Prentice Hall

EARTH SCIENCE

Tarbuck ◆ Lutgens

16.1 Atmosphere Characteristics

Composition of the Atmosphere

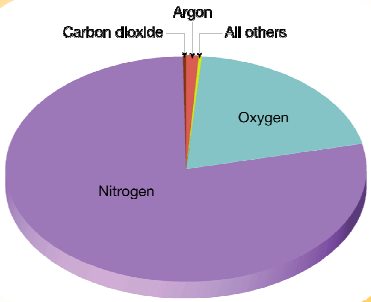
- Weather is constantly changing, and it refers to the state of the atmosphere at any given time and place. Climate, however, is based on observations of weather that have been collected over many years. Climate helps describe a place or region.

16.1 Atmosphere Characteristics

Composition of the Atmosphere

- Major Components
  - Air is a mixture of different gases and particles, each with its own physical properties.

Volume of Clean, Dry Air



16.1 Atmosphere Characteristics

Composition of the Atmosphere

- Variable Components
  - Water vapor is the source of all clouds and precipitation. Like carbon dioxide, water vapor absorbs heat given off by Earth. It also absorbs some solar energy.
  - **Ozone** is a form of oxygen that combines three oxygen atoms into each molecule (O_3).
  - If ozone did not filter most UV radiation and all of the sun's UV rays reached the surface of Earth, our planet would be uninhabitable for many living organisms.

16.1 Atmosphere Characteristics

Composition of the Atmosphere

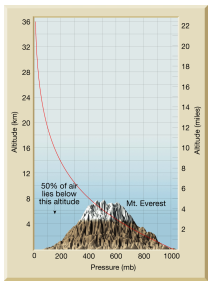
- Human Influence
  - Emissions from transportation vehicles account for nearly half the primary pollutants by weight.

16.1 Atmosphere Characteristics

Height and Structure of the Atmosphere

- The atmosphere rapidly thins as you travel away from Earth until there are too few gas molecules to detect.
- Pressure Changes
  - Atmospheric pressure is simply the weight of the air above.

Atmospheric Pressure vs. Altitude



16.1 Atmosphere Characteristics

Height and Structure of the Atmosphere

- Temperature Changes
  - The atmosphere can be divided vertically into four layers based on temperature.
  - The **troposphere** is the bottom layer of the atmosphere where temperature decreases with an increase in altitude.
  - The **stratosphere** is the layer of the atmosphere where temperature remains constant to a height of about 20 kilometers. It then begins a gradual increase until the stratopause.

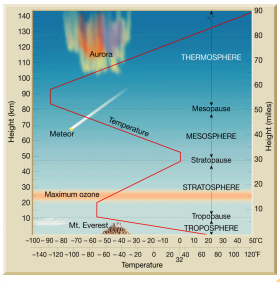
Snowy Mountaintops Contrast with Warmer Snow-Free Lowlands

16.1 Atmosphere Characteristics

Height and Structure of the Atmosphere

- Temperature Changes
  - The **mesosphere** is the layer of the atmosphere immediately above the stratosphere and is characterized by decreasing temperatures with height.
  - The **thermosphere** is the region of the atmosphere immediately above the mesosphere and is characterized by increasing temperatures due to the absorption of very short-wave solar energy by oxygen.

Thermal Structure of the Atmosphere

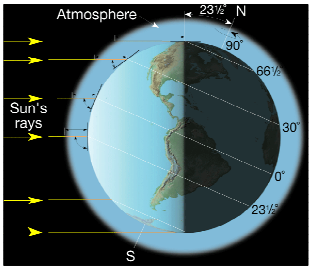


16.1 Atmosphere Characteristics

Earth-Sun Relationships

- Earth's Motions
  - Earth has two principal motions—rotation and revolution.
- Earth's Orientation
  - Seasonal changes occur because Earth's position relative to the sun continually changes as it travels along its orbit.

Tilt of Earth's Axis



16.1 Atmosphere Characteristics

Earth-Sun Relationships

- Solstices and Equinoxes
  - The **summer solstice** is the solstice that occurs on June 21 or 22 in the Northern Hemisphere and is the "official" first day of summer.
  - The **winter solstice** is the solstice that occurs on December 21 or 22 in the Northern Hemisphere and is the "official" first day of winter.

16.1 Atmosphere Characteristics

Earth-Sun Relationships

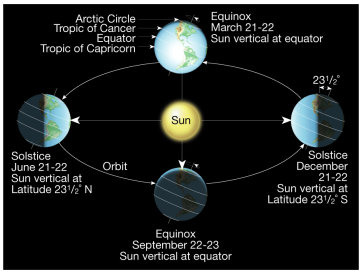
- Solstices and Equinoxes
  - The **autumnal equinox** is the equinox that occurs on September 22 or 23 in the Northern Hemisphere.
  - The **spring equinox** is the equinox that occurs on March 21 or 22 in the Northern Hemisphere.

16.1 Atmosphere Characteristics

Length of Daylight

- The length of daylight compared to the length of darkness also is determined by Earth's position in orbit.

Solstices and Equinoxes



16.2 Heating the Atmosphere

Energy Transfer as Heat

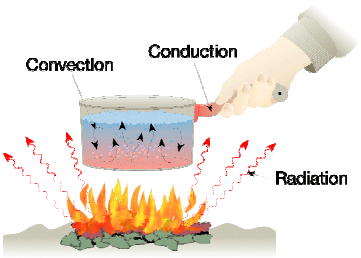
- **Heat** is the energy transferred from one object to another because of a difference in the objects' temperature.
- **Temperature** is a measure of the average kinetic energy of the individual atoms or molecules in a substance.

16.2 Heating the Atmosphere

Energy Transfer as Heat

- Three mechanisms of energy transfer as heat are conduction, convection, and radiation.
- Conduction
  - **Conduction** is the transfer of heat through matter by molecular activity.
- Convection
  - **Convection** is the transfer of heat by mass movement or circulation within a substance.

Energy Transfer as Heat

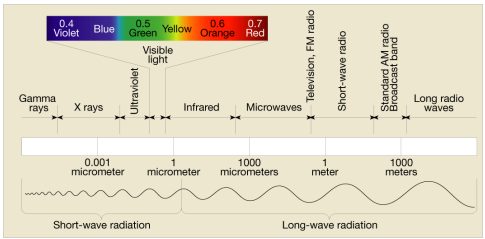


16.2 Heating the Atmosphere

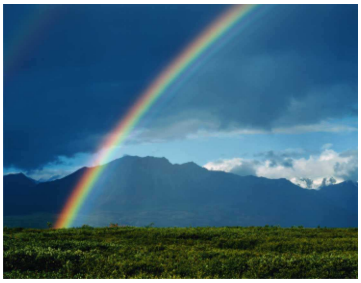
Energy Transfer as Heat

- Electromagnetic Waves
  - The sun emits light and heat as well as the ultraviolet rays that cause a suntan. These forms of energy are only part of a large array of energy emitted by the sun, called the electromagnetic spectrum.

Electromagnetic Spectrum



Visible Light Consists of an Array of Colors



16.2 Heating the Atmosphere

Energy Transfer as Heat

- Radiation
  - **Radiation** is the transfer of energy (heat) through space by electromagnetic waves that travel out in all directions.
  - Unlike conduction and convection, which need material to travel through, radiant energy can travel through the vacuum of space.

17.2 Heating the Atmosphere

Energy Transfer as Heat

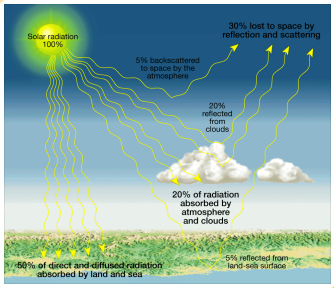
- Radiation
  - All objects, at any temperature, emit radiant energy.
  - Hotter objects radiate more total energy per unit area than colder objects do.
  - The hottest radiating bodies produce the shortest wavelengths of maximum radiation.
  - Objects that are good absorbers of radiation are good emitters as well.

16.2 Heating the Atmosphere

What Happens to Solar Radiation?

- When radiation strikes an object, there usually are three different results.
  1. Some energy is absorbed by the object.
  2. Substances such as water and air are transparent to certain wavelengths of radiation.
  3. Some radiation may bounce off the object without being absorbed or transmitted.

Solar Radiation



16.2 Heating the Atmosphere

What Happens to Solar Radiation?

- Reflection and Scattering
  - **Reflection** occurs when light bounces off an object. Reflection radiation has the same intensity as incident radiation.
  - **Scattering** produces a larger number of weaker rays that travel in different directions.

16.2 Heating the Atmosphere

What Happens to Solar Radiation?

- Absorption
  - About 50 percent of the solar energy that strikes the top of the atmosphere reaches Earth's surface and is absorbed.
  - The **greenhouse effect** is the heating of Earth's surface and atmosphere from solar radiation being absorbed and emitted by the atmosphere, mainly by water vapor and carbon dioxide.

16.3 Temperature Controls

Why Temperatures Vary

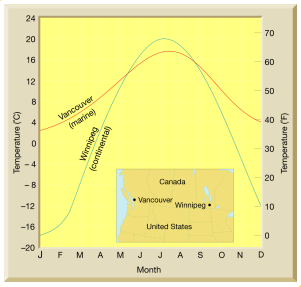
- Factors other than latitude that exert a strong influence on temperature include heating of land and water, altitude, geographic position, cloud cover, and ocean currents.

16.3 Temperature Controls

Why Temperatures Vary

- Land and Water
  - Land heats more rapidly and to higher temperatures than water. Land also cools more rapidly and to lower temperatures than water.

Mean Monthly Temperatures for Vancouver and Winnipeg

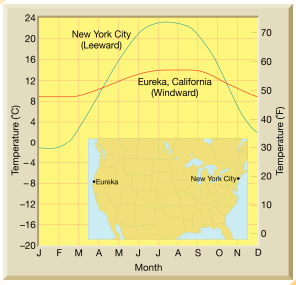


16.3 Temperature Controls

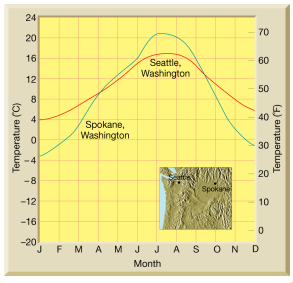
Why Temperatures Vary

- Geographic Position
  - The geographic setting can greatly influence temperatures experienced at a specific location.

Mean Monthly Temperatures for Eureka and New York City



Mean Monthly Temperatures for Seattle and Spokane

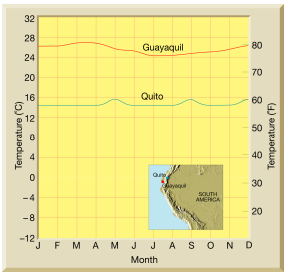


16.3 Temperature Controls

Why Temperatures Vary

- Altitude
  - The altitude can greatly influence temperatures experienced at a specific location.

Mean Monthly Temperatures for Guayaquil and Quito

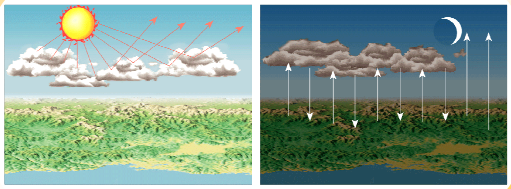


16.3 Temperature Controls

Why Temperatures Vary

- Cloud Cover and Albedo
  - **Albedo** is the fraction of total radiation that is reflected by any surface.
  - Many clouds have a high albedo and therefore reflect back to space a significant portion of the sunlight that strikes them.

Clouds Reflect and Absorb Radiation



16.3 Temperature Controls

World Distribution of Temperature

- **Isotherms** are lines on a weather map that connect points where the temperature is the same.
  - Isotherms generally trend east and west and show a decrease in temperatures from the tropics toward the poles.