SKYWARN Spotter Training

Chris Kimble
National Weather Service
Weather Forecast Office
Gray, Maine
www.weather.gov/gray

Overview

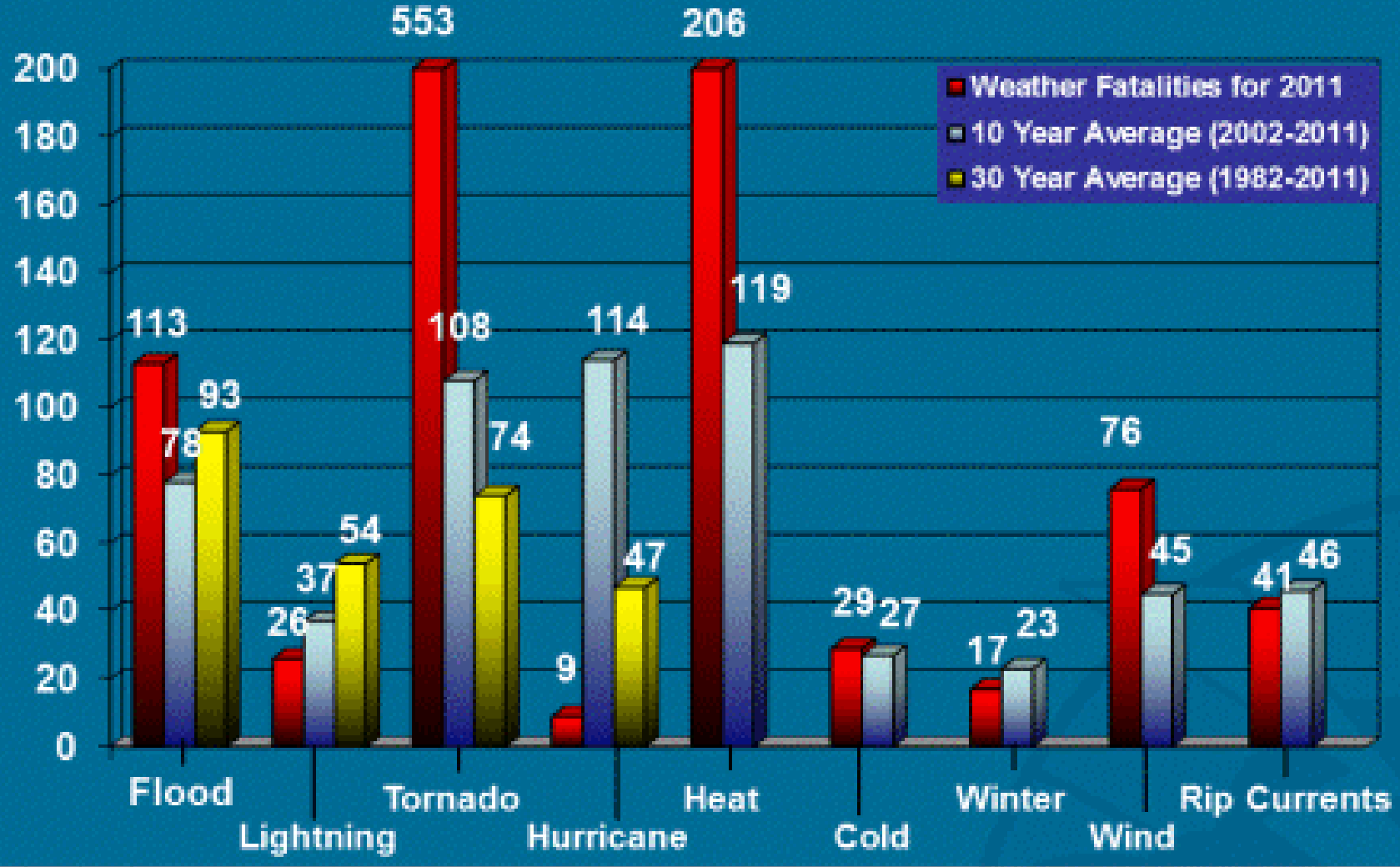
- National Weather Service Definitions and Forecasting Tools
- Weather Spotters…Why they're important?
- Thunderstorms
- Tornadoes
- Flash Flooding
- Storm Safety

NWS Mission

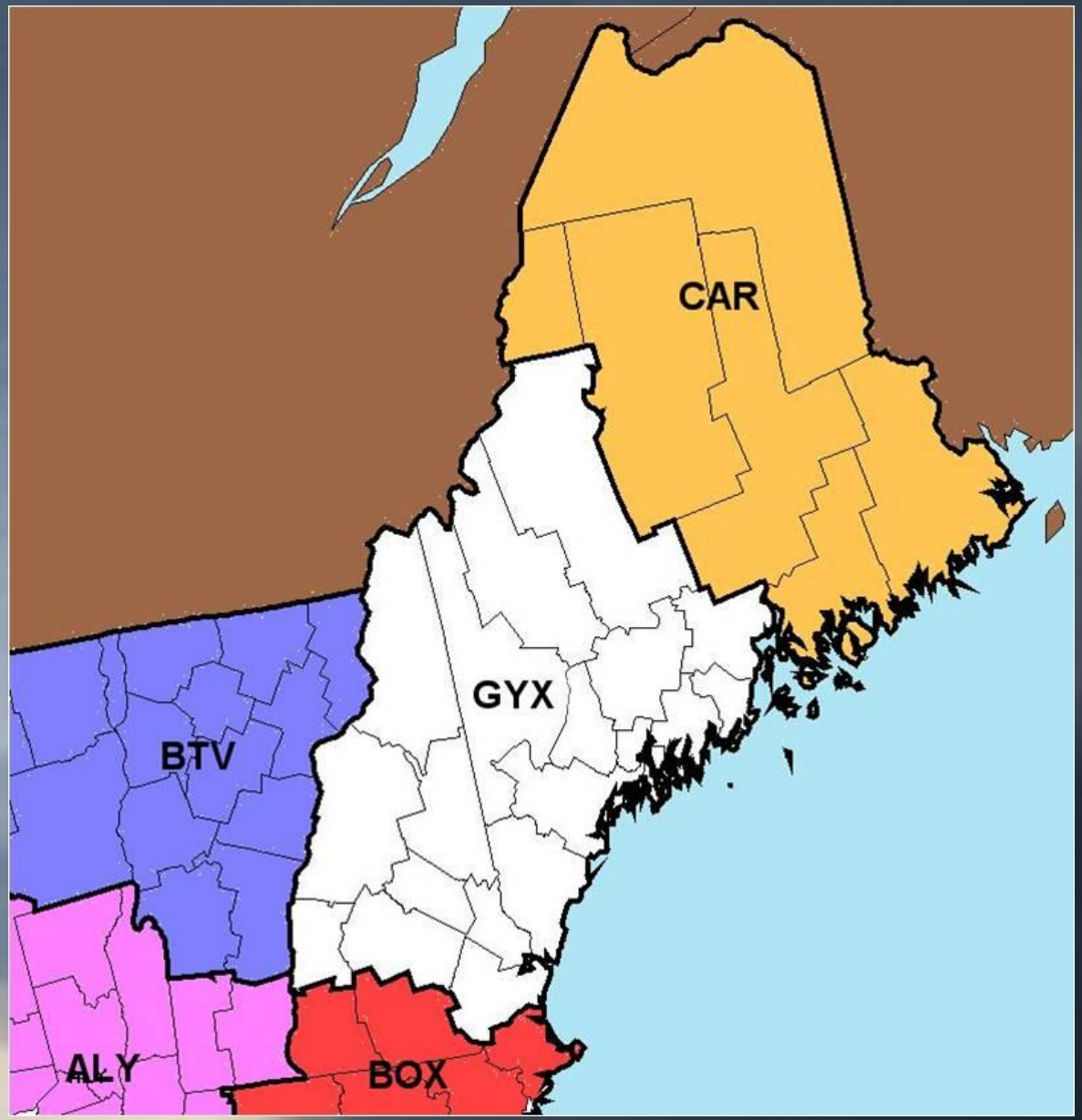
"To protect the lives and property of the citizens of the United States…"

- Watches and Warnings
- Outreach and Training

Weather Fatalities



NWS County Warning Areas



Basic Definitions

- WATCH – conditions are favorable for severe weather to develop. Valid 4-6 hours. Contains several counties.
- WARNING – severe weather has been visually observed or detected on radar. Valid usually 1 hour or less, issued on a storm-by-storm basis.
- STATEMENT – provides follow-up information to a warning which is in effect.

Basic Definitions

- TORNADO – a violently rotating column of air, attached to a thunderstorm, and in contact with the ground.
- SEVERE THUNDERSTORM – a thunderstorm which produces hail 1 inch diameter, and/or wind gusts 58 mph (50 knots) or stronger.
- FLASH FLOOD – a rapid rise in water, usually during or after a period of heavy rain.

Tools for Detecting Storms

- Observations
- Computer models
- Satellite
- Radar
- Lightning Detection Network

Observations

- We take many measurements of the atmosphere:

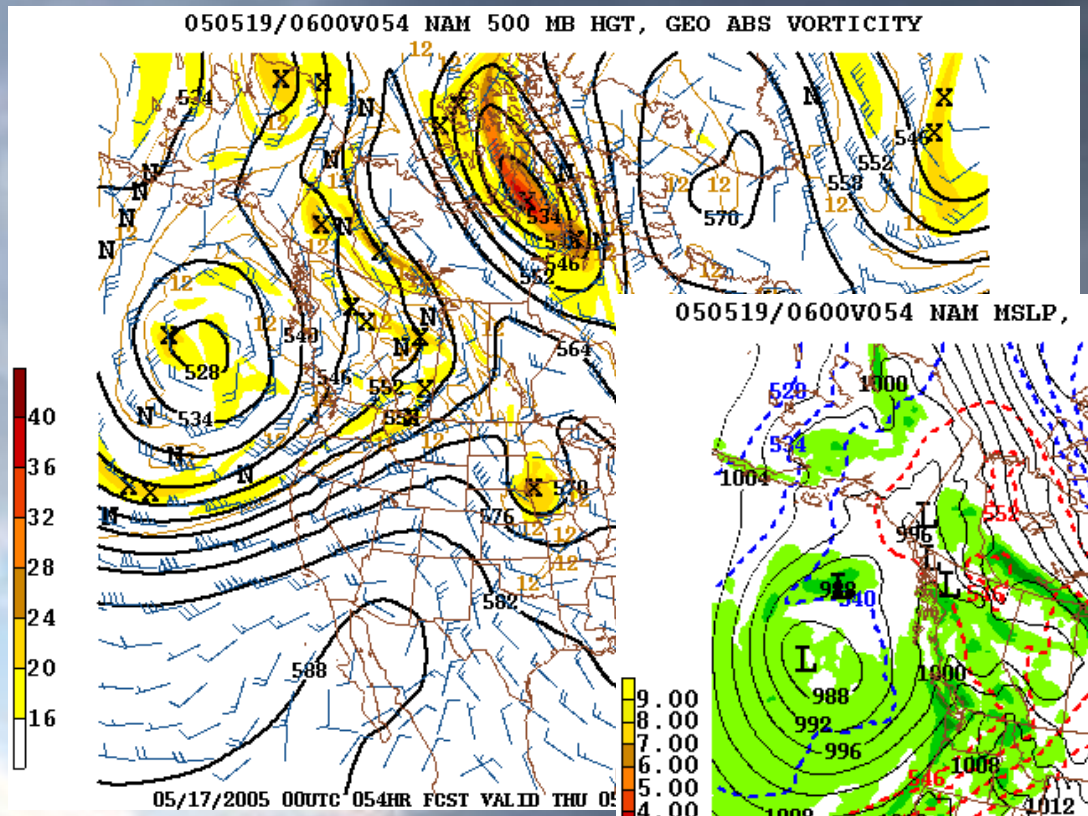
Weather Balloons

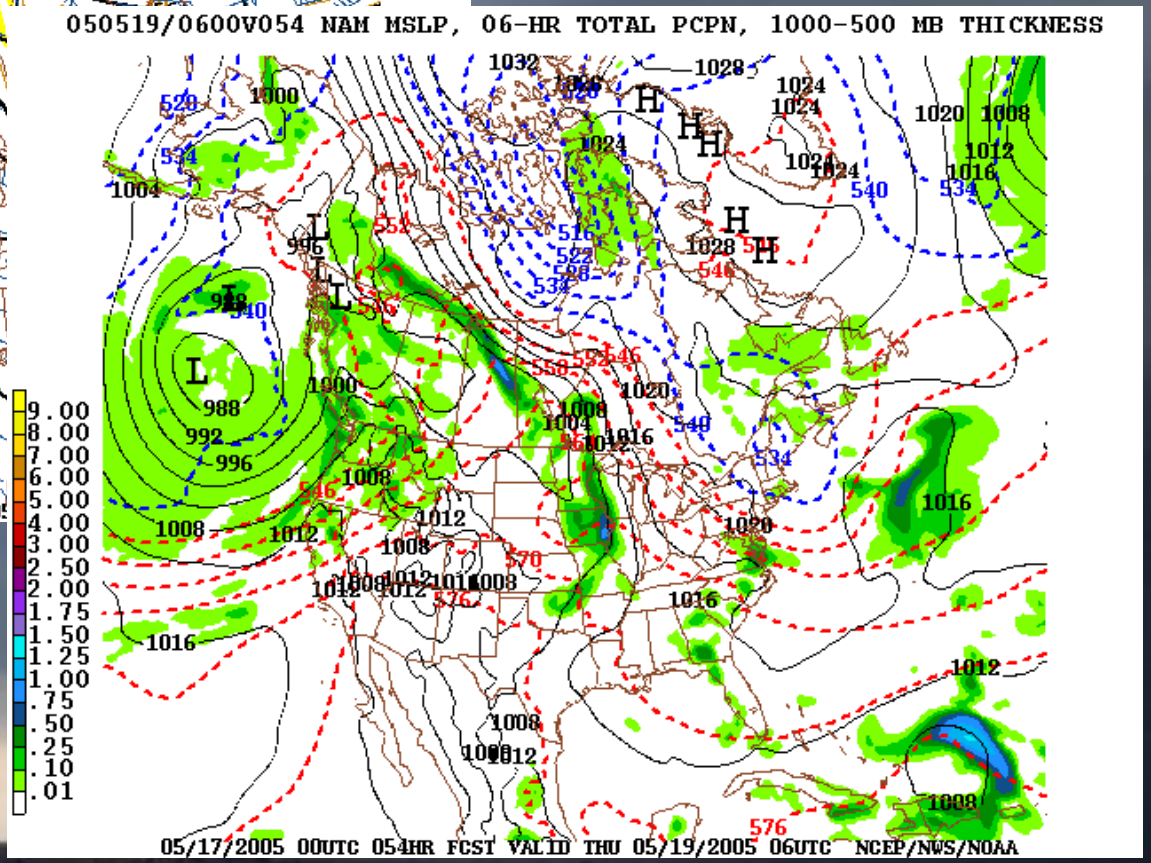
- Releases twice a day all over the world at the same time – 900 stations worldwide
- Measures temperature, humidity, pressure as it goes up
- Flight lasts about 2 hrs and can reach as high as 115,000 ft
- Data is input into computer models

Computer Models

- Complex computer programs
- Computer solves equations at future points in time
- Helpful for determining environment in which storms will form

Computer Model Output

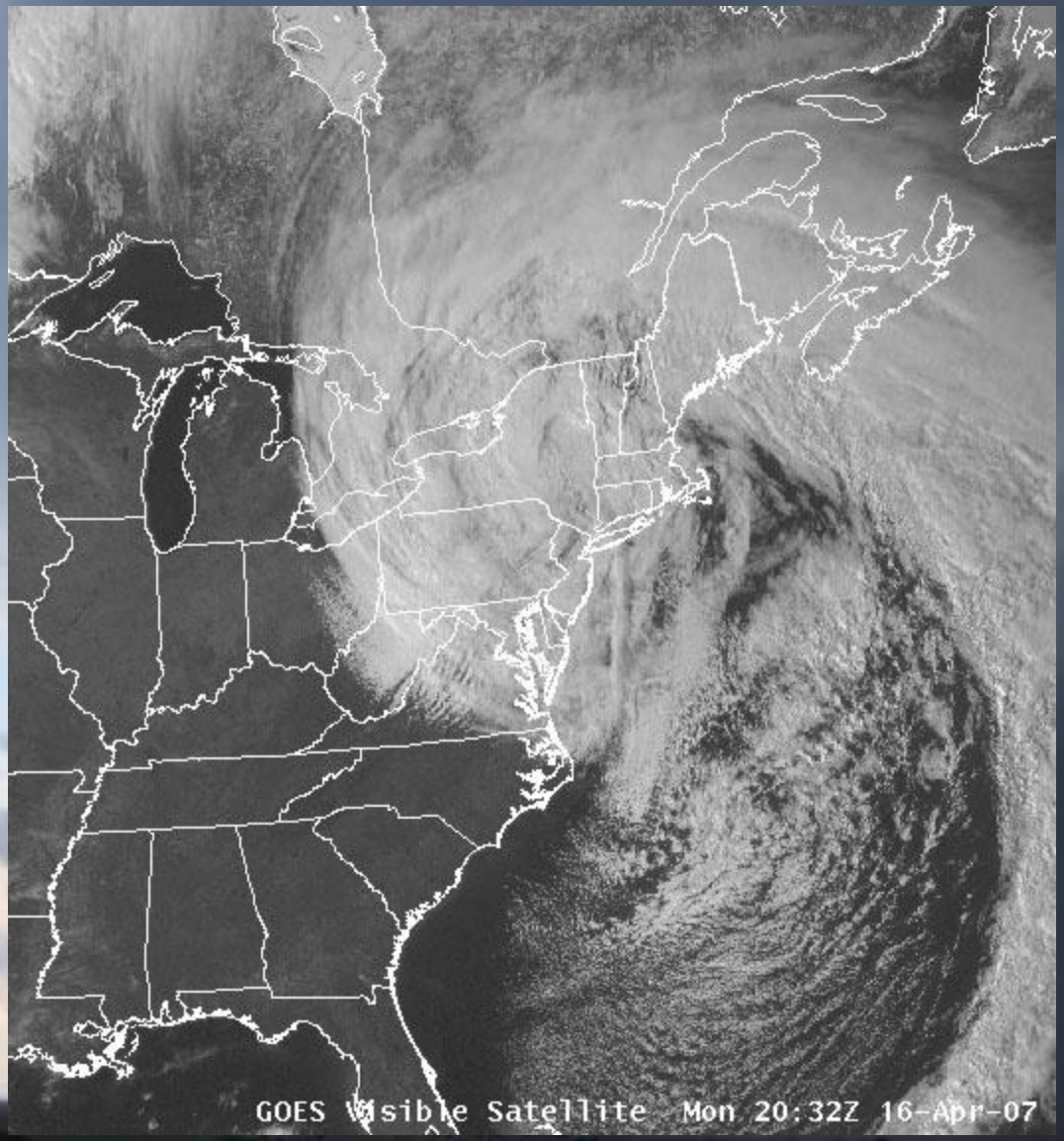




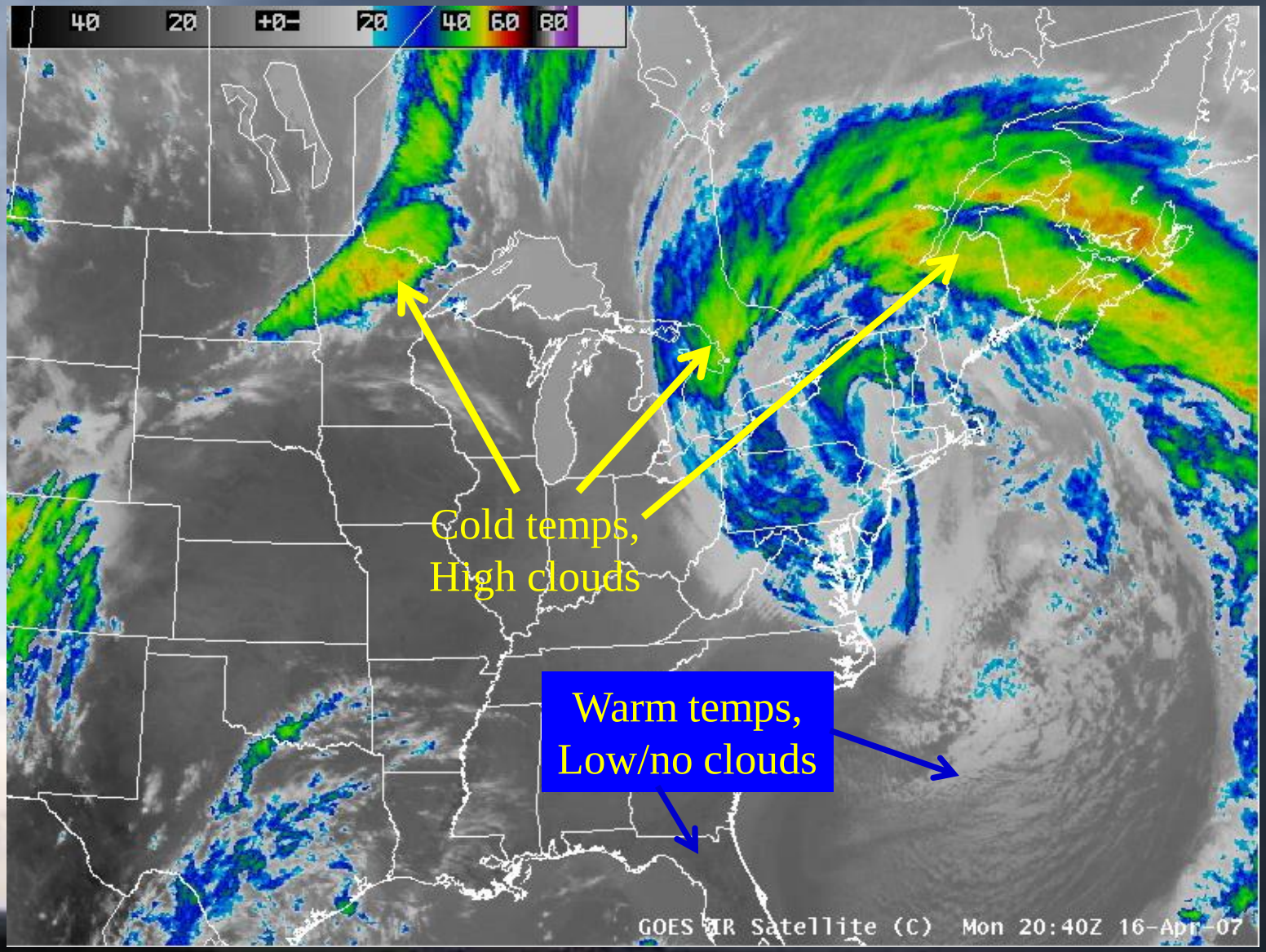
Weather Satellites

- Orbit 22,000 miles above the earth
- Stay over the same point on the earth (geostationary)
- Images of the same areas produced every 5 to 30 minutes
- Images can be made into movies (Loops)
- Visible and infrared images available

Visible Satellite



Infrared Satellite



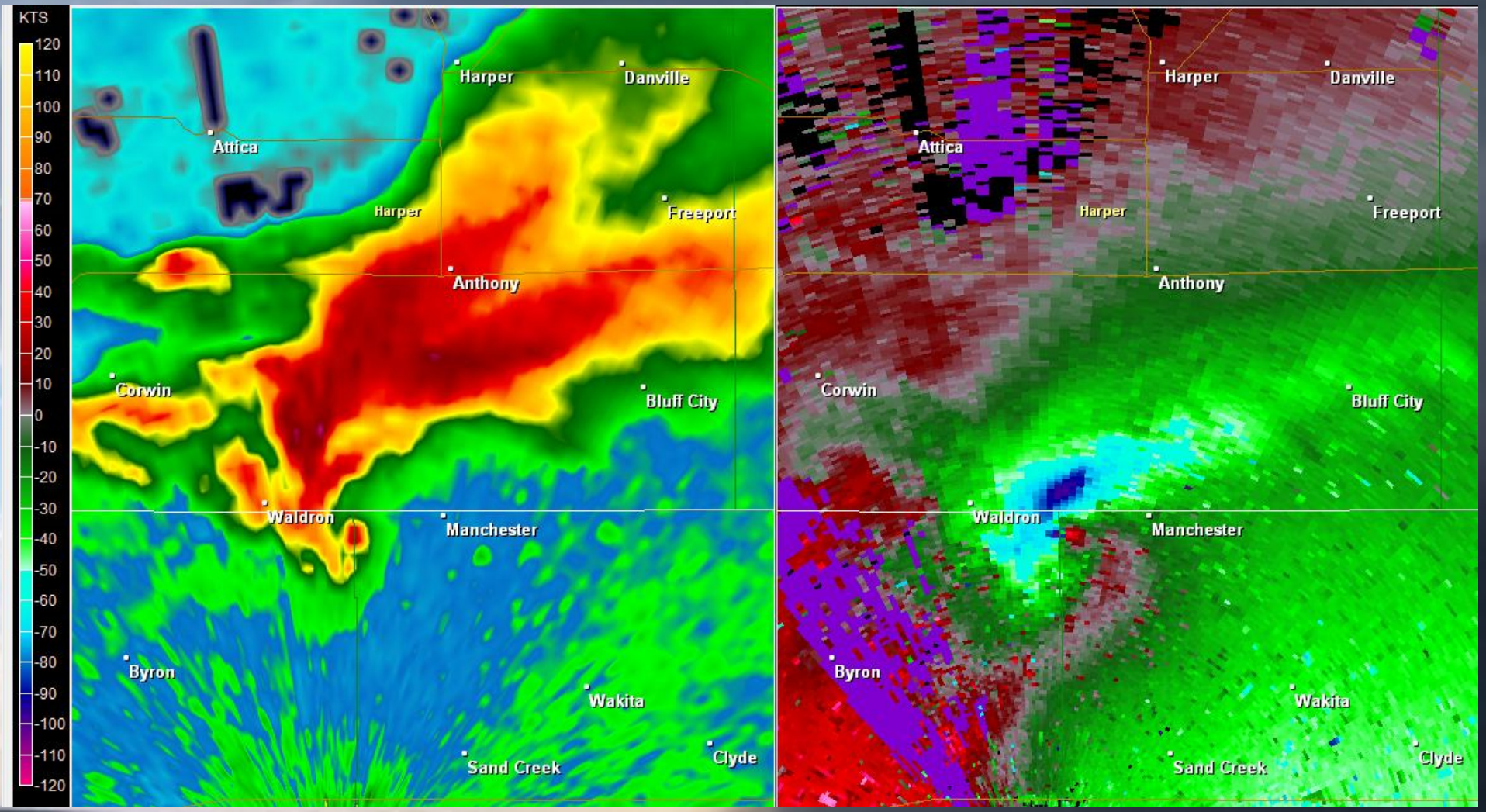
Weather Radar Overview

- Transmitter sends out short burst of radio waves
- When waves strike an object, a very small portion of the energy is returned
- Process repeats about 1,000 times a second

Radar Limitations

The **radar** is limited close in by its inability to scan directly overhead. Therefore, close to the **radar**, data are not available due to the radar's maximum tilt elevation of 19.5°. This area is commonly referred to as the radar's "**Cone of Silence**".

WSR-88D Reflectivity + Velocity



Storm Spotters

- Radar only provides data where scatterers (rain drops or hailstones) are present
- Cloud formations can also provide insight into a storm's intensity
- Trained volunteer spotters provide visual observations to go with the radar and satellite data

The Spotter's Role

Ground Truth - What's really happening:

Phippsburg, ME

The Spotter's Role

To be the eyes of the NWS where severe weather is occurring or has occurred:

- Reporting storm type or structure
- Reporting damage, flooding or injury from storms

This is Ground Truth

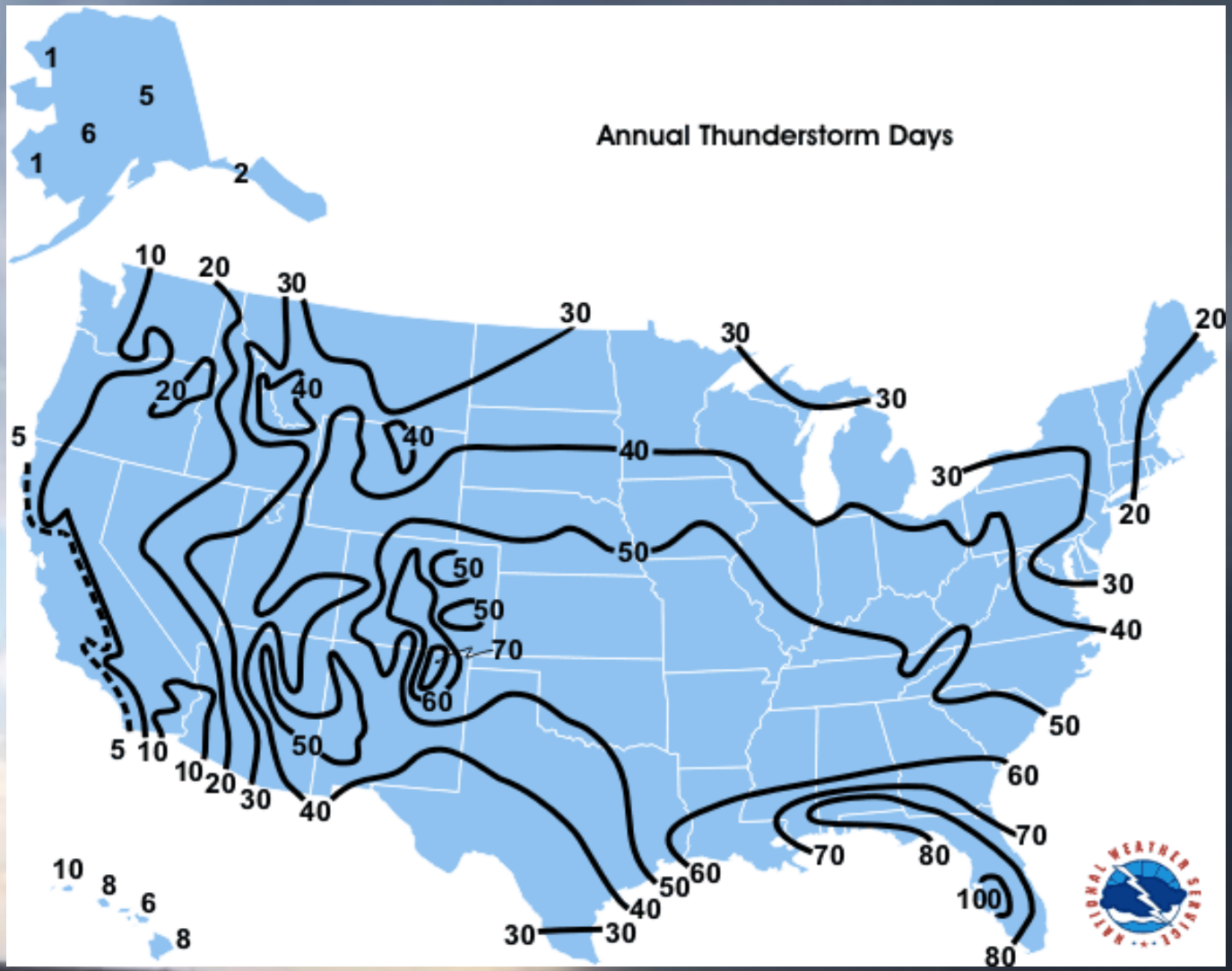
The Spotter's Role

Spotter reports are the single most important type of information that the National Weather Service can receive.

In New Hampshire and Maine…

- Most severe weather occurs from May through July
- Most severe weather occurs during the late afternoon and evening
- BUT…severe weather can occur any time!

Thunderstorm Days



Conditions for Thunderstorms

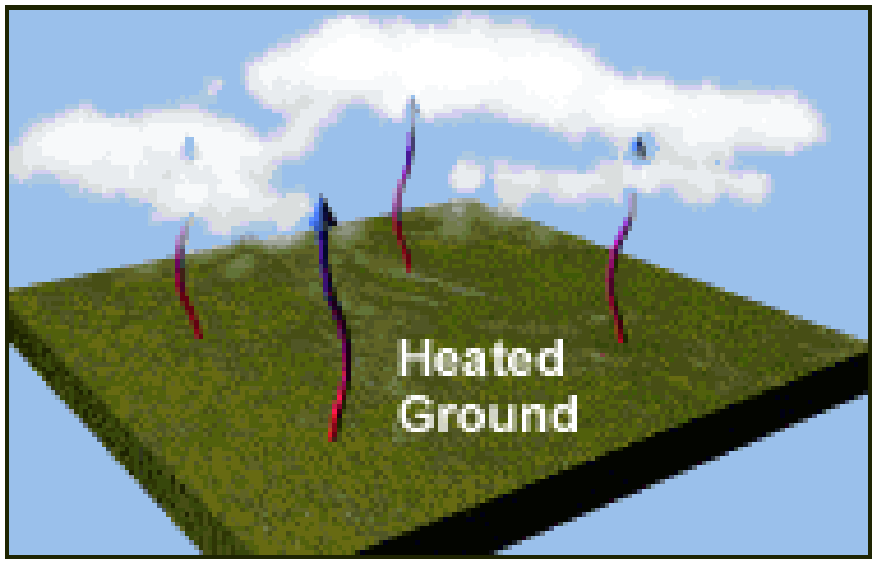
All thunderstorms, severe or not, need three ingredients in order to form:

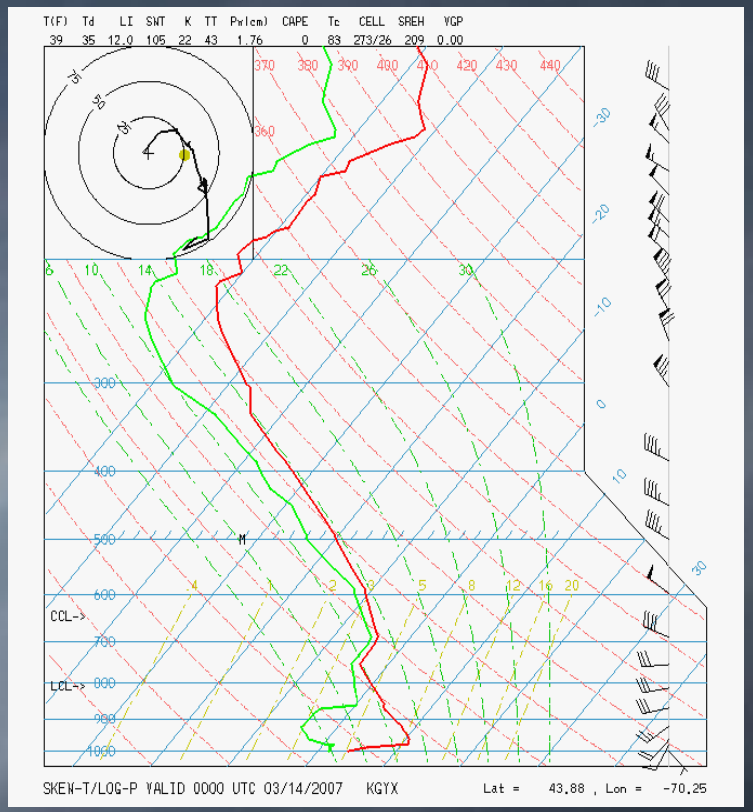
1.) Moisture 2.) Instability 3.) Lift

Instability (Non-mechanical Lift)

Convection:

The sun heats the earth's surface, parcels of air rise like bubbles. They continue to rise as long as they remain warmer than the air around them.

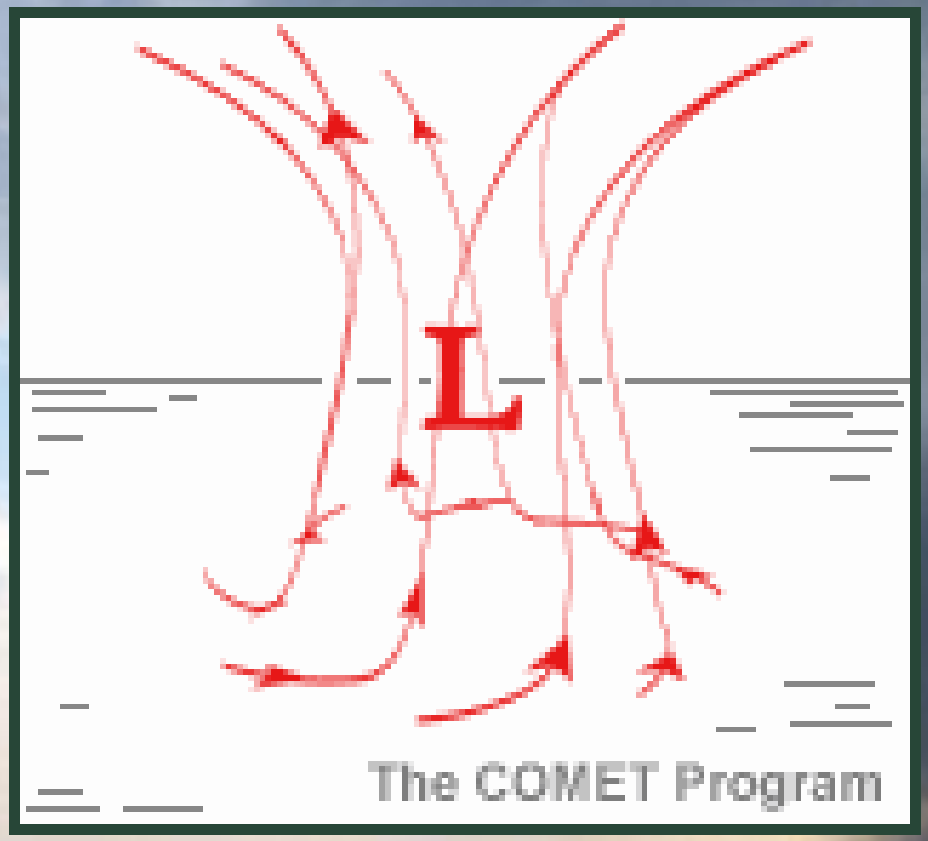




Weather balloons provide a vertical profile of the air, which help us “see” instability.

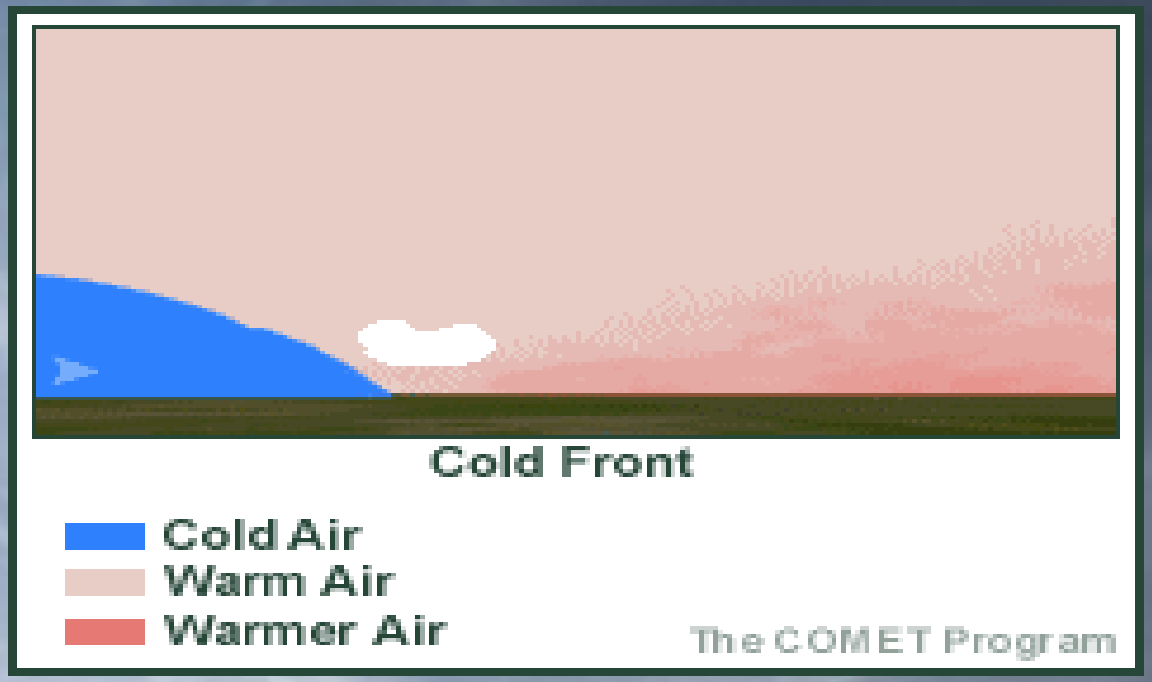
Thunderstorms

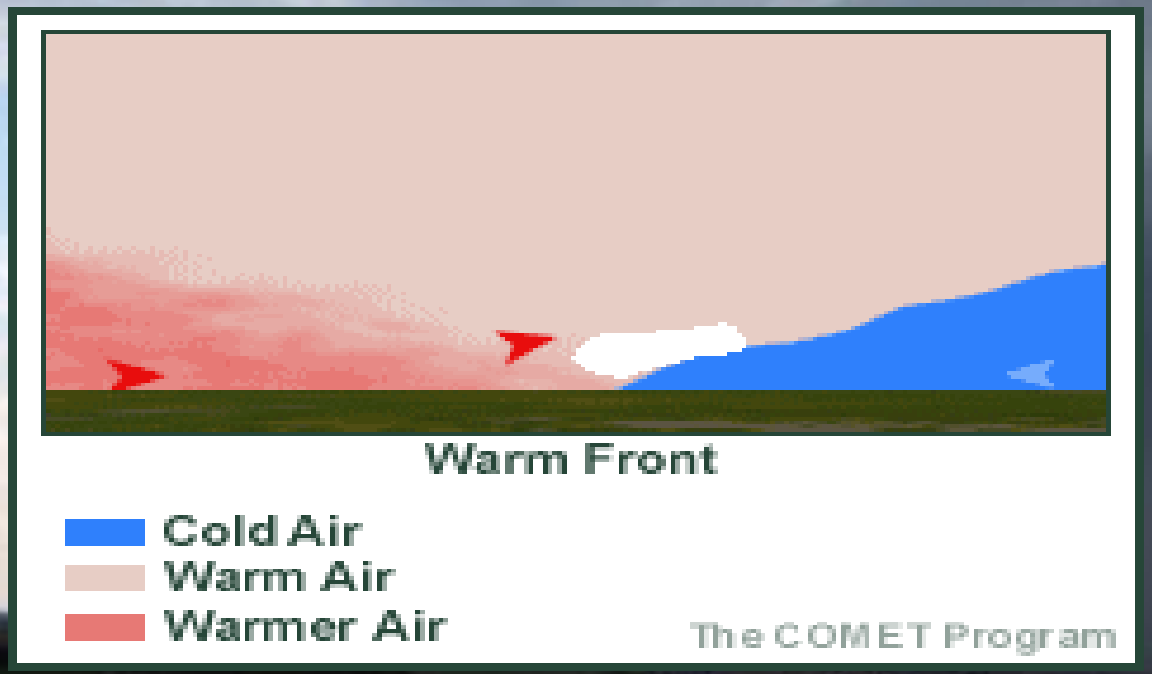
Mechanical Lift



Convergence:
where winds from different directions meet, or fast winds meet slow winds.

Mechanical Lift





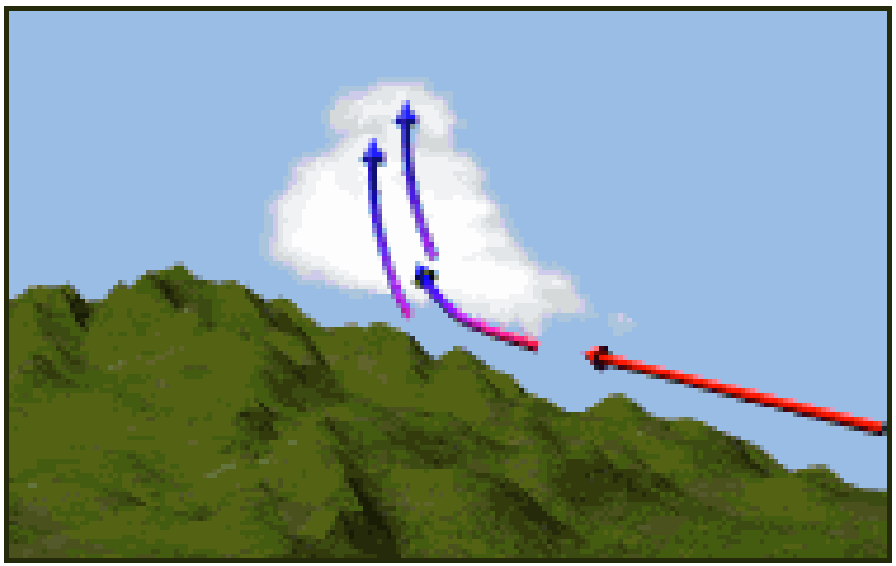
Fronts:

boundary between two air masses with different characteristics.

Cooler (drier) air is more dense – acts as a wedge.

Thunderstorms

Mechanical Lift

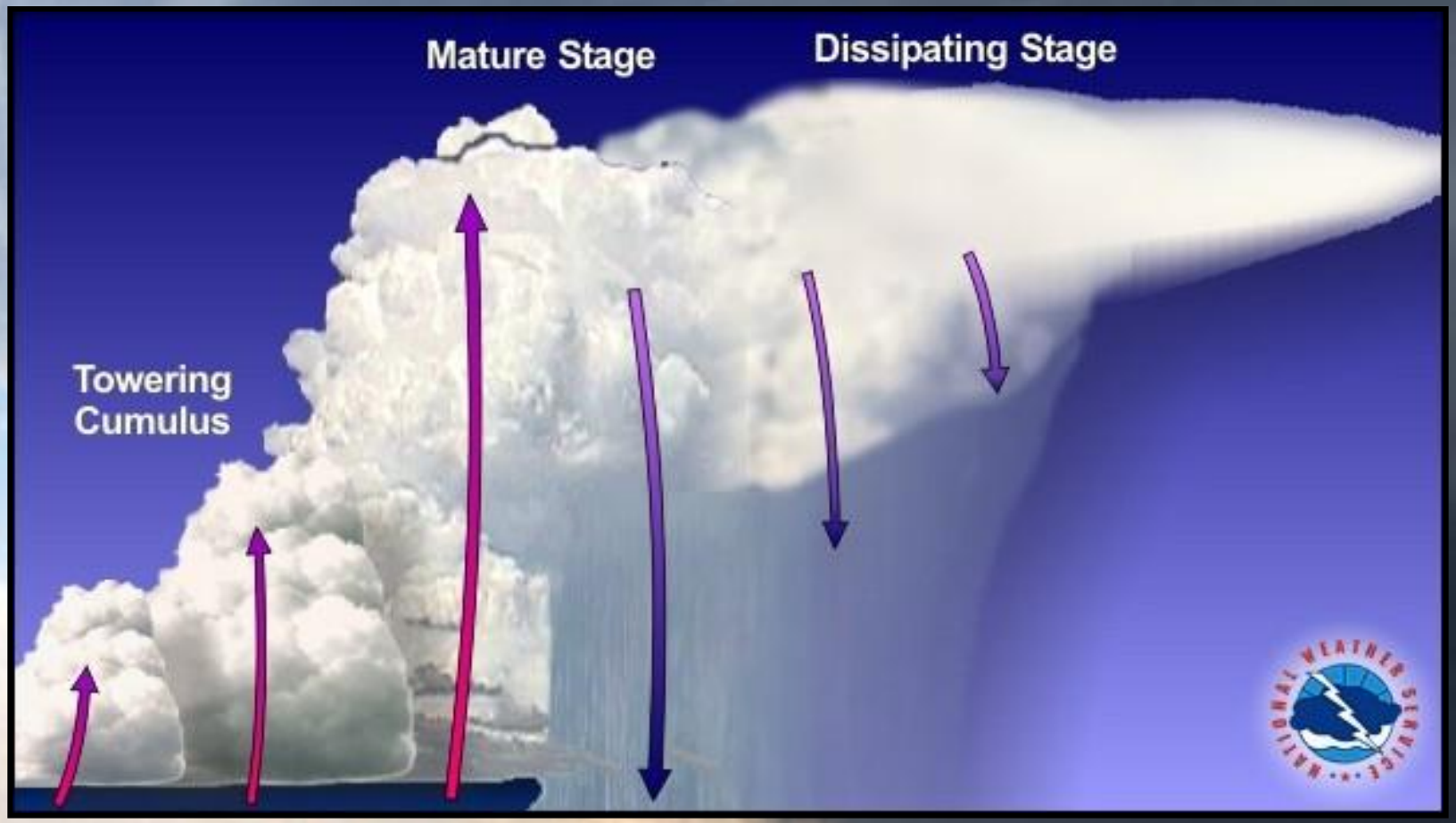


Terrain:
forces air upward when wind blows toward higher terrain.

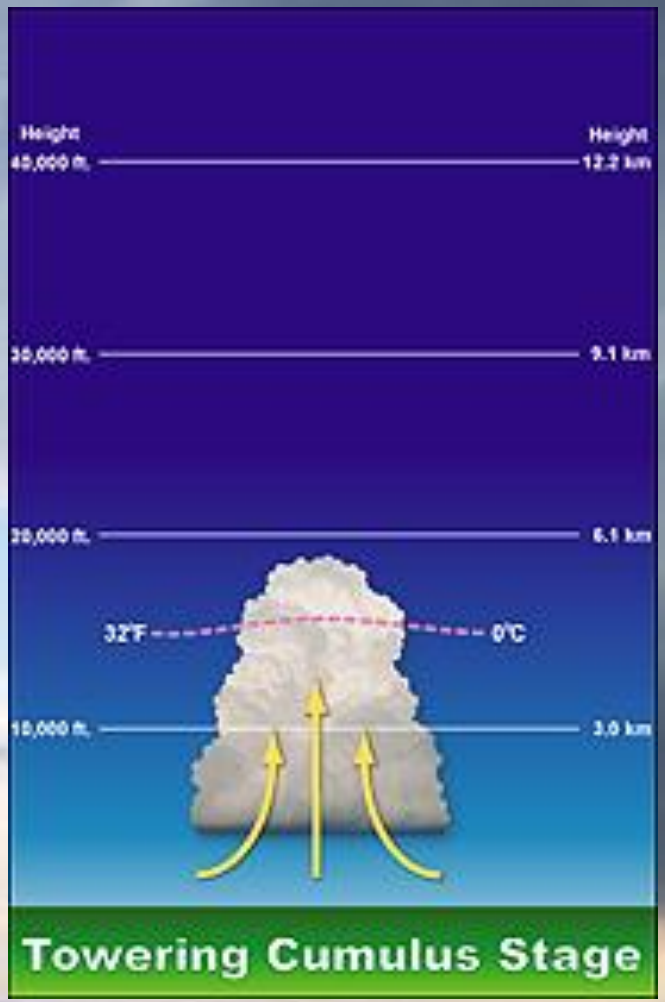
Pulse Storms

- Some severe weather comes from *pulse thunderstorms.*
- Pulse storms are thunderstorms, which can be briefly severe.
  - Their core aloft ‘collapses’ resulting in a downburst
  - Warning lead time will be short, but some lead time can be provided.
  - No mesocyclone

Thunderstorm Life Cycle



Thunderstorm Life Cycle

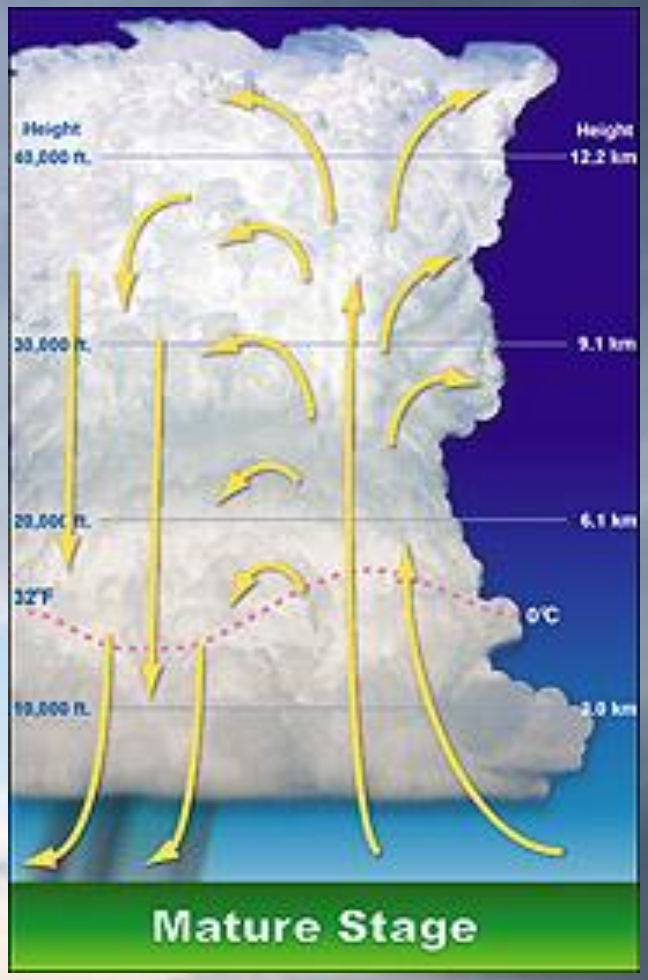


- First Stage: Towering cumulus
- First significant updrafts reaching 10-20,000 feet
- Nearly all motion is upward

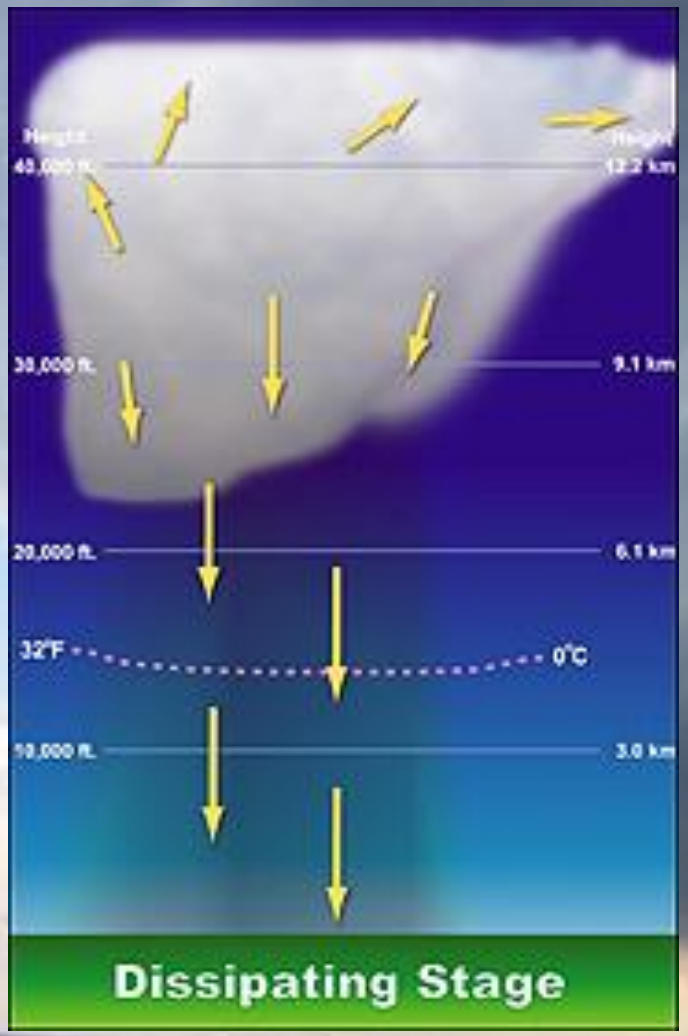
Thunderstorm Life Cycle

- Mature Stage: Storm is at its strongest
- Updrafts, downdrafts, precipitation all occurring
- Most likely time for severe weather

Thunderstorm Life Cycle



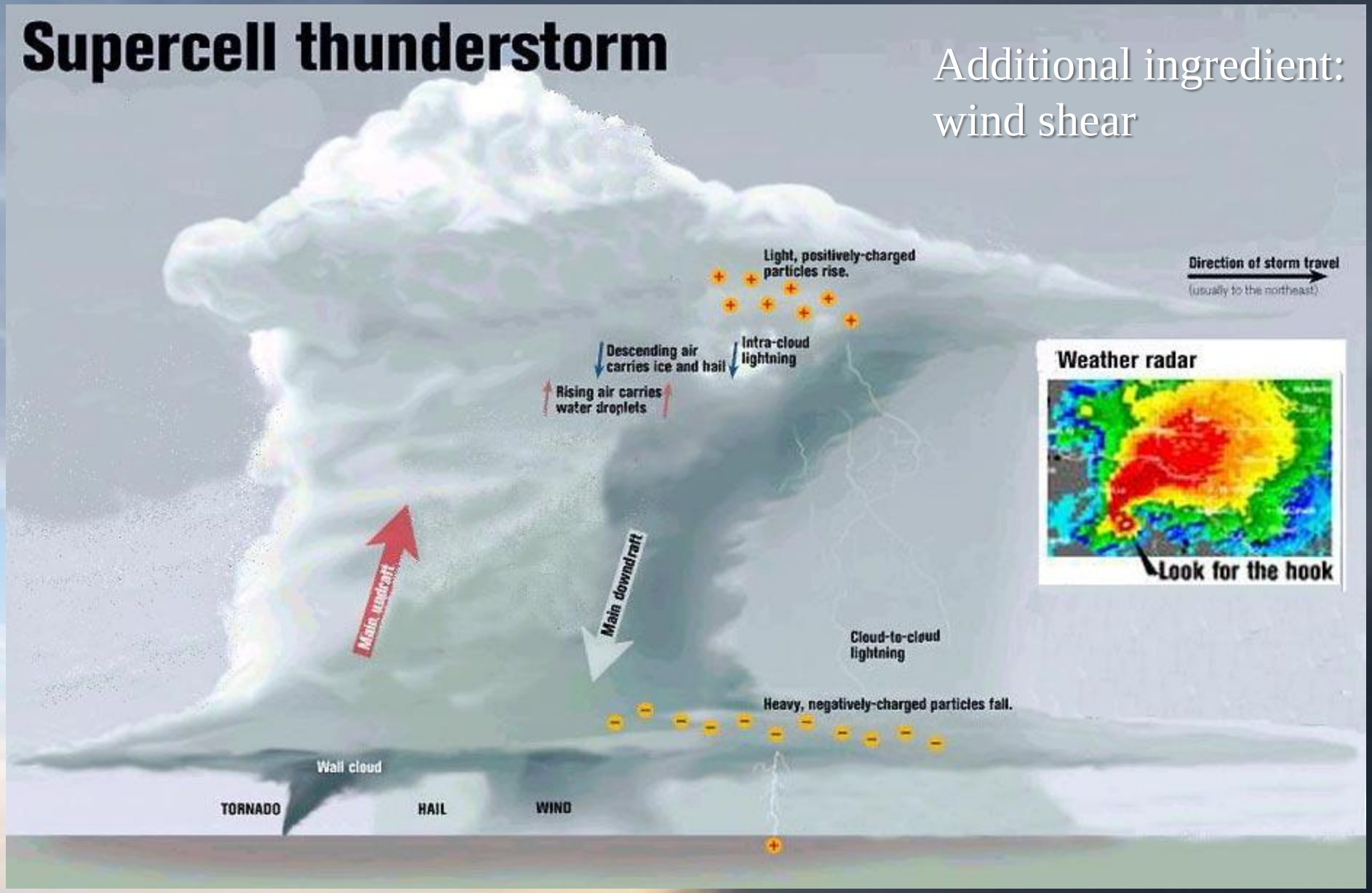
Thunderstorm Life Cycle



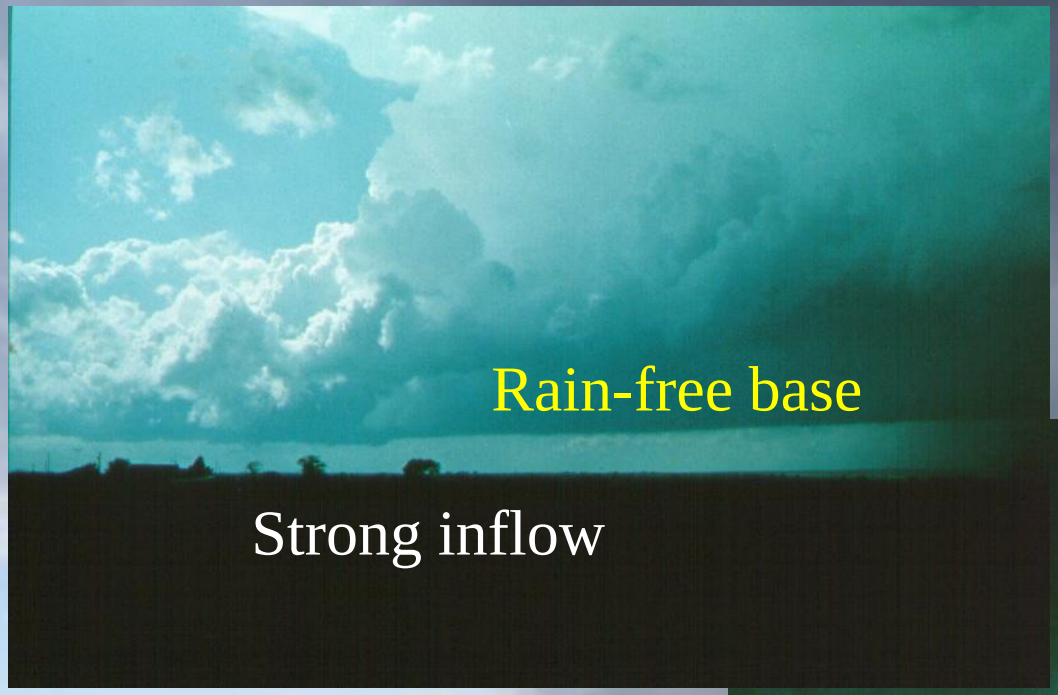
- Finally storm begins to dissipate
- Weak updrafts, mainly in mid and upper levels
- Precipitation and downdrafts are dominant in lower levels

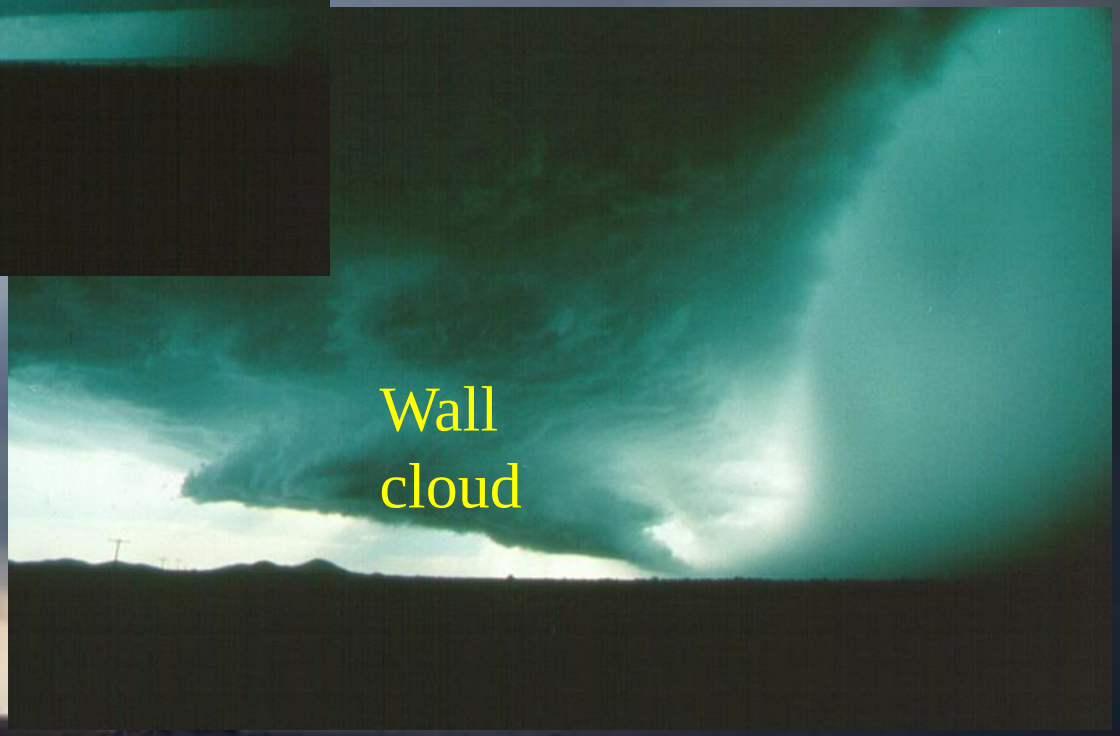
Supercell thunderstorm

Additional ingredient: wind shear



Severe Thunderstorms



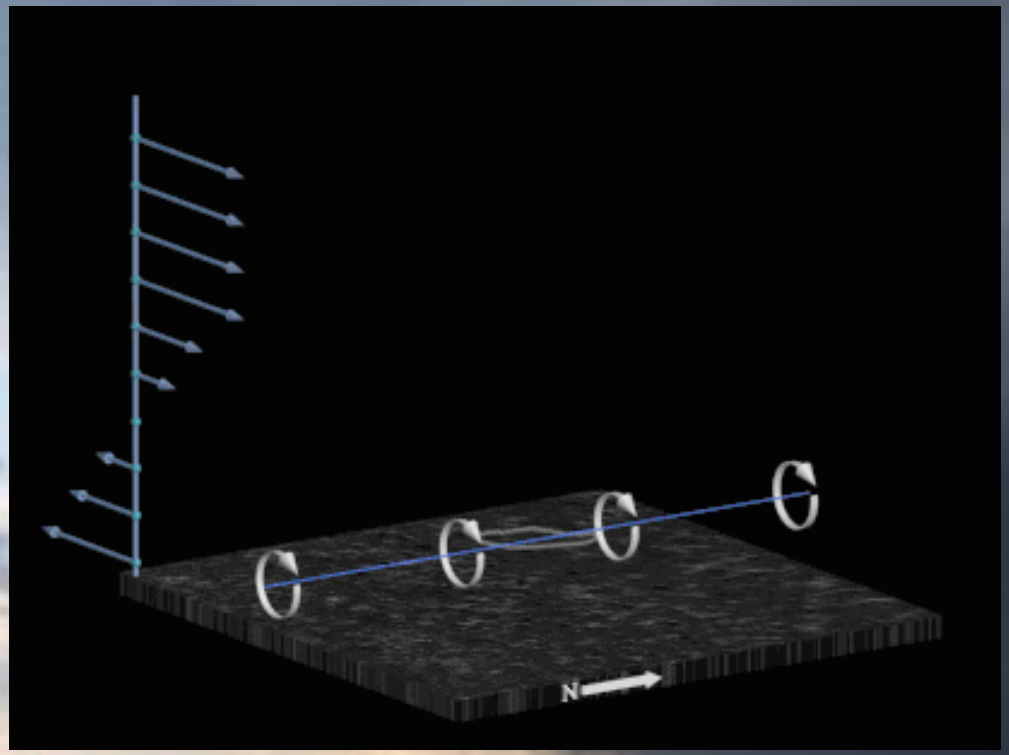


Important Thunderstorm Features

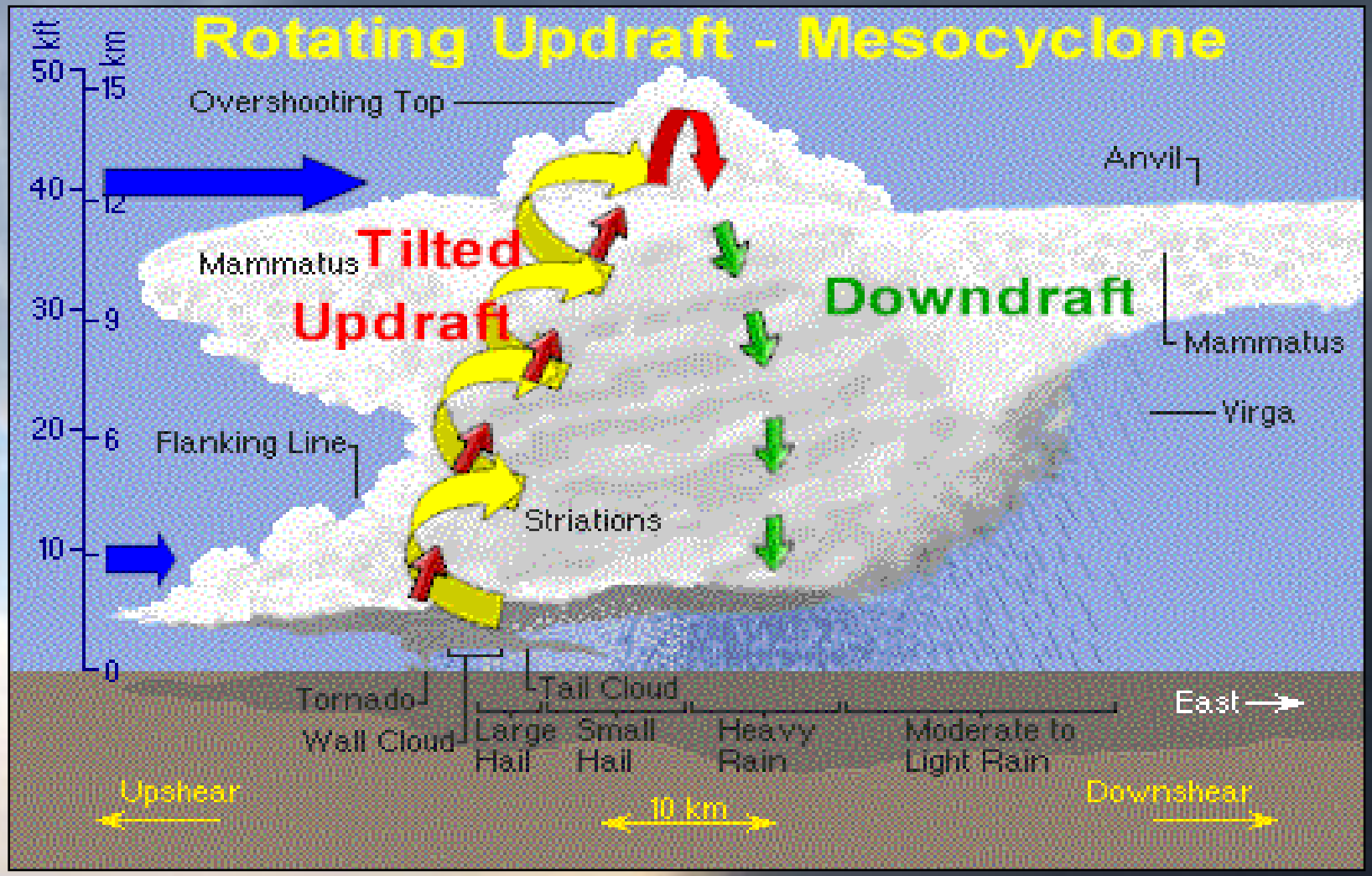
- Mesocyclone
- Wall Cloud
- Funnel/Tornado
- Hail
- Downburst/Microburst

Mesocyclone

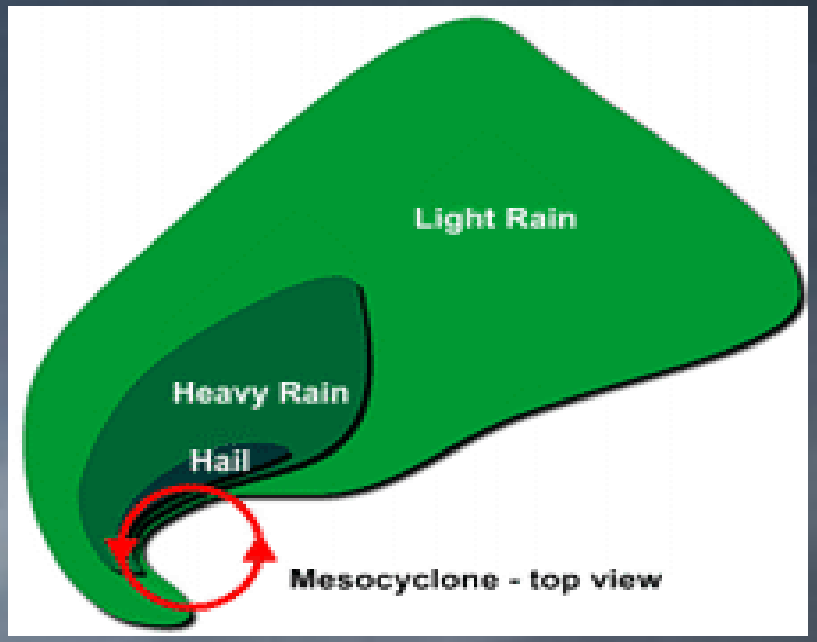
Rotation of updraft at or below cloud base



Mesocyclone

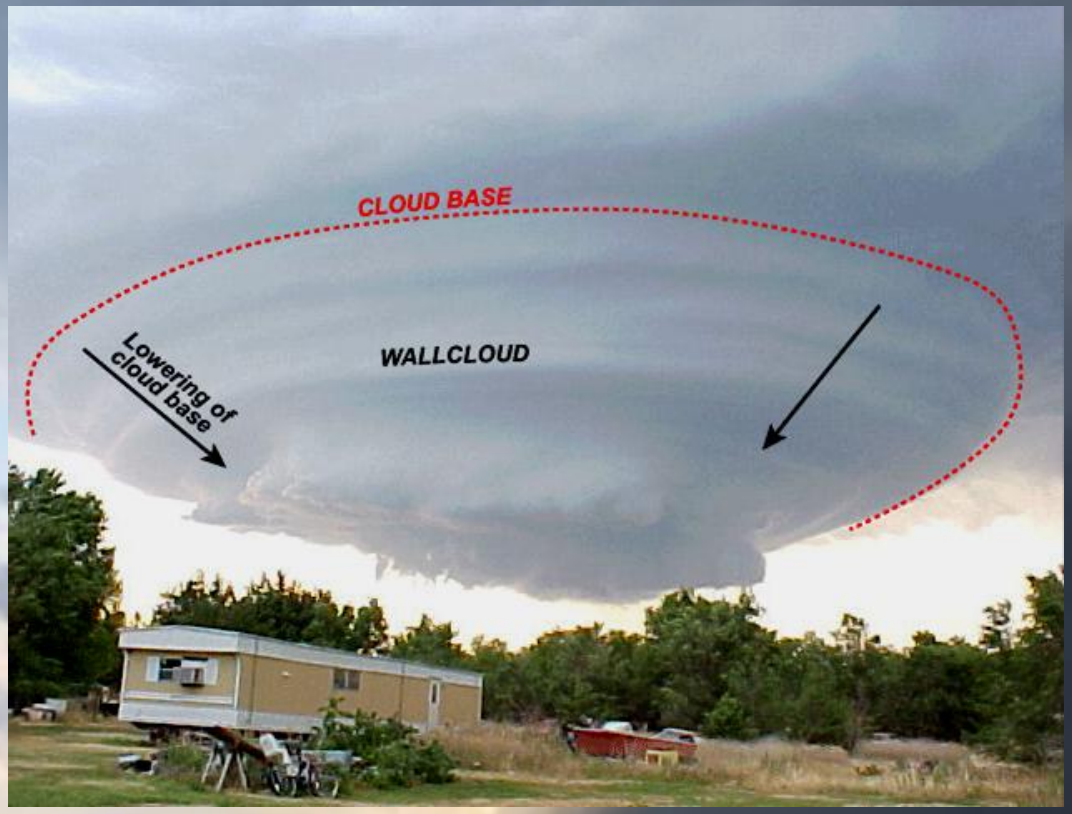


Mesocyclone



Wall Cloud

Lowering of the cloud base – enhanced condensation and inflow



May or may not rotate - rotation is precursor to tornado development

Tilts downward toward the rain

Wall Cloud in NH

Scud

Funnel Cloud

Rotating funnel-shaped cloud extending downward from a thunderstorm base, but not necessarily in contact with the ground.

Funnel cloud

National Weather Service Forecase Office, San Antonio, TX NOAA Central Library

Tornado

Violently rotating column of air, attached to a thunderstorm base, and in contact with the ground

Look for the dust/debris to determine contact with ground

Large Hail

The most destructive weather element

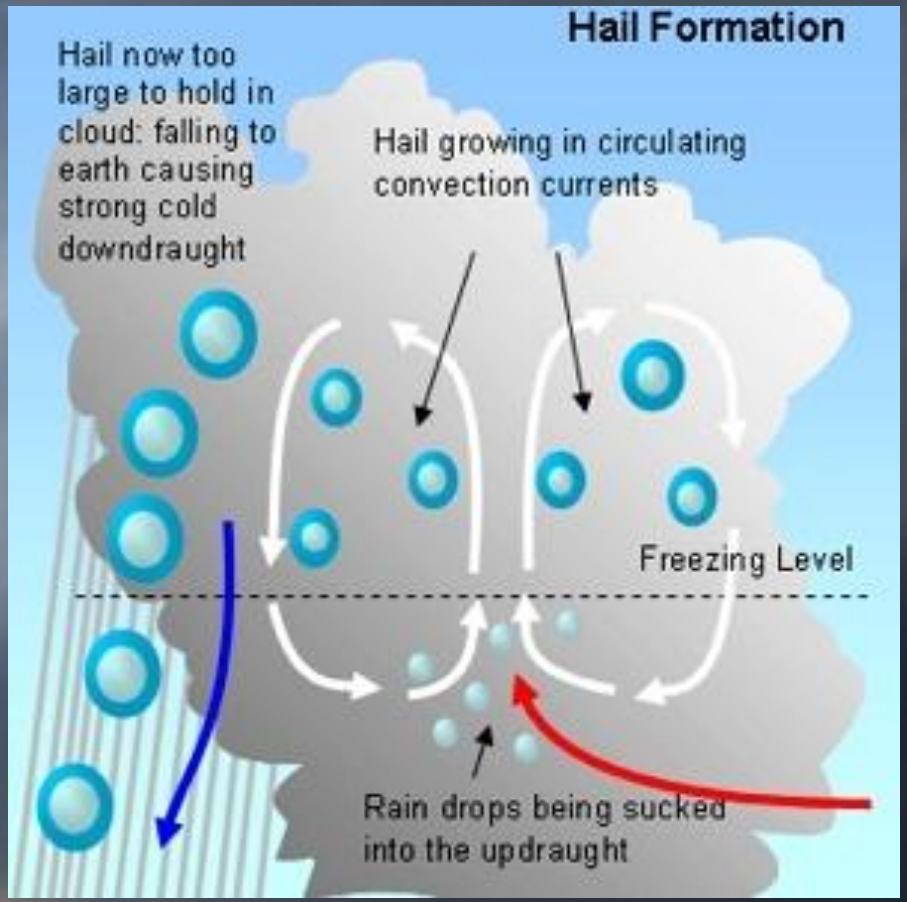
Annually causes $1 billion in damage

Can reach the size of softballs

Fall speeds up to 100 mph (potentially fatal)

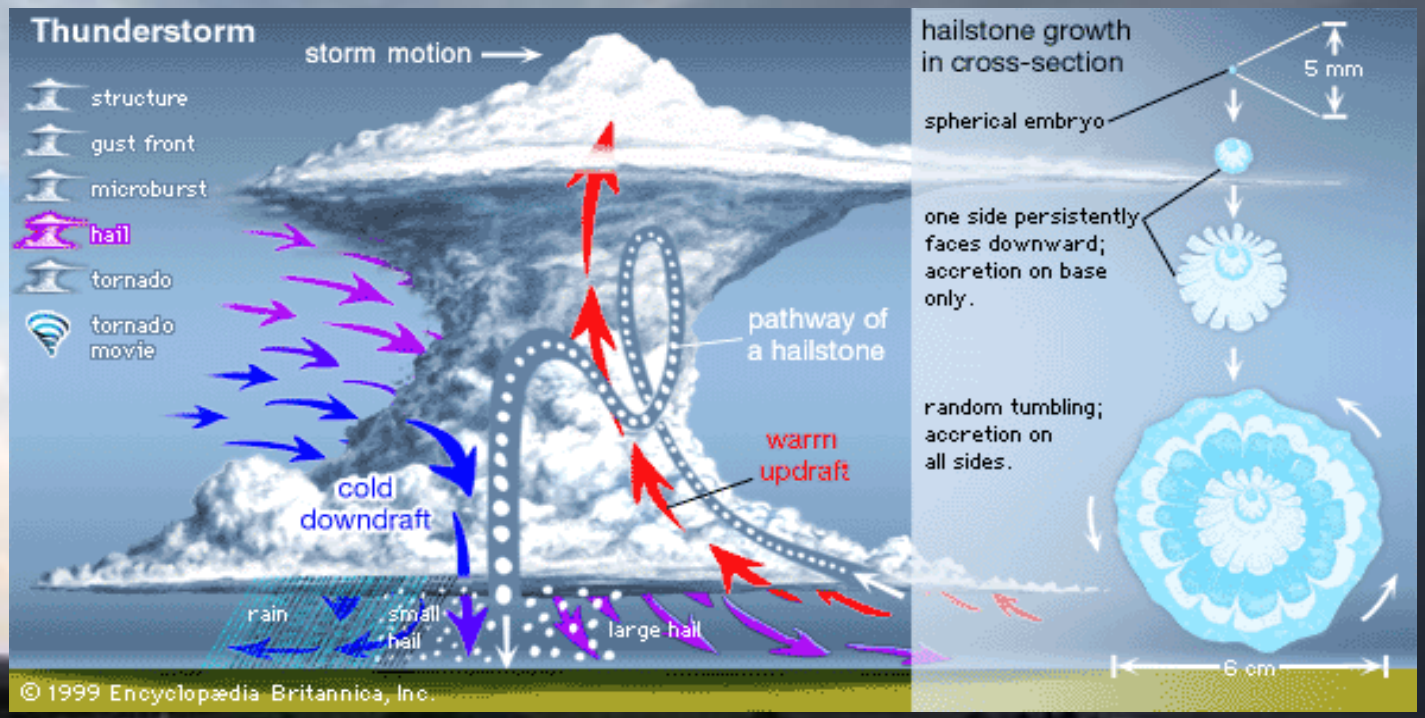
Hail Formation

- Updrafts quickly move water droplets to upper portion of storm
- Droplets freeze, serve as “nuclei” for hailstones
- Supercooled water droplets freeze to nuclei



Hail Formation

- Updraft continues moving water droplets above freezing level
- Droplets freeze to nuclei, hailstones grow
- Hailstones fall when they move out of updraft or become too heavy



- 0.25” - Pea
- 0.50” - Mothball (M&M)
- 0.75” - Penny/Dime
- 0.88” - Nickel
- 1.00” - Quarter
- 1.25” - Half Dollar
- 1.50” - Ping Pong
- 1.75” - Golf Ball
- 2.00” - Hen Egg
- 2.50” - Tennis Ball
- 2.75” - Baseball
- 4.50” - Softball

Coins or Sports Balls (or candy?)

Thunderstorm Winds or Downbursts

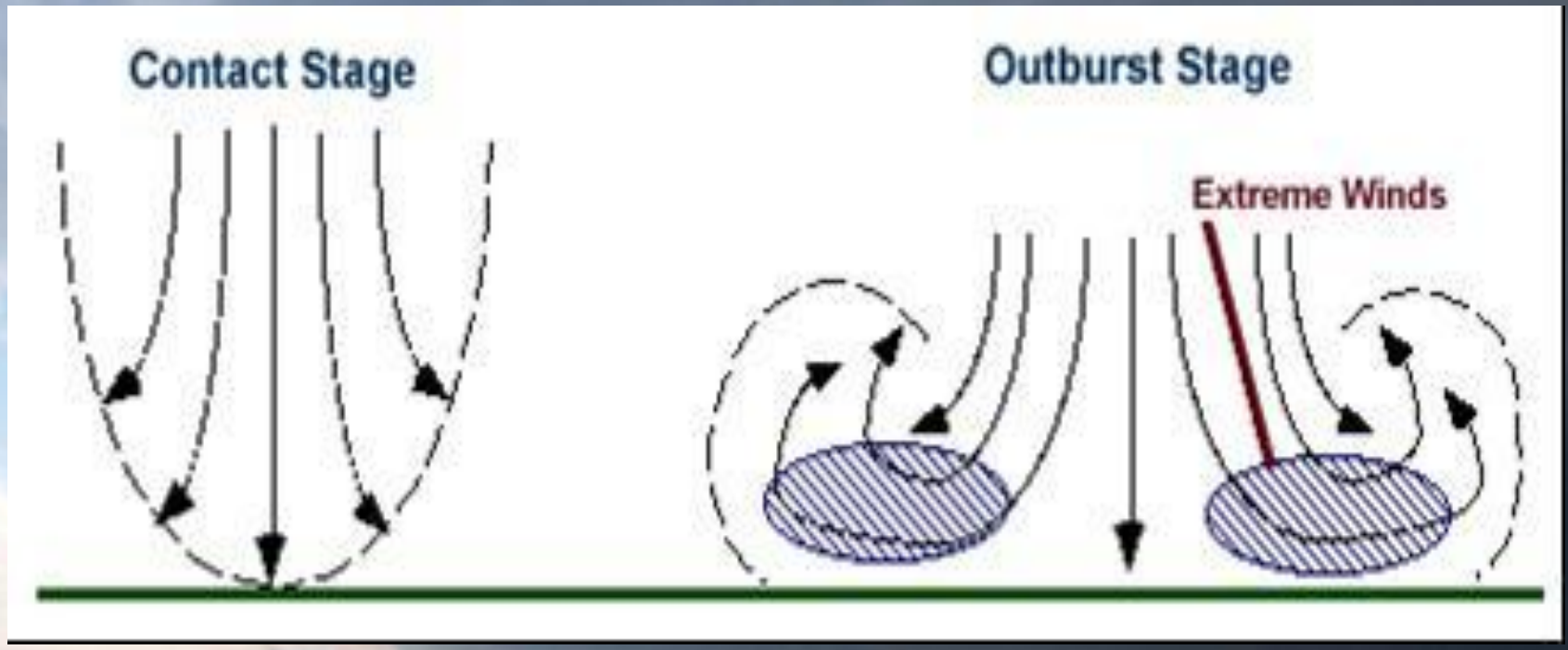
Much more common than tornadoes

Especially dangerous to mobile homes, vehicles, and aircraft

Winds can exceed 100 mph

Damage swath can cover several hundred miles

Downbursts




AM 10:50:53

Tornadoes vs. Downbursts

Tornadoes

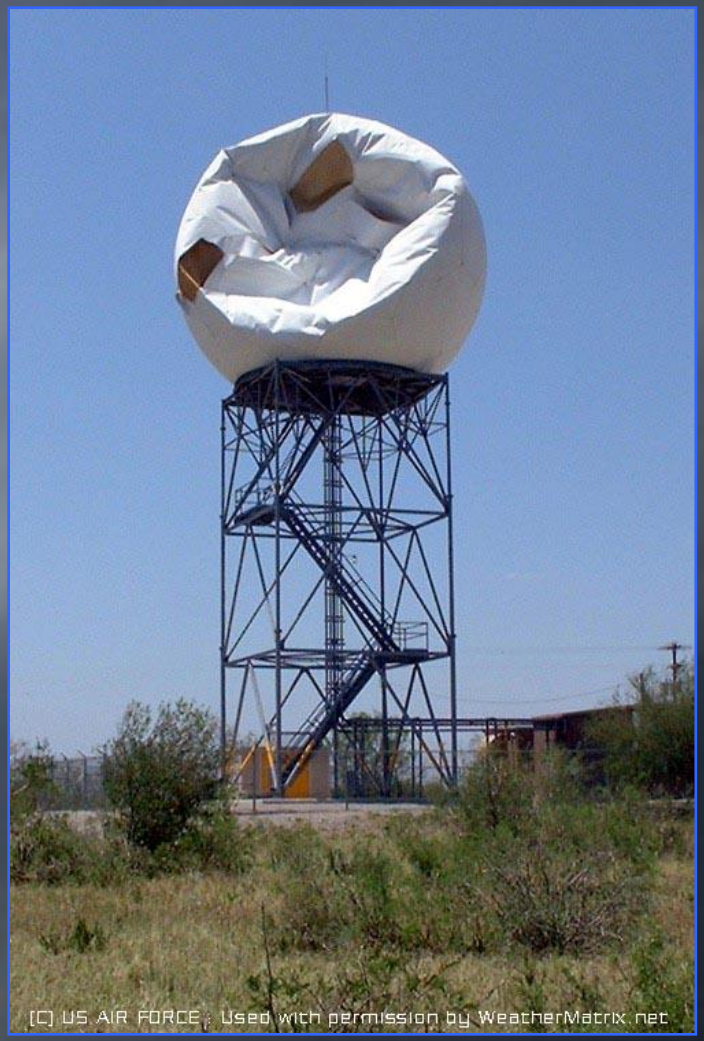
- Occurs in thunderstorm **updraft**
- Air is pulled INTO the tornado and up into the thunderstorm.
- Debris is lifted into the tornado and tossed out

Downburst

- Occurs in thunderstorm **downdraft**
- Air is thrust OUT from the thunderstorm toward the ground and then spreads outward along the ground.
- Debris is blown along the ground but rarely lifted.

Thunderstorm Safety

- Go indoors
- Stay away from windows
- If you are in a vehicle, point it into the wind
- If you are outside, get down as low as you can without laying on the ground.
- Can cause significant damage similar to a tornado!



Tornadoes

- Strong/violent tornadoes are rare, but cause most damage
- Enhanced Fujita scale rates tornadoes based on damage

Tornadoes - Weak

About 82% of tornadoes nationwide

Winds up to 110 mph

Lifetime about 1-10 min

Path length usually a couple miles or less

Low percentage of national casualties/damage

Fujita scale: EF0 and EF1

Tornadoes - Strong

About 17% of tornadoes nationwide

Winds 110 to 167 mph

Lifetime about 10-20 min

Path length usually 5-15 miles

Medium percentage of national casualties/damage

Fujita scale: EF2 and EF3

Tornadoes - Violent

Only about 1% of tornadoes nationwide

Winds > 168 mph

Lifetime up to an hour

Path length up to 50 miles

Large percentage of national casualties/damage

Fujita scale: EF4 and EF5

New Hampshire TORNADO
July 24, 2008

About 50 mile path length.
Max width ½ mile

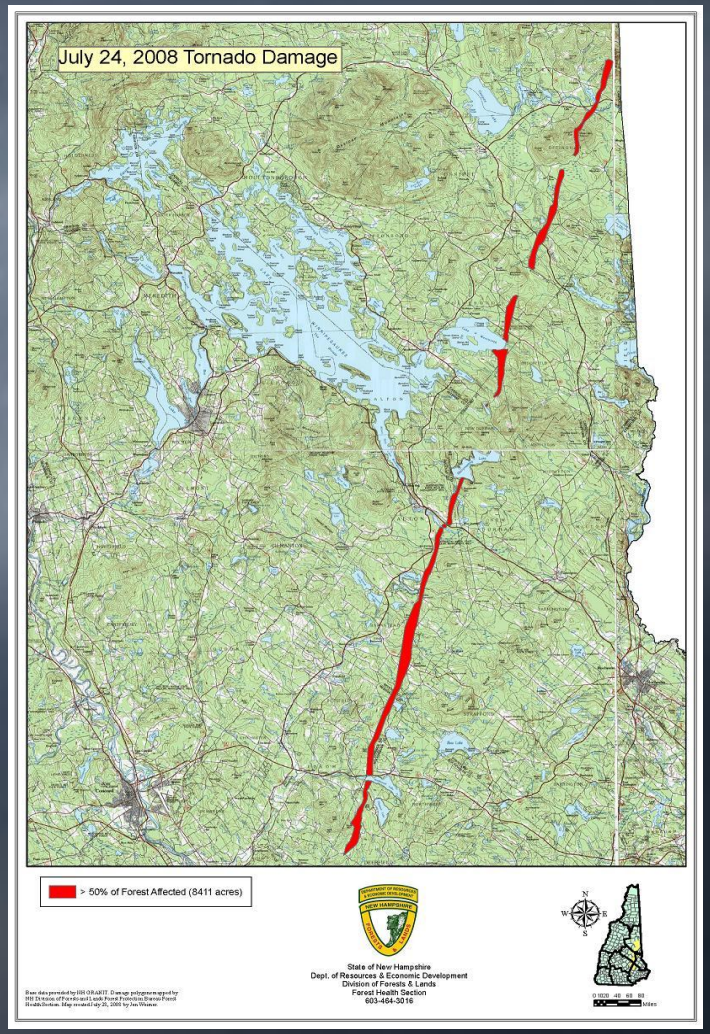
Moved through 5 counties

Tornado wrapped in rain. No eyewitness reports of funnel.

One fatality

Rated EF2

Areas in red on map had 50% or greater tree damage



New Hampshire TORNADO
July 24, 2008

Hampton Falls TORNADO
May 21, 2006

Path length - about 100 yards.

Path width about 20 yards

Touched down on I-95, 2 miles south of Hampton tolls.

Lifted and flipped pickup truck stopped on side of highway.

Rated E-F2.

Hampton Falls TORNADO

May 21, 2006

Hampton Falls TORNADO

May 21, 2006

Hampton Falls TORNADO

May 21, 2006

Hampton Falls TORNADO

May 21, 2006

Leighton, AL TORNADO

Tornado Safety at Home or Work

- Someplace underground is best
- If no underground shelter, get to a small, interior room on the lowest floor
- Closets and bathrooms are good
- Cover yourself with blankets or a mattress

Tornado Safety in Mobile Homes

- Manufactured homes are unsafe in a tornado/high wind event
- Even if anchored, abandon them for a substantial reinforced building

Tornado Safety in Vehicles

- Abandon vehicles for a substantial building
- Cars can be easily tossed about by a tornado's winds
- As a last resort, take cover in a culvert or ditch, but this is not as safe as a solid building

Bad Idea

Highway Overpasses

- NOT a safe place to take shelter!
- Winds and debris can be funneled underneath the overpass
- In the best cases, they offer only limited shelter
- Exposed, above-ground location
- Traffic congestion problems

Flash Flooding

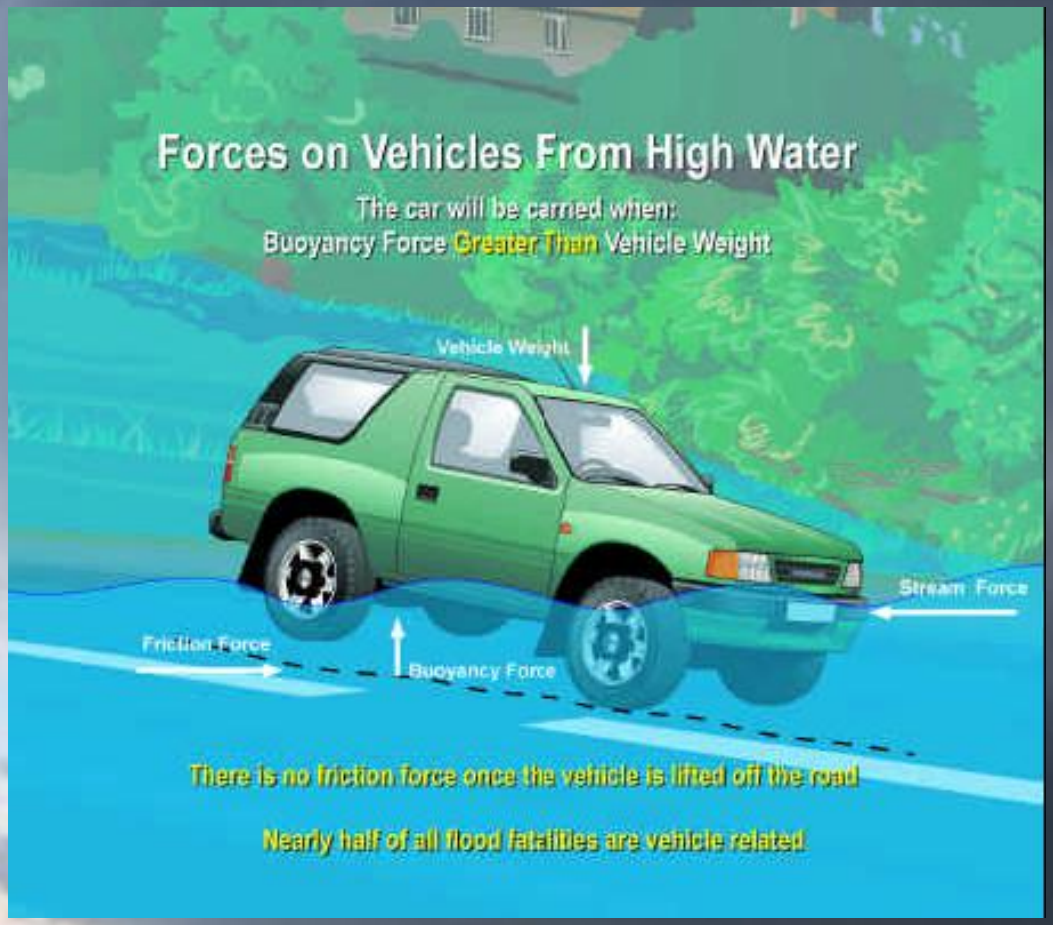
The #1 killer among weather events

Approximately 100 deaths annually

Most deaths occur in vehicles

Many deaths occur at night

Flash Flood Dangers



- 2-3 feet of water can float most vehicles
- 6-12 inches can knock a person off balance

Another Bad Idea

Flash Flood Safety

- Turn Around, Don't Drown tm
- Stay clear of flooded areas!
- Stay away from creeks or ditches
- If camping or hiking, know where the high ground is
- Be especially cautious at night

October 1996

Westbrook, ME

Old Orchard Beach, ME

Scarborough, ME

Lightning

The #3 killer among weather events

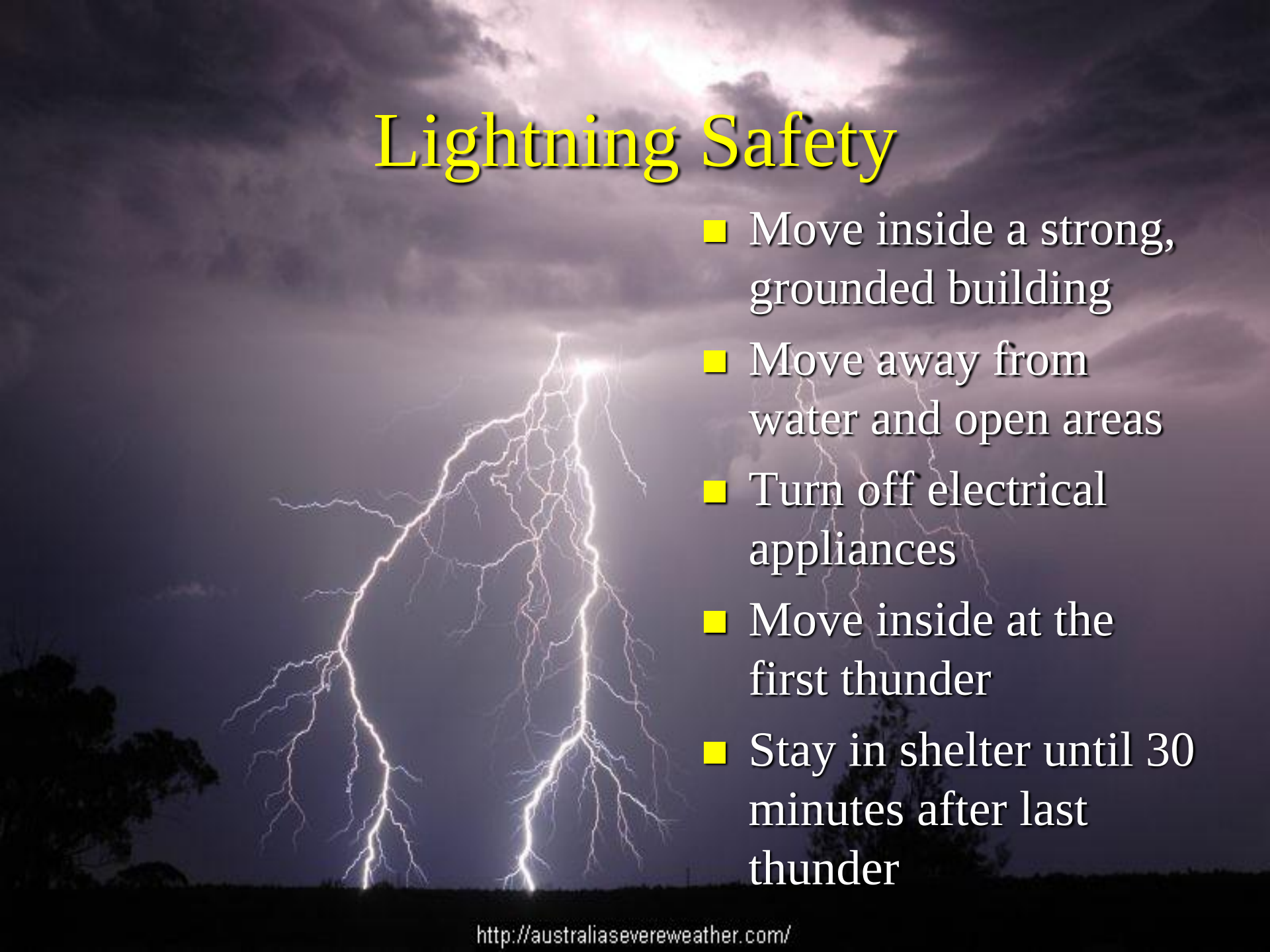
Boaters, golfers, people in open are most vulnerable

Temperature is about 50,000 degrees F

Electric current about 30,000 amperes

Lightning Safety

- Move inside a strong, grounded building
- Move away from water and open areas
- Turn off electrical appliances
- Move inside at the first thunder
- Stay in shelter until 30 minutes after last thunder



http://australiasevereweather.com/

http://australiasevereweather.com/

Timely Damage Reports ARE Important!

Severe Winds

North Berwick

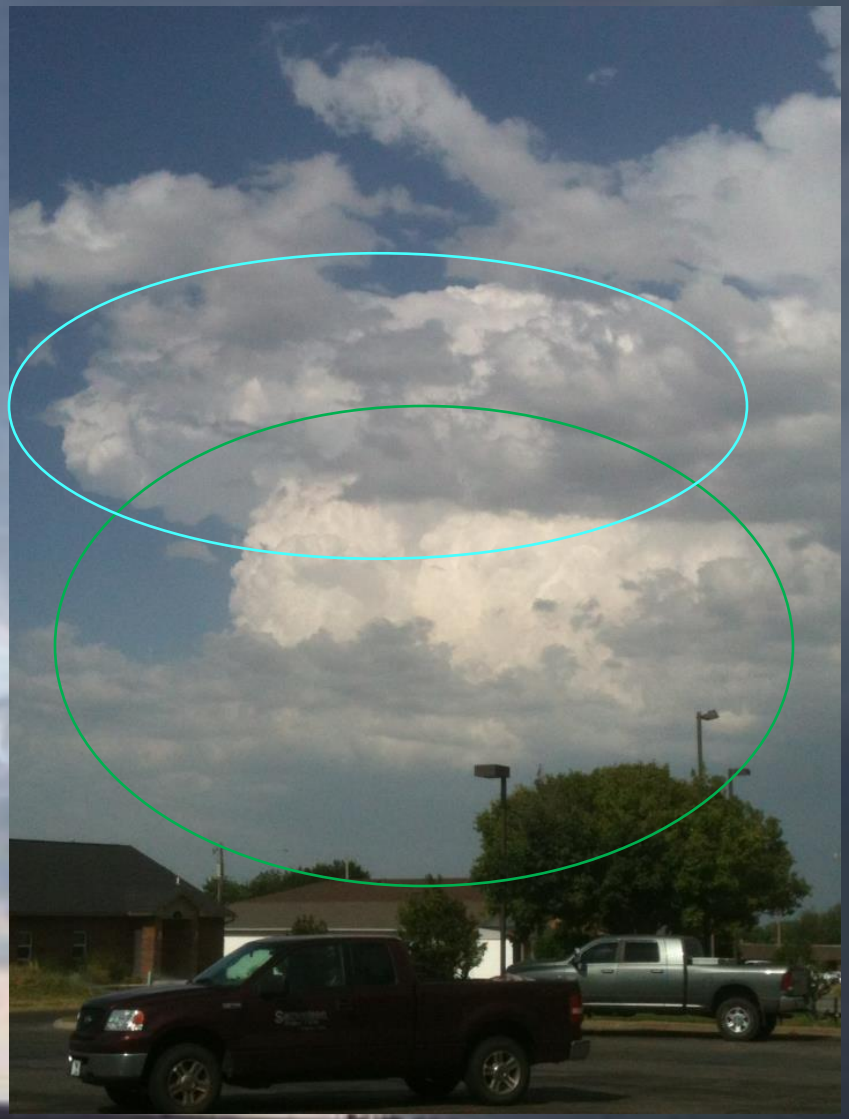
Thunderstorm Review

Towering Cumulus

Puffy nature of clouds indicates rising motion

Woodward, OK
May 19, 2012

Thunderstorm Review



Mature Thunderstorm

Clouds spread out at a stable layer (tropopause)

Large sustained updraft

Woodward, OK
May 19, 2012

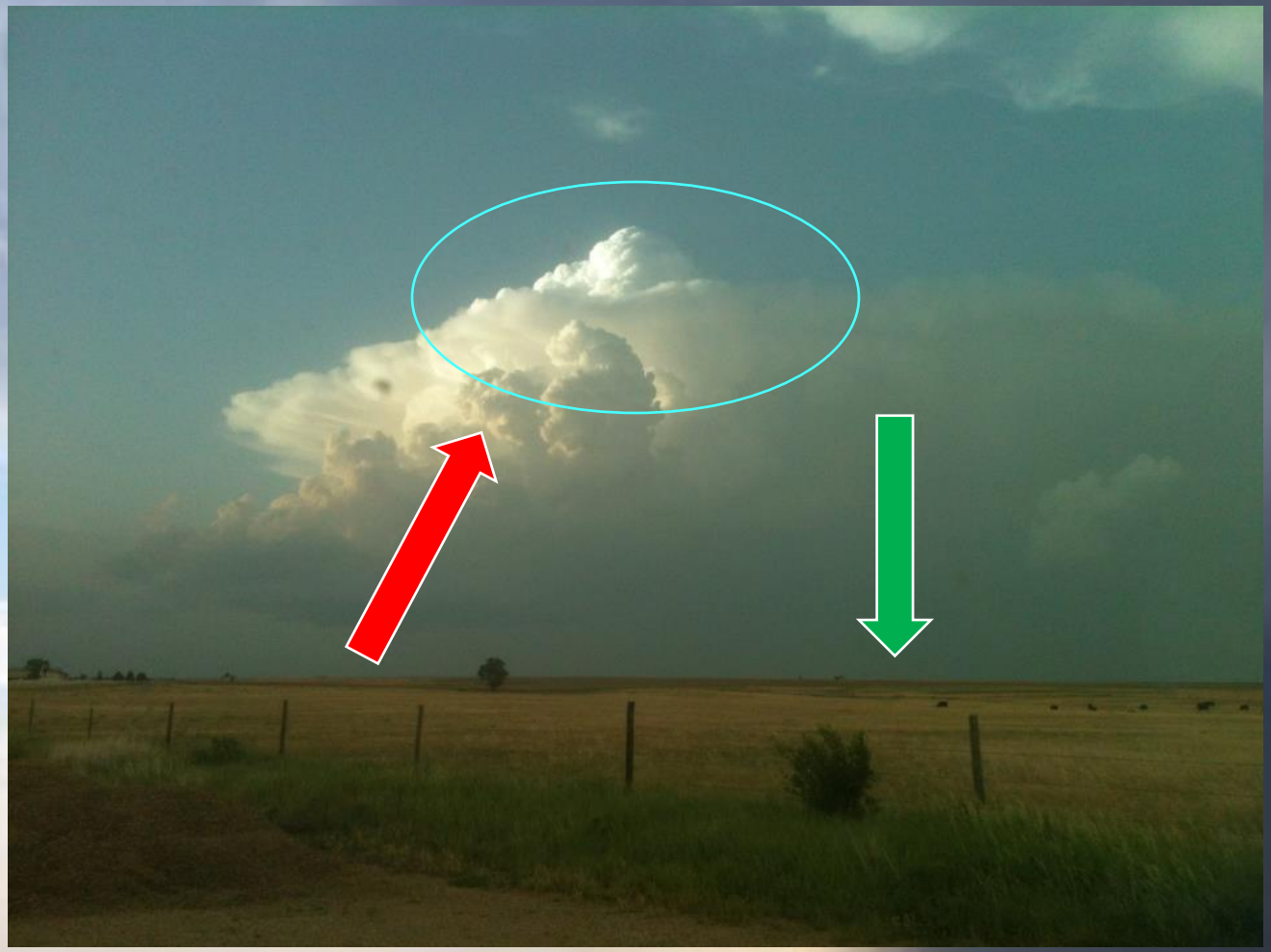
Thunderstorm Review

Supercell Thunderstorm

Well developed "anvil" structure

Hays, KS
May 27, 2012

Thunderstorm Review



Overshooting top

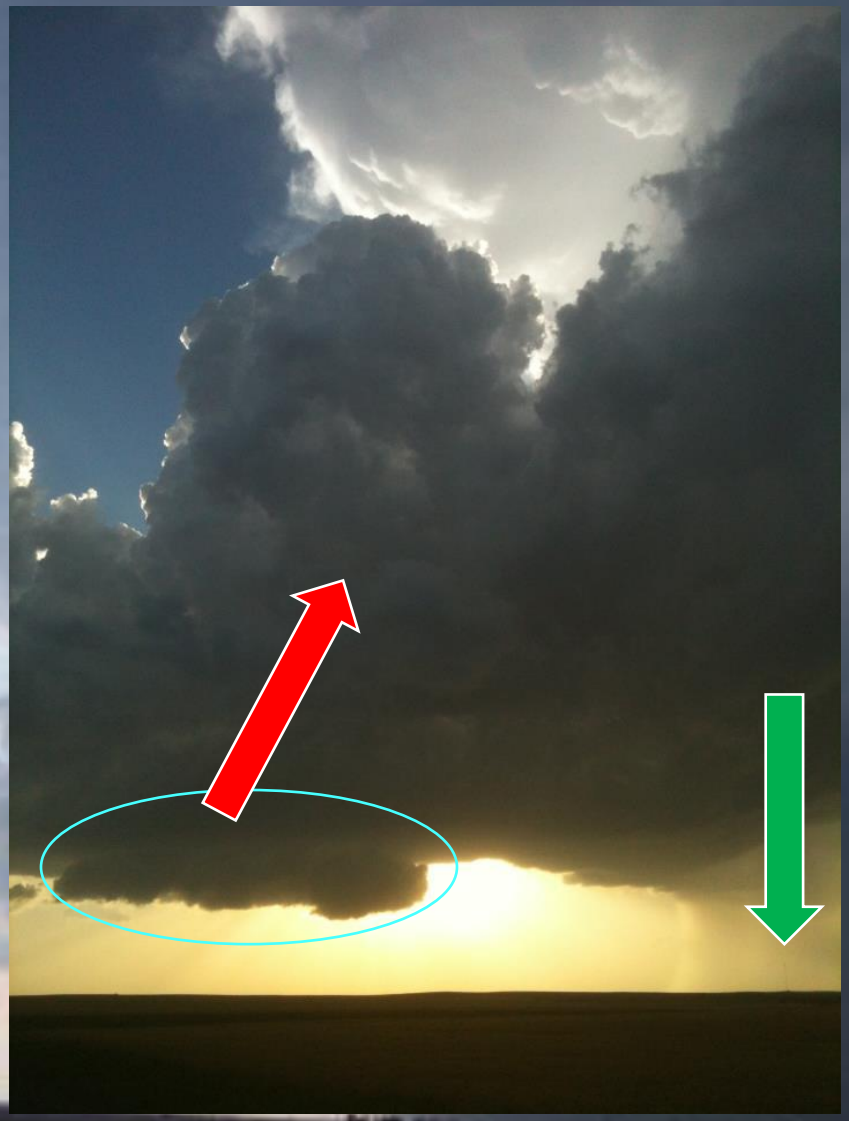
Updraft is strong enough to penetrate the stable tropopause

Tilted updraft w/ rain-free base

Downdraft with rain/hail

Hays, KS
May 27, 2012

Thunderstorm Review

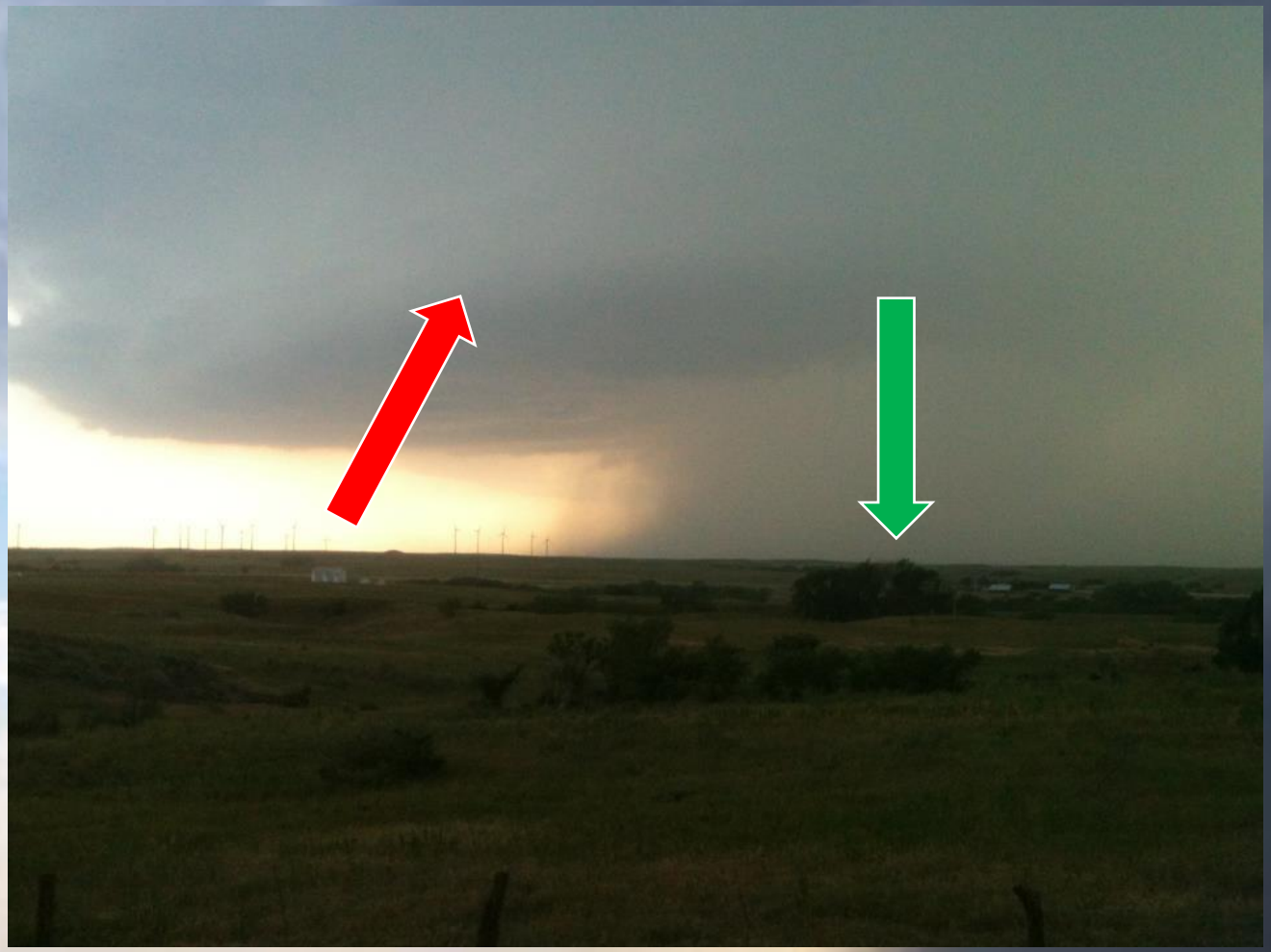


Wall Cloud

Wall Cloud is an area of lower cloud bases beneath the updraft

Hays, KS
May 27, 2012

Thunderstorm Review



Where is the updraft?

Where is the downdraft?

Elk City, OK
May 19, 2012

Thunderstorm Review

Scud

Rising air condenses to form small clouds being pulled into the updraft

Elk City, OK
May 19, 2012

Thunderstorm Review

Wall Cloud

Anadarko, OK
May 19, 2011

Thunderstorm Review

Mesocyclone

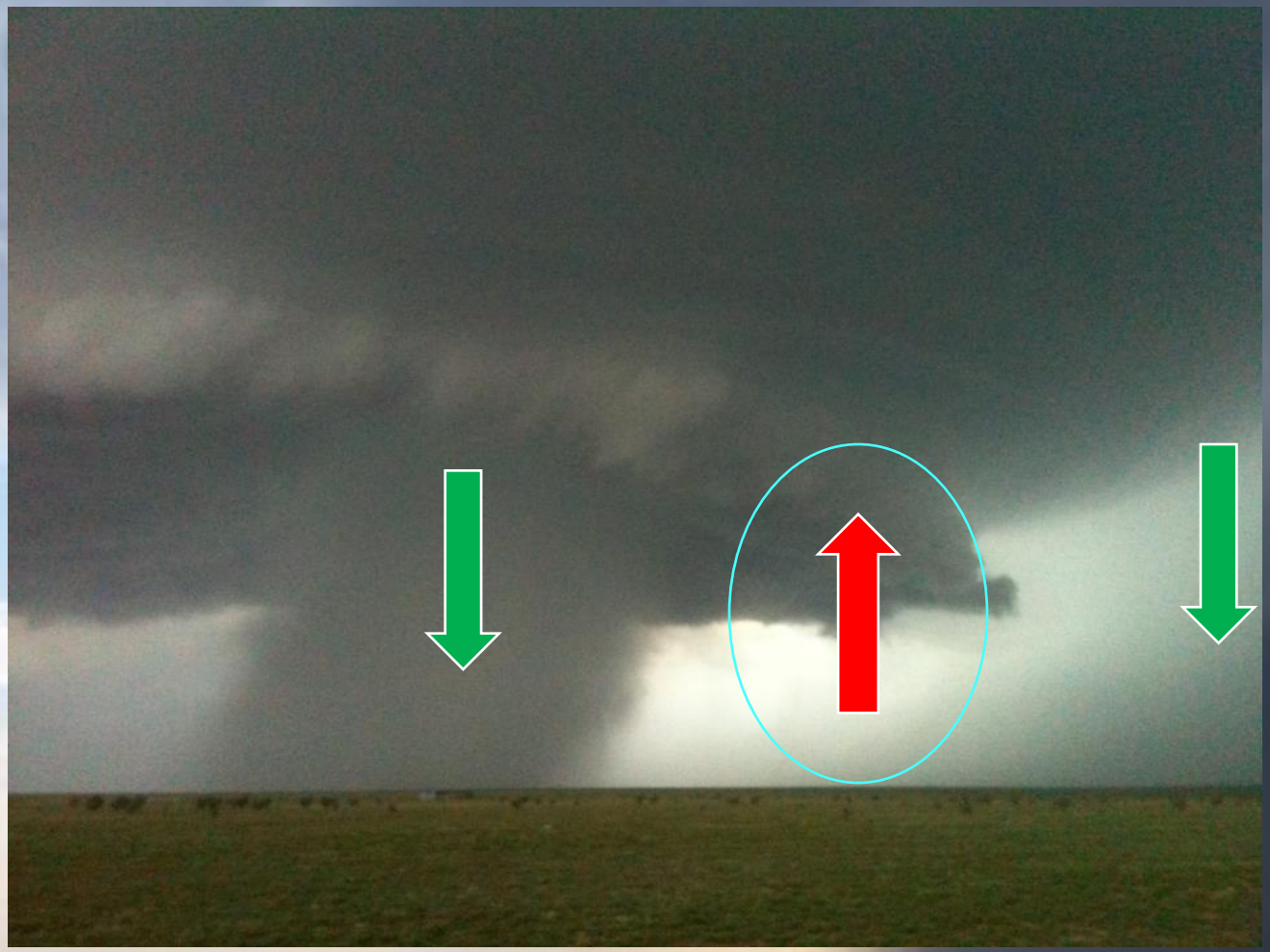
Adrian, TX
May 21, 2012

Thunderstorm Review

Scud

Adrian, TX
May 21, 2012

Thunderstorm Review



Where are the updraft(s) and downdraft(s)?

Where would a tornado form?

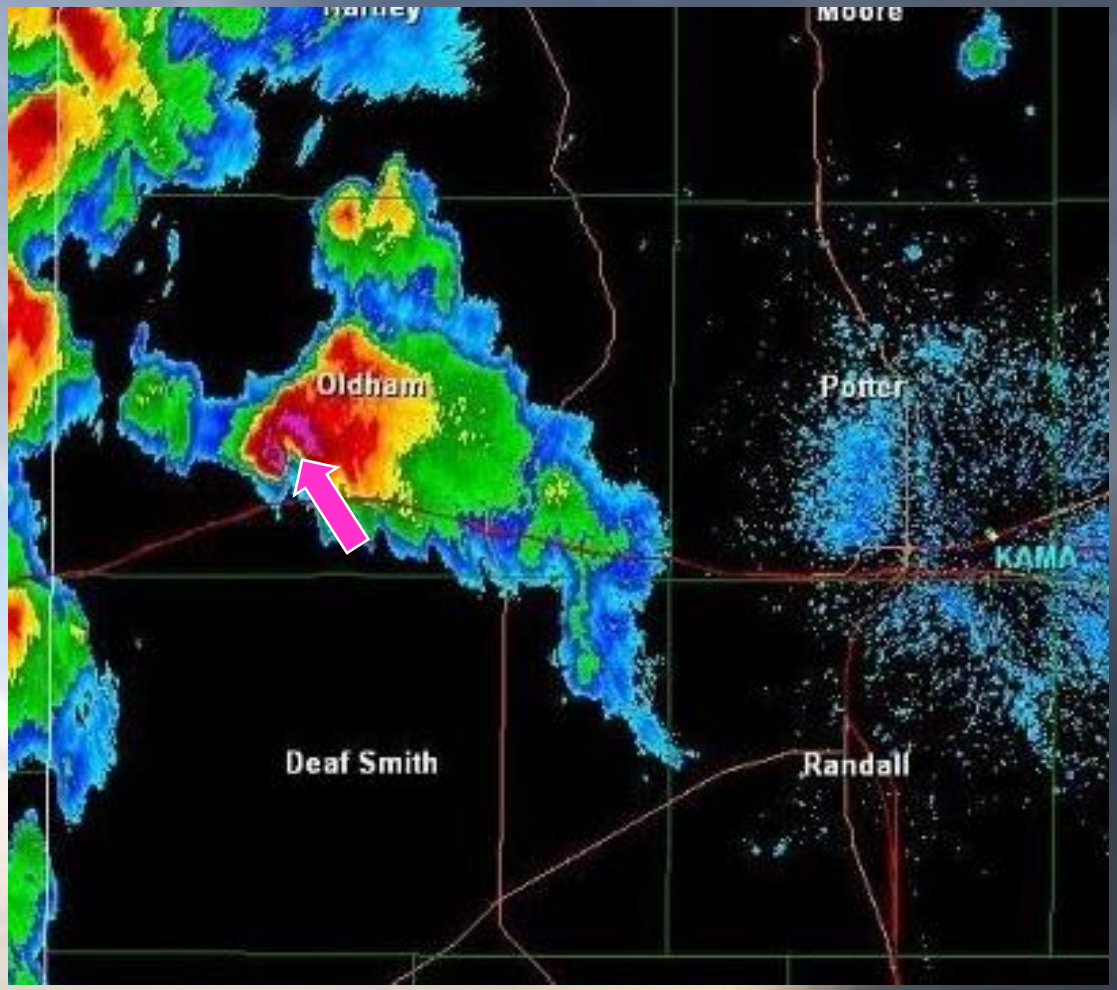
Adrian, TX
May 21, 2012

Thunderstorm Review

Funnel Cloud?
Tornado?

Adrian, TX
May 21, 2012

Thunderstorm Review



Where would the tornado form?

Adrian, TX
May 21, 2012

Thunderstorm Review

Funnel Cloud

Rear Flank Downdraft (RFD)

Larned, KS
May 18, 2013

Thunderstorm Review

Tornado

Larned, KS
May 18, 2013

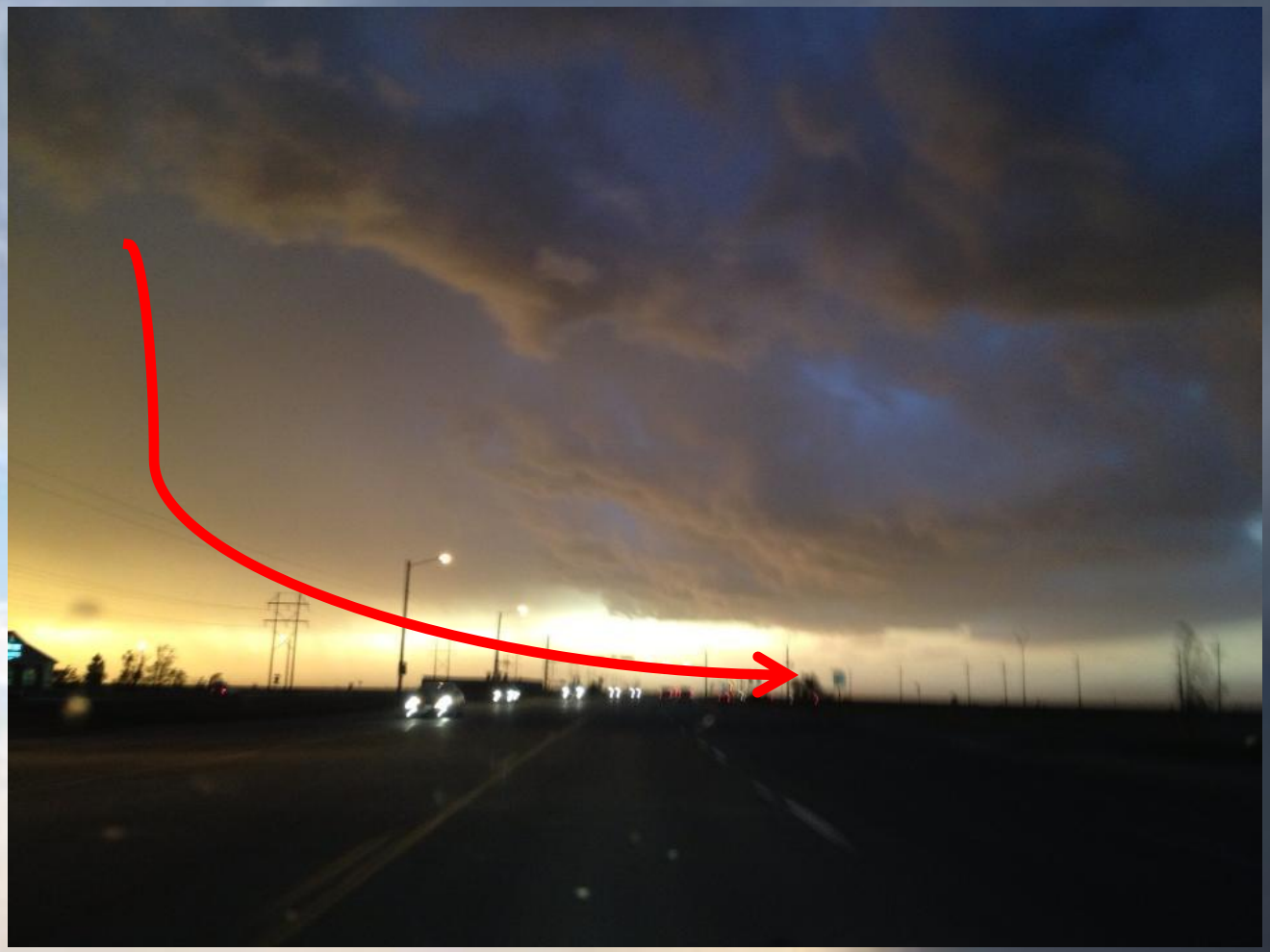
Thunderstorm Review

Funnel Cloud or Tornado?

Tornado

Larned, KS
May 18, 2013

Thunderstorm Review



Shelf Cloud

Amarillo, TX
May 25, 2013

Thunderstorm Review

Wall Cloud

Purcell, OK
May 30, 2013

Thunderstorm Review

Scud

Purcell, OK
May 30, 2013

Thunderstorm Review

Funnel Cloud

Purcell, OK
May 30, 2013

Thunderstorm Review

Wall Cloud

Purcell, OK
May 30, 2013

Thunderstorm Review

Wall Cloud

Purcell, OK
May 30, 2013

Thunderstorm Review

Updraft/Downdraft?

Wall Cloud?

Funnel Cloud?

Campo, CO
May 31, 2010

Thunderstorm Review

Where would a tornado form?

Wall Cloud?

Funnel Cloud?

Campo, CO
May 31, 2010

Thunderstorm Review

Where would a tornado form?

Wall Cloud?

Funnel Cloud?

Campo, CO
May 31, 2010

Thunderstorm Review

Original circulation dissipates. New circulation takes over

Campo, CO
May 31, 2010

Thunderstorm Review

Find the tornado

Campo, CO
May 31, 2010

Thunderstorm Review

Find the tornado

Campo, CO
May 31, 2010

What to report?

Tornado	Hail (any size)
Funnel Cloud	Winds 50 mph or greater
Rotating Wall Cloud	Rain: 1” an hour or more
Flash Flooding	Rain: 2” or greater in < 6 hours

What to report

- Any damage caused by storms, including lightning damage
- We commonly verify Severe Thunderstorm Warnings with downed trees – how many, how large in diameter, and where.

What *NOT* to report:

- Lightning- we have an accurate detection system
- “Dark sky,” “It’s starting to rain,” “It’s raining hard,” etc.

How to report

- **Call:**

  800-482-0913

- **E-mail:**

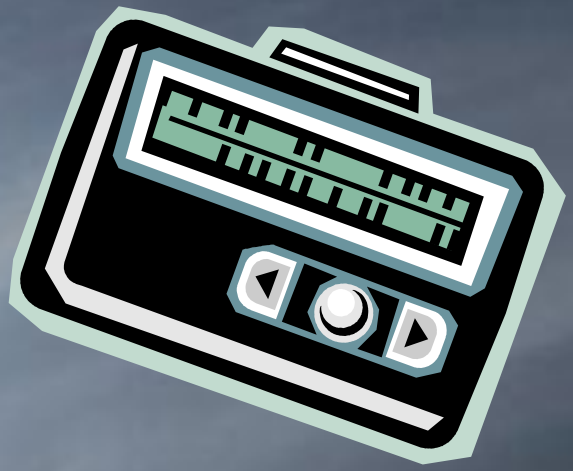
  gyx.skywarn@noaa.gov

- **Web site:** *www.weather.gov/gray*

  "Send a storm report"

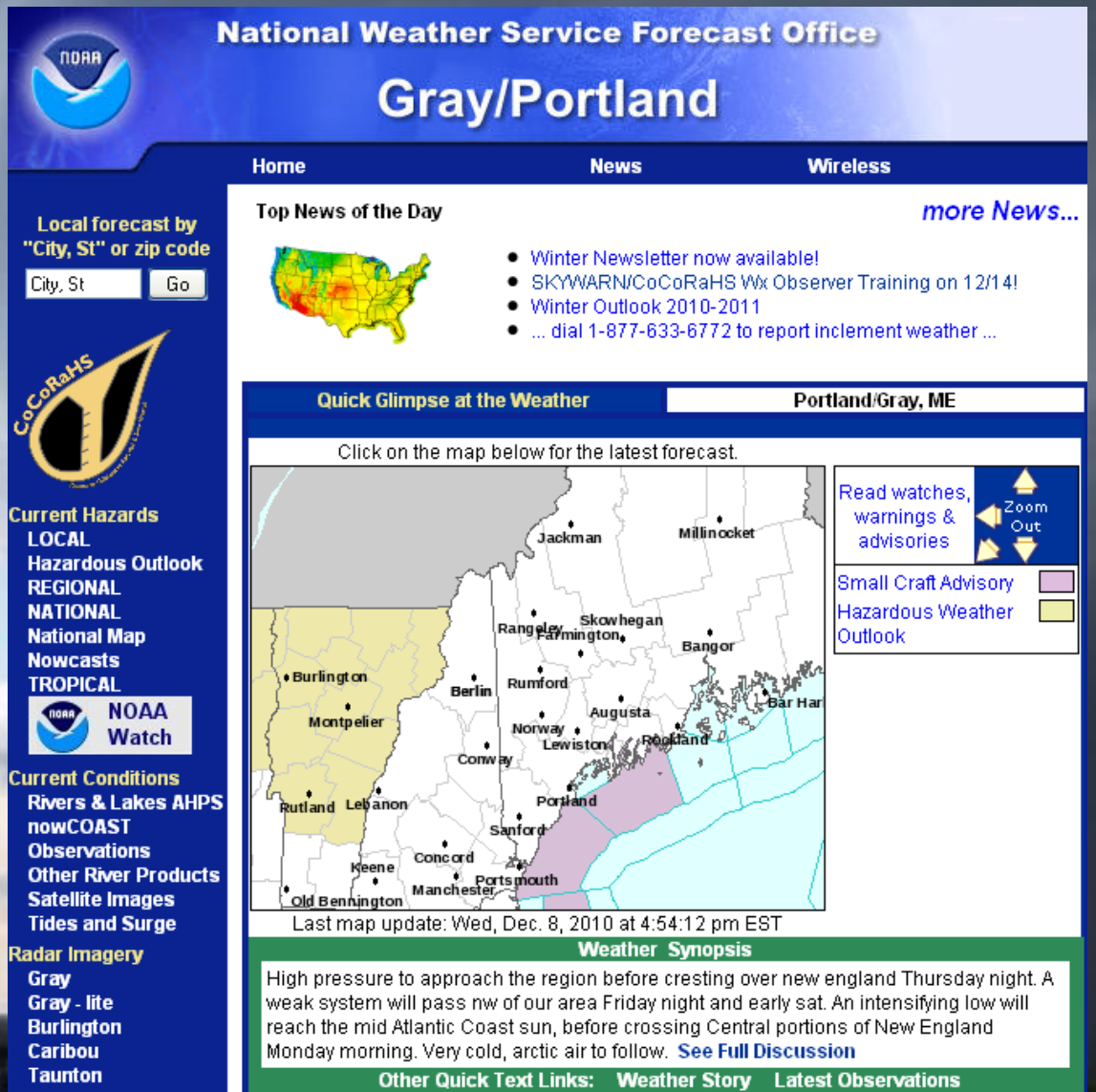
Getting the Word

- NOAA Weather Radio
- Commercial TV
- Commercial radio
- Cable TV
- Internet
- Sirens



NWS Gray Website

www.weather.gov/gray



Summary

- The NWS has tools for detecting severe weather
- Only by combining the tools with skilled forecasters and spotters can we provide the best service
- Severe storms pose a variety of threats
- We all must be ready when storms threaten

Questions? Contact Us!

National Weather Service
1 Weather Lane, Route 231
Gray, ME 04039
207-688-3216

Website: www.weather.gov/gray