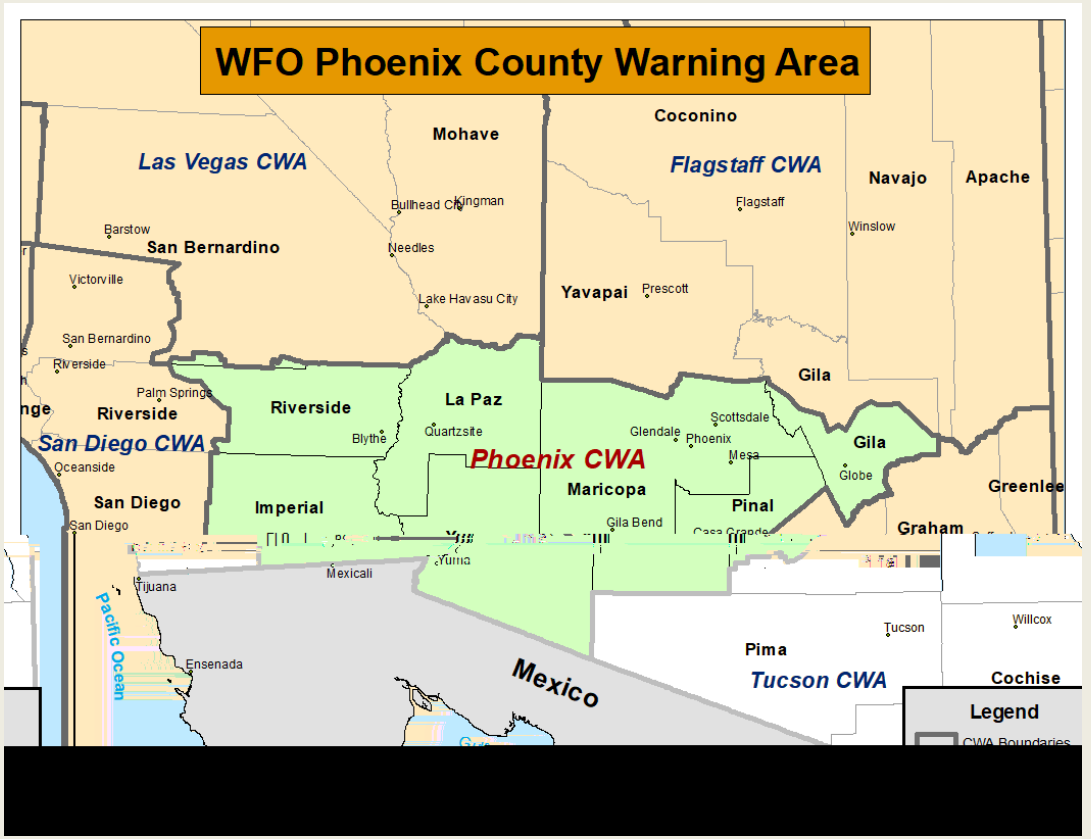
Advanced Spotter Training 2021

Austin Jamison
National Weather Service – Phoenix, AZ

Photo: Mark Rebilas

About Our Office



Program Outline

Five Fundamental Rules

Organized Storm Ingredients

Stan Celestian

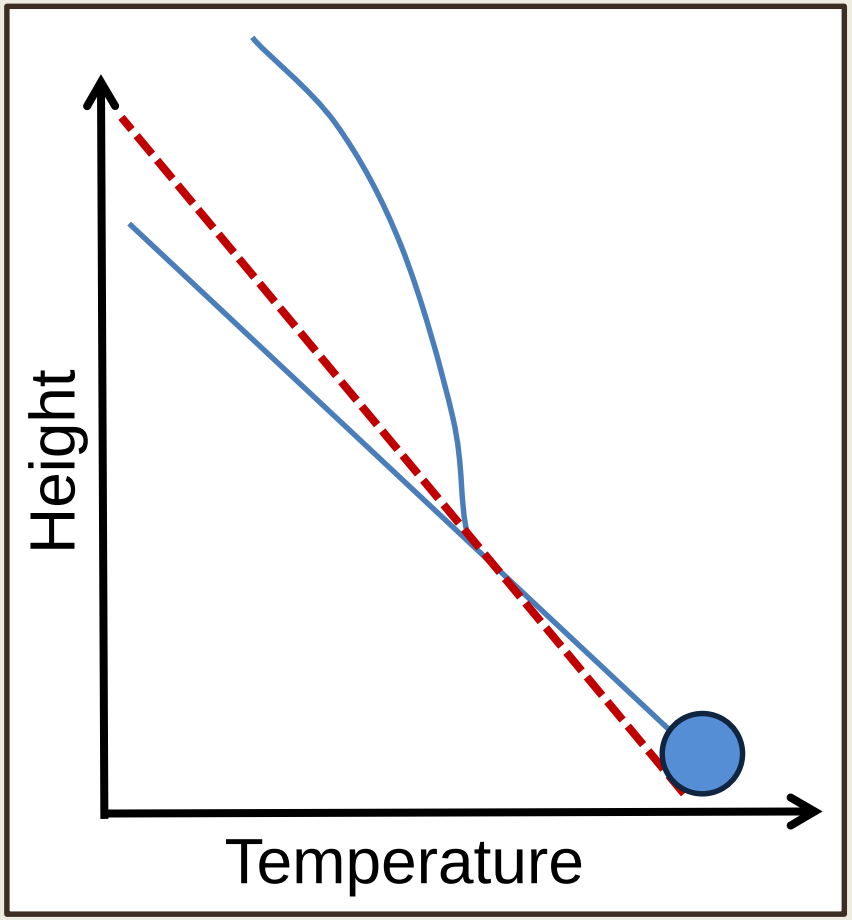
Moisture

Why is this?

LATENT HEAT RELEASE –

condenses

warmed



Instability

UNSTABLE

STABLE

Jeremy Perez

How do we measure instability?

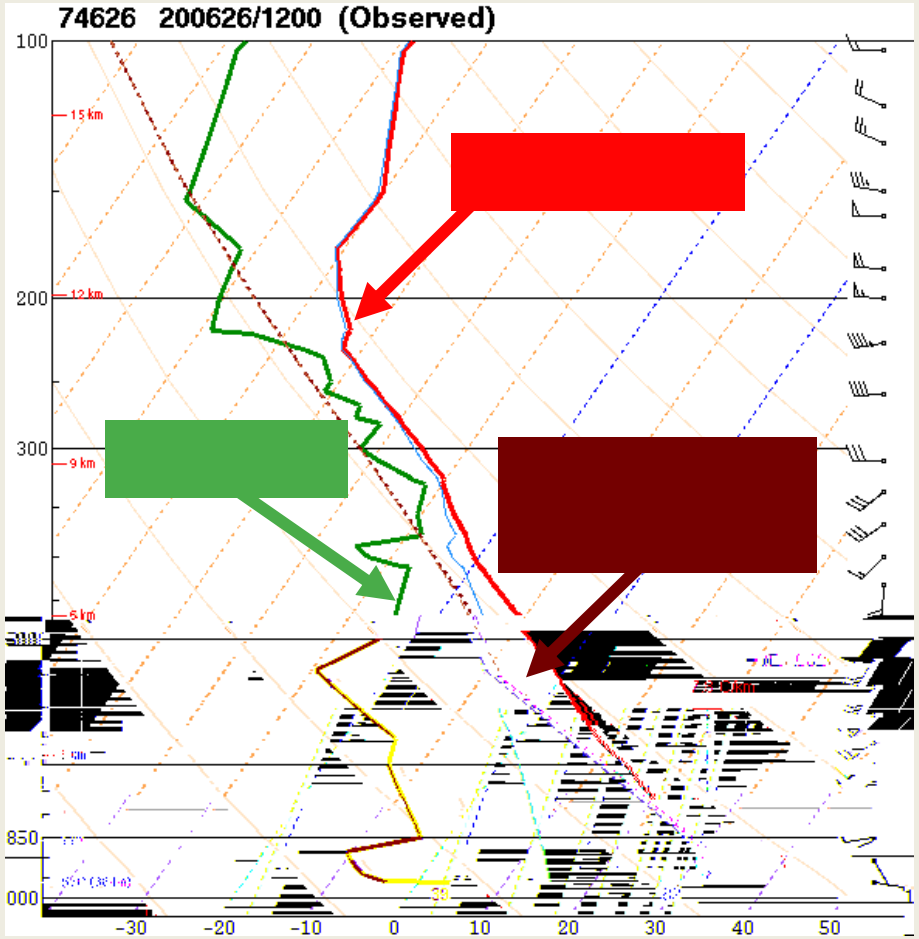
CAPE **C** **A** **P** **E**

CIN **C** **In**

CAPE Value (J/kg)	Severe Weather Potential

Thunderstorm Ingredients and Skew-T's

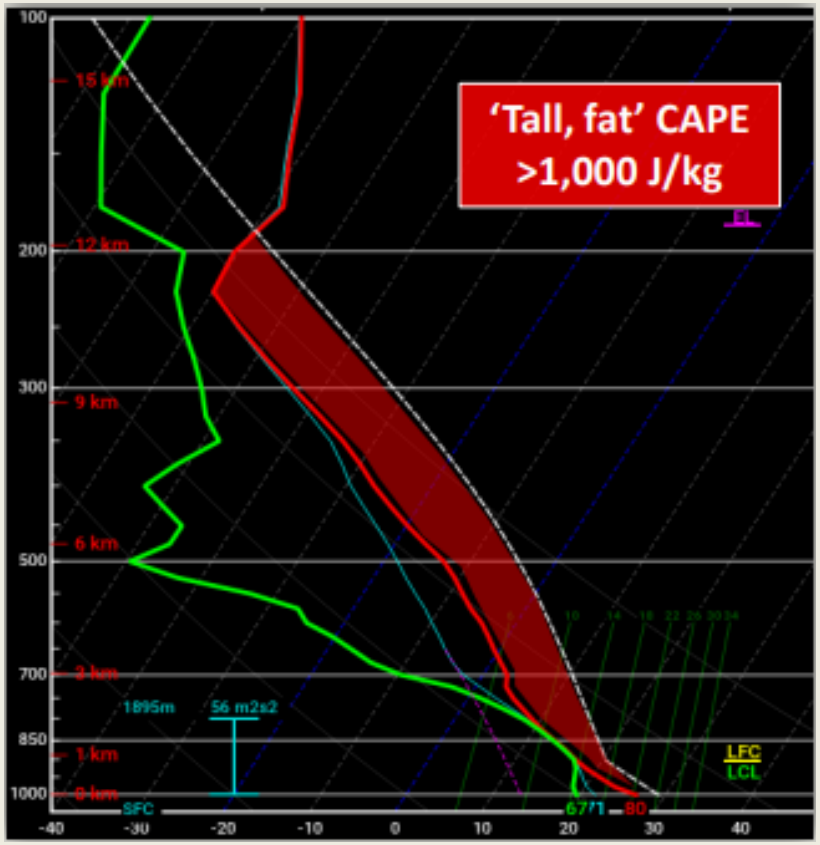
Skew T:

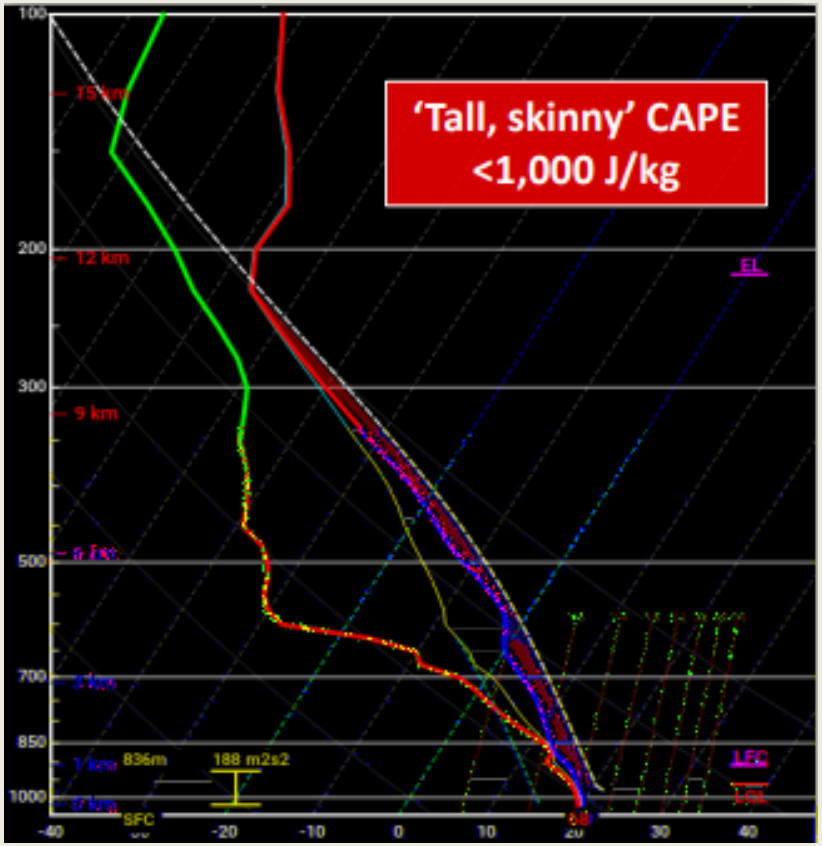


Wind Barbs

For real-time observed soundings:
https://www.spc.noaa.gov/exper/soundings/

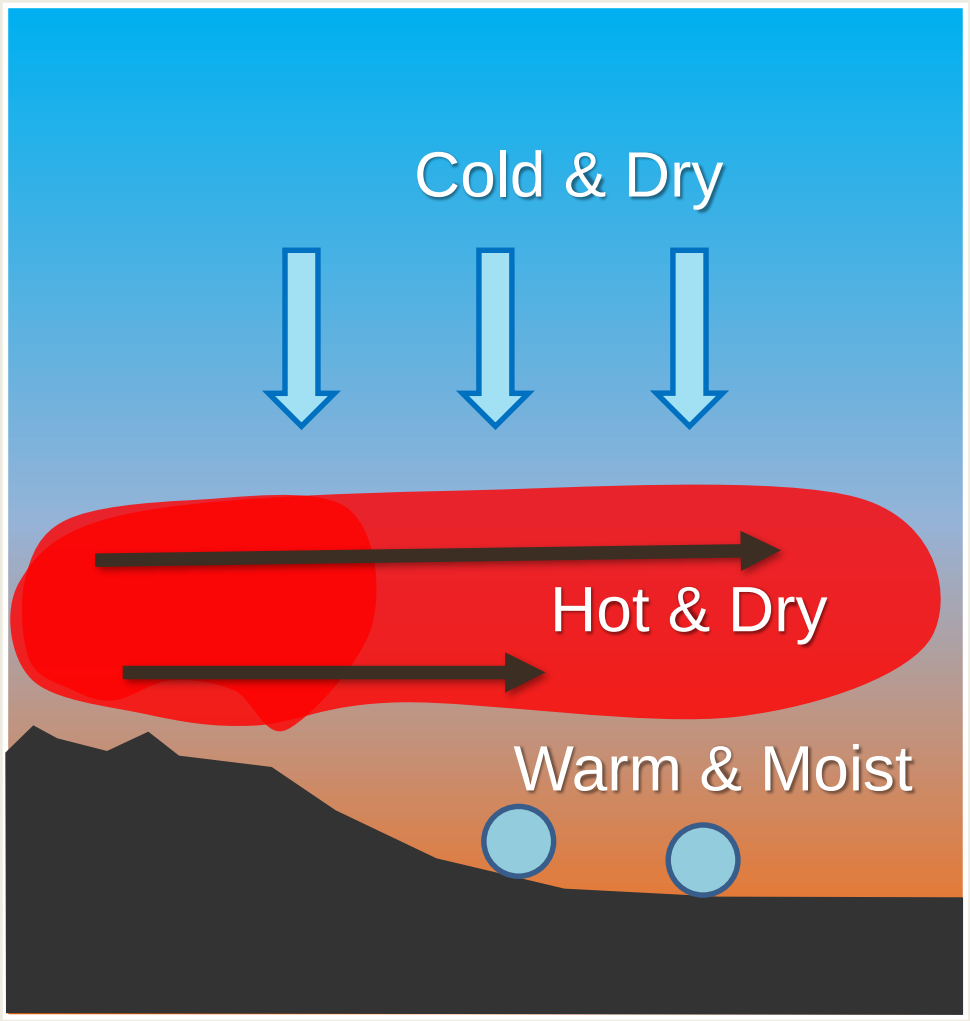
Instability – Weak vs. Strong CAPE



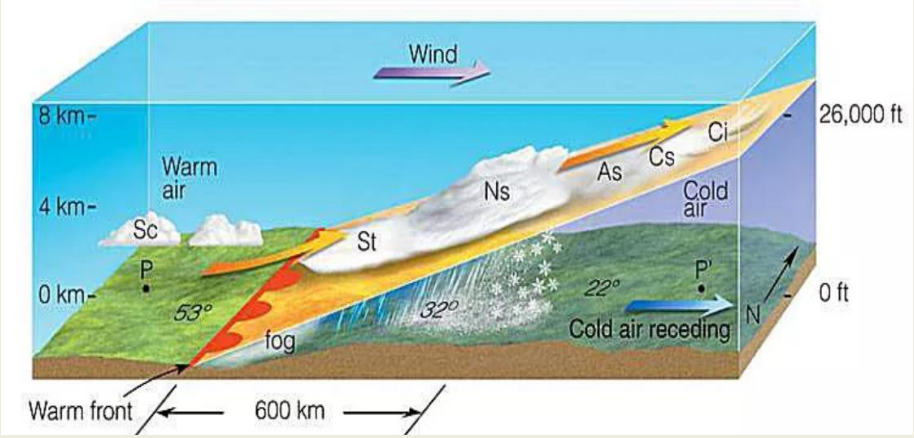


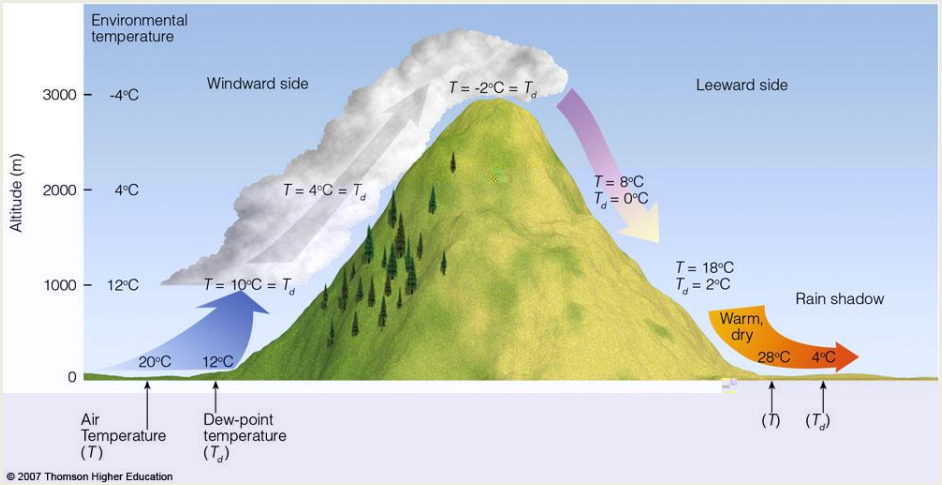
NWS Birmingham

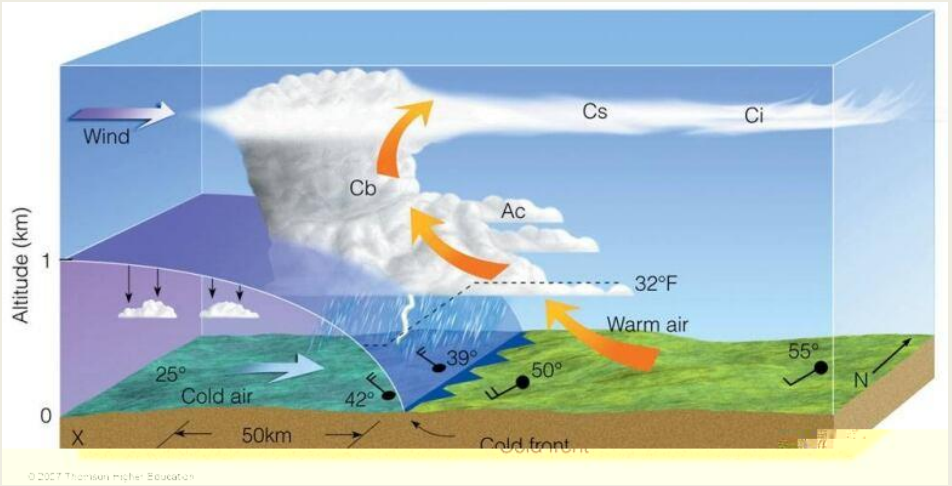
Instability – The Cap (aka CIN)



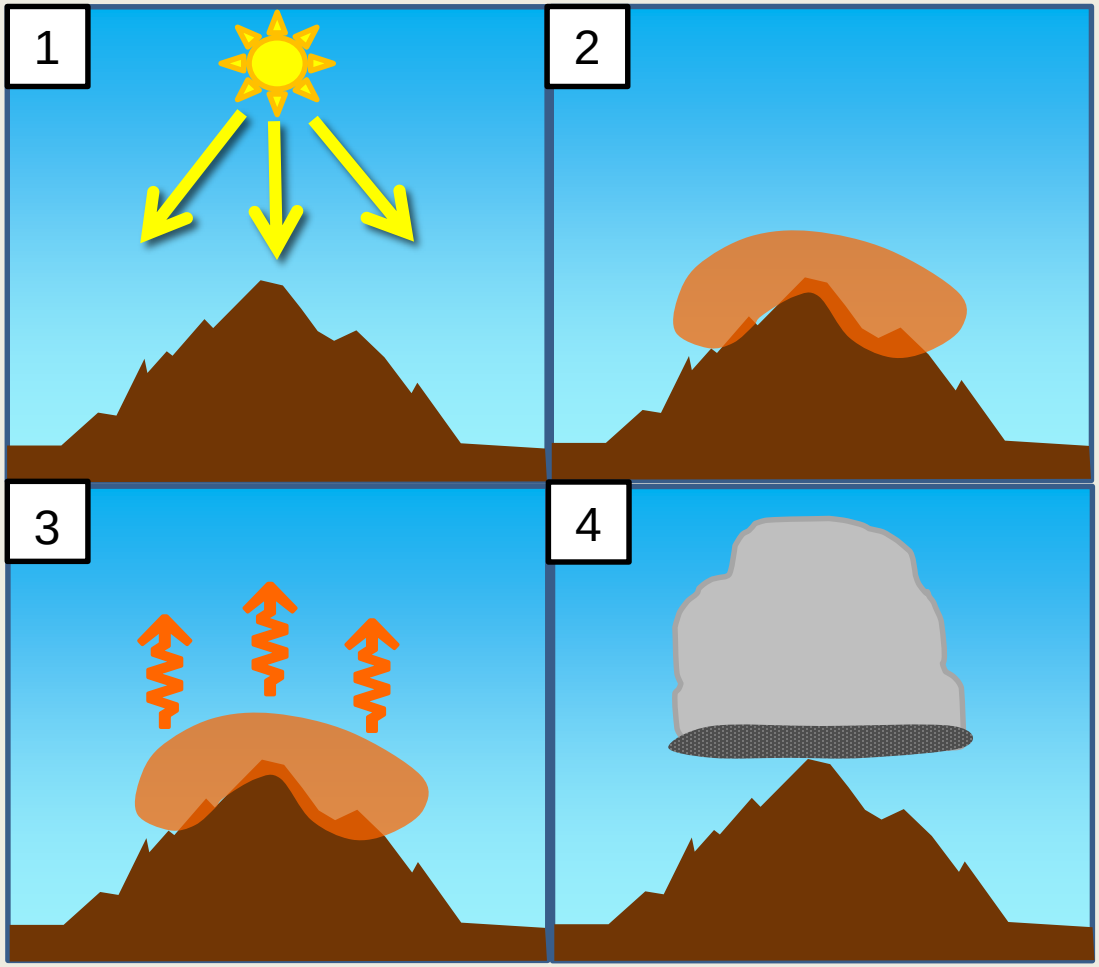
Lift


Wind
8 km
4 km
0 km
26,000 ft
0 ft
Warm air
Sc
St
Ns
As
Cs
Ci
Cold air
P
P'
53°
32°
22°
fog
Cold air receding
N
Warm front
600 km

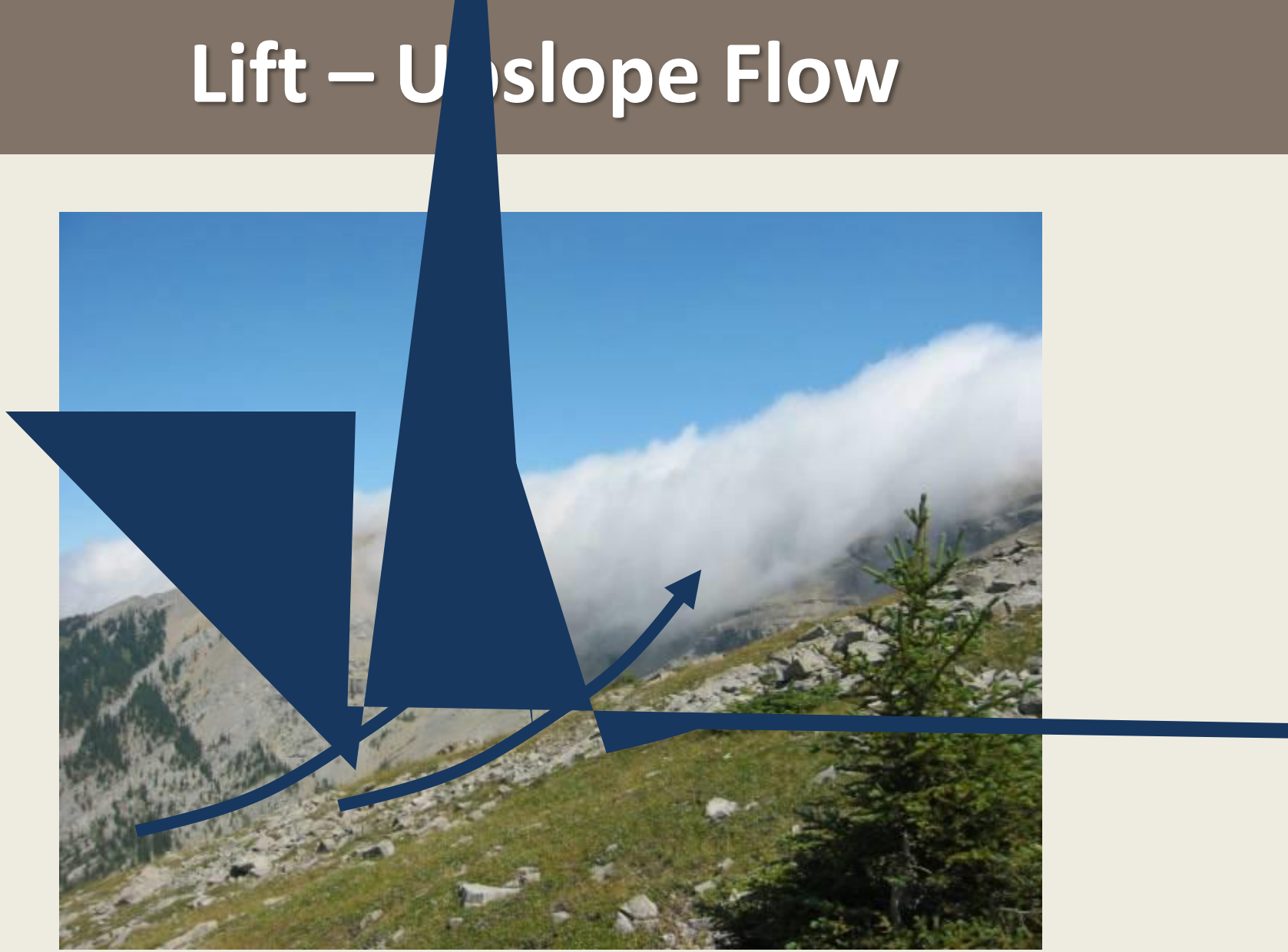

Environmental temperature
Windward side
Leeward side
3000
2000
1000
0
Altitude (m)
-4°C
4°C
12°C
T = -2°C = T_d
T = 4°C = T_d
T = 10°C = T_d
T = 8°C
T_d = 0°C
T = 18°C
T_d = 2°C
Warm, dry
Rain shadow
20°C
12°C
28°C
4°C
Air Temperature (T)
Dew-point temperature (T_d)
(T)
(T_d)
© 2007 Thomson Higher Education


Wind
Cs
Ci
Cb
Ac
Altitude (km)
1
0
32°F
Warm air
25°
Cold air
42°
39°
50°
55°
N
X
50km
Cold front

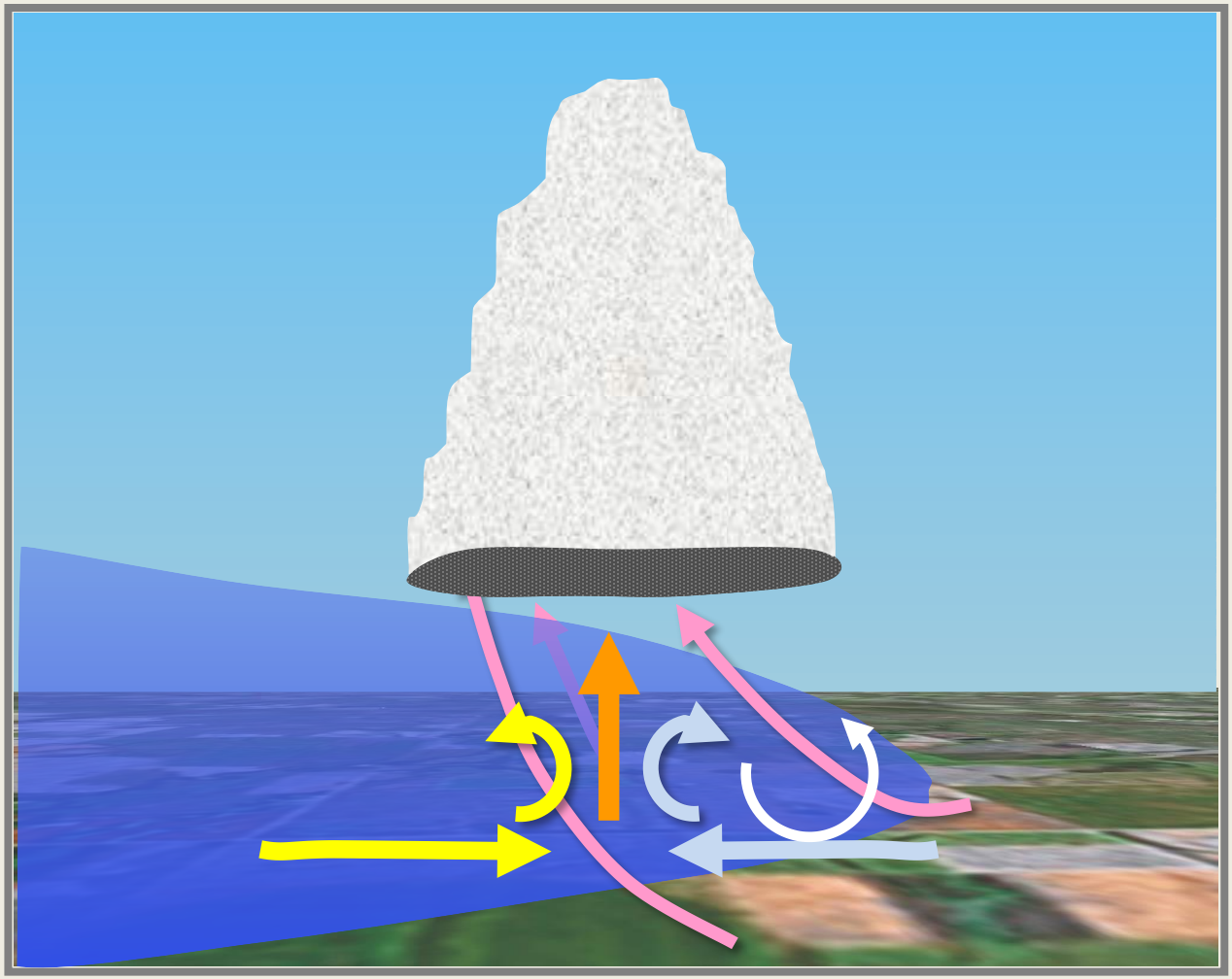
Lift – Elevated Heat Source



Lift – Upslope Flow

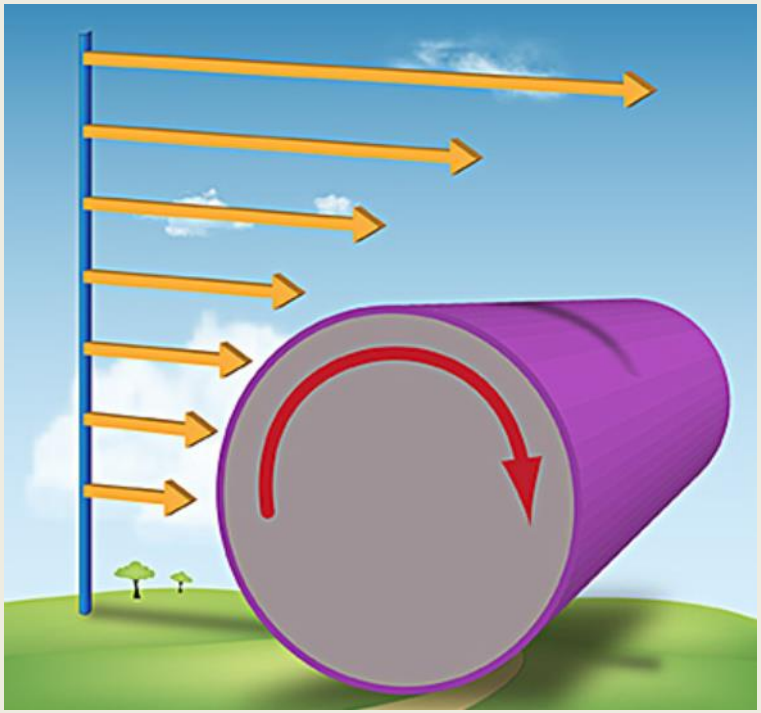


Lift – Fronts & Boundaries

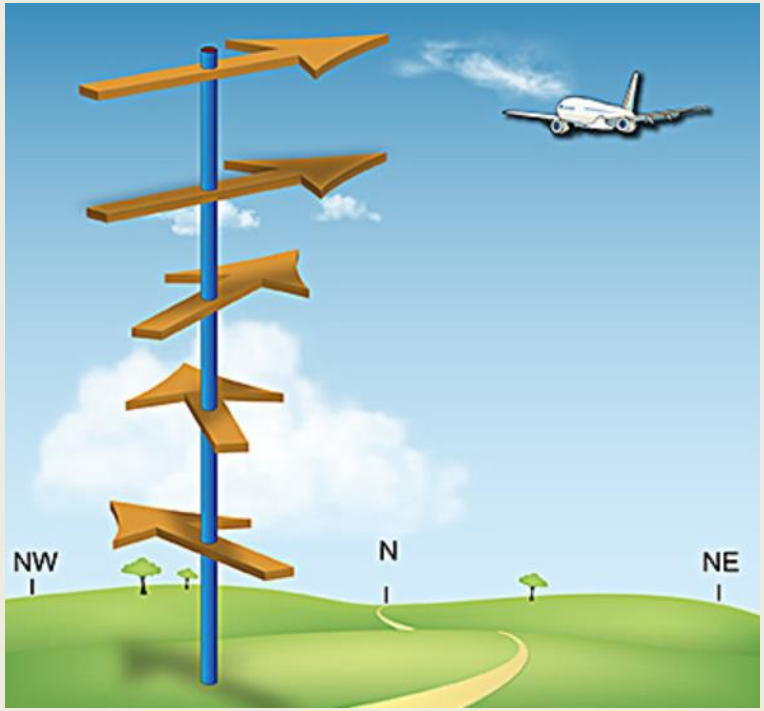


Vertical Wind Shear

Wind Shear – Types

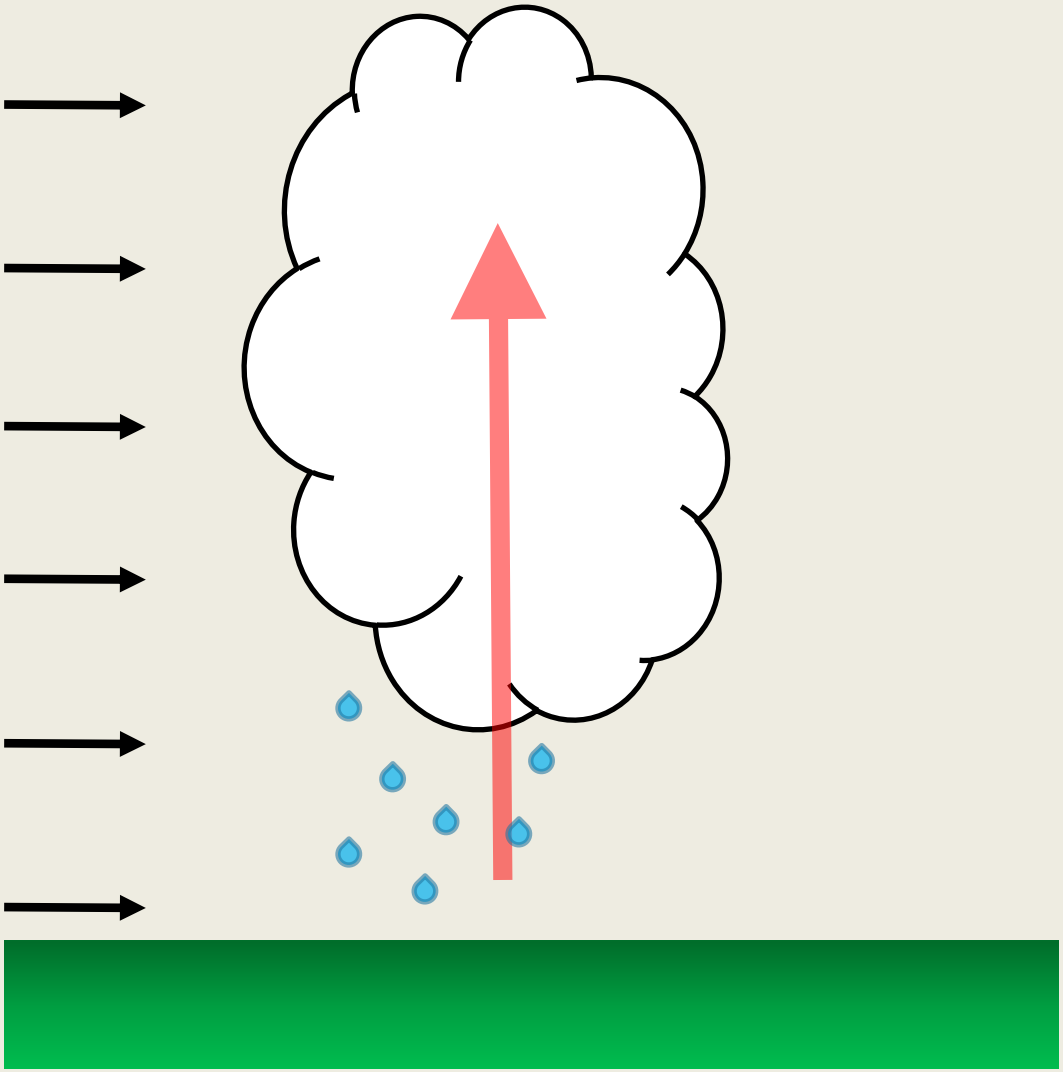


speed

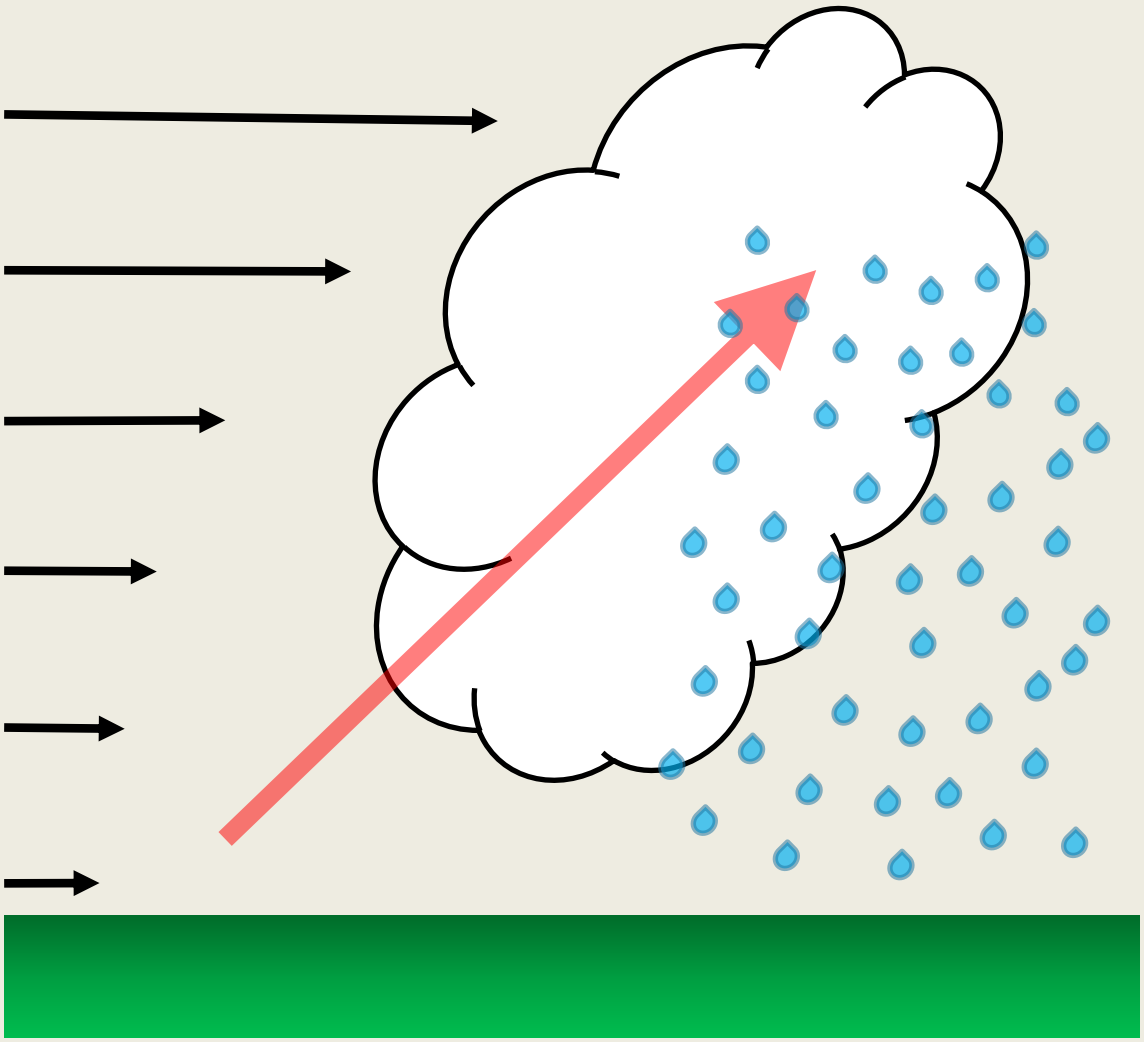


direction

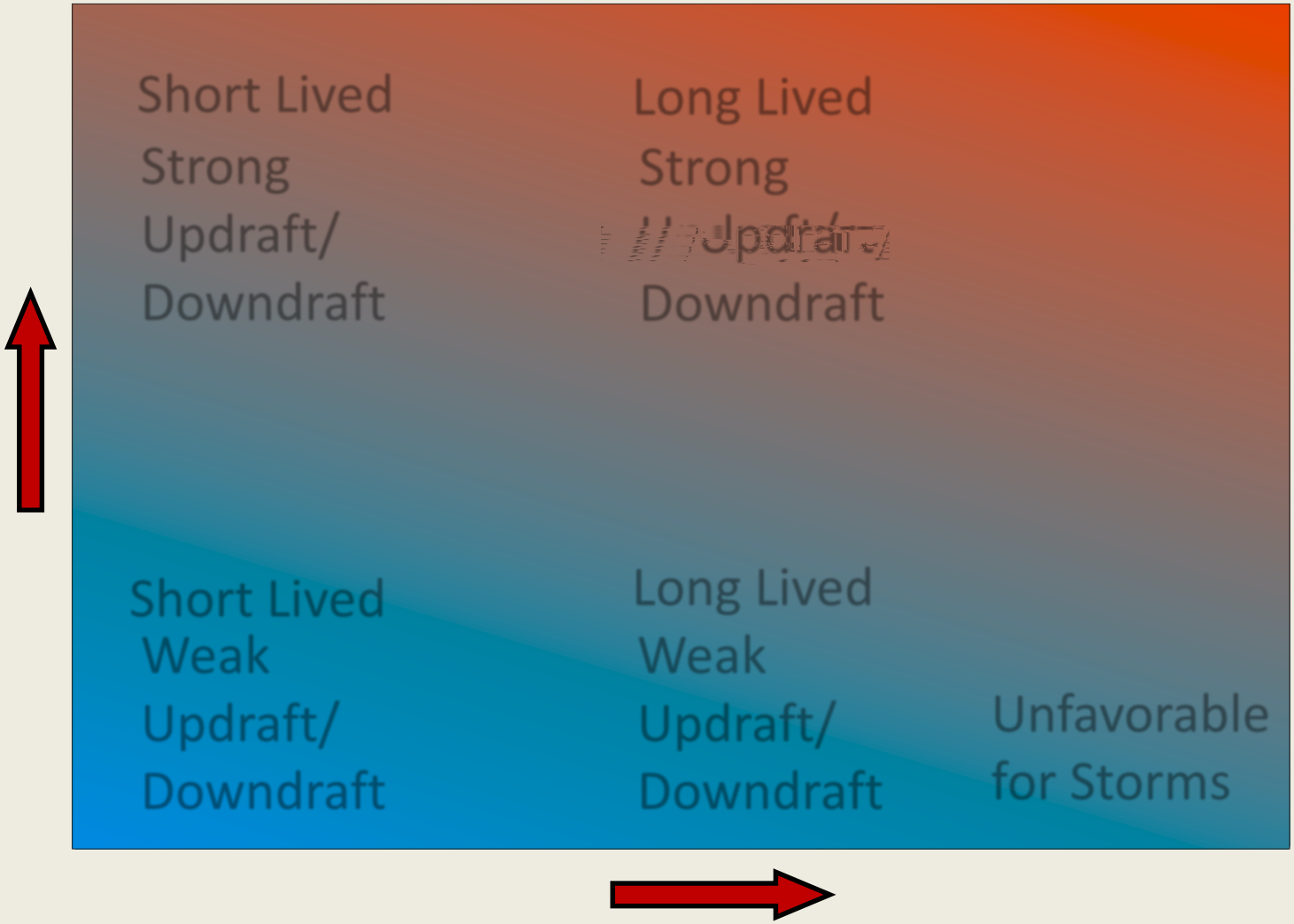
Weak Deep-Layer Shear



Strong Deep-Layer Shear

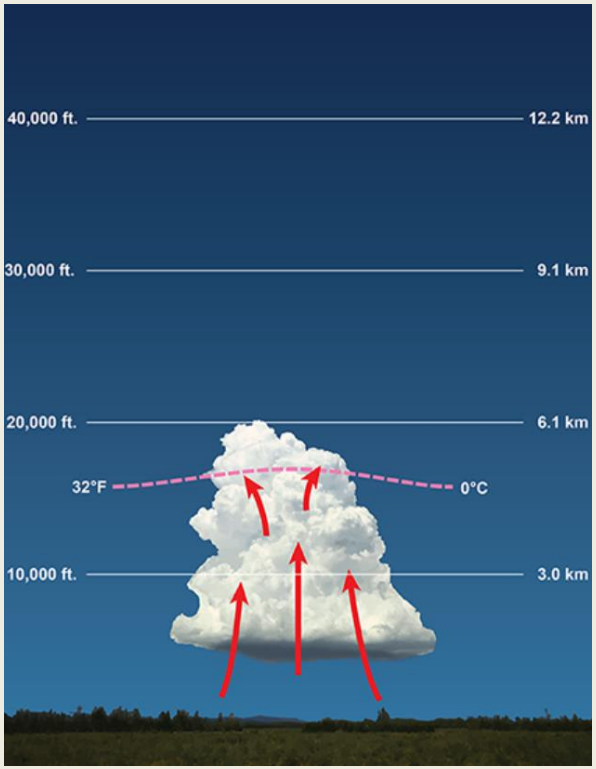


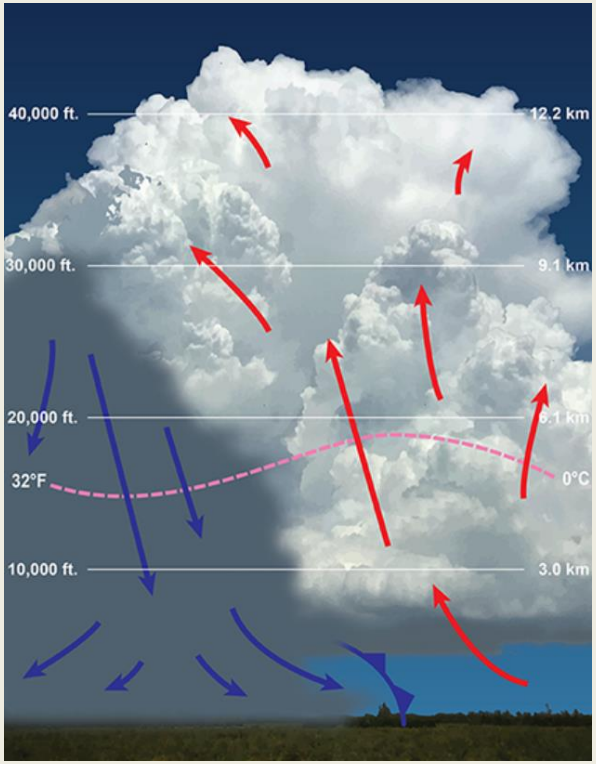
Instability and Vertical Shear

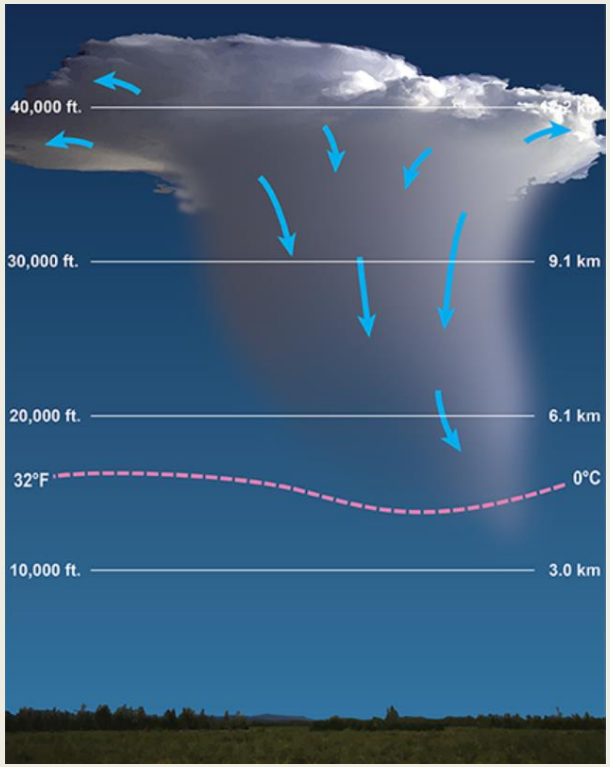


Program Outline

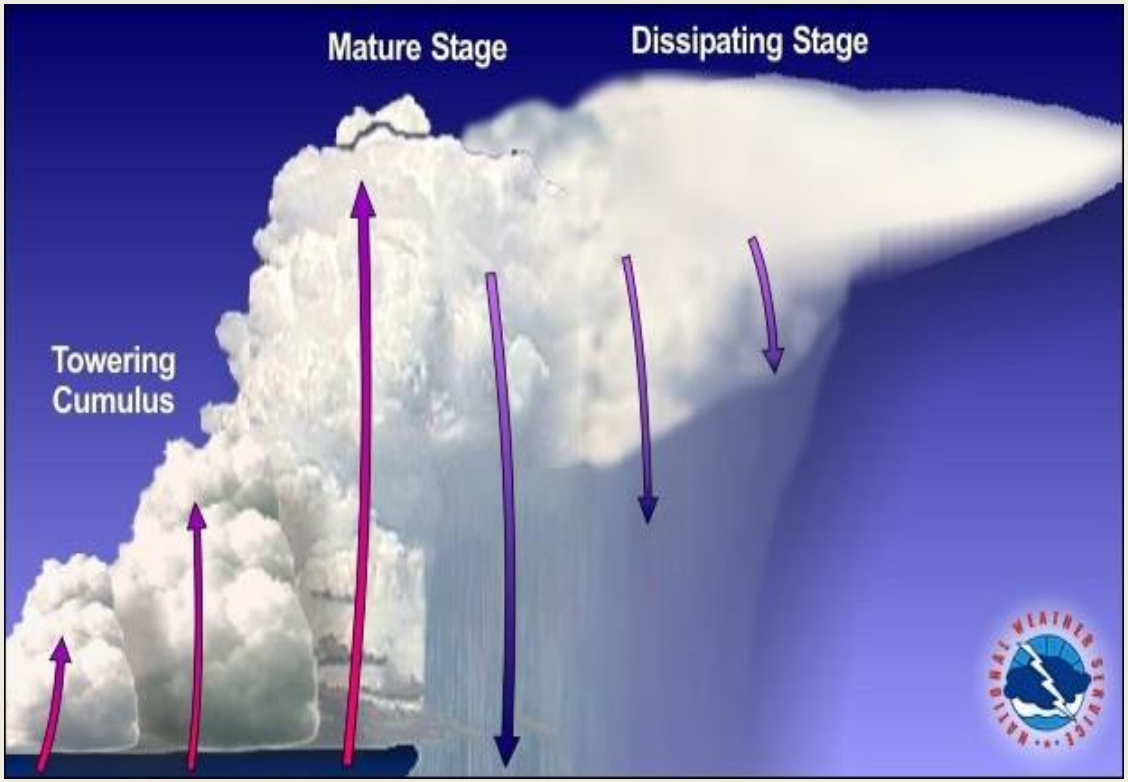
Ordinary Thunderstorms





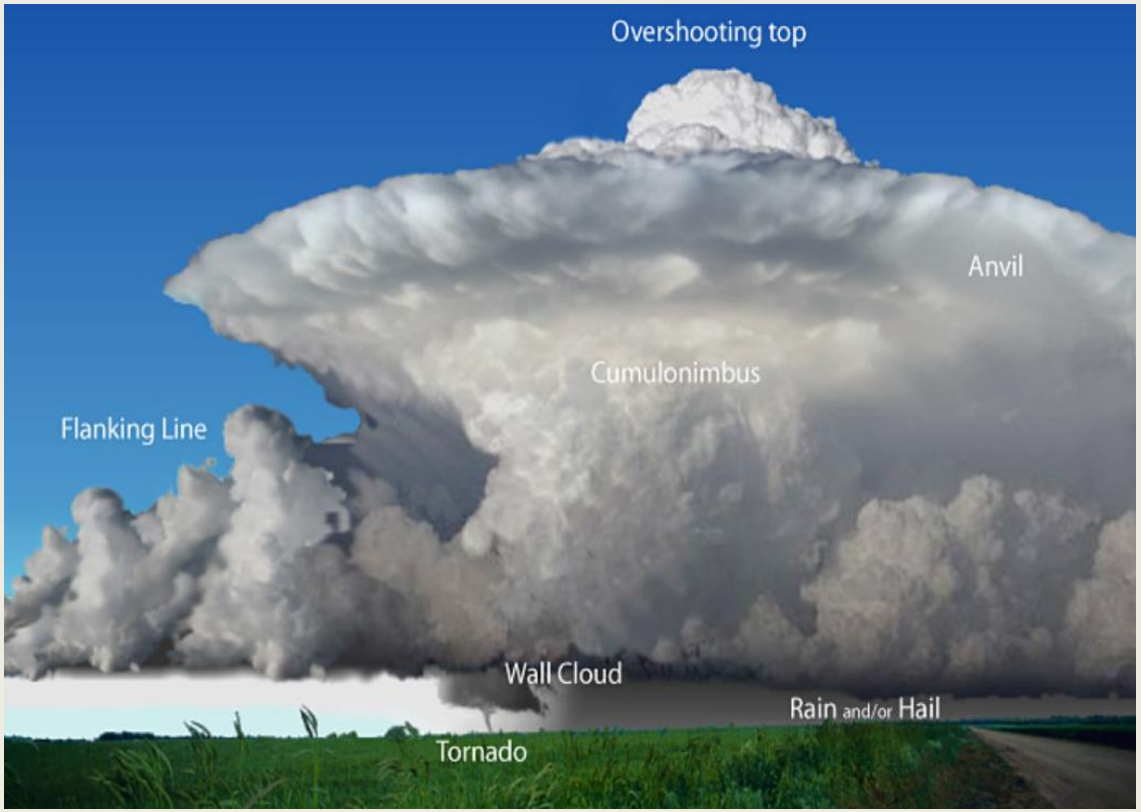


Multi-cell Thunderstorms



backbuilding

Supercell Thunderstorms



flash flood threat

Supercells

Mesocyclone

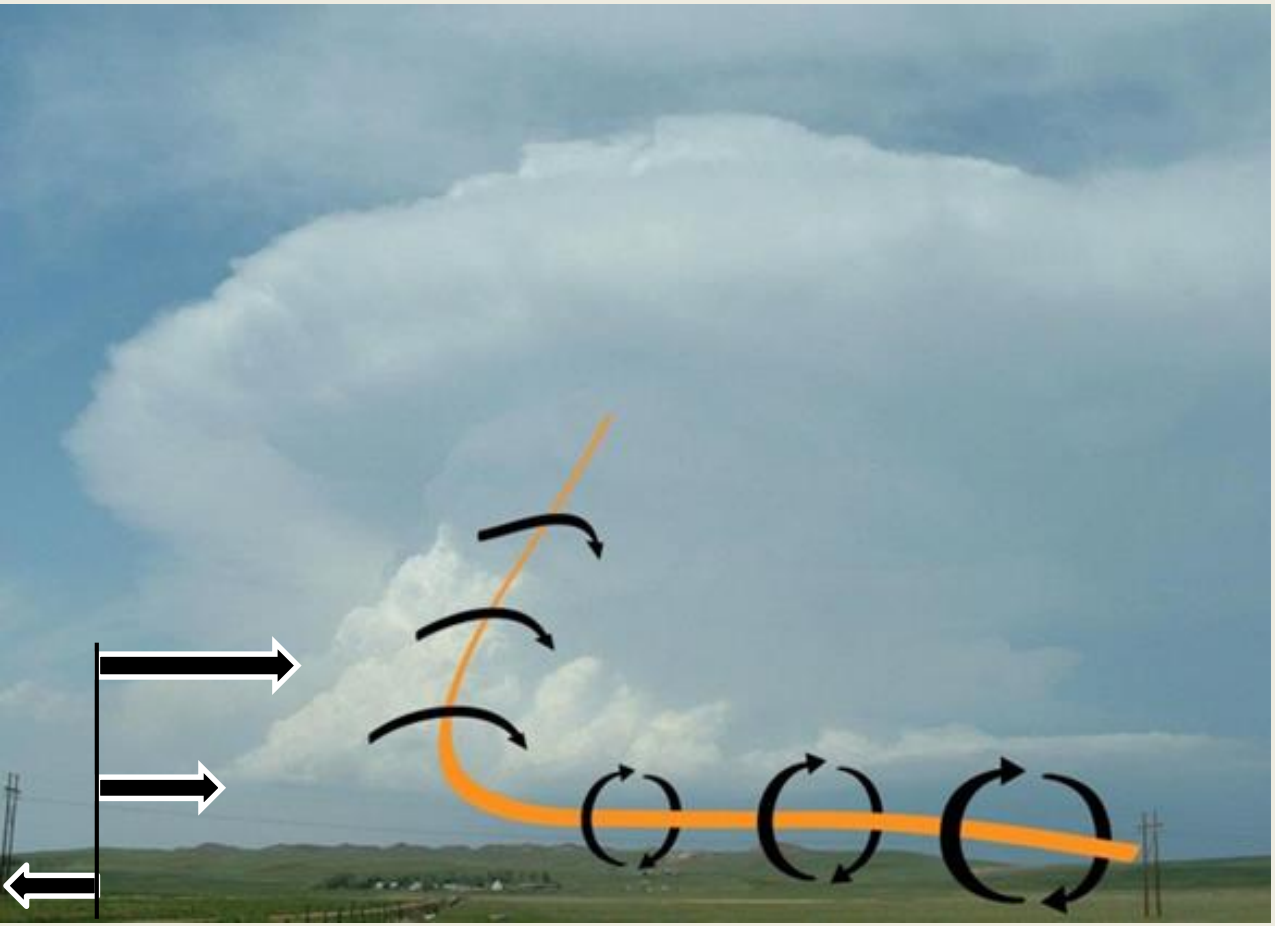
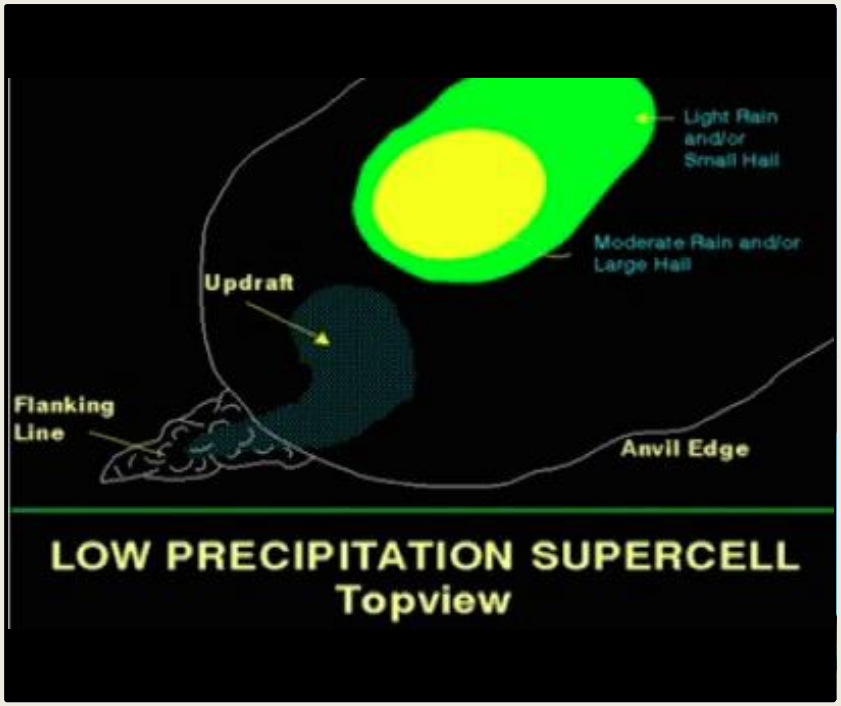
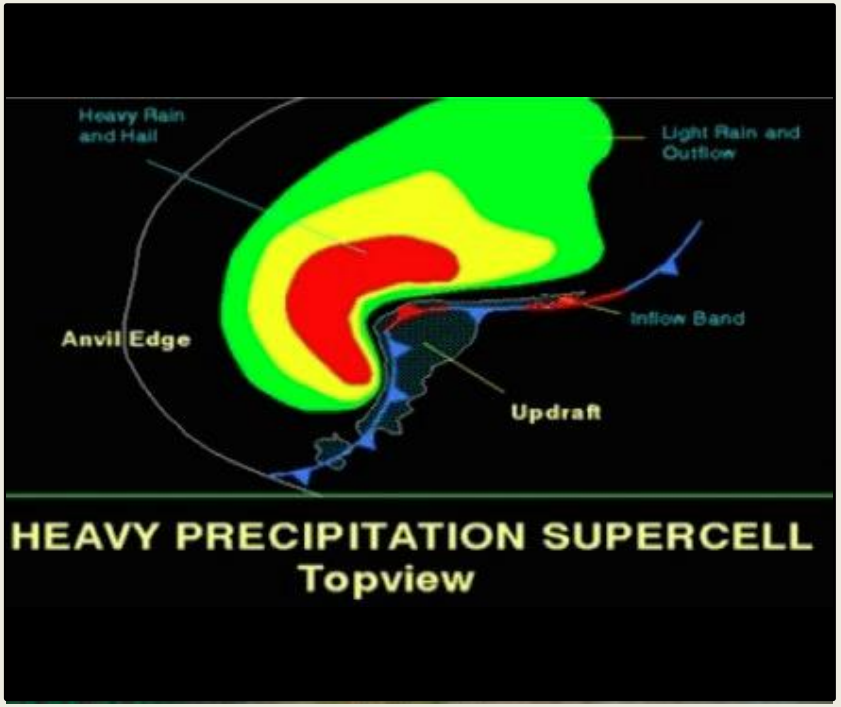


Photo: Markowski and Robinson (2010)

Types of Supercells



Low-Precip (LP) Supercells



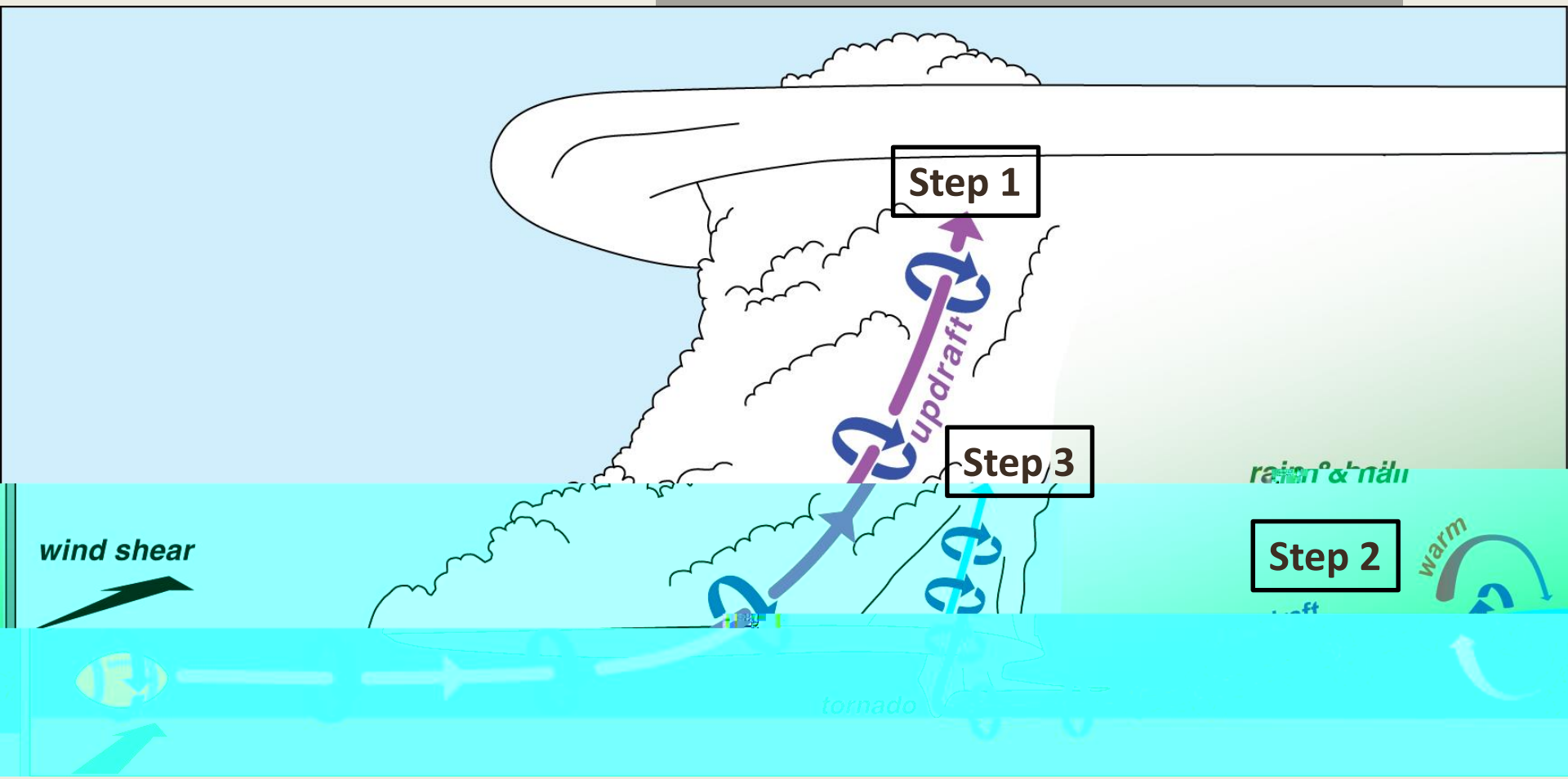
High-Precip (HP) Supercells

Program Outline

Tornadoes - Tornadogenesis

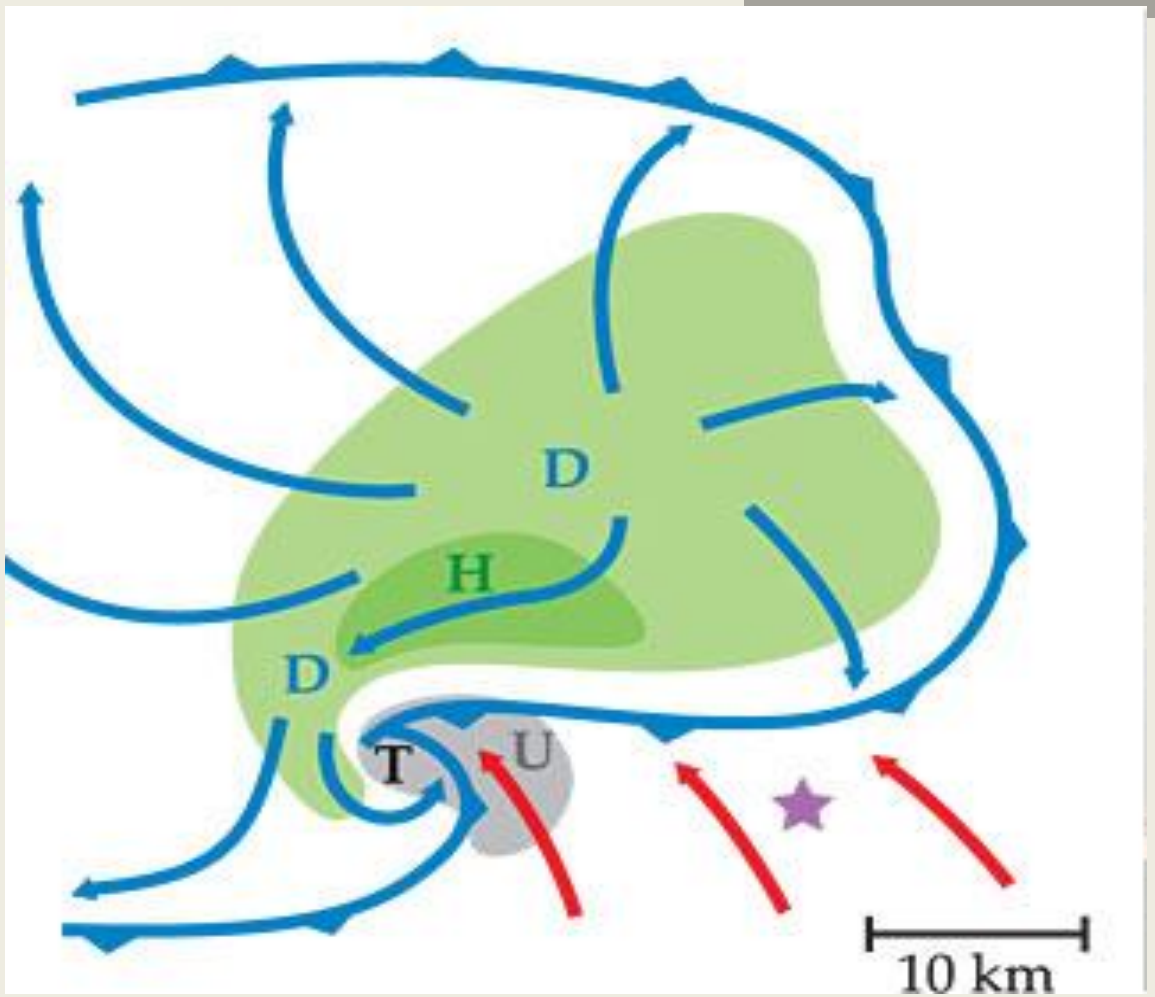
3 step process to tornado formation

Tornadoes - Tornadogenesis



Images: https://sites.psu.edu/tornadoes/

Tornadoes - Tornadogenesis

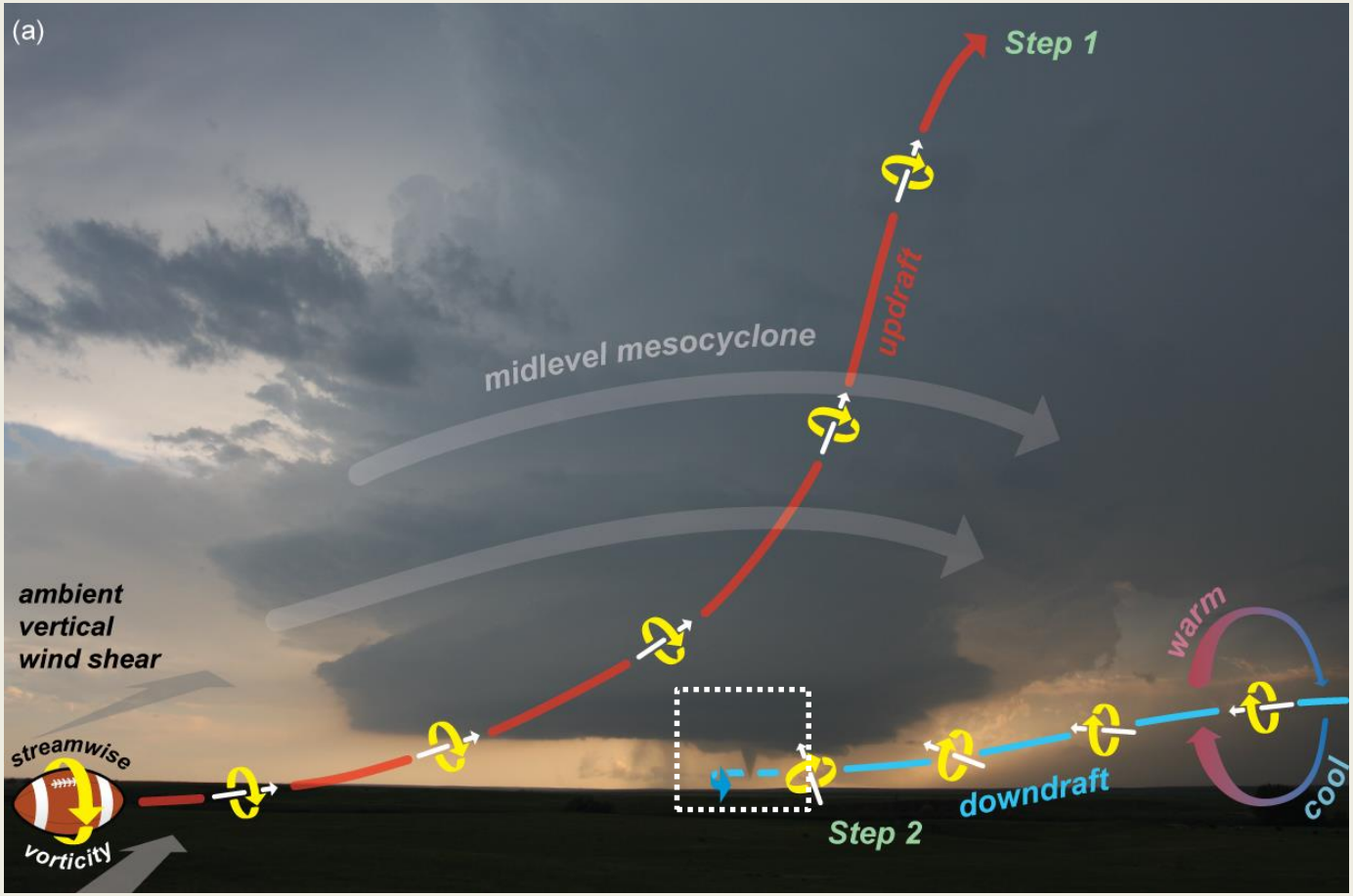


Tornadic Supercell Top View

Images: Physics Today - Markowski and Richardson (adapted from Lemon and Doswell)

Tornadoes - Tornadogenesis

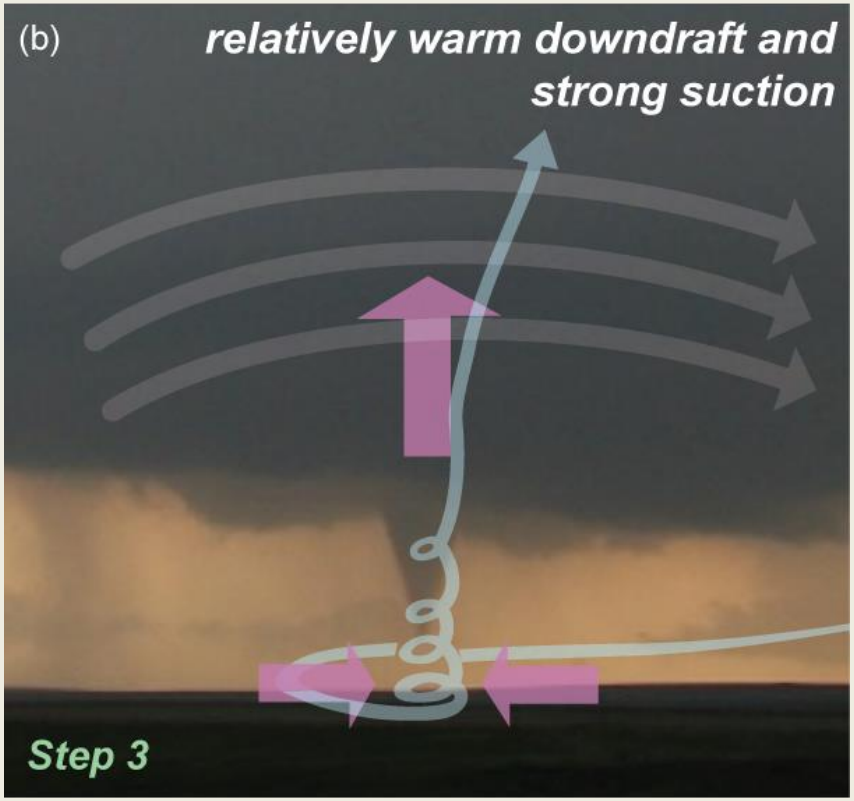
Steps 1 & 2



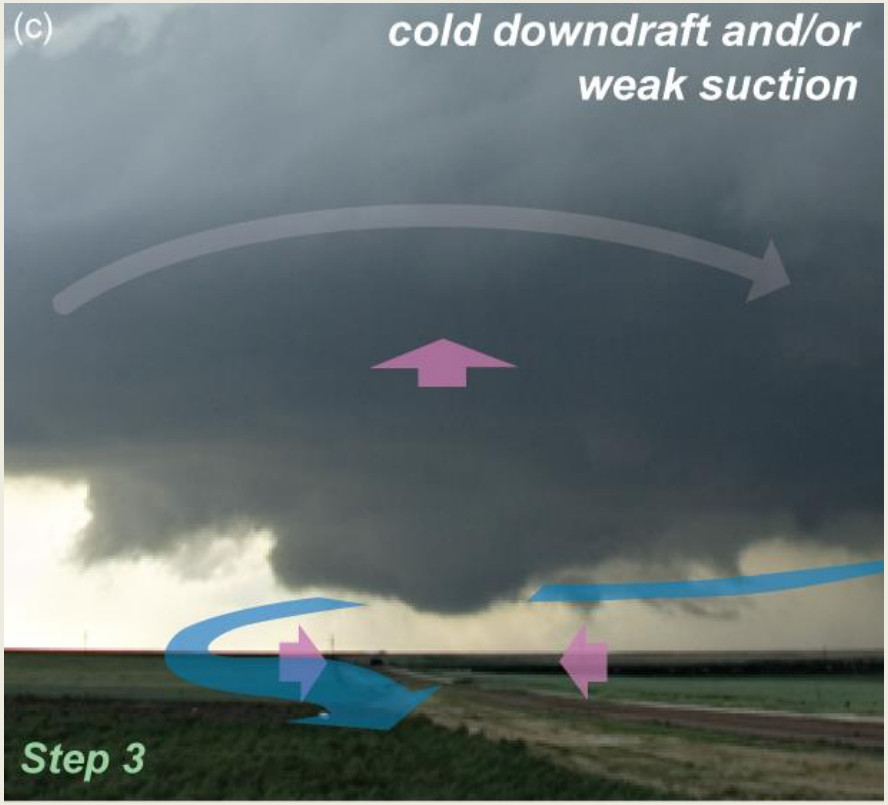
Images: https://sites.psu.edu/tornadoes/

Tornadoes - Tornadogenesis

Step 3 - Tornado



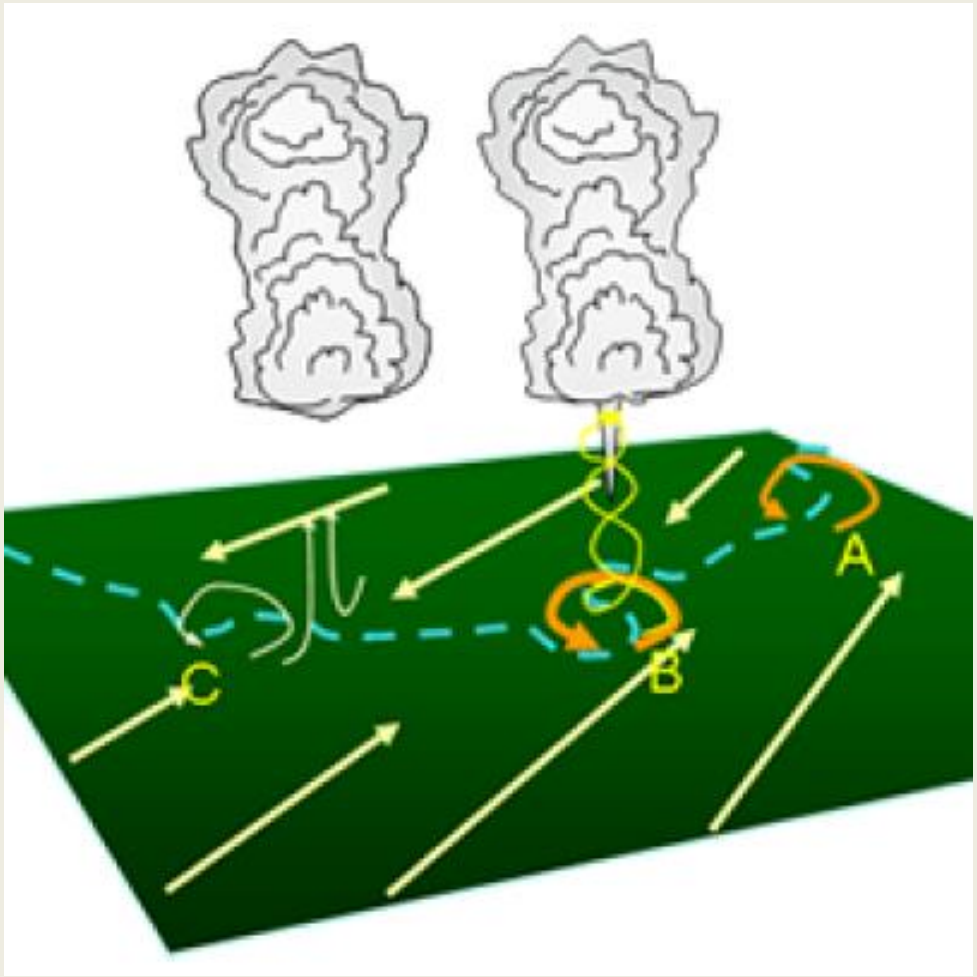
Step 3 – No Tornado



Images: https://sites.psu.edu/tornadoes/

Landspouts – Formation

Non-Supercell

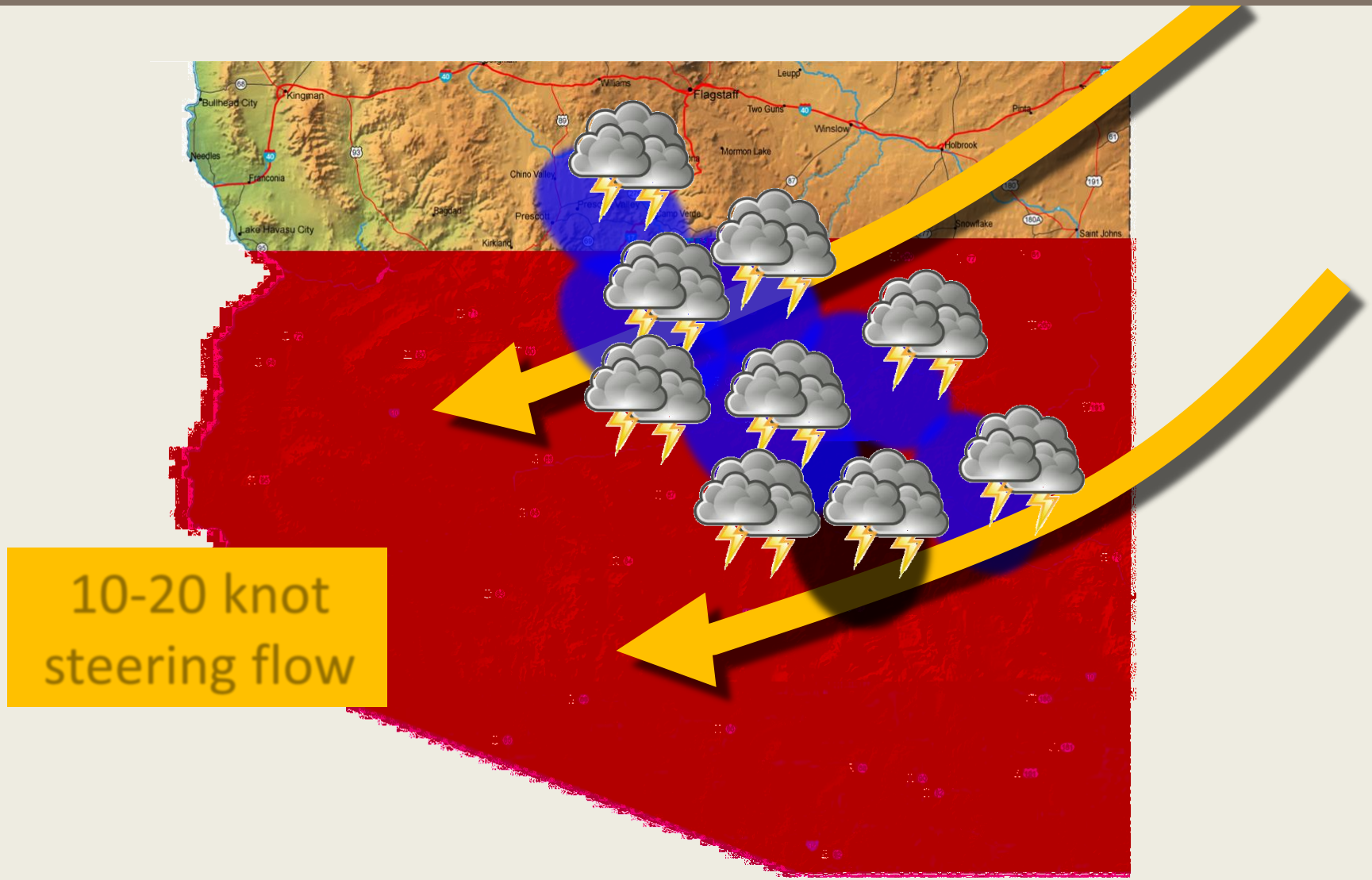


Landspouts

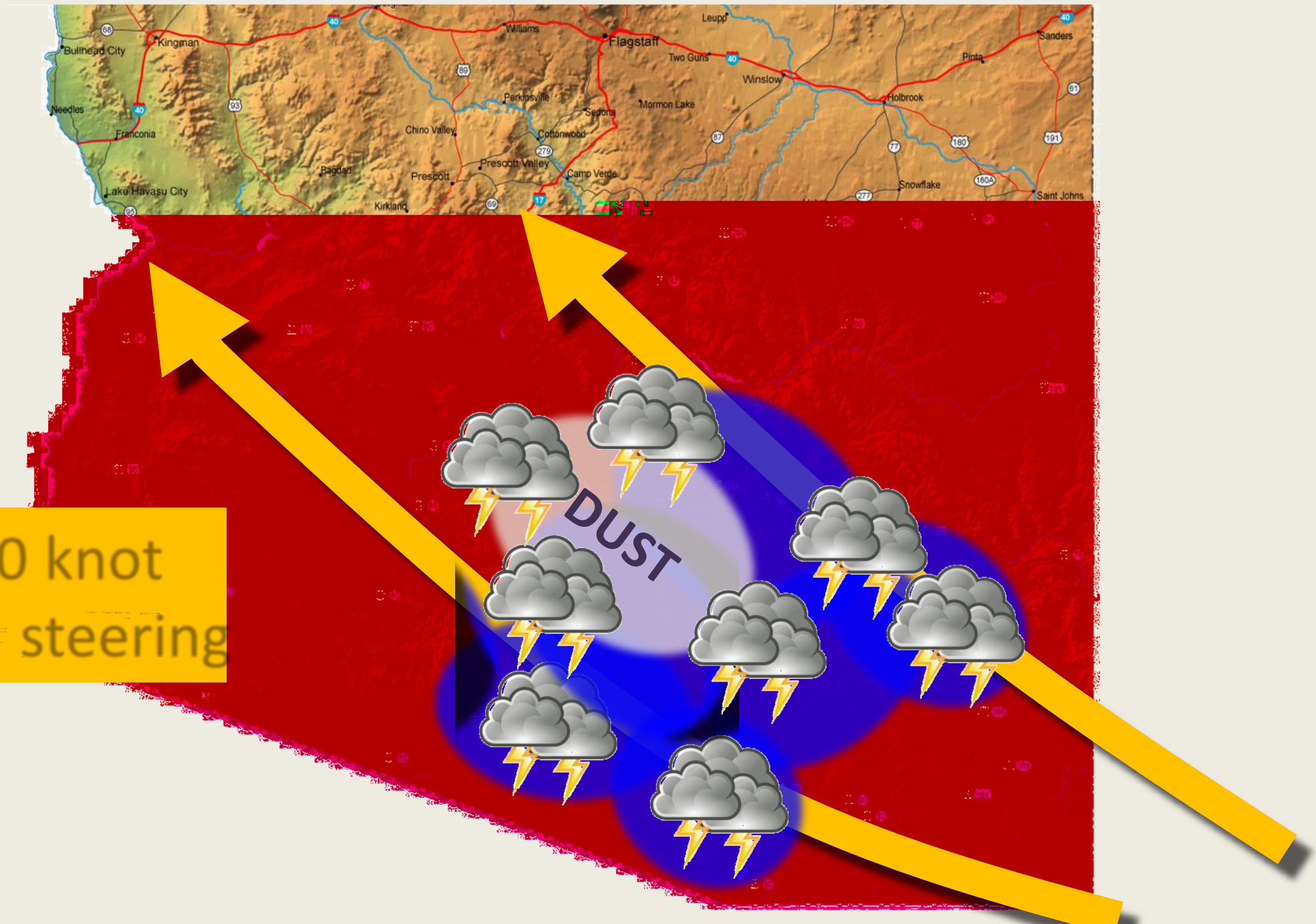
Program Outline

Monsoon Storm Evolutions

Mongollon Rim Storm Evolution

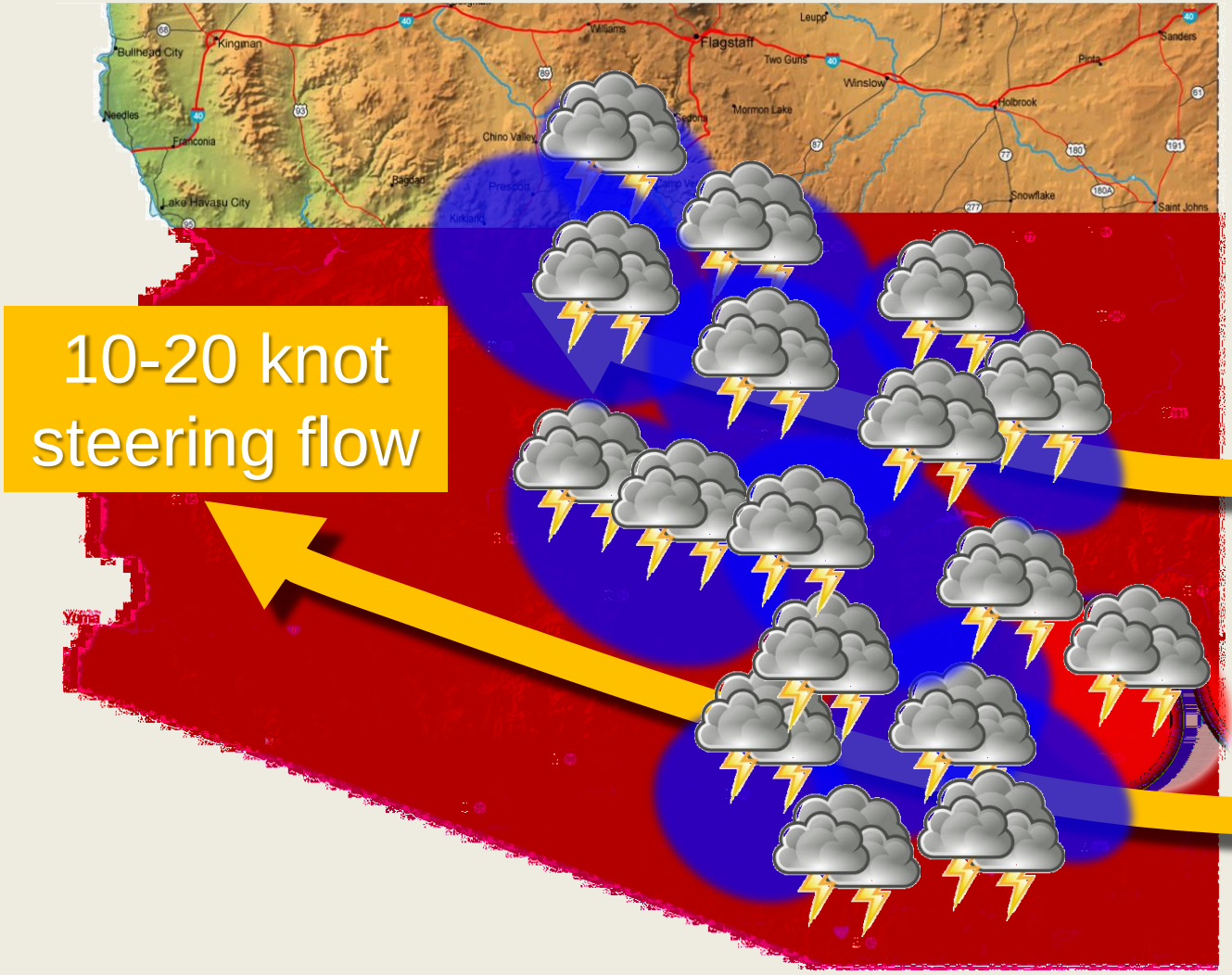


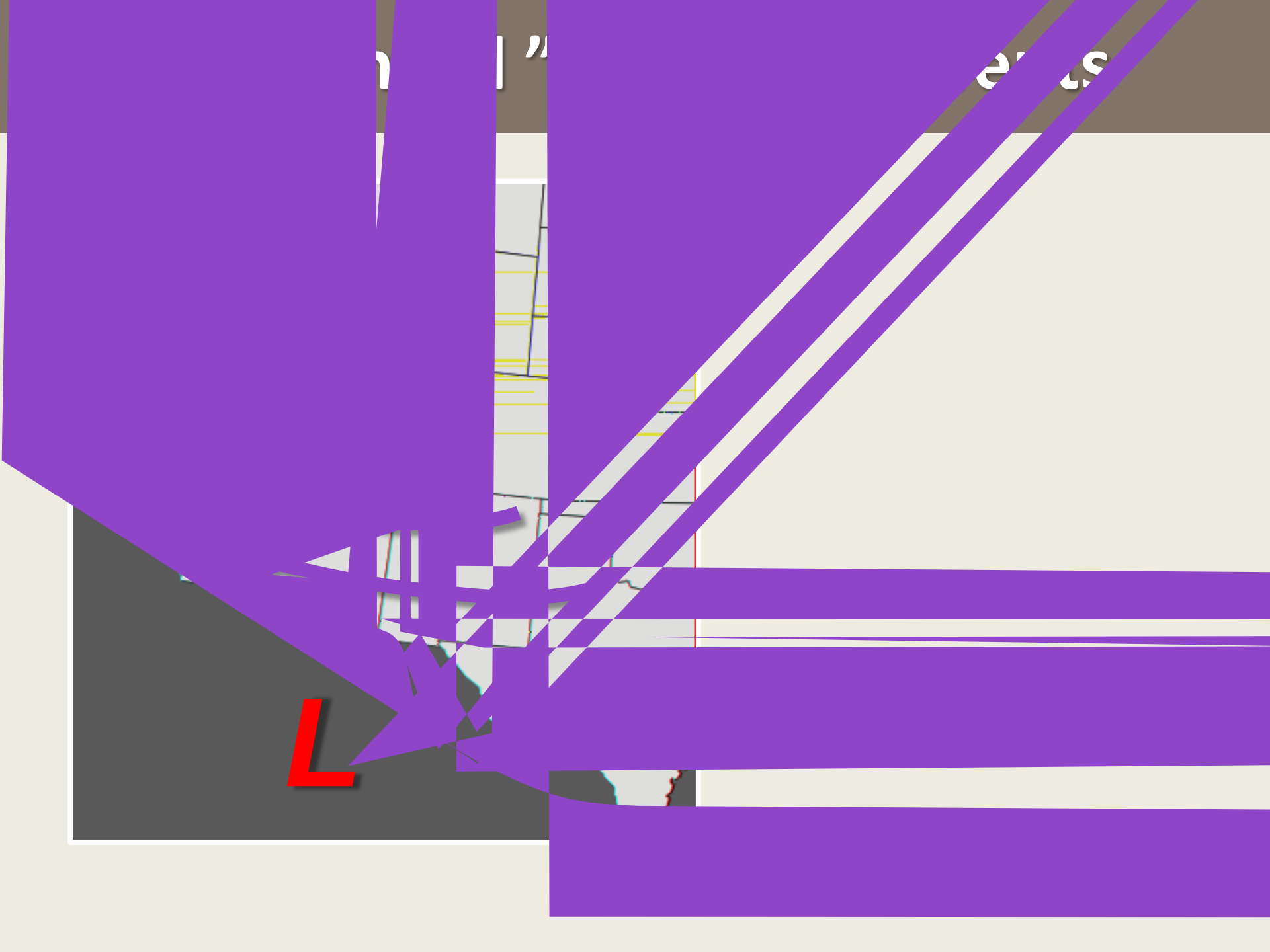
Southern Arizona Storm Evolution



10-20 knot flow steering

Combined Storm Evolution




L

“Transition” Event

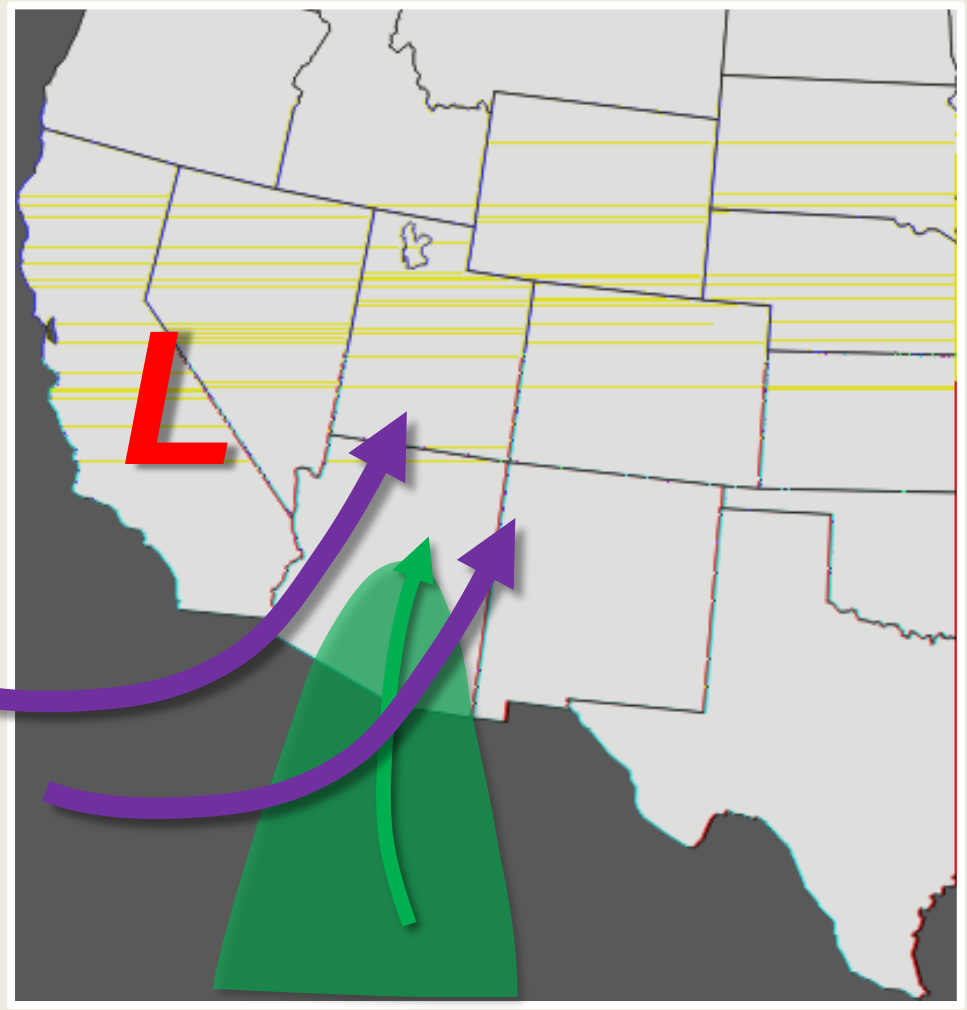
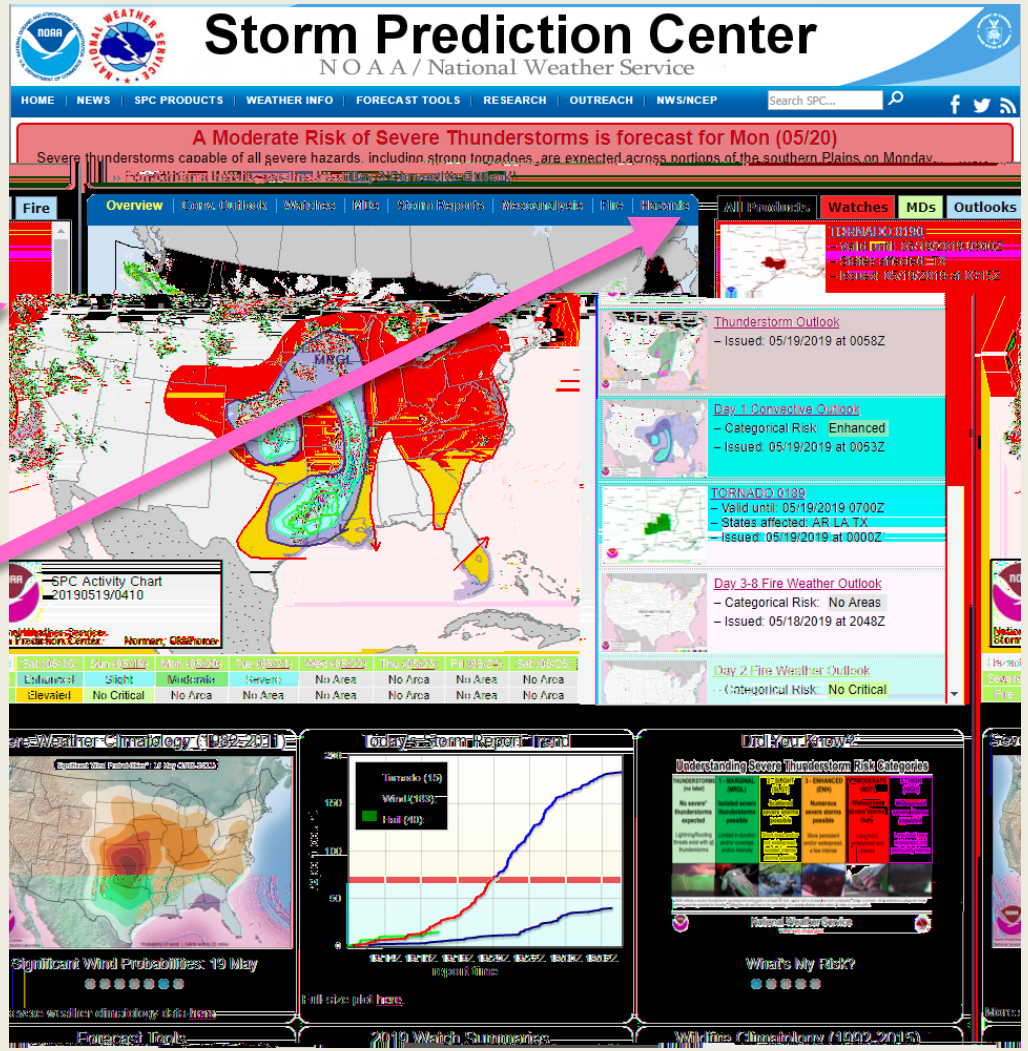


Photo: Mike Oblinski Photography

Program Outline

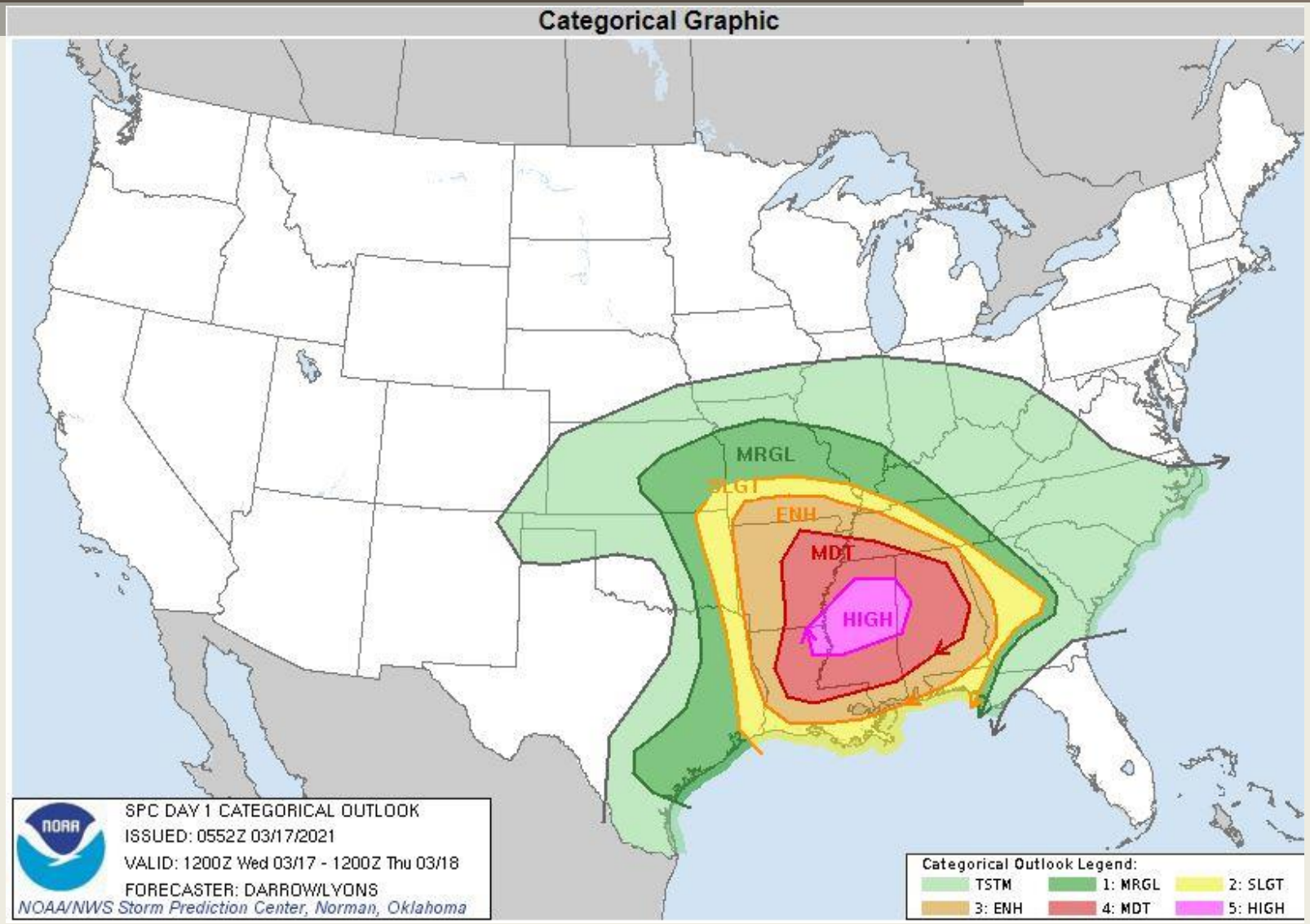
Storm Prediction Center

www.spc.noaa.gov



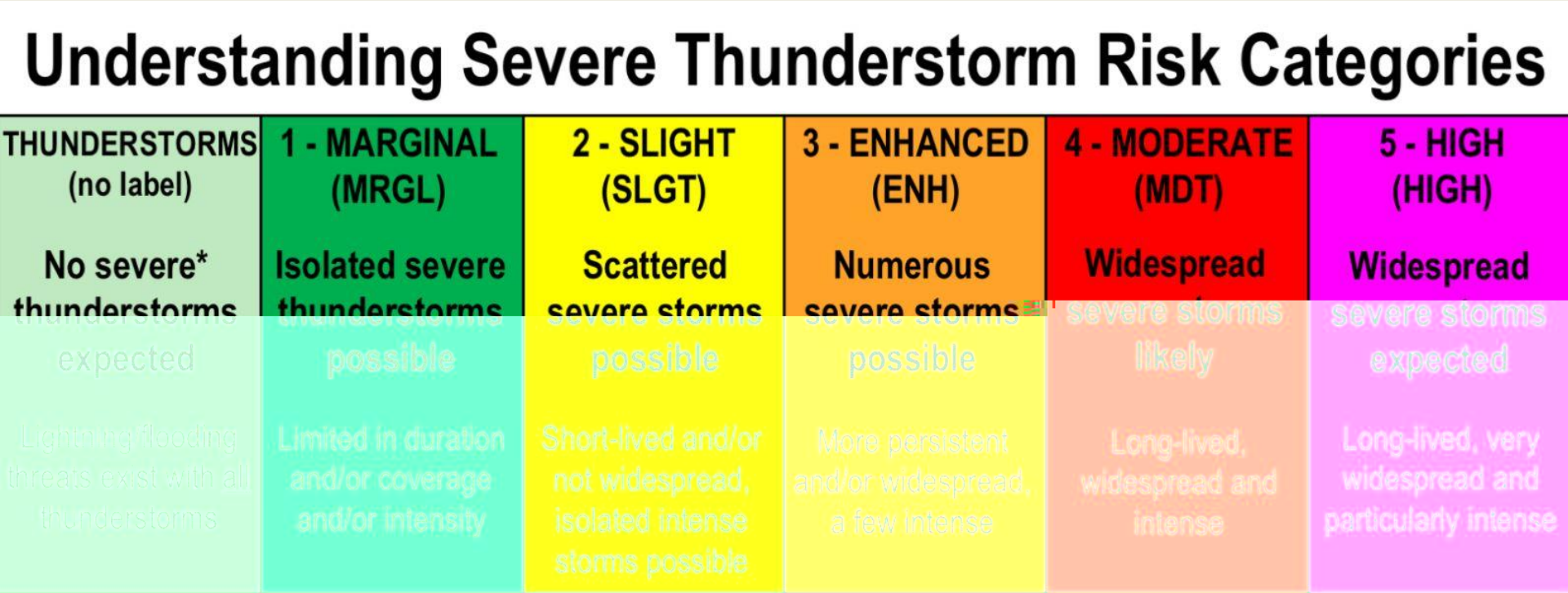
/NWSPhoenix @NWSPhoenix /NWSPhoenix www.weather.gov/psr

SPC Convective Outlook - example

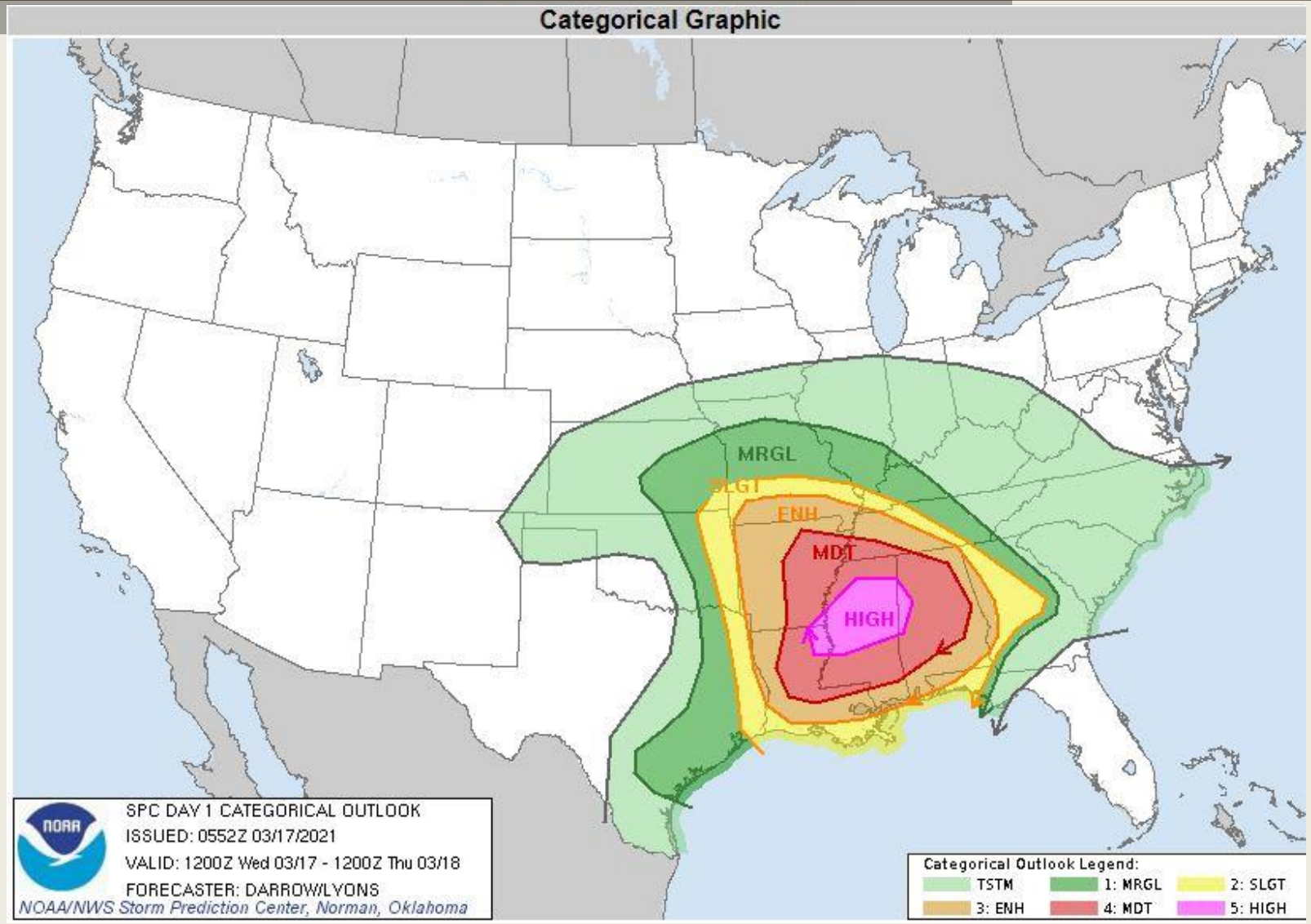


SPC Convective Outlook

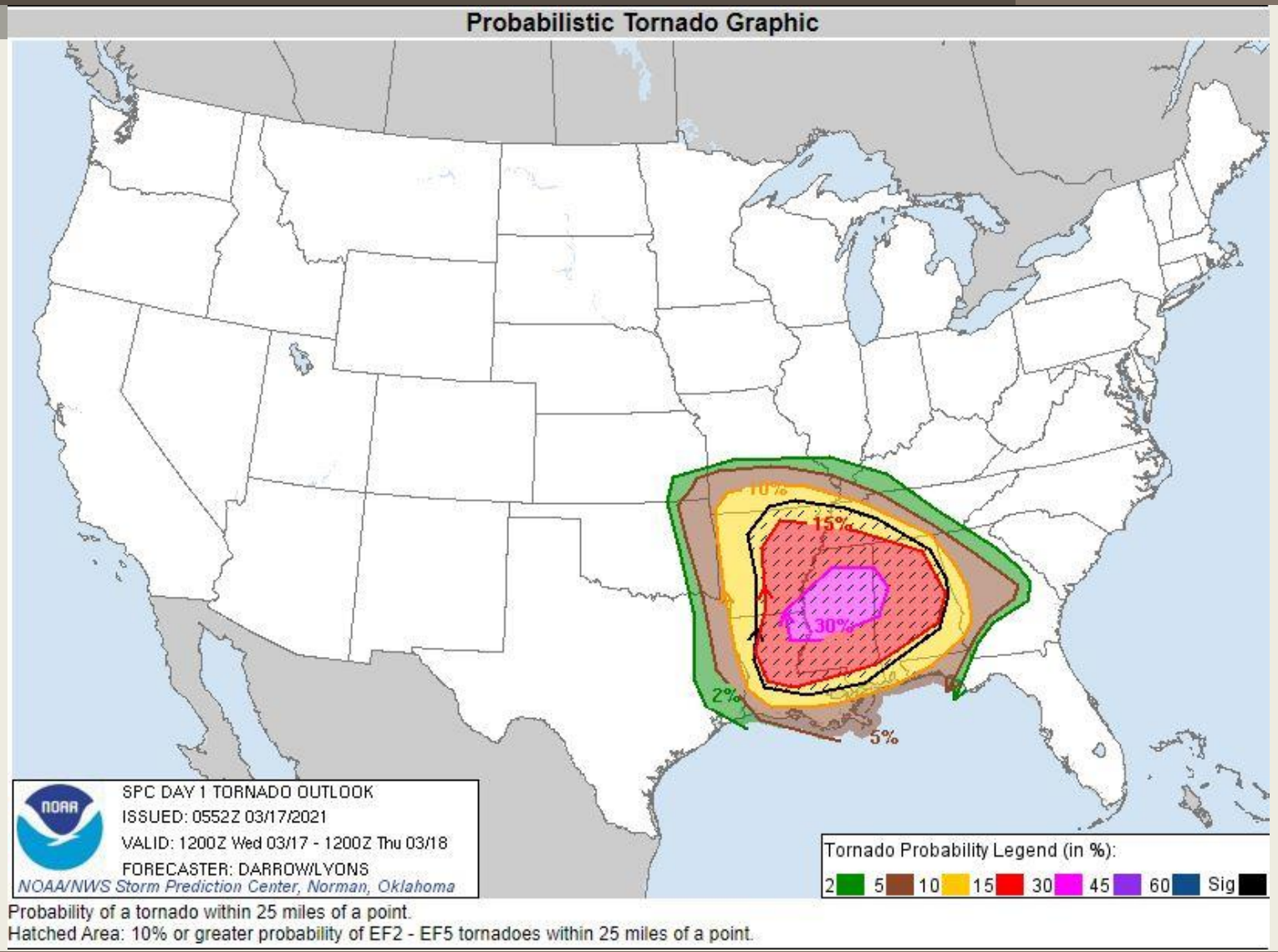
Risk Categories



SPC Convective Outlook - example

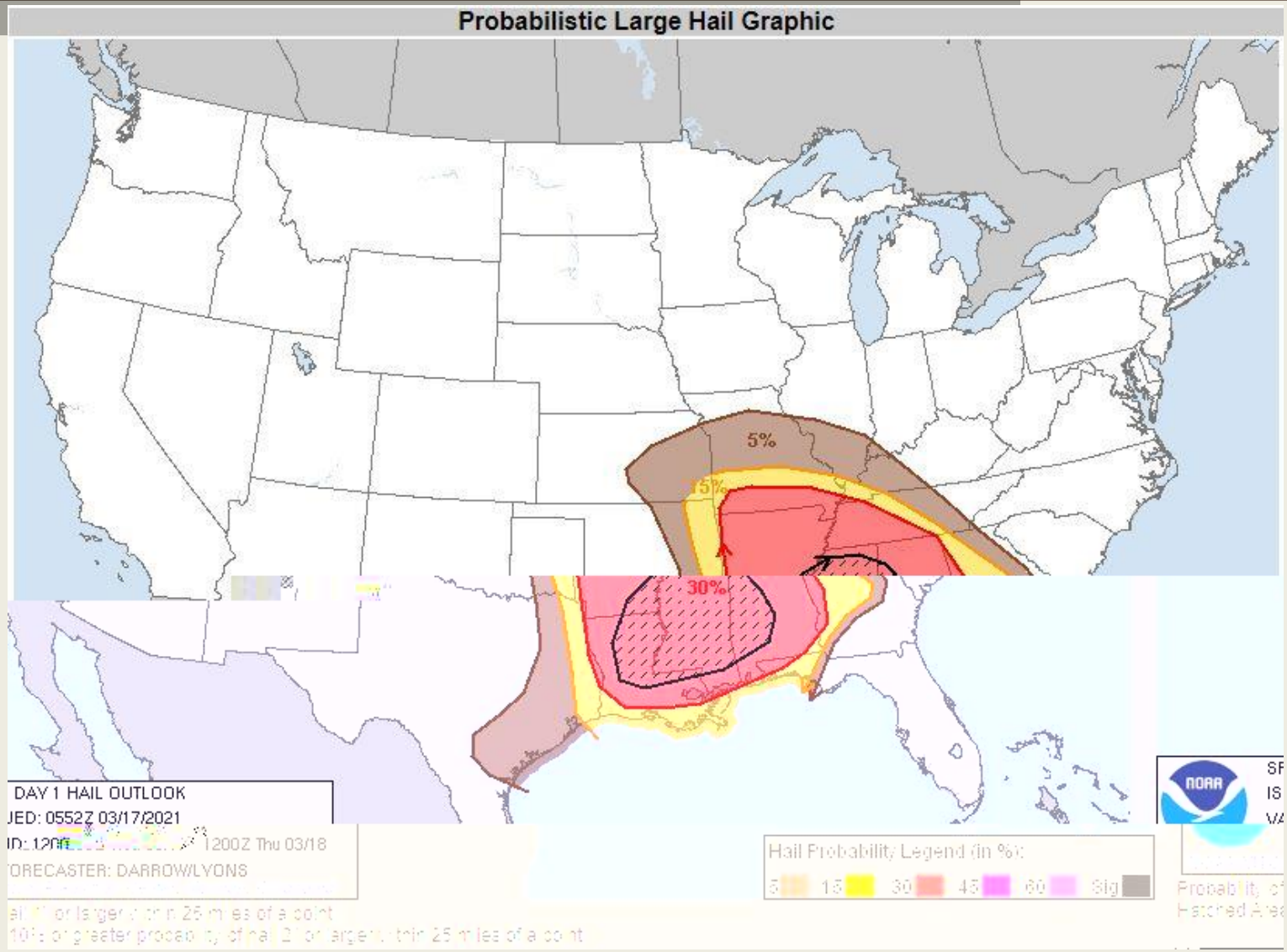


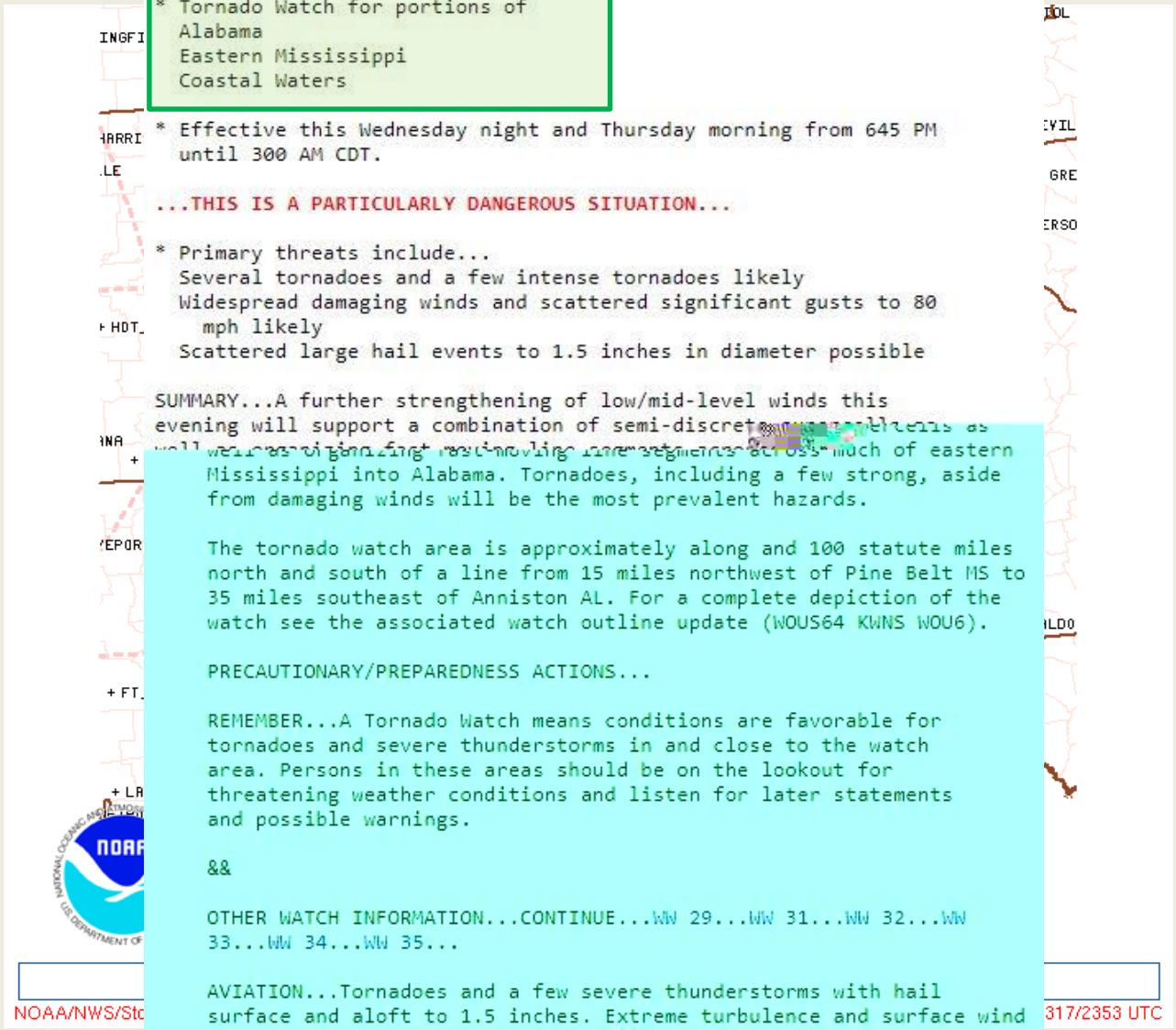
SPC Convective Outlook - example



SPC Convective Outlook - example

SPC Convective Outlook - example





URGENT - IMMEDIATE BROADCAST REQUESTED
Tornado Watch Number 36
NWS Storm Prediction Center Norman OK
645 PM CDT Wed Mar 17 2021

The NWS Storm Prediction Center has issued a

* Tornado Watch for portions of
  Alabama
  Eastern Mississippi
  Coastal Waters

* Effective this Wednesday night and Thursday morning from 645 PM
  until 300 AM CDT.

...THIS IS A PARTICULARLY DANGEROUS SITUATION...

* Primary threats include...
  Several tornadoes and a few intense tornadoes likely
  Widespread damaging winds and scattered significant gusts to 80
    mph likely
  Scattered large hail events to 1.5 inches in diameter possible

SUMMARY...A further strengthening of low/mid-level winds this
evening will support a combination of semi-discrete supercells as
well as organizing fast-moving line segments across much of eastern
Mississippi into Alabama. Tornadoes, including a few strong, aside
from damaging winds will be the most prevalent hazards.

The tornado watch area is approximately along and 100 statute miles
north and south of a line from 15 miles northwest of Pine Belt MS to
35 miles southeast of Anniston AL. For a complete depiction of the
watch see the associated watch outline update (WOUS64 KWNS WOU6).

PRECAUTIONARY/PREPAREDNESS ACTIONS...

REMEMBER...A Tornado Watch means conditions are favorable for
tornadoes and severe thunderstorms in and close to the watch
area. Persons in these areas should be on the lookout for
threatening weather conditions and listen for later statements
and possible warnings.

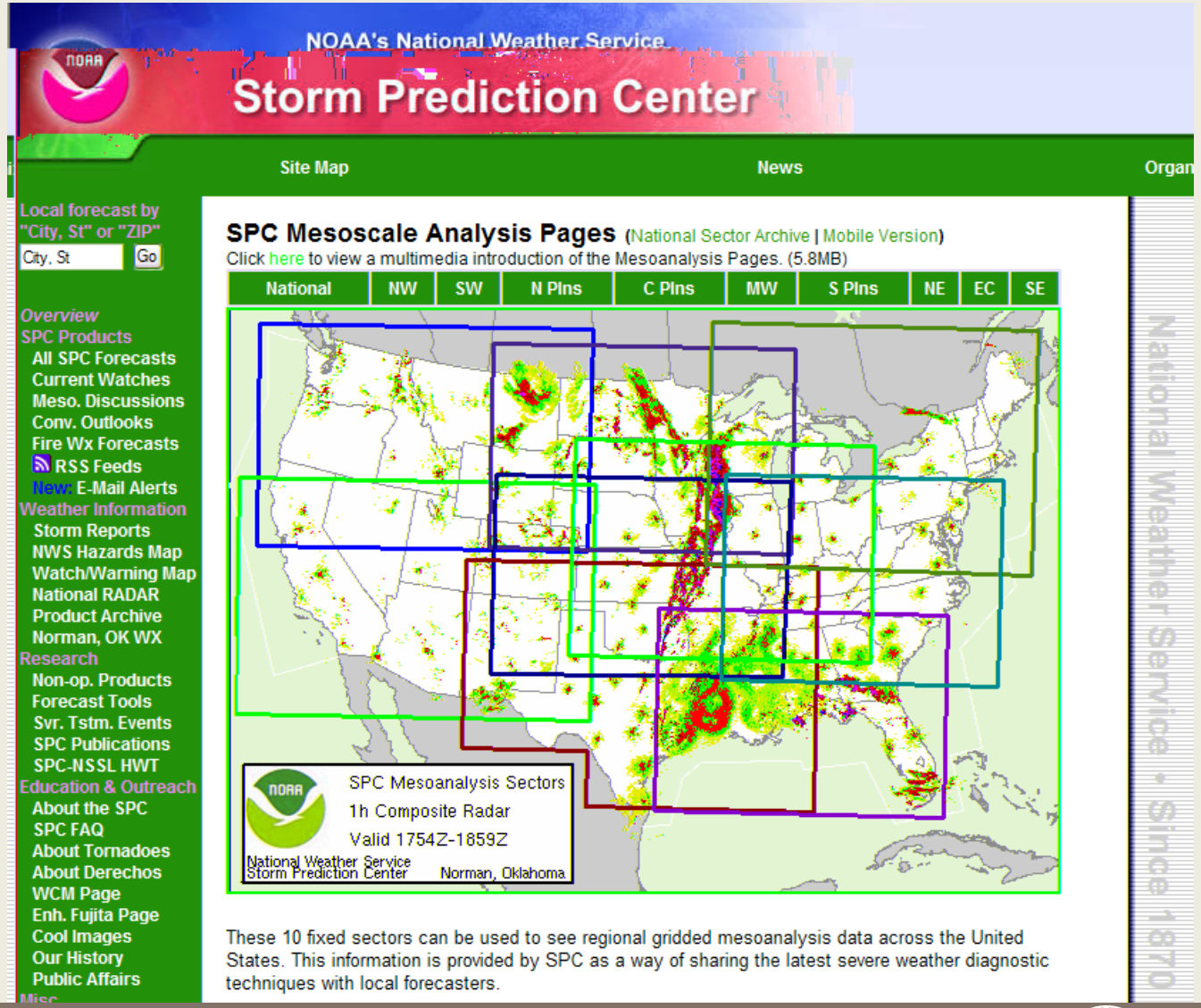
&&

OTHER WATCH INFORMATION...CONTINUE...WW 29...WW 31...WW 32...WW
33...WW 34...WW 35...

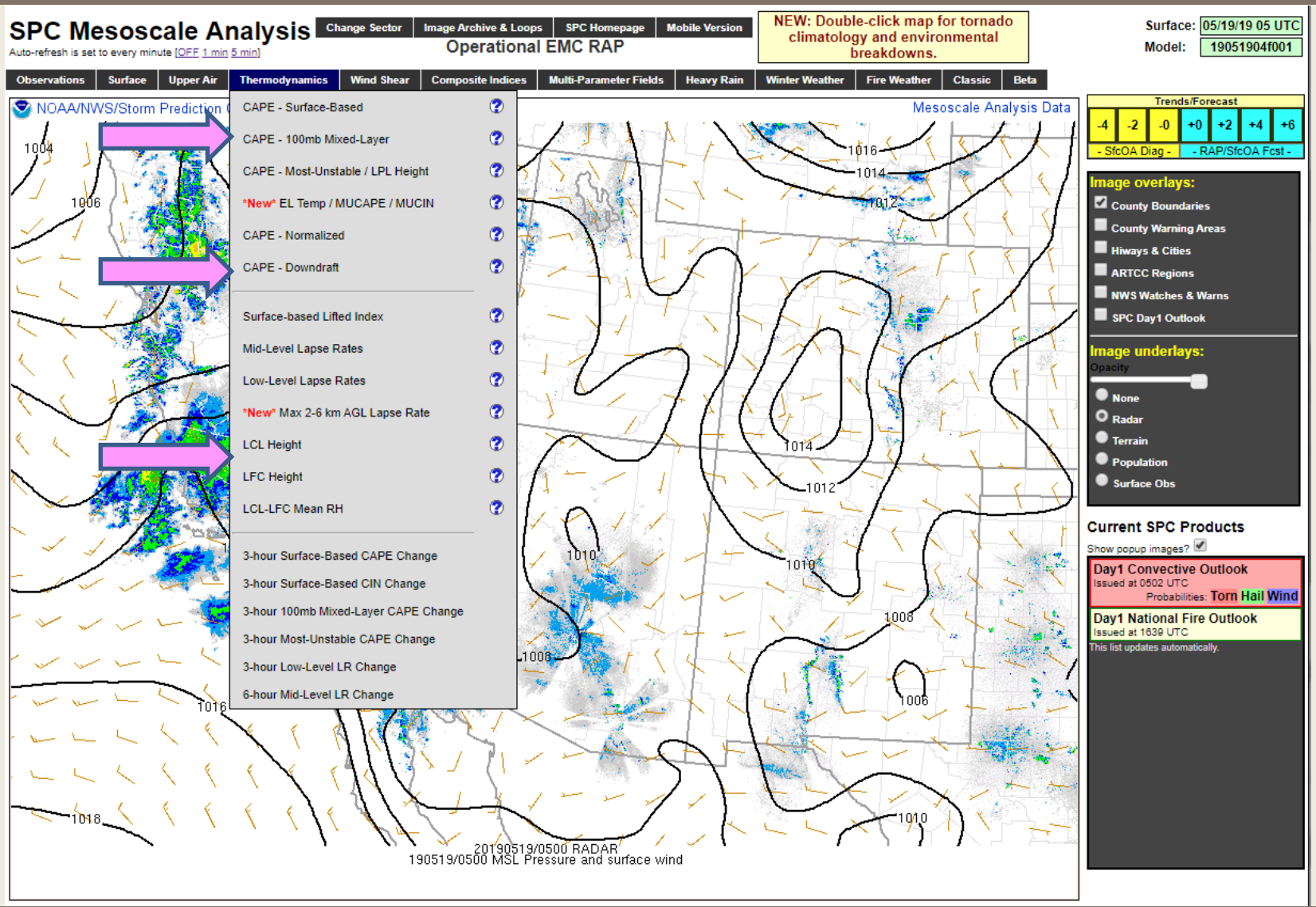
AVIATION...Tornadoes and a few severe thunderstorms with hail
surface and aloft to 1.5 inches. Extreme turbulence and surface wind
gusts to 70 knots. A few cumulonimbi with maximum tops to 500. Mean
storm motion vector 24040.

...Guyer

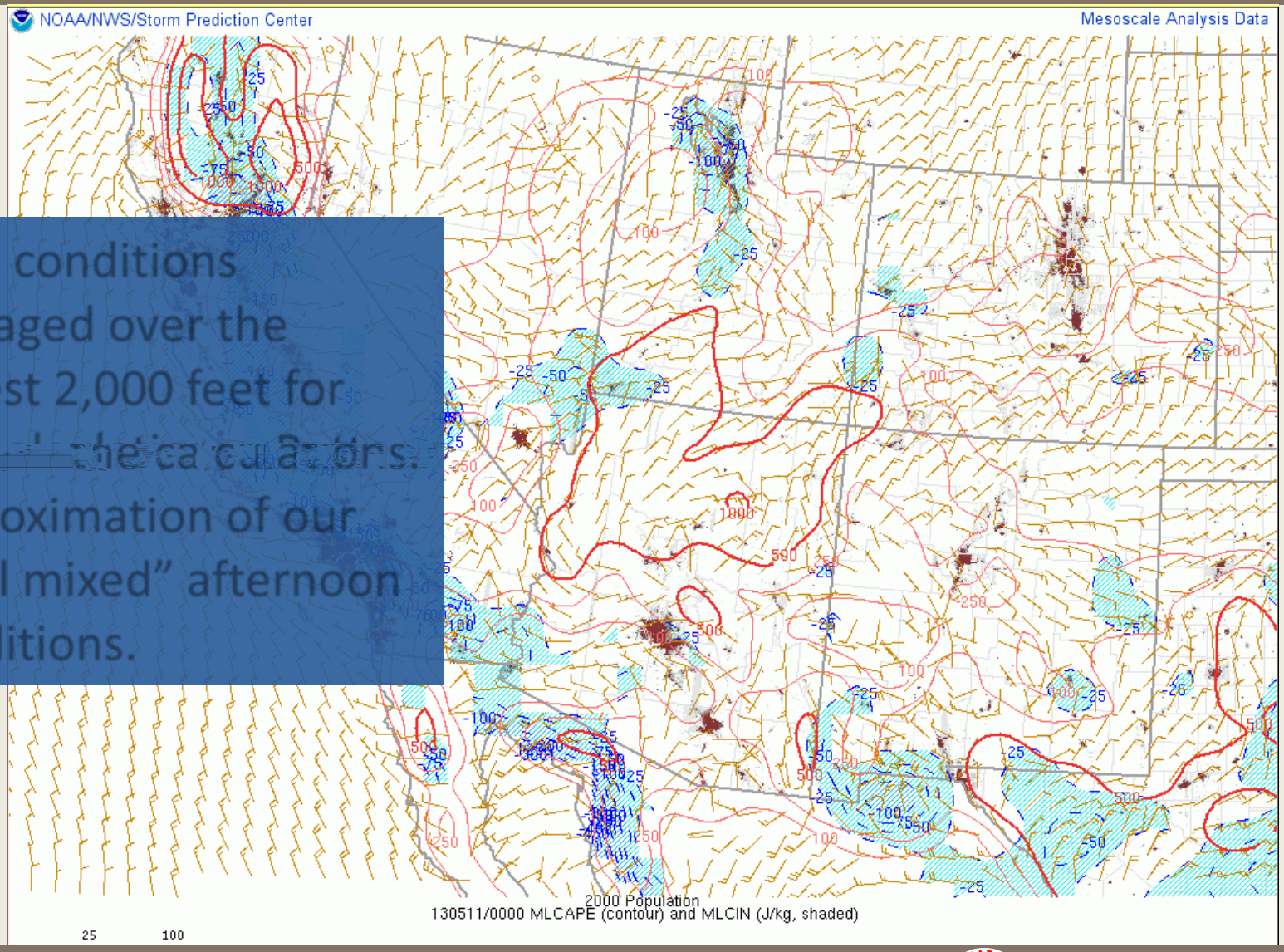
Main Mesoanalysis Page



Drop-Down Menu: Thermo



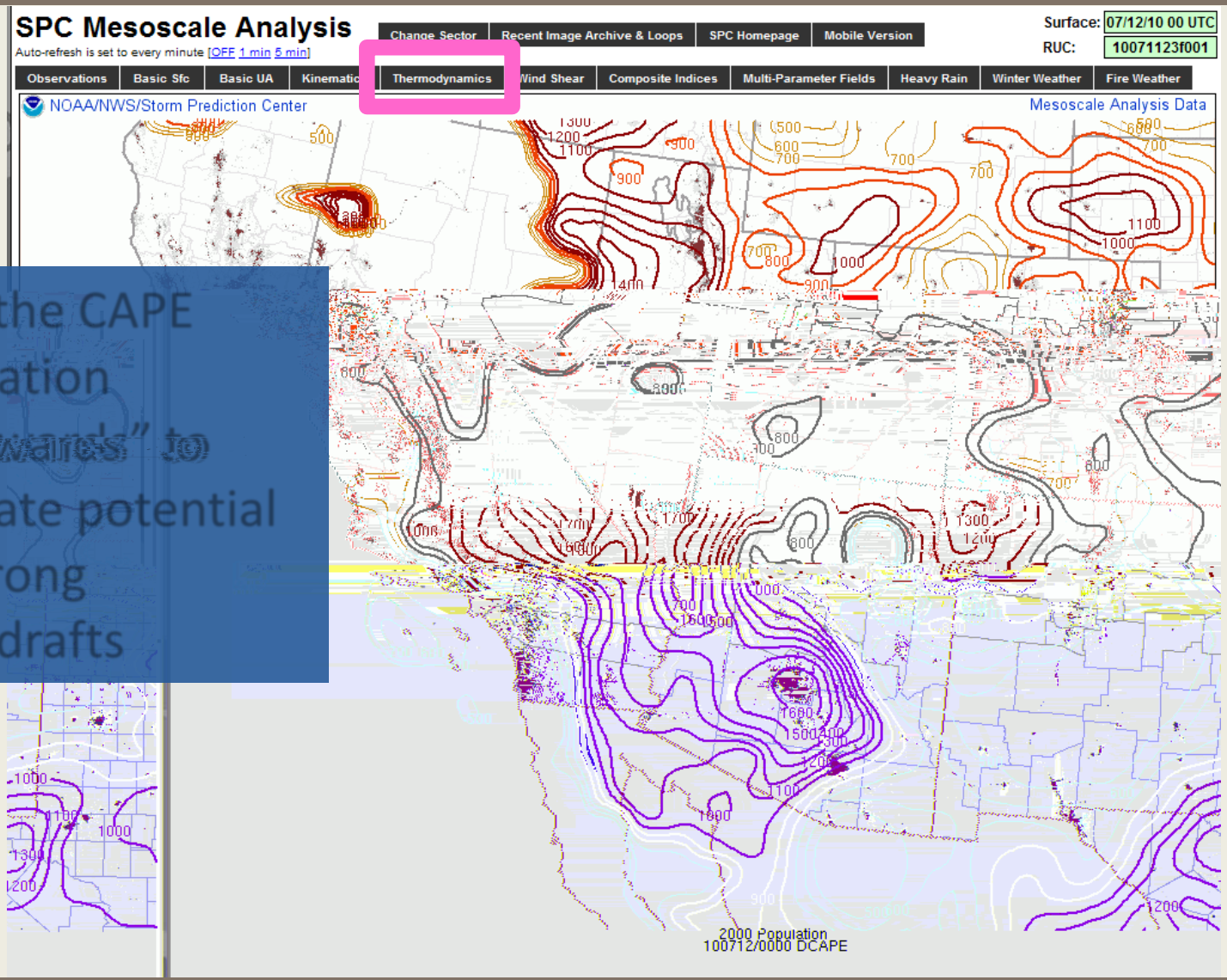
Mixed-Layer CAPE



Uses conditions averaged over the lowest 2,000 feet for better thermodynamics.

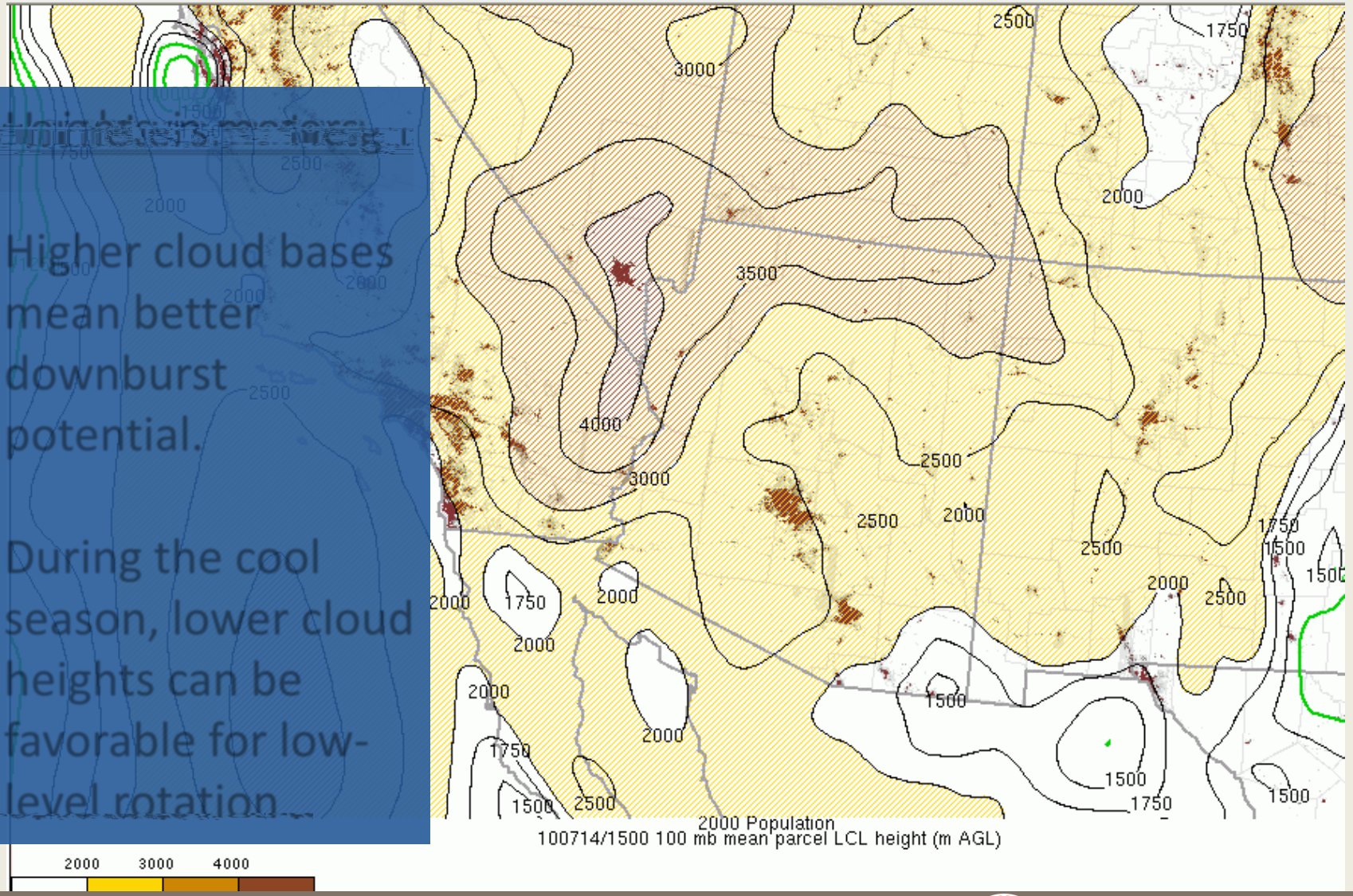
approximation of our "well mixed" afternoon conditions.

Downdraft CAPE

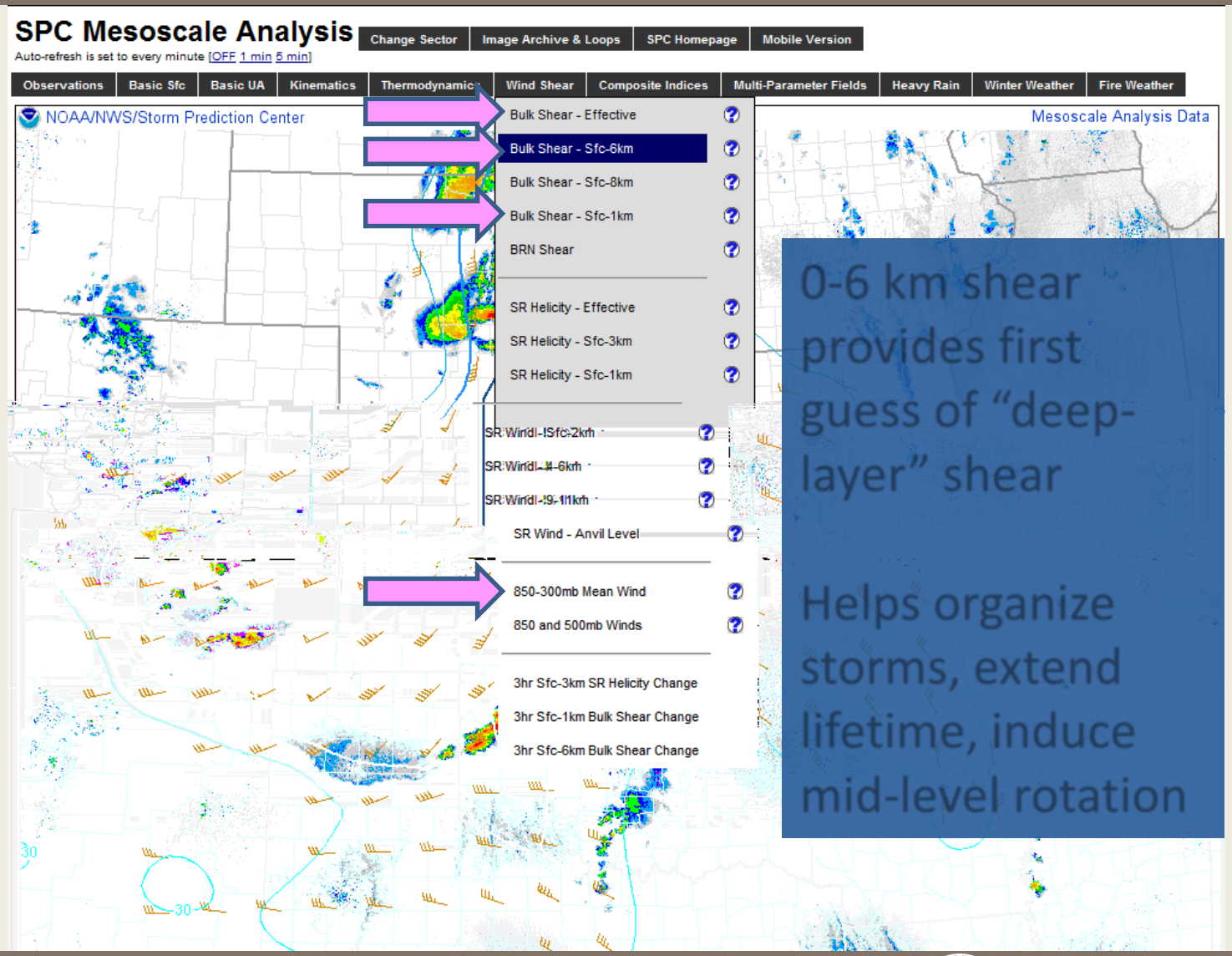


Runs the CAPE calculation "backwards" to estimate potential for strong downdrafts

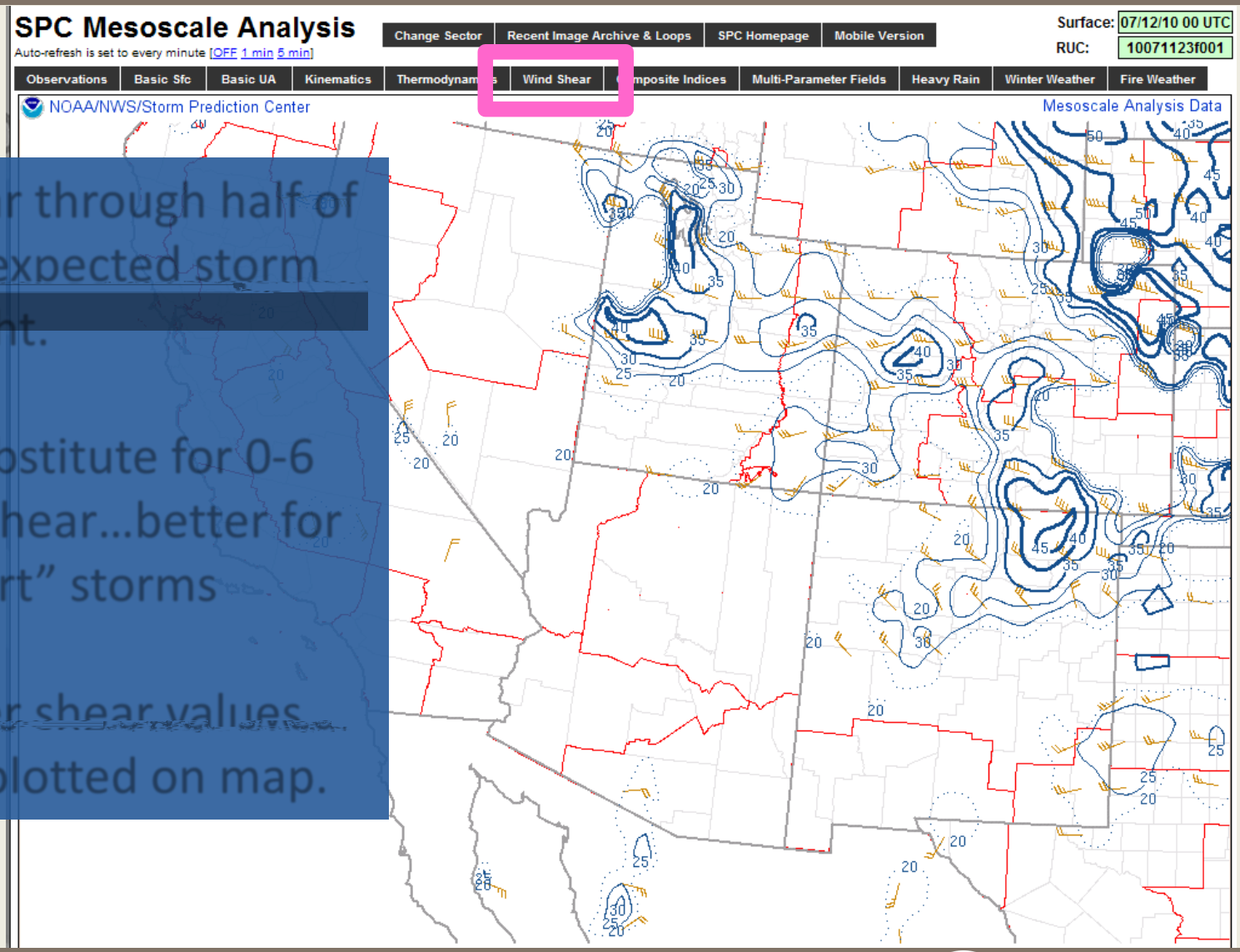
LCL (Cloud Height)



Wind Shear


SPC Mesoscale Analysis
Change Sector
Image Archive & Loops
SPC Homepage
Mobile Version
Auto-refresh is set to every minute [OFF 1 min 5 min]
Observations
Basic Sfc
Basic UA
Kinematics
Thermodynamics
Wind Shear
Composite Indices
Multi-Parameter Fields
Heavy Rain
Winter Weather
Fire Weather
NOAA/NWS/Storm Prediction Center
Mesoscale Analysis Data
Bulk Shear - Effective
Bulk Shear - Sfc-6km
Bulk Shear - Sfc-8km
Bulk Shear - Sfc-1km
BRN Shear
SR Helicity - Effective
SR Helicity - Sfc-3km
SR Helicity - Sfc-1km
SR Wind - Anvil Level
850-300mb Mean Wind
850 and 500mb Winds
3hr Sfc-3km SR Helicity Change
3hr Sfc-1km Bulk Shear Change
3hr Sfc-6km Bulk Shear Change
0-6 km shear provides first guess of “deep-layer” shear
Helps organize storms, extend lifetime, induce mid-level rotation

“Effective” Wind Shear

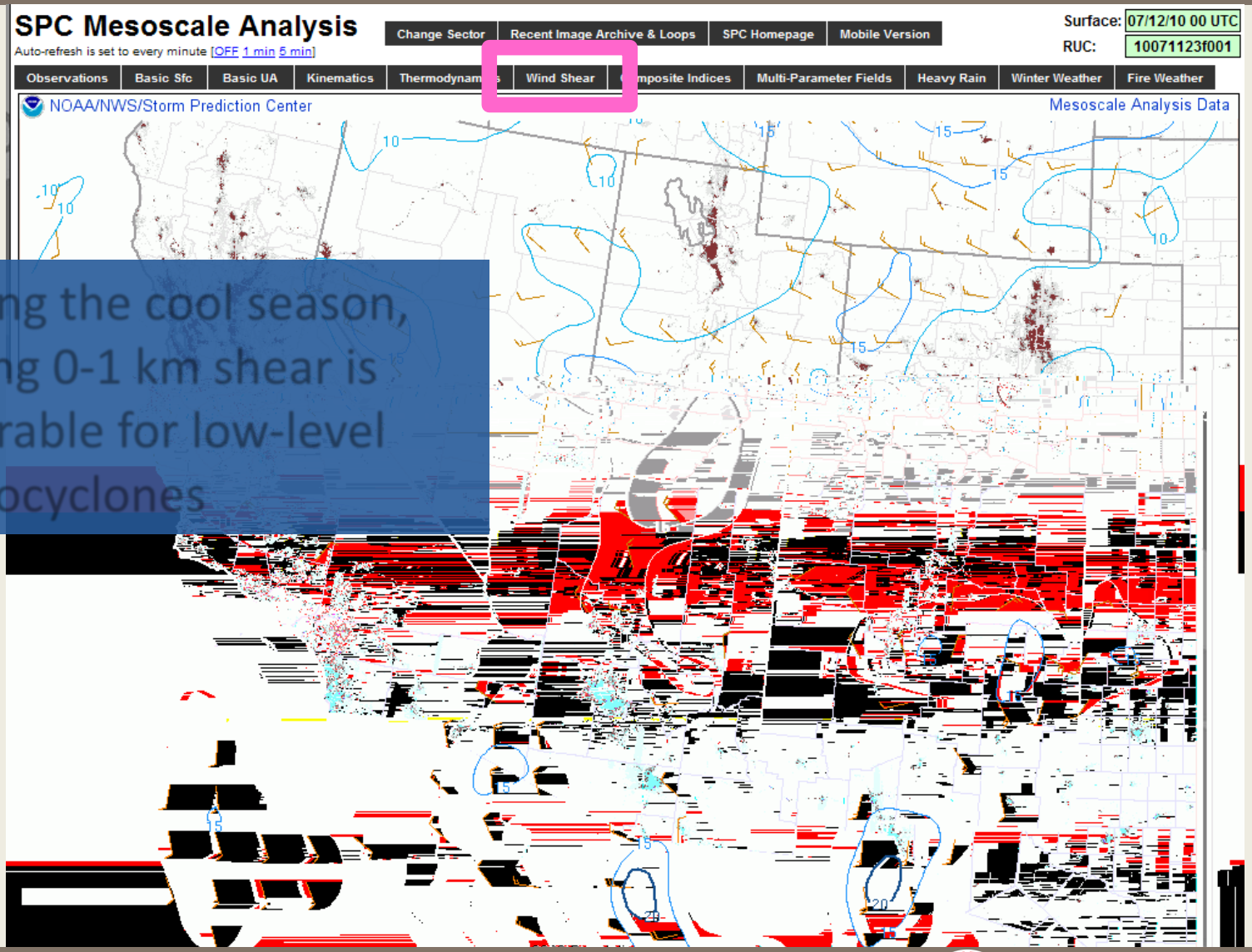


Shear through half of the expected storm height.

A substitute for 0-6 km shear…better for “short” storms

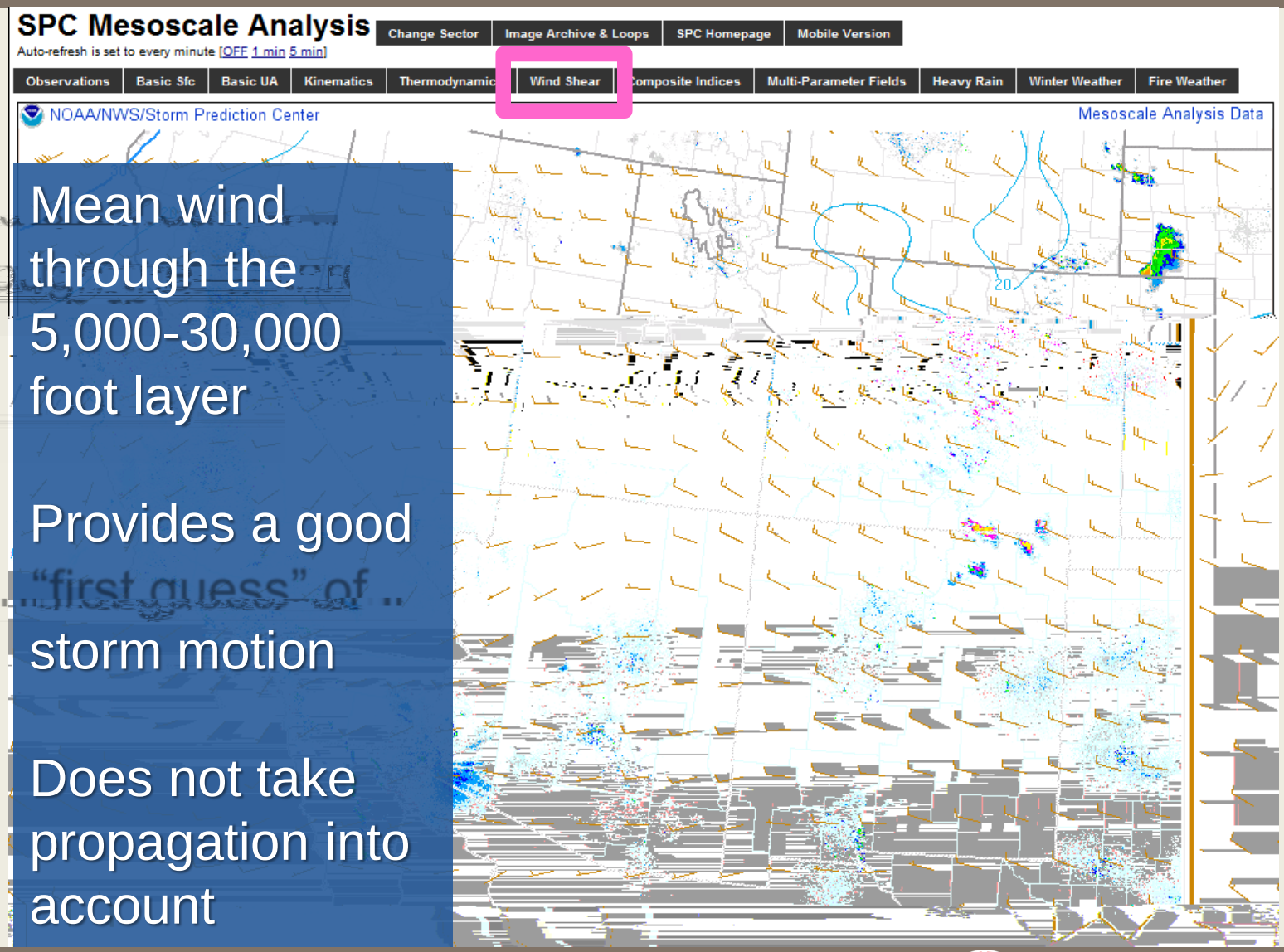
lower shear values are plotted on map.

0-1 km Wind Shear



During the cool season, strong 0-1 km shear is favorable for low-level mesocyclones

850-300 mb Mean Wind



Mean wind through the 5,000-30,000 foot layer

Provides a good "first guess" of storm motion

Does not take propagation into account

Key Parameter Guidelines

CAPE:

CIN:

Downdraft CAPE:

Deep layer shear (effective or 6 km):

0-1 km shear (cool season or transition):

LCL height (cool season/transition):

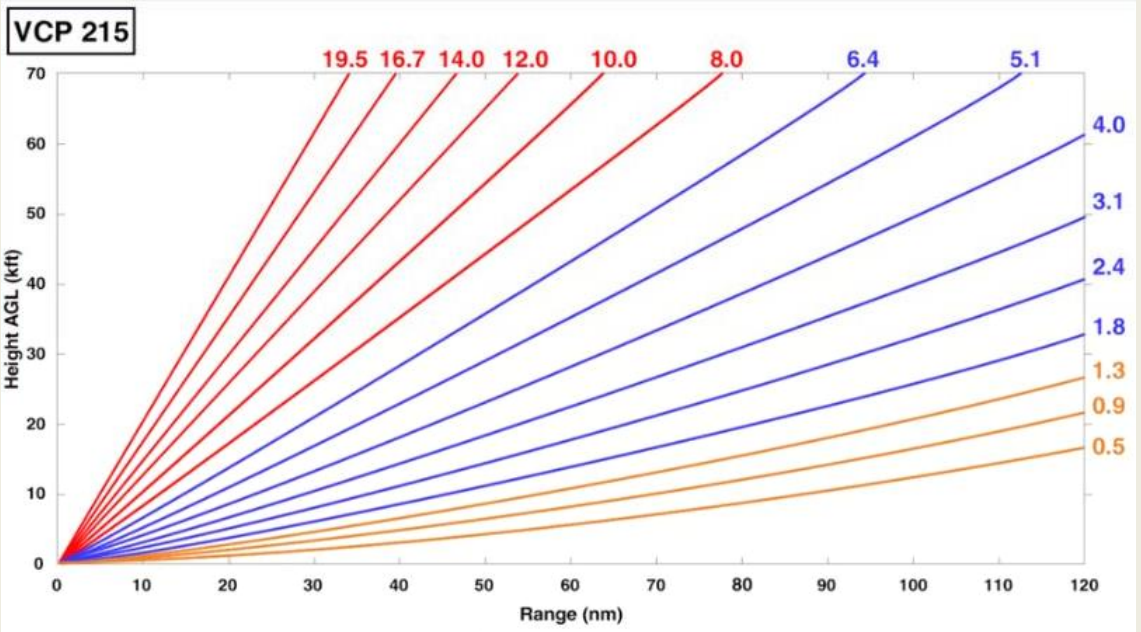
Program Outline

What is Radar?

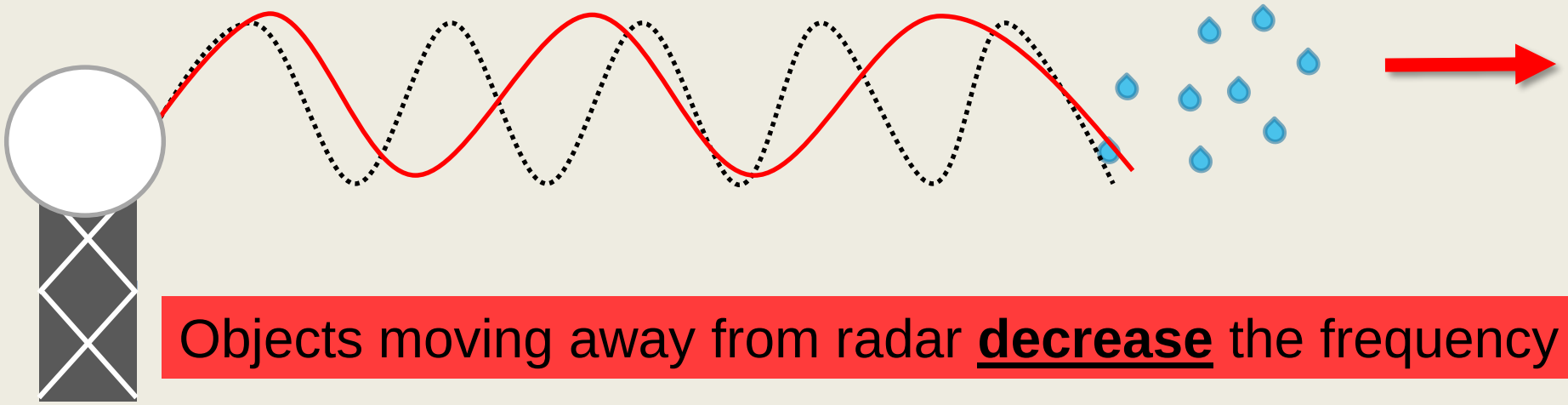
RA D A R

How Does Radar Work?

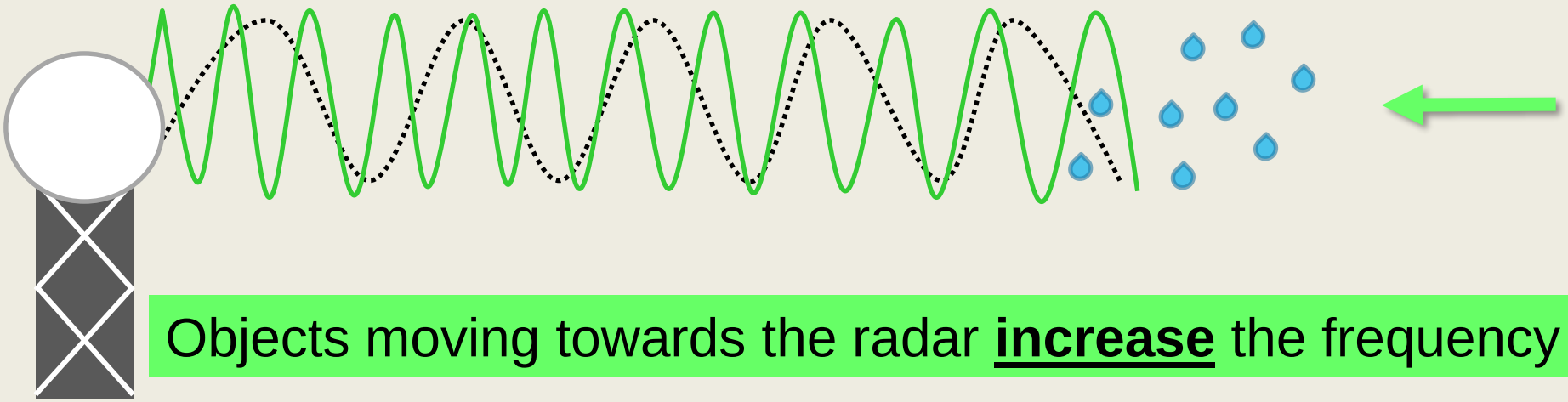
WSR-88D Overview



WSR-88D Velocity



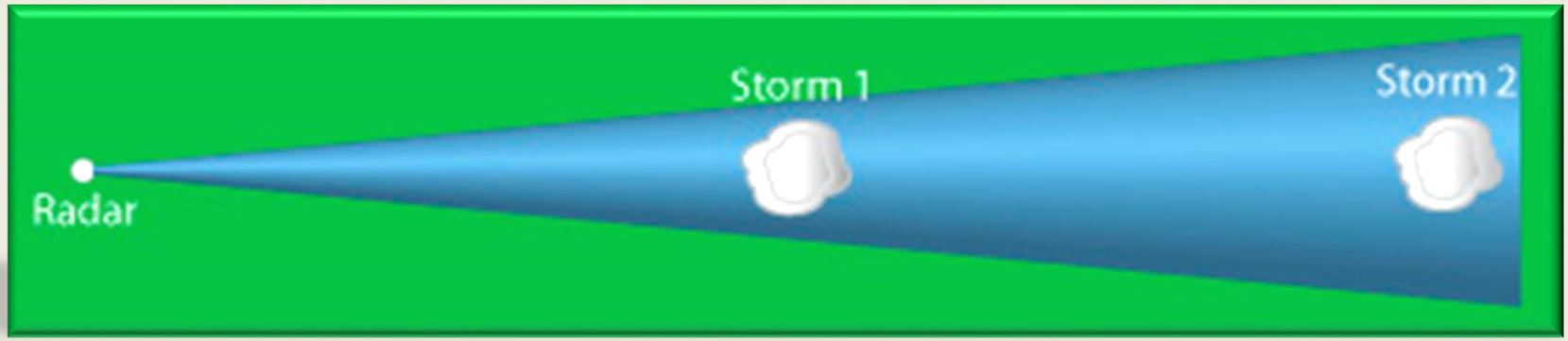
Objects moving away from radar **decrease** the frequency



Objects moving towards the radar **increase** the frequency

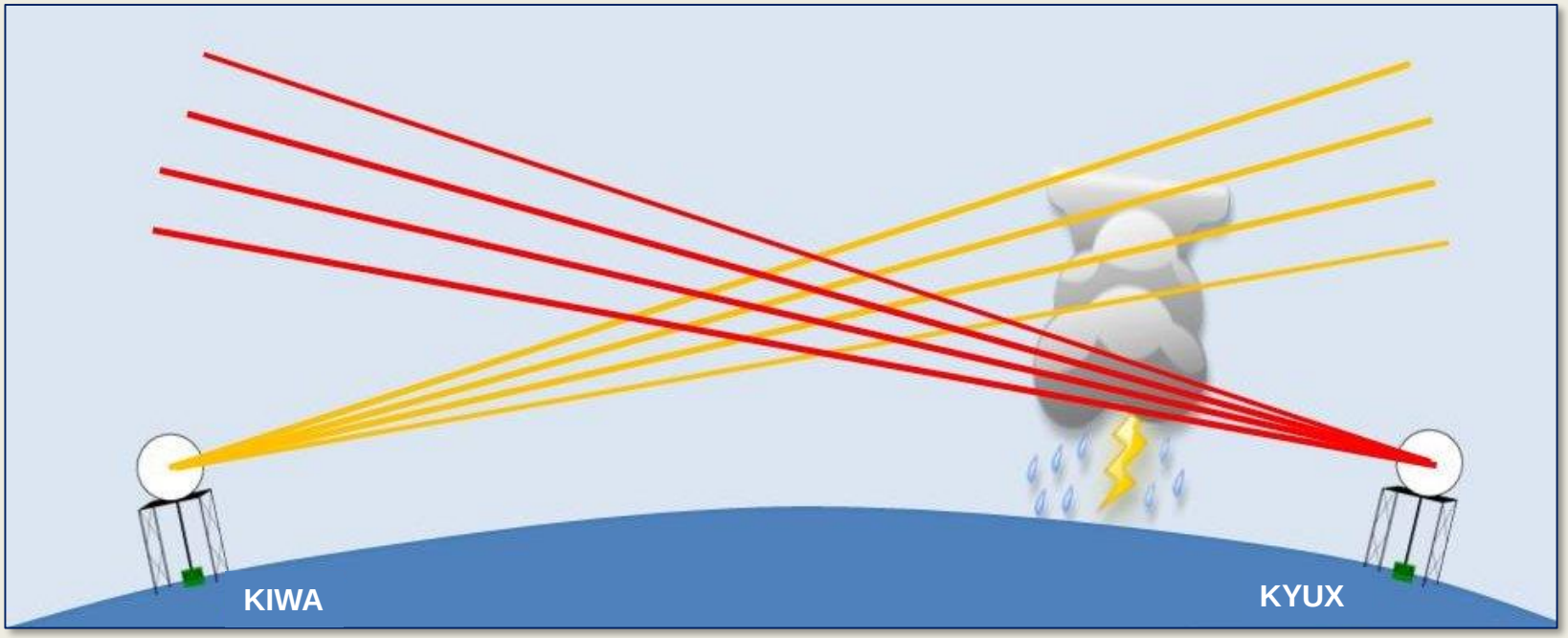
RADAR Limitations

Beam Spreading



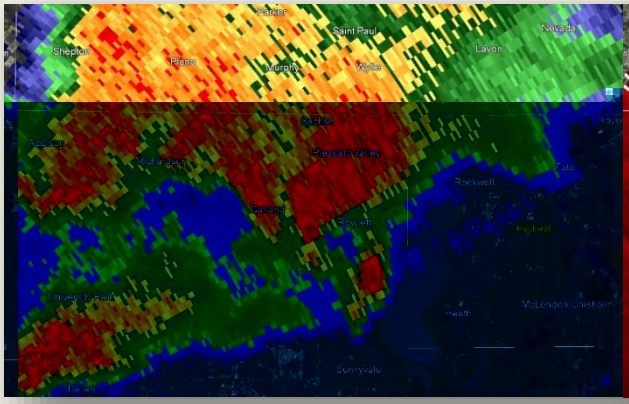
RADAR Limitations

Curvature

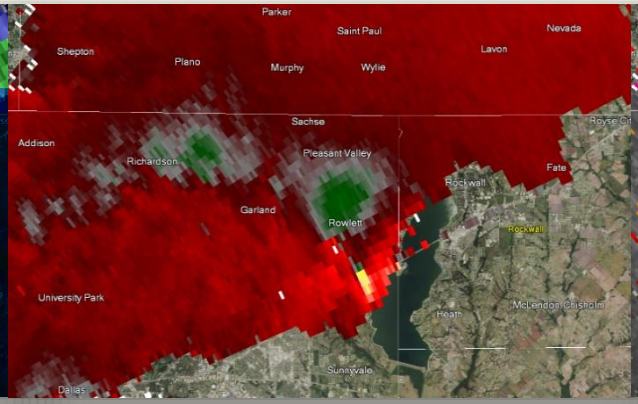


Due to the curvature of the earth, the radar beam will increase in height relative to the ground meaning only higher and higher hydrometeors will be detected. At increasing distances, low objects become undetectable.

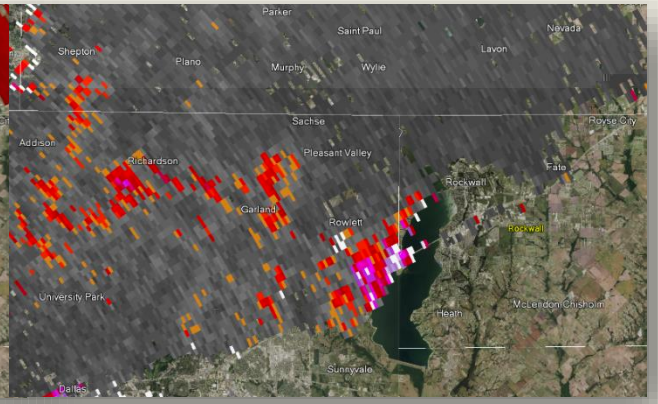
Classic Radar Products



Reflectivity

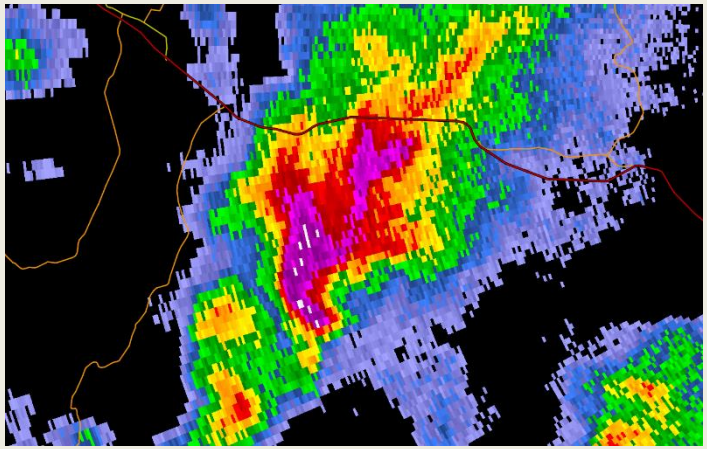


Velocity



Spectrum Width

Reflectivity: What & How Much



Extremely Heavy or hail

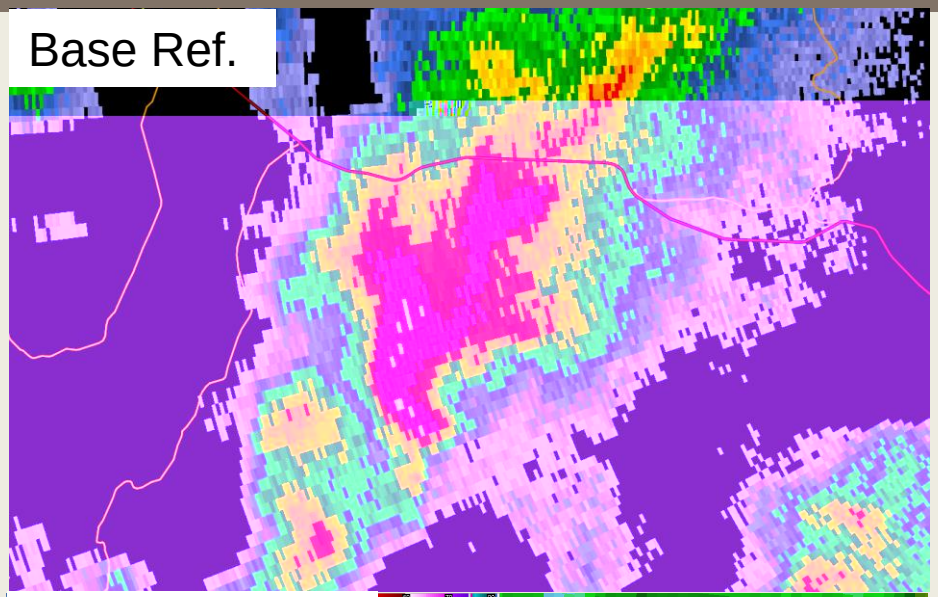
Heavy

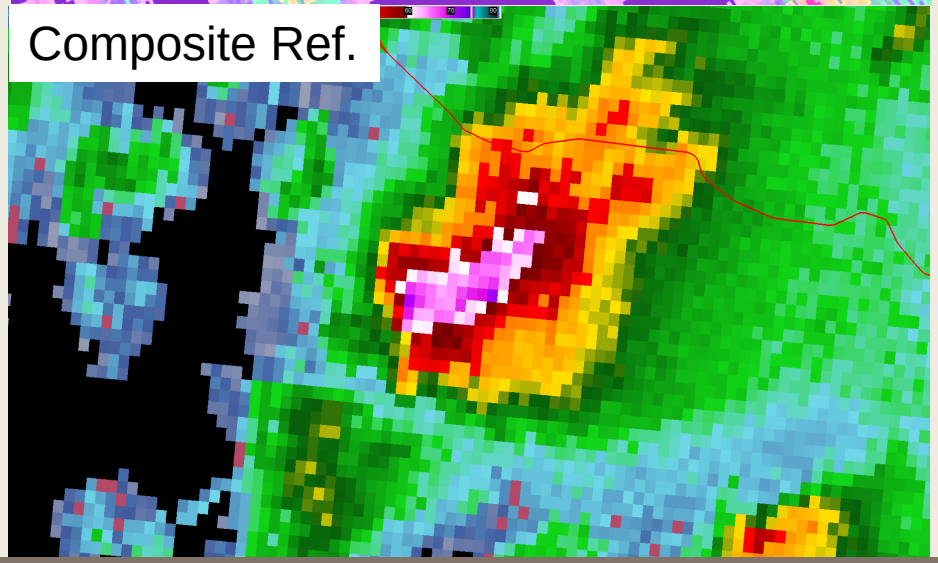
Moderate

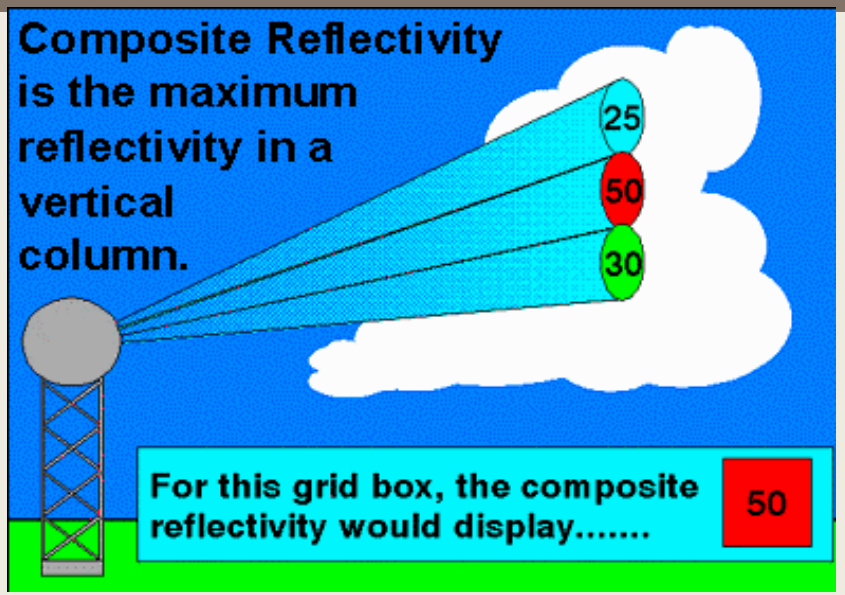
Light

Extremely Light

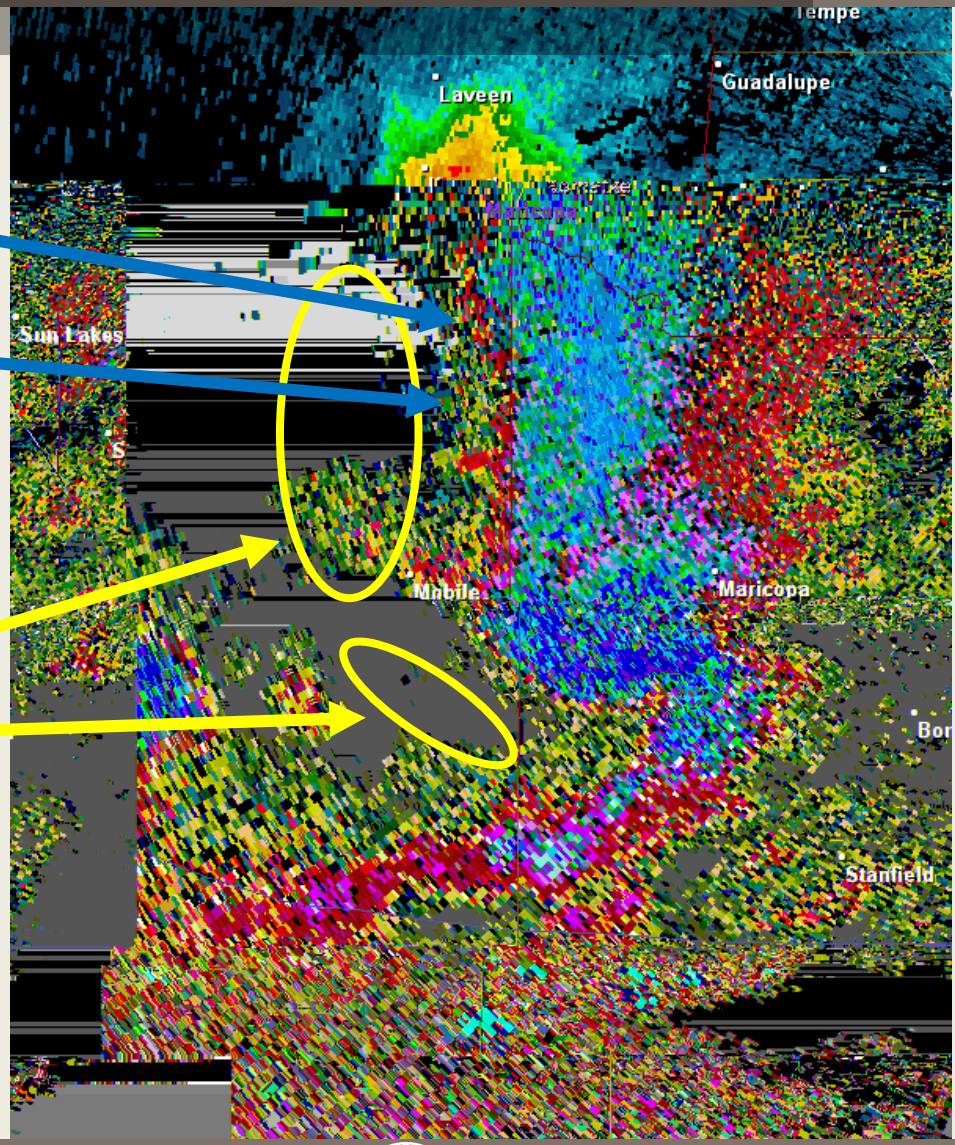
Base vs. Composite Reflectivity

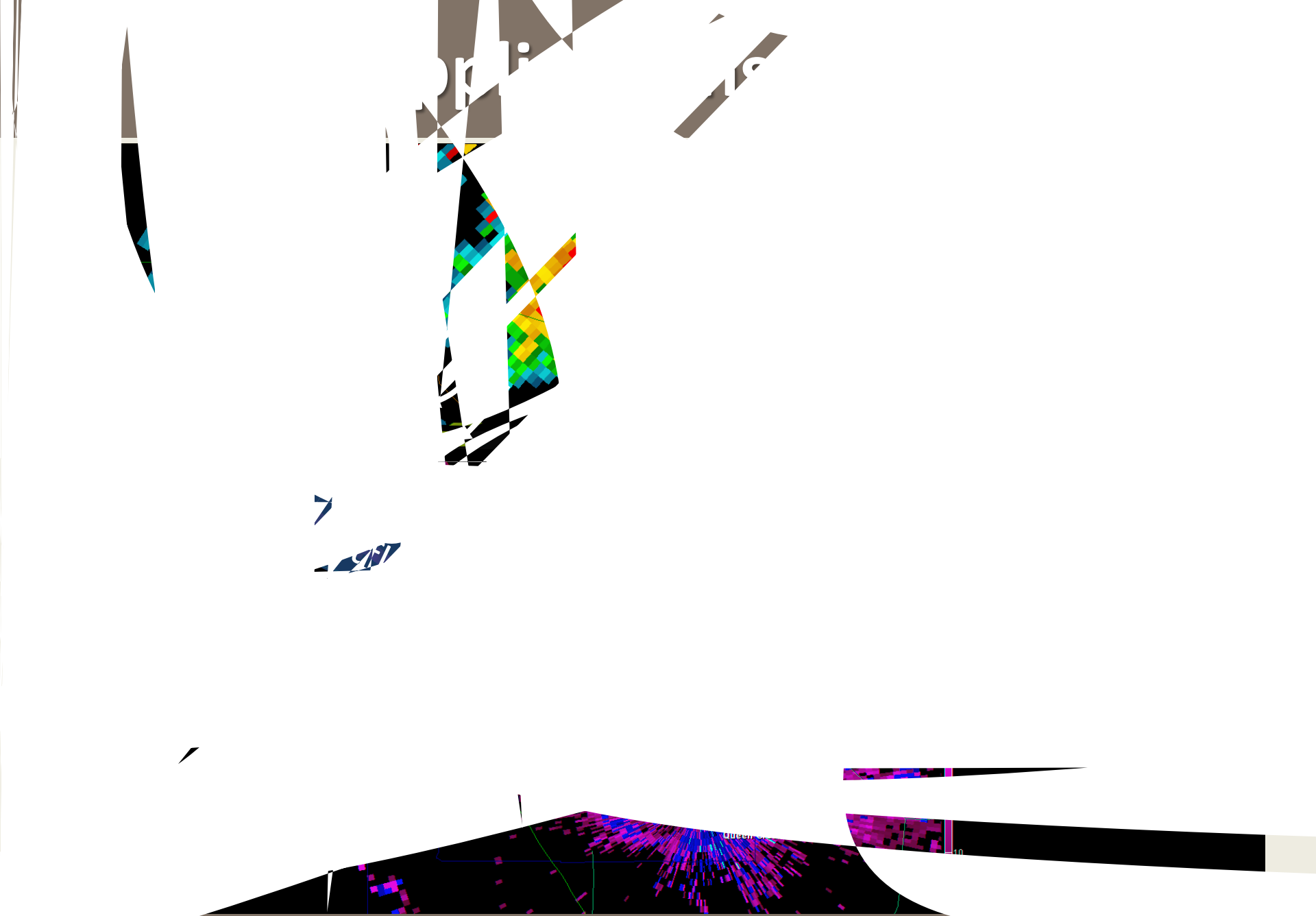






Radar Applications: Reflectivity





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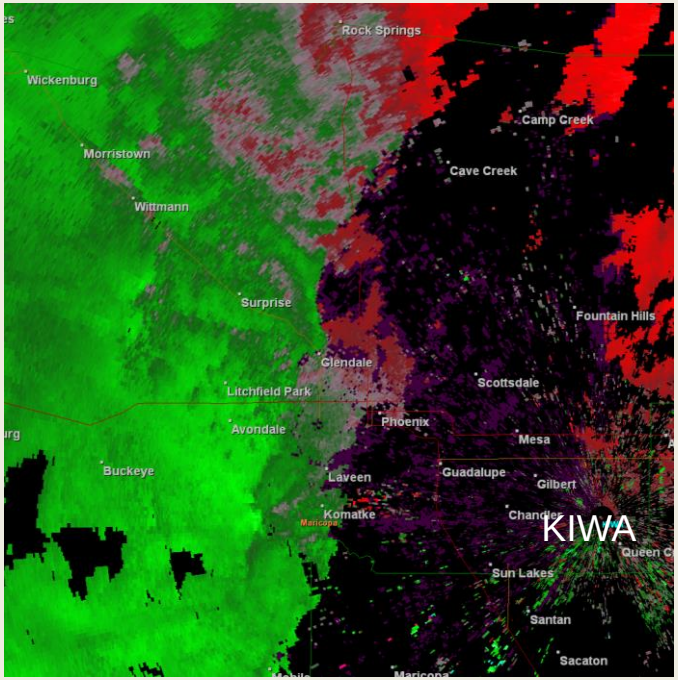
Velocity: Which Direction & How Fast



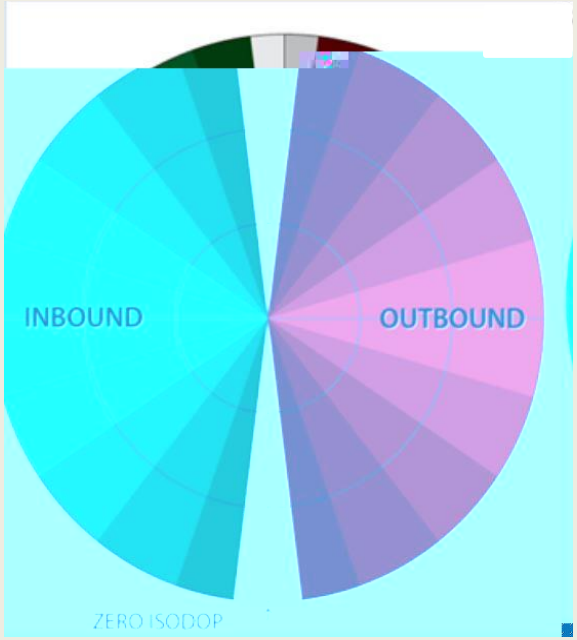
Radial velocity

_____

_____

_____

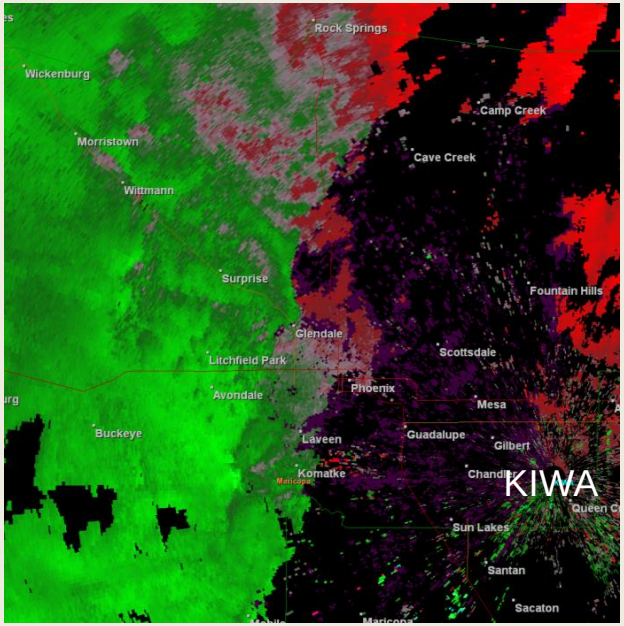
zero



Base Velocity vs. Storm Relative Velocity

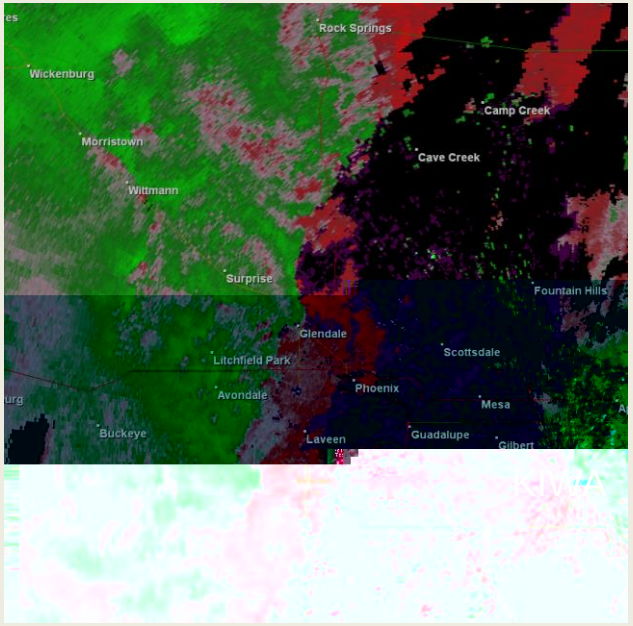
Base Velocity

Best for estimating straight line wind speeds

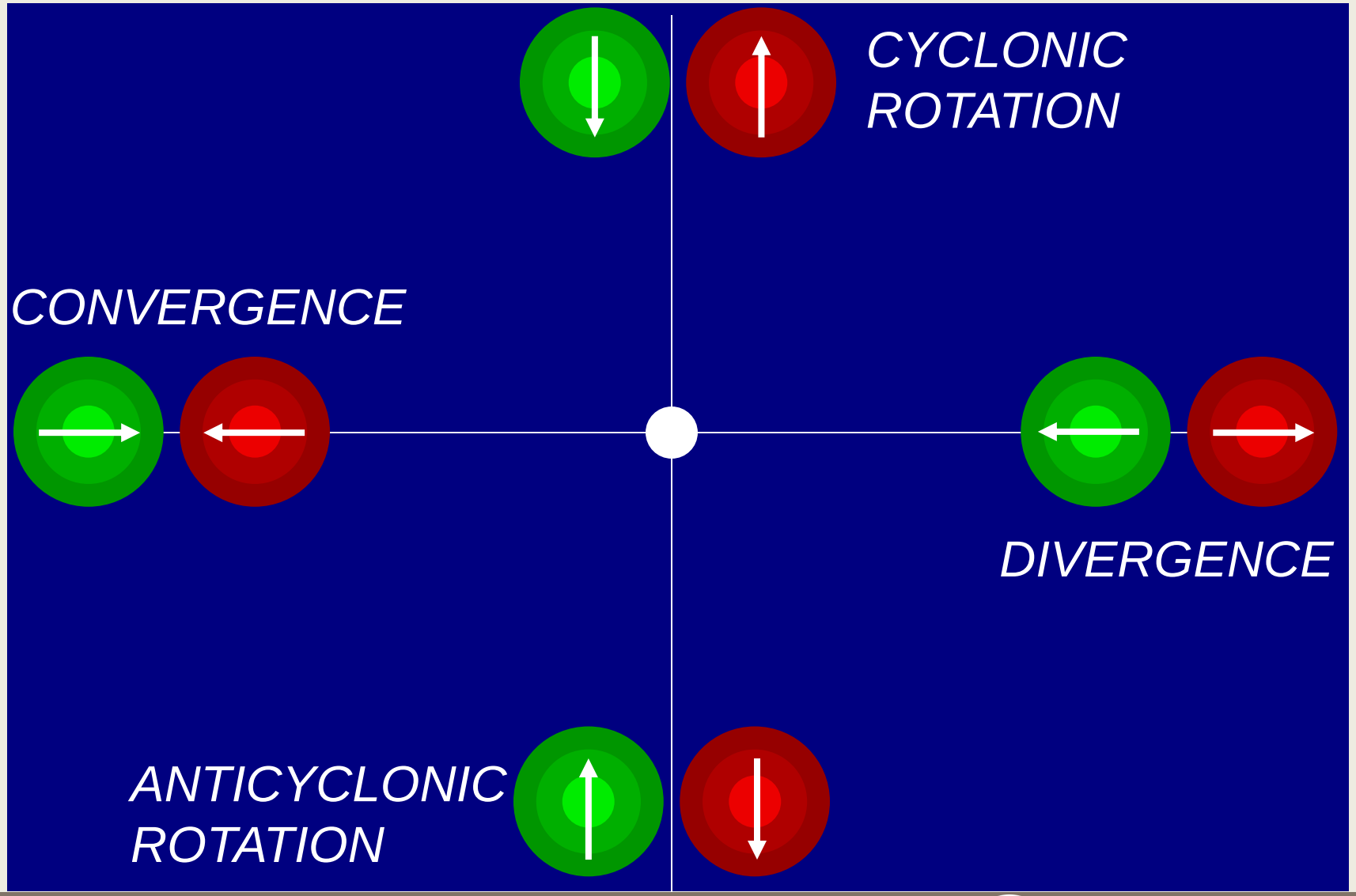


Storm Relative Velocity

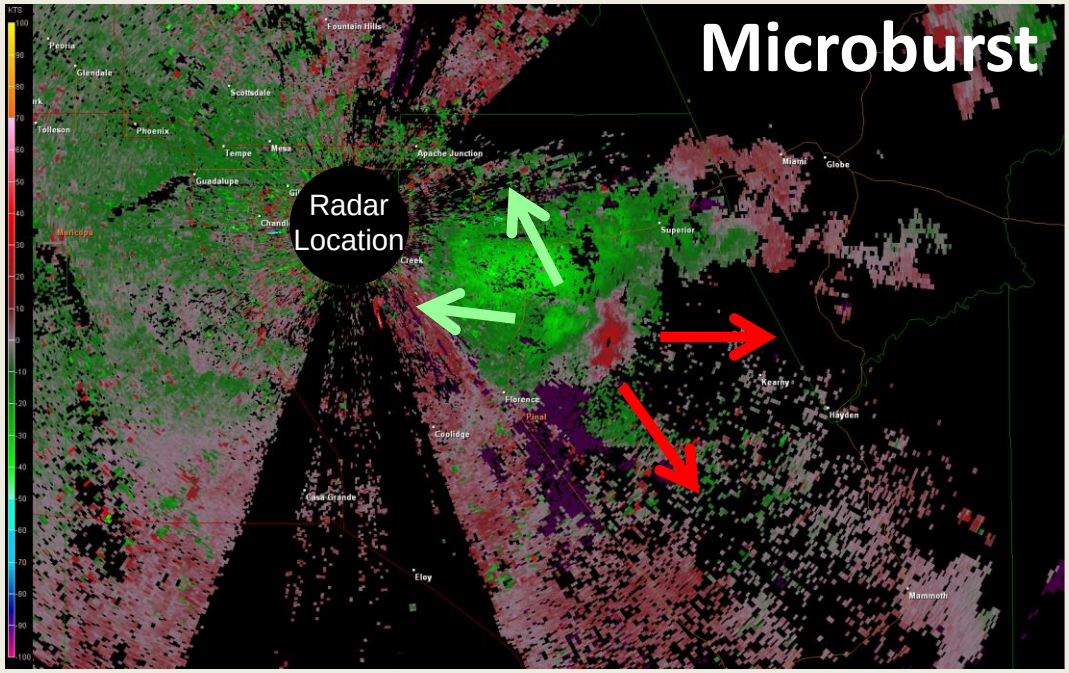
Best for identifying rotation

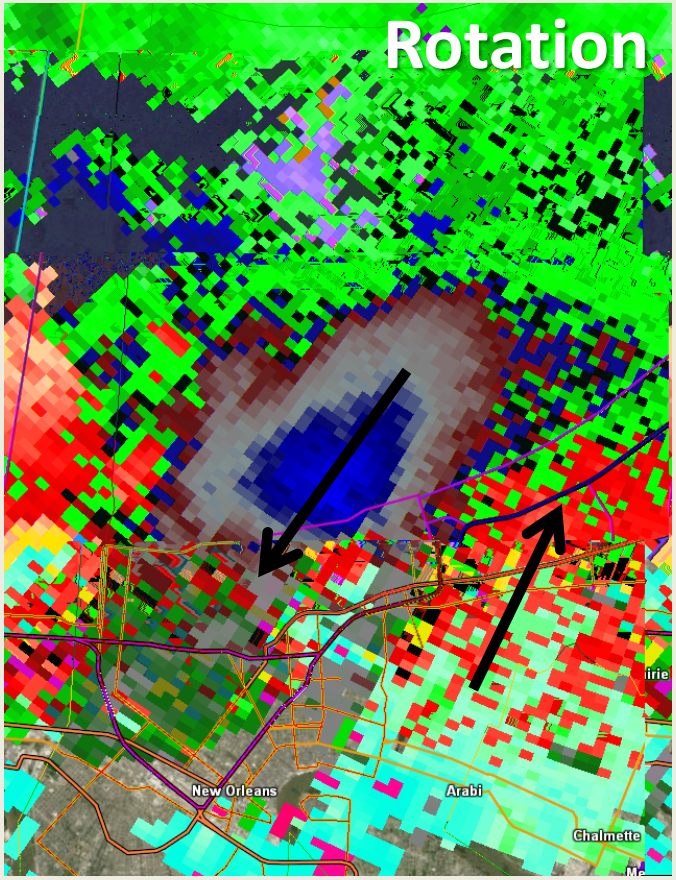


Radial Velocity Signatures

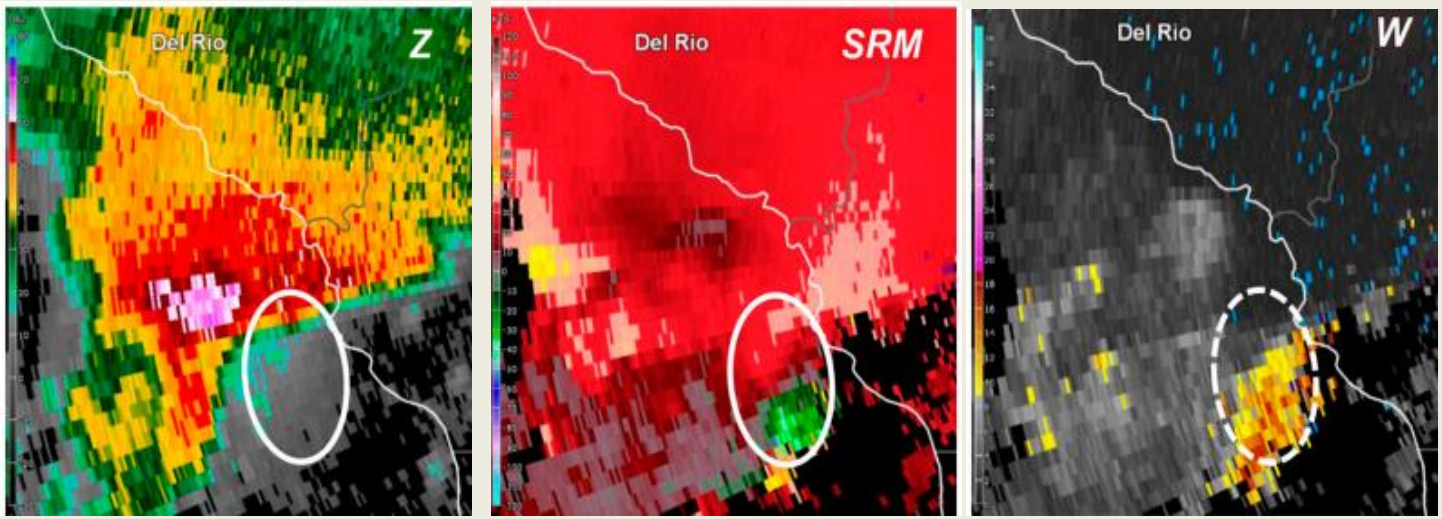


Velocity Signatures

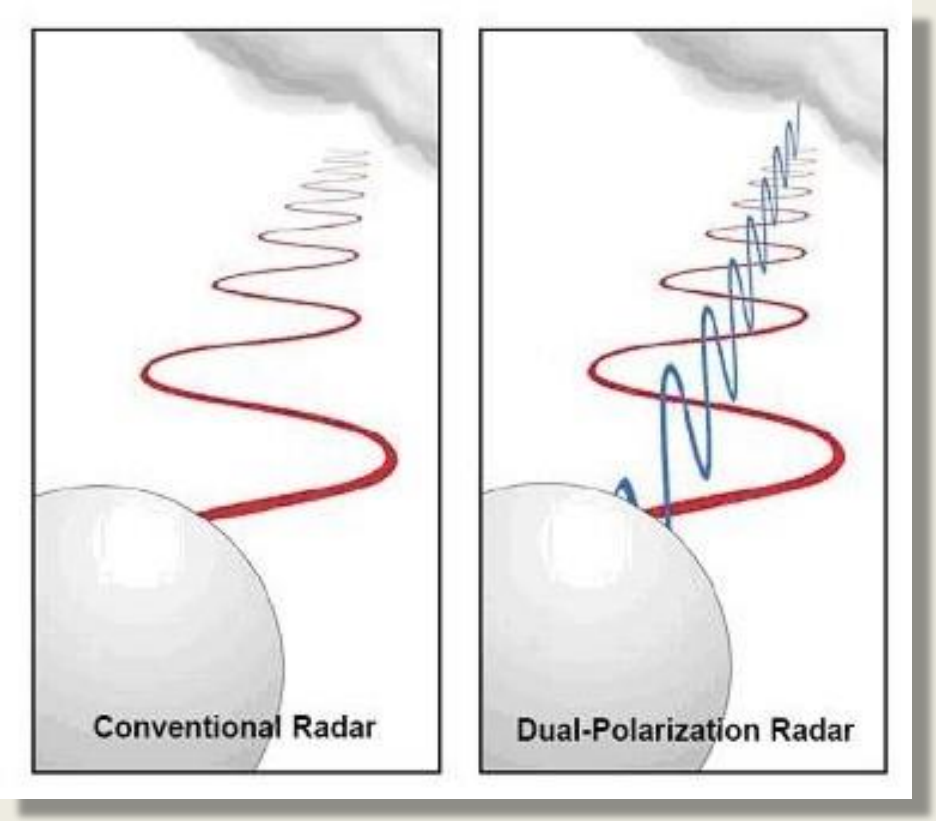




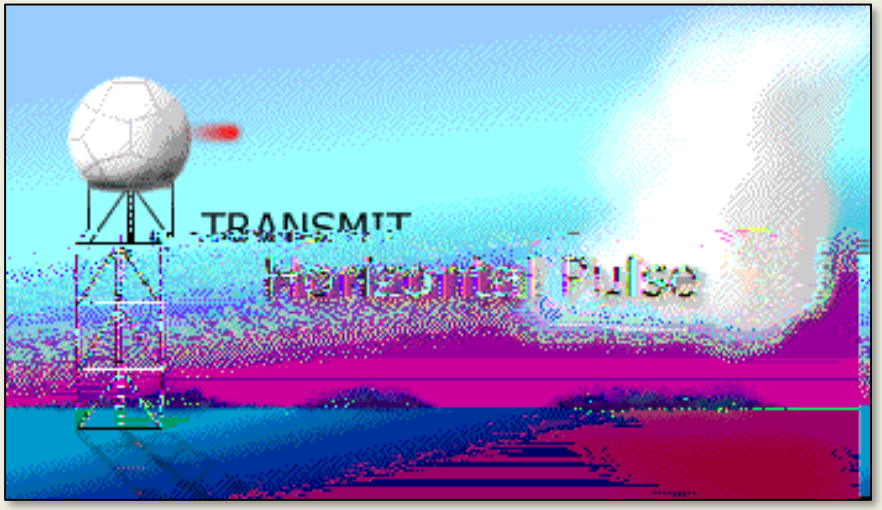
Spectrum Width: Variability of Motion

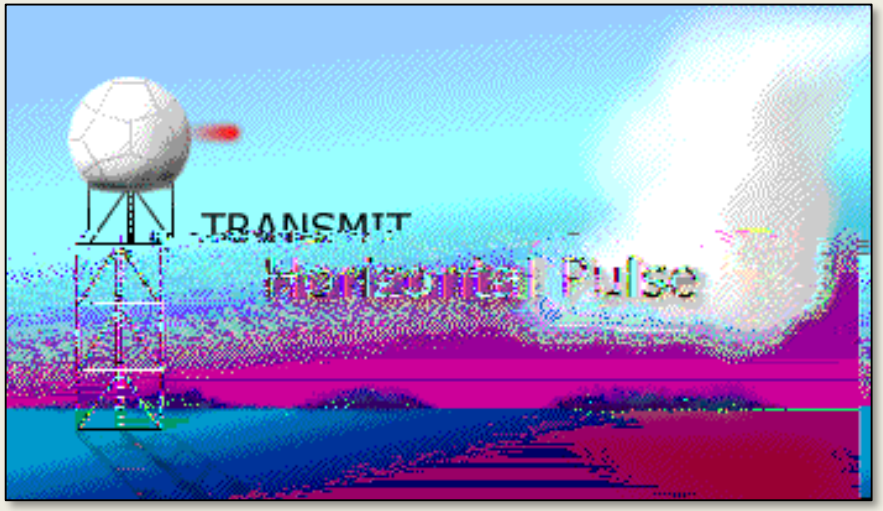


Dual Polarization

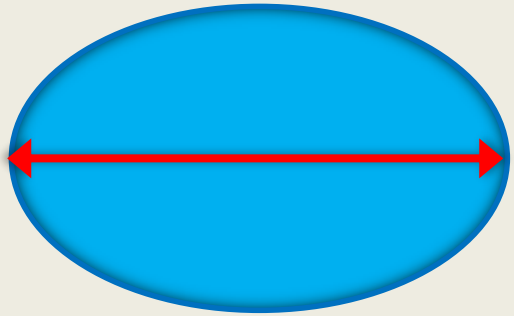


Dual Polarization

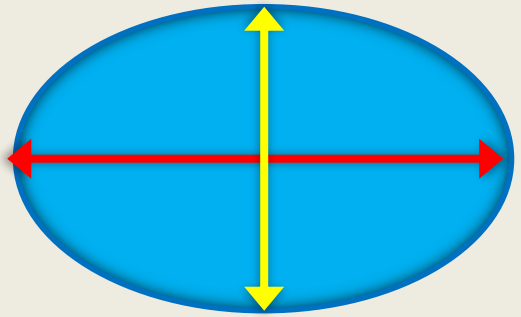




Reflected Energy → Reflectivity

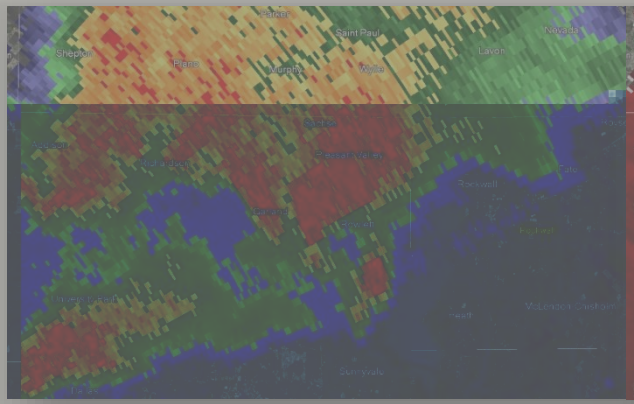


Bigger the drop, the more energy reflected, the higher the <u>reflectivity</u>.

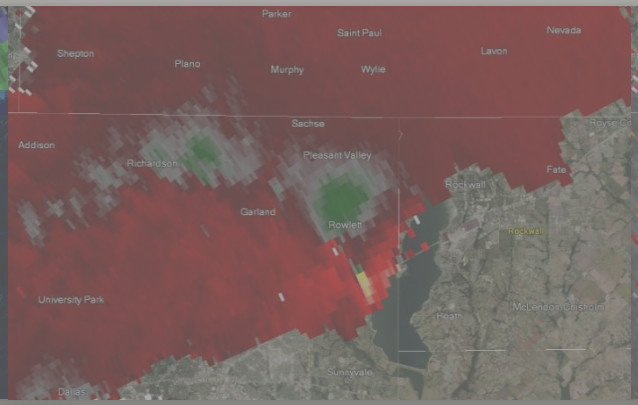


For a big drop, there is more energy reflected in the horizontal than vertical.

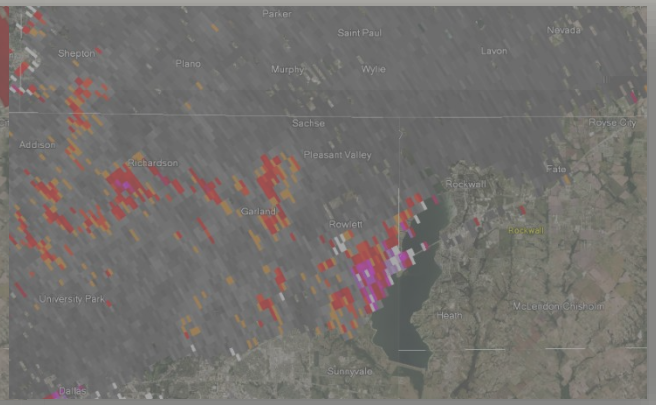
Dual-Pol Radar Products



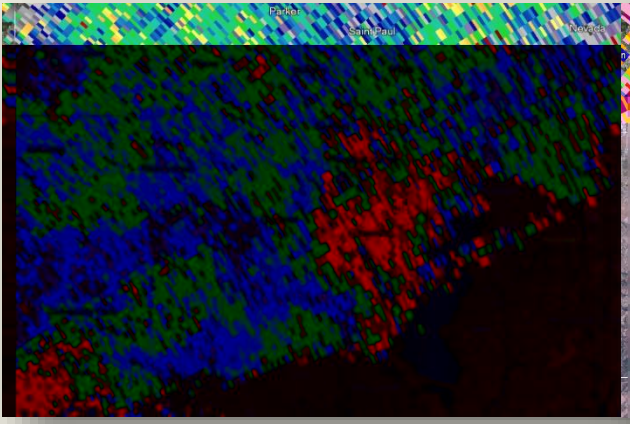
Reflectivity



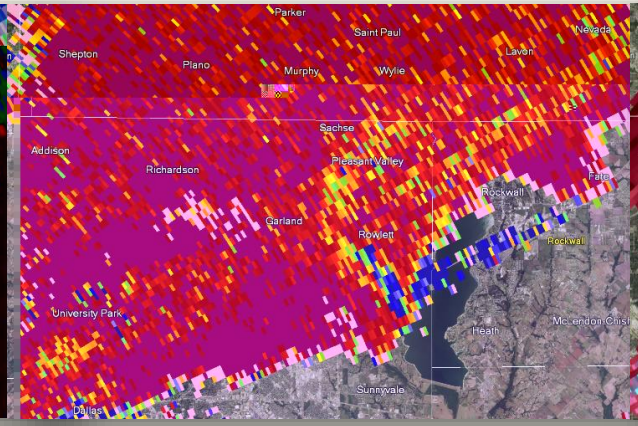
Velocity



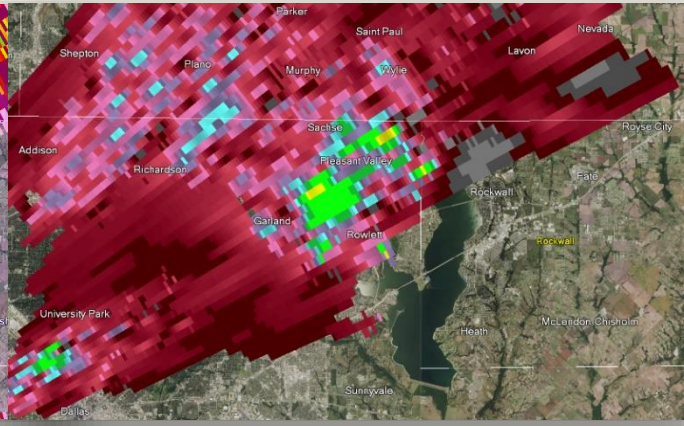
Spectrum Width



Differential Reflectivity

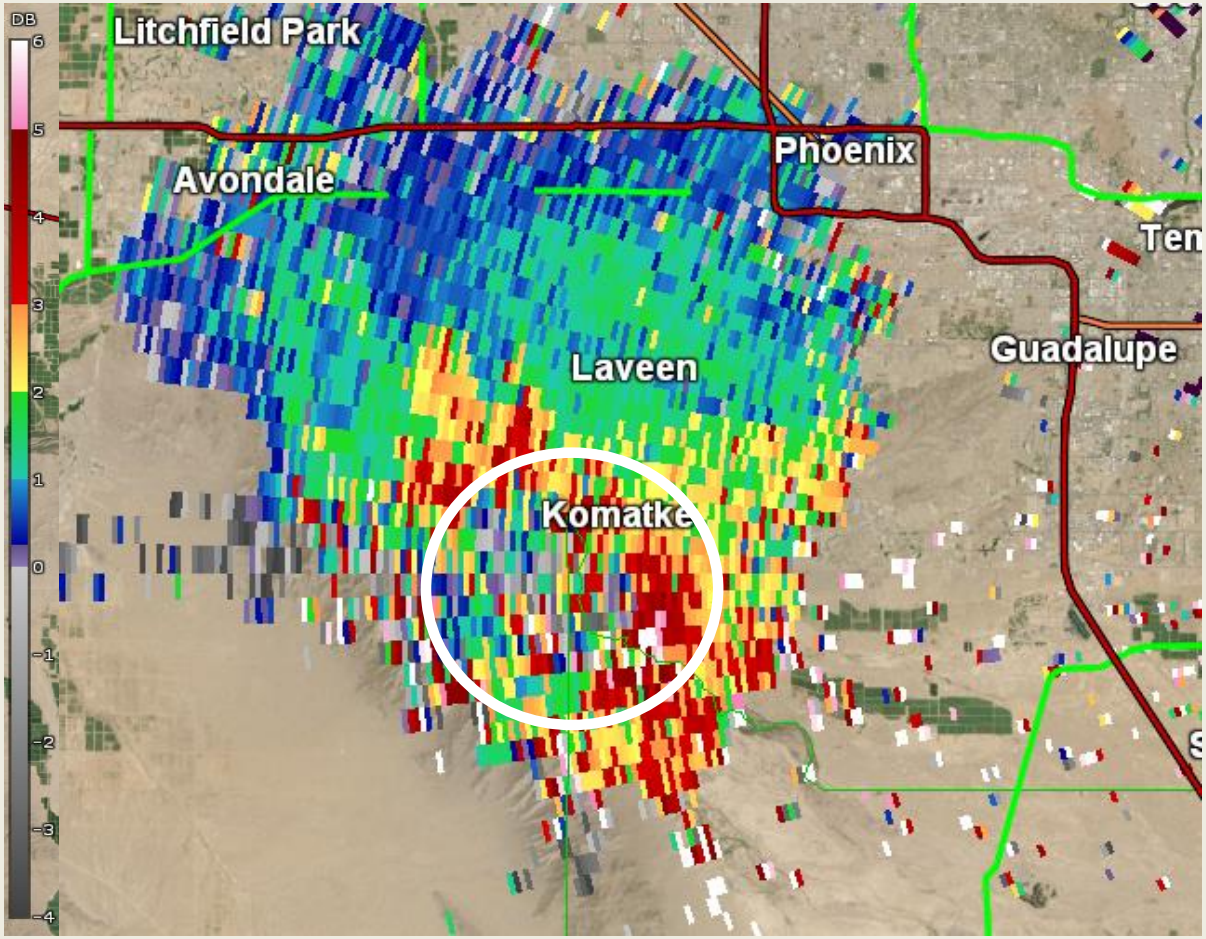


Correlation Coefficient

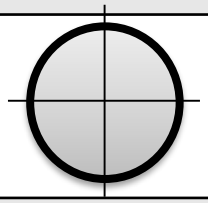
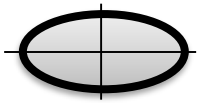
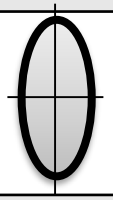


Specific Differential Phase

Differential Reflectivity: What Shape



Differential Reflectivity: What Shape

Spherical	Horizontally Oriented	Vertically Oriented
X = Y	X > Y	Y > X
		
Z_{DR} ~ 0 dB	Z_{DR} > 0 dB	Z_{DR} < 0 dB

NWS State College

A measure of the mean shape of particles in the sampling volume.

Differential Reflectivity: What Shape

Spherical

Z_{DR} = 0 dB

Small, non-spherical

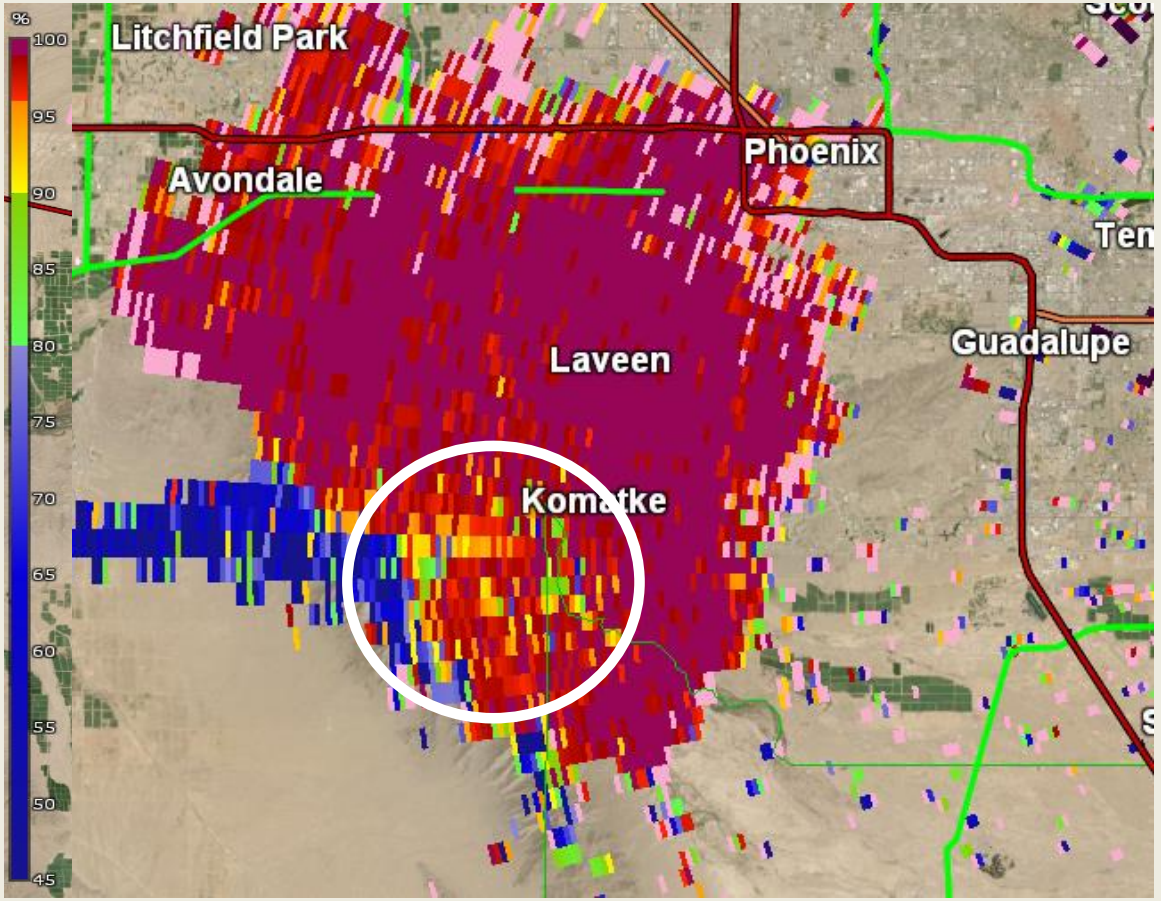
horizontal:

Z_{DR} > 0 dB

vertical:

Z_{DR} < 0 dB

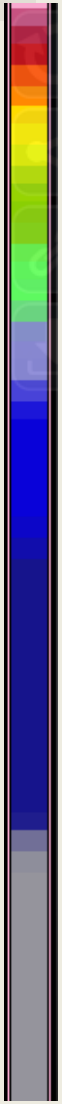
Correlation Coefficient: How Similar



Correlation Coefficient: How Similar

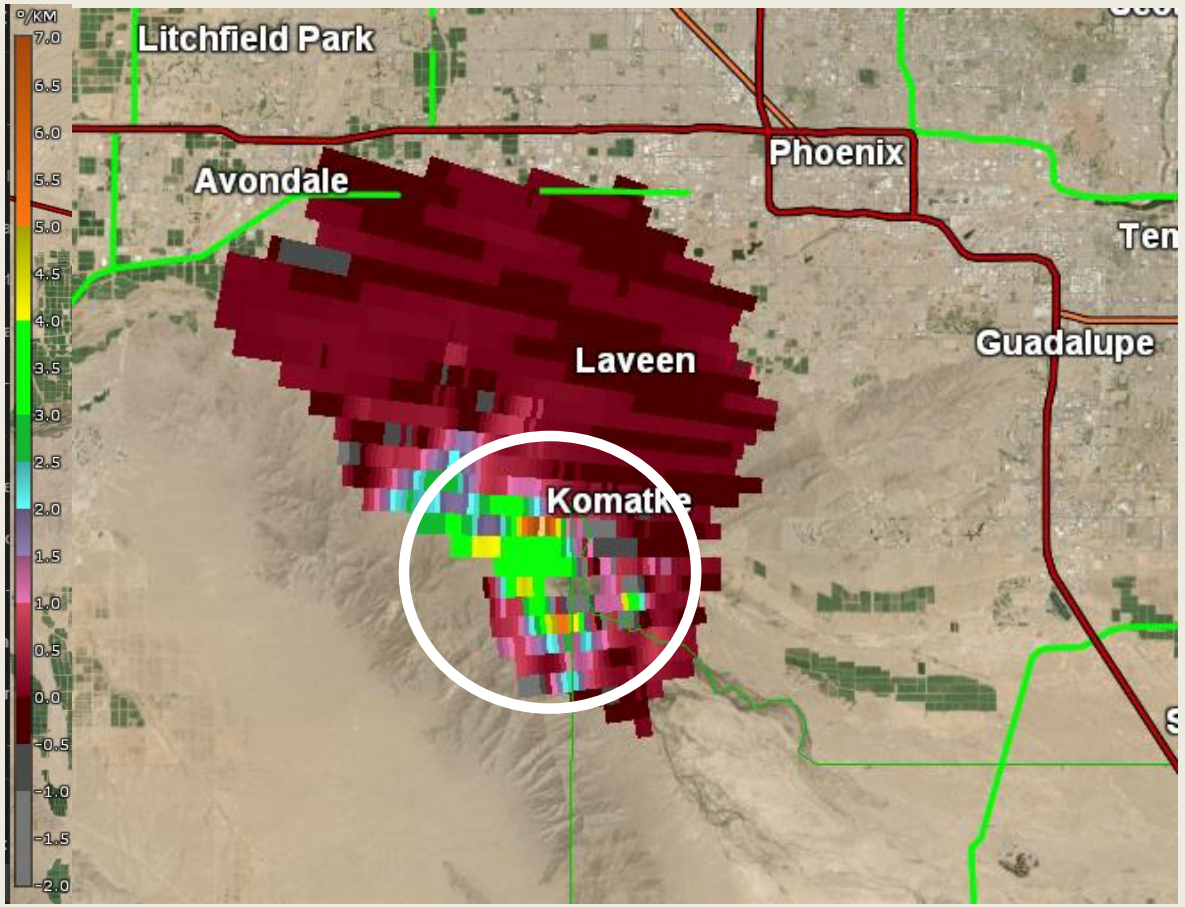
Meteorological (Uniform)	Meteorological (Non-Uniform)	Non-Meteorological
Rain, Snow, etc	Hail, Wet Aggregates (melting snow)	Birds, insects, debris
High CC (>0.97)	Moderate CC (0.80 to 0.97)	Low CC (<0.8)

NWS State College

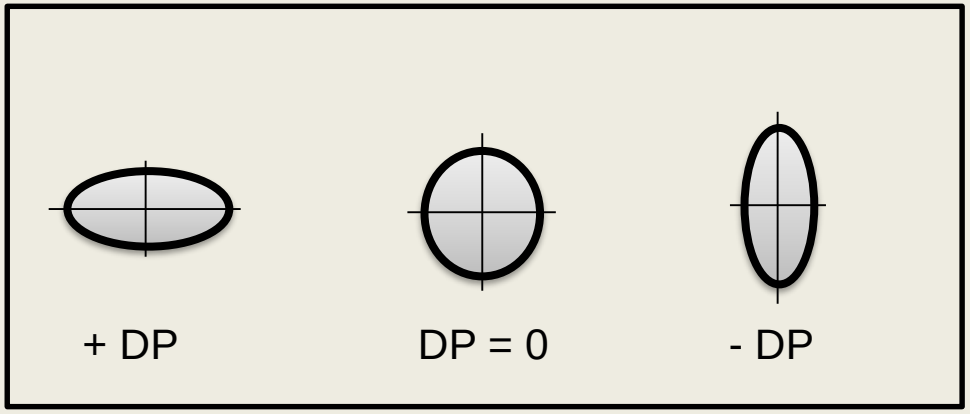


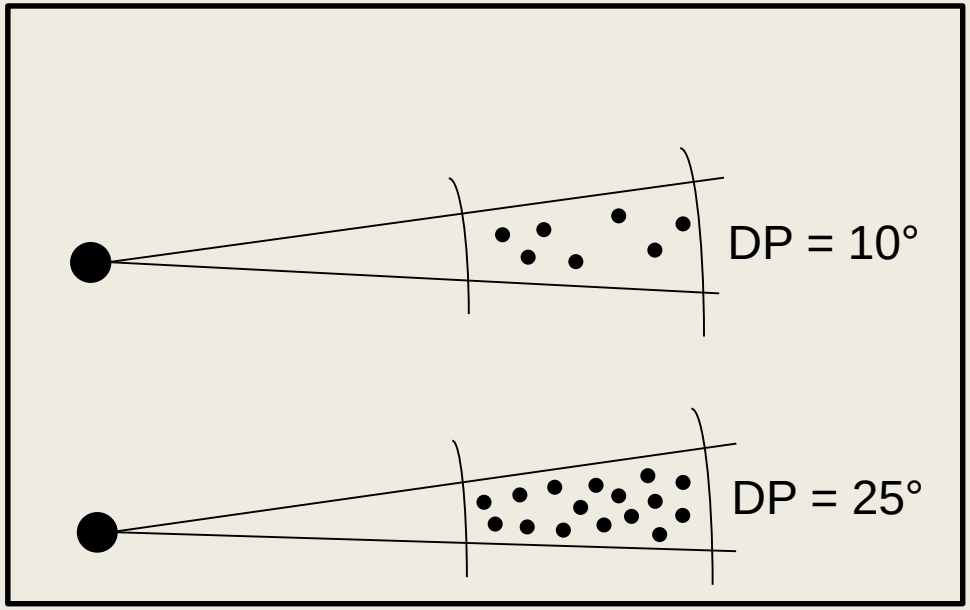
Units: None

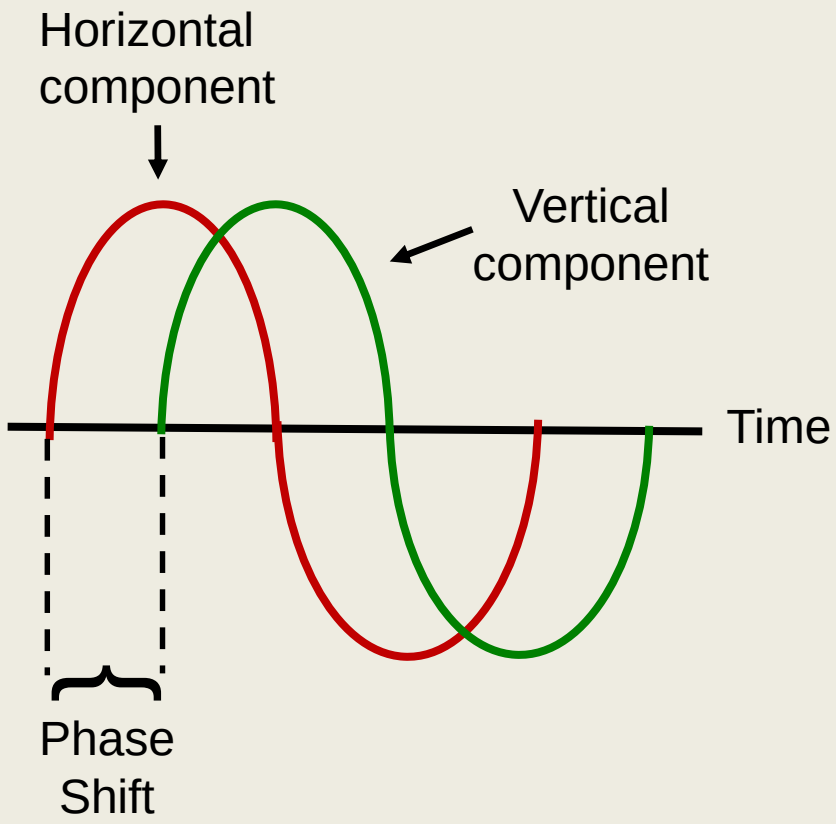
Specific Differential Phase: How Many



Specific Differential Phase: Phase Shift





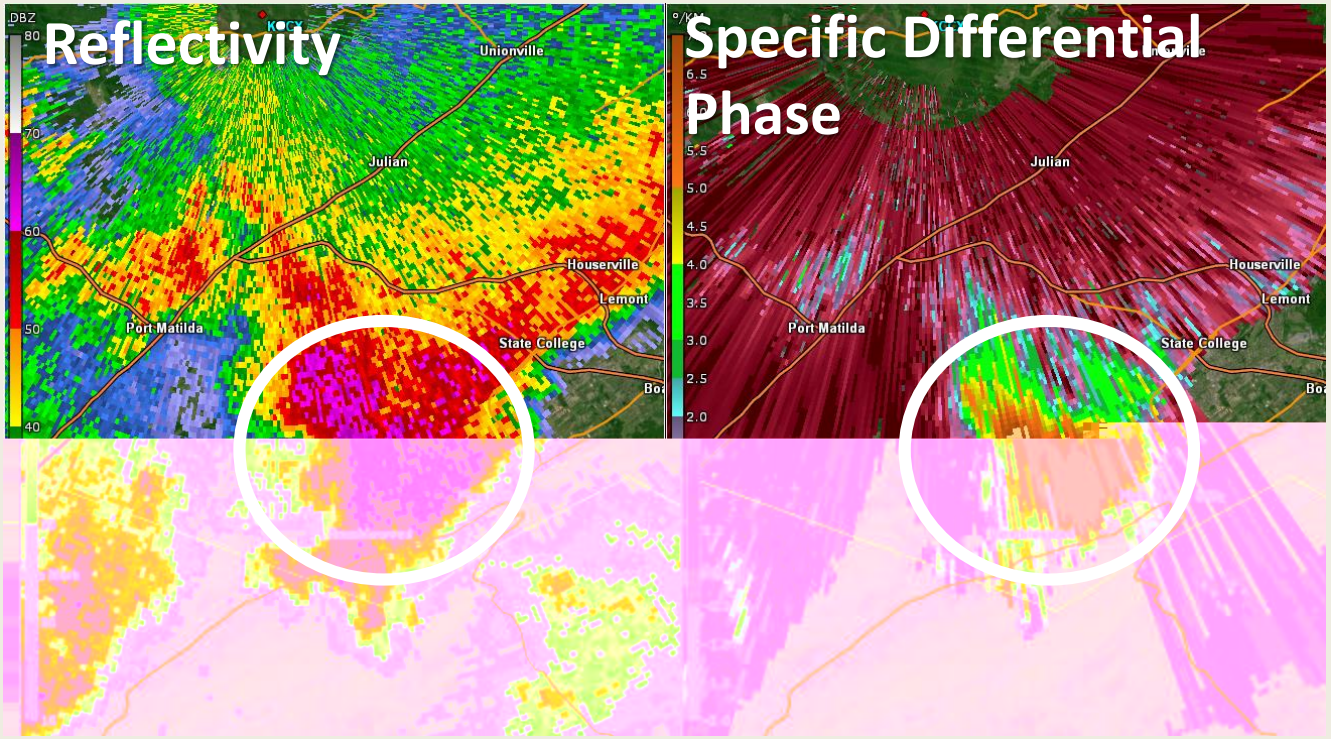


Specific Differential Phase: Application

very heavy rain

or

large amounts of small melting hail

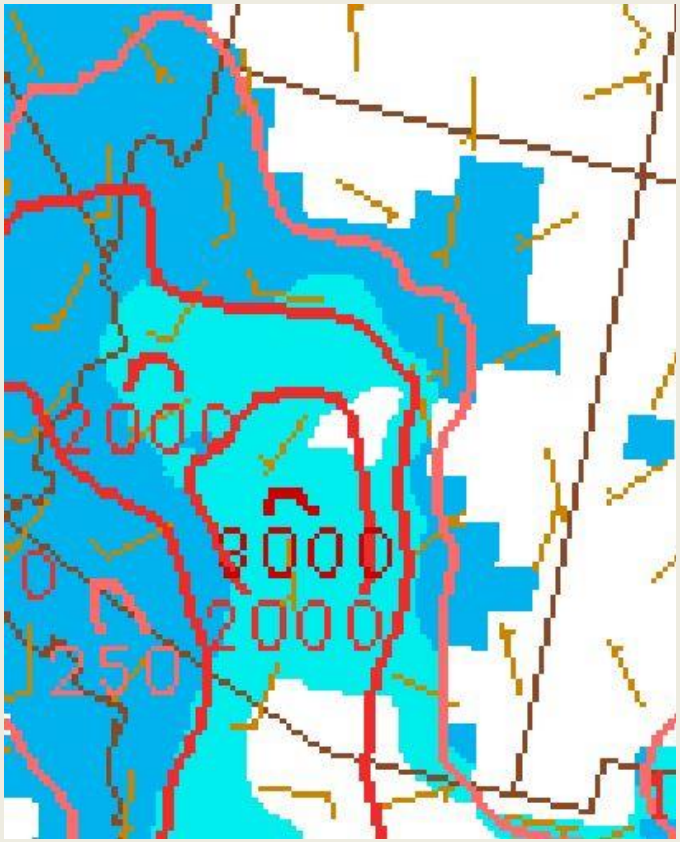


Program Outline

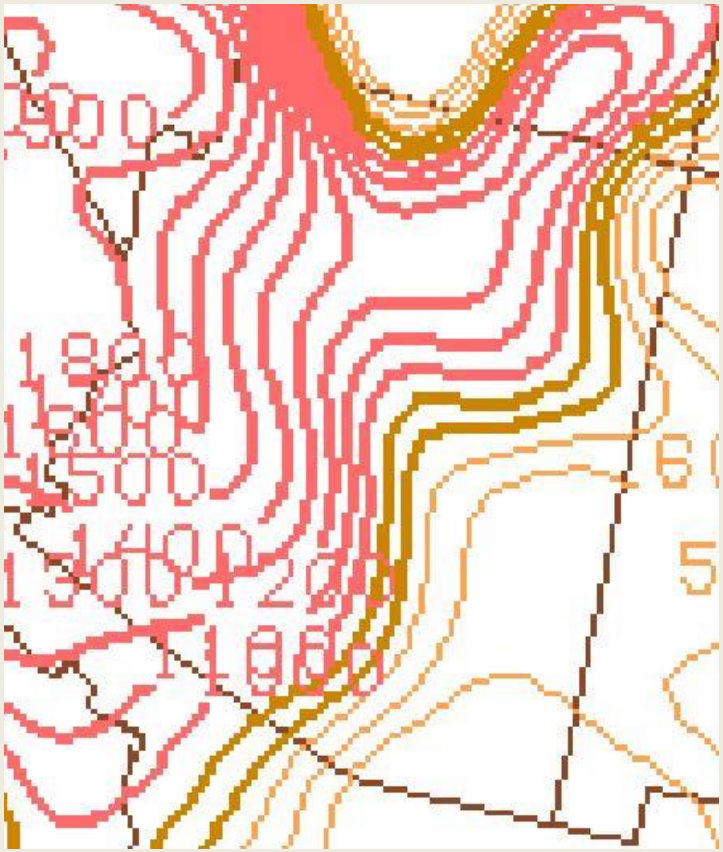
Case Study #1

Thermodynamics

MLCAPE

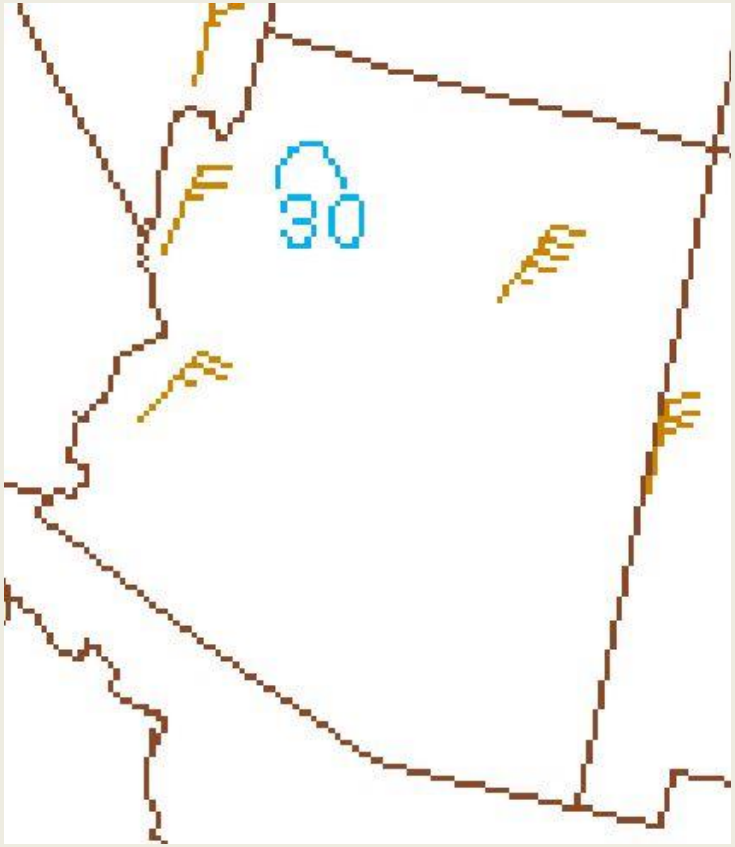


DCAPE

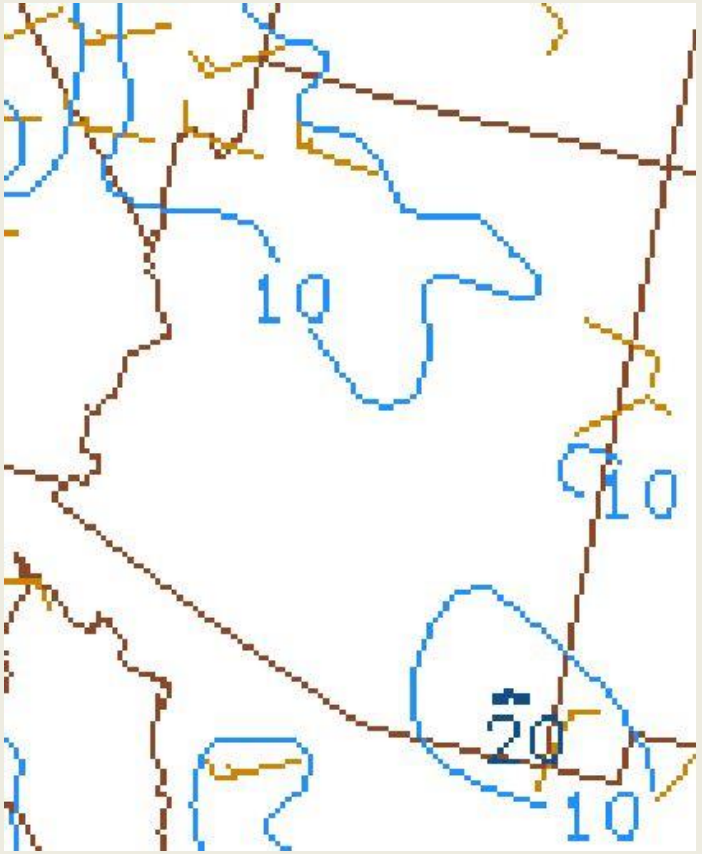


Kinematics

Effective Shear



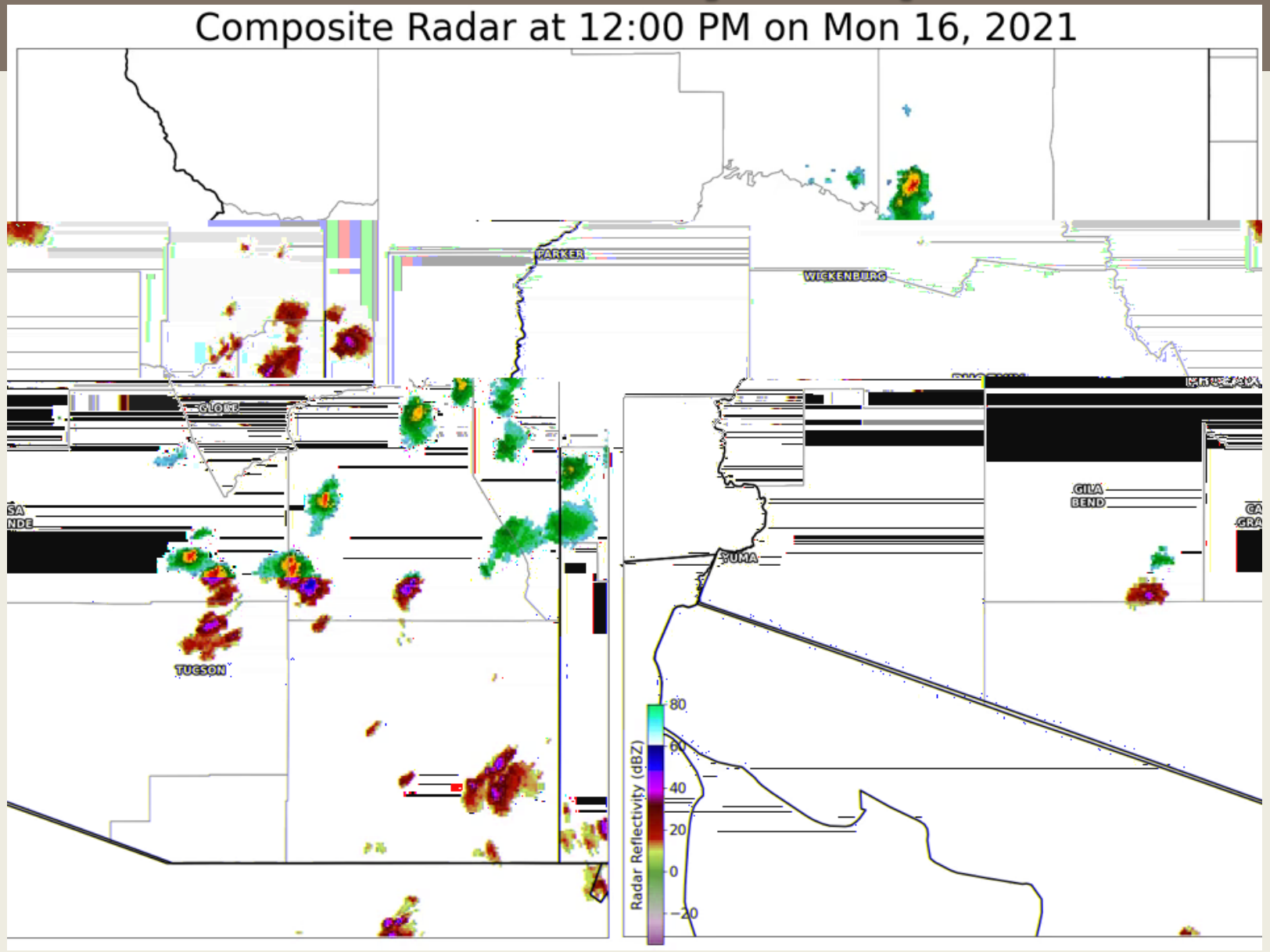
0-1km Shear



Kinematics

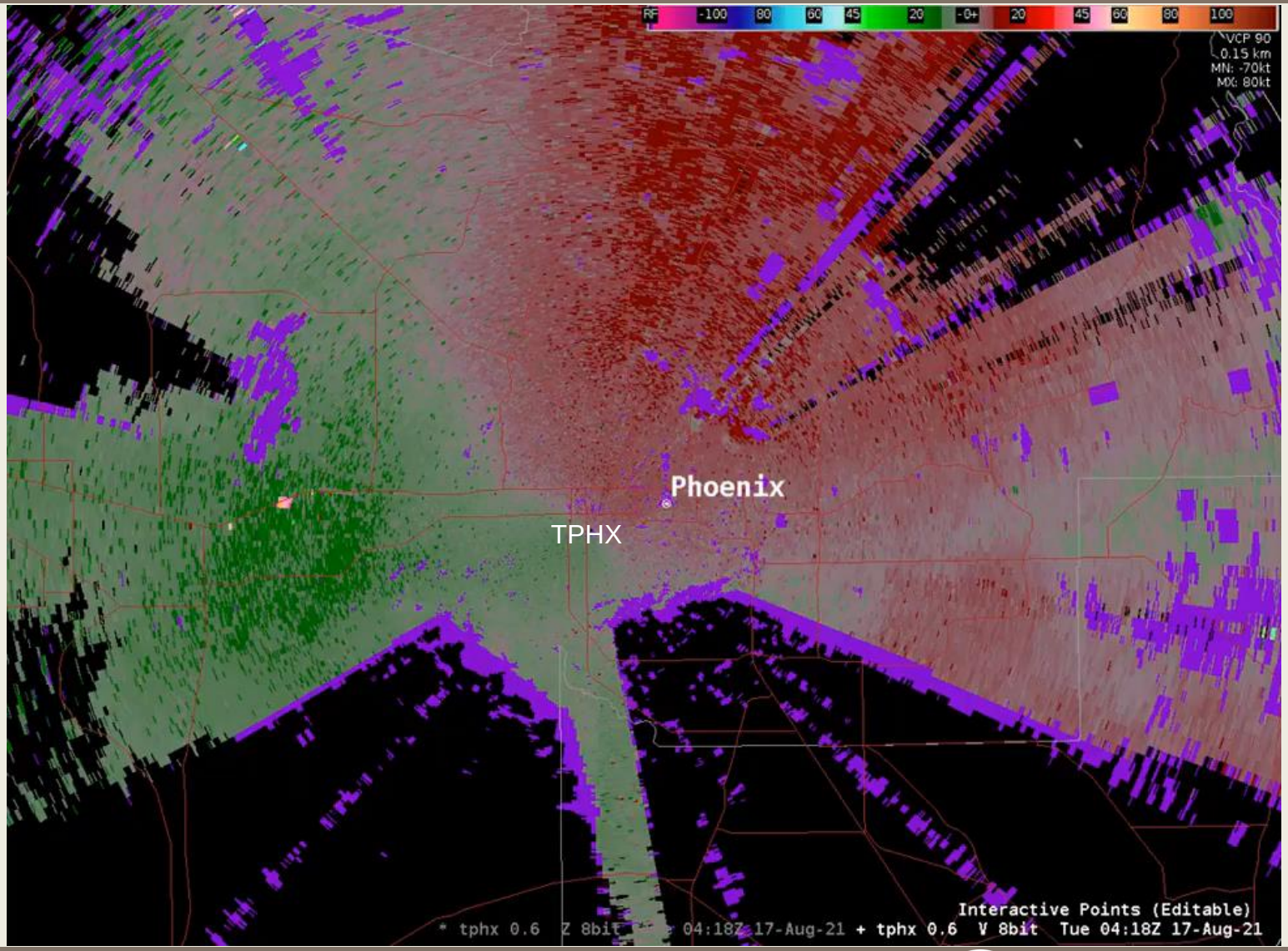
850mb - 300mb
Average Winds

Reflectivity Loop



Base Velocity Loop

9:19 PM – 12:59 AM



Phoenix

Kim Quintero AZ Family

/NWSPhoenix

Laveen

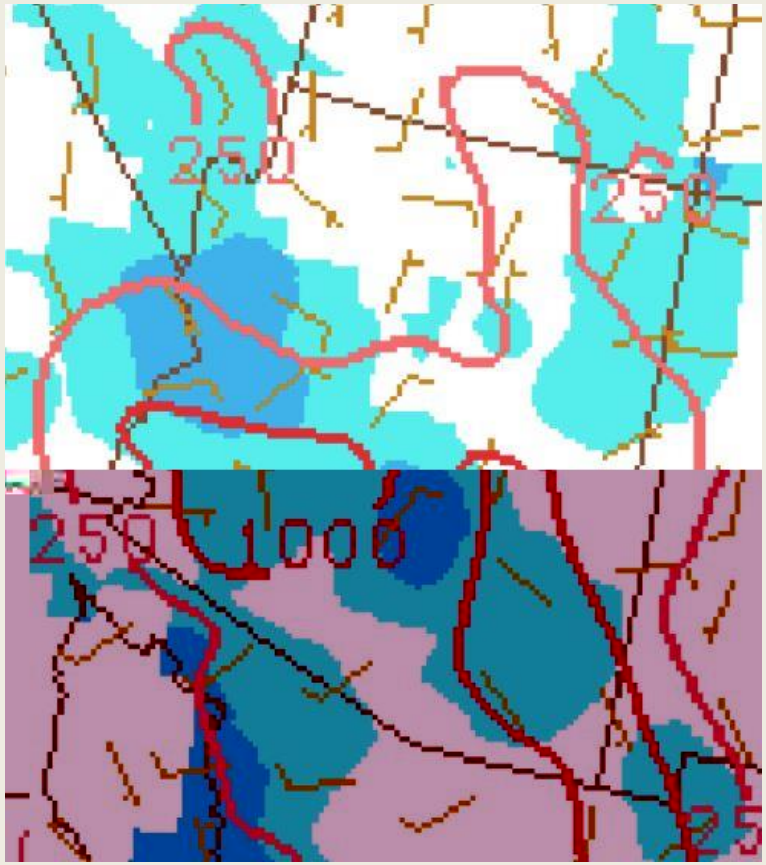
@reinazee

w.weather.gov/psr

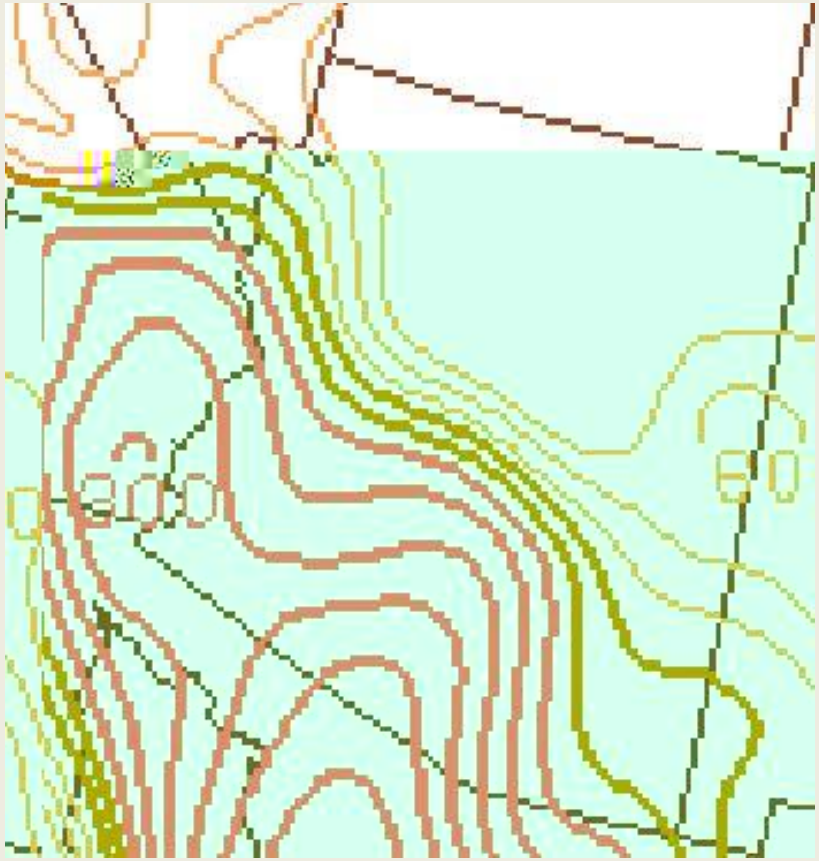
Case Study #2

Thermodynamics

MLCAPE

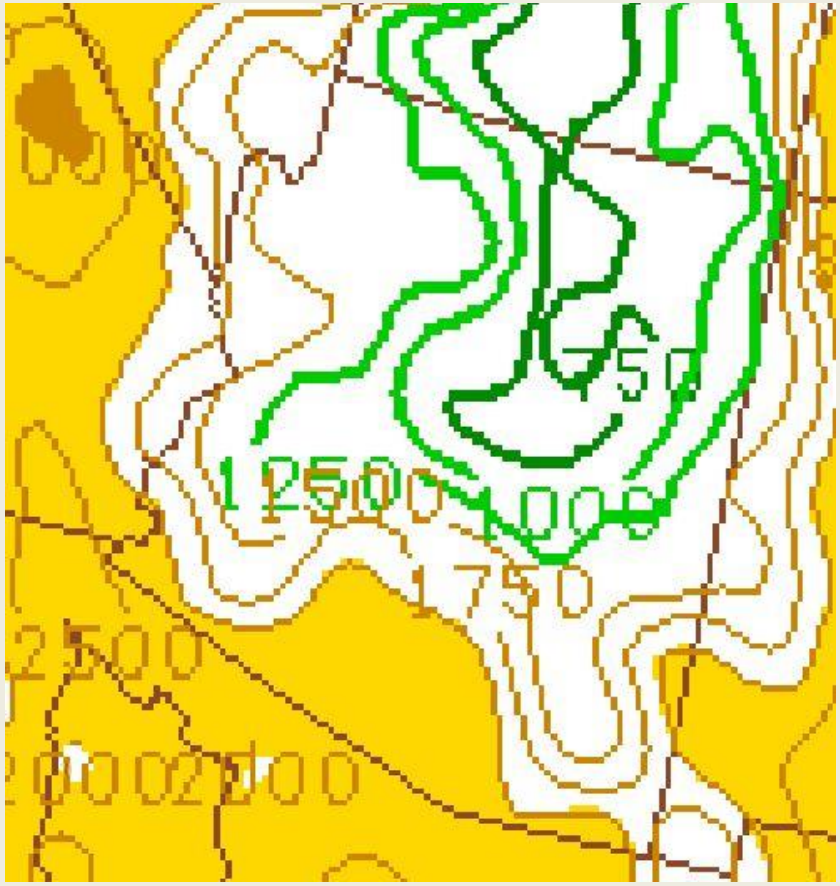


DCAPE



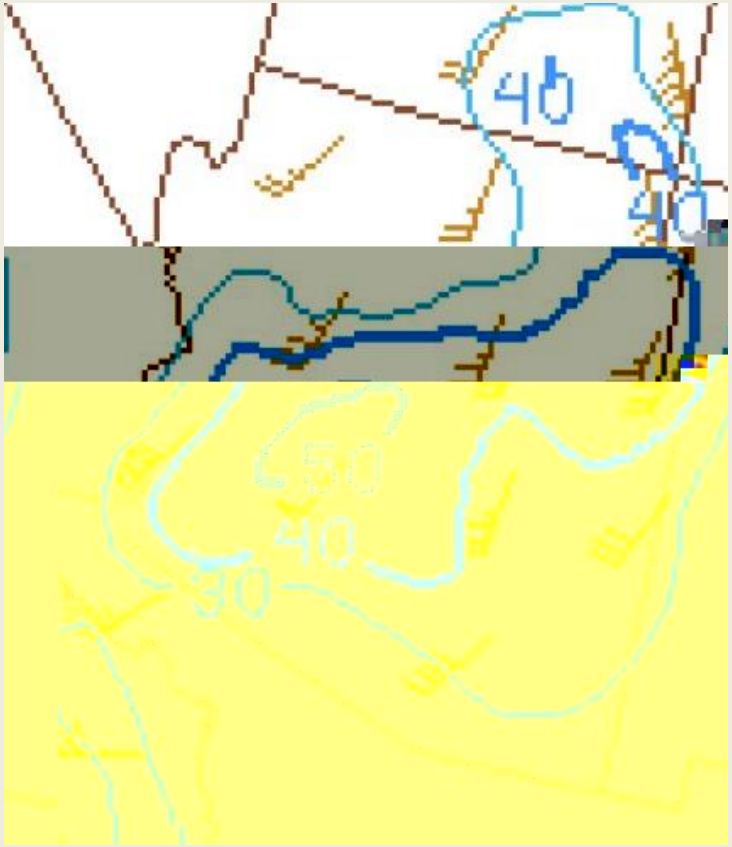
Thermodynamics

LCL Height



Kinematics

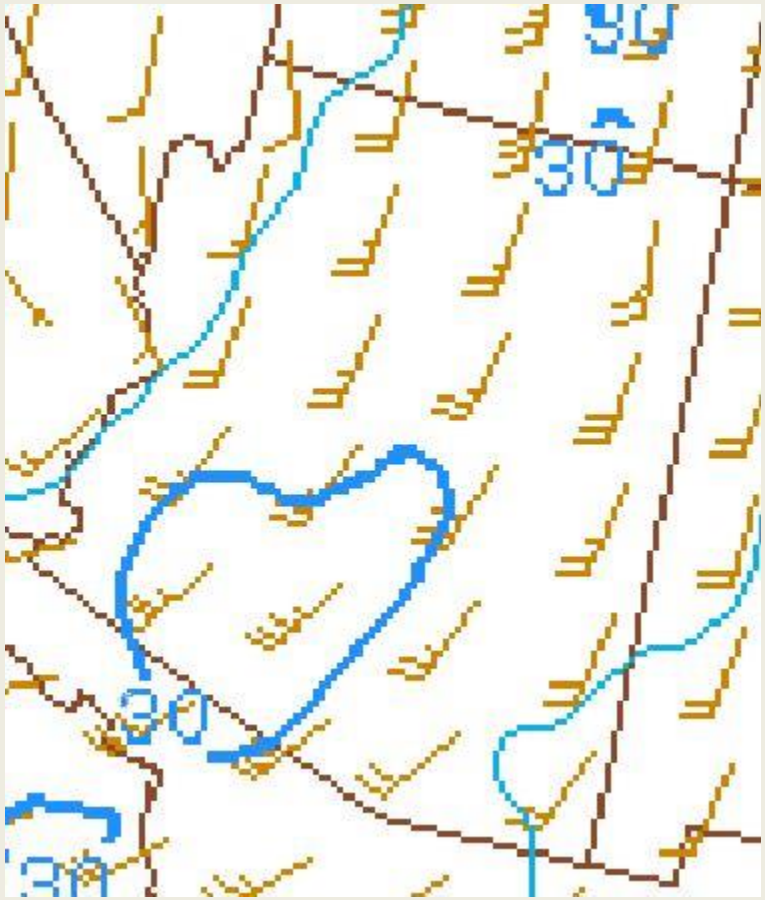
Effective Shear



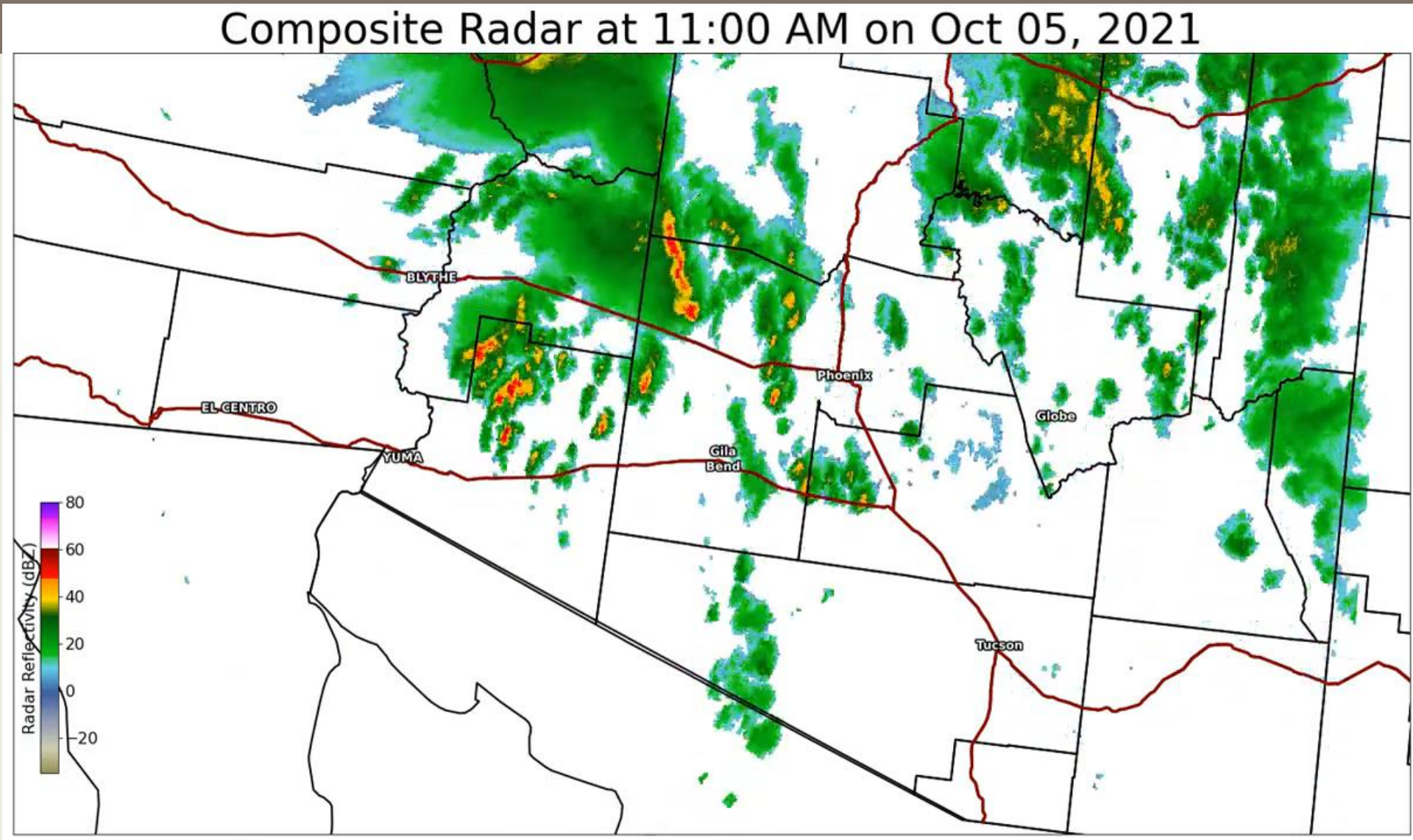
0-1km Shear

Kinematics

850mb - 300mb Average Winds



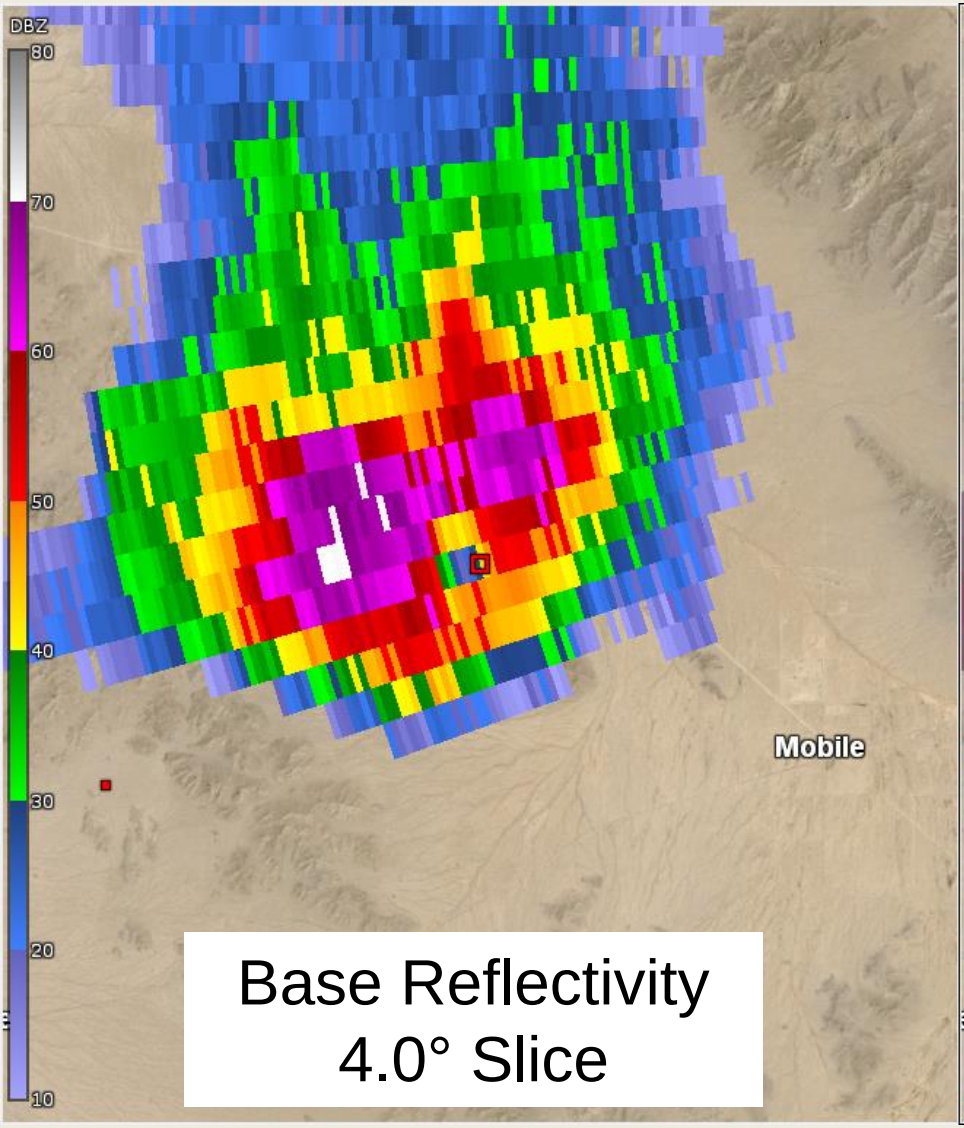
Reflectivity Loop



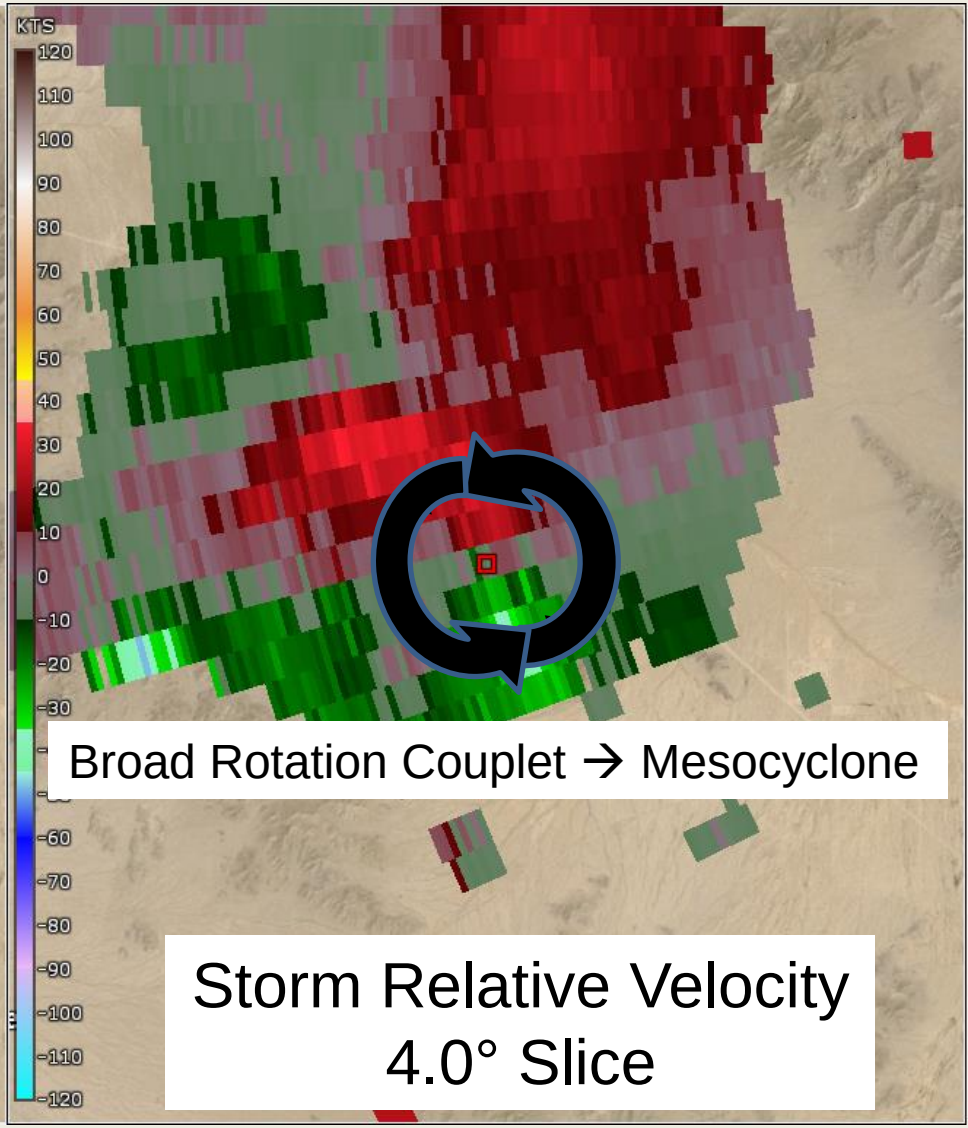
Base Reflectivity Loop

2:06 PM – 6:36 PM

5pm



Base Reflectivity
4.0° Slice

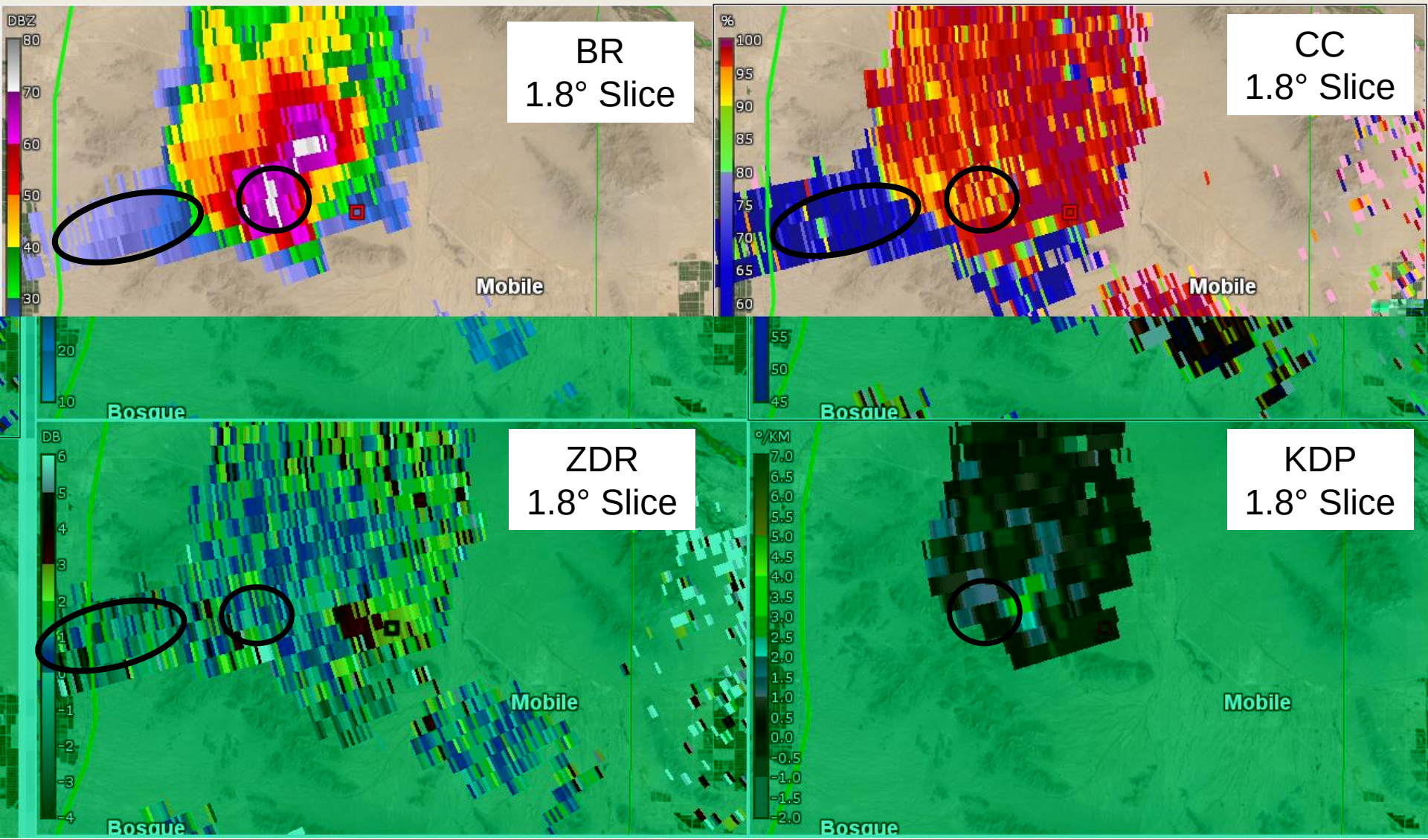


Broad Rotation Couplet → Mesocyclone

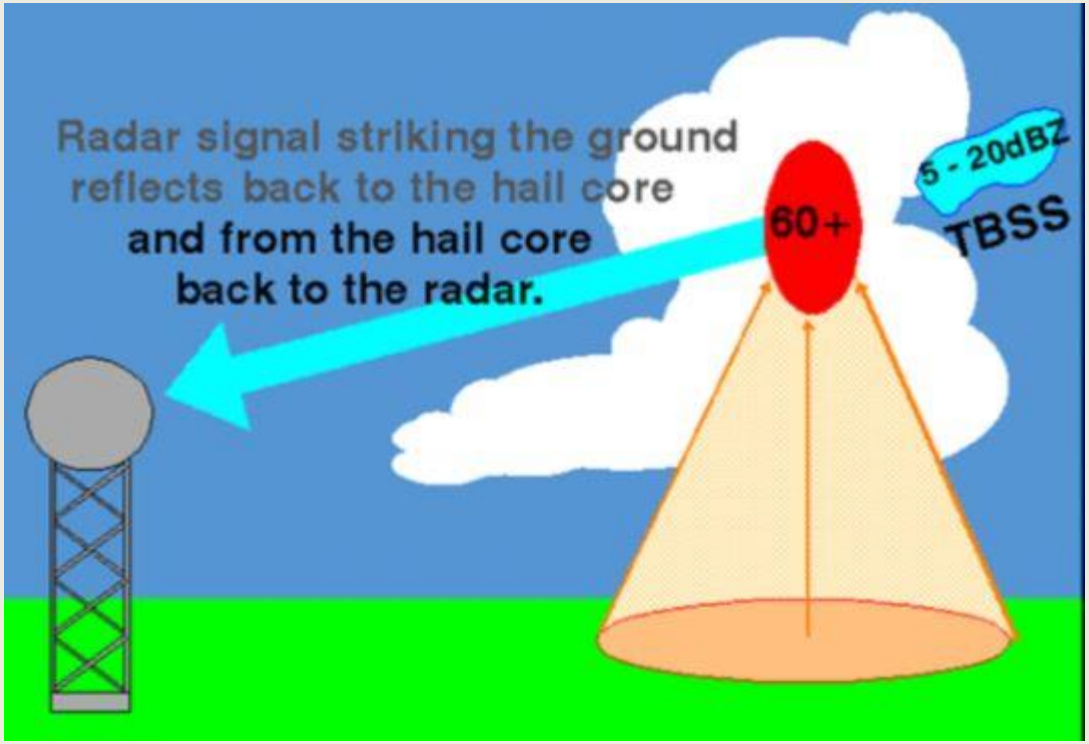
Storm Relative Velocity
4.0° Slice

Dual Pol Data

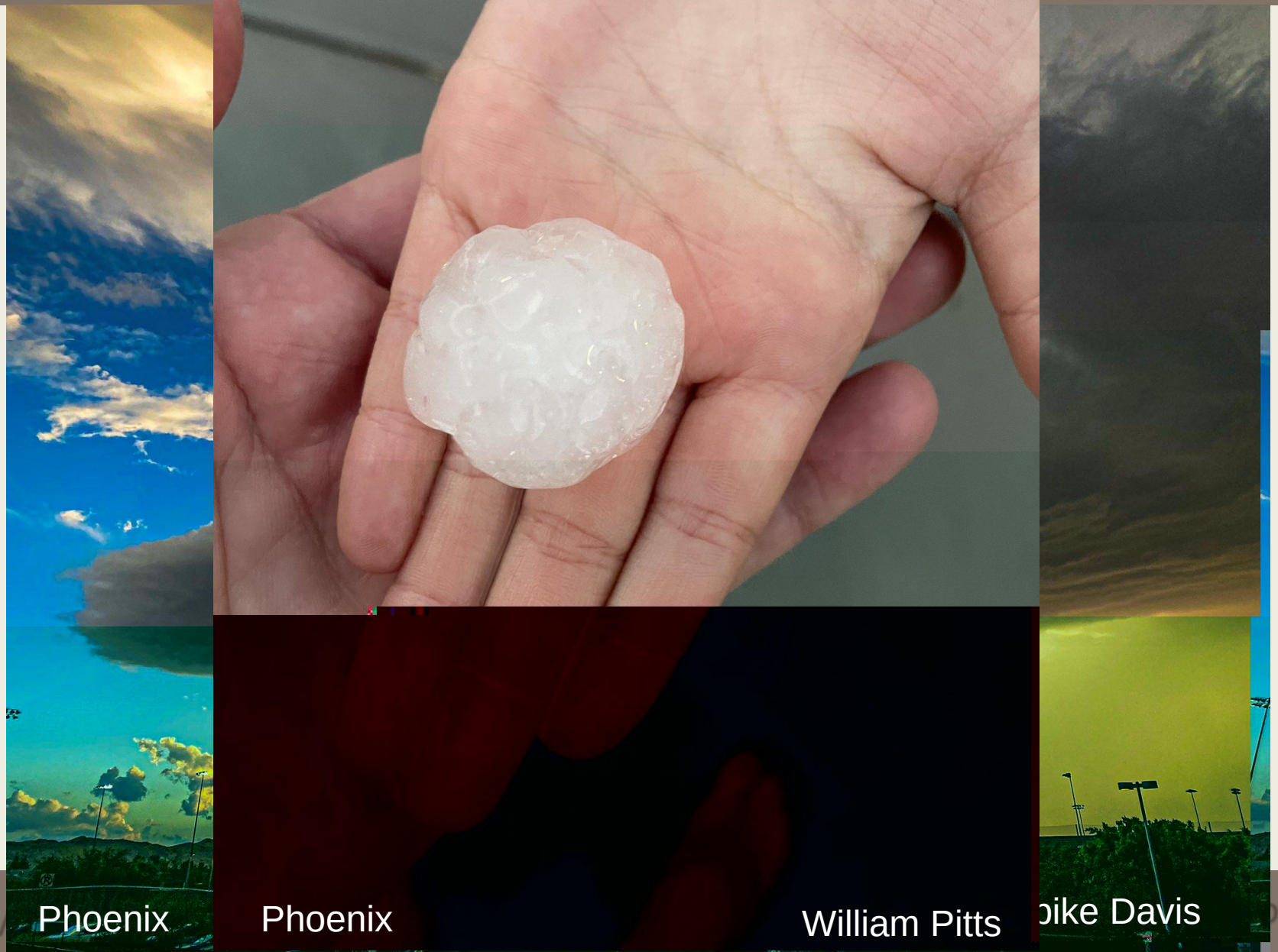
5PM



Three Body Scatter Spike (Hail Spike)



NWS WDTD


Phoenix
Phoenix
William Pitts
ike Davis

Course Summary

Questions? Contact Us!