General Circulation of the Air in the Troposphere

Differences in air temperature and pressure in various portions of the troposphere cause air to be in constant motion. This circulation of air produces convection cells throughout the troposphere.

Convection Cells

The unequal distribution of insolation on Earth results in unequal heating and differences in air pressure. Cooler air, being denser, sinks toward Earth under the influence of gravity, causing the less dense, warmer air to rise. The result is a series of convection cells around Earth at various latitudes, as shown in Figure 7-8. As indicated by the solid arrows, there are upward currents in the vicinity of 0° latitude (the equator) and 60° North and South latitudes. Downward currents exist near 30° and 90° North and South latitudes. Regions where air comes together to form vertical currents are regions of convergence. Regions where air spreads out from the vertical currents are regions of divergence.

As part of these tropospheric convection cells, there are bands of easterly moving air at the top of the troposphere, called **jet streams.** The winds of the jet stream can blow 200 miles an hour or more. Commercial airplanes flying with the jet stream can save a half hour of flight time traveling from the west to east coasts of the contiguous United States, or lose an hour going in the other direction, if the jet stream is not avoided. The jet streams have an important influence on the formation and direction of weather pattern movement in mid-latitude regions such as the United States. The jet streams help steer the air masses and low pressure centers. The locations of the jet streams are shown on Figure 7-8 and on the Planetary Wind and Moisture Belts in the Troposphere in the *Earth Science Reference Tables.*

Planetary Wind and Pressure Belts

At Earth's surface, winds blow horizontally away from regions of divergence and high air pressure, and toward regions of convergence and low air pressure. Figure 7-8 shows the pressure belts of Earth with generally consistent high or low air pressure. Because of the Coriolis effect, winds moving away from high air pressure are deflected to the right in the Northern

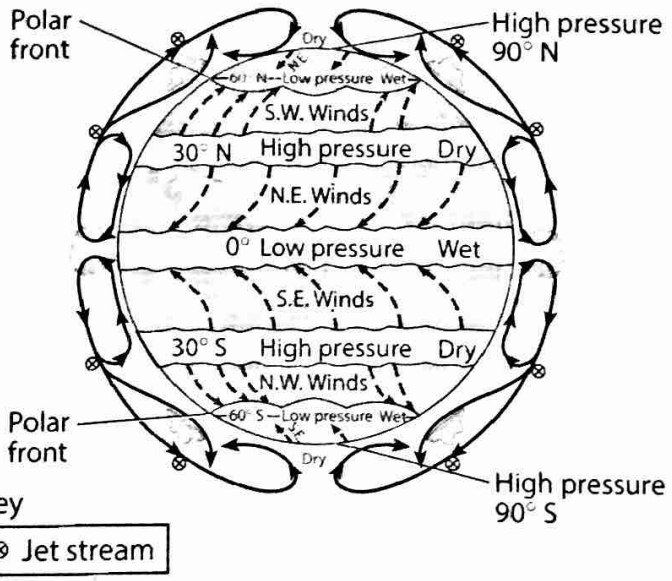


Figure 7-8. Planetary wind, pressure, and moisture belts in the troposphere: The drawing shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the sun's vertical rays.

Hemisphere and to the left in the Southern Hemisphere, as indicated by the dashed arrows in Figure 7-7. The result is a series of **planetary wind belts** within which the winds move generally in a specific direction much of the time—thus they are prevailing winds.

Seasonal Shifting of the Wind and Pressure Belts Because the vertical rays of the sun shift north and south with the seasons, the pressure belts and the resulting wind belts generally follow the vertical rays of the sun. This results in many parts of Earth being under the influence of different wind and/or pressure belts in different seasons. Difference in air pressure and prevailing winds can often mean quite different weather conditions. As an example, in the winter the northern portions of the contiguous United States often get cold weather conditions from Canada caused by northerly prevailing winds. These same regions in summer usually get more southerly winds of the prevailing southwesterlies and warmer weather conditions.

In some regions of Earth, there are regular and extreme weather changes caused by the shifting wind and pressure belts. These extreme weather changes are called the **monsoons.** Figure 7-9 shows the changing monsoon conditions of part of Asia around India. Note that the wind that brings the rain blows from the high pressure area over the ocean to the low pressure area over the land.

Weather Movement in the Contiguous United States Much of the contiguous United States is affected by planetary winds that blow from the southwest to the northeast—called the prevailing southwesterly winds. Therefore, weather changes in the United States move generally from a southwesterly direction to a northeasterly direction.

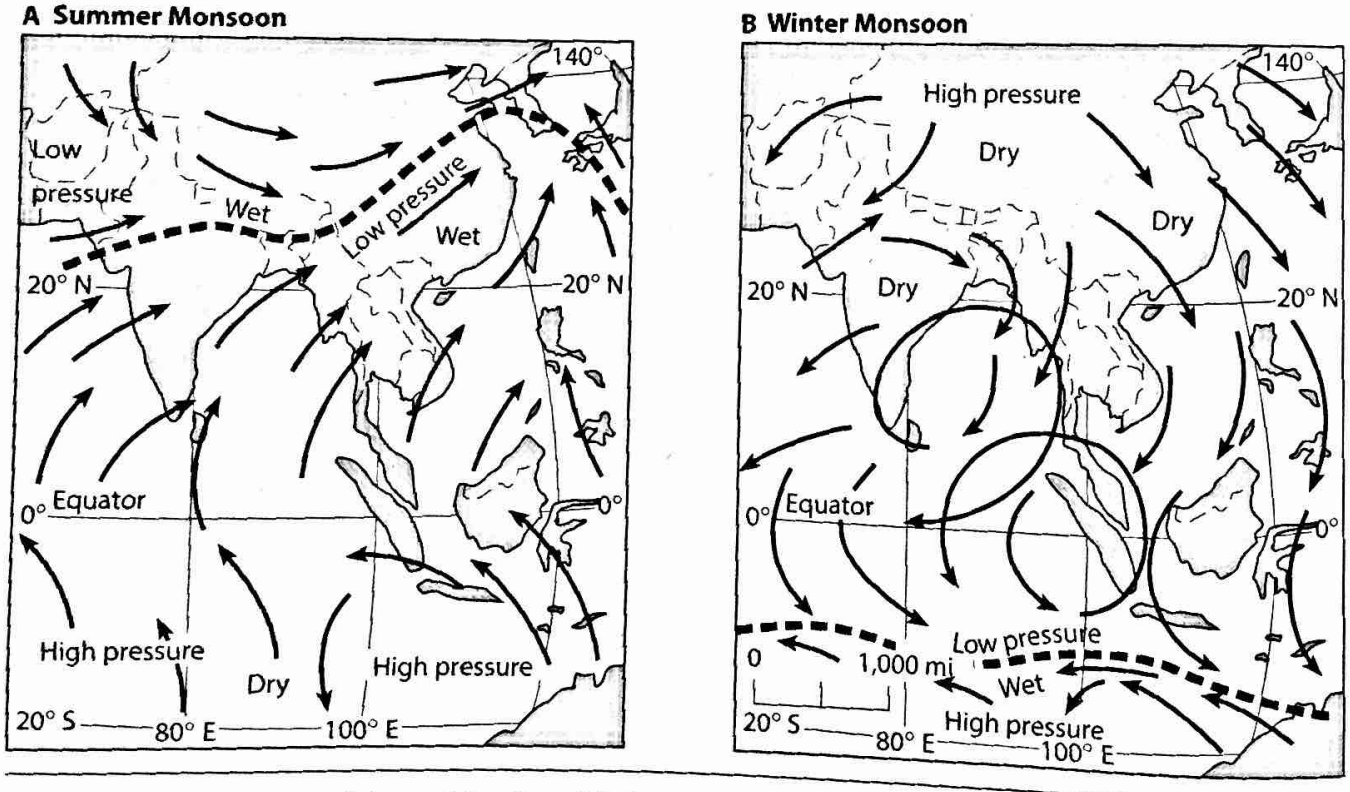


Figure 7-9. Monsoon conditions of Southeast Asia: (A) In the summer, the wet, low pressure belt that is normally over the equator (see Figure 7-8) moves northward and brings high amounts of rain to much of Southeast Asia, including India. (B) In the winter, the high pressure area is over the land, and this brings dry air from Central Asia over Southeast Asia towards the low pressure belt.

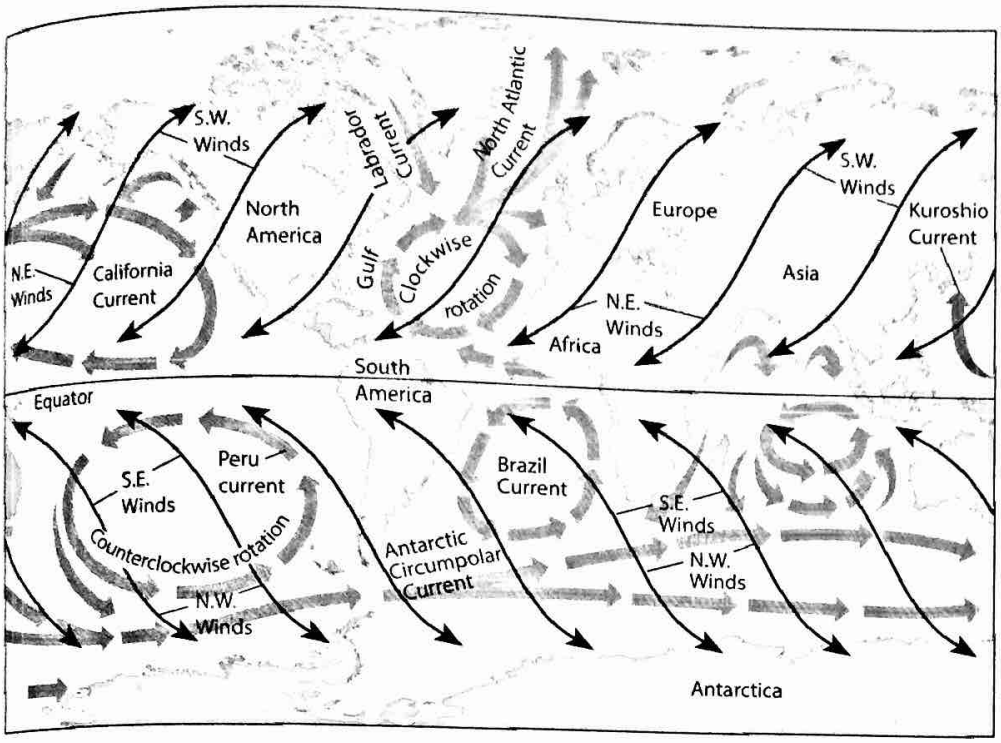


Figure 7-10. Cause of surface ocean currents: When you observe a comparison of the directions of Earth's prevailing winds and the location of the surface ocean currents, it is obvious that they are related. Prevailing winds transmit kinetic energy and "drive" the surface ocean currents. The Coriolis effect twists the direction of the currents to the right in the Northern Hemisphere creating a clockwise rotation of the currents there. In the Southern Hemisphere, the Coriolis effect shifts currents to the left (west), creating a counterclockwise rotation of the surface ocean currents.

Formation of Surface Ocean Currents Surface ocean currents are caused by wind blowing over the oceans and transferring energy to the water. The direction of these currents is affected by the direction of the planetary winds. Compare the map Surface Ocean Currents with the diagram Planetary Winds and Moisture Belts in the Troposphere in the *Earth Science Reference Tables* as well as with Figure 7-10. The directions of the surface ocean currents are also affected by blocking by landmasses and the rotation of Earth through the Coriolis effect. Note that the maps of the surface ocean currents show that they are often part of a circular pattern that spins clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. This difference in spinning direction is caused by the Coriolis effect's deflection to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. Ⓡ

Since the surface ocean currents are a direct result of the transfer of energy from the movement of the prevailing winds, they can seasonally shift their positions. Some of the surface ocean currents shift position north and south as the winds of the prevailing wind belt do—following the motions of the vertical rays of the sun.

Review Questions

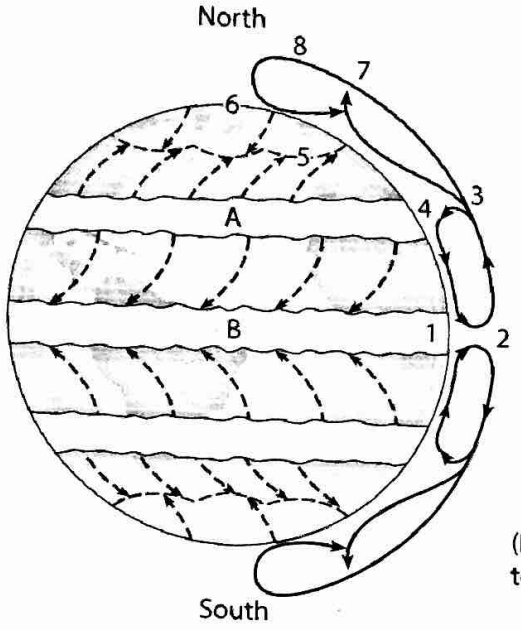
25. Planetary winds do not blow directly north or south because of

(1) the Coriolis effect
(2) gravitational force
(3) magnetic force
(4) Earth's revolution

26. On a certain day in Syracuse, New York, there is a high-pressure center directly north and a low-pressure center directly south. Because of the effect of Earth's rotation, the air in Syracuse will

(1) blow directly to the south
(2) blow directly to the north
(3) be deflected toward the southwest
(4) be deflected toward the northeast

To answer questions 27 through 31, refer to the following diagram, which shows movement of air in the lower part of the atmosphere around the time of an equinox.



(Not drawn to scale.)

27. The movement of air from 1 to 2 to 3 to 4 to 1 would be called a

(1) high-pressure cell
(2) contiguous cell
(3) convection cell
(4) Coriolis cell

28. What is the basic underlying reason for the movement of air shown?

(1) differences in gravity
(2) differences in air density
(3) differences in pressure gradient
(4) differences in magnetism

29. What would be the most likely cause of the movement of air at position 1?

(1) low moisture content and low temperature
(2) high moisture content and high temperature
(3) low moisture content and high temperature
(4) high moisture content and low temperature

30. The air moves at the surface of Earth, from position A to position B, because

(1) positions A and B have low pressure
(2) positions A and B have high pressure
(3) position A has low pressure, and position B has high pressure
(4) position A has high pressure, and position B has low pressure

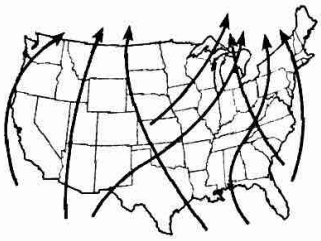
31. Condensation would most likely occur at position

(1) 3 (2) 4 (3) 6 (4) 7

32. Pilots flying from the west coast of the United States to New York may sometimes shorten their flight time by using a high-speed tailwind. They are most likely using the

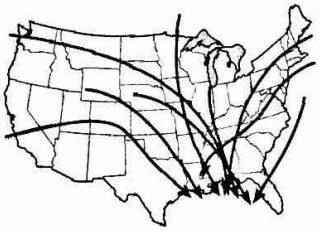
(1) prevailing northwesterlies
(2) jet stream
(3) convection cells
(4) prevailing southeasterlies

33. Which diagram shows the usual path of low-pressure storm centers as they pass across the United States?

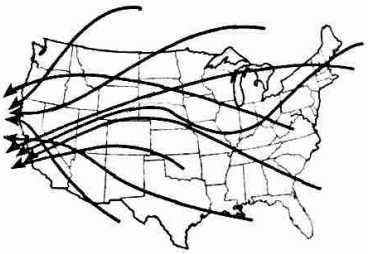


(1)

(3)



(2)



(4)

34. What is the primary source of energy for ocean currents and waves?

(1) the moon
(2) the atmosphere
(3) the continents
(4) the sun

35. What is the most direct cause of major surface ocean currents?

(1) prevailing winds
(2) gravity
(3) tides
(4) salinity differences