Two Mesoscale Features affecting winter weather:

Lake Effect

And

Cold Air Damming

Meteorology 417 – Iowa State University – Week 2

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Lake Effect Rules

- Lake water temperature must be at least 13 C warmer than 850 mb air temperature
- Minimal shear is best (< 30 degrees in 700mb – sfc layer; 30-60 degrees is marginal)
- 850 mb wind speeds of 15-20 knots ideal
- Sfc, 850 mb wind direction determine where it happens, relative to lake

More rules

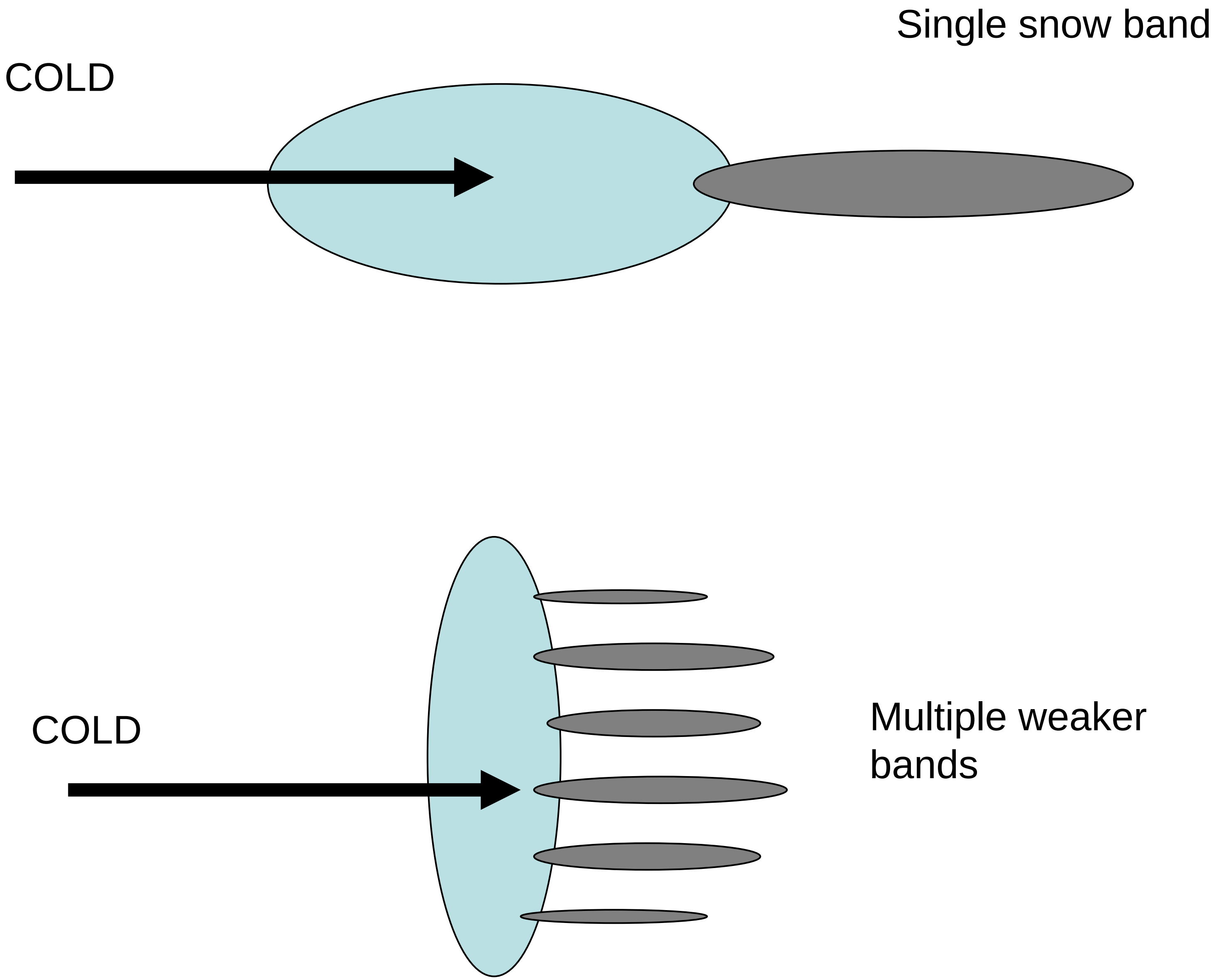
- Ice cover diminishes chances (need at least 50 km of “fetch” of open water for lake effect, with 100 km needed for big snows)
- Height of low-level inversion (1-2 km normal, 3 km or more allows INTENSE snow)
- Surface convergence greatly helps (look for cyclonically-curved isobars) – L.E. may shut down if curvature becomes anticyclonic

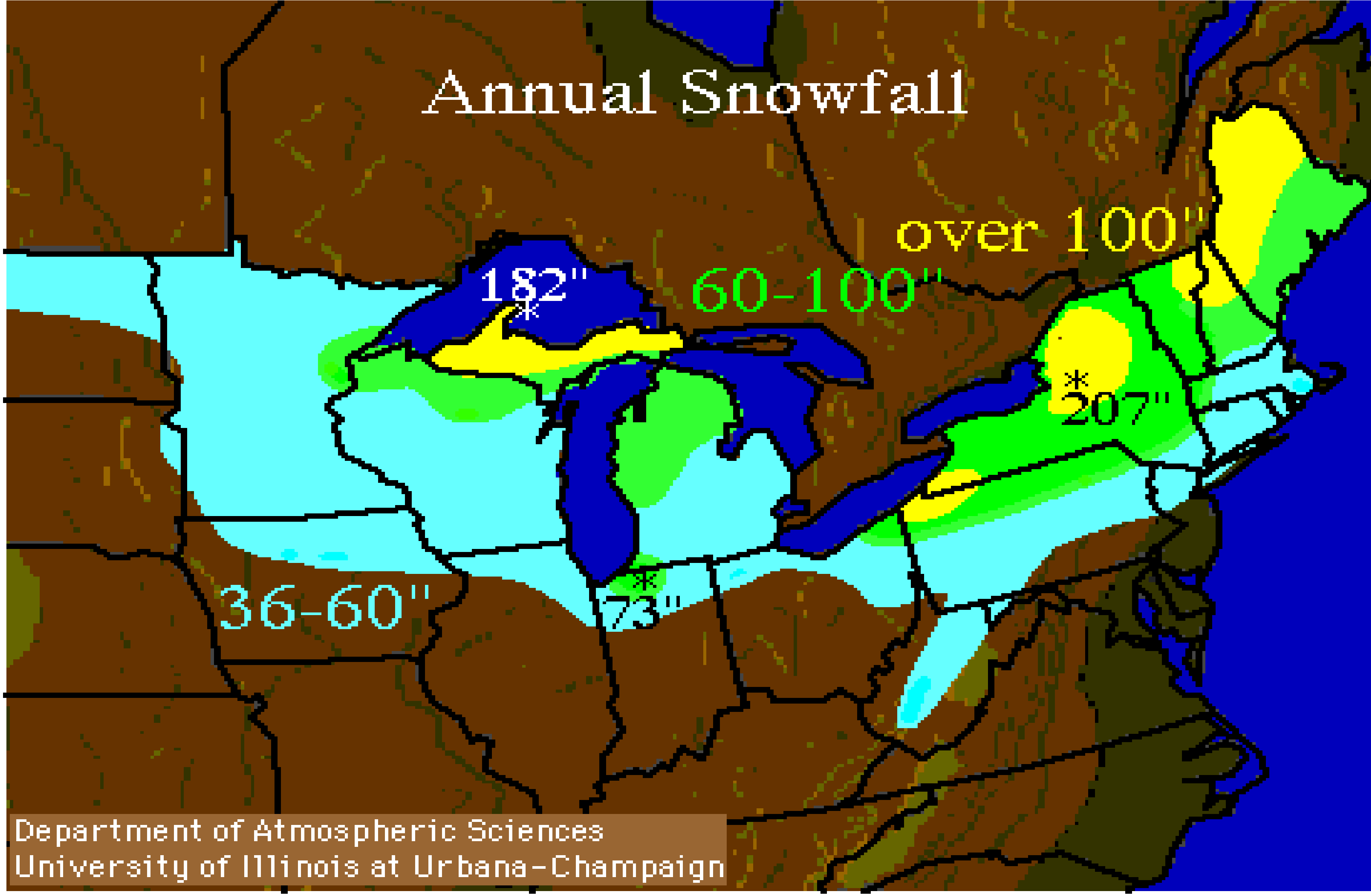
Rules (cont)

- PVA helps by providing general lift
- Moist air in cloud layer is helpful (high RH in sfc-700 mb layer)

Impact of lake geography and winds

- Winds blowing along long-axis of lake lead to INTENSE single-lake bands roughly 20-50 km wide
- Winds blowing along short-axis lead to multiple bands 10-20 km apart and < 20 km wide
- Topography helps lift the air and leads to more extreme snowfall rates (e.g. Tug Hill Plateau in New York)

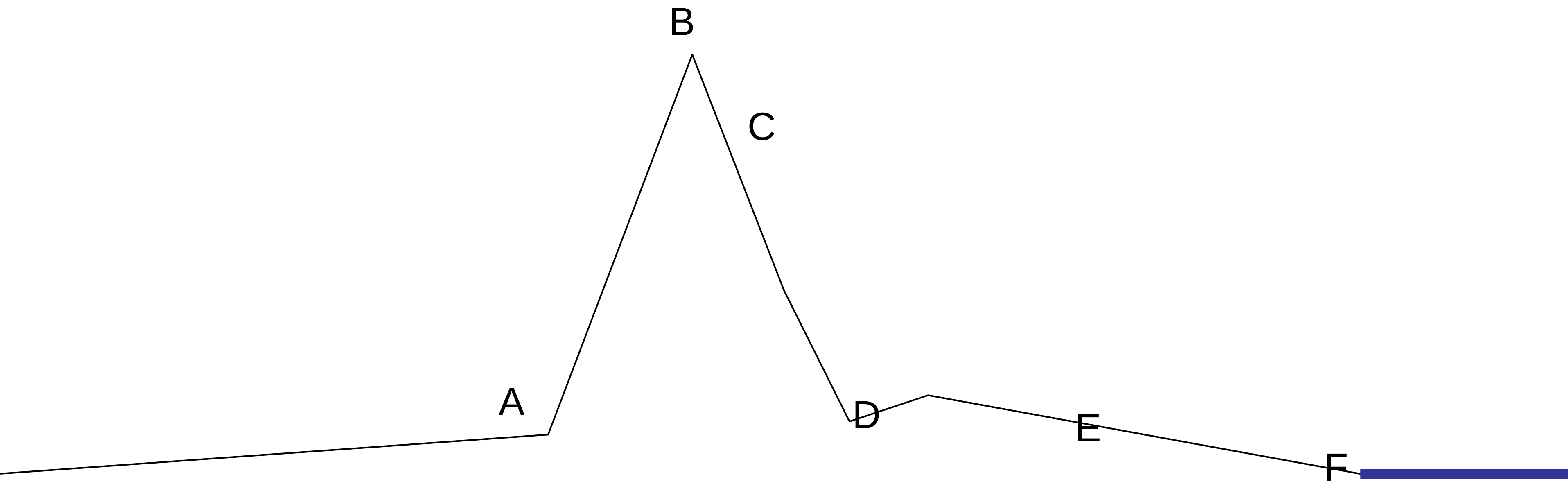

Single snow band
COLD
COLD
Multiple weaker
bands



Note heaviest annual snows east of Lake Ontario – terrain plus depth of Lake Ontario allowing it to never freeze results in these high totals.

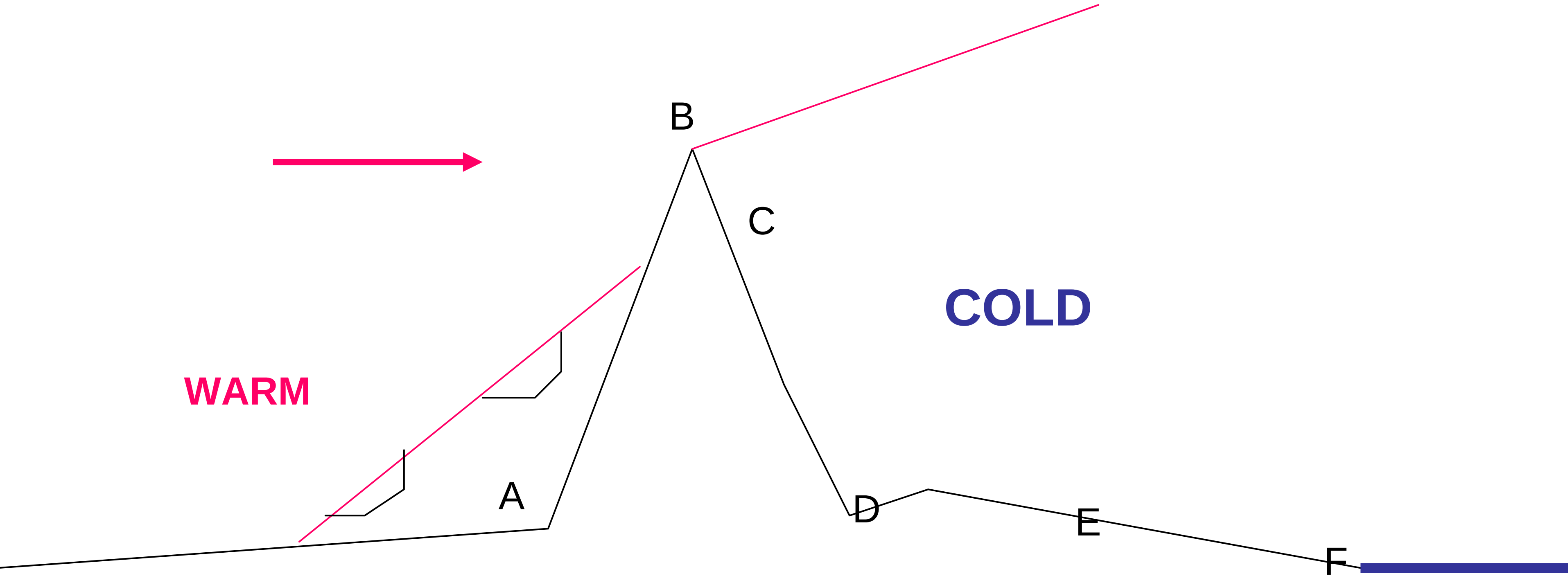
Cold Air Damming

- In which order will the cities below feel warm air moving in?



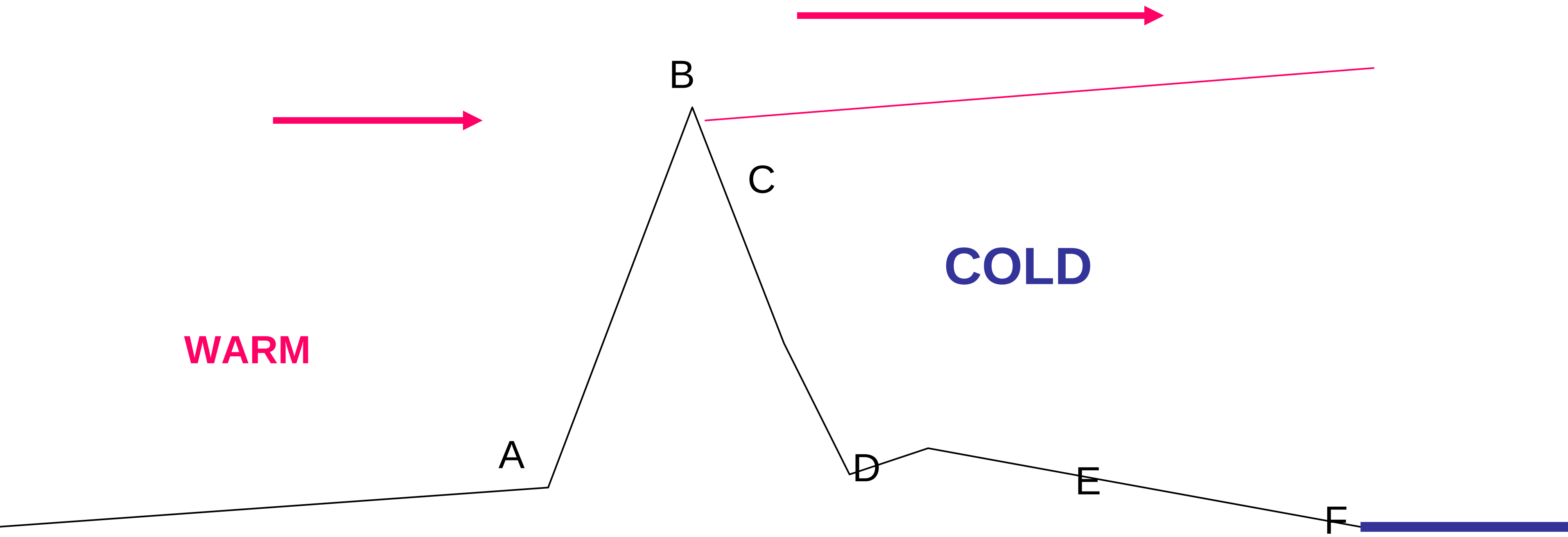
Cold Air Damming

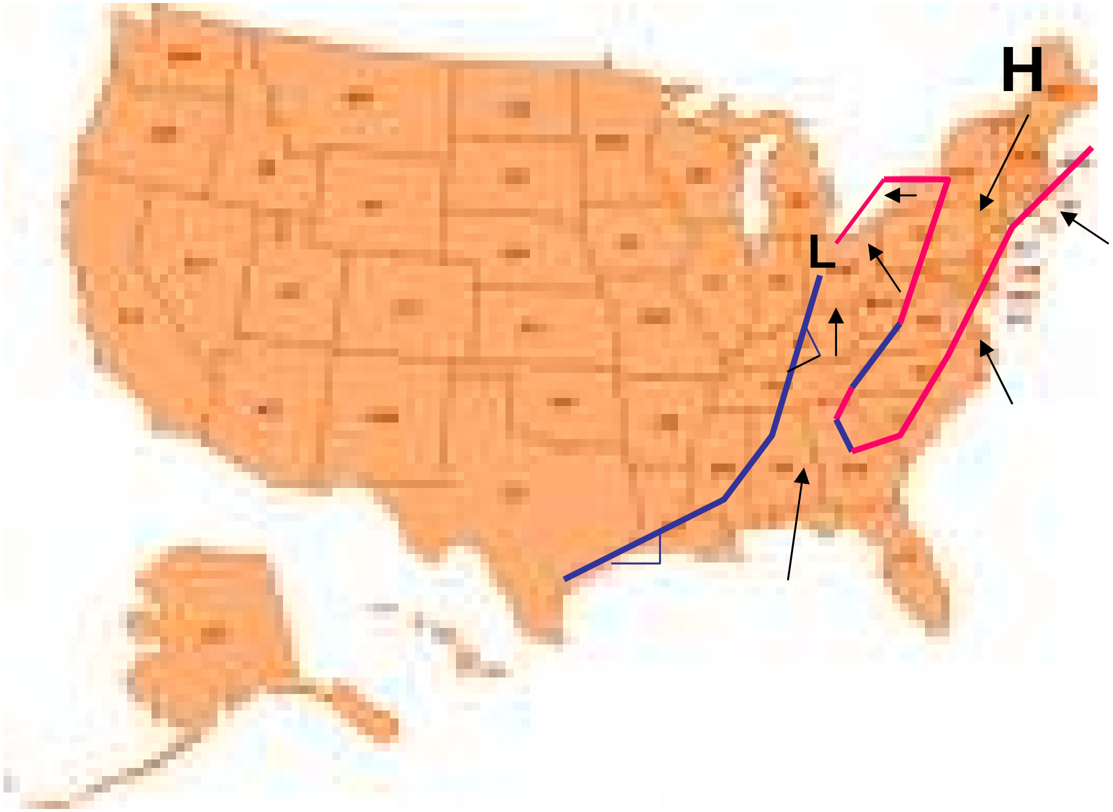
- Remember that warm air "overruns" cold air since it is lighter – B may feel it first, but A and B definitely will get into the warm air



Cold Air Damming

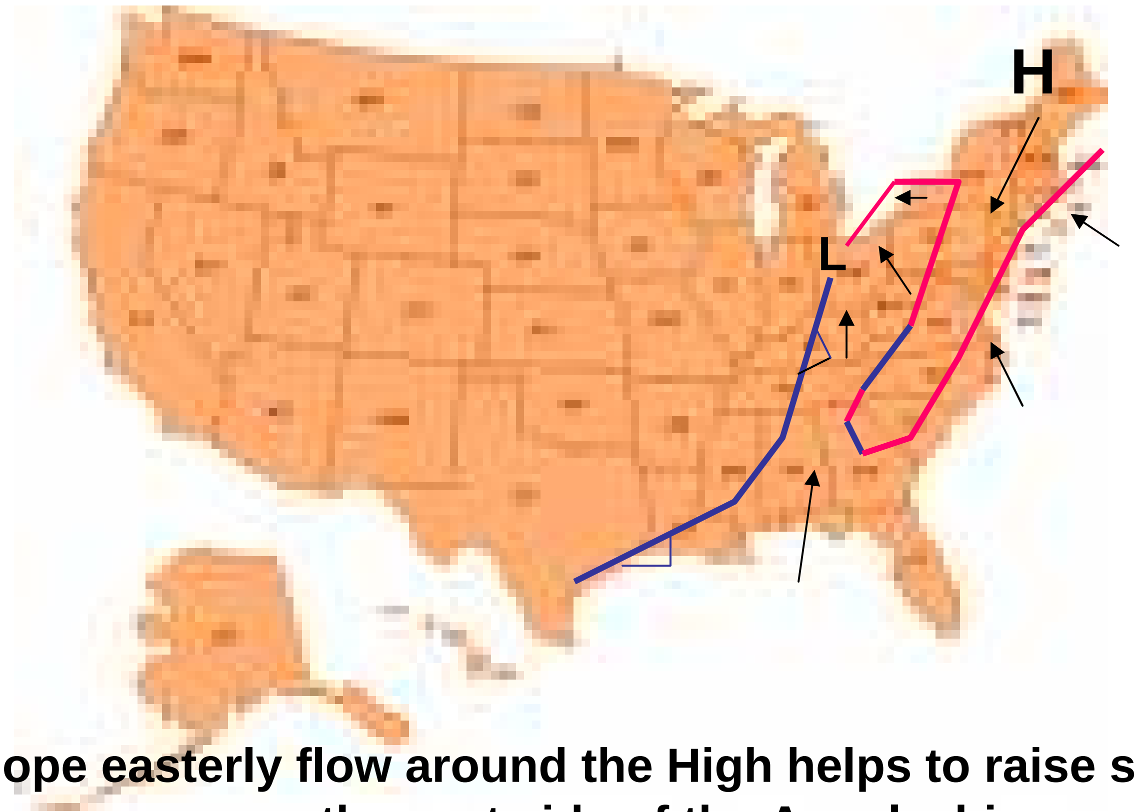
- How can the warm air go down into the very stable cold air?





Eventually the warm air may begin coming in off the ocean due to the low pressure to the west, and a very convoluted surface map results….

Original Warm front is "stuck" at crest of mountains, it accelerates north on west side of mountains due to downslope, and a Coastal Front advances west from the Atlantic



The upslope easterly flow around the High helps to raise surface pressures on the east side of the Appalachians

The stable (heavy) air does not want to blow up the mountains, and the effect is like increasing friction. Wind speeds slow down, so the Coriolis force is weaker and not balancing the Pressure Gradient Force, and thus a very ageostrophic flow develops, with the winds almost matching the PGF – out of the NE (instead of the geostrophic SE or E direction)

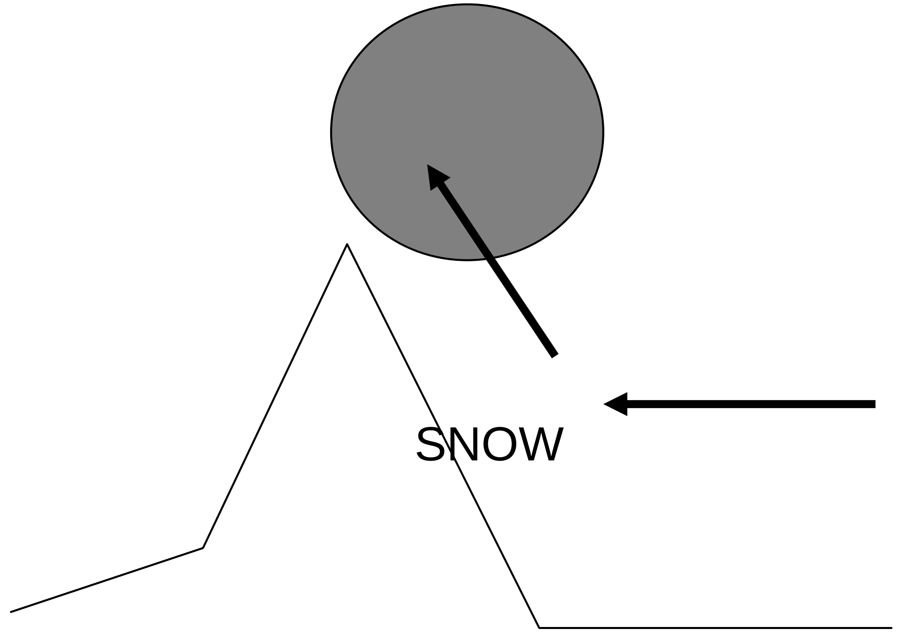
The resulting area of high pressure is called a Baker Ridge on the E side of the mountains

Factors favoring cold air damming

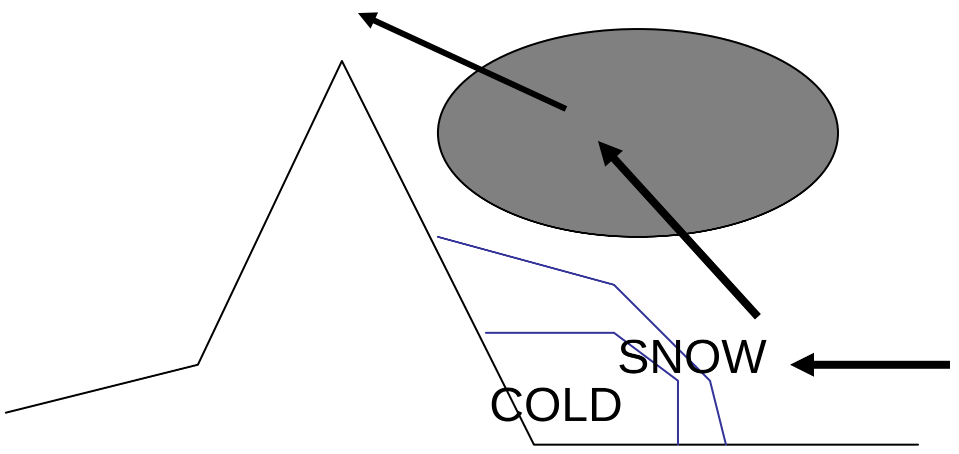
- Upper level convergence (confluence) over/near northern New England – which helps keep Arctic high pressure in place there
- Cold air to begin with
- Microphysical cooling (evaporation)
- Strong inversion, cloudcover to limit surface heating – maintain stability

Not just an E. Coast thing…

- Cold air damming in the East USA often causes ice storms
- Cold air damming also happens east of the Rockies – but there, it usually results in a shift of the heaviest snow band from the foothills to the more populated areas just east on the Plains



Without cold air damming, greatest lift will be over relatively empty foothills



With cold air damming, the cold air piles up at base of mountain (shown with isentropes) and thus the lift happens over the cold air dome and not over the foothills. Heavy snow now affects big population centers