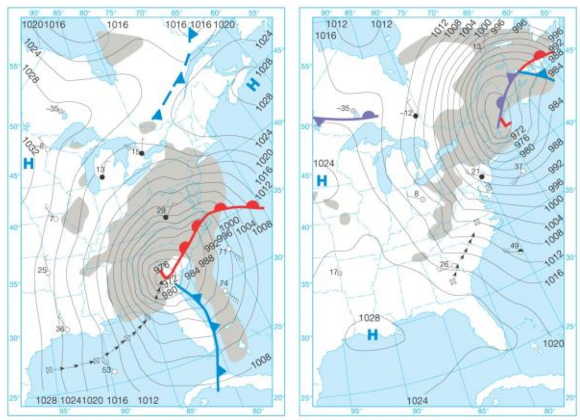
Chapter 9: Weather Patterns

Mid Latitude Cyclones: extratropical cyclones, Nor'easters

Region southern FL to Alaska

Lifecycle and associated weather

Regional Influence



(a) Saturday, March 13, 1993 (b) Sunday, March 14, 1993

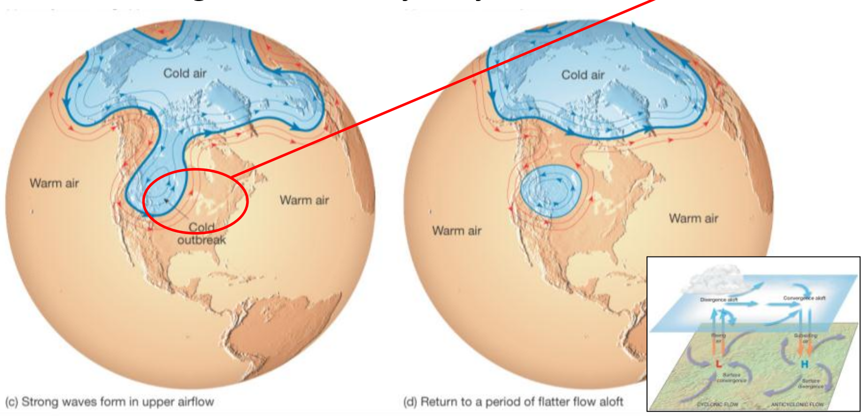
Polar Front Theory:

-Norwegian Cyclone Model

-**WWI**

-describes birth, growth and decay of cyclones

Generates cyclone at the surface



(c) Strong waves form in upper airflow (d) Return to a period of flatter flow aloft

Midlatitude Cyclone:

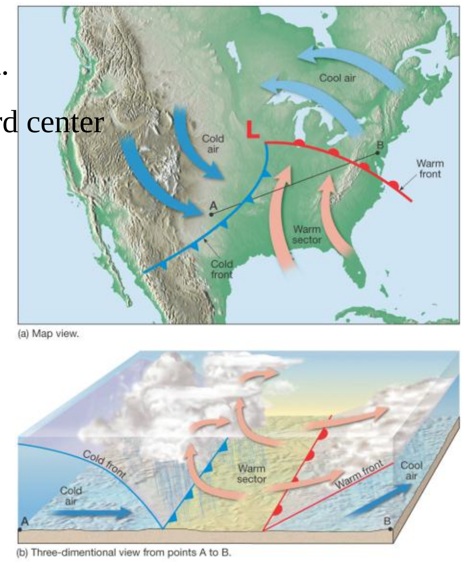
-primary weather producers

-low pressure systems, 1000 km dia.

-counterclockwise circulation toward center

-warm and cold **fronts**

-upward flow initiates precipitation



(a) Map view.
(b) Three-dimentional view from points A to B.

Fronts:

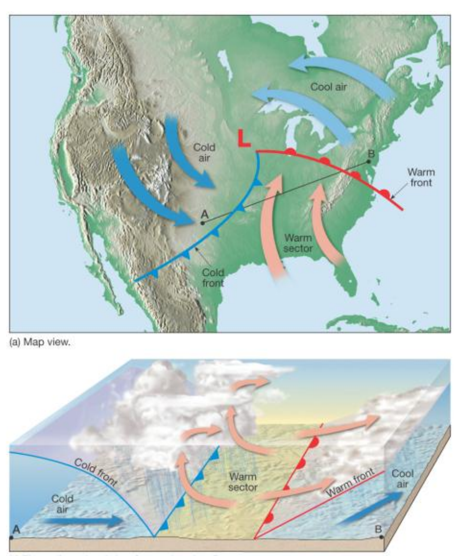
-boundary surfaces that separate air masses of different densities

temperature

moisture

-15-200km wide

-line on the weather map



(a) Map view.
(b) Three-dimentional view from points A to B.

Fronts:

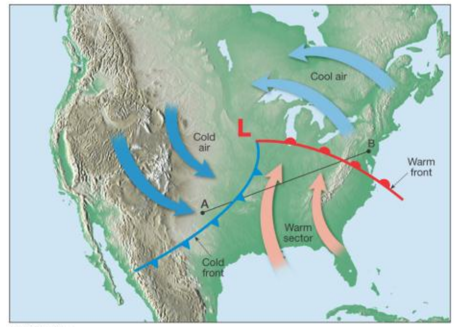
-surface **slope is gradual**

-warm air overlies cold air

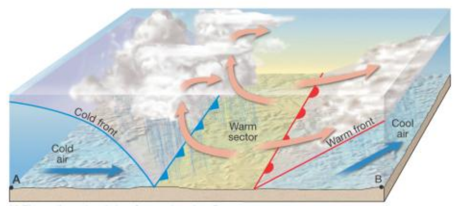
-air masses move at different speeds

-one air mass will **advance**

-clashing produces weather



(a) Map view.

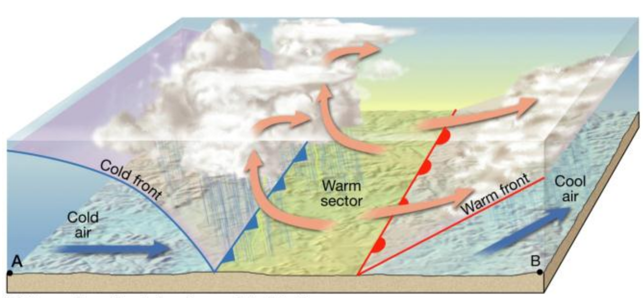


(b) Three-dimentional view from points A to B.

Fronts:

-warm air is always forced **aloft**

-**overrunning**: warm air gliding on top of cold air



(b) Three-dimentional view from points A to B.

5 Types of Fronts:

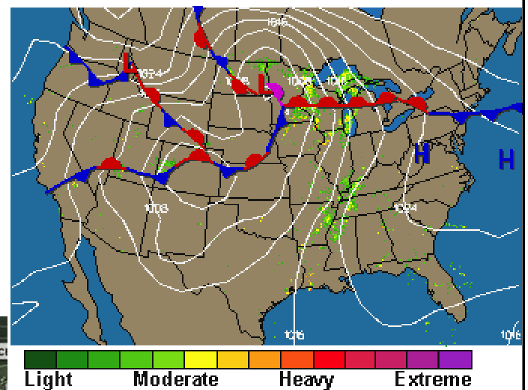
-warm

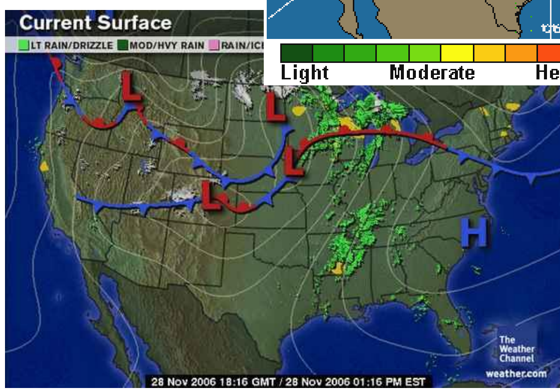
-Cold

-Stationary

-Occluded

-Dryline





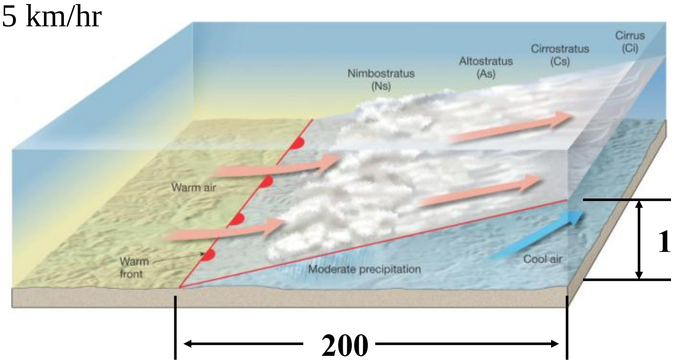
Warm Front:

-warm air mass is advancing, displaces colder air at the surface

-red line with half circles

-gradual slope (1:200)

-speed = 25-35 km/hr



Warm Front:

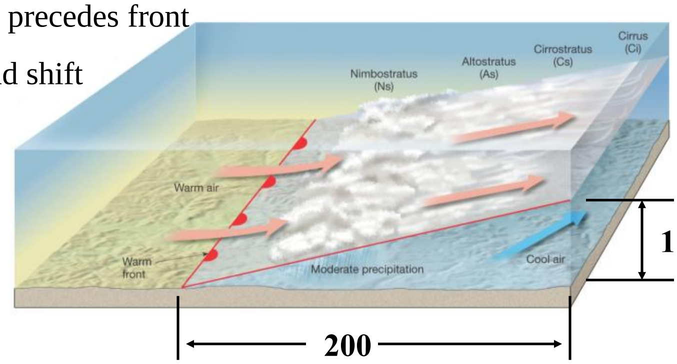
-adiabatic cooling

-cloud sequence

-gradual slope & slow advance: widespread, light precip. long duration

-precipitation precedes front

-E to SW wind shift



Cold Front:

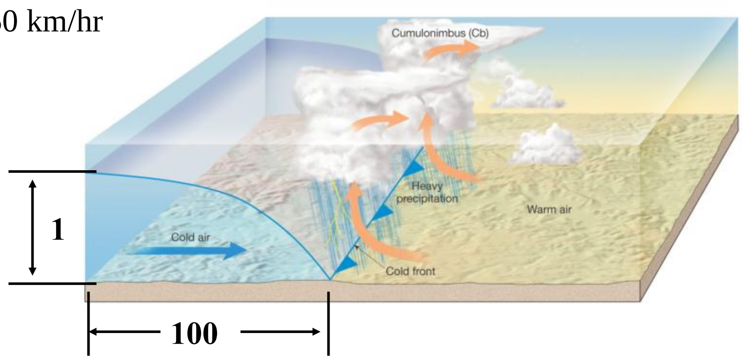
-cold air mass is advancing, displaces warmer air at the surface

-cold air more dense forces warm air aloft

-blue line with triangles

-steeper frontal boundary (1:100)

-speed = 35-50 km/hr

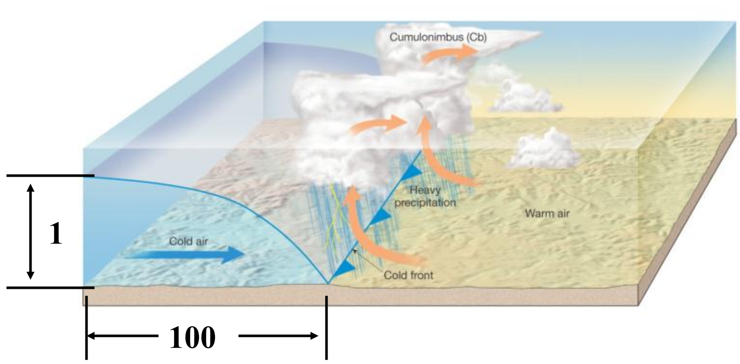


Cold Front:

-precipitation follows the passage of the front

-steeper frontal boundary & speed: more violent weather

-altocumulus and cumulonimbus



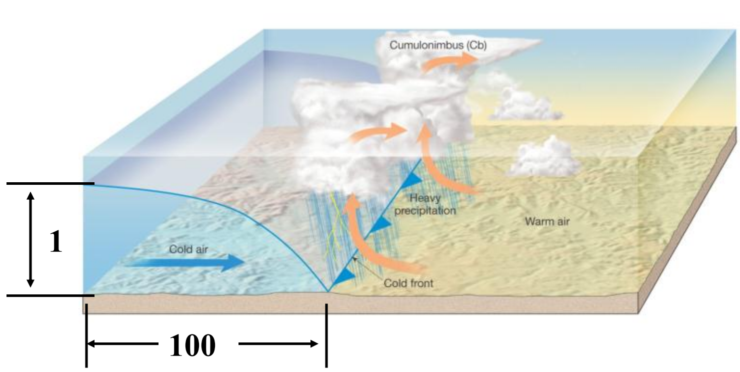
Cold Front:

-same lifting of warm air, only quicker over a shorter distance

-heavy downpours, short duration, narrow band of precipitation

-passage of front temperature drops, polar air, clear skies

-SW to NW wind shift

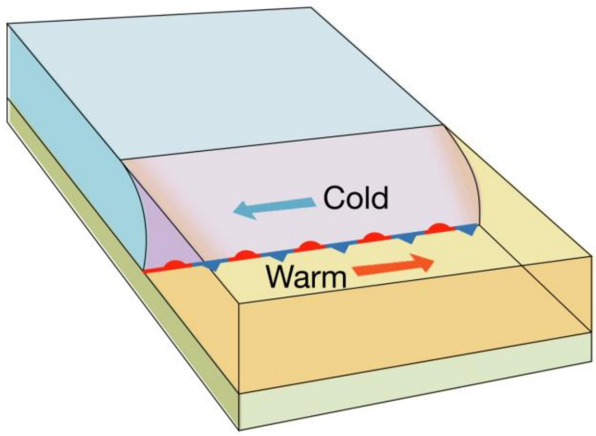


Stationary Front:

-little to no horizontal movement across the front by either air mass

-lateral motion

-**overrunning**, light precipitation



Occluded Front:

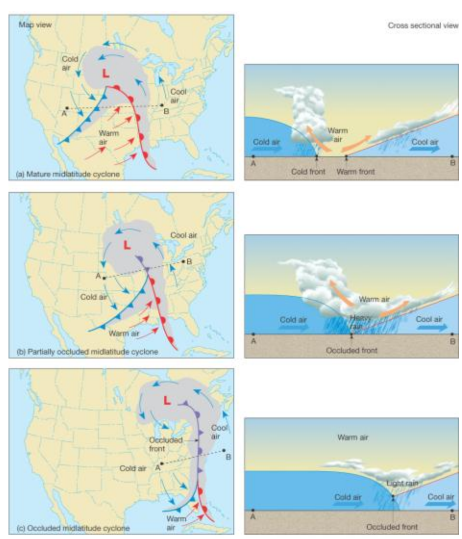
-rapid moving **cold front** overtakes a **warm front**

-warm air driven aloft

-precipitation from wedging

-strong temperature gradients

-intense weather

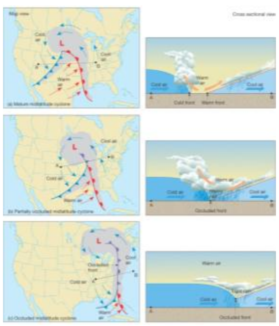


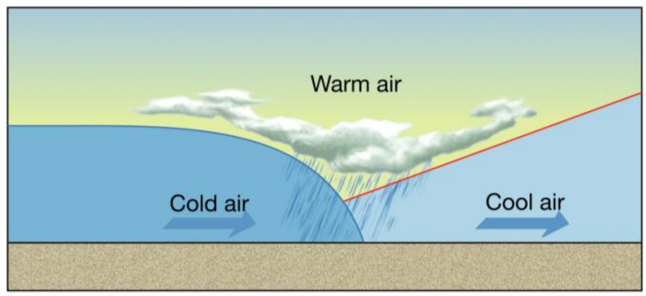
Occluded Front:

-cold type occluded front

advancing air is colder than air mass it is overtaking

common east of the Rockies (cP overtakes mP)





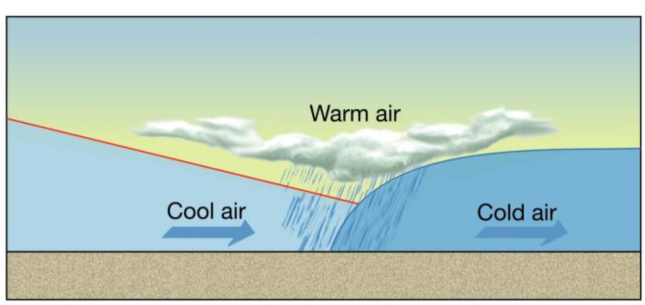
(a) Cold-type

Occluded Front:

-warm type occluded front

advancing air is warmer than air mass it is overtaking

Pacific coast (mP overtakes cP)



(b) Warm-type

Drylines:

-fronts based on moisture content

-not necessarily a difference in temperature

-dry air forces moist air aloft

-cT (southwest US) displaces mT (Gulf) spring and summer

-severe T-storms from Texas to Nebraska

Life of a Midlatitiude Cyclone (2-10 days)

6 basic stages

Front develops

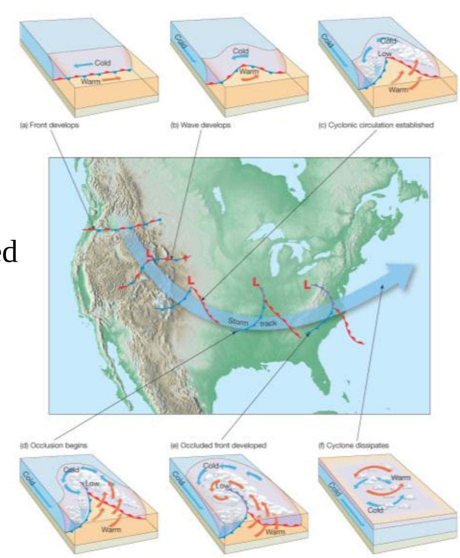
Wave develops

Cyclonic circulation established

Occlusion begins

Occluded front developed

Cyclone dissipates



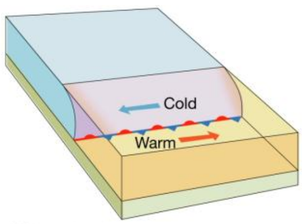
Cyclogenesis = cyclone formation

Front develops

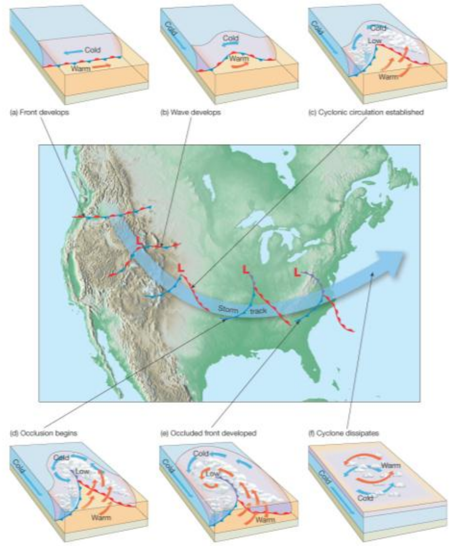
Stationary front

cP on the North (easterlies)

mT on the South (westerlies)



(a) Front develops

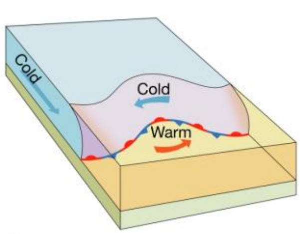


Life of a Midlatitiude Cyclone

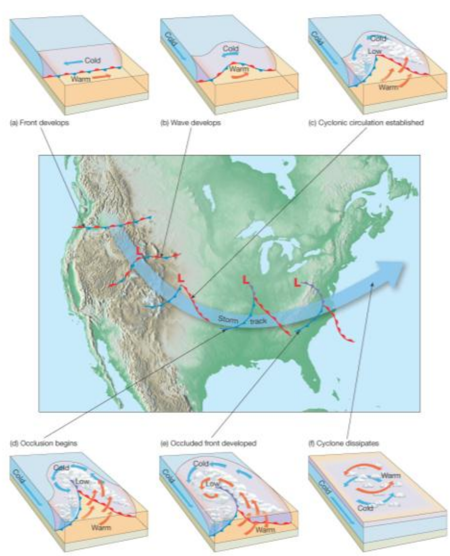
Wave develops

wavelength (O 100 km)

wave steepens



(b) Wave develops

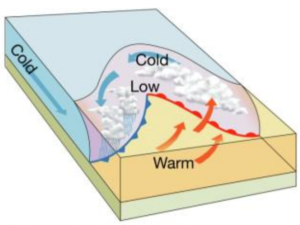


Cyclonic circulation established

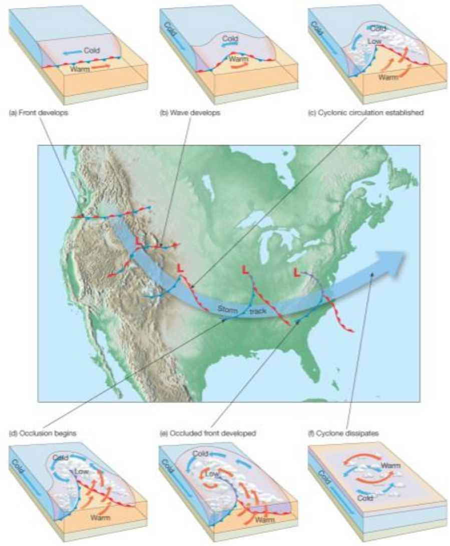
Warm air invades north (warm front)

Cold air advances south (cold front)

Low pressure at the crest



(c) Cyclonic circulation established



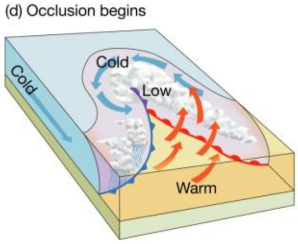
Life of a Midlatitiude Cyclone

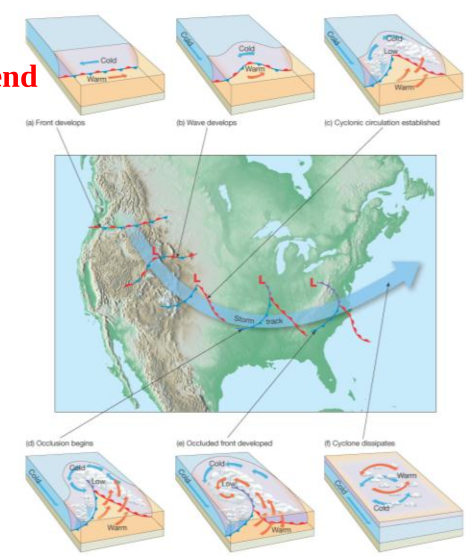
Occlusion: beginning of the end

Cold front advances past the warm front

Strong temperature gradients, storm intensifies

(d) Occlusion begins





Life of a Midlatitiude Cyclone

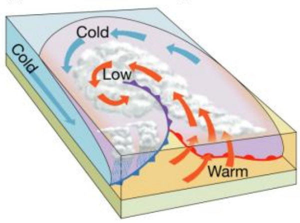
Occluded front developed

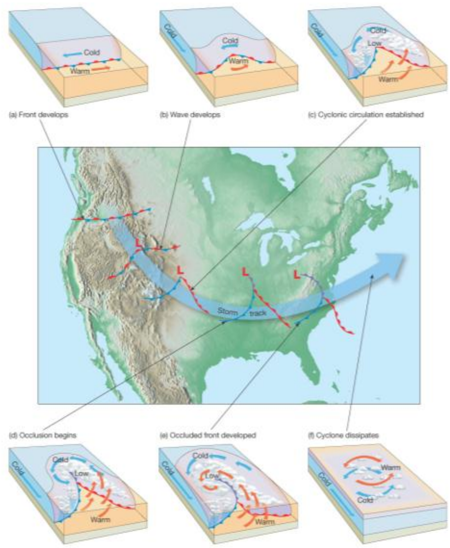
blizzards, strong winds

energy is being exhausted

within a few days warm front driven aloft

(e) Occluded front developed





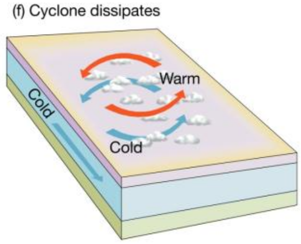
Life of a Midlatitiude Cyclone

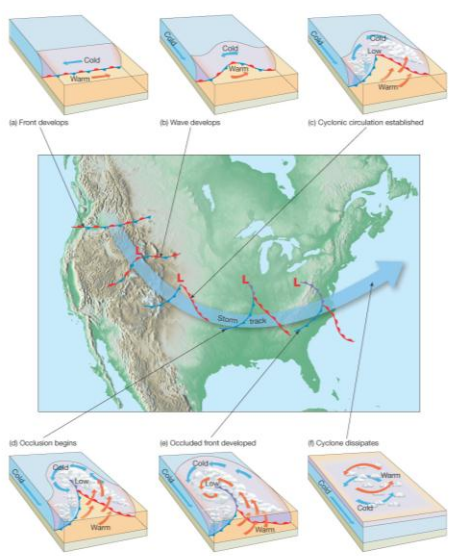
Cyclone dissipates

cold air mass surrounds the low at the surface

horizontal temperature gradient eliminated

(f) Cyclone dissipates



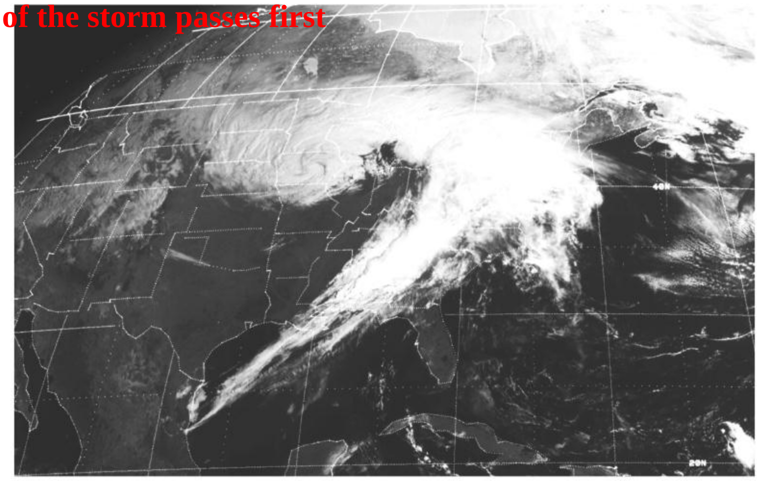


Idealized Weather of a Midlatitiude Cyclone

Cyclone generally move from west to east

Steered by the general westerly circulation

Right side of the storm passes first



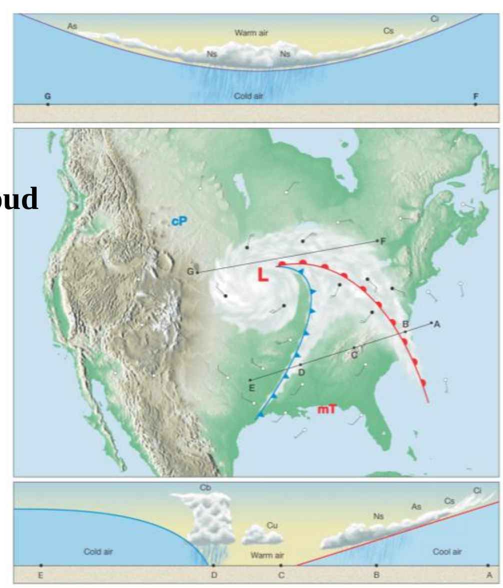
(b)

Idealized Weather of a Midlatitiude Cyclone

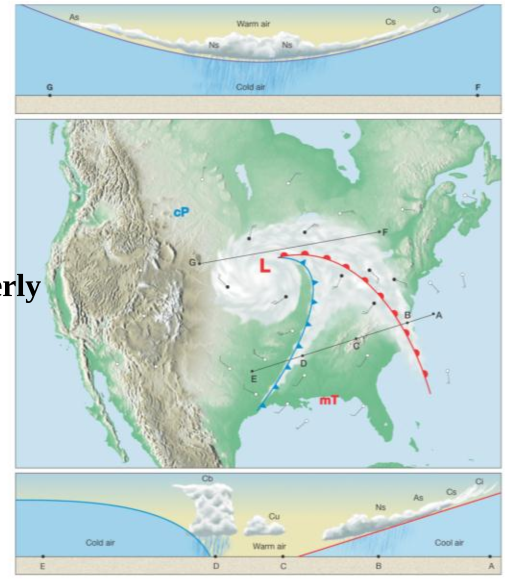
A) Cirrus clouds

Front ~1200 km away

Warm front advances, cloud base lowers (cirrostratus, altostratus, stratus)



Idealized Weather of a Midlatitiude Cyclone



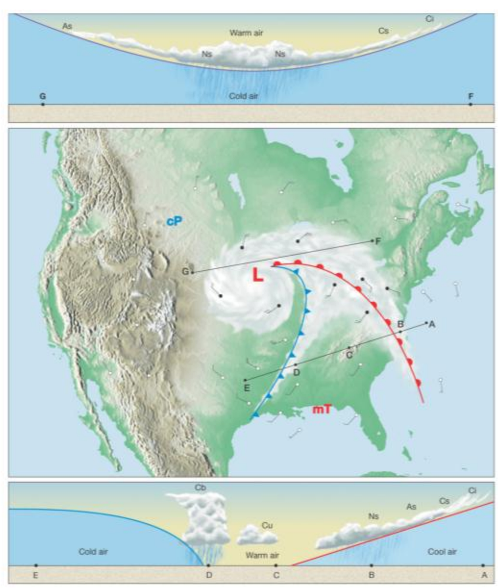
B) **Nibostratus clouds**

Light precipitation, gets heavier as front advances

Temperatures increase

Winds shift from an easterly direction to a southerly direction

Idealized Weather of a Midlatitiude Cyclone



C) **mT Air mass**

Warm, moist

Clear skies

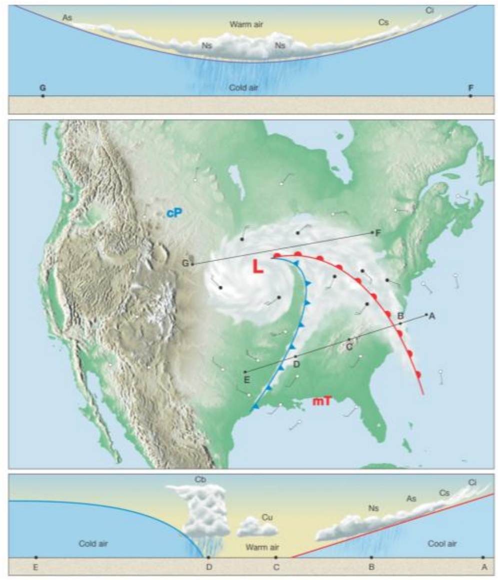
Southerly winds

Idealized Weather of a Midlatitiude Cyclone

D) Cumulonimbus Clouds

Heavy rains

Violent weather as cold front approaches



Idealized Weather of a Midlatitiude Cyclone

E) Temperatures Drop

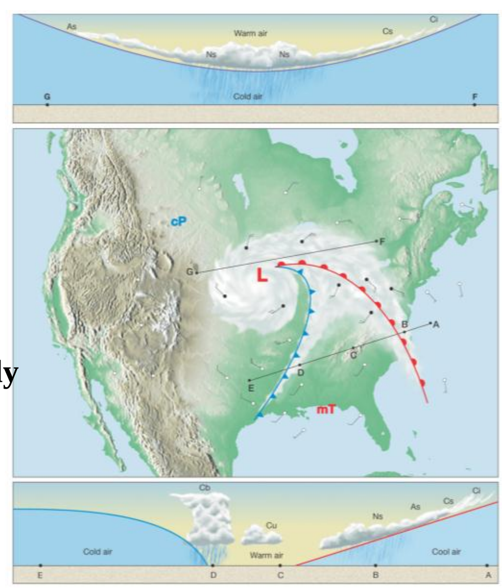
cP Air mass

Descending air

Clear skies

Low precipitation

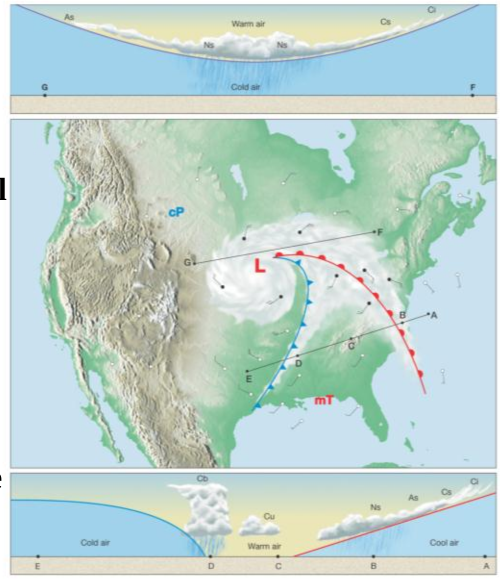
Wind shifts from southerly to westerly.



Idealized Weather of a Midlatitiude Cyclone

F-G)

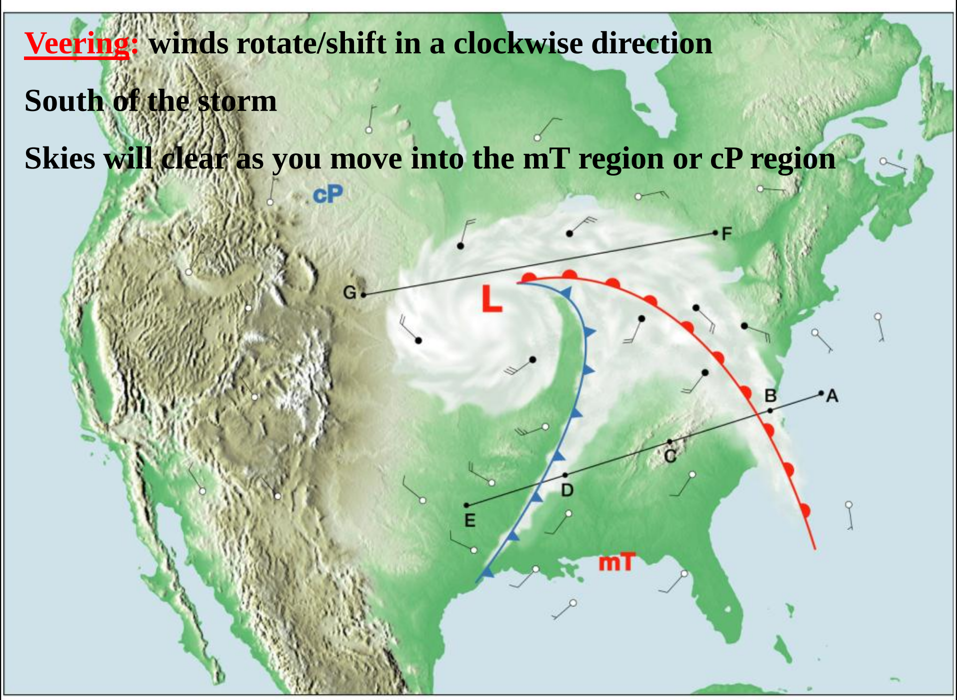
- Occluded front region
- Temperature remains cool
- Precipitation beneath the front
- Type of precipitation depends on the lower temperature profile
- OF moves slower than the warm or cold fronts
- System rotates



Veering: winds rotate/shift in a clockwise direction

South of the storm

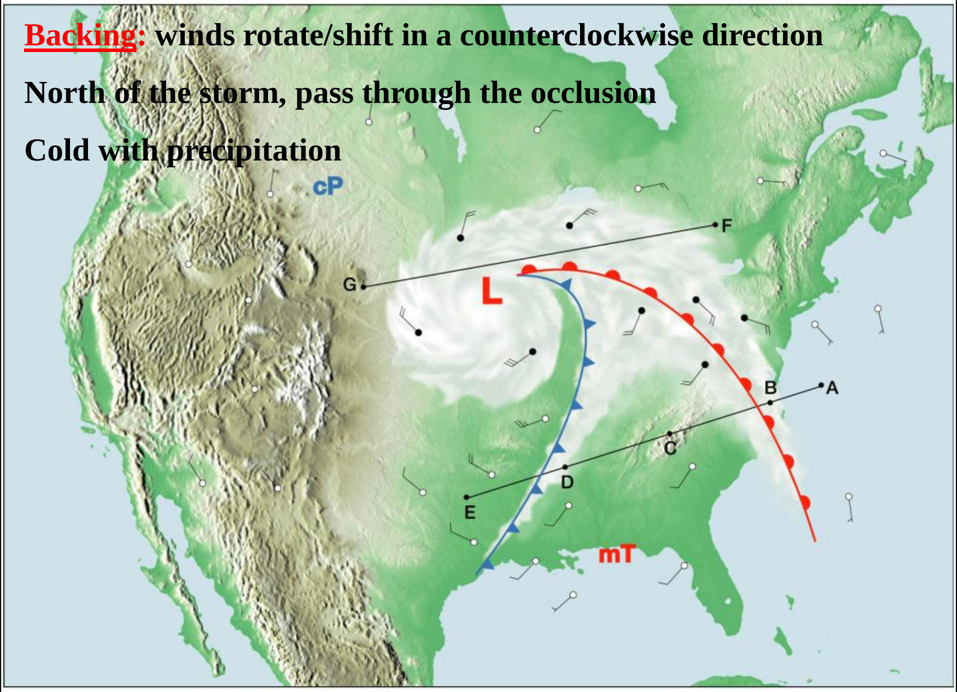
Skies will clear as you move into the mT region or cP region

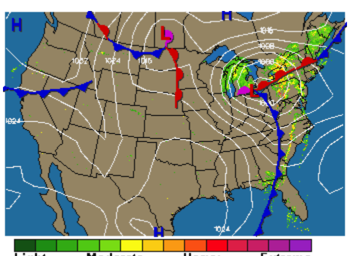


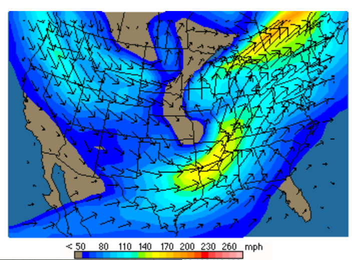
Backing: winds rotate/shift in a counterclockwise direction

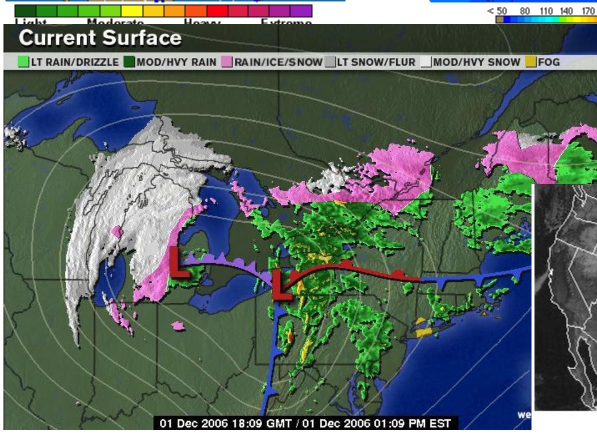
North of the storm, pass through the occlusion

Cold with precipitation









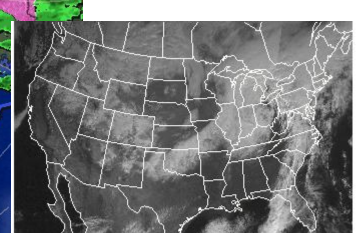


TABLE 9-A Wind, barometric pressure, and impending weather

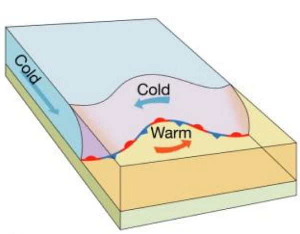
Changes in Wind Direction	Barometric Pressure	Pressure Tendency	Impending Weather
Any direction	1023 mb and above (30.20 in.)	Steady or rising	Continued fair with no temperature change
SW to NW	1013 mb and below (29.92 in.)	Rising rapidly	Clearing within 12 to 24 hours and colder
S to SW	1013 mb and below (29.2 in.)	Rising slowly	Clearing within a few hours and fair for several days
SE to SW	1013 mb and below (29.92 in.)	Steady or slowly falling	Clearing and warmer, followed by possible precipitation
E to NE	1019 mb and above (30.10 in.)	Falling slowly	In summer, with light wind, rain may not fall for several days; in winter, rain within 24 hours
E to NE	1019 mb and above (10.10 in.)	Falling rapidly	In summer, rain probable within 12 to 24 hours; in winter, rain or snow with strong winds likely
SE to NE	1013 mb and below (29.92 in.)	Falling slowly	Rain will continue for 1 to 2 days
SE to NE	1013 mb and below (29.92 in.)	Falling rapidly	Stormy conditions followed within 36 hours by clearing and, in winter, colder temperatures

Source: Adapted from the National Weather Service

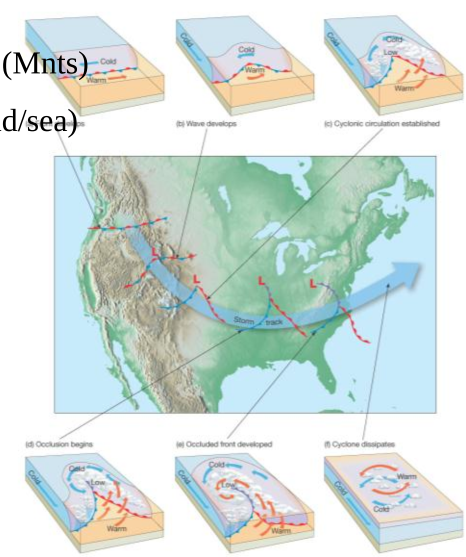
<u>Polar Front Theory</u> developed from surface observations

Wave develops

1. Topographic irregularities (Mnts)
2. Temperature contrasts (land/sea)
3. Ocean current influence (hurricanes)



(b) Wave develops

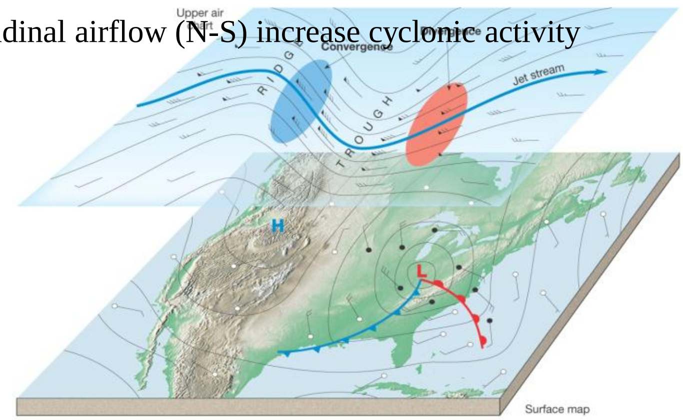


Conditions aloft

Surface cyclones are preceded by intensification of airflow aloft

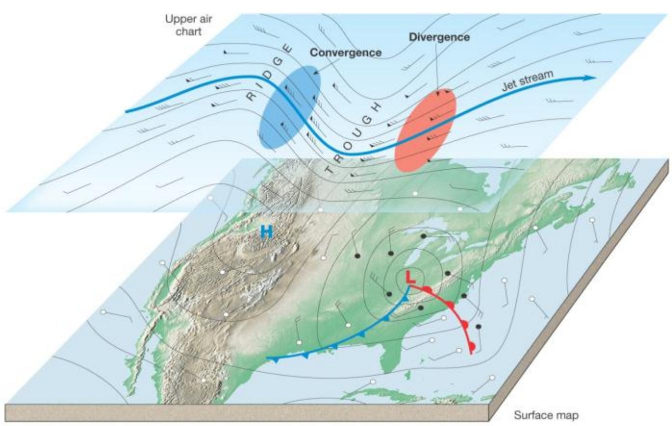
Zonal airflow (W-E) little cyclonic activity

Longitudinal airflow (N-S) increase cyclonic activity



Surface cyclone: centered below the jet stream

downwind of a upper level trough

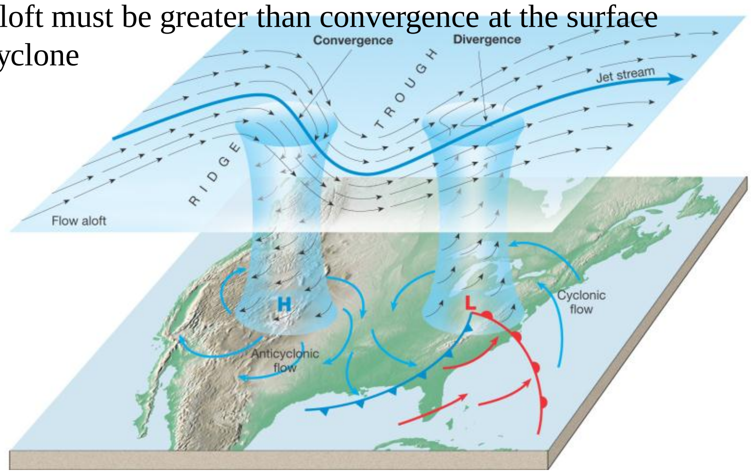


Cyclonic & Anticyclonic Circulation

Cyclones and anticyclones are typically found together

Surface divergence under an anticyclones feeds surface convergence under the cyclone

Divergence aloft must be greater than convergence at the surface under a cyclone

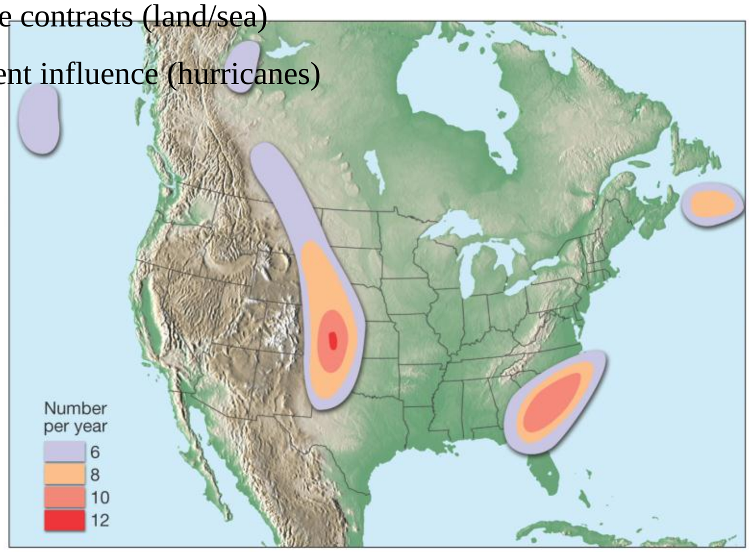


Regions of Cyclogenesis

- Topographic irregularities (Mnts)

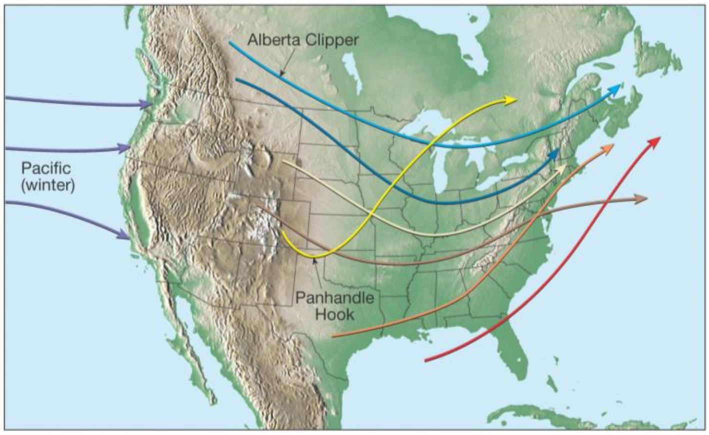
- Temperature contrasts (land/sea)

- Ocean current influence (hurricanes)



Storm Tracks: Patterns of Movement

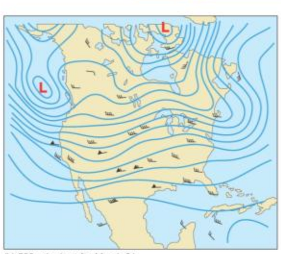
In general east to northeast track



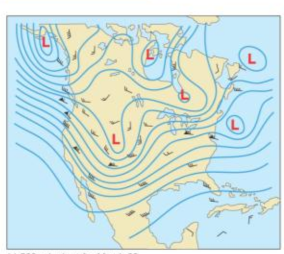
Most of the north Pacific storms that influence the west coast do not make it over the Rockies in tact (redevelop)

Storm Tracks: Patterns of Movement

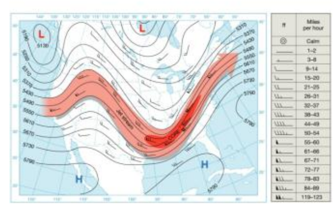
(a) Movement of cyclone from March 21-24

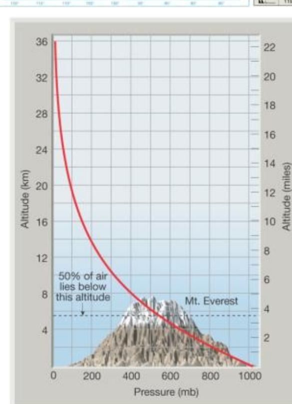


(b) 500-mb chart for March 21



(c) 500-mb chart for March 23



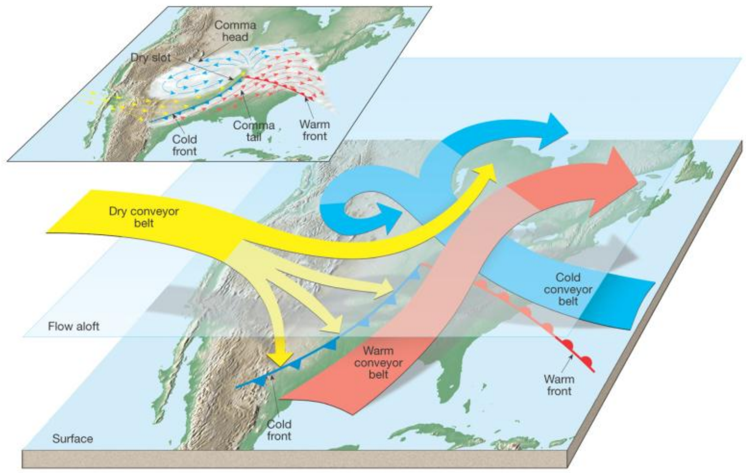


Modern View: The Conveyor Belt Model

3 intersecting air streams (belts)

2 belts originate at the surface and ascend

1 belt originates aloft and descends

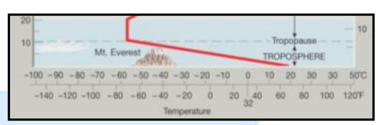


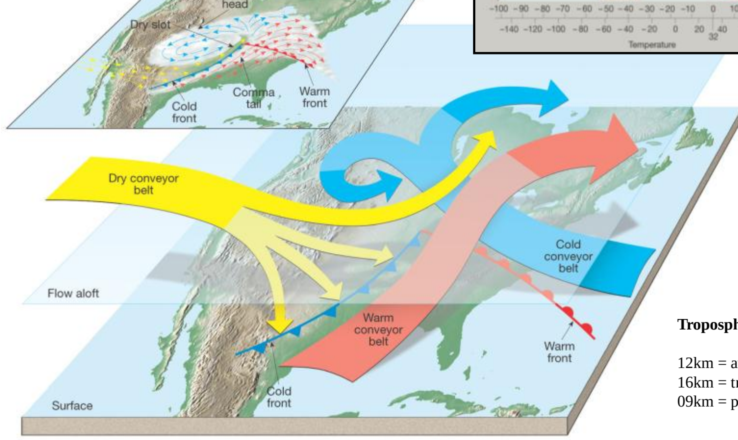
Warm Conveyor Belt:

mT air moves toward the middle of cylone, north over mP or cP air

Ascends to middle troposphere (JS) joins the general westerly flow

Primary producer of precipitation





Troposphere

12km = avg. thickness
16km = tropics
09km = poles

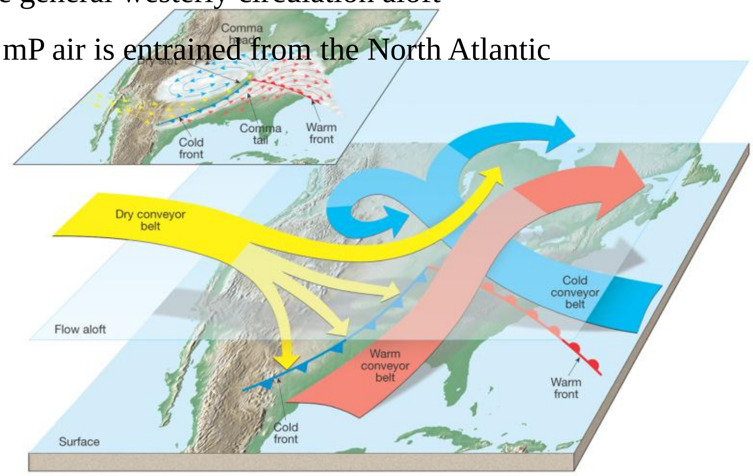
Cold Conveyor Belt:

Originates at surface ahead of the warm front

Flows westerly around the center and ascends, precipitation

Air joins the general westerly circulation aloft

Nor'easter, mP air is entrained from the North Atlantic



Dry Conveyor Belt:

Originates at the uppermost troposphere

Cold and dry

Splits and descends behind the cold front