NOAA'S National Weather Service

Intermediate Concepts of
Severe Storm Spotting

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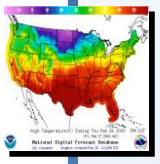
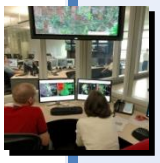
Weather.gov/milwaukee

Class Outline

- **Thunderstorm (T'storm)**
  - *Life Cycle*
  - *Structure*
    - **Updraft & Downdraft**
    - **Shelf Cloud & Wall cloud**
- **Squall Lines**
  - *Cross Section*





Thunderstorm Structure

- **Those two cloud features…can you recognize them?**

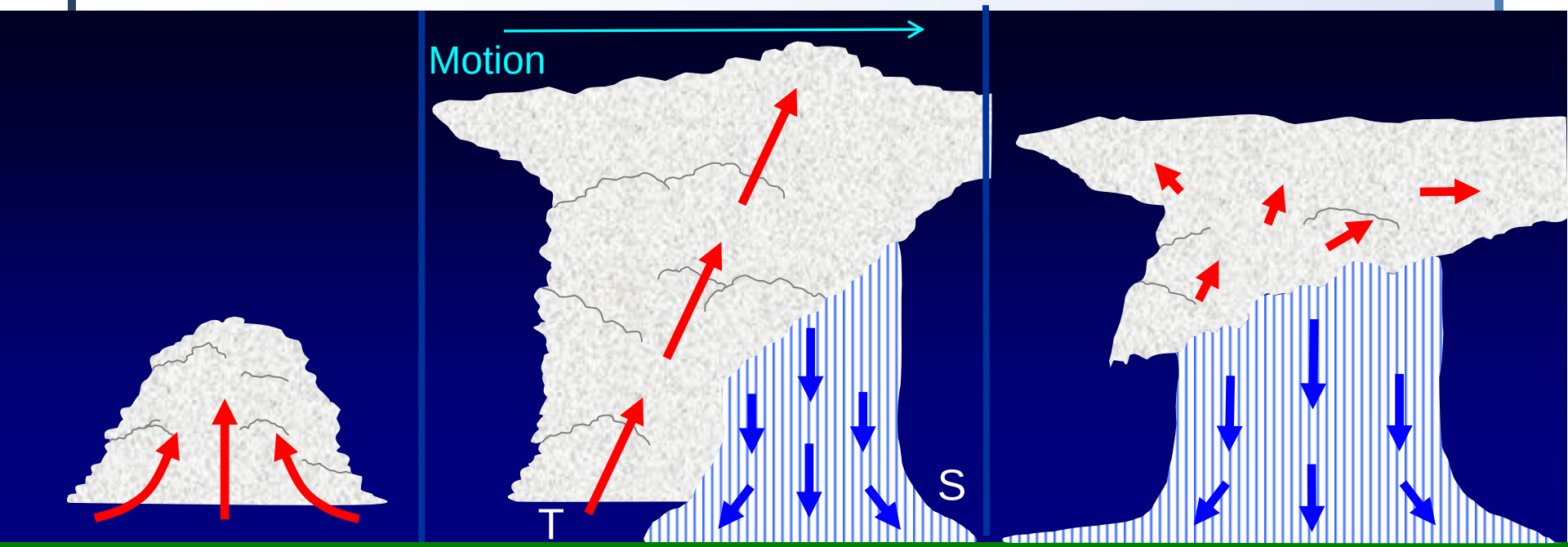
Shelf Cloud

Rain, Hail, Downburst winds

Rotating Wall Cloud

Tornadoes & Funnel Clouds

Thunderstorm Life Cycle



Cumulus Stage | Mature Stage (Cell) | Dissipation Stage

Thunderstorm Structure

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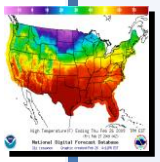
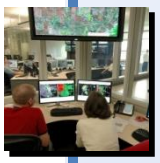


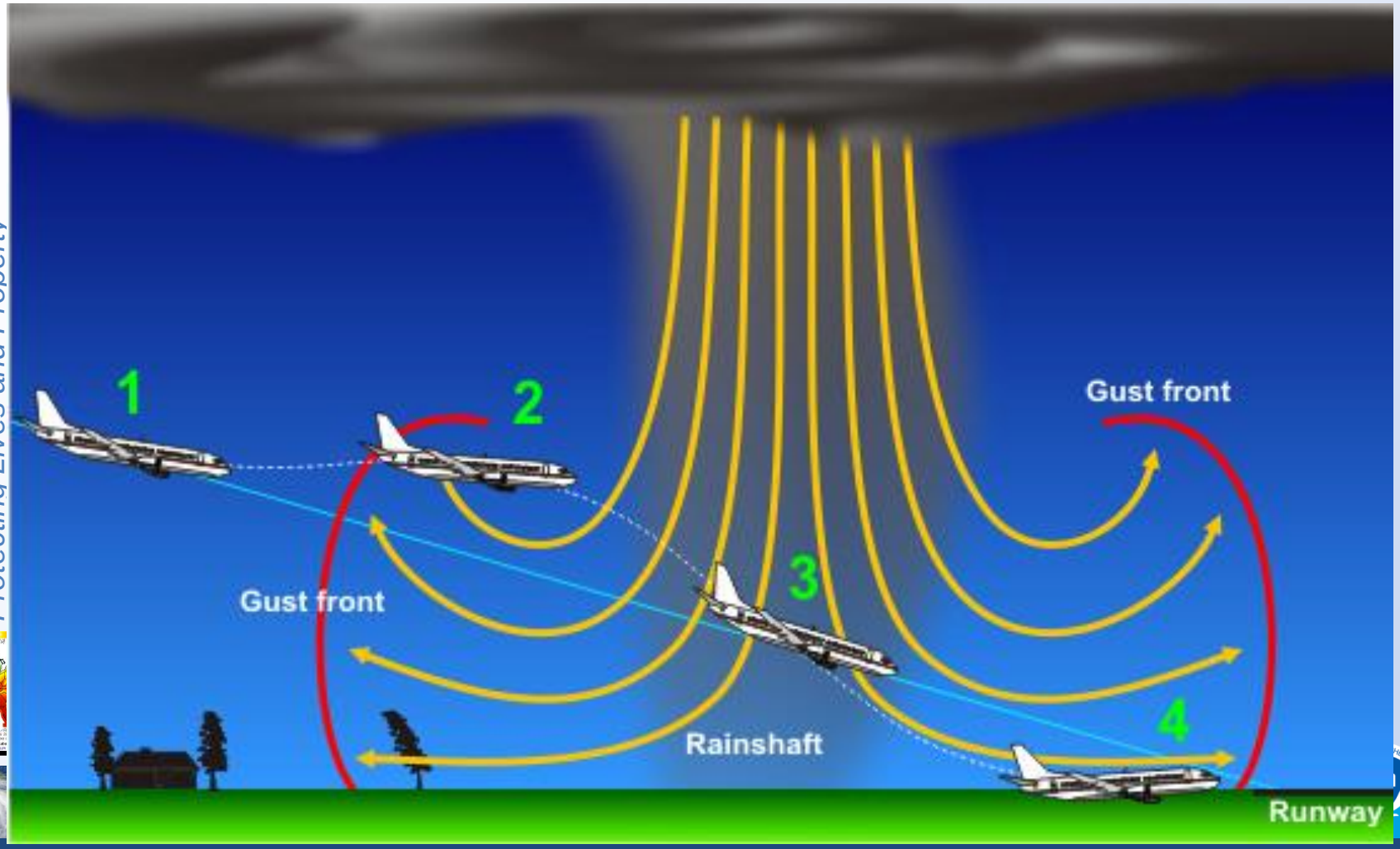


- Think of a thunderstorm as a 2-part engine

- **Updraft tower** – intake manifold (inflow) – inhaling warm, moist air – air goes up at 60 – 120 mph, the warm moist air is the gasoline supply. Rotating wall clouds, tornadoes (T), & funnel clouds underneath updraft tower. (rain-free base)

- **Downdraft tower** – exhaust manifold (outflow) – exhaling of rain, hail, rain-cooled air, and gusty downburst winds that in extreme cases reach speeds of 60 to 150 mph! Shelf cloud (S) precedes

Downdraft - Downburst



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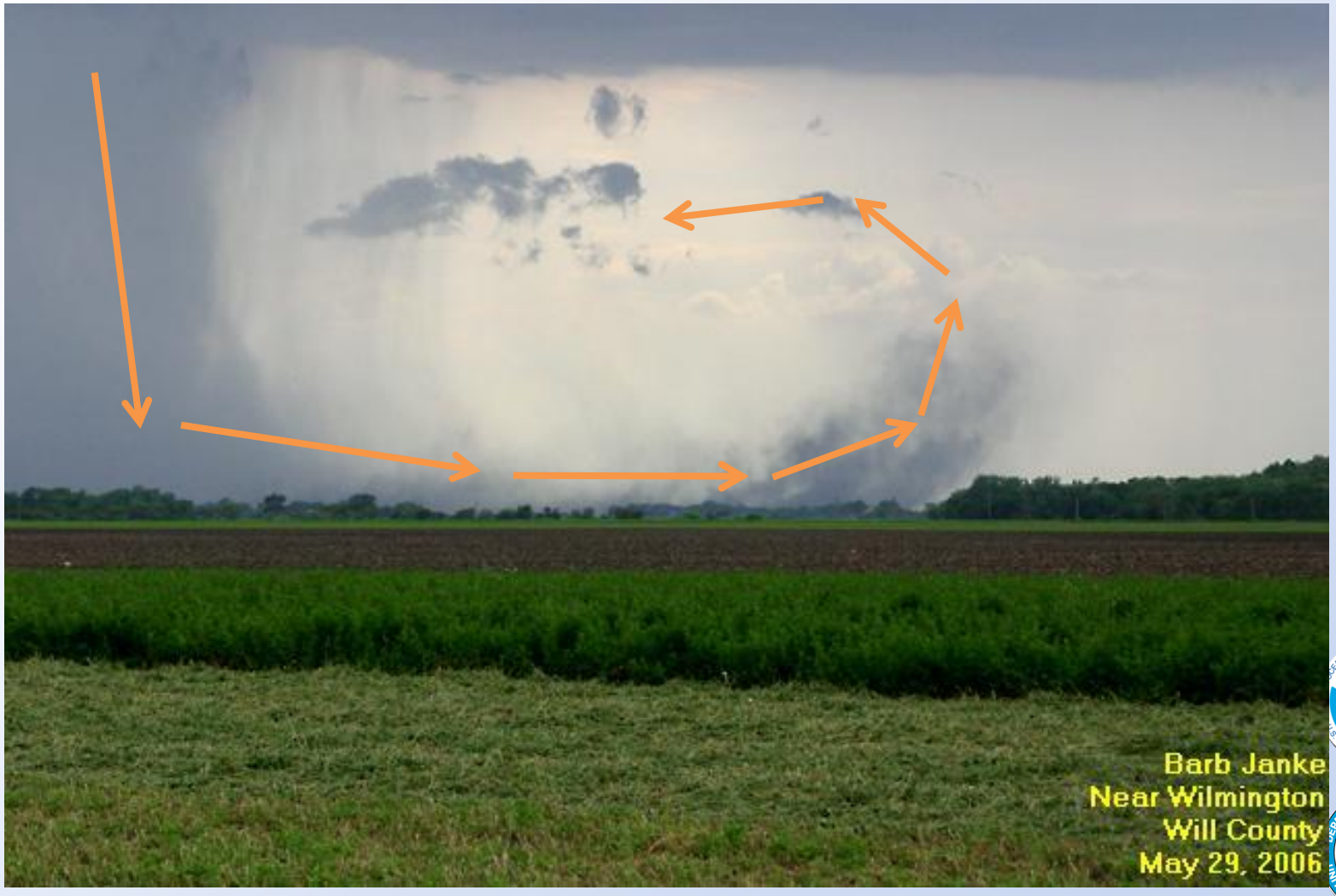
<u>Gust Front</u> - is leading edge of downdraft/ downburst, you don't see it but you do feel it as winds pick up and temperatures drop. Rain, hail, and winds follow behind gust front.

Downdraft - Downburst



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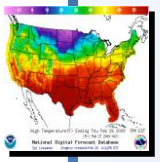
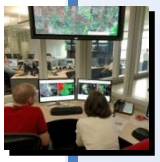
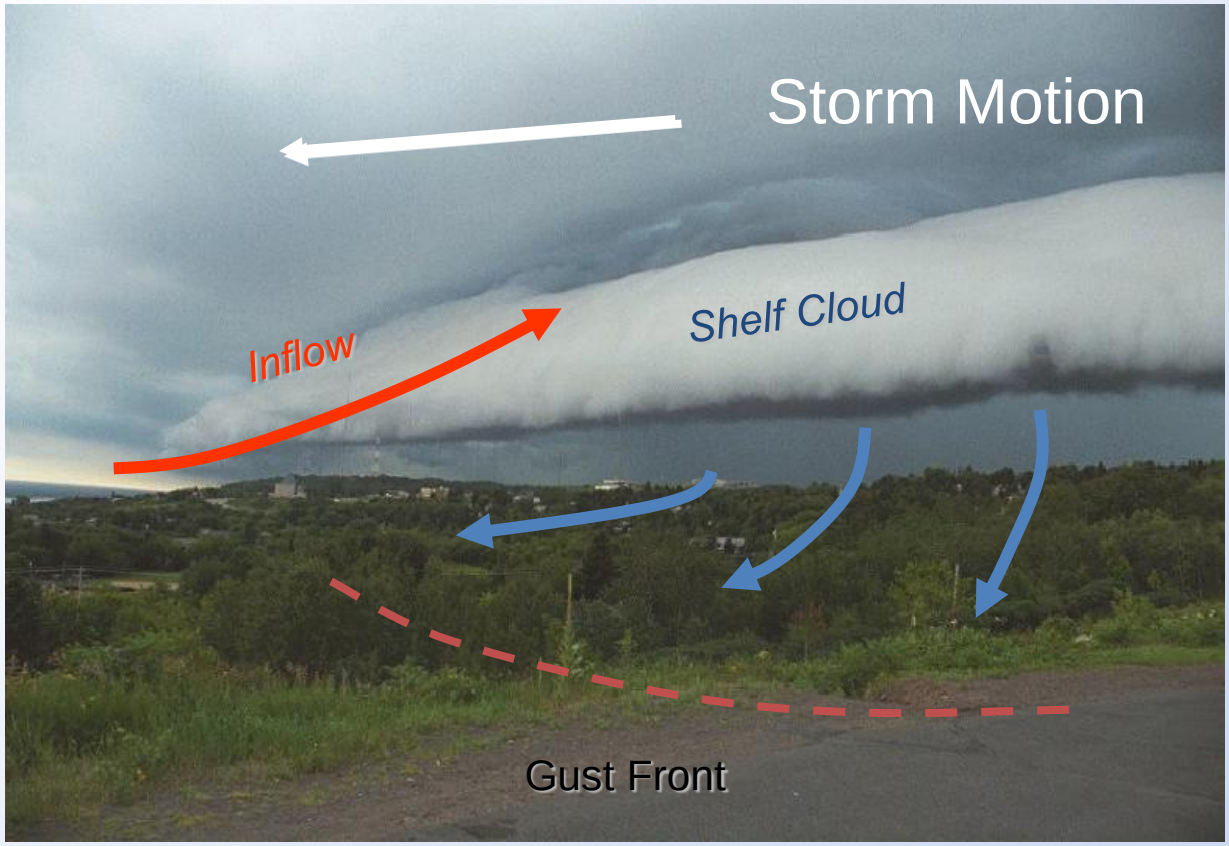




Squall Line Shelf Cloud



- Shelf Cloud “marker” is at leading edge (front side).
- Main hazards after shelf cloud passes overhead are strong downburst winds, large hail and heavy rains. Tornadoes uncommon.

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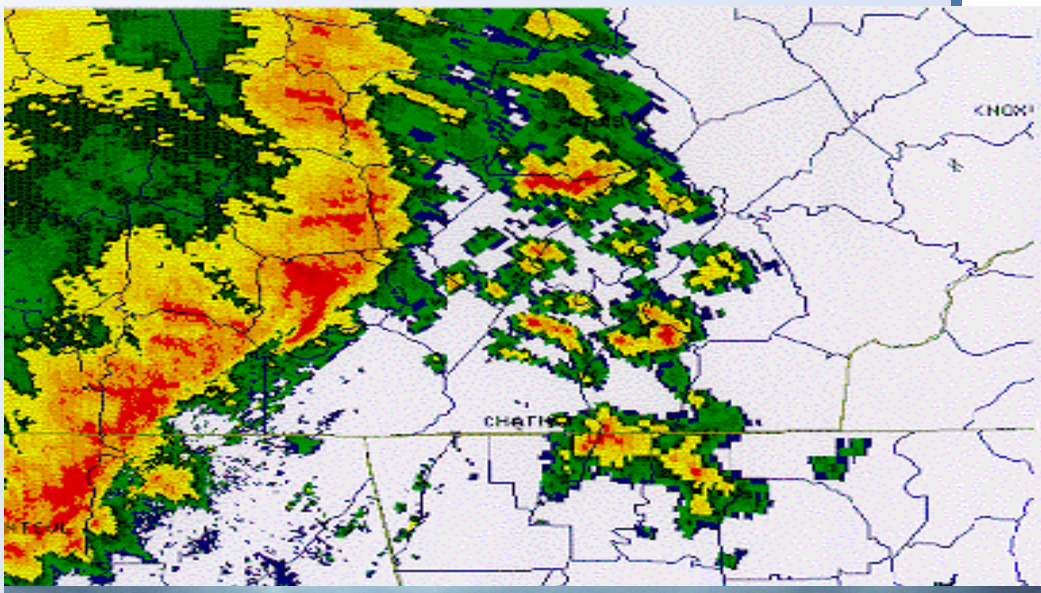
Squall Line

* *Squall Line* – any organized line or narrow band of thunderstorms.

- Main Feature is the Shelf Cloud (we do not want shelf cloud reports).
- Can move at forward speeds of over 60 mph and span over 100 miles or more.



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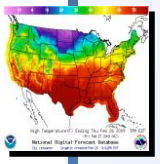
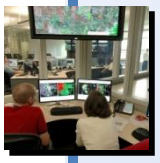
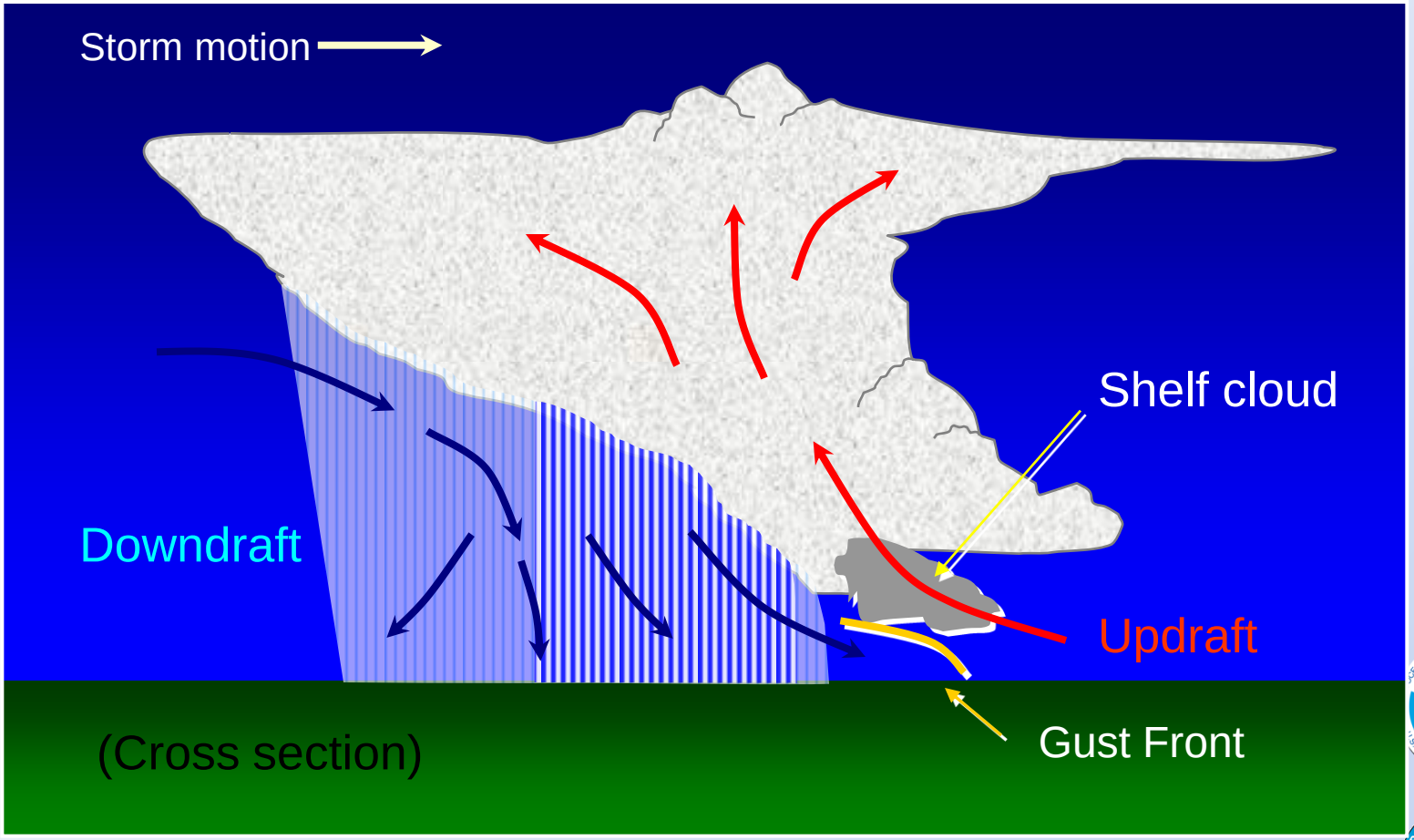




Cross-section of Squall Line



Non-tornadic storm

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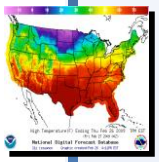

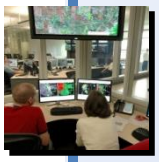

Downburst Winds!

Peak gusts ~75 mph (hurricane- force)

Video – western Ontario, Canada

- Many times downed trees do NOT indicate tornado damage!

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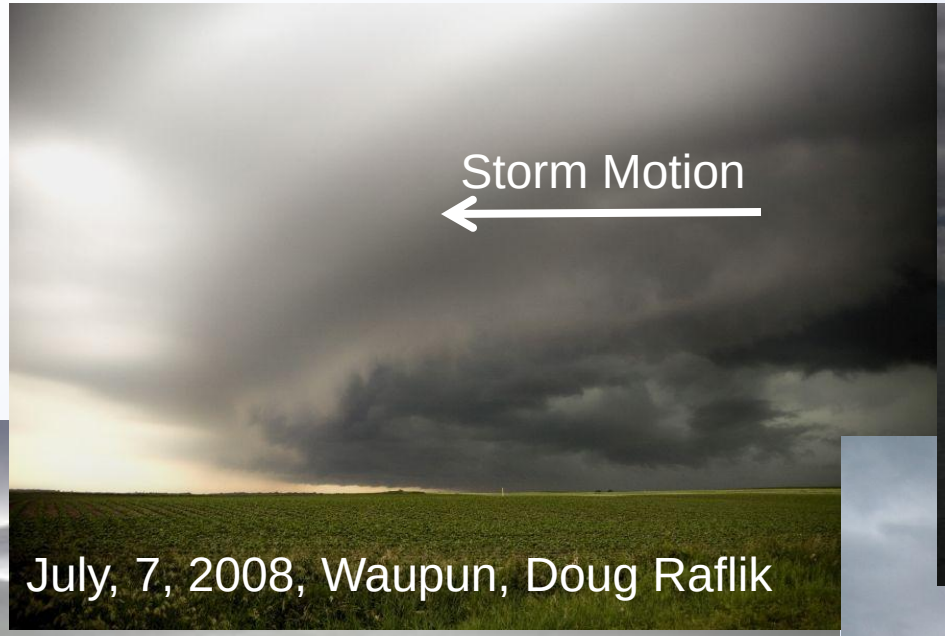
Shelf Cloud

- A low, horizontal wedge-shaped arcus cloud, associated with a thunderstorm gust front.



July, 7, 2008, Waupun, Doug Raflik

"snow-plow' effect"

Paul Kohlman

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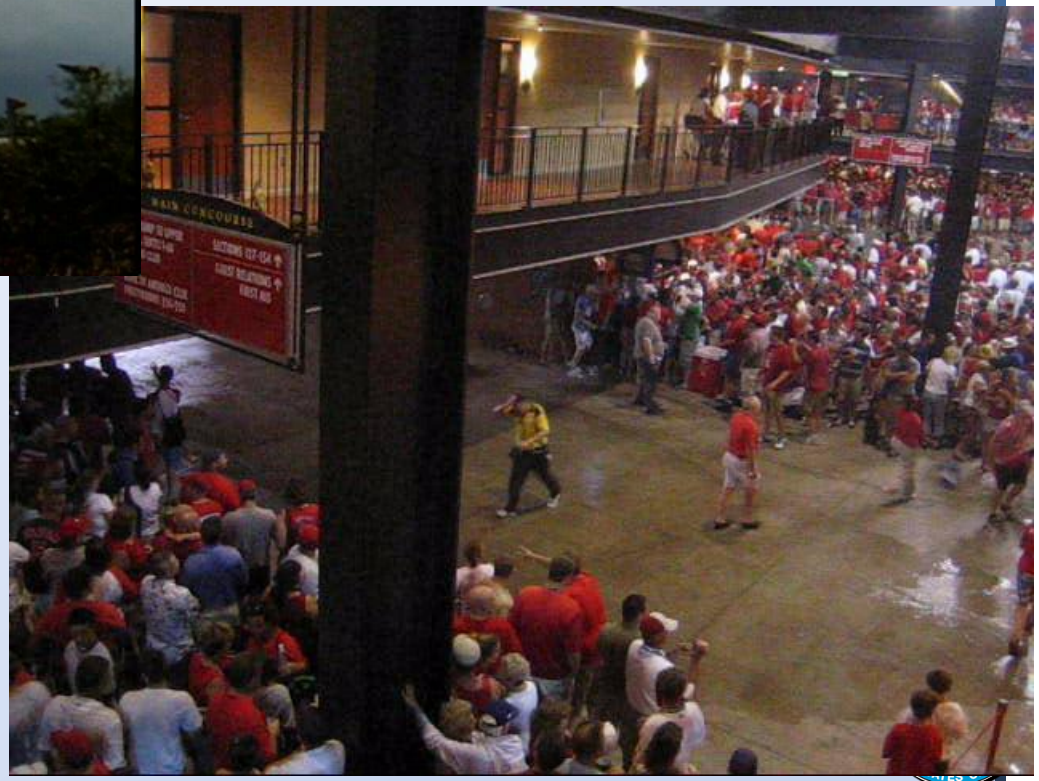
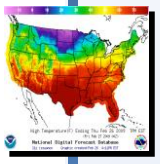
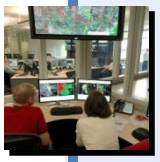
Downburst Winds!

Video (shelf cloud – Duluth, MN)

Video – Busch Stadium







Shelf Clouds

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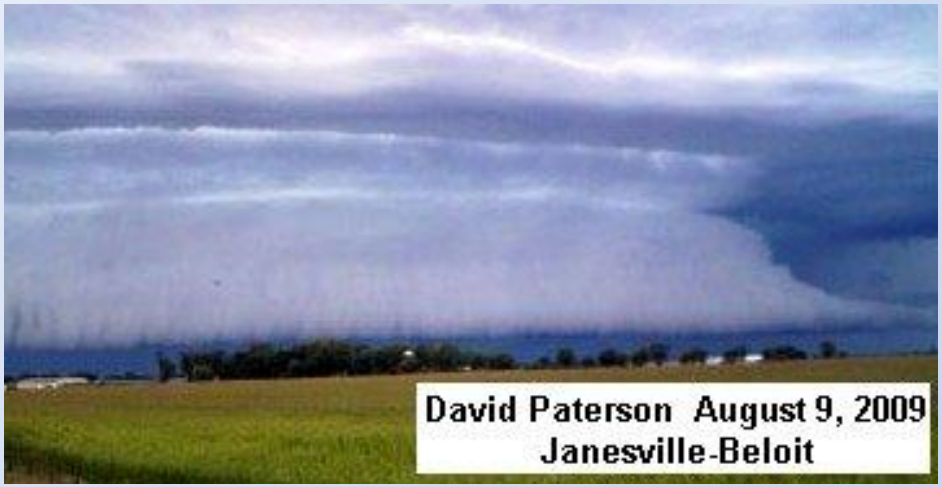
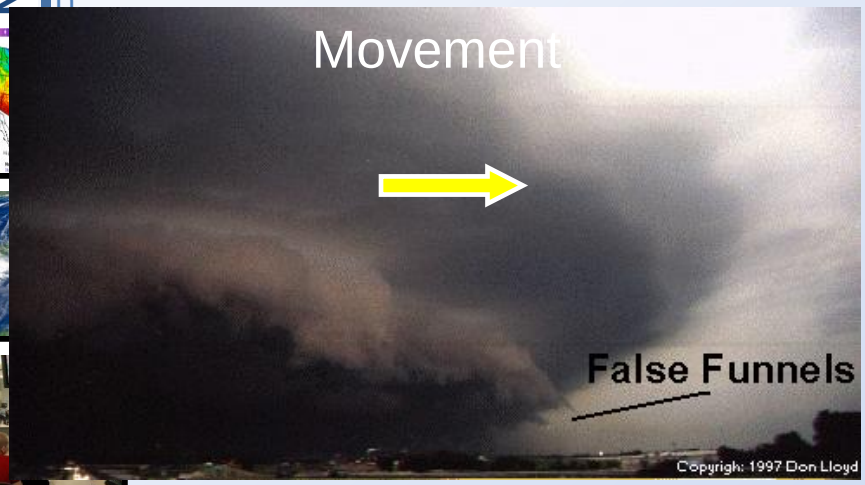


Shelf Cloud - Outflow



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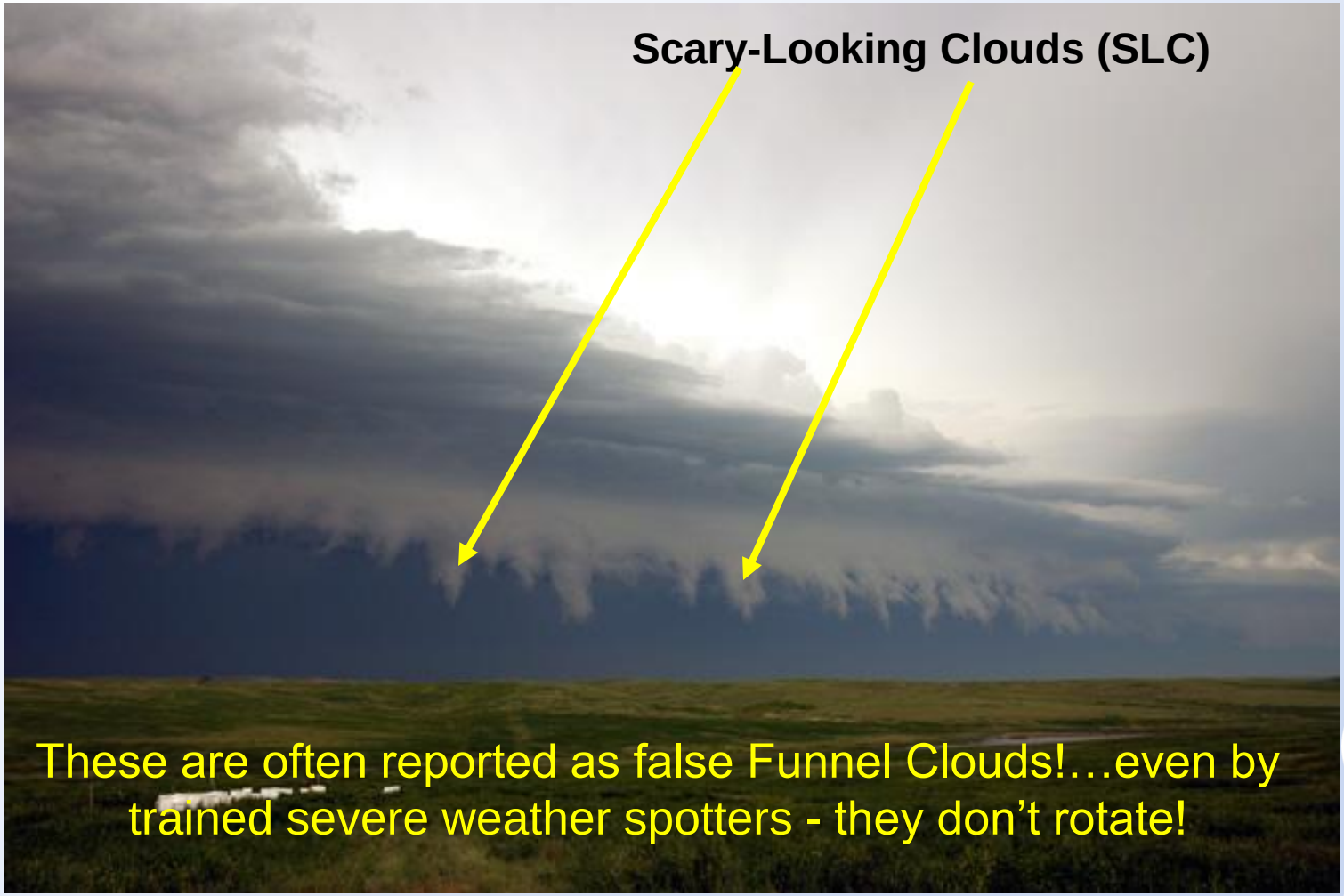
Shelf Clouds – have SLCs



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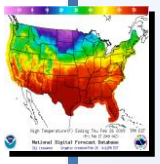
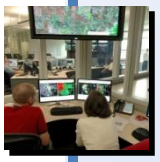
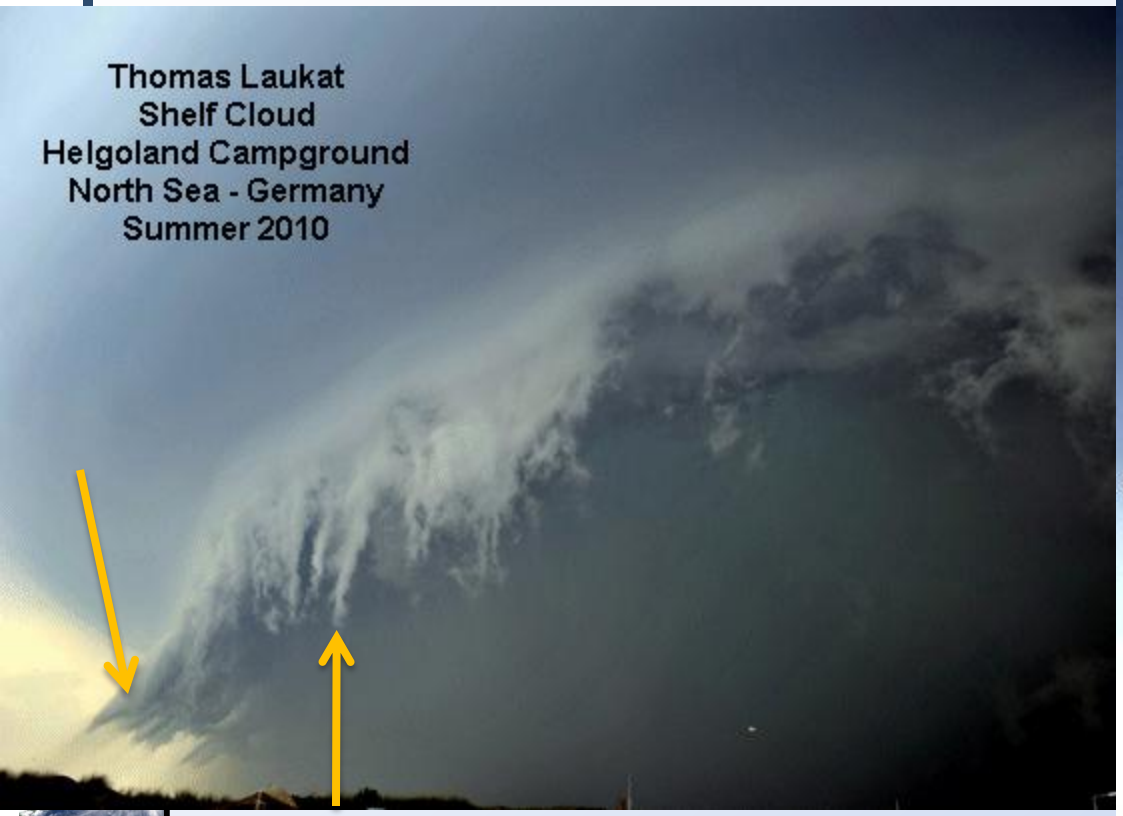
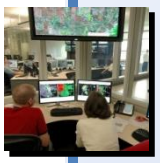




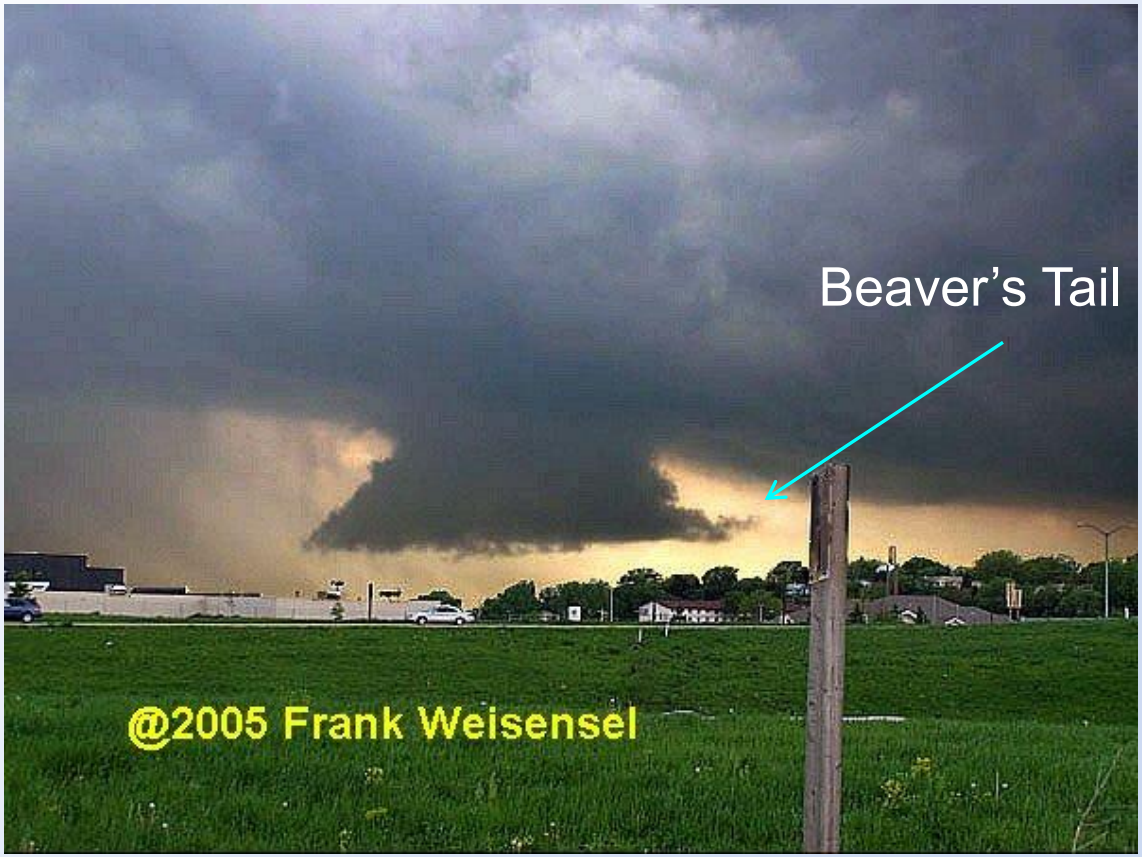
SLC's on Shelf Cloud





Rotating Wall Clouds

An isolated lowering of the rain-free base, rotating on a vertical axis



A good number of, but not all, tornadoes develop underneath or near a rotating wall cloud

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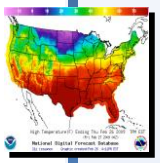
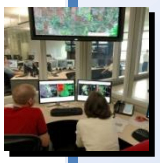
Rotating Wall Cloud

Video

Wall Clouds!

- **<u>Wall Cloud-</u>** A localized, persistent, often abrupt lowering from a rain-free base.
  - *Often exhibit cyclonic (Counter Clockwise) rotation.*
  - *<u>However</u>, not all wall clouds rotate.*
- **<u>Strong, upward motion</u>** is often found in the vicinity of the rotating wall cloud and its beaver tail.
  - *This is where the updraft is the strongest – vacuum sweeper effect. Rising motion - scud is being lifted into the base.*
- **<u>BUT, rotating wall clouds</u>** do…
  - *NOT always lead to tornado development*
  - *AND tornadoes do NOT always develop in association with rotating wall clouds*





Shelf Clouds vs. Wall Clouds

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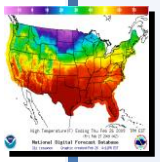

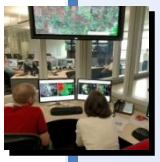

Shelf Clouds

Suggest downdraft/outflow

Move away from precipitation areas

Horizontally orientated and can extend for miles. Rare…but may "roll" like a rolling pin.

Wall Clouds

Suggest updraft/inflow

Maintain position with respect to precipitation

Isolated, vertically orientated, *and rotating, like a spinning skater*

Shelf Clouds vs. Wall Clouds

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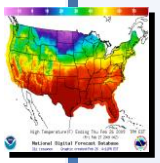
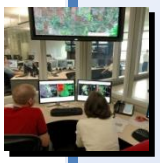




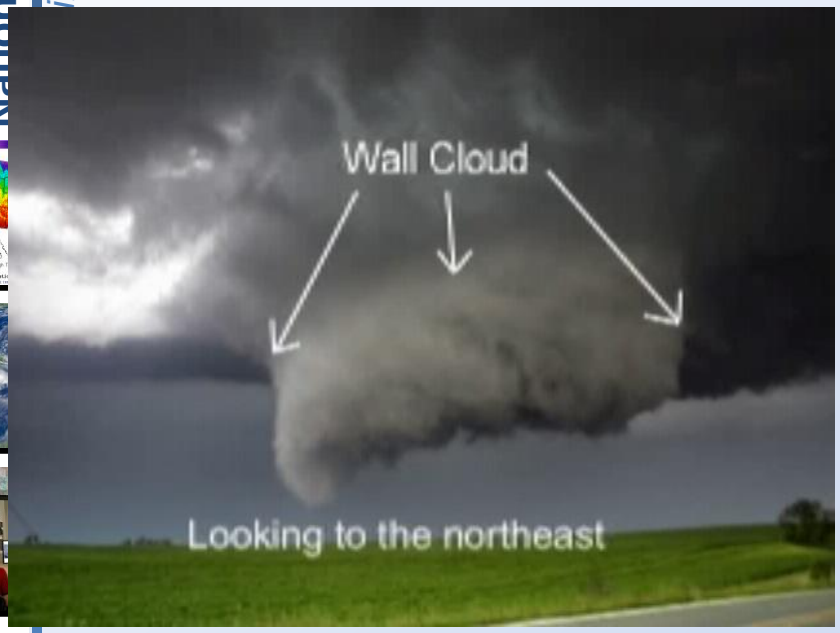
Shelf Clouds

- Appear on front side of thunderstorm cells just ahead of the downdraft.
- Can extend for 10 to 50+ miles and have cloud fragments that *briefly resemble funnel clouds – Scary-Looking Clouds*
- Often resemble a “snow plow” since the colder air with the downdraft undercuts warmer air found out ahead of the storm.

Wall Clouds

- Appear on backside of potentially tornadic thunderstorm
- Will change their shape, size and color with time. Width typically ½ mile to 2 miles
- They can be/become fragmented or look like a beer barrel

Rotating Wall Clouds



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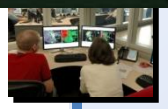
Rotating Wall Clouds



Wall Cloud Evolution

…5 minutes later

Raflik – Iowa (state)