# National Weather Service Advanced Storm Spotter Training

#### GERALD SATTERWHITE, METEOROLOGIST NWS BIRMINGHAM, AL





### Advanced Spotter Training Outline --Disclaimer: This is Not Storm Chaser Training--

### Part I

- Atmospheric features, types and scale
- Severe weather ingredients
- Using our products
- Basic course recap

### Part II

- RADAR signatures
- Demo a severe weather event



### The Atmosphere



### Large to Small Scale

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

### Synoptic Weather Patterns



# Neutrally-Tilted Troughs



- Trough axis extends from the lowest pressure north to south
- Active weather occurs between the trough and downwind (eastward) ridge

# Positively-Tilted Trough



- Trough axis extends from the lowest pressure northeast to southwest
- Active weather can occur, but not 'too much' in the way of severe storms

# Negatively-Tilted Trough



- Trough axis extends from the lowest pressure northwest to southeast
- Active weather + highest severe potential

# Cut-off Low



- Persistent area of low pressure removed from the steering flow
- Can meander for several days, sometimes over a week
- Produce unsettled weather

# **Blocking Patterns**



- When weather systems set up in a way that prevents progressive movement
- Result in long spans of persistent weather conditions for a given area

## Synoptic Weather Patterns: Top-down





#### Imagery via NWS JetStream School

# Features Associated with Surface Low Pressure



### Cold Front Structure





Cold front definition: A zone separating two air masses, of which the cooler, denser mass is advancing and replacing the warmer air mass

### Warm Front Structure





Warm front definition: A transition zone between a mass of warm air and the colder air it is replacing

# Other Boundaries – Dryline



\*most common in the Plains, though strong weather systems can sometimes sweep the dryline eastward into the Mississippi Valley region



Dryline definition: The boundary between a moist and dry air mass. Dry air forces moist air upward as the boundary moves eastward, which can trigger severe storms.

### Other Boundaries – Outflow



Outflow boundary definition: A small-scale boundary that separates rain-cooled air from the surrounding air

\*similar in effect to a cold front. Passage is marked with a wind shift/increase and drop in temperature. These boundaries can trigger new showers and storms.

# Outflow Boundaries in Action (GIF) --via Satellite and RADAR--



### Collision of 2 Boundaries --Interesting Things Happen at the Boundaries--



# Advanced Spotter Training Outline



### Part I

- Atmospheric features, types and scale
- Severe weather ingredients
- Using our products
- Basic course recap

### Part II

- RADAR signatures
- Demo a severe weather event







### Instability - Weak vs. Strong CAPE



# Wind Shear



# **Stages of Activity**





# Advanced Spotter Training Outline



### Part I

- Atmospheric features, types and scale
- Severe weather ingredients
- Using our products
- Basic course recap

### Part II

- RADAR signatures
- Demo a severe weather event



#### **National Weather Service Birmingham** Hazardous Weather Outlook ISSUED: 4:29 PM Wednesday, April 3, 2019 EXPIRES: 6:30 AM Thursday Tropical Tornado Severe Storms Wind Heat/Cold lazardous weather is not Flood expected through tonight. Fog Fire Winter Weather No Hazards 3 Sat Tue Thu Fri Sun Mon Confidence Factor : High Low 3 4 5 1 2

# weather.gov/bmx

Hazardous Weather Outlook National Weather Service Birmingham AL 311 AM CDT Wed Apr 3 2019

#### ALZ011>015-017>050-041115-

Marion-Lamar-Fayette-Winston-Walker-Blount-Etowah-Calhoun-Cherokee-Cleburne-Pickens-Tuscaloosa-Jefferson-Shelby-St. Clair-Talladega-Clay-Randolph-Sumter-Greene-Hale-Perry-Bibb-Chilton-Coosa-Tallapoosa-Chambers-Marengo-Dallas-Autauga-Lowndes-Elmore-Montgomery-Macon-Bullock-Lee-Russell-Pike-Barbour-311 AM CDT Wed Apr 3 2019

This Hazardous Weather Outlook is for the counties served by the National Weather Service office in Birmingham.

.DAY ONE...Outlook through Tonight.

No hazardous weather is expected at this time.

.DAYS TWO THROUGH SEVEN ... Thursday through Tuesday.

No hazardous weather is expected at this time.

#### SPOTTER INFORMATION STATEMENT..

Activation of storm spotters and emergency management is not expected at this time.

\$\$

# weather.gov/bmx



--Slight Risk of severe storms Monday afternoon to evening w/ large hail and damaging wind potential--

A shortwave trough will move from the Midwest toward the Central Appalachian region on Monday while a secondary shortwave trough moves from the Southern Plains into the Southeastern CONUS. The secondary trough will be the primary factor in Monday's severe threat.

The primary forecast complication is with respect to upstream precipitation that is forecast to move into the northwestern part of the forecast area early morning Monday. It appears that this activity should begin weakening as it continues eastward, setting the stage for a lingering boundary/differential heating zone. As the secondary impulse arrives during ensuing daytime heating, we'll be looking at an increasingly unstable air mass with support for renewed convection. Pending this scenario, strong to severe storms could occur during the afternoon and evening hours.

Surface flow ahead of the associated cold front won't be ideal for rapid or significant recovery/advection of higher-dew point air, though guidance continues to agree with a corridor of upper 50s to around 60 dews arriving by/into the afternoon hours. This will coincide with peak daytime heating, aiding in ample surface-based and mixed-layer CAPE for strong to severe convection given bulk shear of ~40-50 knots. A look at forecast soundings across Central Alabama show a low-level inverted-V profile with steep lapse rates. This will support a risk of damaging winds up to 60 MPH. A plume of mid-level dry air moving into the base of the trough + some overlap of the convective area and leading edge colder 500mb temperatures will supply mid-level lapse rates in the midupper 6 degrees C range. This will support a risk of severe-caliber hail. Given the unidirectional flow, a tornado threat isn't evident at this time. Due to limited vertical moisture content and surface convergence, we shouldn't see a high number of severe-caliber storms.

# **Types of Tornado Warnings**

BULLETIN - EAS ACTIVATION REQUESTED Tornado Warning National Weather Service Birmingham AL 158 PM CST SUN MAR 3 2019

The National Weather Service in Birmingham has issued a

\* Tornado Warning for... Central Lee County in east central Alabama... Northwestern Russell County in southeastern Alabama...

\* Until 245 PM CST.

\* At 158 PM CST, a severe thunderstorm capable of producing a tornado was located near Tuskegee National Forest, or 9 miles south of Auburn, moving east at 60 mph.

HAZARD...Tornado.

#### SOURCE...Radar indicated rotation.

- IMPACT...Flying debris will be dangerous to those caught without shelter. Mobile homes will be damaged or destroyed. Damage to roofs, windows, and vehicles will occur. Tree damage is likely.
- \* Locations impacted include...

Auburn, Phenix City, Opelika, Smiths, Smiths Station, Ladonia, Beauregard, Bleecker, Griffen Mill, Bibb City, Monterey Heights, Chewacla State Park, Ladonia Sports Complex, Marvyn and Bartletts Ferry Dam.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

TAKE COVER NOW! Move to a basement or an interior room on the lowest floor of a sturdy building. Avoid windows. If you are outdoors, in a mobile home, or in a vehicle, move to the closest substantial shelter and protect yourself from flying debris.

&&

LAT...LON 3239 8544 3250 8544 3250 8549 3253 8556 3268 8511 3267 8509 3265 8509 3265 8511 3263 8508 3262 8509 3258 8507 3251 8500 3249 8499 3247 8500 3245 8499 TIME...MOT...LOC 1958Z 252DE6 53KT 3246 8552

TORNADO...RADAR INDICATED

HAIL...<.75IN

\$\$

Severe Weather Statement National Weather Service Birmingham AL 207 PM CST SUN MAR 3 2019

ALC081-113-032045-/O.CON.KBMX.TO.W.0023.000000T0000Z-190303T2045Z/ Lee AL-Russell AL-207 PM CST SUN MAR 3 2019

...A TORNADO WARNING REMAINS IN EFFECT UNTIL 245 PM CST FOR CENTRAL LEE AND NORTHWESTERN RUSSELL COUNTIES...

At 206 PM CST, a confirmed large and extremely dangerous tornado was located near Society Hill, or 10 miles southeast of Auburn, moving east at 55 mph.

This is a PARTICULARLY DANGEROUS SITUATION. TAKE COVER NOW!

HAZARD...Damaging tornado.

#### SOURCE...Radar confirmed tornado.

IMPACT...You are in a life-threatening situation. Flying debris may be deadly to those caught without shelter. Mobile homes will be destroyed. Considerable damage to homes, businesses, and vehicles is likely and complete destruction is possible.

Locations impacted include...

Auburn, Phenix City, Opelika, Smiths, Smiths Station, Ladonia, Beauregard, Bleecker, Griffen Mill, Bibb City, Monterey Heights, Chewacla State Park, Ladonia Sports Complex, Marvyn and Bartletts Ferry Dam.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

To repeat, a large, extremely dangerous and potentially deadly tornado is on the ground. To protect your life, TAKE COVER NOW! Move to a basement or an interior room on the lowest floor of a sturdy building. Avoid windows. If you are outdoors, in a mobile home, or in a vehicle, move to the closest substantial shelter and protect yourself from flying debris.

88

LAT...LON 3239 8544 3250 8544 3250 8549 3253 8556 3268 8511 3267 8509 3265 8509 3265 8511 3263 8508 3262 8509 3258 8507 3251 8500 3249 8499 3247 8508 3245 8499 TIME...MOT...LOC 2006Z 258DEG 48KT 3247 8538

TORNADD...OBSERVED TORNADO DAMAGE THREAT...CONSIDERABLE

HAIL...<.75IN

Severe Weather Statement National Weather Service Birmingham AL 209 PM CST SUN MAR 3 2019

ALC081-113-032045-/0.CON.KBMX.TO.W.0023.000000T0000Z-190303T2045Z/ Lee AL-Russell AL-209 PM CST SUN MAR 3 2019

... TORNADO EMERGENCY FOR southern Lee County and northern Russell County...

...A TORNADO WARNING REMAINS IN EFFECT UNTIL 245 PM CST FOR SOUTHEASTERN LEE AND NORTHWESTERN RUSSELL COUNTIES...

At 209 PM CST, a confirmed large and destructive tornado was located near Griffen Mill, or 11 miles southeast of Auburn, moving east at 60 mph.

TORNADO EMERGENCY for southern Lee County and northern Russell County. This is a PARTICULARLY DANGEROUS SITUATION. TAKE COVER NOW!

HAZARD...Deadly tornado.

#### SOURCE...Radar confirmed tornado.

IMPACT...You are in a life-threatening situation. Flying debris may be deadly to those caught without shelter. Mobile homes will be destroyed. Considerable damage to homes, businesses, and vehicles is likely and complete destruction is possible.

Locations impacted include...

Phenix City, Smiths, Smiths Station, Ladonia, Bleecker, Griffen Mill, Bibb City, Monterey Heights, Ladonia Sports Complex, Marvyn and Bartletts Ferry Dam.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

To repeat, a large, extremely dangerous, and potentially deadly tornado is on the ground. To protect your life, TAKE COVER NOW! Move to an interior room on the lowest floor of a sturdy building. Avoid windows. If in a mobile home, a vehicle or outdoors, move to the closest substantial shelter and protect yourself from flying debris.

88

LAT...LON 3242 8540 3250 8544 3268 8511 3267 8509 3265 8509 3265 8511 3263 8508 3262 8509 3258 8507 3251 8500 3249 8499 3247 8500 3245 8499

TIME...MOT...LOC 2009Z 252DEG 53KT 3248 8533

FORNADO...OBSERVED

TORNADO DAMAGE THREAT...CATASTROPHIC

HAIL...<.75IN

# Advanced Spotter Training Outline



### Part I

- Atmospheric features, types and scale
- Severe weather ingredients
- Using our products
- Basic course recap

### Part II

- RADAR signatures
- Demo a severe weather event



### What Makes a Storm Severe?

#### **SEVERE THUNDERSTORM WARNING** POTENTIAL OF \_\_\_\_OCCURRING, OR OBSERVED

•Wind gusts of 58 mph or greater, and/or

•Hail 1 inch or more in diameter



#### **TORNADO WARNING** POTENTIAL OF \_\_\_\_ OCCURRING, OR OBSERVED

#### •A tornado

-Tornadic storms can also produce damaging straight-line winds and large hail





Understanding Severe Thunderstorm Risk Categories							
THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)		
No severe* thunderstorms expected	Isolated severe thunderstorms possible	Scattered severe storms possible	Numerous severe storms possible	Widespread severe storms likely	Widespread severe storms expected		
Lightning/flooding threats exist with <u>all</u> thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense		
4					and, risk		
Winds to 40 mph     Small hail	<ul> <li>Winds 40-60 mph</li> <li>Hail up to 1"</li> <li>Low tornado risk</li> </ul>	<ul> <li>One or two tornadoes</li> <li>Reports of strong winds/wind damage</li> <li>Hail ~1", isolated 2"</li> </ul>	<ul> <li>A few tornadoes</li> <li>Several reports of wind damage</li> <li>Damaging hail, 1 - 2"</li> </ul>	<ul> <li>Strong tornadoes</li> <li>Widespread wind damage</li> <li>Destructive hail, 2" +</li> </ul>	<ul> <li>Tornado outbreak</li> <li>Derecho</li> </ul>		

categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.



# Watch vs. Warning



WATCHES: Conditions are favorable for severe WARNINGS: Severe weather is very likely weather to develop; cover large areas and last soon or is occurring; cover smaller areas several hours. BE AWARE & PREPARED!

and last an hour or less. TAKE ACTION!



# What to Report --Strong or Damaging Wind--



Estimating wind speed is difficult. It will be much easier to describe damage. If you report a speed, let us know if it was <u>estimated</u> or <u>measured</u>.

Trees or large limbs blown down

 Snapped or uprooted
 <u>Were the trees or limbs dead or alive</u>

 Power poles downed
 Damage to buildings



# What to Report --Hail--

Report the size of the largest hail stone you see. *Please do not report "marble-sized hail."* 

Measure with a ruler or caliper
 Reference a common item

 Coins (quarter, half-dollar, etc.)
 Sporting equipment (golf ball, tennis ball, etc.)

 Did the hail cause damage?



### Wall Cloud -> Tornado Evolution





# **Reporting Options Recap**

•Call the NWS office: 205-664-3010, option 2

•Social media: Twitter and Facebook

•Spotter Network

•HAM radio

•Our webpage: weather.gov/bmx -> Submit a Storm Report page

•After-the-event reports: sr-bmx.dss@noaa.gov -Don't use e-mail for urgent reports









			_
Storm Repo	rt		
The exertace is intended to	to be used safely for the relation	ny of storm information to nal Ubrather Service Birrs	the MAS, Other
Courty Characteristic based of the second			
Location (7 NW Mytowe)			
mm (dd/yyyy			
Event Time			
Shample 1100 ASA			
Event Type (Sel	ect all that anni	1	
Clok tate rest to every yo	u charred have print ap	propriete sub-descriptor	n pull-doon metaa
to deocrate event.			
Field	•		
114			
High Wird Speed			
Tamado / Furnel Cloud			
Wind Damage			
Wester Descipitation			
Snew			
in the second			
Heavy Rain			
· · ·			
AddSoral Details Provide any additional others	star that you had in particul	TH PRO ADDRESS (100	Auracova
	u along additional informatio a. maioritatio <u>prictico palitita</u>	to by an mailing them to the star Occass out	Advina Heather











# Advanced Spotter Training Outline



### Part I

- Atmospheric features, types and scale
- Severe weather ingredients
- Using our products
- Basic course recap

### Part II

- RADAR signatures
- Demo a severe weather event





### Three Body Scatter Spike > Large Hail



Halladara alara	Measurement		Updraft Speed	
nalistone size	in.	cm.	mph	km/h
bb	< 1/4	< 0.64	< 24	< 39
pea	1/4	0.64	24	39
	1/2	1.3	35	56
dime	7/10	1.8	38	61
penny	3/4	1.9	40	64
nickel	7/8	2.2	46	74
quarter	1	2.5	49	79
half dollar	1 1/4	3.2	54	87
walnut	1 1/2	3.8	60	97
golf ball	1 3/4	4.4	64	103
hen egg	2	5.1	69	111
tennis ball	2 1/2	6.4	77	124
baseball	2 3/4	7.0	81	130
tea cup	3	7.6	84	135
grapefruit	4	10.1	98	158
softball	4 1/2	11.4	103	166

# Vertical Wind Speed for Different Hail Sizes (updraft speeds)



# **Dual-polarization Radar**



# Confirming Tornado Debris on RADAR



BEWARE: Not all 'Blue' on CC is Tornado Debris! --This takes a trained eye--

It could be...

**OContaminants in the inflow region** 

oHail

○Noise in the data

○Non-uniform beam filling

oTerrain, communication towers, buildings, wind farms, etc.

At minimum we must use a combination of reflectivity, velocity, and CC + RADAR scans over time and depth.

# Advanced Spotter Training Outline



### Part I

- Atmospheric features, types and scale
- Severe weather ingredients
- Using our products
- Basic course recap

### Part II

• RADAR signatures



• Demo a severe weather event, or two



# Additional Materials

Visit our SKYWARN spotter page for useful links and information: weather.gov/bmx/skywarnschedule

- •This presentation in PDF format
- •Spotter schedule
- •Training materials
- •Brochures and guides
- •Certificate > weather.gov/advancedspottertraining



