES TO 2500-4000 J/KG ALONG AND S OF THE REMNANT OUTFLOW BOUNDARY...AND REDUCE CONVECTIVE INHIBITION BY ABOUT MIDDAY. THIS WILL ALLOW THE DEVELOPMENT OF SCATTERED-NUMEROUS WARM SECTOR SUPERCELLS ALONG CONFLUENCE BANDS E OF THE COLD FRONT/DRYLINE BY EARLY AFTERNOON. THE VERTICAL SHEAR ENVIRONMENT WILL BECOME VERY FAVORABLE FOR TORNADIC SUPERCELLS...CHARACTERIZED BY LONG/CURVED HODOGRAPHS WITH EFFECTIVE BULK SHEAR IN EXCESS OF 70 KT AND EFFECTIVE SRH OF 300-600 M2/S2 IN THE UNSTABLE WARM SECTOR.

The 3-Dimensional Atmosphere
Location of that Perfect Balance



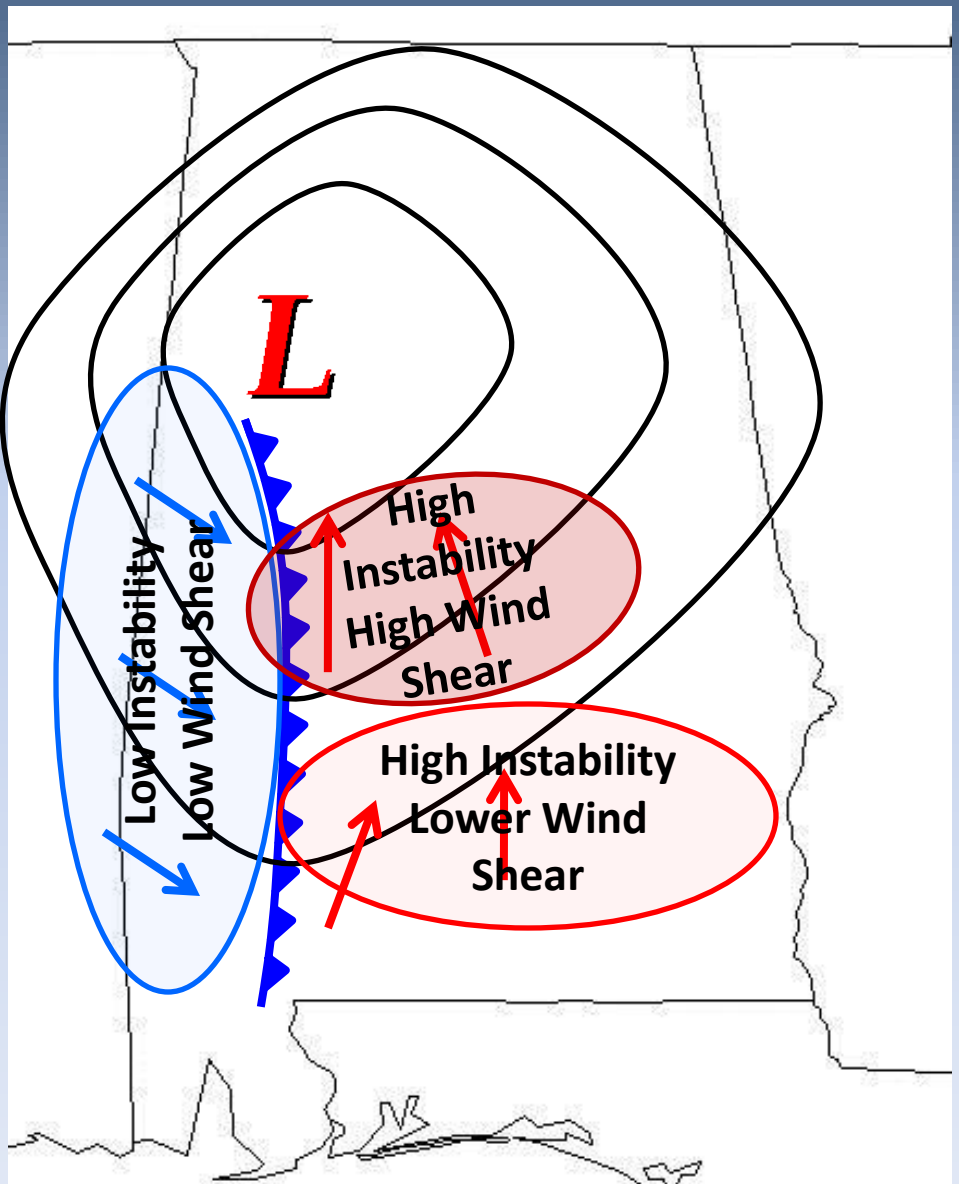


The 3-Dimensional Atmosphere
Warm Front



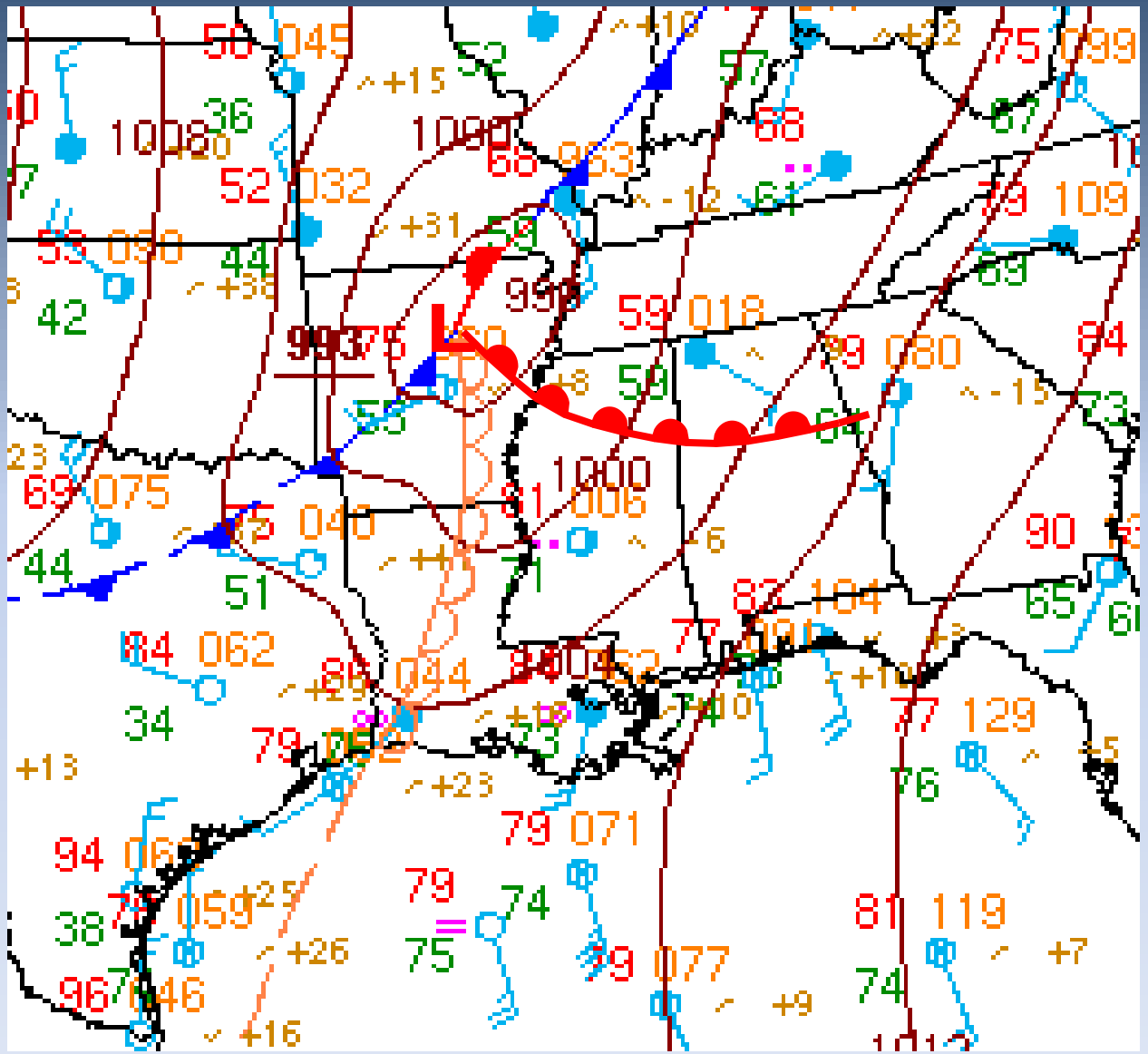
- Warm fronts are typically characterized by a distinct wind-shift from the south to the east as you go from south to north.
- South of the warm front the airmass is unstable with high wind shear.
- North of the warm front the wind shear can remain high, but the instability decreases significantly.

The 3-Dimensional Atmosphere
Cold Front

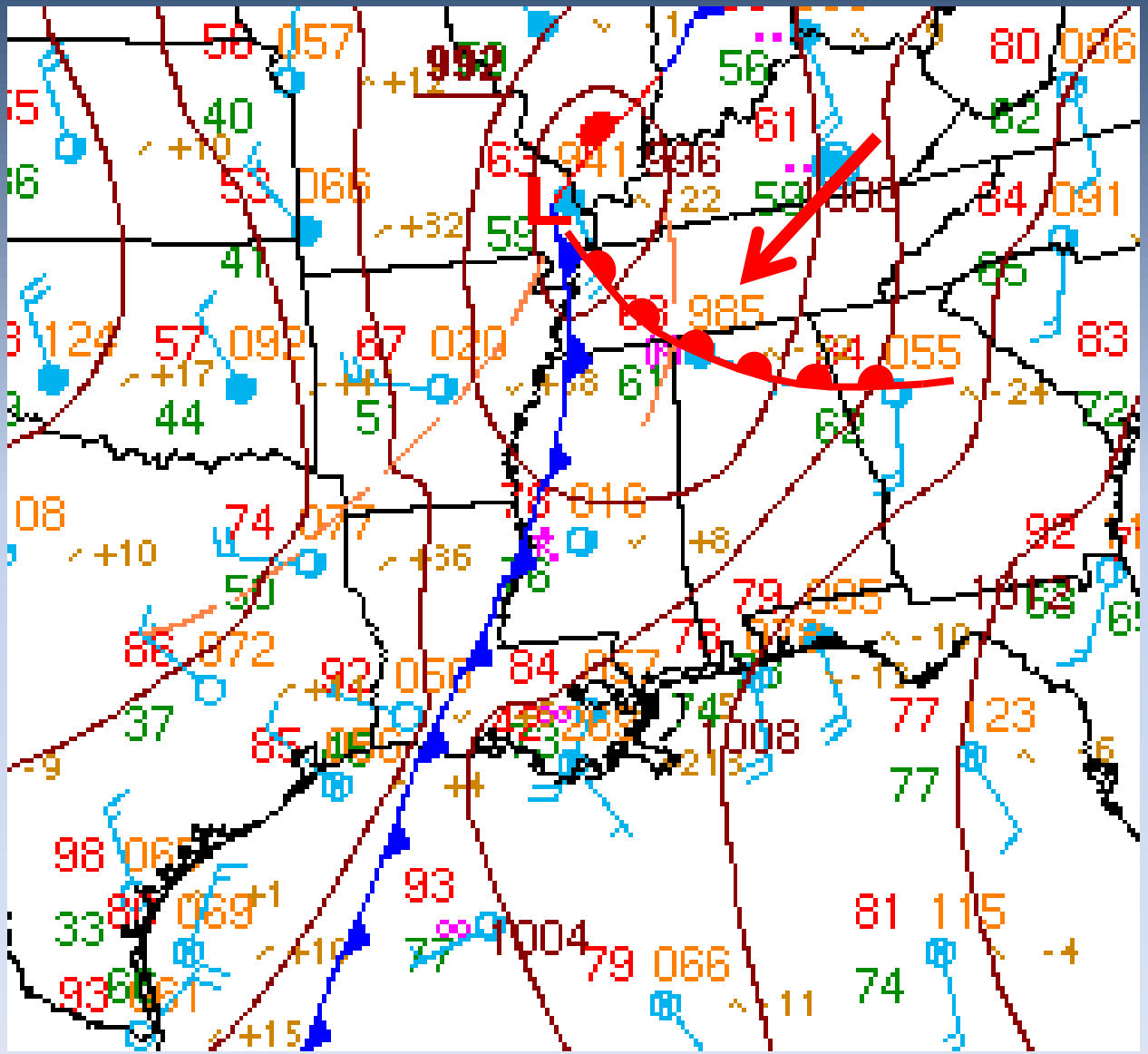


- Cold Fronts are characterized by an abrupt wind-shift from the south to the northwest as you go from east to west.
- Ahead of the cold front, generally there is unstable air with high wind shear.
- Behind the cold front the air is colder, drier and virtually no instability or wind shear.

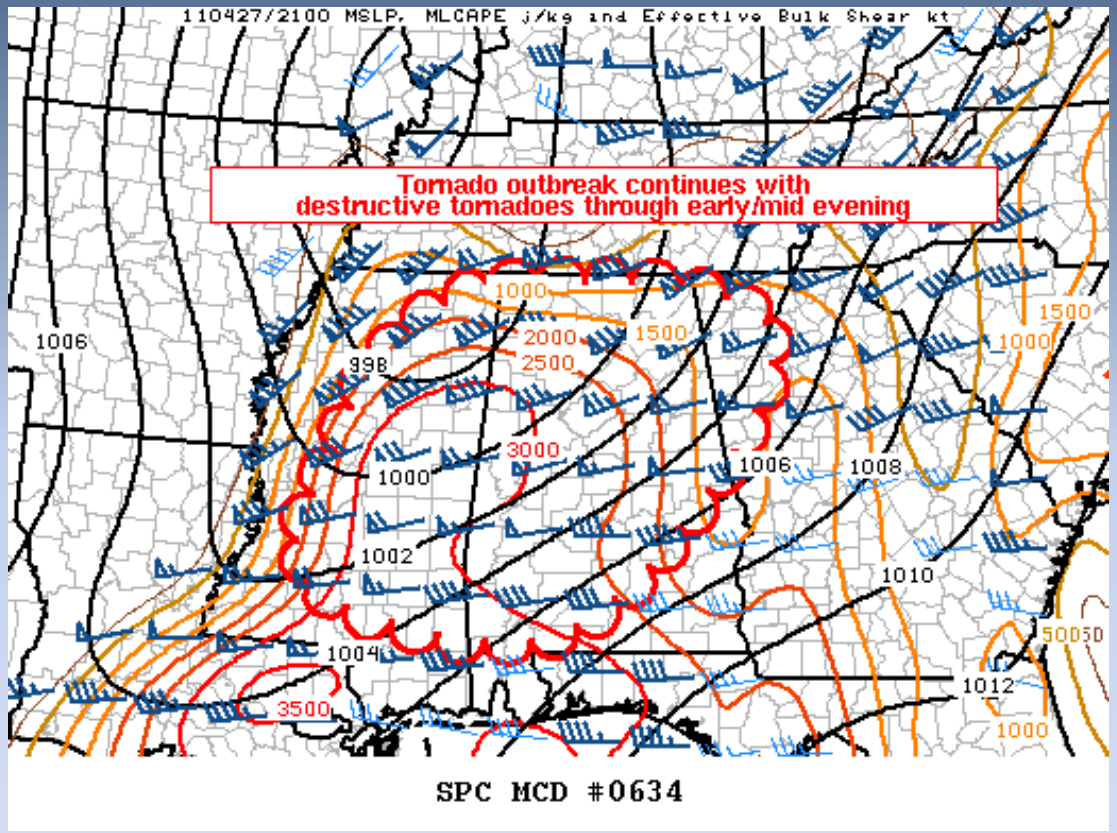
1 pm Sfc Analysis



4 pm Sfc Analysis



MESOSCALE DISCUSSIONS
NWS STORM PREDICTION CENTER
WEDNESDAY APRIL 27, 2011

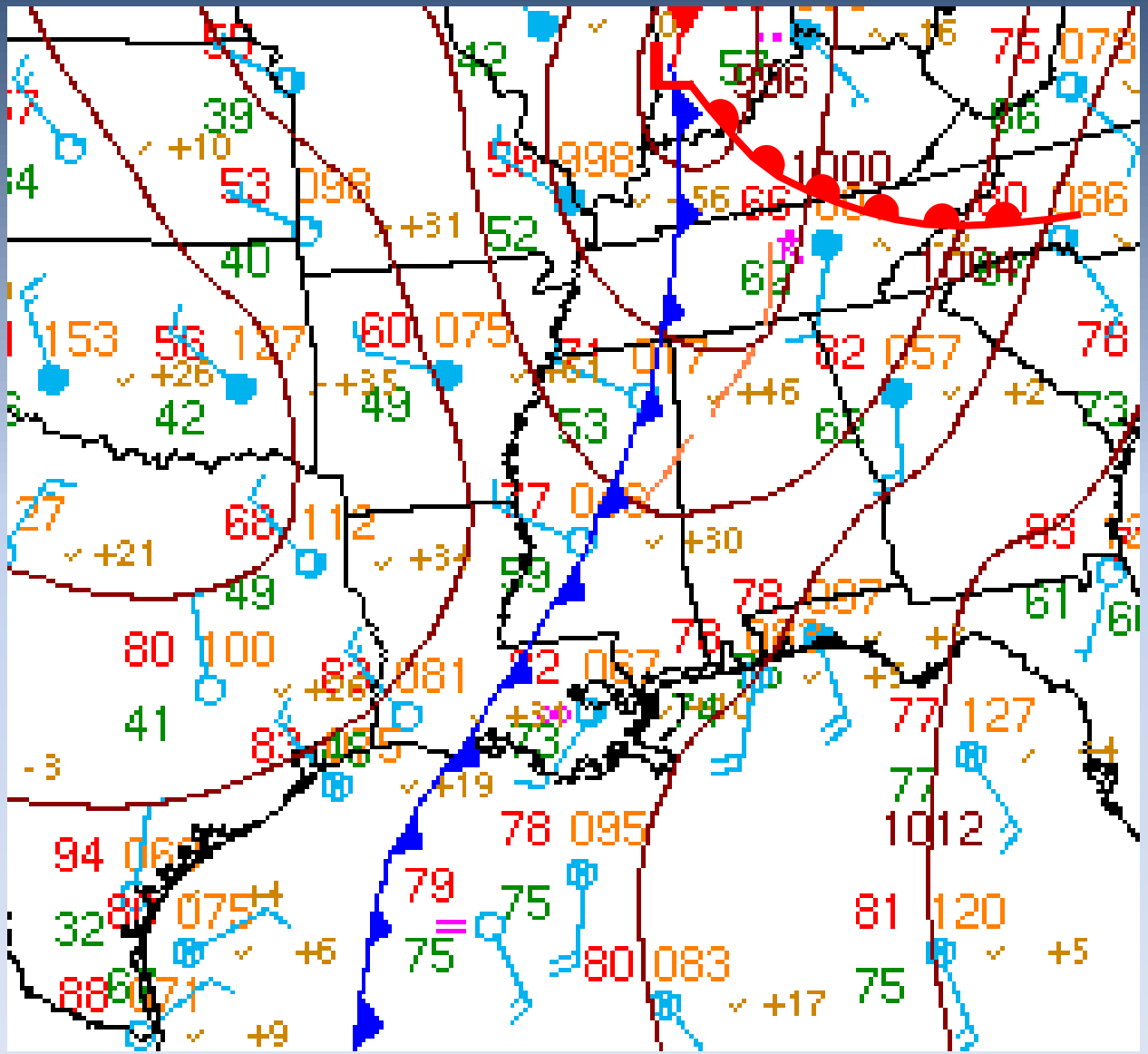


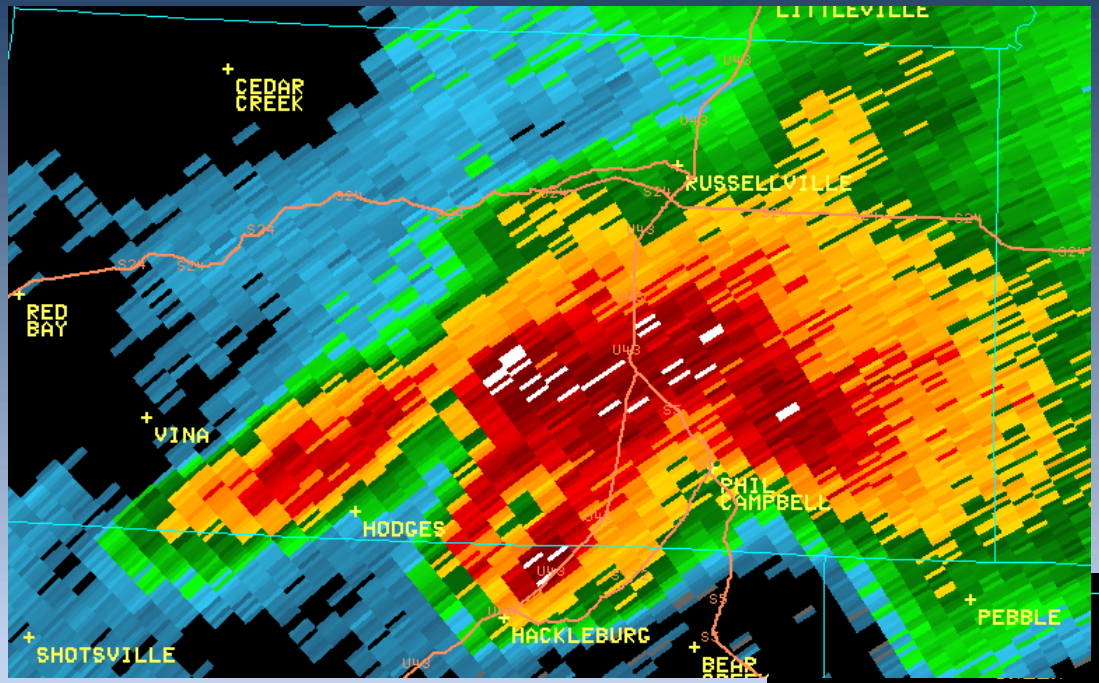
"MLCAPE VALUES ARE AS HIGH AS 2000-4000 J/KG WITHIN THE WEAKLY CAPPED WARM SECTOR"

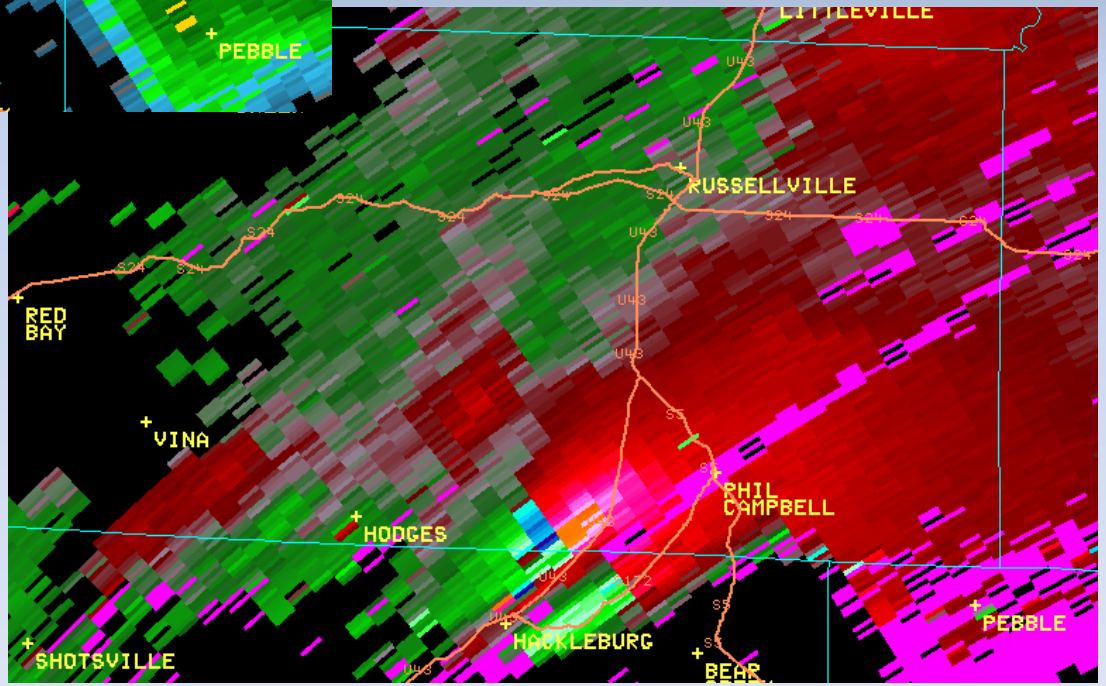
"WSR-88D VWP DATA NOW REFLECTS 0-1 KM SRH IN EXCESS OF 600 M2/S2"

"A LONG CURVING HODOGRAPH WITHIN THE LOWEST 1-2 KM"

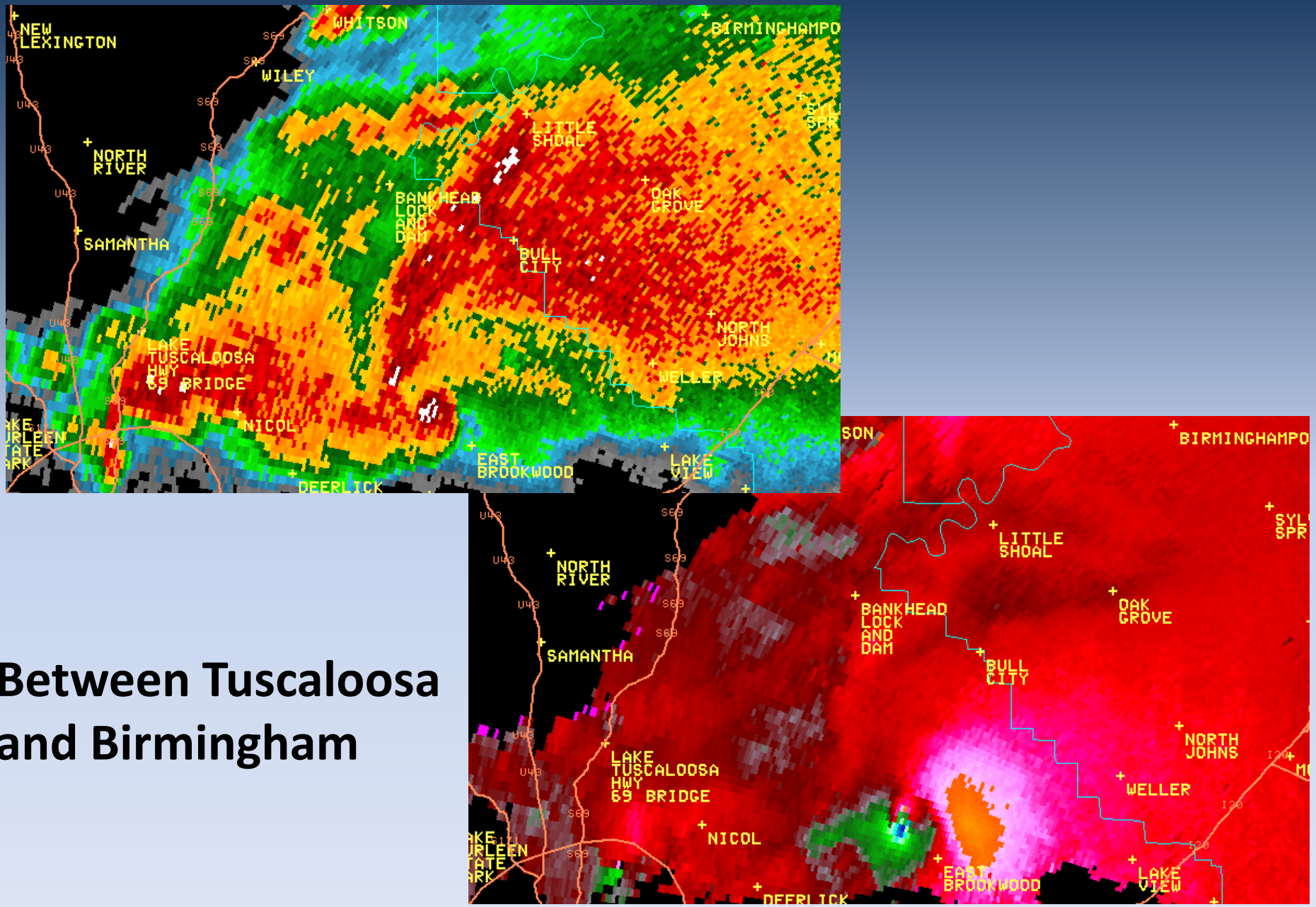
7 pm Sfc Analysis





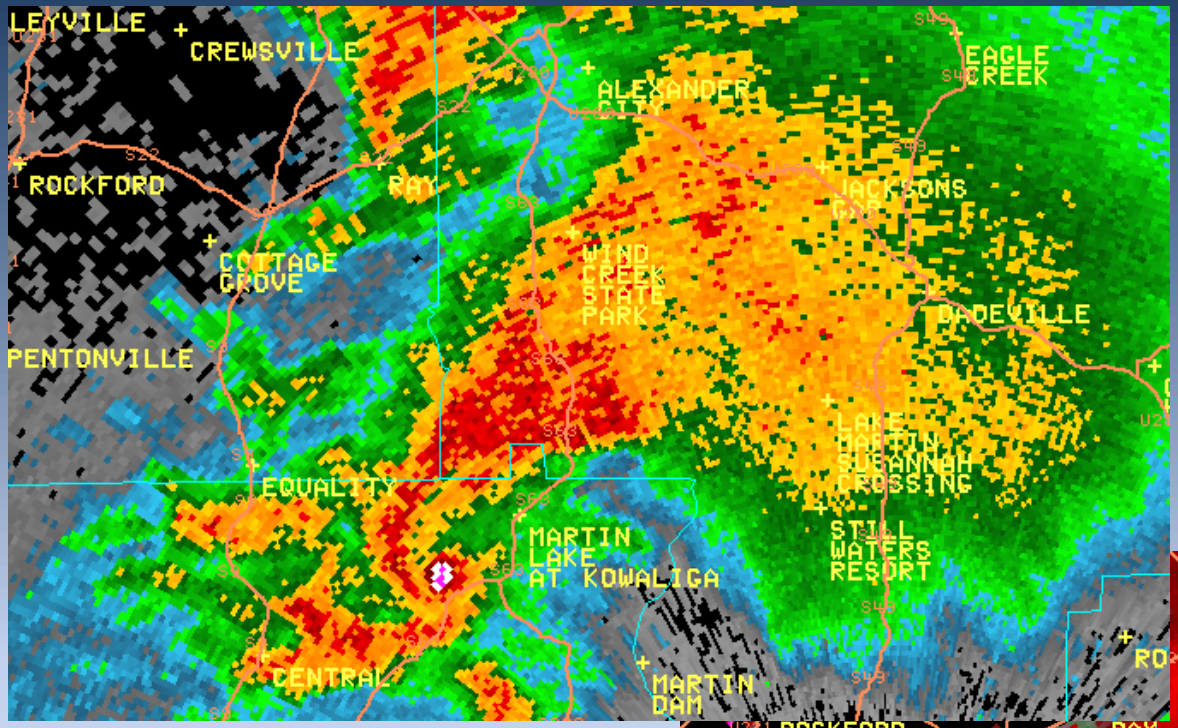


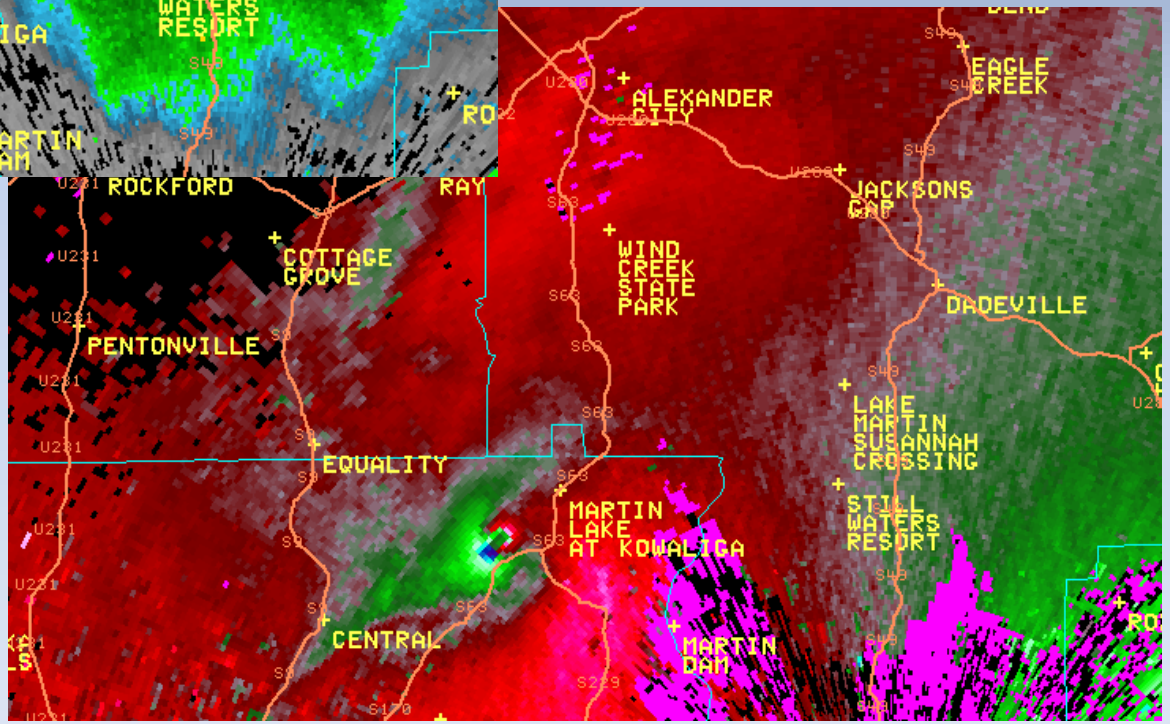
Between Hackleburg And Phil Campbell



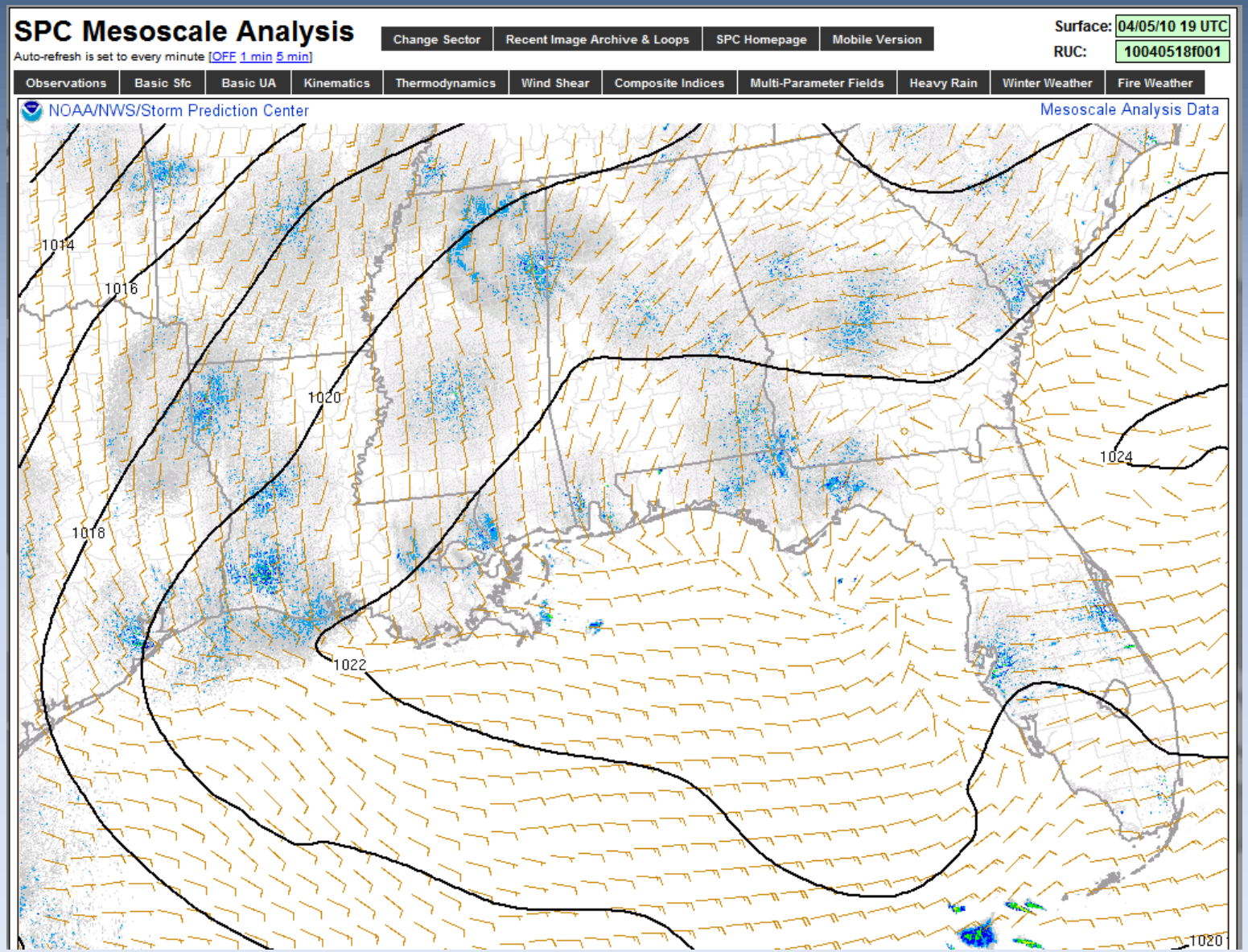
Between Tuscaloosa and Birmingham

Entering Lake Martin





Instability, Wind Shear, and Lifting Mechanisms Where Can I Get Help?



University of Wyoming
College of Engineering
Department of Atmospheric Science

Region	Type of plot	Year	Month	From	To
North America	Text: List	2009	Nov	29/12Z	29/12Z

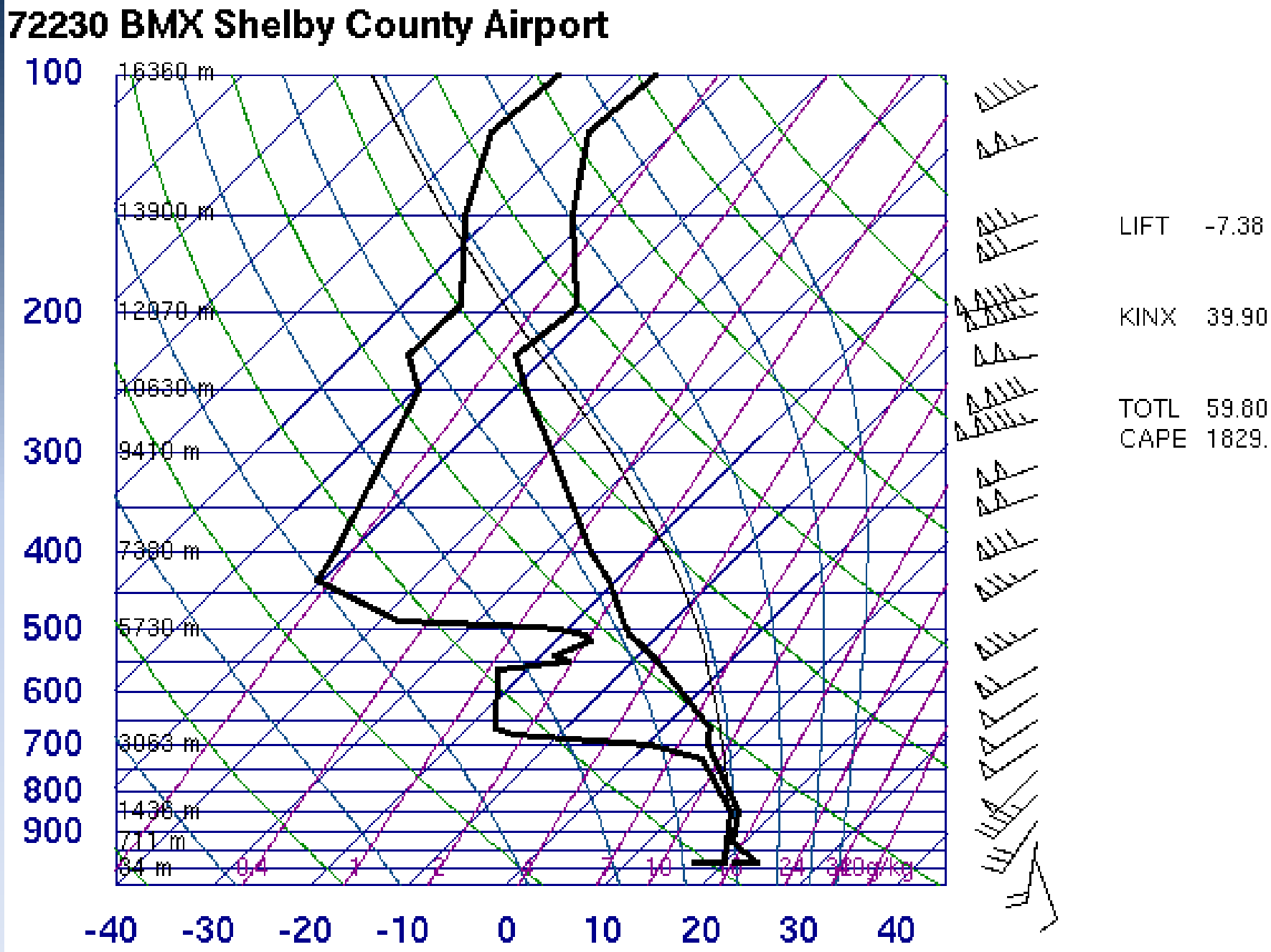
Click on the image to request a sounding at that location or enter the station number below.

Station Number: 72249

☐ Recalculate Data

72249 Ft Worth, TX (FWD)

Internet


72230 BMX Shelby County Airport
100
200
300
400
500
600
700
800
900
16360 m
13900 m
12070 m
10630 m
9410 m
7380 m
5730 m
3063 m
1436 m
711 m
84 m
-40
-30
-20
-10
0
10
20
30
40
LIFT -7.38
KINX 39.90
TOTL 59.60
CAPE 1829.
00Z 09 Apr 1998
University of Wyoming

Instability, Wind Shear, and Lifting Mechanisms
Where Can I Get Help?

http://www.spc.noaa.gov/exper/mesoanalysis/

http://weather.uwyo.edu/upperair/sounding.html

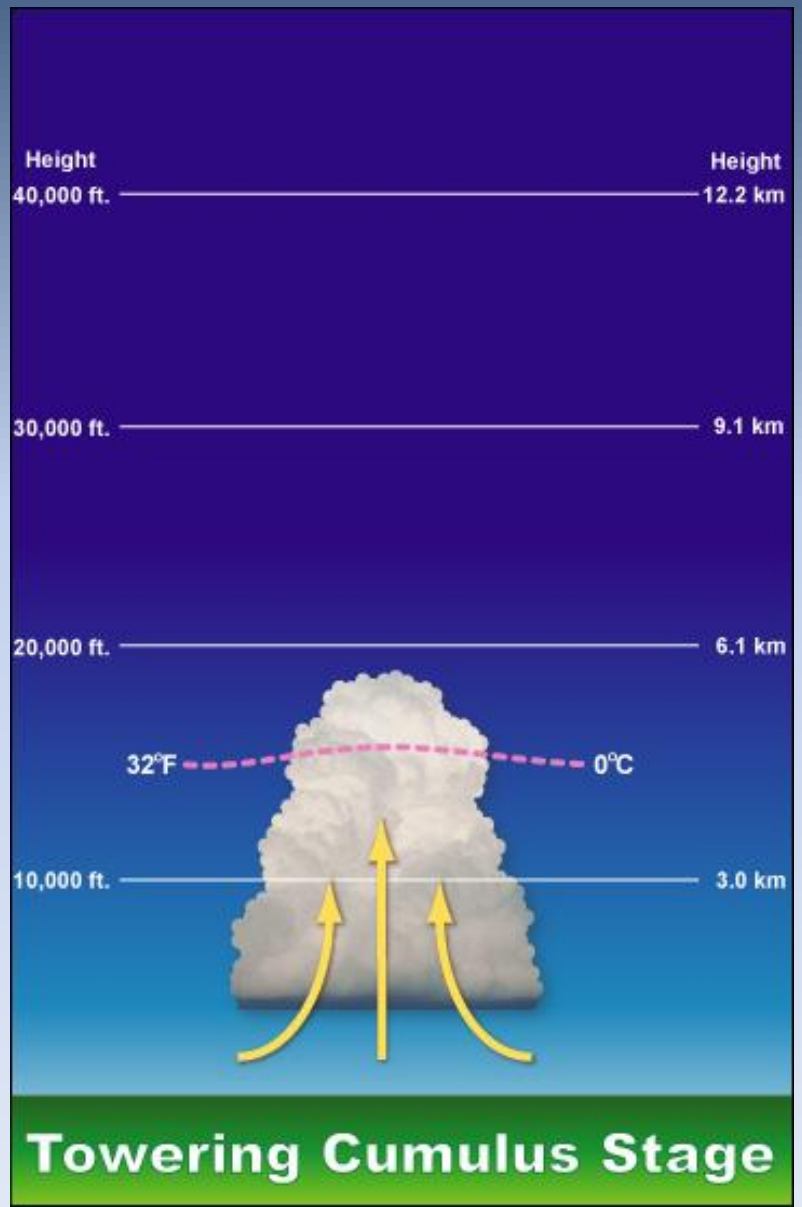
http://www.srh.noaa.gov/bmx/?n=outreach_severeparameters

BREAK TIME

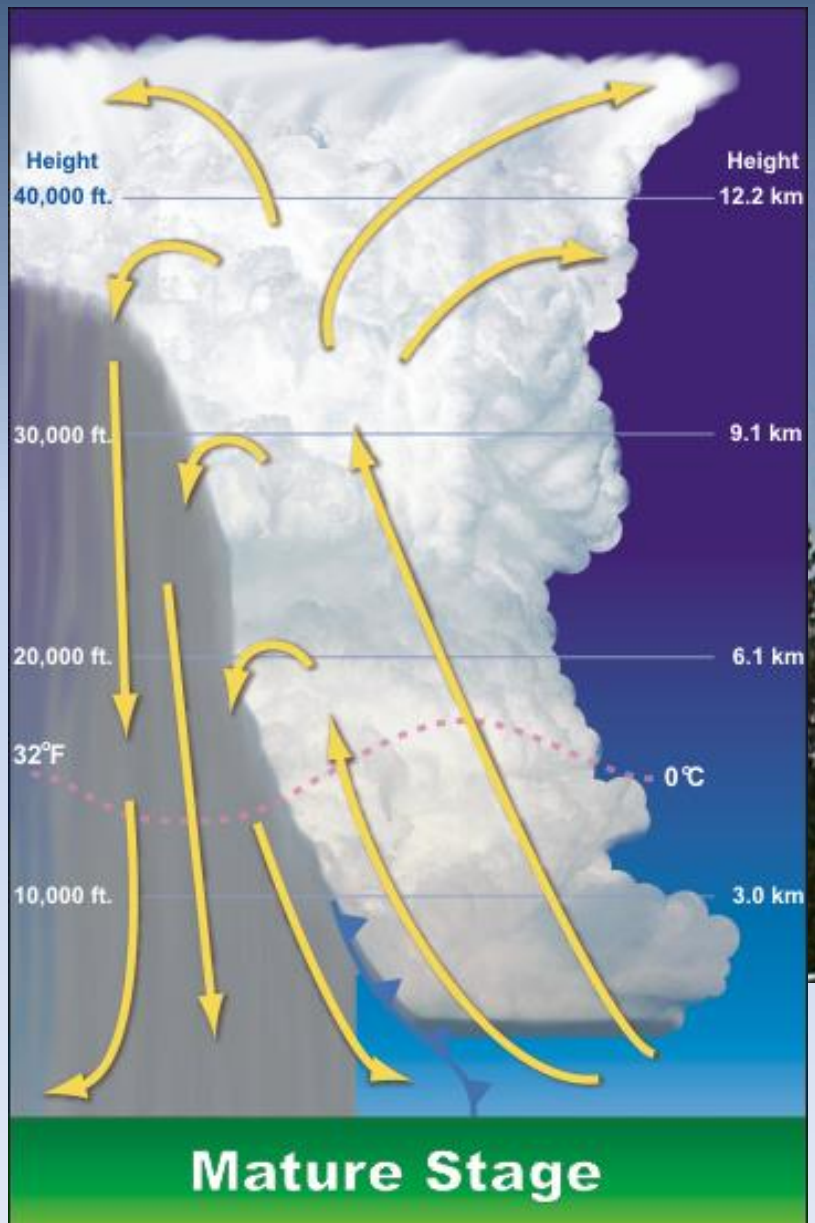
What We Observe When Spotting Plains versus The Southeast

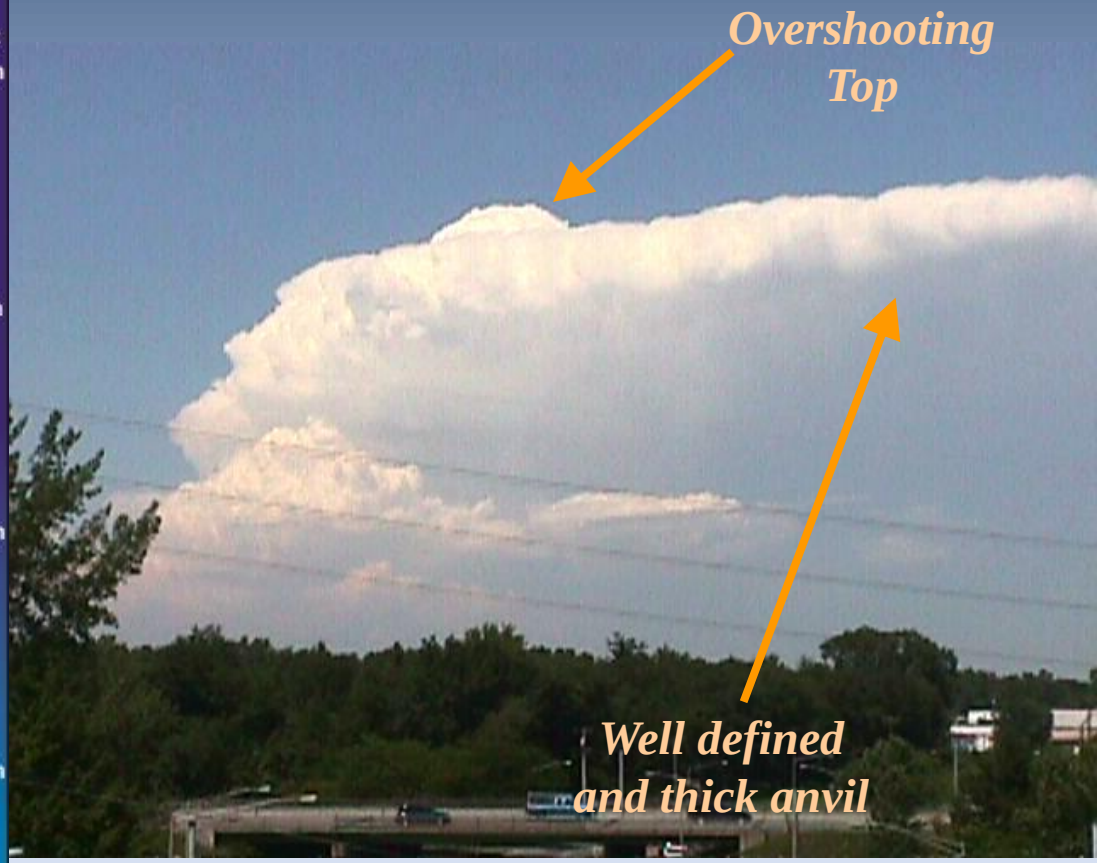
Copyright Ryan McGinnis

What We Observe When Spotting Towering Cumulus



What We Observe When Spotting Mature Stage



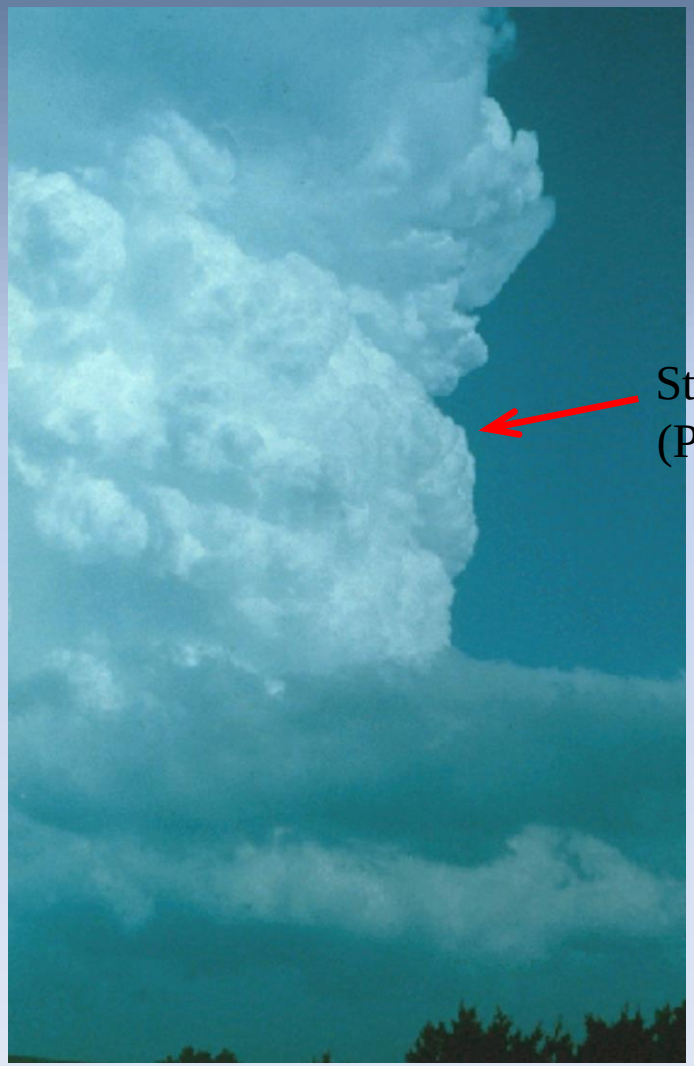


Anvil Thickness/Texture

If the anvil is thick, smooth-edged, and cumuliform (puffy, like the lower part of the storm), then the storm probably has a strong updraft and is a good candidate to produce severe weather.

If the anvil is thin, fuzzy, and glaciated (wispy, similar to cirrus clouds), then the updraft is probably not as strong, and the storm is less likely to produce severe weather.

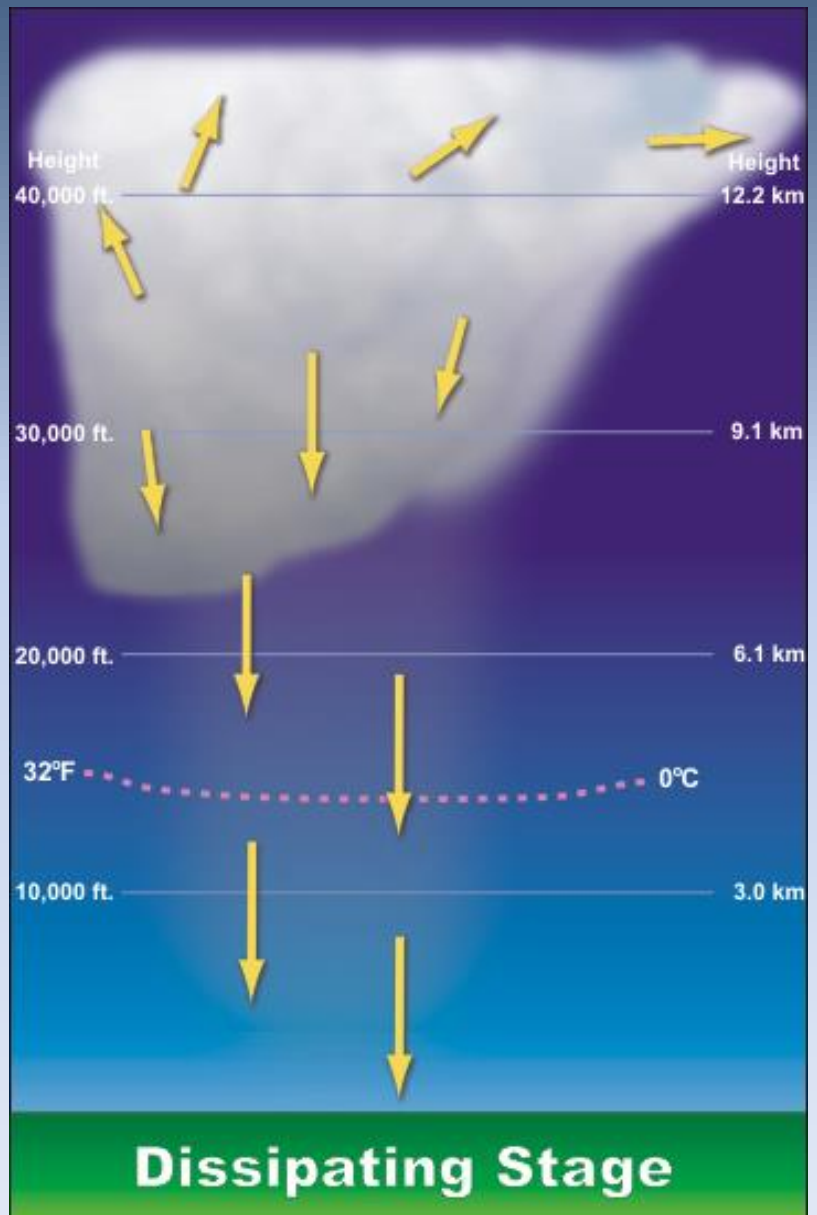
A Updraft Tower Comparison



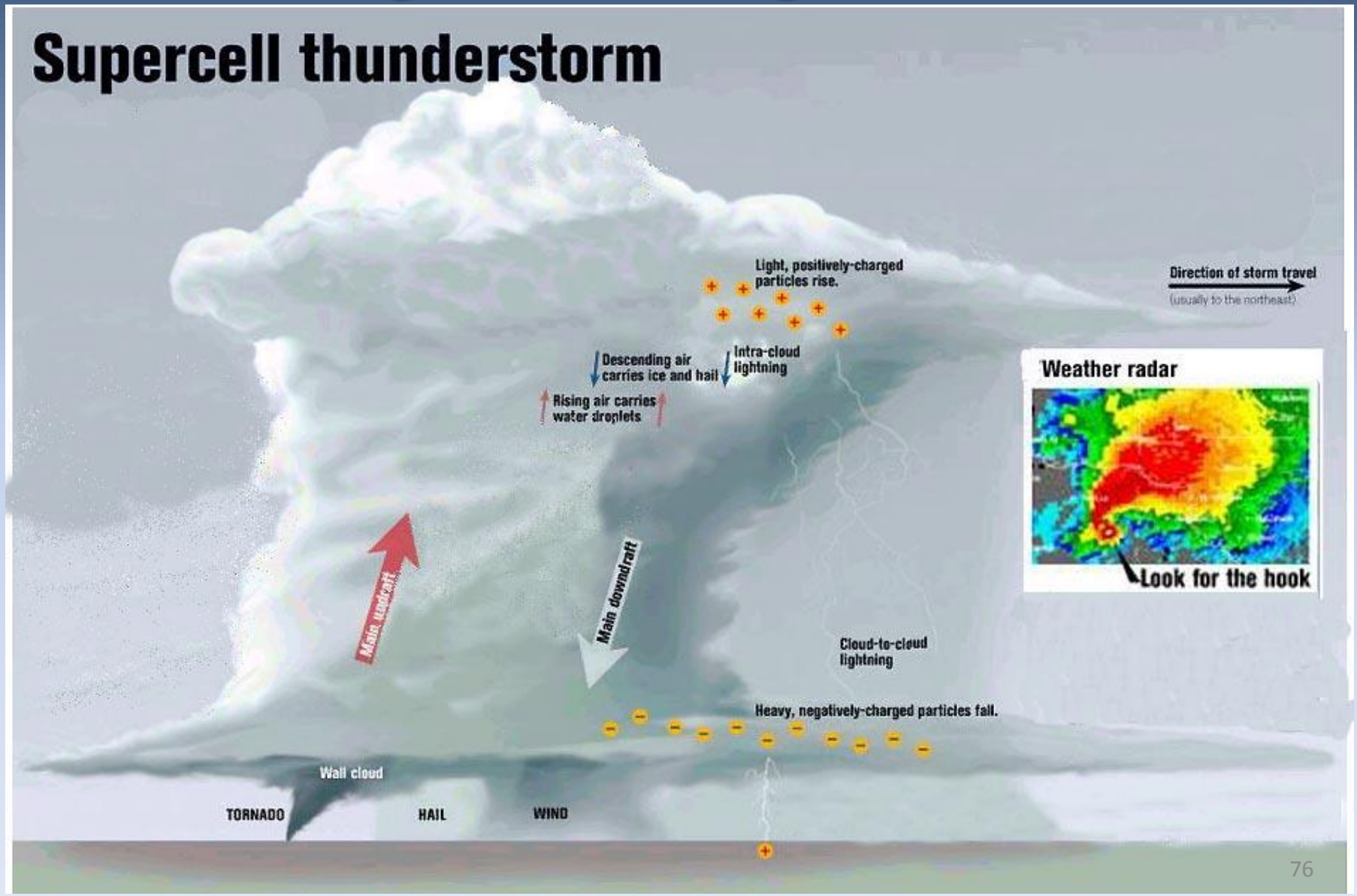
Strong Updraft (Probably high CAPE)

Weak Updraft (Probably low CAPE)

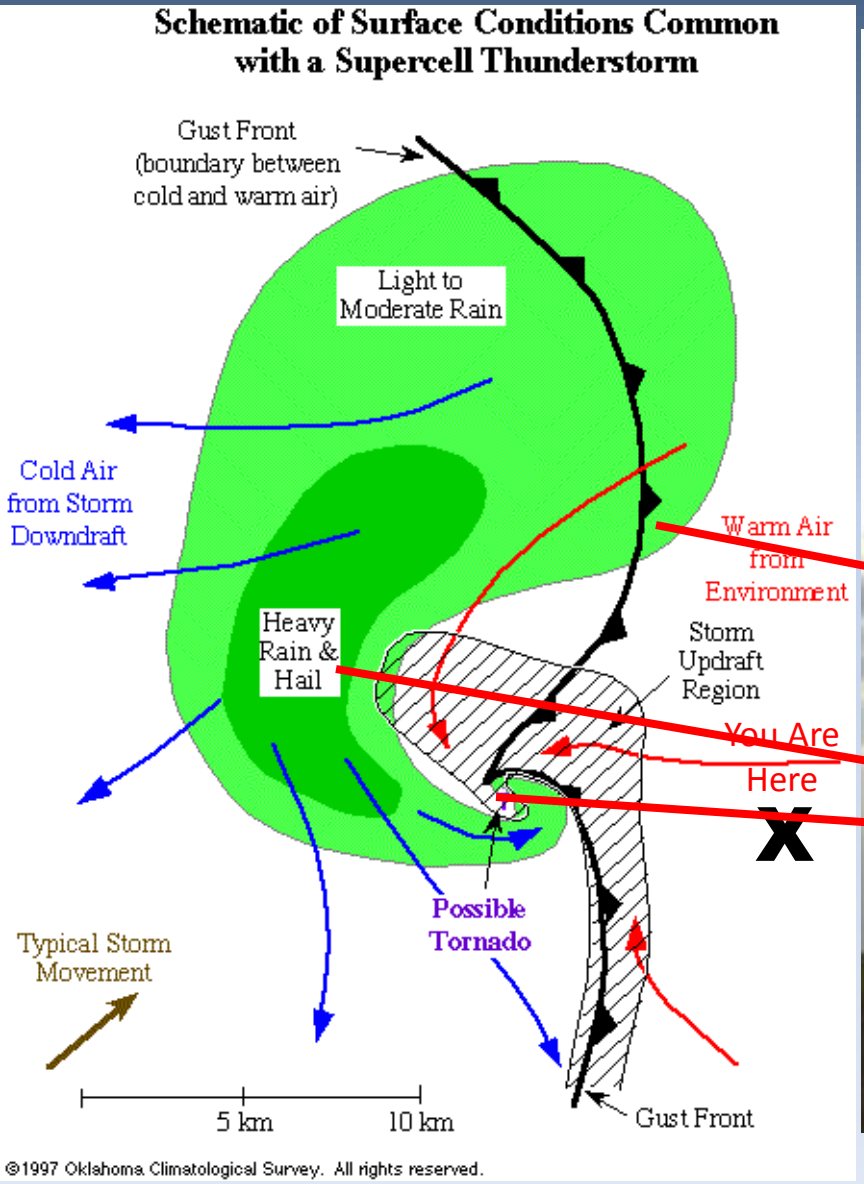
What We Observe When Spotting Dissipation Stage



What We Observe When Spotting Right Place - Right Time

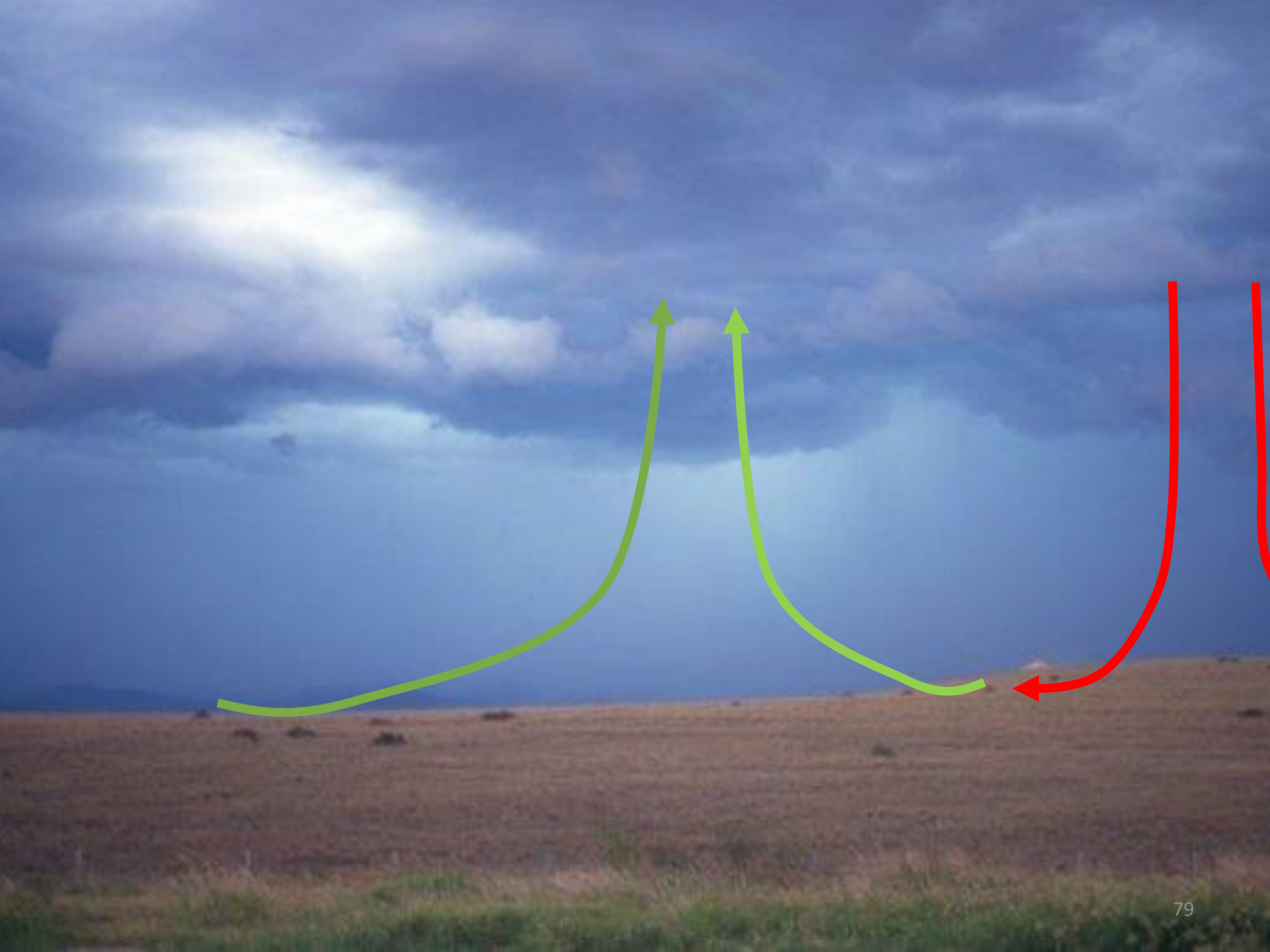


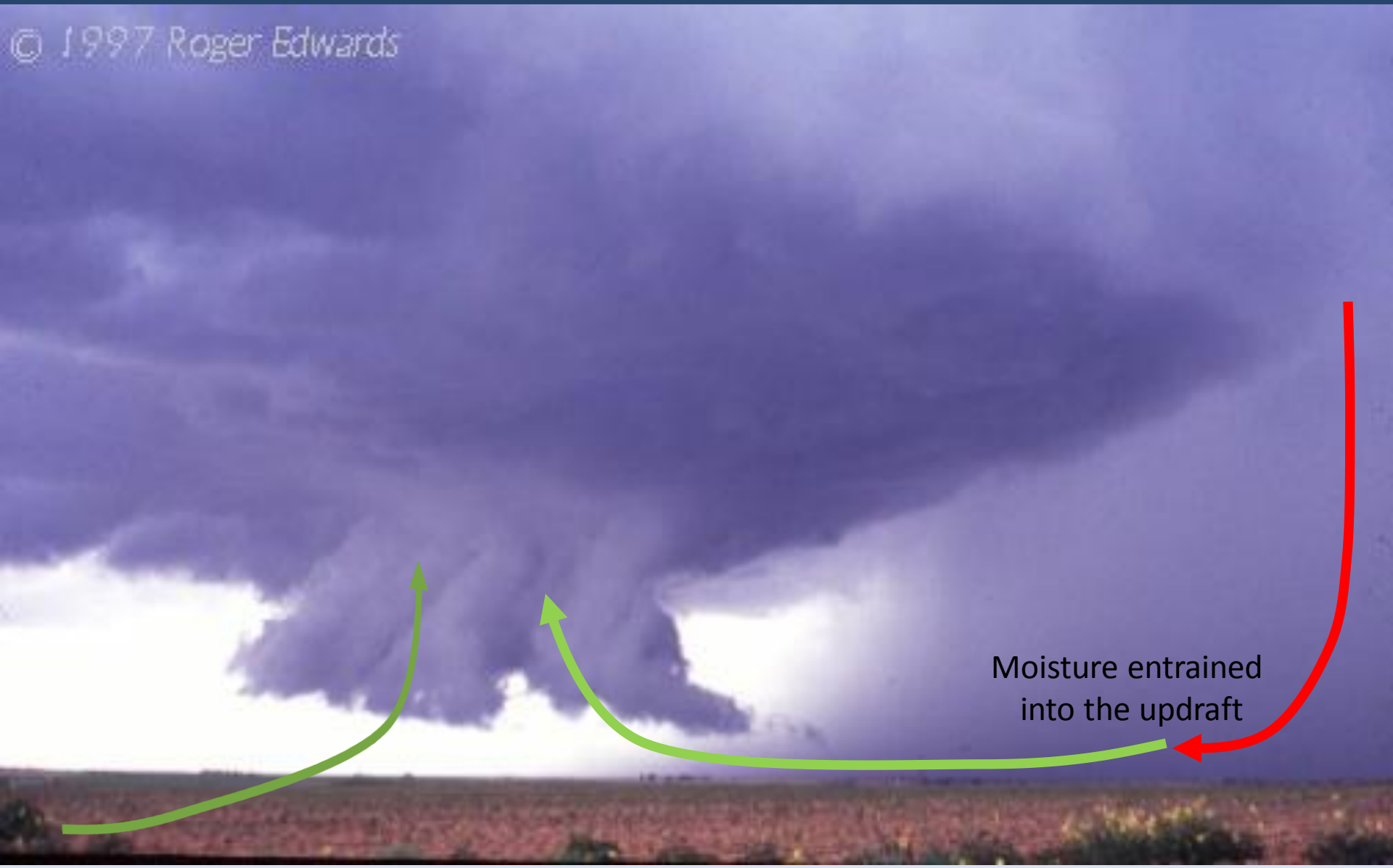
What We Observe When Spotting SuperCell



What We Observe When Spotting Wall Cloud

- A wall cloud is nothing more than the base of an updraft.
- Downward sloping towards the precipitation.
- Organized Rotation?




© 1997 Roger Edwards
Moisture entrained
into the updraft

What We Observe When Spotting Shelf Cloud

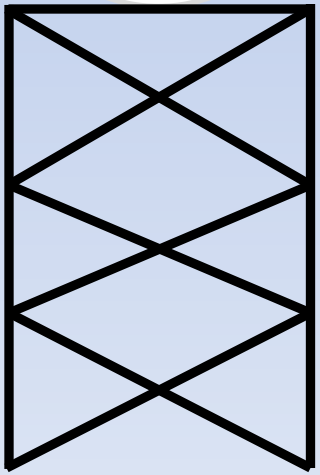
- A shelf cloud is the leading edge of a gust front that is moving out and away from the precipitation.
- Downward sloping away from the precipitation.
- Not rotating!

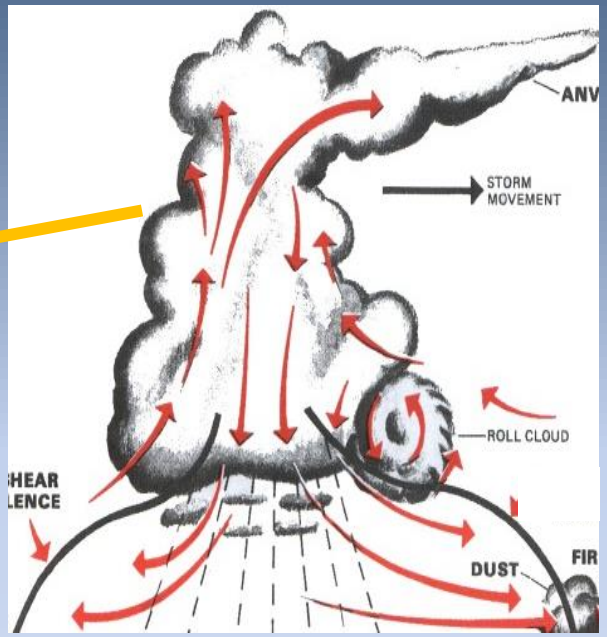
When the cool air from the
downdraft reaches the surface....
... it creates the outflow which pushes forward and
provides lift for clouds to form (along the black line.

Dual Polarization Concepts

Dual Polarization

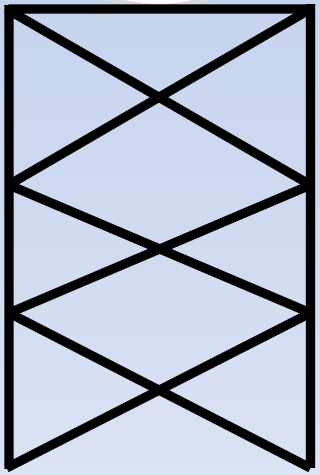
Radar

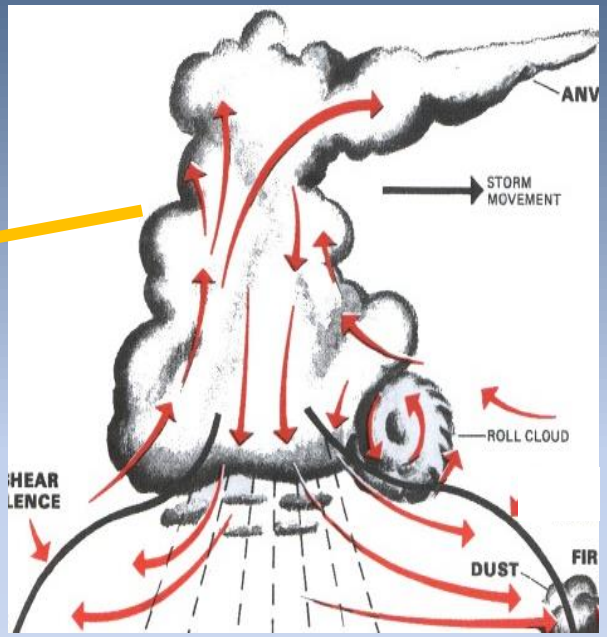




Dual Polarization

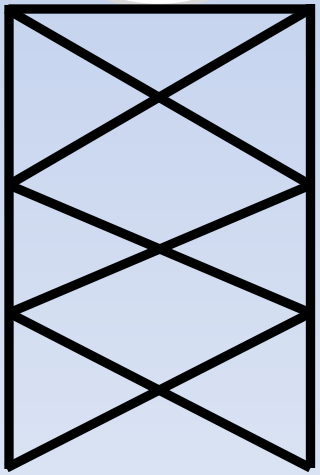
Radar

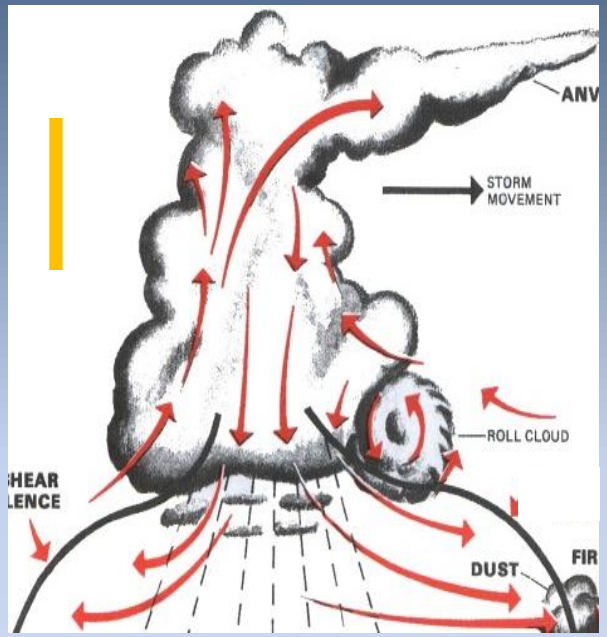




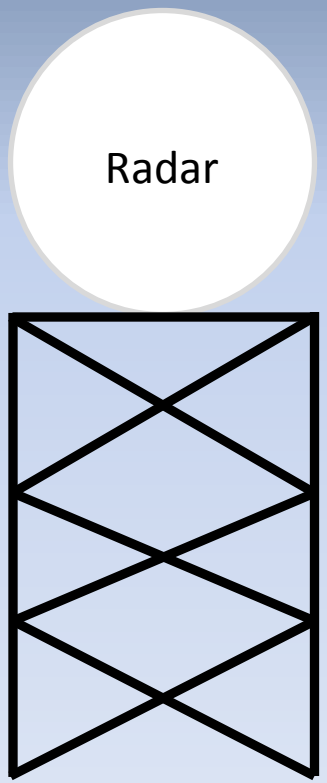
Dual Polarization

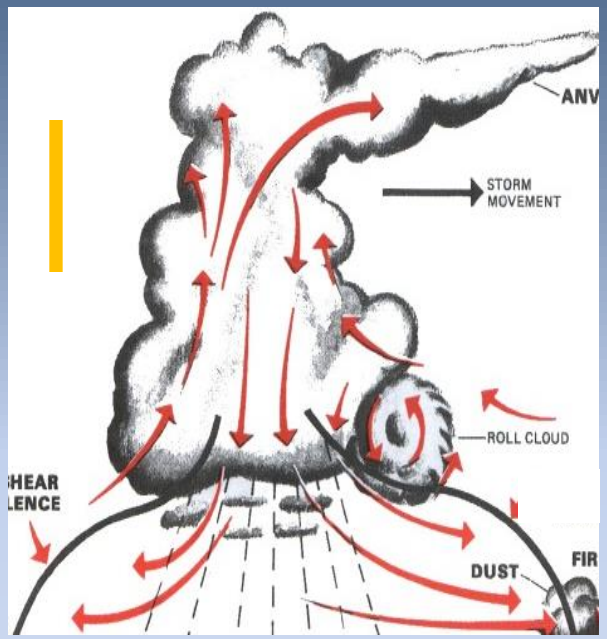
Radar





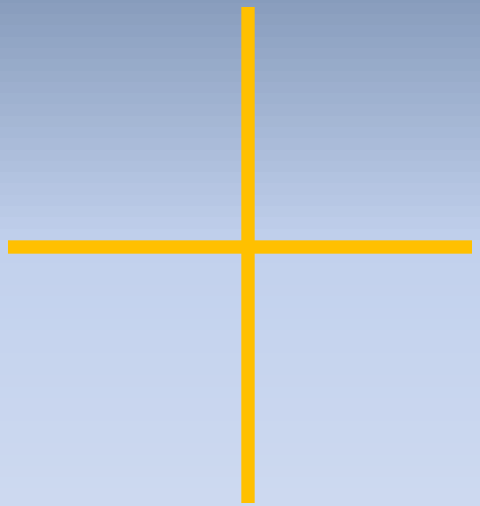
Dual Polarization





Dual Pol: The Cross Section

Vertical Pulse



Horizontal Pulse

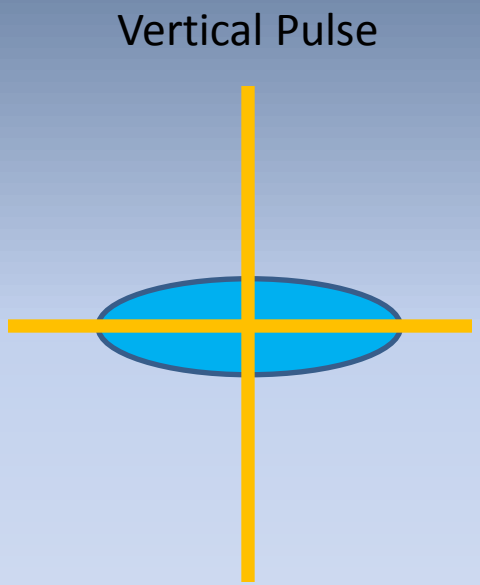
Targets measured in a ratio:

Example: Hail stone of 3 in X 3 in

Ratio: 3 to 3 or 1 to 1

or the target has the same height and width

Dual Pol: The Cross Section

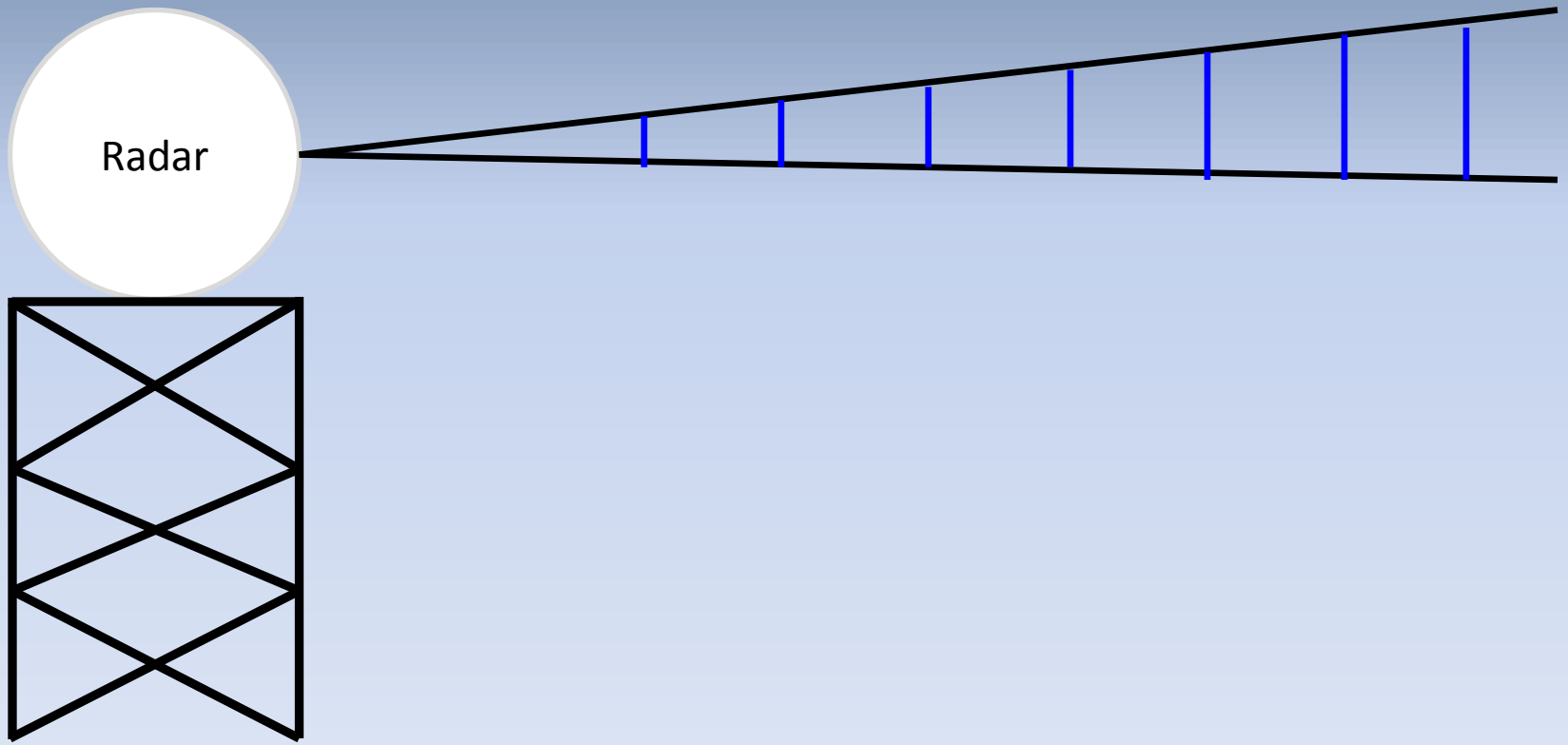


Raindrops are flattened as they fall
Targets measured in a ratio:
Example: width of 3, height of 1 or a ratio of 3 to 1

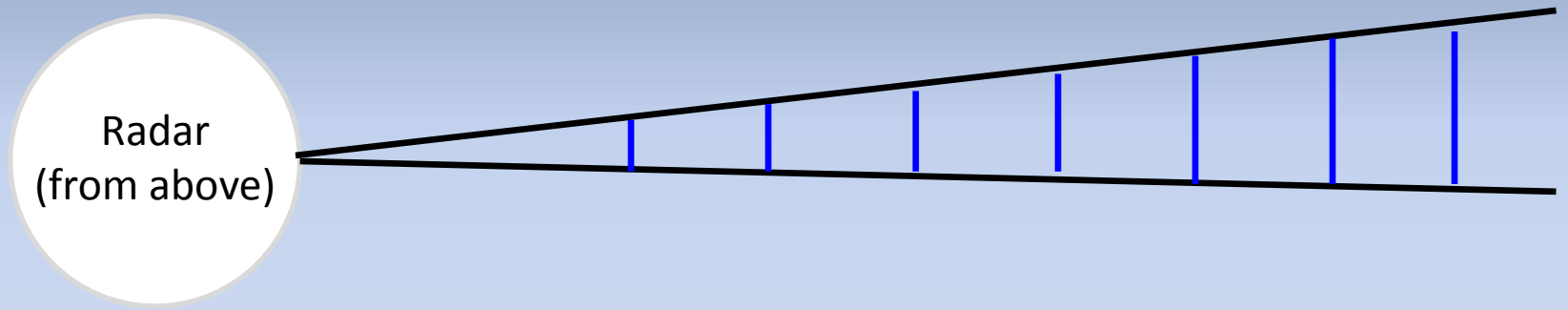
The Dual Pol Cross Section

- Allows us to determine the difference between targets in the atmosphere
  - Do we have hail or rain?
- Product called Differential Reflectivity
  - Improved ability to measure rainfall
- Called them targets because rain/hail aren't necessarily the only thing in the air

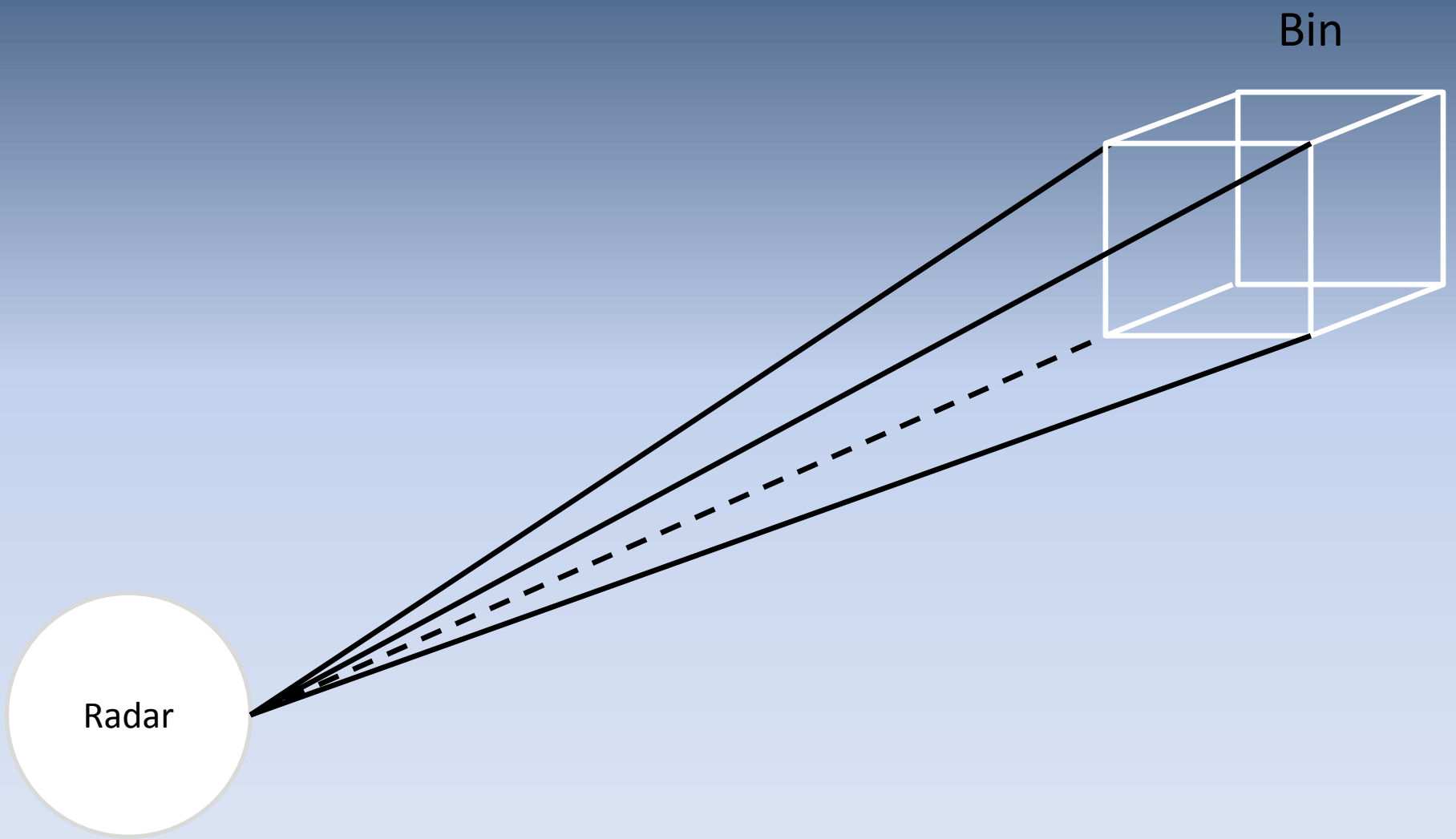
Dual Polarization



Dual Polarization

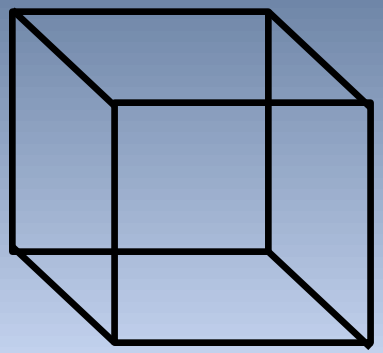


Dual Polarization



Dual Polarization

Bin



Ratio 3 to 1

Ratio 1 to 1

Ratio ???

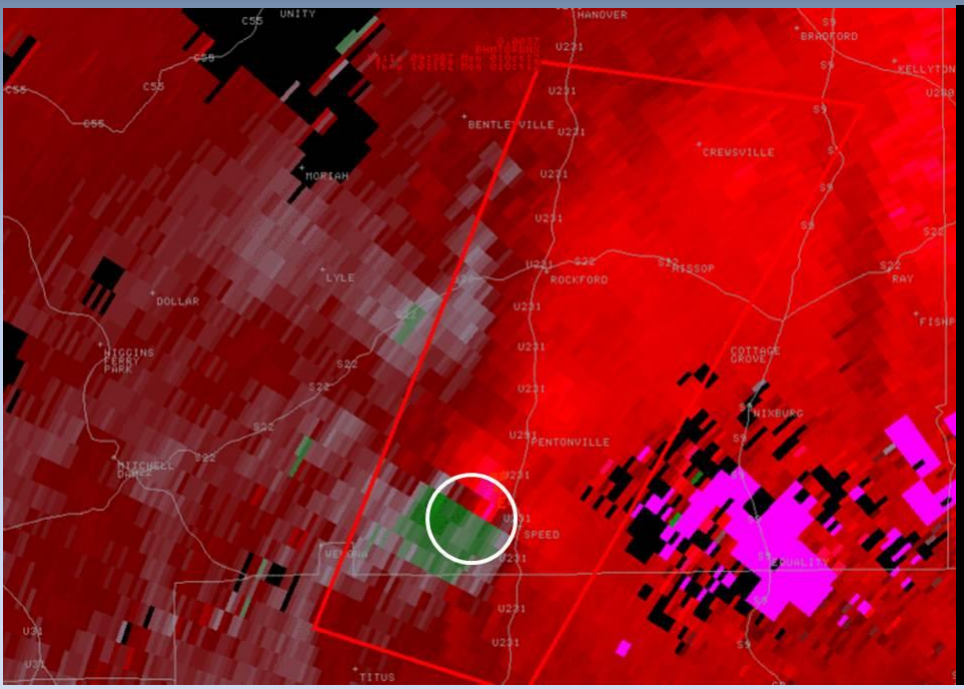
Wood, Insulation, Leaves, Twigs, Paper, etc.

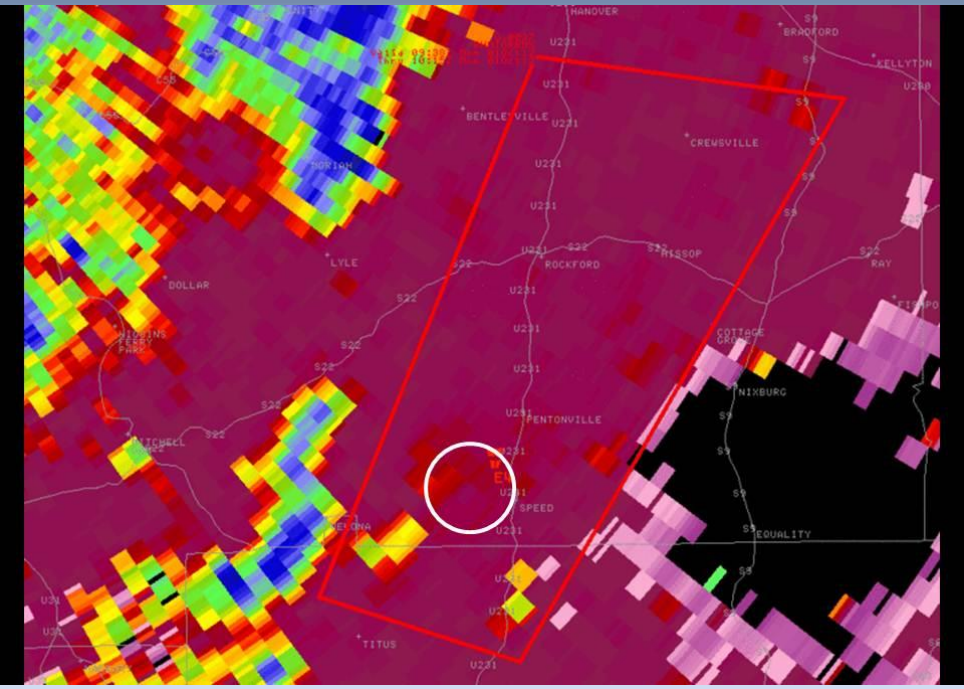
Correlation Coefficient

- All of those targets are in the bin and the radar has to distinguish between them
- It calculates the ratios of all those targets
- When you have all different kinds of targets in a bin, and their ratios are not correlated.
  - Correlation Coefficient of that bin is LOWERED

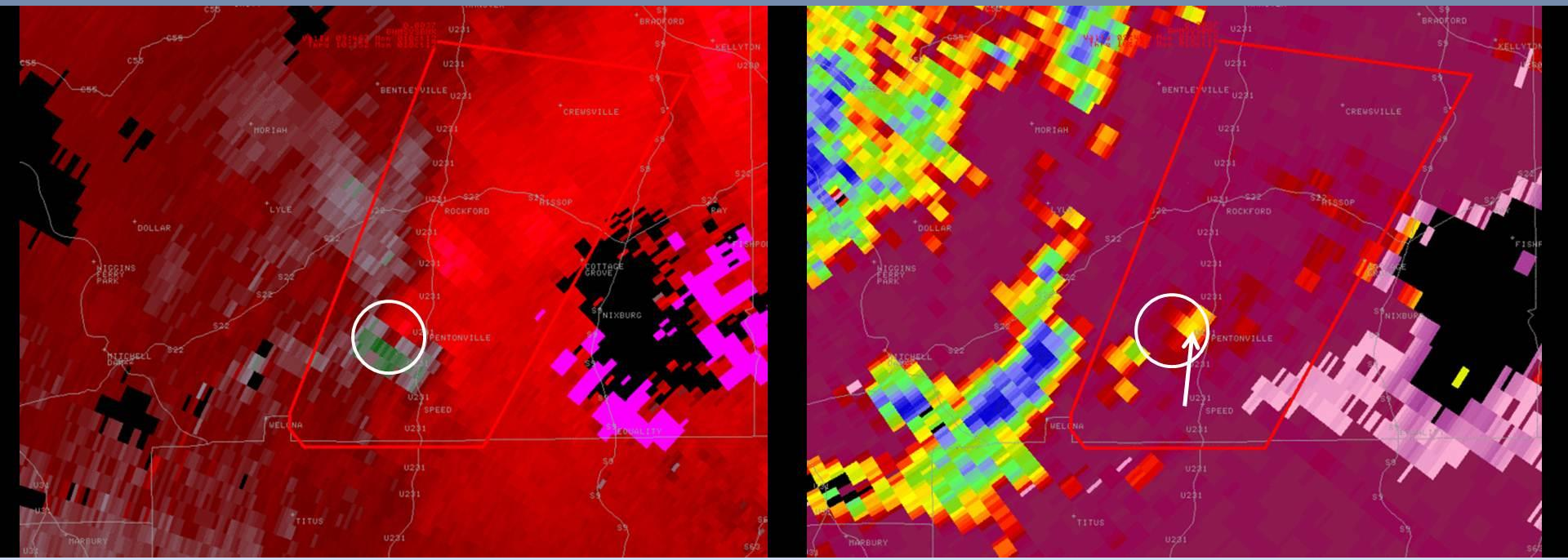
TORNADO DEBRIS SIGNATURE

Tornado Debris Signature

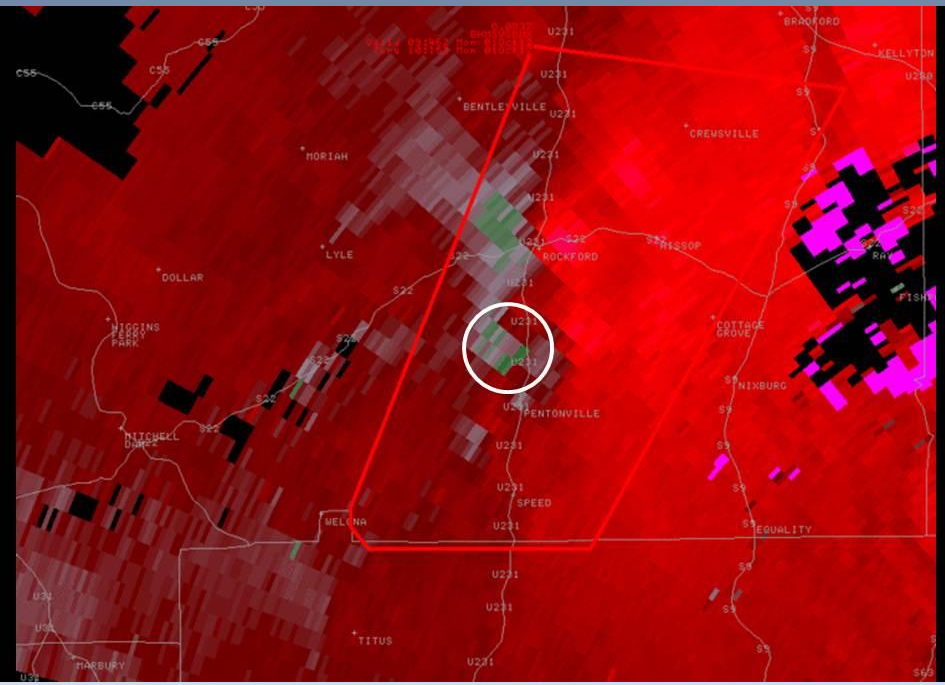


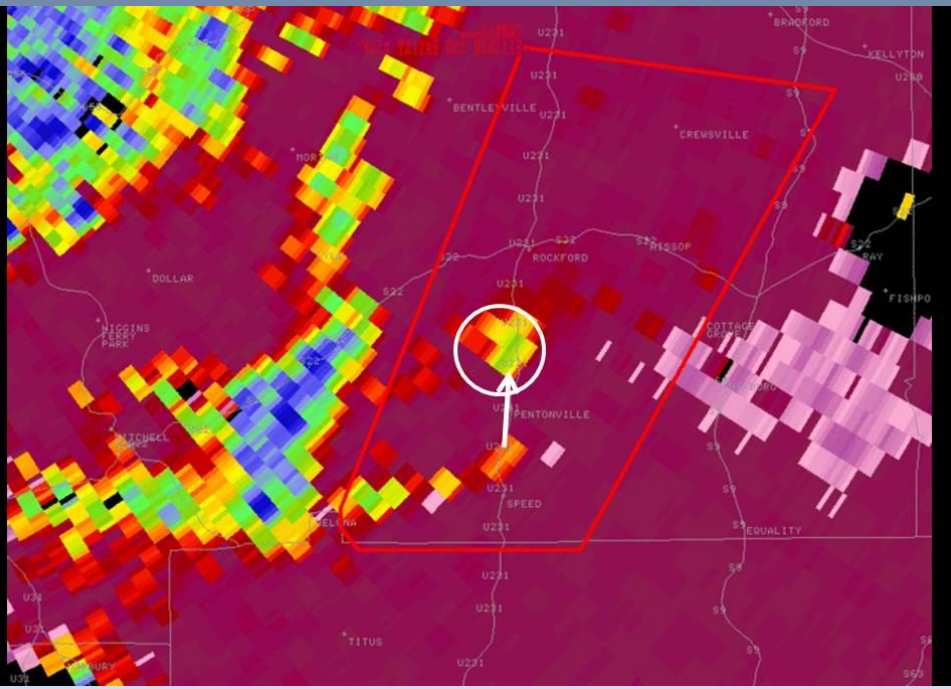


Tornado Debris Signature



Tornado Debris Signature





Questions or Comments?

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Please, send me an email with the number of people in attendance at your computer, if more than one

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Weather Service – Birmingham, AL