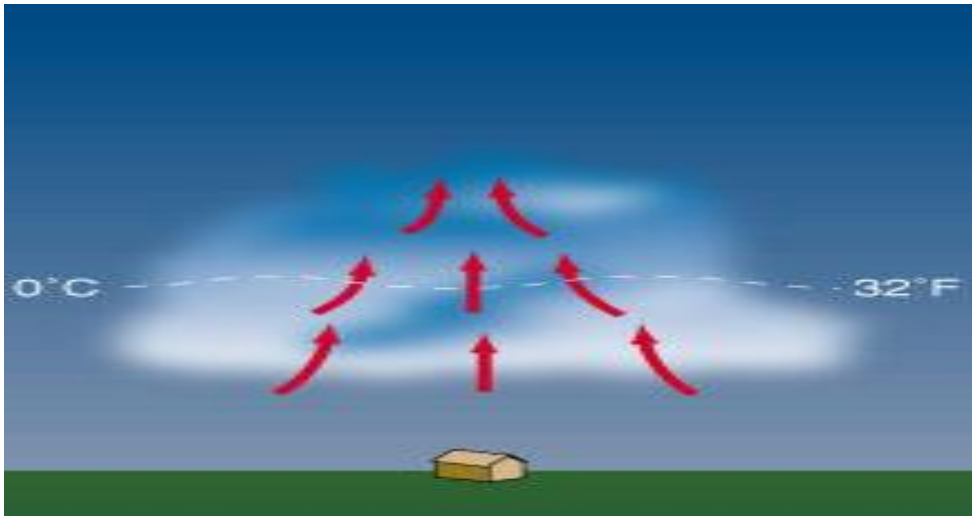
Tornadoes --- by Jeff Passner

“Born to Chase”

- Fascinated by weather even at age 5. Tornado in New Jersey on March 10, 1964 passed over our home. That’s when I knew.
- Went to undergrad at SUNY (Meteorology)
- Went to the University of Oklahoma (grad school) 1984
- Began storm chasing in 1982 and am “semi-retired” now.
- Worked at an Oklahoma City private weather company and did radio on WKY – OKC. 1985.
- Got job at WSMR in early 1986 and have spent 32 years working for Army Research Lab. Variety of assignments included C-Station, HELSTF, forecasting for WSMR and Space Shuttle, and later doing atmospheric research for the military.

Thunderstorms (photos by Jeff Passner)

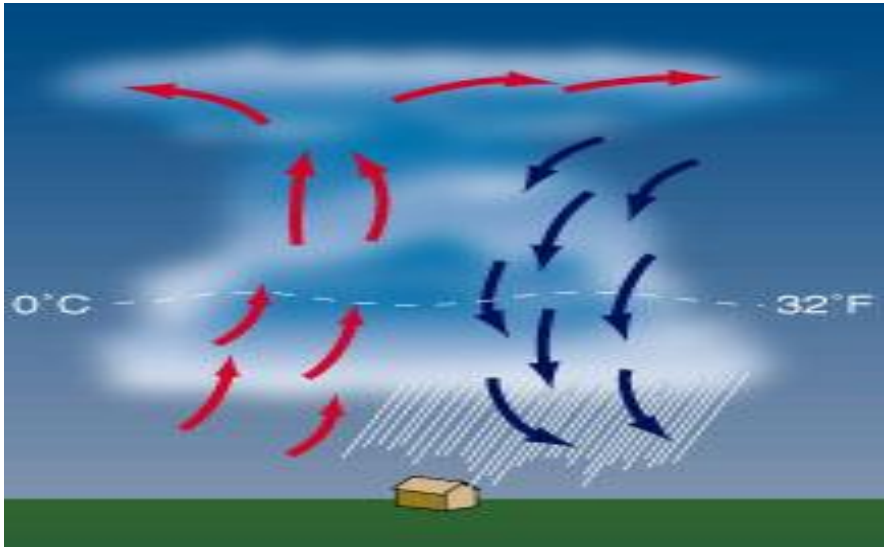
How do thunderstorms form?



Convection --- Sun heats the surface of the earth or convergence of air causes rising motion. The air is cooled and if it is moist the air will condense into a cloud.

Photo: physical.geography.net

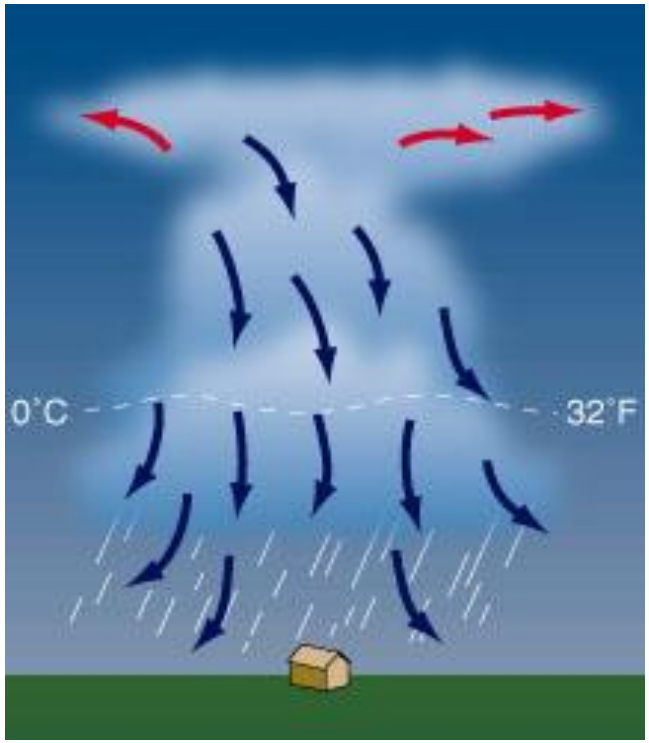
How do thunderstorms form – The mature stage



The mature stage --- updrafts and downdrafts exist at the same time. It rains, the downdraft air reaches the surface.

Photo: Physical.geography.net

The decaying or Dissipating stage



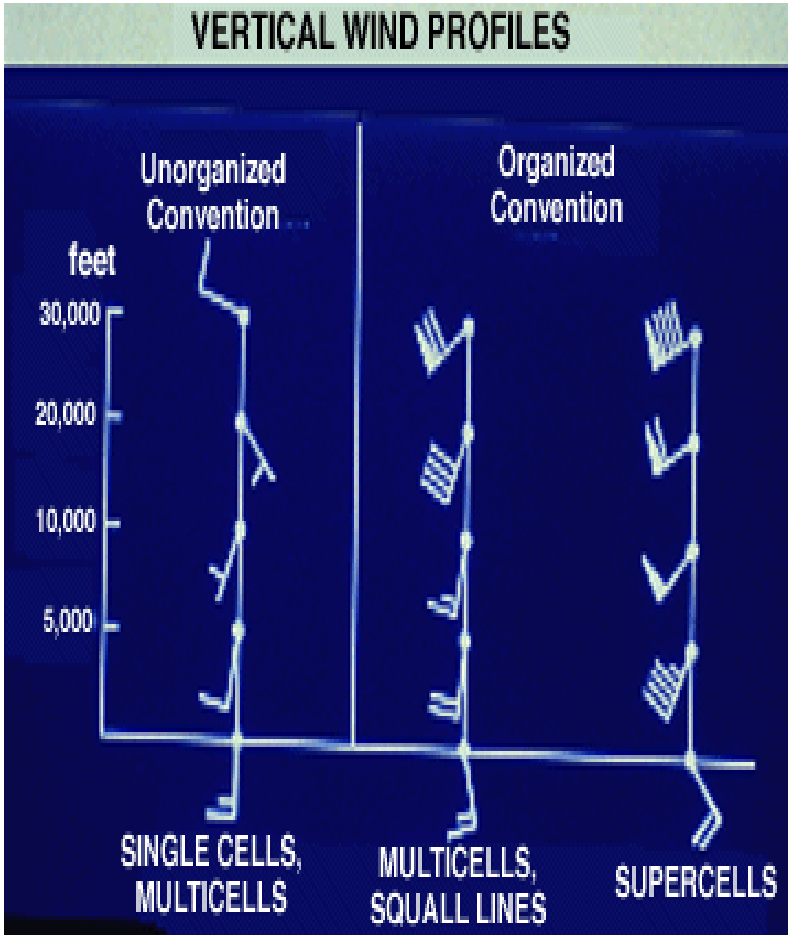
The end is near for the storm. The downdraft and rain overcome the updraft and the storm dies. Lasts about 30 to 60 minutes.

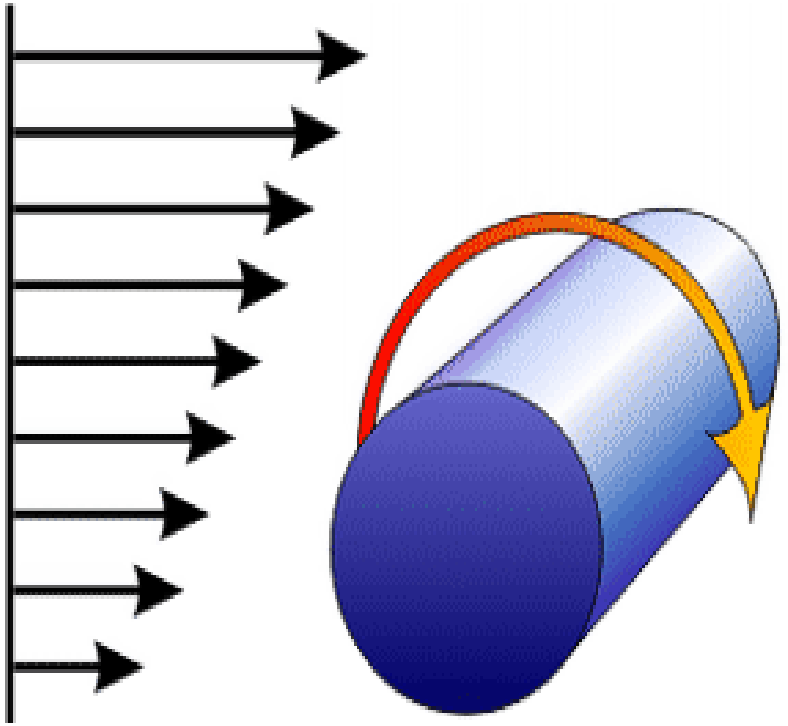
Photo by David Jenkins

Tornadoes

- A VIOLENTLY rotating column of air extending from a thunderstorm to the ground in the form of a funnel. Typically the rotation is not really considered a “tornado” unless wind speeds are over 60 mph.
- Tornadoes occur most of the time in areas of mild/warm surface temperatures, high dew points, instability, surface convergence of some form, and favorable wind shear (supercells/mesocyclones).
- Tornadoes can occur anywhere and anytime but are most favorable in the USA Midwest and southeast between 3:00-9:00 PM
- The funnel does NOT have to reach the ground, but the circulation must be on the ground.
- Tornadic storms also features large hail, intense rain cores, strong inflow and strong outflow winds.
- Tornado watches (and severe thunderstorm watches) are the responsibility of the Storm Prediction Center in Norman, Oklahoma.
- Tornado warnings (and severe thunderstorm warnings) are the responsibility of the local National Weather Service.
- TV broadcasters should not put out their own warnings because it can conflict with the NWS and confuse the general public to taking the wrong action.

Shear's the reason for most severe storms –Directional and speed shear





From University of Illinois
http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/svr/comp/wind/cnvt.rxml

http://www.tornadochaser.net/windshear.html

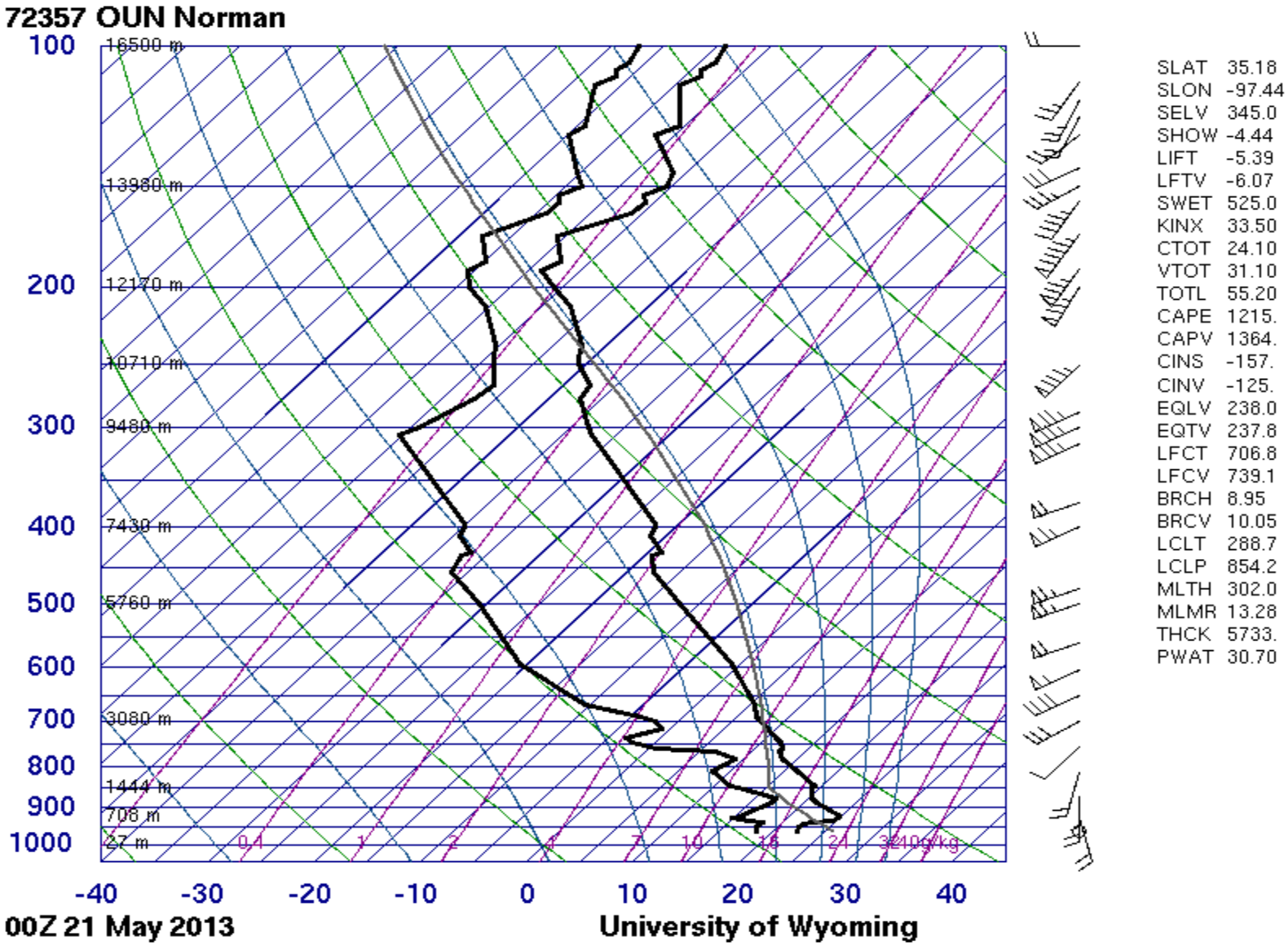
What shear looks like

Near Mineola, Kansas May 26, 2008 –Jeff Passner

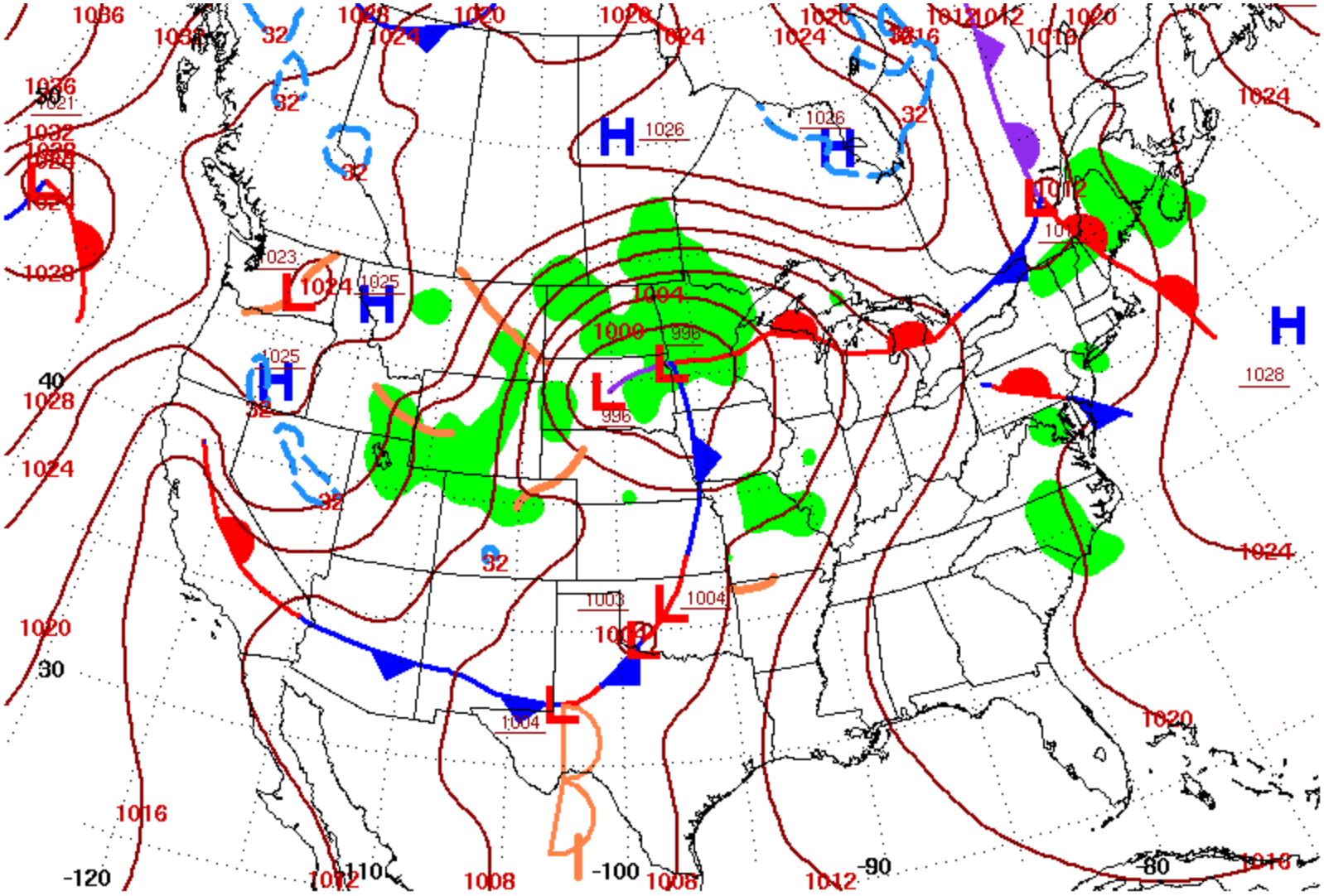
The meteorology of tornado day

Groom, Texas April 22, 2010 Looking west (photo by Jeff Passner)

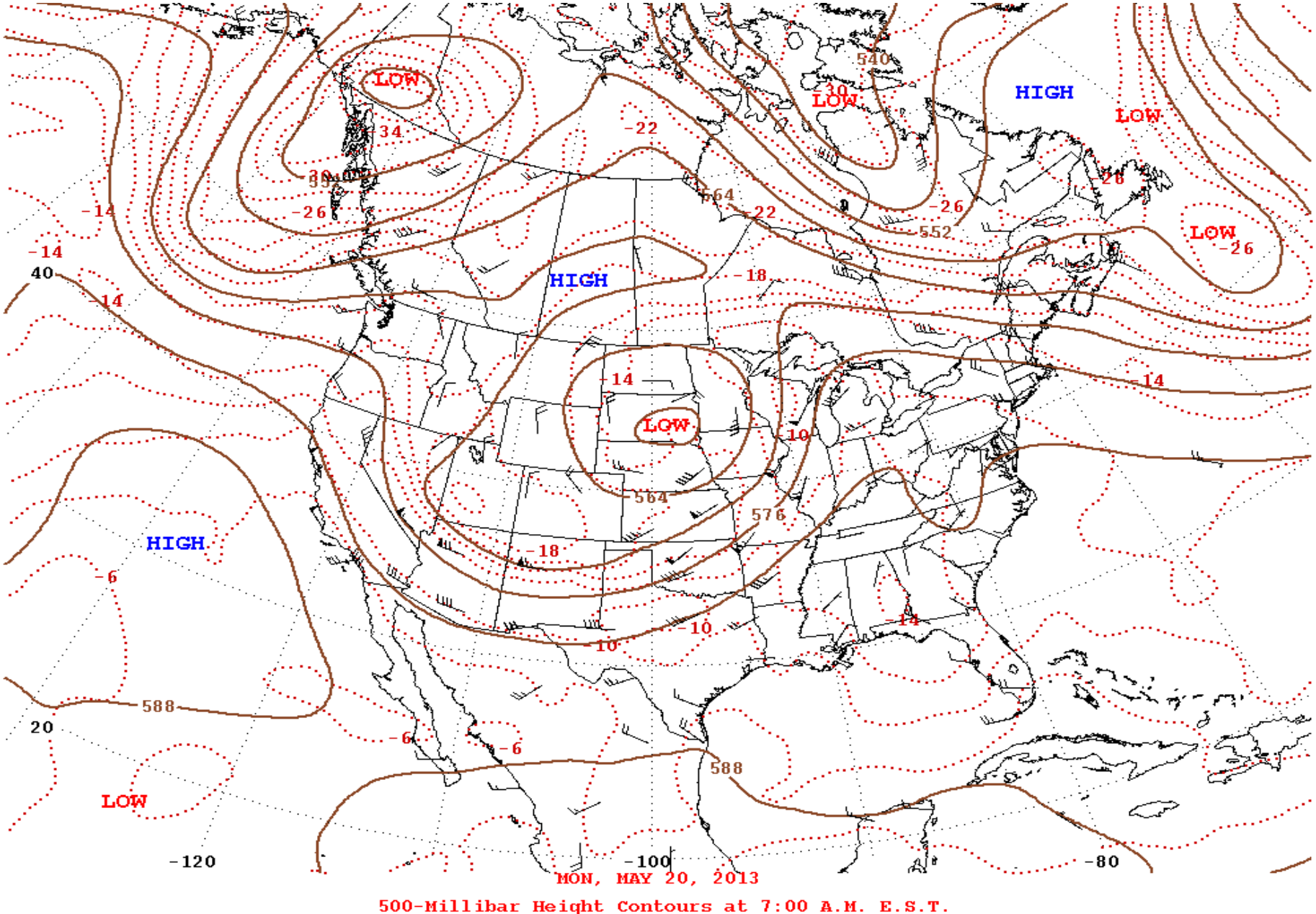
Skew-T diagram for Norman, Oklahoma May 21, 2013 0000 UTC



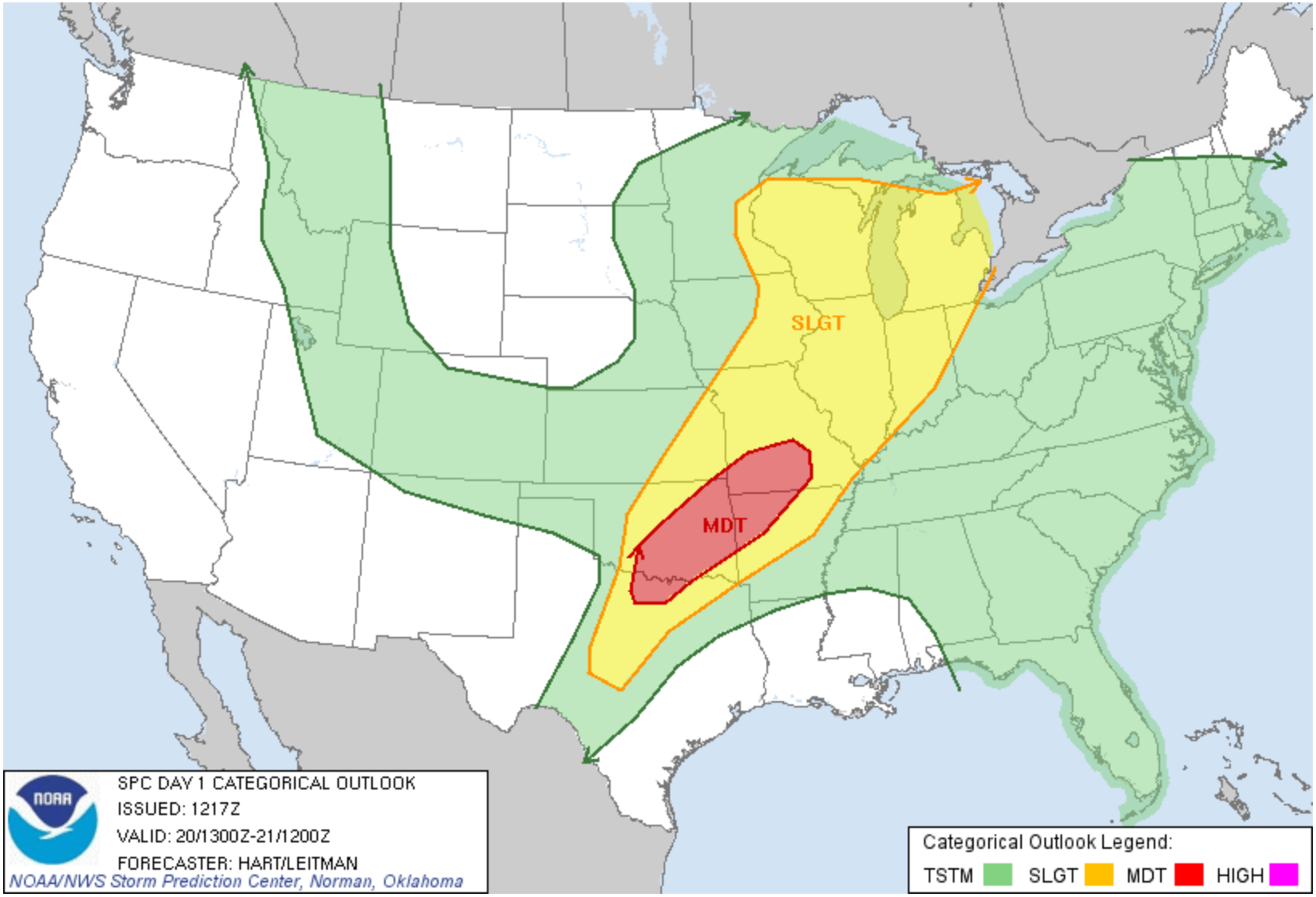
Surface weather May 20, 2013 1200 UTC



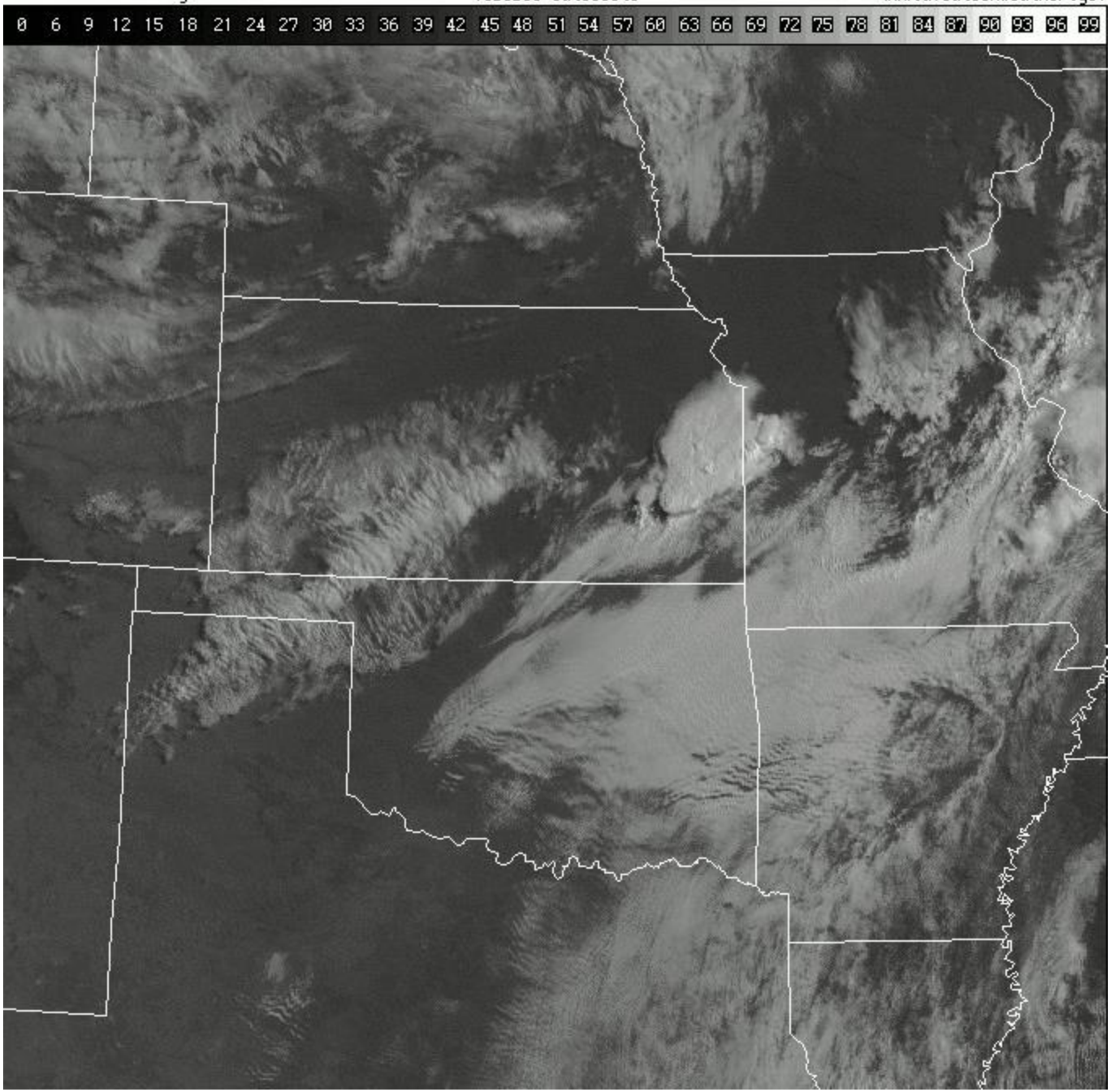
Upper air map at 500 hPa May 20, 2013 1200 UTC



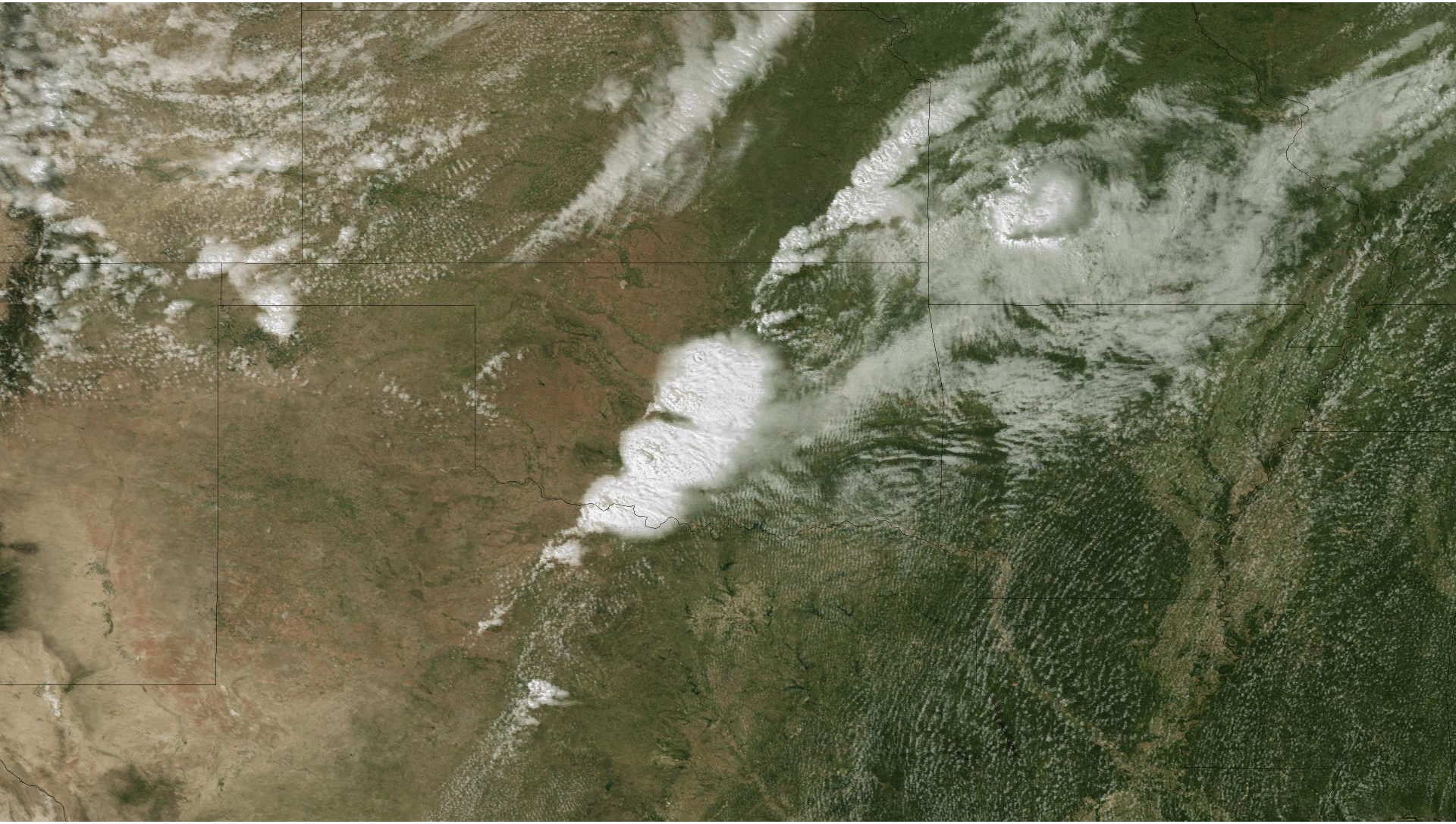
Storm Prediction Convective Outlook for May 20, 2013



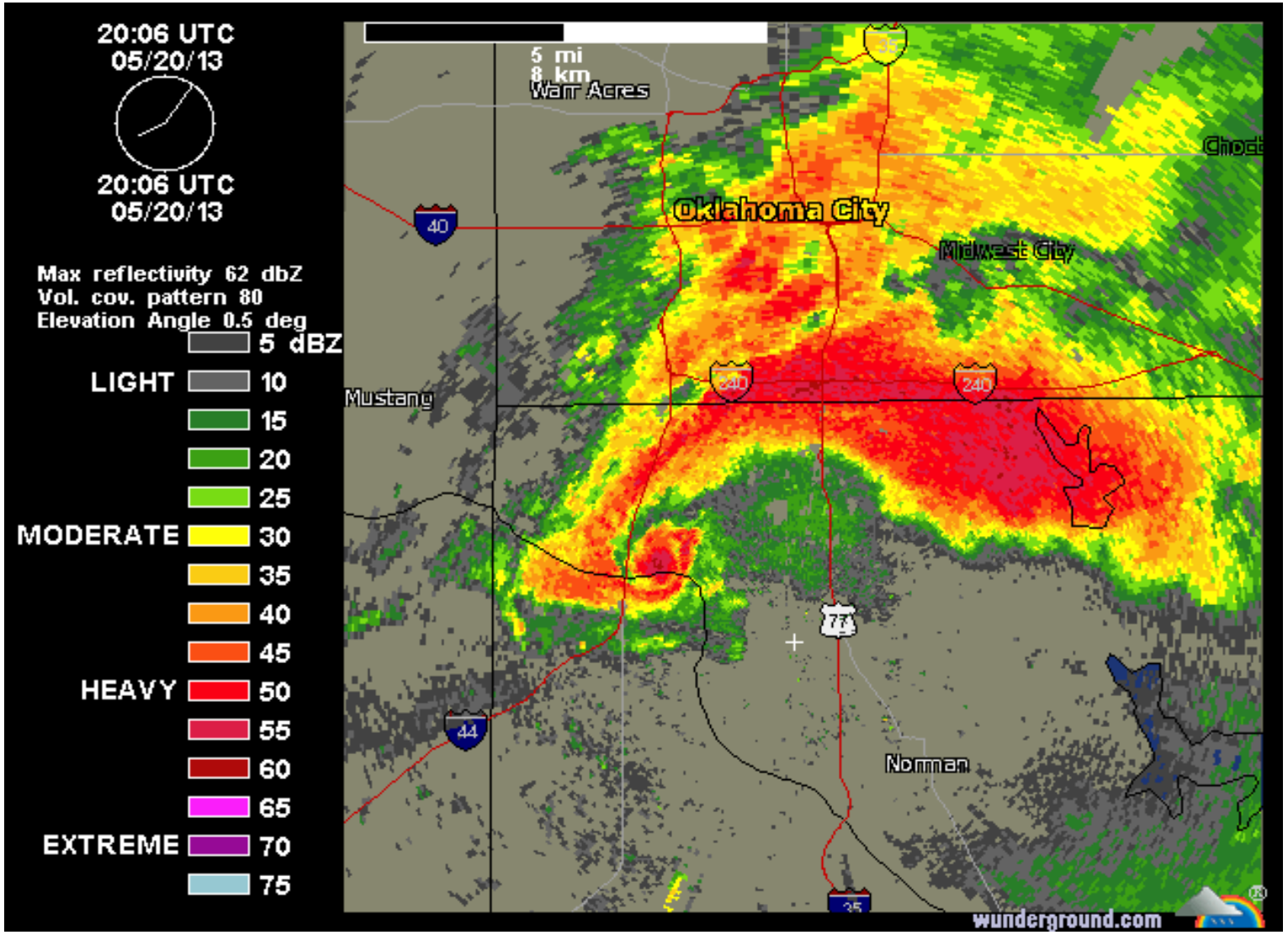
1345 UTC Mon 20 May 2013 Visible Satellite www.aviationweather.gov



Approximately 3:00 PM May 20, 2013 Oklahoma



May 20 2013 3:15 PM Moore, Oklahoma (photo by Jeff Passner)

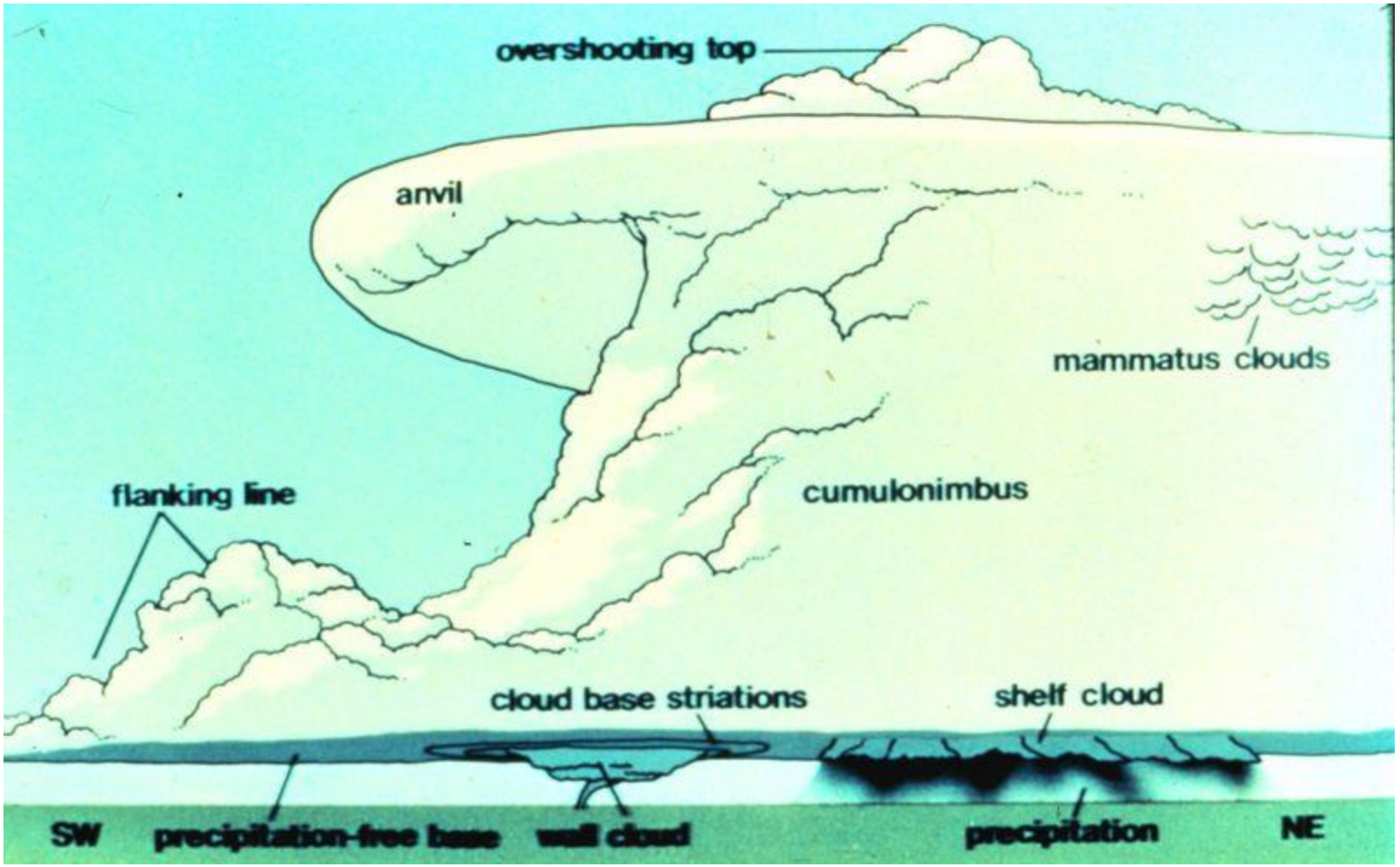


Moore, Oklahoma May 20 2013 3:06 PM Norman NWS radar

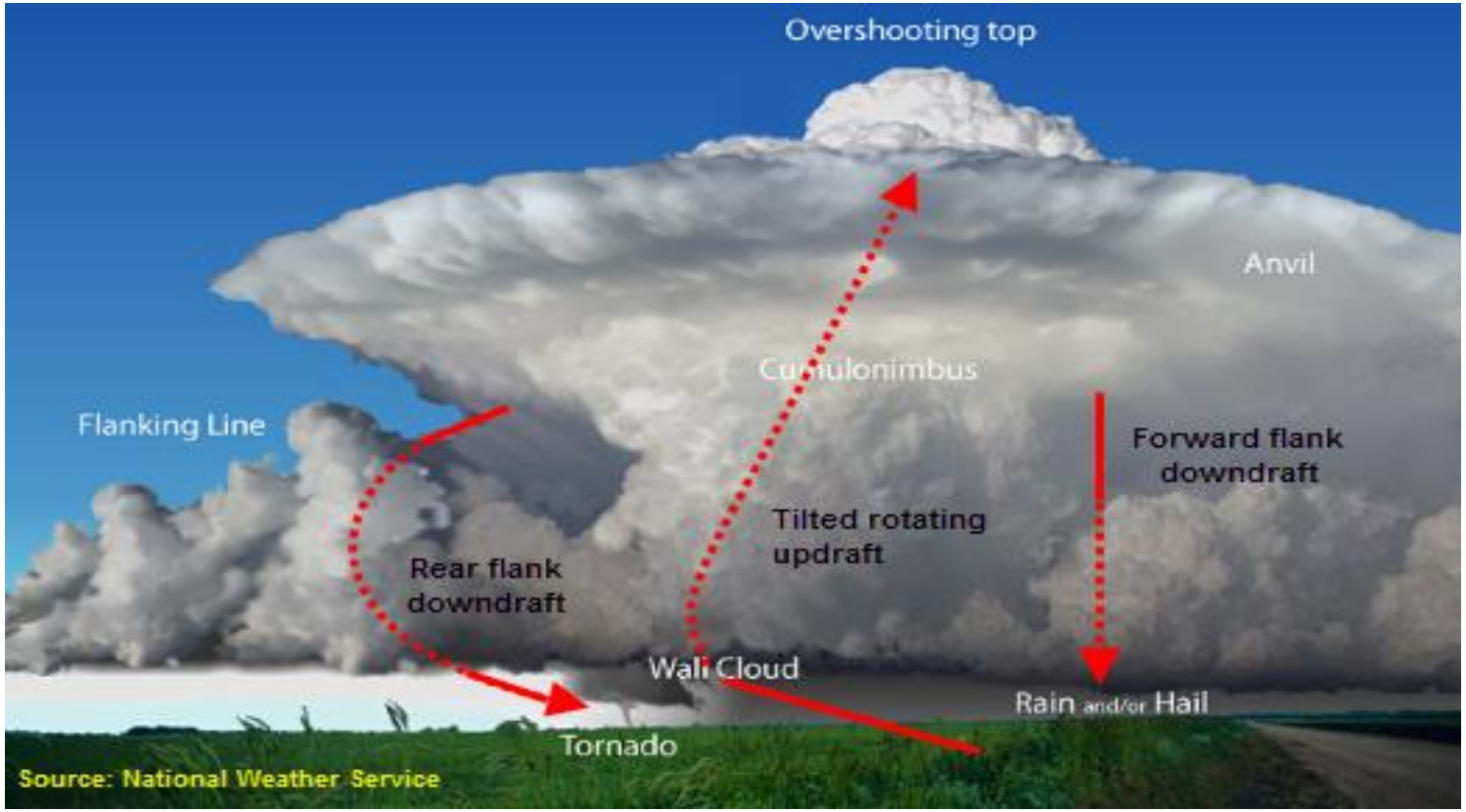
Supercells produce the most violent severe storms

- The stronger winds with height blow the air away from the origin of the updraft.
- The rain (cloud droplets), gets blown away so they do not fall on the updraft.
- The updraft region of the cloud is called the rain-free base.
- A strong updraft area is important to form a tornado. It forms in a local area of low pressure under the rain-free base where winds convergence.

SUPERCELLS

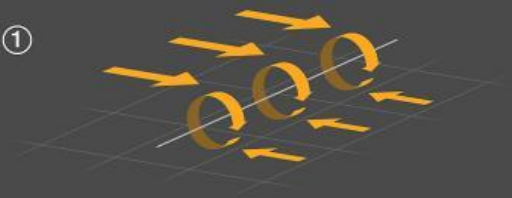

overshooting top
anvil
mammatus clouds
flanking line
cumulonimbus
cloud base striations
shelf cloud
SW
precipitation-free base
wall cloud
precipitation
NE

What it looks like in real life



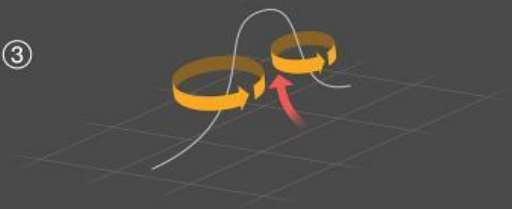
How a Tornado Forms

While tornadoes can differ in size, strength, and location, they all share certain characteristics. They are spawned from a type of rotating storm called a supercell thunderstorm.

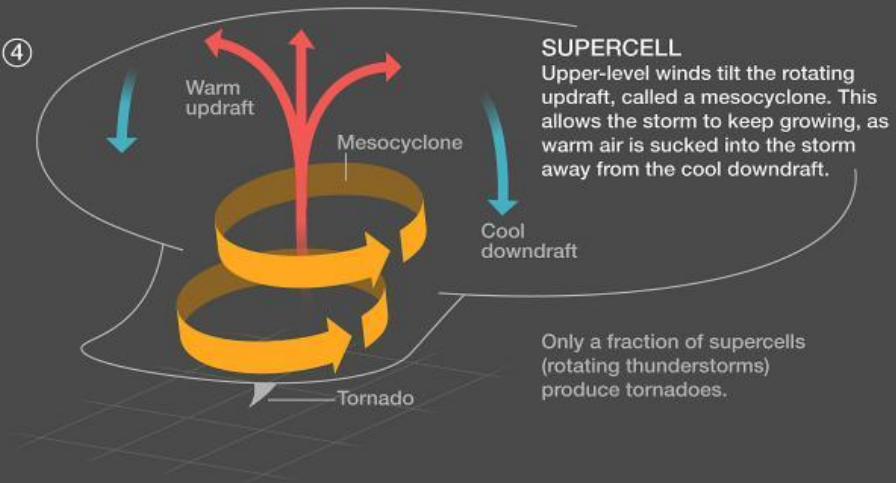


① **WIND SHEAR**
Fast-moving winds roll air below into a horizontal vortex—a spinning tube—above opposing surface winds.

② **UPDRAFT**
Warmed by the sun, buoyant air near the ground begins to lift a section of the horizontal vortex into a vertical position.



③ **STORM**
The stronger of the two vortices created by the updraft becomes the heart of the thunderstorm. The other one dies.

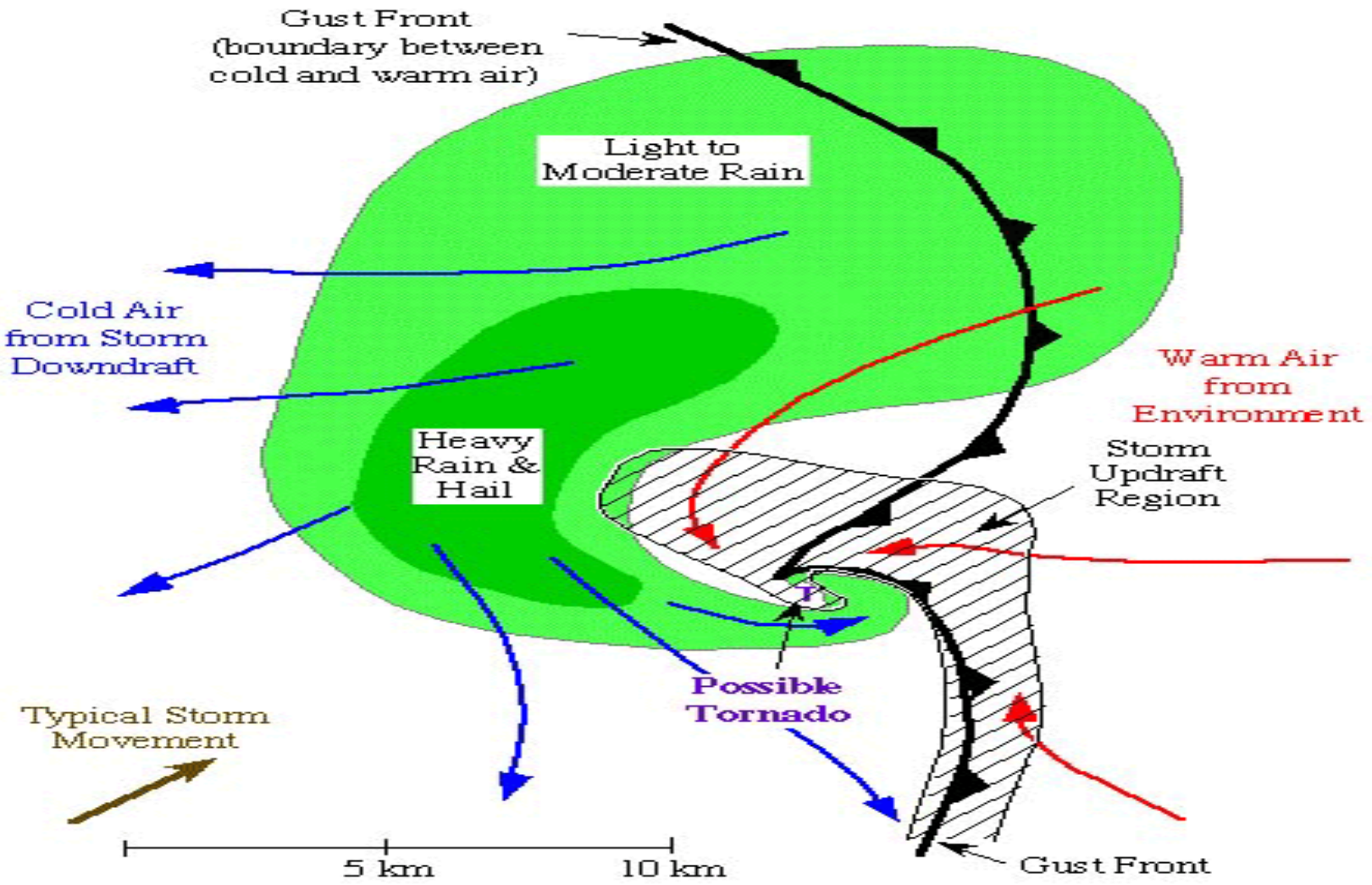


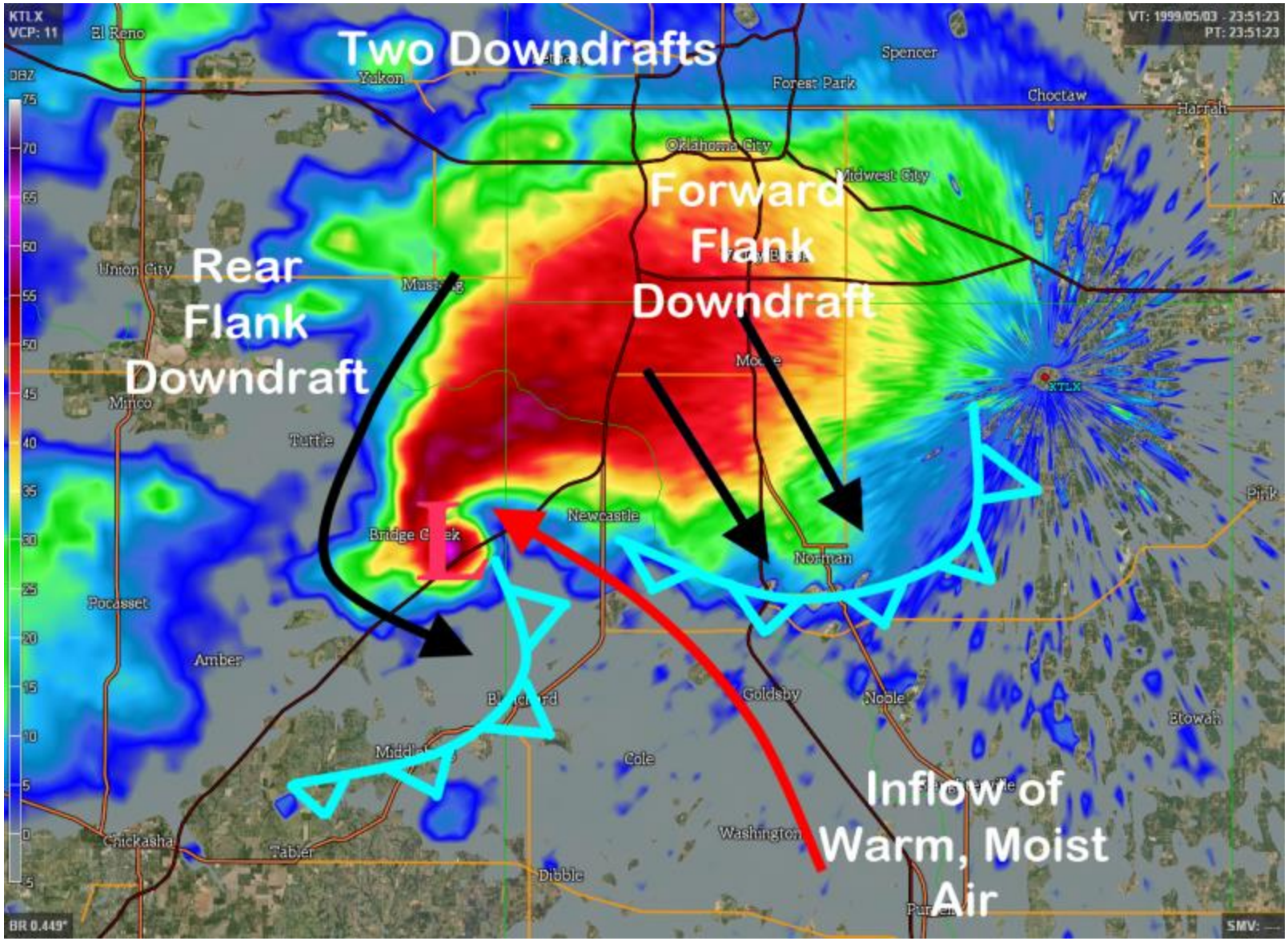
④ **SUPERCELL**
Upper-level winds tilt the rotating updraft, called a mesocyclone. This allows the storm to keep growing, as warm air is sucked into the storm away from the cool downdraft.

Only a fraction of supercells (rotating thunderstorms) produce tornadoes.

NG STAFF. SOURCE: GABE GARFIELD, NATIONAL WEATHER SERVICE AND COOPERATIVE INSTITUTE FOR MESOSCALE METEOROLOGICAL STUDIES

From above, classic tornado formation





KTIK radar May 3, 1999

Visual Signs

Supercells --- Anvil (cirrus) spreading out (divergence) rain core, rain-free base (Jeff Passner photo south of Midland, Texas)

Visual signs

A lowered cloud base or wall cloud shows signs of rotation (Jeff Passner)

Visual Signs

Funnel forms north of Roswell, May 5, 2008 (Jeff Passner)

FAKE NEWS!!!

- Tornadoes don’t hit large cities
- Our town is protected!!
- Tornadoes can’t occur near mountains
- Tornadoes are caused by cold air meeting warm air on cold fronts (rarely)
- Tornadoes are attracted to mobile homes
- In the movies cows/cars/oil tankers fly
- “It sounded like a freight train”
- Open your windows to protect your house
- **Tornadoes do not occur in or around Las Cruces, New Mexico**

Truths about tornadoes

- There are 100,000 thunderstorms in the U.S. each year and about 1,200 tornadoes
- Most tornadoes are harmless. They last 1-2 minutes, are about 50 yards wide, and hit nothing.
- Tornado damage has increased because of increasing population.
- Tornadoes have occurred in all 50 states. Most common in Florida, Oklahoma, Texas, and Kansas. Alaska one tornado.
- From 1950-1995 New Mexico recorded 399 tornadoes
- USA leads the world in tornadoes!!!!! We're number one!!
- Less than 5 percent of all tornadoes kill people. On average 50-60 people are killed by tornadoes each year, which is far less than flooding and lightning.
- Worst was the Tri-State tornado in 1925 which stayed on the ground for hours and killed 675 people.
- Tornadoes have occurred in Oklahoma City, Salt Lake City, downtown Atlanta, Dallas, Nashville and many other cities.
- Cordell, Kansas got hit three years in a row on May 20, 1916, 1917, 1918.

July 2, 2008 Porter Drive, Las Cruces, New Mexico Landspout tornado

Photo by Peter Bennett, city of Las Cruces

My yard, West Mesa, Near Airport, 15 miles south of WSMR (photos Jeff Passner)

Funnel Oct 23, 2000

Photo by Jessie C. Aug 1, 2007 Below Oct 15, 2006

Wall cloud May 24, 1999

September 9, 2007 SW of Las Cruces, New Mexico (photo by Jeff Passner)

July 13, 2008 The East Mesa, Las Cruces, New Mexico

Photos by Jeff Passner

May 2, 2007 White Sands Missile Range

Photo by Miriam Rodriquez

Oct 4, 2010 -- Just south of Mesilla (photo by Jeff Passner)

Aug 31, 2008 Looking Southwest from Las Cruces

Photo by Jesse C. 8:21 PM

Tornado Research – the 80s

Invented by Dr. Al Bedard in 1979 in Norman, Oklahoma. The Totable Tornado Observatory (TOTO) was placed into the path of tornados but failed. It was extremely dangerous to get in front of the tornado. On April 30, 1985 University of Oklahoma grad students got TOTO in the path but the instrument got blown over. TOTO is retired today and was the motivation for “Dorothy” in the movie Twister.

Tornado Research – the 90s

Verification of the **O**rigins of **R**otation in **T**ornadoes **Ex**periment (VORTEX)

Turtles – photo by Dorothy Grazullus

Tornado Research 2018

Doppler on Wheels

IMAX Tornado Intercept Vehicle (TIV) -- on the right… Photo by Matt Crowther

Storm chasing

- First chasers were on their own. Roger Jensen and David Hoadley chased in the Plains in the 1950s and photographed storms. Hoadley is 80-years-old now.
- In the 1970s, NSSL and the University of Oklahoma starting organizing students to study the storms and use instruments to measure them.
- The media joined in, they had live feeds back to the studio. Makes great TV!! 1980s. National Geographic, Life Magazine, Discovery all started making “documentaries” about storm chasing.
- The Weather Channel started broadcasting in 1982.
- In 1982 there were about 50 storm chasers, most associated with OU. They chased for both research, photography, and just for fun. We had no access to weather data in the car. Had to make calls back to NSSL for radar updates or simply use your eyes and watch the storm.
- “Twister” (1996) sent hundreds of curious people hunting for tornadoes. It influenced a whole generation of kids. Meteorology became “cool.”
- Today, there are thousands of storm chasers in the USA/World. Many have web pages, Facebook pages, books, chase groups, web pages, conventions, storm tour companies, reality TV shows, blogs, and video posted on You Tube and other social media.
- Modern technology means you can watch live storms and tornadoes on your computer!! And means ANYONE can jump in their car and chase storms.

What a Chaser Needs

- A reliable car!!! Check everything before leaving.
- In the trunk --- spare tire, plastic, duct tape, oil, knife, tire pump or air, blanket, pillow, jacket, jumper cables, FIRST AID KIT!!!
- In car – extra water, towels, extra food, maps, lots of music, something to keep you busy.
- For Chasing – cell phone, cameras, laptop (tablet, smart phone, whatever), any other equipment you need for getting weather data.

The bad – Chasing

- On 75 percent of the days I do not see tornadoes.
- On 12 percent of the days nothing happens.
- Driving… Borrrring. It's uncomfortable. It's hot, humid, you drive through torrential rain, deal with floods, fog, other cars, cows and animals, hail and there's a real danger of being hit by lightning.
- Can be incredibly stressful
- COST!!! Gas is $3.00 (was $4.00) a gallon. Hotels are $60.00 or more now.
- Chasers get tired.
- Sometimes there are no roads or rain/hail obscures the features, storms move fast, it gets dark, flat tires…. Things go wrong.
- Must live with what you see (no damage photos)
- Limited areas to chase; can't chase the southeast (trees and terrain) and even New Mexico because of lack of roads.

THE CHASERS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The
WIZARD
of OZ

The end of storm chasing as we know it

Chaser spotter network--- where the chasers are.

The modern chaser ----- 2017 photo

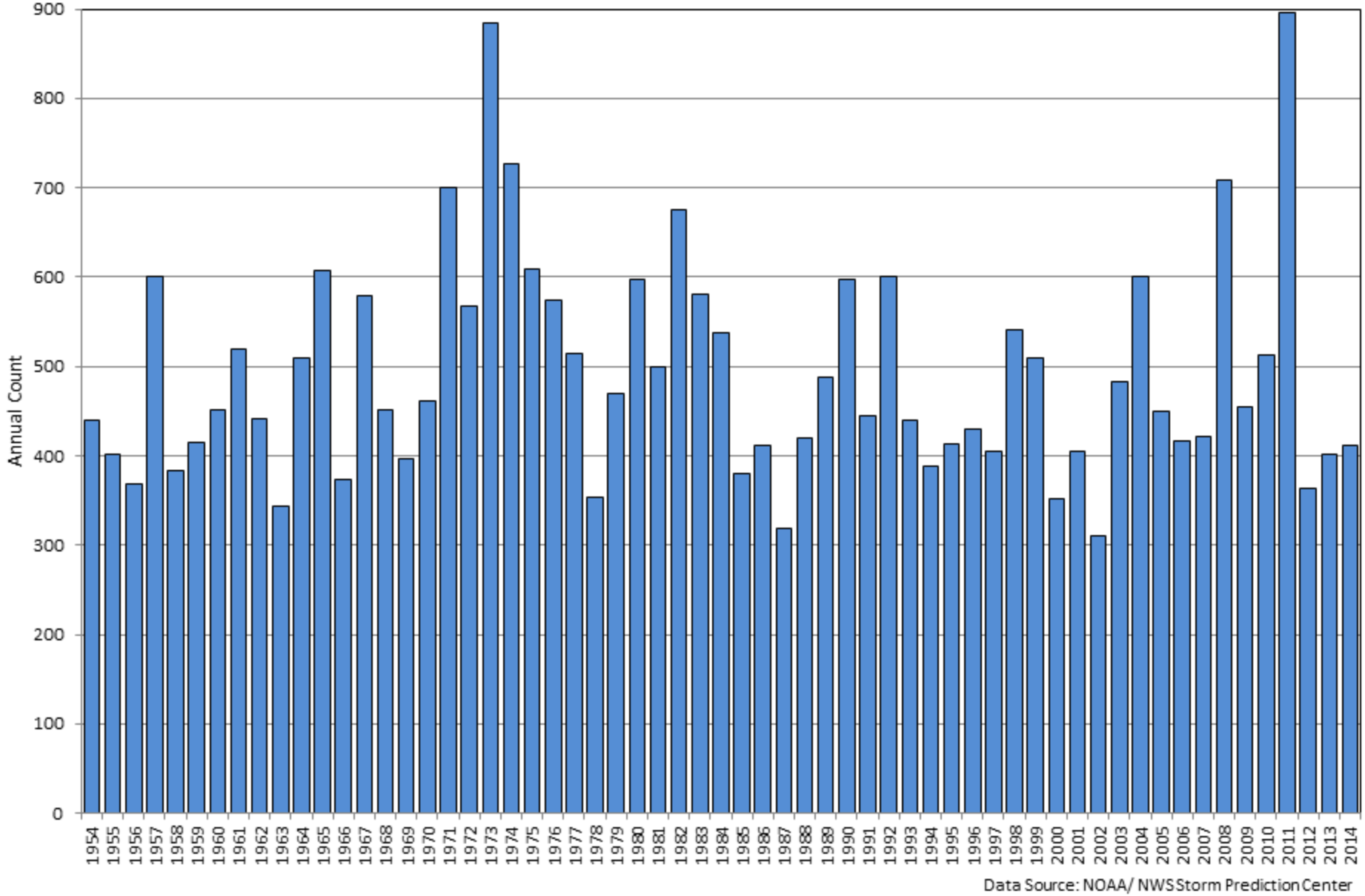
Chasing in the 2000s ---seeing scenes like this more often

Storm chasers are hated in many places

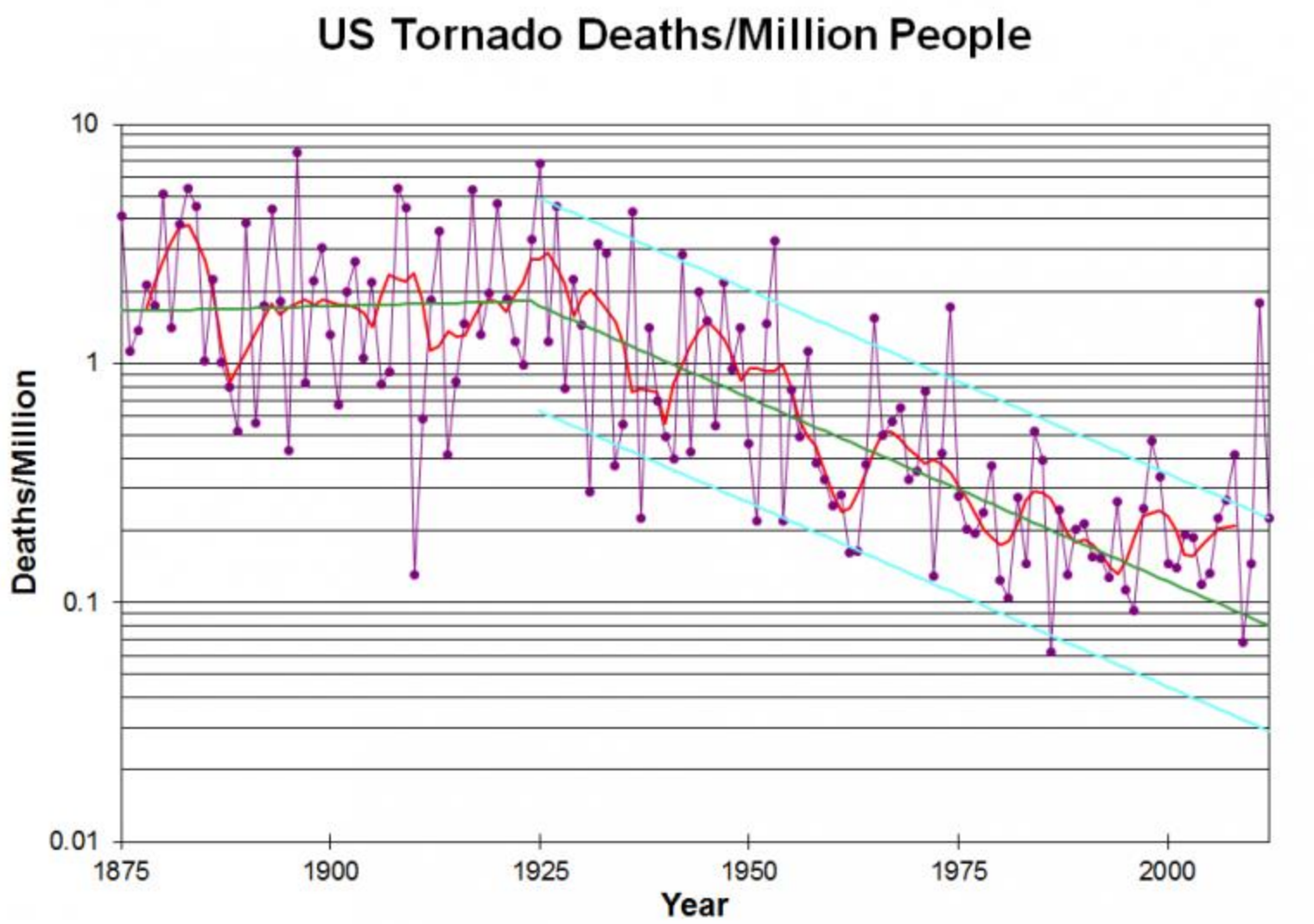
What happened to storm chasing?

- “Twister” and The Weather Channel and the media made it look like a game. Recreational chasing took over the Plains. The weekends and Holidays are the worst. The media basically tells you where the tornado is.
- Modern Technology and social media has increased interest and provided easy access. There are thousands of videos of storms on You Tube. Everyone is a meteorologist today.
- It’s almost impossible to chase near any major city now.
- Rural roads are jammed with hundreds of cars in a line.
- There’s no place to park. Some chasers park in the middle of the road.
- Emergency vehicles can’t get to the scene of injured citizens.
- Police are blocking roads, especially major highways. This creates a very dangerous situation for everyone with a long line of cars which can be hit by large hail or the tornado.
- The number of car crashes has increased.

U.S. Annual Count of EF-1+ Tornadoes, 1954 through 2014



Data Source: NOAA/ NWS Storm Prediction Center


US Tornado Deaths/Million People
10
1
0.1
0.01
Deaths/Million
1875
1900
1925
1950
1975
2000
Year

From NSSL

2018 tornadoes

- Unofficially 704 tornadoes in 2018
- FOUR fatalities
- Only the second time in recorded history that there were no fatalities in May and June.
- Oklahoma has had 18 tornadoes (none above EF2). Normal is 62.

THE
END