# Snow.  Why?

## Or, A Brief Look at the Science of Snowfall

2015 Winter Weather Talk Series, National Weather Service, Gaylord MI

# Lake Effect Snow

"…cold air blowing across the relatively warm waters of the Great Lakes will produce lake effect snow blah blah blah…"

But *why*?

# Instability and Buoyancy

What is **instability**, and why is it important?

Let's answer the "why" question first:

Rising air - especially, rising *moist* air - creates clouds and precipitation.

Warm air rises relative to cooler air because it has a lower density. Cooler (more dense) air tends to sink.

Upward motion

Downward motion

# Instability and Buoyancy

Any process that warms the atmosphere from underneath can create **instability**. In addition to warming…adding moisture to the air will reduce its density as well (replacing more dense air molecules with less dense water vapor).

Warming a layer of air from below while the air above remains cooler results in a difference in air density (less dense air below/more dense air above).

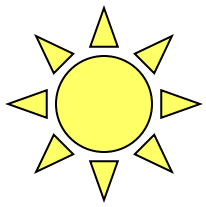
The result of this process is that warmer/more moist lower layers want to rise due to **buoyancy**.

Buoyancy can be a powerful force…it's what allows hot air balloons to take flight.

# So What Happens, Exactly?

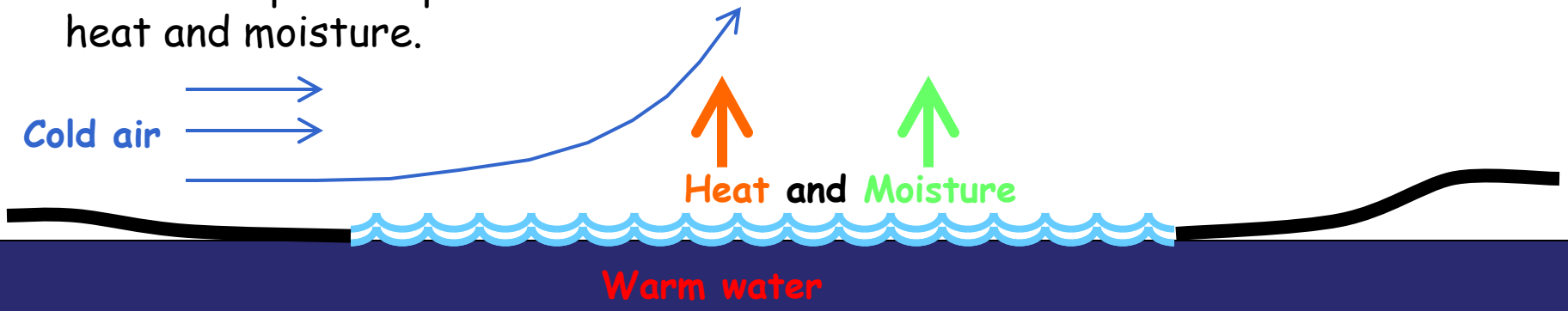
Like the hot air balloon example…we can think of the Great Lakes as being giant "burners" that heat (and moisten) the air crossing them.

Imagine a cold air mass coming out of Wisconsin…moving across a "relatively" warm Lake Michigan:



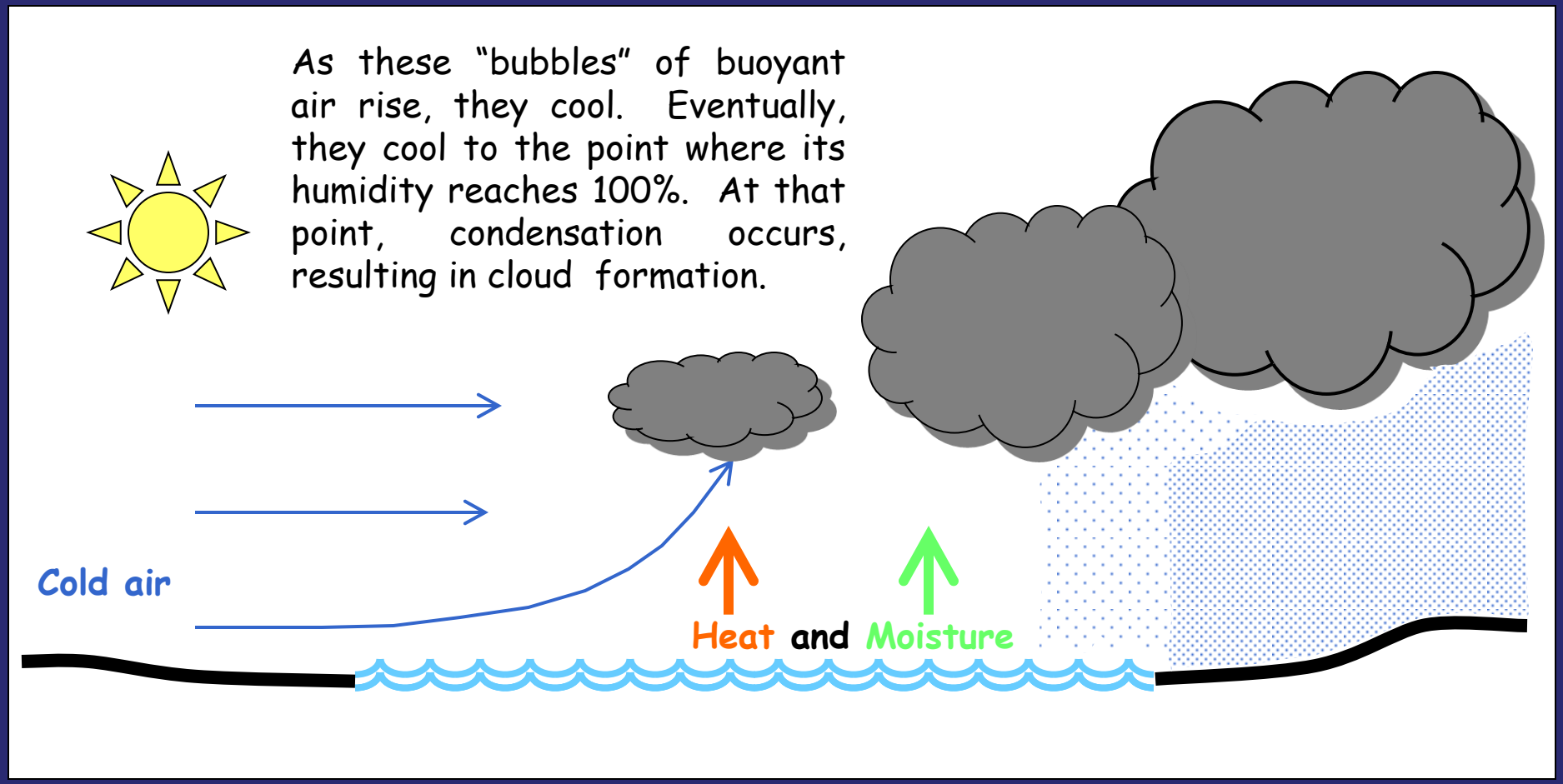
As cold air moves out across a warmer body of water…it picks up heat and moisture.

As the air near the water becomes warm and moist…it becomes less dense than the colder air above it. This creates buoyancy…causing the air to rise.



# Formation of Lake Effect Precipitation

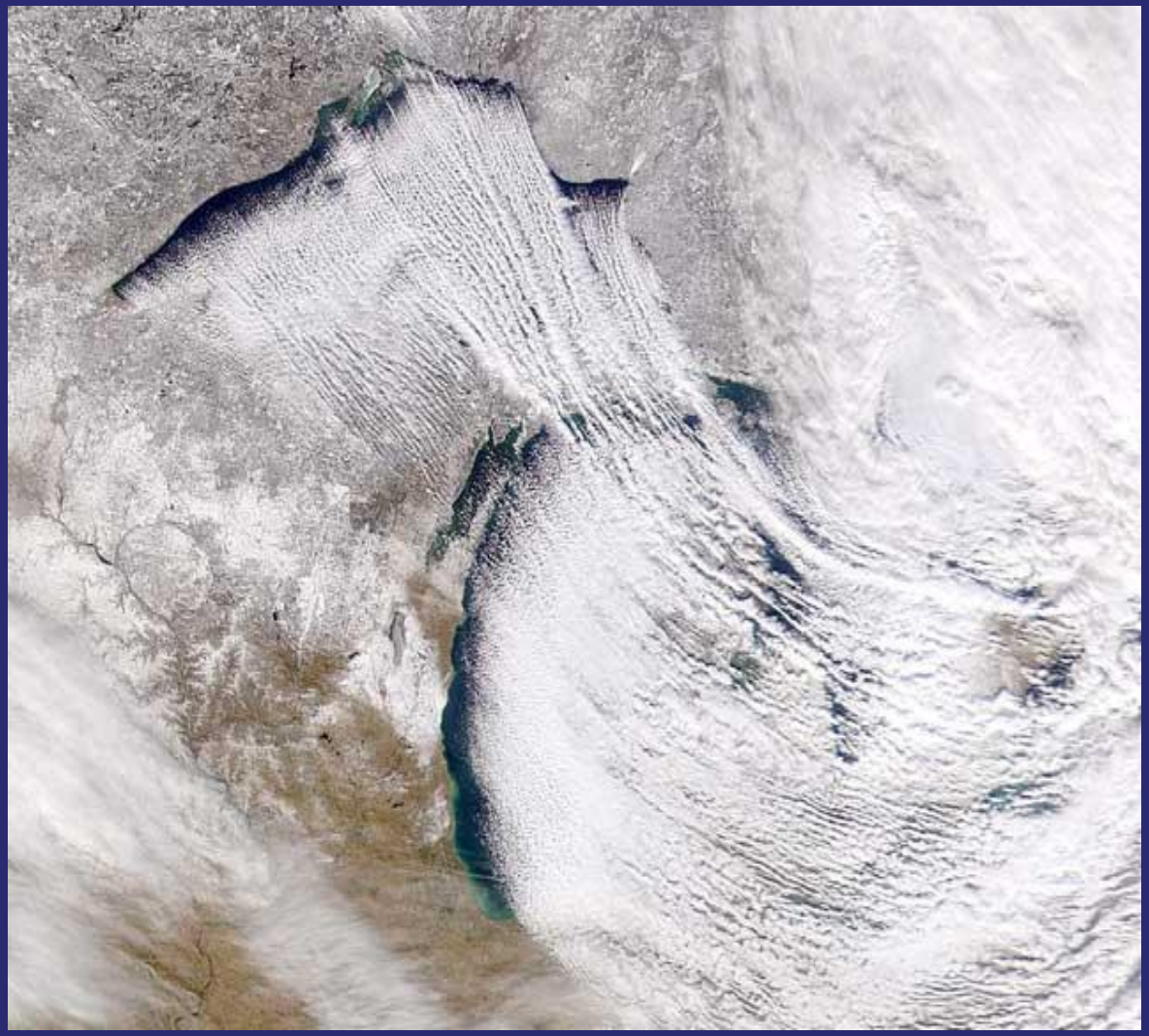
The buoyant, moist, rising air eventually cools and *saturates.* Continued lifting least to clouds and precipitation (usually snow, sometimes rain).



# But wait a second…

- Not only does the warm, moist air at the surface want to rise…
- …but the cold air above wants to sink
  - In fact, it *must* sink to replace the rising air below
- How can we do both at the same time?

# Answer: Bands

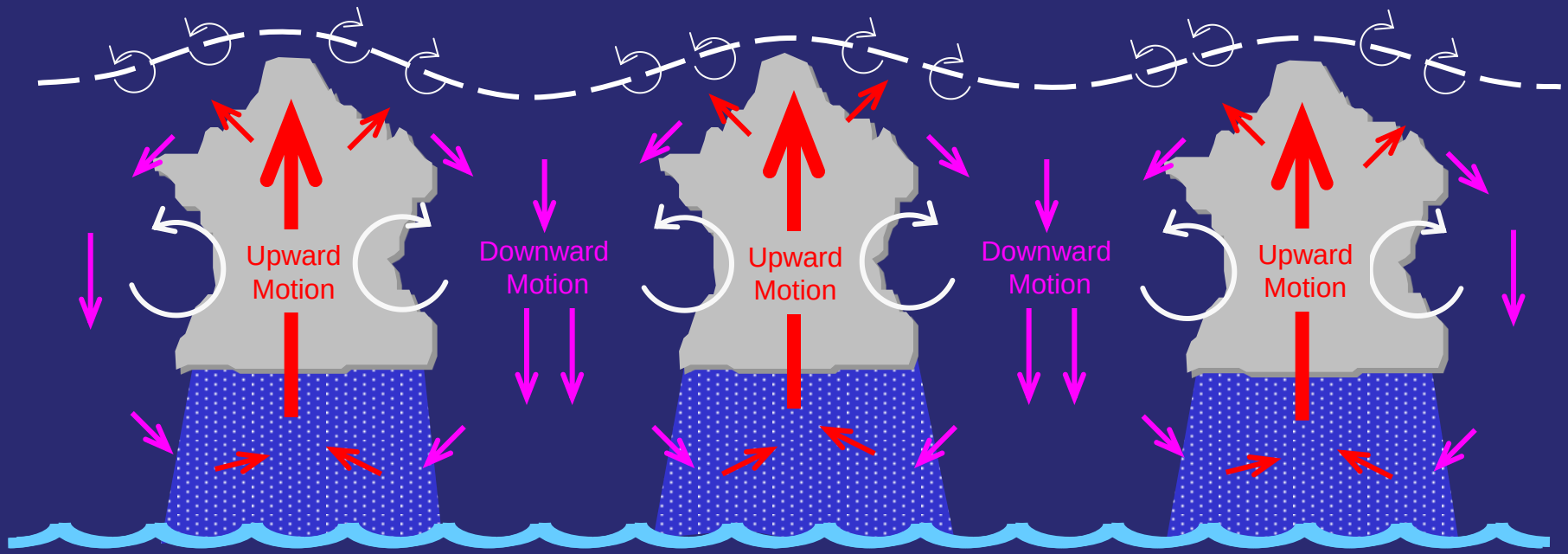


Lake effect snow bands are where warmed, moistened air is ascending from the lakes.

In between the bands, cold air is descending to the surface from aloft.

# Multiple Bands

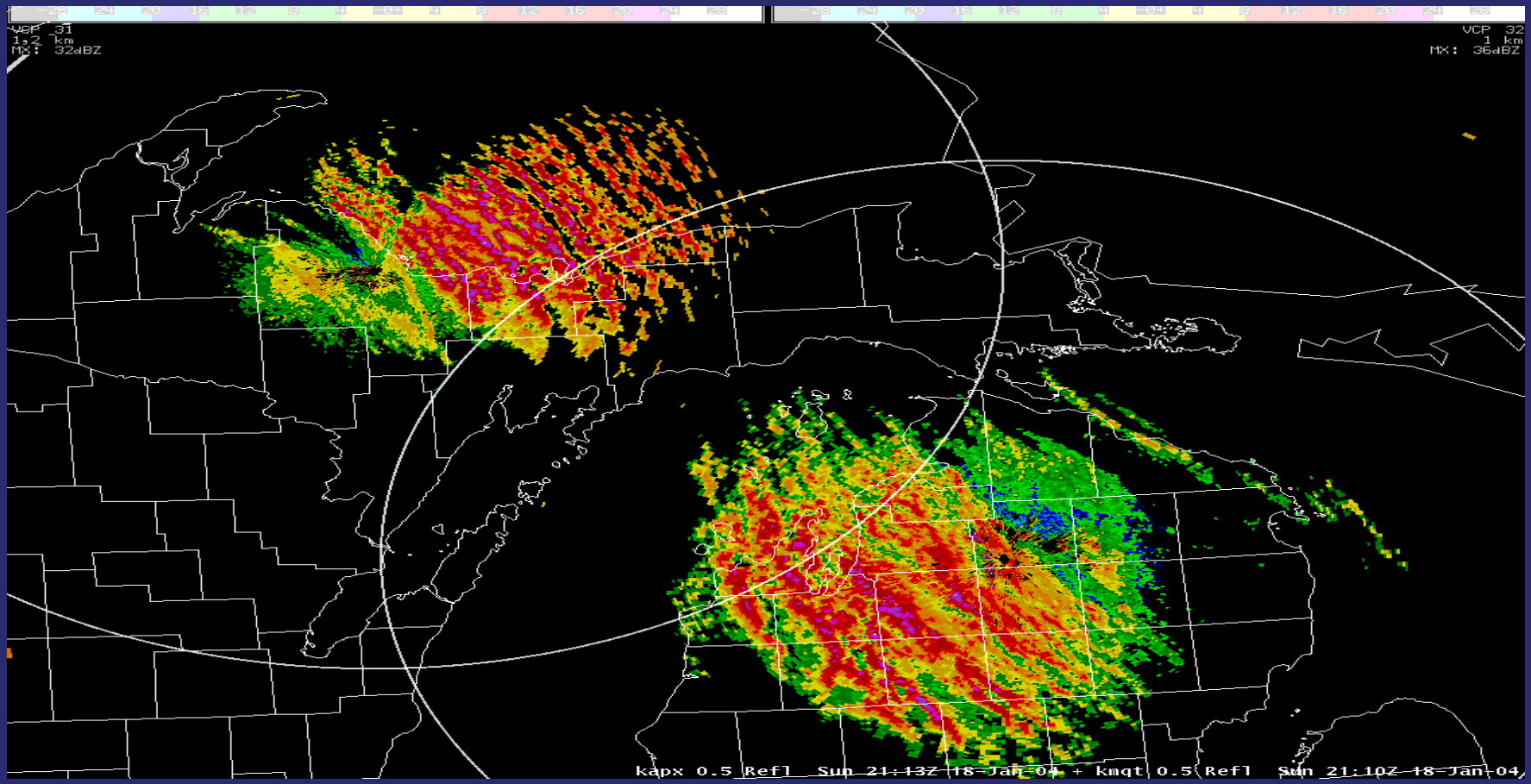
- Each individual snow band reflects warm, moist air ascending from low levels.
- That air is replaced by cold air aloft, that descends to the surface between snow bands.



# Types of Lake Effect Snow Bands

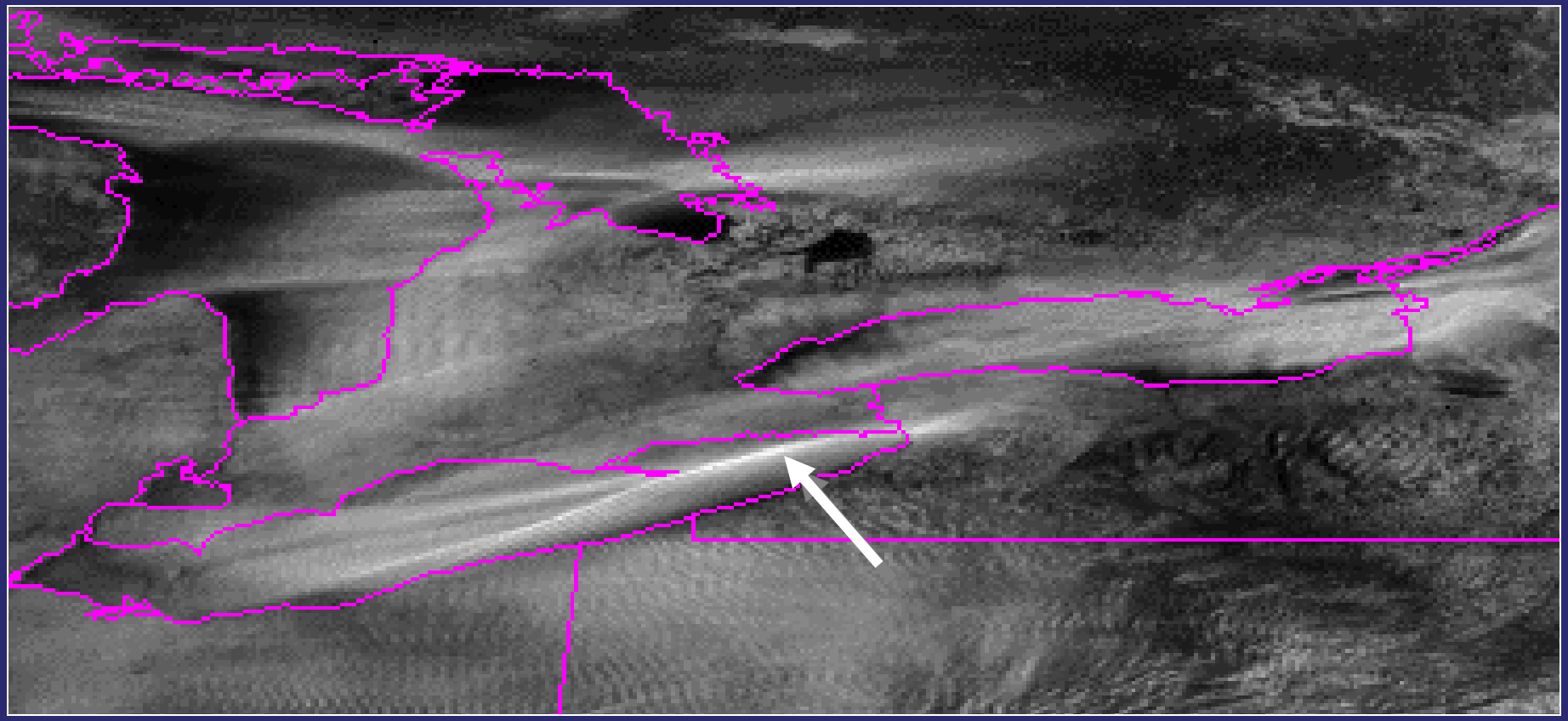
## Multiple Bands

- Most common type of lake effect snow in northern Michigan.
- Bands are parallel to the average wind direction within the cloud layer.



# Single Bands

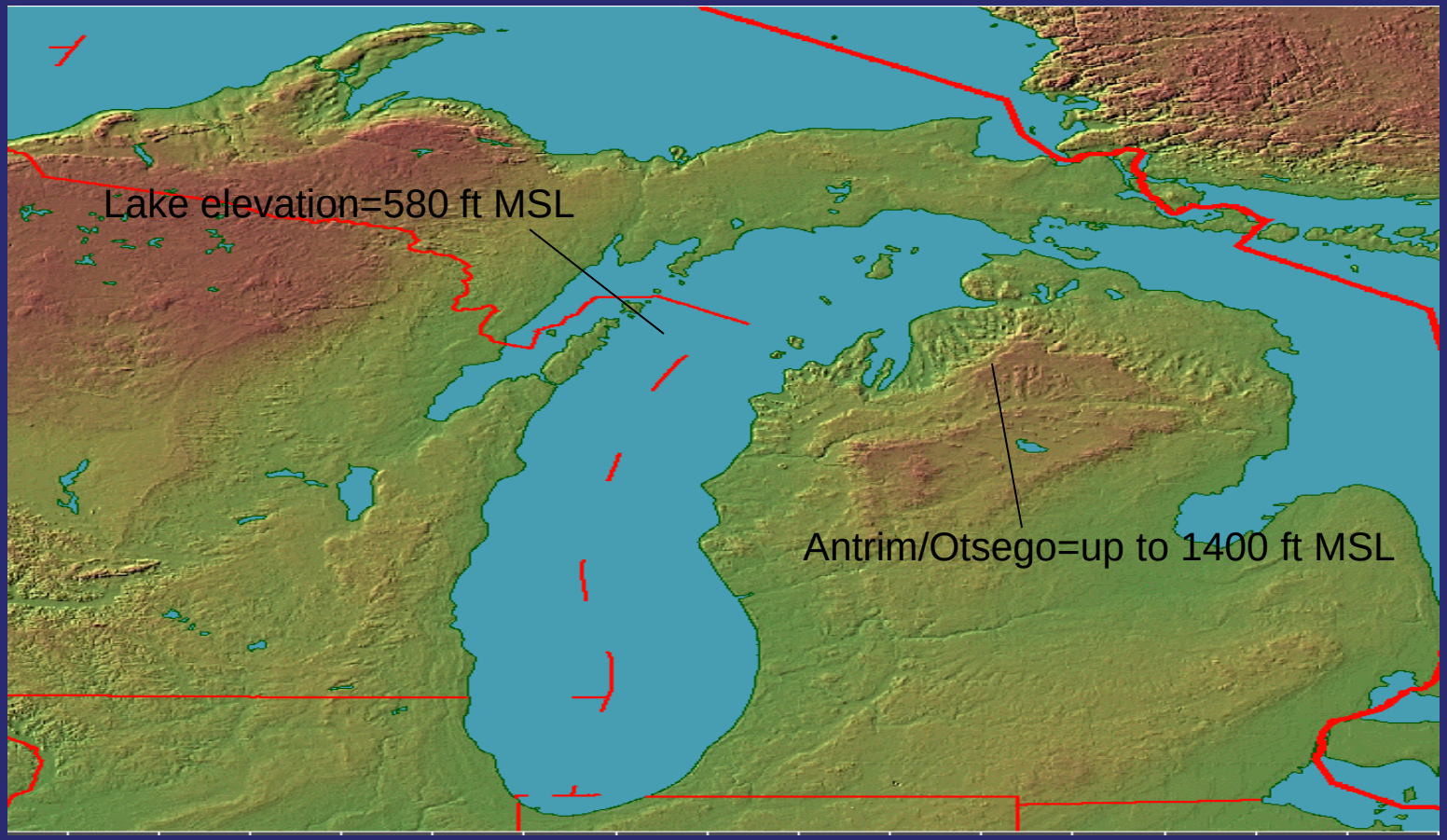
- More common on the eastern Great Lakes (think Buffalo).
- Occur when winds blow down the long axis of a relatively narrow lake.
- Tend to be more intense than multiple band convection (3+ inches per hour accumulations at times)



# Factors That Can Enhance Snowfall Intensity

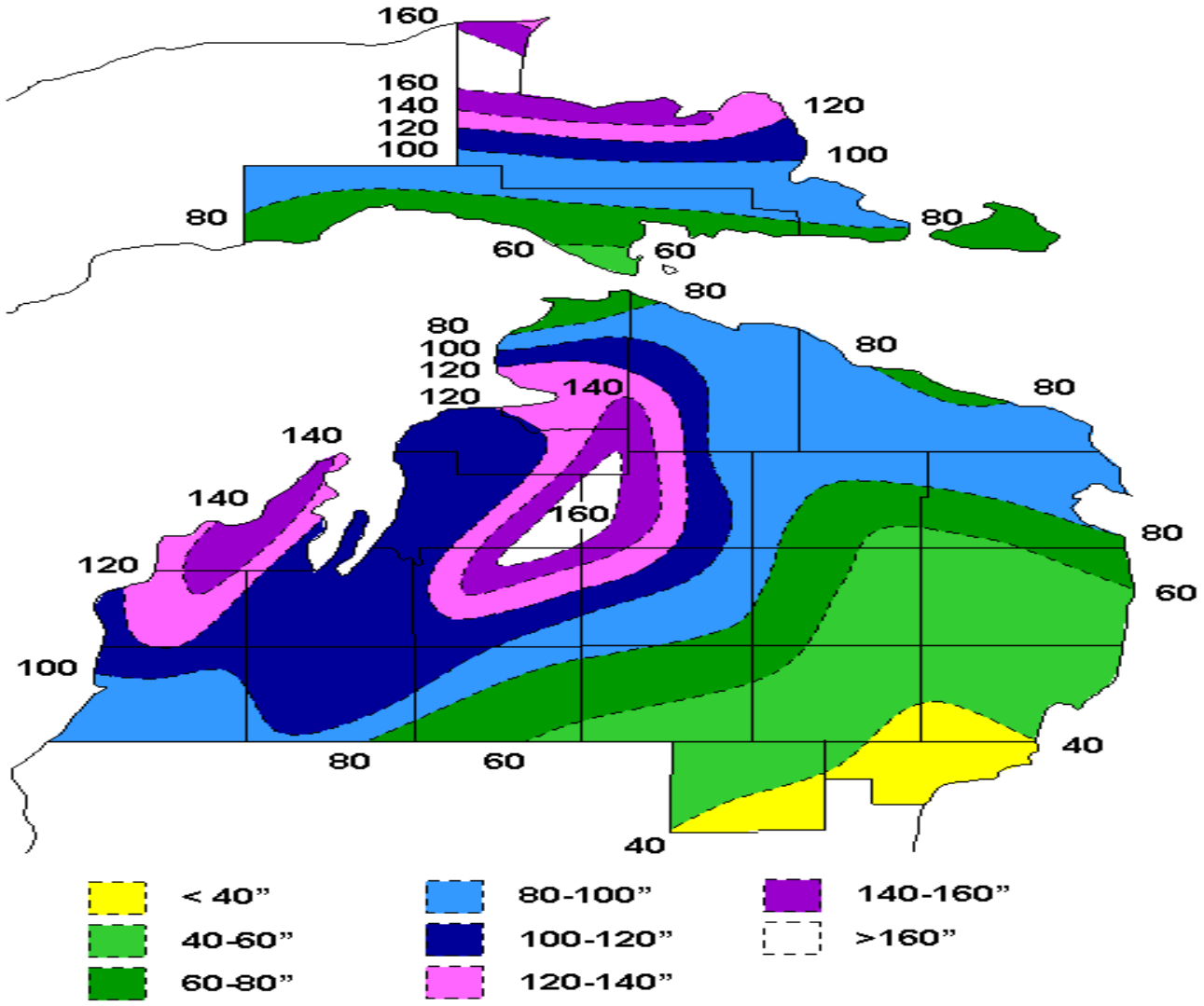
**Topography** plays an important role in enhancing snowfall rates associated with lake effect snow bands.

100 feet of elevation change can result in an 8 to 12 inch increase in annual snowfall.



# Mean Annual Snowfall

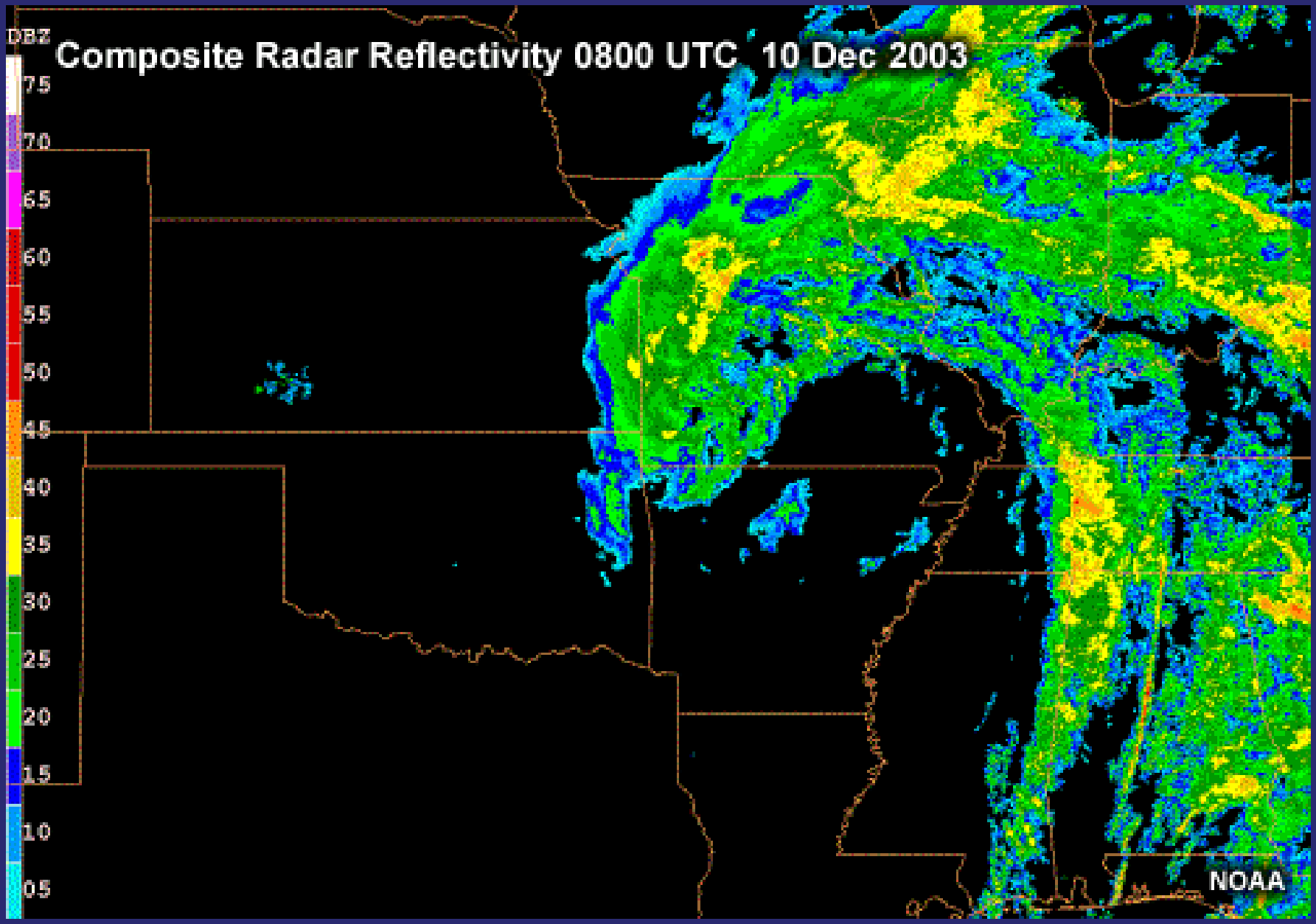
## NWS Gaylord Forecast Area



# Factors That Affect Snowfall Intensity

- Degree of Instability
  - The greater the difference between air and water temperatures, the more intense the snow can be.
- Moisture
  - If the air crossing the lakes is initially very dry, it will take longer for the lakes to add enough moisture to allow precipitation to develop, and snow tends to be less intense.
- Temperature
  - It doesn’t get too cold to snow…but it can get too cold to snow a lot.
    - Moisture is limited
    - Snowflake size gets very small – “talcum powder snow”

# Snow Storms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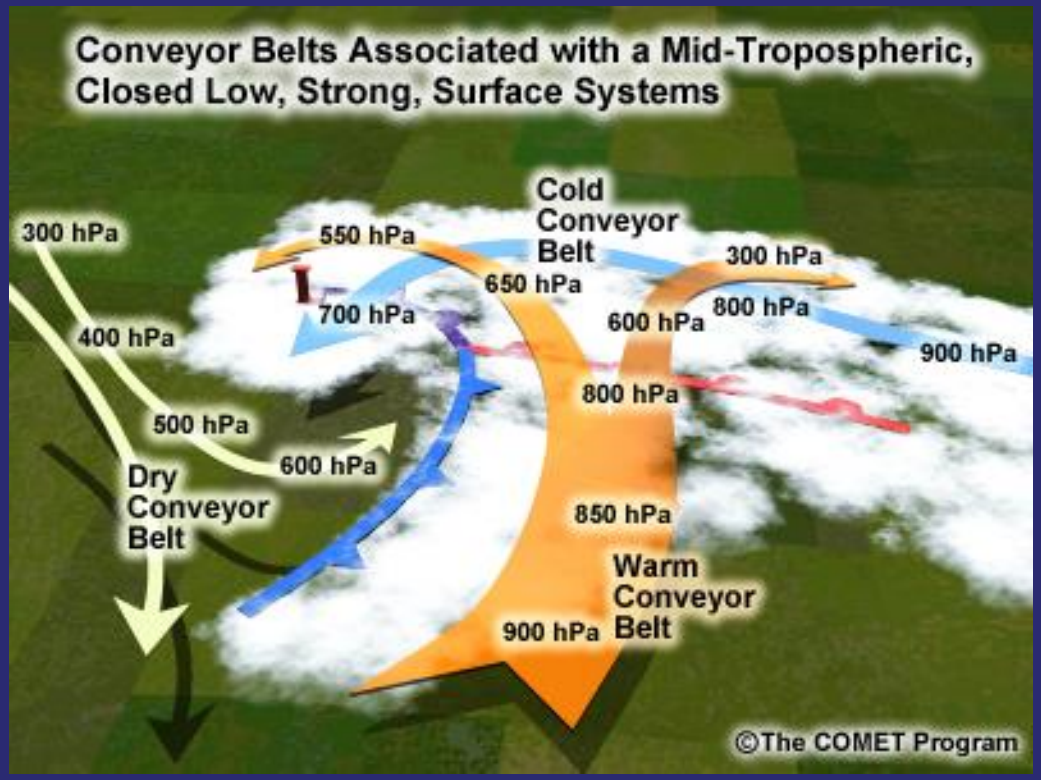
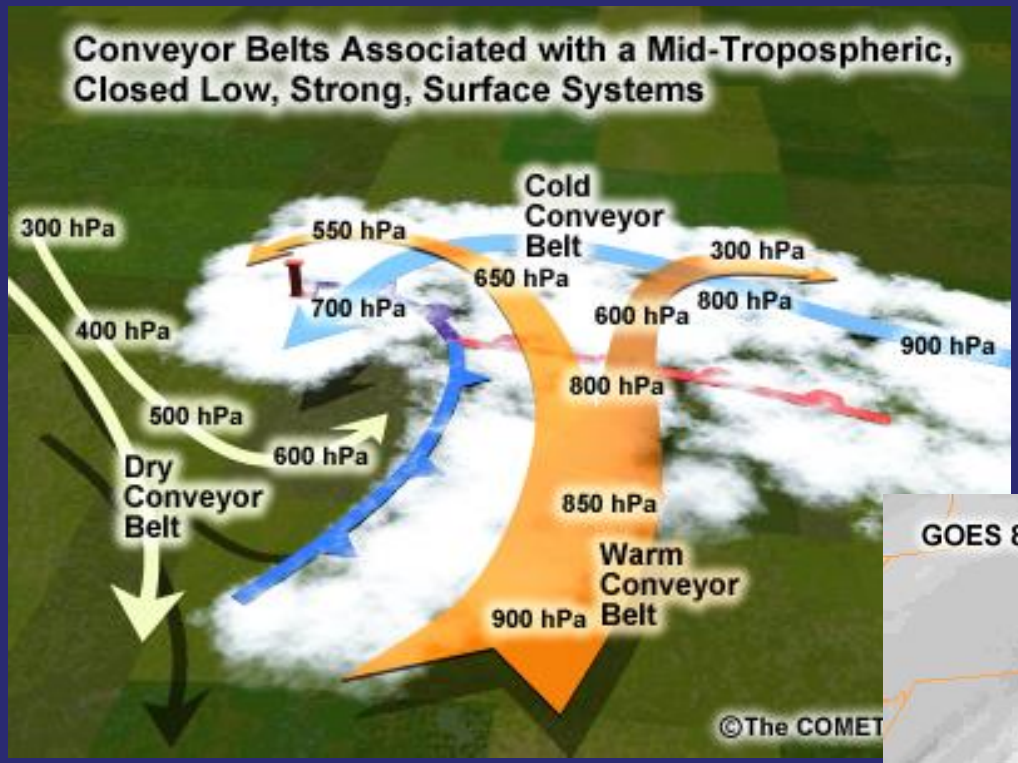
# Snow Storms

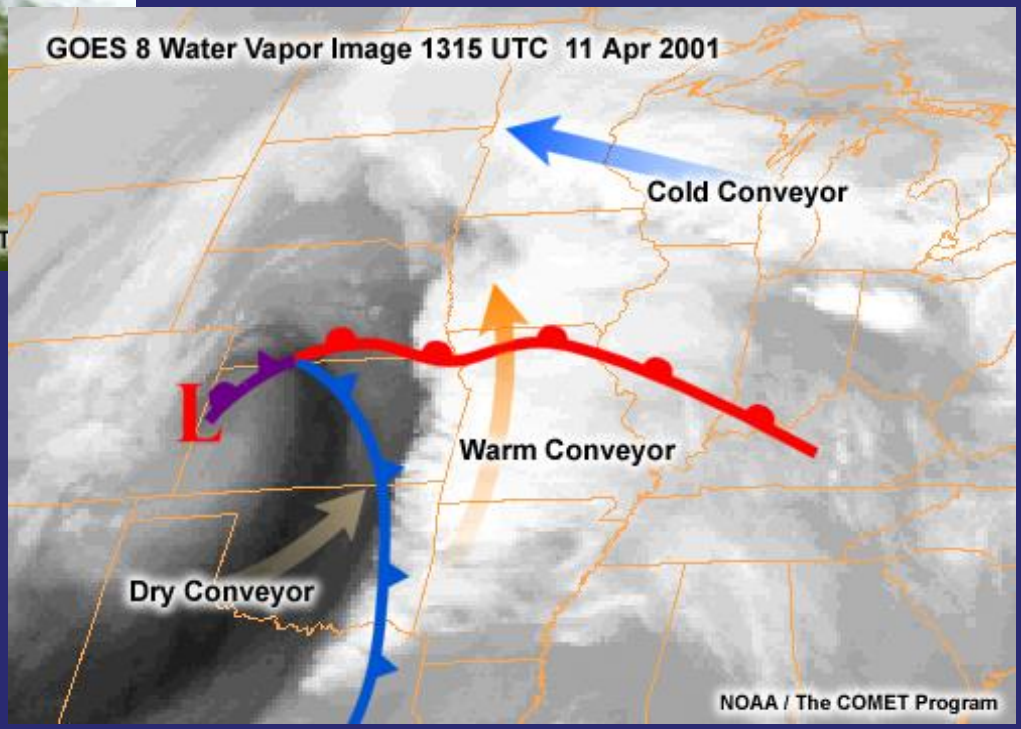



- Most low pressure systems have 3 main air streams:
  - *Warm Conveyor Belt*
  - *Cold Conveyor Belt*
  - *Dry Conveyor Belt*
- These conveyor belts can be though of as three dimensional “rivers” of ascending and descending air.

# Storm Systems

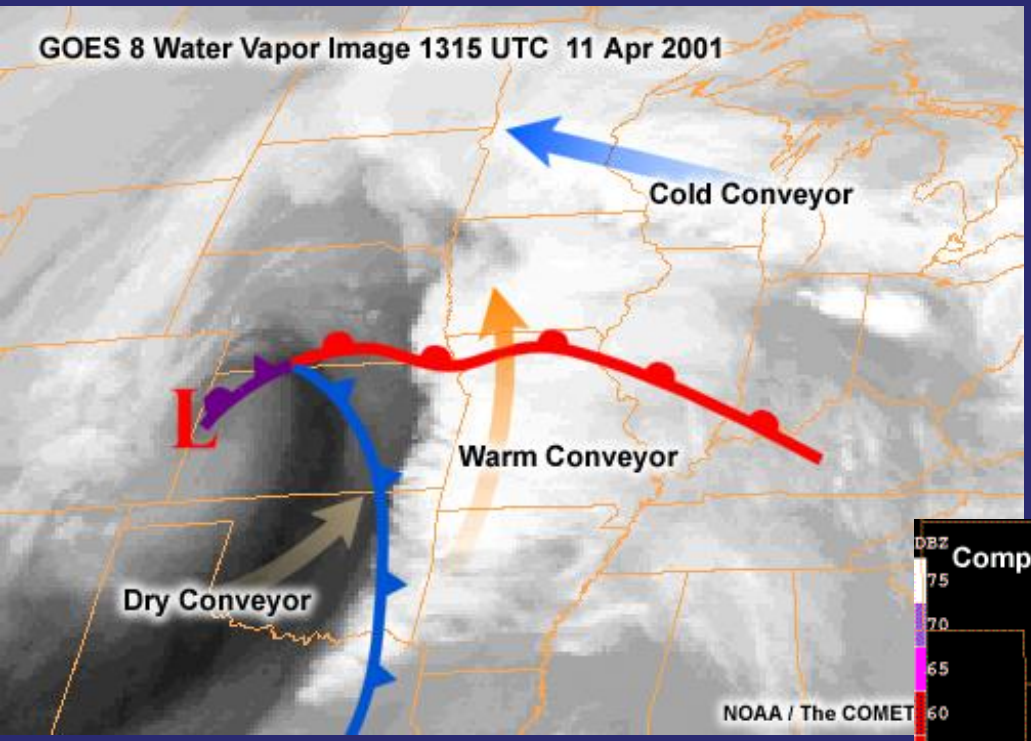



The *Warm* and *Cold* conveyor belts are **ascending**, and produce all of the precipitation with the system

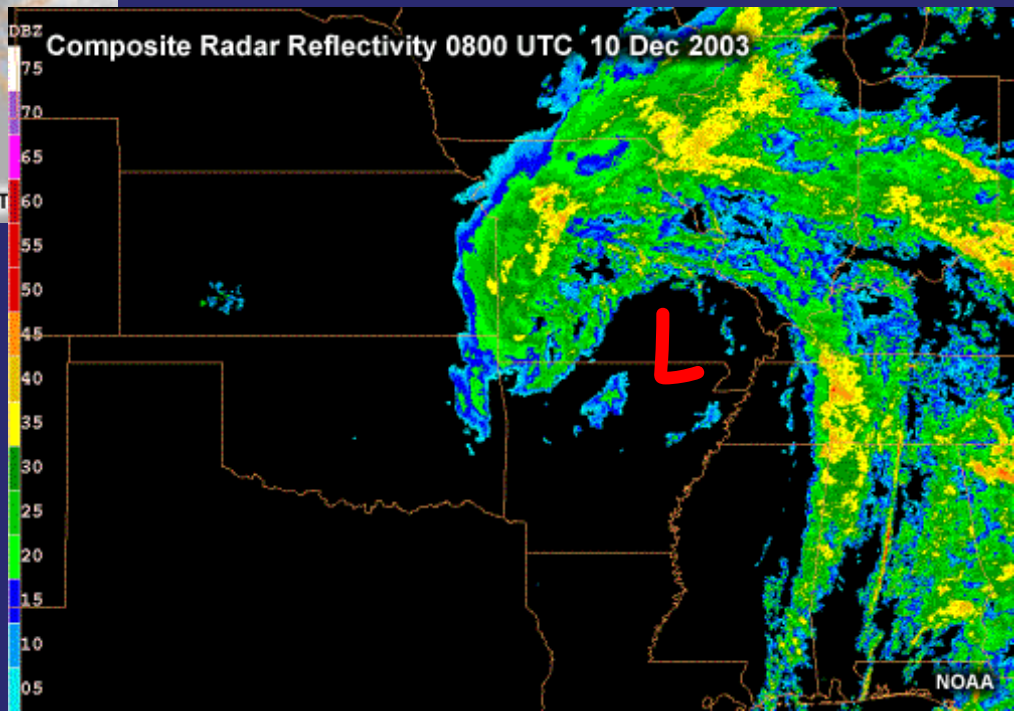



The *Dry* conveyor belt supplies drier, **descending** air behind the surface cold front

# Storm Systems



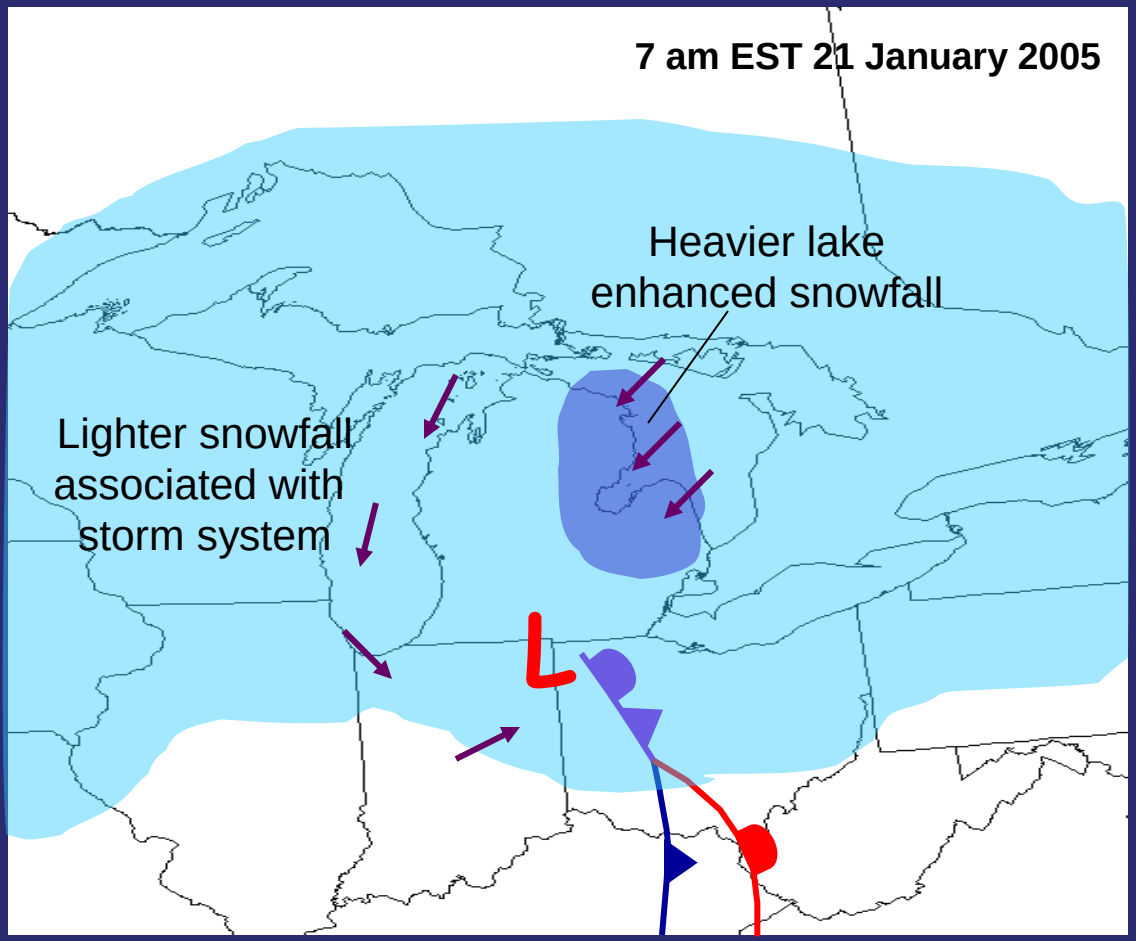

These “conveyor” belts lead to the uneven distribution of precipitation around a low pressure center.

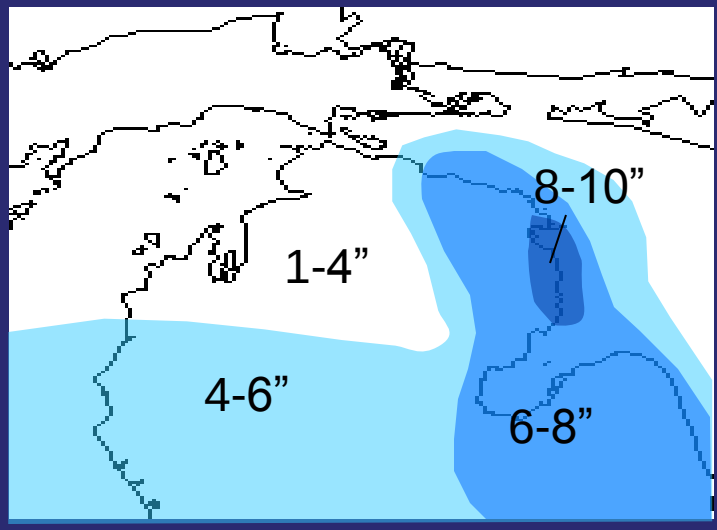


# Lake Enhanced Snow

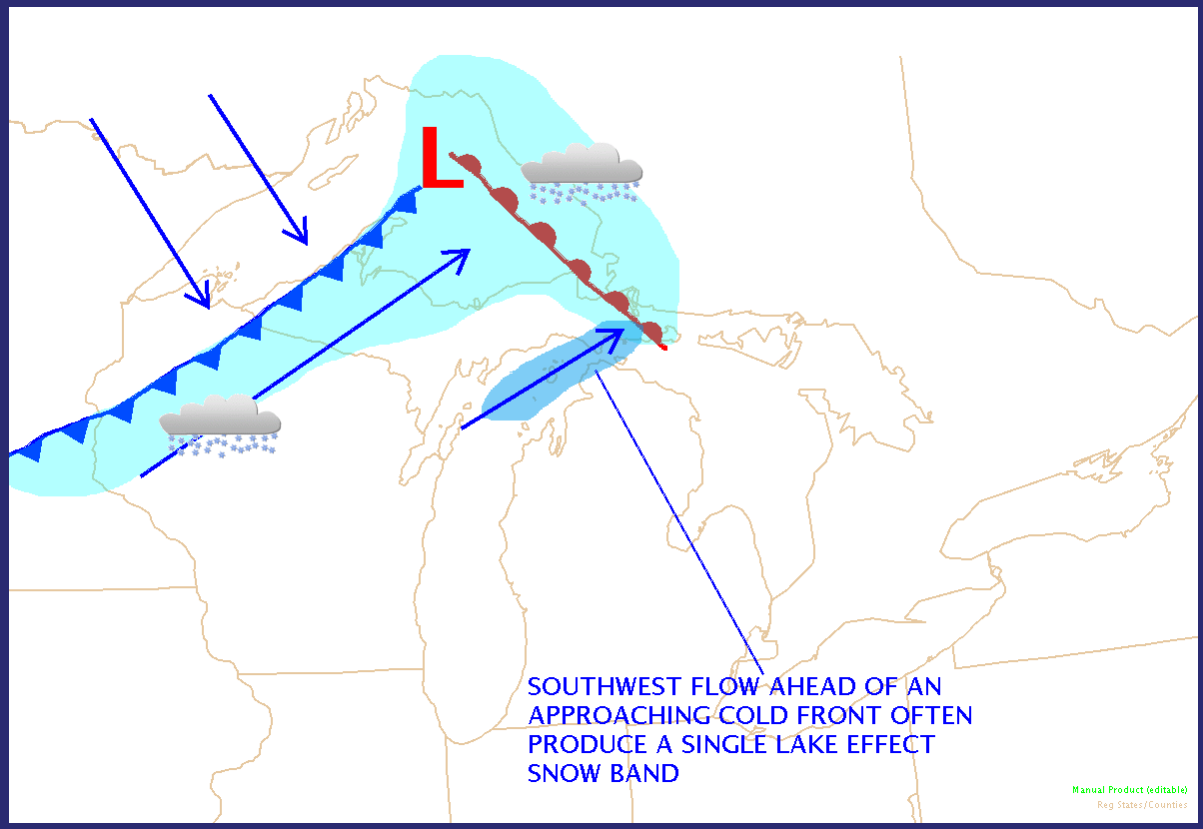
Lake enhanced snow refers to snowfall associated with a passing weather system being enhanced by the addition of moisture from the Great Lakes.

A storm system that passes to our south can result in *lake enhanced* snow off of Lake Huron…as cold northeast winds pass across the lake.



# Lake Enhanced Snow




- Because they occur during cold weather, Alberta Clippers often produce ***lake enhanced*** snowfall as they approach the Great Lakes from the northewst.
- Southwest winds ahead of a clipper can produce a band of heavy snow in Eastern Upper Michigan and near the Lake Michigan coast.

# The End (of the talk, not winter)