EOSC 112: THE FLUID EARTH

WIND-DRIVEN OCEAN CIRCULATION

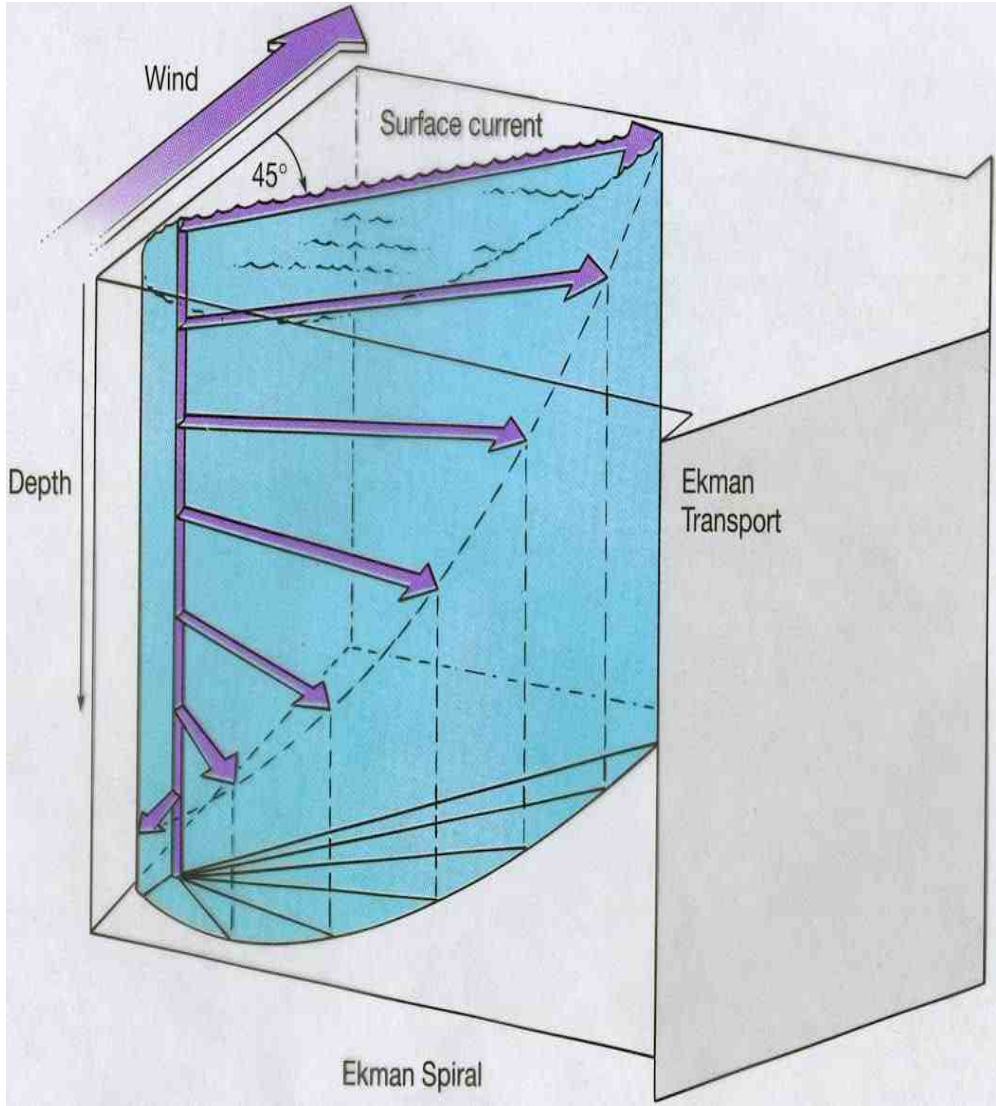
Oc2 Read: Kump et al. Chap.5, p. 85-88

Objectives:

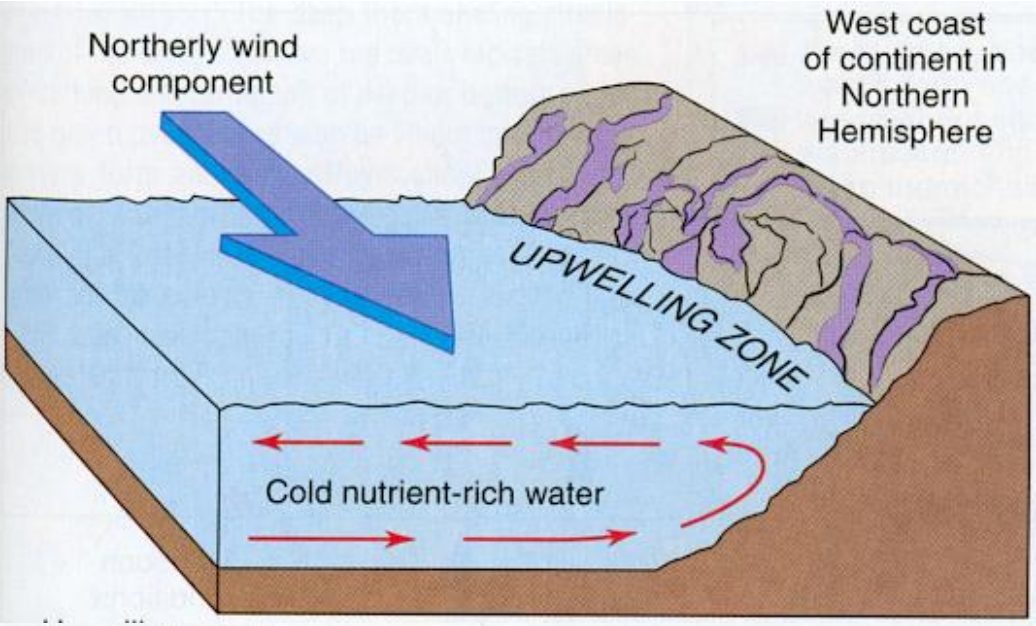
1. **To describe the dominant forces in the 0-100m layer;**
2. **To describe the dominant forces in the 100-1000m layer.**

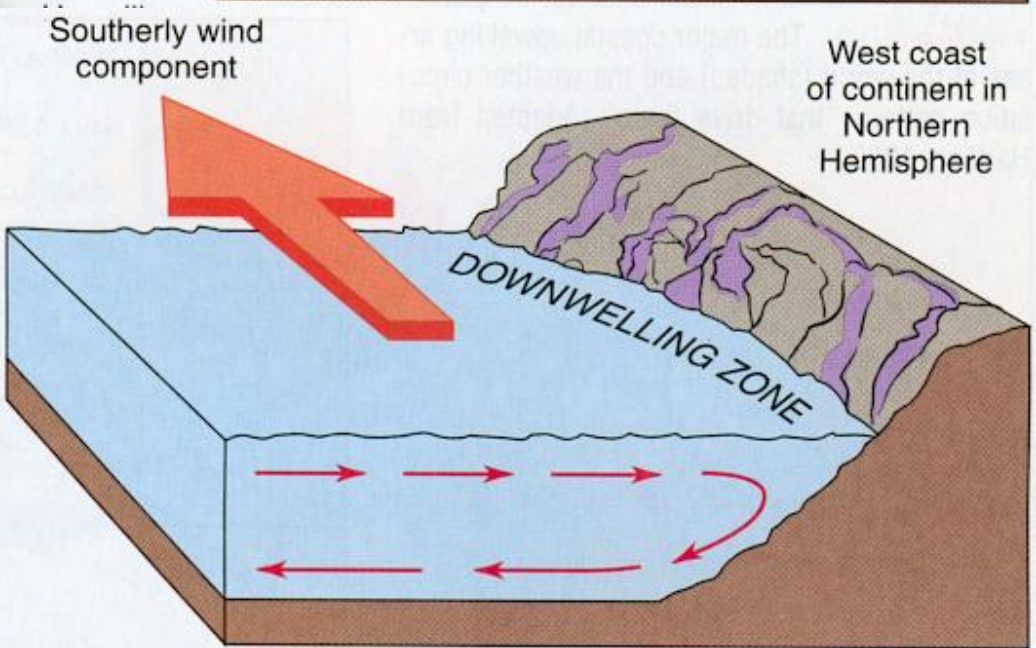
1. Forces in the top layer (0-100m)

- Nansen (1890s) observed icebergs moving 20-40° to right of wind.
- Ekman (1905) solution has surface current at 45° to right of wind in Northern Hem. (to the left in S.Hem.) (again… Coriolis effect).



Upwelling & Downwelling



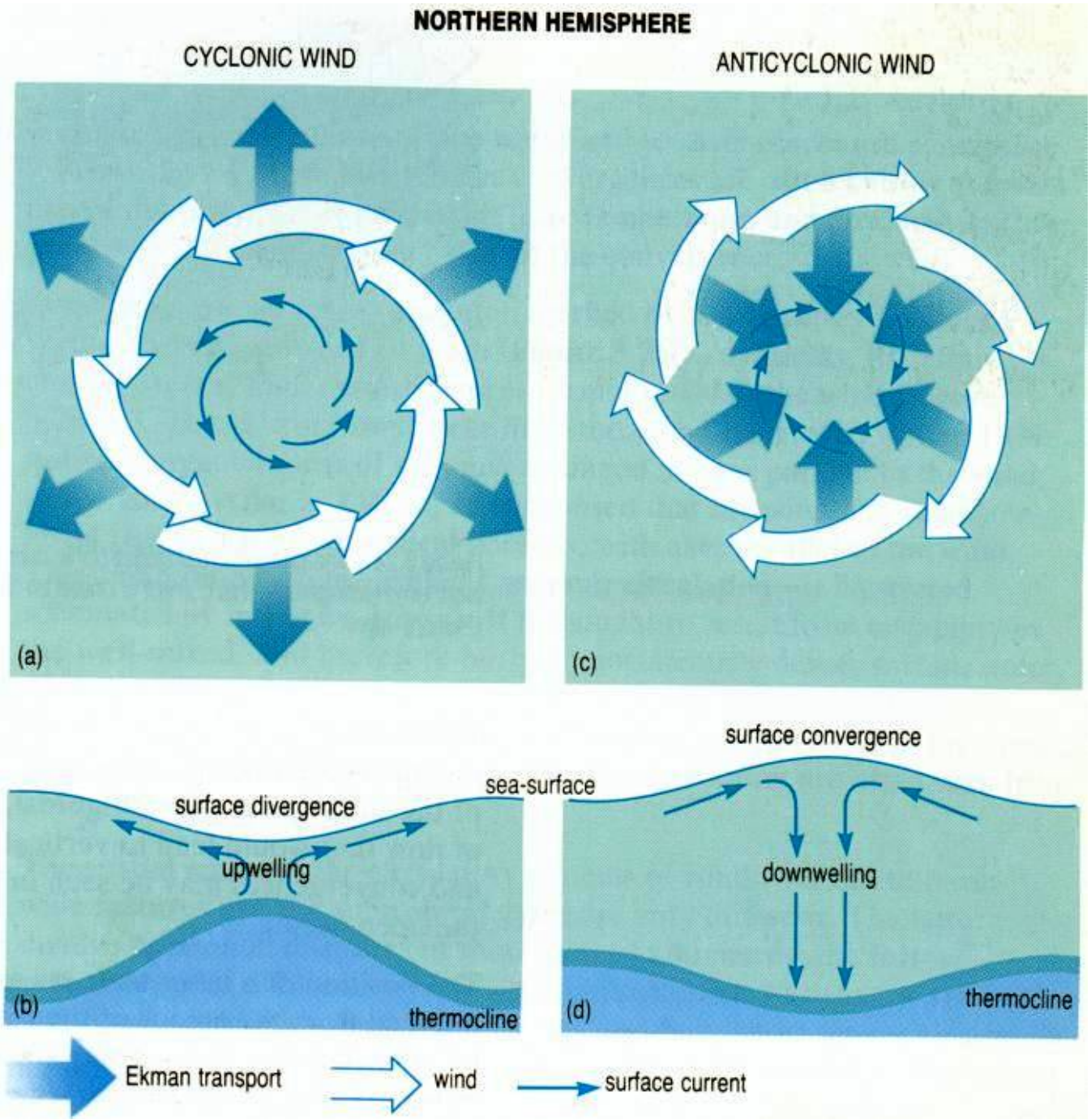


- Wind blowing alongshore can generate offshore Ekman transport

=> Upwelling of lower, cool nutrient-rich water

=> Enhanced biological productivity

- Onshore Ekman transport => downwelling => poor biological productivity

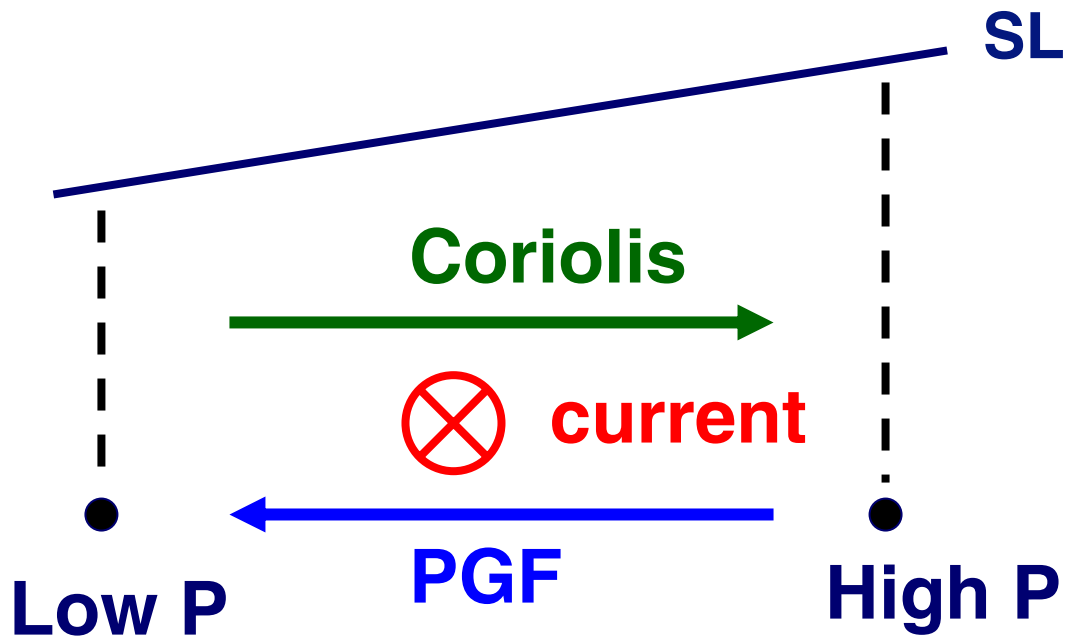


Upwelling occurs under cyclones.

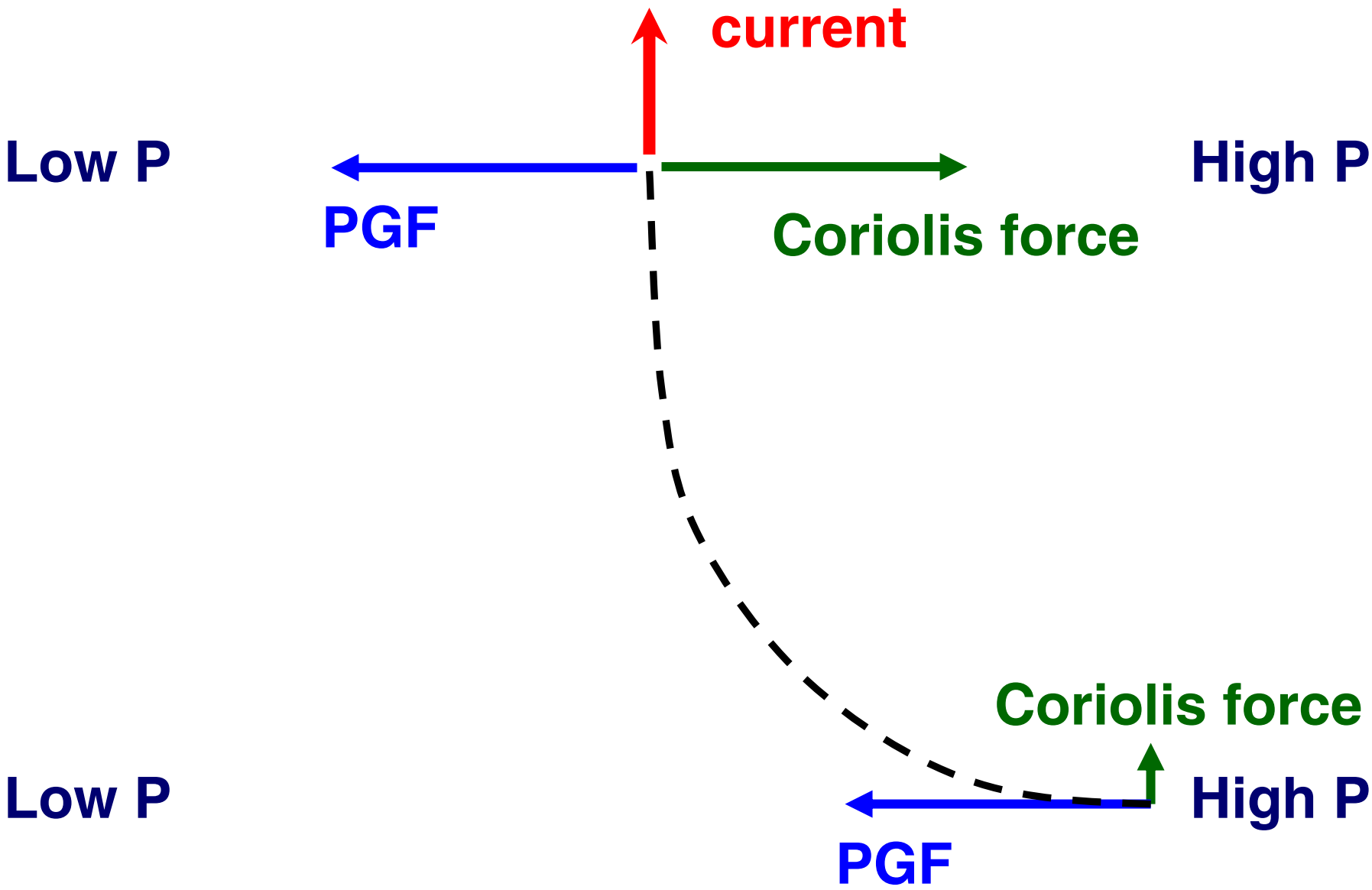
Downwelling occurs under anti-cyclones.

2. Forces in 100-1000m (Geostrophic Currents)

Tilt in sea level (SL) => pressure gradient => PGF force. When PGF is balanced by the Coriolis force => geostrophic current.



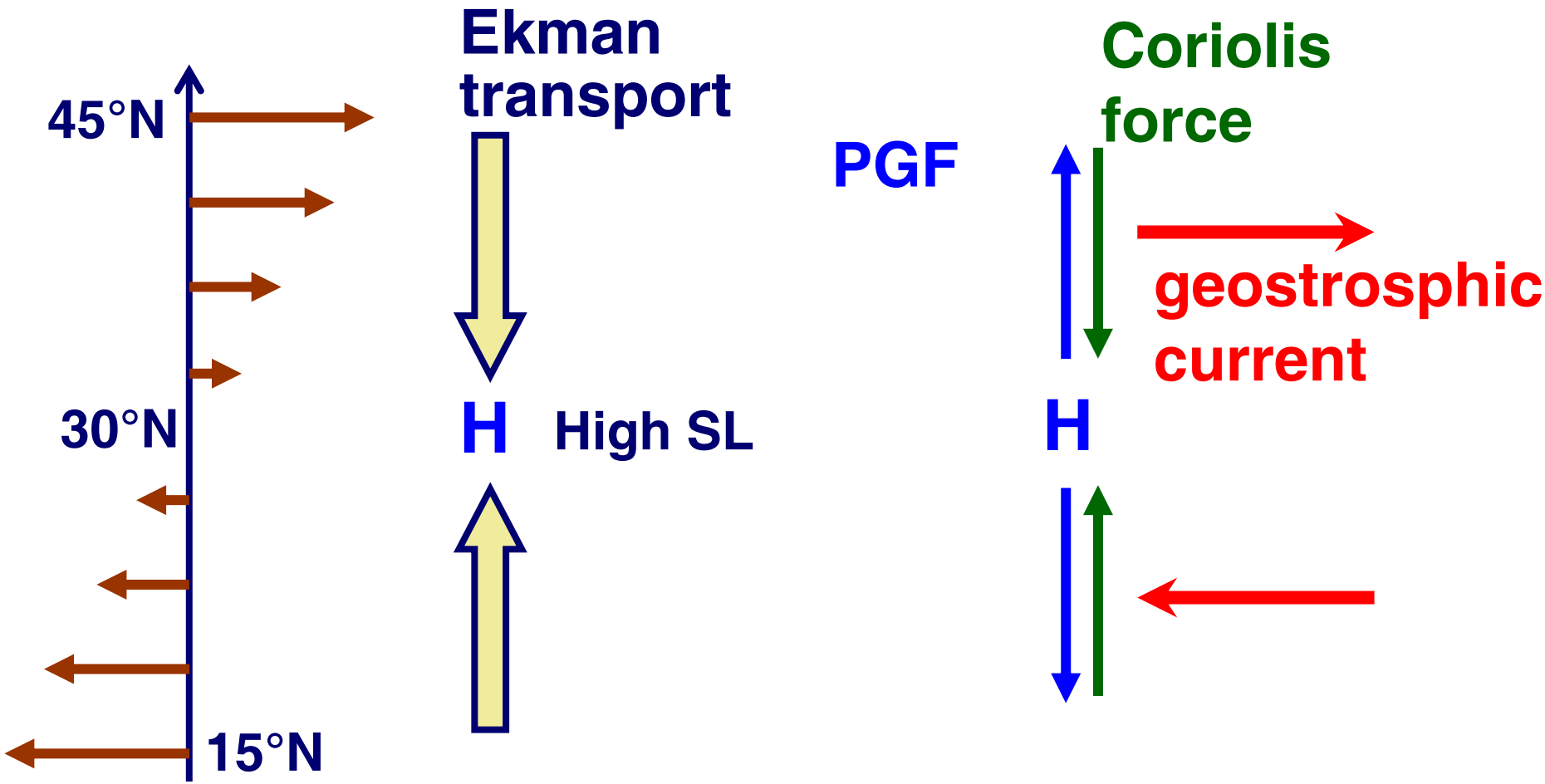
Gradual buildup of a geostrophic current:



N.Hem.: low-lat. Easterly winds, mid-lat. Westerlies

=> converging Ekman transport & high sea level (SL) at ~30°N

=> geostrophic currents.



- With eastern and western boundaries, ocean circulation forms large clockwise or anticlockwise cells = gyres.
- Pressure gradient from SL tilt disappears by ~1000m depth => geostrophic current only in top 1000m.

SUMMARY

- Wind stress, pressure gradient, Coriolis
- In Ekman layer (top 100m): Coriolis force + Friction force balancing wind stress.
- 100-1000m: Coriolis force balancing Pressure Gradient Force => geostrophic current.