

Severe Weather Hazards and Storm Chasing



Leah Grant 2011



Angela Rowe May 2004

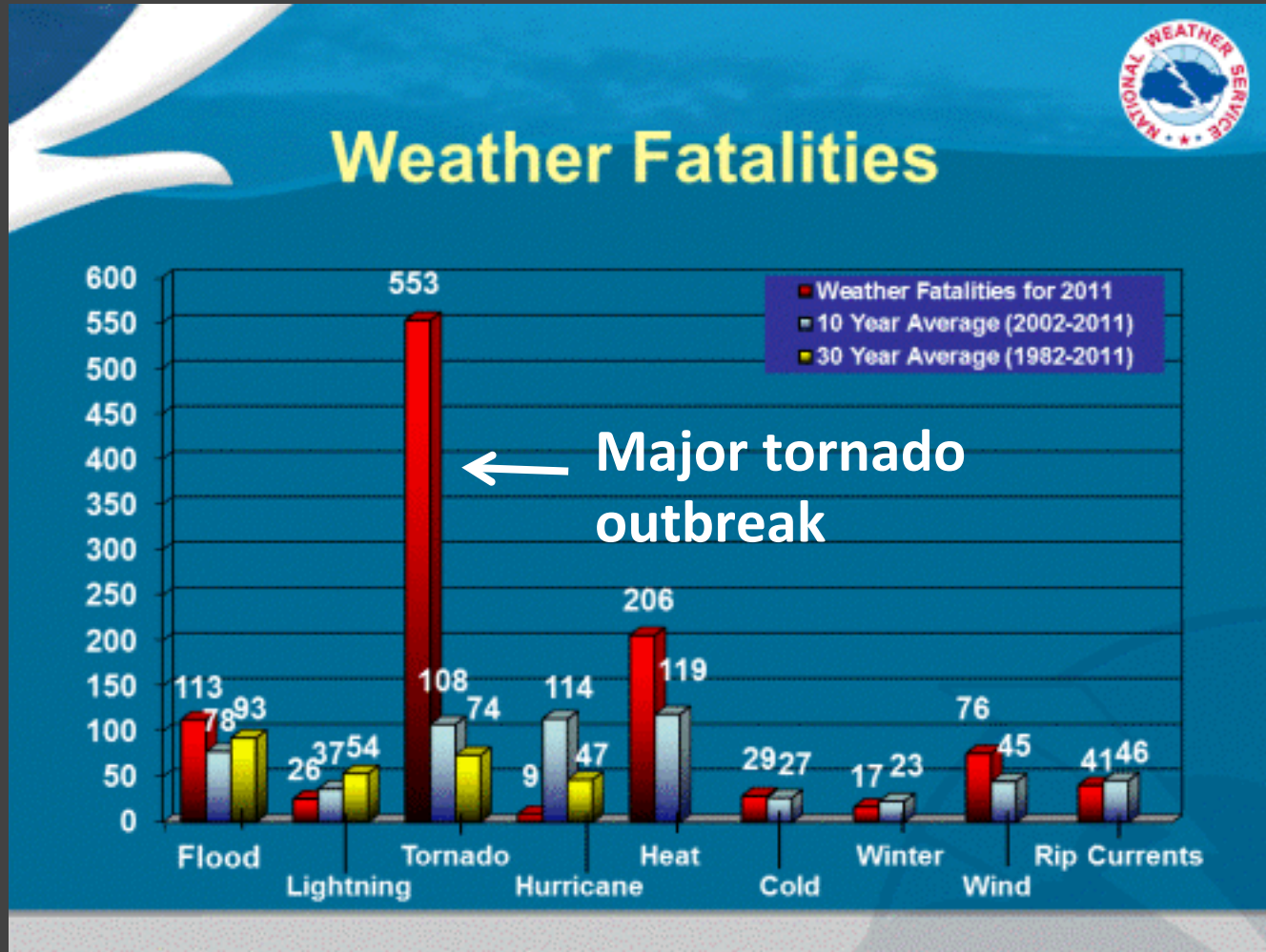


Doug Stolz June 2012

Why do we care?

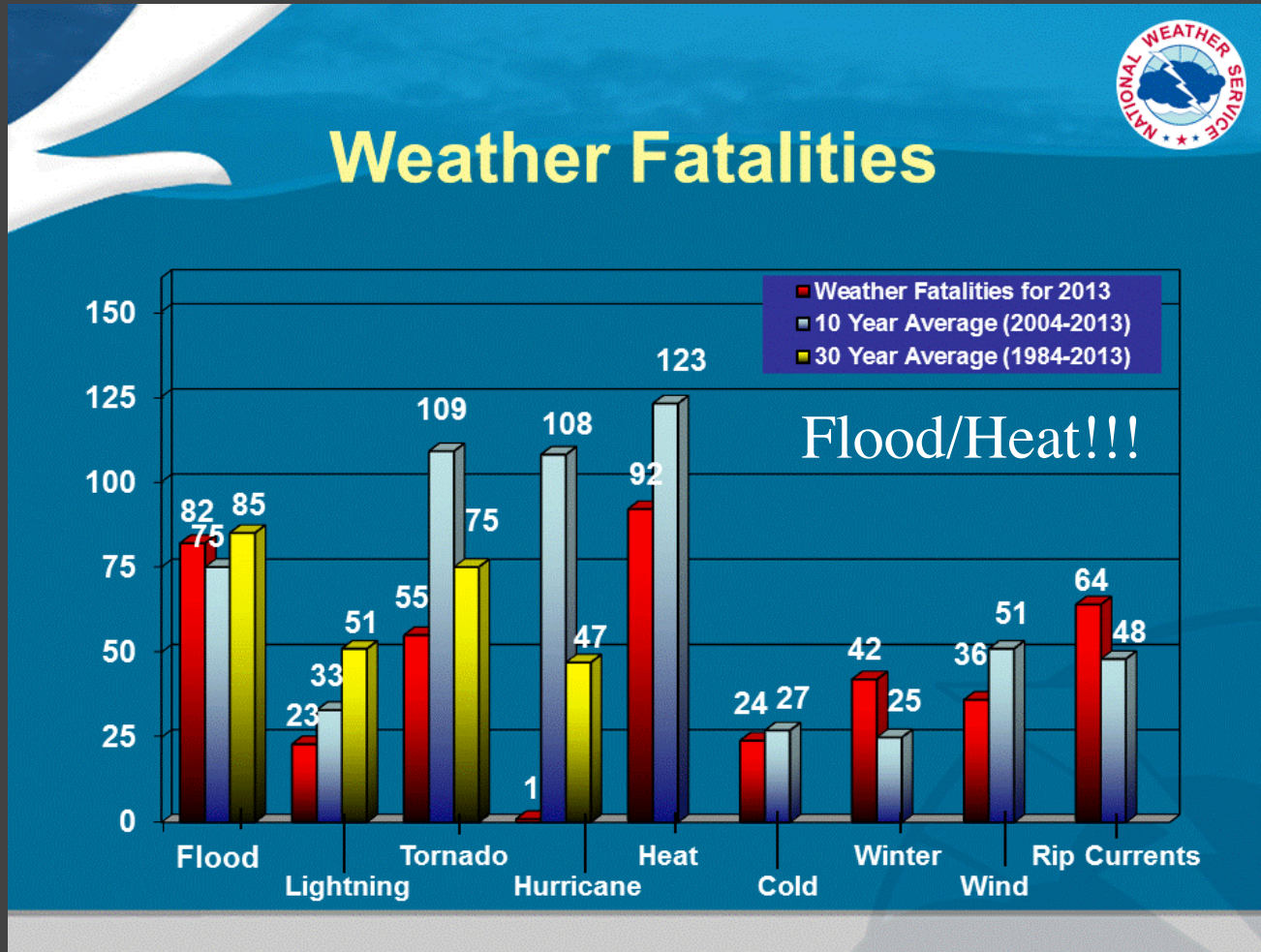


Weather Fatalities: 2011



Source: NOAA

Weather Fatalities: 2013



Source: NOAA

What Makes a Thunderstorm?

What is a thunderstorm made of?

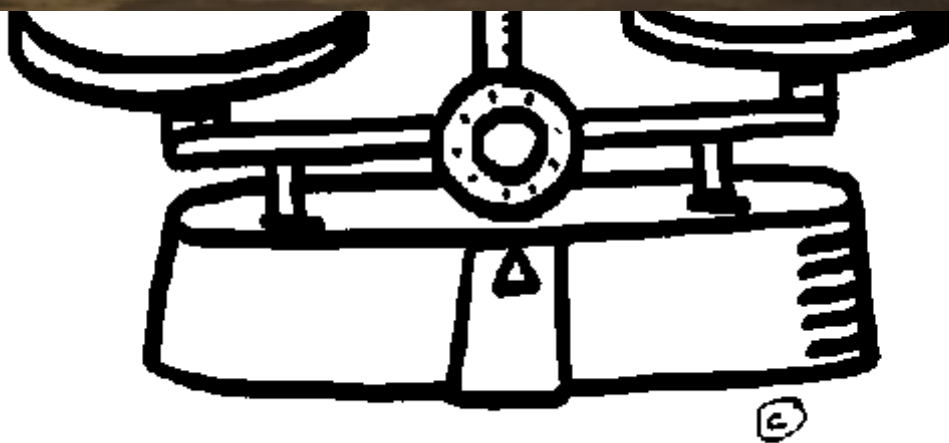


Leah Grant

**What is a
cloud
made of?**

Water!

50,000 cars





**What makes
cloudy air rise?**

Heat!

**This is the
buoyancy force!**

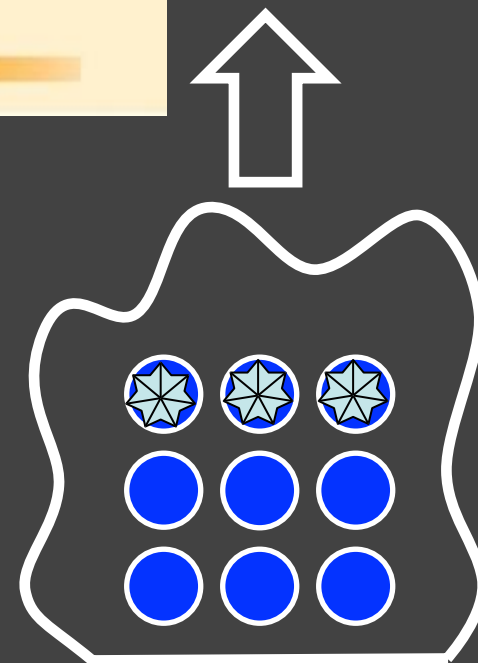
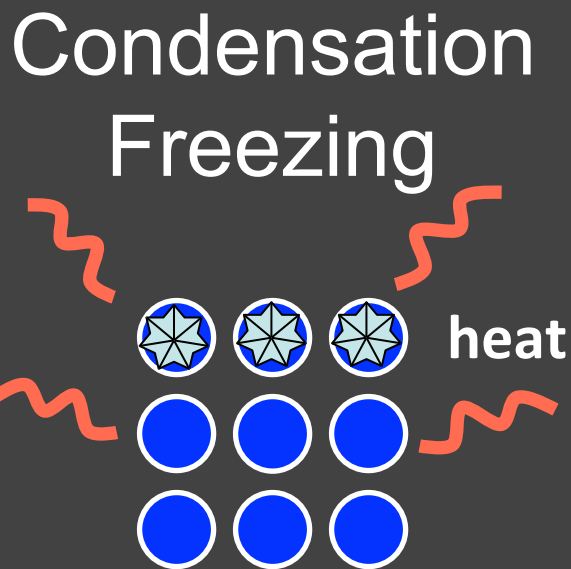
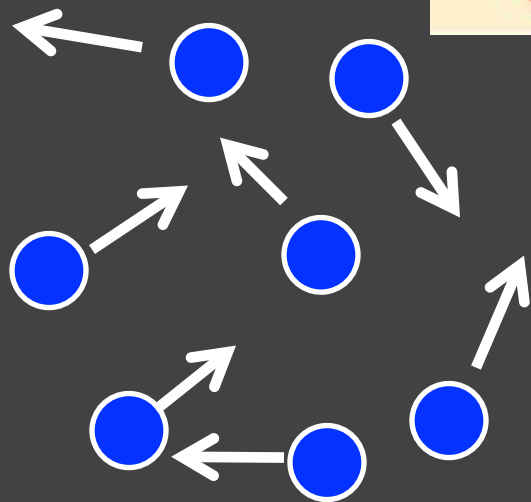
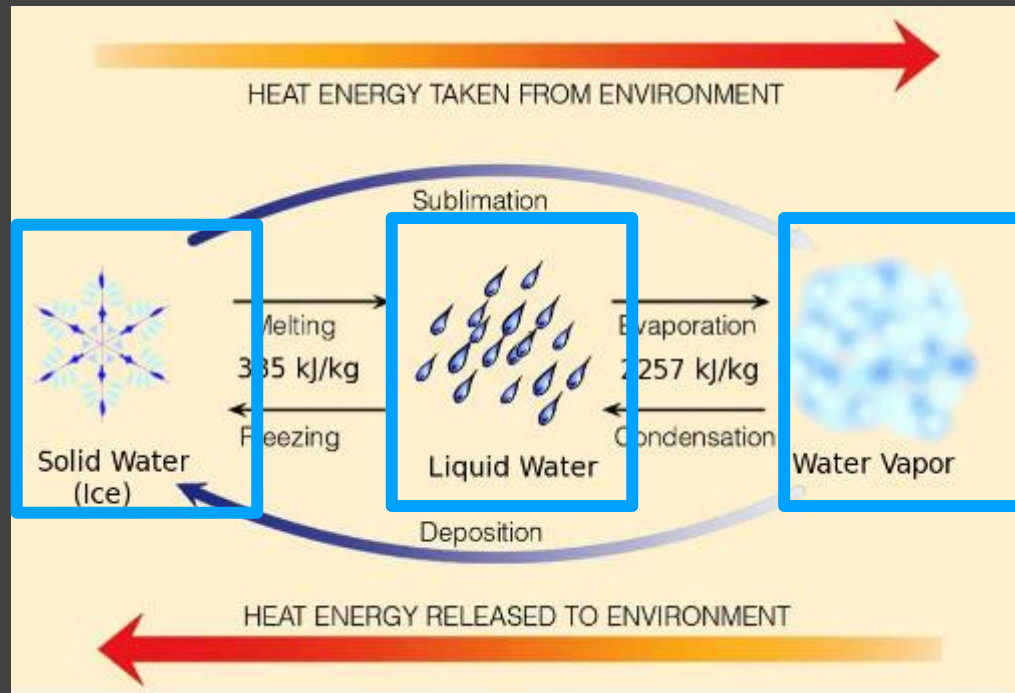


**Where does a cloud get its
heat?**

Latent heat release!

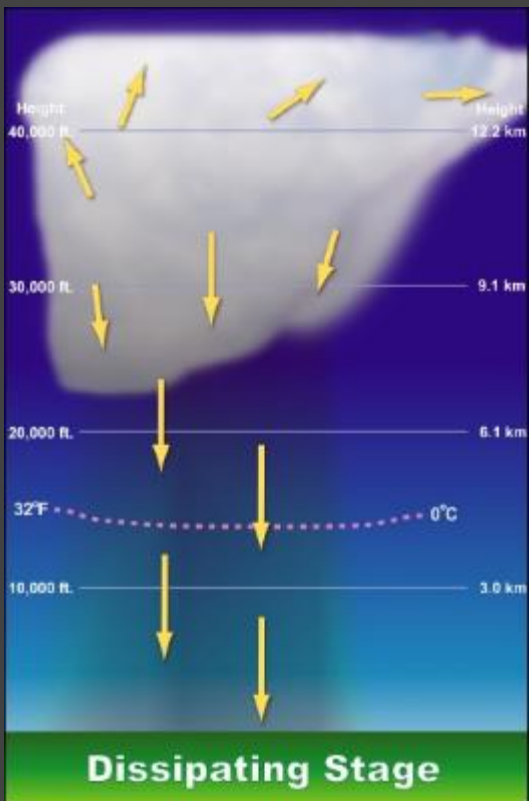
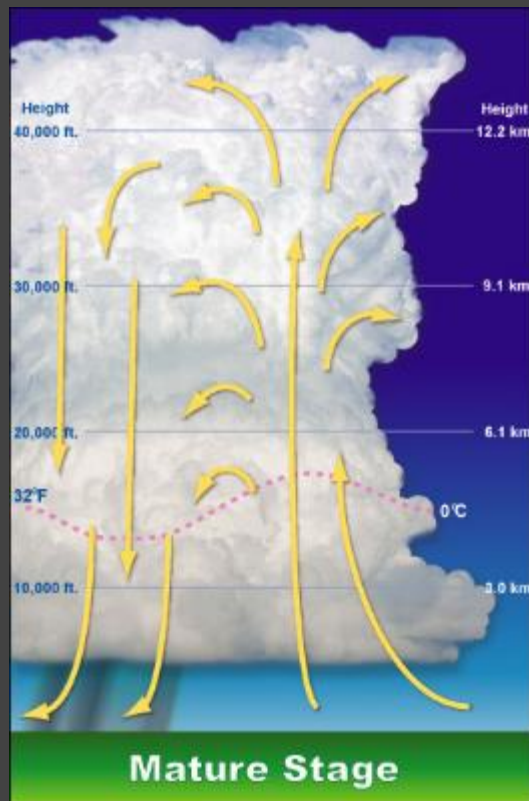
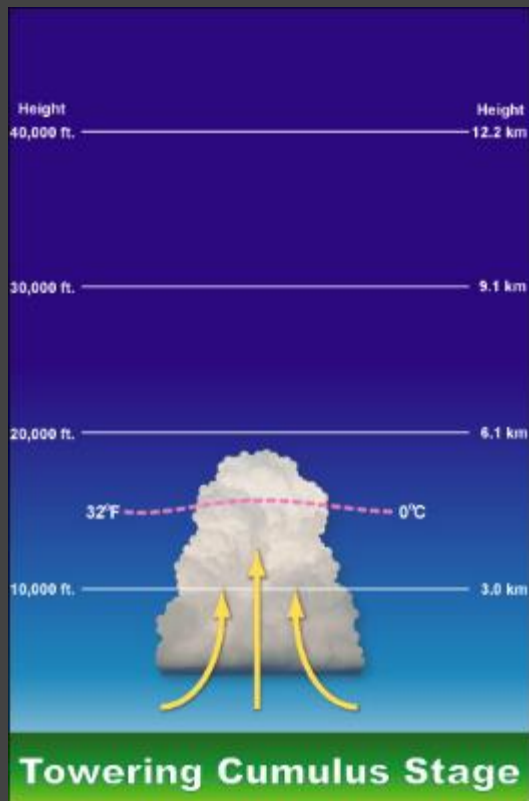
Latent heat release pouches

Website for pouches: http://www.branders.com/product/promotional_items_Heat_Pack_Reusable_Circle_4_?prdid=30961

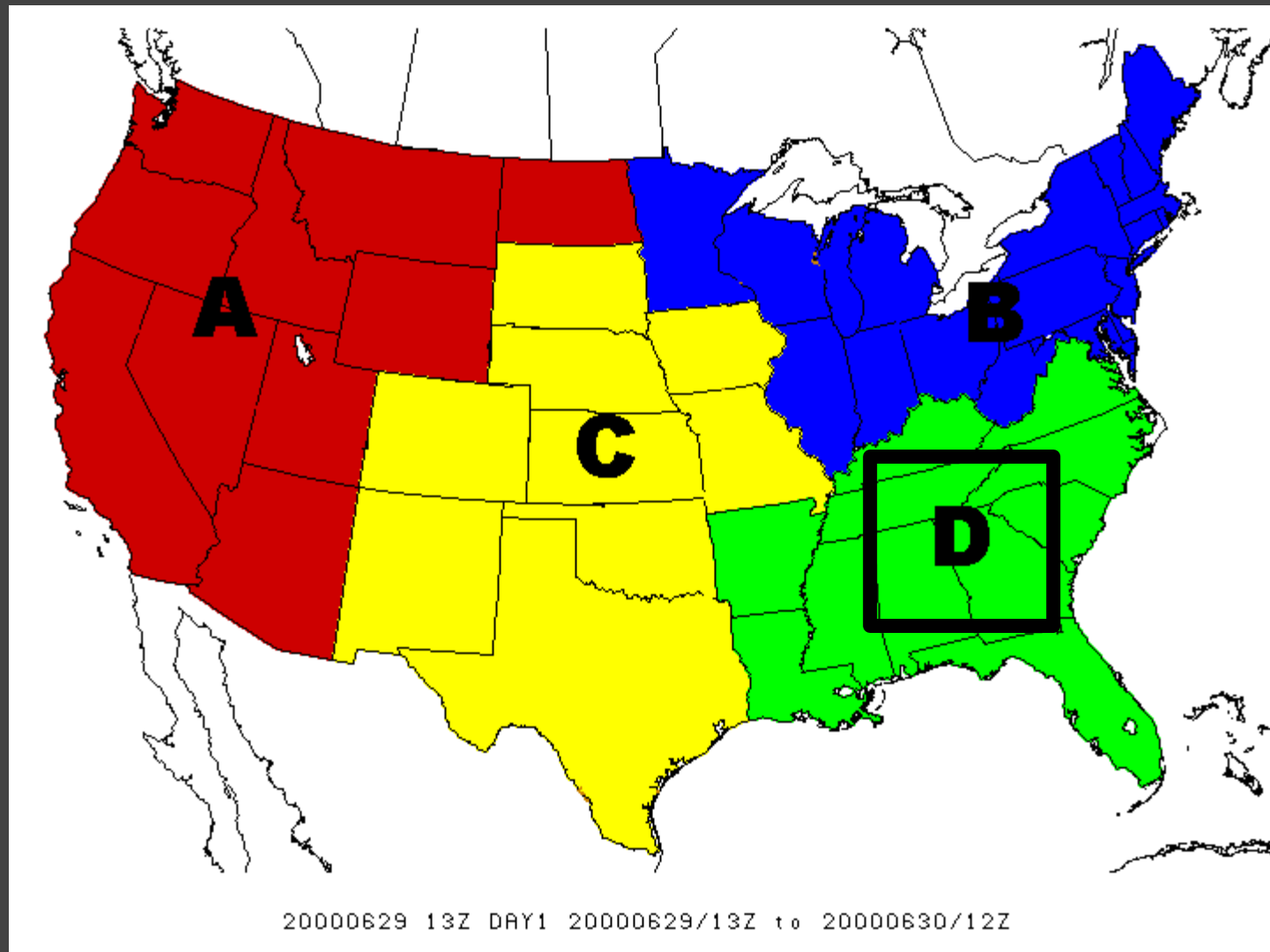


Thunderstorms

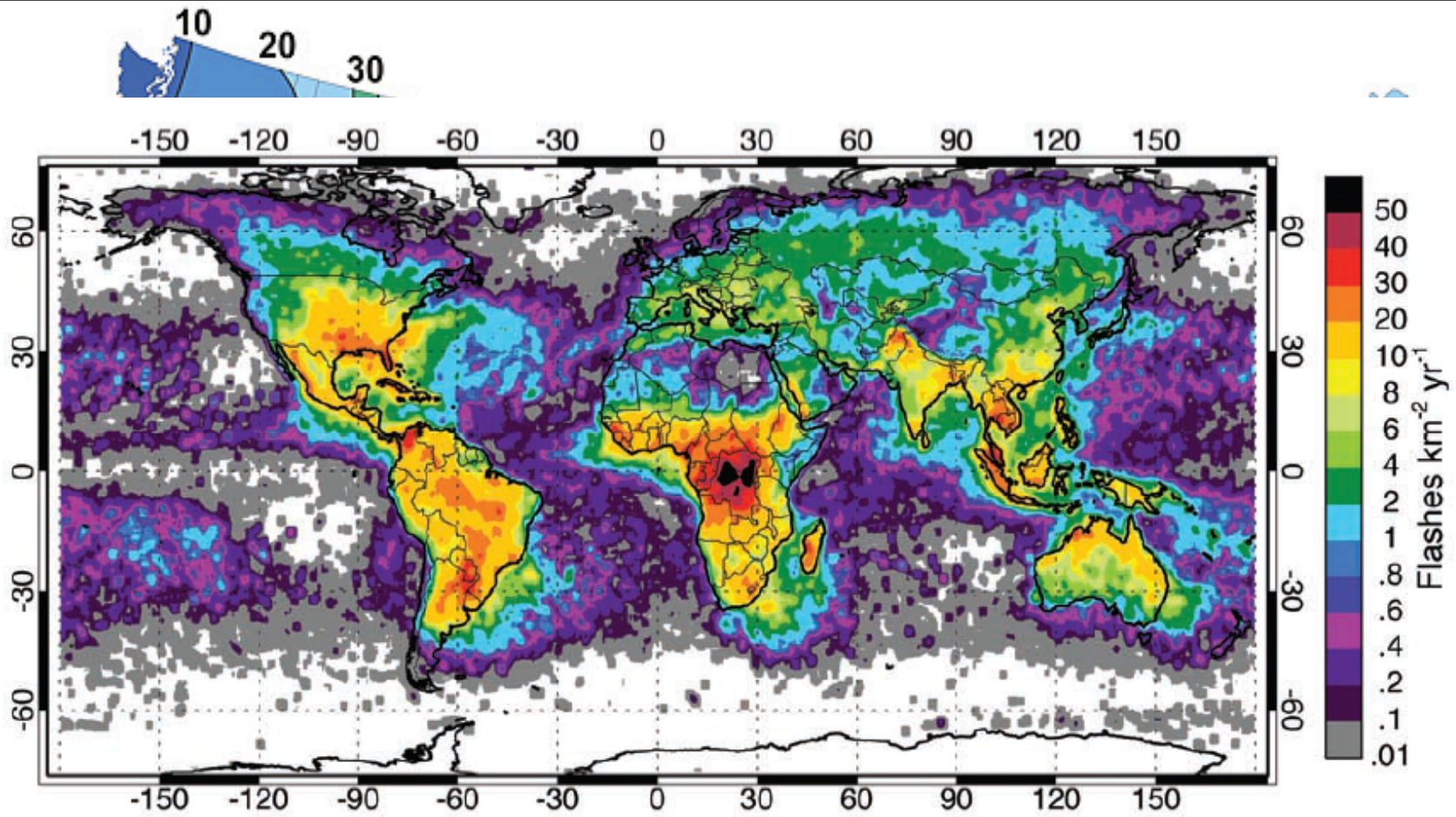
Three stages of an ordinary thunderstorm:



Where do the most thunderstorms occur?



Annual Thunderstorm Activity

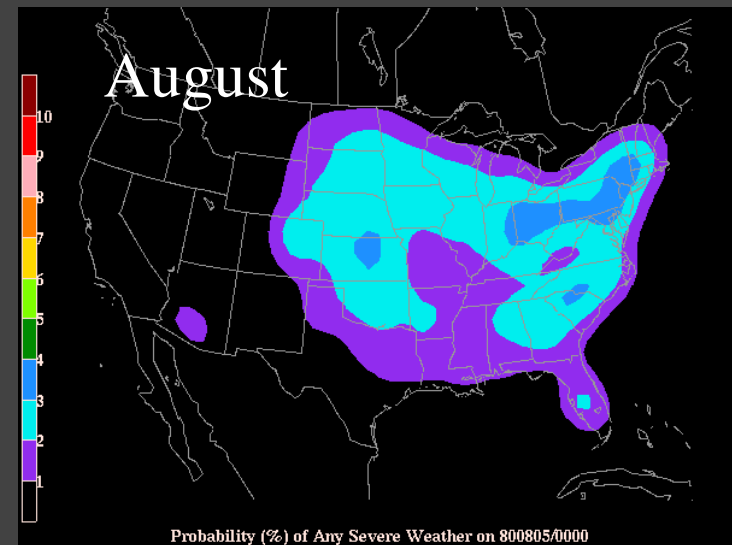
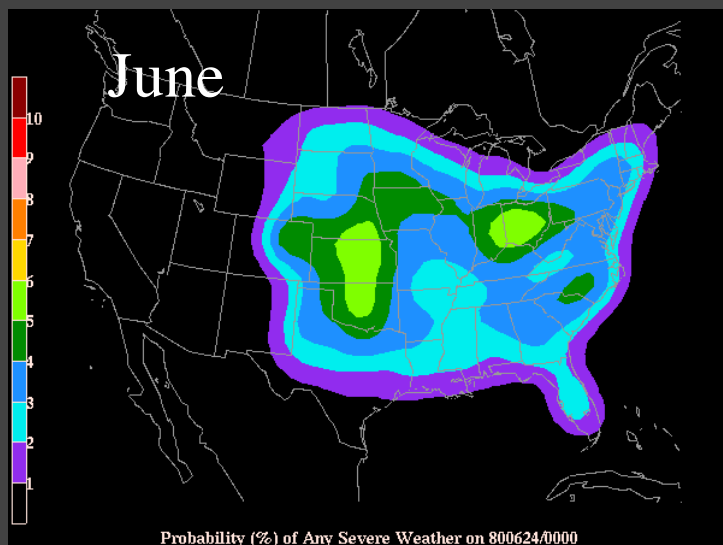
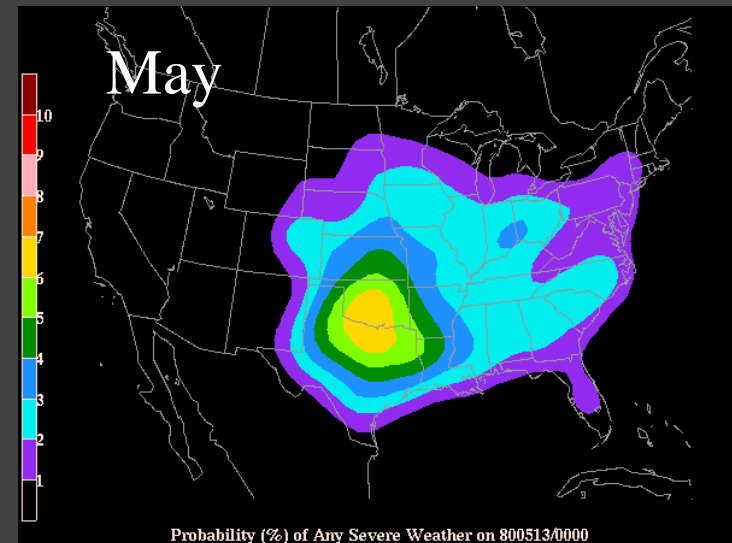
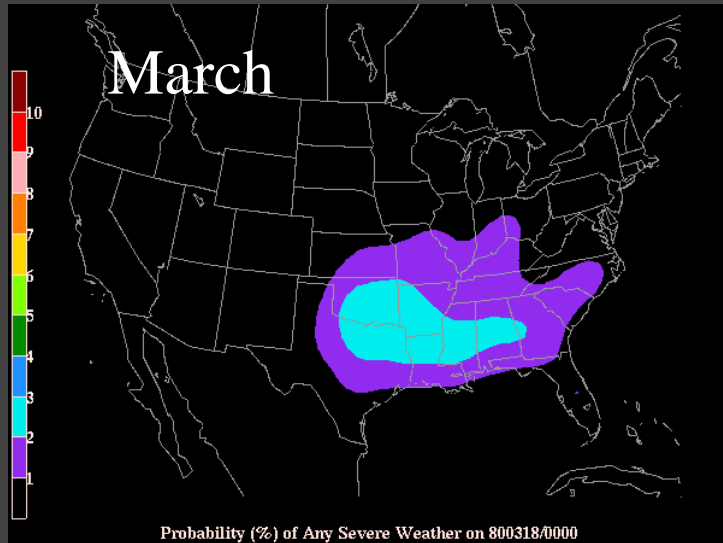


Maritime tropical air



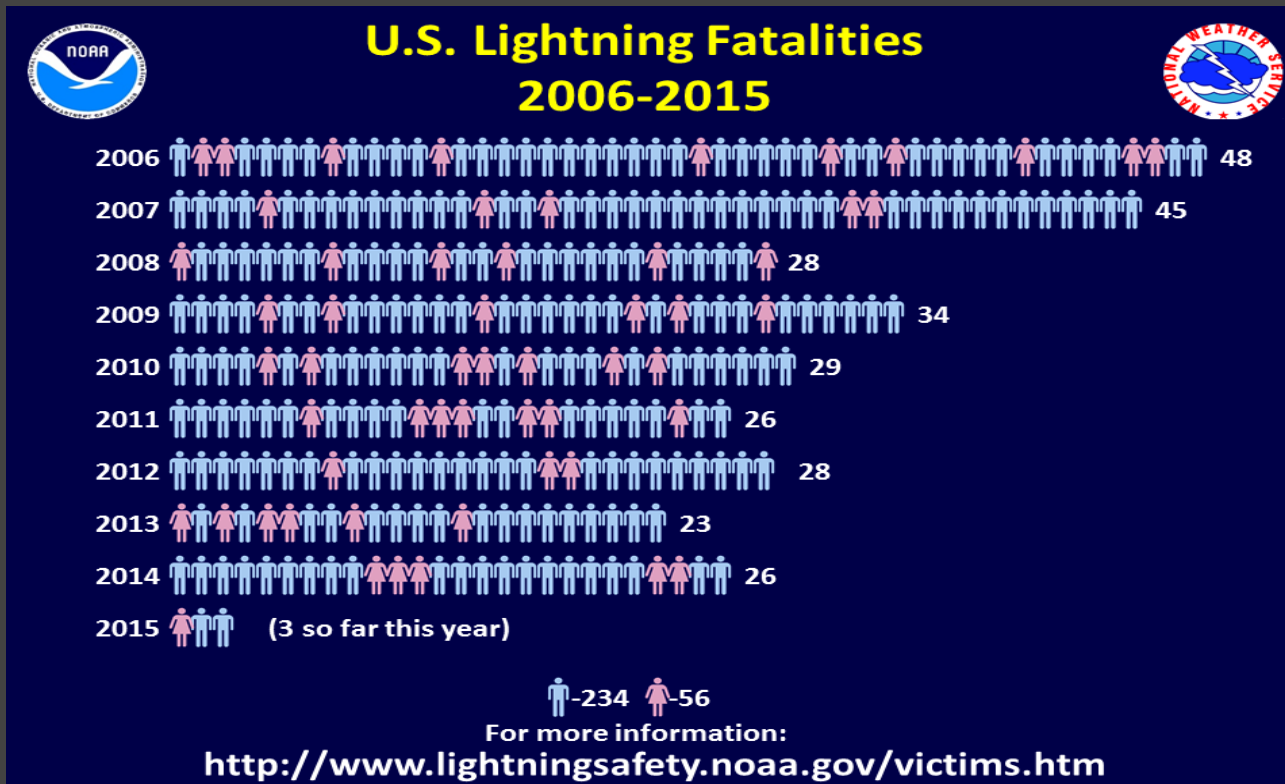
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When do thunderstorms occur?



Common Dangers of Thunderstorms

Lightning



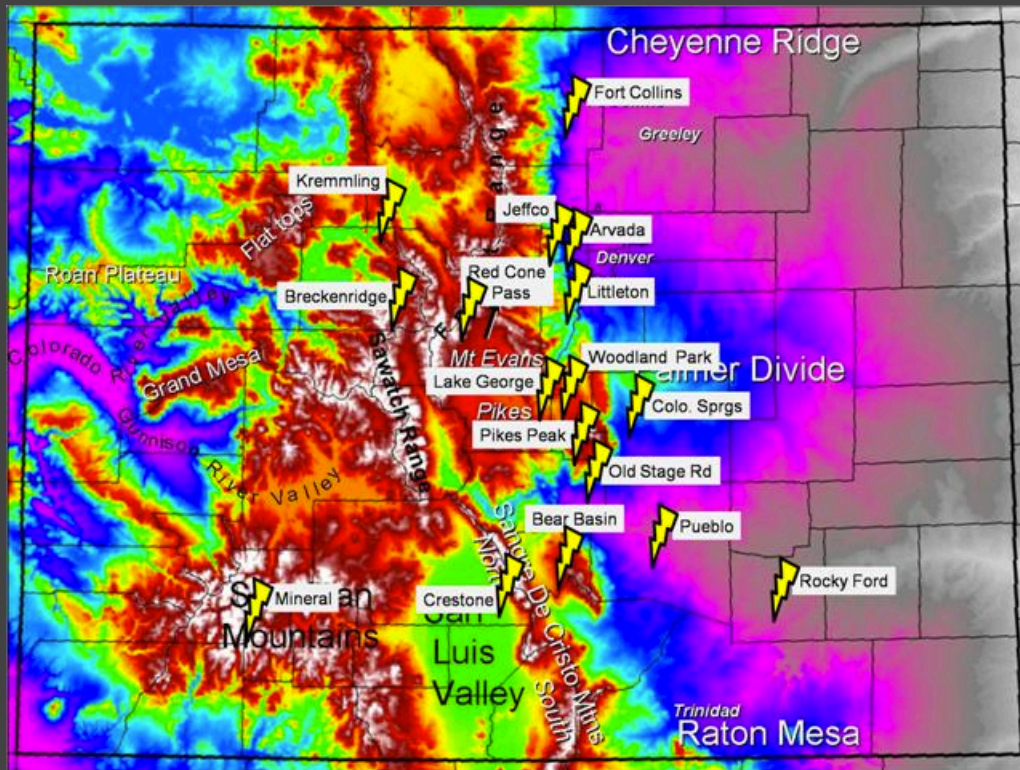
- Approximately 10% of lightning strikes fatal
- Lightning also causes billions of dollars in damages
 - Electronics, aviation, wildfires (High Park, 2012)

<http://warnerimages.smugmug.com/Video>

Colorado Lightning

Lightning deaths in CO

Sept 2007: tent fatality (west of CO Springs)



“The key to being safe in a thunderstorm is to get to a safe place before the lightning threat becomes significant”

—J.S. Jensenius, NWS, Lightning Safety Specialist

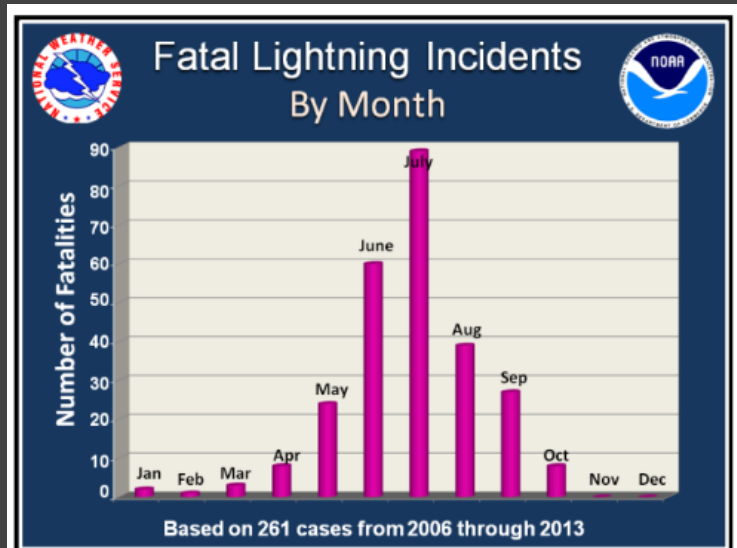


Figure 3.3 Number of lightning fatalities from 2006 through 2013 by month.

Lightning: how does it work?

License available at WeatherVideoHD.TV



Time: Fri Aug 03 2007 19:23:24.186 536
Img#: -13624 AcqRes: 640 x 480 Rate: 7207 Exp: 135 μ s Durat: 0.436 s

Tom A. Warner

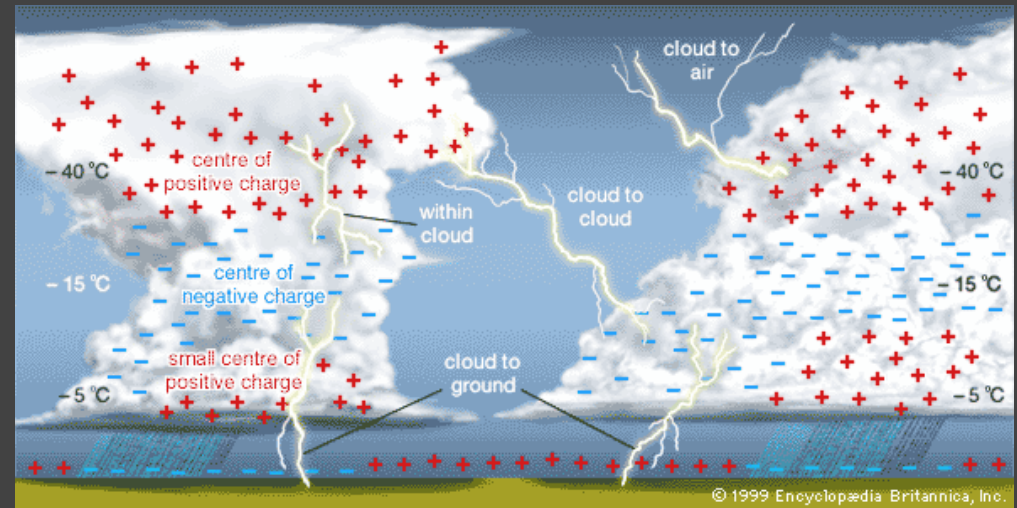


Lightning Attachment

from ZT Research PLUS 10 months ago ALL AUDIENCES

<https://vimeo.com/99036081>

Lightning: how does it work?

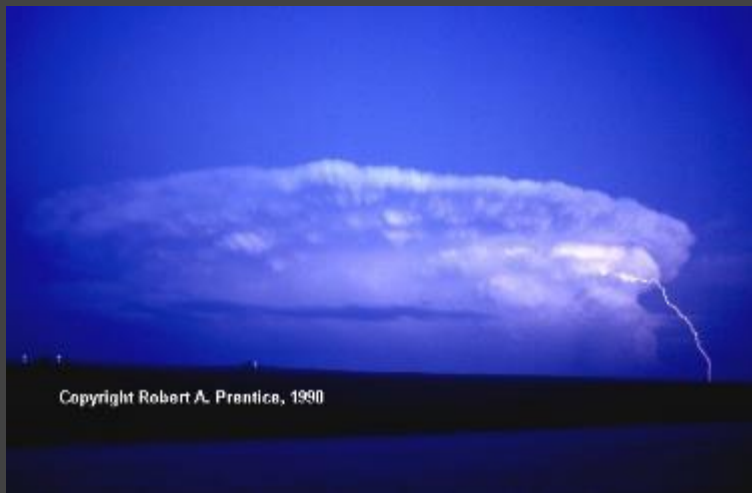


- Key to charge in cloud: large ice particles (hail and graupel)
- Lightning neutralizes regions of charge
- “Step leaders” seek something on Earth discharge the cloud
- Most flashes occur in-cloud, sometimes difficult to diagnose lightning threat
- Can heat the air to $30,000^{\circ}\text{C}$
 - More than twice the surface temperature of the sun!

“If thunder roars, go indoors”

- * Thunder caused by heating of air in lightning channel
- * Sound travels 1 mile every 5 seconds
- * 30/30 RULE
 - If less than 30 seconds between lightning and thunder, **SEEK SHELTER**
 - Stay inside 30 minutes after last clap of thunder

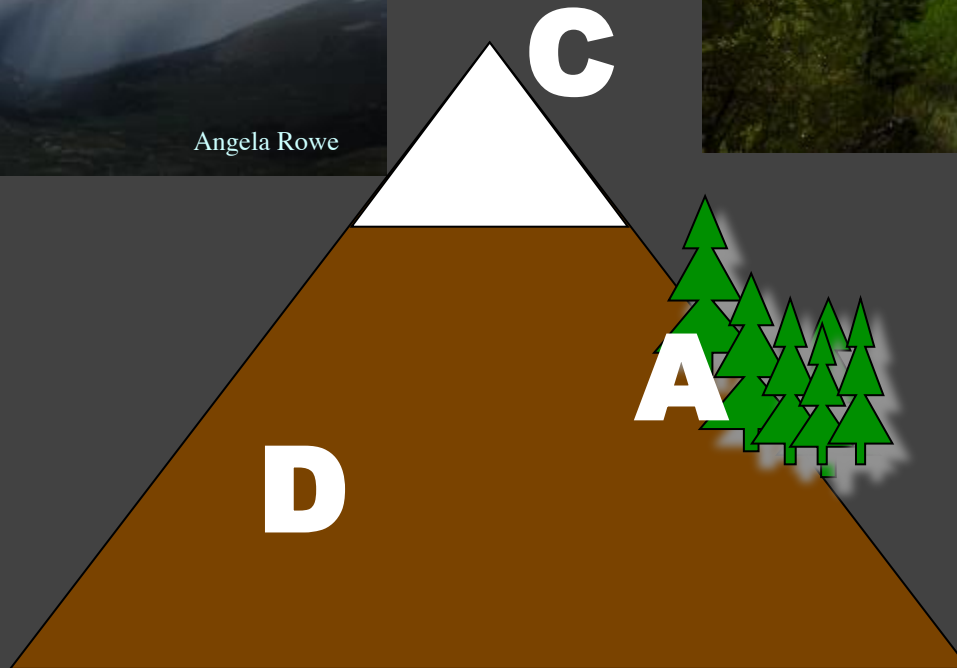
“Bolt from the blue”



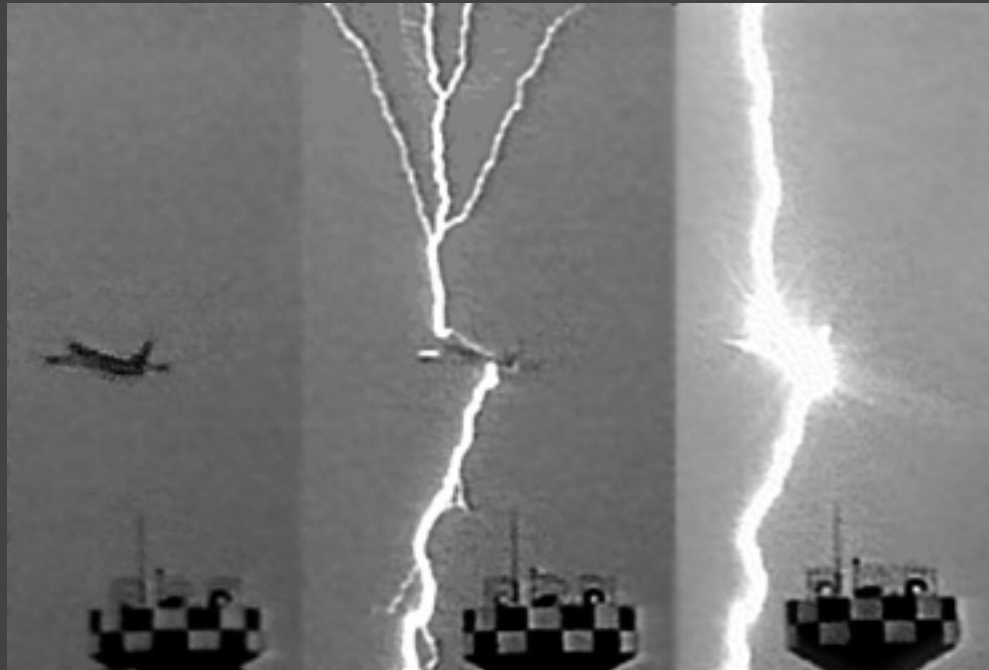
Courtesy of Beth Stuckmeyer

Link: <http://www.lightningsafety.noaa.gov/struck.shtml>

Where is the safest place to go?



B



<http://schlicks.files.wordpress.com/2010/10/lightning-strikes-plane.jpg>

Lightning Facts

- If you hear thunder, you're within striking distance
- If a building is unavailable, get inside a vehicle
- Avoid:
 - Tall isolated objects (these are like lightning rods!)
 - Don't be a tall isolated object!!!
 - Electronic equipment (e.g., landline phones, computers)
 - Water/plumbing/shower

More safety info:

www.nws.noaa.gov/os/lightning/resources/CoachGuide.pdf

Colorado Flood: Sep 9–15 2013

8 killed, 6 missing

Over \$1 Billion in damages



https://www.youtube.com/watch?v=XwbdAJGvj_o

Big Thompson (July 1976)



139 people killed

Flooding

- Most flood deaths are vehicle-related
- Areas near rivers are especially prone to flash flooding during heavy rains



Supercells

Leah Grant, 2010



James Ruppert, 2011

Supercells



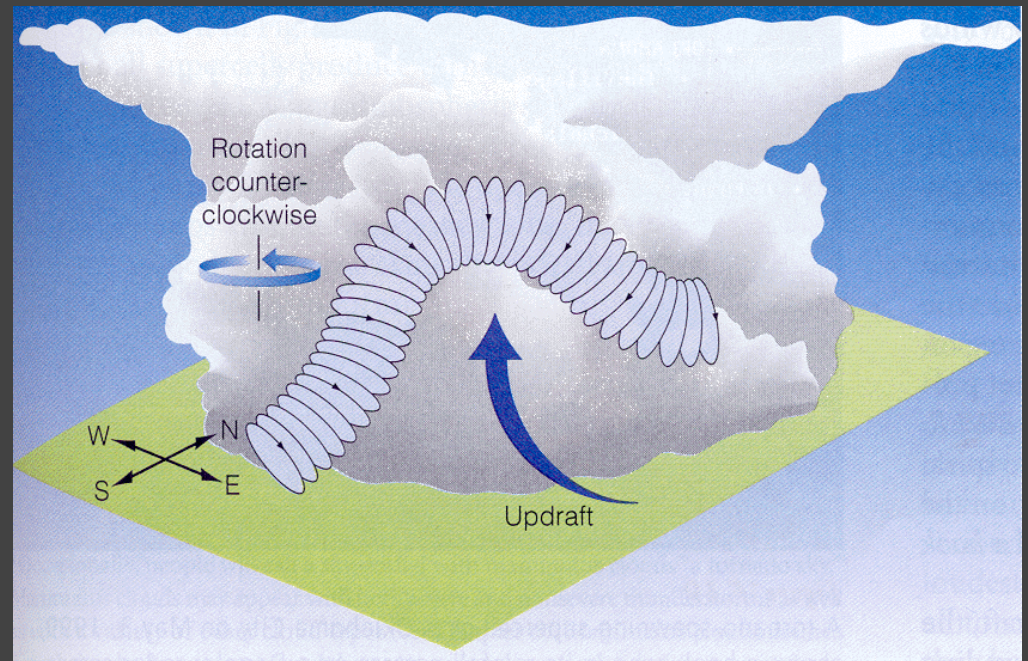
Time lapse photography

© 2005, Kevin Tory & Wesley Terwey

[Time lapse video: May 18 2014 Wyoming supercell](#)

What makes a thunderstorm a supercell?

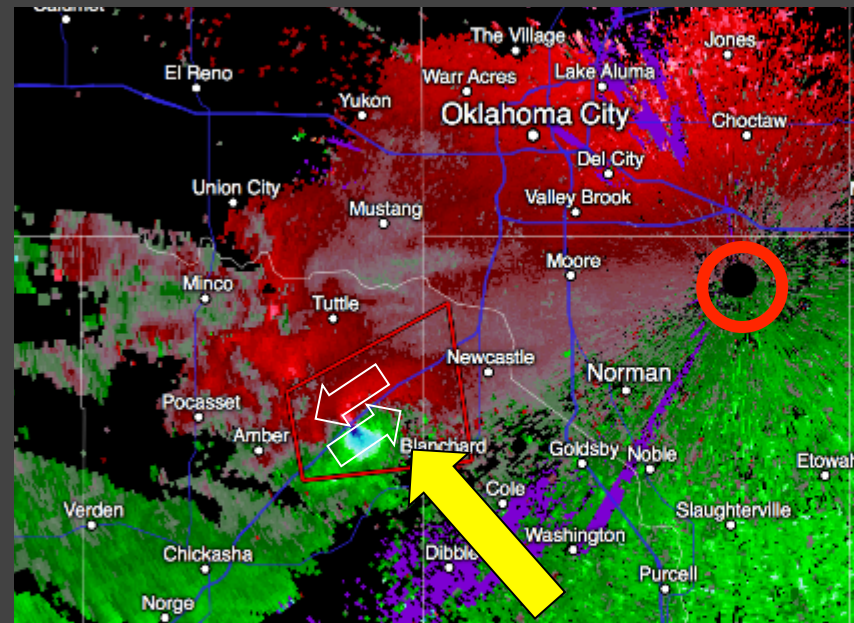
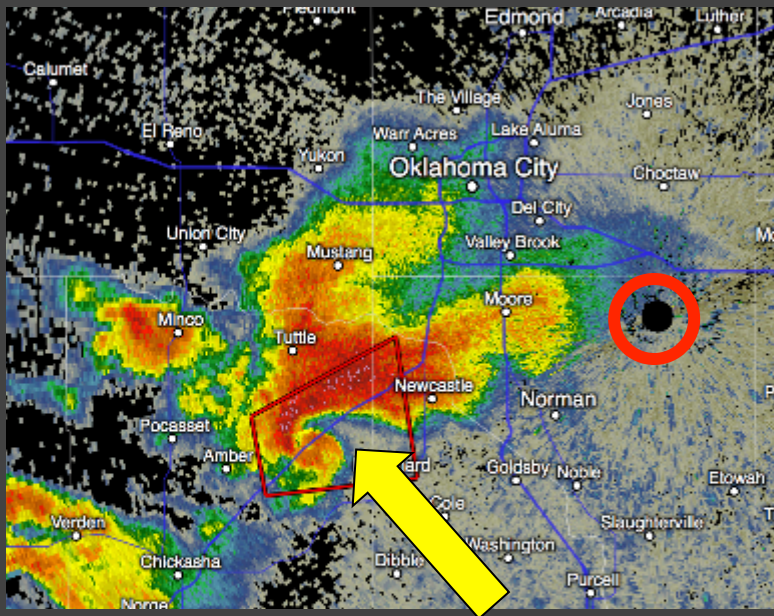
- When wind changes speed or direction with height (“wind shear”), rotation can form



Demonstration!

Supercells on radar

- Hook echo
- Rotation in velocity field



Green = toward the radar, red = away

May 5, 2015 tornadic supercell near Oklahoma City

What are the 3 types of “Severe” weather according to the NWS?

- Hail (1.0 inch or greater)
- Strong winds (at least 58 mph)
- Tornado of ANY strength



Leah Grant



Angela Rowe

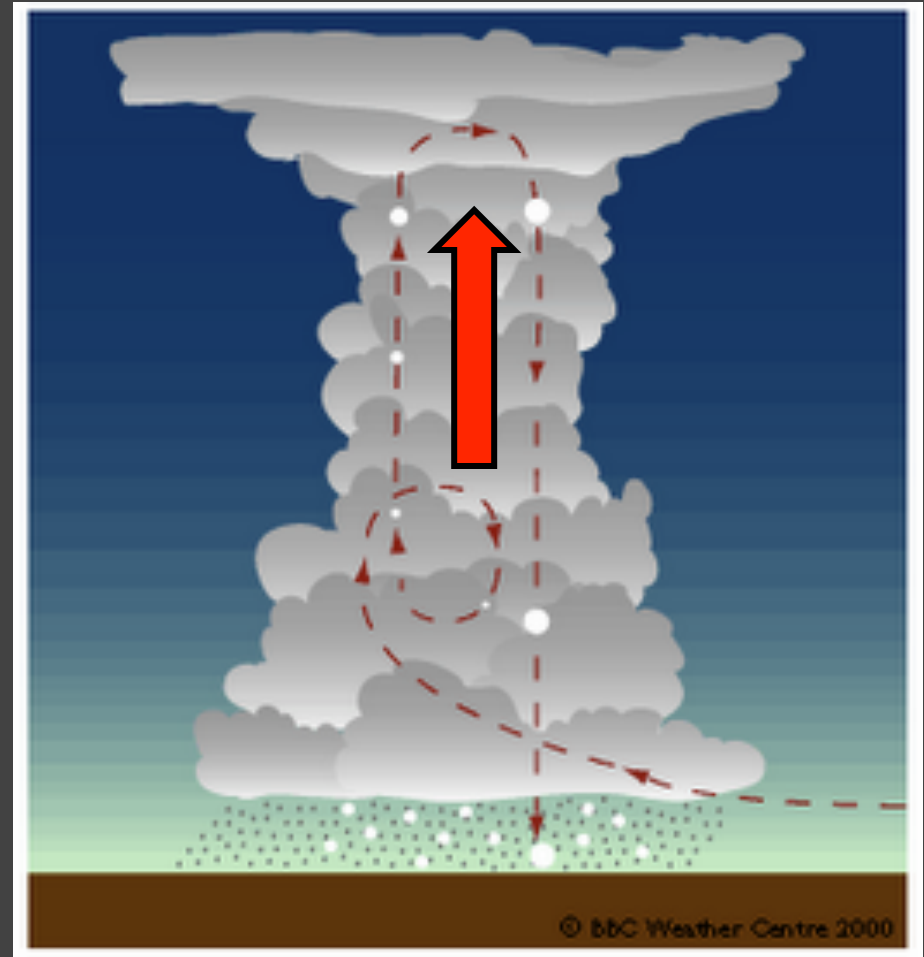
Hail



Video

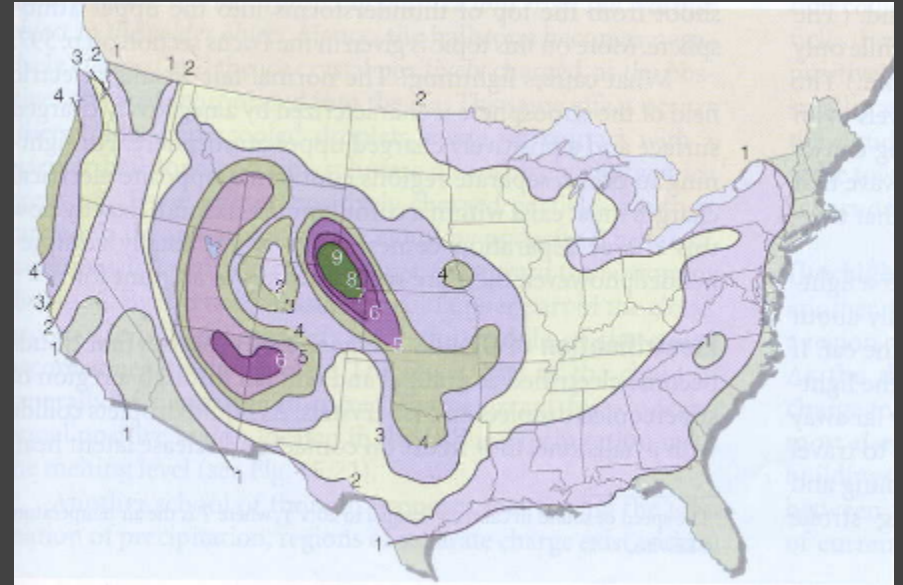
Hail

- Water droplets freeze high in the atmosphere
- As they go up and down within thunderstorm, their surface can melt, refreeze, melt, refreeze...
- This continues until large enough to fall out
- ***The stronger the updraft, the larger the hailstone can get***



Hail in Your Backyard

- Hail season: March-October
- May & June has the most hailstorms
- July & August have the most severe hailstorms



Rachel Storer



Beth Stuckmeyer

Hail Facts

- Around \$1 billion in damage every year in the U.S. to property and crops
- Largest hailstones can fall faster than 100 mph!
- Largest hailstone: July 23, 2010 in Vivian, SD (>8" in diameter)



Hail



>5 inches

Severe Wind



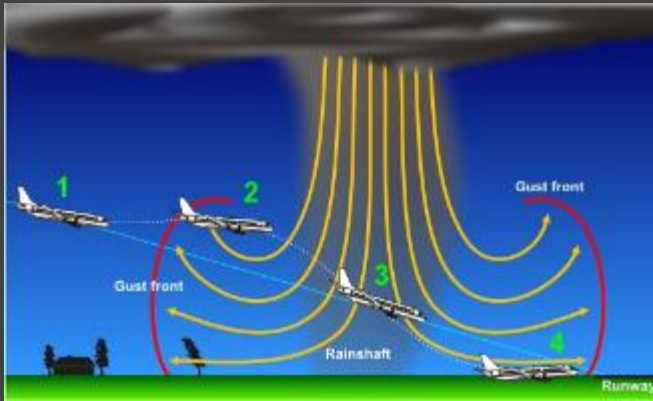
Thunderstorm Outflows



- Reds next to green rotation!!
- Air spreading close

Severe Wind

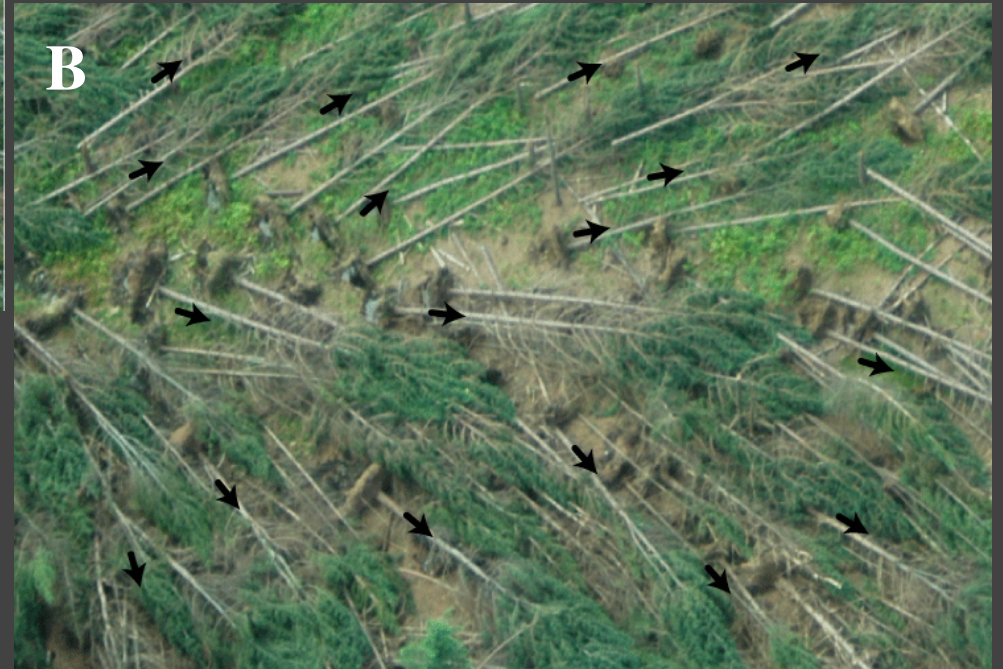
- Condensation → warming and rising
- Evaporation → cooling and sinking → “microburst”



Dust storm called a haboob over Phoenix, AZ 2011

Severe Wind

- Severe wind damage vs tornado damage?



Tornadoes

Tornado outbreak: April 2011
Tuscaloosa (Videos 5 and 6)

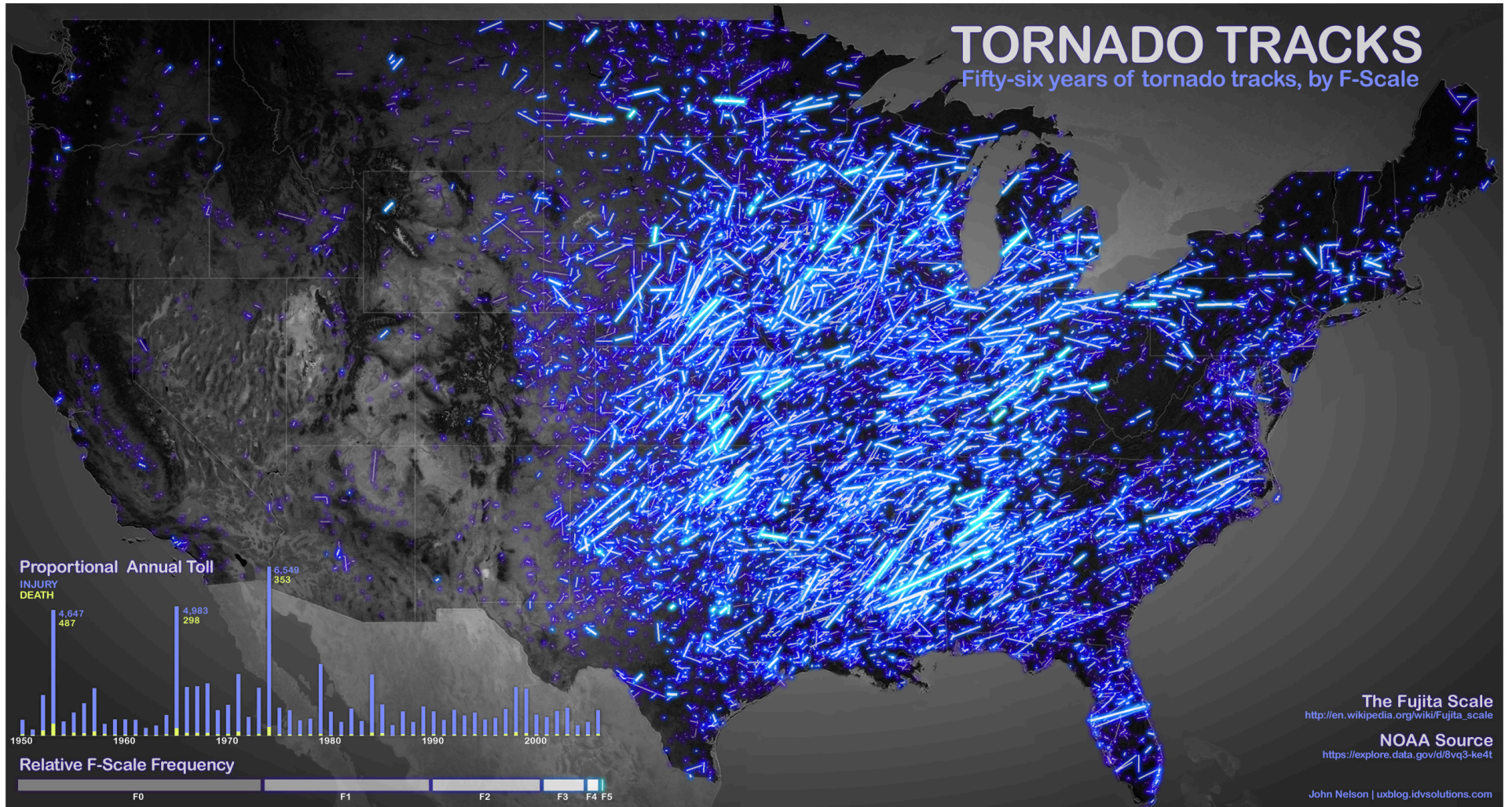
Tornadoes

- The key process:
Conservation of Angular
Momentum

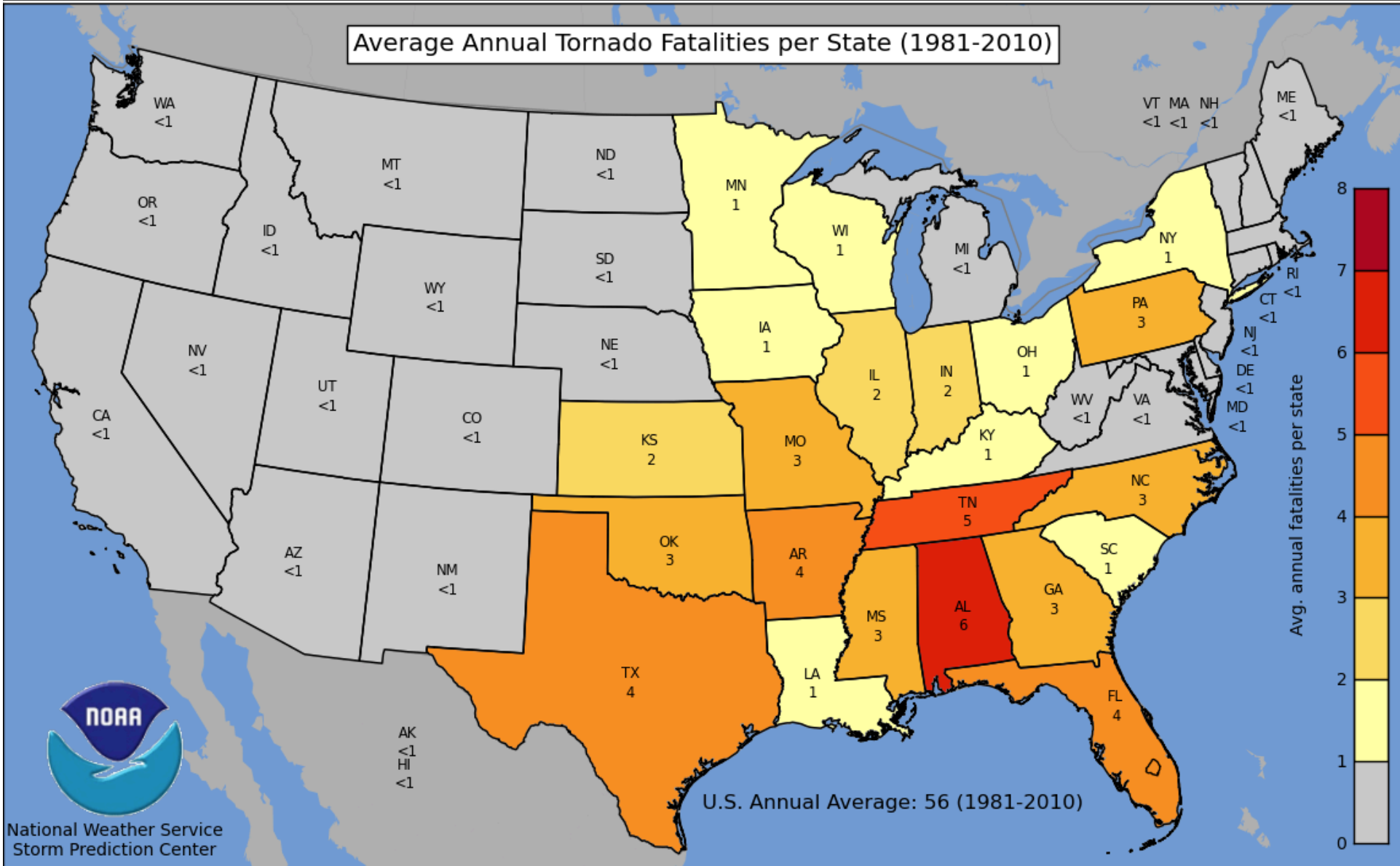
Demonstration!



Historical Tornado Tracks

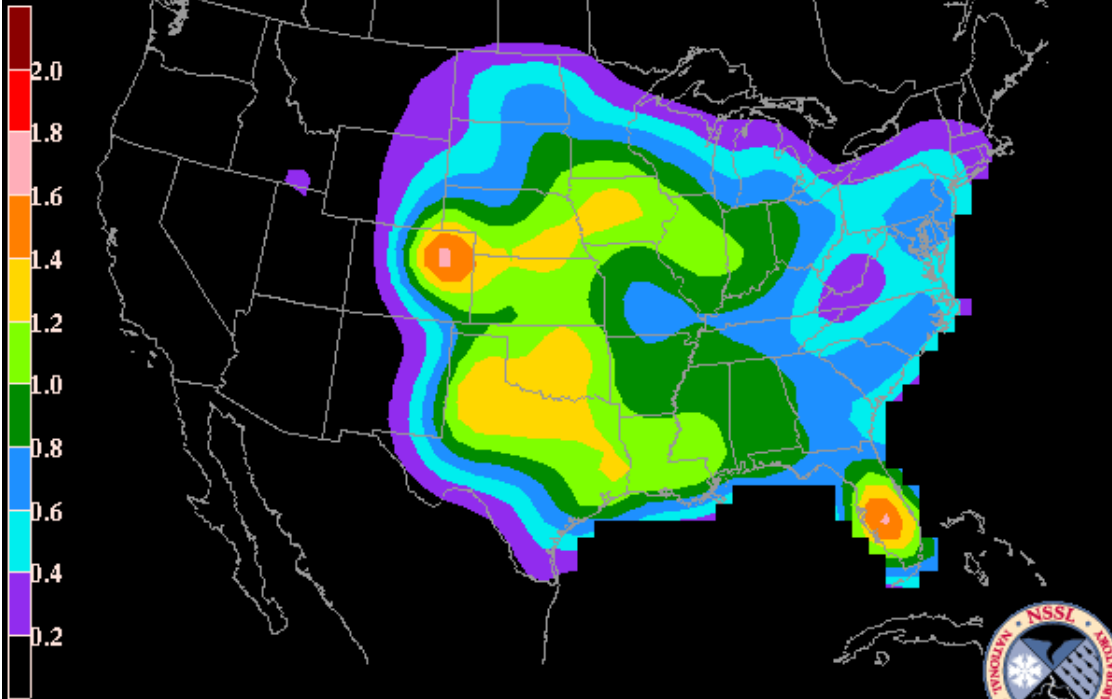


Average Annual Tornado Fatalities per State (1981-2010)



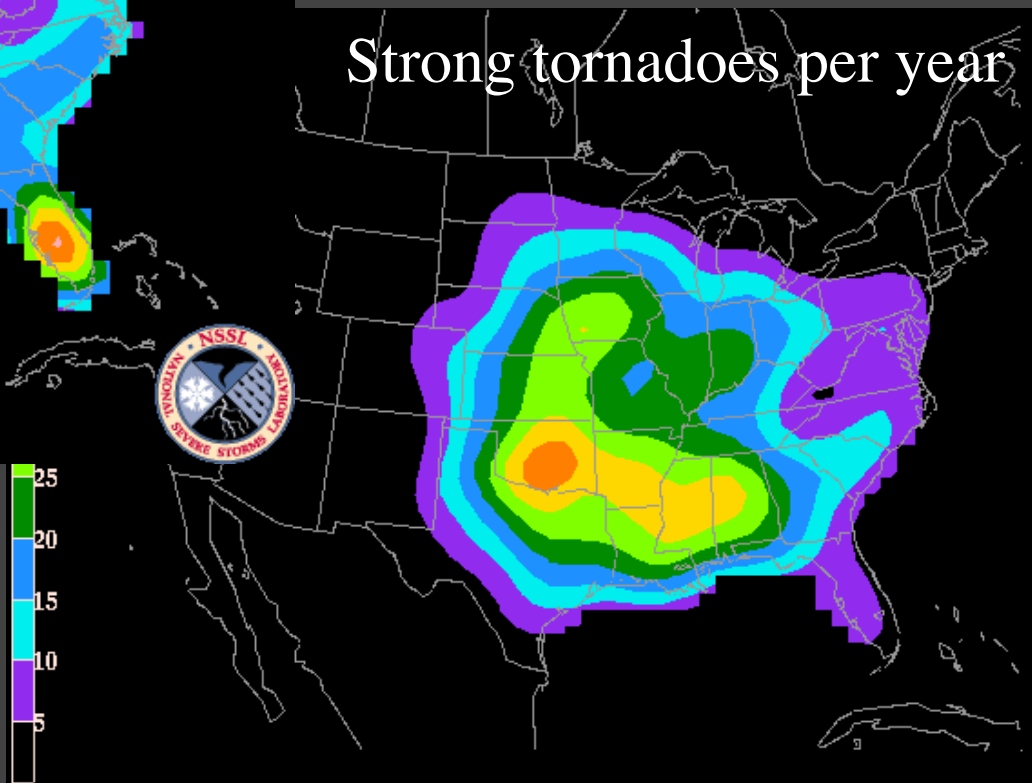
Tornado Climatology

Number of tornadoes per year



Tornado Days Per Year (1980–1999)

Strong tornadoes per year



Significant (F2 or greater) Tornado Days Per Century (1921–1995)

Colorado has a lot of tornadoes,
but most are weak

Tornadoes



Before a tornado forms, a “wall cloud” will lower beneath the main rotating updraft

Tornado?



- A: left
- B: right
- C: neither
- D: both

Enhanced Fujita Scale

OPERATIONAL EF SCALE	
EF #	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

The Enhanced Fujita Scale is based on damage surveys that happen after the storm



May 22nd 2008, Windsor, CO (EF3)



Tornadoes & the EF Scale

Violent tornadoes are rated EF4 or EF5.



EF4

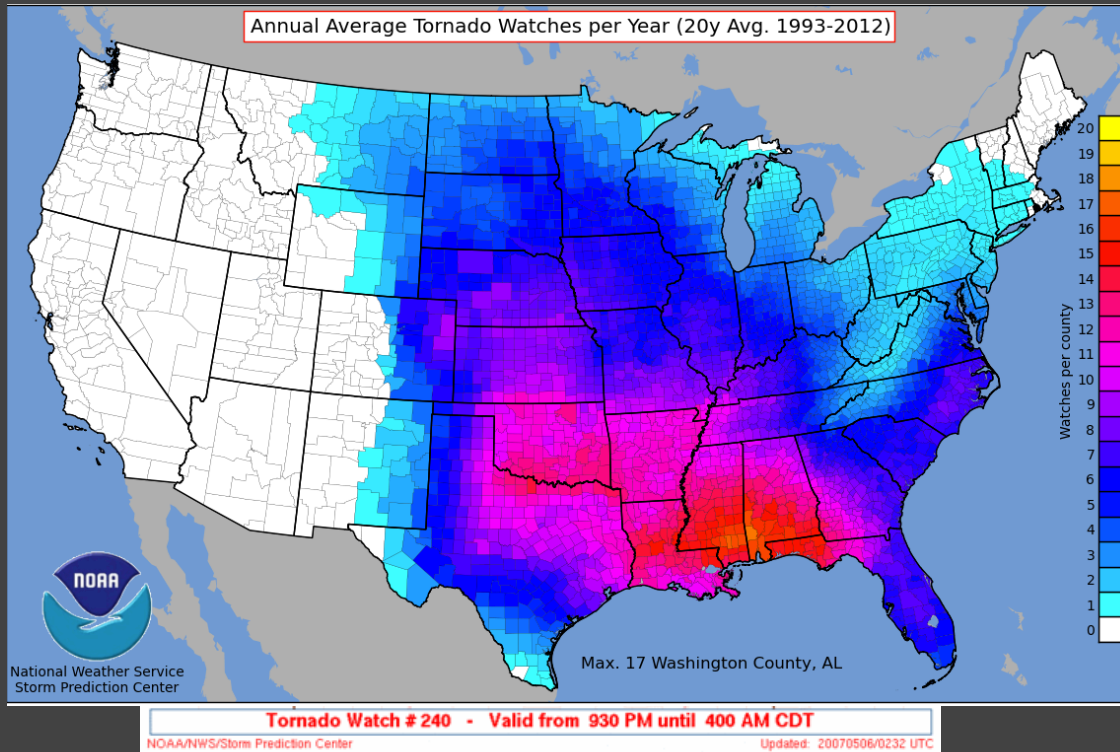


EF5: Greensburg, KS (May 4, 2007)



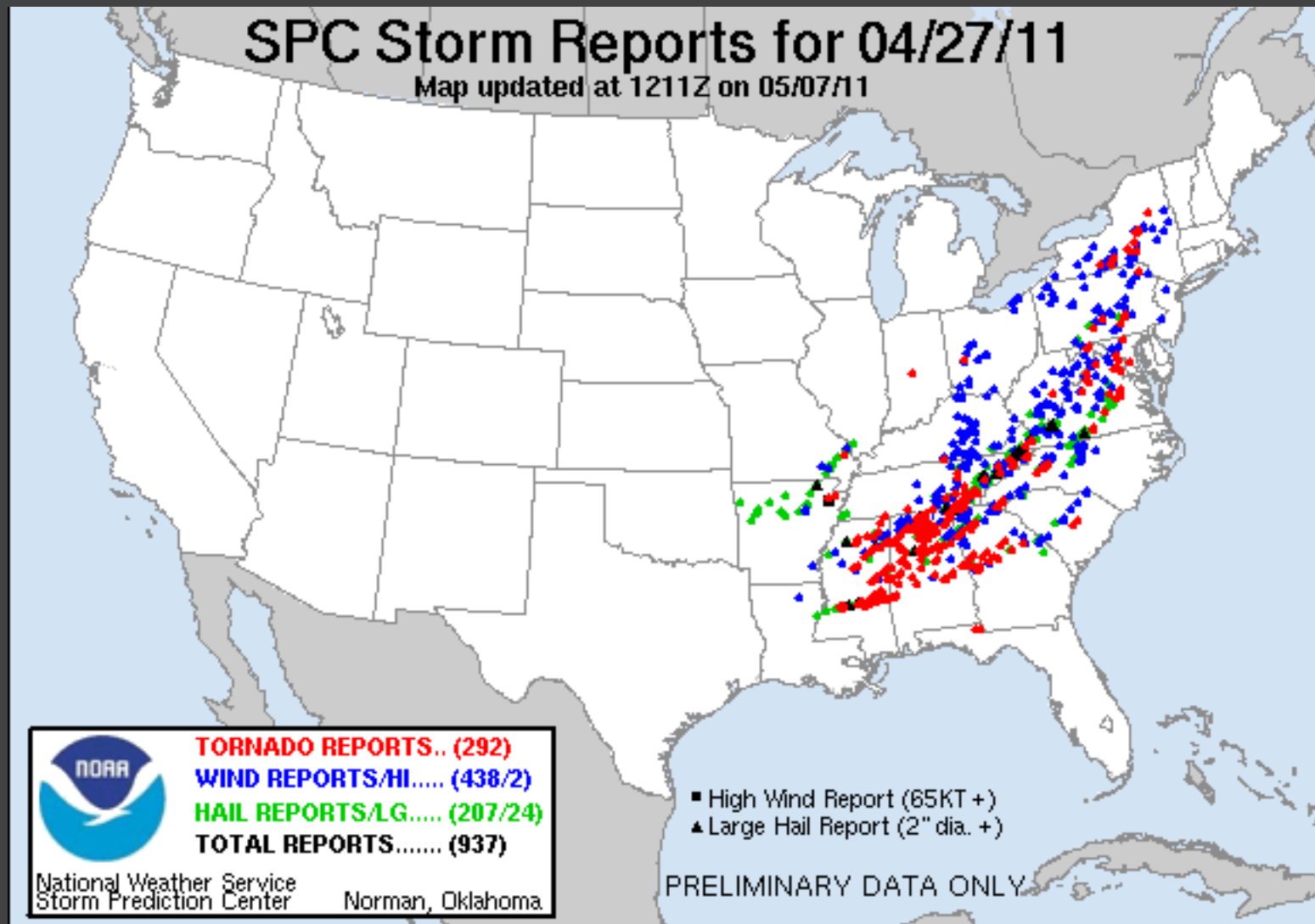
Tornado Watch

- Conditions exist that favor tornadoes over a broad area
- Gives you an idea of where tornadoes are most likely to happen



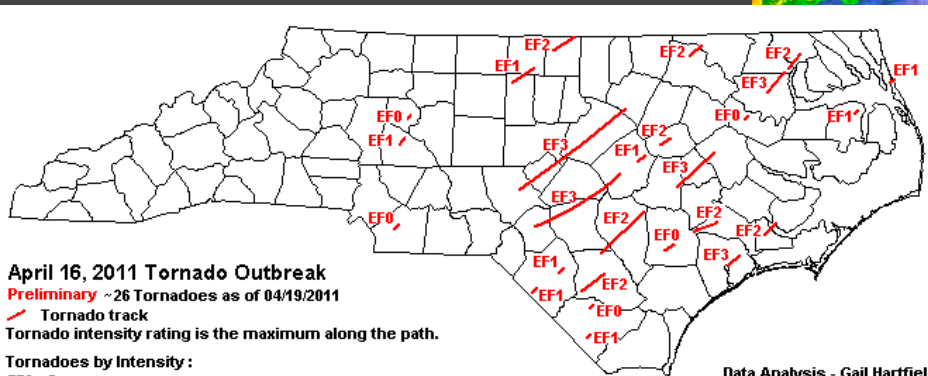
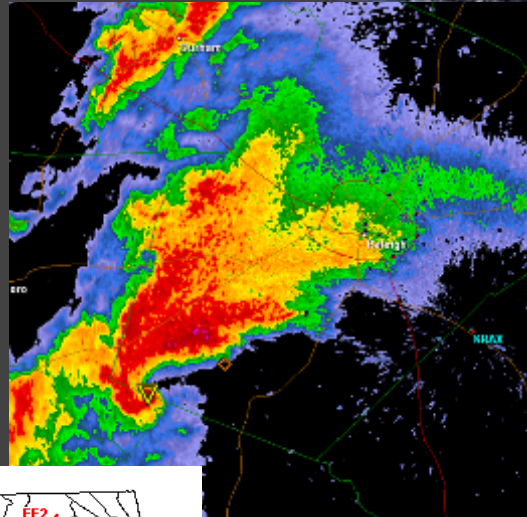
Southeast Outbreak, April 2011

Death toll: 325



North Carolina, April 2011

- Record-breaking tornado reports (over 100 in NC)
- 24 deaths, over 100 injuries



April 16, 2011 Tornado Outbreak
Preliminary ~26 Tornadoes as of 04/19/2011
Tornado track
Tornado intensity rating is the maximum along the path.

Tornadoes by Intensity:
EF0 - 5
EF1 - 8
EF2 - 8
EF3 - 5

VIDEO

Data Analysis - Gail Hartfield
Graphic - Brandon Vincent
MWS Raleigh, NC
www.weather.gov/raleigh

Southeast Outbreak, April 2011



Church in Cullman, AL



Joplin Tornado May 22nd 2011

Death toll:
158



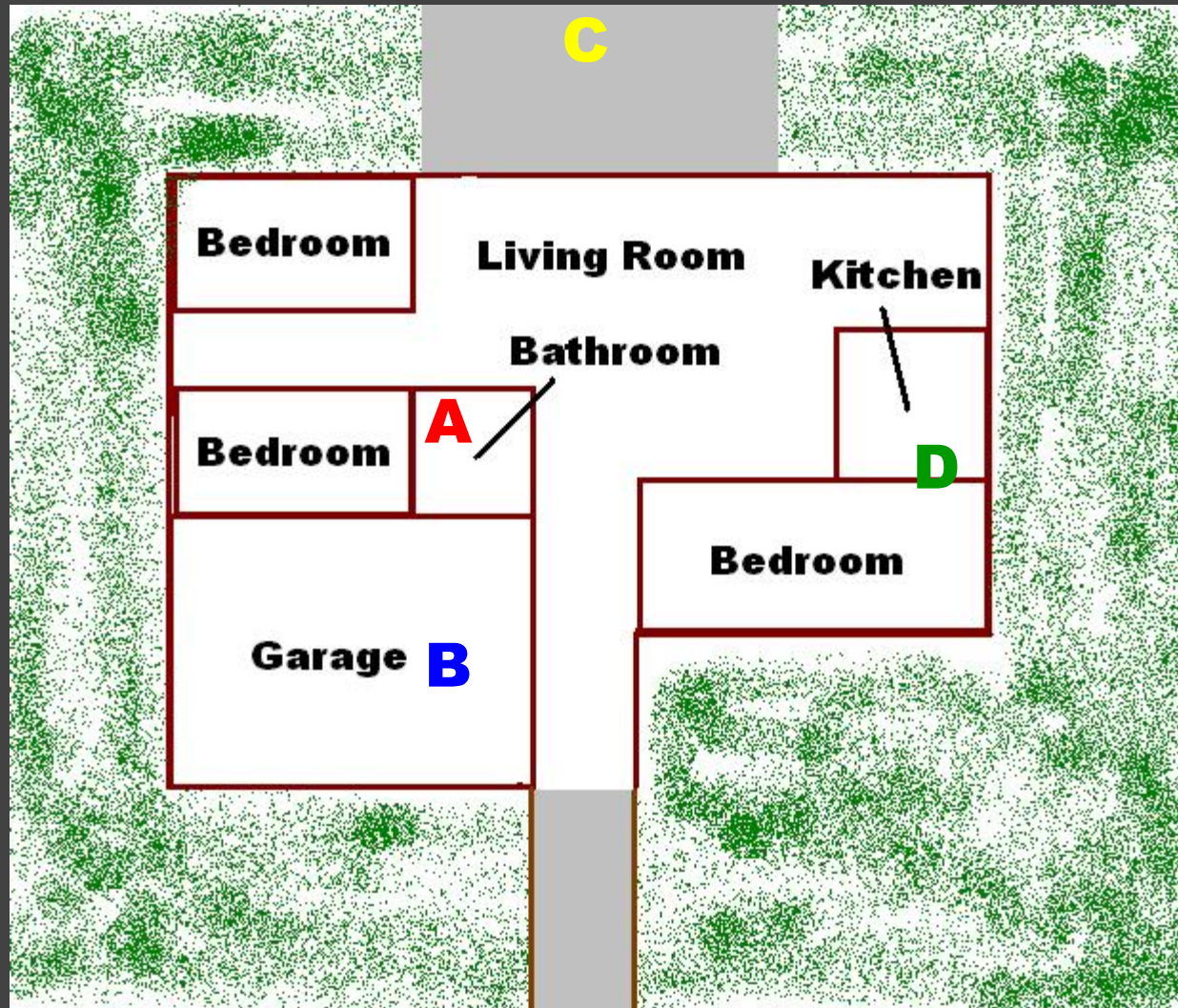
Moore Tornado

May 20th 2013 (24 killed)

<https://www.youtube.com/watch?v=0hcsQMJWfAc>



Where would you go??



Storm Chasing: Why?

- Study and learn about severe thunderstorms
- Certified Skywarn storm spotters



Logistics

- Group of experienced chasers:
 1. Focused driver
 2. Map navigator (riding shotgun)
 3. A data person in the back watching radar
- Navigator and data person determine best/safest routes to track storms

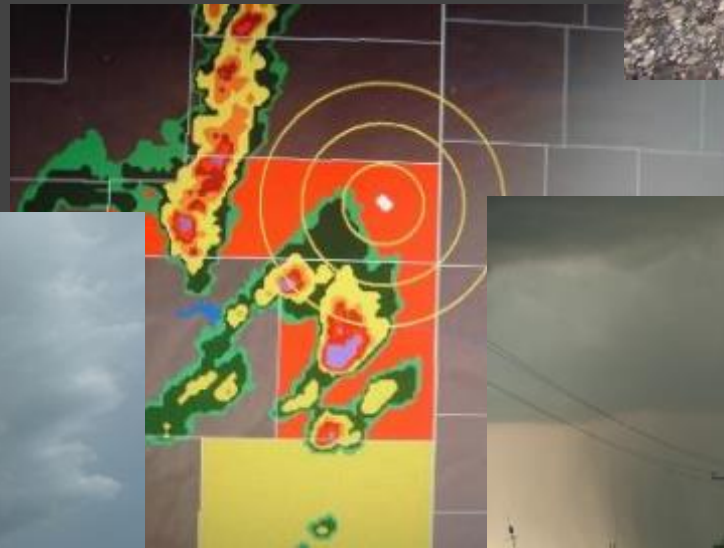


Chasing Hazards

- Situation can change and become dangerous rapidly
- Never drive into something if you don't know what it is
- *Never chase at night*
- Do not chase rain-wrapped tornados
- Roads pose great challenges:
 - Dirt roads become muddy, and can have a poor, unreliable network
 - Know where the storm is, have an escape route
 - Be wary of chaser traffic

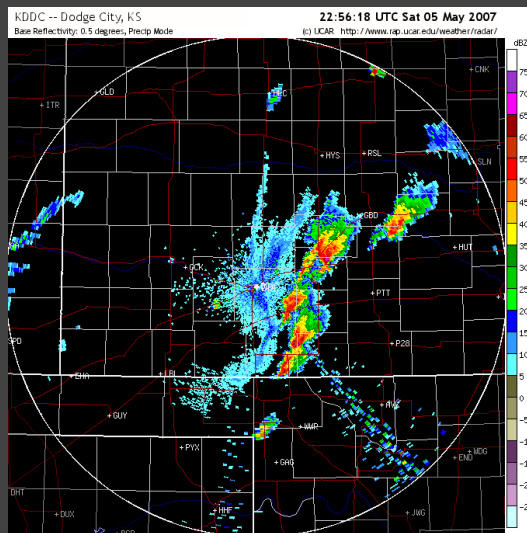
Chasing Hazards

- BE PREPARED is our motto
- Always have an escape route
- Training and expertise are crucial in any chase group



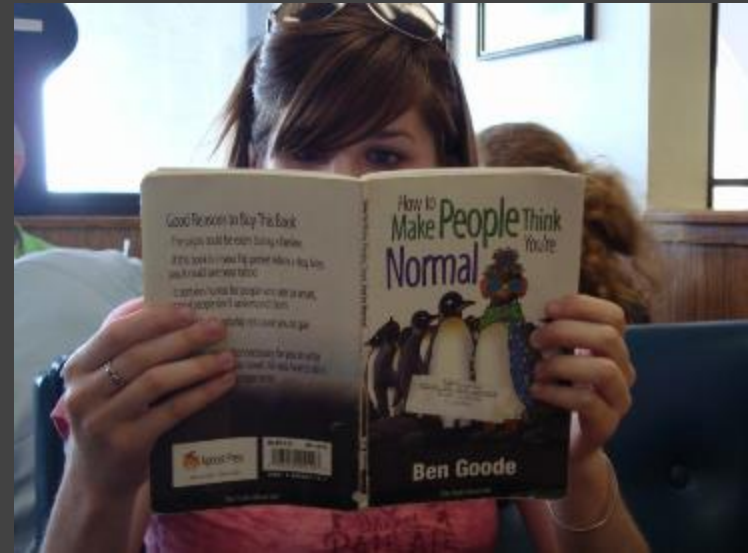
Logistics

- Reliable vehicle (spare tires), detailed paper maps, computers, and cell phones
- Communication
 - NOAA Weather Radio, two-way radios, CB, cell phone
 - Phone number to report severe weather
- Other essentials
 - Food/water, first aid, sturdy athletic shoes...



Drive to Initial Location

- Can be very long road trips to get to target chase regions
- Storm chasing can be a game of hurry up and wait (need entertainment!)



Adam Rydbeck



In Position on Storm

- Always watching where things are moving
- ...What might be developing around you
- Lightning!



Beth Stuckmeyer



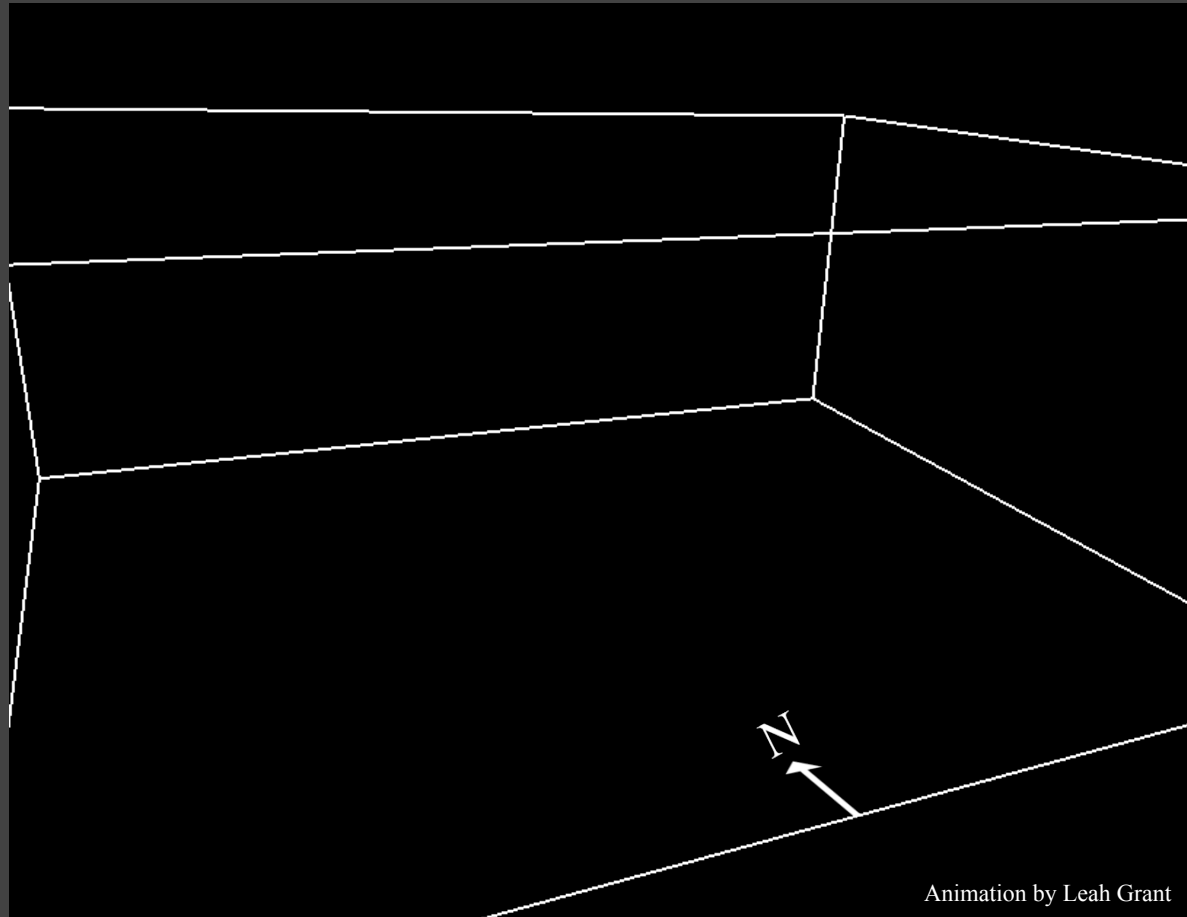
Angela Rowe



Leah Grant 2012

During the Storm

- Where should you be?
- Storms can move in different directions!!



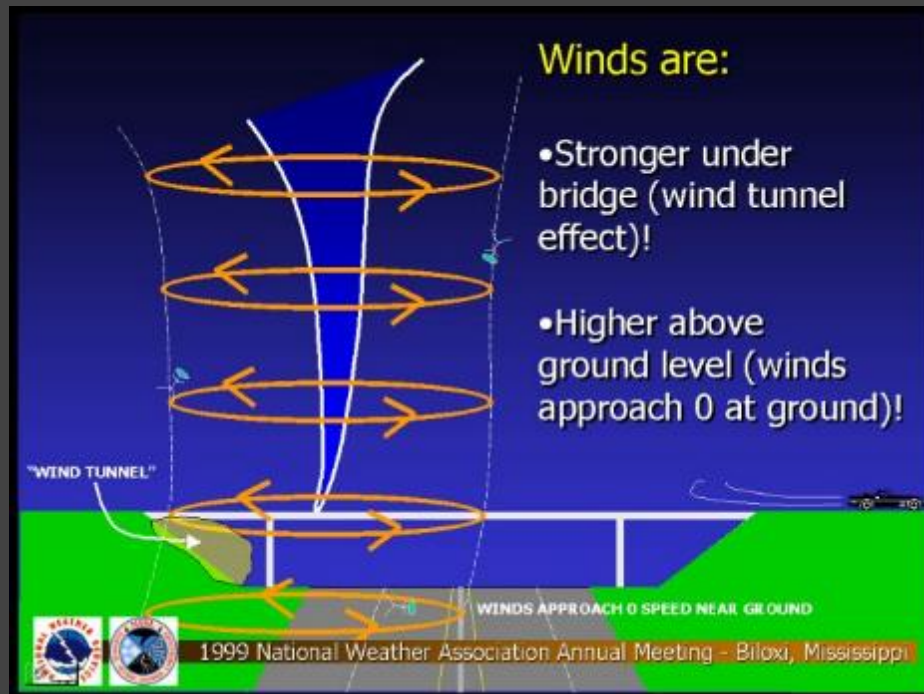
Animation by Leah Grant



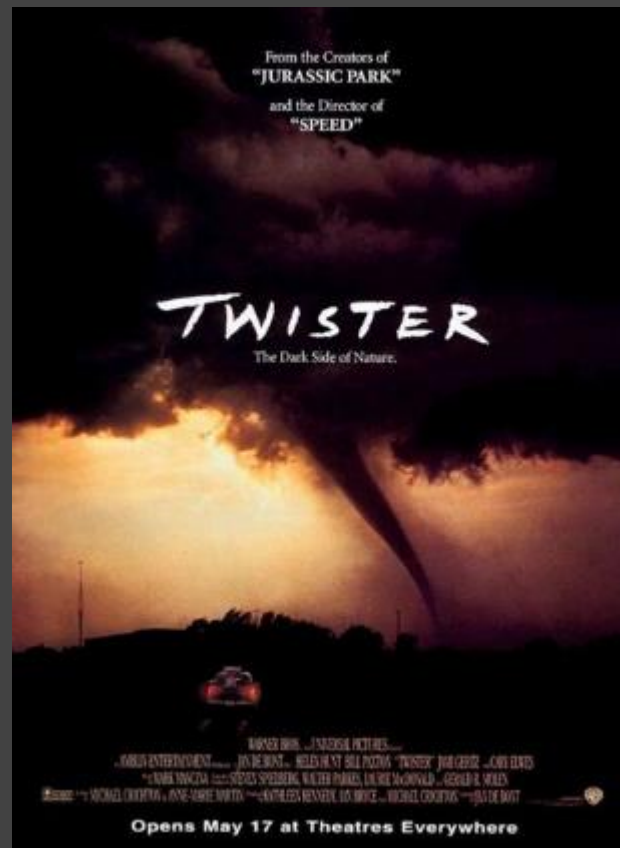


What if you get too close?

- If too close, GET OUT OF CAR and seek shelter in a solidly constructed building
- If all else fails, find a ditch for shelter
- OVERPASSES ARE UNSAFE:

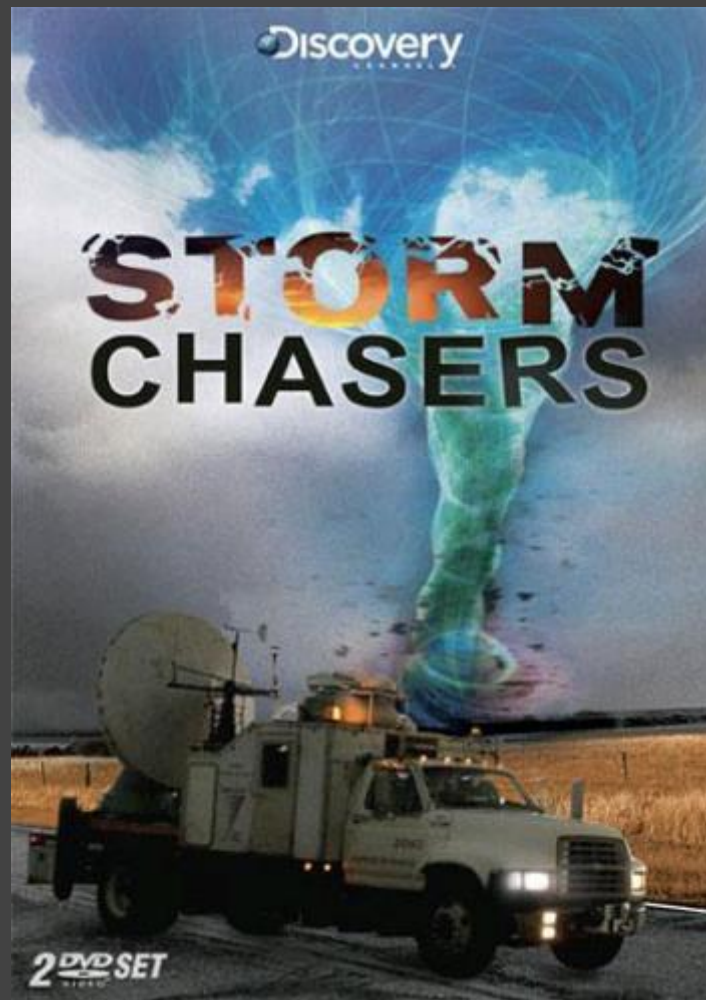


What not to do...



Video 7

What not to do...



Some Weather Links

- Storm prediction center:
 - <http://www.spc.noaa.gov/>
- National Weather Service:
 - <http://weather.gov/>

How to get Involved

- Study meteorology in college – many colleges have storm chase teams
- NWS trains storm spotters (Skywarn)
- CoCoRAHS
- Join American Meteorological Society (AMS)





Hope you enjoyed!



James Ruppert