

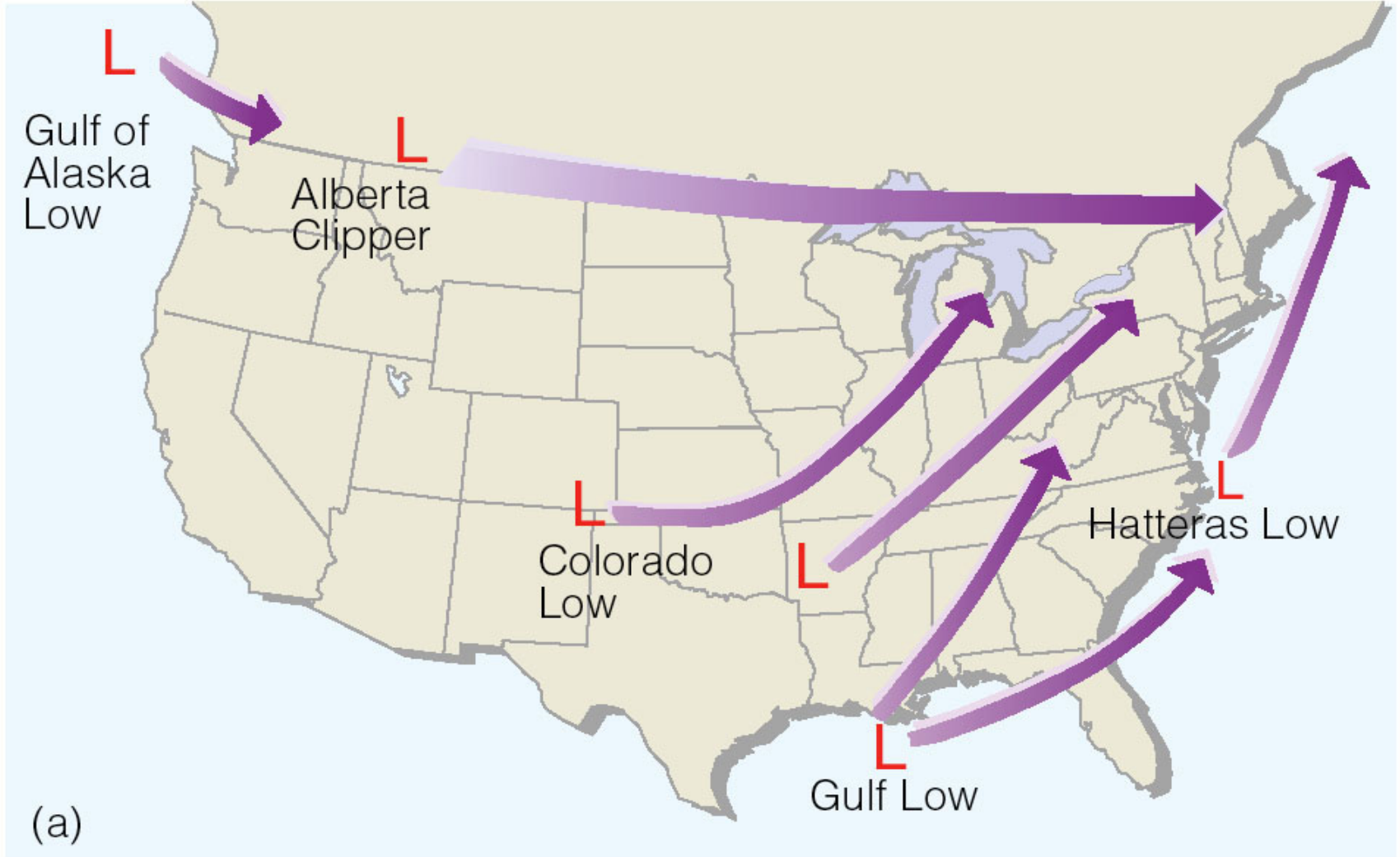
MET 4300/5355

Lecture 11
East Coast Cyclones
& Gulf Coast Cyclones
(Coastal Cyclones CH11)

Extratropical Cyclones in **US** and North America in Winter

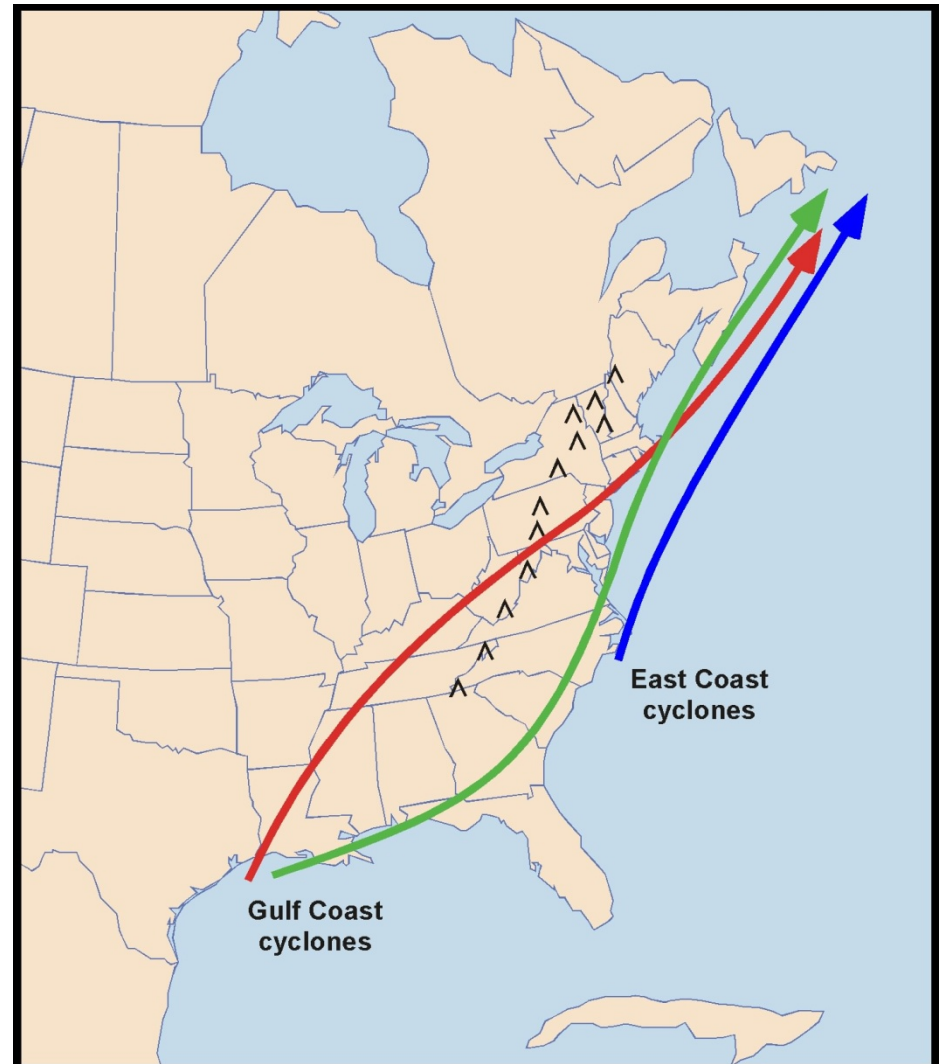
- **Lee Cyclones (Lee side of the Rockies, see Lecture 12/CH10)**
 - **Alberta Clippers:** FAST MOVING and usually don't have too much precip associated with them because they are far from a moisture source
 - **Colorado Low:** Intense Low, with strong warm air advection in the warm sector, very cold temps in the cold sector. If there is a lot of Gulf moisture to work with, there is usually sleet, freezing rain and rain associated with the warm front, strong thunderstorms along the southern edge of the cold front and snow along the backside and to the NW of the Low (even BLIZZARDS)
- **Coastal Cyclones (East and Gulf Coast Cyclones, Lec13/CH11)**
 - **Gulf Low/Gulf cost cyclones (Two tracks):** Form along the southern coast where there is a thermal boundary between the warm ocean and cool land. Usually have a lot of precip associated with them because they are so close to the ocean
 - **Northeasters/ Hatteras Low / East cost cyclones:** These are the MOST INTENSE systems, forming along the thermal boundary between the warm Gulf Stream and the cold Atlantic coast. Can bring flooding rains along the coast and several feet of snow further inland (a lot of moisture from the ocean). They can also develop very quickly and sometimes have pressure drops of 24mb in a single day (**Bomb cyclone!**).
- *Alaska Low*

What are their typical tracks?

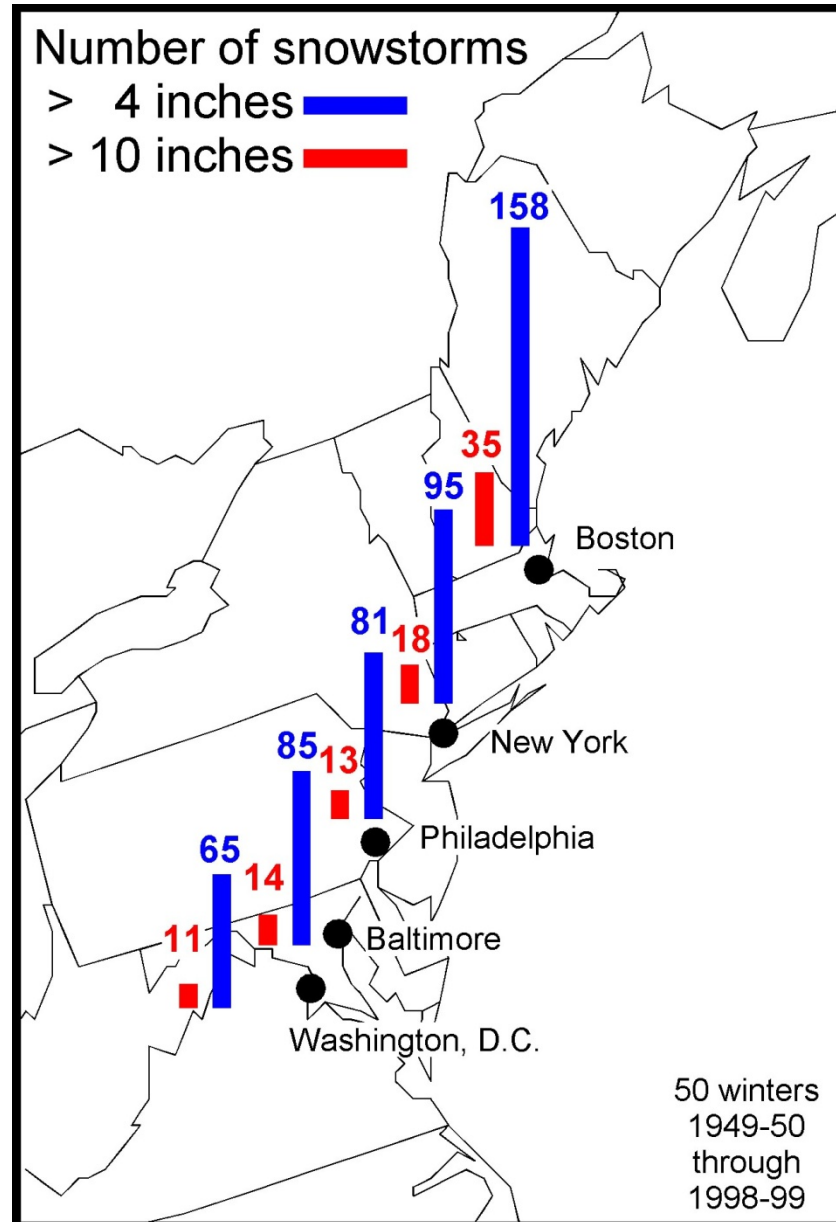


Tracks of Coastal Cyclones: East Coast and Gulf Coast Cyclones

- **East coast cyclones (Nor'easters):** track northeast along the coast and out to northeast of Canadian's Atlantic provinces.
- **Gulf coast cyclones**
 - East coast storm track
 - Mississippi-Ohio valley storm track



50 Years of Snowstorms in the Northeast

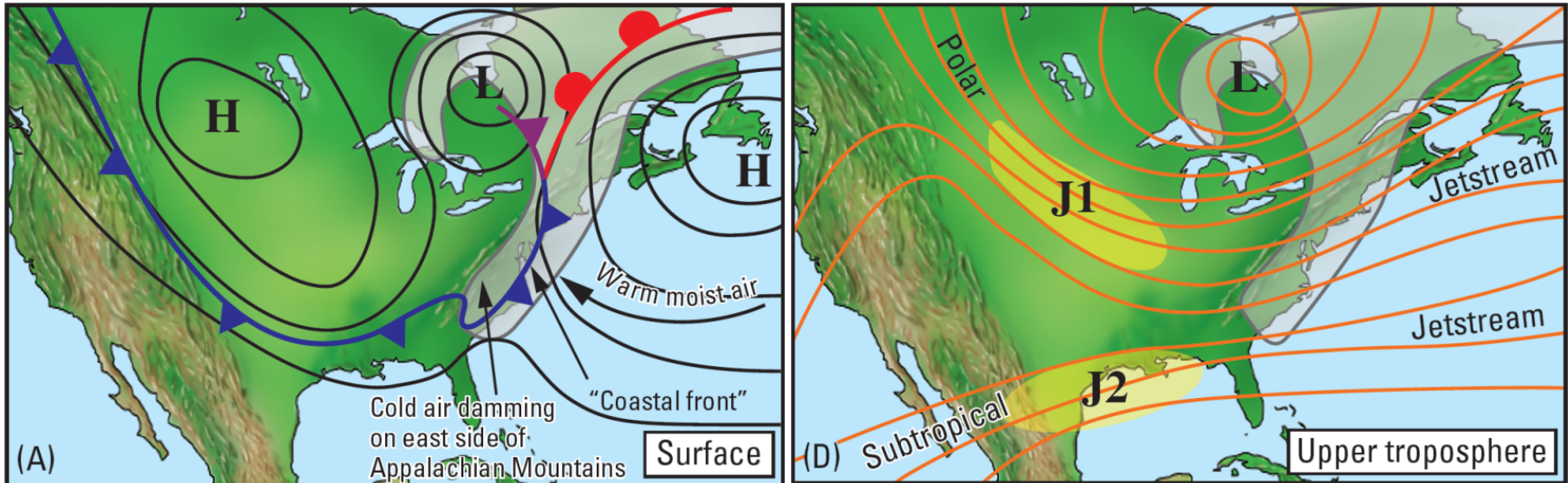


Why are Coastal Cyclones Often More Intense than Lee Cyclones?

1. Latent heat release during condensation in clouds contribute more to storm intensification: heavy precipitation due to warm water over the Gulf & Atlantic Gulf stream
2. Sensible heat from the ocean surface acts to heat the atmosphere, contributing more to storm intensification
3. Strong thermal contrast between ocean & land enhance & maintain a sharp thermal boundary along the coastline
4. Superposition of Jet Streaks from the Polar-Front and Subtropical Jets to create upper-level divergence (More during El Niño years, like 2010)
5. Less friction over water than over land

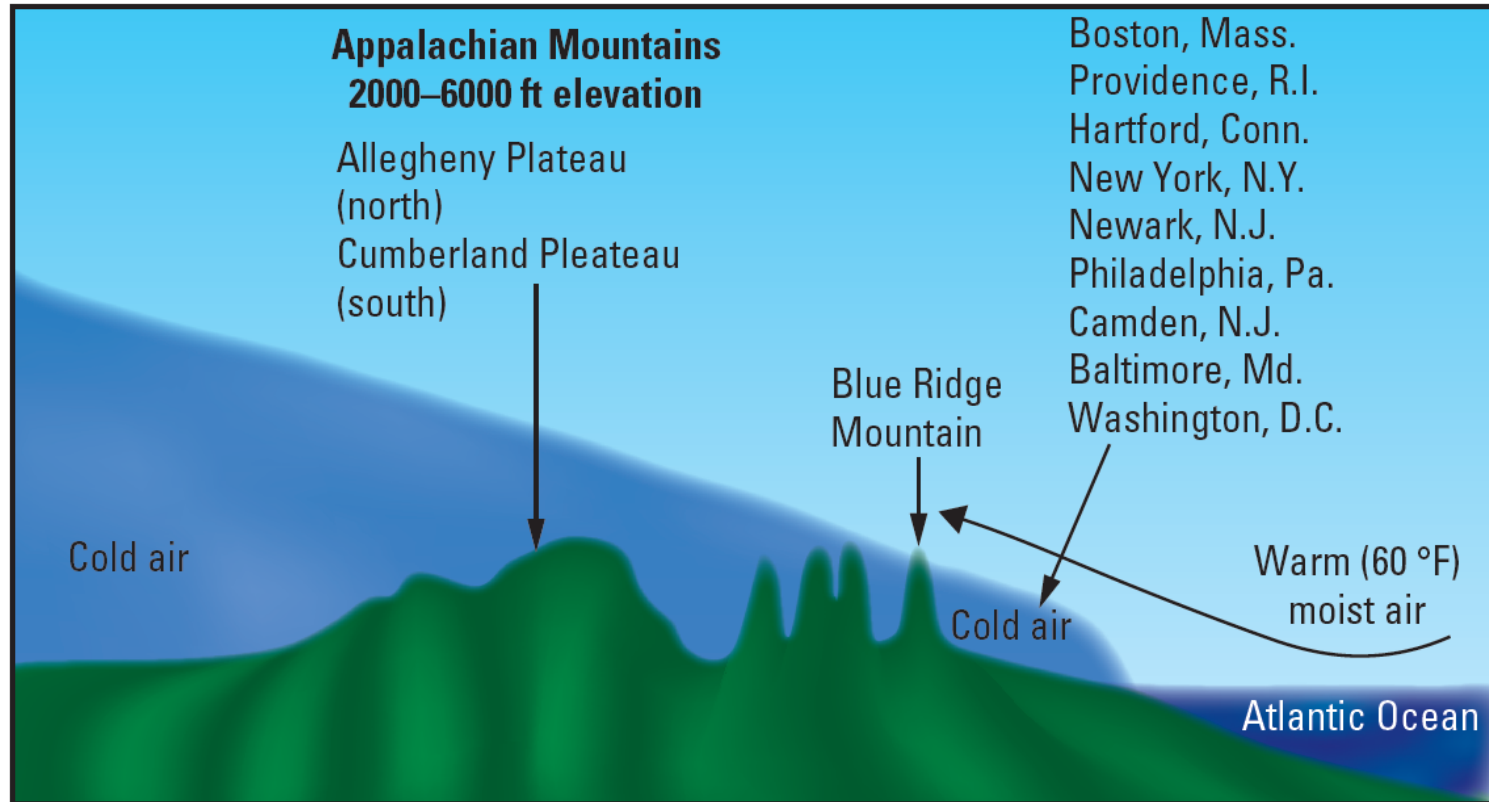
East Coast Cyclones (Nor'easters): typical weather patterns

The environment prior to the development: Precursor Lee Cyclone Sets Up Cold-Air Damming as Jet Streaks Approach



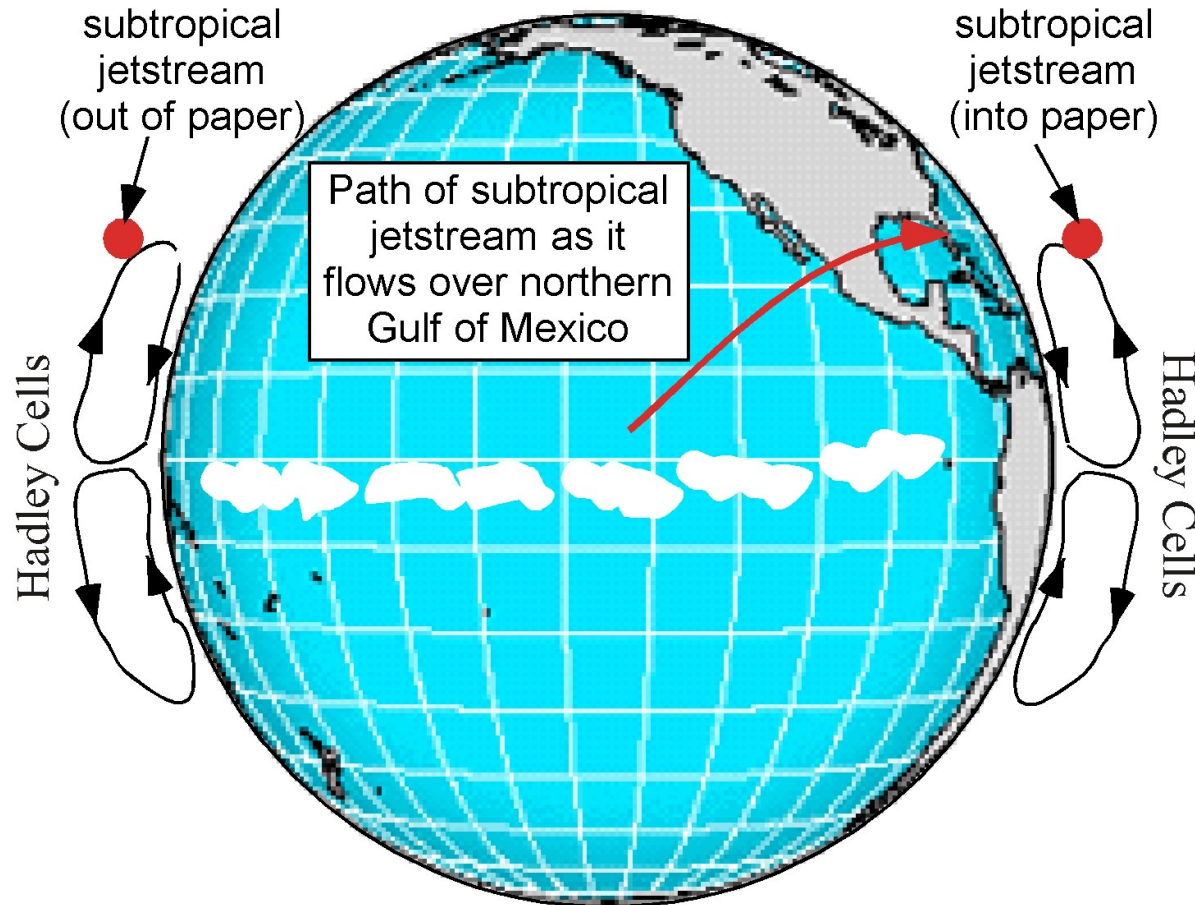
- Typically after an earlier lee cyclone gets to the eastern great lake regions or Canada as shown in this case.
- Cold air from the precursor front sets up cold-air damming
- High pressure from North ATL brings warm moist air from the ocean
- A coastal front forms– the focal point for the cyclone genes
- Upper level two jet streams: a strong jetstreak (polar jet) west of the lee cyclone trough (300mb) & a secondary jetstreak (subtropical jet, 200mb)

Cold Air Damming



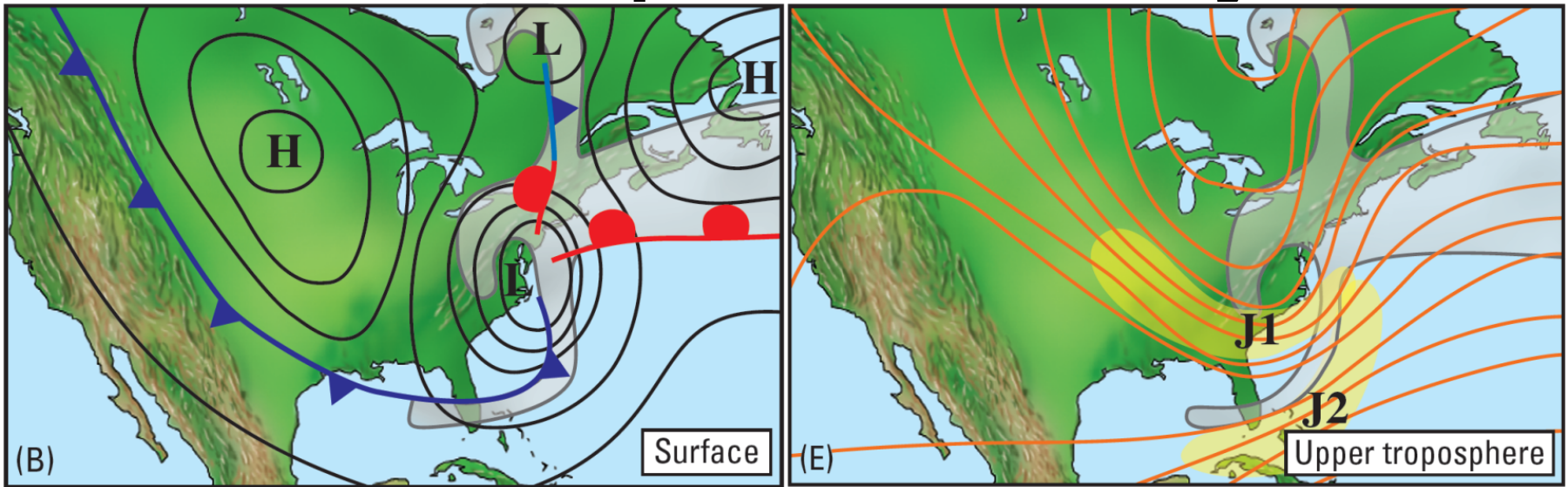
- **Cold Air Damming**: As cold continental air arrives on the east side of the Appalachians, the warm, moist flowing moving westward off the Atlantic forces the cold air into a narrow wedge between the coastline and the mountain chain.
- **A coastal front** forms— a stationary boundary between the dammed cold air and the warm air over the ocean.
- Urban areas along the coast are under the cold air, leading to heavy wet snow, ice pellets, or freezing rain.

Subtropical Jet Stream



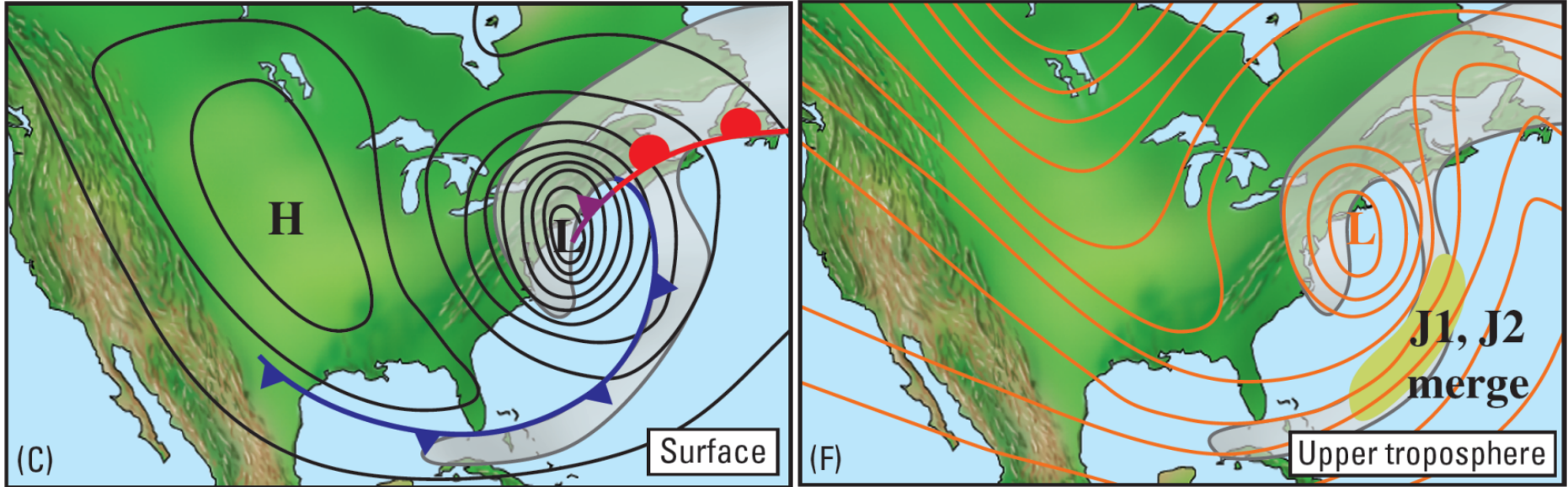
- **Upper-level northward flow turns right (eastward) due to the Coriolis force, creating the subtropical jetstream**

Initial Development of the Cyclone



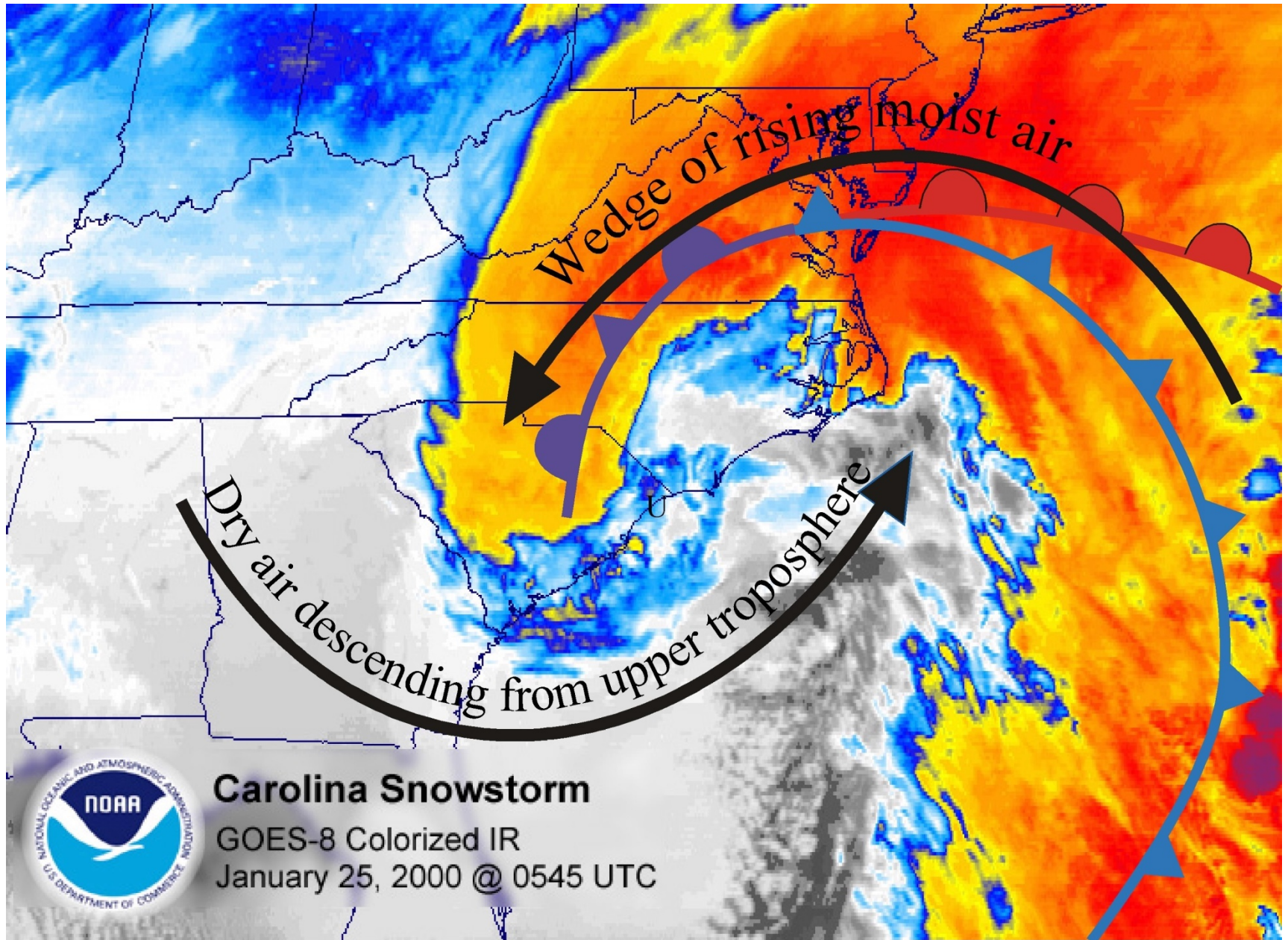
- **Jet streaks in phase** – two left exits+curvature effect -> very strong divergence
- **Divergence is further enhanced** by latent heating release in clouds and sensible heat transported upward from ocean surface by strong winds.
- **A bomb cyclone (surface pressure fall of at least 24 mb per 24 hours)** can form directly underneath the max. upper-level divergence.
- Strongest storms can reach **hurricane intensity (960-970mb, 60-80 kts).**
- The east coast cyclones are called **Nor'easters** by mariners in New England because the winds blow from northeast over New England.
- **Weather** associated with the warm front: heavy snow, even T-storms; Cold front associated with the older cyclone can enhance total snowfall

Occluded Stage: most intense



- **Dry slot**: due to upper level convergence therefore descending
- **Trowal (wrap-around band)**: warm moist air trapped between the advancing dry air and the cold air to the north & west
- **Two jetstreams merge**, move to into the ridge, and weaken
- **Cut-off low** above the surface low (form a deep vortex): no curvature effect
- **Low center begins to fill** slowly due to less friction over water: storm can remain very strong for several days

New Years Blizzard of 2000 (Enhanced IR image)

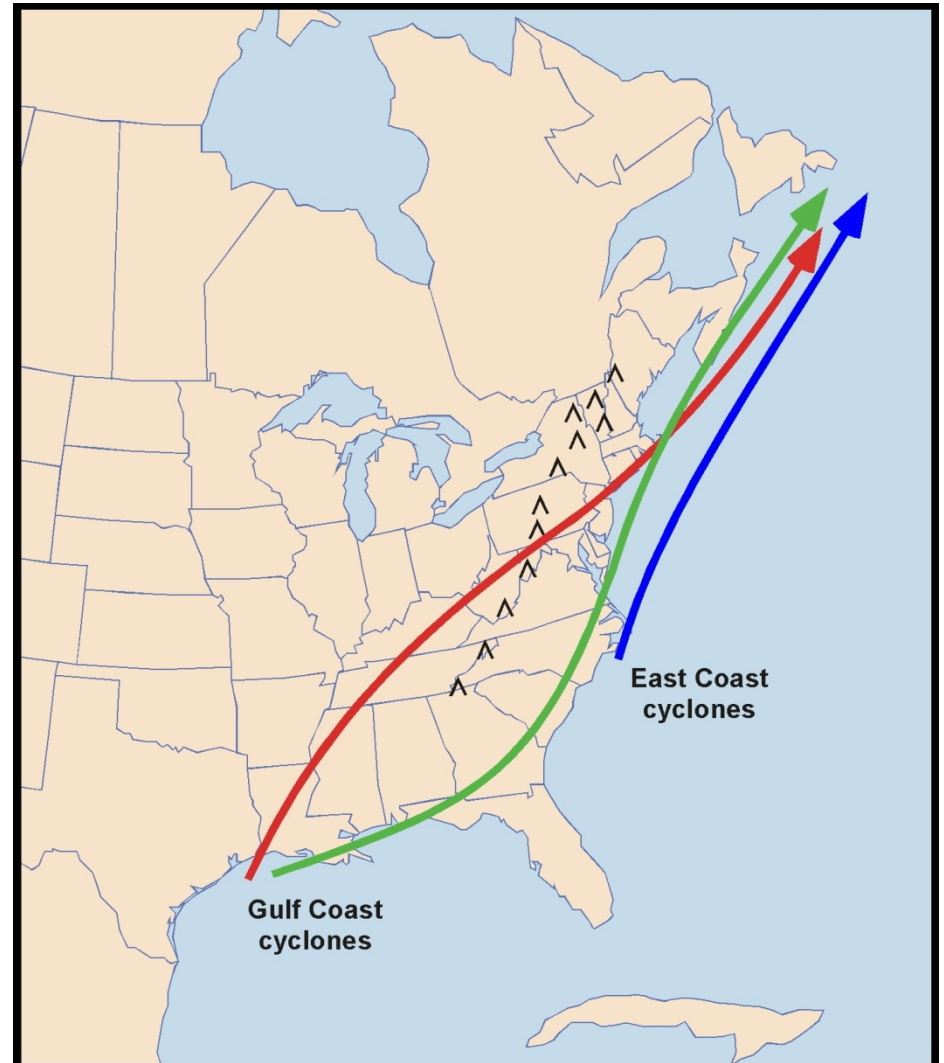


Example: The Blizzard of 1888. Stalled for Two Days off Long Island. Shut the City Down. Led to underground utilities in New York & Boston



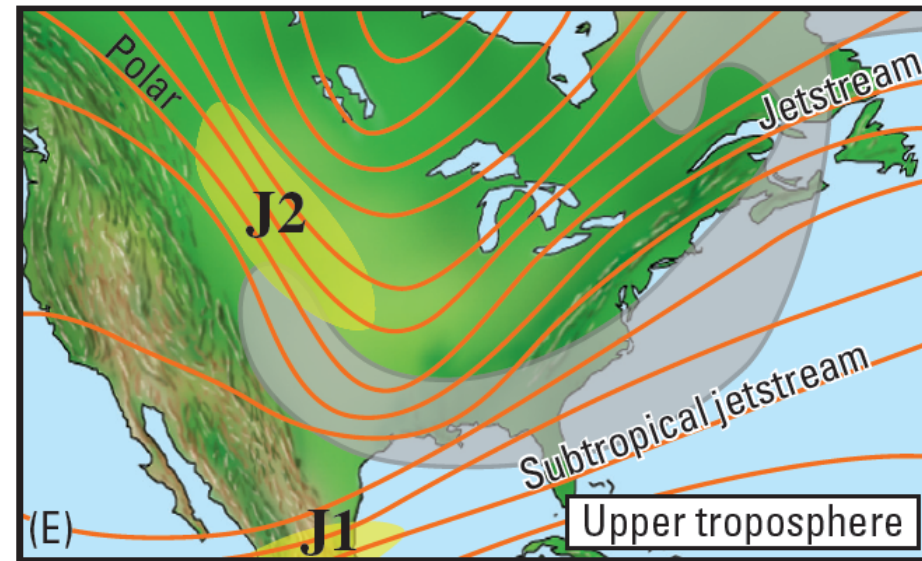
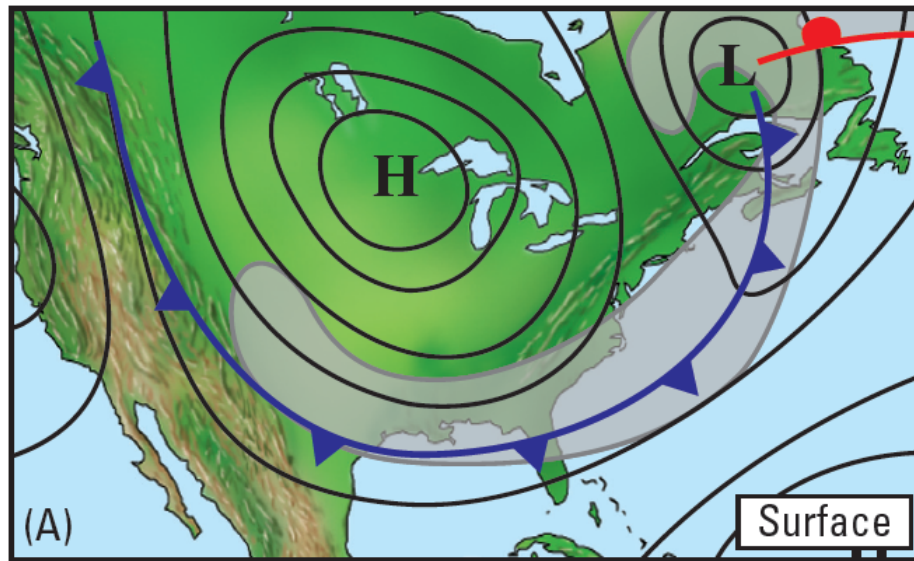
Gulf Coast Cyclones

- **Gulf coast cyclones:** most frequently when the subtropical jet is persistent (strongest during El Nino years)
- **Two storm tracks**
 - East coast storm track
 - Mississippi-Ohio valley storm track



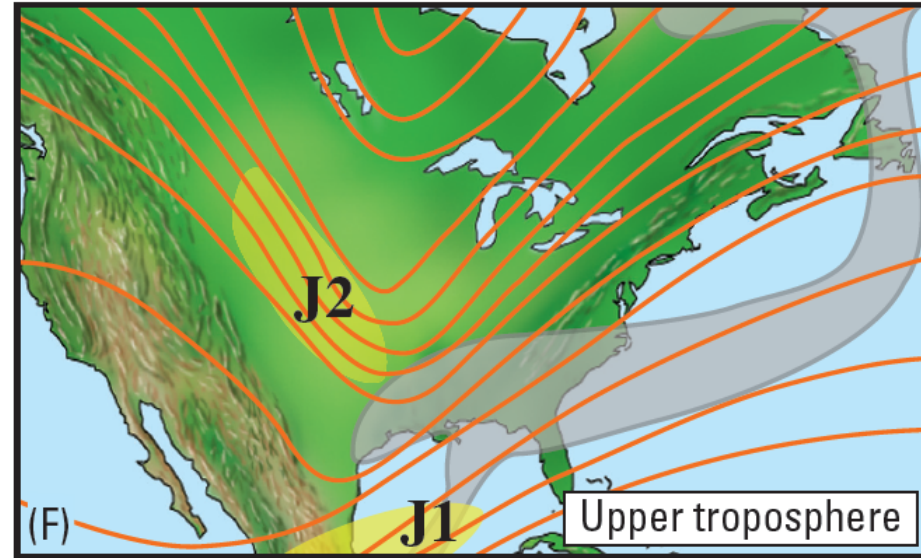
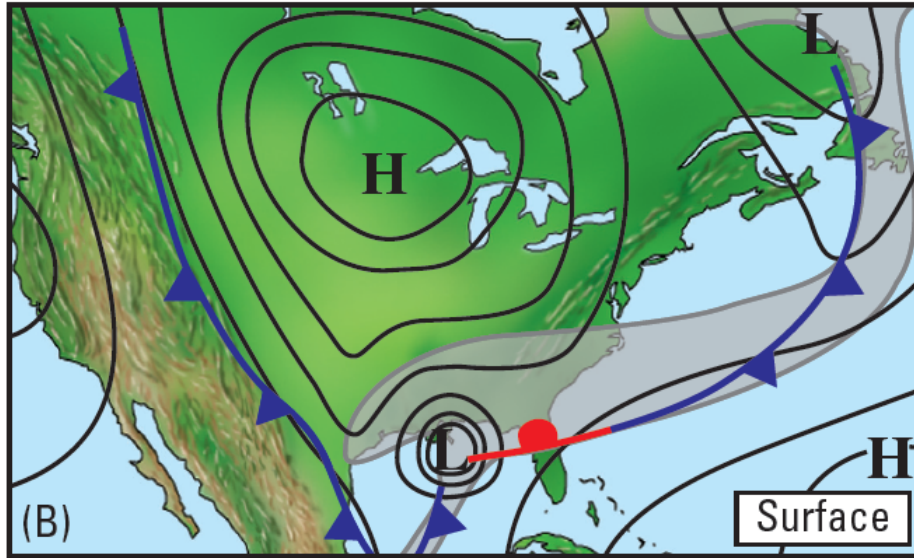
Gulf Coast Cyclones: 1) The East Coast Storm Track

A: Setting the Stage



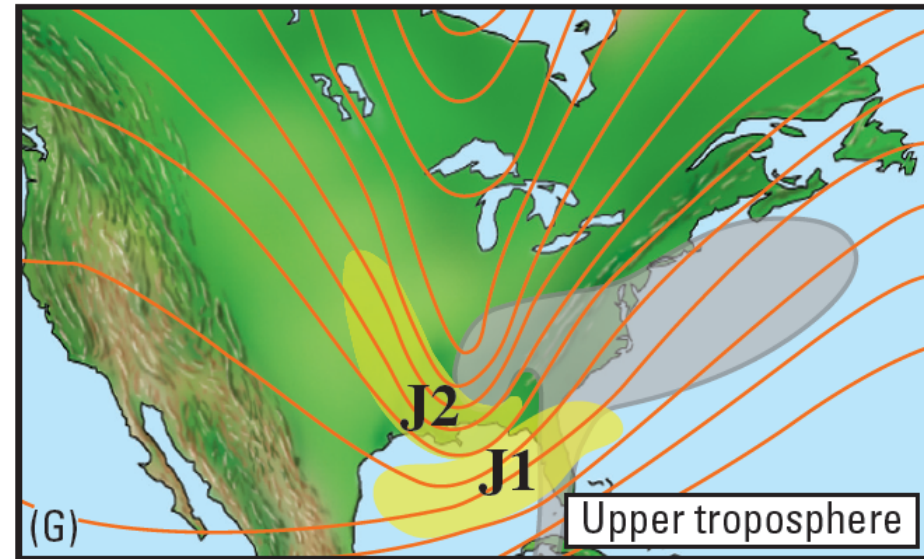
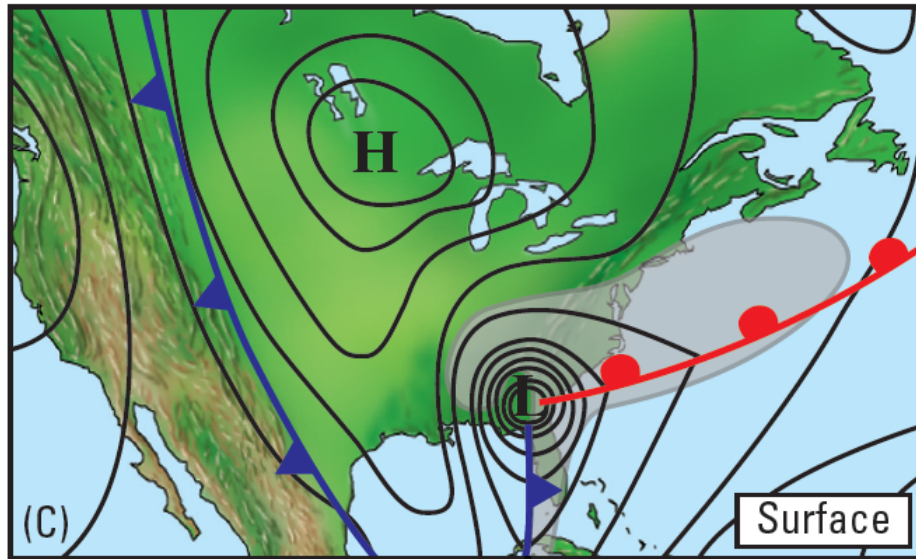
- **Precursor Lee cyclone** that pushes a cold front or arctic front far south to the Gulf Coast: sharp contrast between warm & cold air
- Aloft, a large trough over the entire eastern US with **polar jet**
- A **subtropical jet** flows from the tropical Pacific Ocean, across Mexico, and over the Gulf Coast.

B: Early Development



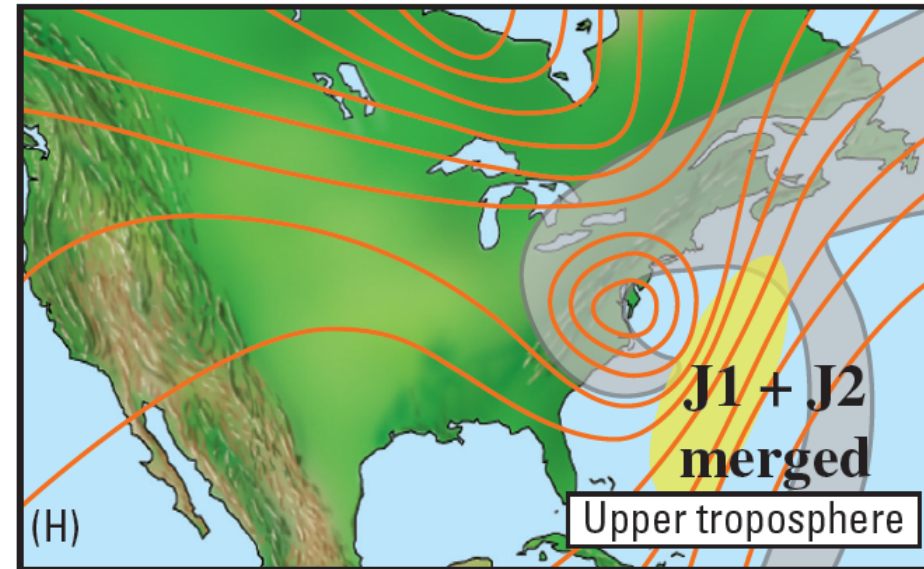
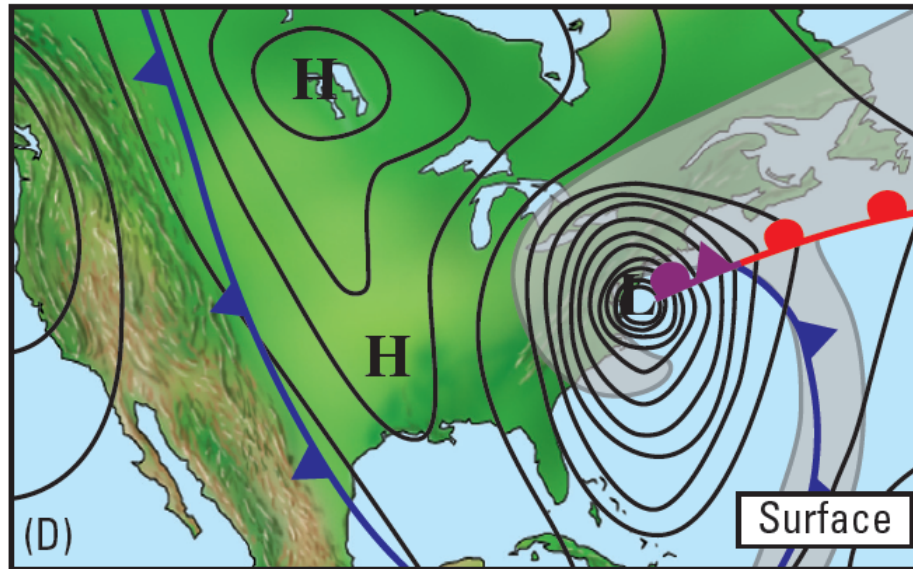
- Jetstreak in the subtropical jetstream triggers storm formation: as the left-exit region moves over the cold front
- A line of T-storms along the cold front over the Gulf
- The “Old” cold front becomes a warm front

C: Rapidly Deepening Stage (only for storms with two jetstreams)



- Left exit divergent quadrants in two Jetstreams are superimposed over one another + latent heat → Cause surface low deepen rapidly
- Warm front produces rain, freezing rain, ice pellets, and heavy snow (from southern states to the North)
- Cold front produces T-storms over FL & GA
- The media calls them as Nor'easters too when they track along the East Coast

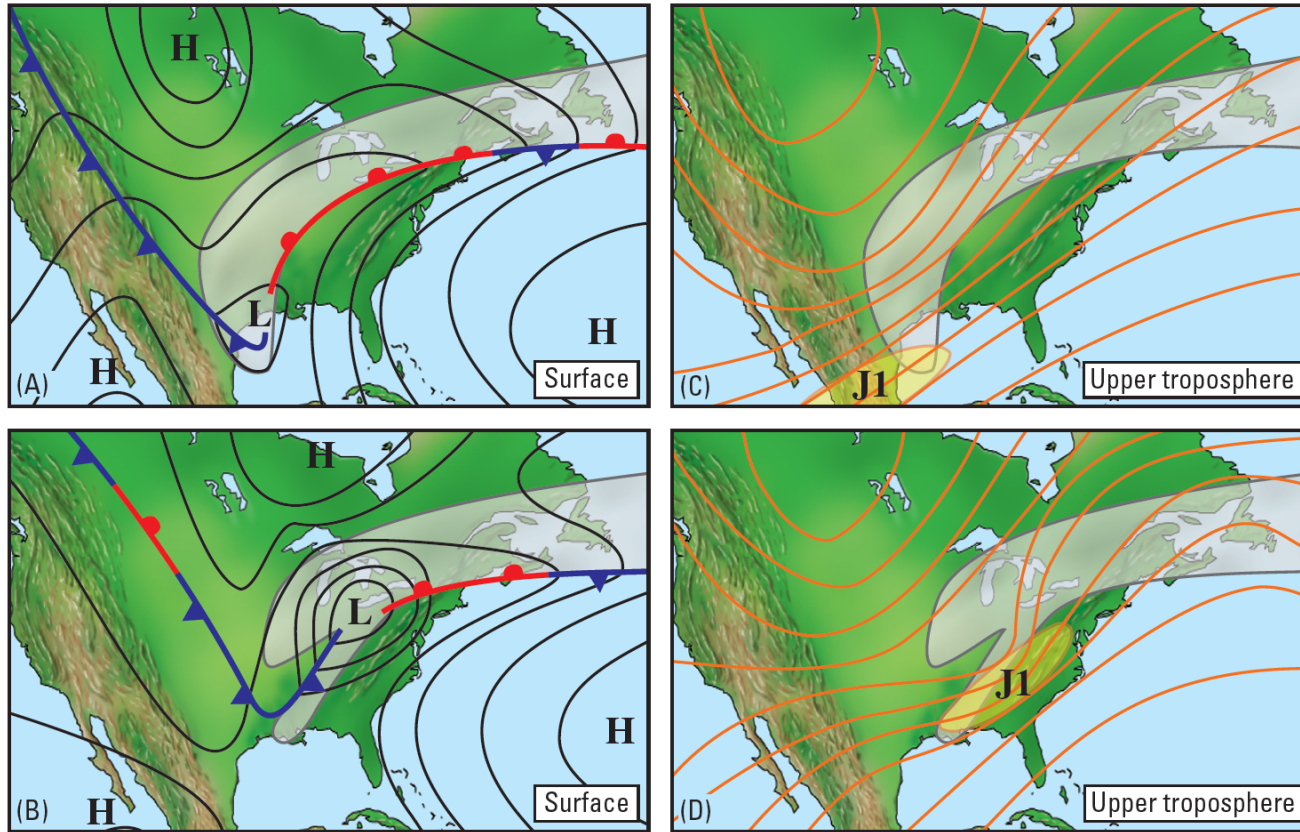
D: Occluded & most intense stage



- Two jetstreaks merge east of the storm
- Trowal wrap-around cloud band (between cold air and dry air); heavy snow in the trowal region
- Dissipate similar to East Coast storms: cut-off low, no more divergence, friction

Gulf Coast Cyclones:
2) The Mississippi-Ohio River Valley
Storm Track

When upper-level trough is farther west over central US



- Upper level trough farther west over central US;
- Subtropical jetstream merges the polar jet stream; only one Jet Streak; Storms are usually weaker.
- Precursor cold front reached the western Gulf coast, triggering the cyclone formation.
- Freezing rain & heavy snow north of the warm front; The wrap-around precipitation band extends northwest of the surface low center.