Extratropical Cyclones
AOSC 200

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Class Web Site: http://www.atmos.umd.edu/~tcanty/aosc200

Topics for today:

Fronts
Cyclogenesis

Lecture 21
Nov 7 2019

Fronts

Front: transition between two air masses

The upward extension of the front is called the "Frontal Zone"

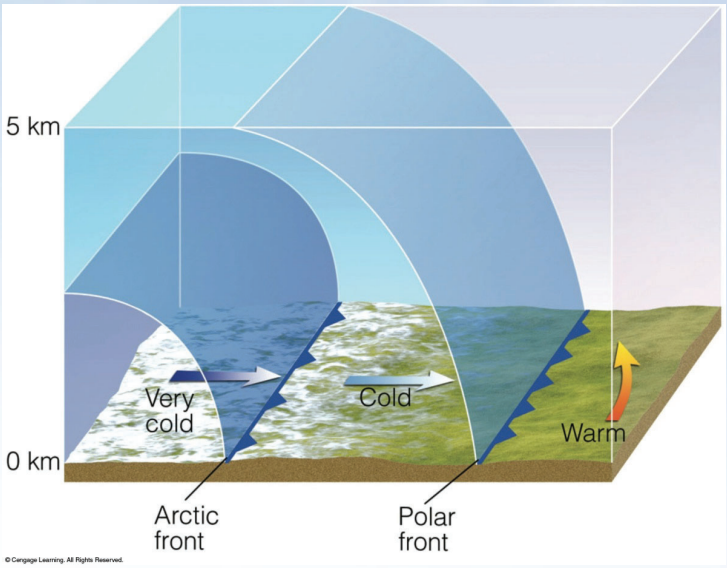
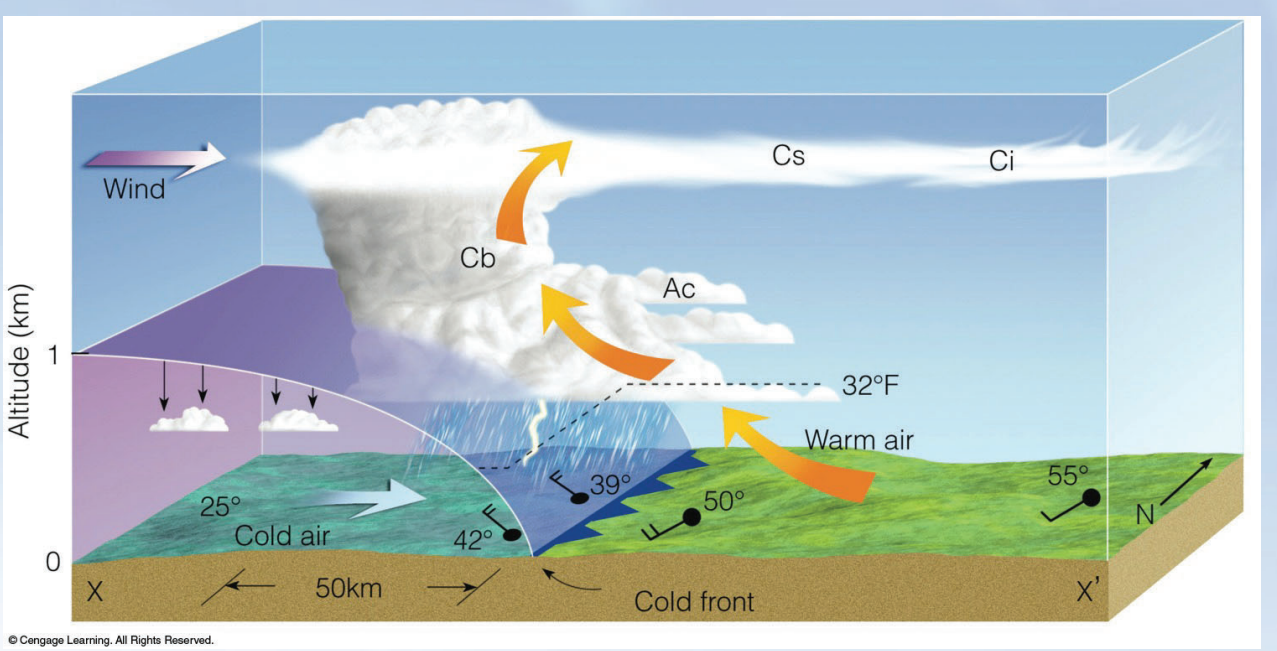


Fig 8.13: ***Essentials of Meteorology***

Cold Fronts



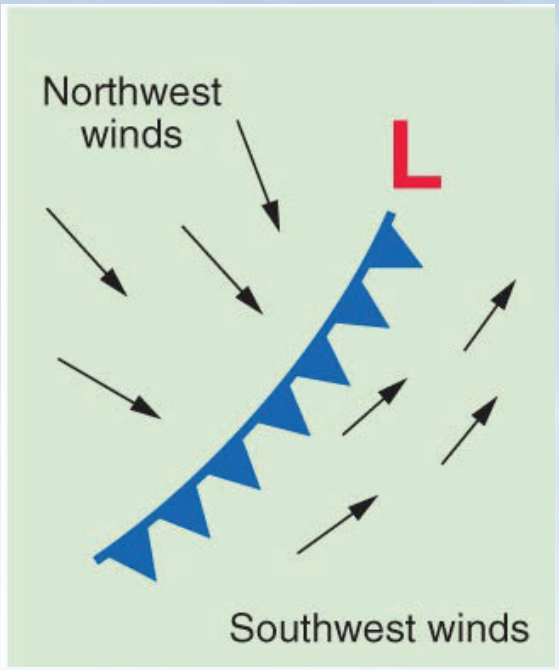
Represented as blue triangles pointing toward warm air

Travels ~25 knots

Warm air forced up, cools, releases latent heat, leads to storms

Fig 8.17: ***Essentials of Meteorology***

Cold Fronts



As cold front moves through, temps. hold steady then drop

Pressure drops then rises after front passes

Precipitation forms along leading edge of front, "squall line"

Winds shift from southwest to northwest

Cold fronts generally move to the south, southeast, or east

Fig 9-13 *Meteorology: Understanding the Atmosphere*

Warm Fronts

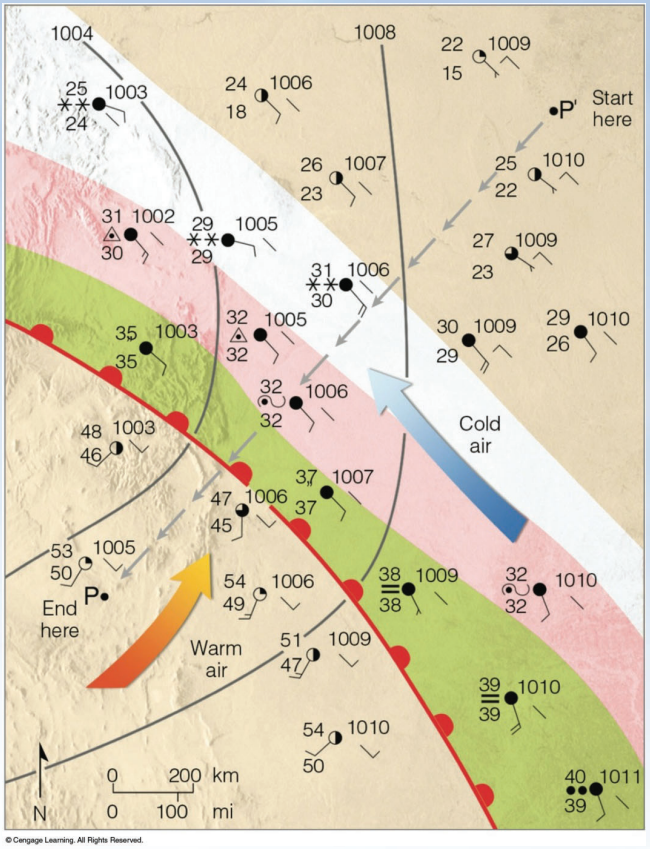
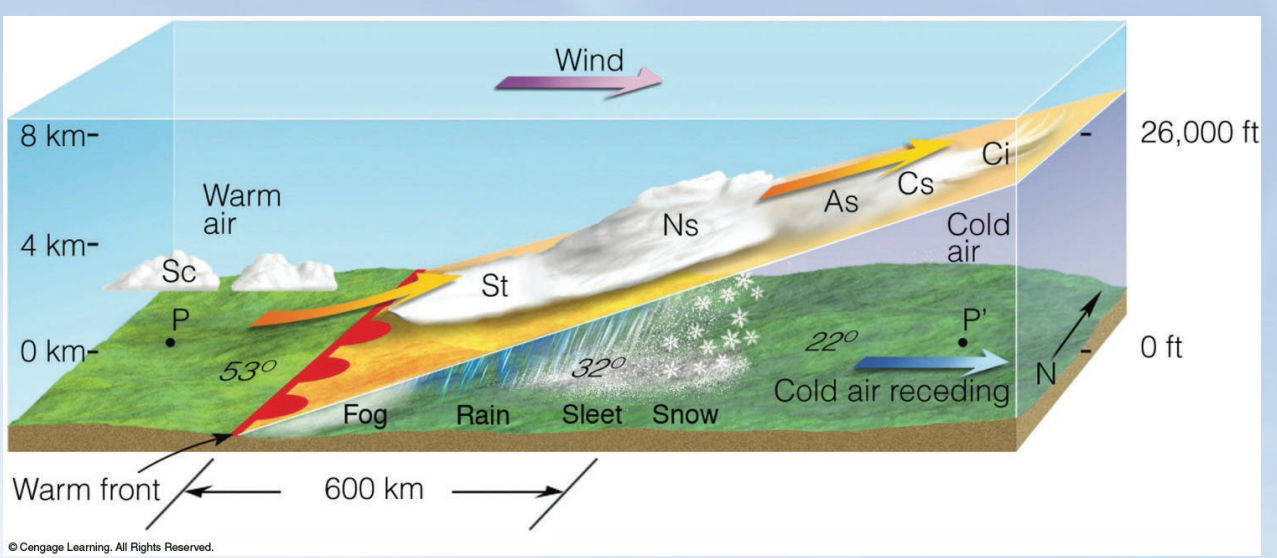


Fig 8.19: ***Essentials of Meteorology***

Warm Fronts



Represented as red semi-circles pointing toward cold air

Travels ~10 knots

Warm air slides over cold air and slowly cools.

As front approaches, cirrostratus become altostratus then stratus

Fig 8.20: ***Essentials of Meteorology***

Warm Fronts

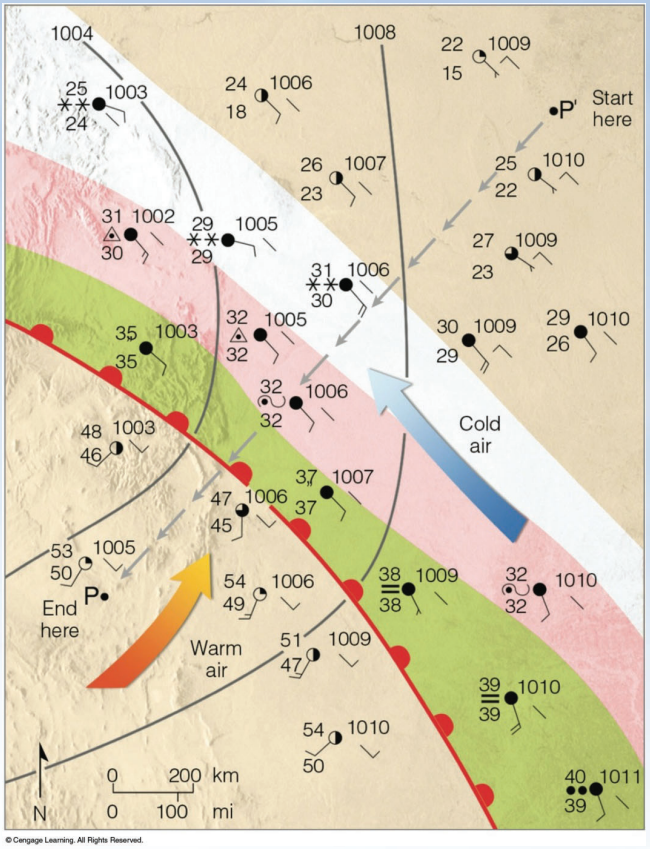
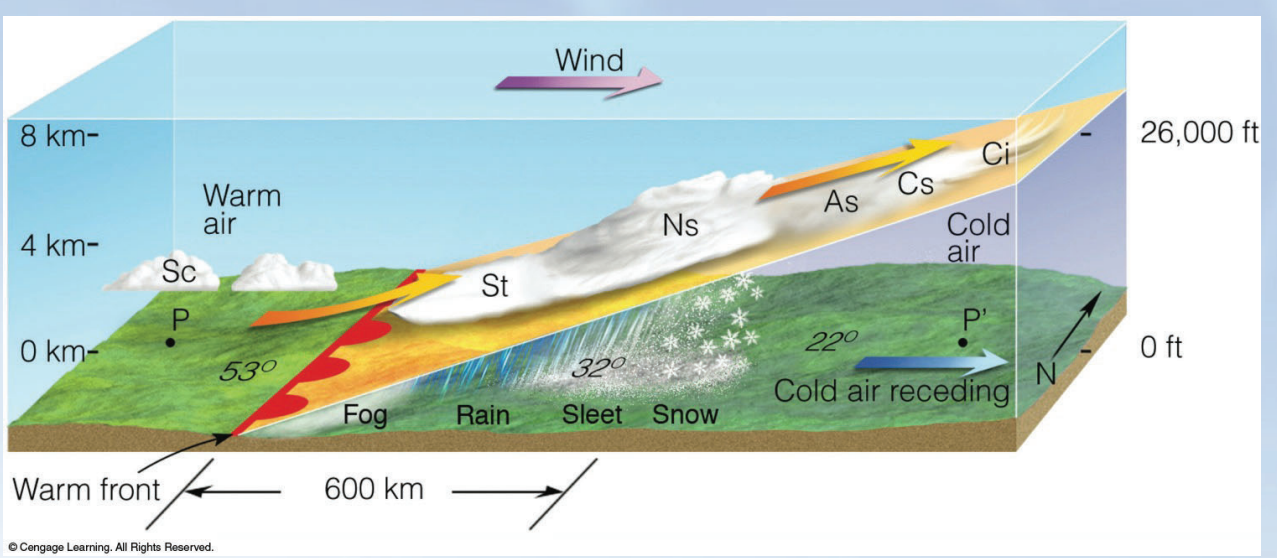


Fig 8.19: ***Essentials of Meteorology***

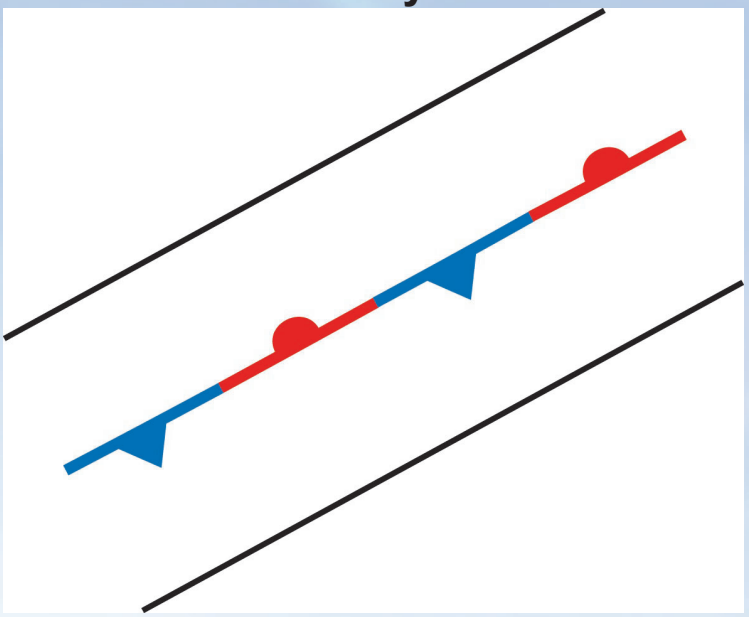
Warm Fronts



Winds change from south or southeast to south or southwest

Fig 8.20: ***Essentials of Meteorology***

Stationary Fronts



Represented as red semi-circles and blue triangles

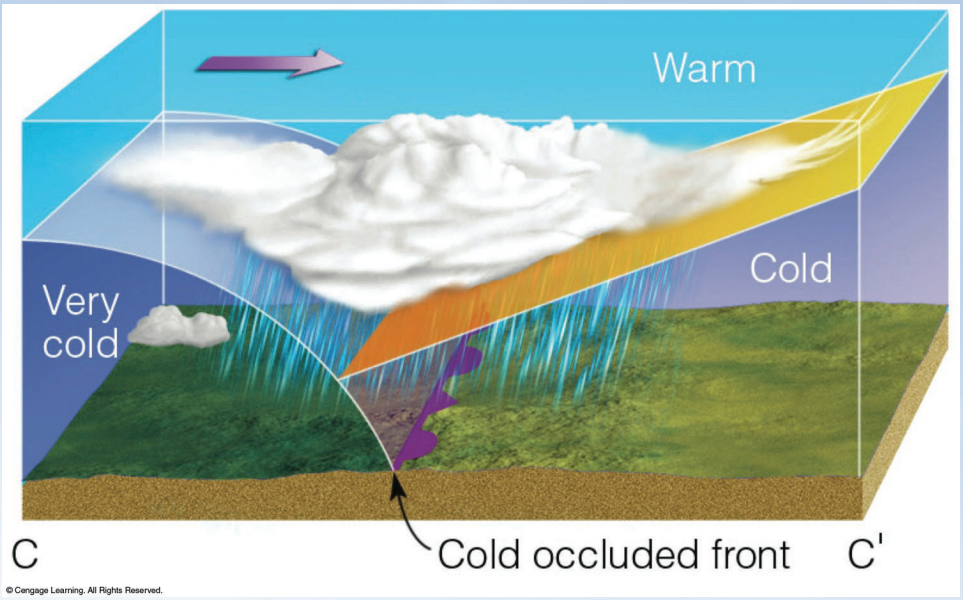
Front doesn't move

Winds blow along front but in opposite directions

Fig 10.3 *Weather: A Concise Introduction*

Occluded Fronts (cold type occlusion)

cP



mP

Cold front moves faster than warm front, may catch warm front

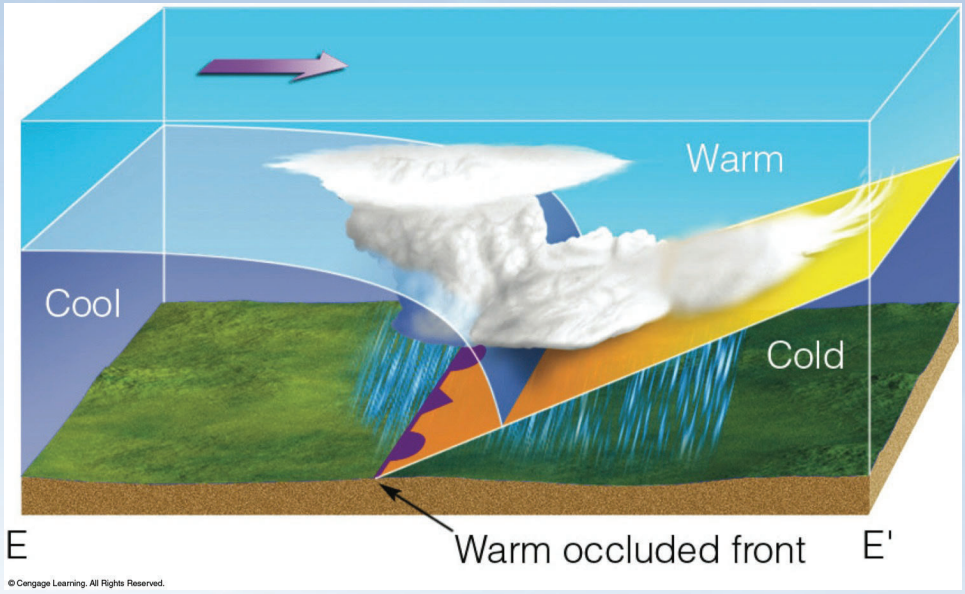
Warm air is forced up over both cold/very cold air masses

May have mix of clouds similar to both cold and warm fronts

Fig 8.22: ***Essentials of Meteorology***

Occluded Fronts (warm type occlusion)

mP



cP

Cold front moves faster than warm front, may catch warm front

Cool air is forced up over cold air mass

May have mix of clouds similar to both cold and warm fronts

Fig 8.22: *Essentials of Meteorology*

Warm type occluded Front

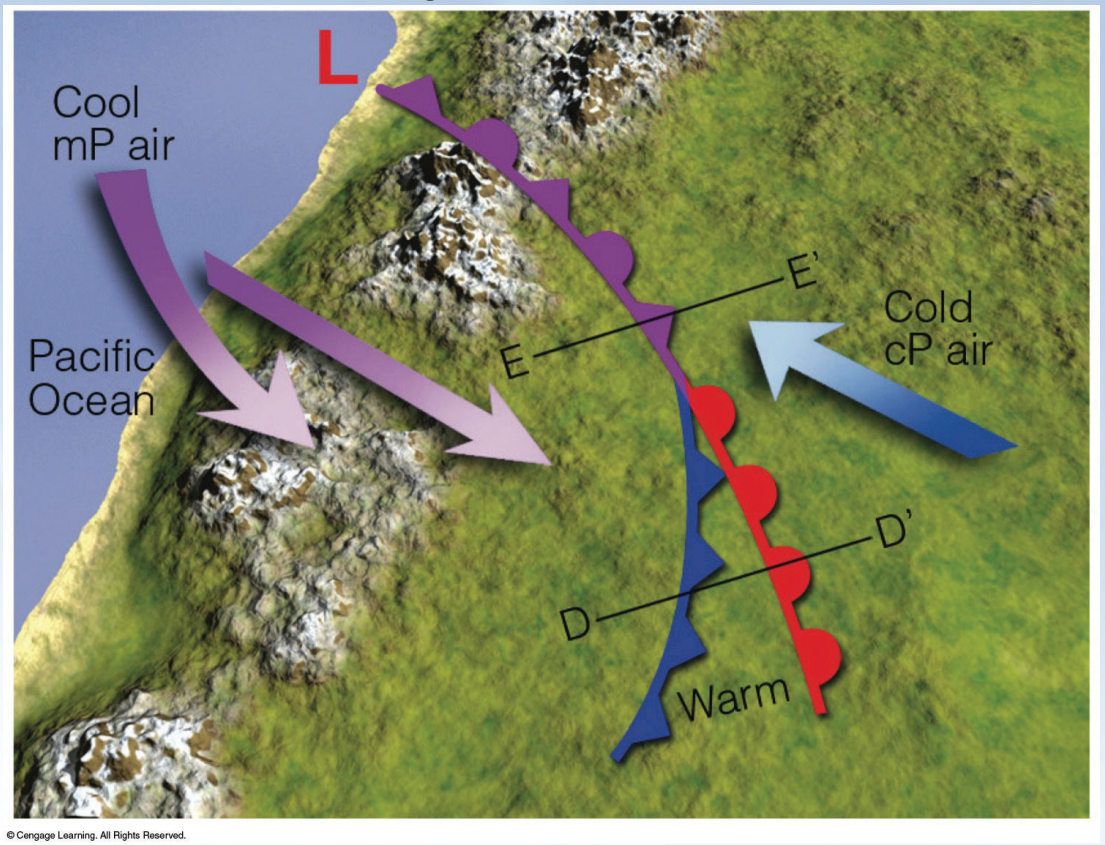
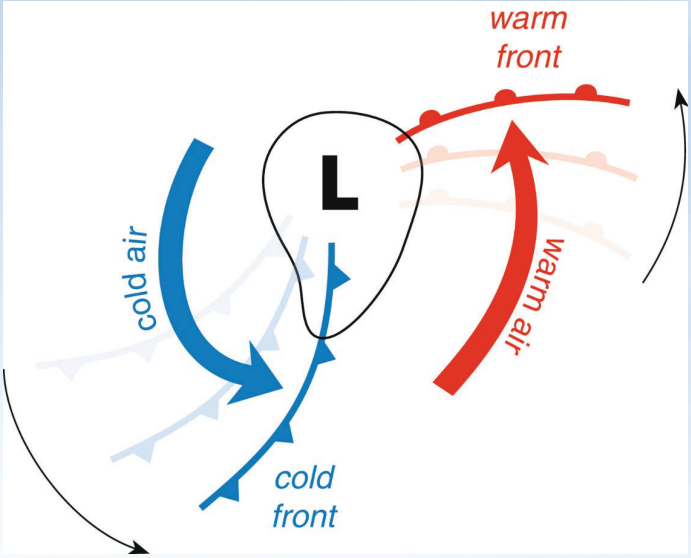


Fig 8.23: *Essentials of Meteorology*

Mid-latitude cyclones



Cold, warm, and occluded fronts are often part of a larger system called the *mid-latitude* or *extra-tropical cyclone*

Fig 10.2 *Weather: A Concise Introduction*

Cyclone Model

1920's: Bjerknes described the evolution of cyclones

Begins as a frontal wave along stationary front separating cP air from mT air – birth stage

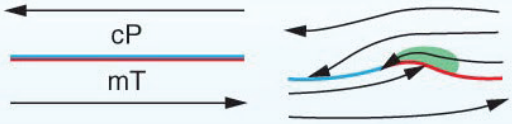
Stage	Weather Map Depiction of Norwegian Cyclone Model	Typical Satellite Image of Life-Cycle Stage	Typical Sea-Level Pressure at Cyclone Center
Birth (frontal wave)			1000-1010 mb

Table 10-1 *Meteorology: Understanding the Atmosphere*

Cyclone Model

1920's: Bjerknes described the evolution of cyclones

Open wave develops strong cold and warm fronts, precipitations falls along broad area – young adult stage

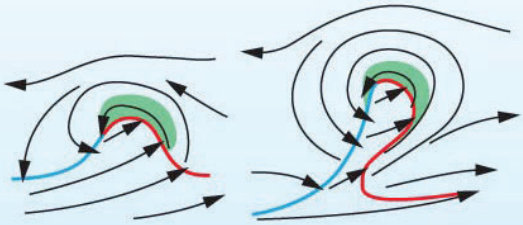
Stage	Weather Map Depiction of Norwegian Cyclone Model	Typical Satellite Image of Life-Cycle Stage	Typical Sea-Level Pressure at Cyclone Center
Young adult (open wave)			990-1000 mb

Table 10-1 *Meteorology: Understanding the Atmosphere*

Cyclone Model

1920's: Bjerknes described the evolution of cyclones

Occluded front develops, pressure reaches minimum, winds reach maximum, – mature stage

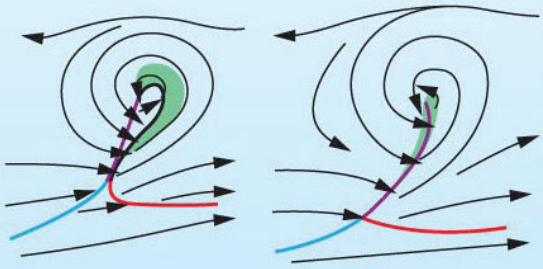
Stage	Weather Map Depiction of Norwegian Cyclone Model	Typical Satellite Image of Life-Cycle Stage	Typical Sea-Level Pressure at Cyclone Center
Mature (occluded cyclone)			960-990 mb

Table 10-1 *Meteorology: Understanding the Atmosphere*

Cyclone Model

1920's: Bjerknes described the evolution of cyclones

Cut-off cyclone develops, pressure rises, clouds and precipitation dissipates – death stage ☹

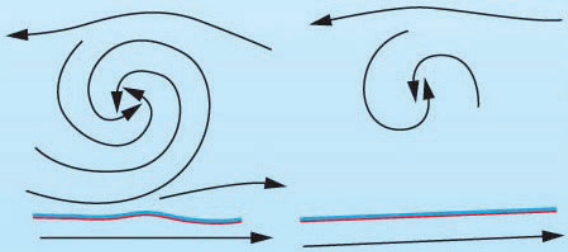
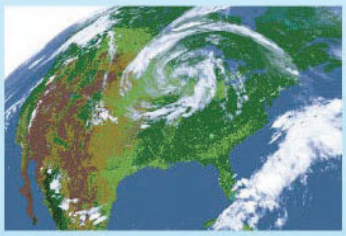
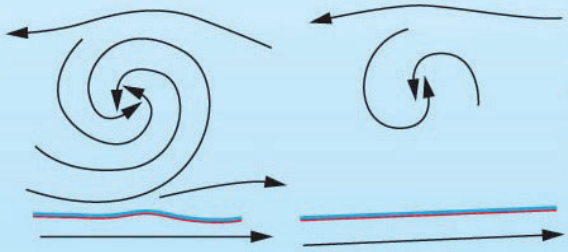
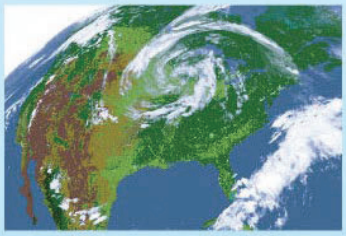
Stage	Weather Map Depiction of Norwegian Cyclone Model	Typical Satellite Image of Life-Cycle Stage	Typical Sea-Level Pressure at Cyclone Center
Death (cut-off cyclone)			Slowly rising from 960-990 mb up to 1010 mb

Table 10-1 *Meteorology: Understanding the Atmosphere*

Cyclone Model

1920's: Bjerknes described the evolution of cyclones

Cut-off cyclone develops, pressure rises, clouds and precipitation dissipates – death stage ☹

Stage	Weather Map Depiction of Norwegian Cyclone Model	Typical Satellite Image of Life-Cycle Stage	Typical Sea-Level Pressure at Cyclone Center
Death (cut-off cyclone)			Slowly rising from 960-990 mb up to 1010 mb

Cyclogenesis needs: temperature gradients, strong jet stream, and surface boundary (mountain, coastline near warm ocean)

Table 10-1 *Meteorology: Understanding the Atmosphere*

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Regions of Cyclogenesis

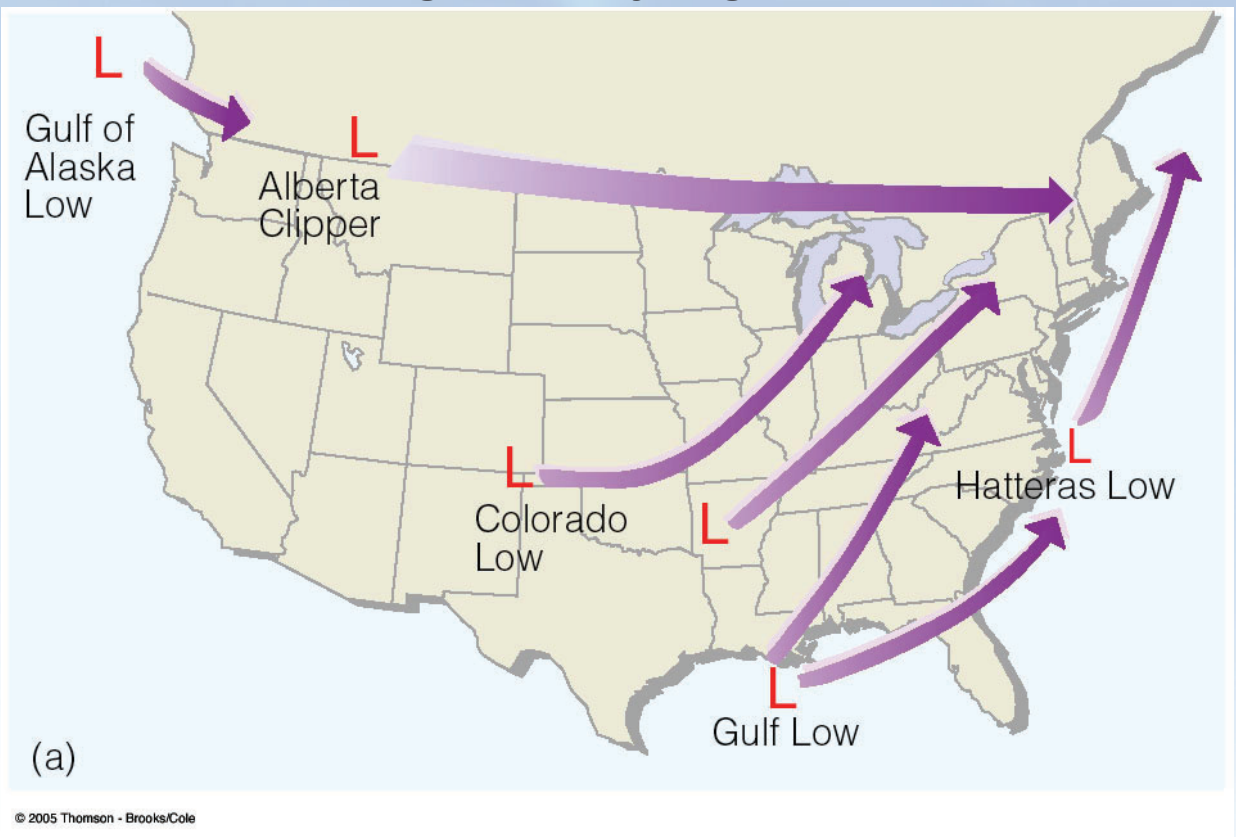
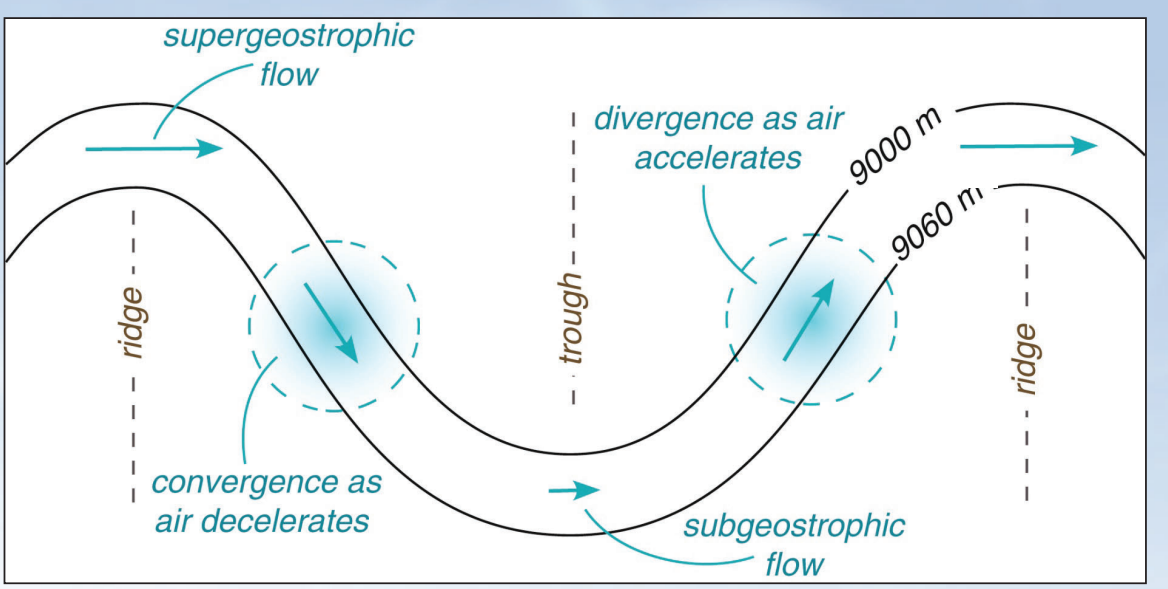


Fig 8.28: ***Essentials of Meteorology***

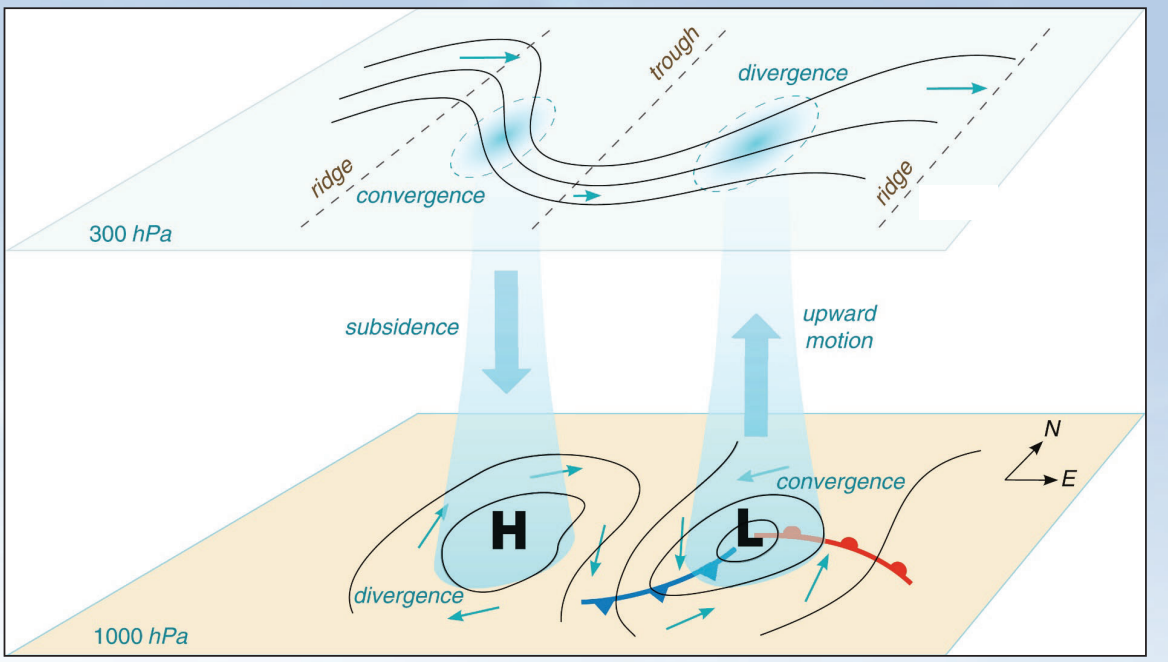
Cyclogenesis in 3-D



Surface high pressure directed to southeast by jet stream
Surface low pressure directed northeast by jet stream

Fig 10.10 *Weather: A Concise Introduction*

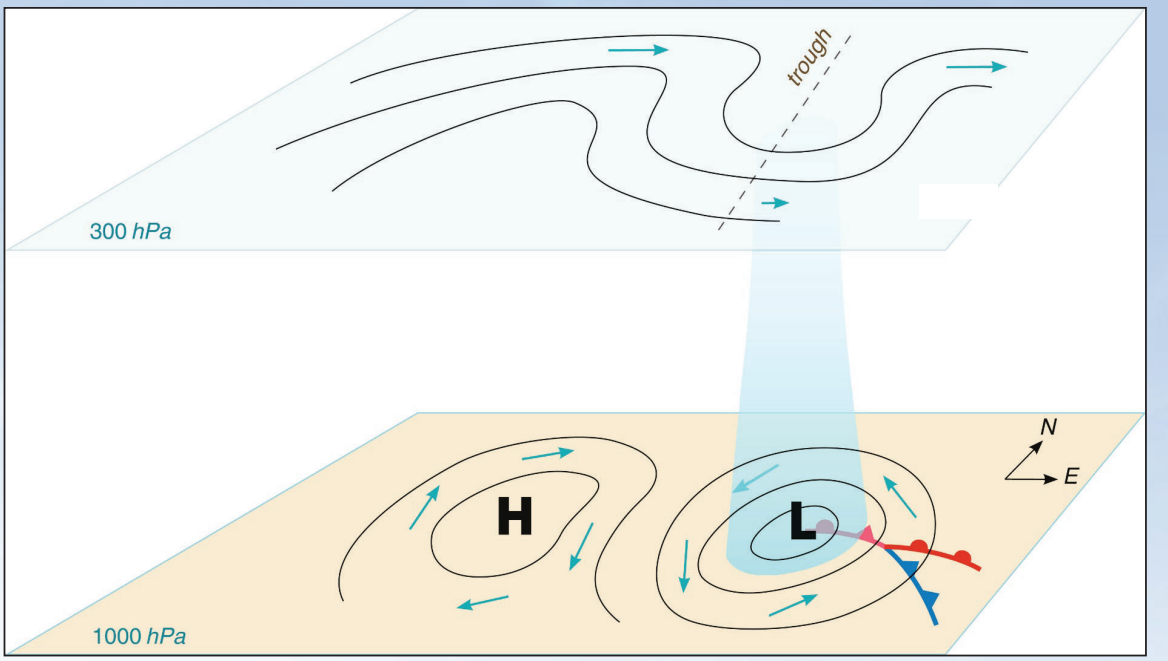
Cyclogenesis in 3-D



Surface high pressure directed to southeast by jet stream
Surface low pressure directed northeast by jet stream

Fig 10.11 *Weather: A Concise Introduction*

Cyclogenesis in 3-D



Upper level trough moves over the surface low and the cyclone begins to decay.

Fig 10.12 *Weather: A Concise Introduction*

Cyclogenesis in 3-D

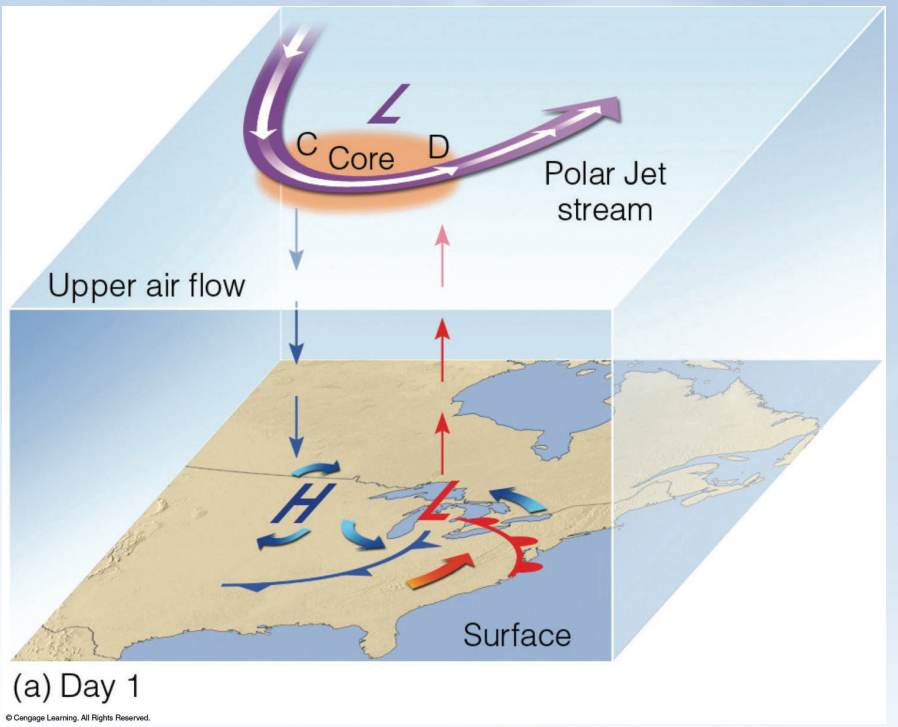


Fig 8.33: *Essentials of Meteorology*

Cyclogenesis in 3-D

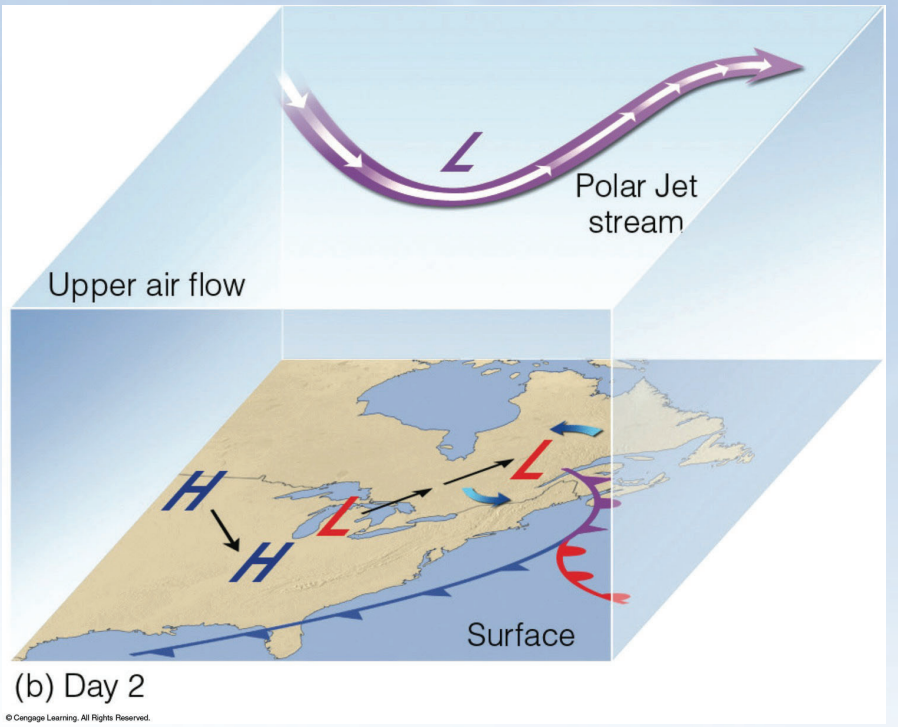
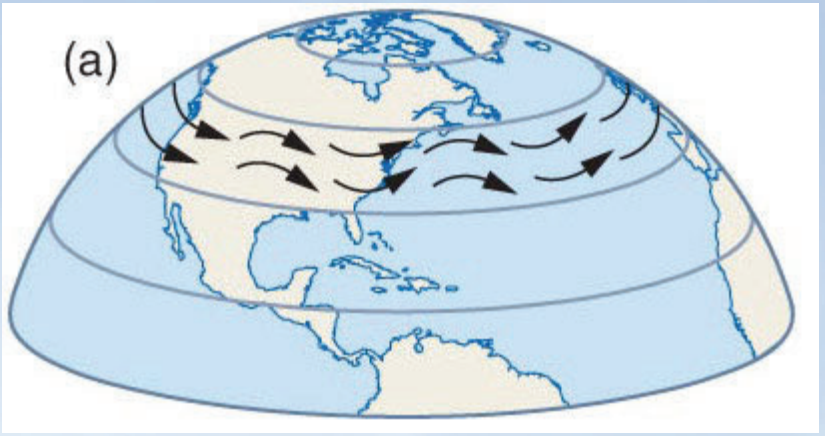


Fig 8.33: *Essentials of Meteorology*

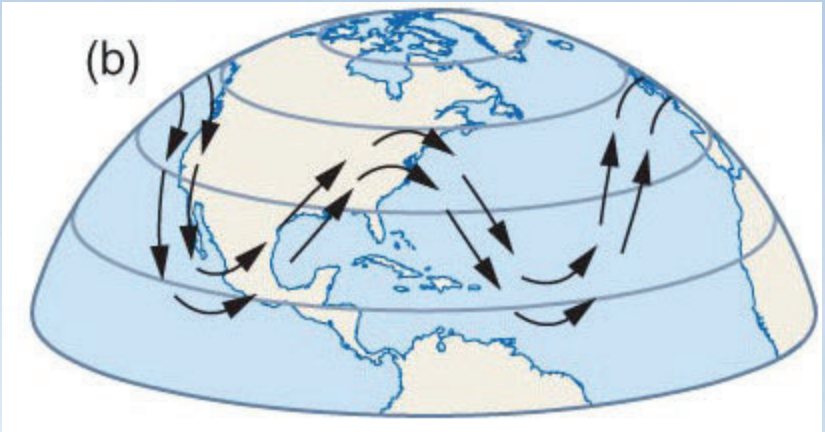
Rossby Waves



Zonal Flow: Jet stream moves from west to east without meandering around much

Fig 7-15 *Meteorology: Understanding the Atmosphere*

Rossby Waves



Meridional Flow: Jet stream wanders around a lot as the wind moves from west to east

Sometimes happens when a large pacific storm hits the jet stream

Fig 7-15 *Meteorology: Understanding the Atmosphere*

Rossby Waves