Midlatitude Cyclones

July 7th, 2021

Midlatitude Cyclones

Large migratory low-pressure system that occurs within the mid-latitudes (30°- 70° latitude) and moves generally with the Westerlies.

AKA ***lows, wave cyclones or extratropical cyclones*** **(United States)** ***and depressions*** **(Europe)**.

They are found almost entirely in the band of Westerly winds; their general path of movement is toward the east.

Probably most significant of all atmospheric disturbances.

- Basically responsible for most day-to-day weather changes
- Bring precipitation to much of the world's populated regions.

Characteristics

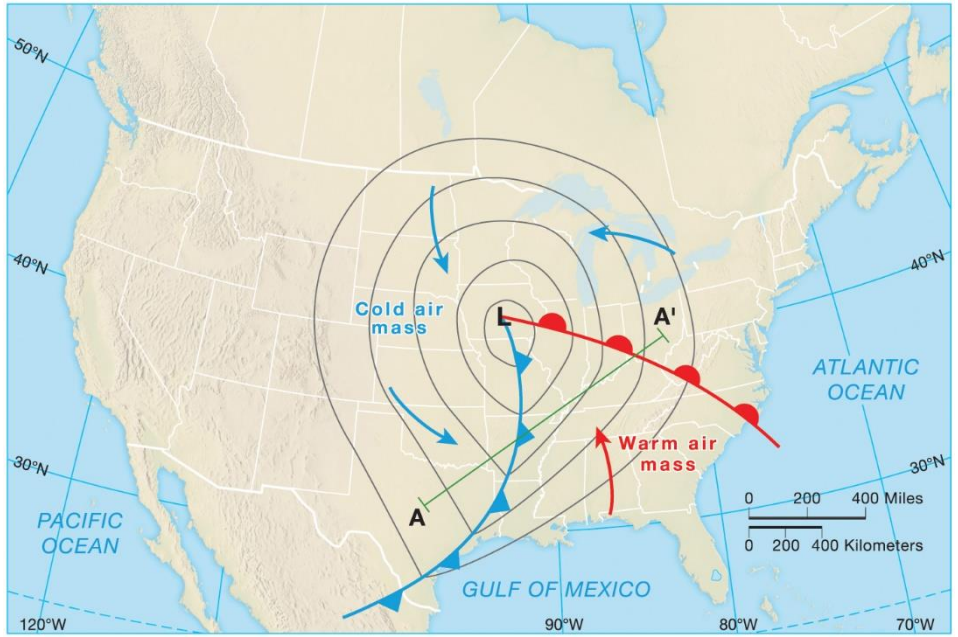
Typical mature midlatitude cyclone is 1,600 kilometers (1,000 miles) in diameter; **a vast cell of low pressure**, with ground level pressure in the center typically **between 990 and 1000 millibars (compare to tropical cyclone)**.

- Typically oval shape, with long axis trending northeast-southwest
- Patterns of isobars, fronts, and wind flow in Southern Hemisphere are mirror images of those in Northern Hemisphere.

Characteristics

In Northern Hemisphere:

- Circulation pattern converges counterclockwise.
- Wind-flow pattern **attracts cool air from the north and warm air from the south**; **convergence of unlike air masses creates two fronts**.
- These two fronts divide the cyclone into **a cool sector north and west of center** and **a warm sector south and east where the air masses are in contact with the ground**.

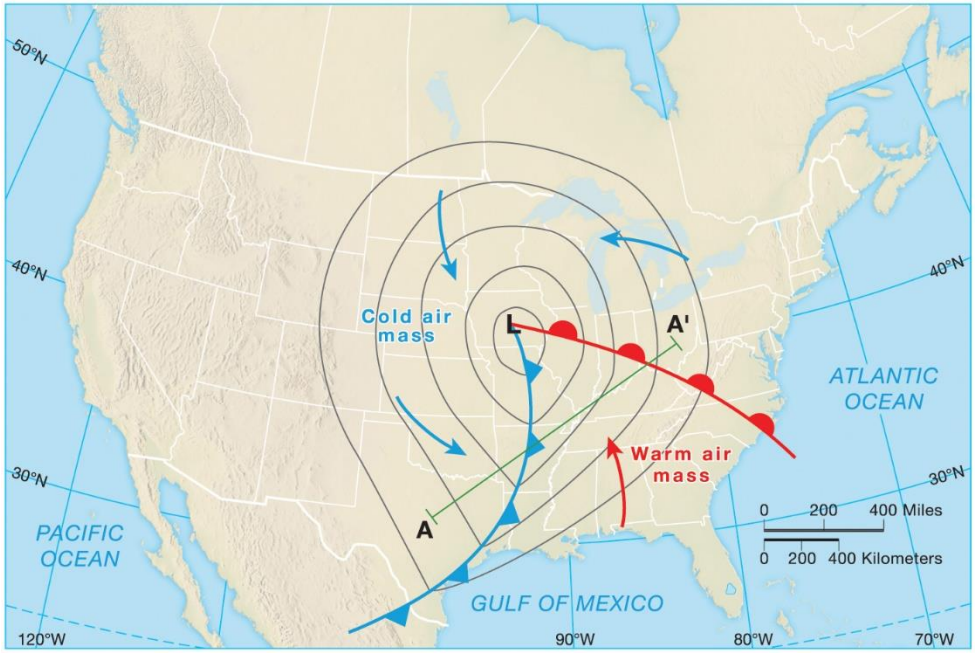


(a)

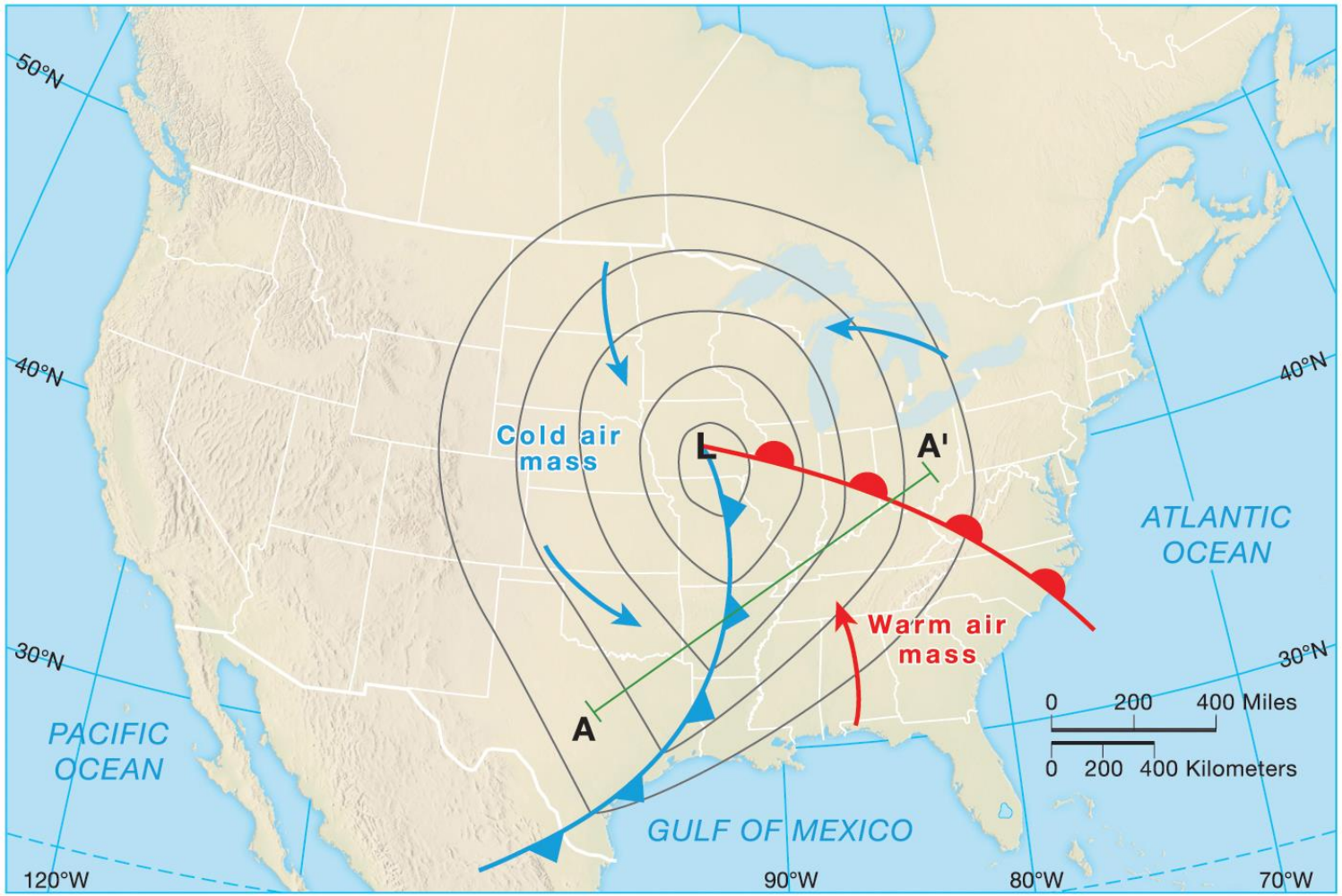
Characteristics

In Northern Hemisphere:

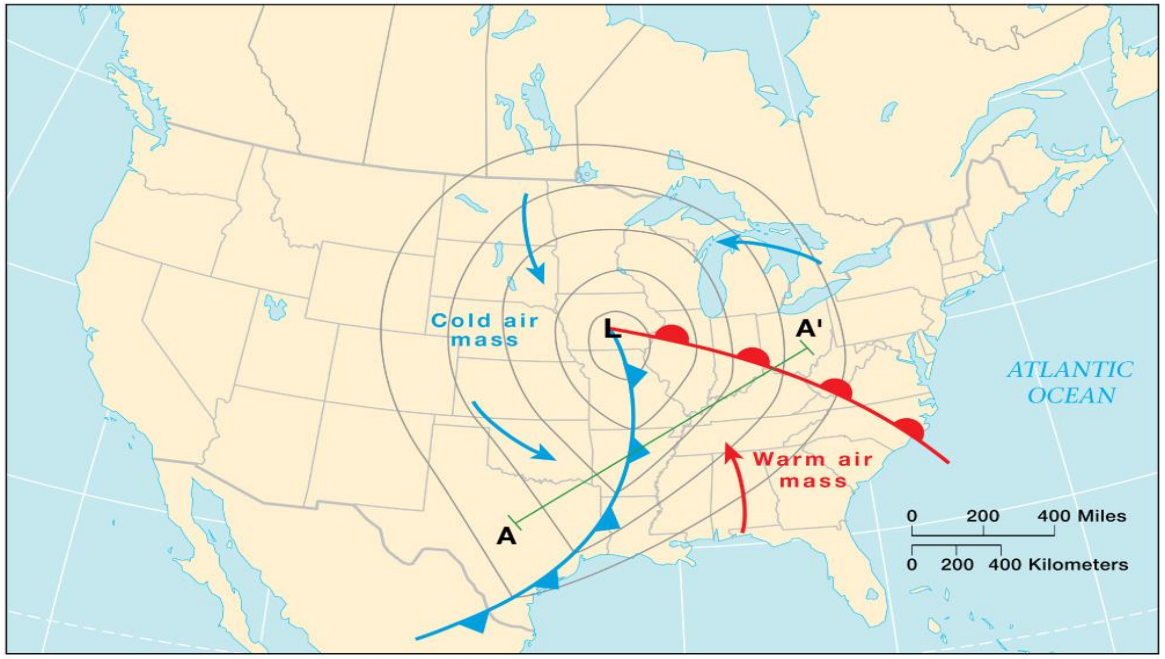
- Size of sectors vary with location: **on the ground, cool sector is larger, but in the atmosphere, the warm sector is more extensive**.
- Warm air rises along both fronts, **causing cloudiness and precipitation**, which follows patterns of cold and warm fronts.
- Much of cool sector is typified by clear, cold, stable air, while air of warm sector is often moist and tending toward instability, so may have sporadic thunderstorms.



(a)


50°N
40°N
30°N
120°W
90°W
80°W
70°W
Cold air mass
L
A'
A
Warm air mass
ATLANTIC OCEAN
PACIFIC OCEAN
GULF OF MEXICO
0 200 400 Miles
0 200 400 Kilometers

(a)



In the Northern Hemisphere, there is usually a cold front trailing to the southwest and a warm front extending toward the east.

Arrows in (b) indicate the direction of frontal movement.

Weather Changes with a Passing Front

When the cold front passes, all four elements of weather will change:

- Temperature: decreases sharply
- Pressure: decrease as the front approaches and then rises after it passes
- Wind: warm sector from south before front arrives; shifts to west or northwest once the front passes
- Clouds and precipitation: clear skies ahead of the cold front are replaced by cloudiness and precipitation at the front, clear skies return once the front passes

Movements

Midlatitude cyclones move throughout their existence.

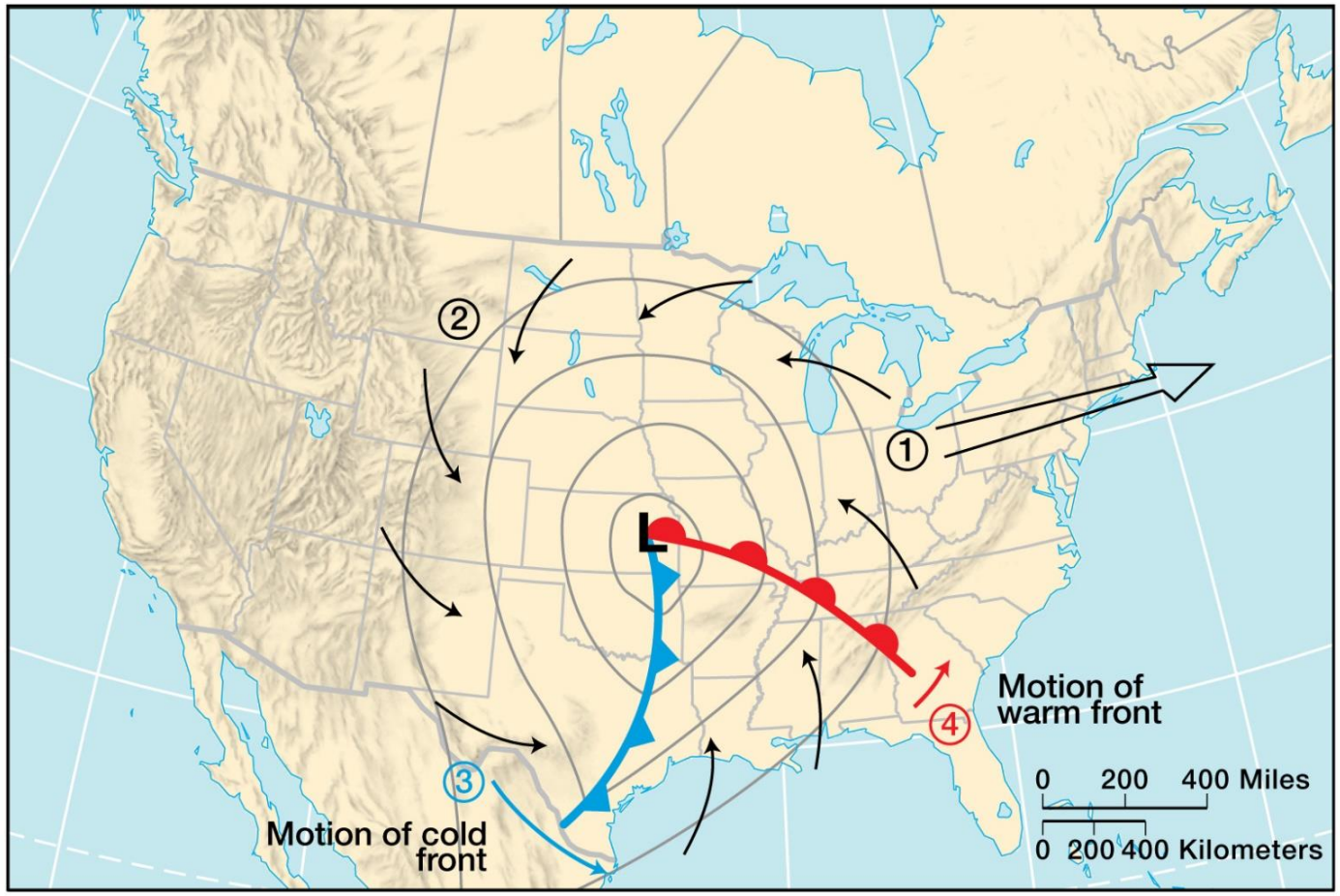
The whole system moves as a major disturbance in the Westerlies.

Rate of movement between 30-45 kmp/h – crossing North America in 3-4 days.

Faster in winter than summer.

Route of cyclone is likely to be undulating and erratic, but it generally moves west to east.

Cloud front advances faster than the storm



(a) Day 1

Four varieties of motion occur in a typical midlatitude cyclone:

(1) The entire system moves **west to east** in the general flow of the westerlies; (2) there is cyclonic counterclockwise airflow; (3) the cold front advances; (4) the warm front advances.

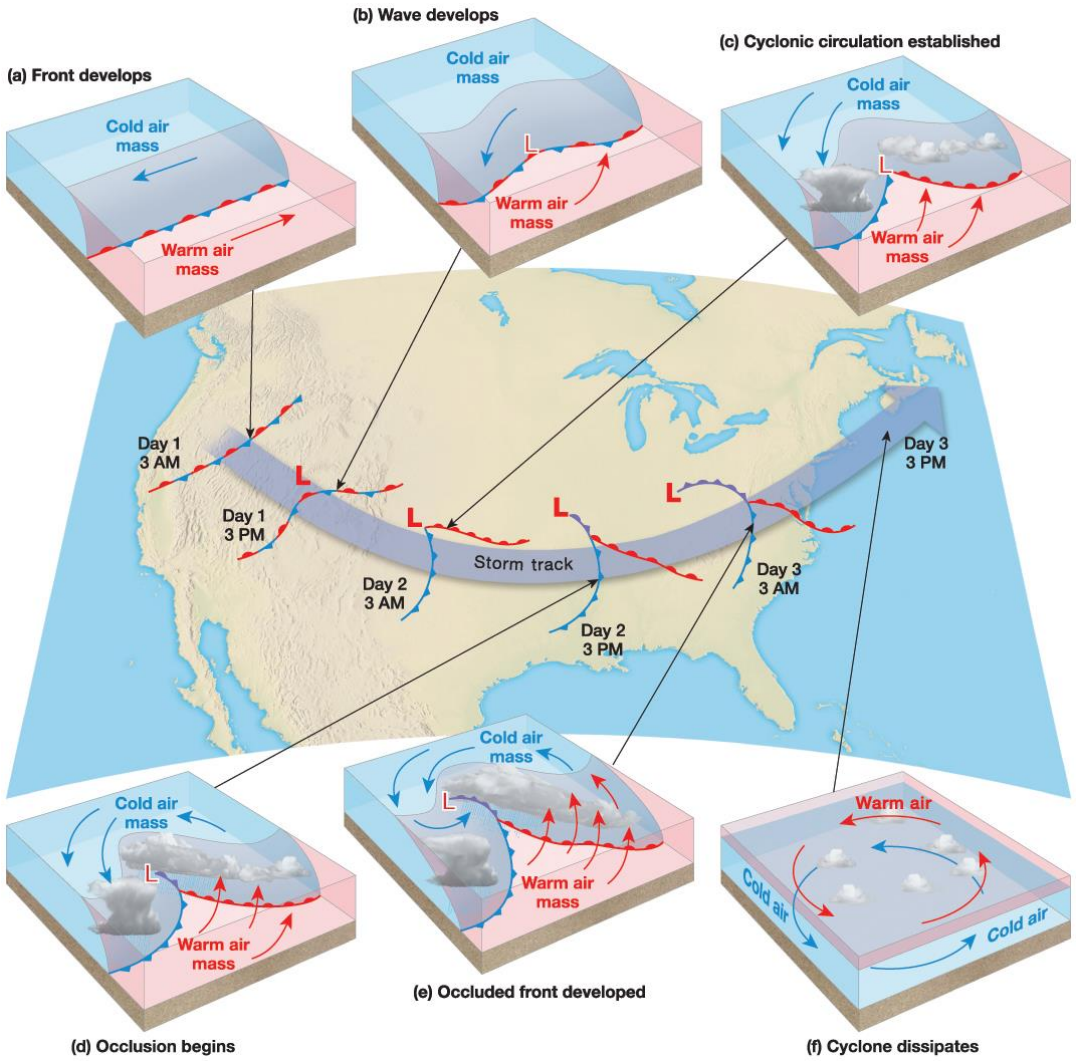
Lifecycle

Cyclogenesis

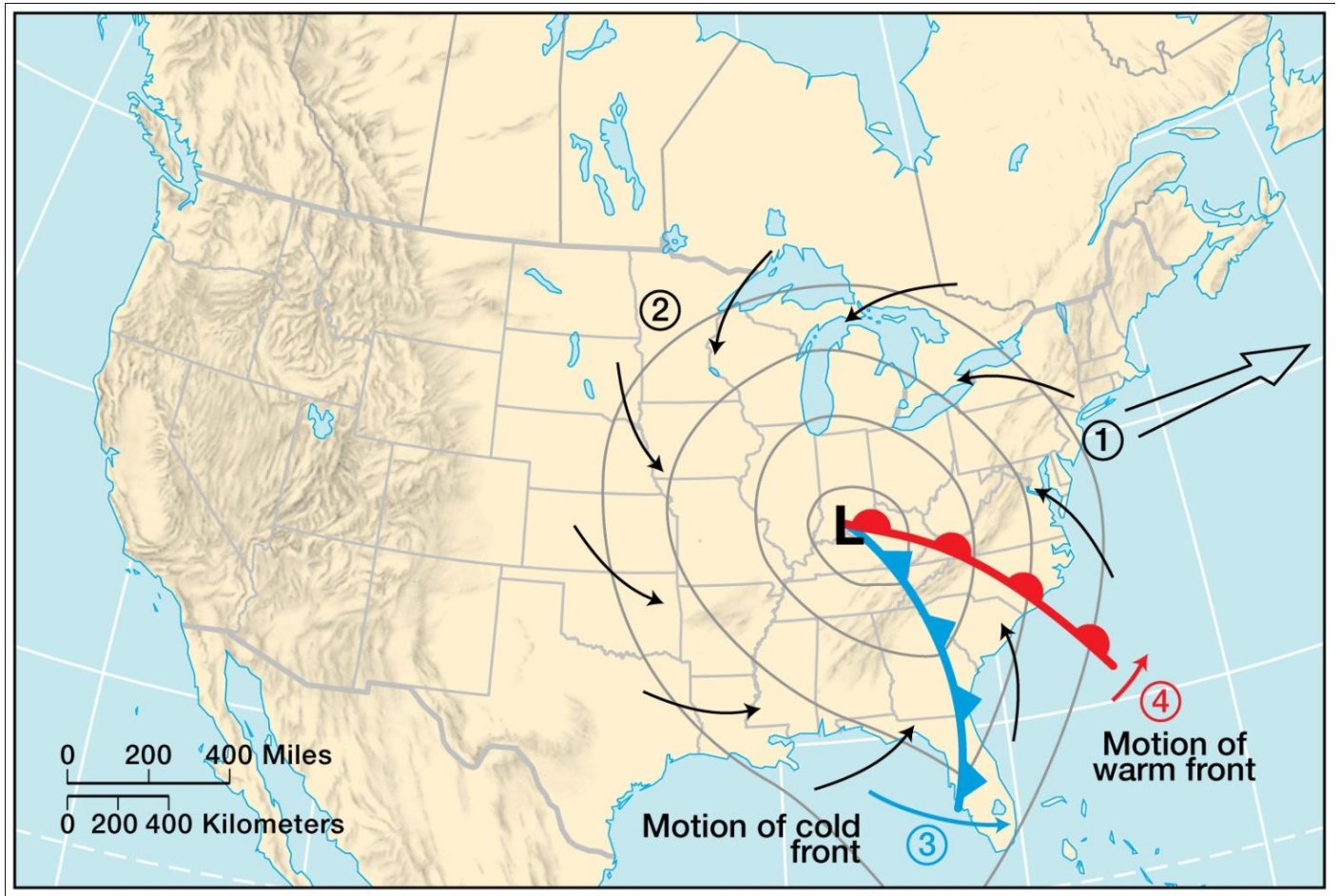
- Origin to maturity, then to dissipation **takes between 3 to 10 days**.
- *Cyclogenesis*—birth of cyclones.
- Most common cause believed to be upper-air conditions (meridional airflow) in the vicinity of the polar-front jet stream.
- Most begin as waves along the polar front.
- Often bring heavy rain or snowstorms to the northeastern United States and southeastern Canada.

Occlusion

- After cyclonic circulation is well developed, occlusion begins.
- After occluded front is fully developed, cyclone dissipates.

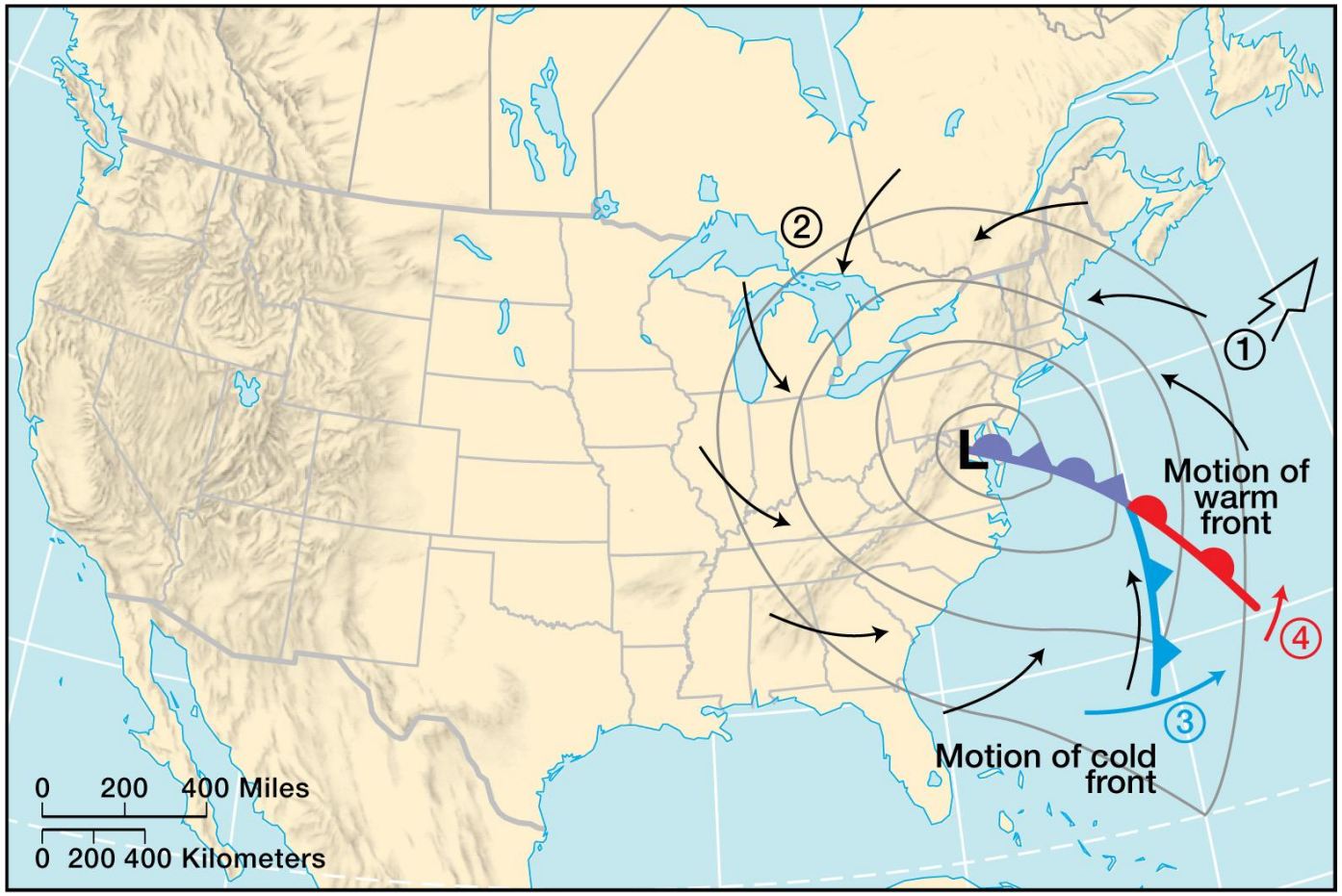


(a) Front develops.
(b) Wave appears along front.
(c) Cyclonic circulation is well developed.
(d) Occlusion begins.
(e) Occluded front is fully developed.
(f) Cyclone dissipates



(b) Day 2

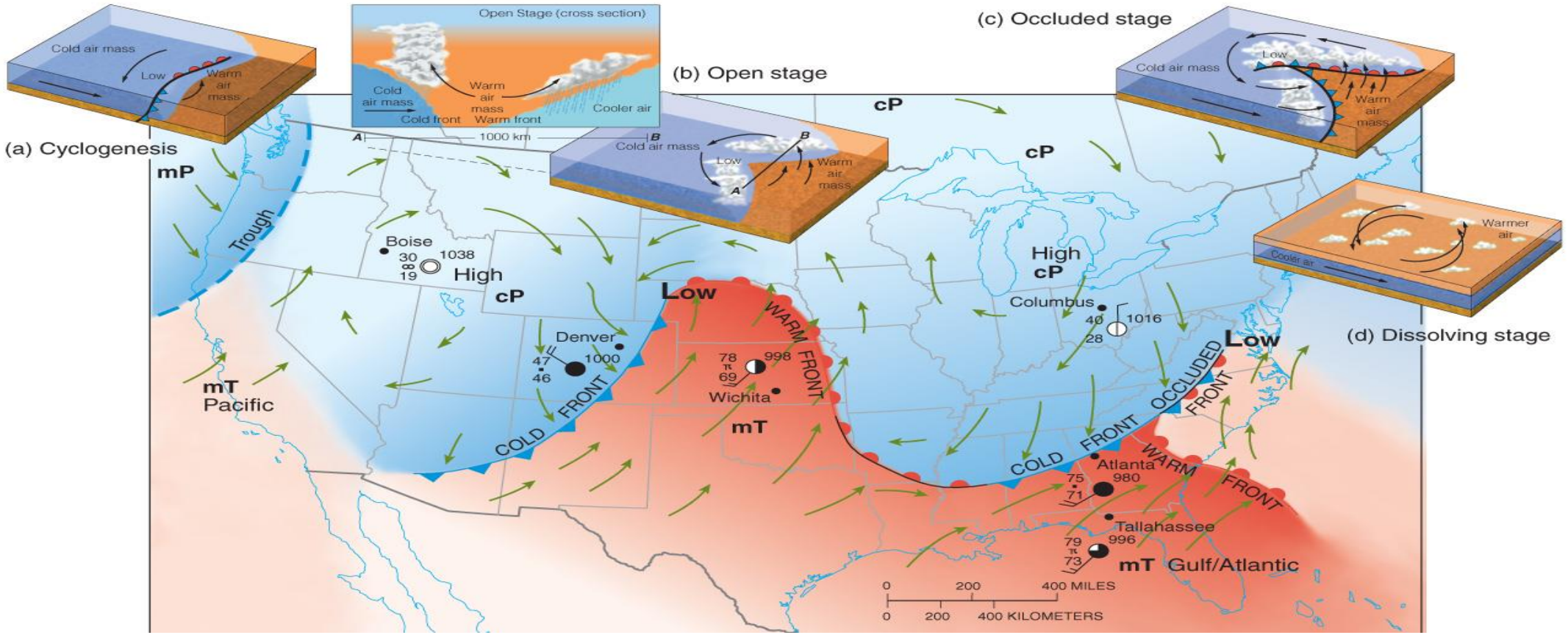
(b and c) Days 2 and 3: because the cold front is traveling faster than the warm front, the distance between the two decreases over time.

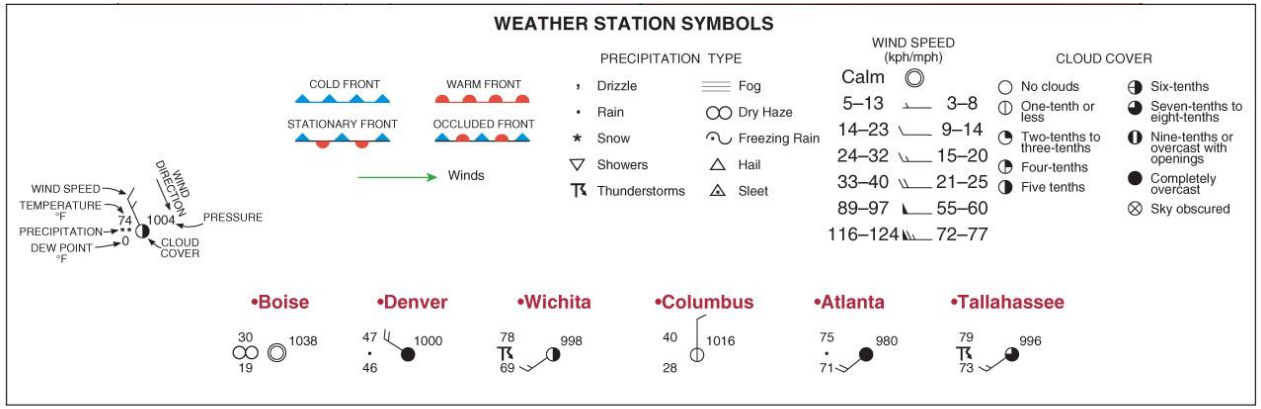


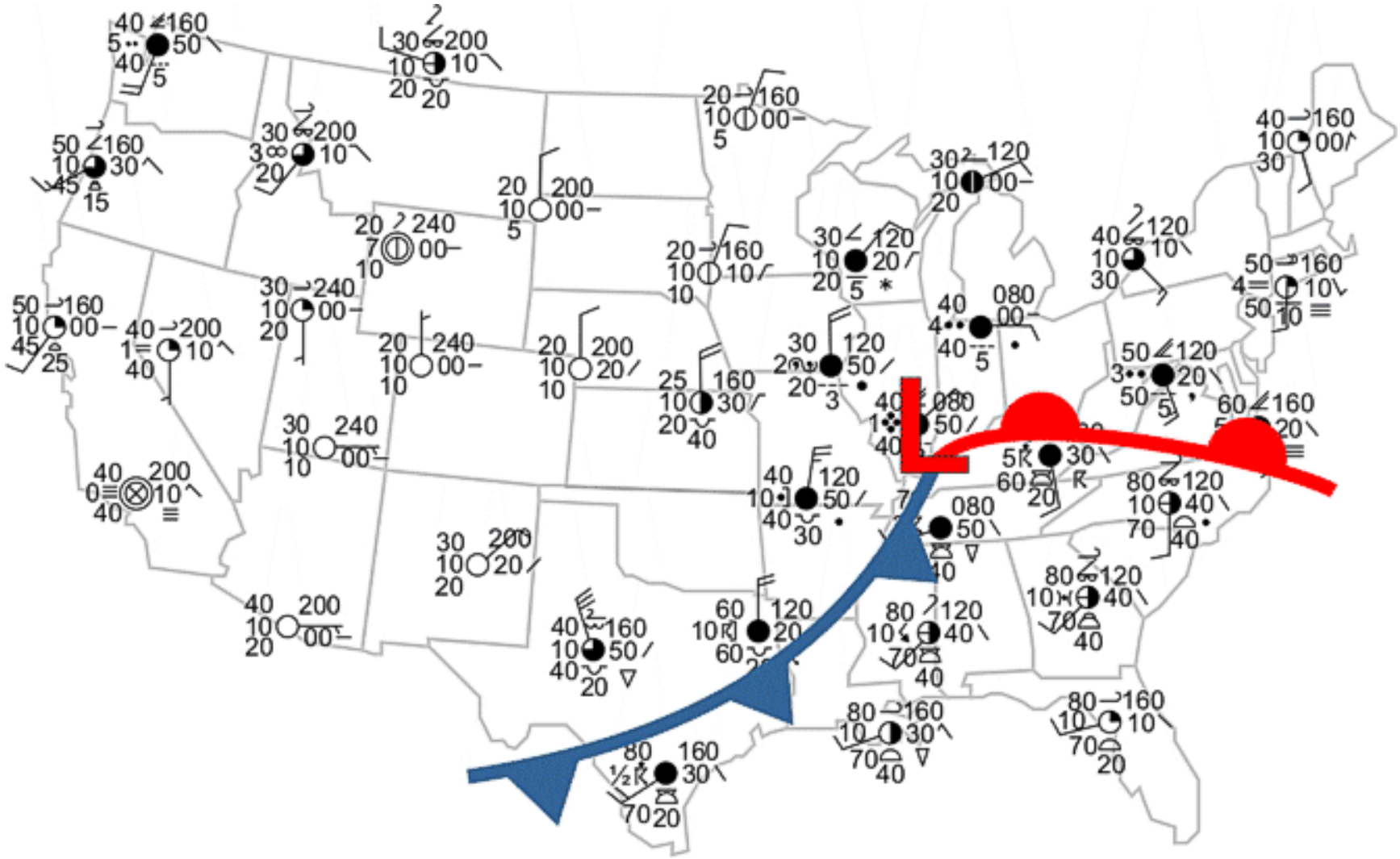
(c) Day 3

On day 3, the storm has started to occlude.

Midlatitude Cyclone and the Weather Map







http://oceanservice.noaa.gov/education/yos/resource/JetStream/synoptic/ll_analyze_fronts.htm

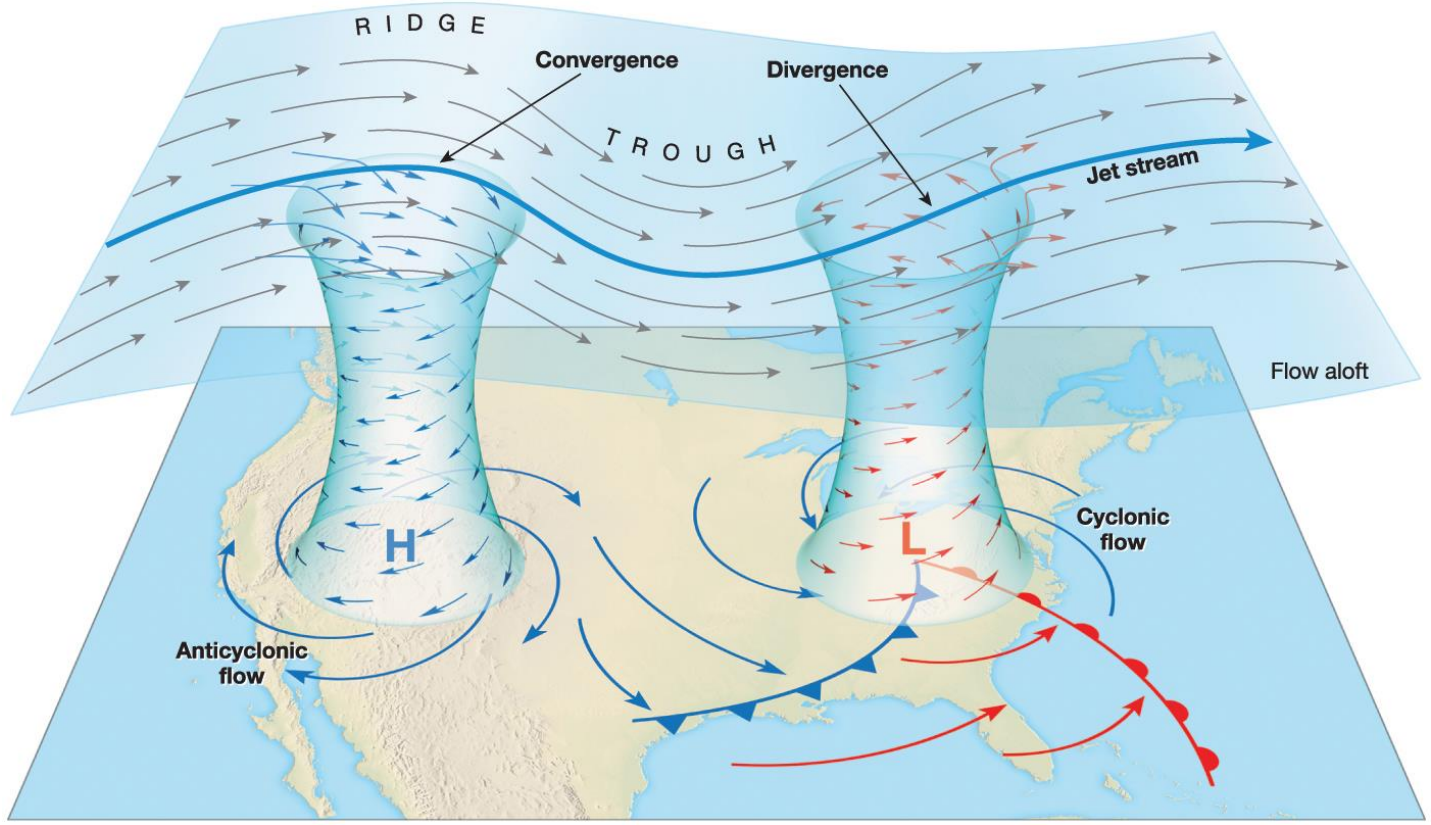
Other disturbances..

Midlatitude anticyclone

Tropical cyclones

Tornadoes – associated with midlatitude cyclones

- A typical winter situation in which the upper-level airflow is meridional (**meanders north and south**), creating "standing waves" aloft and cyclonic flow at the ground level, as opposed to being ***zonal;*** that is, flowing straight from west to east.
- **A cyclone is unlikely to develop at ground level unless there is divergence above it. The convergence of air near the ground must be supported by divergence aloft** (but topographic irregularities, temperature contrasts between sea and land, and ocean currents may also be responsible).
- Such divergence can be related to changes in either speed or direction of the wind flow, but it nearly always involves broad north-to-south meanders in the Rossby waves and the jet stream



Tropical Cyclones

Developed in the tropics 5° - 30° N or S latitude.

Also called as hurricanes, typhoons, and cyclones.

Smaller, but stronger than extra tropical cyclones (diameter between 100- 600 miles).

Forms only over warm tropical oceans

Hurricane Formation

Hurricanes need:

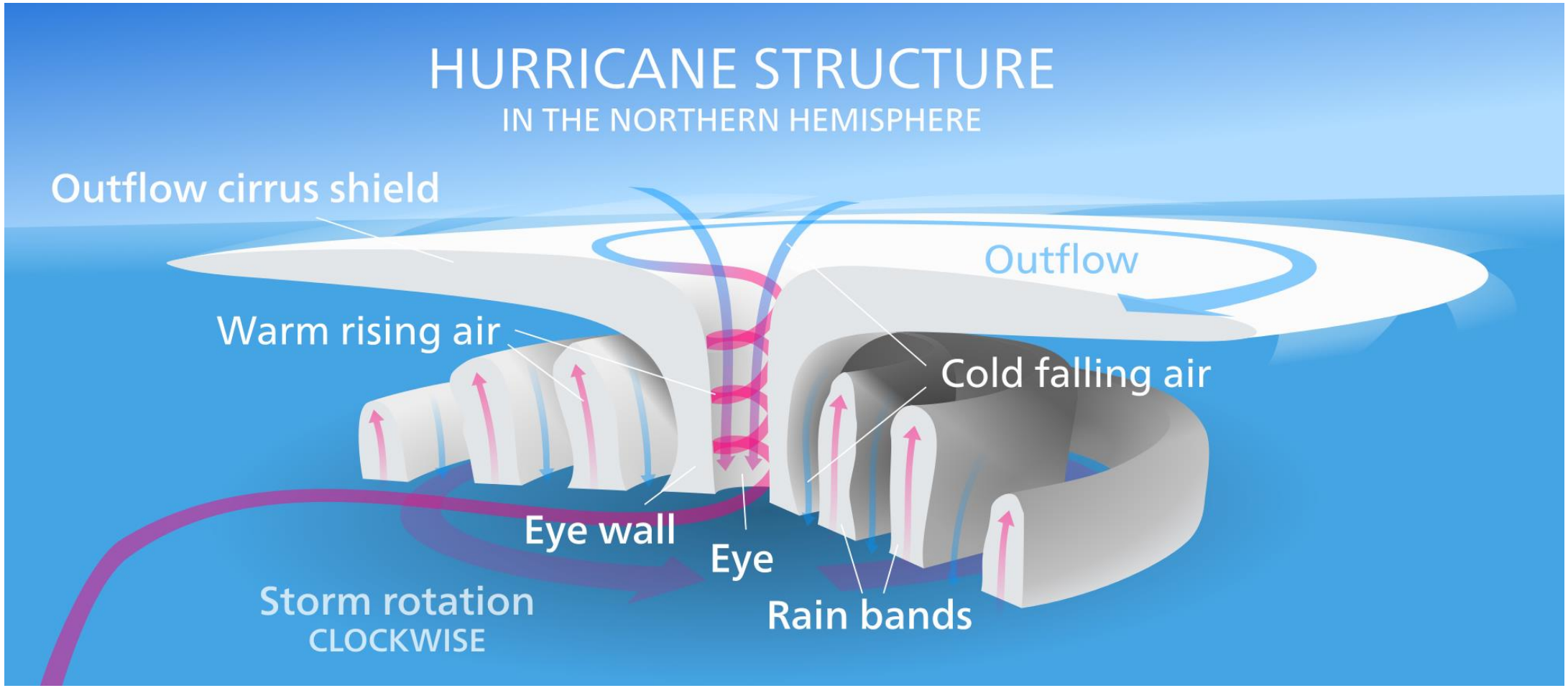
Low pressure cell

Warm temperatures

Moist ocean air

Winds near the tropics (Tropical winds, near the equator)

Tropical wave → Tropical Disturbance → Tropical Depression → Tropical Storm→ Hurricane.


HURRICANE STRUCTURE
IN THE NORTHERN HEMISPHERE
Outflow cirrus shield
Outflow
Warm rising air
Cold falling air
Eye wall
Eye
Storm rotation
CLOCKWISE
Rain bands

Damage and Destruction

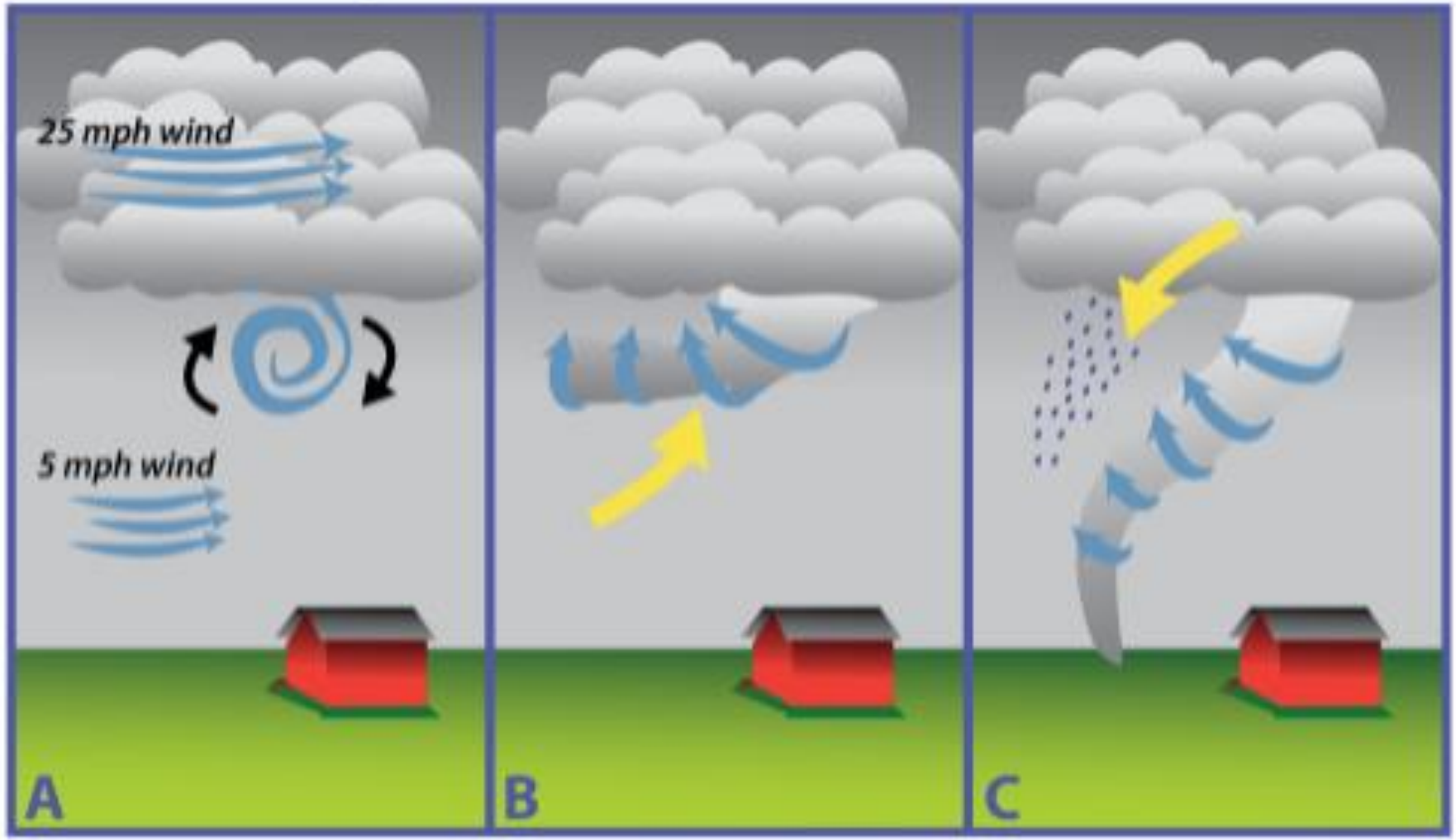
Storm surge

Tornadoes

Small storms compared to cyclones (0.25 mile in diameter)

Extreme pressure gradients

Develop in the warm, moist, unstable air associated with an Extratropical Cyclone



https://sites.google.com/site/themightytornado/how-do-tornadoes-form