Spring 2017
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”

• Infrequently Discussed Radar Concepts

• Dual Polarization Concepts
The Atmosphere

Large to Small Scale
- Global (Largest)
- Synoptic (Large)
- Mesoscale (Small)
Global Weather Patterns

Global-Scale Drivers
- General atmospheric circulation, etc.
- From 1000s of km to planetary motions

Synoptic-Scale Drivers
- Jetstreams and fronts, etc.
- From a few hundred km to 1000s of km

Mesoscale Drivers:
- Air-sea interactions, etc.
- From 1 km to a few hundred km
Global Weather Patterns

Weather Patterns should flow North to South, RIGHT?

Two More Things to Factor in:
- Rotation of the Earth
- Gravity

Coriolis Effect
Most of our weather comes from the west:

- **Westerlies**
- **Easternlies**

Hurricanes come from the east:
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
Negatively Tilted Trough Axis
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)
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
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.
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.
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- How is the instability calculated?
Multimedia Impact Briefing
For Central Alabama

Morning Upper Air Balloon Launch
Surface Tropopause Height Increasing
Temperature Increasing
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

- Weak Instability
- Strong Instability
http://www.spc.noaa.gov/exper/mesoanalysis/
The 3-Dimensional Atmosphere Instability

0 – 1000 = Marginally Unstable

1000 – 2500 = Moderately Unstable

2500 + = Look Out

CAPE at 6 pm on Dec 23rd
Instability, Wind Shear, and Lifting Mechanisms
Where Can I Get Help?

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

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

BREAK TIME
The Schematics to Getting Thunderstorms

Thunderstorms
- Instability
- Moisture
- Lift Mechanism

Severe
- Instability
- 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
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 km (storm motions)
- 0 to 3 km (supercells, multicell, or ordinary cell?)
- 0 to 1 km (tornadoes?)
The 3-Dimensional Atmosphere
Wind Shear

0-3 km SRH at 6 pm on Dec 23rd

0-3 km SRH of 250 m²/s² or more
Is good for supercell formation

0-1 km SRH of 100 m²/s² or more
Is good for supercell formation

0-1 km SRH at 6 pm on Dec 23rd
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

- Main updraft
- Main downdraft
- Wall cloud
- Tornado
- Hail
- Wind
- Light, positively-charged particles rise.
- Descending air carries ice and hail
- Rising air carries water droplets
- Intra-cloud lightning
- Cloud-to-cloud lightning
- Heavy, negatively-charged particles fall.

Direction of storm travel
(usually to the northeast)

Weather radar

Look for the hook
DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
0137 PM CST WED DEC 23 2015

...SYNOPSIS...
A NEGATIVELY TILTED MID-LEVEL TROUGH...

...OH VALLEY INTO THE TN AND LOWER-MS VALLEYS...
AFTERNOON MLCAPE VALUES ARE EXPECTED TO RANGE FROM 250-500 J/KG ACROSS THE OH VALLEY TO AS HIGH AS 1500-2500 J/KG OVER THE LOWER-MS VALLEY WHERE RICHER LOW-LEVEL MOISTURE AND THE POTENTIAL FOR STRONGER DAYTIME HEATING WILL RESIDE. ...CONTINUE NEWD ALONG THE OH RIVER WITH AN ATTENDANT RISK FOR POTENTIALLY WIDESPREAD DAMAGING WINDS AND EMBEDDED TORNADOES GIVEN THE PRESENCE OF STRONG LOW-LEVEL AND DEEP-LAYER SHEAR....THE FAVORABLE OVERLAP OF MODERATE INSTABILITY AND STRONG VERTICAL SHEAR WILL YIELD AN ENVIRONMENT CONDUCIVE FOR TORNADIC SUPERCELLS ... WHERE THE POTENTIAL WILL EXIST FOR A FEW INTENSE...LONG-TRACKED TORNADOES.
The 3-Dimensional Atmosphere
Location of that Perfect Balance
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.
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.
3 pm Sfc Analysis
“THESE STORMS HAVE RECENTLY EXHIBITED AN INCREASING TREND IN LOW-LEVEL ROTATION”

“0-1 KM SRH VALUES RANGING FROM 300-600 M2/S2”

“VERY STRONG DEEP-LAYER WIND PROFILES AND A GRADUALLY MOISTENING BOUNDARY LAYER WILL CONTINUE TO SUPPORT THE POTENTIAL FOR A FEW TORNADOES THIS EVENING”
6 pm Sfc Analysis
Click on the image to request a sounding at that location or enter the station number below.

Station Number: 72249

Google “Wyoming Soundings”
http://weather.uwyo.edu/upperair/naconf.html

72249 Ft Worth, TX (FWD)
Infrequently Discussed Radar Concepts
Radar cannot see the lower portion of storm “B”
Where is the circulation in the reflectivity?

EF-2 in Perry County
615 pm, Just before touchdown
Size of Radar “Bin”
Size of Radar “bin”
Radar versus Reality

EF-3 in Wayne County
659 pm, 4 mins after touchdown
Radar versus Reality

EF-1 in Wayne County
704 pm, 4 mins after touchdown
Down Beam vs Cross Beam

Radar (from above)
Down Beam vs Cross Beam

Radar (from above)
From HTX on July 14, 2015
July 14, 2015 EF1 Cookeville Tornado

FAST FACTS

- NWS Storm Survey confirmed an EF1 tornado west of Cookeville, TN
  - Path length 2.6 miles & path width 150 yards
  - Max winds 105 mph
- Only previous July tornado recorded in Putnam County occurred on July 13, 1956

Photo via WKRN-TV
Dual Polarization Concepts
Dual Polarization
Dual Pol: The Cross Section

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
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
Size of Radar “Bin”
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
Tornado Debris Signature
Tornado Debris Signature

• Things to remember:
  – a TDS is a lowering of the CC due to all different types of targets with one particular bin of data.
  – It is extremely important that the lowered CC be co-located with the circulation in the storm. The lowered CC HAS to be co-located with the circulation or it is NOT a TDS.
  – Useful at night and in rural areas, due to scarcity of reports.
  – When a TDS is present, it means a tornado is or already has been on the ground.
    • It’s not used to warn, but it will allow us to increasing the wording within a tornado warning or a follow-up statement to raise the level of awareness.
    • A good tool for surveying the next day
Questions or Comments?

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YOUR CERTIFICATE IS AT THIS LINK:
http://www.weather.gov/media/ohx/PDF/advanced.pdf

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

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