ATOC 1060-002
OUR CHANGING ENVIRONMENT

Class 12 (Chp 4)

Objectives of Today's Class:

1. Lab Demo: Hadley circulation without rotation; Effects of rotation-Coriolis force; Global animation of water vapor and real earth; videos of the lab experiments;
2. Lecture: Coriolis force; surface & upper-level winds; geostrophic balance;

Lab experiments

Hadley circulation without rotation;
Effect of rotation (low rotational rate-zonal winds; high rotational rate-instabilities, waves);
Global animation of satellite observed water vapor, which will indicate atmospheric general circulation;

Videos will be shown after each lab experiment, in order to better digest what you have seen in the experiment.

All these materials are designed to let the students better understand the important concepts covered in the lectures, and to let them visualize the observed climate variability.

Summary: lab experiments & previous class

Meridional circulation

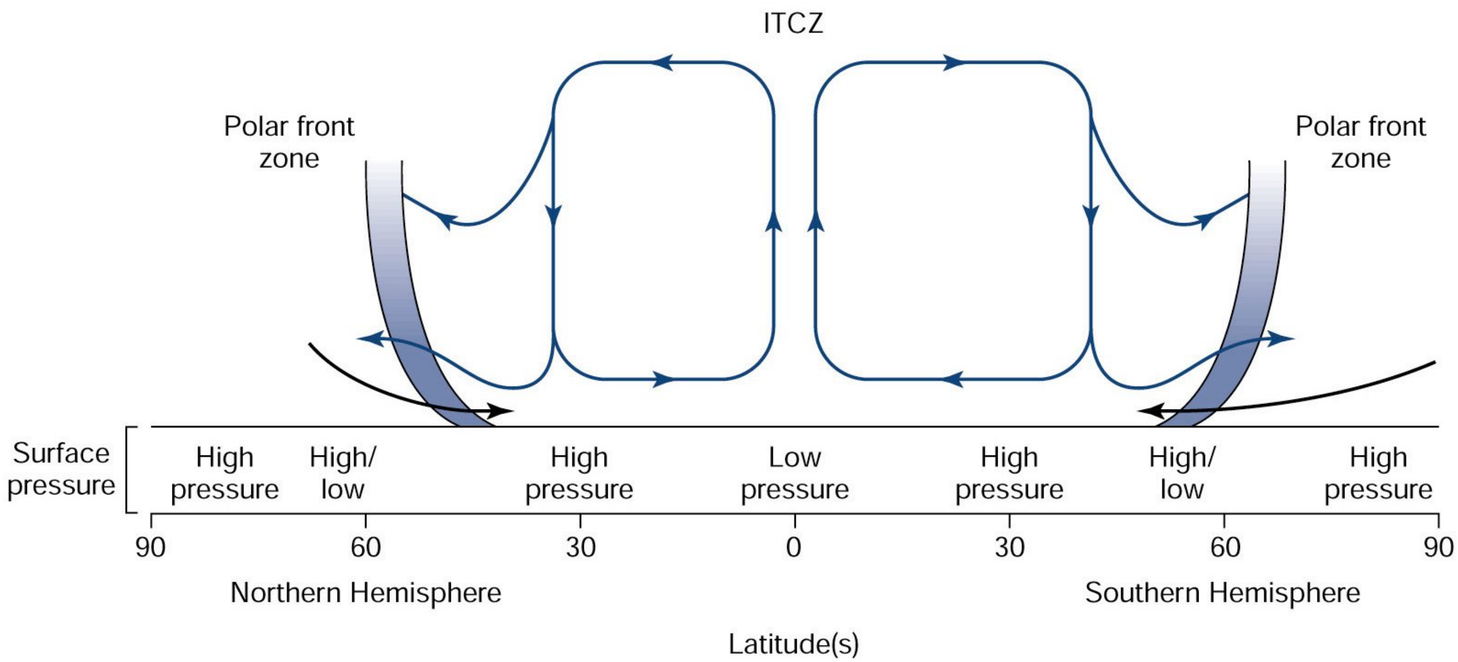
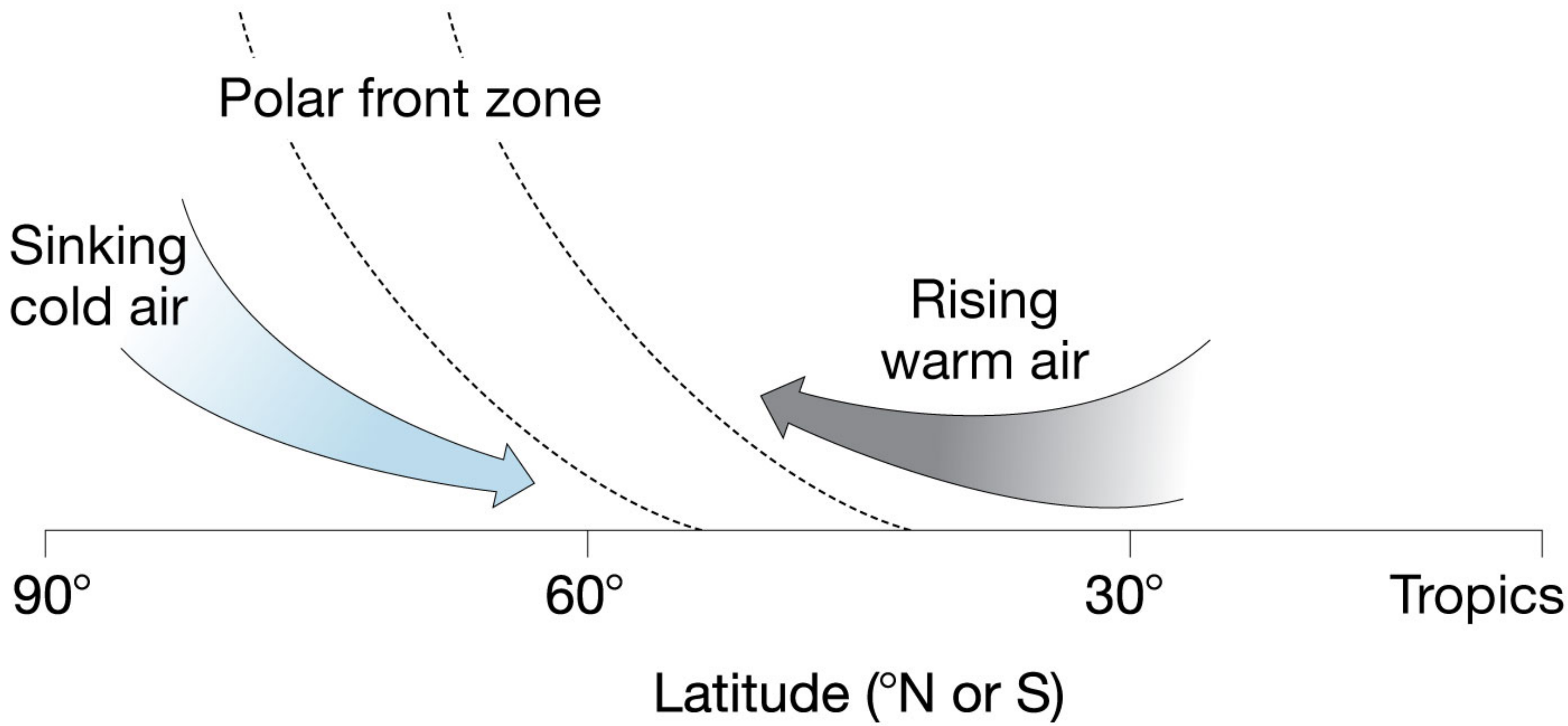


Fig. 4-7

- Hadley Circulation + Polar front


Polar front zone
Sinking
cold air
Rising
warm air
90°
60°
30°
Tropics
Latitude (°N or S)

Coriolis Effect

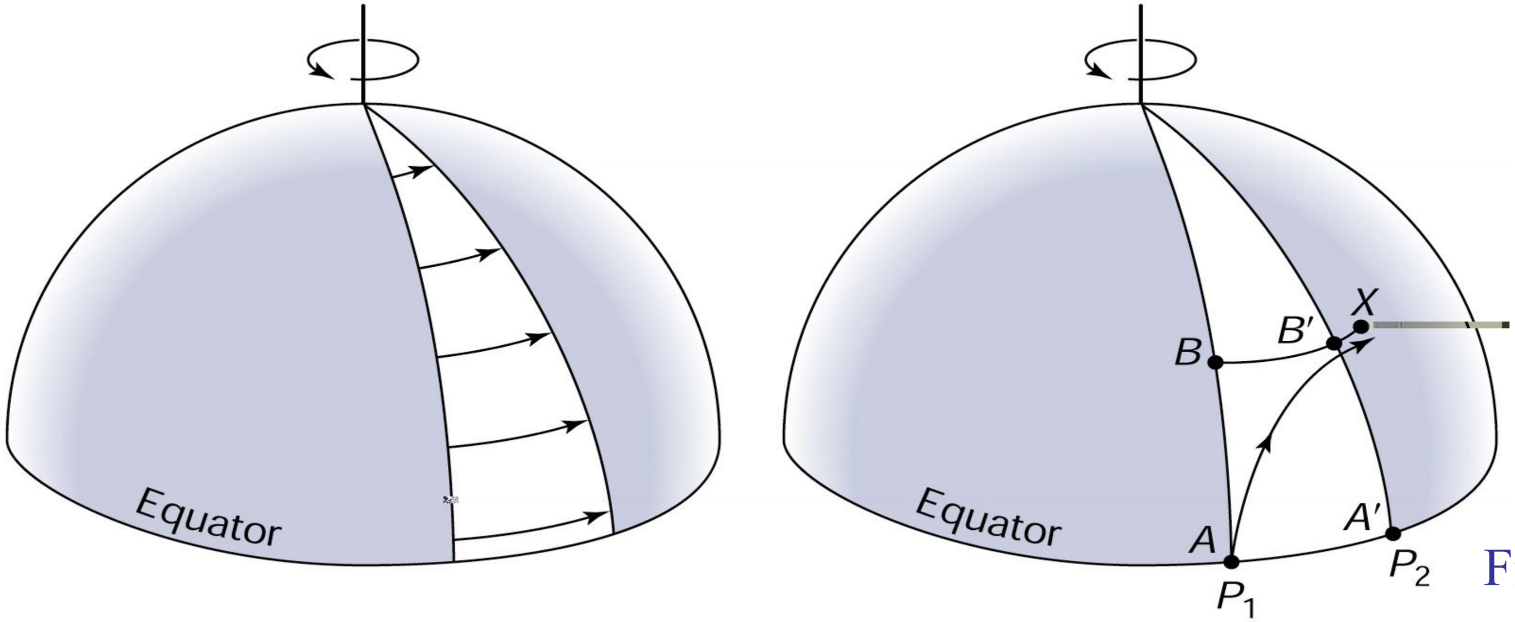


Fig. 4-9

- Earth rotates: surface speed fastest at equator, slowest at poles
- Imagine a cannonball fired due north from point A
  - Cannonball starts with eastwards motion equal to rotation at equator
  - B rotates slower; so cannonball moves farther east than B
  - Cannonball appears to be ***deflected*** to RIGHT
  - Seen from space, cannonball moves in a straight line

Important Features:

- Polar easterlies
- Midlatitude Westerlies
- Subtropical High:
  - – Weak winds
- Easterly Trades
- ITCZ:
  - – ‘Doldrums’
  - – Weak winds

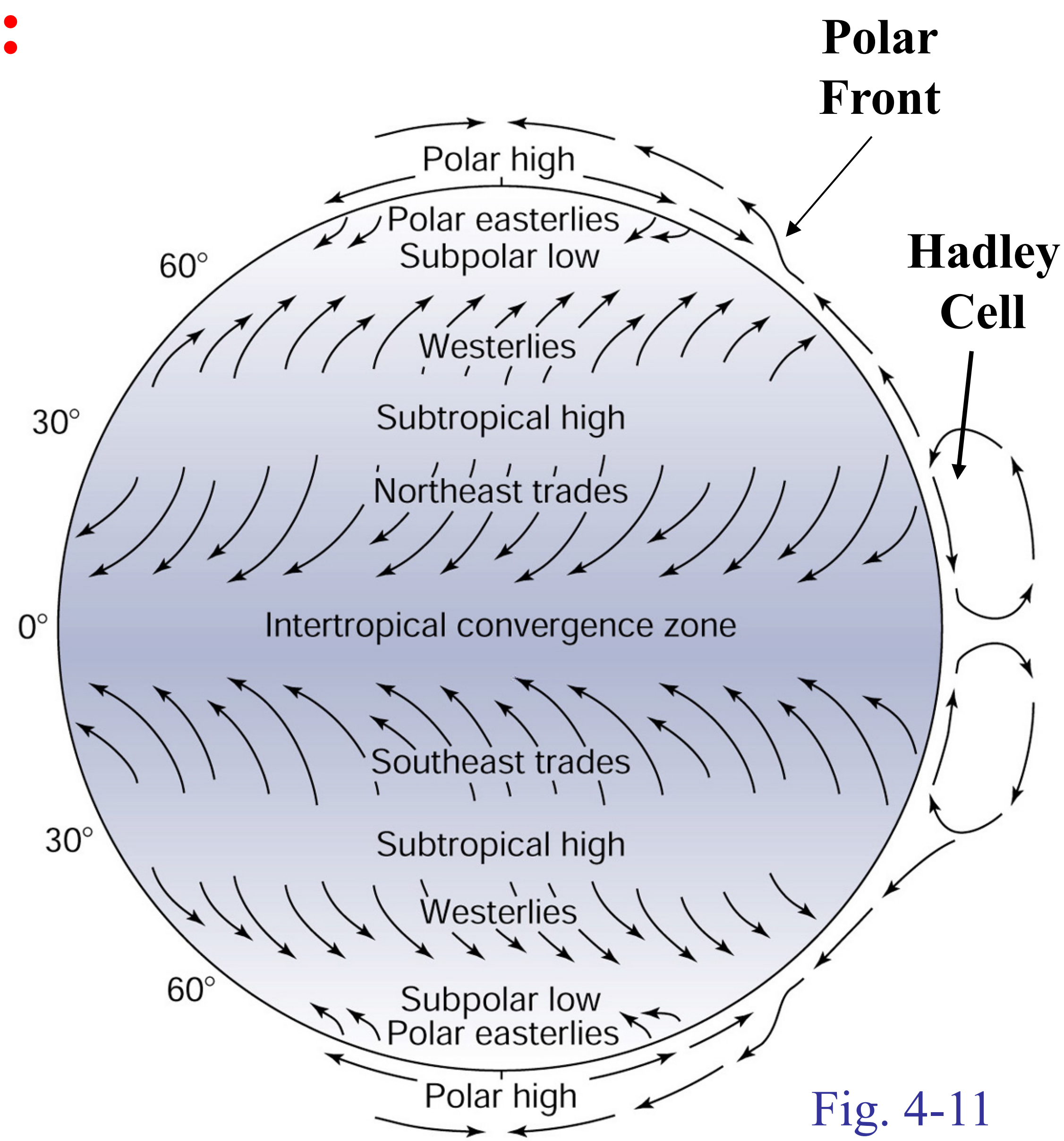
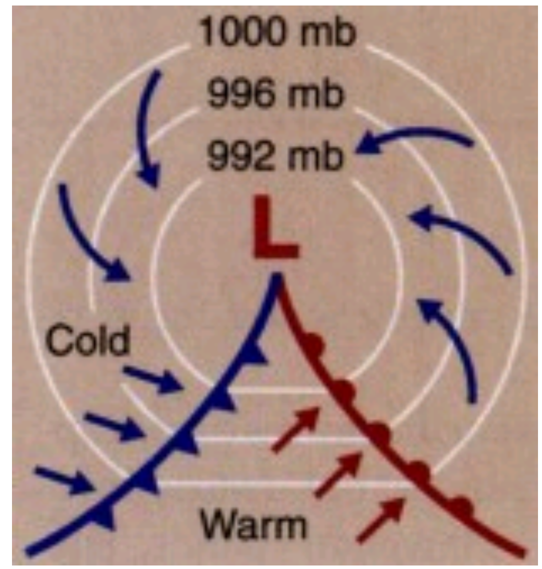


Fig. 4-11

Mid-latitude waves

- Actual surface flow is highly variable
  - ITCZ is discontinuous
  - Midlatitude westerlies are disrupted by passage of extratropical highs & lows
- Extratropical Cyclones (lows):
  - Form near polar front
  - Winds spiral into low pressure
  - Important for heat transport & precipitation



Upper-level flow : Vertical Cross-Section, Pressure gradient force

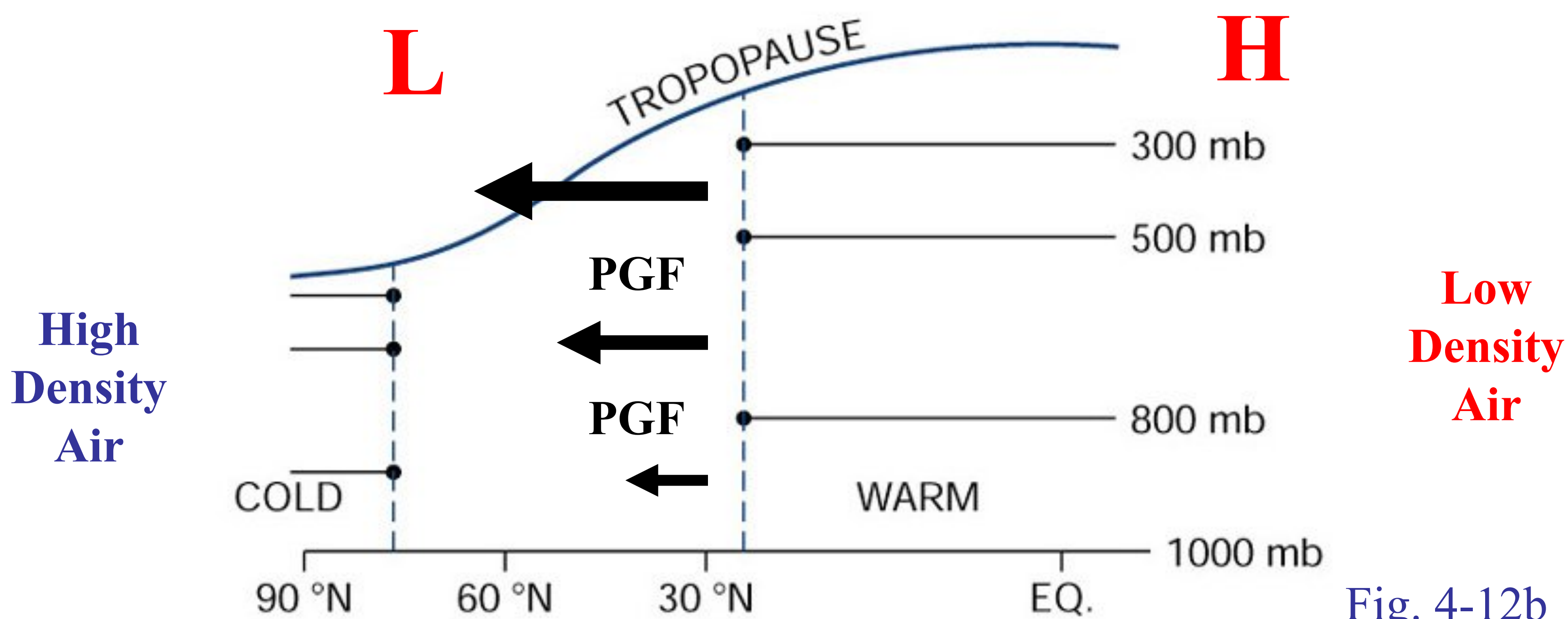


Fig. 4-12b

- Lines of constant pressure slope down from equator
- Pressure gradient Force (PGF) points poleward above surface
  - Strongest PGF at tropopause

Geostrophic Flow

- Balance between PGF and Coriolis force
  - Parallel to pressure lines
  - Low pressure to left (right) of flow in NH (SH)
- Not very accurate approximation near surface (friction)
- Very good in upper atmosphere. The stronger the PGF (tighter the isobars), the stronger the Vg.

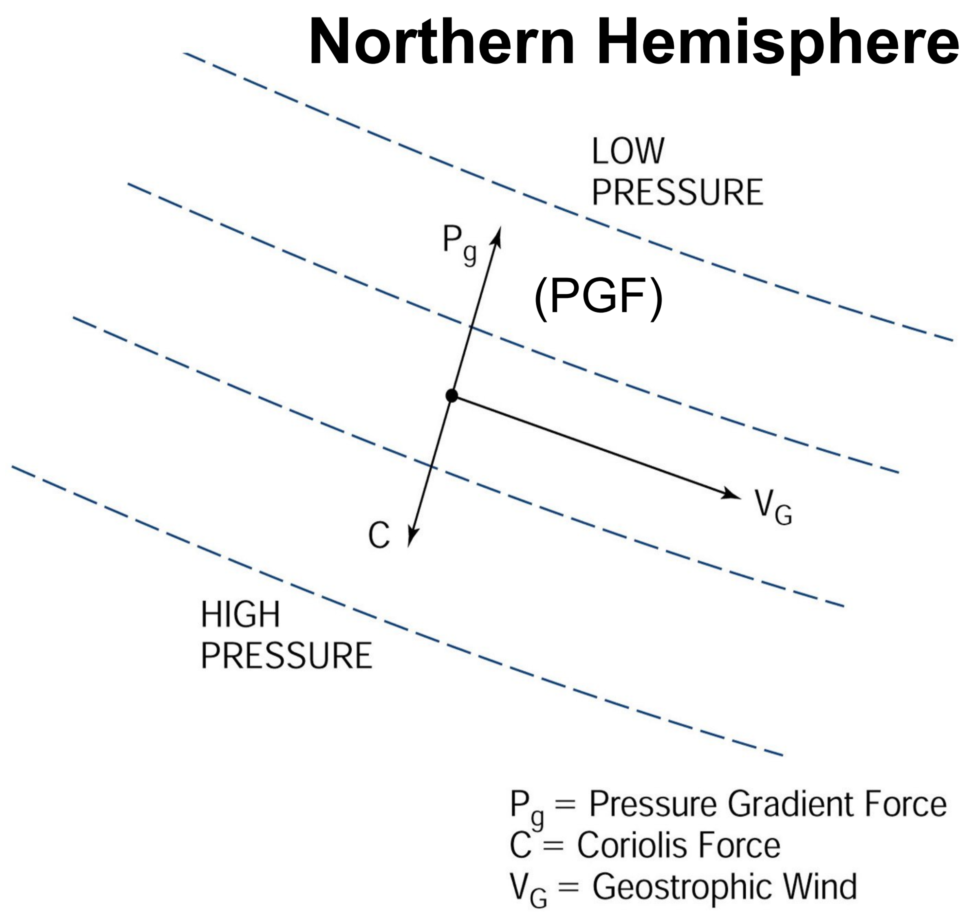
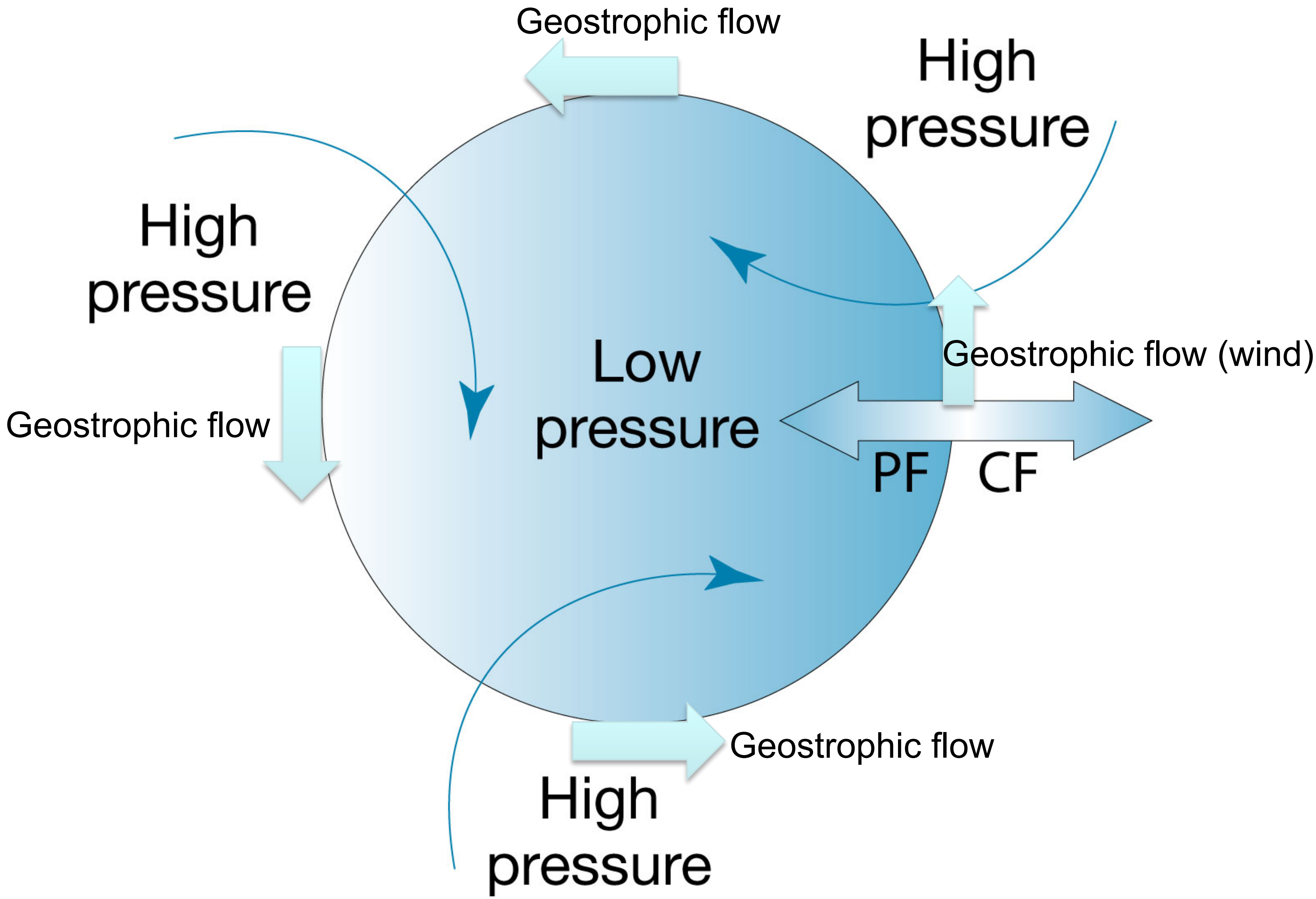


Fig. 4-13



Geostrophic flow
High pressure
High pressure
Low pressure
Geostrophic flow (wind)
Geostrophic flow
PF
CF
Geostrophic flow
High pressure

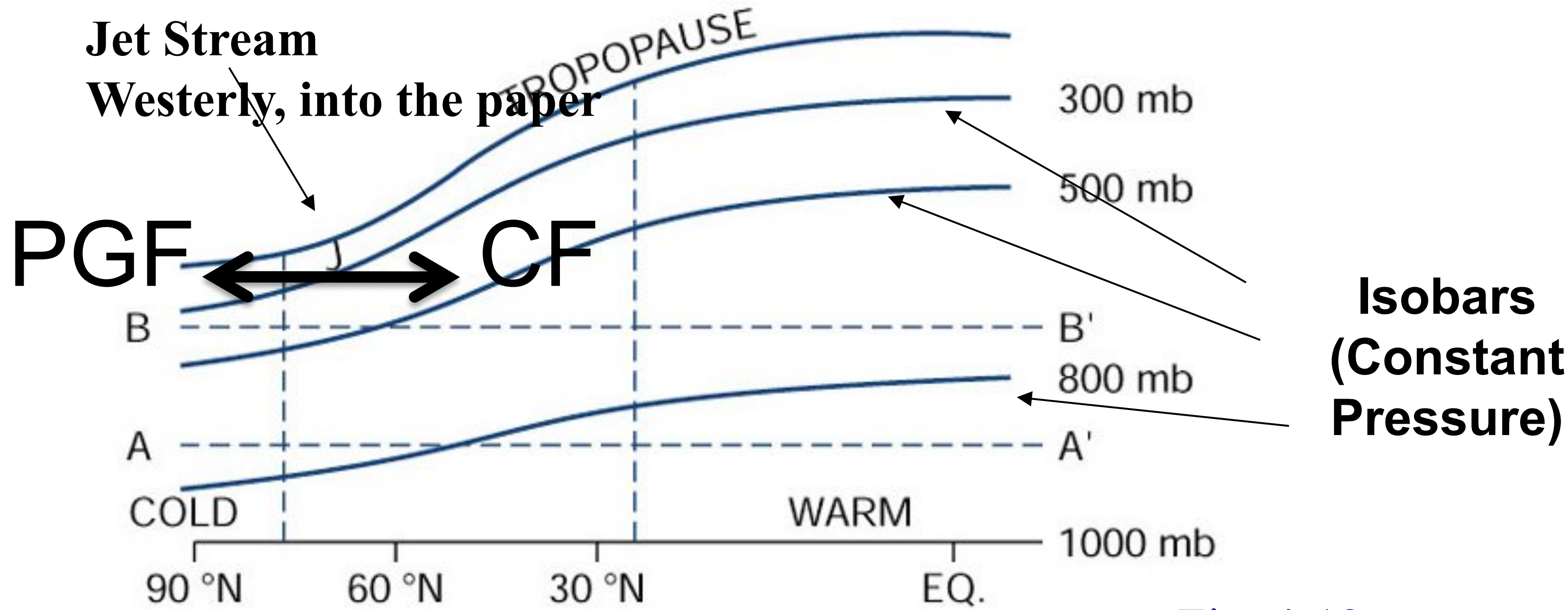
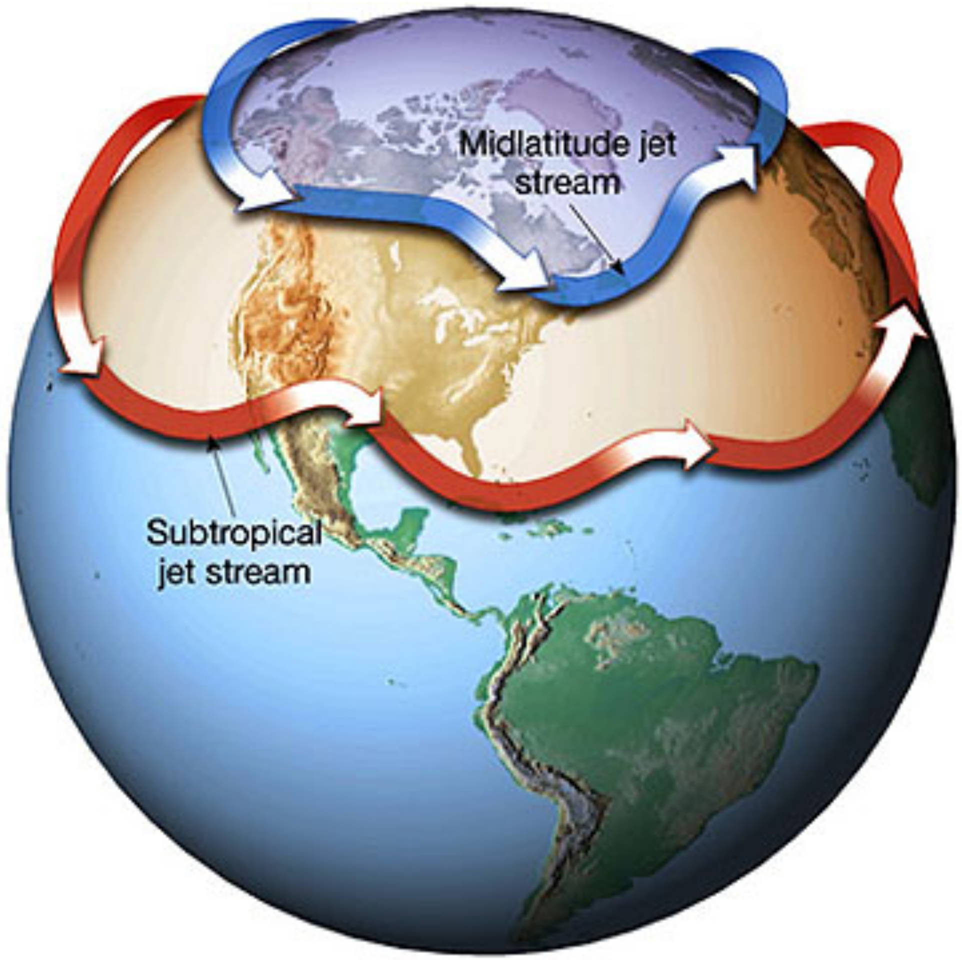


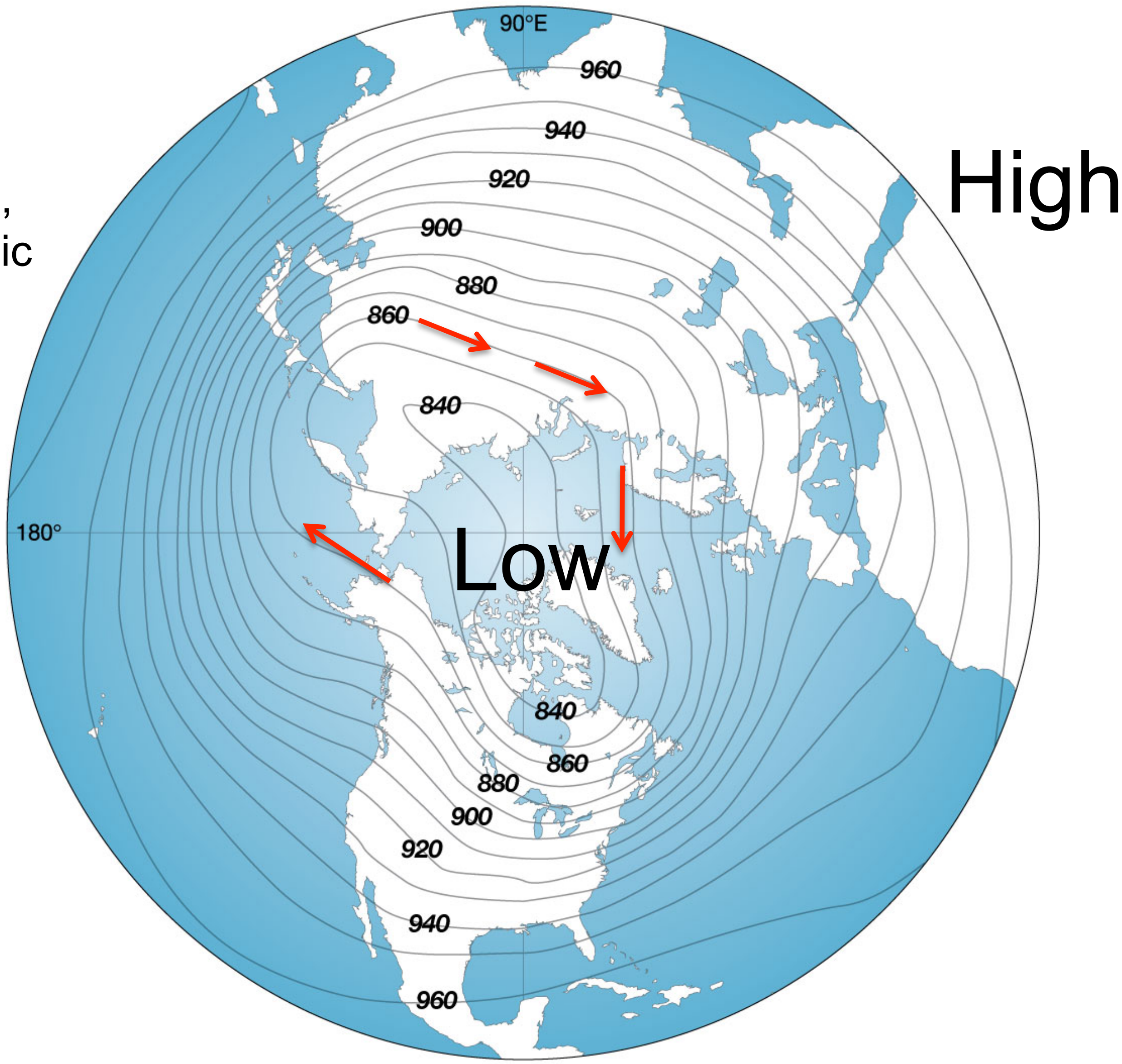
Fig. 4-12c

- Adding Coriolis: Westerly geostrophic flow
- Fastest flow in tightest isobars (Jet Stream)

Upper level flow - Jet stream: Geostrophic flow



Jet stream, Geostrophic flow



4-14. Northern hemisphere mean january 300-mbar geopotential heights (decameters; 1 decameter=10m).