



**A GUIDE  
FOR  
NATIONAL  
WEATHER  
SERVICE  
SPOTTERS  
IN SOUTH CENTRAL TEXAS**

**2012 Edition**

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Central Texas Chapter/American Red Cross  
National Weather Service Office, Austin-San Antonio, TX

## Severe Weather Spotter:

This guide is intended to be used as an outline for observing, interpreting, and reporting severe weather conditions in south central Texas for and to the National Weather Service.

An important part of the mission of the National Weather Service is to issue severe weather and flash flood and flood watches, warnings, and statements to help protect life and property. In order to carry out that mission, the National Weather Service needs the help of other agencies, organizations, the media, and the general public to relay pertinent ground observed information back to the National Weather Service.

Although satellite, radar, and surface weather observations are useful, we still, in this age of modernization, will need a network of spotters to properly cover all regions within our county warning area.

The National Weather Service currently works with the following groups as far as our spotter program is concerned:

- ...Texas Department of Public Safety (Division of Emergency Management)
- ...County Judges/County Emergency Management Coordinators
- ...County Sheriffs/Sheriff Offices
- ...City Police Departments
- ...Fire and Rescue Agencies
- ...Texas Department of Parks and Recreation
- ...The Lower Colorado River Authority
- ...Ham Radio Organizations  
(including the Central Texas Traffic Net, Hill Country Weather Net, Austin Amateur Club, San Antonio Radio Club, San Antonio Repeater Organization, 3M Austin Radio Club, RACES, and ARES)
- ...The News Media and associated weather spotter groups
- ...The General Public

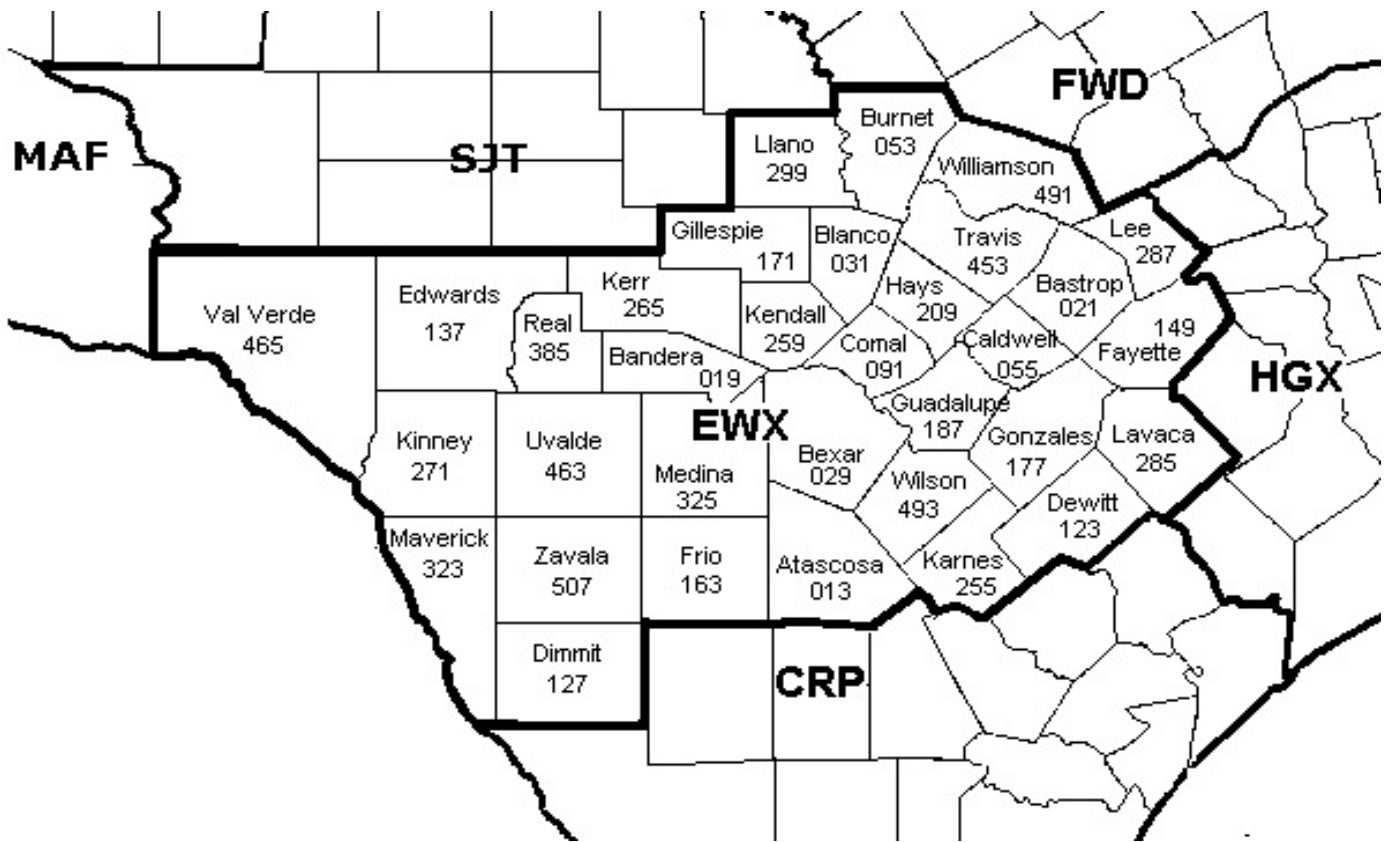
The work by trained spotters is very much appreciated. With the important information provided by trained spotters, the National Weather Service is able to disseminate timely and **accurate** weather information to the general public, which we hope will help to **protect life and property**.

Although the National Weather Service is not able to provide money for your services, we do provide various levels of weather training for spotters. In addition, we have some brochures, pamphlets, and handouts on weather phenomena for your use.

Thanks for your dedicated support and effort in our SkyWarn program here in south central Texas!

Joe Arellano  
Meteorologist In Charge  
Austin-San Antonio NWSFO

Paul Yura  
Warning Coordination Meteorologist  
Austin-San Antonio NWSFO



The NWS Office responsible for severe weather occurrences in the counties shown above is:

**National Weather Service Forecast Office / Austin - San Antonio**  
**2090 Airport Road**  
**New Braunfels, TX 78130**

**Phones:**

**Administrative Hours (8:30am - 4:00pm M-F)... (830) 606-3617**

**Severe Weather Reports ONLY**

**(UNLISTED NUMBER/DO NOT RELEASE)... ( ) -**

**Web Site: <http://www.srh.noaa.gov/ewx/>**

**Joe Arellano, Meteorologist In Charge**  
**Paul Yura, Warning Coordination Meteorologist**  
**Jon Zeitler, Science and Operations Officer**  
**Mark Lenz, Senior Service Hydrologist**

SkyWarn Spotter Program information may be obtained through this office.



## ✓ SNOWFALL/ICE ACCUMULATION (Freezing drizzle, freezing rain, sleet, snow)

\*When did the freezing/frozen precipitation start?

\*Is the **freezing** precipitation (freezing rain, freezing drizzle) starting to accumulate on trees, power lines, bridges, and roadways?

\*Is the **frozen** precipitation (sleet, snow) starting to accumulate? If so, use a ruler in several locations in the open (away from buildings, trees, fences) and obtain an average depth.

\*Is the freezing/frozen precipitation still occurring?

\*Is travel becoming difficult and/or dangerous? Are you aware of any traffic accidents?

\*Are tree limbs or power lines being severely bent or broken due to the weight of ice accumulation?

\*Are you experiencing a power outage? Are you aware of any power outages?

## ✓ WEATHER SIGNIFICANTLY DIFFERENT FROM THE CURRENT FORECAST

\*Report **anytime** the weather conditions are **significantly** different from the weather forecast.

## WHAT'S "SEVERE" AND WHAT'S NOT

✓These are **SEVERE** weather events:

**TORNADO:**

- (1) Any tornado reported to be on the ground (any credible report from a trained spotter, law enforcement, or emergency management agency)
- (2) Any waterspout that moves onshore
- (3) Any waterspout that originated as a tornado onshore

**SEVERE T'STORM/ WINDS**

- (1) Measured convective wind gusts, 50 knots/58 mph or more
- (2) Estimated convective wind gusts, 50 knots/58 mph or more from reliable sources (e.g., a trained spotter, law enforcement, etc.)
- (3) Trees blown down or uprooted
- (4) Large limbs and branches blown down
- (5) Power lines blown down
- (6) **Permanent** signs blown down
- (7) Roof damage from the wind (large area of roofing material removed)
- (8) Windows broken by the wind
- (9) Structural damage to homes, businesses, barns, sheds, circus tents, etc.
- (10) Radio towers or large antennas blown down
- (11) Home television antennas blown down (must be **more** than one)
- (12) Campers heavily damaged or destroyed
- (13) Mobile home damage

**SEVERE T'STORM/ HAIL:**

- (1) Hail 1" in diameter (the size of a quarter) or larger at the surface or aloft
- (2) Windows or windshields broken by hail (assume 1" diameter or larger hail)
- (3) Roofs or house siding damaged by hail (assume 1" diameter or larger hail)

✗These are **NOT SEVERE** weather events:

**TORNADO:**

- (1) Tornado-like winds (no sighting of a tornado)
- (2) Funnel cloud, possible funnel cloud, unconfirmed funnel cloud

**SEVERE T'STORM/ WINDS:**

- (1) Measured convective wind gusts less than 50 knots/58 mph
- (2) Estimated convective wind gusts less than 50 knots/58 mph
- (3) Estimated convective wind gusts that are obvious guesses
- (4) Estimated convective wind gusts from unreliable sources
- (5) Winds of "50 to 60 mph," since the average is 55 mph (below severe limits)
- (6) Non-specific tree damage
- (7) Blown down limbs and branches with no size given
- (8) Non-specific reports (e.g., "high winds," "strong winds," "damaging winds," etc.)
- (9) Wind damage to crops
- (10) Power lines downed by lightning or other non-wind event
- (11) Non-specific minor structural damage

**SEVERE HAIL:**

- (1) Hail less than 1" in diameter (the size of a quarter)
- (2) Non-specific reports (e.g., "large hail," etc.)
- (3) Hail damage to crops
- (4) Hail with no size description provided

**PLEASE NOTE:** A **Convective Wind Gust** is defined as any gust of 50 knots/58 mph or greater that is associated with thunderstorm activity and (1) is accompanied by thunder at the observing point, (2) occurs at the observing point while lightning is being observed, or (3) thunder occurs at the observing point within 30 minutes after a gust occurs. **When this type of wind occurs, the NWS considers the parent thunderstorm "severe."**

**✓ ESTIMATING THE INTENSITY OF RAINFALL (based upon the rate of fall)**

**Light**.....Scattered drops that do not completely wet an exposed surface, regardless of the duration (up to 0.1" per hour; maximum of 0.01" in a six minute period).

**Moderate**.....0.11" to 0.3" per hour; more than 0.01" to as much as 0.03" in a six minute period.

**Heavy**.....More than 0.3" per hour; more than 0.03" in a six minute period.

**✓ ESTIMATING THE INTENSITY OF RAINFALL (based upon ground observations)**

**Light**.....Scattered drops that do not completely wet an exposed surface, regardless of duration; individual drops are easily seen; slight spray may be observed over pavement; puddles form slowly; sounds on roofs range from slow light pattering to gentle swishing; steady small streams may flow in gutters and downspouts.

**Moderate**.....Individual drops are not clearly identifiable; spray is observed just above pavement and other hard surfaces; puddles form rapidly; downspouts on buildings seen 1/4 to 1/2 full; sounds on roofs range from swishing to a gentle roar.

**Heavy**.....Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to a height of several inches is observed over hard surfaces; downspouts on buildings run more than 1/2 full; visibility is greatly reduced; sounds on roofs resemble a roll of drums or a distant roar

**✓ HAIL SIZES**

**IMPORTANT NOTE: Please report the approximate inch diameter of hail rather than generalized (e.g., "golfball" or "marble") sizes. This chart is provided to help you determine the inch diameter.**

<b>IF YOU EXPERIENCE HAIL THIS SIZE...</b>	<b>..THEN..</b>	<b>REPORT A HAIL DIAMETER OF...</b>
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**NON-SEVERE REPORTS**

Pea Size.....	1/4 inch
Marble (Regular) Size.....	1/2 inch
Penny Size.....	3/4 inch

**SEVERE REPORTS**

Quarter Size.....	1 inch
Golfball Size.....	1 3/4 inch
Hen Egg Size.....	2 inches
Tennis Ball Size.....	2 1/2 inches
Baseball Size.....	2 3/4 inches
Tea Cup Size.....	3 inches
Softball Size.....	4 1/2 inches
Grapefruit Size.....	5 inches

## ✓ BEAUFORT WIND SCALE CHART

**HOW TO USE:** (1) Observe wind conditions and closely match them to those listed in the "specification" column.  
 (2) Move to the left on the chart until you reach the "MPH" column; this is the estimated range of the wind speed in miles per hour.

MPH	KNOTS	DESCRIPTION	SPECIFICATION
< 1	< 1	Calm	Calm; smoke rises vertically
1-3	1-3	Light Air	Wind direction shown by smoke drift; direction not shown by wind vanes.
4-7	4-6	Light Breeze	Wind felt on face; leaves rustle; wind vanes moved by wind.
8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; wind will extend a light flag.
13-18	11-16	Moderate	Raises dust or loose paper; small branches are moved.
19-24	17-21	Fresh	Small trees in leaf begin to sway; crested wavelets form on inland waters.
25-31	22-27	Strong	Large branches in motion; whistling heard in overhead power/telephone wires; umbrellas used with difficulty.
32-38	28-33	Near Gale	Whole trees in motion; resistance felt walking against the wind.
39-46	34-40	Gale	Breaks twigs off trees; impedes walking progress.
47-54	41-47	Strong Gale	Slight structural damage occurs.
55-63	48-55	Storm	Trees uprooted or broken off; more substantial structural damage begins to occur.
64-72	56-63	Violent Storm	Widespread damage.
73-82	64-71	Hurricane	Widespread damage

## ✓ ENHANCED FUJITA TORNADO DAMAGE CLASSIFICATION SCALE

EF SCALE	WIND SPEED	DAMAGE SPECIFICATIONS
EF0	65-85 mph	<b>Light Damage:</b> Peels surface off some roofs; some damage to gutters and some siding; branches broken off trees; shallow rooted trees pushed over.
EF1	86-110 mph	<b>Moderate Damage:</b> Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135 mph	<b>Considerable Damage:</b> Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off the ground.
EF3	136-165 mph	<b>Severe Damage:</b> Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown some distance away.
EF4	166-200 mph	<b>Devastating Damage:</b> Well-constructed houses and whole frame houses completely leveled; cars thrown; small missiles generated.
EF5	> 200 mph	<b>Incredible Damage:</b> Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

## OTHER INFORMATION FOR WEATHER SPOTTERS:

### ✓ WSR88D / DOPPLER WEATHER RADAR

The WSR88D/Doppler Radar (**W**eather **S**urveillance **R**adar; **88** stands for 1988, the year that the technology was brought online; **D** stands for Doppler) is the technological keystone. The WSR88D excels in detecting the severe weather events that threaten life and property, from early detection of damaging winds to estimating rainfall amounts in river and flood forecasting. Most important, WSR88D can increase advance warning - and the specificity of such warnings - for short-lived, often catastrophic events such as tornadoes, downbursts, and flash floods. Using Doppler technology, the WSR88D calculates both the speed and direction of air motion (toward and away from the radar site) within thunderstorms. A total of 160 Doppler Radars have been installed in the United States and its island territories. The WSR88D Radars covering our area are in New Braunfels (EWX), Granger/Fort Hood (GRK), and Laughlin AFB/Del Rio (DFX).

### ✓ NOAA WEATHER RADIO FREQUENCIES

#### NWS/Austin - San Antonio

*Austin 162.400 mhz	*Del Rio 162.400 mhz	*Gonzales 162.525 mhz	*Kerrville 162.450 mhz	*La Grange 162.500 mhz
*Llano 162.425 mhz	*San Antonio 162.550 mhz	*Uvalde 162.425 mhz	*D'Hanis 162.525 mhz	*Dilley 162.500 mhz
*Seguin 162.475 mhz	*Carrizo Springs 162.550 mhz			

#### NWS/Houston

*Bay City 162.450 mhz	*Houston 162.400 mhz	*Bryan/Coll Stn 162.550 mhz	*New Taiton 162.450 mhz
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#### NWS/Dallas - Fort Worth

*Dallas 162.400 mhz	*Fort Worth 162.550 mhz	*Waco 162.475 mhz	*Milano 162.525 mhz	*Stephenville 162.450 mhz
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#### NWS/San Angelo

*Abilene 162.400 mhz	*Junction 162.475 mhz	*San Angelo 162.550 mhz	*Coleman 162.475 mhz	*Richland Springs 162.525 mhz
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#### NWS/Corpus Christi

*Corpus Christi 162.550 mhz	*Three Rivers 162.450 mhz	*Victoria 162.400 mhz	*Laredo 162.475 mhz	*Port O'Connor 162.475 mhz
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### ✓ HAM RADIO FREQUENCIES

\*Austin / Travis County Weather Net: Primary 146.940 (PL 107.2) / Secondary 147.360 (PL 131.8)

### ✓ HAM RADIO CONTACTS

Larry D. Gensch, K9MBB 509 Whitetail Drive Georgetown TX 78628-9689 (512) 259-1517 Email: Lgensch@aol.com	Jeff Draper, N5SSI Texas Severe Storm Intercept Travis County ARES ( <a href="http://www.chase-1.com/">http://www.chase-1.com/</a> ) Email: chase-1@austin.rr.com	Glen Reid, K5FX Emergency Coordinator Email: k5fx@arrl.net Website: <a href="http://www.tcares.org">www.tcares.org</a>	Jim Hester, K5HTK Williamson County ARES Emergency Coordinator Email: jimhester@hester.ws Website: <a href="http://www.wc-ares.org">www.wc-ares.org</a>
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### ✓ PRIMARY EMERGENCY ALERT SYSTEM (EAS) RADIO STATIONS

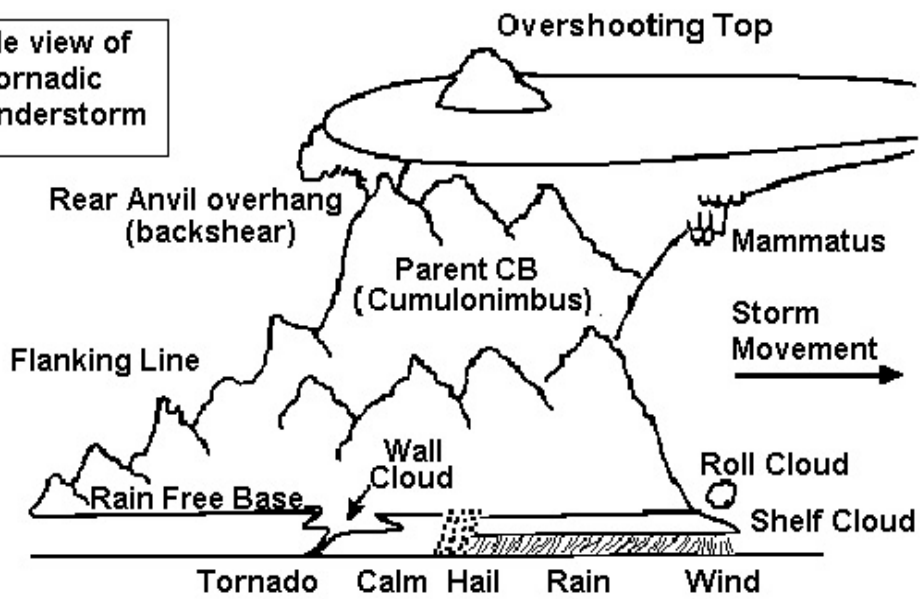
KLBJ Newsradio 590 AM	KASE 100.7 FM	KVET 98.1 FM
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### ✓ ONLINE NWS WEATHER SPOTTER TRAINING GUIDES

NWS/Basic Spotter Training (PDF): <http://www.nws.noaa.gov/om/brochures/basicspot.pdf>  
NWS/Advanced Spotter Training (PDF): [http://www.nws.noaa.gov/om/brochures/adv\\_spotters.pdf](http://www.nws.noaa.gov/om/brochures/adv_spotters.pdf)  
NWS/Comprehensive Glossary of Wx Terms for Storm Spotters: <http://www.srh.noaa.gov/oun/?n=spotterglossary>  
NWS/Thunderstorms, Tornadoes, Lightning ... (PDF): <http://www.nws.noaa.gov/om/severeweather/resources/ttl6-10.pdf>  
NWS/Hurricanes ... Unleashing Nature's Fury (PDF): <http://www.nws.noaa.gov/os/hurricane/pdfs/HurricanesUNF07.pdf>  
NWS/Floods .. The Awesome Power (PDF): [http://www.nws.noaa.gov/om/brochures/Floodsbrochure\\_9\\_04\\_low.pdf](http://www.nws.noaa.gov/om/brochures/Floodsbrochure_9_04_low.pdf)  
NWS/Winter Storms (PDF): <http://www.nws.noaa.gov/om/brochures/winterstorm.pdf>  
NWS/Heat Waves (PDF): <http://www.nws.noaa.gov/om/brochures/heatwave.pdf>

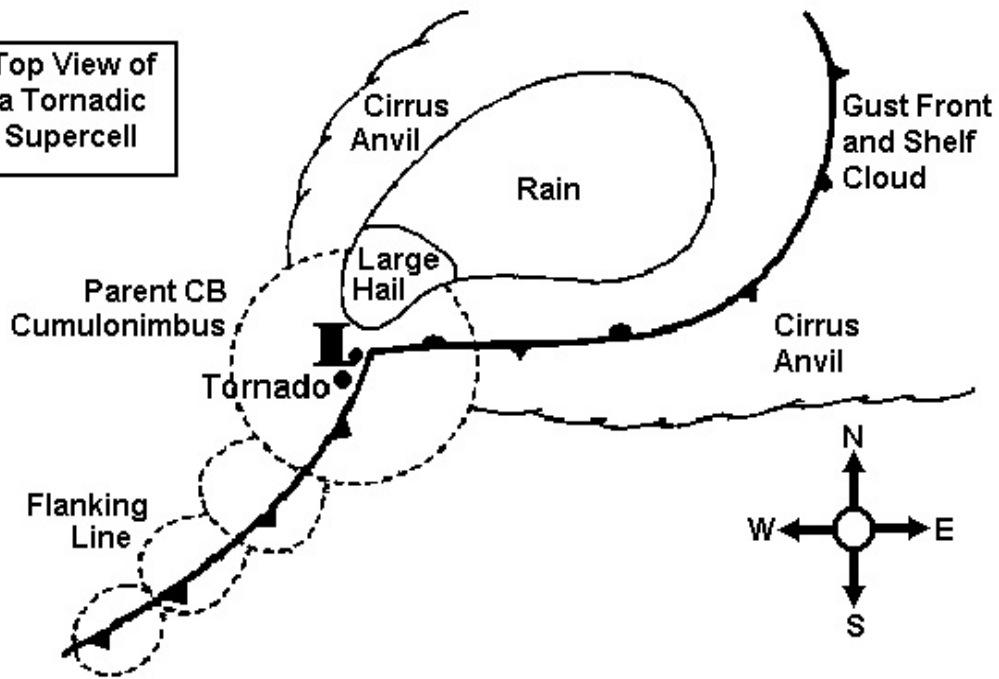
✓ DIAGRAMS THAT ALL STORM SPOTTERS SHOULD KNOW

Side view of a tornadic thunderstorm



Average movement is to the northeast at 25 to 35 mph  
Watch for right turns and erratic movement.

Top View of a Tornadic Supercell



# NATIONAL WEATHER SERVICE PRODUCTS ISSUED IN ADVANCE OF AND DURING PERIODS OF SEVERE OR INCLEMENT WEATHER

## ● WEATHER WARNINGS (Severe, Flooding, Wind, and Winter Weather)

**Use:** When severe, potentially severe, or life threatening weather is imminent or is in progress. Severe thunderstorm and tornado warnings are usually short-fused and small in geographic coverage, in effect for an hour or less. Flash flood warnings are for longer time periods (2-4 hours) due to longer time for rainfall runoff. Winter storm warnings are usually in effect for larger geographical areas and for longer time periods.

River flood warnings are in effect along rivers/river basins and usually for much longer time periods.

**Examples:** \*Flash Flood Warnings \*River Flood Warnings  
\*Severe Thunderstorm Warnings \*Tornado Warnings  
\*Winter Storm Warnings \*Ice Storm Warnings  
\*Blizzard Warnings  
\*High Wind Warnings (Sustained winds of 40 mph or greater are expected)

## ● SEVERE WEATHER STATEMENTS

**Use:** To provide additional information (severe storm reports) on severe weather conditions which have recently occurred or are occurring. They also provide additional information on current severe weather warnings.

## ● WEATHER WATCHES (Severe, Flooding, Wind, and Winter Weather)

**Use:** To define a threat of severe or potentially severe weather, but the occurrence is not necessarily certain or imminent. Usually covers a large geographic area for a longer time period.

**Examples:** \*Flash Flood Watches \*Tornado Watches  
\*Severe Thunderstorm Watches \*Winter Storm Watches  
\*High Wind Watches

## ● SPECIAL WEATHER STATEMENTS

**Use:** To define and/or explain a weather situation that warrants public attention (inclement weather events).

**Example:** \*2 to 7 day forecast of inclement weather events

## ● WEATHER ADVISORIES (Flooding, Wind, Fog, and Winter Weather)

**Use:** To define and/or explain a weather situation that warrants public attention but does not meet warning criteria.

**Examples:** In winter weather situations, may be issued as a general **Winter Weather Advisory** (if many winter precipitation types/conditions are forecast and/or occurring) or it may be specific. Examples of specific weather advisories are:

\*Urban/Small Stream Flood Advisory \*Wind Advisory (20-30 mph winds)  
\*Dense Fog Advisory \*Wind Chill Advisory  
\*Freezing Rain/Drizzle Advisory

## ● HAZARDOUS WEATHER OUTLOOK

**Use:** Issued on a daily basis in the early morning hours and updated as necessary to indicate potential weather threats that might result in the issuance of watches, warnings, and advisories within the next 7 days. Threats would include tornadoes, severe thunderstorms, flooding, winter storms, tropical systems, high wind, and dense fog. This outlook includes a "spotter information statement" which discusses the likelihood of spotter activation.

## ● SHORT-TERM FORECASTS

**Use:** Issued on an irregular basis (normally every 1 to 2 hours) during periods of significant weather (precipitation, thunderstorms, fog) to further define the on-going weather in the forecast area.

## ● RECORD METEOROLOGICAL REPORT

**Use:** To notify the public of a record meteorological event.

**Examples:** \*Record High/Low Temperatures \*Record Rainfall Amounts

# NATIONAL WEATHER SERVICE

## SEVERE STORM GLOSSARY

**These definitions cover much of the material presented in SkyWarn severe weather spotter training sessions. It would be a good idea to keep this glossary nearby to used as a reference as you encounter this weather terminology.**

**ACCESSORY CLOUDS** -- Clouds that are dependent on a larger cloud system for development and continuance. Accessory clouds associated with thunderstorms include roll clouds, shelf clouds, mammatus clouds, and wall clouds.

**ANVIL** -- The spreading of the upper portion of a cumulonimbus cloud into an anvil-shaped plume, usually of fibrous or smooth appearance. Strong or severe thunderstorms often have thicker anvils with the side and bottom having a cumuliform or slowly boiling appearance in the immediate vicinity of the parent cumulonimbus cloud.

**CAP (Slang)** -- A layer of warm air (temperature inversion) several thousand feet above the ground that effectively keeps a "lid" on the underlying unstable air and prevents thunderstorms from forming. On certain days, all conditions important to severe thunderstorm development can be favorable, but the cap prevents thunderstorm development.

**COLLAR CLOUD** -- Frequently used incorrectly as a synonym for a wall cloud, although it actually is a generally circular ring of cloud surrounding the upper portion of the wall cloud.

**CONVERGENCE** -- A wind pattern that results in air being forced into the same general area. Convergence occurs along fronts and low pressure areas and is the mechanism that "piles" up the air and causes it to rise.

**CUMULONIMBUS CLOUD** -- The parent cloud of a thunderstorm. The cumulonimbus cloud towers above ordinary cumulus clouds, with stronger or severe storms often having a more sharply outlined, crisp appearance than non-severe storms. The cloud's upper portion includes the anvil. Accompanying precipitation is often heavy and the usual occurrence of lightning and thunder with these clouds leads to the popular names of "thunderhead" and "thundercloud." Also see **thunderstorm**.

**CUMULUS CLOUD** -- A column of rising air that has condensed into a dense, non-fibrous cloud with distinct outlines, appearing much like a rising mound, a dome, or a cauliflower. The base of the cloud is relatively flat and dark, while the tower is usually white and sunlit. The cumulus cloud is the first stage of a developing thunderstorm, although most cumulus do not form into thunderstorms.

**CYCLIC STORM** -- A thunderstorm that undergoes cycles of intensification and weakening (pulses) while maintaining its individuality. Cyclic storms are capable of producing multiple tornadoes and/or several bursts of severe weather.

**DENSE FOG** -- A fog situation that creates widespread visibilities of less than a quarter of a mile.

**DEW POINT TEMPERATURE** -- A measure of atmospheric moisture. It is the temperature to which the air must be cooled in order for the atmosphere to reach saturation, assuming that air pressure and moisture content remain constant.

**DOWNBURST** -- A strong downdraft, usually accompanying a thunderstorm, resulting in an outward burst of damaging winds on or near the ground. Downburst winds can produce damage similar to a strong tornado. Downbursts can infrequently occur with showers too weak to produce thunder.

**DOWNDRAFT** -- A column of generally cooler air that sinks rapidly to the ground, most often accompanying precipitation in a shower or thunderstorm. Areas of downdraft usually contain little cloud and the clouds are usually dissipating.

**DRY LINE** -- A boundary separating moist and dry airmasses, it is an important factor in severe weather occurrence and frequency in the Plains states. It typically lies north-south across the central and southern Great Plains states during the spring and early summer, where it separates moist air from the Gulf of Mexico and dry continental desert air from the southwestern states and northern Mexico. The dry line typically advances eastward during the afternoon and retreats westward at night; however, a strong storm system can sweep the dry line eastward into the Mississippi Valley, or even further east, regardless of the time of day. A typical dry line passage results in a sharp drop in humidity (thus the name), clearing skies, and a wind shift from the south southeast to a west or southwesterly surface wind flow. These changes occur in reverse order when the dry line retreats westward. Severe and sometimes tornadic thunderstorms often develop along or just east of the dry line, especially when it begins moving eastward.

**FLANKING LINE** -- A line of cumulus clouds connected to and extending outward from the most active part of a parent cumulonimbus cloud, it is usually found on the southwest edge of the cumulonimbus cloud. The cloud line has a rough stair-step appearance with the taller clouds adjacent to the parent cumulonimbus cloud. It is most frequently associated with strong or severe thunderstorms.

**FLASH FLOODING** -- Flooding that develops very quickly on creeks, streams, and river tributaries, usually as a result of thunderstorms. Sometimes the onset of flash flooding comes before the end of heavy rains. There is little time between the detection of flood conditions and the arrival of the flood crest. Swift action is essential to the protection of life and property. Flash flooding is in a tie with lightning to be the top weather killer in the United States.

**FRONT** -- A transition zone between two differing airmasses. Basic frontal types are **cold fronts**, where cooler air advances replacing warmer air forcing it upward; **warm fronts**, where warmer air advances replacing cooler air from aloft downward to the surface; and **stationary fronts**, where warmer air meets cooler air with neither airmass moving appreciably. Thunderstorms can form in association with any of these fronts, with cold fronts more commonly spawning thunderstorms due to a greater frontal slope and a more dynamic nature; **however, it is important to note that fronts are not necessary for thunderstorm development.**

**FUNNEL CLOUD** -- A funnel-shaped cloud extending from a towering cumulus or cumulonimbus cloud base. It is associated with a rotating air column that is not in contact with the ground. The cloud becomes a **tornado** if ground-based debris or a dust whirl is visible below the funnel aloft.

**GUST FRONT** -- The leading edge of the thunderstorm downdraft (outflow) air, the gust front is usually most prominent on the leading edge of an approaching thunderstorm. It is usually marked by gusty, cool winds and sometimes blowing dust. The gust front often precedes the thunderstorm precipitation by several minutes. The **shelf** or **roll cloud** sometimes accompanies the gust front, especially when the gust front precedes a **squall line**.

**GUSTNADOES** -- A small vortex, usually weak and short-lived, that develops along the leading-edge gust front of a thunderstorm. Often, only a dust whirl is visible at the ground. There are two types of gustnadoes: tornadic and non-tornadic. Tornadic gustnadoes have their circulation connected to an updraft along the leading edge of the shelf cloud, sometimes visible as dust whirls or a rotating tube of dust. Non-tornadic gustnadoes have weak circulations caused by the relative surges of cold air along the **outflow boundary** and do not reach the cloud base.

**HAIL** -- Precipitation in the form of balls, lumps, or clumps of ice produced by thunderstorm updrafts and downdrafts. A common rule is that the larger the hailstones, usually the more severe the thunderstorm. The larger the hailstones, the better developed the storm's updraft/downdraft couplet. Hail diameter the size of a quarter (1" diameter) or larger indicates a **severe thunderstorm**.

**HIGH PRESSURE RIDGE** -- A region or axis of higher atmospheric pressure where the air spirals out and away from the center. High pressure is normally associated with fair weather.

**HIGH RISK OF SEVERE THUNDERSTORMS** -- Terminology used in National Weather Service's Storm Prediction Center outlooks to indicate that severe thunderstorms are expected to affect more than 10% of the area outlooked. This situation is relatively rare and usually implies a dangerous situation with the possibility of a major severe weather outbreak. **Also see slight and moderate risk.**

**HIGH WIND** -- Sustained winds of 30 miles per hour or greater or winds gusting to 58 miles per hour or greater.

**HOOK ECHO** -- A radar pattern sometimes observed in the southwest quadrant of a tornadic thunderstorm. Appearing like the number "6" or a fishhook turned in toward the east, the hook echo is precipitation aloft around the periphery of a rotating column of air two to seven miles in diameter. See **mesocyclone**. The hook echo is often found in a local area favorable for tornado development; however, please note that many tornadoes occur without a hook echo and not all hook echoes produce tornadoes.

**INSTABILITY** -- The tendency for a parcel of air to accelerate upward when lifted. Instability is a prerequisite for severe thunderstorms. The greater the instability, the greater the threat of severe weather.

**JET STREAM** -- Relatively strong winds concentrated in a narrow stream in the atmosphere. The position and orientation of jet streams vary from day to day. General weather patterns such as hot and cold or wet or dry are closely related to the position and strength of the jet streams. The subtropical jet stream, with winds normally between 25,000 and 45,000 feet and its position in the upper atmosphere, is closely related to severe weather occurrences in Texas.

**LIGHTNING** -- Any and all of the various forms of visible electrical discharge caused by thunderstorms. Severe thunderstorms usually have very frequent and sometimes nearly continuous lightning; however, some non-severe thunderstorms also contain frequent and vivid electrical displays, while some severe storms are accompanied by little lightning. **Please note that ANY lightning can cause death.** Lightning can strike up to ten to fifteen miles away from the parent thunderstorm in clear air. Lightning is in a tie with flash flooding in causing the most deaths on average in the United States during any given year.

**LOW PRESSURE TROUGH** -- An elongated area of lower atmospheric pressure. Winds typically **converge** in the vicinity of a trough which can lead to thunderstorm formation if other conditions are favorable.

**MAMMATUS (MAMMA) CLOUDS** -- These clouds appear as hanging, rounded protuberances or pouches on the underside of the cloud. With the cumulonimbus/thunderstorm cloud, mammatus clouds are most commonly seen on the underside of the anvil. These clouds in themselves **do not produce** tornadoes, funnel clouds, hail, or any other type of severe weather, although they commonly accompany severe thunderstorms.

**MESOCYCLONE** -- An intense, rotating updraft usually associated with a **supercell** thunderstorm. Mesocyclones almost always produce severe weather, with roughly 50 percent producing at least one tornado. A hook echo is a radar reflectivity pattern indicative of a mesocyclone, although **Doppler Radar** velocity (wind) fields much more readily depict mesocyclone presence.

**MODERATE RISK OF SEVERE THUNDERSTORMS** -- Terminology used in National Weather Service's Storm Prediction Center outlooks to indicate that severe thunderstorms are expected to affect between 5% and 10% of the outlooked area. A moderate risk indicates the possibility of a significant severe weather episode.

**OUTFLOW BOUNDARY** -- A small- to medium-scale boundary separating thunderstorm-cooled air (outflow) from the surrounding air, it is similar in effect to a cold front, with passage marked by a wind shift and usually a drop in temperature. Outflow boundaries may persist for 24 hours or more after the thunderstorms that generated them dissipate and may travel hundreds of miles from their area of origin. New thunderstorms often form along outflow boundaries, especially near the point of intersection with another boundary (e.g., cold front, dry line, another outflow boundary). See **triple point**.

**OVERSHOOTING TOPS** -- A dome-like protrusion above a thunderstorm anvil (looks like a pimple emerging upward from the top of the anvil) representing a very strong **updraft** and hence a higher potential for severe weather with that storm. Persistent overshooting tops are often observed with **supercells**. A short-lived overshooting top, or one that forms and dissipates in cycles, may indicate a **pulse storm** or **cyclic storm**.

**PRECIPITATION SHAFT** -- A visible column of rain and/or hail falling from a cloud base. When viewed against a light background, heavy precipitation appears very dark gray, sometimes with a turquoise or greenish tinge. This greenish tinge has been commonly attributed by some atmospheric scientists to the presence of hail.

**PULSE STORM** -- A thunderstorm within which a brief period (pulse) of strong **updraft** occurs, during and immediately after which the storm produces a short episode of severe weather. These storms generally are not tornado producers, but often produce large hail and/or damaging winds.

**RAINFOOT (Slang)** -- A horizontal bulging near the surface in a precipitation shaft, forming a "foot-shaped" prominence. It is a visual indication of a wet **downburst**.

**RAINFREE BASE** -- A horizontal dark cumulonimbus cloud base that has no **visible** precipitation beneath it. The structure usually marks the location of the thunderstorm **updraft**. Tornadoes most commonly develop (1) from **wall clouds** that are attached to the rainfree cloud base, or (2) from the rainfree base itself. This is particularly true when the rainfree cloud base is observed to the south or southwest of the precipitation shaft or precipitation area.

**REAR ANVIL OVERHANG** -- That portion of the anvil which extends upward against the upper-level wind flow. A backsheared anvil in the strong upper-level winds indicates a strong storm updraft.

**RIGHT MOVER (Slang)** -- A thunderstorm that moves appreciably to the right relative to the main atmospheric steering winds and to the movement of other nearby thunderstorms. Right movers typically are associated with a high potential for severe weather. **Supercells** are often right movers.

**RIVER FLOOD** -- A flood that occurs on rivers, usually after flash flooding has occurred on creeks, streams, and river tributaries. River floods develop and reach their peak more slowly than flash floods. In many cases, the river flood peak occurs well after the rain has ended.

**ROLL CLOUD** -- A low, horizontal tube-shaped cloud associated with a thunderstorm gust front (or sometimes a cold front). Roll clouds are relatively rare and they are completely detached from the thunderstorm cloud base or other cloud features, thus differentiating them from the more familiar **shelf cloud**. Roll clouds usually appear to be "rolling" about a horizontal axis, but should not be confused with **funnel clouds**.

**ROPE STAGE** -- The dissipating stage of a tornado, characterized by thinning and shrinking of the condensation funnel into a rope funnel during this stage. Damage can still occur during this dissipation stage.

**SCUD CLOUDS** -- Low cloud fragments often seen in association with and behind thunderstorm gust fronts. These clouds are very ragged and wind torn and usually are not attached to the cloud base. Scud clouds do not produce severe weather. In some cases, when scud clouds are attached to the thunderstorm cloud base, they can be mistaken for **wall clouds** or **tornadoes**.

**SEVERE THUNDERSTORM** -- A thunderstorm that produces tornadoes, hail 1" or more in diameter, **and/or** convective wind gusts of 50 knots/58 miles per hour or more. Structural wind damage may imply the occurrence of a severe thunderstorm.

**SHELF CLOUD** -- A low-level accessory cloud that frequently appears to be wedge-shaped as it approaches. It is usually attached to the thunderstorm cloud base and forms along the gust front where warm, moist air is forced upward by the cooler surface-based outflow. The leading edge of the shelf cloud is often smooth and at times layered or terraced. The underside is concave upward, turbulent, boiling, or wind-torn and often is marked by light and dark areas. It is often seen along the leading edge of an approaching line of thunderstorms, accompanied by gusty **straight line winds** as it passes overhead and is followed by precipitation. **Tornadoes** rarely occur with the shelf cloud.

**SLIGHT RISK OF SEVERE THUNDERSTORMS** -- Terminology used in National Weather Service's Storm Prediction Center outlooks to indicate that severe thunderstorms are expected to affect 2% to 5% of the area outlooked. This terminology usually indicates that severe weather events are expected to be isolated.

**STRAIGHT LINE WINDS** -- Non-rotating winds associated with thunderstorms, most frequently found with the advance of the gust front at the leading edge of the thunderstorm. These winds originate as downdraft air reaches the ground and rapidly spreads out, becoming strong horizontal surface wind flow. Damaging straight-line winds are much more common than tornadoes. The damage pattern on the ground is often divergent.

**SUPERCCELL** -- A relatively long-lived thunderstorm with a persistent rotating **updraft**. Supercells are relatively rare but are responsible for a remarkably high percentage of severe weather events, especially **tornadoes**, extremely large **hail**, and damaging **straight line winds**. They frequently travel to the right of the main atmospheric steering winds; that is, they are **right movers**. Some radar characteristics and terminology include **hook echoes** and **mesocyclones**. Visual characteristics often include a **rain free base**, **wall cloud**, **tail cloud**, **flanking line**, and **overshooting top**.

**TAIL CLOUD** -- A low tail-shaped cloud extending outward from the northern quadrant of a wall cloud toward the moist, cooler precipitation area. Motions in the tail cloud are toward the wall cloud with rapid updraft at the junction of the **tail** and **wall clouds**. This horizontal cloud is not a funnel or tornado.

**THUNDERSTORM** -- A local storm accompanied by lightning and thunder and produced by a cumulonimbus cloud, usually with gusty winds, heavy rain, and sometimes hail. Non-severe thunderstorms rarely have lifetimes over two hours. A typical non-severe thunderstorm life cycle consists of three stages: **(1) The Cumulus Stage**, when warm, moist air rises (**updraft**) and condenses into tiny cloud droplets which make up the visible cloud; **(2) The Mature Stage**, where the cloud grows above the freezing level; precipitation forms and becomes heavy enough to fall back down to Earth. The updrafts and downdrafts co-exist during this stage. Precipitation generates cool air which sinks back to the Earth with the precipitation – this is the downdraft; and **(3) The Dissipation Stage**, where cool rain and downdraft spread throughout the storm replacing the updraft, which is the life blood of the thunderstorm. The visible cumulonimbus cloud becomes softer in appearance, less distinctly outlined or "fuzzy," and dissipates, sometimes leaving only the high anvil cloud as the storm rains itself out.

**TORNADO** -- A violently rotating narrow column of air in contact with the ground and extending from a thunderstorm cloud base. The tornado is most often found in the southwest quadrant of the storm, near the trailing edge of the cumulonimbus cloud. Research observations indicate that tornadoes and **funnel clouds** are usually pendant from **(1) wall clouds** or **(2) directly from the thunderstorm base**, within a few miles to the southwest of the precipitation shaft or the main precipitation area. The spinning motion of the tornado is most often left to right (counter clockwise). Tornadoes are often referred to as "twisters" and "cyclones," but these words are all synonyms for the most violent storm on Earth. Tornado wind speeds can reach to around 300 miles per hour.

**TRIPLE POINT** -- An intersection point between three atmospheric air mass boundaries (**outflow boundaries**, **cold fronts**, **dry lines**, **etc.**), it often acts as a focus area for thunderstorm development. It **also may refer to** a point on the **gust front** of a **supercell**, where warm, moist inflow; the rain-cooled moist outflow from the forward flank downdraft; and the rear-flank downdraft (dry air) all intersect. This point in the thunderstorm structure is a favored location for **tornado** development or redevelopment.

**URBAN/SMALL STREAM FLOODING** -- Flooding of small creeks and streams, streets, and low lying areas such as underpasses and urban storm drains. It is generally an inconvenience, not life threatening, nor significantly damaging to property.

**UPDRAFT** -- Warm, moist air which rises and condenses into a visible cumulus or cumulonimbus cloud. Once the cloud forms, it depends on the updraft for continuance and further development.

**UPPER-LEVEL DISTURBANCE** -- A weather disturbance in the middle or upper levels of the atmosphere which induces rising motion ahead of it. If other conditions are favorable, the upward motion can contribute to thunderstorm formation.

**VIRGA** -- Wisps or streaks of precipitation falling out of a cloud but not reaching the Earth's surface. When seen from a distance, these streaks can be mistaken for **funnel clouds** or **tornadoes**.

**WALL CLOUD** -- A local and often abrupt lowering of a rain-free cumulonimbus cloud base into a low-hanging accessory cloud from one to four miles in diameter. The wall cloud is usually situated in the southwest portion of the storm below an intense updraft and marked by the main cumulonimbus cloud tower directly above. This cloud feature is almost always associated with a strong or **severe thunderstorm**. Not all wall clouds produce **tornadoes**, but wall cloud formation typically precedes tornado activity. When seen from several miles away, tornadic wall clouds exhibit rapid upward motion and rotation in the same sense as a tornado, except with considerably slower speed. Tornadic wall clouds also have better time continuity (several tens of minutes) and strong warm inflow from the southeast than non-tornadic wall clouds. A rotating wall cloud usually develops before tornadoes and funnel clouds by a time which can range from a few minutes up to possibly an hour. Spotters should key in on any lowering of the cumulonimbus cloud base as a suspect wall cloud. Wall clouds should always be reported. **NOTE:** Sometimes other low-hanging accessory clouds are mistakenly identified as wall clouds.

**WARNING** -- Issued when the specified weather has already developed, has been reported by severe weather spotters, is indicated by radar, or is imminent. Warnings are statements indicating imminent danger and are issued for relatively small areas near and "downstream" from the location where the weather type is indicated.

**WATCH** -- Issued when the conditions are favorable for the specified weather in a fairly large geographic area for the time period indicated and usually for a longer time period (e.g., severe thunderstorm and tornado watches are usually 4 to 6 hours in length).

**WIND PROFILE** -- The way that the wind changes with height above the ground. A weather pattern that results in the wind speed increasing with height and the wind direction changing in a clockwise fashion with height is favorable for long-lived severe weather outbreaks and tornadoes.