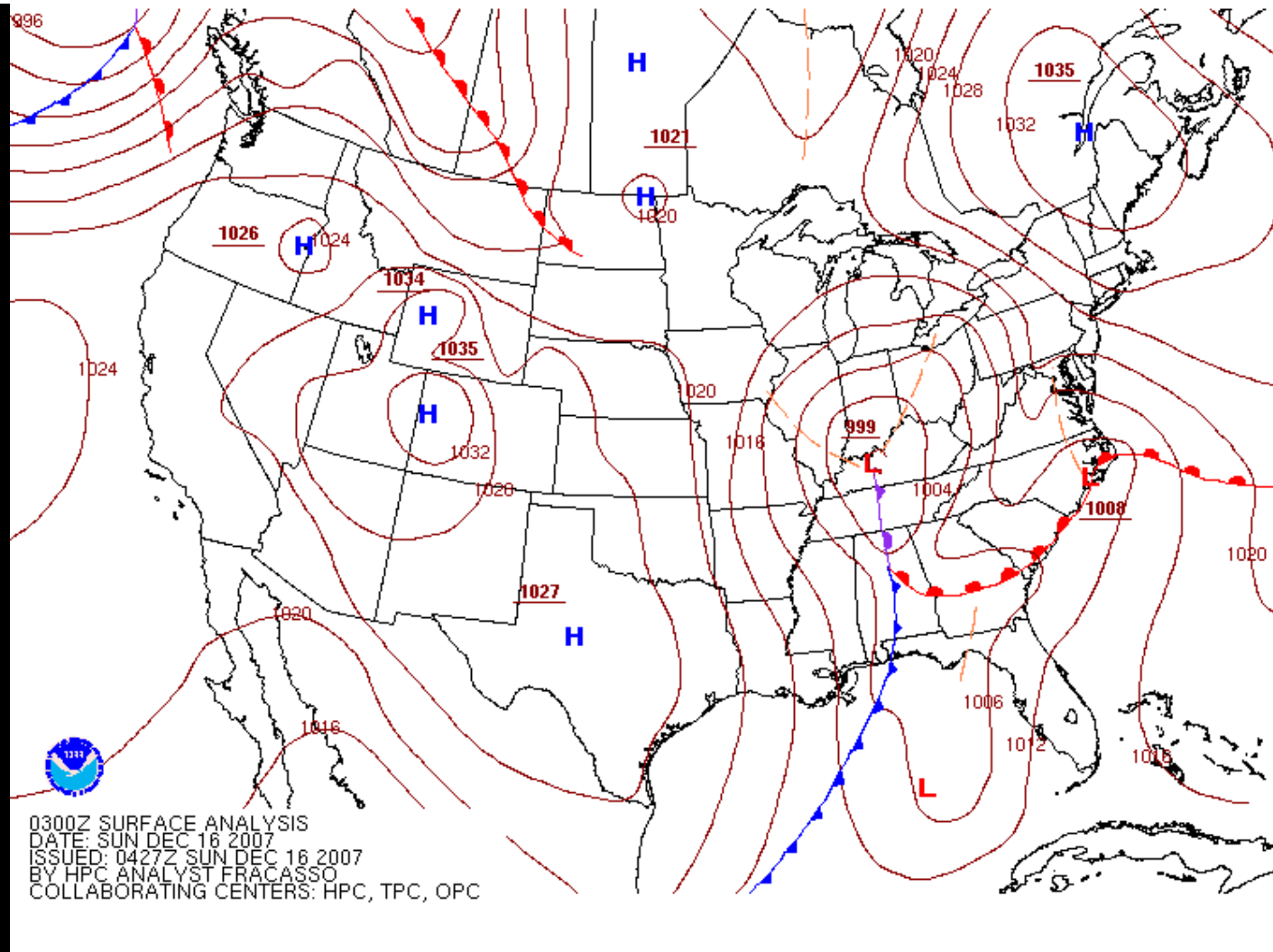


Meteorology – Lecture 14

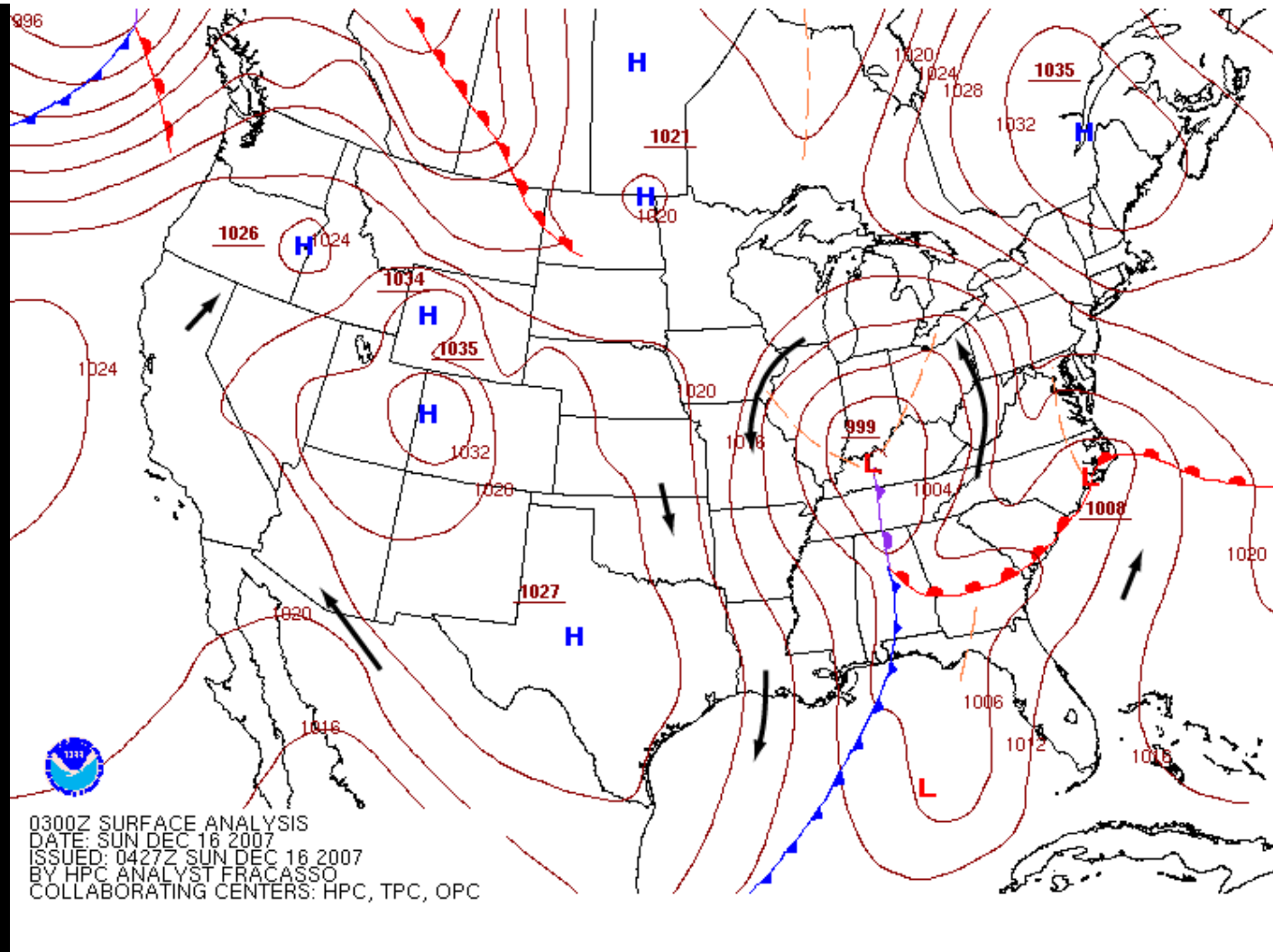
Robert Fovell
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Important notes

- These slides show some figures and videos prepared by Robert G. Fovell (RGF) for his “Meteorology” course, published by The Great Courses (TGC). Unless otherwise identified, they were created by RGF.
- In some cases, the figures employed in the course video are different from what I present here, but these were the figures I provided to TGC at the time the course was taped.
- These figures are intended to supplement the videos, in order to facilitate understanding of the concepts discussed in the course. *These slide shows cannot, and are not intended to, replace the course itself and are not expected to be understandable in isolation.*
- Accordingly, these presentations do not represent a summary of each lecture, and neither do they contain each lecture’s full content.



Here is a map depicting surface weather for 3Z December 16, 2007. 3Z means 3 AM Greenwich Mean Time. During Standard Time, the Eastern Time Zone is 5 hours earlier than GMT, so this is 10 PM on the East Coast, and 7 PM on the West Coast.



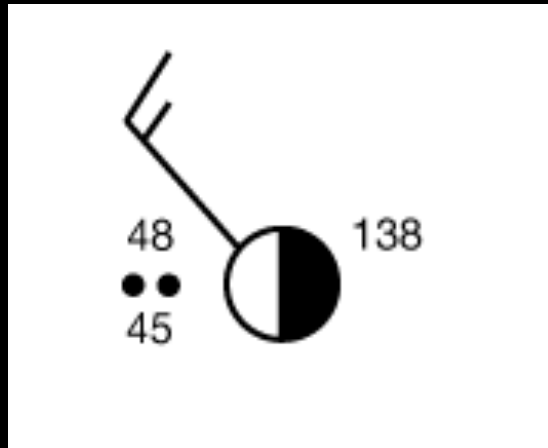
The contours are isobars of sea-level pressure - SLP. Isobars are drawn every 4 mb, centered on 1000 mb. I've sketched on some wind arrows on this figure, based on reasonable guesses. Longer arrows indicate faster speeds. Remember, winds will blow with low pressure to the left. Isobar spacing reflects PGF and wind speed, so winds will be faster where isobars are more "packed".



COLLABORATING CENTERS: HPC, TPC, OPC

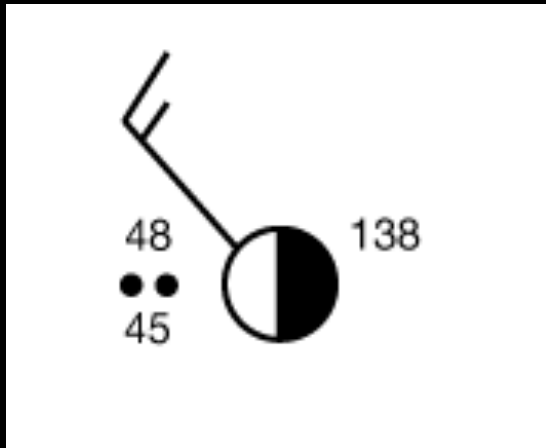
5

Surface map station model



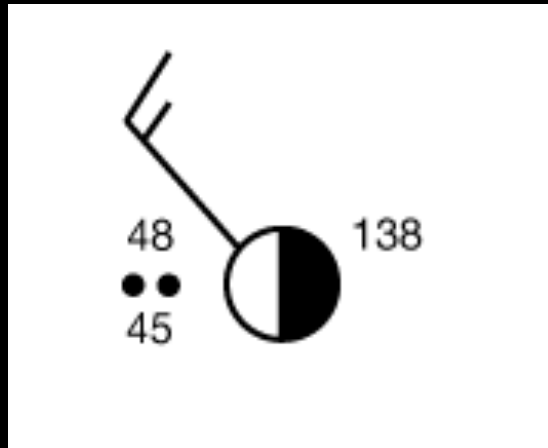
- In the U.S., the standard surface station model presents
 - T and TD in Fahrenheit
 - Wind direction and speed in knots
 - Sky condition
 - Coded SLP
 - Present weather
 - Other information also sometimes included

Surface map station model



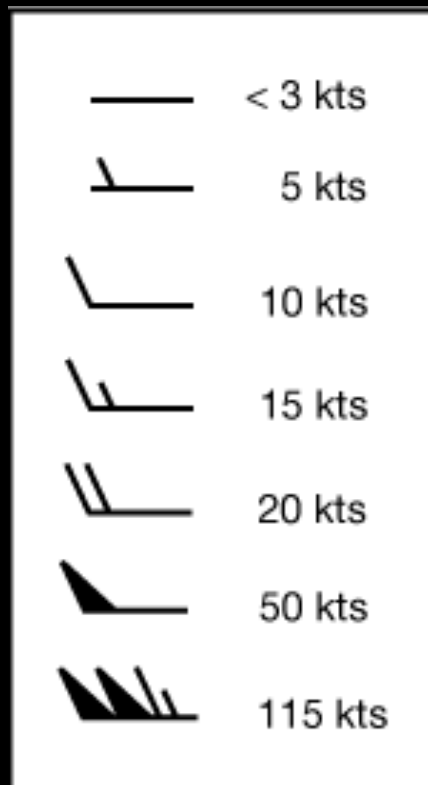
- T and TD are plotted at upper and lower left of the “station circle”
- T is 48F. TD is 45F
- Wind direction is indicated by the barb extending from the station circle
 - Barb points to direction wind comes FROM.
 - This wind is coming from the NW, a NW’ly wind

Surface map station model



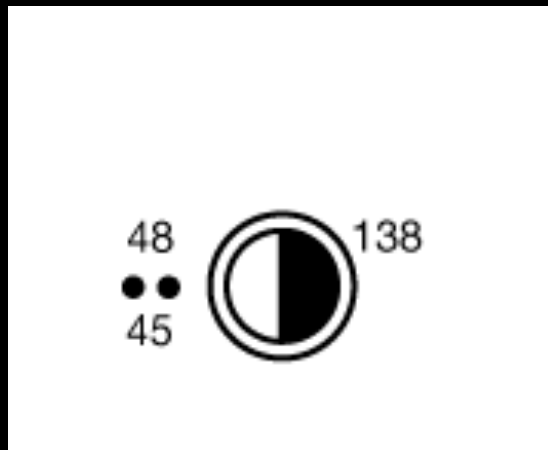
- Wind speed is indicated by the flags extending from the barb
 - A full flag is 10 knots
 - A half flag is 5 kts
 - This wind is 15 kts
- A **knot** is a nautical mile per hour
 - A nautical mile is 1.15 statute miles
 - A knot is 1.15 mph or almost 2 km/hr
- This 15 kt wind is a little over 17 mph or 28 km/h

Surface map station model



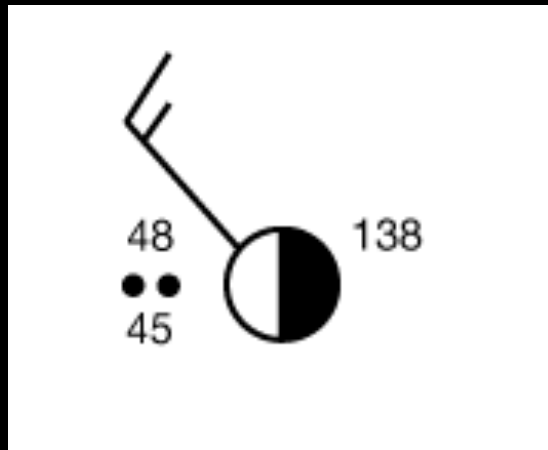
- For faster winds, pennants are used. Each pennant represents 50 kts
- A 5 kt wind is indicated by a half-flag, displaced inward from the barb's end
- A flagless barb used when the wind is less than 3 kts

Surface map station model

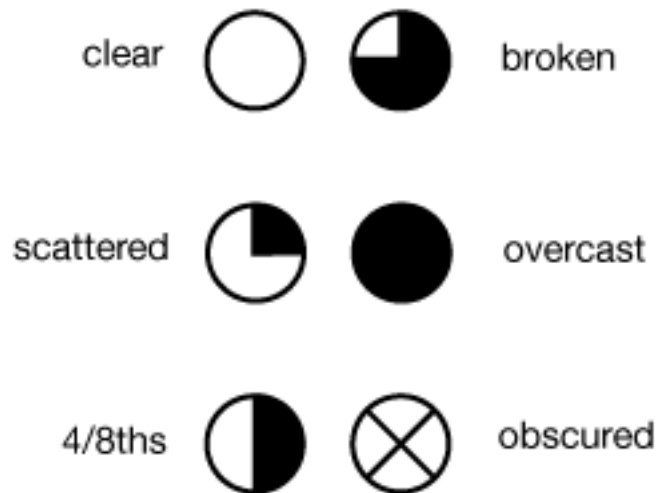


- A perfectly calm condition is reported by replacing the barb with a circle surrounding the station circle, as shown here

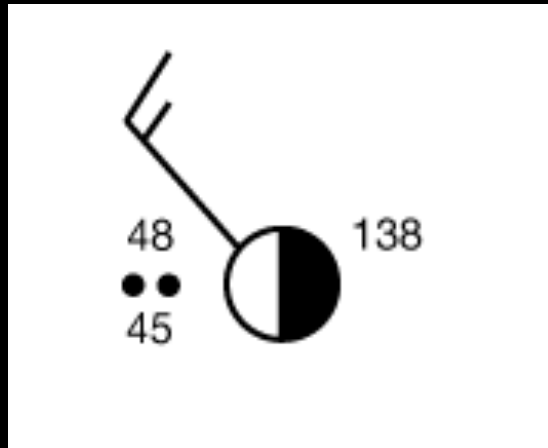
Surface map station model



- Inside the station circle, sky conditions are reported.
- Here are some of the more common symbols used to depict cloud coverage
- Our example station, therefore, has a cloud coverage of about half
- “Obscured” means the sky cannot be seen

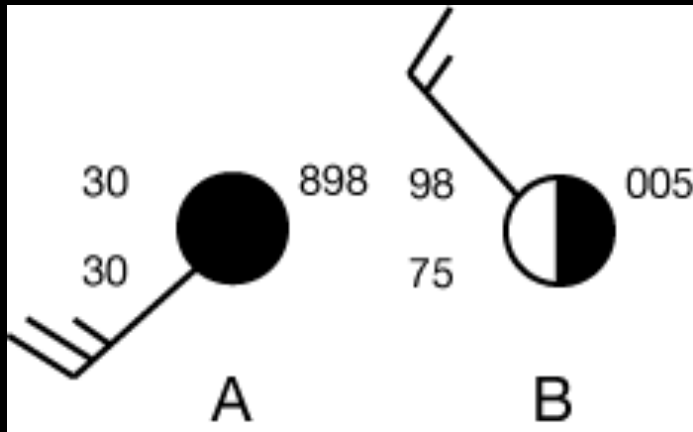


Surface map station model



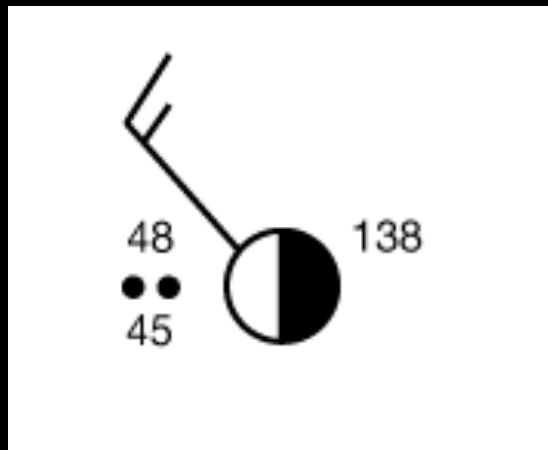
- The three digit number at the upper right represents coded SLP in mb, to tenths of a mb
- The pressure is coded in the following way
 - If the first digit is 0, 1 or 2, add 10 in front.
 - Thus, 138 becomes 1013.8 mb
 - Otherwise, add a 9 in front of the number

Surface map station model



- Here are two surface reports. Which station has the lower SLP?
 - Station B's coded report is 005, so that's 1000.5 mb after adding "10" in front
 - Station A's report is 898. Add a 9 in front, to make 989.8 mb
 - Therefore, Station A's SLP is lower
- Look for reasonableness in decoding pressures.
 - Keep in mind that, outside of hurricanes and tornadoes, SLPs don't drop below 930 mb
 - A code of 112 is more likely 1011.2 mb rather than 911.2 mb

Surface map station model



- The symbol between the T and TD at left indicates the present weather
- Two dots means continuous, light rain
- There are many, many symbols used to indicate present weather.
- Let's look at a few of the more common ones

•	••	•••	••••	<i>rain</i>
*	**	*•	*••	<i>snow</i>
,	,,	,•	,••	<i>drizzle</i>

- Symbols for precipitation



thunder heard, no rain

thunderstorm with rain

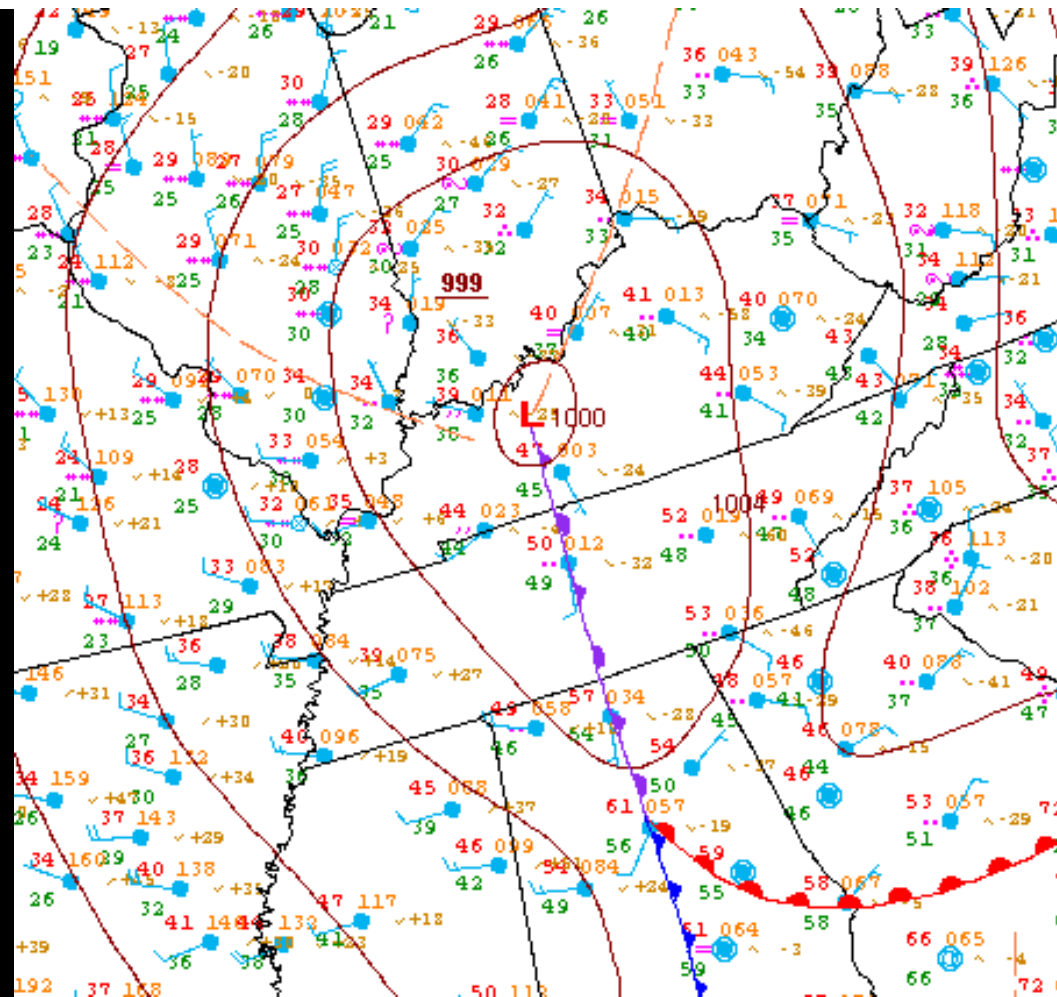
strong thunderstorm with rain

strong thunderstorm with hail

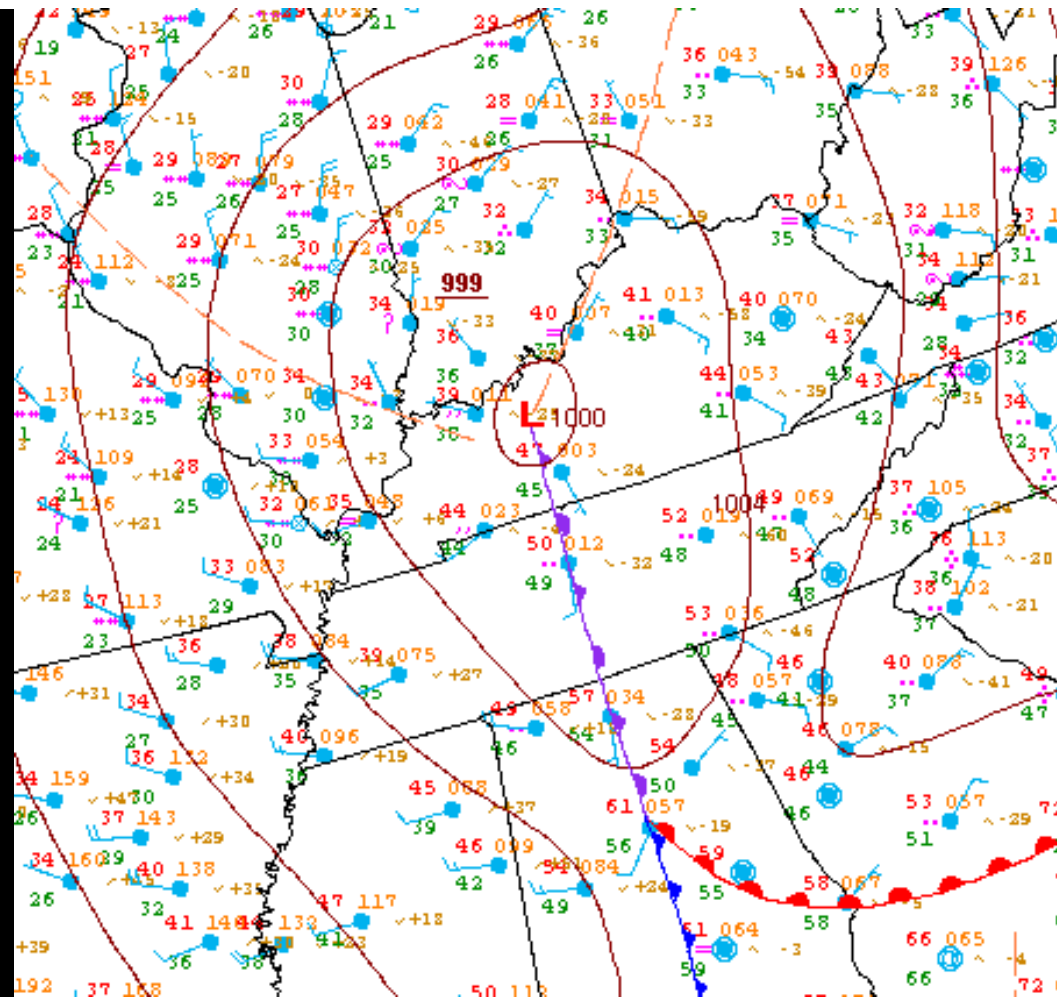
- Symbols for thunderstorms

	<i>rain shower</i>
	<i>snow shower</i>
	<i>haze</i>
	<i>fog</i>
	<i>blowing sand</i>

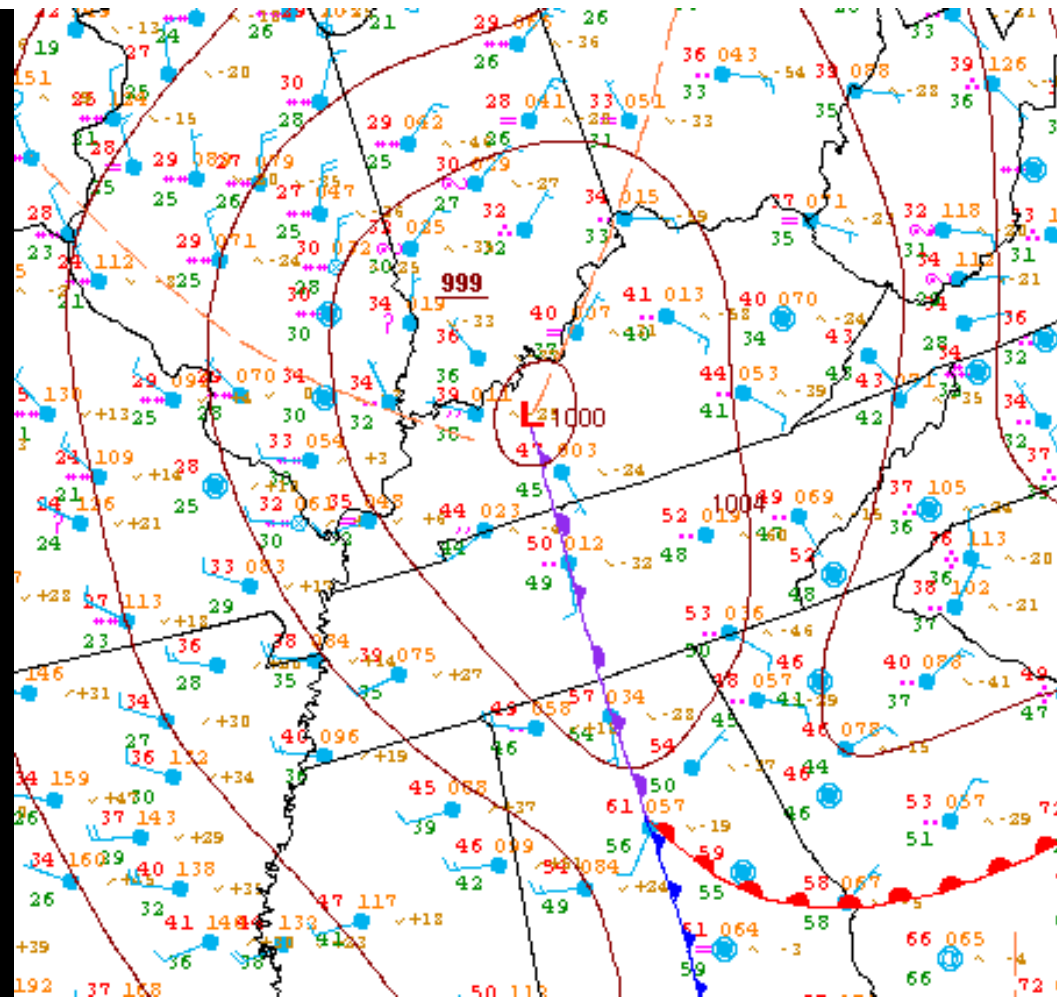
- Here are some other common symbols



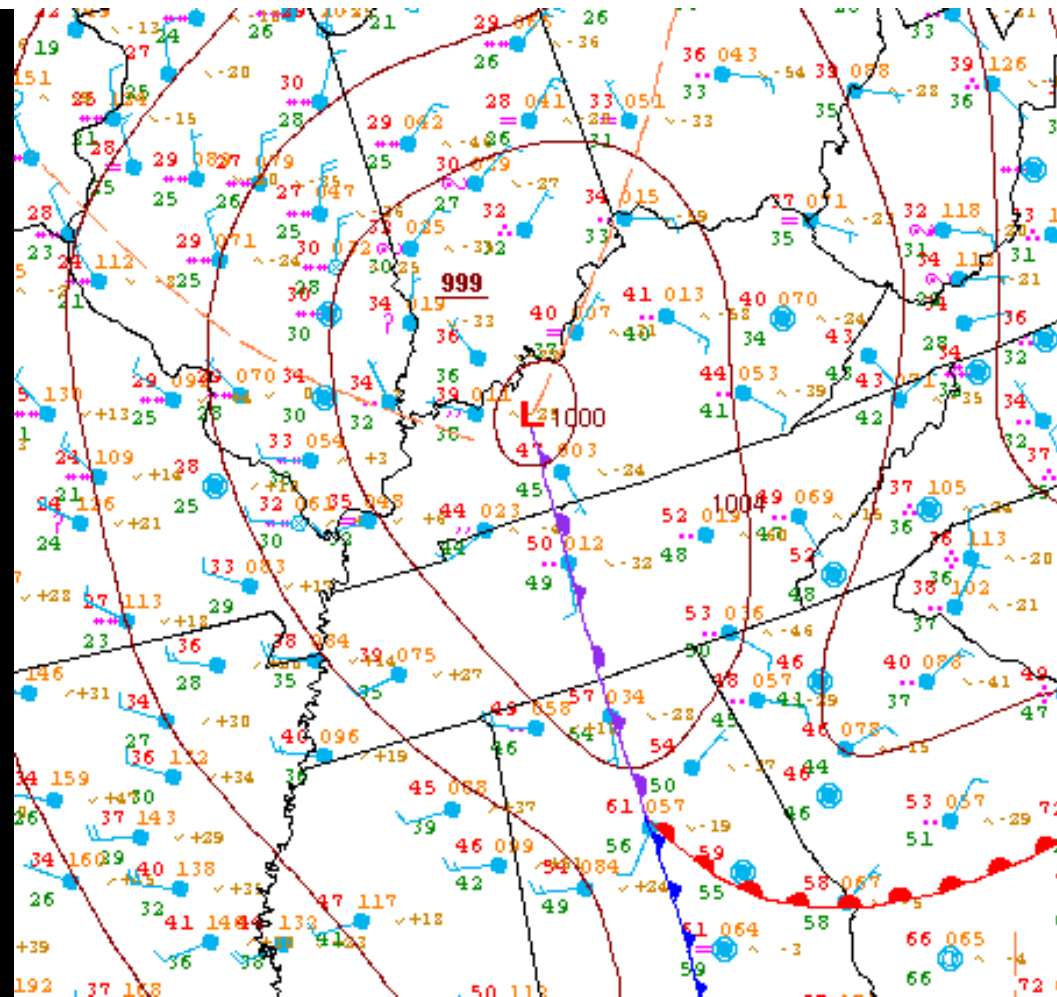
Notice that the winds do swirl CCW around the cyclone, but most winds are angled across the isobars towards the low. The angle varies from place to place, partly reflecting local influences.



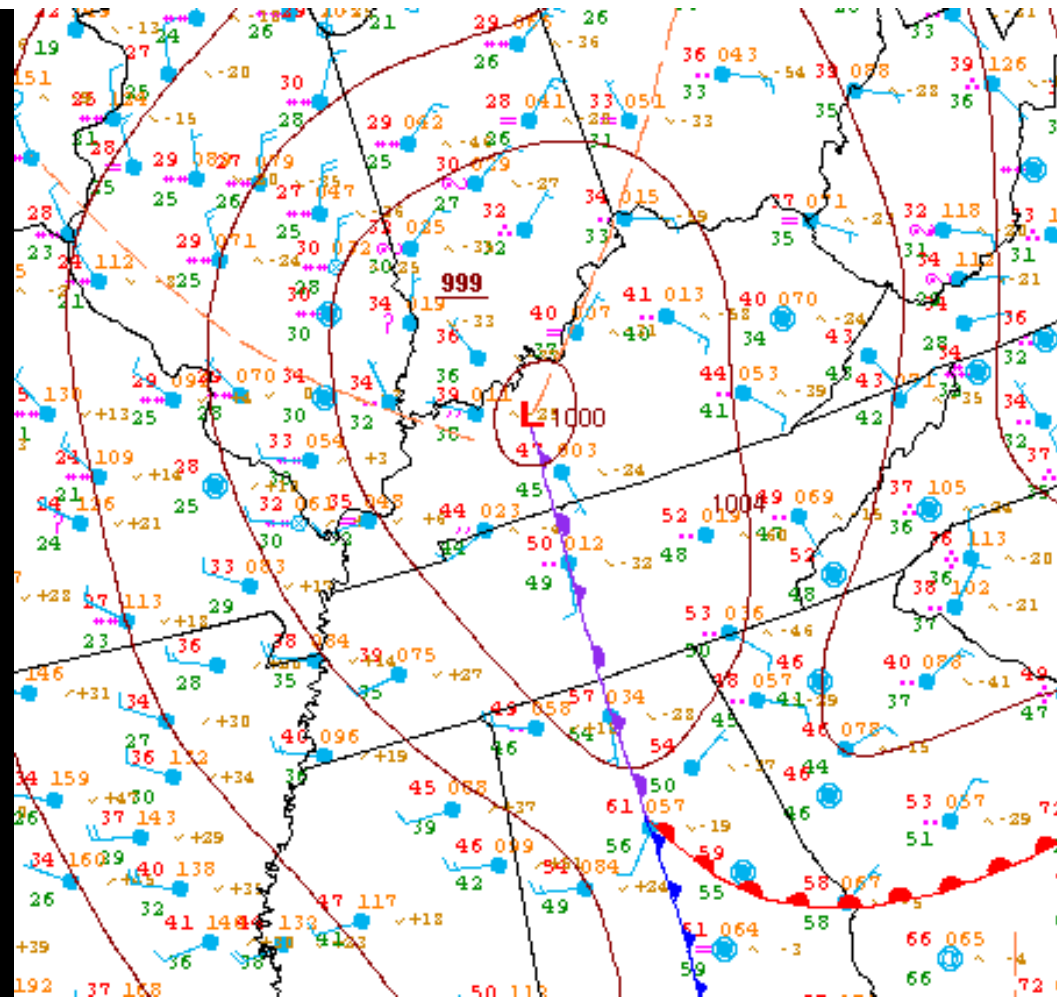
Recall that creates surface convergence, leading to ascent, the major reason we associate cyclones with clouds and storms. Note most of the sky reports indicate overcast, 100% coverage



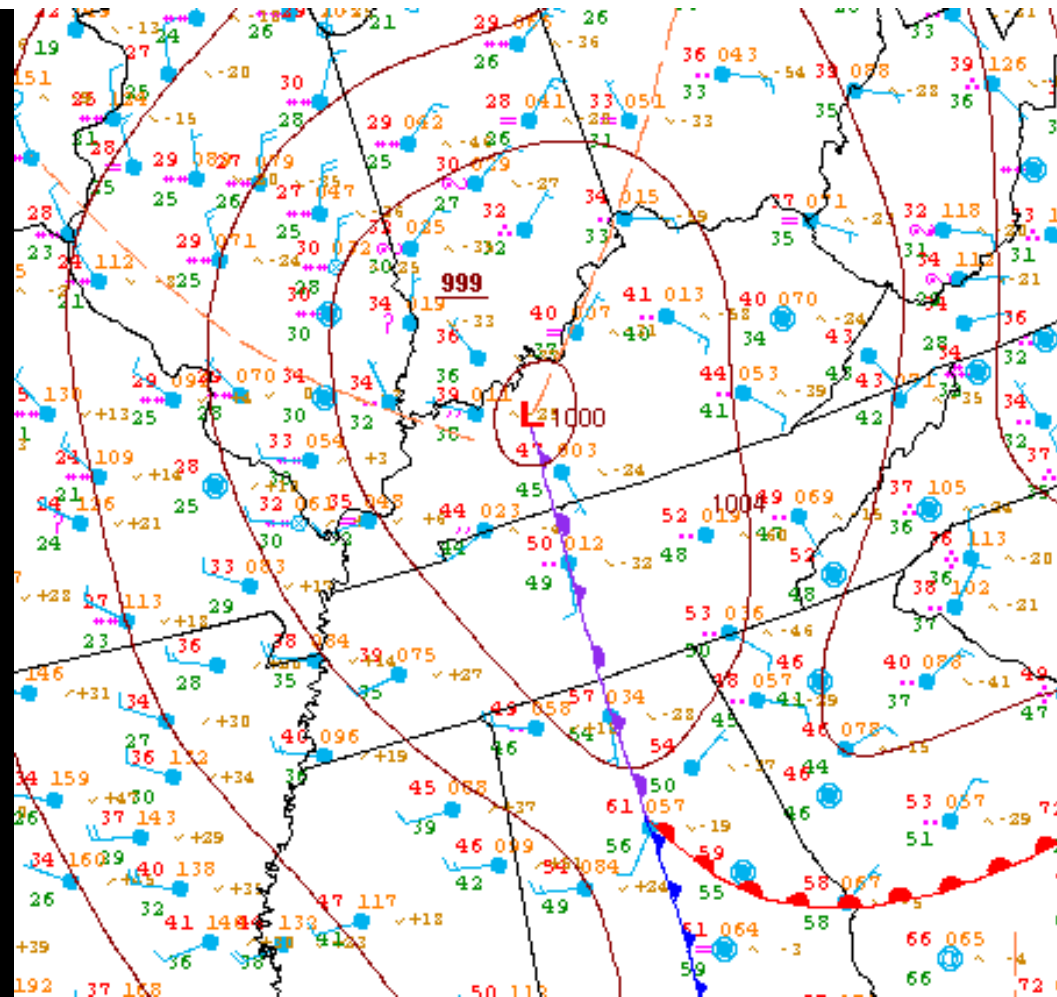
Near the cyclone center, stations are reporting coded SLPs like 023, 013, and 019. Those decode to about 1002 mb. The cyclone central pressure is marked as just under 1000 mb.



Is 1000 mb low? We've been using this nice round number for average sea-level pressure. But, recall the actual value is 1013.25 mb, so 1000 mb is actually low relative to that average.



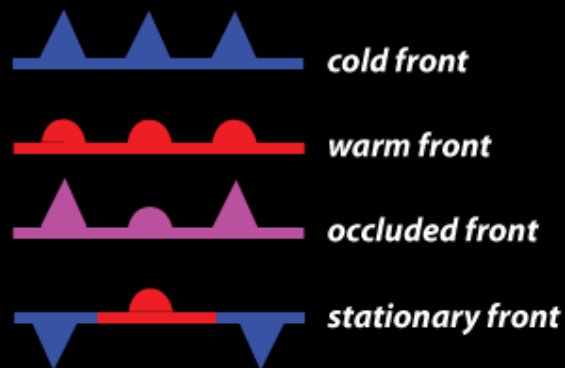
Southwest of the cyclone center, there are no precipitation reports. To the east & SE, I see stations reporting two, three and four dots -- continuous rain of slight, moderate and heavy intensity



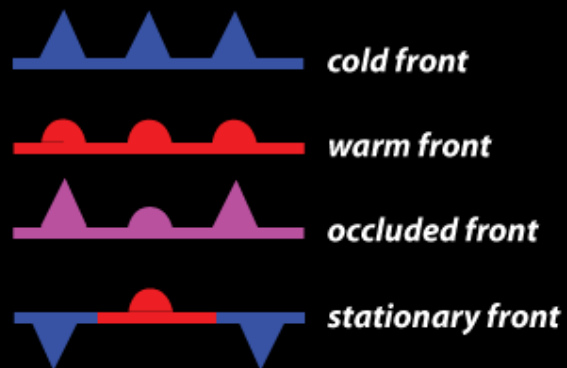
Now let's turn to fronts.

There are 4 basic types. 3 are seen on this figure --
a **cold** front, a **warm** front and an **occluded** front.

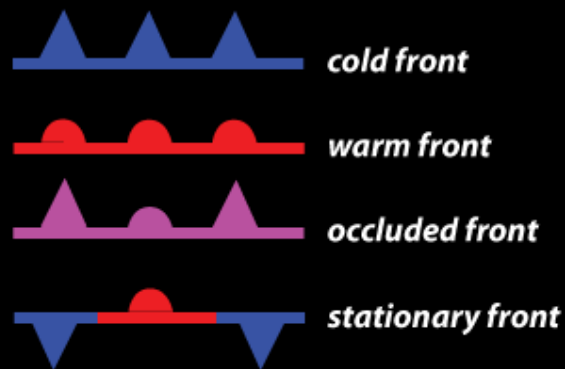
The fourth type of front is the **stationary** front.
Let's look at the symbols we use to mark these fronts.



- Cold fronts are marked by triangular flags, pointing towards the warm, less dense air. Colored blue.
- Warm fronts sport red half-circles, extending towards the colder air

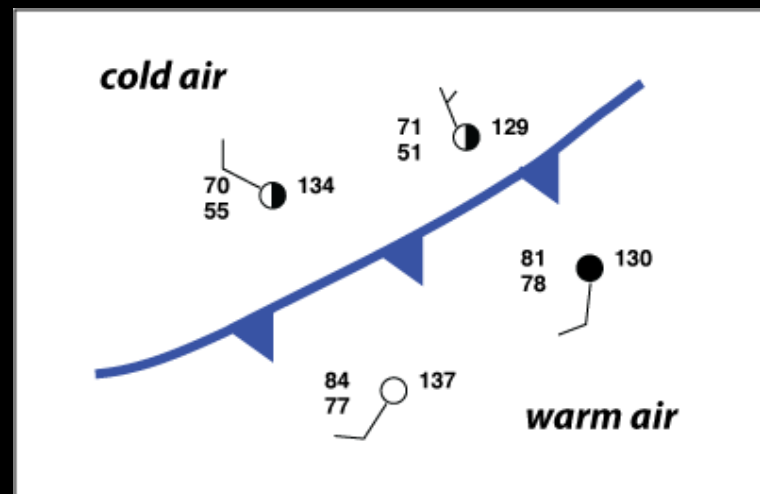


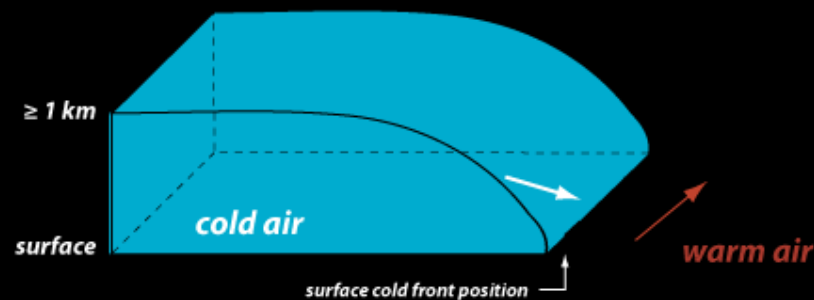
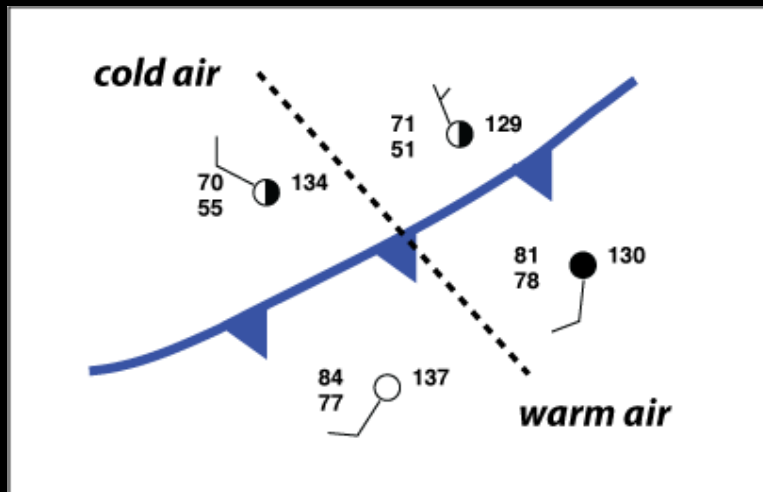
- Occluded fronts share characteristics of cold and warm fronts, and their markings also represent a blend



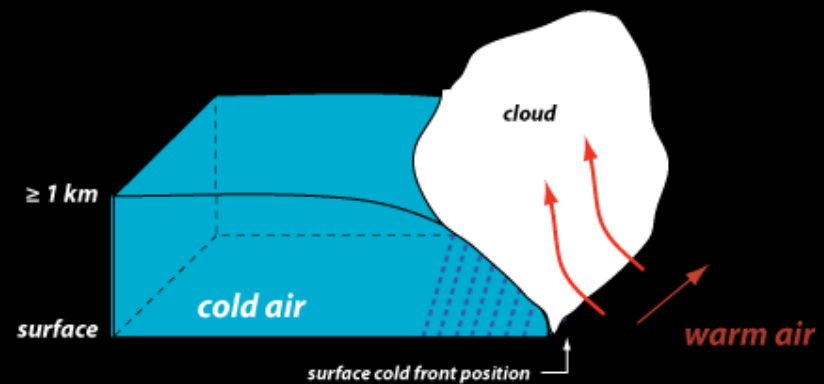
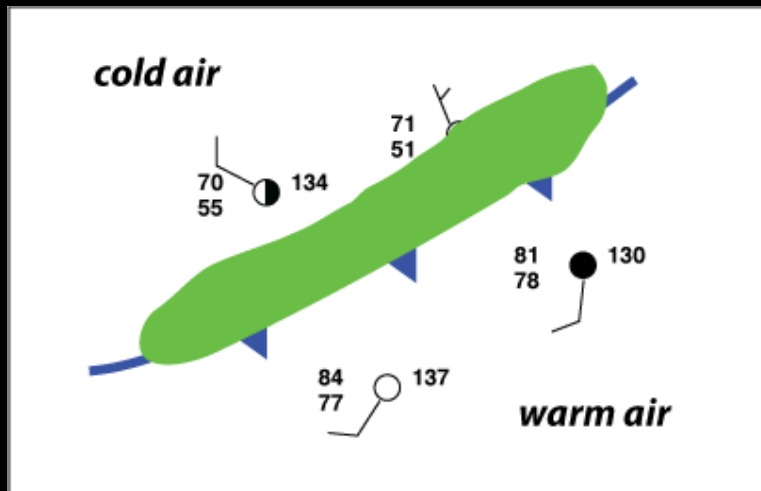
- Usually fronts **MOVE**. When they don't, they're stationary fronts, indicated by alternating flags and half-circles, located on opposite sides of the front

If the cold air is forcing the warm air to retreat,
it's a cold front. If the warm air is pushing
against the cold air, it's a warm front.
This is a cold front.

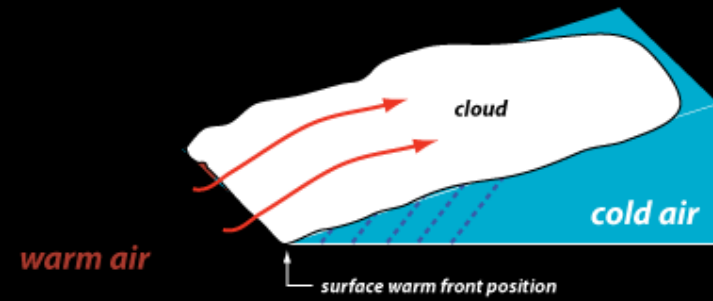
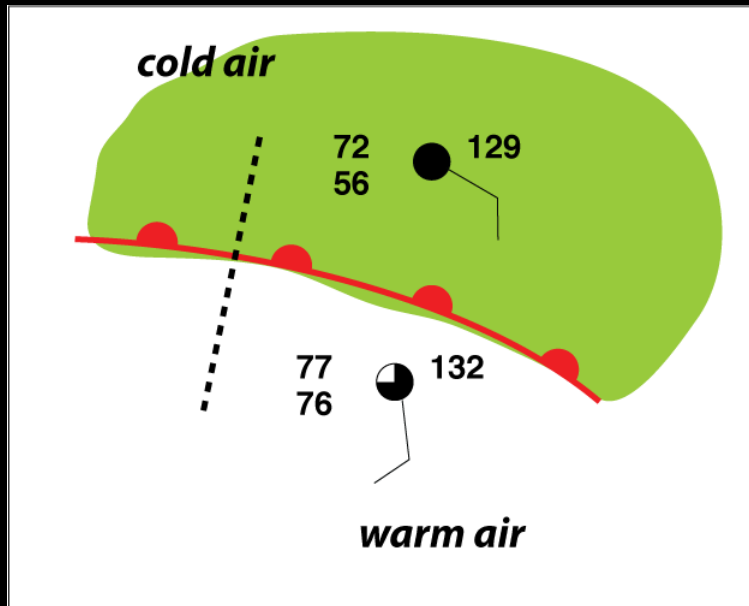




Vertical cross-section across the cold front,
from the cold air to the warmer air



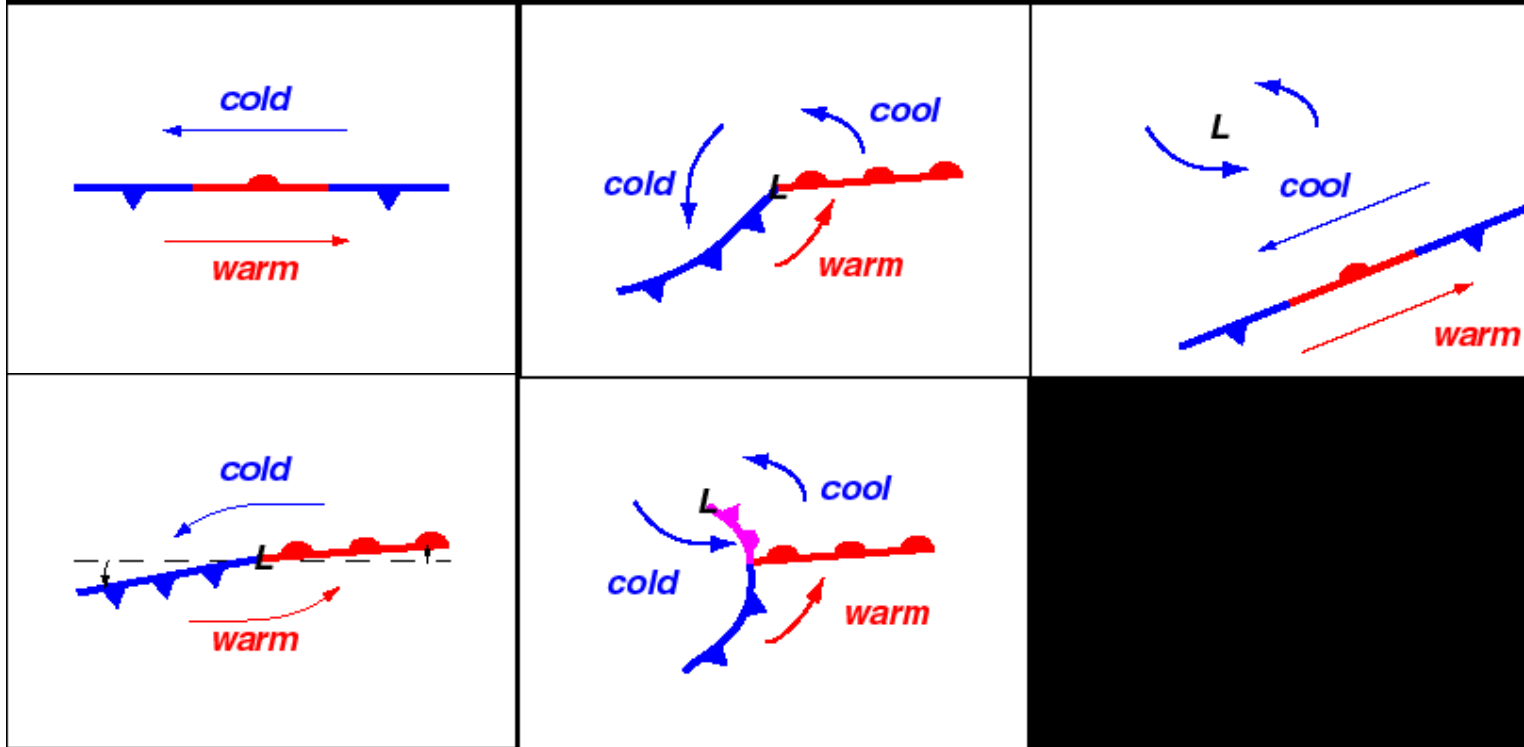
The colder air is underrunning the warmer air, forcing the less dense air to rise, possibly leading to precipitation

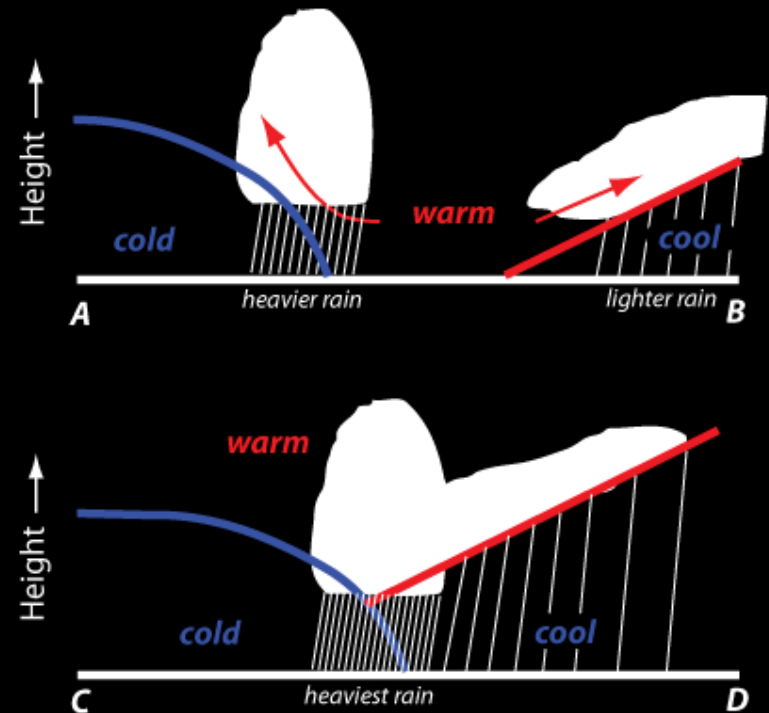
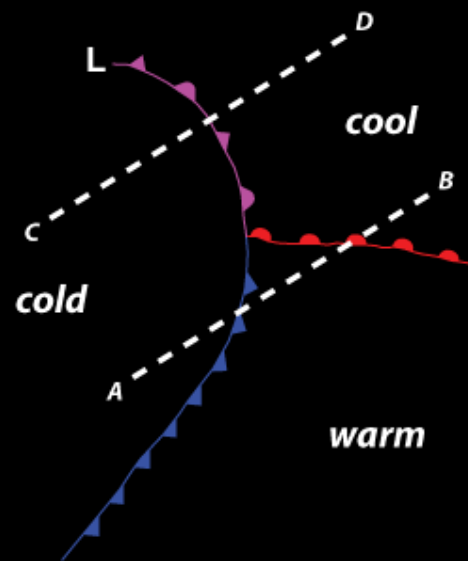


If we had a warm front, we'd have warm air gliding more gently over the cold air, which is far less likely to yield upon being pushed, resulting in lighter and more widespread precipitation.

Classical model of the extratropical cyclone

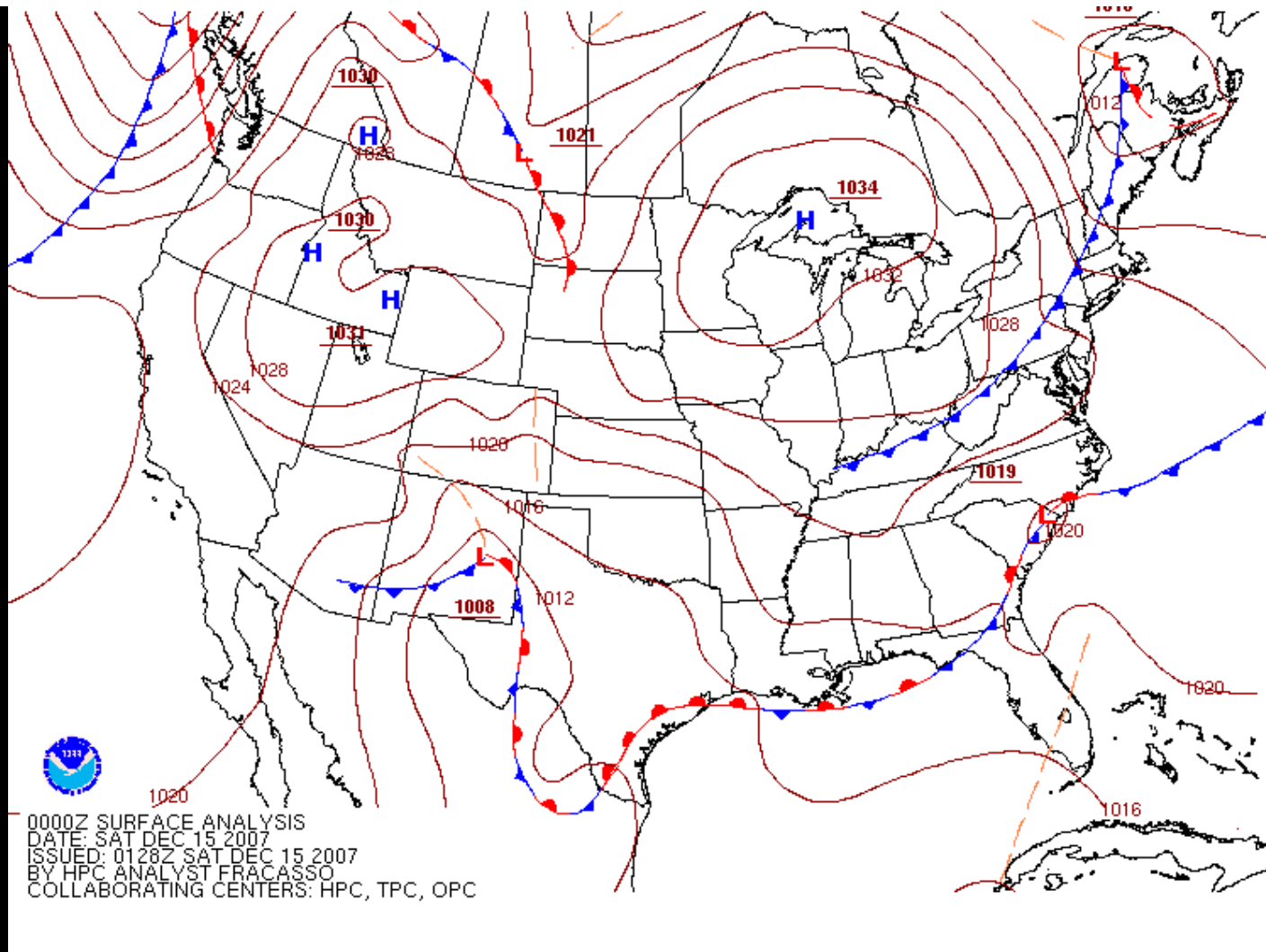
Stages of the cyclone life cycle



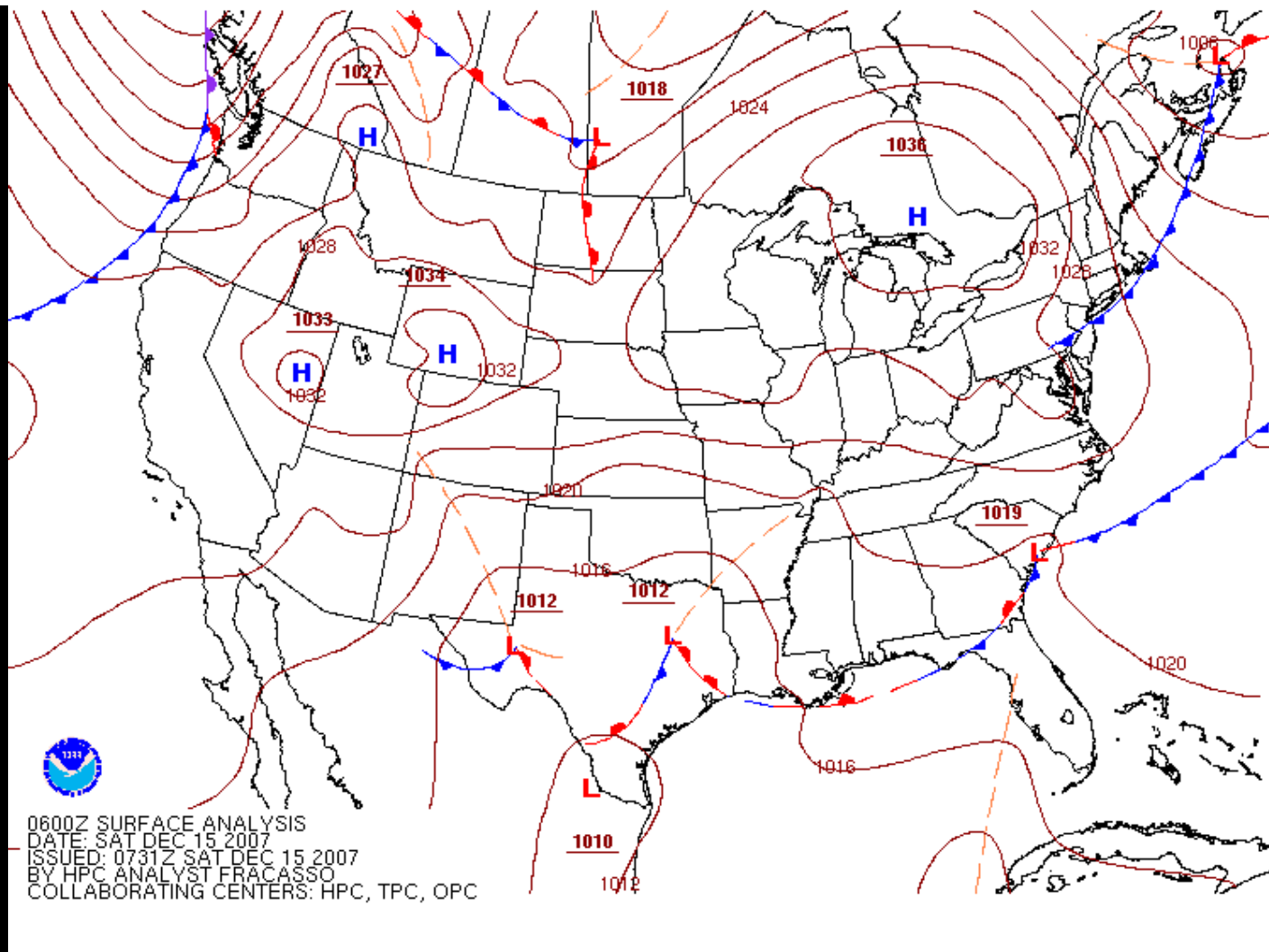


The occluded front forms when the cold and warm fronts meet. What happened to the warm air?
It's been completely lifted above the ground!

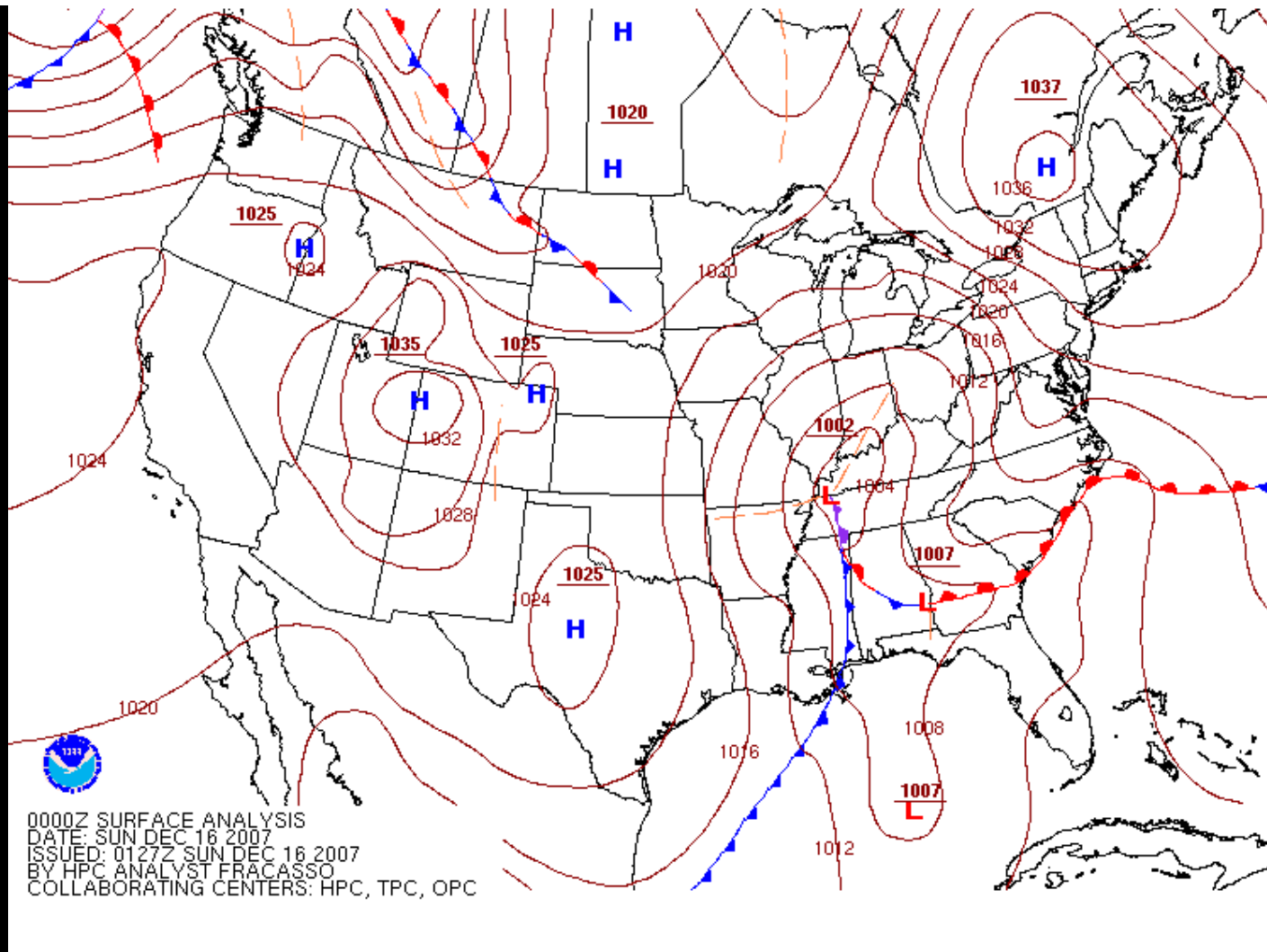
Example of cyclone motion



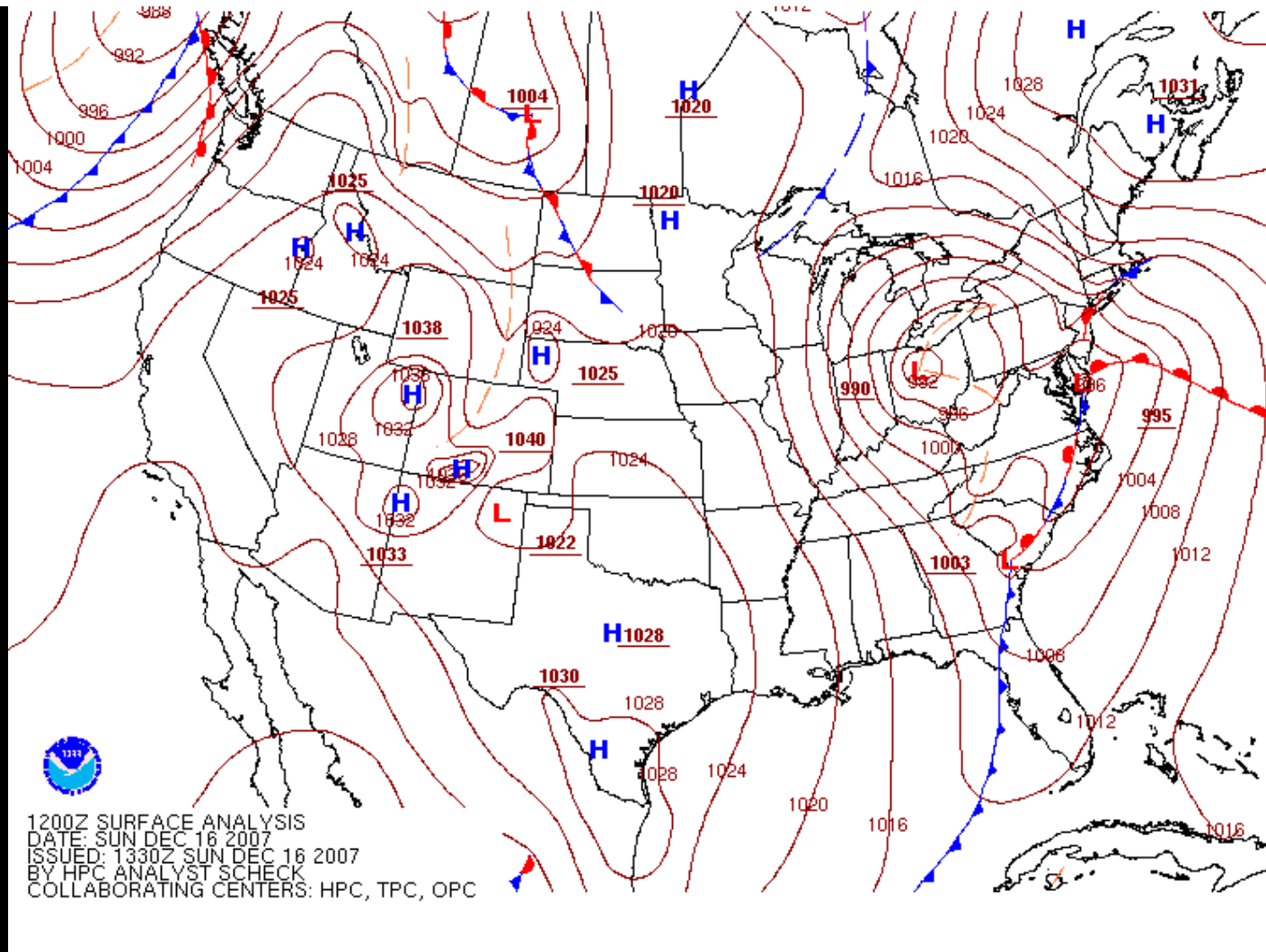
Our cyclone formed along a stationary front which extended along the Gulf Coast, one several in a series that formed along that front and developed into Eastern US snowstorms



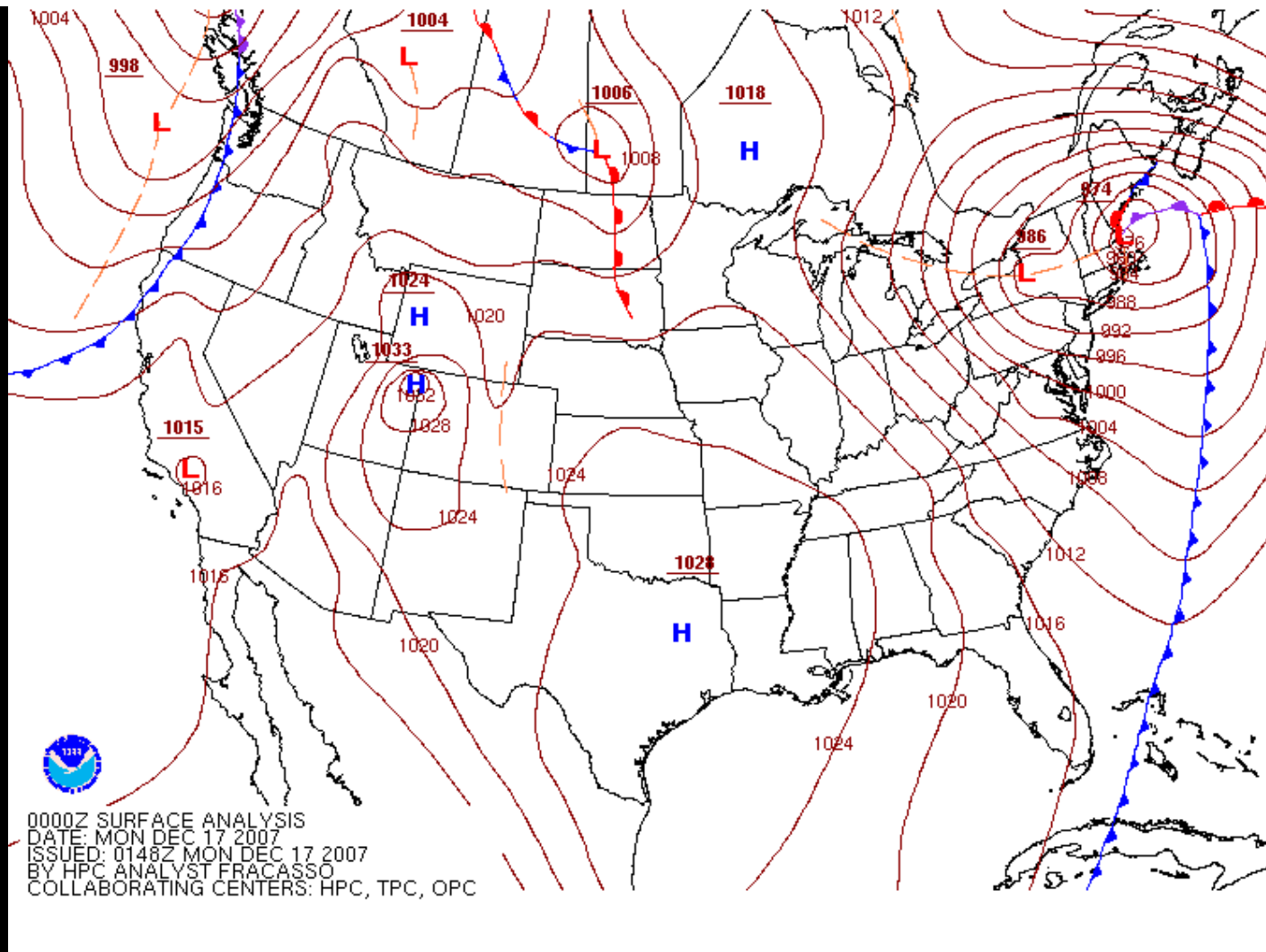
6 hours later
our incipient cyclone has formed in east Texas, its
circulation altering the formerly stationary front
into cold and warm fronts



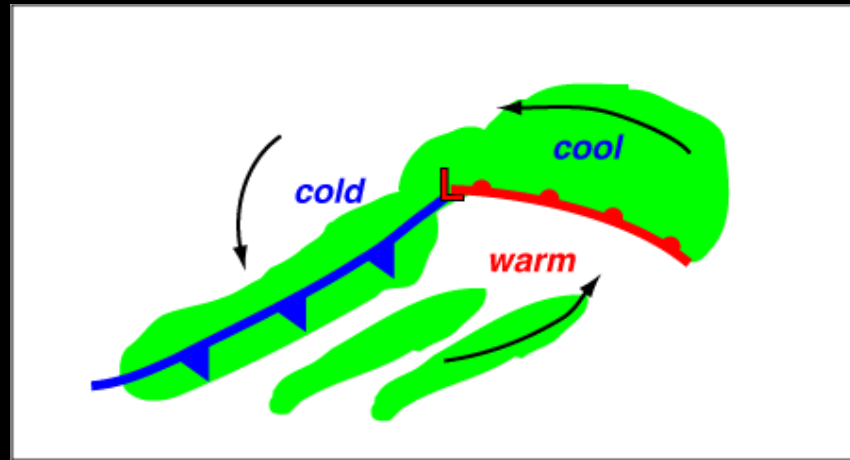
The cyclone is evolving as it moves NE'ward.
This cyclone occluded very quickly.
Other localized areas of low pressure are also
noted along the front.



Our first cyclone is now over Ohio, fully occluded, cut off from the front. Two new cyclones are developing along the front, in SC and Delaware



Of the two new storms, the northeast cyclone survives long enough to occlude. This storm brought substantial snowfalls to eastern Canada

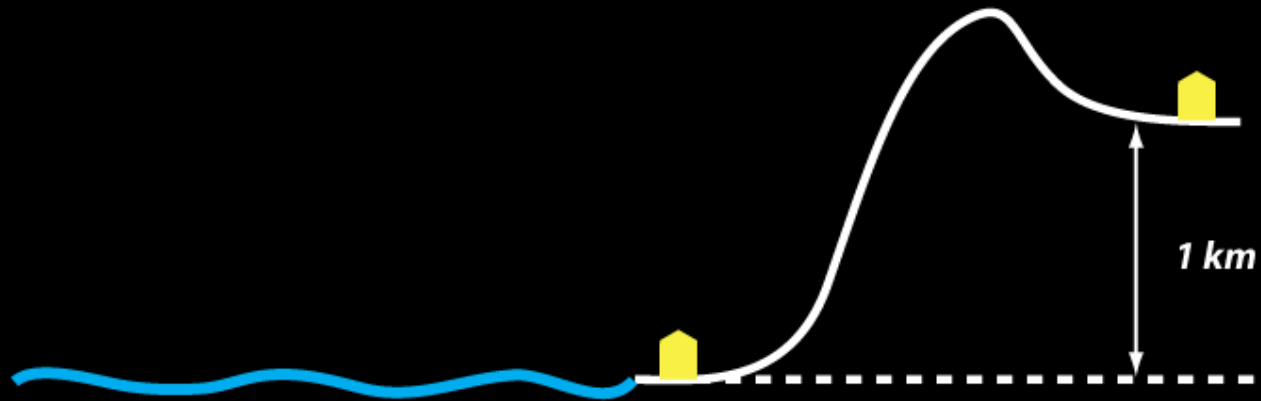


A typical extratropical cyclone in the middle of its life cycle might look like this. On one side, cold air is being pushed against warm air at the cold front. Strong, narrow lifting results in heavy and localized precipitation.

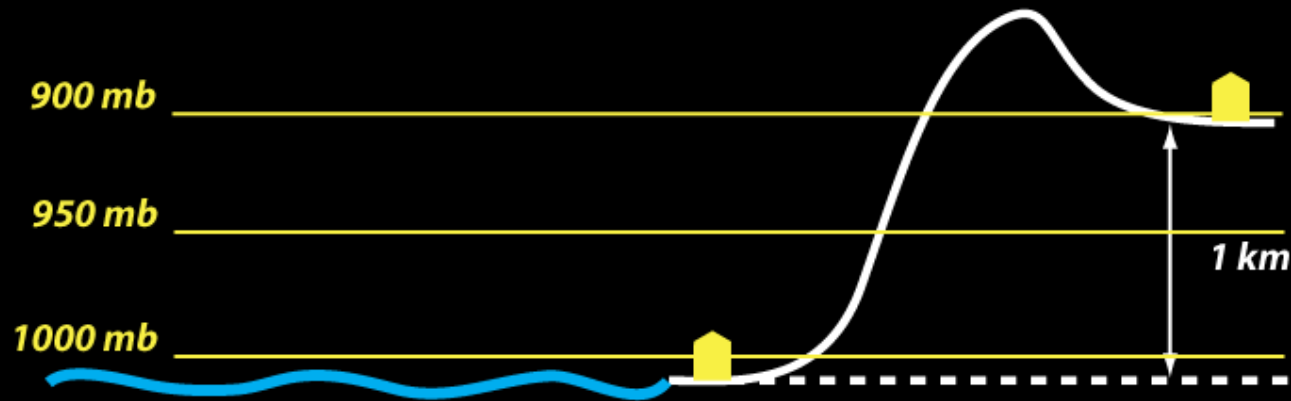
Also shown are bands of precipitation in the warm air ahead of the cold front, in the warm air sector.

These are **prefrontal squall lines**.

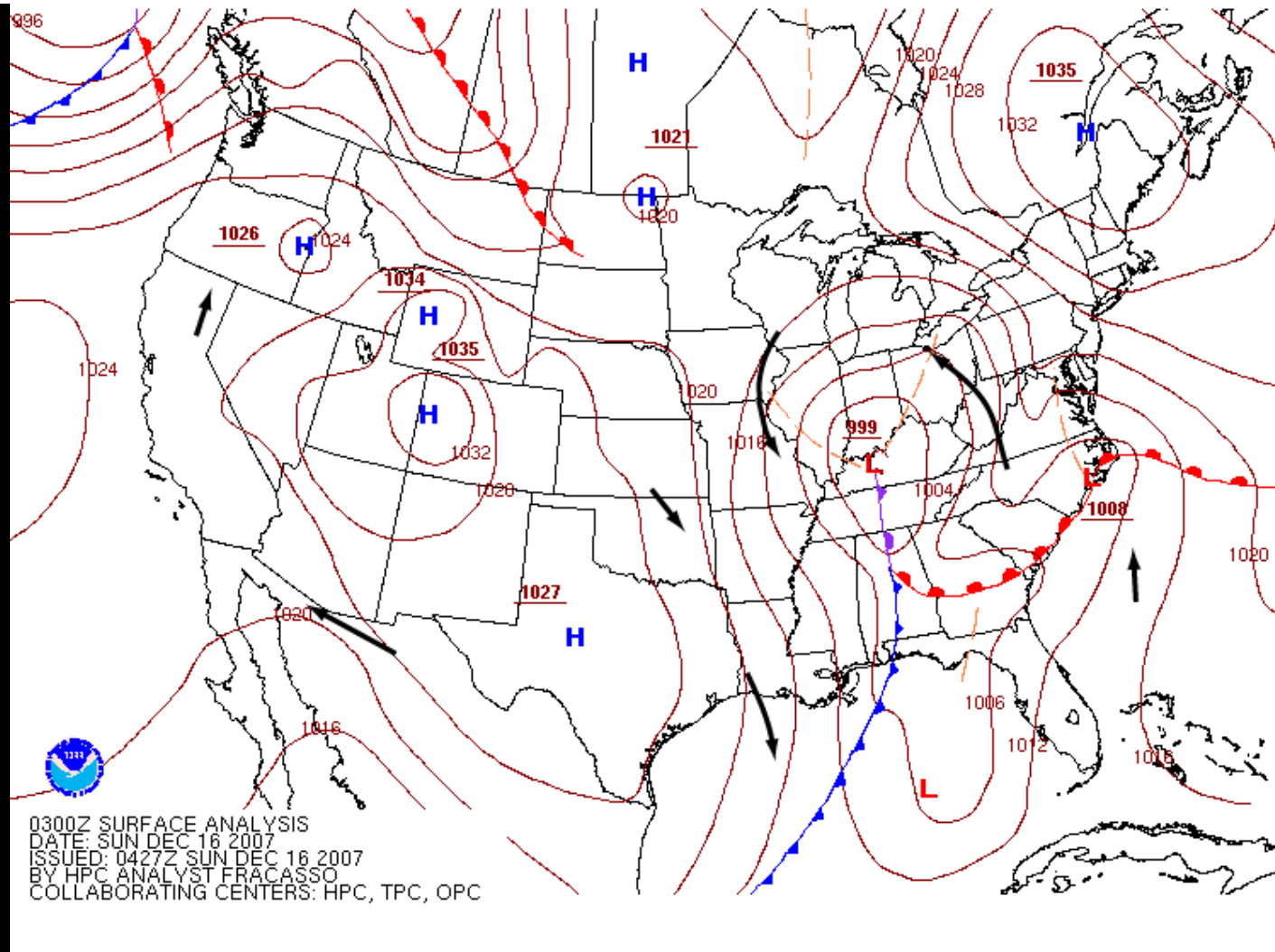
Sea-level pressure



Two stations, one located at sea-level,
and one on an inland plateau 1 km above sea-level
Will the wind be directed offshore or onshore?
We need to know the magnitude and direction of the
pressure difference.



Station pressures at the two locations might be 1000 and 900 mb respectively. But that very largely reflects the 1 km difference in elevation. To determine the sign and magnitude of the PGF between the two stations, we need to **adjust** all surface pressures to a common elevation -- we choose **sea-level**.



Consider the high SLP in Colorado and the L in Kentucky. The station pressure is much lower in Colorado owing to its considerably higher elevation. After adjustment we see the SLP is higher there, so the winds across Kansas are from the north instead of from the south. Big difference!

[end]