

Severe Weather Spotter and Safety Course



**National Weather Service
Gaylord, Michigan**

Thunderstorm Development

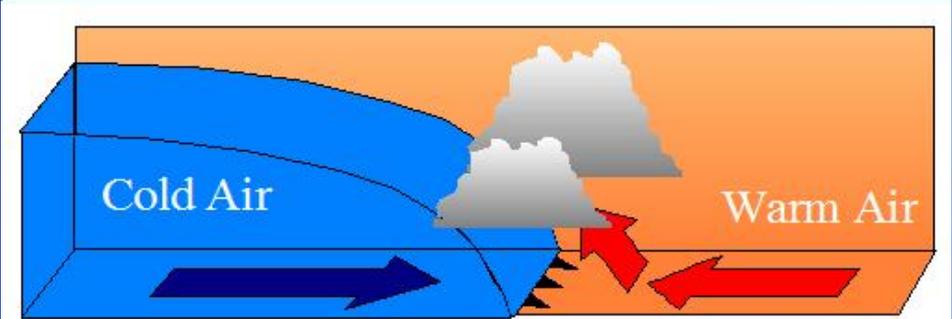
The Three Essential Ingredients



- Moisture
- Instability
- Lift
 - fronts
 - lake breezes
 - old boundaries

 **Lift Associated with a Cold Front** 

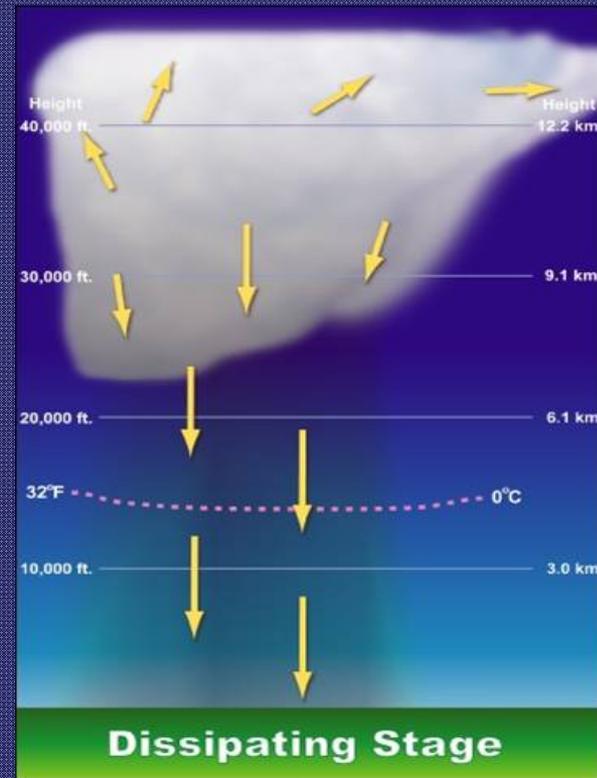
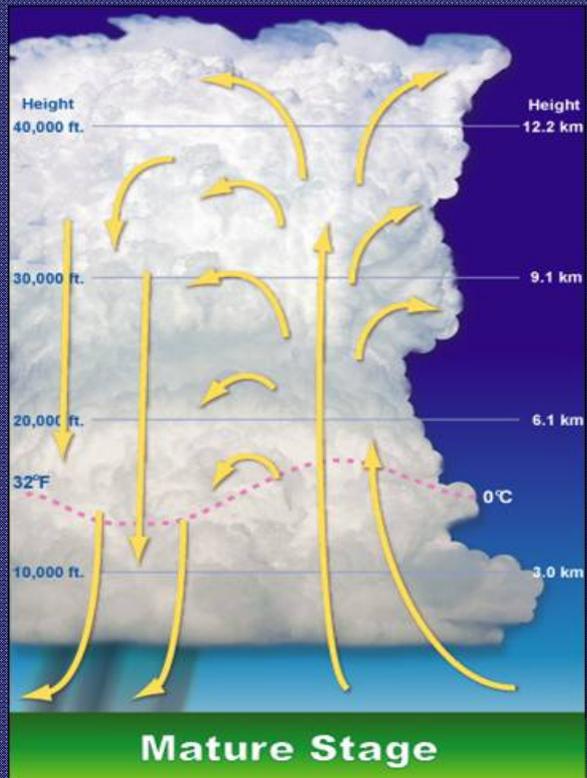
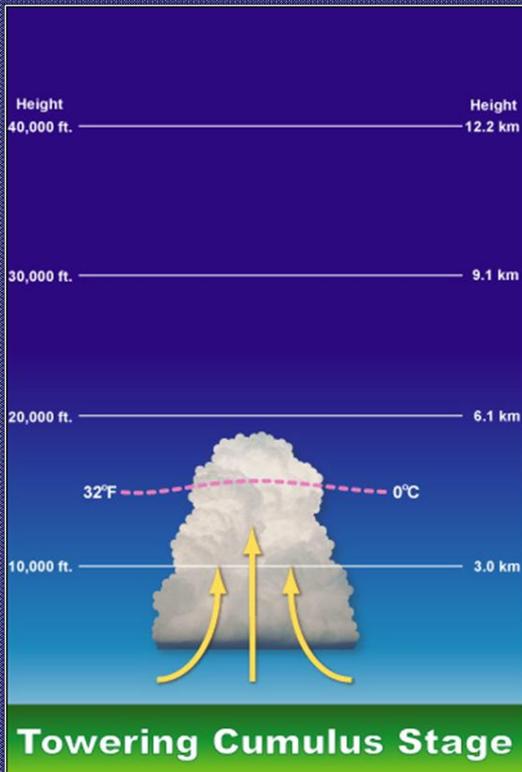
- Colder more dense air pushes underneath warmer moist air, creating condensation and cloud development.
- Air converges along a frontal boundary, forcing it to rise.



The diagram illustrates a cold front where a mass of cold air (blue) moves from left to right, pushing under a mass of warmer, moist air (orange). The warm air is forced to rise, leading to the formation of clouds. Red arrows indicate the direction of the cold air mass, and a blue arrow indicates the direction of the warm air mass.



Thunderstorm Life Cycle



Clues to Thunderstorm Development

- **Moisture**
 - *Hazy, humid days, monitor dew points (60s and 70s)*
 - *Low clouds in the morning*
- **Instability (Will the air rise)**
 - *Once cumulus clouds show up...look for rapid growth and development*
- **Trigger or focusing mechanism**
 - *Fronts, lake breezes, Outflow Boundaries from other thunderstorms*
 - *Afternoon heating*
- **Shear**
 - *Wind shifts/Strong winds*
 - *Clouds at different levels moving different directions*

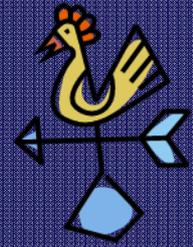
How Does a Thunderstorm Become Severe??

- The general thunderstorm can produce some severe weather, but is usually short-lived and relatively weak.
- The key factor for long-lived severe thunderstorm development is...

Wind Shear



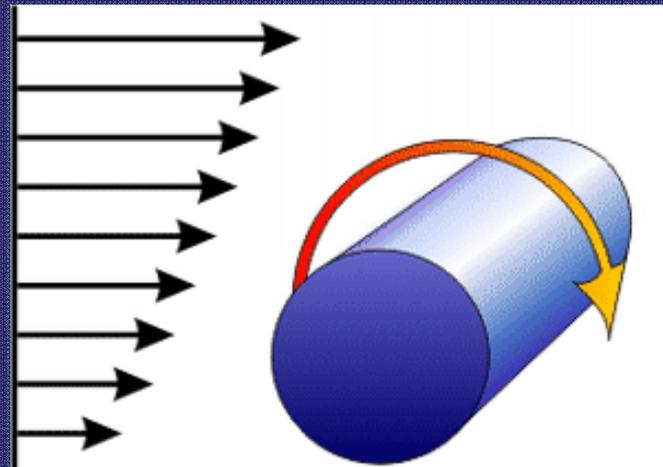
What's Wind Shear?



- Wind Shear is a change of speed and/or direction of the wind with height.



Directional wind shear



Speed wind shear



Wind Shear in a Thunderstorm

Wind Speed/Direction
Example

40,000 ft

Northwest Wind 100
mph

20,000 ft

West Wind 80 mph

10,000 ft

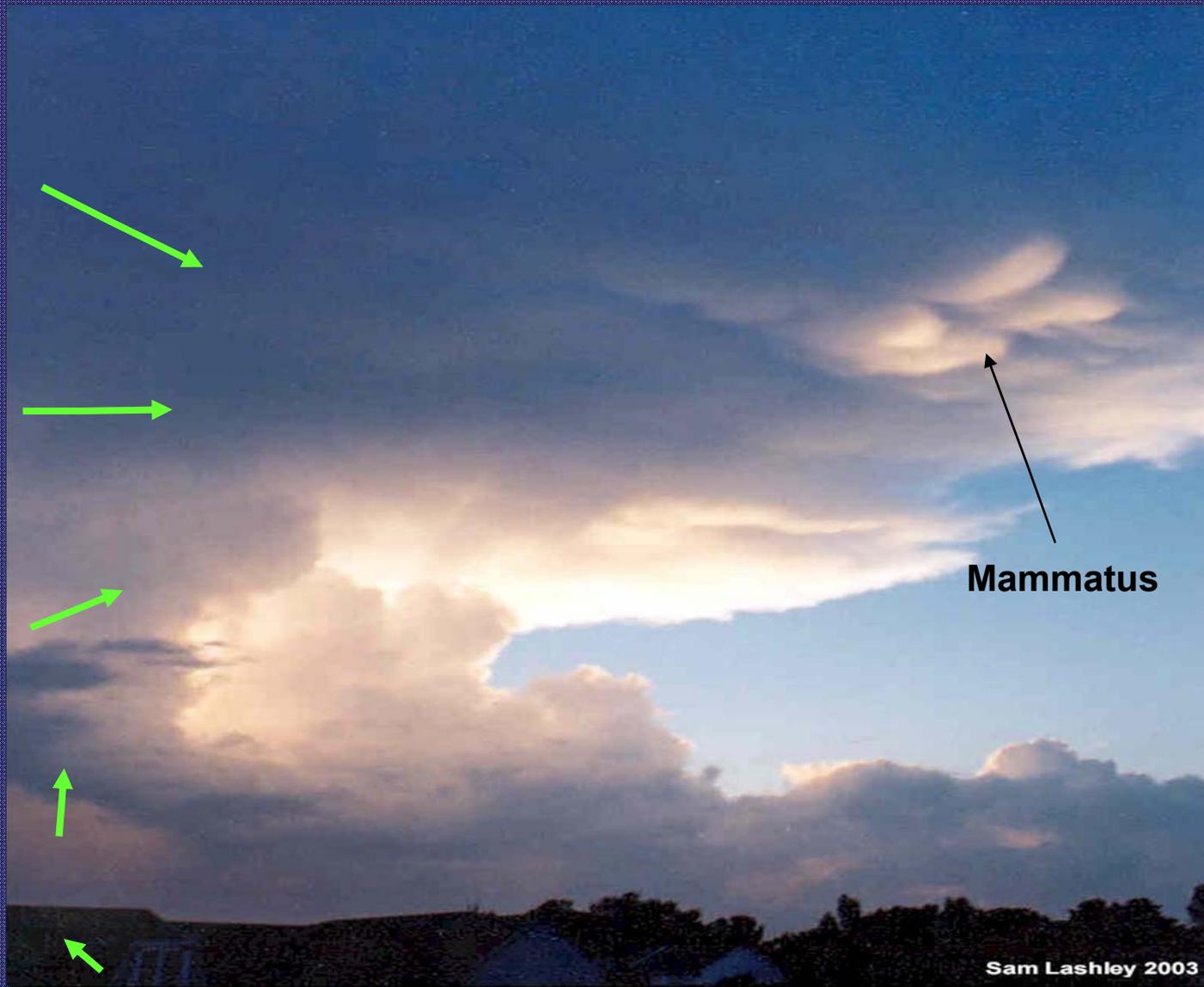
Southwest Wind 60 mph

5,000 ft

South Wind 50 mph

Surface

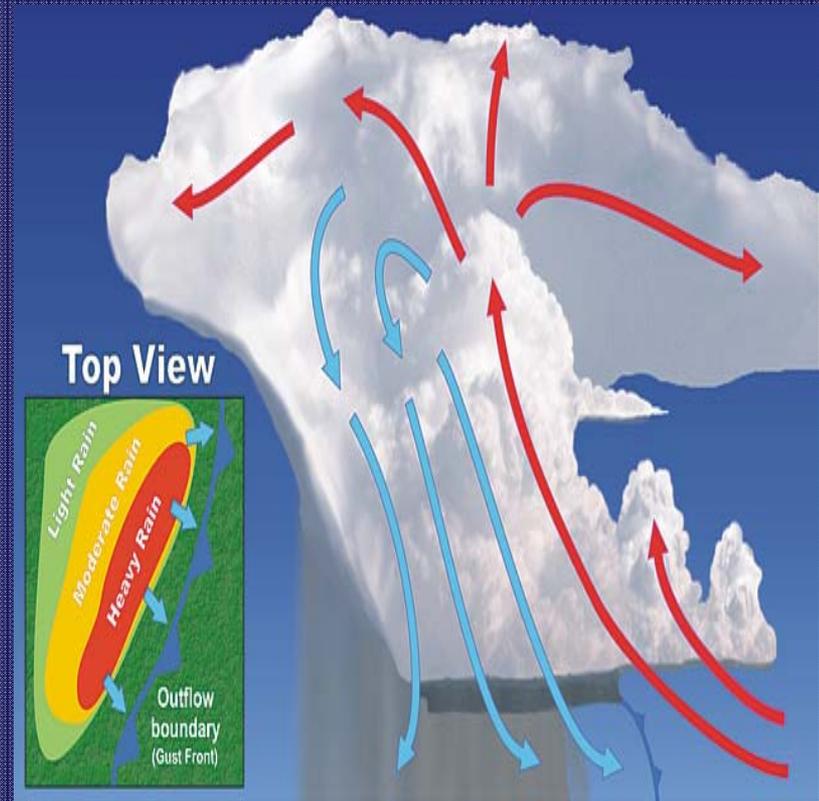
Southeast Wind 20 mph



Sam Lashley 2003

Wind Shear at Work

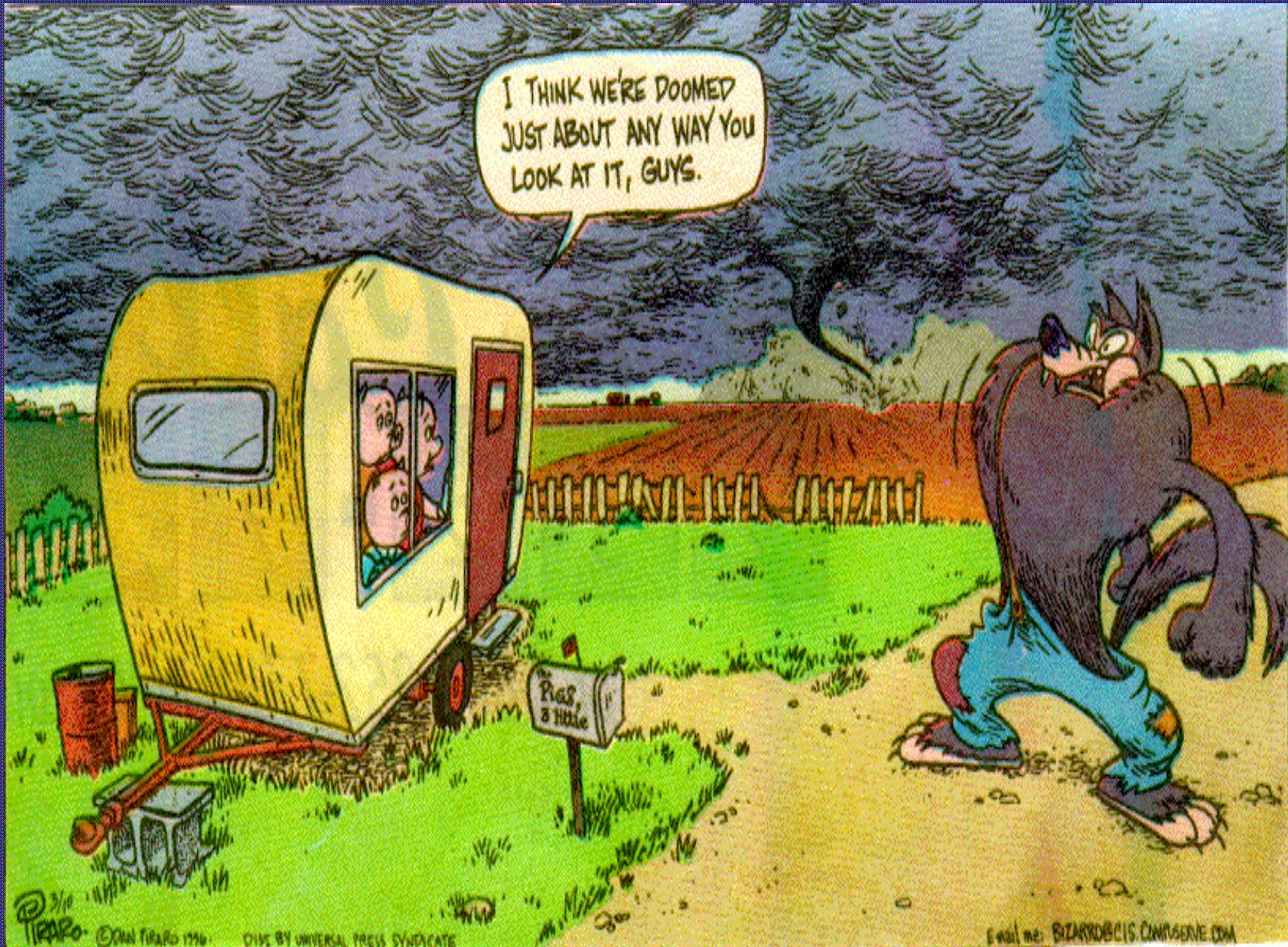
- Change of wind speed/direction with height causes thunderstorm to become tilted
- This tilting allows updrafts and downdrafts to coexist for long periods of time (i.e. well-organized convection)
- This results in well-organized, long-lived convection which can lead to severe weather.



Wind shear is a key component to tornado development



I THINK WE'RE DOOMED
JUST ABOUT ANY WAY YOU
LOOK AT IT, GUYS.



© 1990
TRAP

© 1990 TRAP BY UNIVERSAL PRESS SYNDICATE

email me: BIZARROBELLS.COM/GENE.COM

Tornadoes

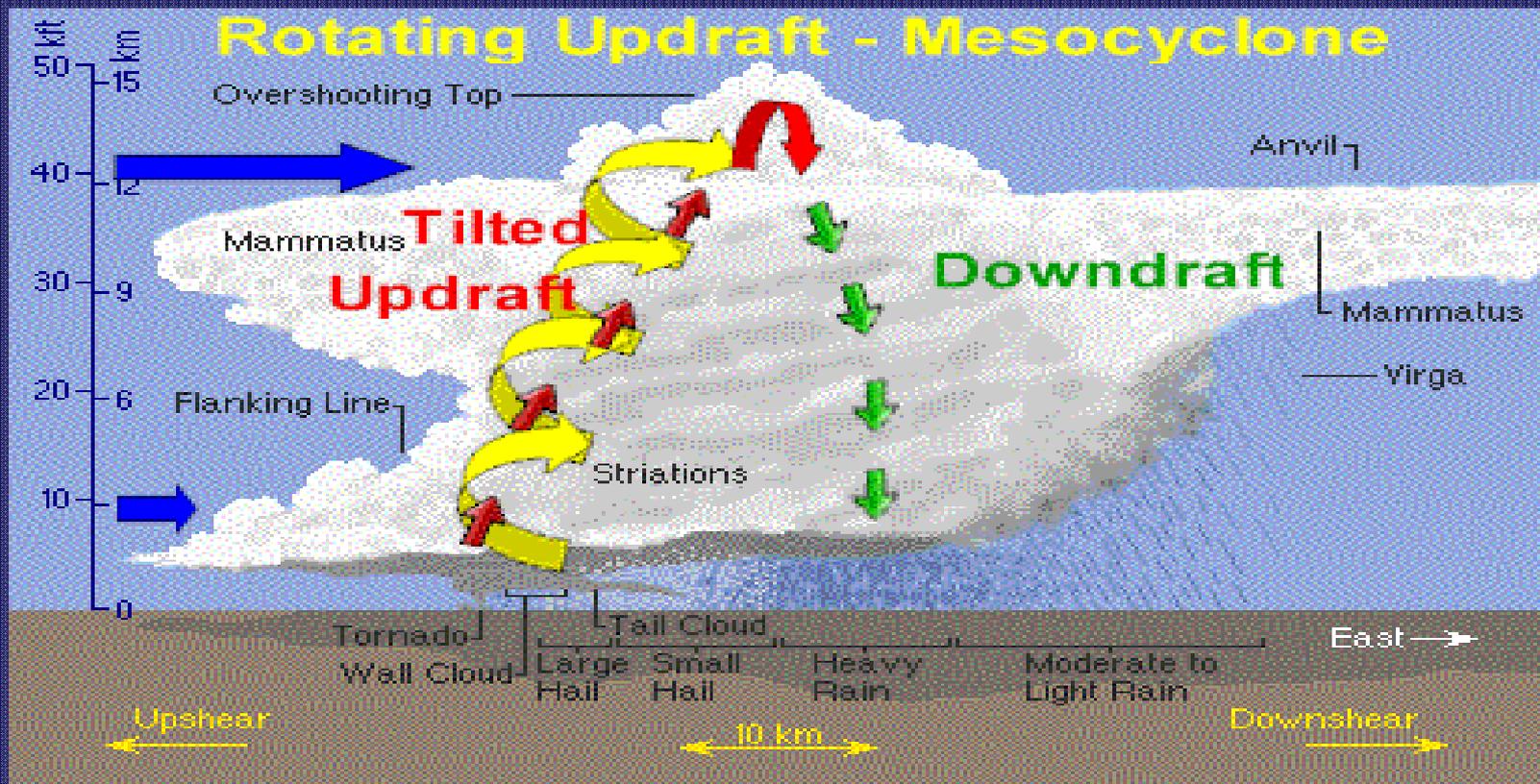
How they develop

- Tornadoes typically develop within Supercell Thunderstorms
- Wind shear (speed and direction) produces horizontal rotation at low levels
- This horizontal rotation is tilted into the vertical by the strong updrafts within a supercell thunderstorm
- The vertical rotation is stretched and narrowed, which accelerates the rotating winds as a tornado forms



Tornadic Supercell Thunderstorm

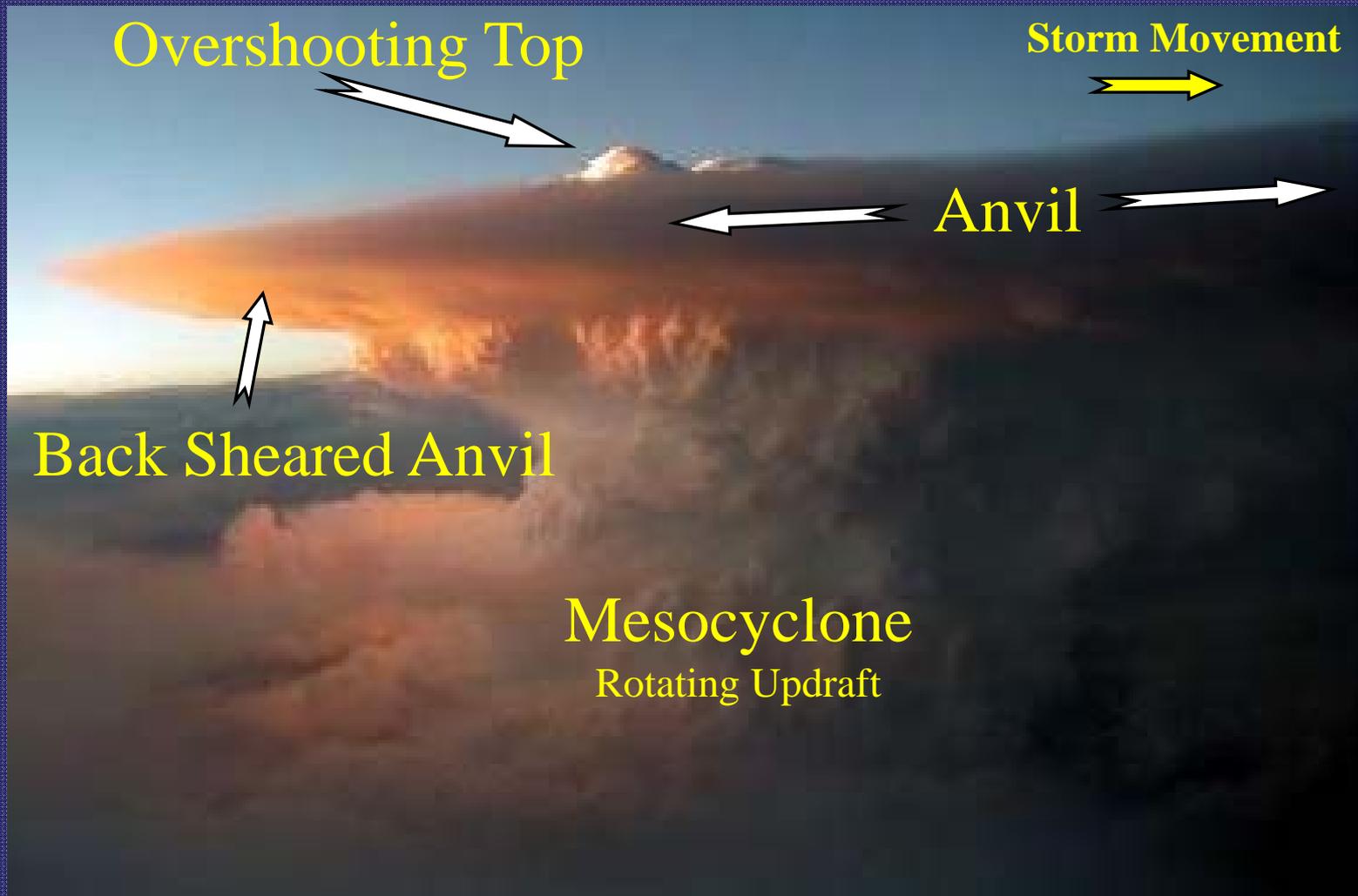
A Cross Section and Important Cloud Features



*Note – Wall Cloud and Tornado occur near the back of the storm (Supercell)

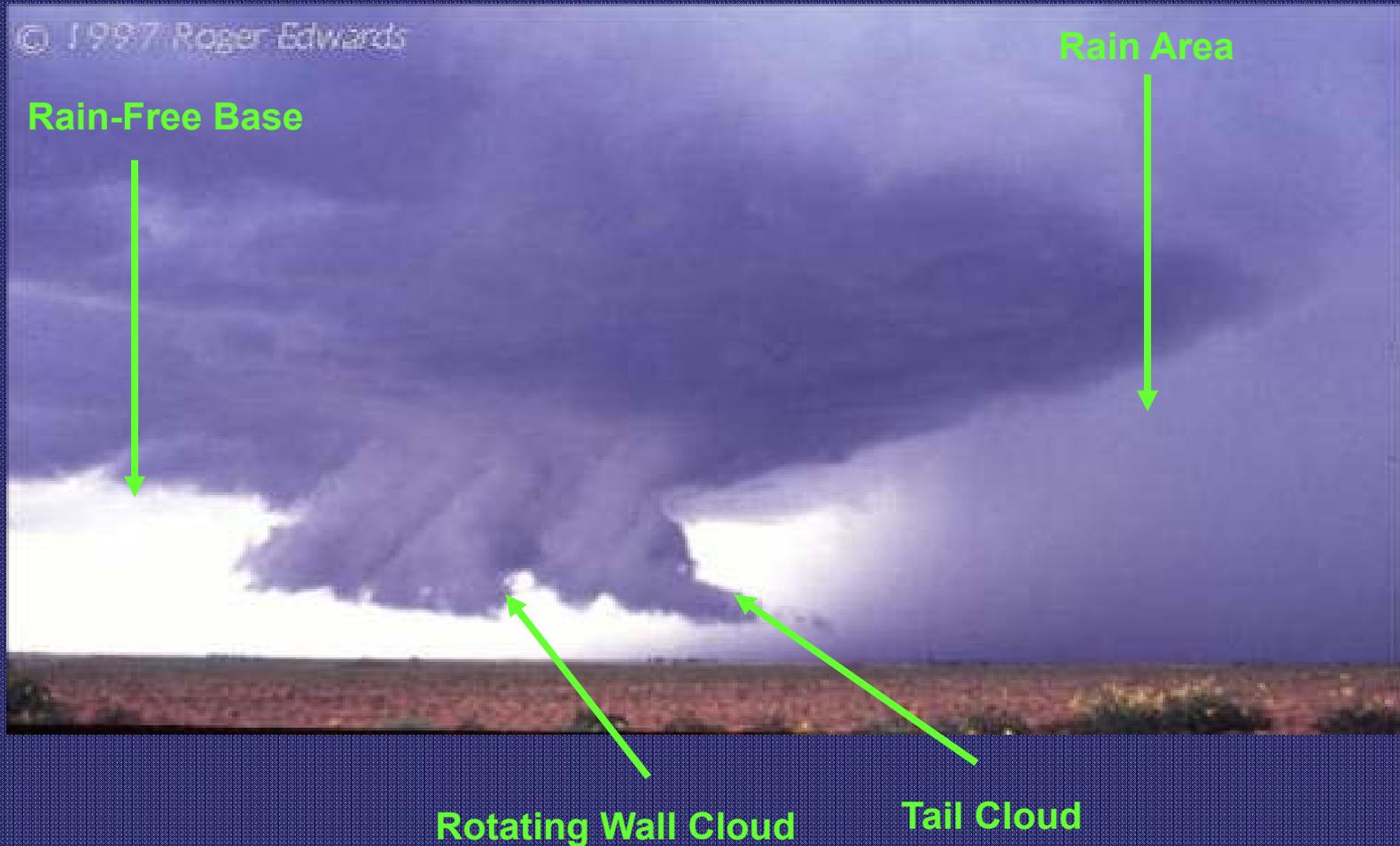


Upper level Supercell Features



Low level Supercell Features

A Close-up View and Important Cloud Features



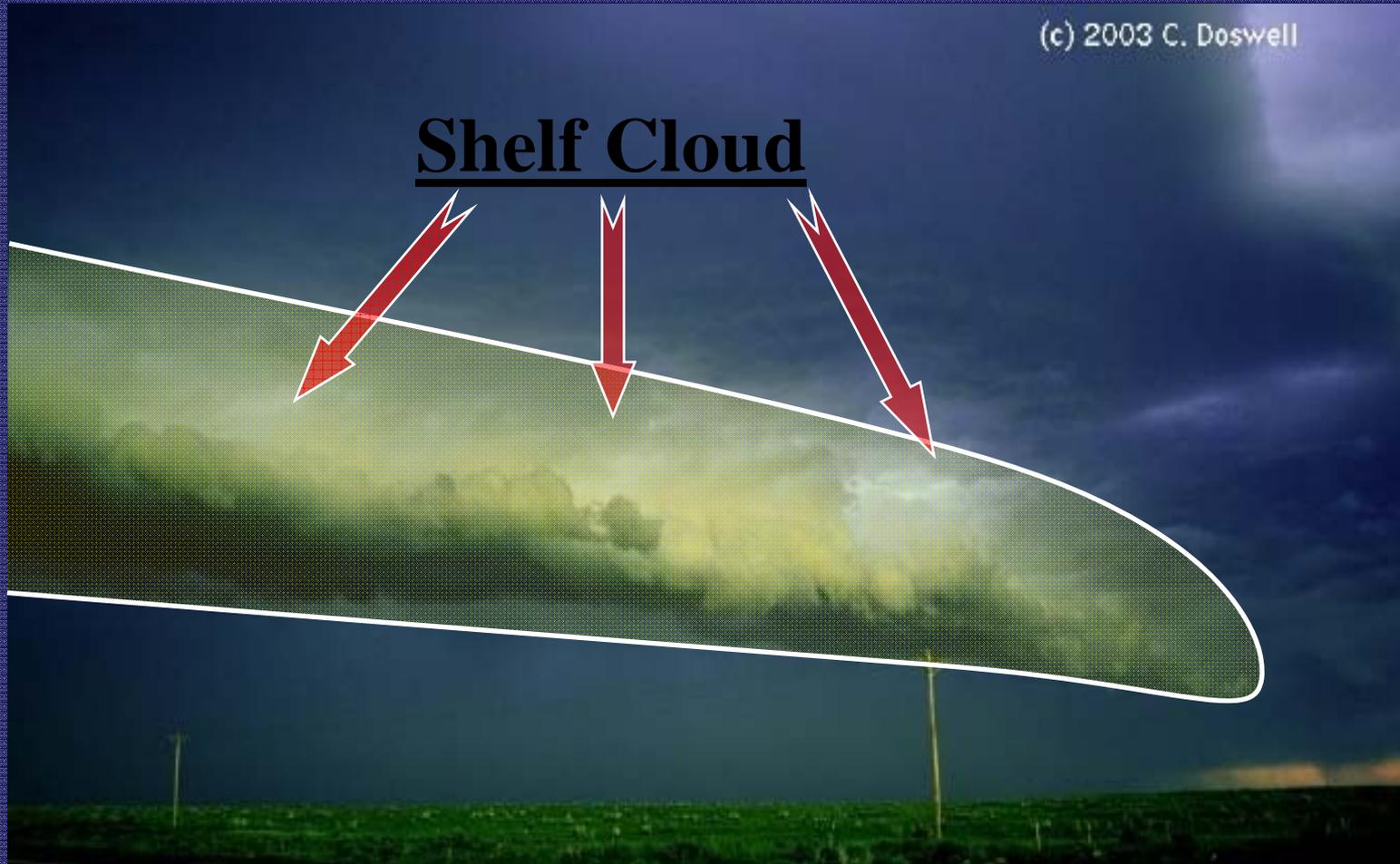


Downbursts



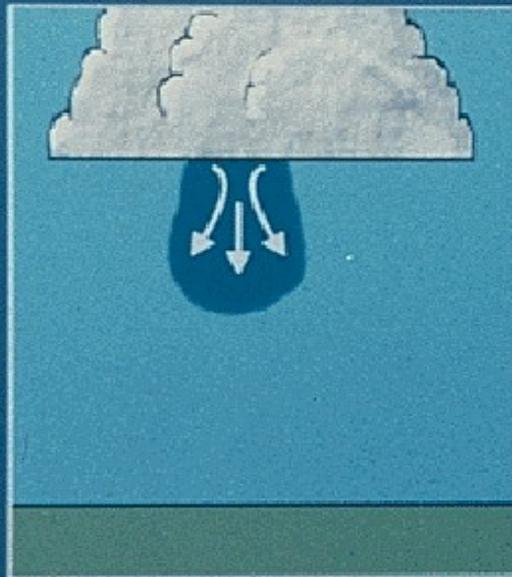
Worst is first, then the rain

Signature squall line cloud – Shelf cloud

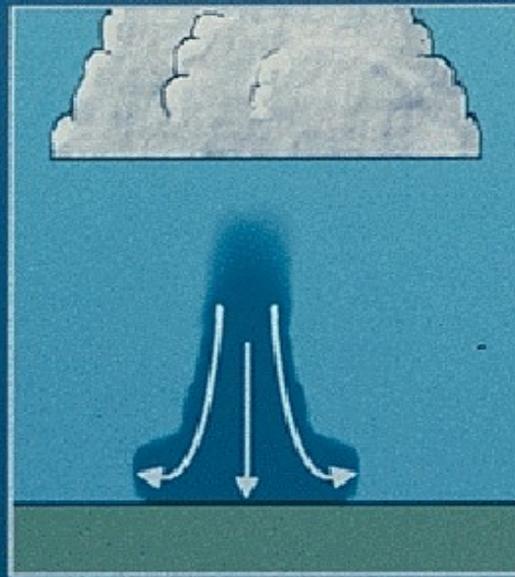


How a downburst develops

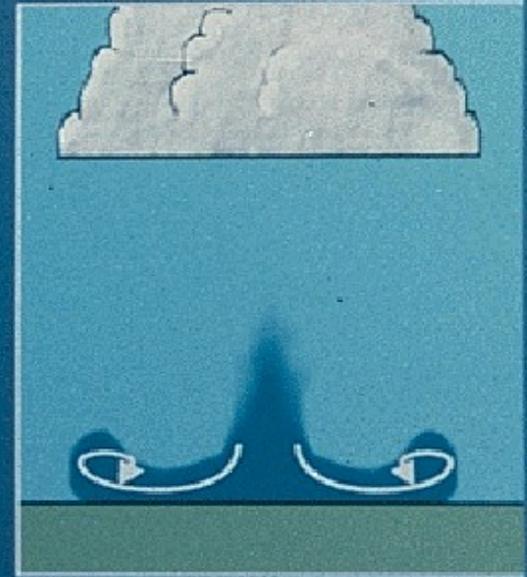
Downburst Life Cycle



FORMATION -
Evaporation and
precip. drag
forms downdraft



IMPACT -
Downdraft quickly
accelerates and
strikes ground



DISSIPATION -
Downburst moves
away from point
of impact

Aftermath of 100 mph downburst winds

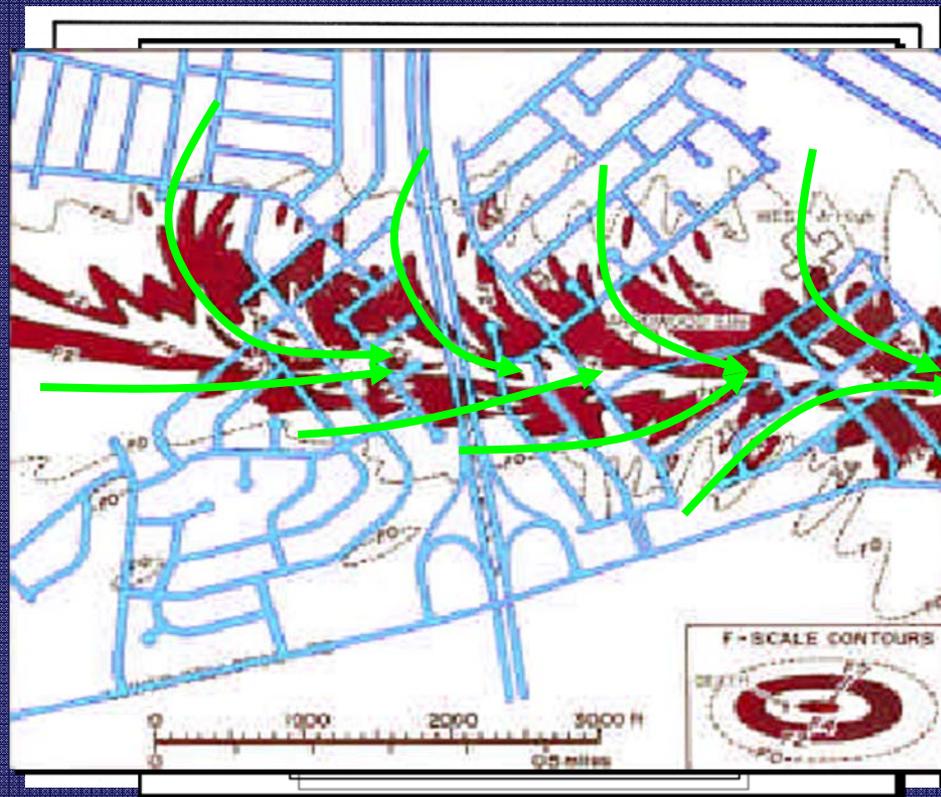
Gaylord, September 1998



Straight Line Wind VS Tornado Wind

What's the Difference?

- Tornado damage is convergent.
- Most tornado damage on right flank.



High Wind and Tornado Safety

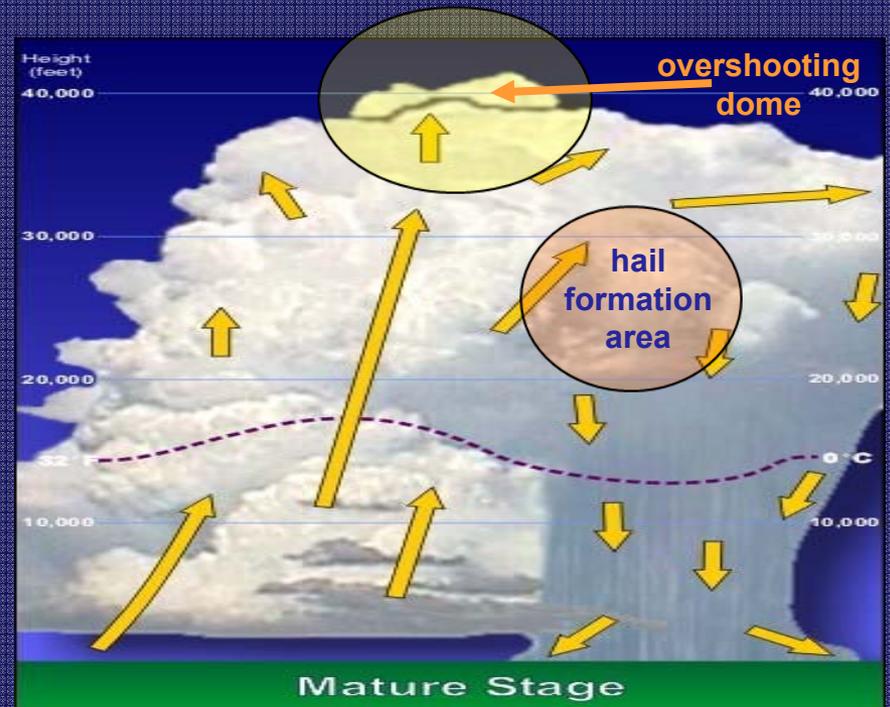
- **Damaging Winds and Tornado Safety**
 - Move to a small interior room or hallway on the lowest floor away from windows.
 - Get under sturdy furniture.
 - Get out of anything “mobile” and seek shelter inside.
 - If caught outside, lie flat in a ditch and cover your head.



“ Avoid windows...they are the first to go!”

More Thunderstorm Threats

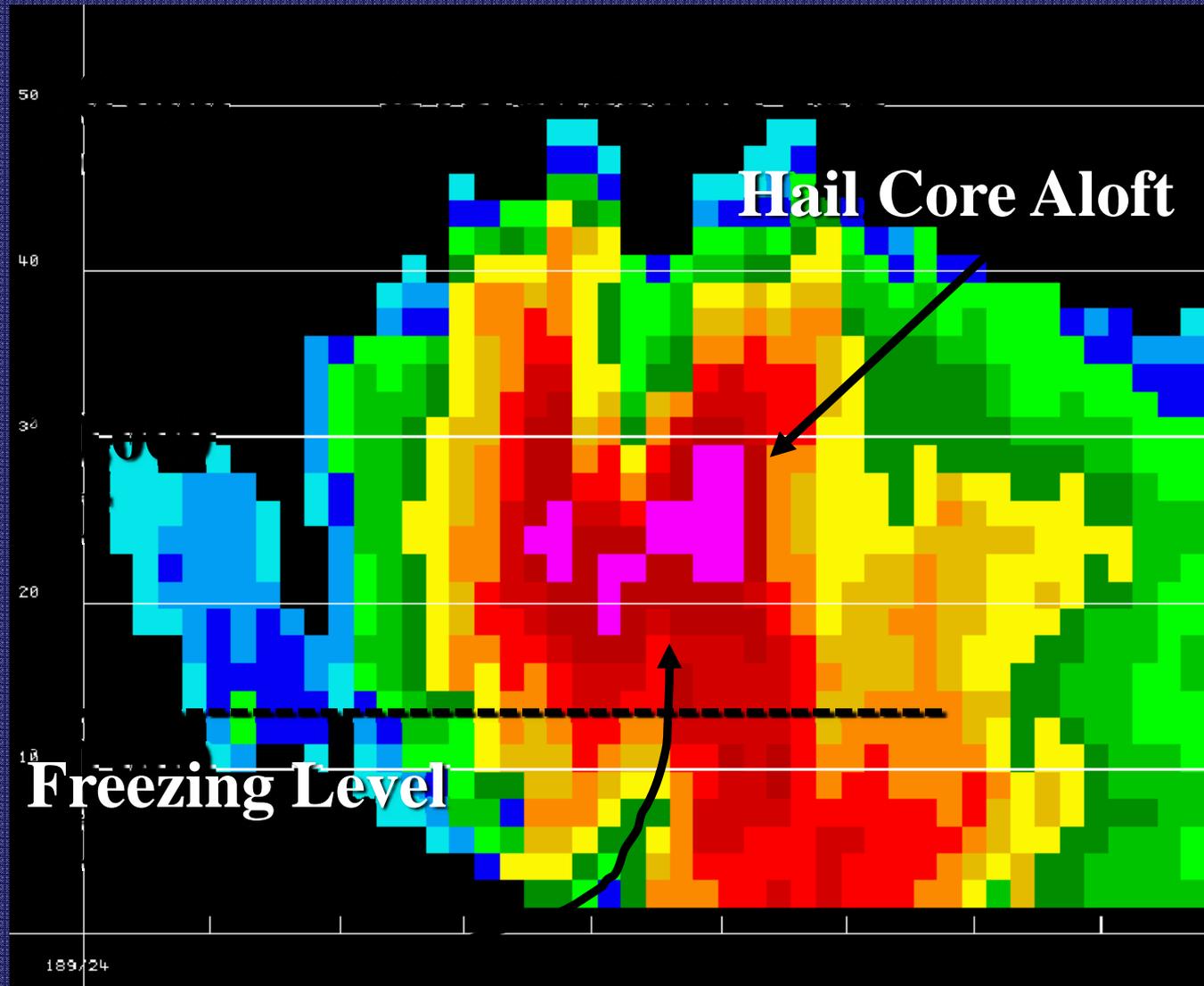
- Large Hail
 - Forms near the updraft / downdraft interface just above the freezing level



- Persistent Overshooting Top indicates a strong updraft and the presence of large hail

Supercell Thunderstorms and hail

Radar Perspective – Vertical Cross Section



Hail Safety

■ Hail Safety

- Stay inside a sturdy building away from windows.
- If stuck in a car, try to find a structure in which to take shelter (i.e. garage, gas station canopy).
- If stuck outside, seek shelter under a sturdy overhang.
- Move all valuable objects inside to avoid damage.



“Large hail stones can fall faster than 100 mph.”

© MARK ANDERSON, ALL RIGHTS RESERVED

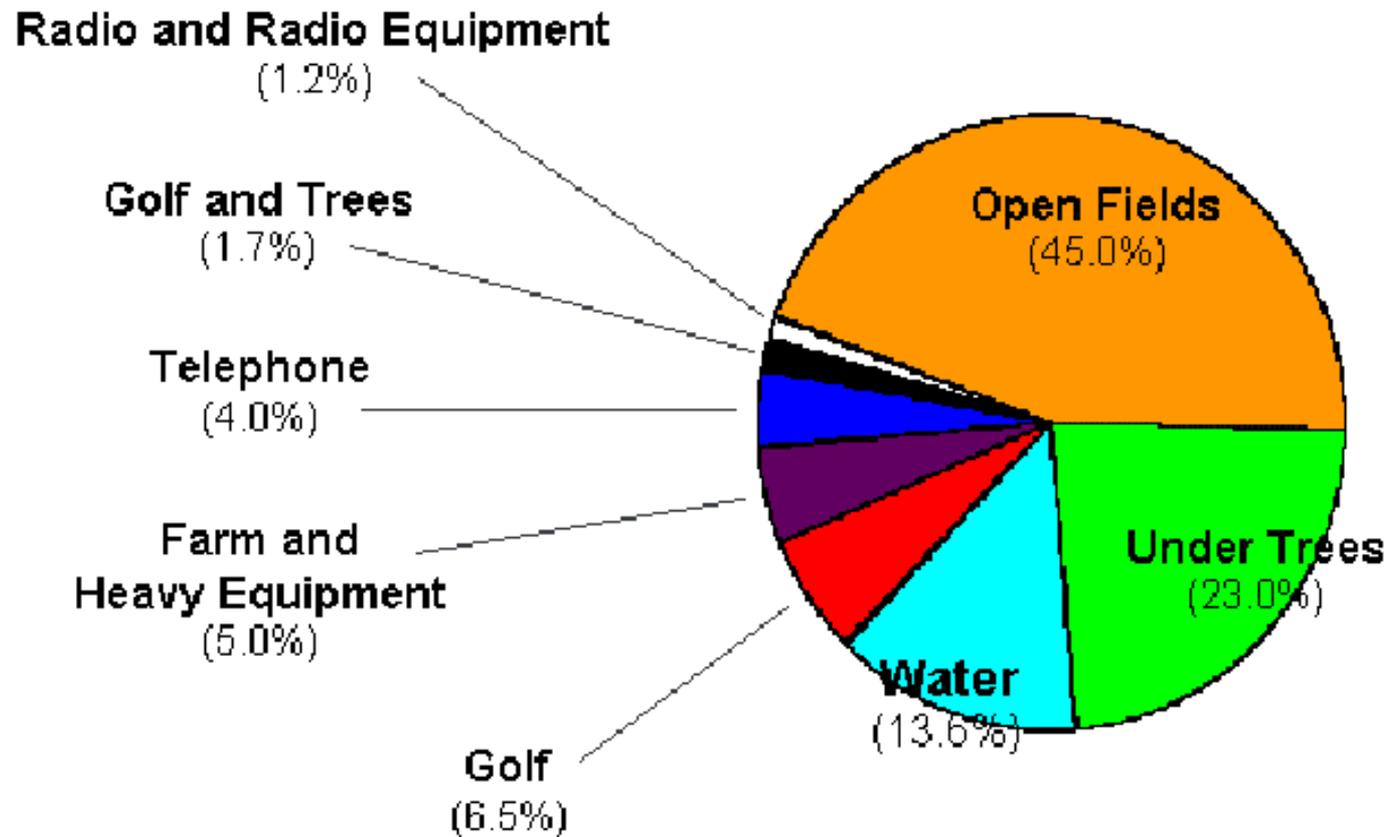
WWW.ANDERTOONS.COM



ANDERSON

"This was a lot more fun before surge protectors."

Where do most lightning deaths occur?



More Thunderstorm Threats

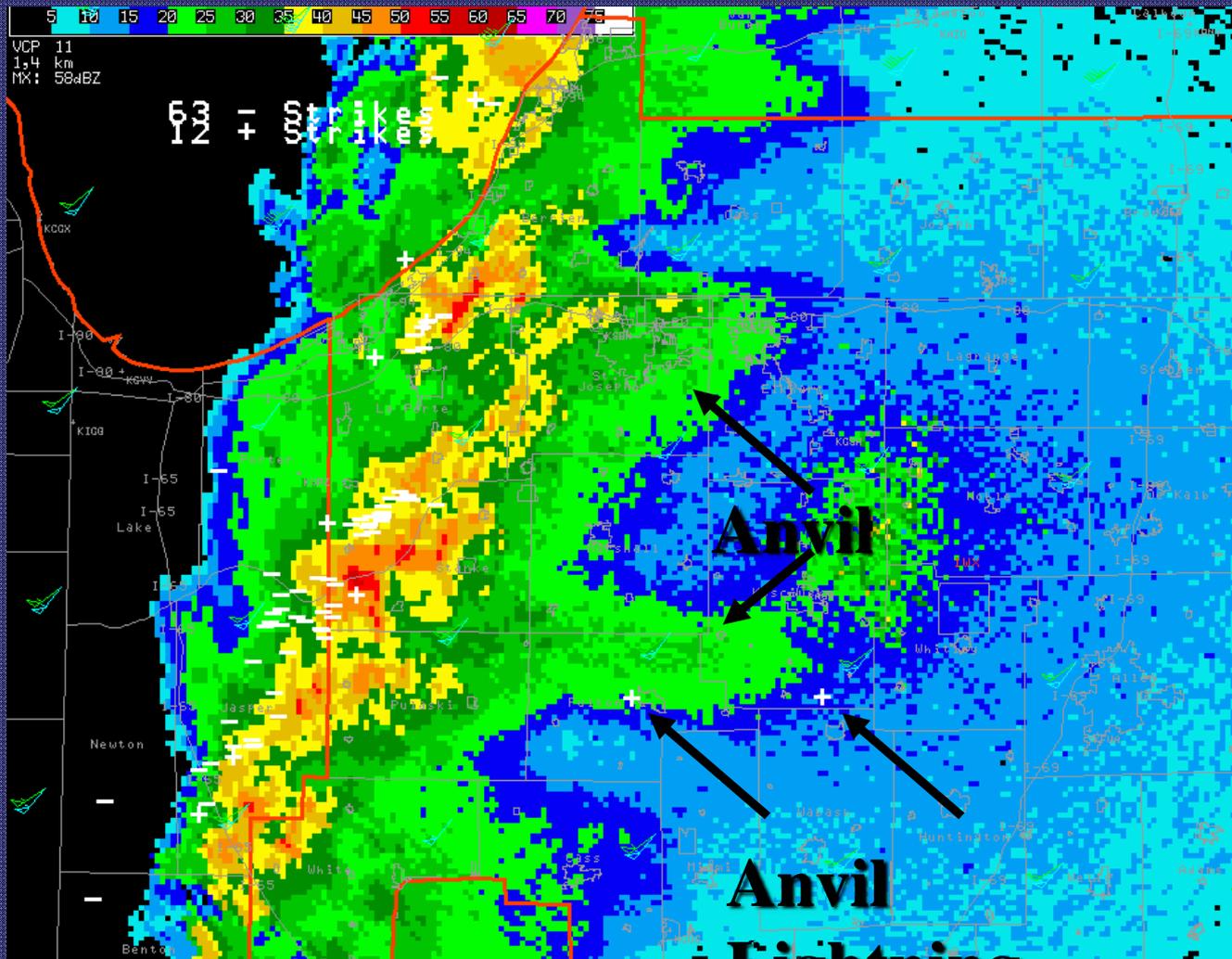
■ Lightning

- Stay inside a sturdy building or a hard top car.
- Avoid water, all metal objects and electrical appliances.
- If outside, stay away from tall objects, such as trees, towers, poles and fences.



“If you can hear the thunder, you can be struck by lightning!”

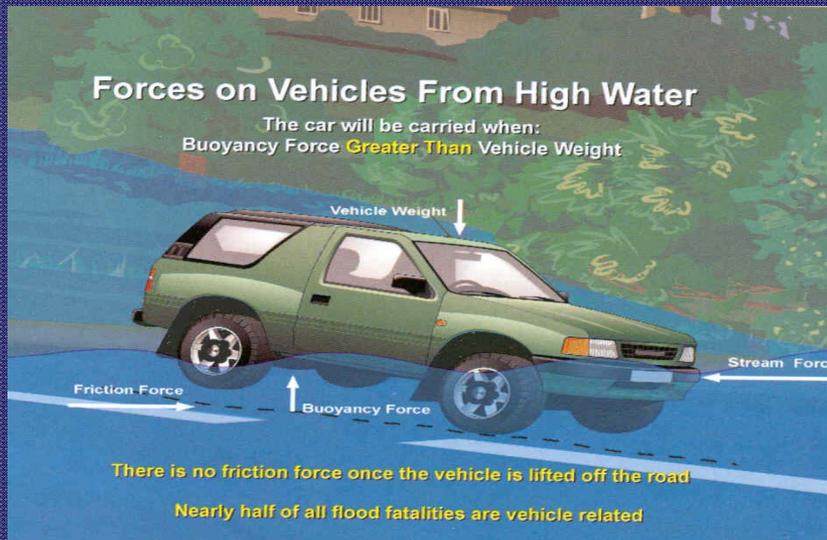
Anvil lightning – be aware



Spotter Tip: Be aware of lightning well ahead of the main line of thunderstorms!

More Thunderstorm Threats

- Large Hail
- Lightning
- Flooding
 - One foot of water displaces 1500 pounds



- Excessive rainfall and snowmelt are the primary causes of flooding / flash flooding in Northern Michigan

Flood Safety

■ Flood Safety

- NEVER drive, walk or swim in flood waters or rising river water.
- Stay away from storm drains, ditches, ravines or culverts.
- If you encounter flood waters, stop, turn around, go another way and seek higher ground.
- Rushing water only 6" deep can knock you off your feet.



***“Water 2 feet deep will
displace and carry away a
3000 pound vehicle!”***

Other Hazardous Weather

- Waterspouts
 - Tornadic waterspouts are simply a tornado over water
 - Non-tornadic waterspouts dissipate upon landfall



Grand Haven, Michigan 2008

- Not associated with thunderstorms
- Occur in early fall as cold air moves over warm lake waters (instability!)



Charlevoix, September 2008

Dust Devils

Dustdevils result from intense, localized heating interacting with the micro-scale wind field.



So with all of our technology, why are spotters important?

- They help overcome Doppler Radar limitations.
- They provide ground truth which can be correlated with radar signatures before, during and after severe weather.
- Ground truth reports in warnings heighten public awareness and allow us to have confidence in our warning decisions.





Severe Weather Definitions

- ✓ **Watch** = conditions are favorable for damaging downburst winds, large hail and/or tornadoes
- ✓ **Warning** = severe weather is occurring or imminent...*Take Action NOW!!!*
- ✓ **Severe Thunderstorm Criteria :**
 - **tornado**
 - **winds \geq 58 mph**
 - **Hail \geq 1 inch in diameter**

A simpler definition...



Spotters need to stay Informed!

- National Weather Service website:
www.weather.gov/gaylord



- NOAA Weather Radio

- Other Media Outlets (TV, radio)



New Hazardous Weather Briefing

Available 7 days a week

The screenshot shows the National Weather Service website for Gaylord, MI. The page features a blue header with the NOAA logo and the text "National Weather Service Weather Forecast Office Gaylord, MI". A navigation bar includes links for Home, Site Map, News, Organization, and a search bar. The main content area is titled "Hazardous Weather Briefing" and includes a link to provide feedback. Below this is a video player with a play button and a message: "Please be patient while video loads. Video may not load if pop-up blocker is turned on." The left sidebar contains a search box and a list of navigation links.

weather.gov

NATIONAL WEATHER SERVICE

National Weather Service Weather Forecast Office
Gaylord, MI

Home Site Map News Organization Search for: NWS All NOAA Go

Local forecast by
"City, St" or Zip Code
 City, St

XML RSS Feeds

Current Hazards
Watches/Warnings
Outlooks
Submit Report

Current Conditions
Observations
Radar
Satellite
Observed Precip

Forecasts
Forecast Discussion
Local Area
Activity Planner
Aviation Weather
Fire Weather
Marine Weather
Severe Weather
Winter Weather

Hydrology
Rivers & Lakes
Climate

Hazardous Weather Briefing

[Click here to let us know what you think of this product!!](#)

Please be patient while video loads. Video may not load if pop-up blocker is turned on.

<http://www.crh.noaa.gov/apx/?n=multimedia>

A few important spotter links on our web page

www.weather.gov/gaylord

- XML RSS Feeds
- [Current Hazards](#)
- [Watches/Warnings](#)
- [Outlooks](#)
- [Submit Report](#)
- Current Conditions
- Observations
- Radar
- Satellite
- Observed Precip
- Forecasts
- Forecast Discussion
- Local Area
- Activity Planner
- Aviation Weather
- Fire Weather
- Marine Weather
- Severe Weather
- Hurricane Center
- Hydrology
- Rivers & Lakes
- Climate
- Local
- National
- Drought
- More...
- Weather Safety
- Preparedness
- Weather Radio
- StormReady
- [SkyWarn](#)
- Additional Info
- Items of Interest
- Education Resources

[View Our Winter Weather Page!](#)

Watches & Warnings Observations Forecast Graphics Rivers & Lakes Climate Marine

Click on the map below for the latest forecast.



Read watches, warnings & advisories Zoom Out

Hazardous Weather Outlook Short Term Forecast

Last map update: Fri, Dec. 18, 2009 at 11:15:06 am EST

Latest Conditions in Traverse City, MI Choose Your Front Page City

Dec 18  **19°F**
10:53 am A Few Clouds (-7°C)

Select A City:

Weather Story Radar Satellite Weather Map

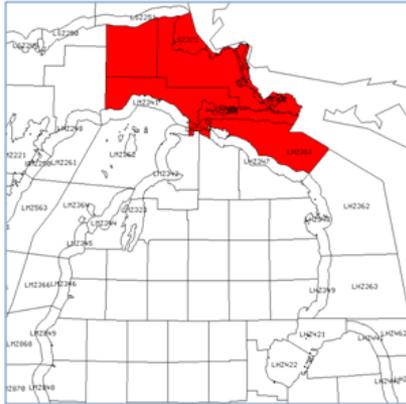
“NOAA Weather Radio - Your own personal Siren,

- **Receive weather information 24 hours a day**
- **Radio will sound a tone to alert you when a watch or warning has been issued**
- **Countless times, lives have been saved by NOAA Weather Radio**

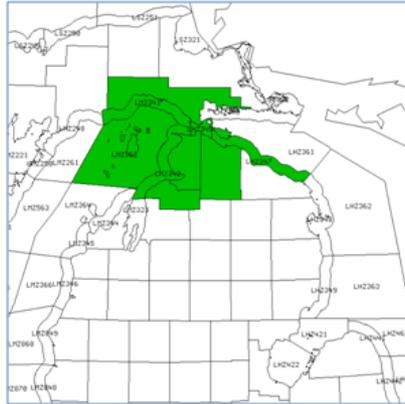


NOAA Weather Radio Coverage Map

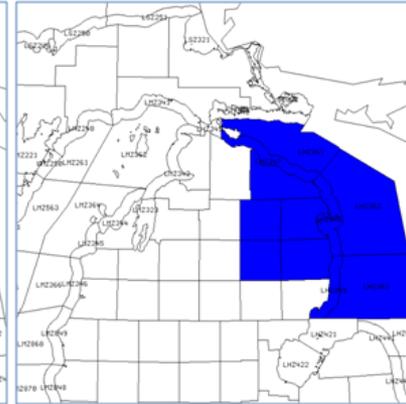
KIG-74 Sault Ste. Marie
162.550 MHz



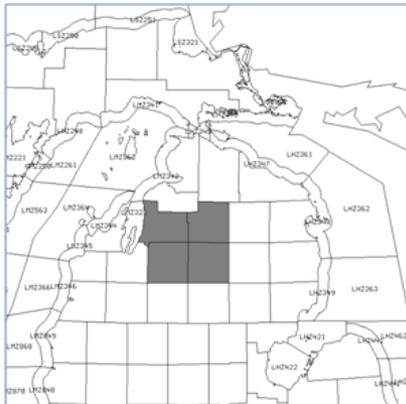
WNG-572 Petoskey
162.475 MHz



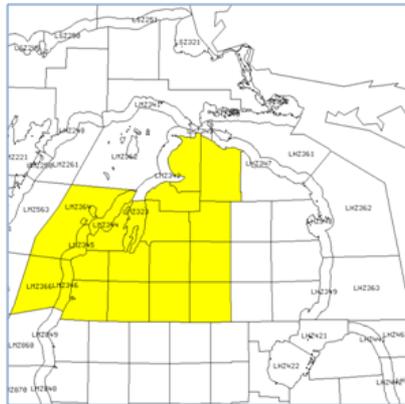
KIG-83 Alpena
162.550 MHz



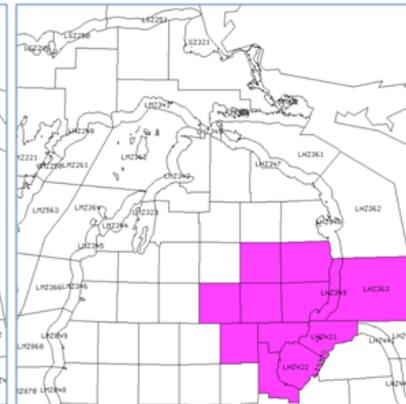
WWF-70 Gaylord
162.500 MHz



KH-22 Traverse City
162.400 MHz

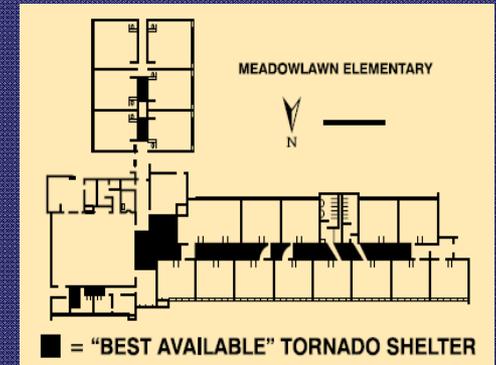


KX1-33 West Branch
162.450 MHz



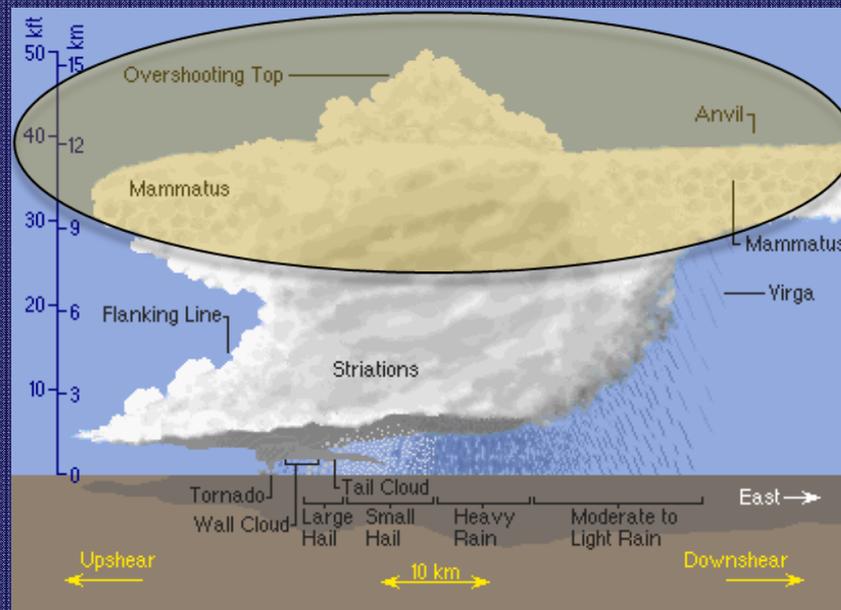
Stay Safe!!

- ***Safety is Priority One!***
- **Have a clear plan in mind :**
 - **An escape route and a safe place to ride out the storm**
 - **Supplies in your safe place, such as bottled water, non-perishable food, flashlight, batteries, charged cell phone, radio, blankets**



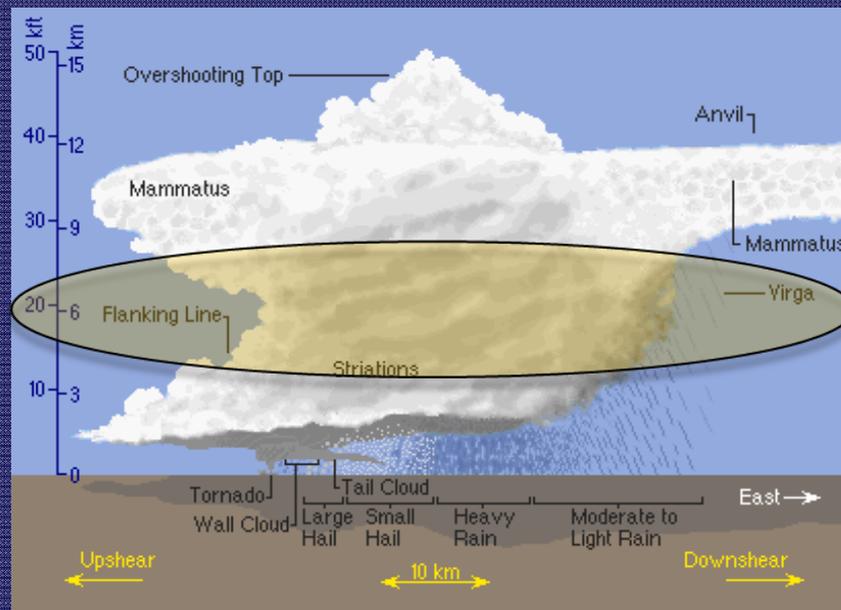
Storm Cloud Clues

- **Upper Level Clues** → seen ~ 20 miles away
 - ✓ Look for Overshooting Dome
 - ✓ Look for Hard Flat Cirrus Anvil Top



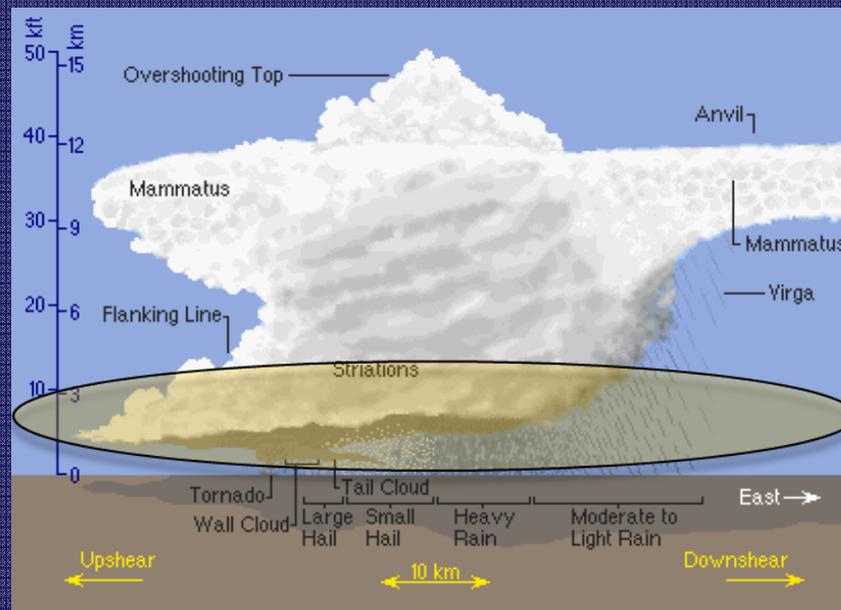
Storm Cloud Clues

- Mid Level Clues → seen 10 to 20 miles away
 - ✓ Solid, tilted Main Storm Tower w/ “cauliflower” texture
 - ✓ Flanking Line at the back of storm
 - ✓ Surrounding clouds dissipating



Storm Cloud Clues

- **Low Level Clues** → seen 3 to 8 miles away
 - ✓ **Front of Storm** → Shelf (Roll) Cloud
 - ✓ **Back of Storm** → Rain-free Base, Rotating Wall Cloud, Tail Cloud, Funnel Cloud, Tornado



Low Level Storm Clues

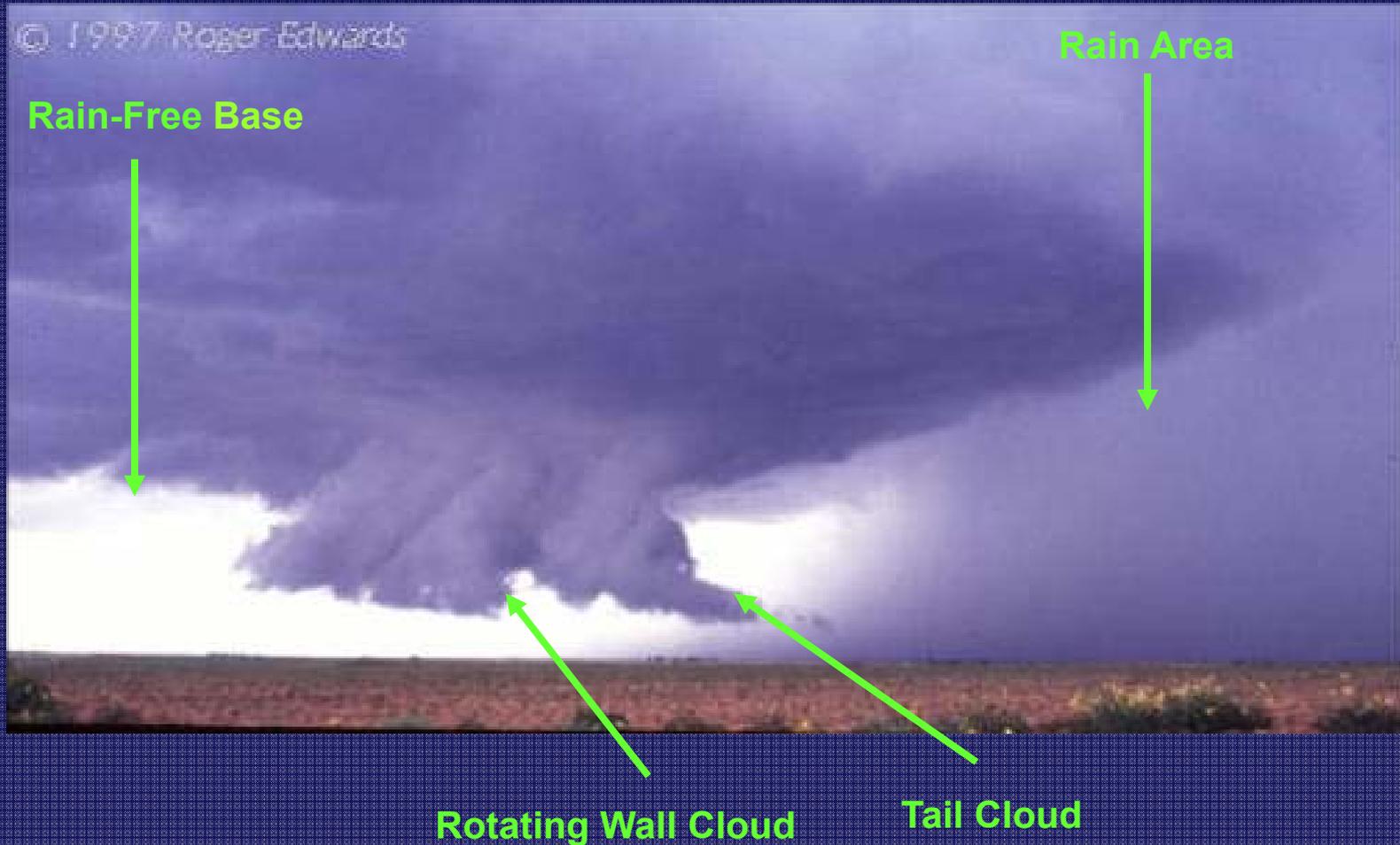
Shelf Cloud / Downburst Winds



Picture taken over Whitefish Bay

Low level supercell features

A Close-up View and Important Cloud Features





Cloud Overview



Mammatus



Shelf Cloud



Overshooting Top



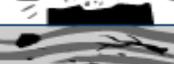
Wall Cloud



Scud Clouds

Wind Estimation

Beaufort Scale

Beaufort number	Wind Speed (mph)	Seaman's term		Effects on Land
0	Under 1	Calm		Calm; smoke rises vertically.
1	1-3	Light Air		Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze		Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze		Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze		Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze		Small trees begin to sway.
6	25-31	Strong Breeze		Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale		Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale		Twigs and small branches broken off trees.
9	47-54	Strong Gale		Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale		Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm		Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force		Violence and destruction.



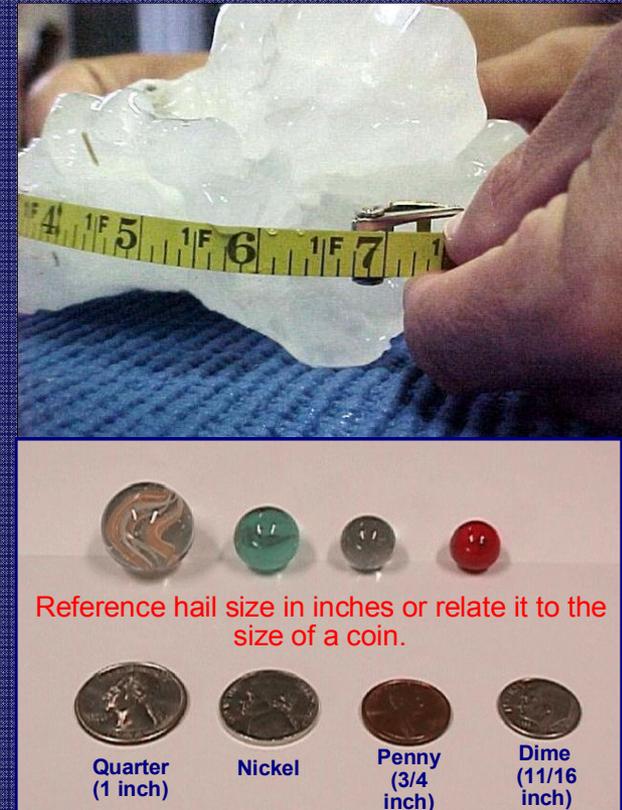
Wind Estimation

Enhanced Fujita Scale

Enhanced F scale	Rating 3 second gust
F0	65-85 mph
F1	86-110 mph
F2	110-135 mph
F3	136-165 mph
F4	166-200 mph
F5	>200 mph

Hail Size Estimation

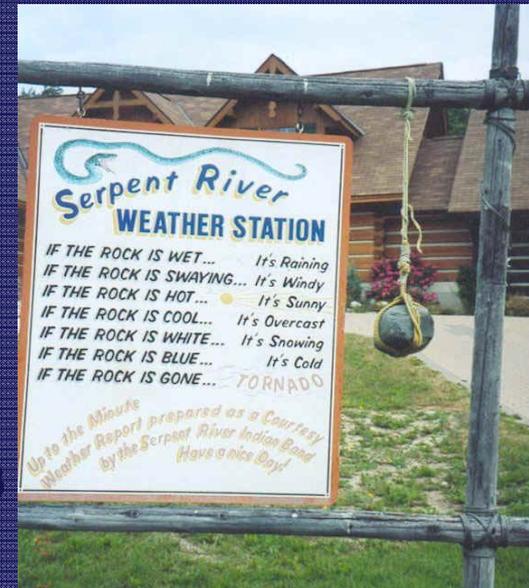
- Do NOT go outside during a hail storm!!
- Measure hail ASAP after the storm.
- Use hail card or ruler to measure hail.
- Do not give hail size reports in terms of “marbles”.



What your complete observation should include

The TEL Method

- Time → When did it happen?
- Event → What did you observe?
 - Wind Damage & Estimated Highest Wind
 - Hail - any size
 - Shelf Clouds, Wall/Tail Clouds, Tornadoes
 - Flooding
- Location → Where did it happen?



So let's look at a few cloud formations and see what you should report to the NWS...



What would you report?

St. Helen, Roscommon County 2009



✓ Overshooting Top

What would you report?

Cheboygan, Cheboygan County



✓ Mammatus Clouds

What would you report?



✓ Wall Cloud

What would you report?



✓ Dust Devil

Contacting the NWS

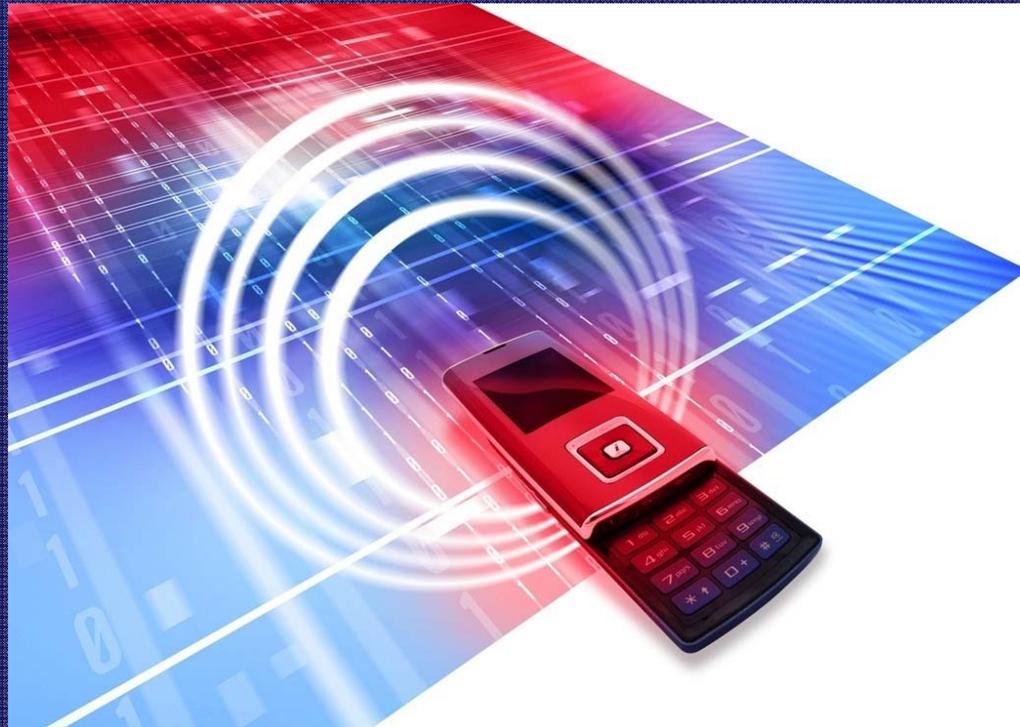
Use for both summer and winter reporting

- ❖ **Call Us → 1-800# (given out at spotter training classes.**
- ❖ **Use your computer (eSpotter)**
(<http://espotter.weather.gov>)
- ❖ **CoCoRaHS**



Call Us

- ❖ **1-800# 24/7 operation**
- ❖ **For spotter report use only (no forecasts)**
- ❖ **Easiest way to report in real-time**
- ❖ **Report will be taken by a real human!**



Text 1: -5:APXWRKLSR

File Edit Options Version Tools Scripts Products Help

AFOS Browser Load History WMO Search Enter Editor Accum Update Obs Clear

AFOS Cnd: WMO TTAai CCCC: AWIPS ID:

```

REPORT TIME: 01/29/2010 19:32 EST (00:32 UTC)
1264811521.3337
EVENT TIME: 01/29/2010 19:31 EST (00:31 UTC)
COUNTY, STATE: Oscoda, MI
CITY: Luzerne
SPOTTER: enchanted2u@juno.com
TEMPERATURE: 12
SNOWFALL:
1." of new snowfall over the past 24 hour(s).
Storm Total: 1."
Snow depth is: 3"
NARRATIVE:

To acknowledge this report, go to: http://intra.crh.noaa.gov/espotter/
Log in, and click 'Acknowledge Incoming' to mark reports as received.

```

How Your Computer



es
O
S

otable



Local forecast for
"City, St" or Zip Code

XML RSS Feeds

- Current Hazards
- Watches/Warning
- Outlooks
- Submit Report**
- Current Conditions
- Observations
- Radar
- Satellite
- Observed Precip

weather.gov



All NOAA

Heavy Freezing Spray

CoCoRaHS

The **C**ommunity **C**ollaborative **R**ain and **H**ail (and Snow) **S**tudy

- ❖ Completely volunteer internet-based precipitation spotter network designed to “fill in the cracks” of traditional observing systems.
- ❖ *Not for reporting severe weather, just precipitation*
- ❖ *Not for real-time reporting either*
- ❖ *We want to get the complete picture of how much rain, snow, or hail fell at your location*

More Info:

<http://www.cocorahs.org>



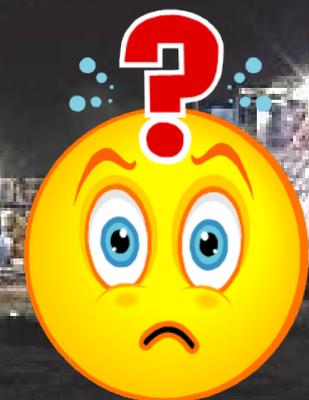


If you have any Video or Pictures...



Please send them via email to
our office:

james.keysor@noaa.gov



james.keysor@noaa.gov
989-731-3384 ext. 726
www.weather.gov/gaylord

