

Midlatitude Cyclones

**Whose air mass reigns
supreme ??**

Ch. 10: Midlatitude Cyclones

- **Norwegian Model of Cyclogenesis**
- **Vorticity**
 - **Relative and Absolute Vorticity**
 - **Vorticity in a Rossby Wave**
 - **Vorticity Advection and Vertical Motion**
- **Baroclinic Model of Cyclogenesis**
- **Conveyor Belt Model**

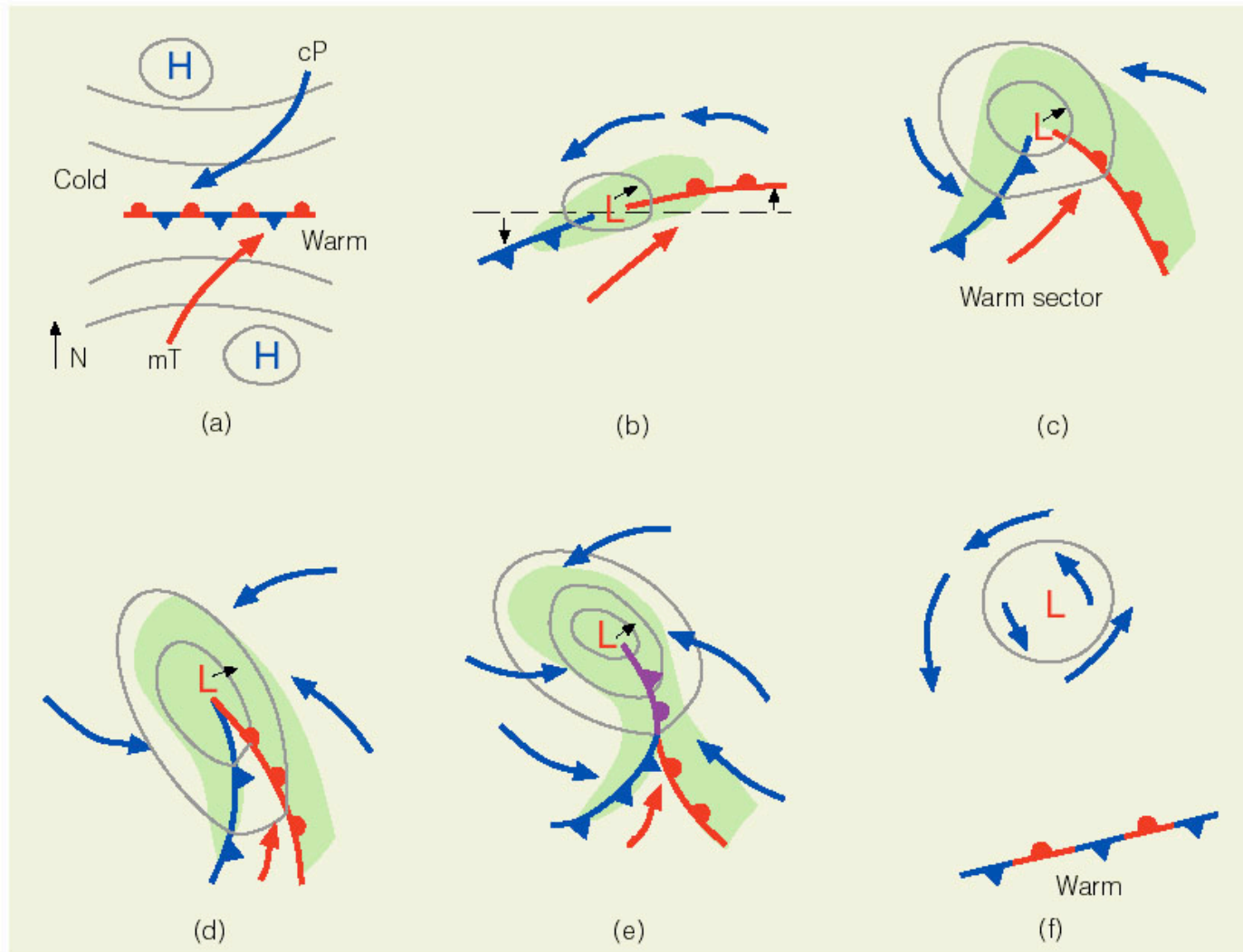
Polar Front Theory

Norwegian Model of Cyclogenesis

- **Formation of a “cyclone”**
 - **Storm associated with surface low pressure**
- **Jacob Bjerknes c. 1920 developed model from surface observations**

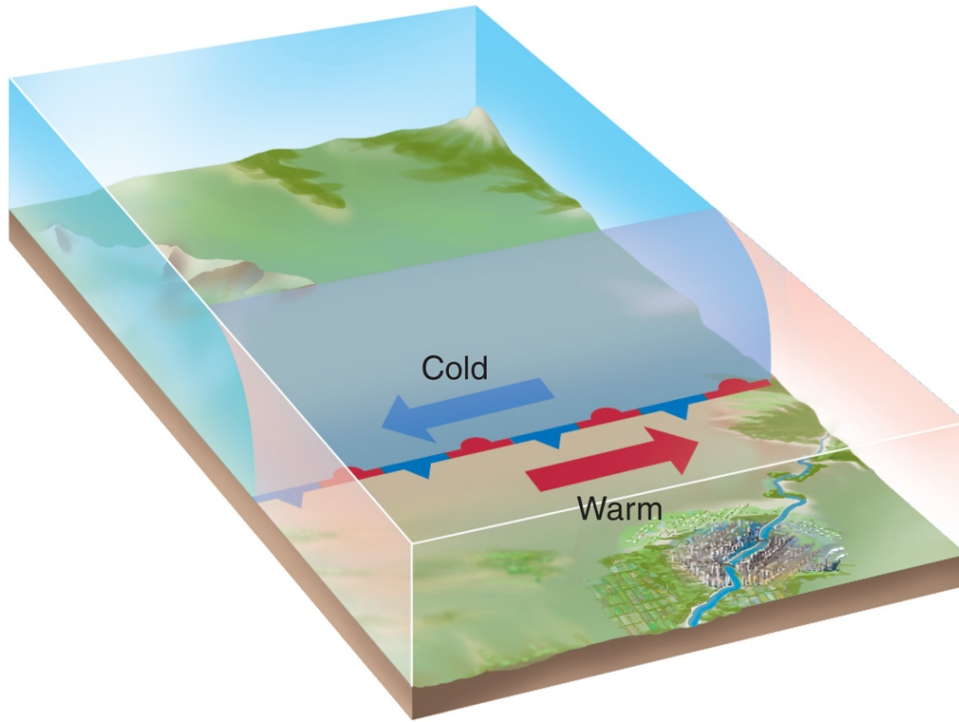
Polar Front Theory

Norwegian Model of Cyclogenesis



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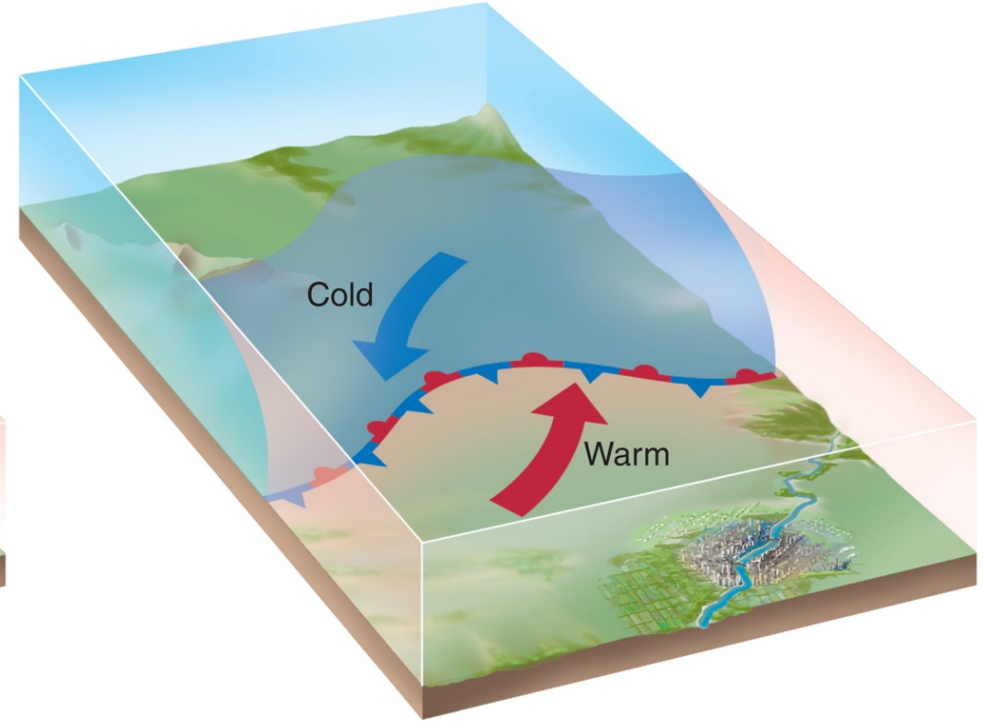
Stationary Phase



(a)

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10-1a, b

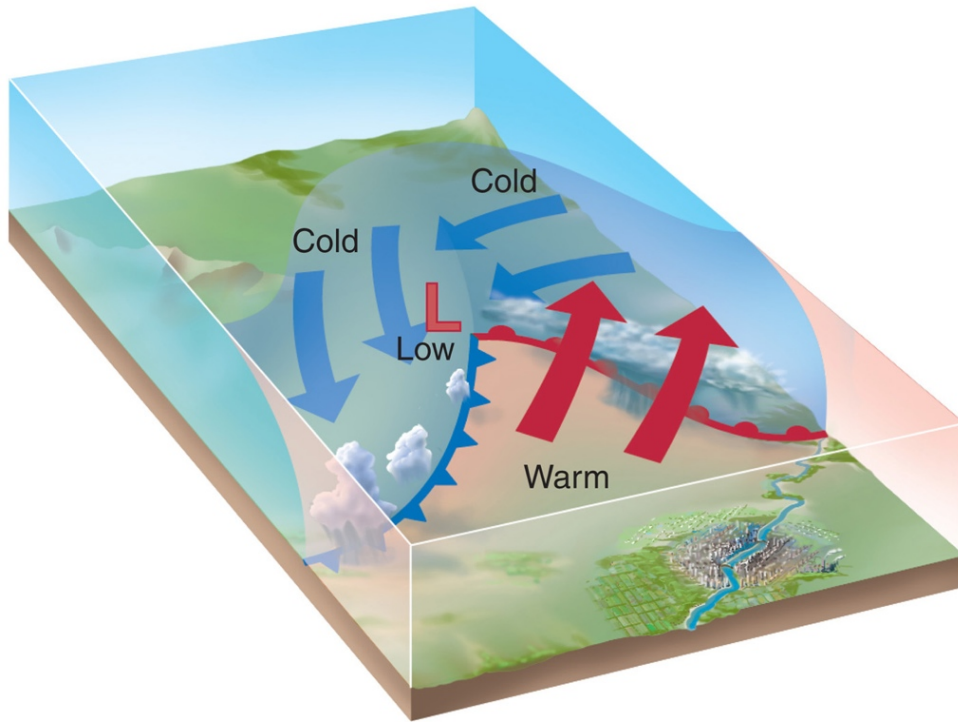


(b)

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**Surface low develops
along Polar Front**

Developing Phase

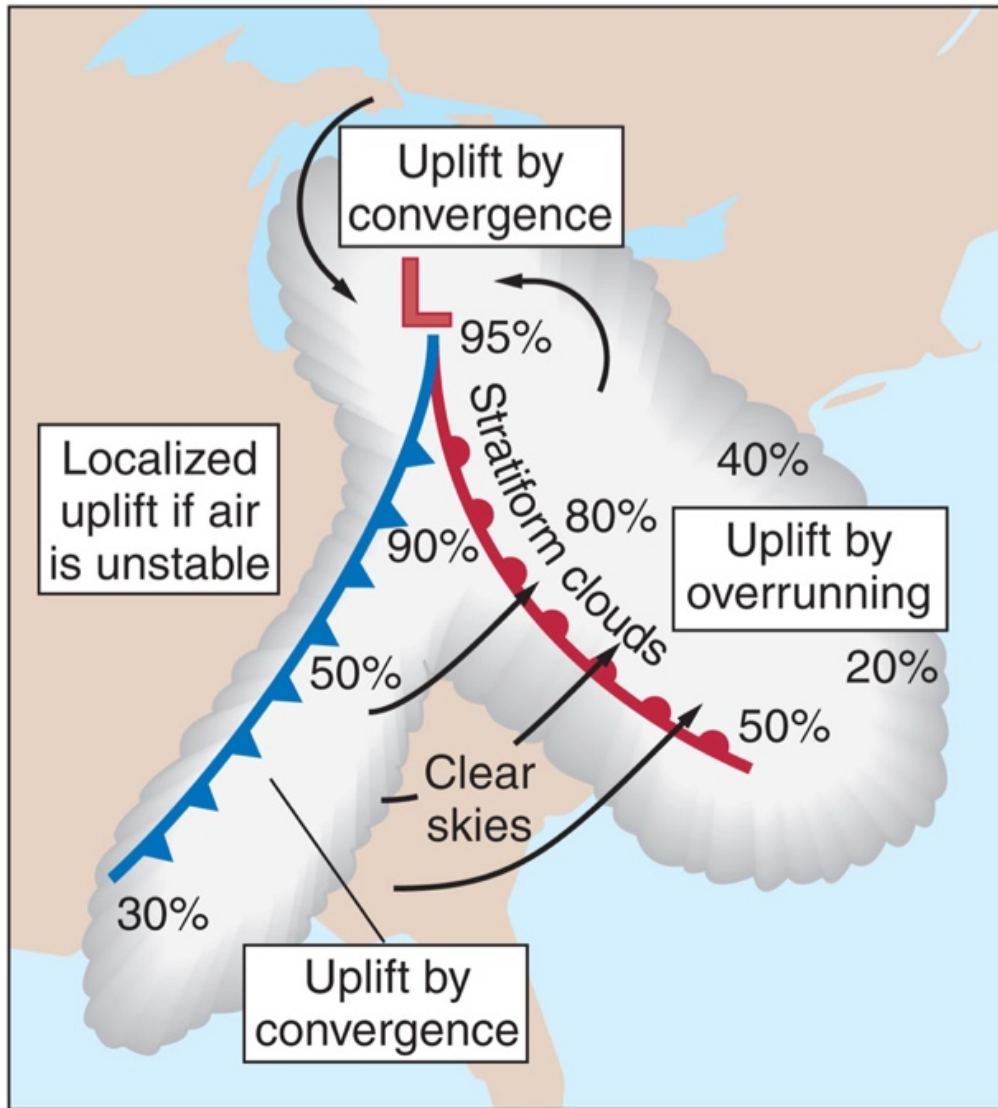


(c)

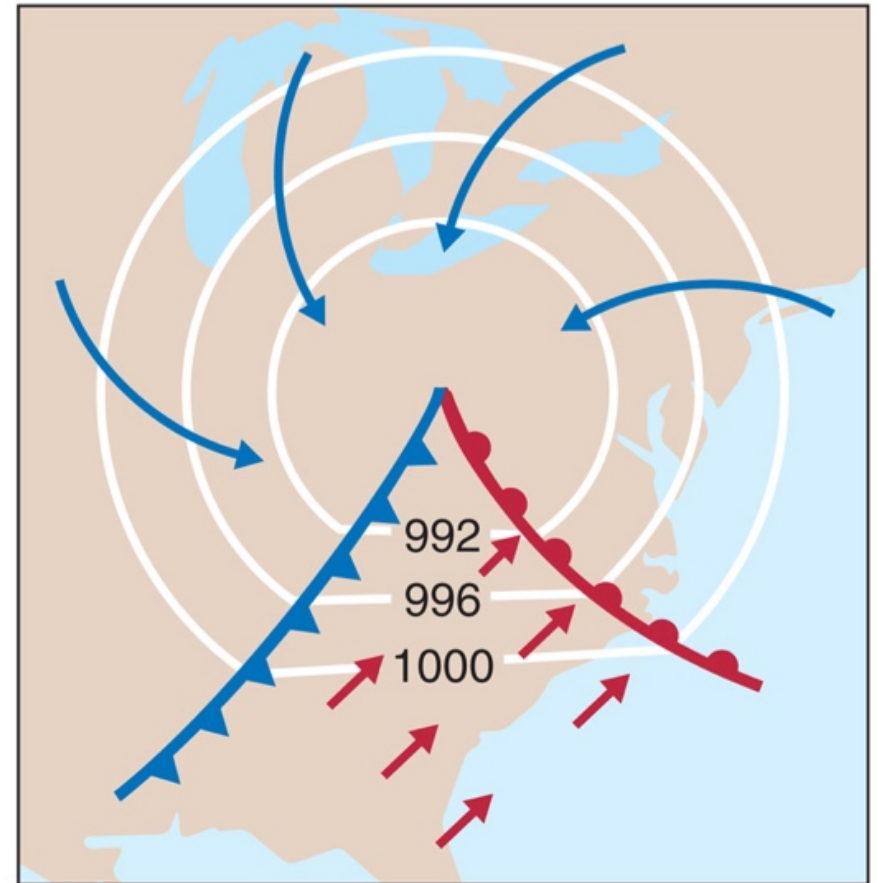
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10-1c

- **Low deepens**
- **Well developed fronts circling the low**
 - **Cold front catching up to slow-moving warm front**
- **Whole system moves toward east-northeast, following surface isobars in the warm sector**



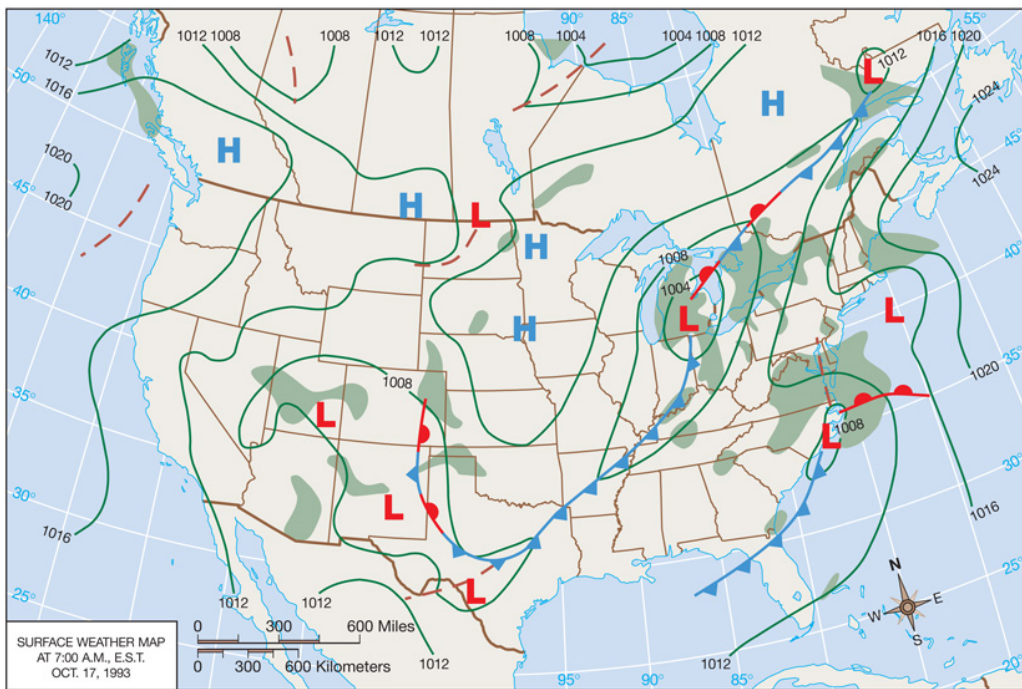
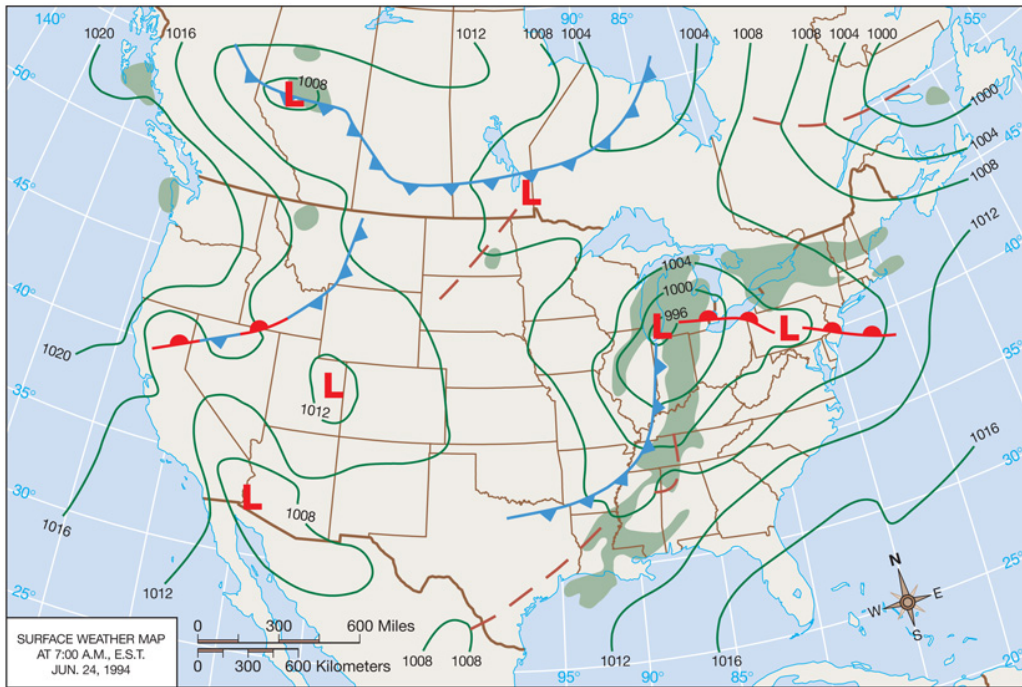
(a)



(b)

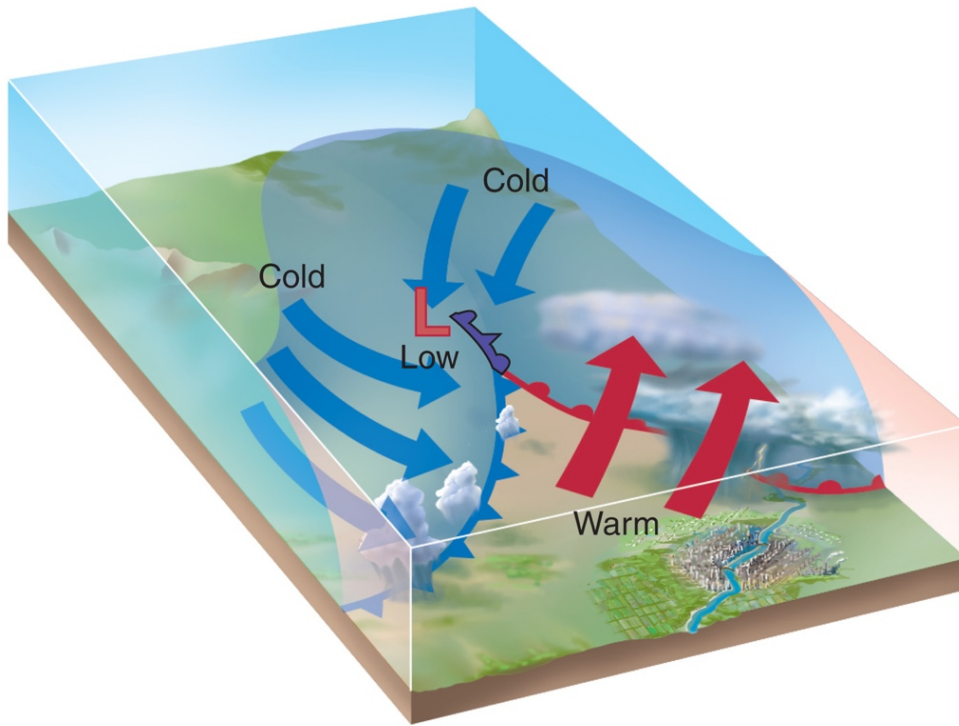
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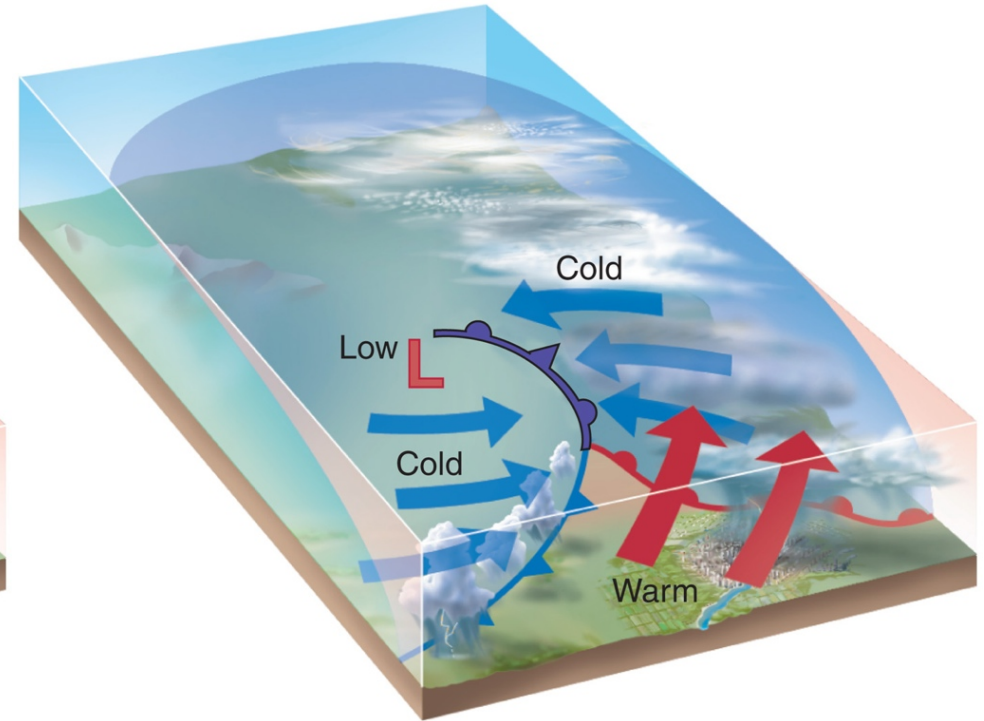
10-3

Mature Phase



(d)

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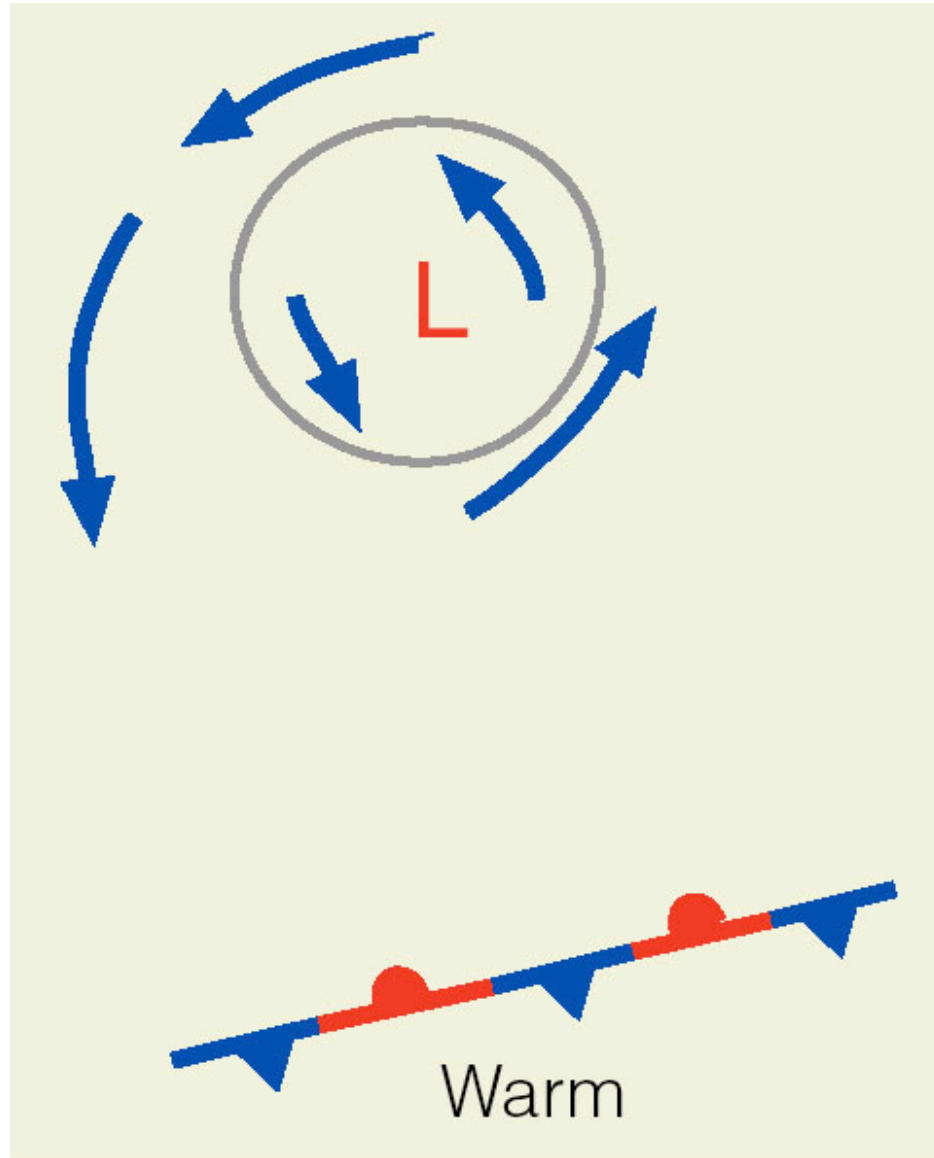
(e)

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Fronts begin to occlude at start of Mature Phase; intensity has reached a maximum and is now decreasing

10-1d. e

Dissipation Phase



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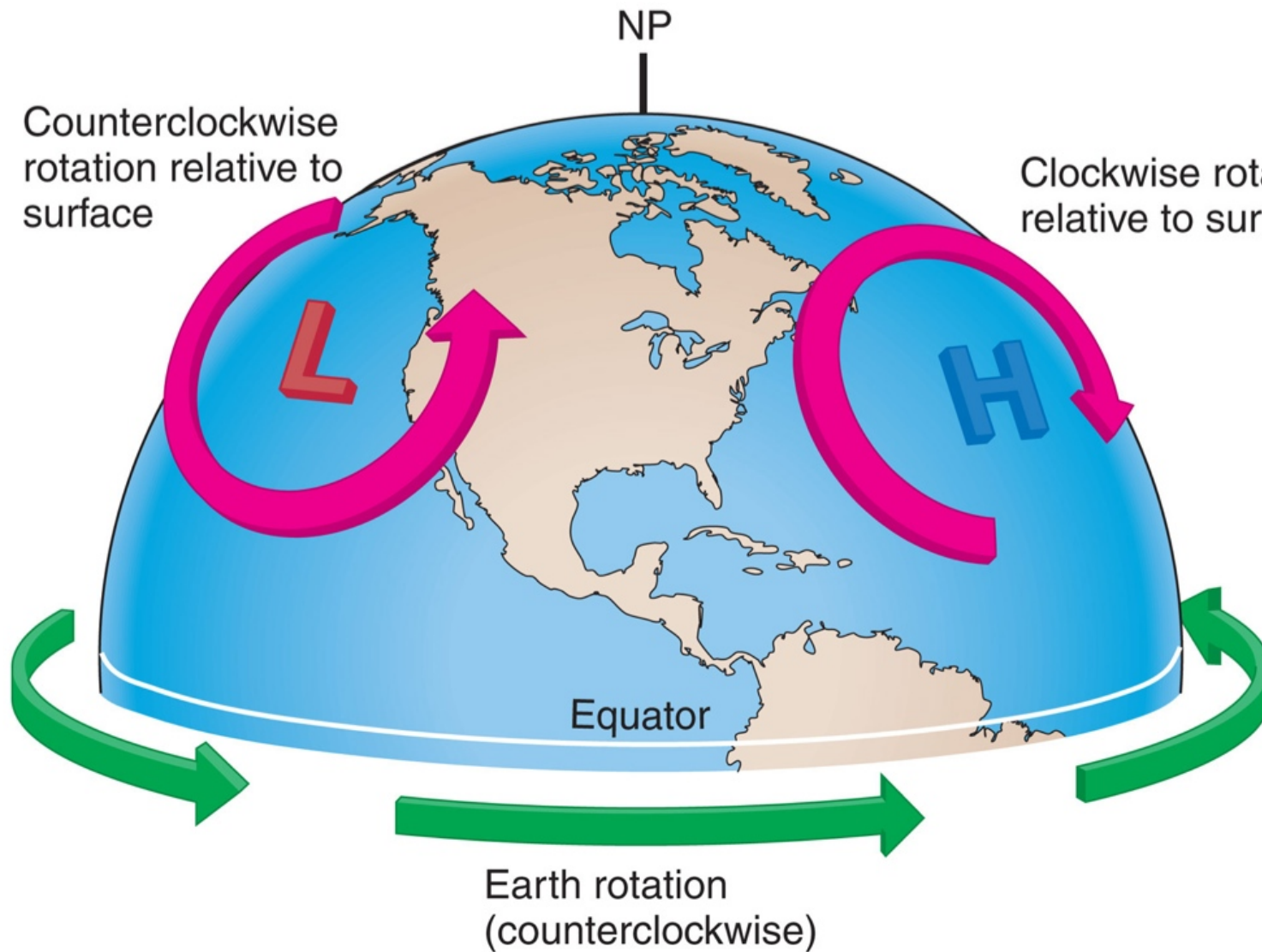
Vorticity

- **“Spin”**
- **Vorticity from:**
 - **Rotation of air on Earth’s surface:
Relative Vorticity ζ_r**
 - **Rotation from being on rotating
Earth: Earth Vorticity ζ_E**
 - **Absolute Vorticity $\zeta = \zeta_r + \zeta_E$**
- **Changes in vorticity result in
vertical motion**

10-5

Counterclockwise rotation relative to surface

Clockwise rotation relative to surface

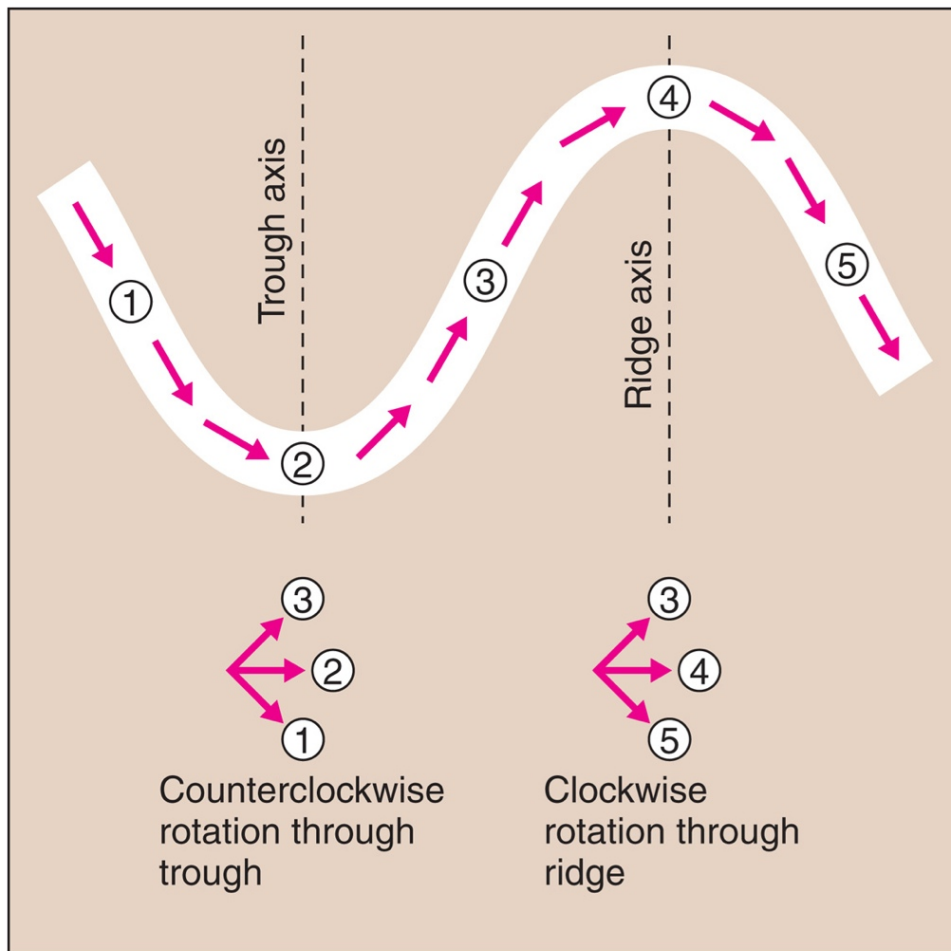


Earth rotation
(counterclockwise)

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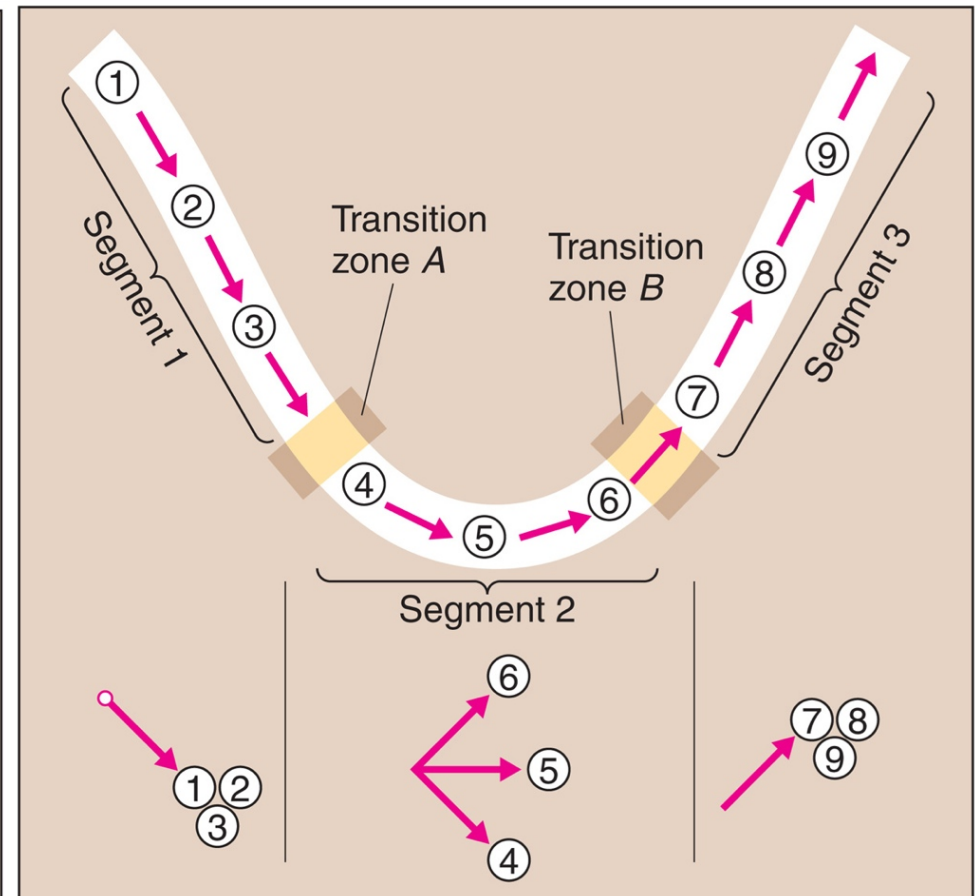
Positive Vorticity: counterclockwise rotation
PVA \equiv Positive Vorticity Advection

Vorticity in a Rossby Wave



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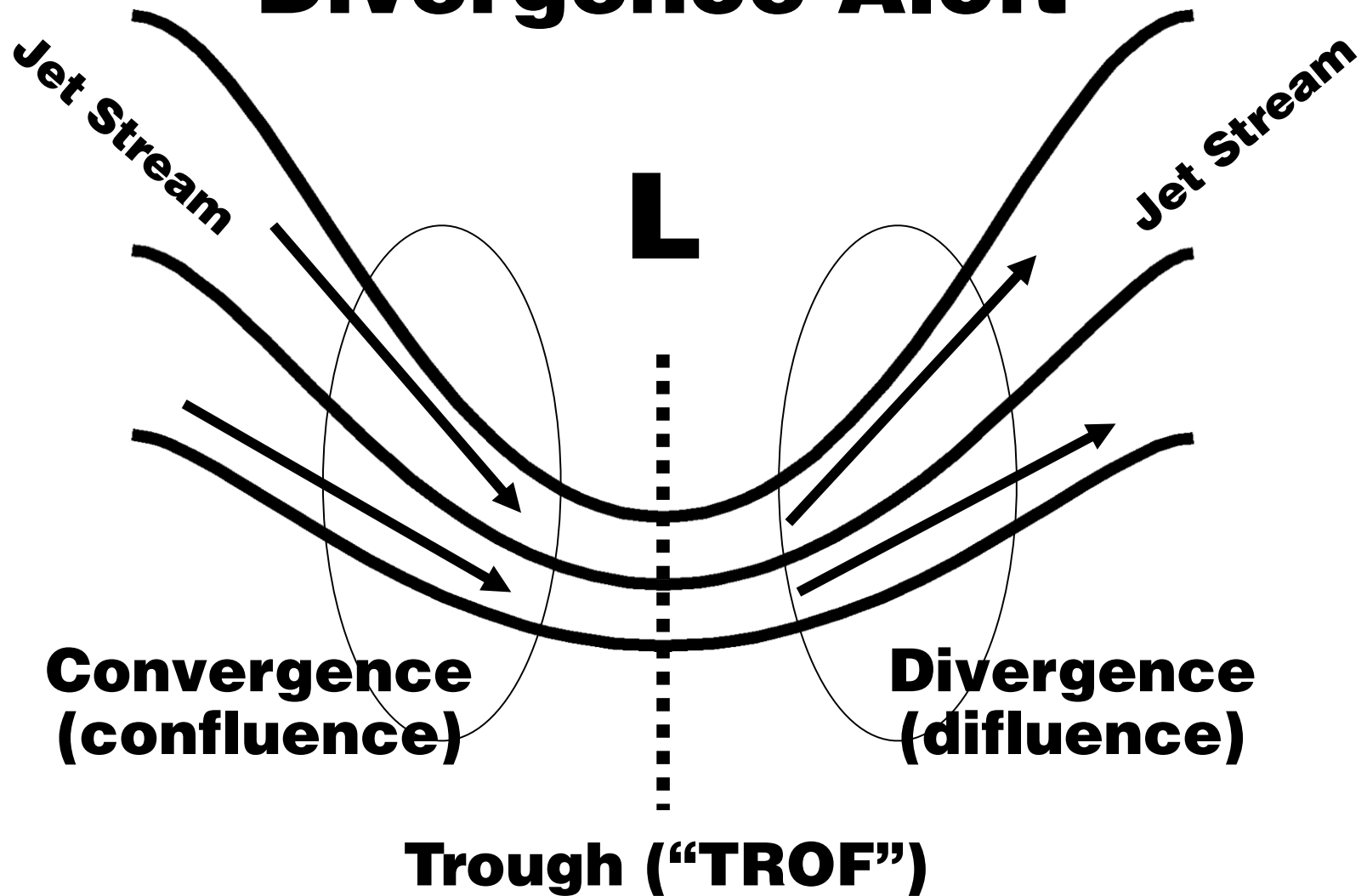
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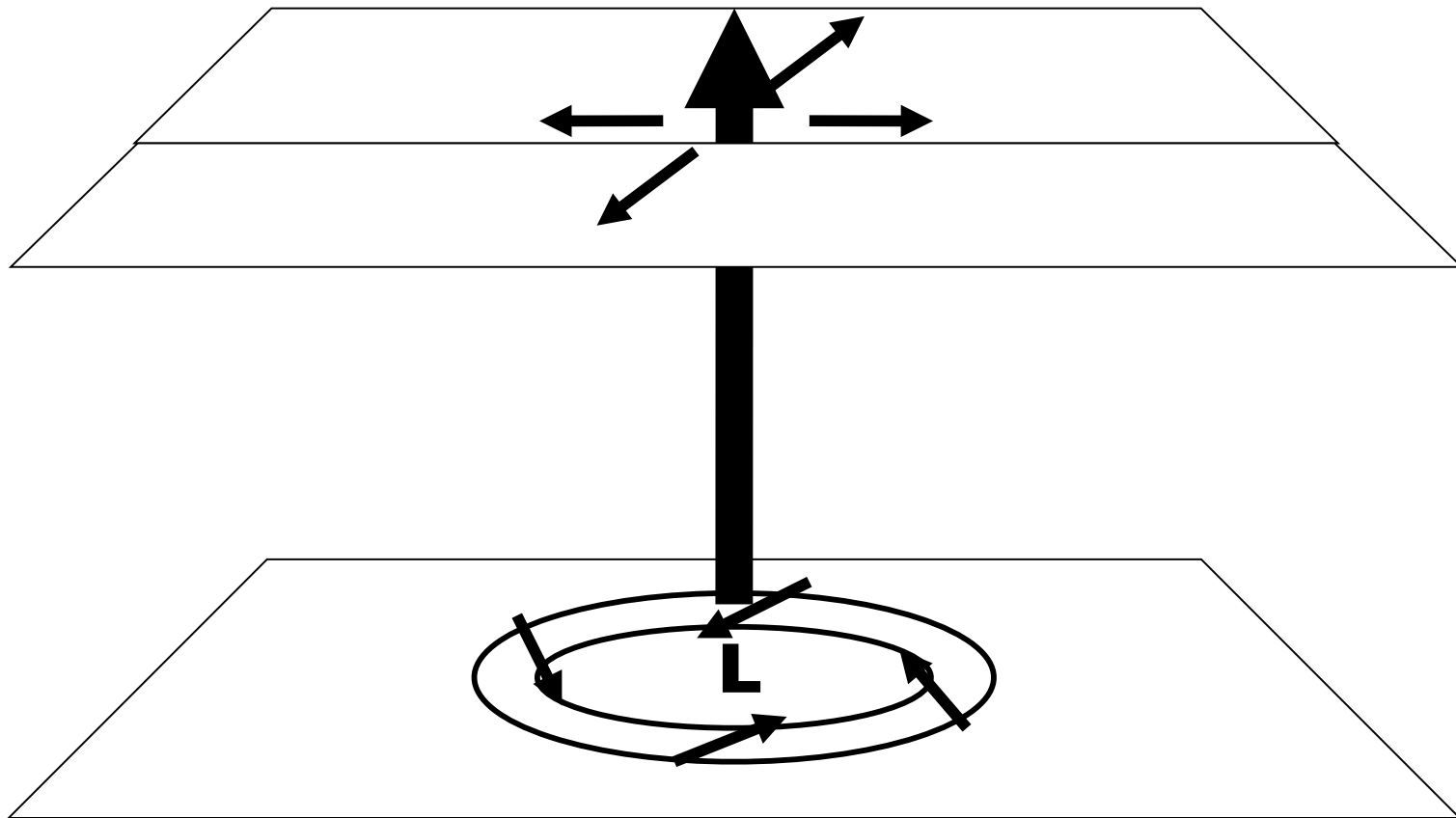
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Convergence and Divergence Aloft

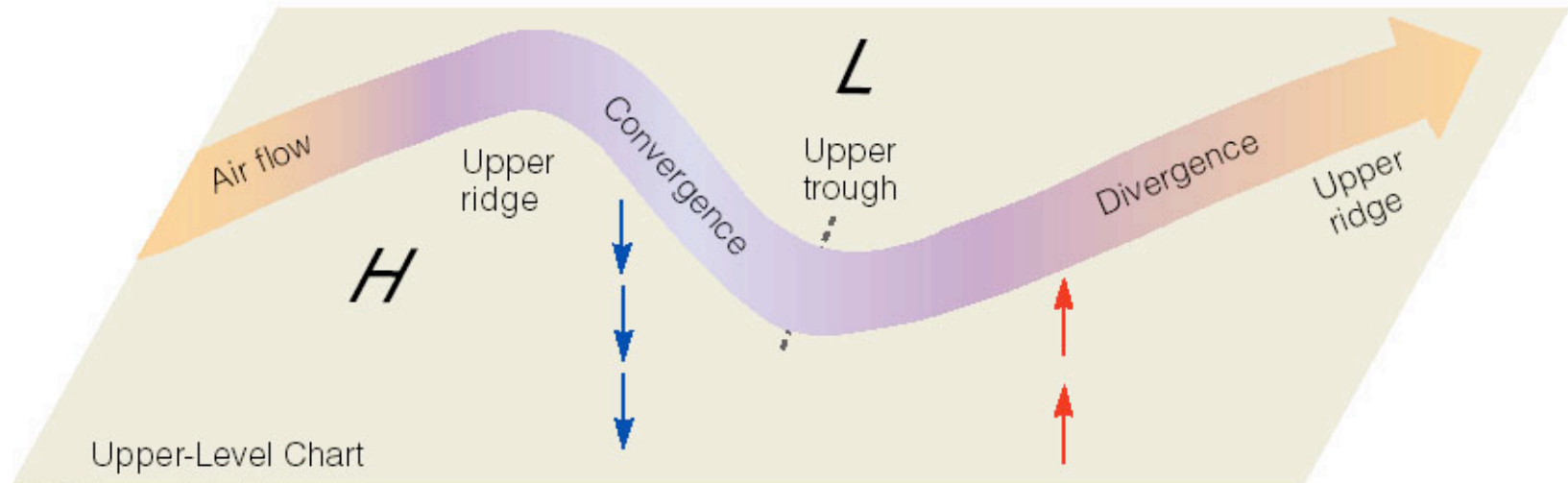


Divergence aloft maintains or strengthens surface low pressure

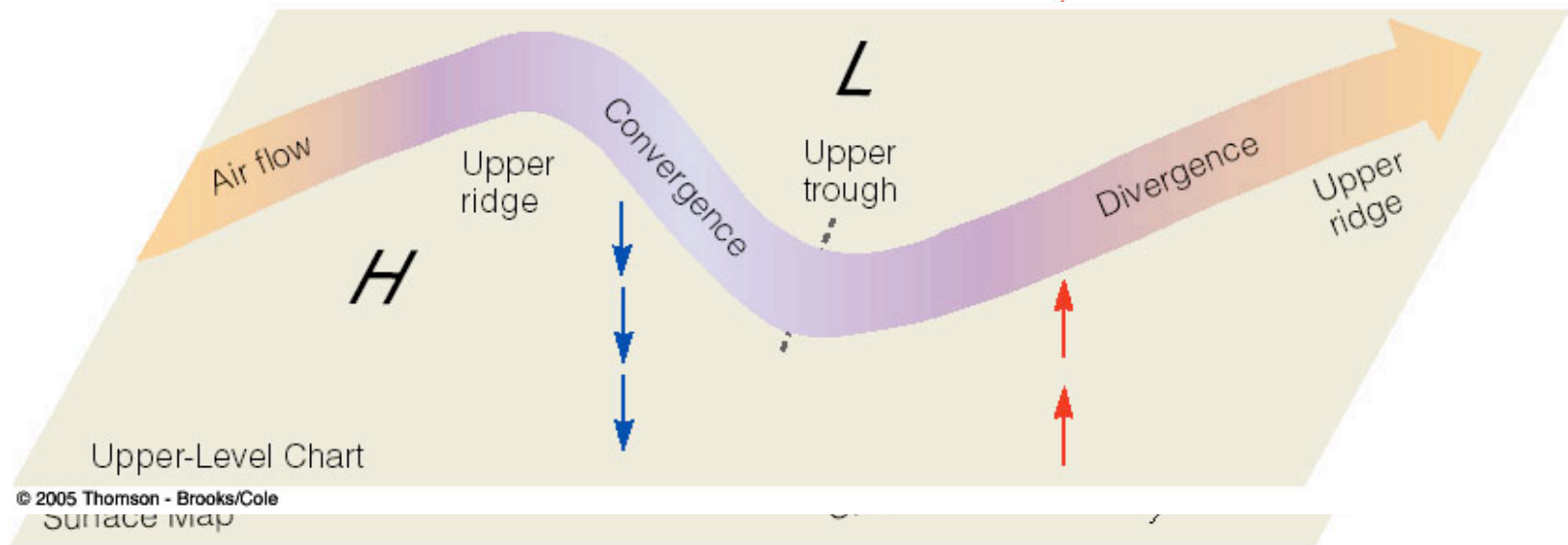


Midlatitude Cyclogenesis

Baroclinic Model



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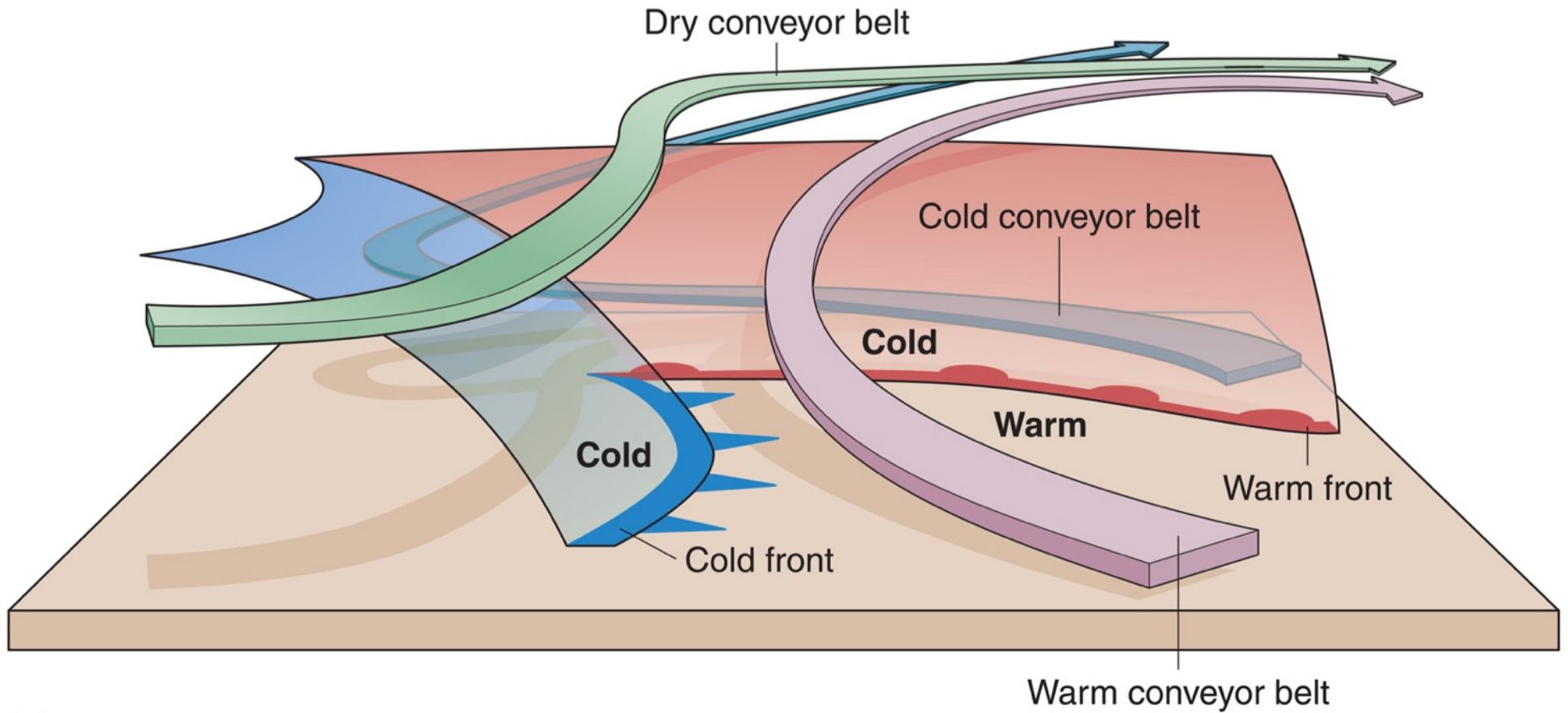
Surface map

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(10-17)

Conveyor Belt Model

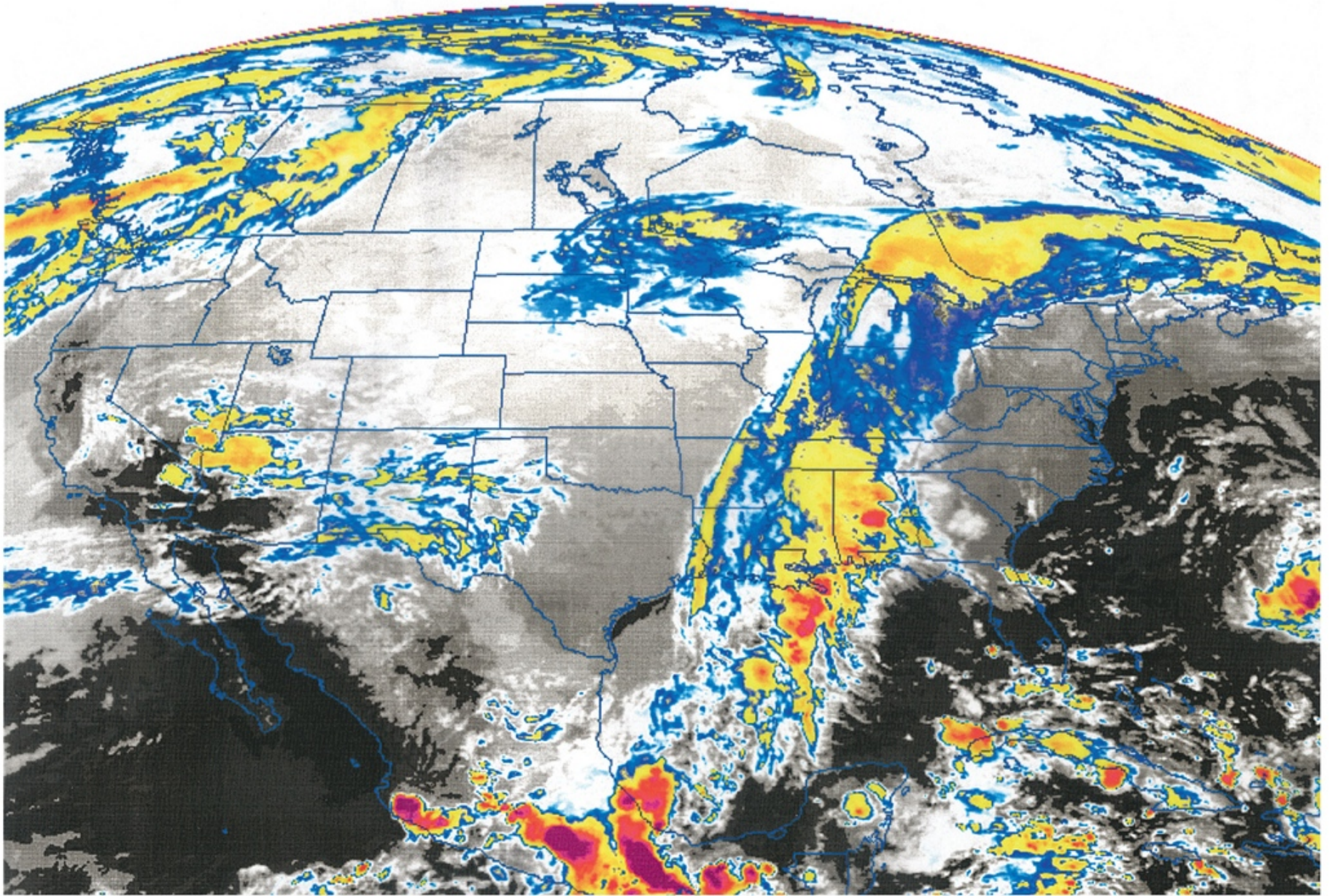
- **Theory based on more recent observations**
- **Conveyor belts are pathways of air through and around a midlatitude cyclone**
- **Refines the process of frontal occlusion—not simply merging cold and warm fronts!**



(a)

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10-18a



(b)

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10-18b