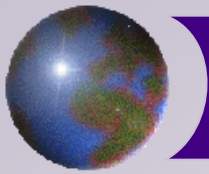


Midlatitude Cyclones

GEOG/ENST 2331 – Lecture 17

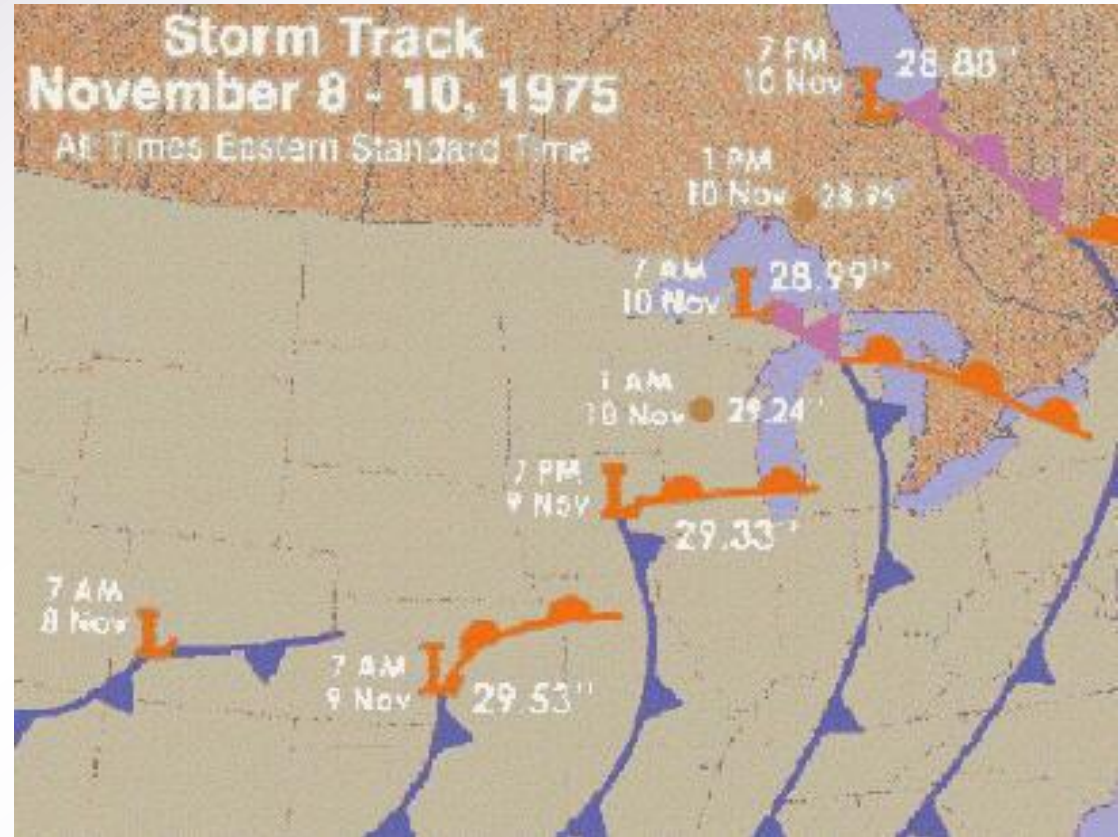
Ahrens: Chapter 12

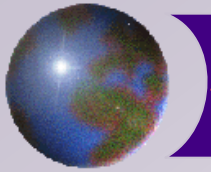


Wreck of the Edmund Fitzgerald

November 10, 1975:
SS Edmund Fitzgerald
sank in Lake Superior as
a result of a strong
midlatitude cyclone.
29 lives were lost.

Music (1976) by Gordon
Lightfoot





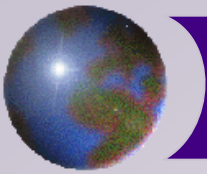
Last lecture

☀ Fronts

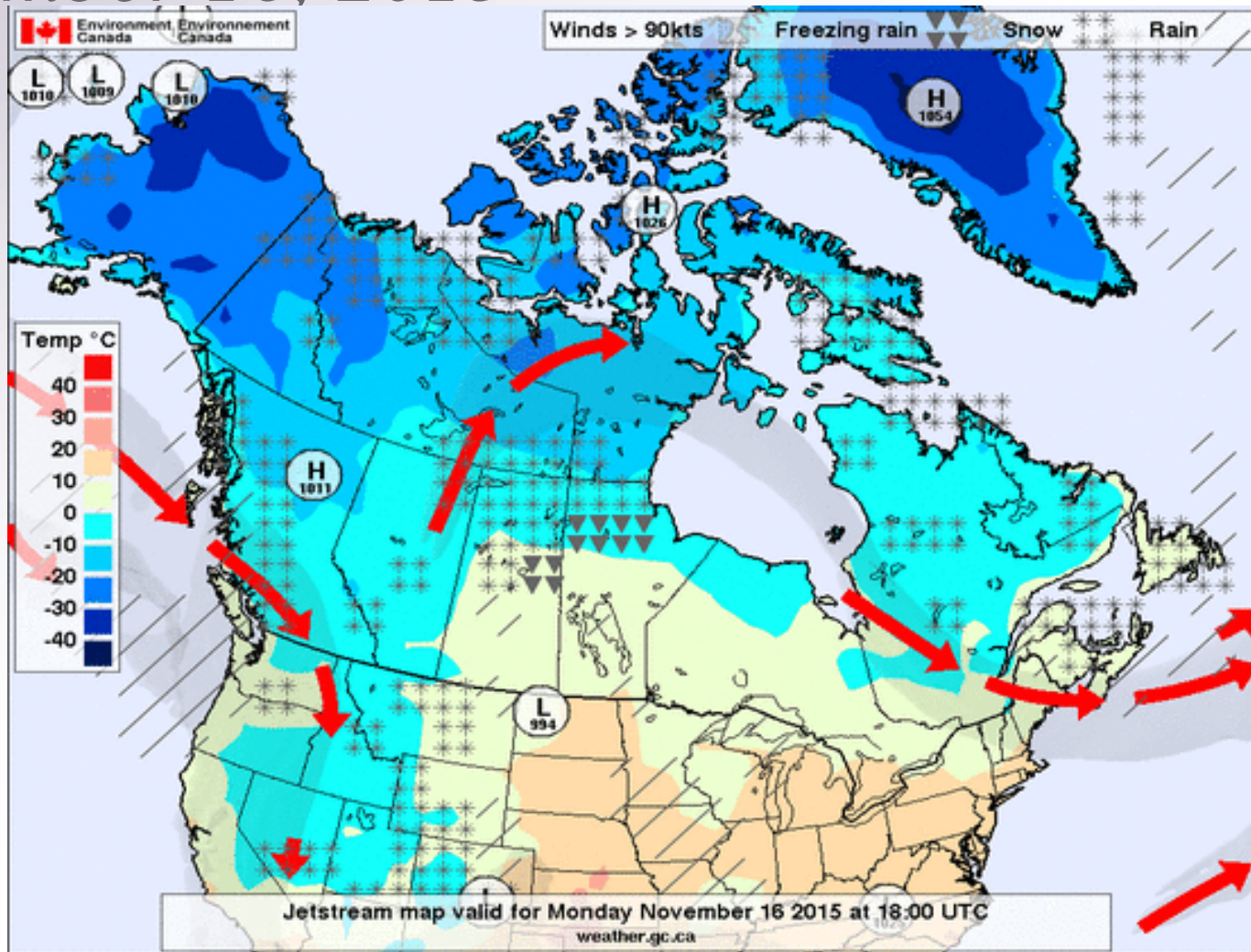
- ☒ Warm and cold fronts
- ☒ Warm and cold occluded fronts
- ☒ Drylines

☀ Station model

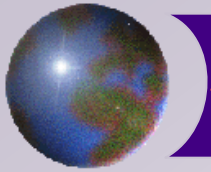
- ☒ Reading temperature, pressure, etc.



November 16, 2015

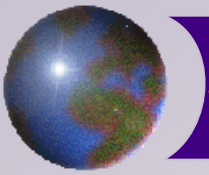


Source: Environment Canada



Midlatitude cyclones

- ❖ **Life cycle of a cyclone**
 - ❖ **Polar front theory**
- ❖ Upper level divergence
 - ❖ Baroclinic instability
 - ❖ Vorticity
 - ❖ Lower atmosphere influence

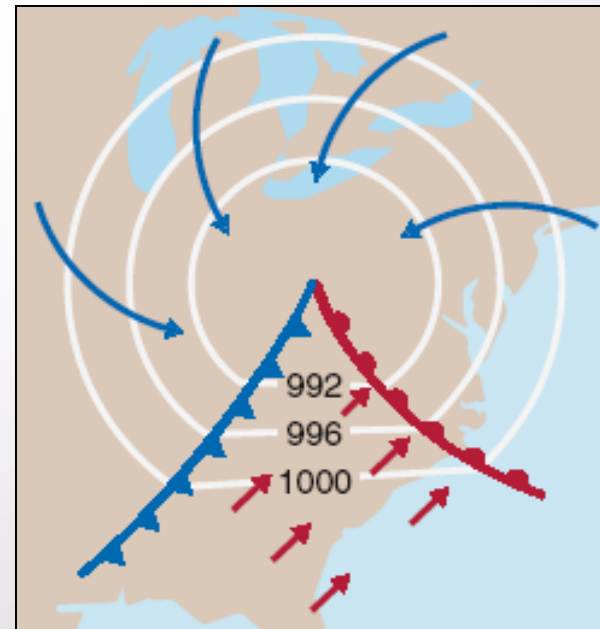
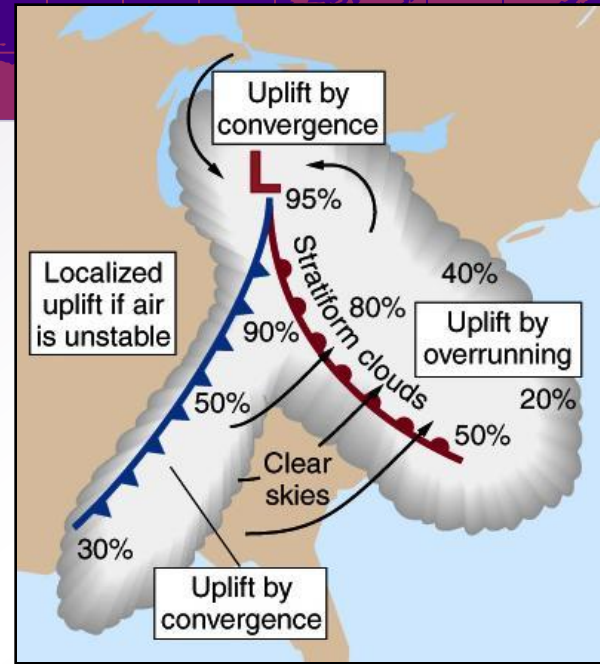


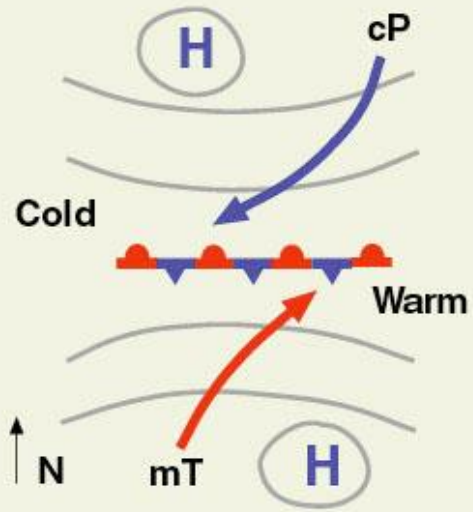
Midlatitude Cyclone

The principal 'weather maker' in midlatitudes

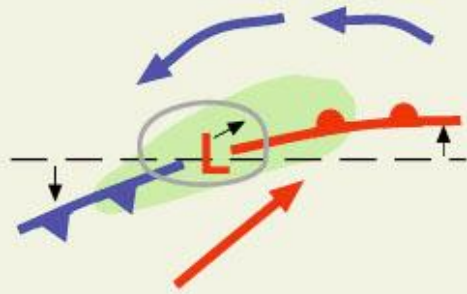
Development of a low pressure begins with a small perturbation or disturbance along the polar front

A&B: Figure 10-2

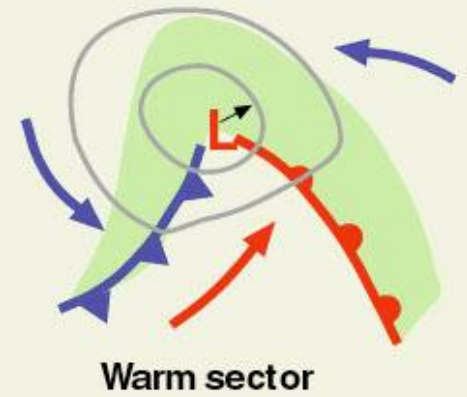




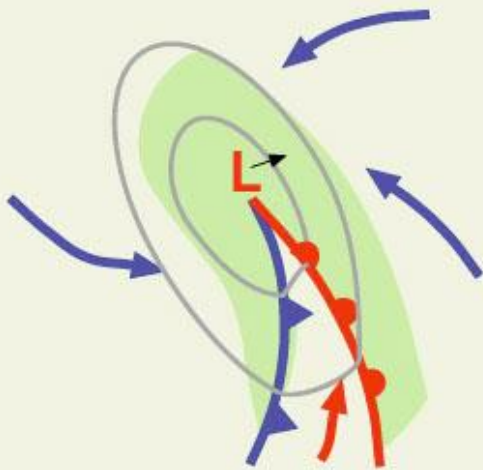
(a)



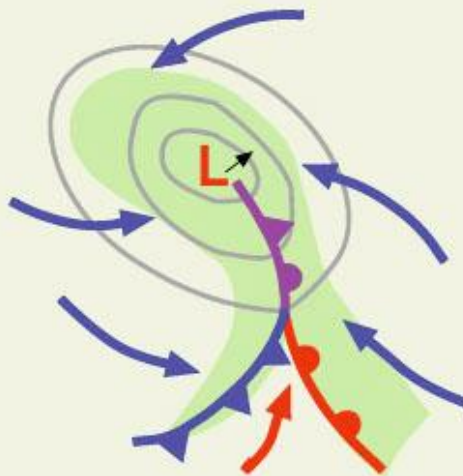
(b)



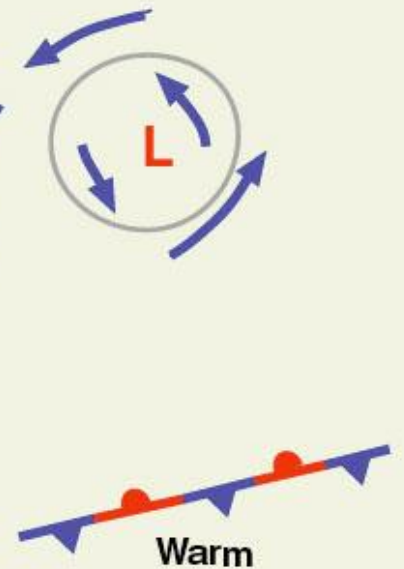
(c)



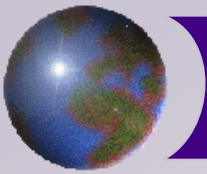
(d)



(e)



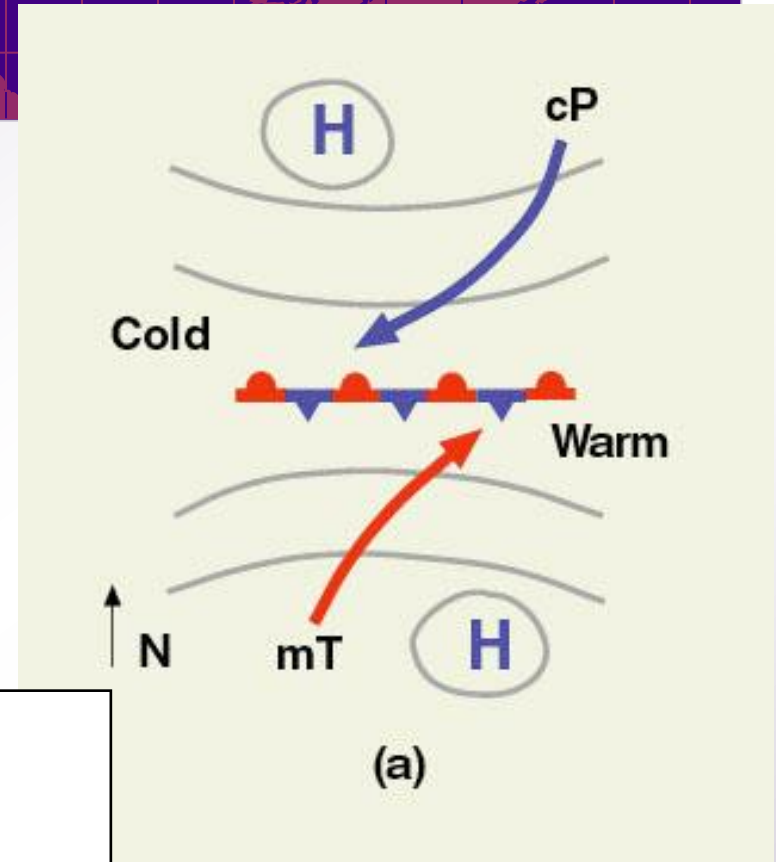
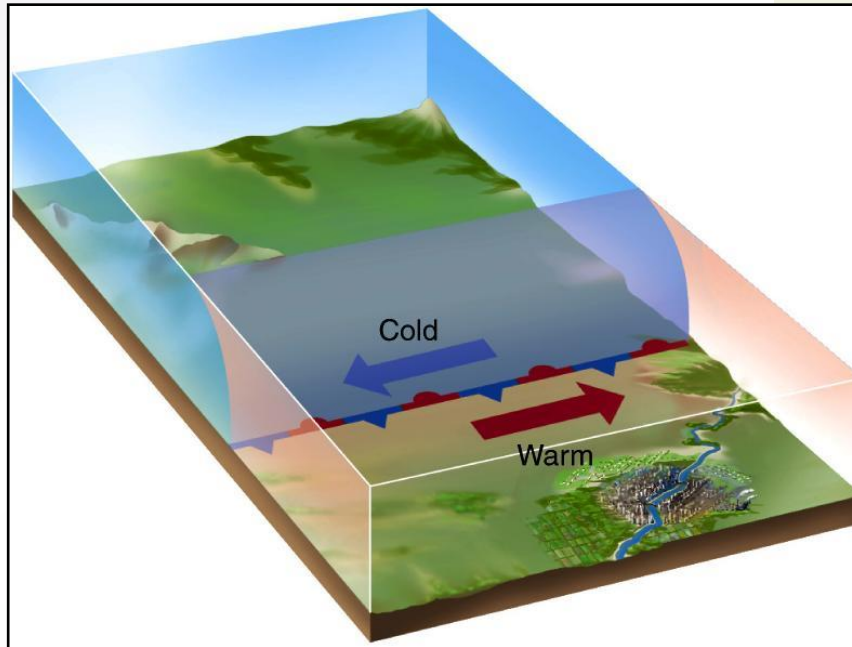
(f)



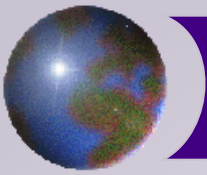
Stationary front

Step One

Stationary front with a strong horizontal wind shear



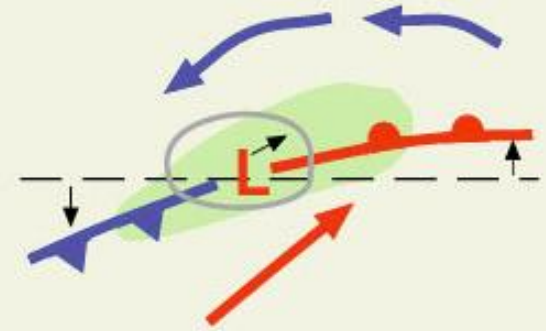
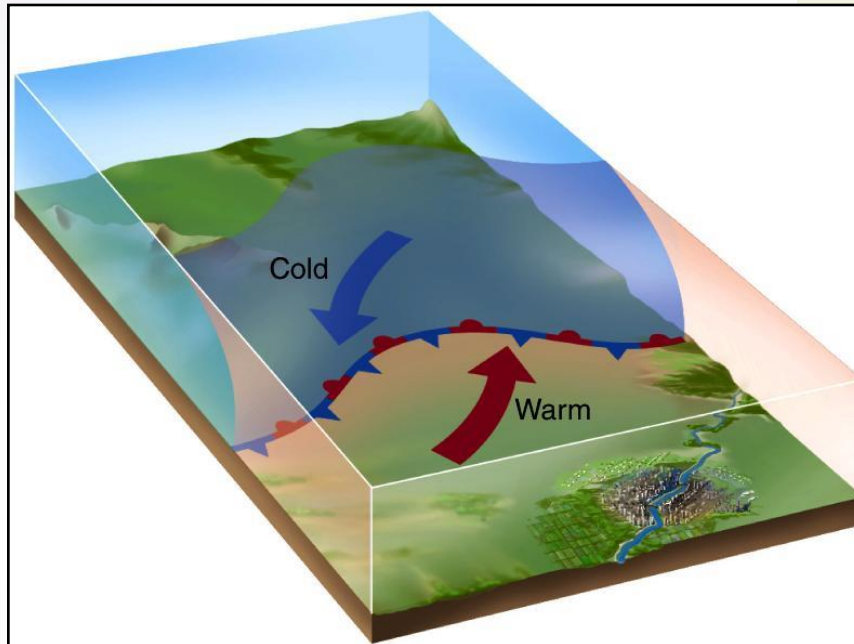
A&B: Figure 10-1



Cyclogenesis begins

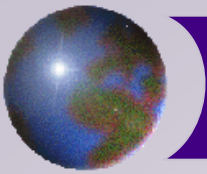
Step Two

Under certain conditions a kink or small disturbance forms along the polar front



(b)

A&B: Figure 10-1

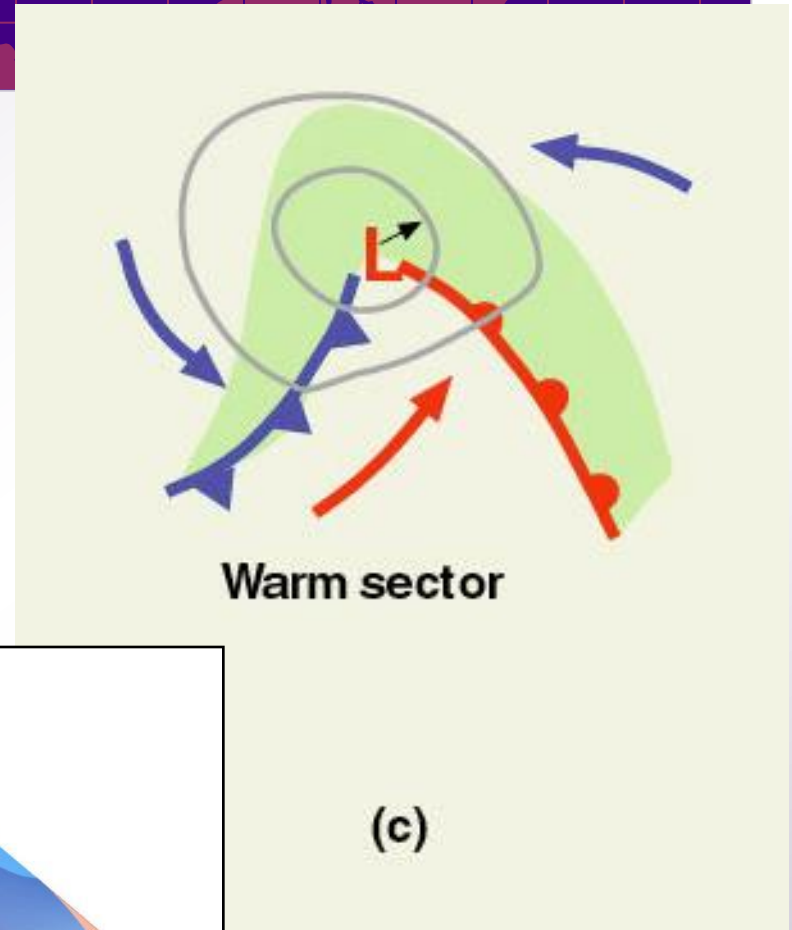
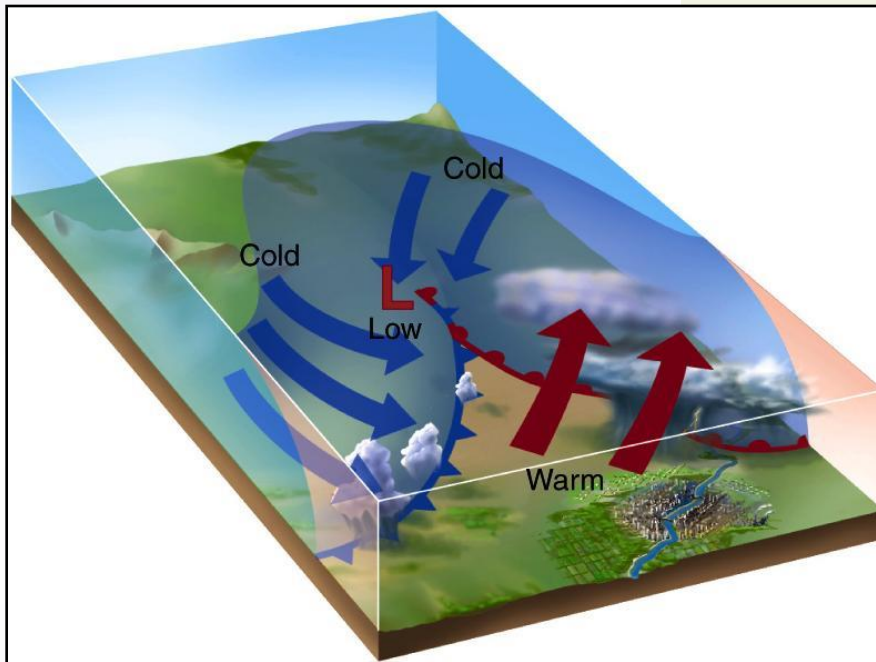


Mature cyclone

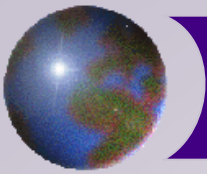
Step 3

Fully developed wave

The wave moves east or northeast. It takes 12 to 24 hours to reach this stage of development



A&B: Figure 10-1



Occlusion

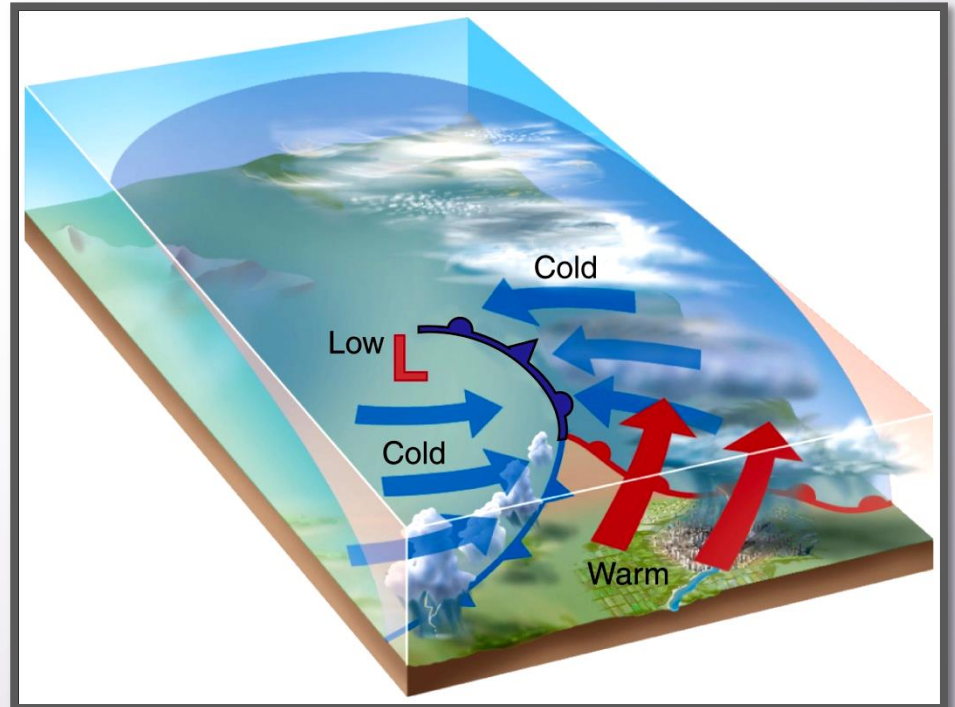
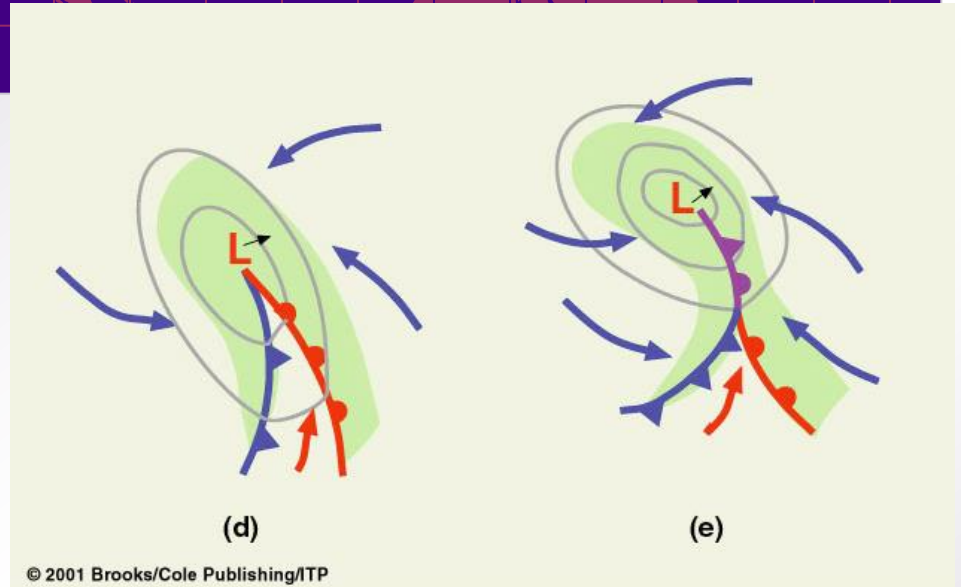
Step 4

The faster moving cold front catches up with the warm front.

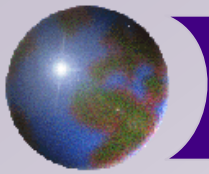
Step 5

Occlusion occurs.

Low pulls back from the fronts.



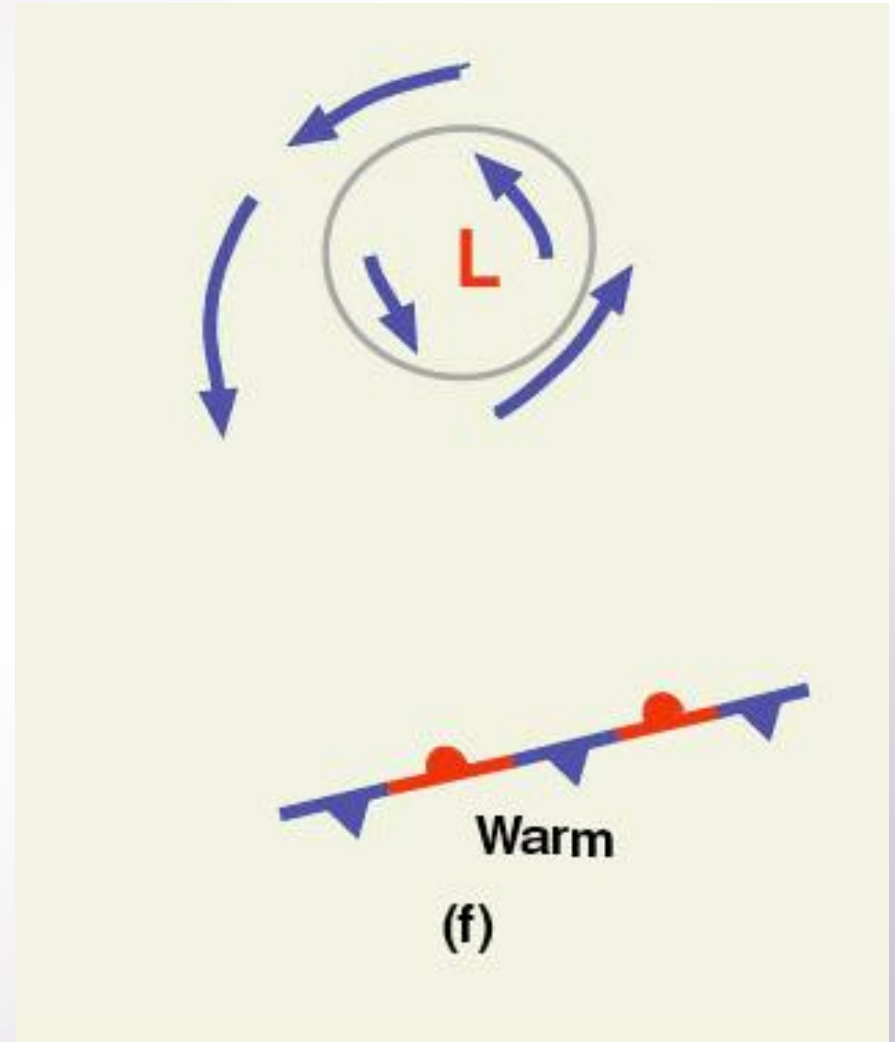
A&B: Figure 10-1

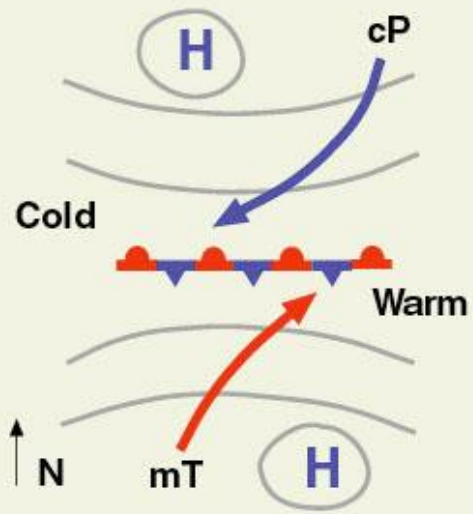


Dissipation

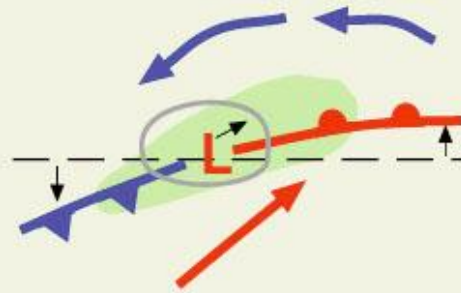
Step 6

Storm dissipates after occlusion. The source of the energy (rising mT air) has been cut off.

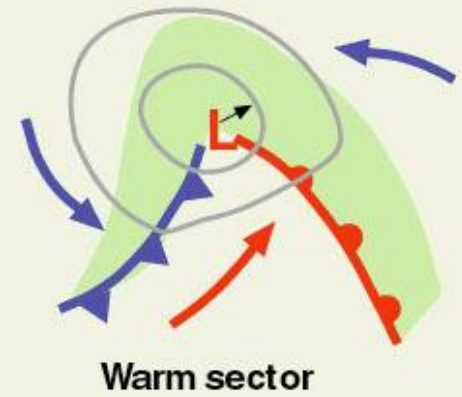




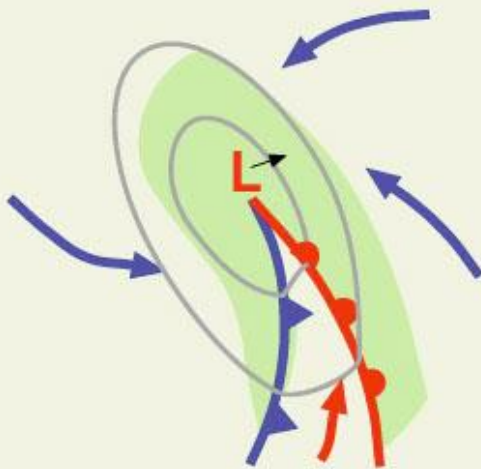
(a)



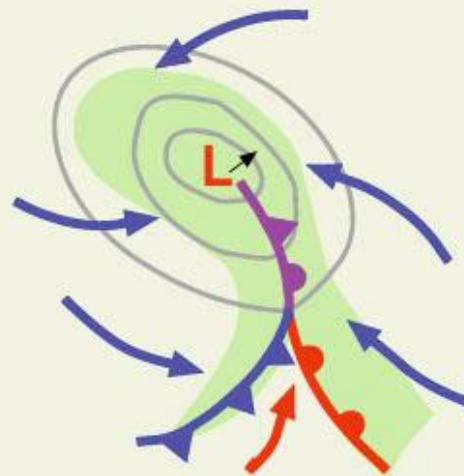
(b)



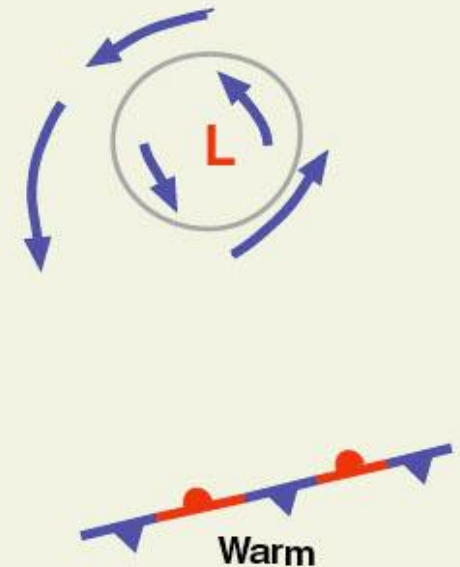
(c)



(d)



(e)

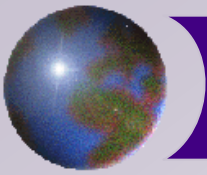


(f)

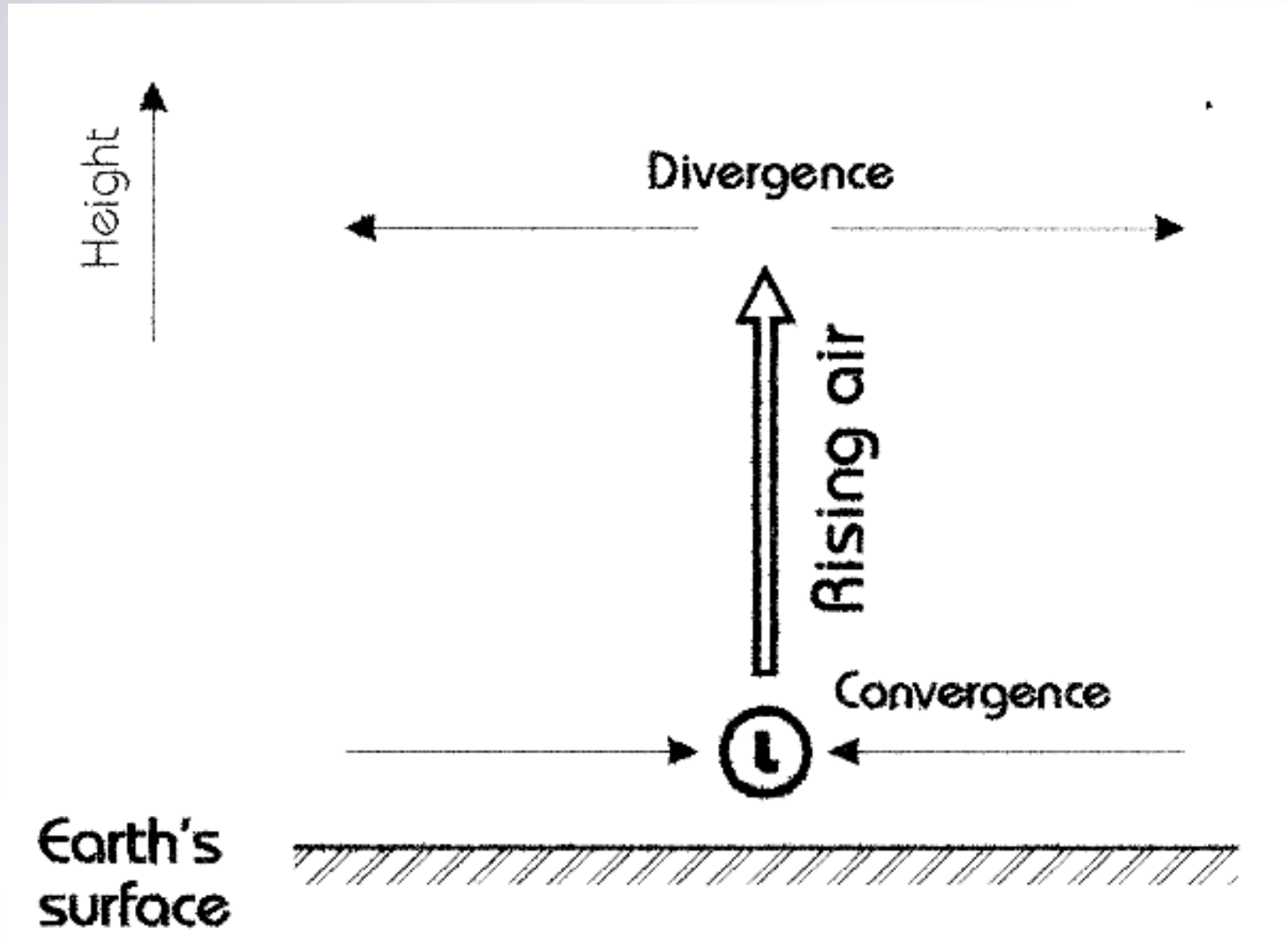


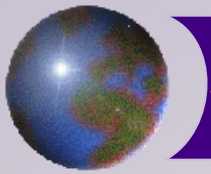
Typical Winter Cyclone Paths

Ahrens: Fig. 12.5



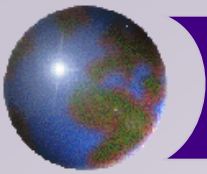
Surface winds and vertical motion



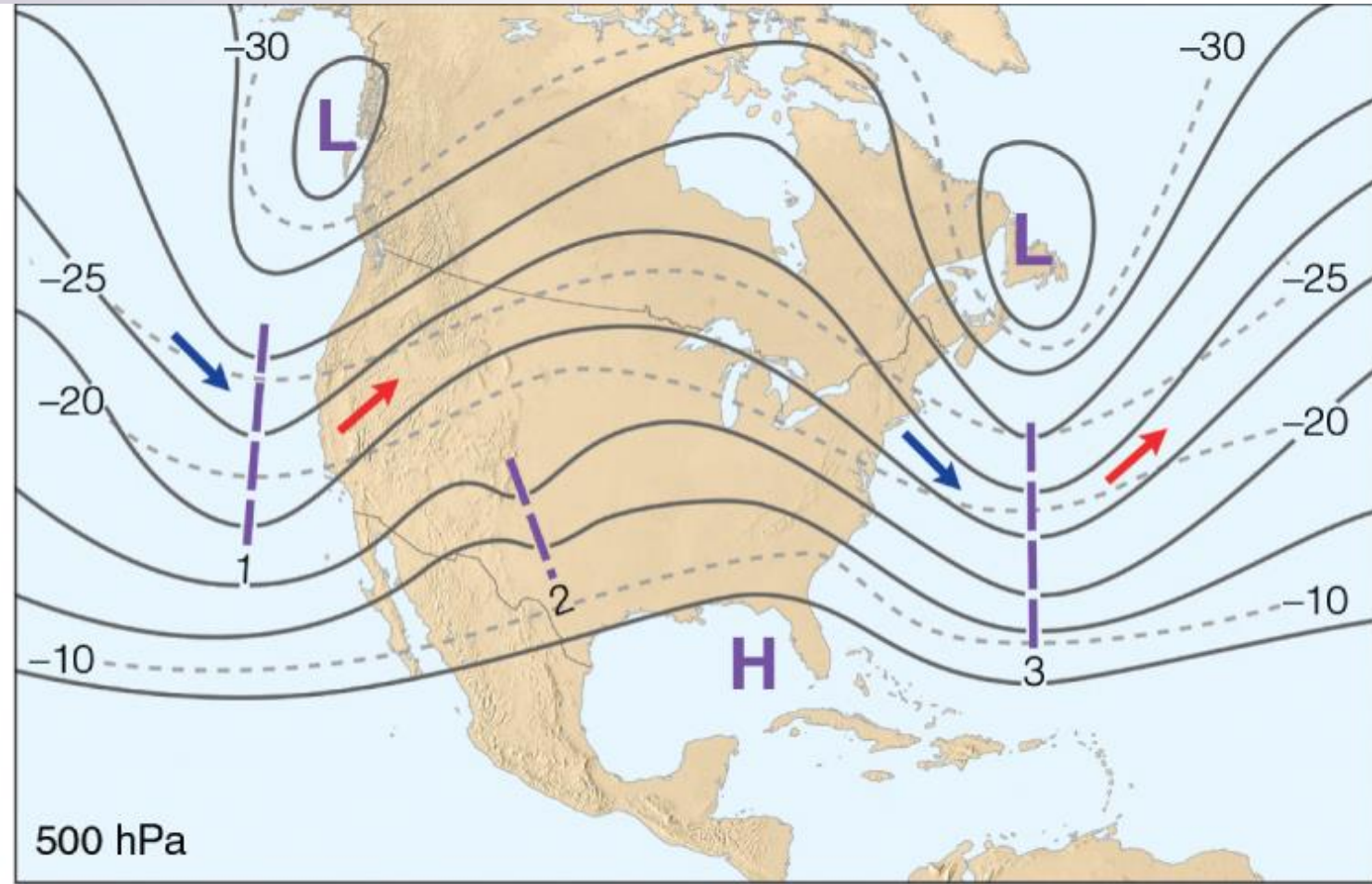


Lecture outline

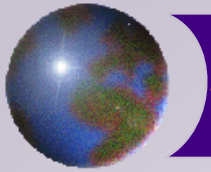
- ☉ Life cycle of a cyclone
 - ☒ Polar front theory
- ☉ **Upper level divergence**
 - ☒ **Baroclinic instability**
 - ☒ **Vorticity**
 - ☒ **Lower atmosphere influence**



Rossby Waves



Ahrens: Fig. 12.9b



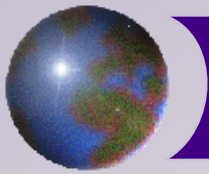
Baroclinic Wave Theory

Barotropic

- ✚ Isotherms are parallel with isobars.
- ✚ No temperature advection.

Baroclinic

- ✚ Isotherms cross isobars.
- ✚ Geostrophic flow produces temperature advection.

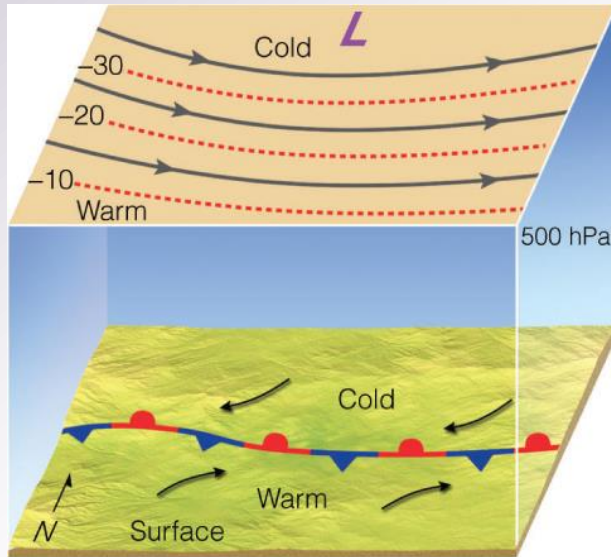


Development of a Baroclinic Wave

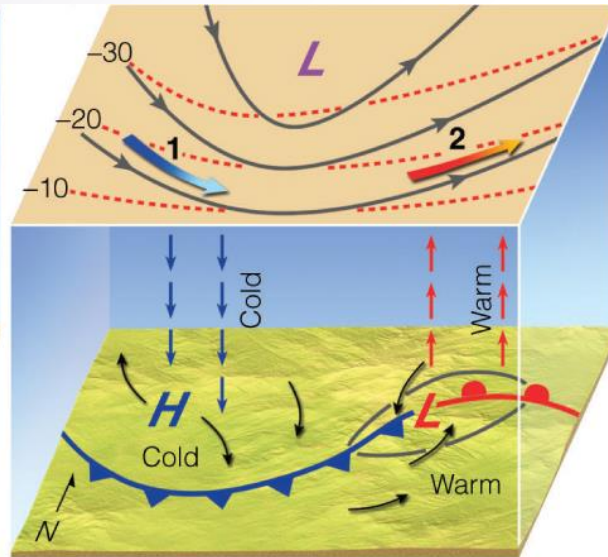
Barotropic

Baroclinic

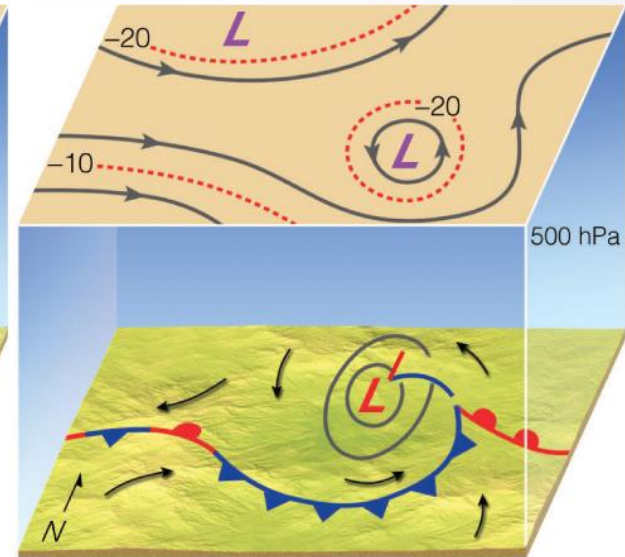
Barotropic



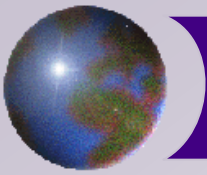
(a)



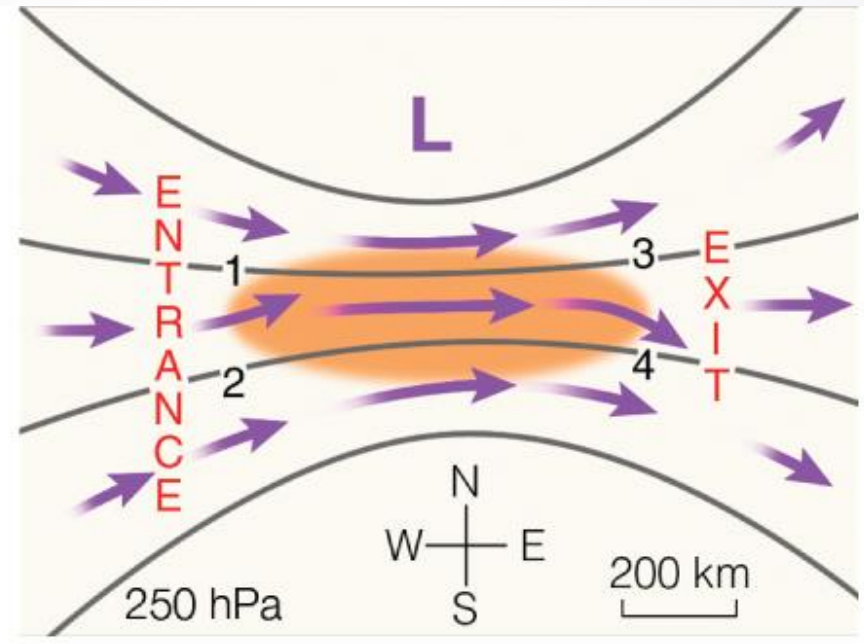
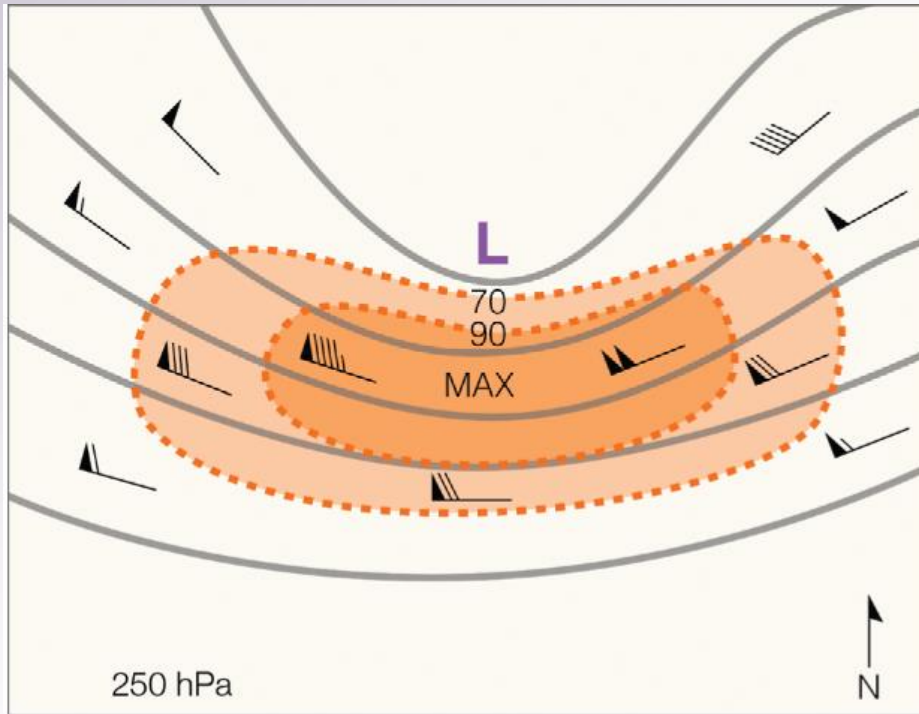
(b)



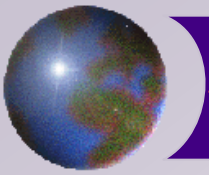
(c)



Jet streaks

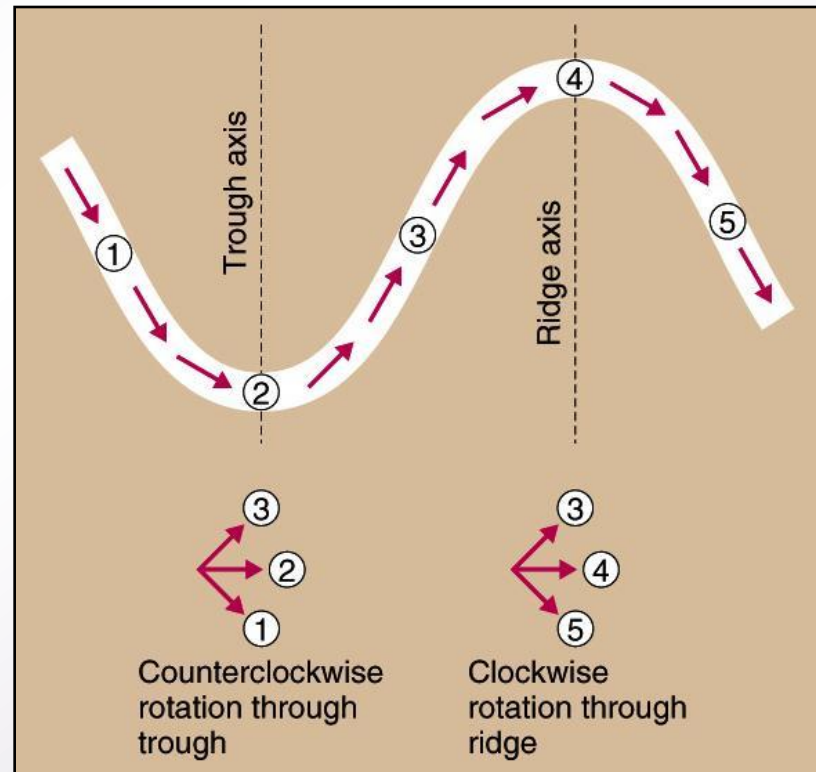


Ahrens: Figs. 4 and 5, p. 364

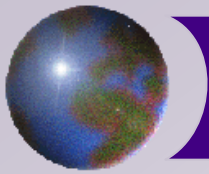


Vorticity

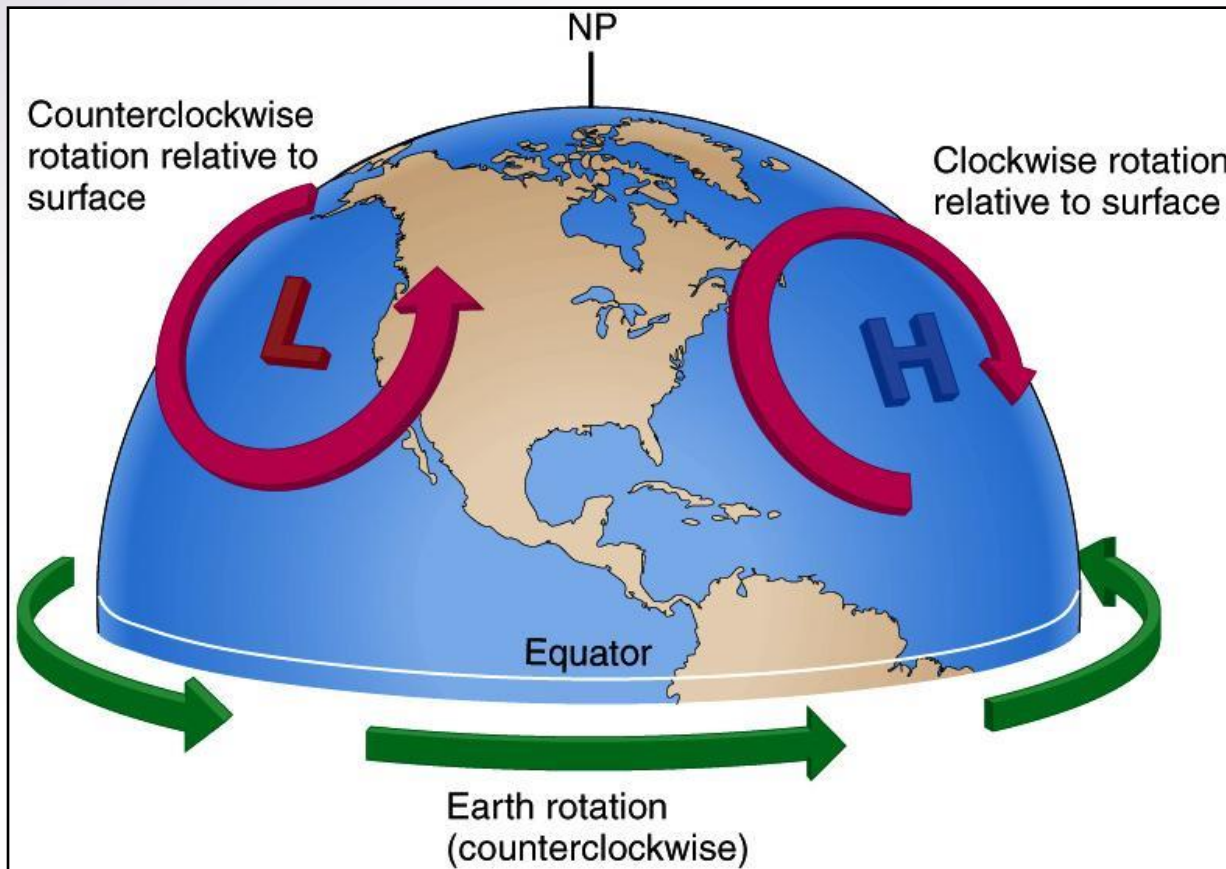
- ✚ Rotation of a fluid
- ✚ Direction of rotation changes between troughs and ridges



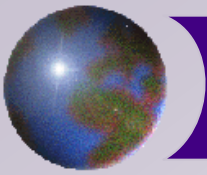
A&B: Figure 10-4



Positive and negative vorticity



A&B: Figure 10-5



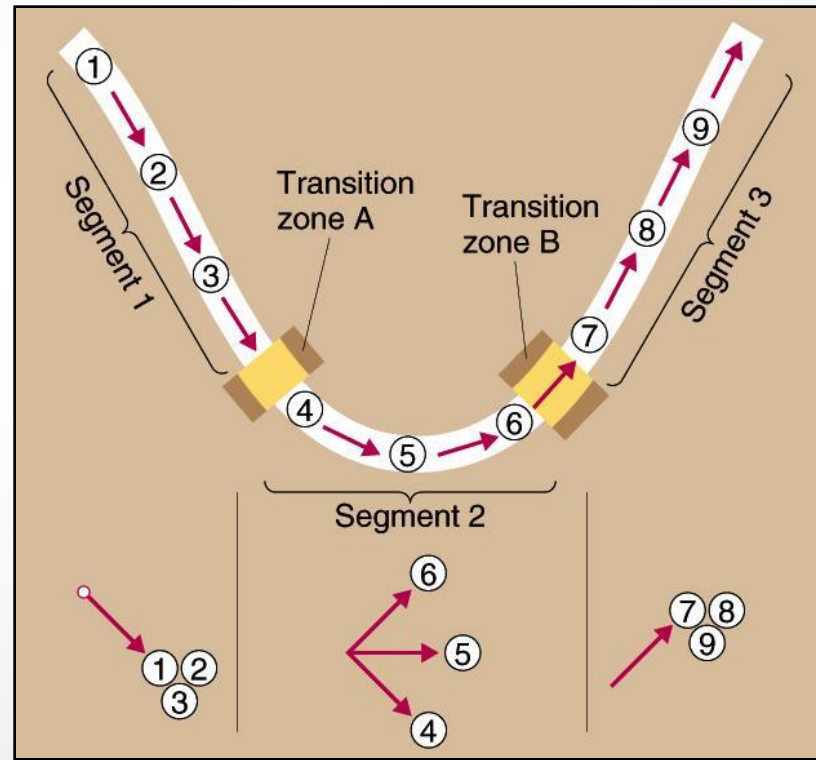
Vorticity and divergence

🌀 A: Increasing spin

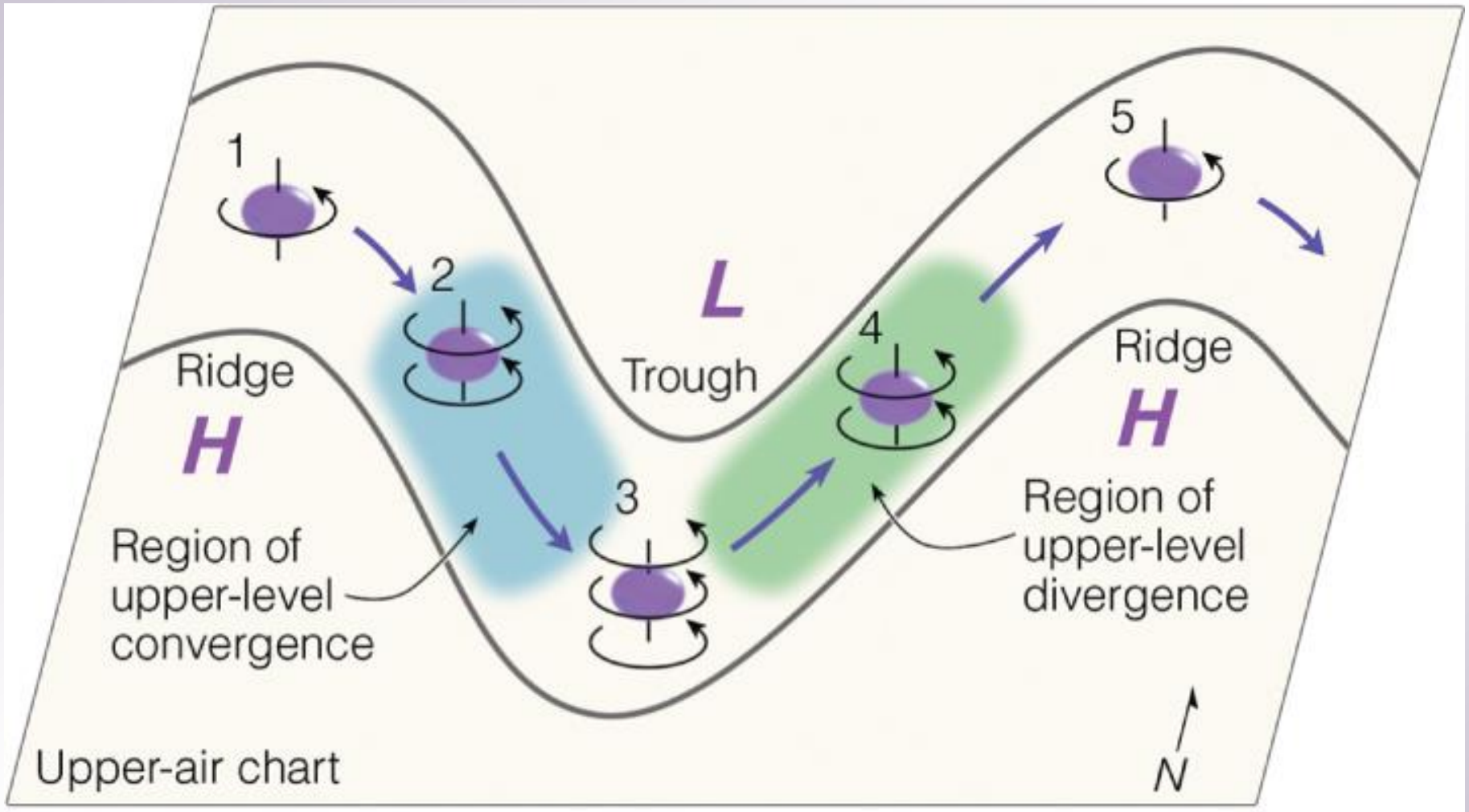
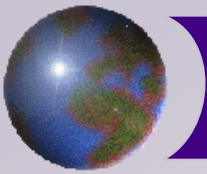
- ❑ Angular momentum stays constant
- ❑ Radius shrinks
- ❑ Convergence

🌀 B: Decreasing spin

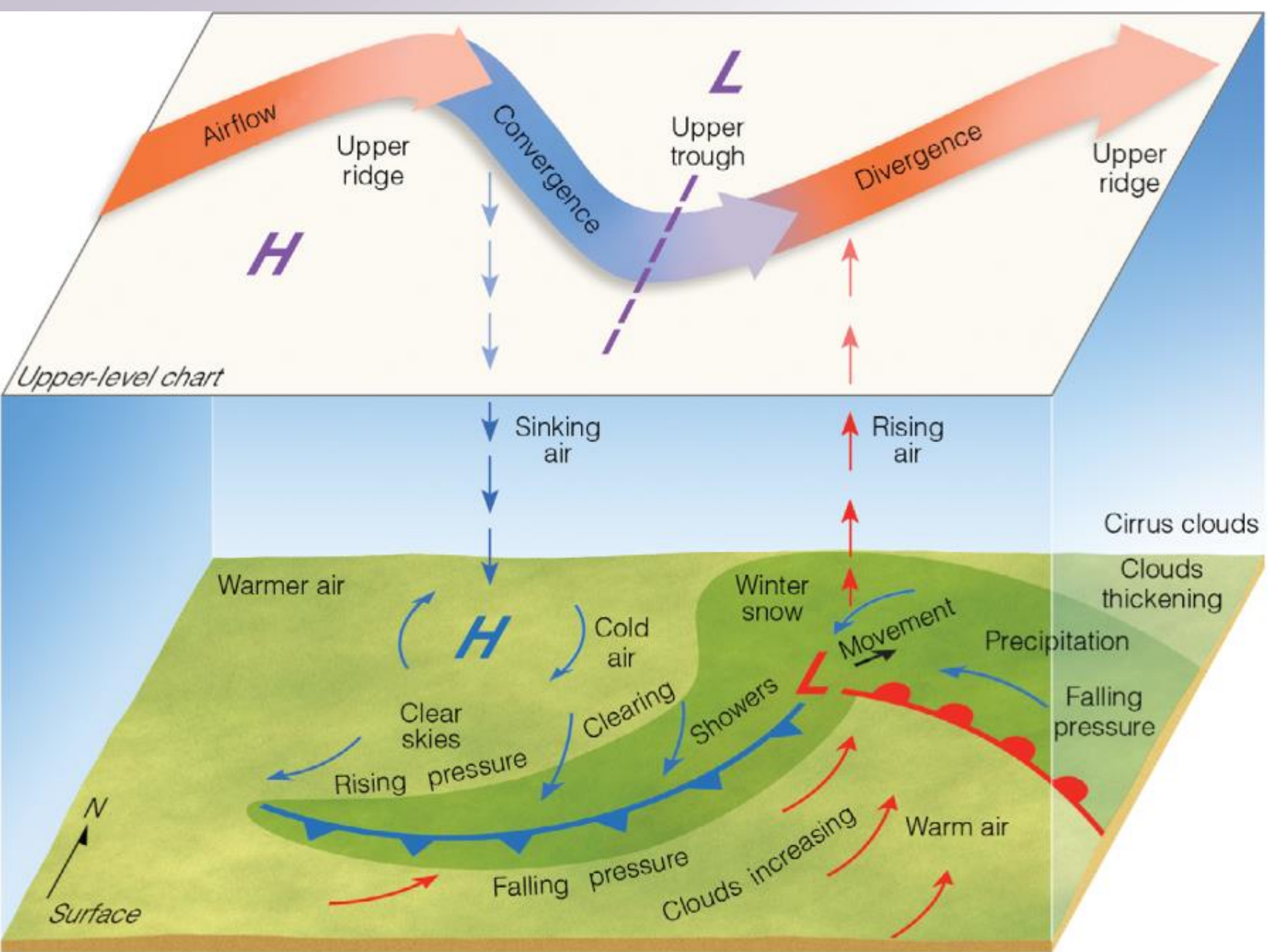
- ❑ Radius increases
- ❑ Divergence

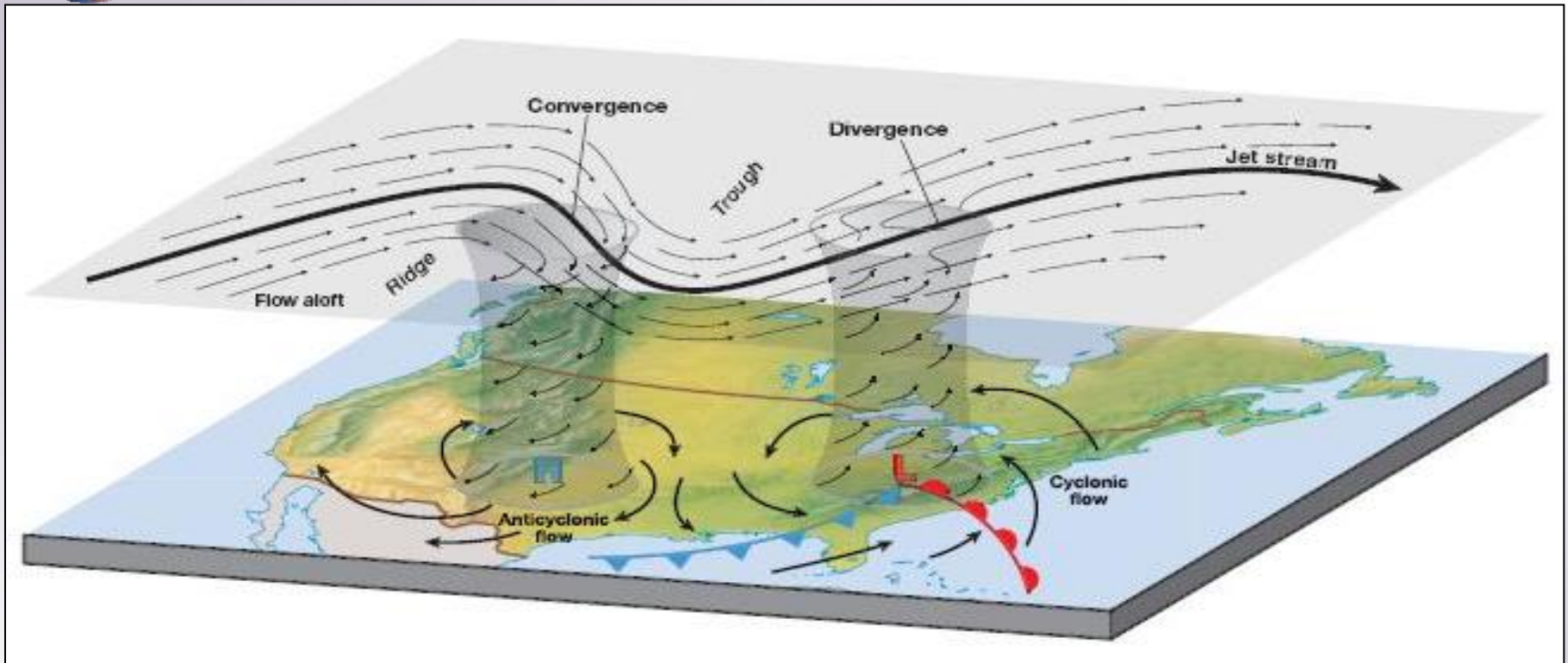
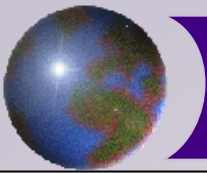


A&B: Figure 10-6



Vorticity Advection
Ahrens: Fig. 12.23



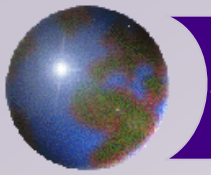


Dynamic pressure systems

Cyclones form in areas of upper-level divergence

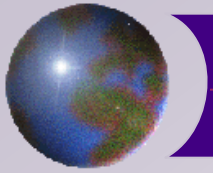
Path of the cyclone most frequently follows the course of upper level flow

A&B: Figure 10-7



Summary

- ❁ Midlatitude cyclones caused by upper troposphere divergence
 - ❁ Baroclinicity
 - ❁ Jet streaks
 - ❁ Vorticity
- ❁ Cyclones are further fuelled by surface conditions
 - ❁ Latent heat added to upper air
 - ❁ Occlusion cuts off this source of fuel



Next lecture

📍 Thunderstorms and tornadoes