CHAPTER 6
Air-Sea Interaction

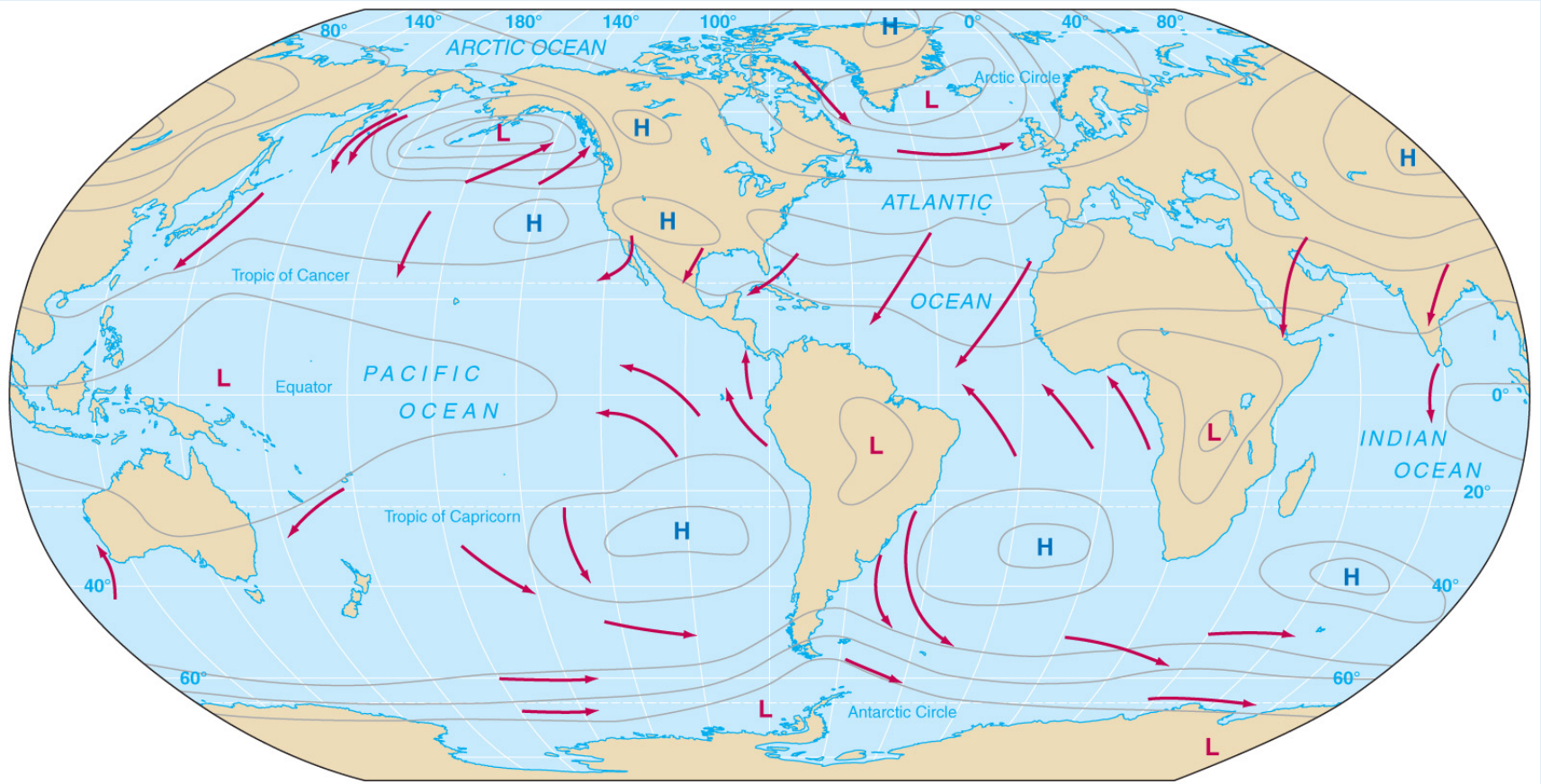


Fig. 6.11

Overview

- Atmosphere and ocean one interdependent system
- Solar energy creates winds
- Winds drive surface ocean currents and waves
- Examples of interactions:
  - El Niño-Southern Oscillation
  - Greenhouse effect

Seasons

- Earth's axis of rotation tilted with respect to ecliptic
- Tilt responsible for seasons
  - Vernal (spring) equinox
  - Summer solstice
  - Autumnal equinox
  - Winter solstice
- Seasonal changes and day/night cause unequal solar heating of Earth's surface

Seasons

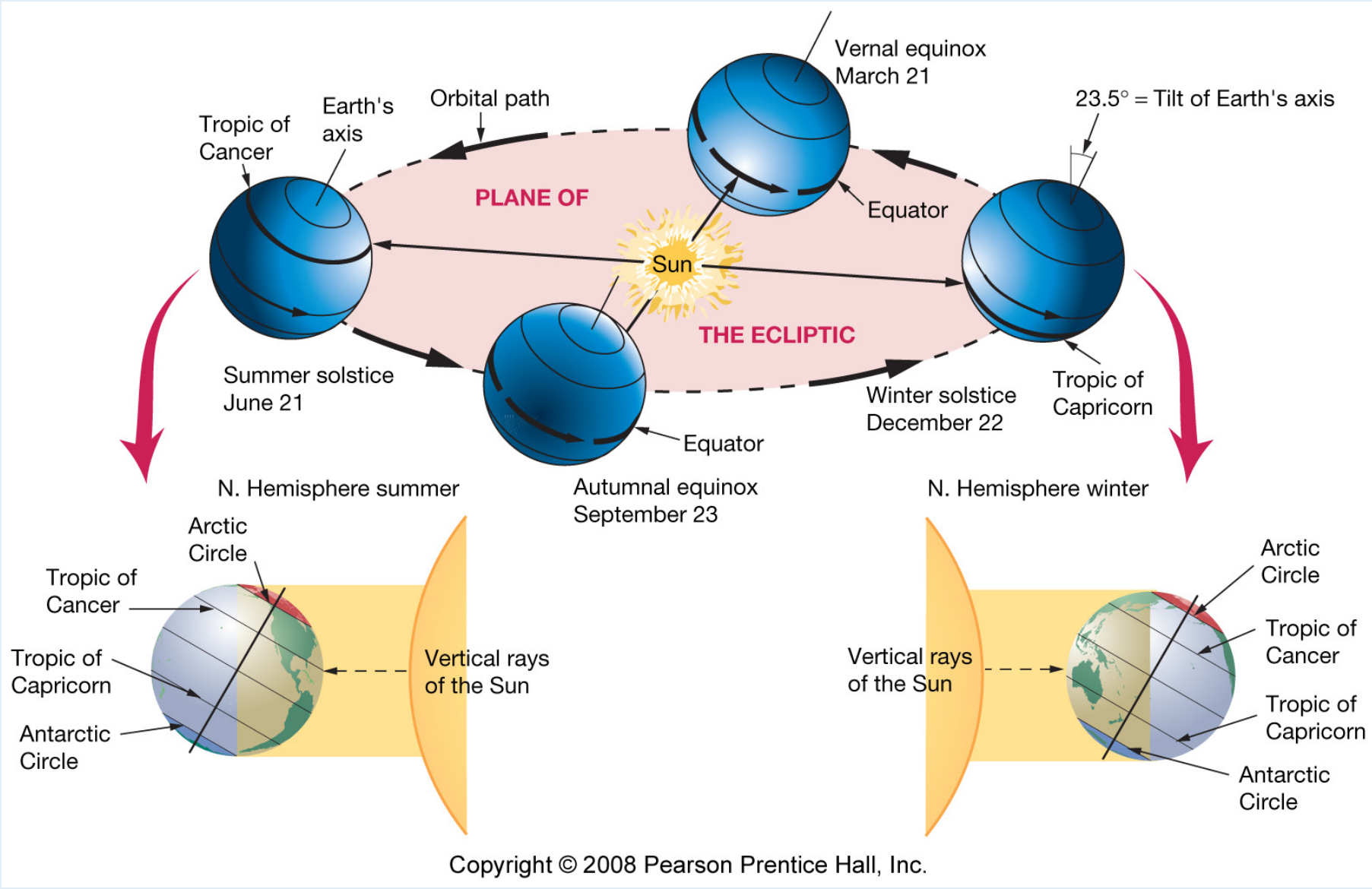
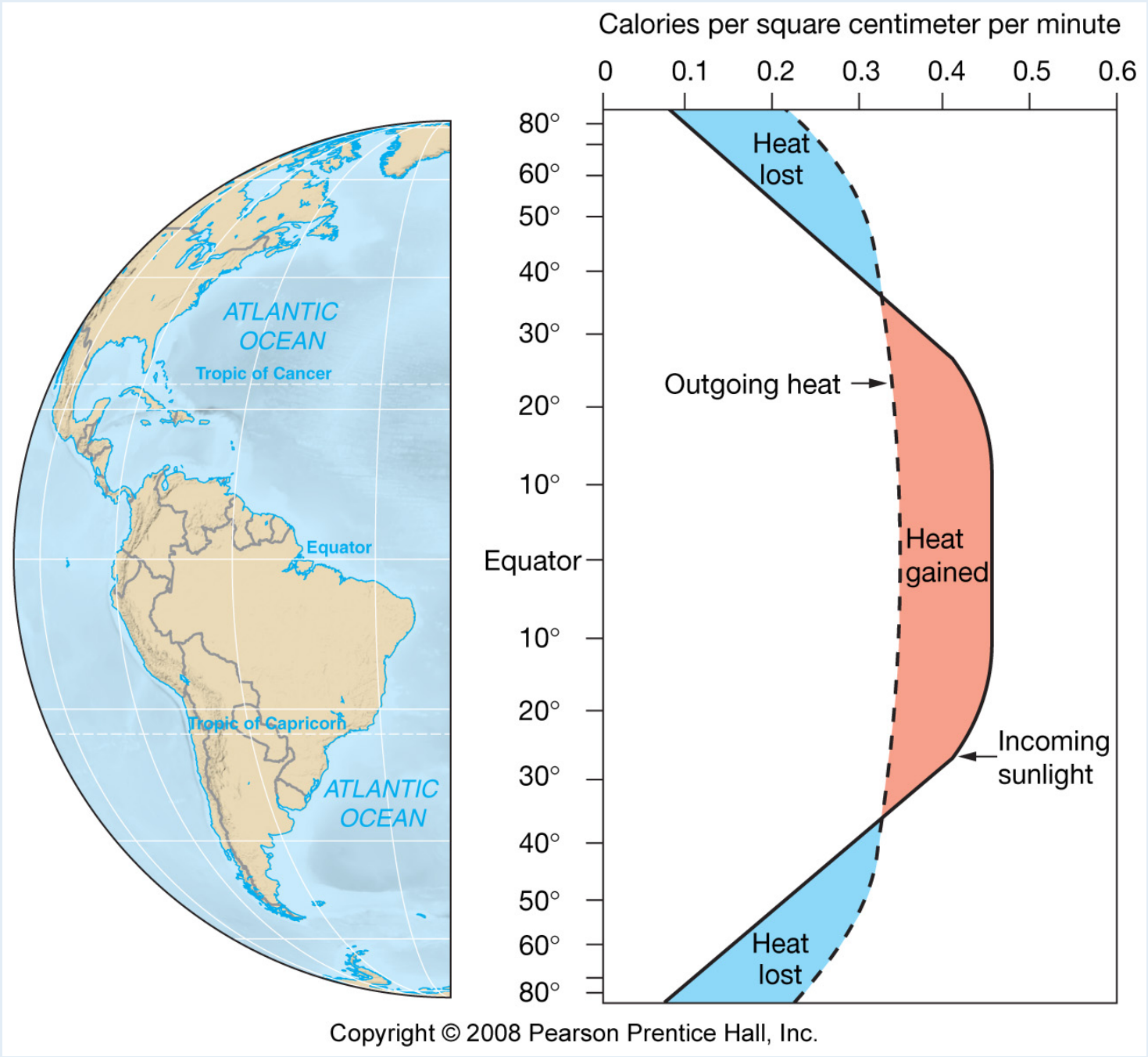


Fig. 6-1

Uneven solar heating

- Angle of incidence of solar rays per area
  - Equatorial regions more heat
  - Polar regions less heat
- Thickness of atmosphere
- Albedo
- Day/night
- Seasons



Insert Fig. 6-3

Oceanic heat flow

- High latitudes more heat lost than gained
  - Due to albedo of ice and high incidence of solar rays
- Low latitudes more heat gained than lost

Physical properties of atmosphere

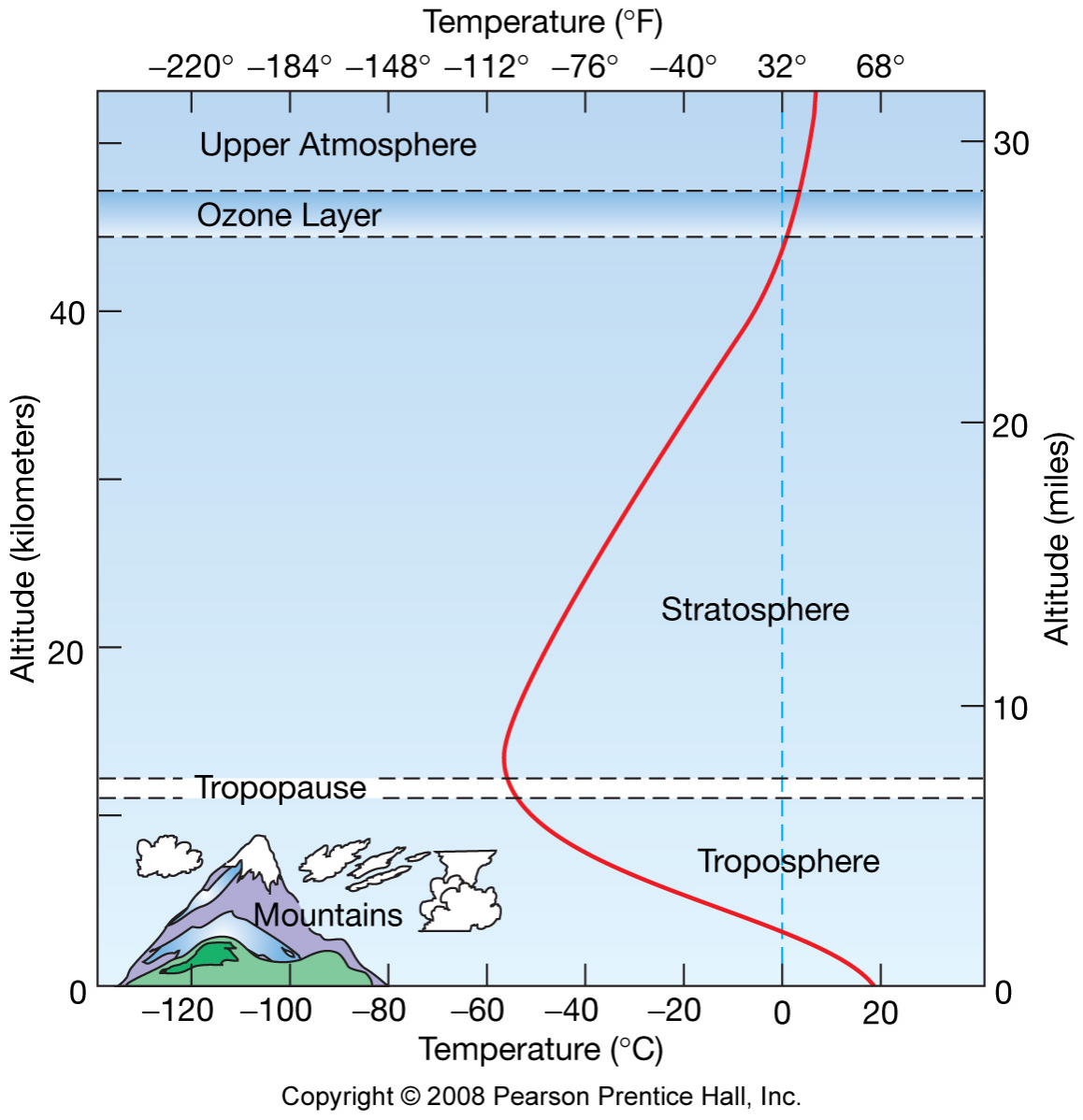


Fig. 6.4

- Atmosphere mostly nitrogen (N_2) and oxygen (O_2)
- Temperature profile of lower atmosphere
  - Troposphere – temperature cools with increasing altitude

Physical properties of atmosphere

- Warm air, less dense (rises)
- Cool air, more dense (sinks)
- Moist air, less dense (rises)
- Dry air, more dense (sinks)

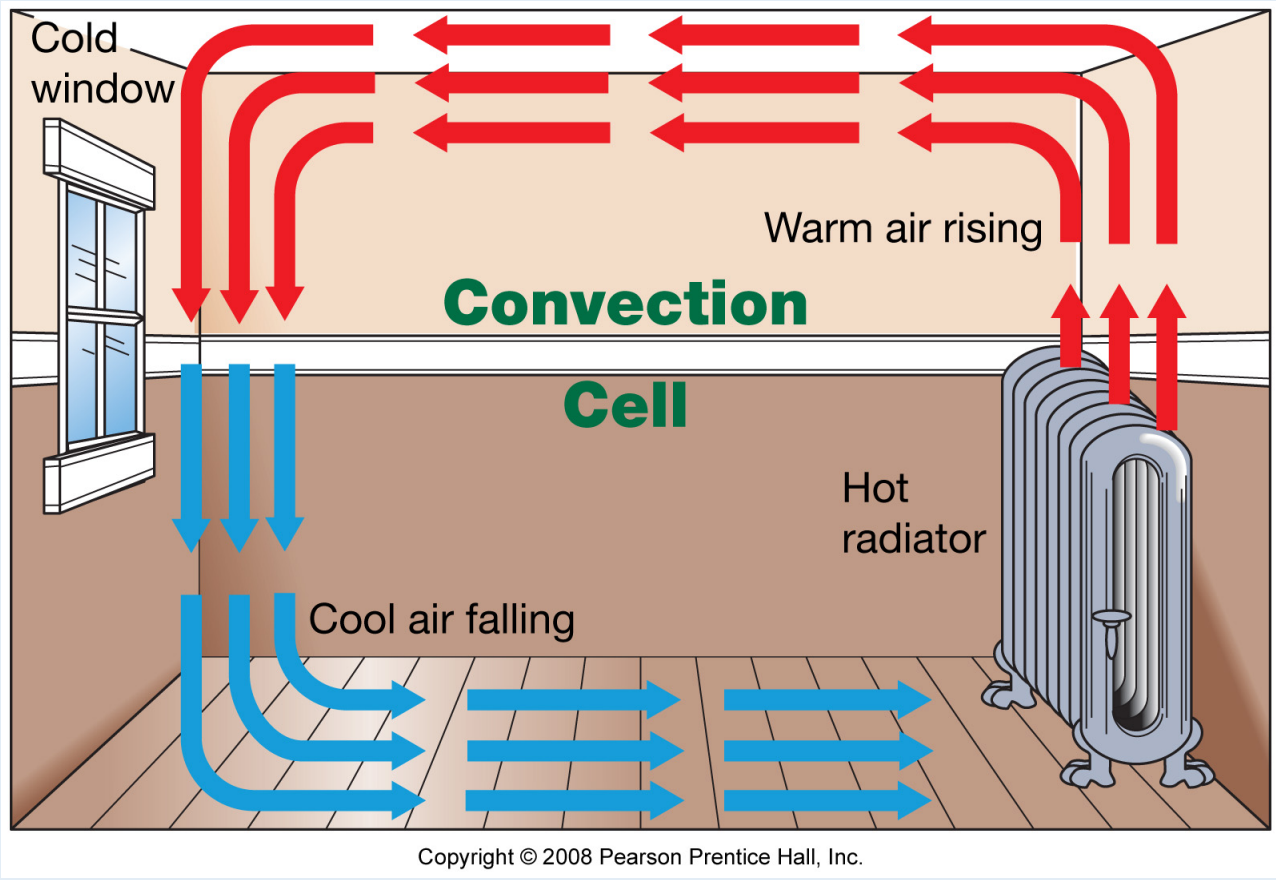


Fig. 6.5

Movements in atmosphere

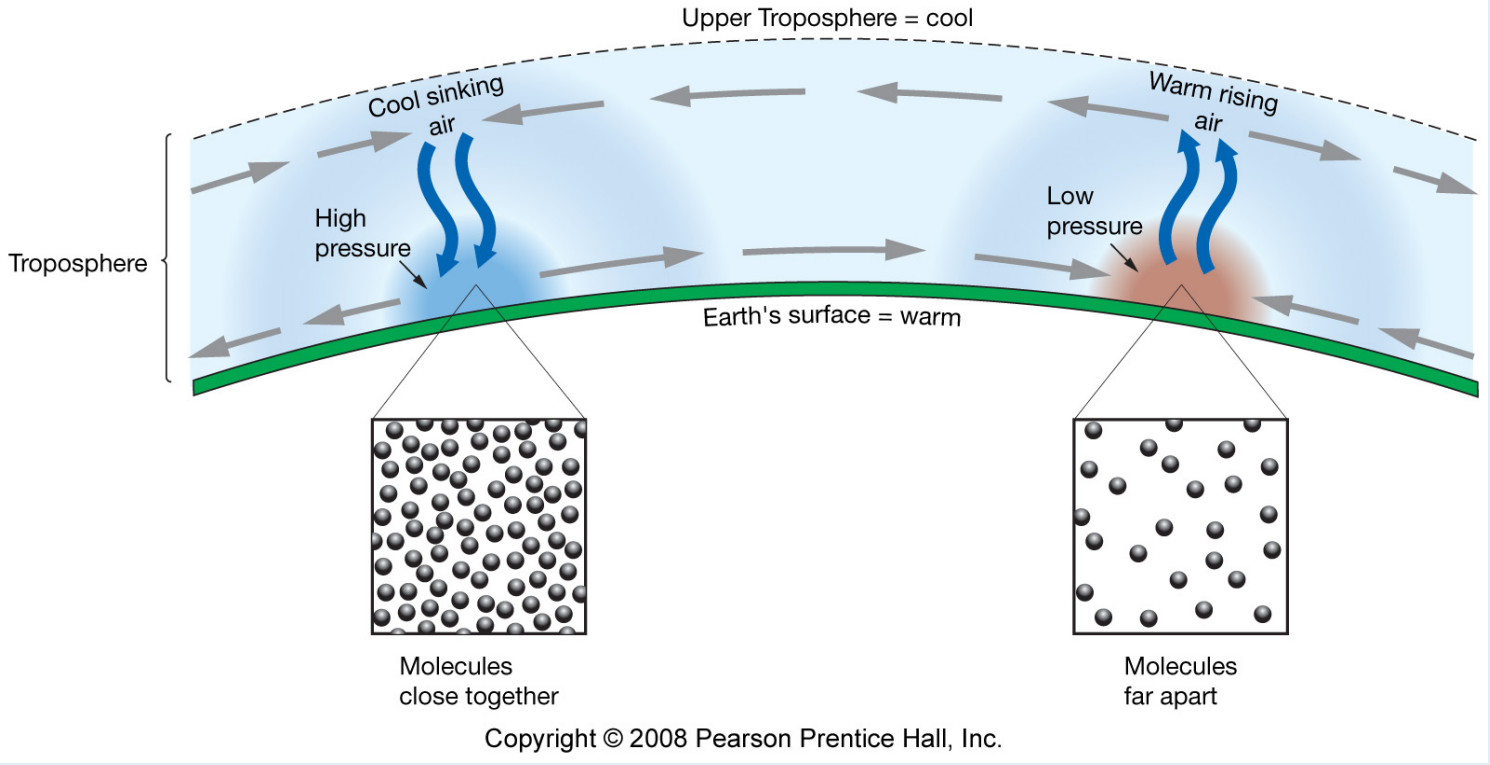


Fig. 6.6

- Air (wind) always moves from regions of high pressure to low
- Cool dense air, higher surface pressure
- Warm less dense air, lower surface pressure

Movements in air

Non-rotating Earth

- Air (wind) always moves from regions of high pressure to low
- Convection or circulation cell

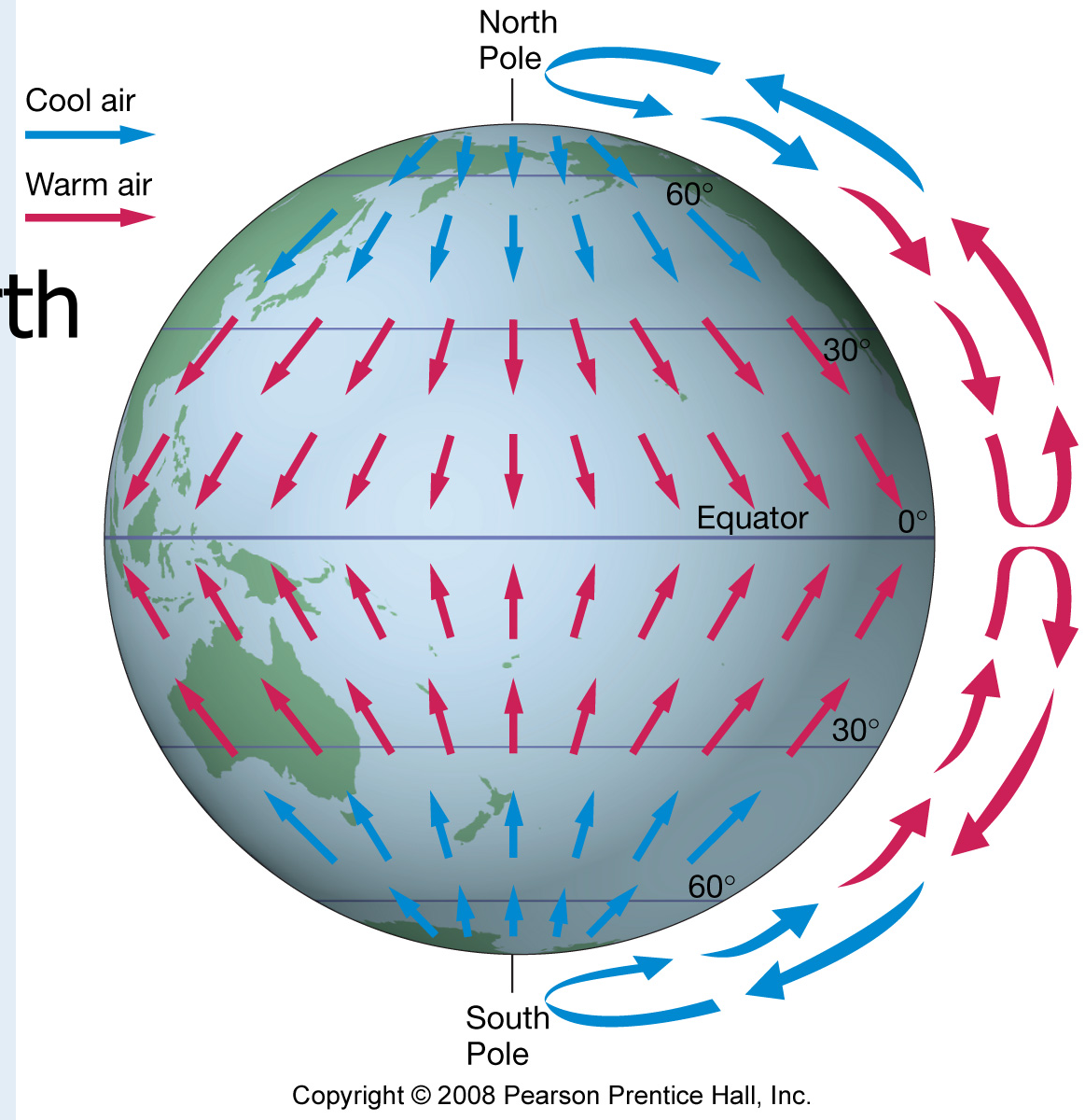


Fig. 6.7

Movements in air on a rotating Earth

- Coriolis effect causes deflection in moving body
- Due to Earth's rotation to east
- Most pronounced on objects that move long distances across latitudes
- Deflection to right in Northern Hemisphere
- Deflection to left in Southern Hemisphere
- Maximum Coriolis effect at poles
- No Coriolis effect at equator

Movements in air on a rotating Earth

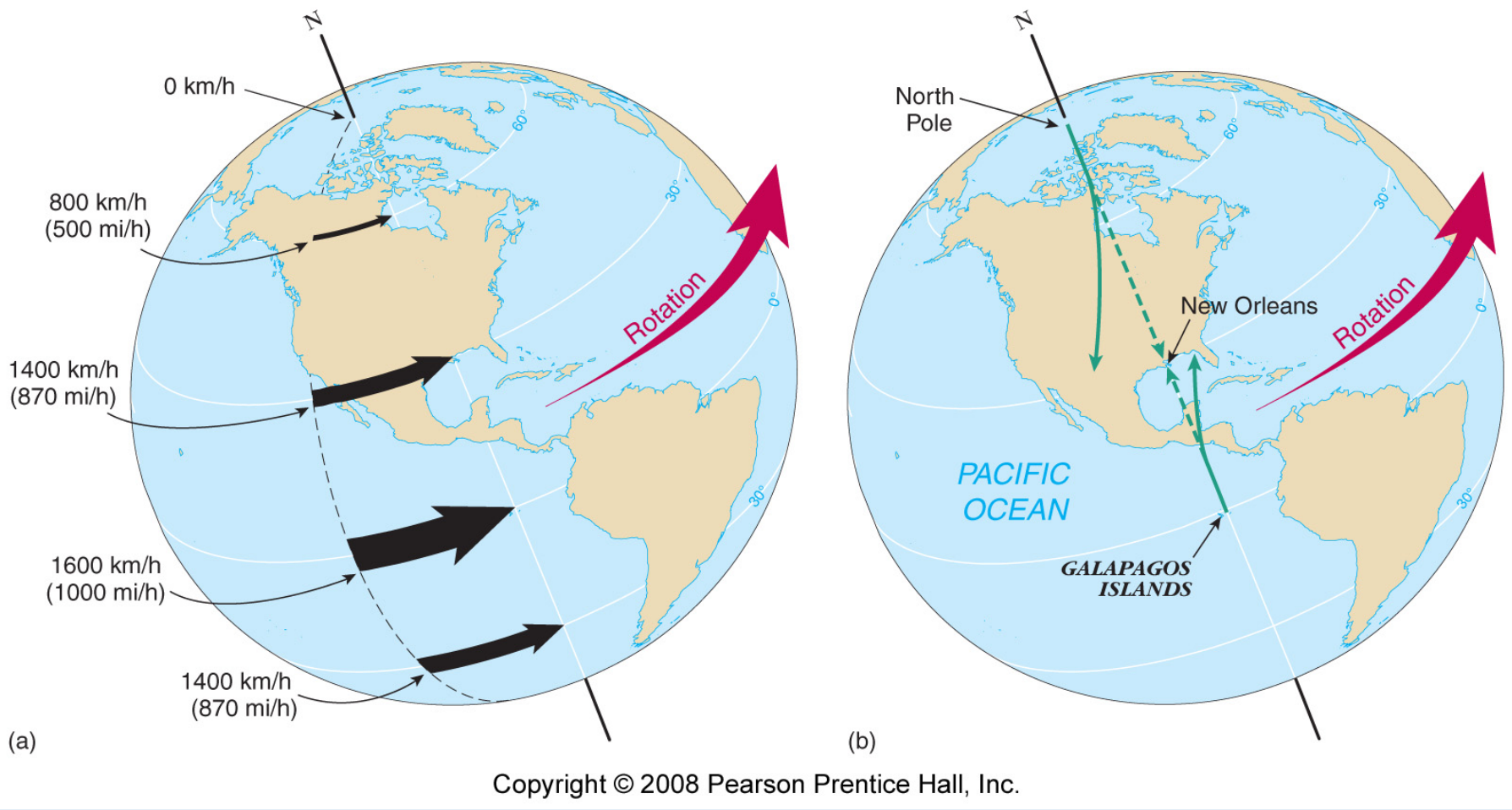


Fig. 6.9

Global atmospheric circulation

- Circulation cells as air changes density due to:
  - Changes in air temperature
  - Changes in water vapor content
- Circulation cells
  - Hadley cells (0^o to 30^o N and S)
  - Ferrel cells (30^o to 60^o N and S)
  - Polar cells (60^o to 90^o N and S)

Global atmospheric circulation

- High pressure zones
  - Subtropical highs
  - Polar highs
  - Clear skies
- Low pressure zones
  - Equatorial low
  - Subpolar lows
  - Overcast skies with lots of precipitation

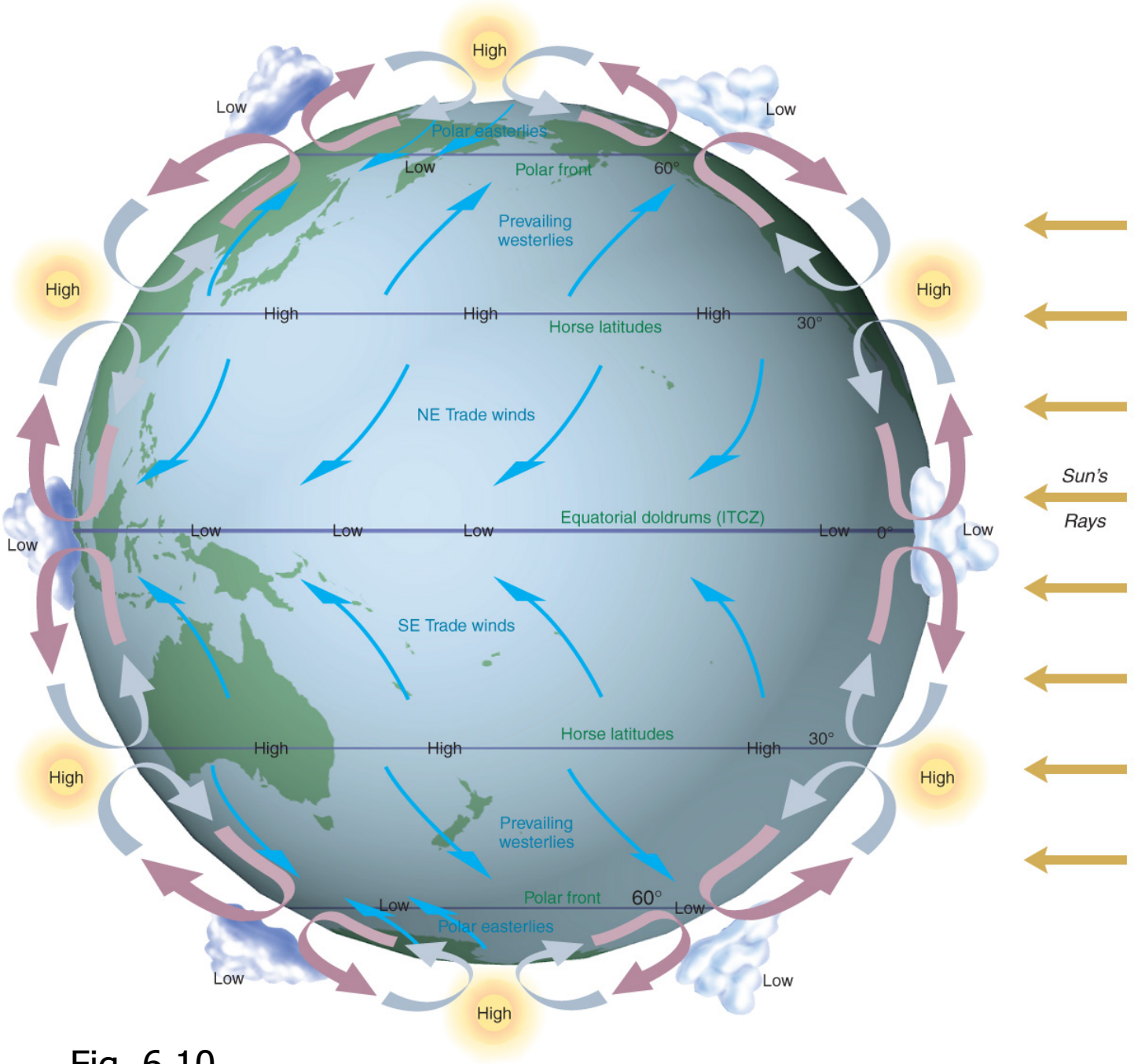


Fig. 6.10

Global wind belts

- Trade winds
  - Northeast trades in Northern Hemisphere
  - Southeast trades in Southern Hemisphere
- Prevailing westerlies
- Polar easterlies
- Boundaries between wind belts
- Doldrums or Intertropical Convergence Zone (ITCZ)
- Horse latitudes
- Polar fronts

Modifications to idealized 3-cell model of atmospheric circulation

- More complex in nature due to
  - Seasonal changes
  - Distribution of continents and ocean
  - Differences in heat capacity between continents and ocean
    - Monsoon winds

Actual pressure zones and winds

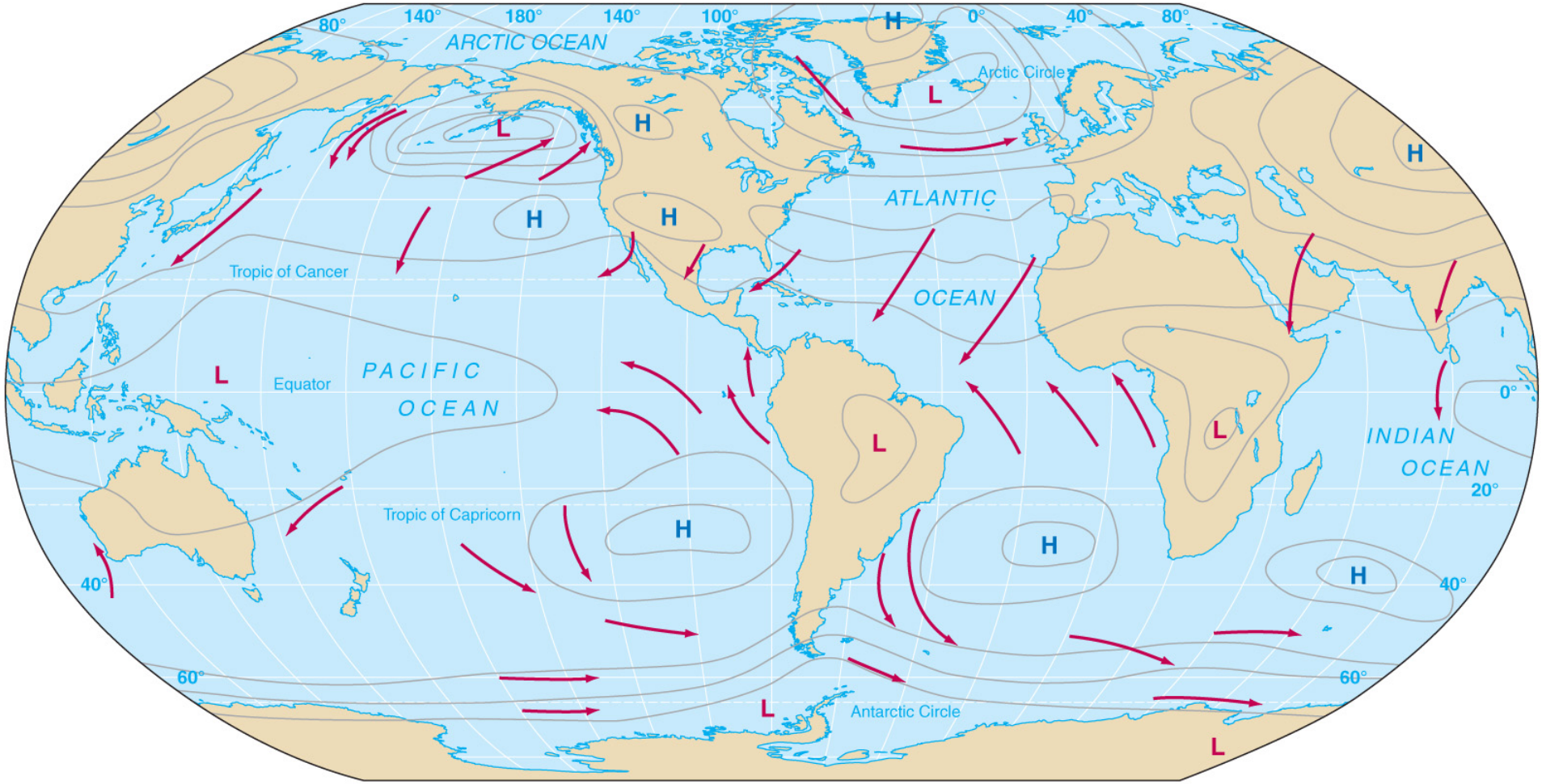


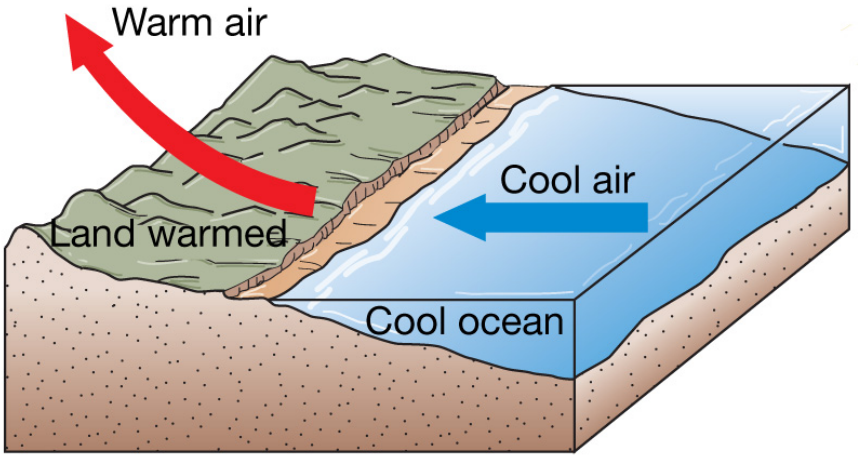
Fig. 6.11

Ocean weather and climate patterns

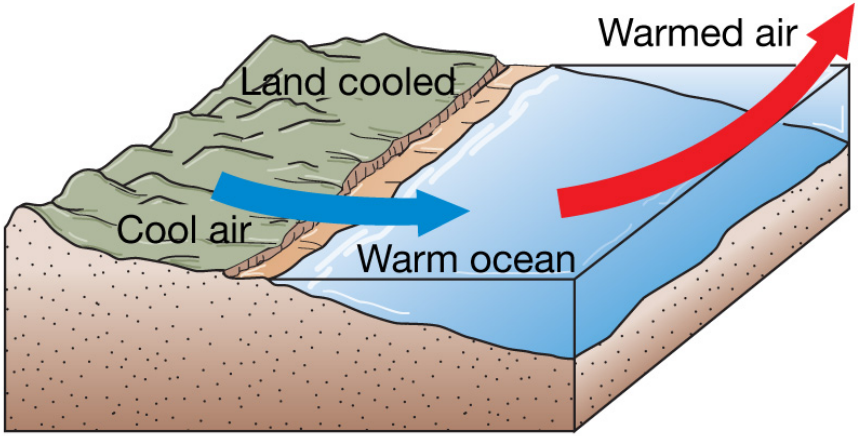
- Weather – conditions of atmosphere at particular time and place
- Climate – long-term average of weather
- Northern hemisphere winds move counterclockwise (cyclonic) around a low pressure region
- Southern hemisphere winds move clockwise (anticyclonic) around a low pressure region

Coastal winds

- Solar heating
- Different heat capacities of land and water
- Sea breeze
  - From ocean to land
- Land breeze
  - From land to ocean



(a) Sea breeze



(b) Land breeze

Fig. 6.13