TOPIC 7

Weather

Vocabulary

air mass
air pressure gradient
anemometer
atmospheric, barometric, or air pressure
atmospheric transparency
barometer
cloud cover
cold front
cyclone
cyclonic storm
dew point
front
humidity
isobar
jet stream
monsoon
occluded front
planetary wind belt
polar front
precipitation
probability
psychrometer
radar
relative humidity
stationary front
station model
troposphere
visibility
warm front
water vapor
weather variables

Topic Overview

Are you going to have a picnic or tennis match today? Will the airplane be able to take off for Florida before the approaching ice storm arrives? Will there be a snow day and no school? So much of what you do and how you feel depends on the weather. These conditions affect such things as purchases, your health, how crops grow, the costs of heating and cooling, and the clothing you wear.

Weather is the state or condition of the variables of the atmosphere at any given location for a short period of time. **Weather variables** include temperature, air pressure, wind, moisture conditions, cloud cover, precipitation, and storms. Most of the weather changes occur in the **troposphere,** the part of the atmosphere immediately above Earth's surface. (See Selected Properties of Earth's Atmosphere in the *Earth Science Reference Tables.*)

Variations in insolation cause heat energy to be unevenly distributed in the atmosphere. This heat energy tends to move toward a condition of more uniform distribution. That movement of heat energy results in the constant changes in the atmosphere that are a major cause of weather.

Atmospheric Temperature

Most of the world uses the Celsius scale to measure temperatures, but in the United States people still use the Fahrenheit scale. However, people who work in medical fields and other areas of science often use either the Celsius or Kelvin scales. You should be able to convert between the Fahrenheit, Celsius, and Kelvin scales using the Temperature section of the *Earth Science Reference Tables.*

Air temperature is usually measured using a liquid-filled glass tube called a thermometer. As the temperature of the liquid in the thermometer rises, the liquid expands and moves up the scale. Often temperature is modeled on maps and charts by the use of isolines called isotherms.

Heating of the Atmosphere

The sun is the original source of almost all the heat in the atmosphere. Generally, the more insolation at a location, the warmer Earth's surface and the atmosphere will be. The atmosphere acquires much of its heat directly by contact with Earth's surfaces, but it also gains energy in other ways. The many ways in which the atmosphere is heated include the following:

- Conduction moves heat from Earth into the atmosphere as air touches Earth's surface.
- Direct absorption of insolation from the sun by gases and aerosols moves heat into the atmosphere. (An aerosol is any liquid or solid particle, such as solid smoke particles or liquid cloud droplets, suspended or floating within a gas.)
- Absorption of long-wave infrared radiations from Earth's surface move heat into the atmosphere. Much of the infrared absorption by the atmosphere is due to the presence of water vapor, methane, and carbon dioxide; the larger the amounts of these greenhouse gases, the more heat is absorbed by the atmosphere.
- Condensation (change of water vapor to liquid water) and sublimation/deposition (change of water vapor directly to ice) release large amounts of stored heat, directly heating the atmosphere. Condensation and sublimation release this energy when clouds, fog, dew, and frost form.
- The Coriolis effect, which results from the rotation of Earth and wind—causes friction where the atmosphere and Earth's surface meet. This friction produces heat, some of which is absorbed by the atmosphere.

Convectional Transfer of Heat in the Atmosphere Heat energy is transferred within the atmosphere by convection. Differences in air density cause differences in air pressure. The air pressure differences in turn cause air to move in circular patterns—convection currents, or cells. These air convectional movements transfer heat energy within the atmosphere, especially the troposphere. Winds are the parts of convection currents that are parallel to Earth's surface.

Heating and Cooling of Air by Expansion and Compression When a gas expands, its temperature decreases; when a gas is compressed—or contracted—its temperature increases. Thus when air rises in the atmosphere, it expands and its temperature decreases; similarly, when it descends, it is compressed and its temperature increases. Under average conditions air temperature in the troposphere decreases with increasing altitude because as air rises there is less air above it and less air pressure and thus the air expands and cools. (See Selected Properties of Earth's Atmosphere in the *Earth Science Reference Tables.*) (R)

MemoryJogger

Recall that temperature is the measure of the average kinetic energy of particles of a body of matter. Therefore, the greater the average kinetic energy of the particles in the air, the higher the atmospheric temperature.

You may also recall that insolation (INcoming SOLar radiATION) is the portion of the sun's radiation that reaches the top of Earth's atmosphere.

Review Questions

1. Where does the greatest amount of daily weather change take place?
   (1) tropopause
   (2) stratopause
   (3) troposphere
   (4) stratosphere

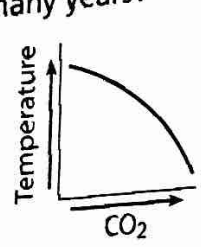
2. The highest air temperature ever recorded in Albany, New York, is 104°F, which occurred on July 4, 1911. This temperature is equal to
   (1) 35°C
   (2) 40°C
   (3) 45°C
   (4) 50°C

3. Which source provides the most energy for atmospheric weather changes?
   (1) radiation from the sun
   (2) radioactivity from Earth's interior
   (3) heat stored in ocean water
   (4) heat stored in polar ice caps

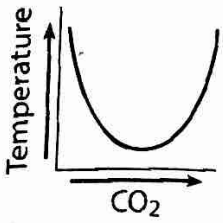
4. The transfer of heat energy within the troposphere occurs primarily by
   (1) insolation
   (2) conduction
   (3) radiation
   (4) convection

5. As a mass of air rises in the troposphere its temperature will usually
   (1) decrease due to expansion
   (2) decrease due to compression
   (3) increase due to expansion
   (4) increase due to compression

6. Which graph best represents what most likely happens to the temperature of Earth's atmosphere as the amount of carbon dioxide in the atmosphere increases over a period of many years?



(1)



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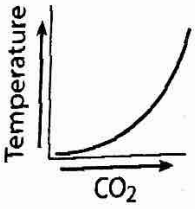

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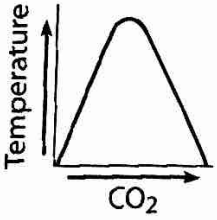
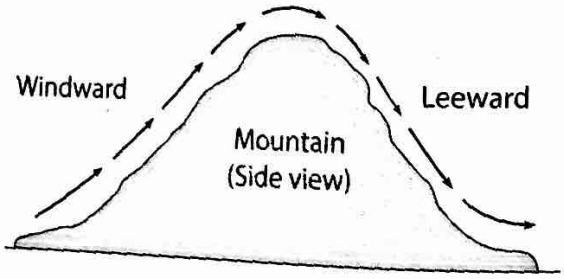


(4)

7. The diagram below shows the direction of movement of air over a mountain. As the air moves down the leeward side of the mountain, the air will



   (1) warm due to compression
   (2) warm due to expansion
   (3) cool due to compression
   (4) cool due to expansion