Fundamentals of Physical Geography 2e

Atmospheric Pressure, Winds, and Circulation

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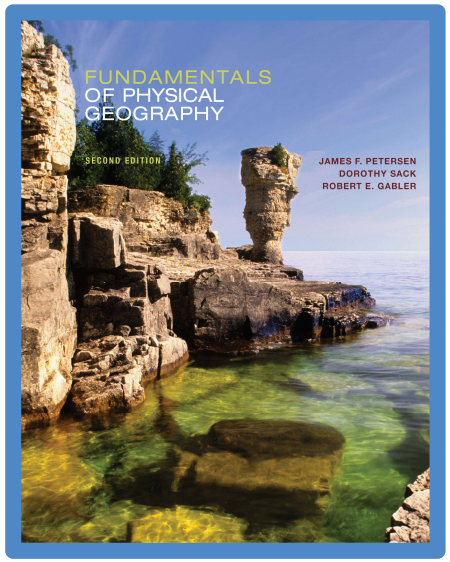
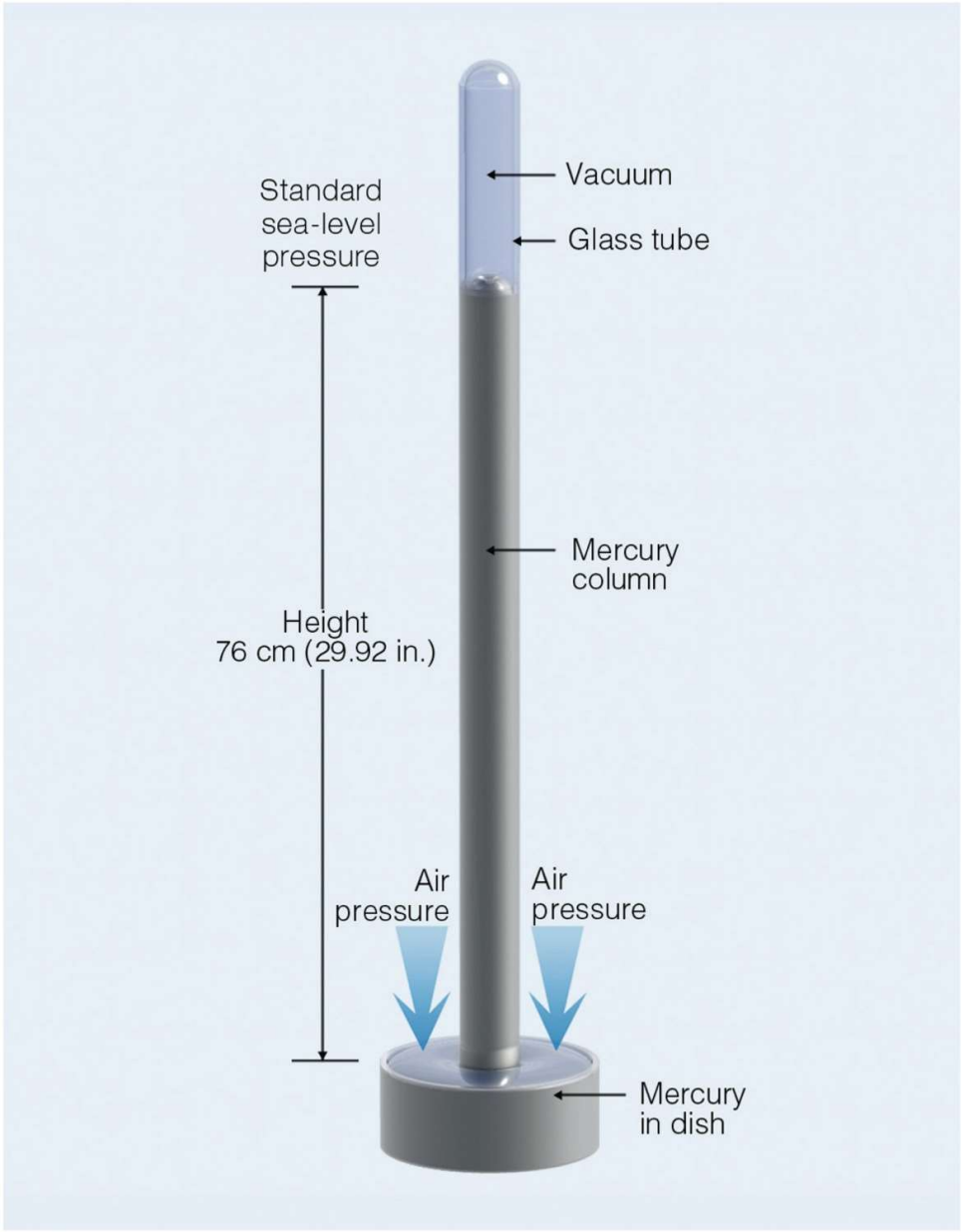


- Peterson
  - Sack
    - Gabler

Atmospheric Pressure

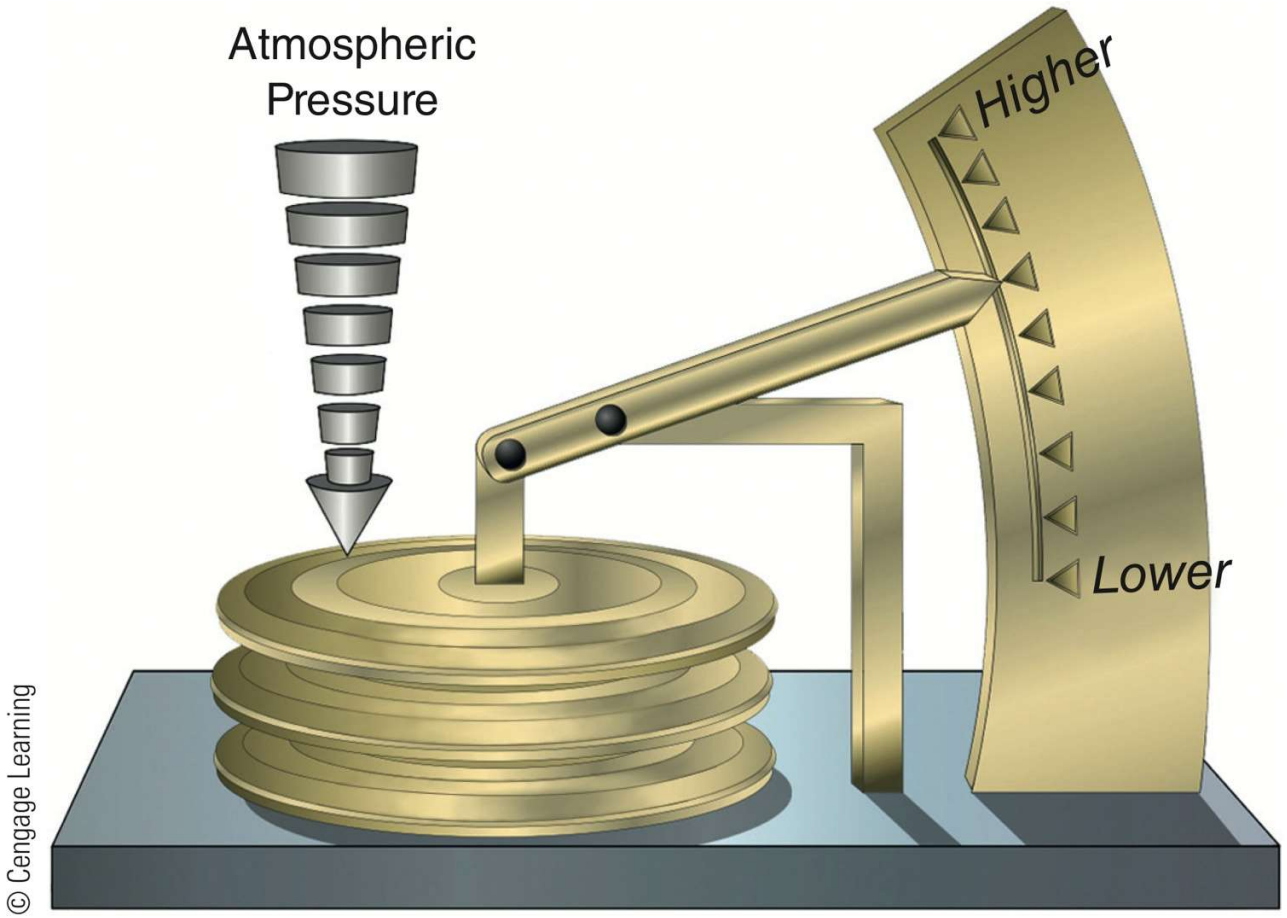
- Introduction
  - Air molecules: exert an average pressure of 1,034 grams per square centimeter (14.7 lb/sq in.) at sea level
  - Differences in atmospheric pressure create wind
  - Mercury barometer measures atmospheric pressure

When air pressure increases, what happens to the mercury in the tube?



Atmospheric Pressure (cont'd.)

- Standard sea-level pressure
  - 1013.2 millibars
  - Supports 76 cm (29.92 in) of mercury in a barometer
- Air pressure, altitude, and elevation
  - Why does air pressure decrease with increasing *elevation* on Earth and with *altitudes* above it?



Why are aneroid barometers advantageous in comparison to a mercurial barometer for some applications?

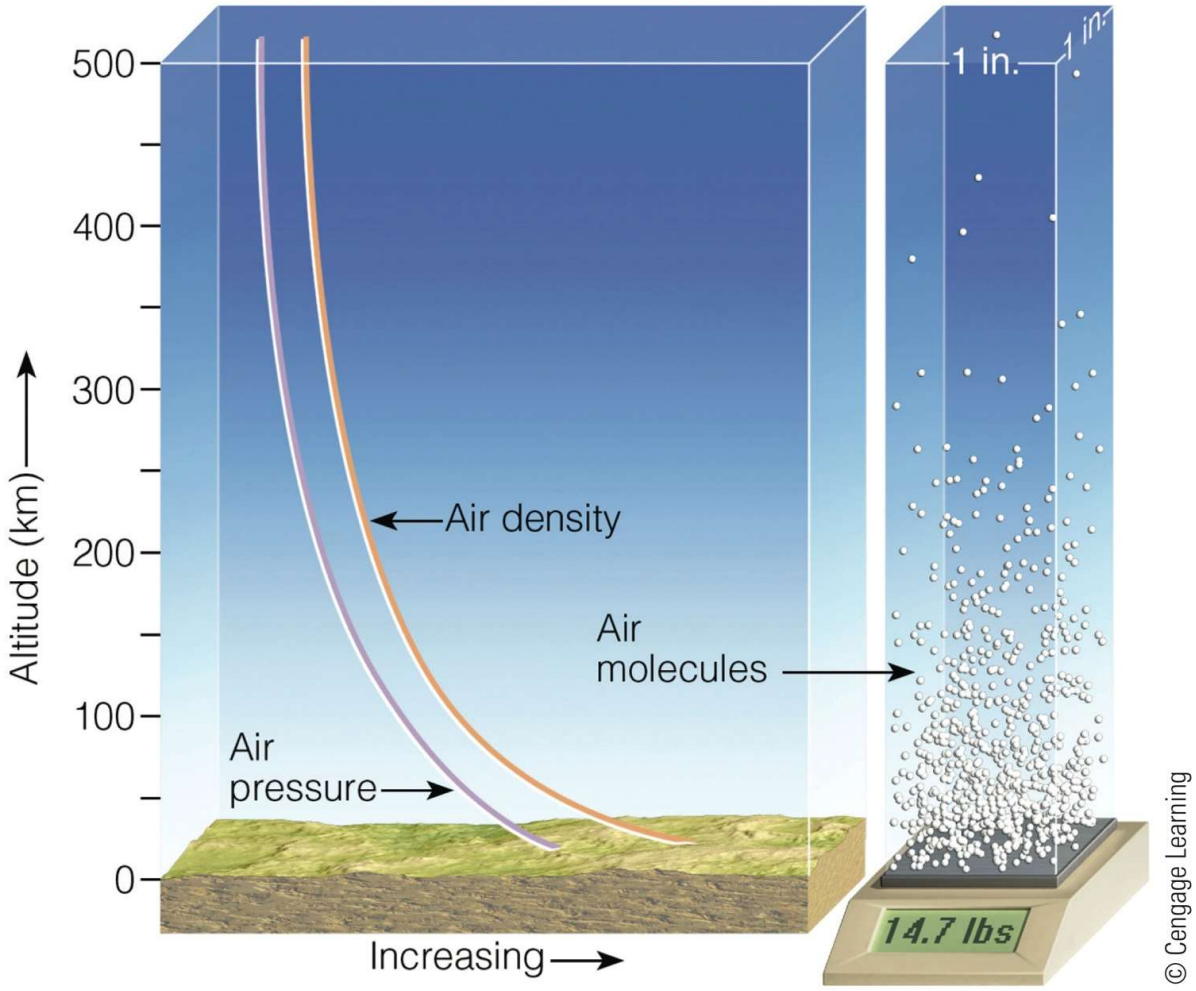
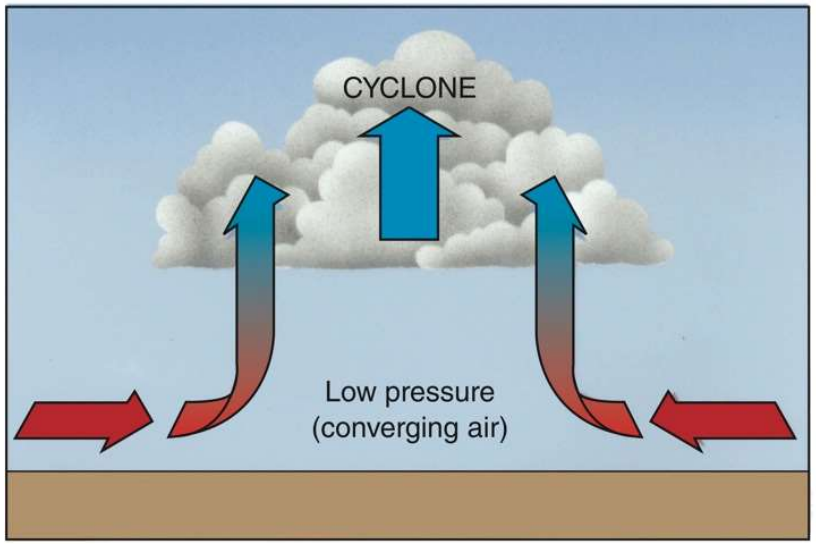
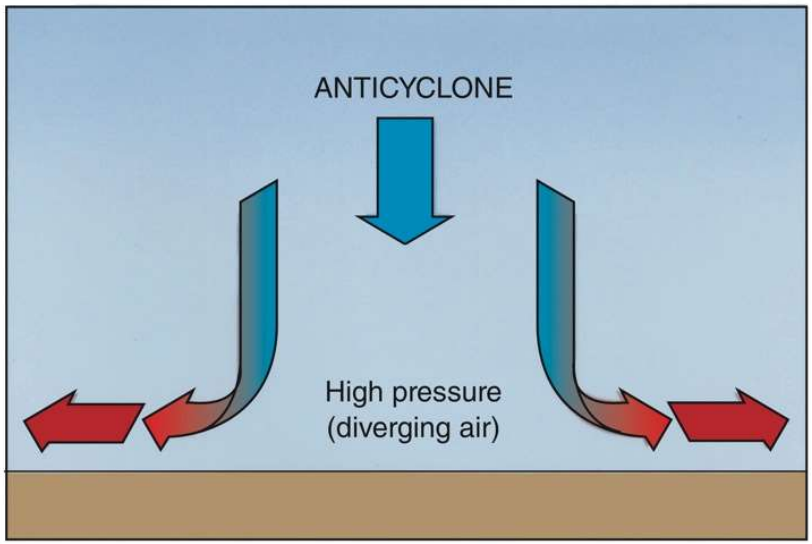


FIGURE 4.3 Both air pressure and air density decrease rapidly with increasing altitude.

Atmospheric Pressure (cont'd.)

- Cells of high and low pressure
  - Low (cyclone): low-pressure area
    - Convergent wind circulation
  - High (anticyclone): high-pressure area
    - Divergent wind circulation





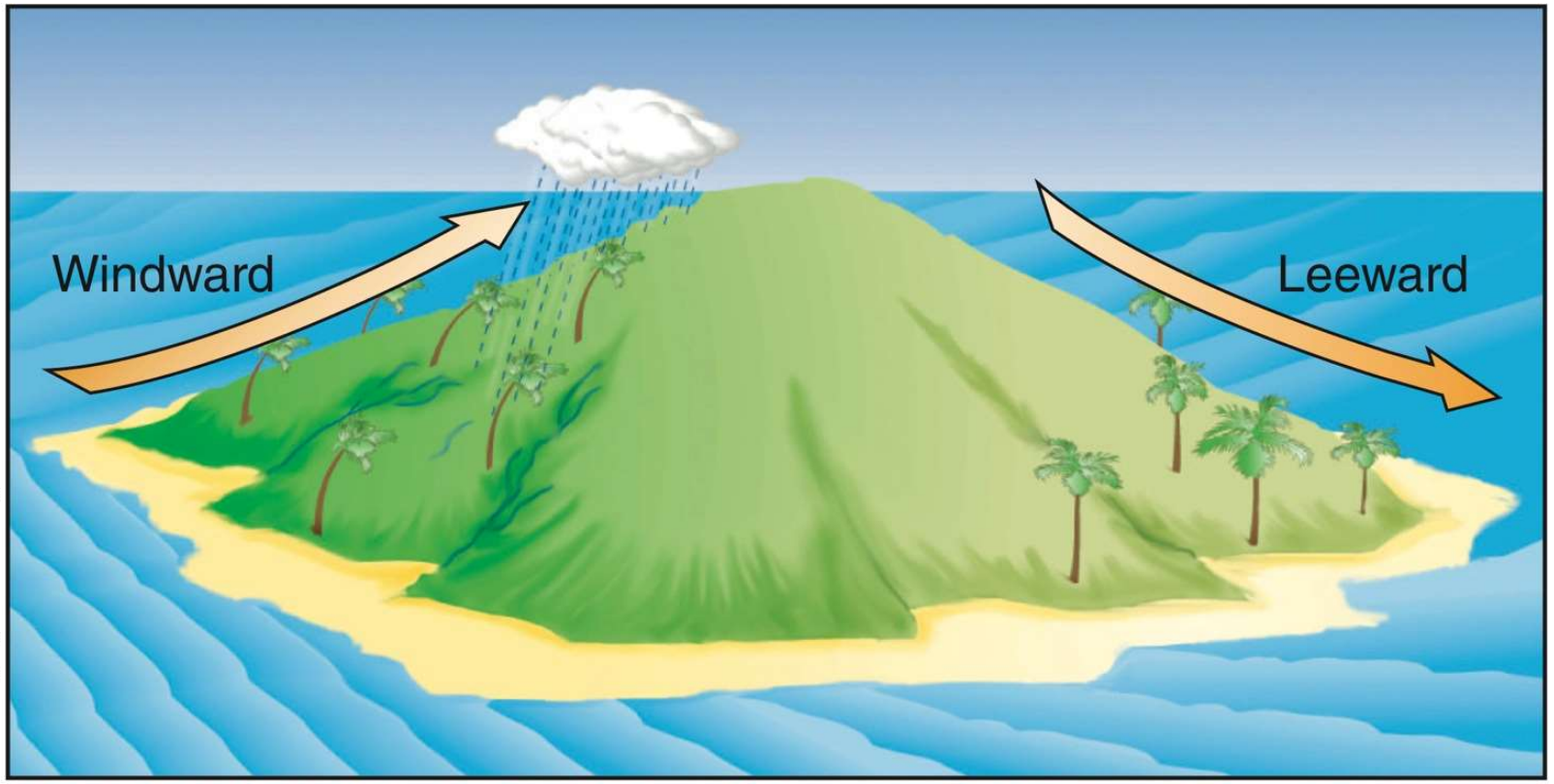
How is temperature related to the density of air?

Atmospheric Pressure (cont'd.)

- Horizontal pressure variations
  - Thermal causes: temperature differences
  - Dynamic causes: patterns of atmospheric circulation
- Mapping pressure distribution
  - Why is it important to adjust air pressures and express them as sea-level equivalent values?
  - Closely spaced isobars: strong pressure gradient

Wind

- Pressure gradients and wind
  - Wind velocity and strength depend on the intensity of the pressure gradient that produces the wind
- Wind terminology
  - What direction is a northeast wind blowing toward?
  - Windward and leeward
  - Prevailing winds



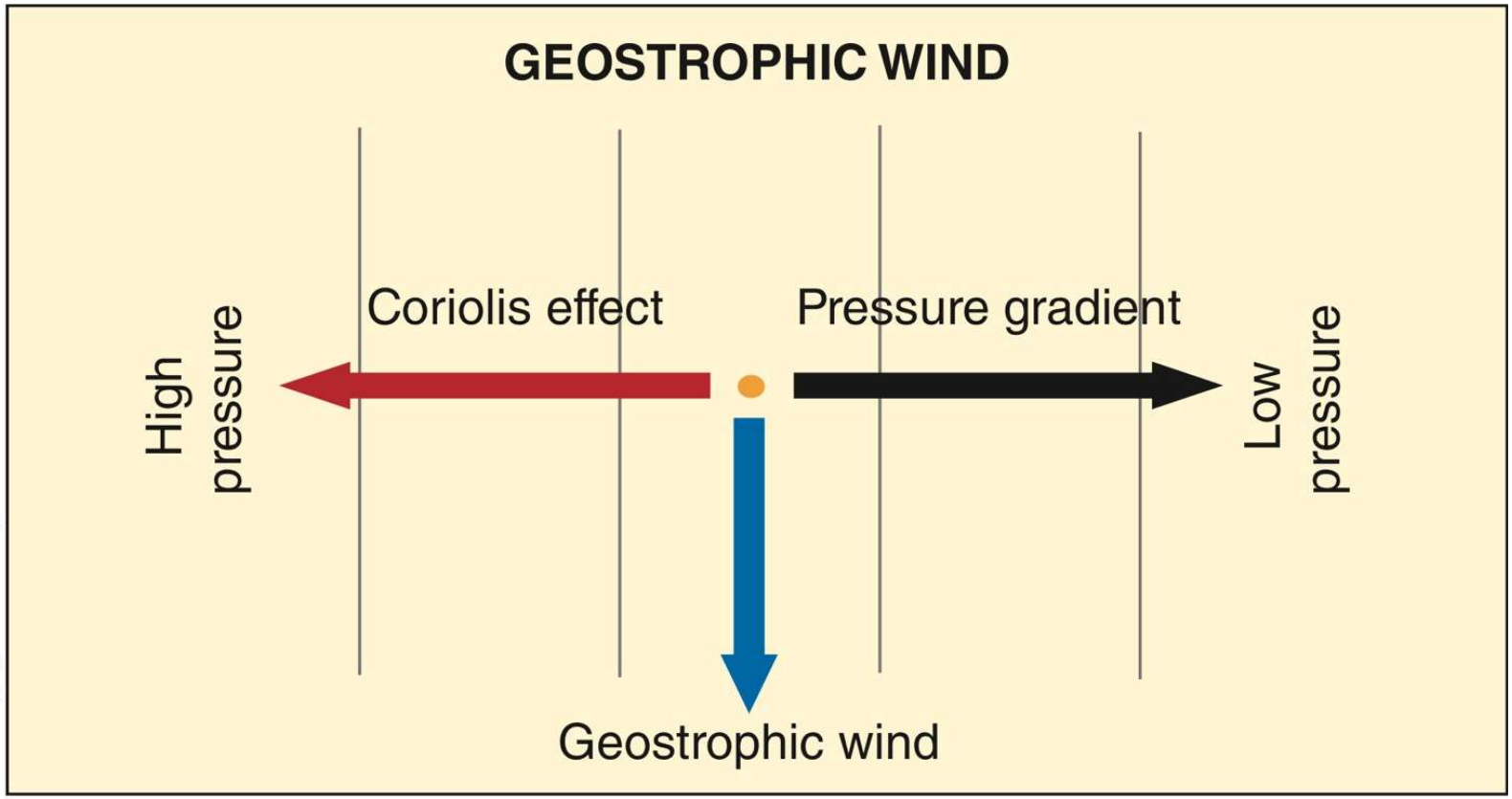
Why might vegetation differ on the windward and leeward sides of an island?

Wind (cont'd.)

- Harnessing the wind's energy
  - Wind power: inexhaustible source of clean energy
  - Criteria for wind turbine locations
    - Persistent strong winds
    - Electricity from the turbines can be linked to an existing electrical grid system
  - What are wind farms?

Wind (cont'd.)

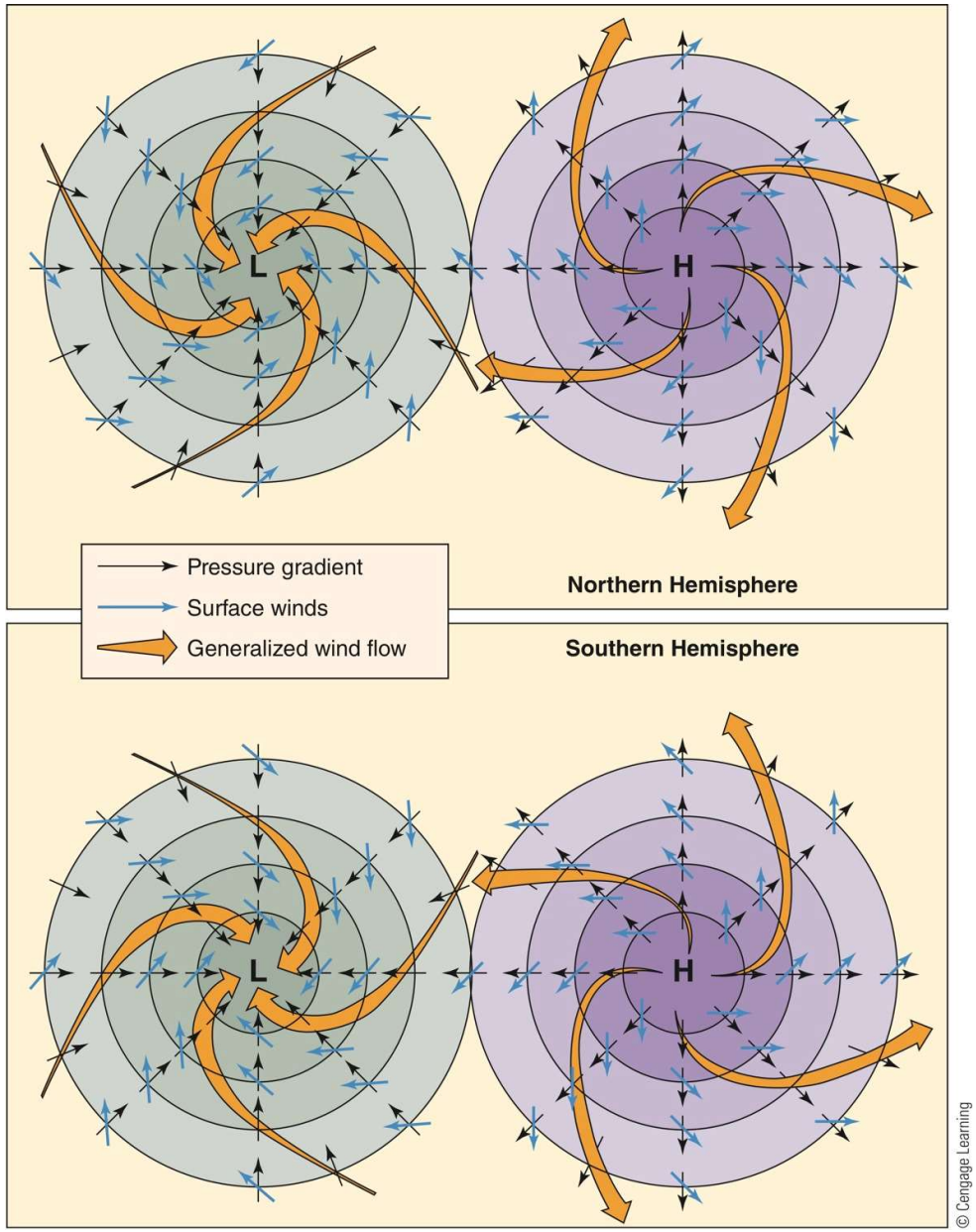
- The Coriolis effect
  - Deflection of movement in a horizontal direction
    - Impacted by an object's speed, the distance traveled, and its latitudinal position
  - Friction affects the pressure gradient and the Coriolis effect
  - Geostrophic wind flows parallel to isobars



Wind (cont'd.)

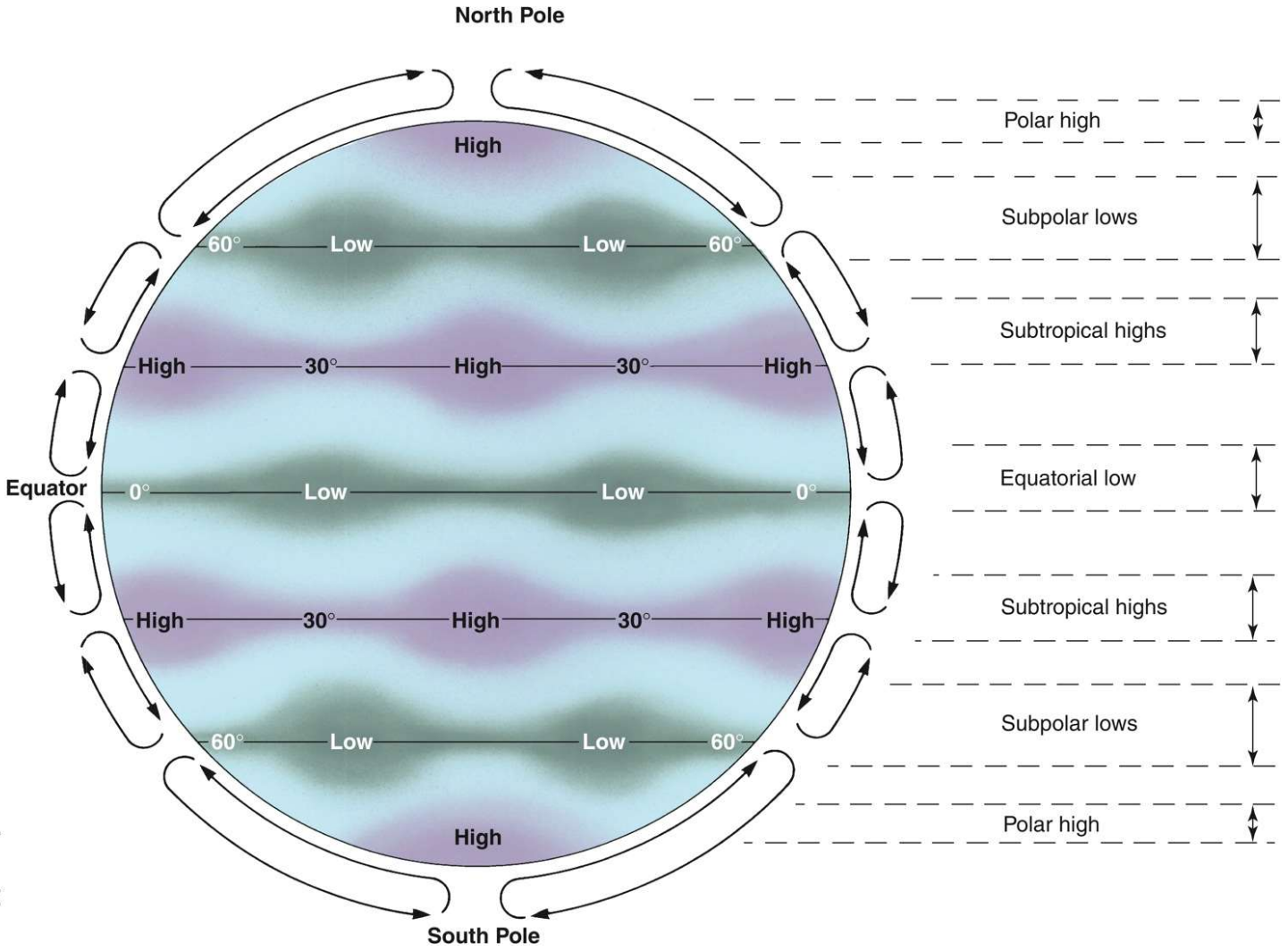
- Cyclones, anticyclones, and wind direction
  - High-pressure cell (anticyclone) in the Northern Hemisphere: winds move away from the center in a clockwise spiral
  - Low-pressure area (cyclone) in the Northern Hemisphere: winds flow into the center in a counterclockwise spiral

What do you think might happen to the diverging air of an anticyclone if there is a cyclone nearby?

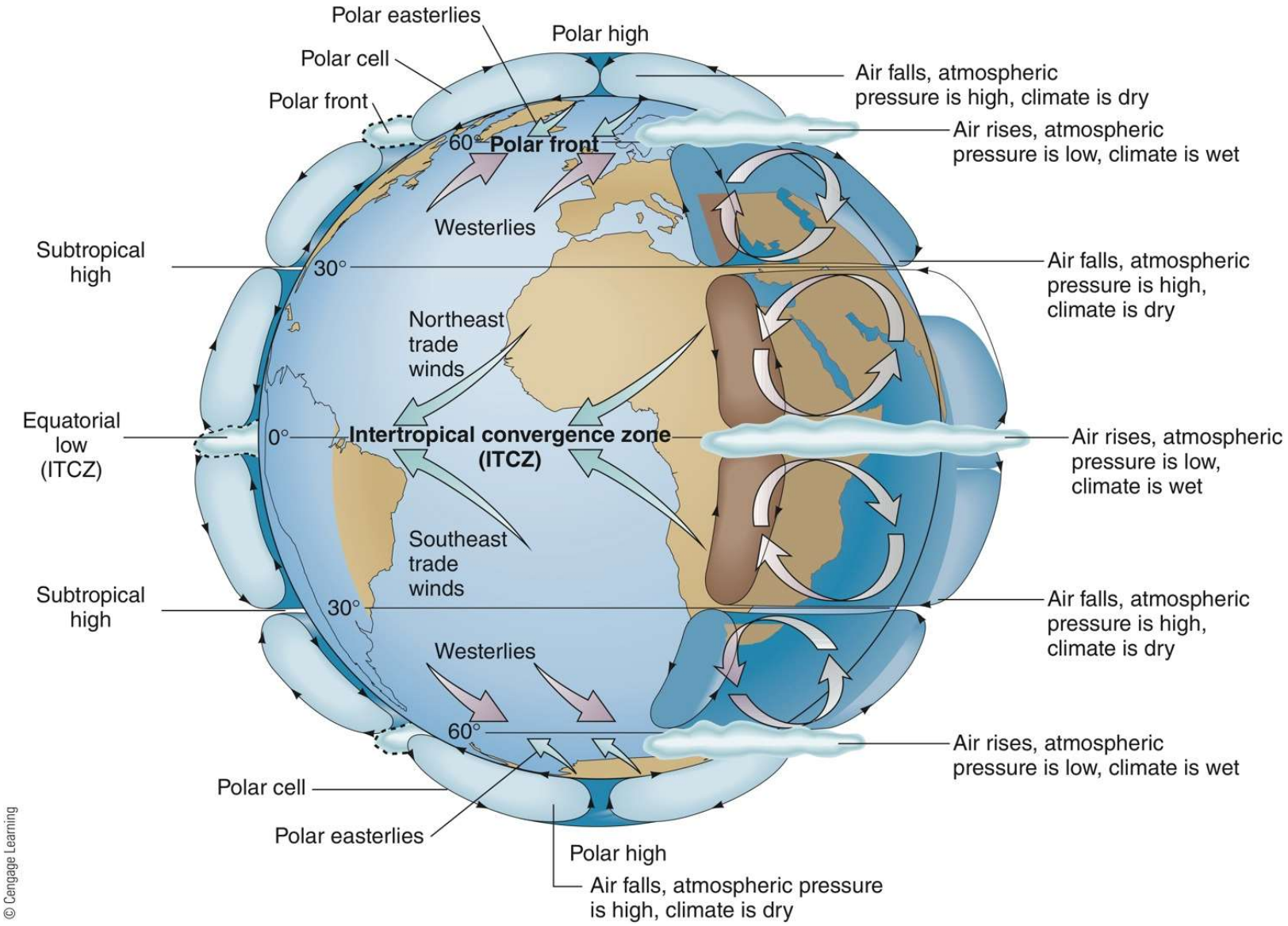


Global Pressure and Wind Systems

- A model of global pressure: refer to Figure 4.10
  - Equatorial low (equatorial trough)
  - Subtropical highs
  - Subpolar lows
  - Polar highs
- A model of atmospheric circulation
  - Idealized model: six wind belts along with seven pressure zones



Why do some of these pressure belts occur in pairs?



Are the cloudy areas associated with convergence or divergence of winds?

Conditions within Latitudinal Zones

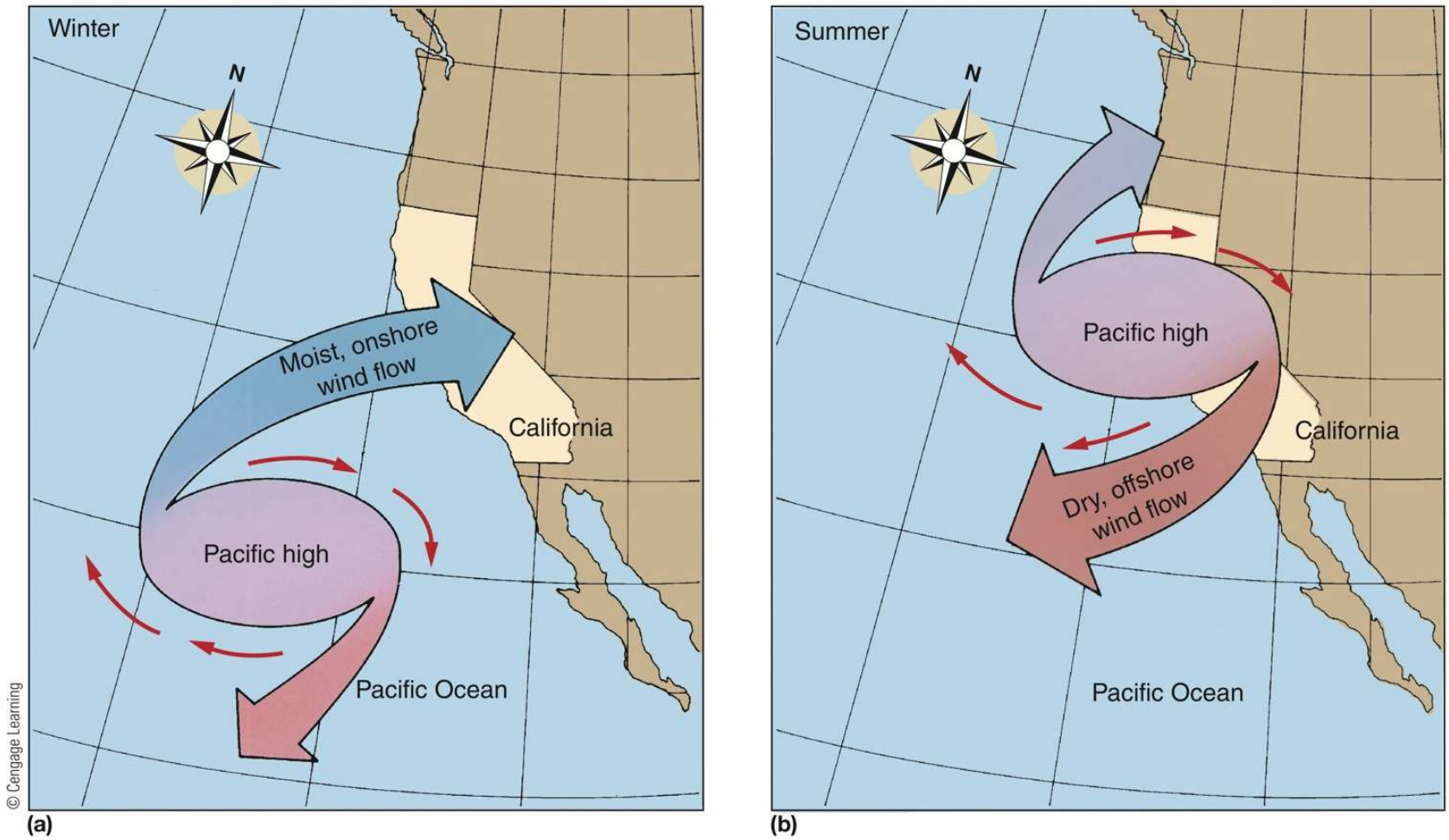
- Trade winds: tropical easterlies
  - Both hemispheres between latitudes 5° and 25°
- Subtropical highs: variable or calm winds
  - Between latitudes 25° and 35° north and south
- Westerlies: strong winds
  - Between about 35° and 65° north and south latitudes
- Polar winds: highly variable
  - What is the polar front?

Seasonal Variations in Pressure and Wind

- Refer to “Understanding Map Content 4.1”
  - January
    - Eastern Asia: Siberian High
    - North America: Canadian High
    - North Atlantic: Icelandic Low
    - North Pacific: Aleutian Low
  - July
    - Pacific High (Hawaiian High)
    - Bermuda High
    - Azores High

Seasonal Variations in Pressure and Wind (cont'd.)

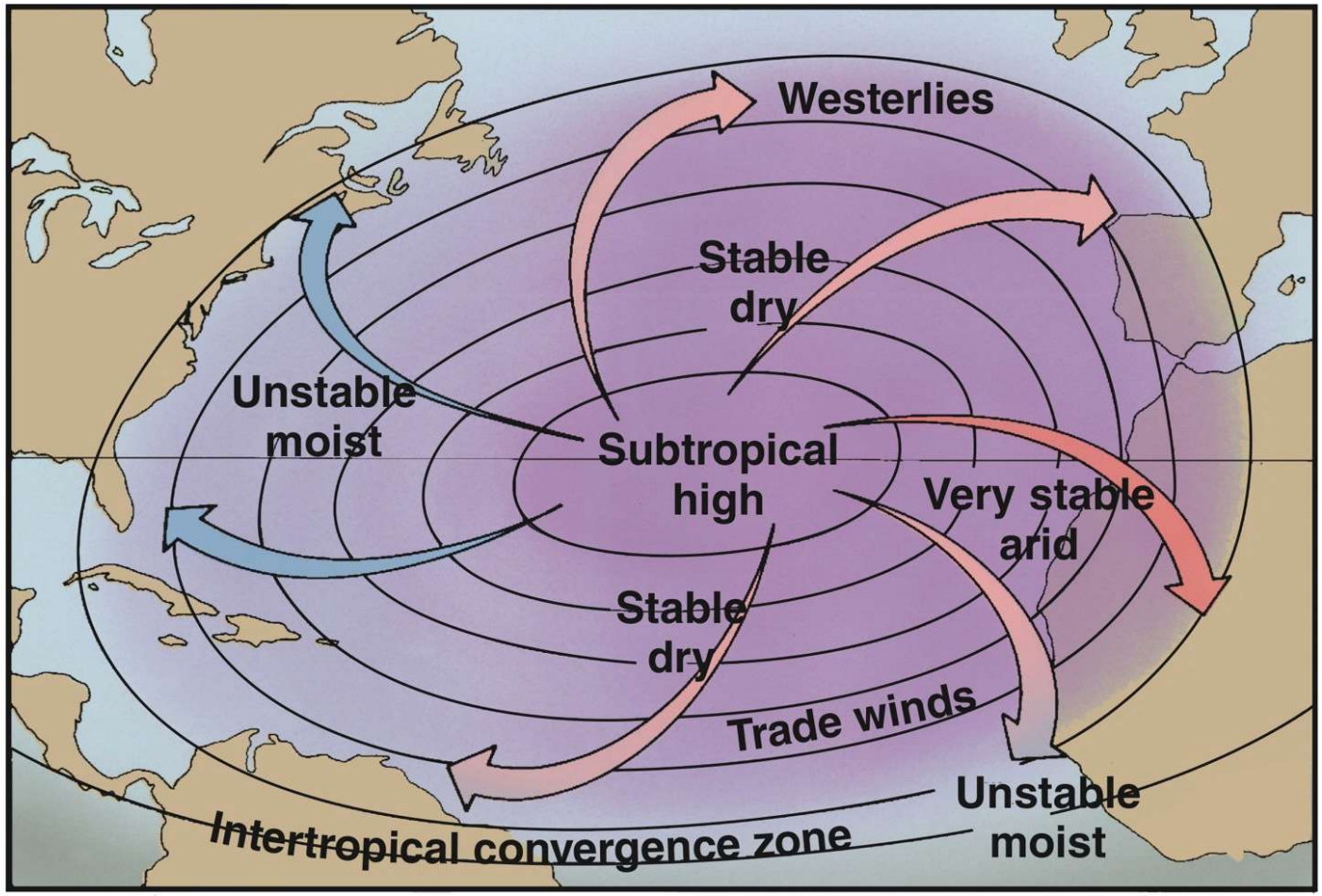
- Latitudinal migration with the seasons
  - Winds and pressure cells shift with seasons: affected by maximum insolation
  - Boundary zones between two wind or pressure systems: regions that are most strongly affected by seasonal migrations



In what ways would the seasonal migration of the Pacific anticyclone affect agriculture in California?

Seasonal Variations in Pressure and Wind (cont'd.)

- Longitudinal variations in pressure and wind
  - Subtropical high-pressure cells
    - Generally centered over the oceans
    - Much stronger on their eastern sides than on their western sides

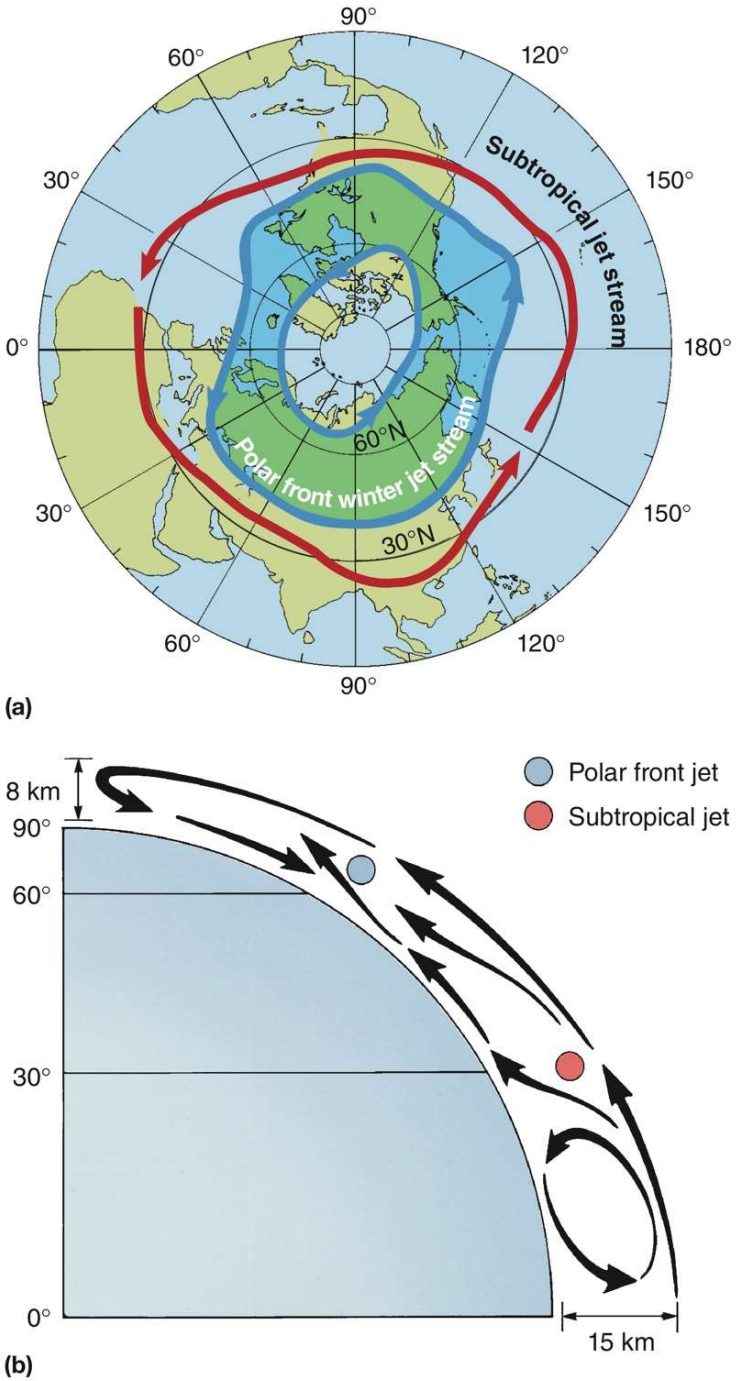


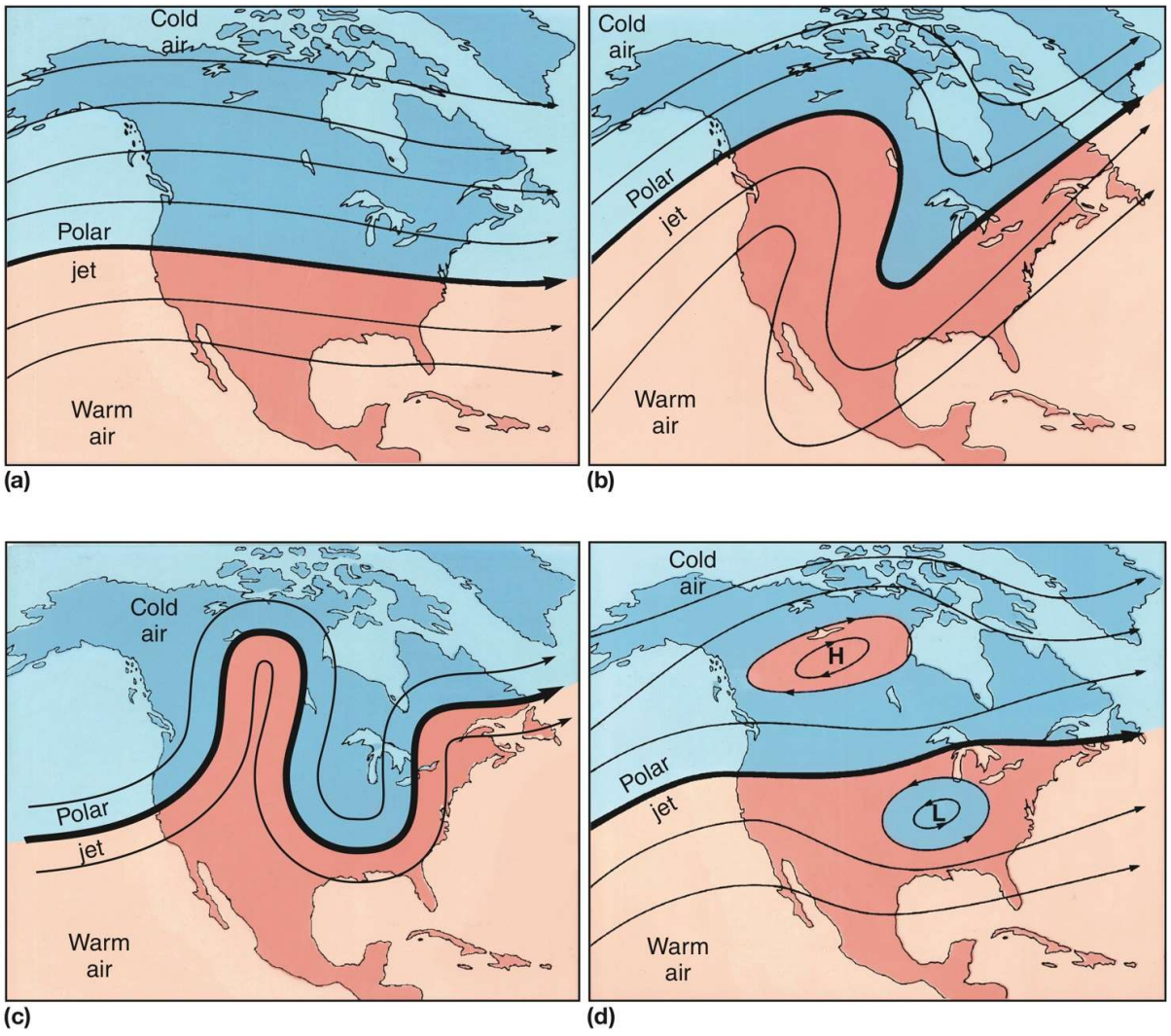
What wind system flows along the northern margin?

Upper Air Winds and Jet Streams

- Generally eastwardly flow in the upper troposphere: upper-air westerlies
- Jet streams
  - Polar jet stream
  - Subtropical jet stream
- What is the importance of jet streams?
- What are Rossby waves?

Which jet stream is most likely to affect your home state?

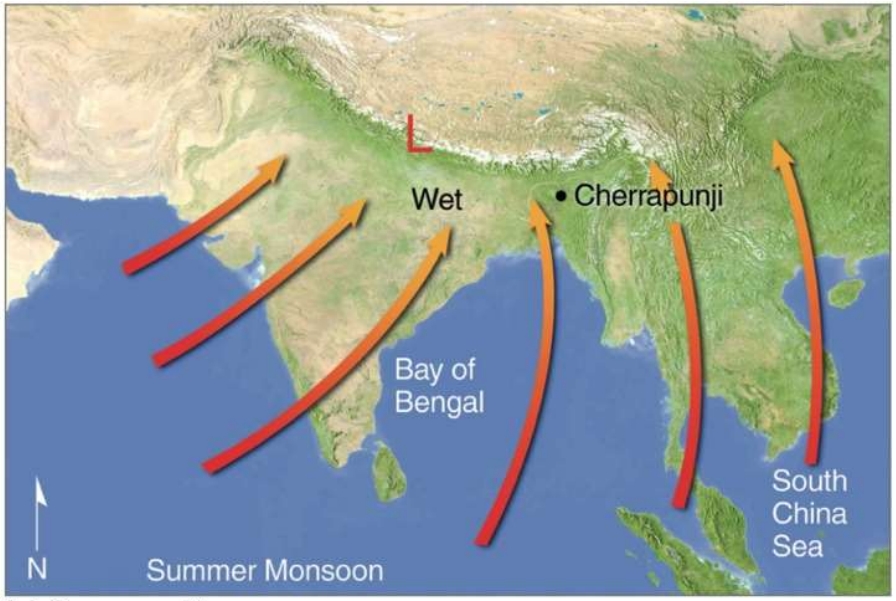




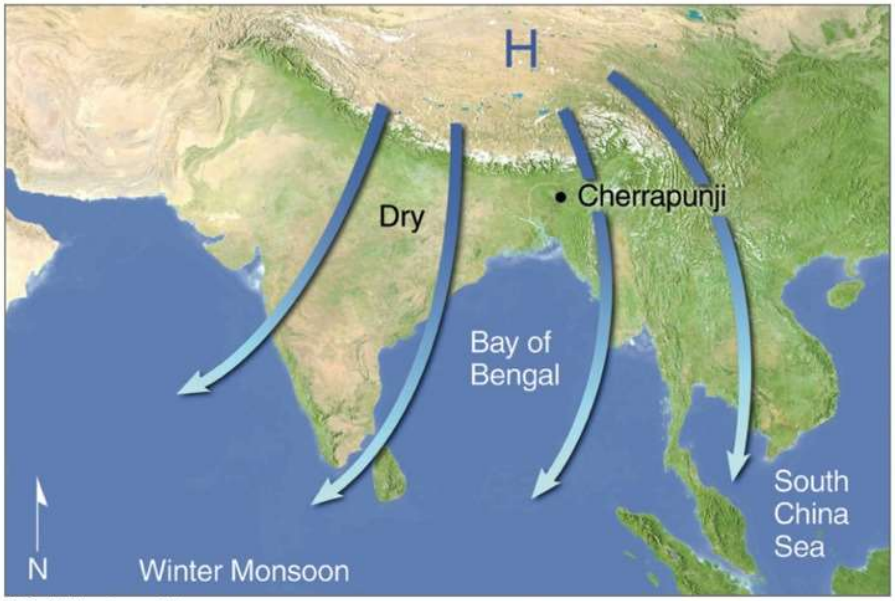
How are Rossby waves associated with the changeable weather of the central and eastern United States?

Regional and Local Wind Systems

- Monsoon winds
  - Directional reversal of winds from one season to the next
  - Locations
    - Southern Asia
    - Northern Australia



(a) Summer Monsoon

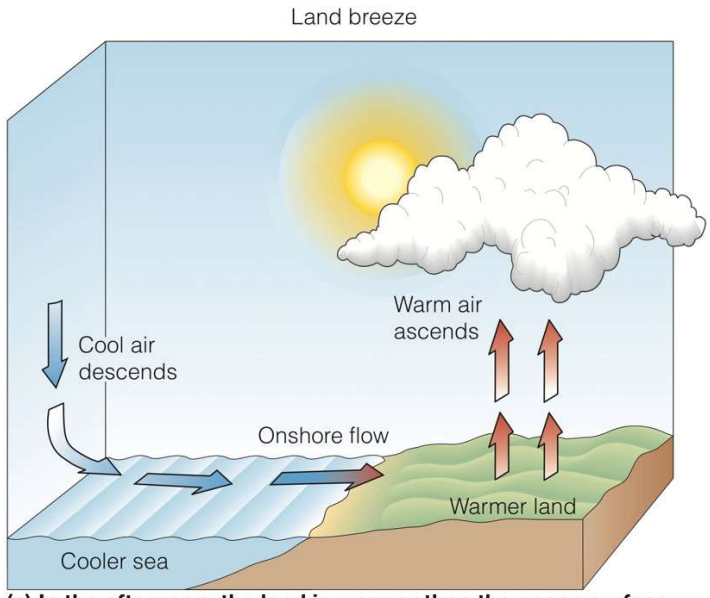


(b) Winter Monsoon

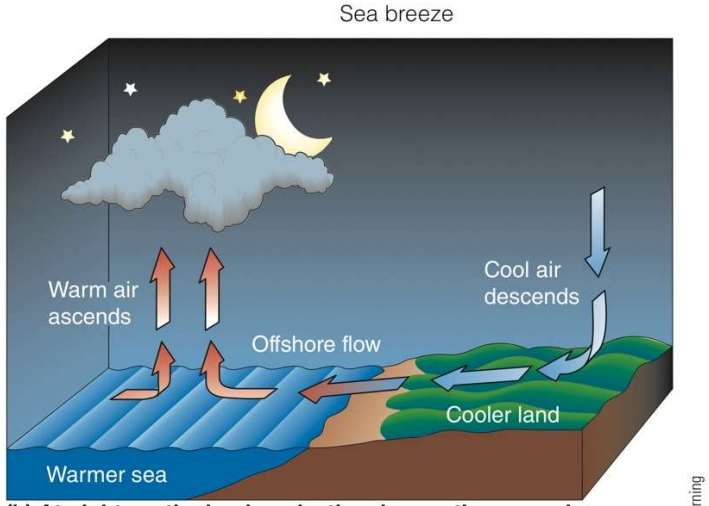
Regional and Local Wind Systems (cont'd.)

- Local winds
  - Affect a small area
  - Land breeze–sea breeze: diurnal (daily) cycle in response to the differential heating of land and water
  - Chinook (foehn) winds: occur when air must pass over a mountain range
  - Santa Ana winds: hot, dry winds of Southern California

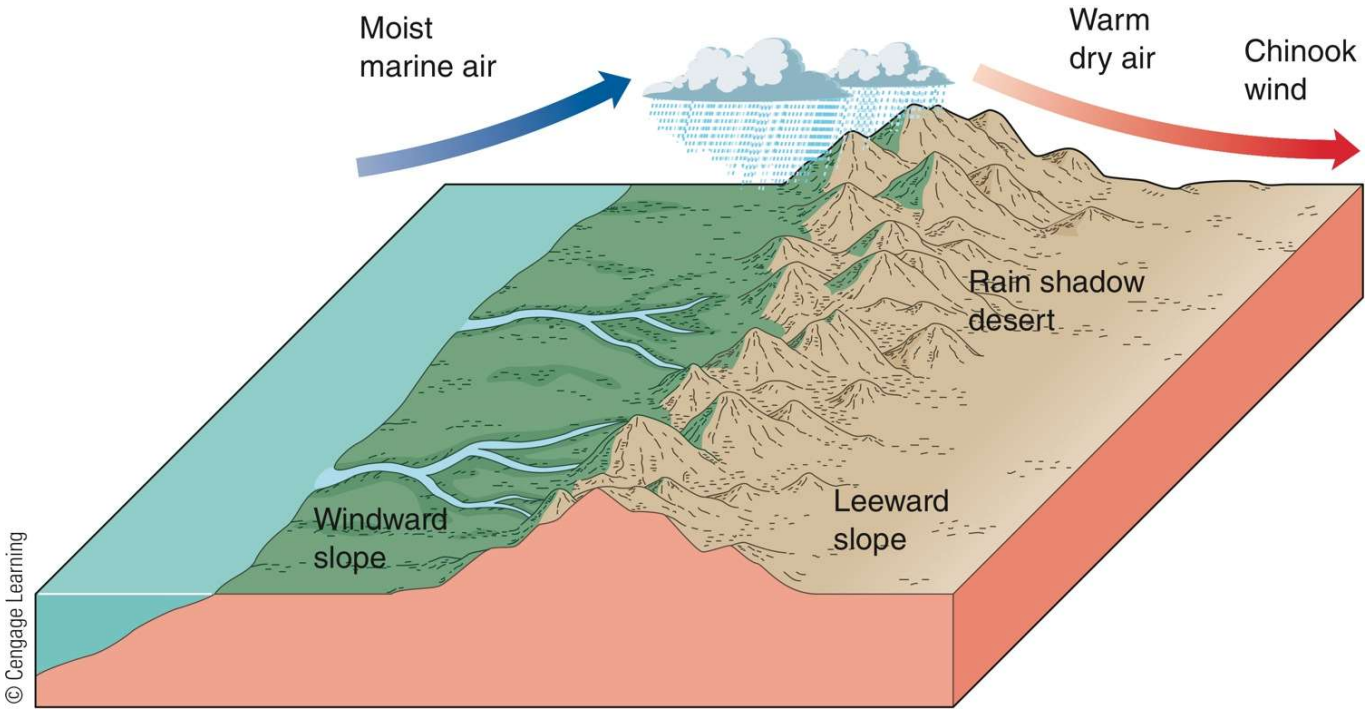
What is the impact on daytime coastal temperatures of the sea breeze?



(a) In the afternoon, the land is warmer than the ocean surface, and warm air rising from the land is replaced by an onshore sea breeze.



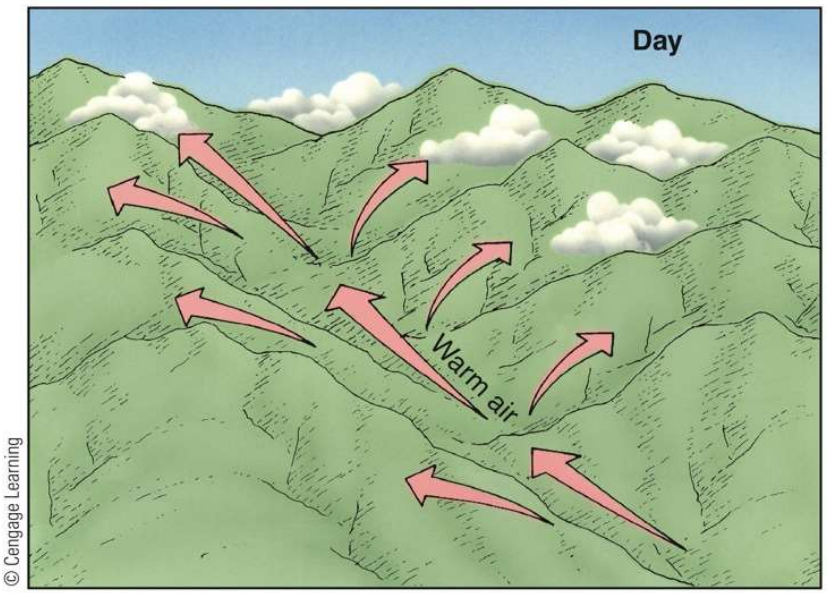
(b) At night, as the land cools, the air over the ocean is now warmer than the air over the land. The ocean air rises. Air flows offshore to replace it, generating an offshore flow (a land breeze).

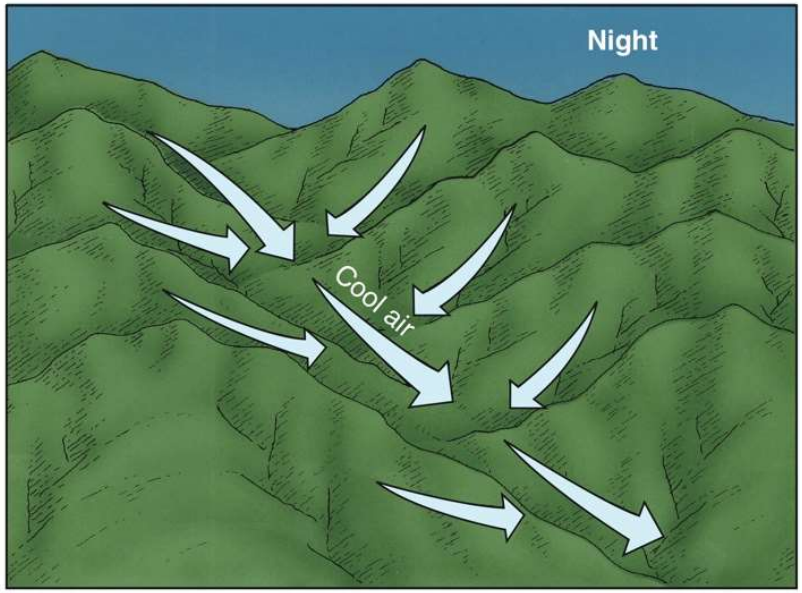


The term Chinook means “snow eater.” Can you offer an explanation for how this name came about?

Regional and Local Wind Systems (cont'd.)

- Local winds
  - Mountain breeze–valley breeze: cycle of warm, daytime breeze and cold, dense nighttime air flowing from high mountains to valleys
  - Drainage winds (katabatic winds): can be extremely cold and strong

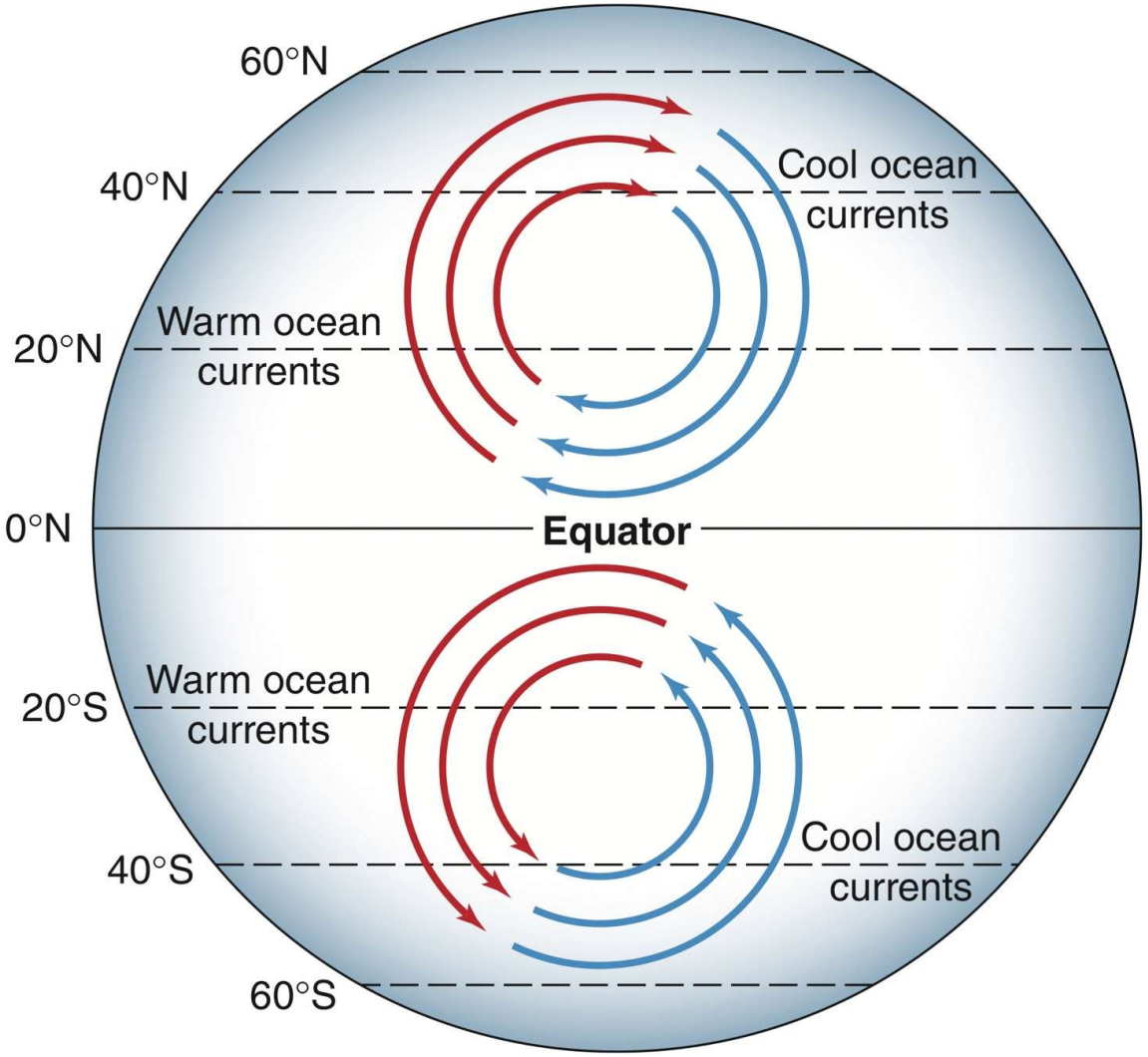




How might a green, shady valley floor and a bare, rocky mountain slope contribute to these changes?

Ocean–Atmosphere Interactions

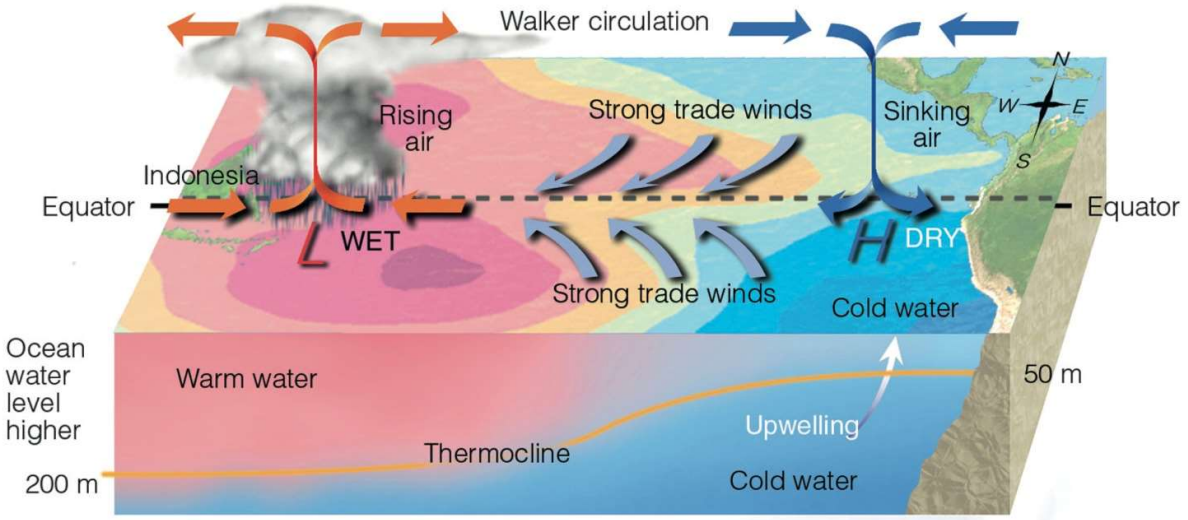
- Ocean currents
  - Surface ocean currents: fairly steady flows of seawater that move in a prevailing direction
  - What factors drive surface ocean currents?
  - Oceanic gyres
    - Northern Hemisphere: clockwise direction
    - Southern Hemisphere: counterclockwise direction
  - Refer to “Understanding Map Content 4.2”



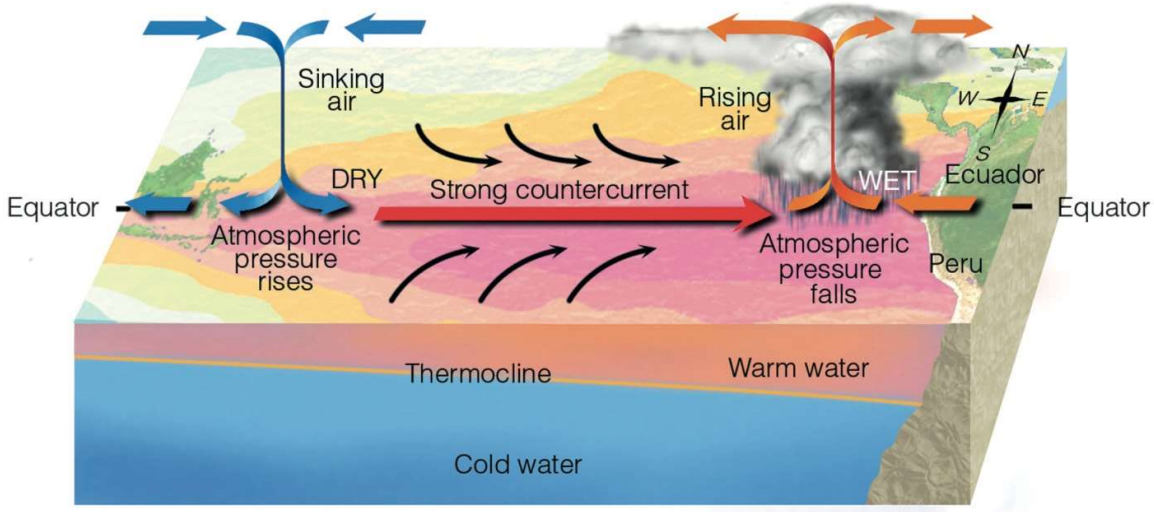
What influences the direction of these gyres?

Ocean–Atmosphere Interactions (cont'd.)

- El Niño: warmer than normal sea-surface temperatures that may last several months
  - El Niño and the Southern Oscillation
    - Rise in pressure in the eastern Pacific often accompanied by a fall in pressure in the western Pacific, and vice versa
  - El Niño and global weather
    - What is the impact of widespread clouds developing over the equatorial region of the Pacific?



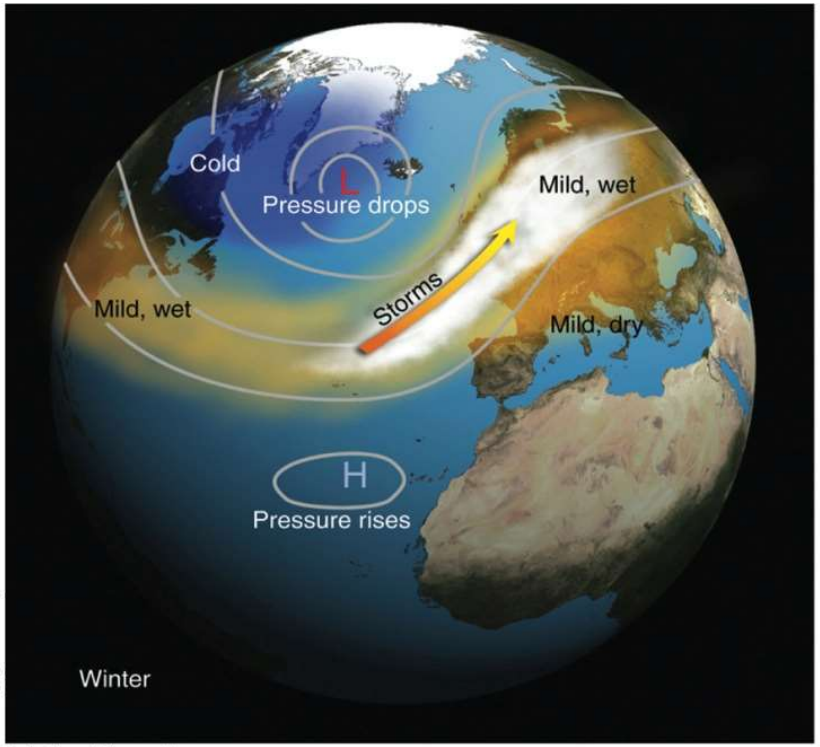
(a) Non-El Niño conditions



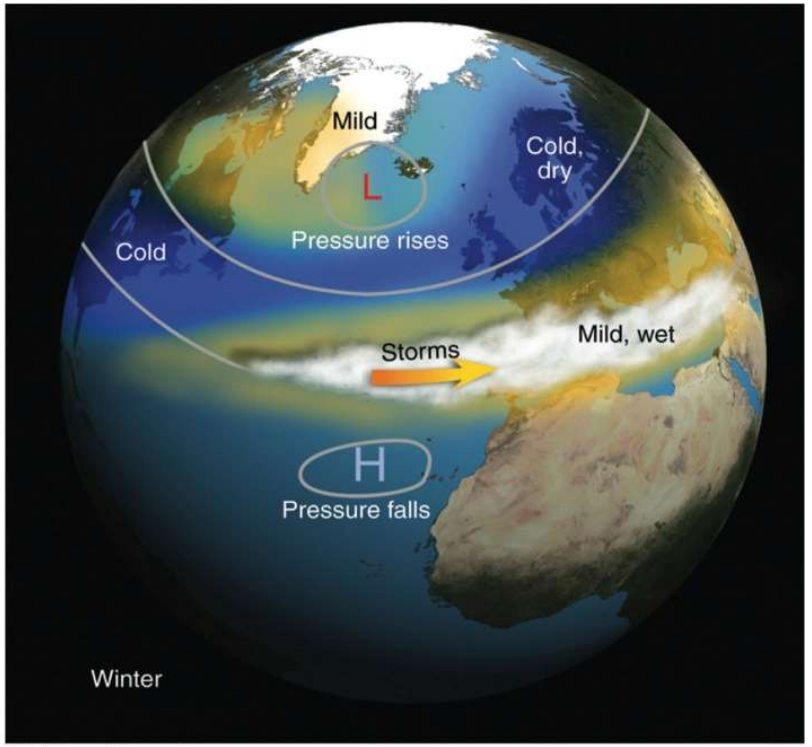
(b) El Niño conditions

Ocean–Atmosphere Interactions (cont'd.)

- North Atlantic Oscillation (NAO)
  - Relationship between the Azores (subtropical) High and the Icelandic (subpolar) Low
    - Positive NAO phase: higher than average pressure in the Azores High and lower than average pressure in the Icelandic Low
    - Negative NAO phase: a weak Azores High and a weak Icelandic Low



(a) Positive phase



(b) Negative phase

Which two pressure systems are used to establish the NAO phases?

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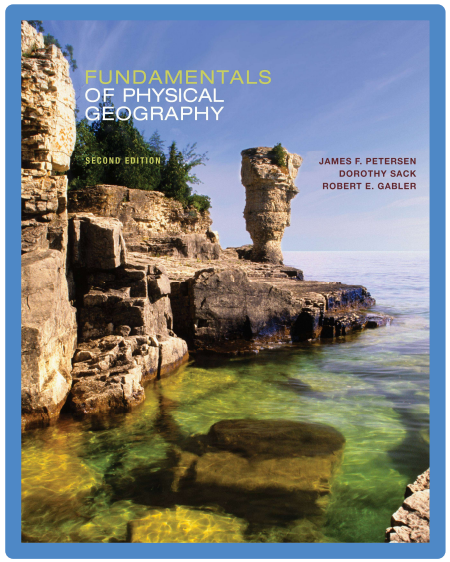

- Peterson
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