Ocean Water Movements

1) **Surface circulation**
2) **Upwelling and Downwelling**
3) **Deep Water Circulation**
4) **Tides**
5) **Wind Generated Waves**

EARTH SCIENCE

QUIZ Chapter 11

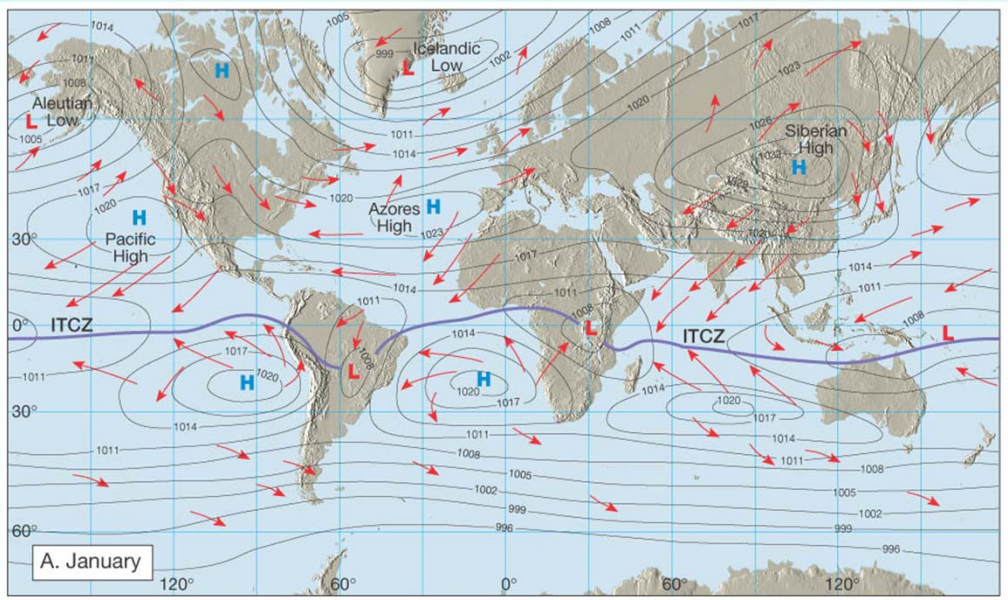
Name_____ **Ed Meye**

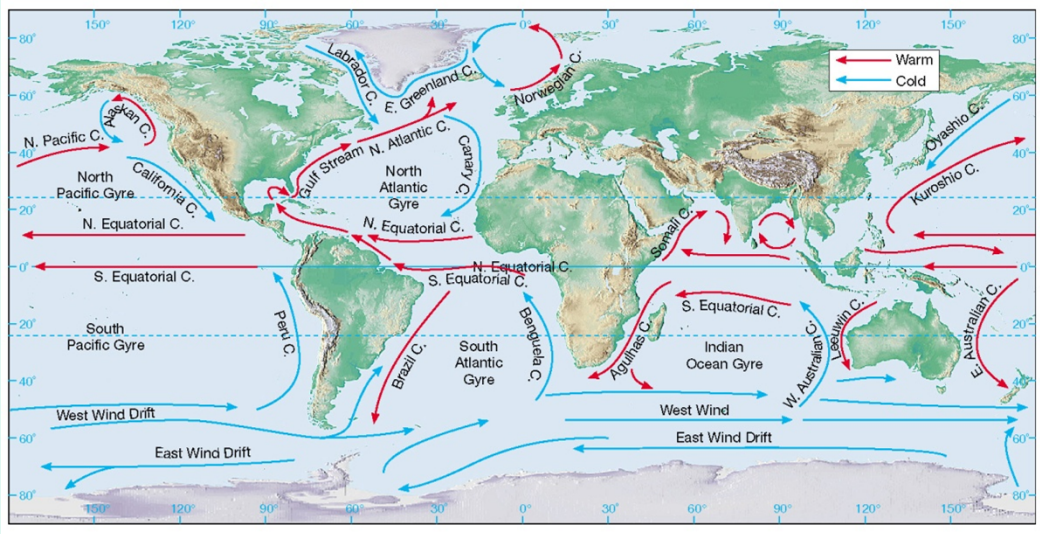
Match the following words with their definition and/or description:

1.	A	Albedo
2.	K	Equinox
3.	G	Conduction
4.	H	Convection
5.	J	Radiation
6.	F	Air Pressure
7.	B	Weather
8.	I	Troposphere
9.	E	Solstice
10.	C	Stratosphere

A. The reflectivity of a substance

Atmospheric and Surface Water Circulation





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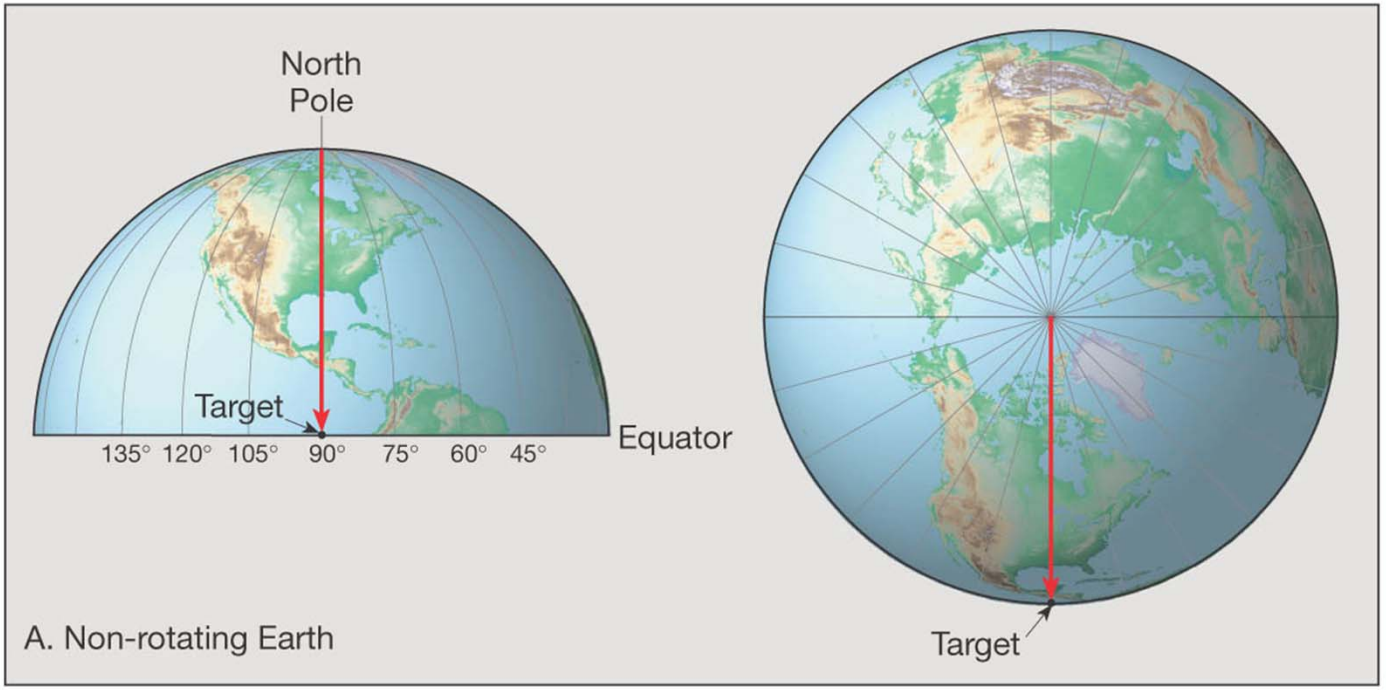
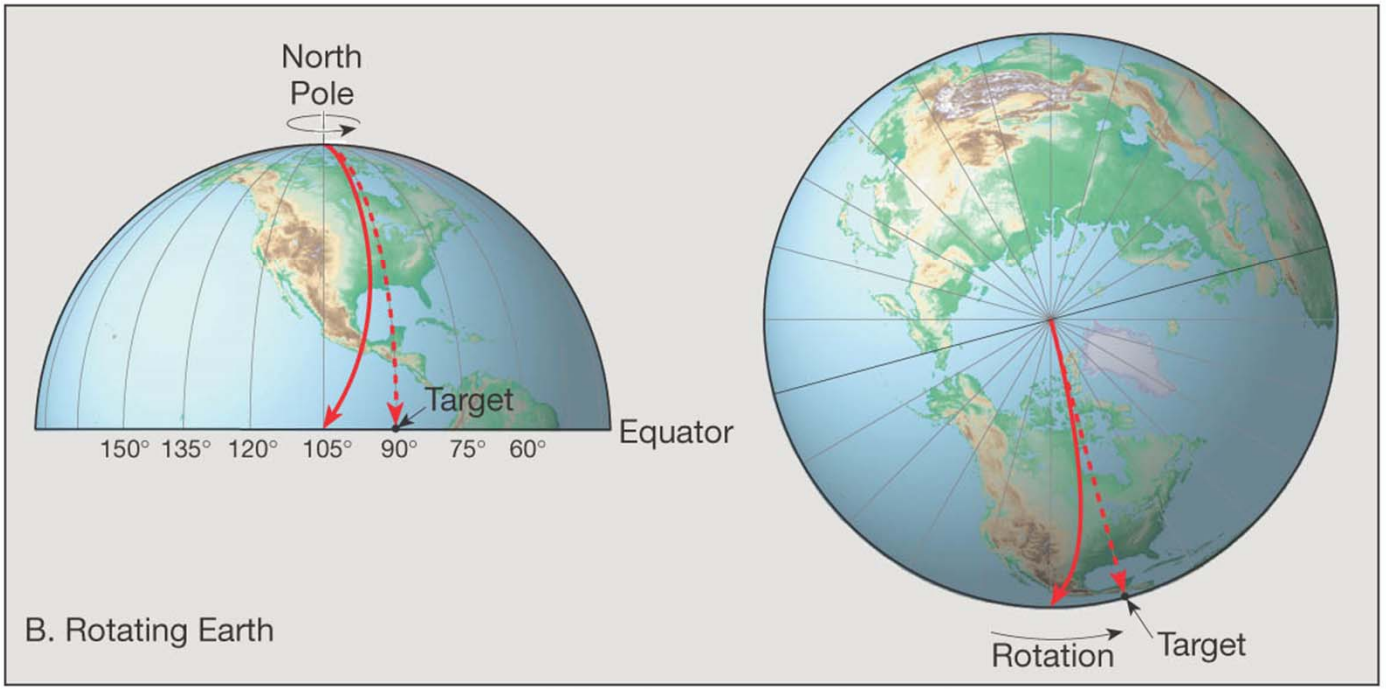
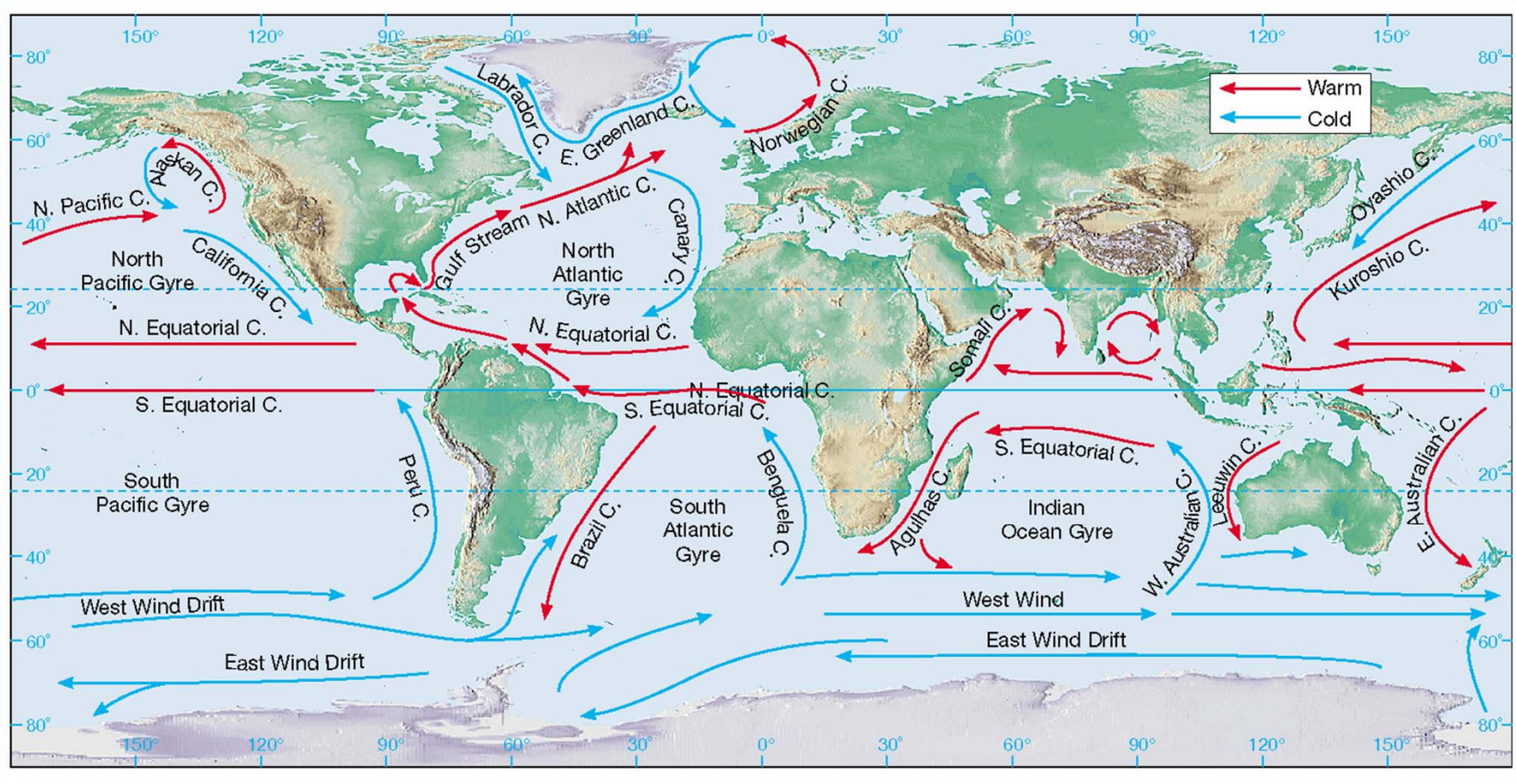




Influenced by land masses



Upwelling and Downwelling

Upwelling

- The replacement of warm surface water by rising cold water from deeper layers
- Most characteristic along west coasts of continents
- Results in some the richest fishing grounds in the world

Idealized "Conveyor Belt" Model of Ocean Circulation

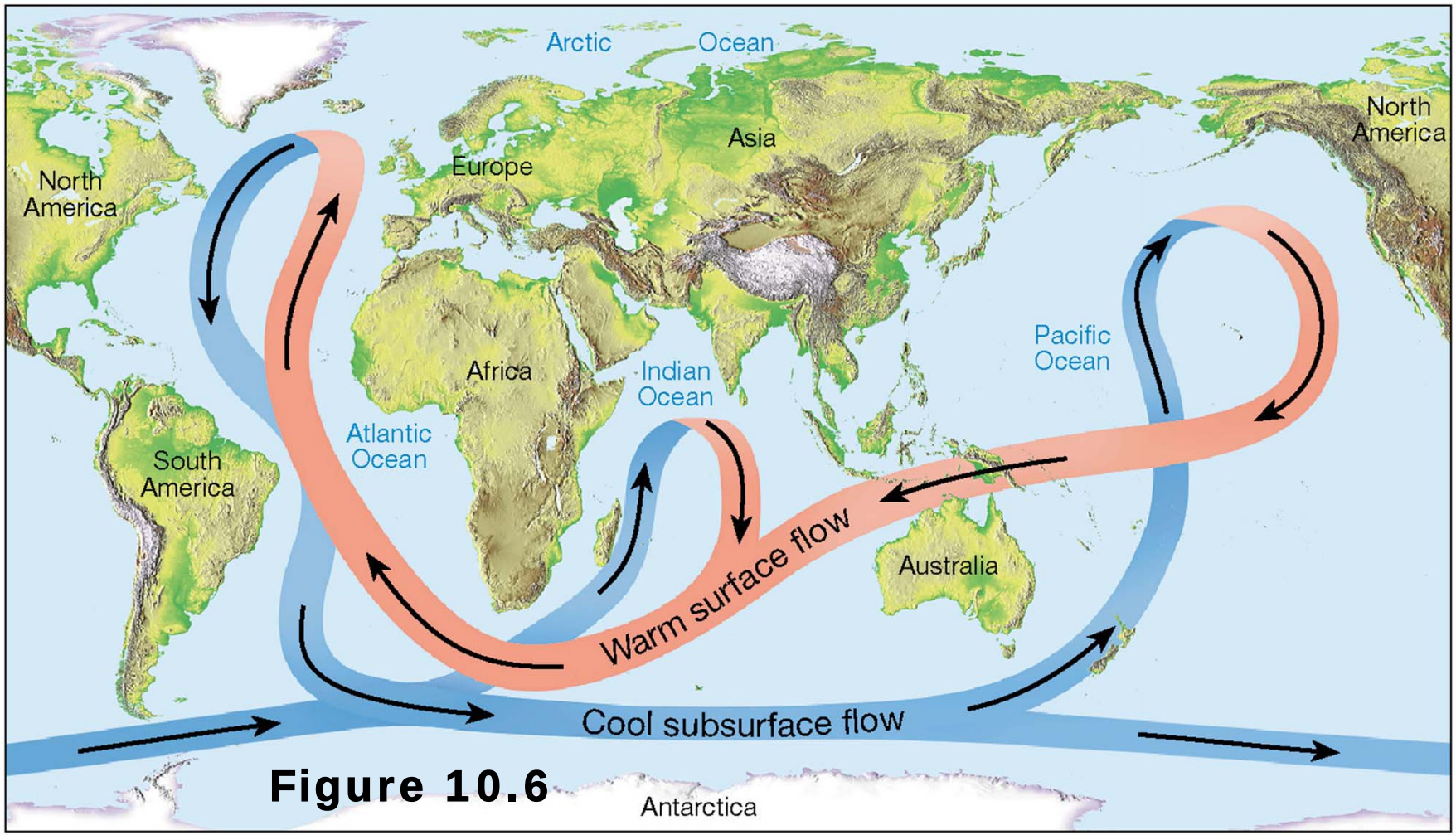
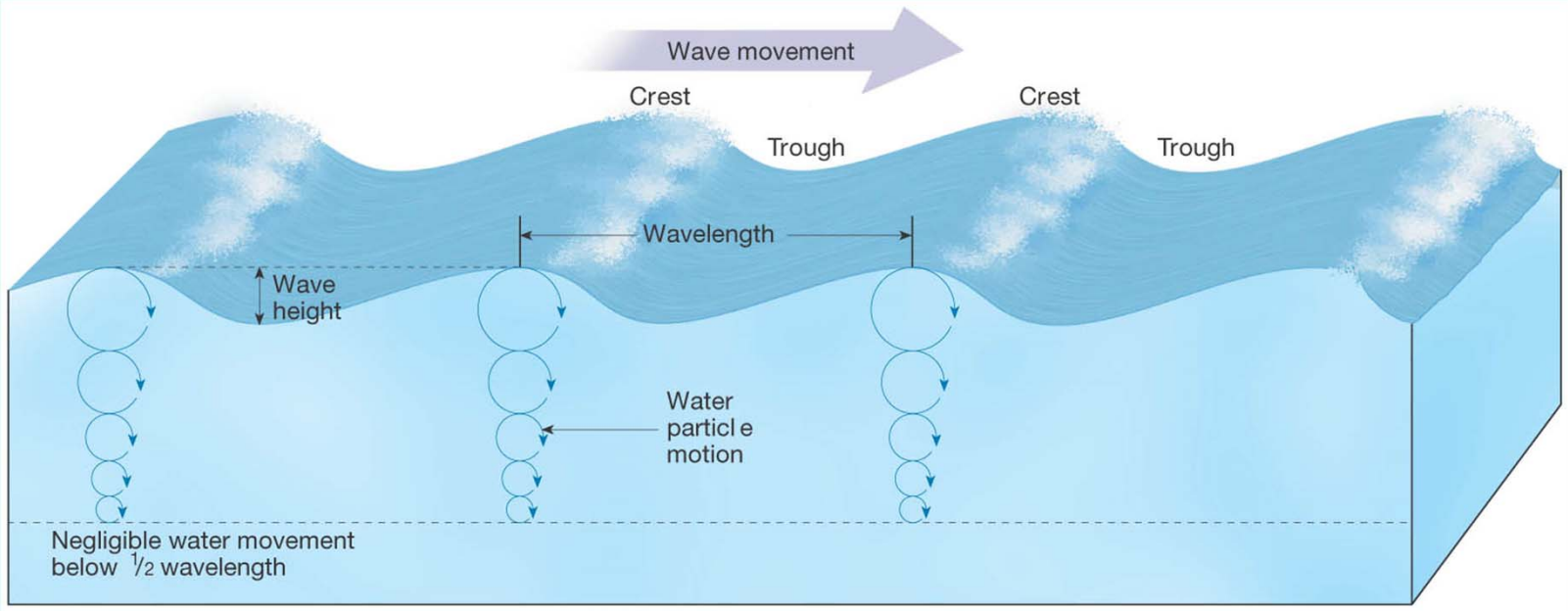


Figure 10.6

Waves

Waves

- **Energy traveling along the interface between ocean and atmosphere**
- **Derive their energy and motion from wind**
- **Parts : *Crest, Trough, Wavelength, height***



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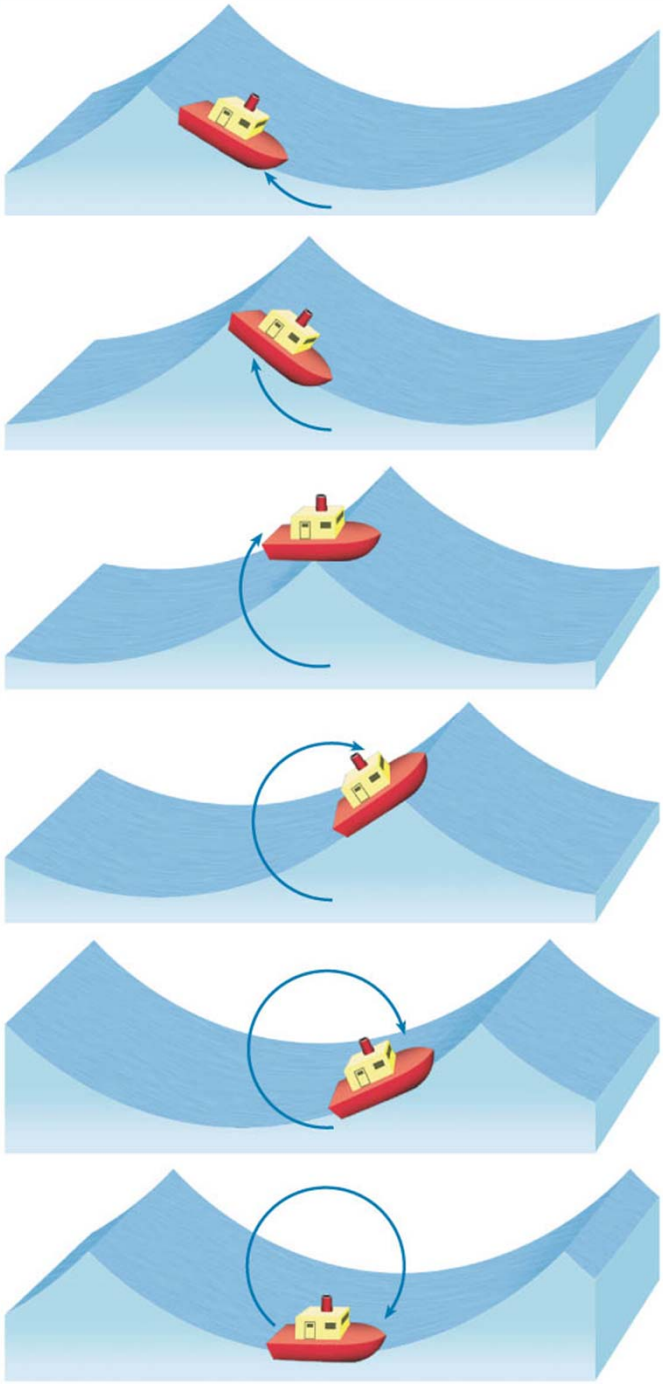


Changes That Occur When a Wave Moves onto Shore

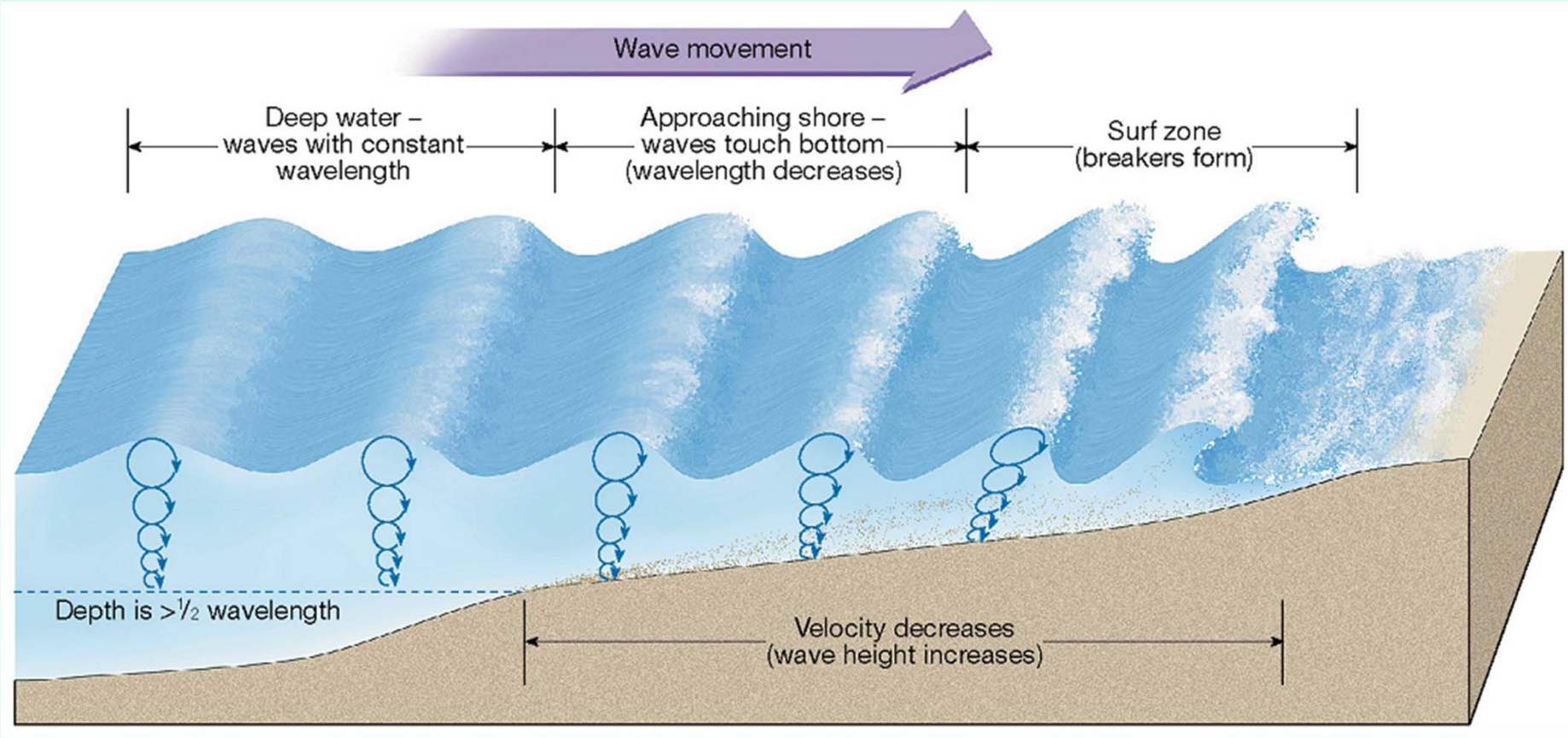
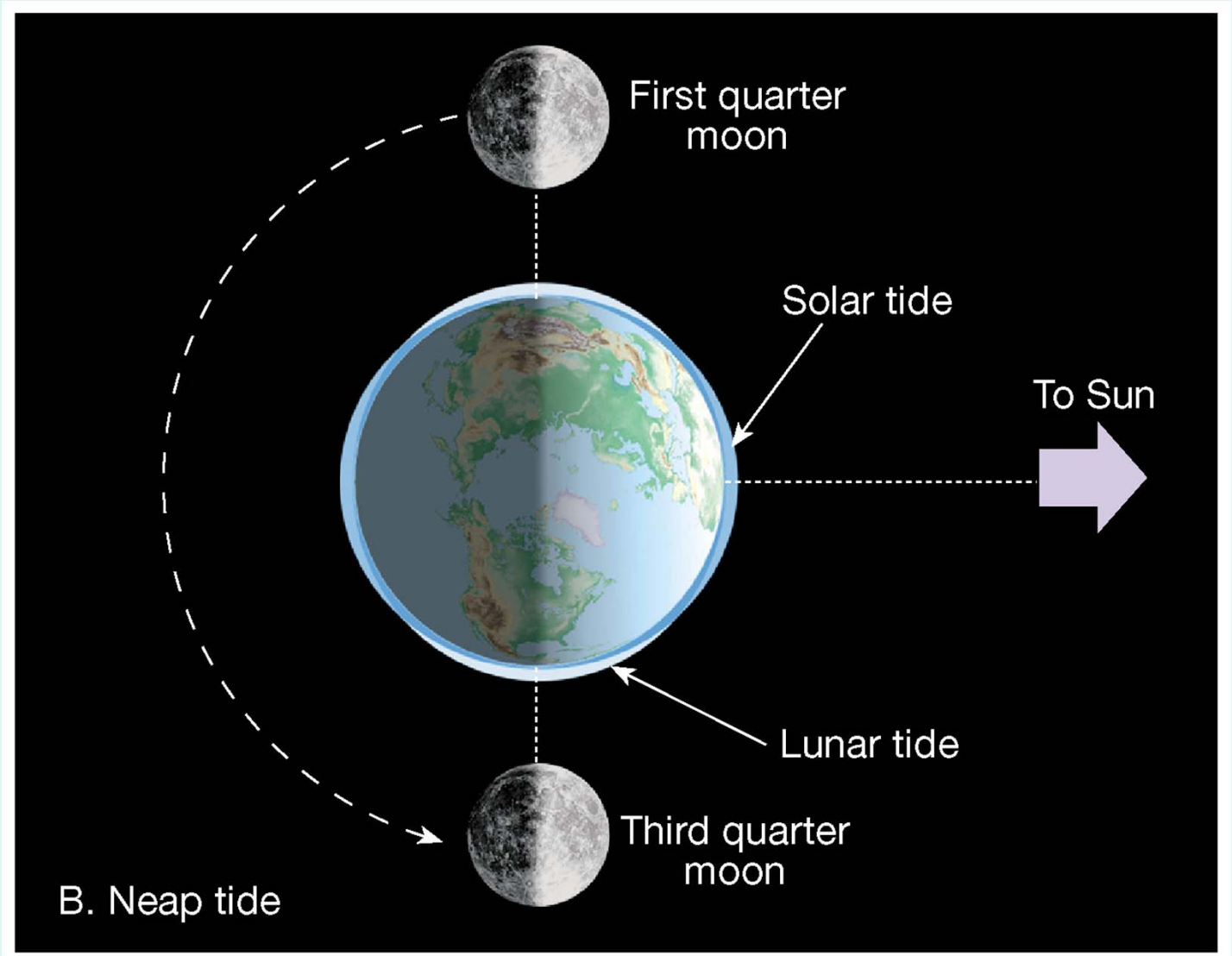


Figure 10.9

Tides

- **Changes in elevation of the ocean surface**
- **Caused by the gravitational forces exerted upon the Earth by the Moon, and to a lesser extent by the Sun**

High Tides Follow Moon

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Beaches and Shoreline Processes

Beaches and Shoreline Processes

- **Wave refraction**
  - **Bending of a waves**
  - **Wave arrives parallel to shore**
  - **Results**
    - **Wave energy is concentrated against the sides and ends of the headland**
    - **Wave erosion straightens an irregular shoreline**

Wave Refraction Along an Irregular Coastline

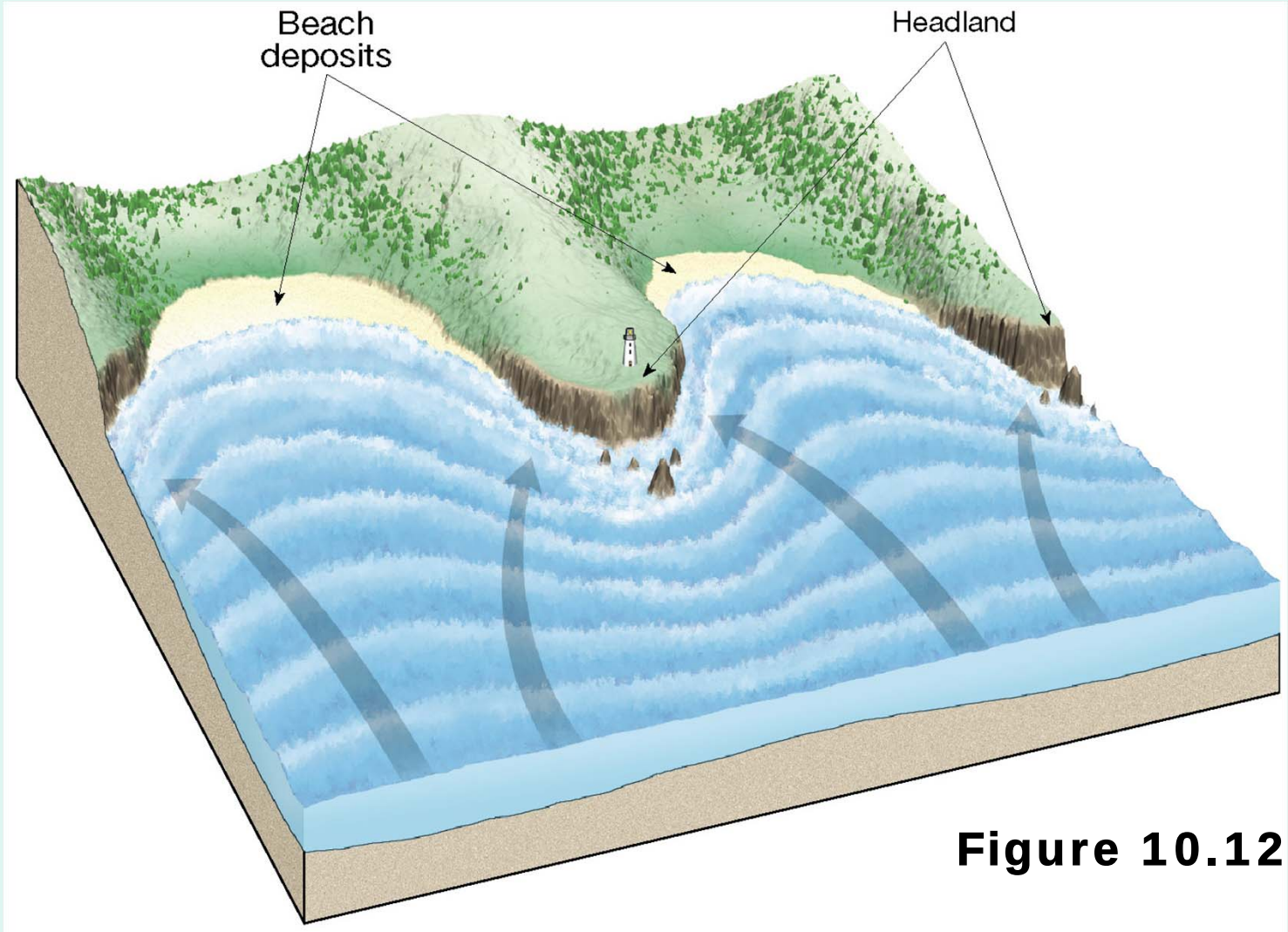

Figure 10.12

Wave Refraction Along an Irregular Coastline


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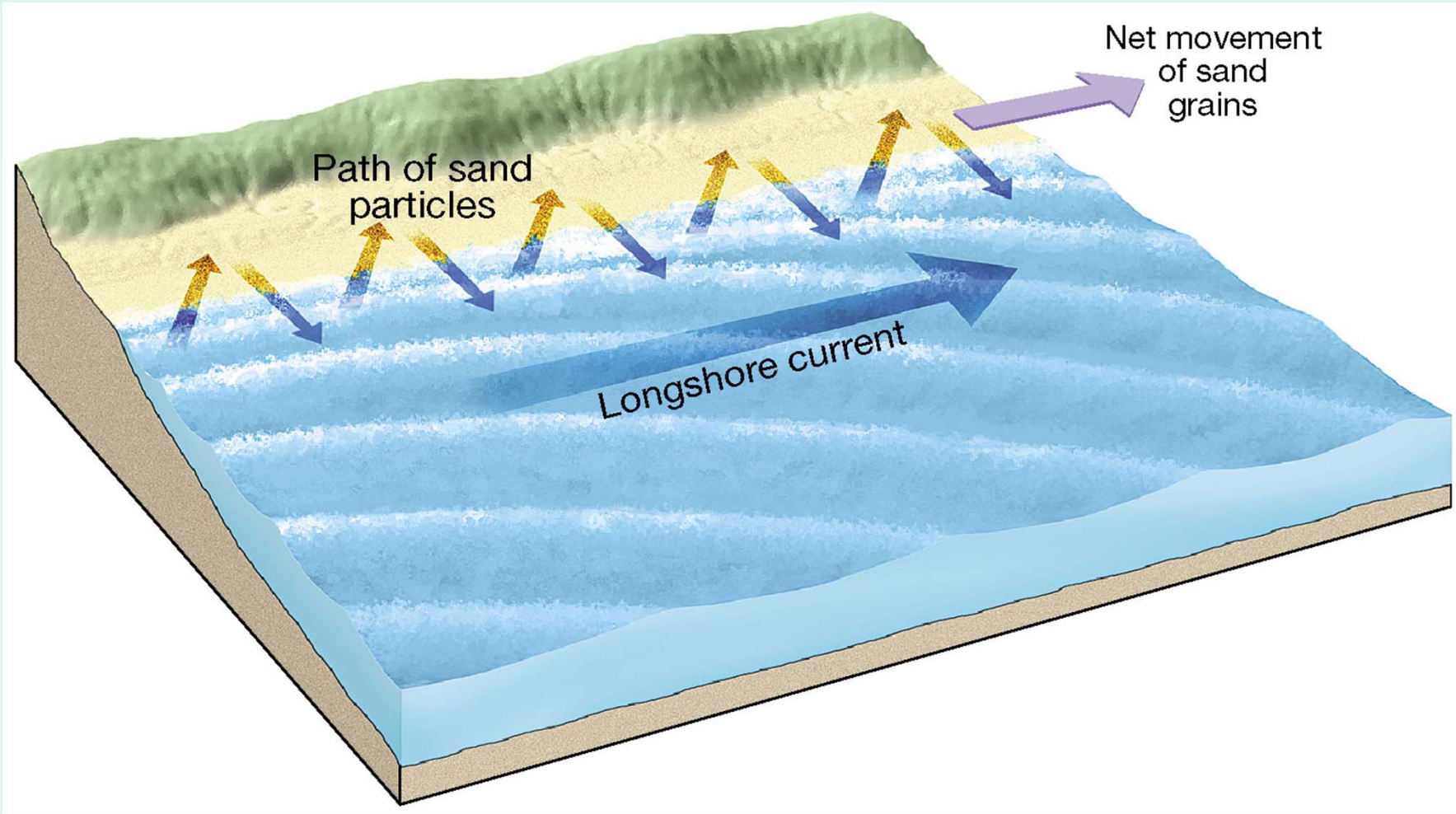
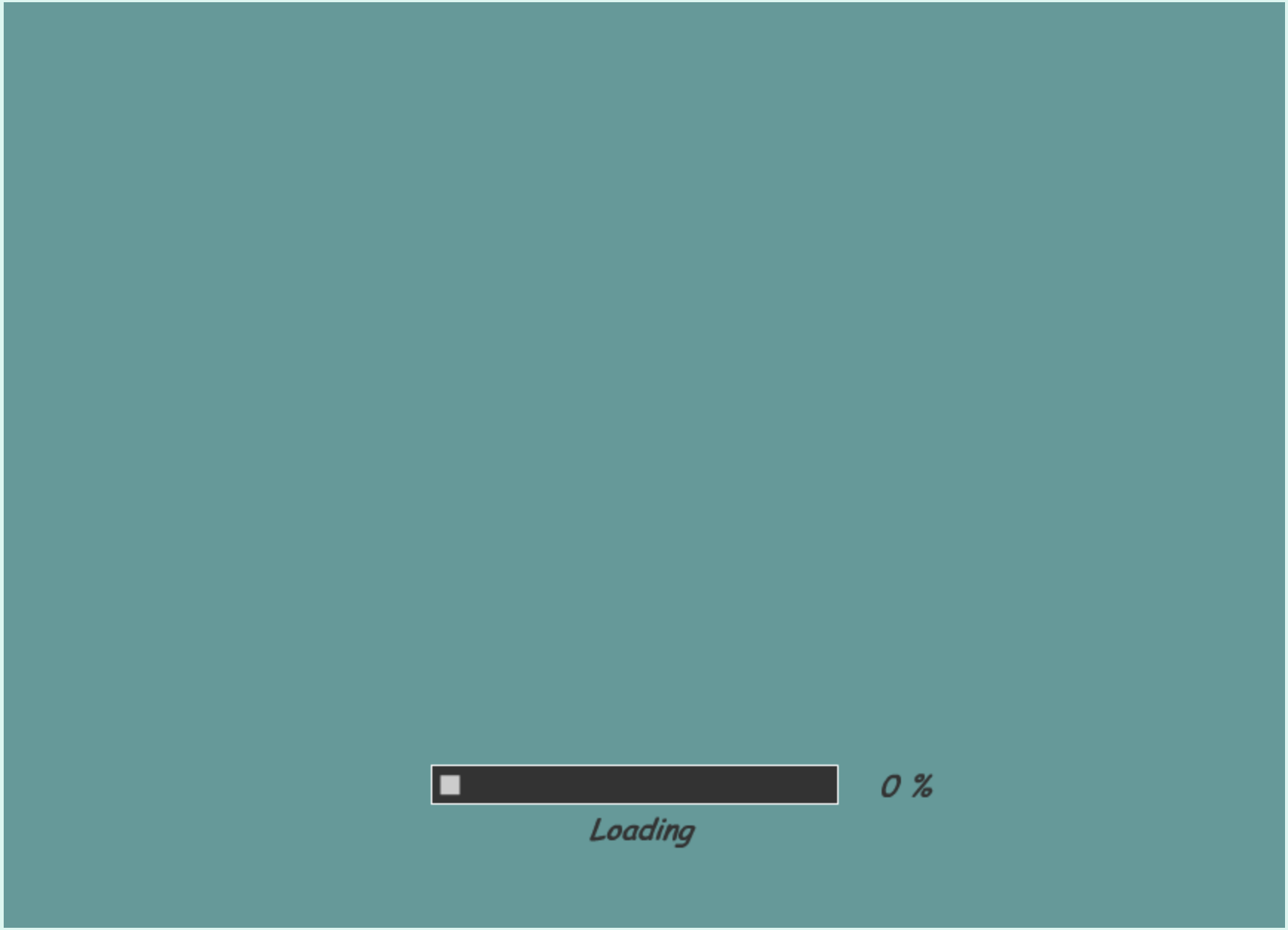
Beaches and Shoreline Processes

- **Longshore transport**
  - ***Beach drift*—Sediment moves in a zigzag pattern along the beach face**
  - **Longshore current**
    - **Current in surf zone**
    - **Flows parallel to the shore**
    - **Moves substantially more sediment than beach drift**

Beach Drift and Longshore Currents

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Shoreline Features

- **Depositional features**
  - ***Spit* —A ridge of sand extending from the land into the mouth of an adjacent bay with an end that often hooks landward**
  - ***Baymouth bar* —A sand bar that completely crosses a bay**
  - ***Tombolo*—A ridge of sand that connects an island to the mainland**

Spit

Baymouth Bar

Aerial View of a Spit and Baymouth Bar Along the Massachusetts Coastline

Tombolo


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Shoreline Features

- **Depositional features**
  - **Barrier islands**
    - **Mainly along the Atlantic and Gulf Coastal Plains**
    - **Parallel the coast**
    - **Originate in several ways**

Shoreline Features

Erosional features

- ***Wave-cut cliff***
- ***Wave-cut platform***
- ***Marine terraces***
- **Associated with headlands**
  - **Sea arch**
  - **Sea stack**

Sea Arch

Figure 10.18 Sea arch

Sea Stack

Sea stack

Stabilizing the Shore

- **Shoreline erosion is influenced by the local factors**
  - **Proximity to sediment-laden rivers**
  - **Degree of tectonic activity**
  - **Topography and composition of the land**
  - **Prevailing wind and weather patterns**
  - **Configuration of the coastline**

Stabilizing the Shore

- **Responses to erosion problems**
  - ***Hard stabilization*—Building structures**
    - **Types of structures**
      - ***Groins* —Barriers built at a right angle to the beach that are designed to trap sand**
      - ***Breakwaters*—Barriers built offshore and parallel to the coast to protect boats from breaking waves**

Stabilizing the Shore

- **Responses to erosion problems**
  - ***Hard stabilization*—Building structures**
    - **Types of structures**
      - ***Seawalls*—Armors the coast against the force of breaking waves**
    - **Often these structures are not effective**

Stabilizing the Shore

- **Responses to erosion problems**
  - **Alternatives to hard stabilization**
    - ***Beach nourishment*** **by adding sand to the beach system**
    - **Relocating buildings away from beach**
- **Erosion problems along U.S. Coasts**
  - **Shoreline erosion problems are different along the opposite coasts**

Miami Beach Before Beach Nourishment

A.

Figure 10.22 A

Miami Beach After Beach Nourishment

B.

Figure 10.22 B

Stabilizing the Shore

- **Erosion problems along U.S. Coasts**
  - **Atlantic and Gulf Coasts**
    - **Development occurs mainly on *barrier islands***
      - **Face open ocean**
      - **Receive full force of storms**
    - **Development has taken place more rapidly than our understanding of barrier island dynamics**

Major Estuaries Along the East Coast of the United States

Coastal Classification

- **Classification based on changes with respect to sea level**
  - ***Submergent coast***
    - **Caused by**
      - **Land adjacent to sea subsides, or**
      - **Sea level rises**
    - **Features of a submergent coast**
      - **Highly irregular shoreline**
      - ***Estuaries* —Drowned river mouths**

Coastal Classification

- **Shoreline classification is difficult**
- **Classification based on changes with respect to sea level**
  - ***Emergent coast***
    - **Caused by**
      - **Uplift of the land, or**
      - **A drop in sea level**

Chapter 11
Heating the Atmosphere

Weather and Climate

- **Weather**
  - **Weather is over a short period of time**
  - **Constantly changing**
- **Climate**
  - **Climate is over a long period of time**
  - **Generalized, composite of weather**

Weather and Climate

- **Elements of weather and climate**
  - **Properties that are measured regularly**
  - **Most important elements**
    - **Temperature**
    - **Humidity**
    - **Cloudiness**
    - **Precipitation**
    - **Air Pressure**
    - **Winds speed and direction**

Origin of the Atmosphere

Outgassing occurred from volcanoes - Original composition of atmosphere is predicted to be similar to composition of present day volcanoes

80% water vapor, 10% CO_2, and <1-2% nitrogen

Origin of the Atmosphere

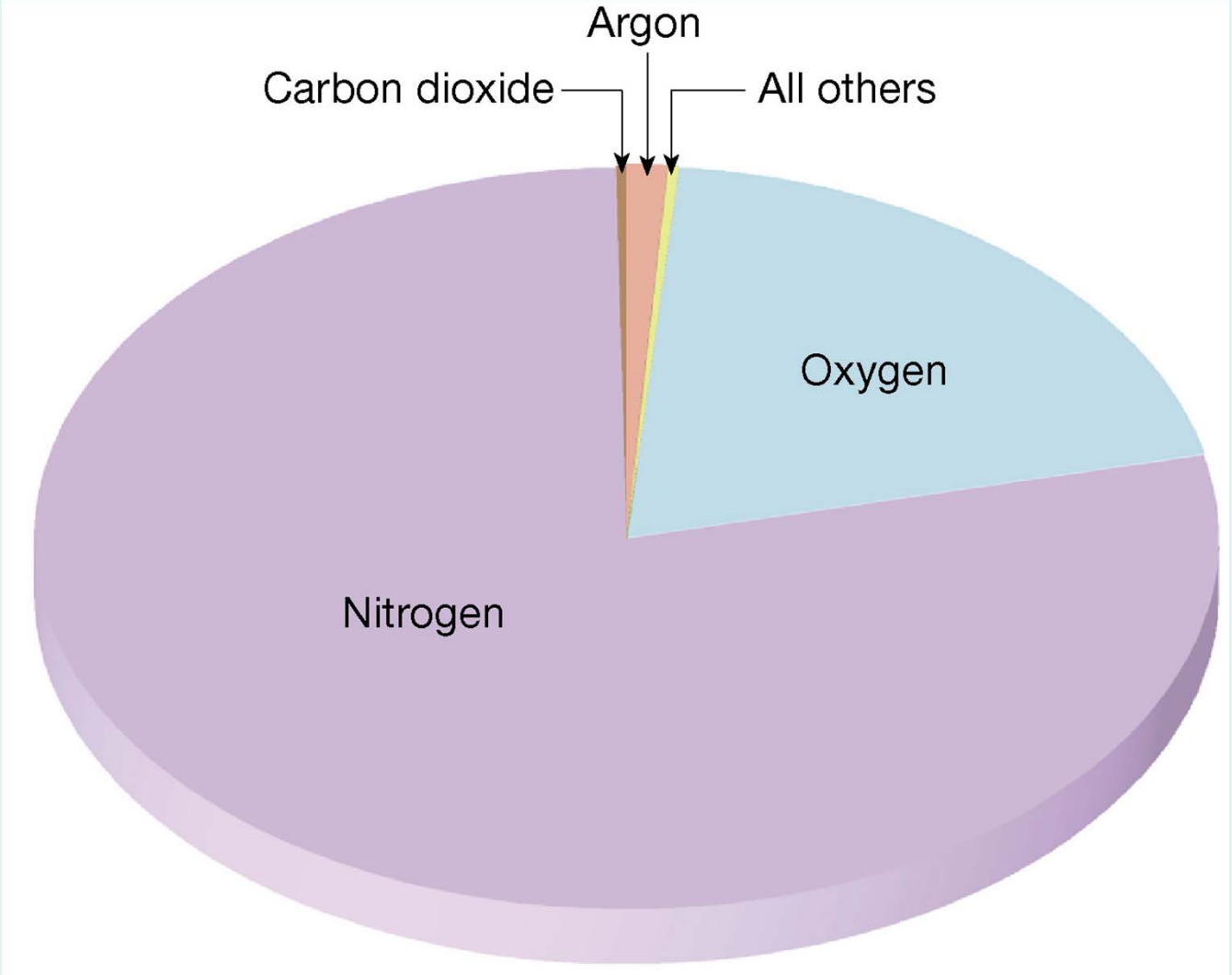
Changes over time

1. Water vapor condensed to form liquid water
2. CO_2 became locked up in rocks
3. Nitrogen, which is chemically inactive, increased
4. When plants evolved oxygen became more abundant
5. Variations - CO_2 changes can cause climate changes

Current Composition of the Atmosphere

- **Air is a mixture of discrete gases**
- **Major permanent components of clean, dry air**
  - **Nitrogen (N)—78%**
  - **Oxygen (O_2)—21%**
  - **Argon and other gases**
  - **Carbon dioxide (CO_2)—0.036%—absorbs heat energy from Earth**

Composition of Dry Air



Composition of the Atmosphere

Major Variable components of air

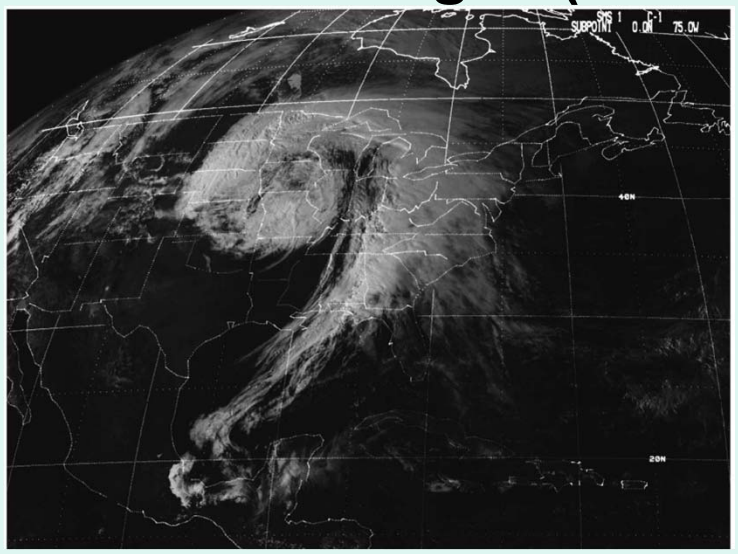
- Water vapor
- Aerosols
- Ozone
- CO2

Composition of the Atmosphere

Importance of Variable components

Water vapor

- Up to about 4% of the air's volume
- Forms clouds and precipitation
- Greenhouse gas (Absorbs heat energy from Earth)

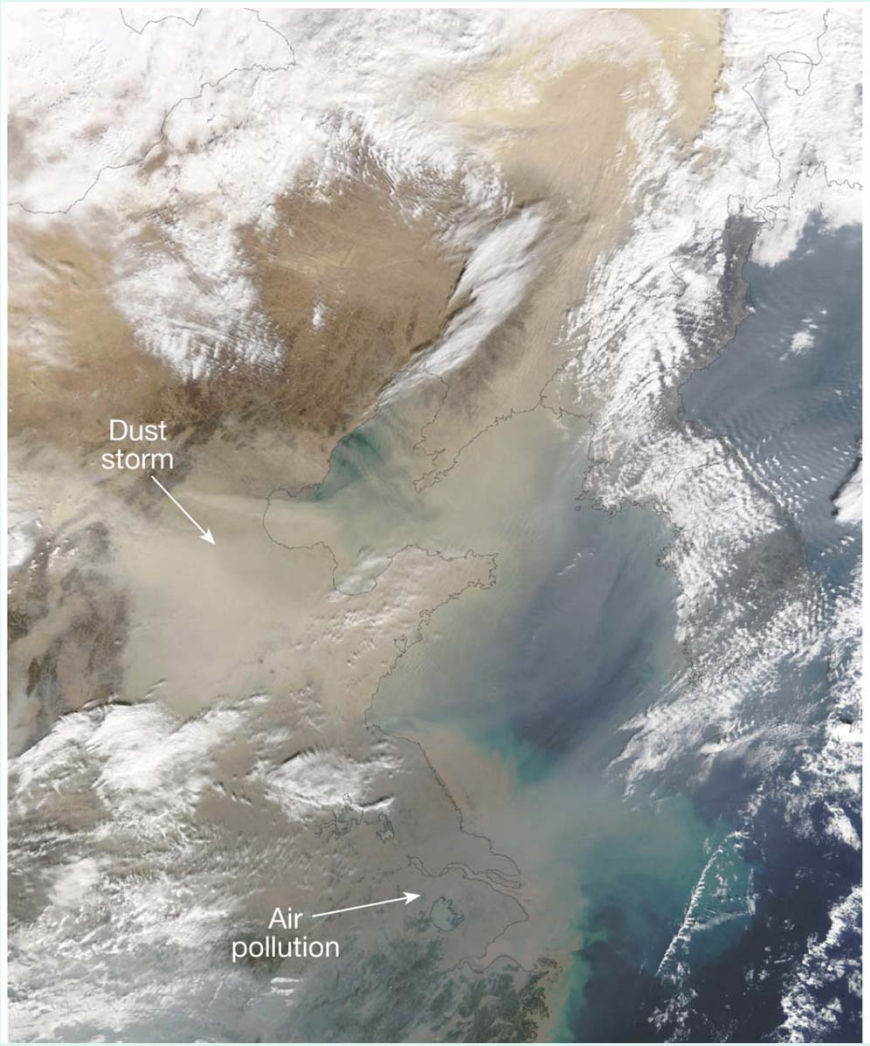


Composition of the Atmosphere

Major Variable components of air

Aerosols

- Tiny solid and liquid particles
- Water vapor can condense on solids
- Reflect sunlight
- Help color sunrise and sunset

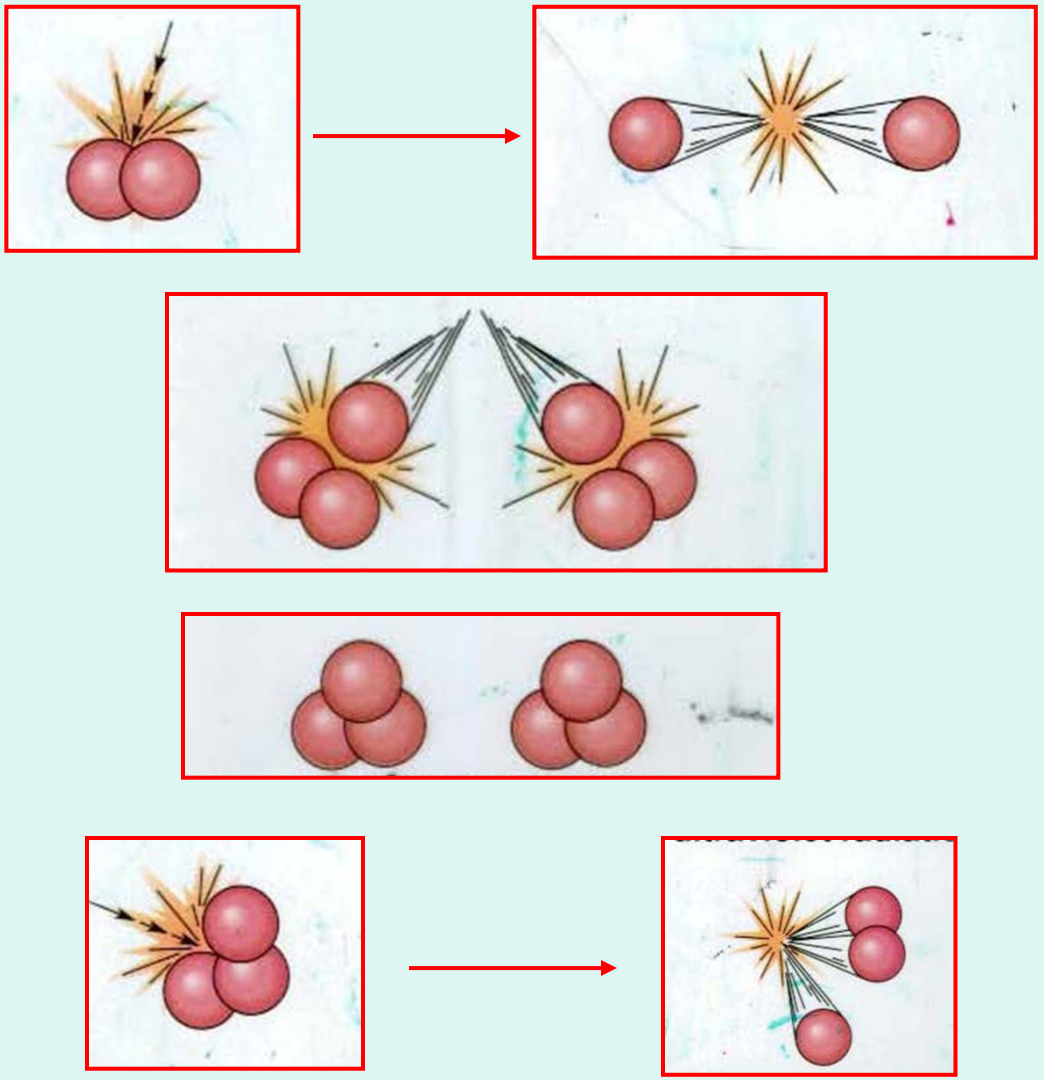


Composition of the Atmosphere

Major Variable components of air

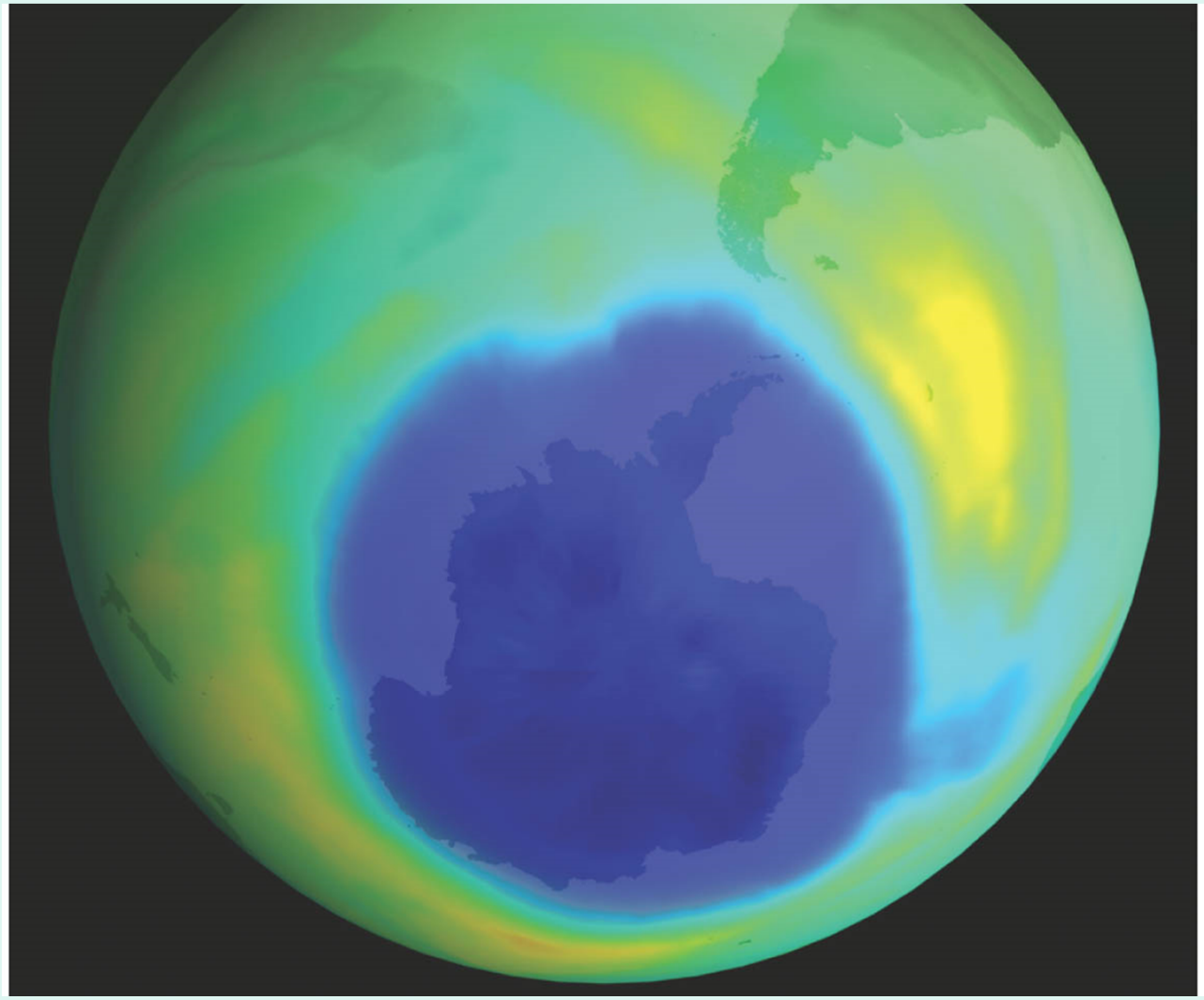
Ozone

- Three atoms of oxygen (O_3)
- Distribution not uniform
- Concentrated between 10 to 50 kilometers above the surface (Stratosphere)
- Absorbs harmful UV radiation
- Human activity is depleting ozone by adding *chlorofluorocarbons (CFCs)*



Composition of the Atmosphere

Ozone Depletion

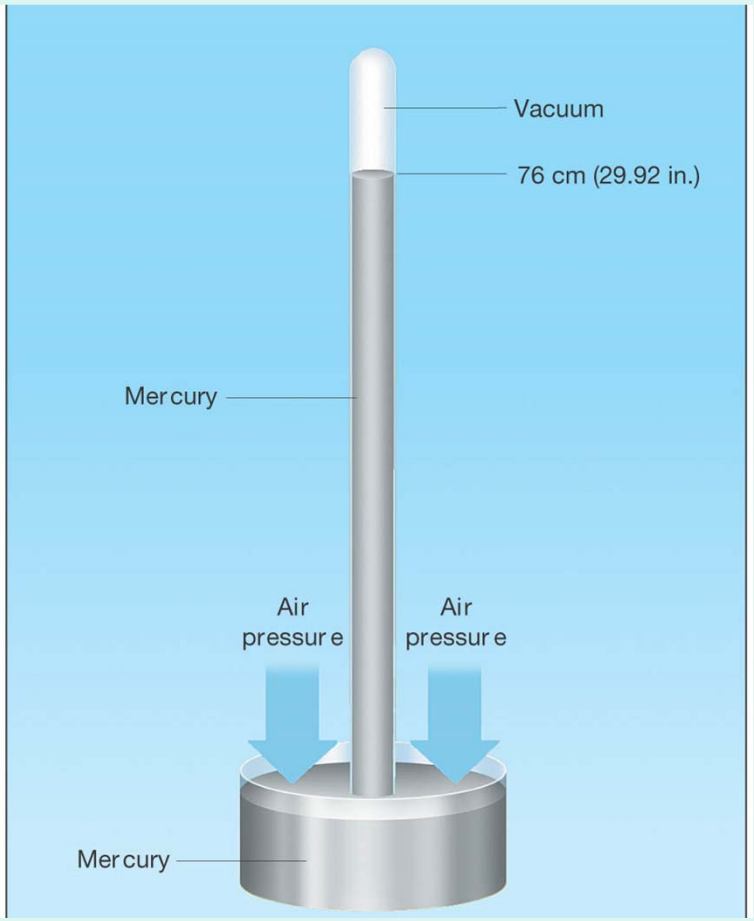


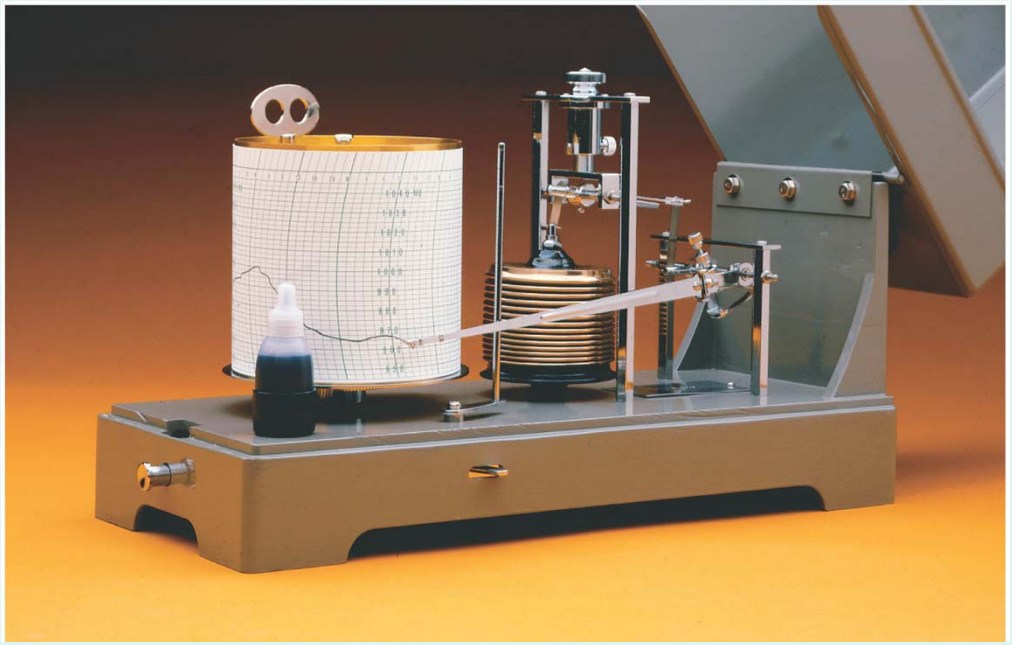
Atmospheric Pressure

- **Pressure changes**
  - **Pressure is the weight of the air above**
  - **Average sea level pressure**
    - **Slightly more than 1000 millibars**
    - **About 14.7 pounds per square inch**
  - **Pressure decreases with altitude**
    - **One half of the atmosphere is below 3.5 miles (5.6 km)**
    - **Ninety percent of the atmosphere is below 10 miles (16 km)**

Atmospheric Pressure

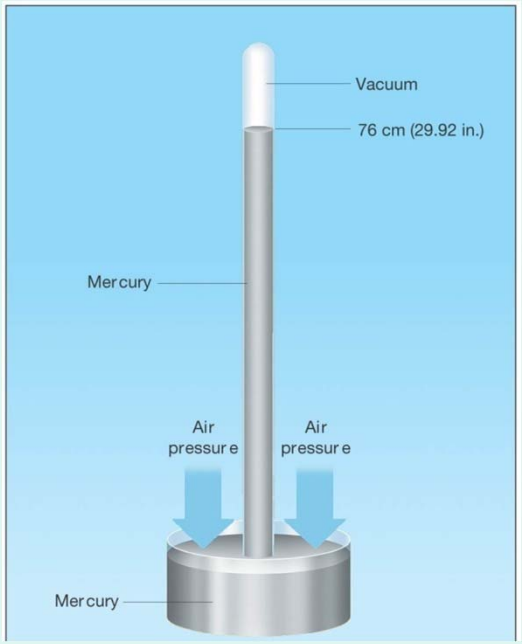
Measurement of Air Pressure

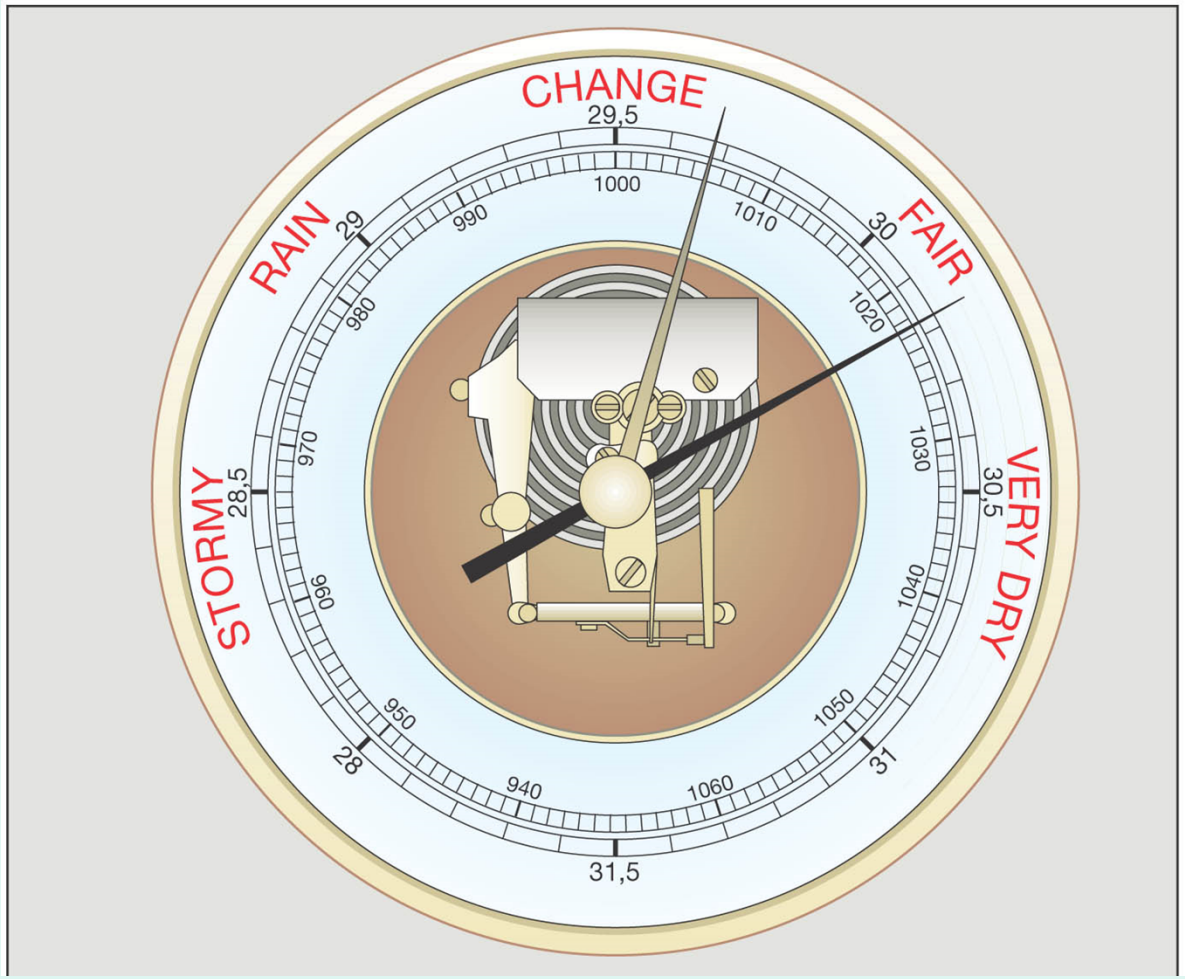


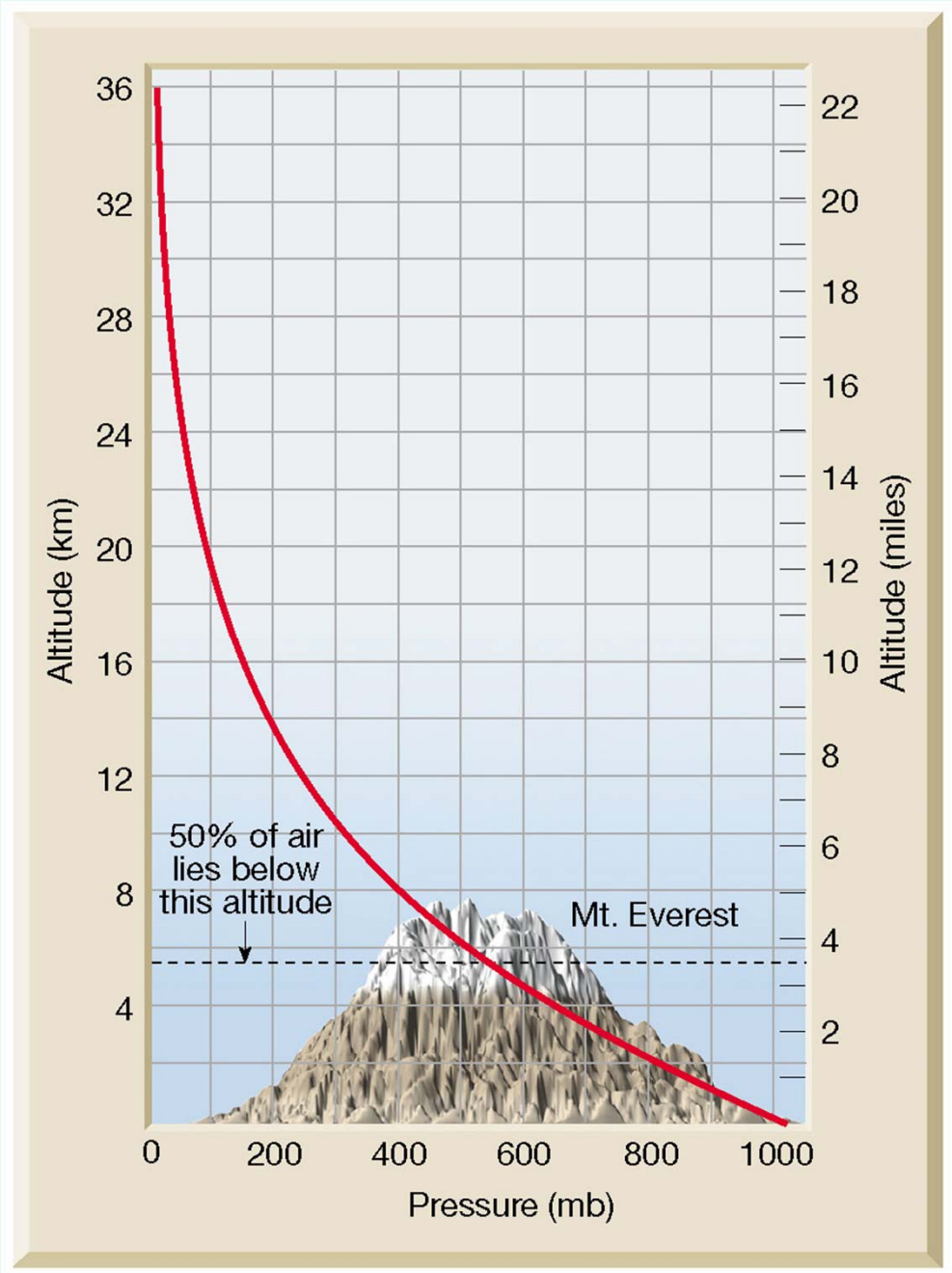


Atmospheric Pressure

Measurement of Air Pressure







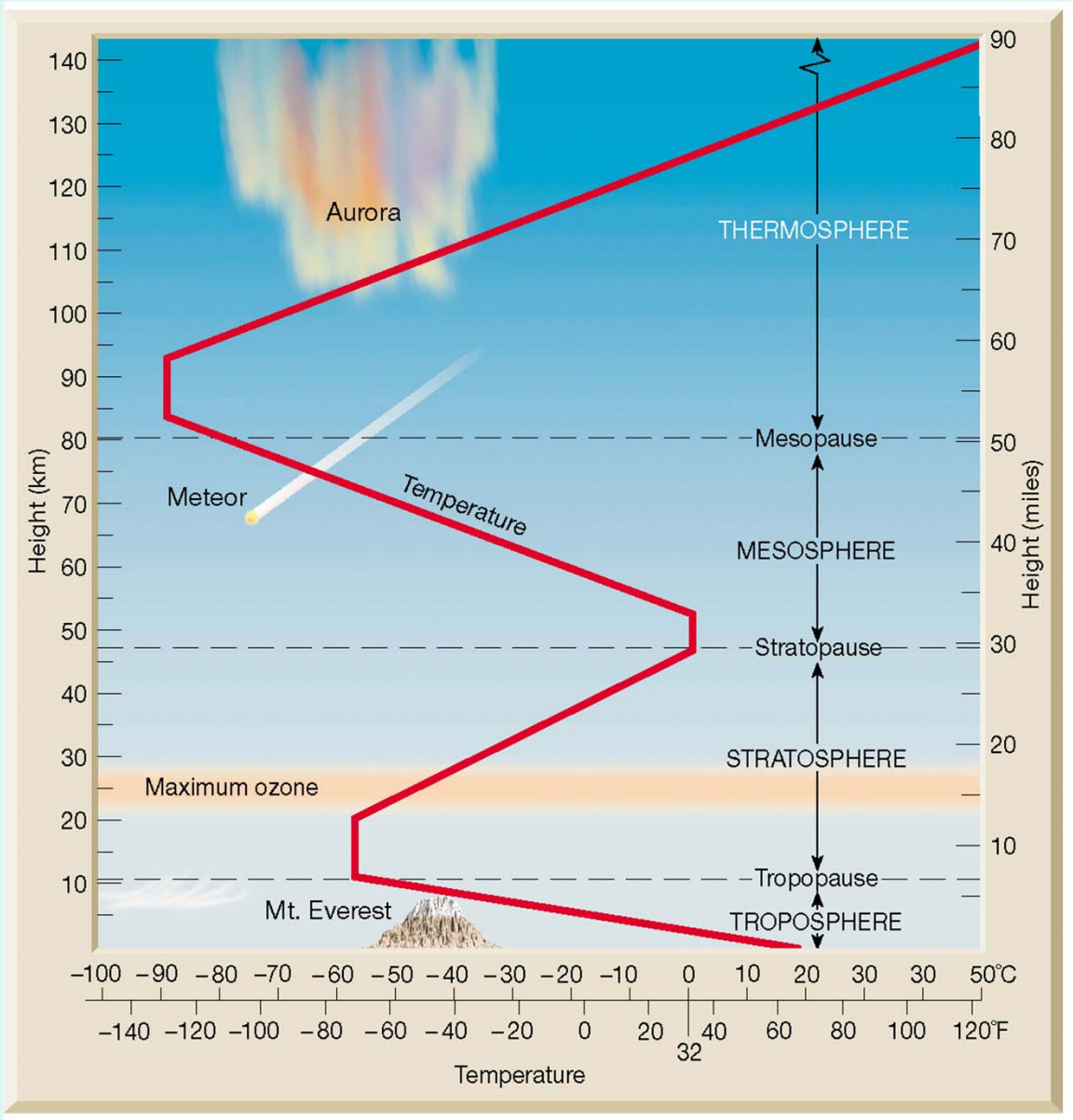
Atmospheric Pressure Variation with Altitude

Heat and Temperature

Heat is the total kinetic energy of the atoms or molecules that make up the substance

Temperature is the average of the kinetic energy of the individual atoms or molecules that make up the substance

Thermal Structure of the Atmosphere

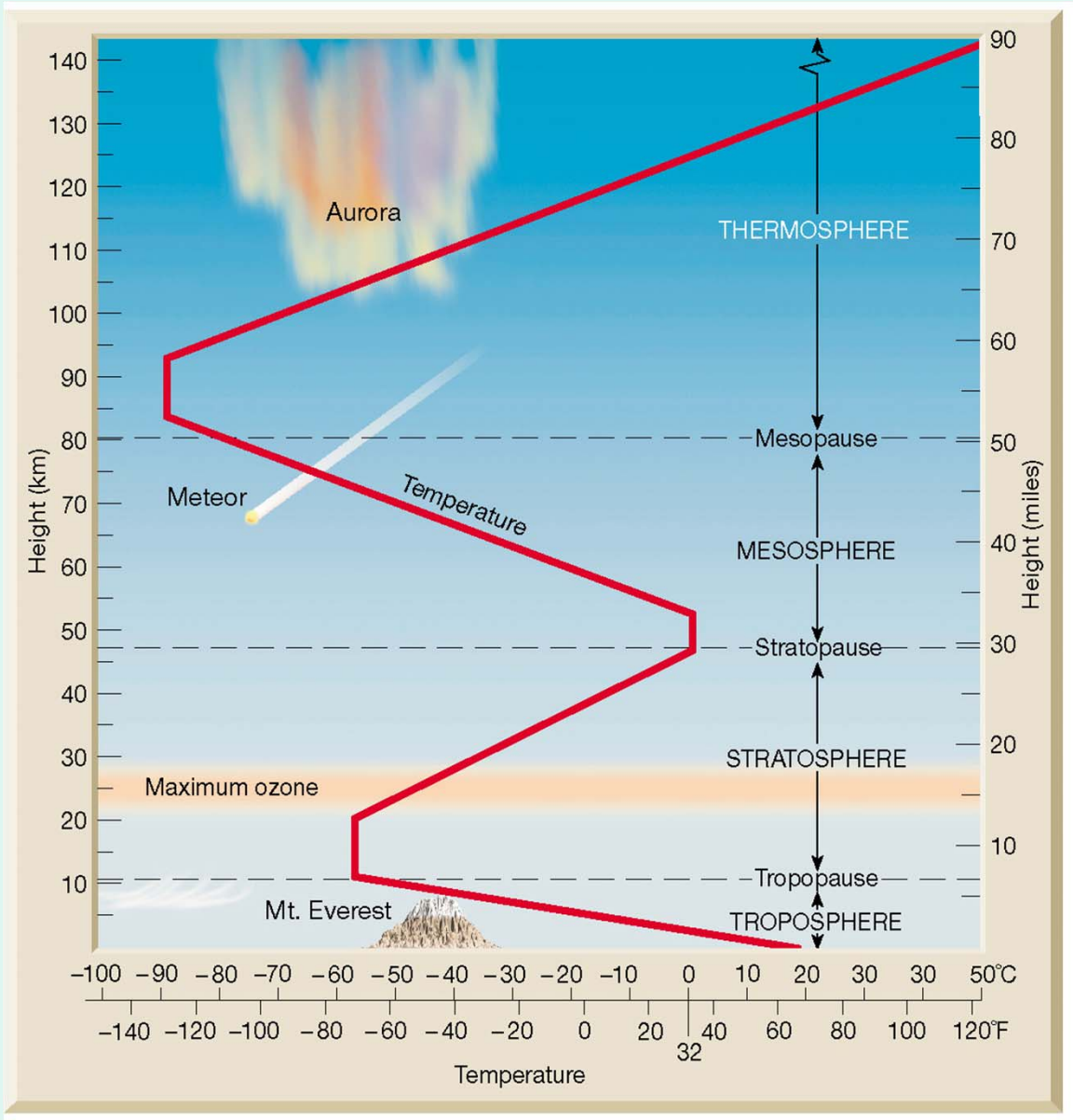


Thermal Structure of the Atmosphere

Atmospheric layers based on Temperature

- ***Troposphere***
  - **Bottom layer**
  - **Temperature decreases with altitude—Called the *environmental lapse rate***
    - **6.5˚C per kilometer (average)**
    - **3.5˚F per 1000 feet (average)**
  - **Thickness varies—Average height is about 12 km**
  - **Outer boundary is named the *tropopause***

Thermal Structure of the Atmosphere



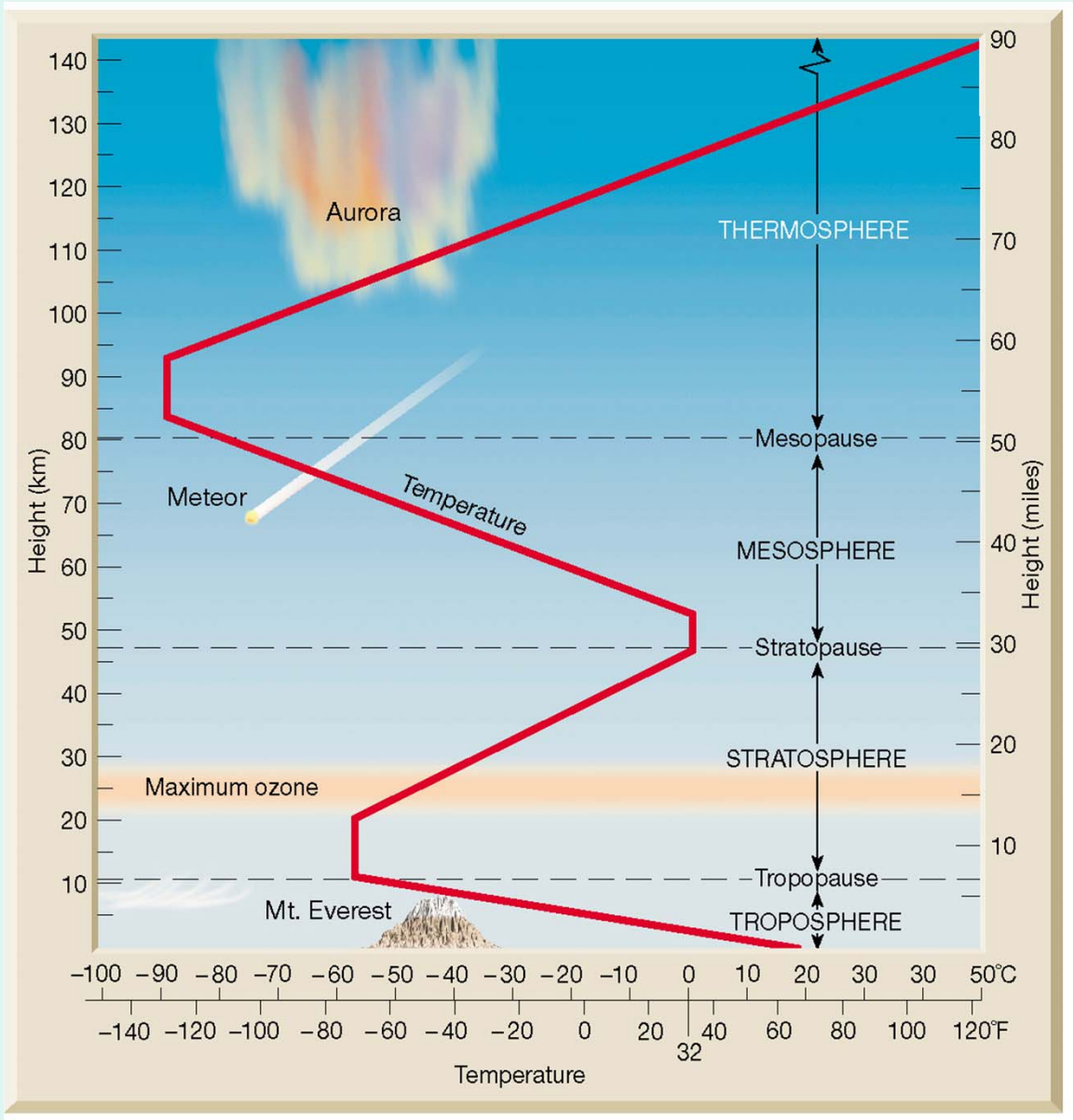
Structure of the Atmosphere

Atmospheric layers based on temperature

- ***Stratosphere***
  - **About 12 km to 50 km**
  - **Temperature increases at top (>20 km)**
  - **Contains most of the atmosphere's ozone**
  - **Outer boundary is named the *stratopause***
  - **>99% of earth atmosphere is below stratopause**

Cruising Altitude

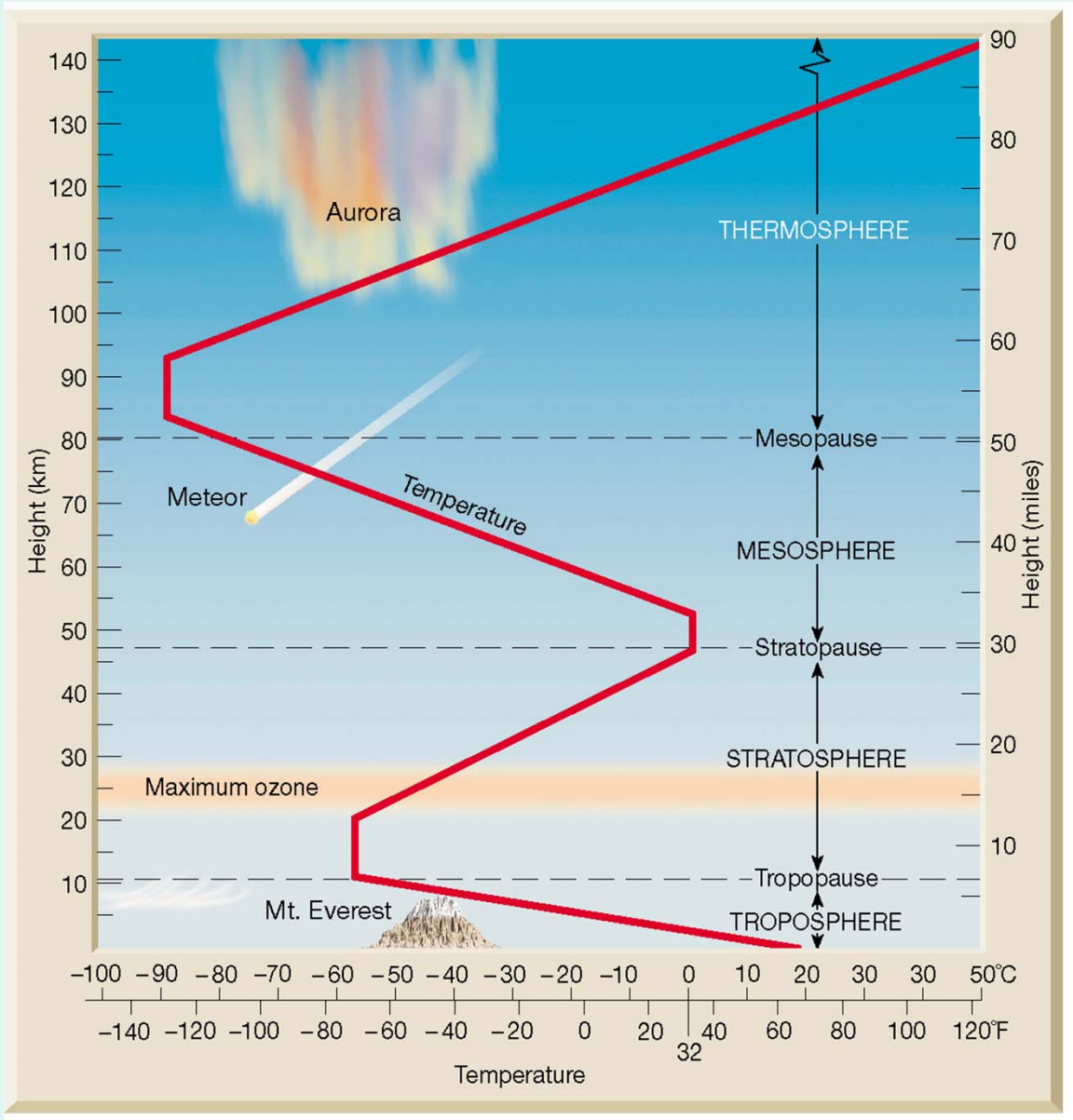
Thermal Structure of the Atmosphere



Structure of the Atmosphere

- **Atmospheric layers based on temperature**
  - ***Mesosphere***
    - **About 50 km to 80 km**
    - **Temperature decreases – coldest portion of atmosphere**
    - **Outer boundary is named the *mesopause***
    - **Contains ionosphere- a region of particles charged by the suns energy**

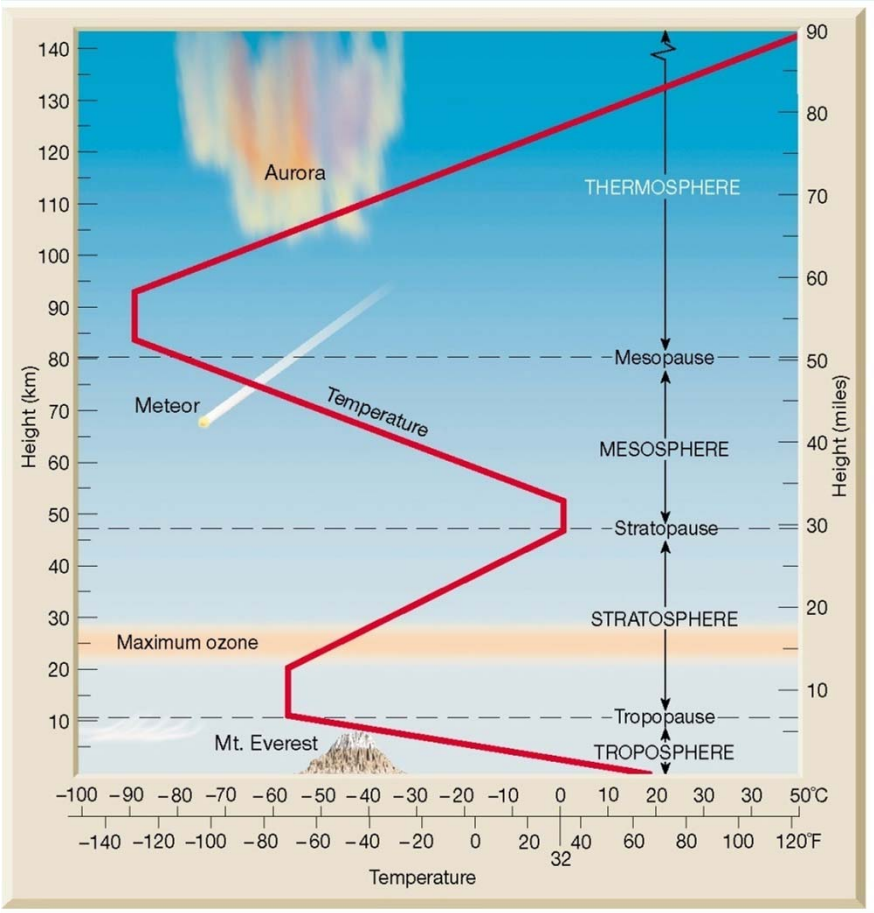
Thermal Structure of the Atmosphere



Structure of the Atmosphere

- **Atmospheric layers based on temperature**
  - ***Thermosphere***
    - **No well-defined upper limit**
    - **Fraction of atmosphere's mass**
    - **Gases moving at high speeds**

Composition of the Atmosphere



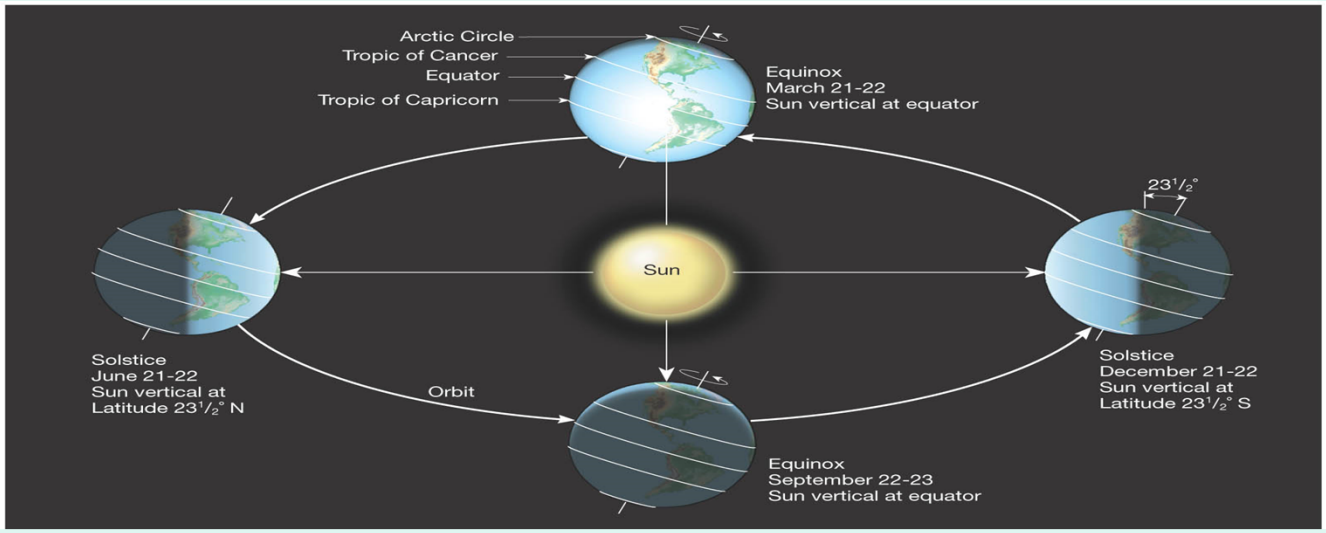
Homosphere – composition of air is well mixed (<80 km)

Heterosphere – composition of air is segregated >80 km)

Earth–Sun Relations

Earth motions

- ***Rotates*** **on its axis – 23½**
- ***Revolves*** **around the Sun every 365¼ days**
- **The earths orbit is elliptical – the erath is 147 million km from the sun on January 3 and 152 million kms on July 4**
- **Average 150km from earth**

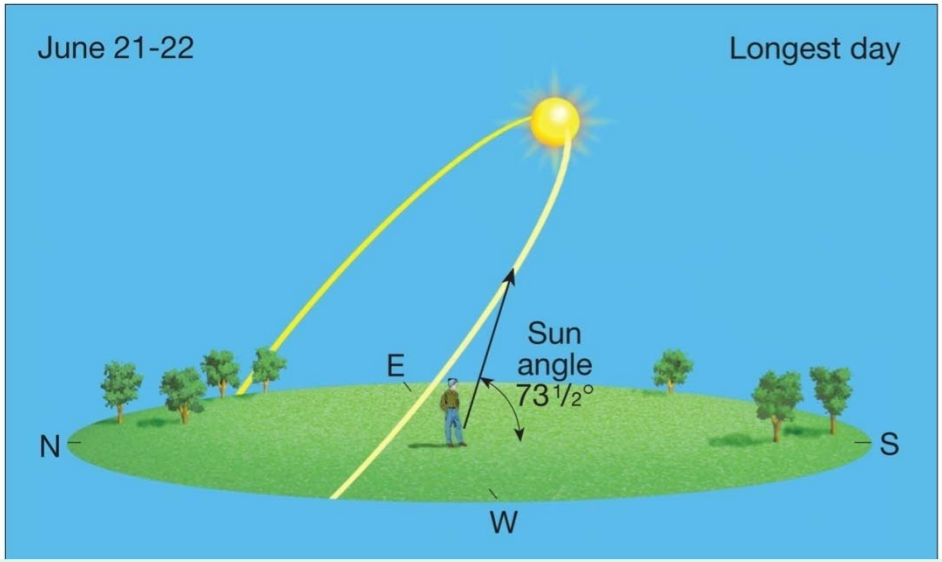


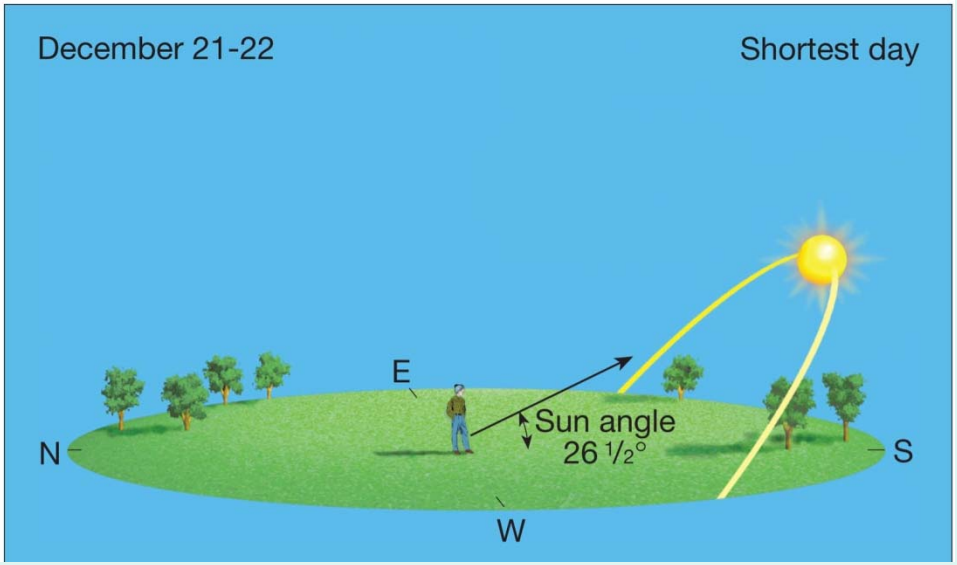
Earth–Sun Relations

Seasons are a result of :

1) **Changing Sun angle**

2) **Changing length of daylight**

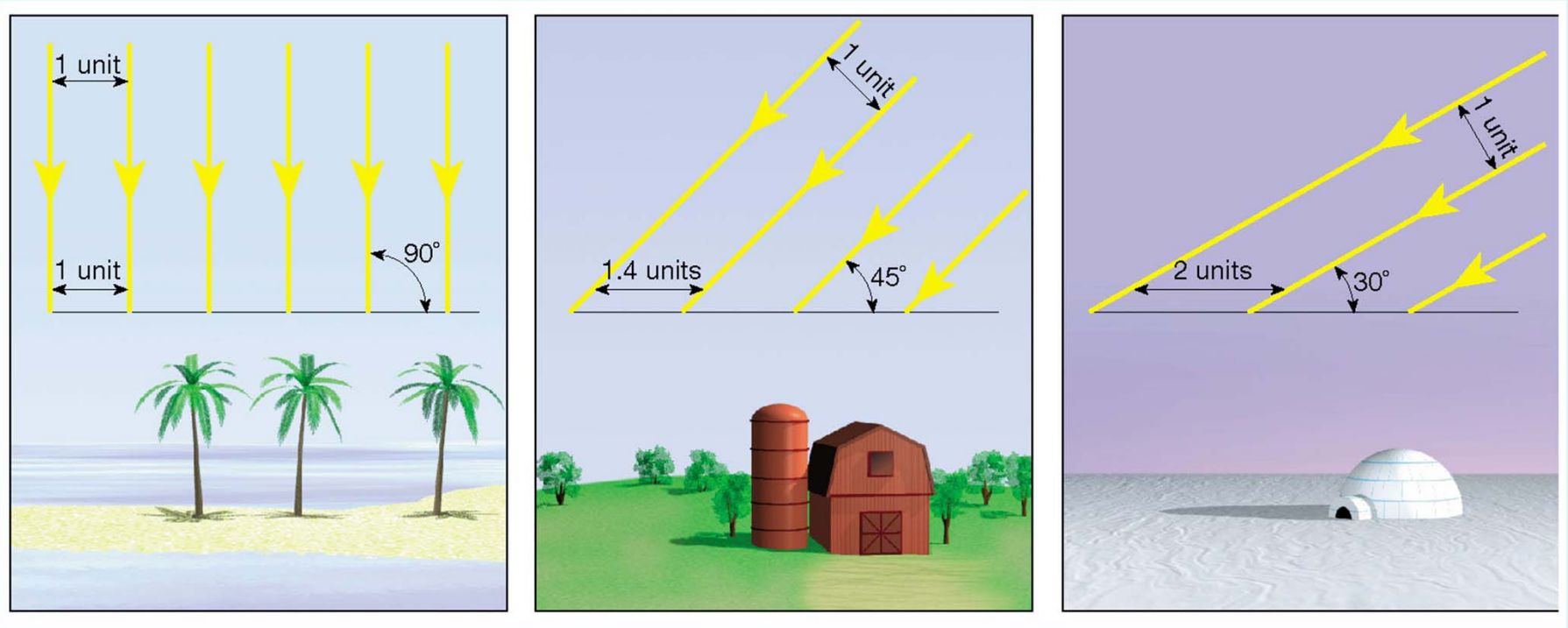




June 21

December 21

Relationship of Sun Angle and Intensity of Solar Radiation

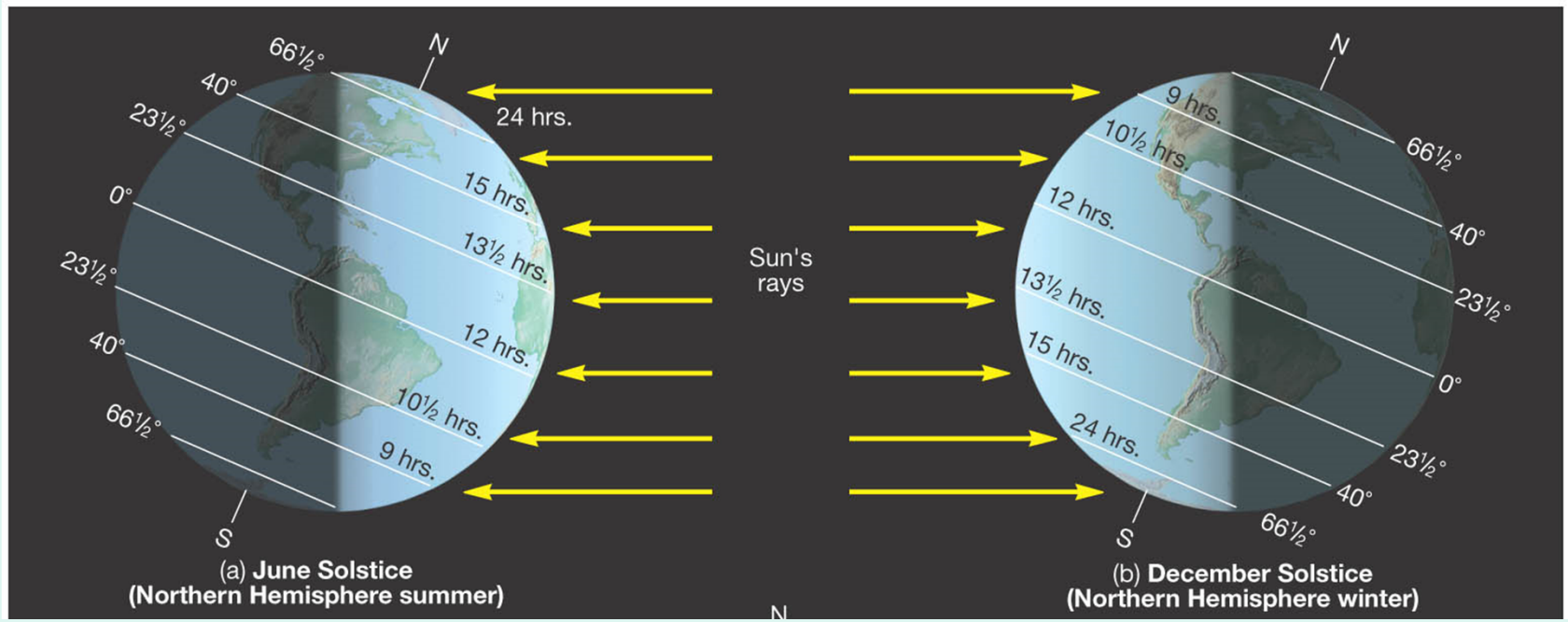


Earth–Sun Relations

Seasons are a result of :

1) Changing Sun angle

2) Changing length of daylight



June 21

December 21

Earth–Sun Relations

Seasons

- Caused by Earth's changing orientation to the Sun
  - Axis is inclined 23½°
  - Axis is always pointed in the same direction
- Special days (Northern Hemisphere)
  - Summer solstice
    - June 21–22
    - Sun's vertical rays are located at the *tropic of Cancer* (23½° N latitude)

Earth–Sun relations

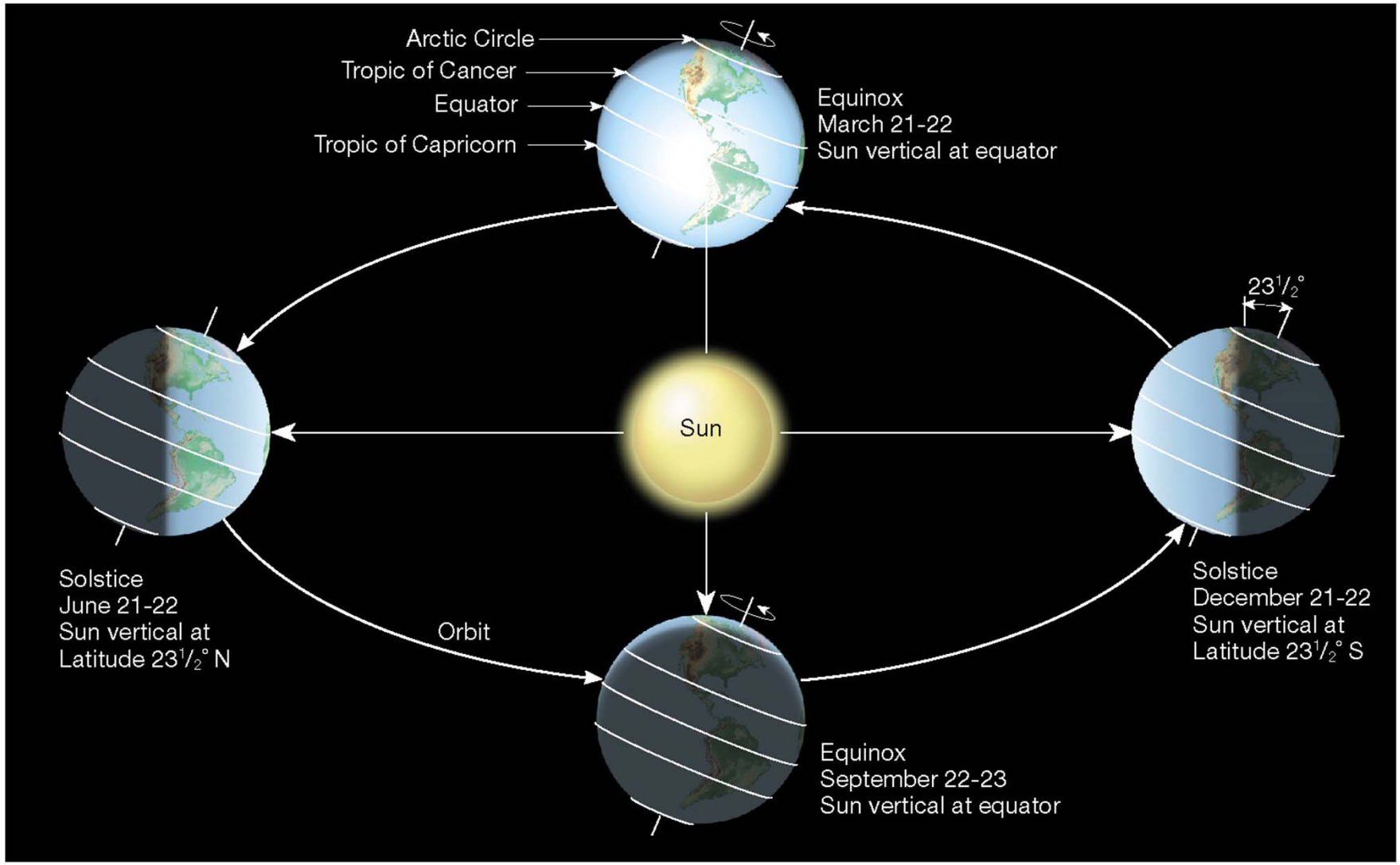
Seasons

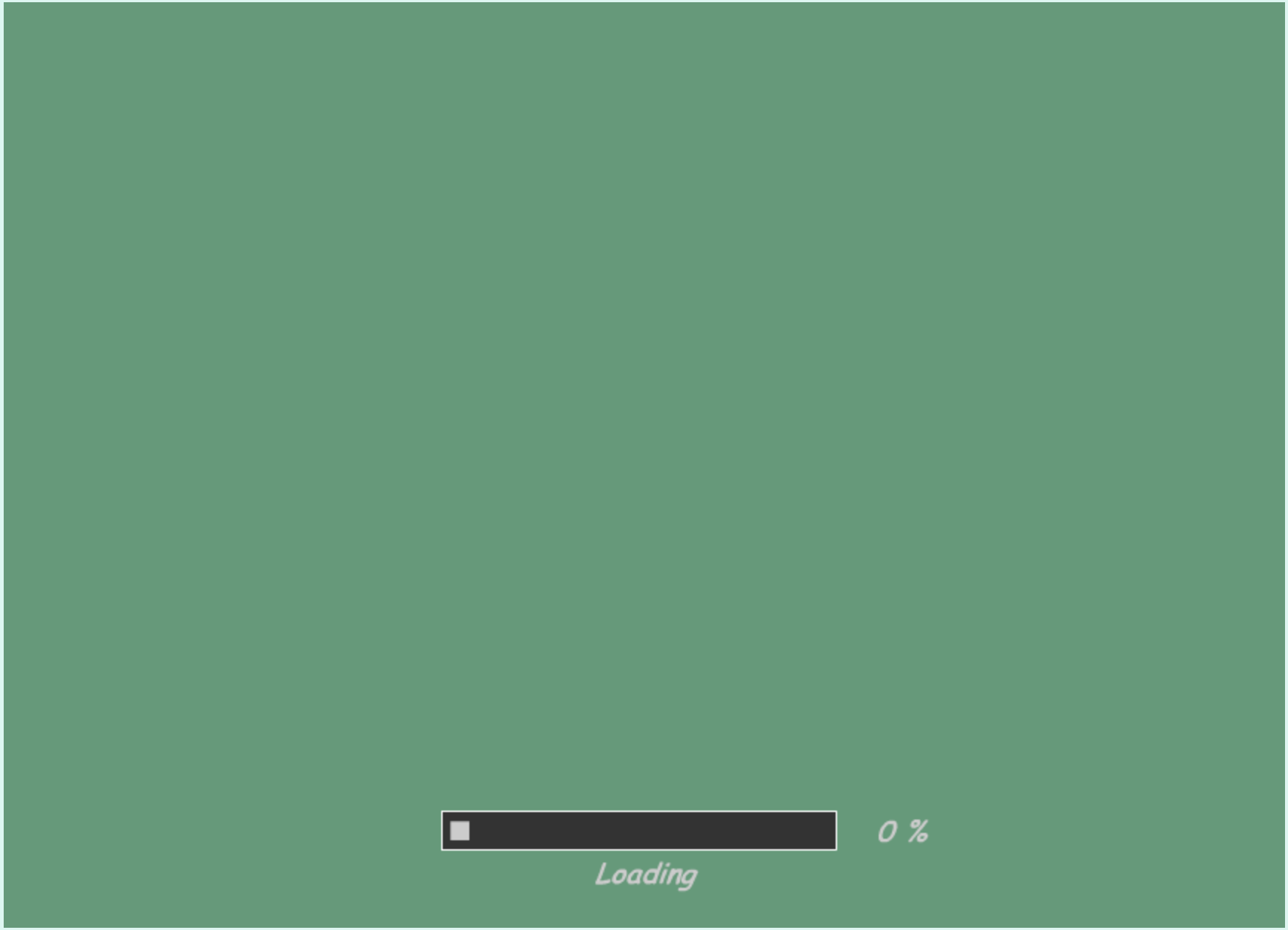
- **Special days (Northern Hemisphere)**
  - **Winter solstice**
    - **December 21–22**
    - **Sun's vertical rays are located at the tropic of Capricorn (23½° S latitude)**
  - **Autumnal equinox**
    - **September 22–23**
    - **Sun's vertical rays are located at the *equator* (0° latitude)**

Earth–Sun relations

- **Seasons**
  - **Special days (Northern Hemisphere)**
    - **Spring equinox**
      - **March 21–22**
      - **Sun's vertical rays are located at the *equator* (0° latitude)**

Earth–Sun Relationships

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Atmospheric Heating

The Second Law of Thermodynamics states that:

Heat is always transferred from warmer to cooler objects

Atmospheric Heating

Mechanisms of heat transfer

Conduction **through molecular activity**

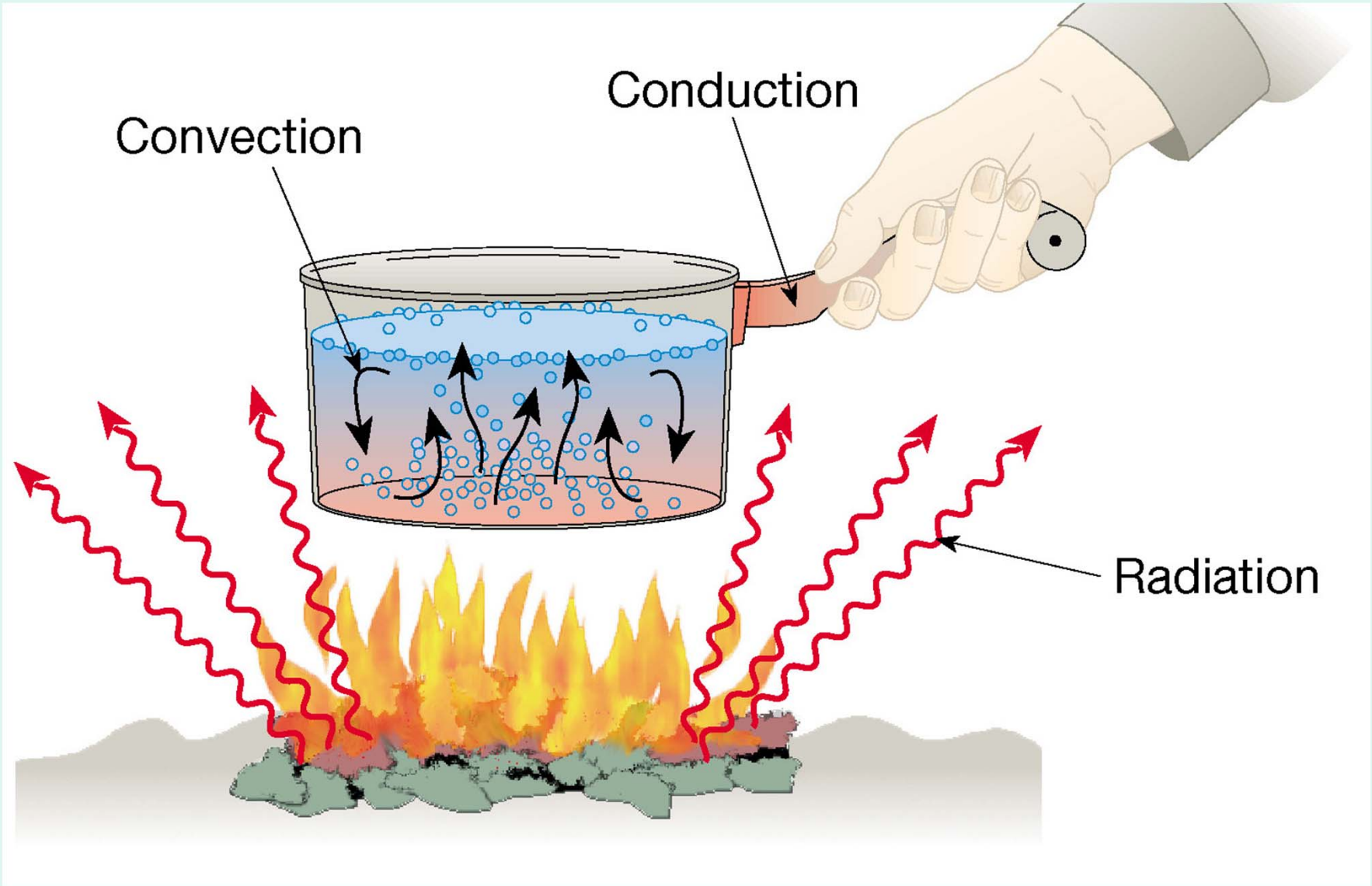
Convection

- **Mass movement within a substance**

Radiation ***(electromagnetic radiation)***

- **Needs no material to transfer heat**
- **Velocity: 300,000 kilometers (186,000 miles) per second in a vacuum**

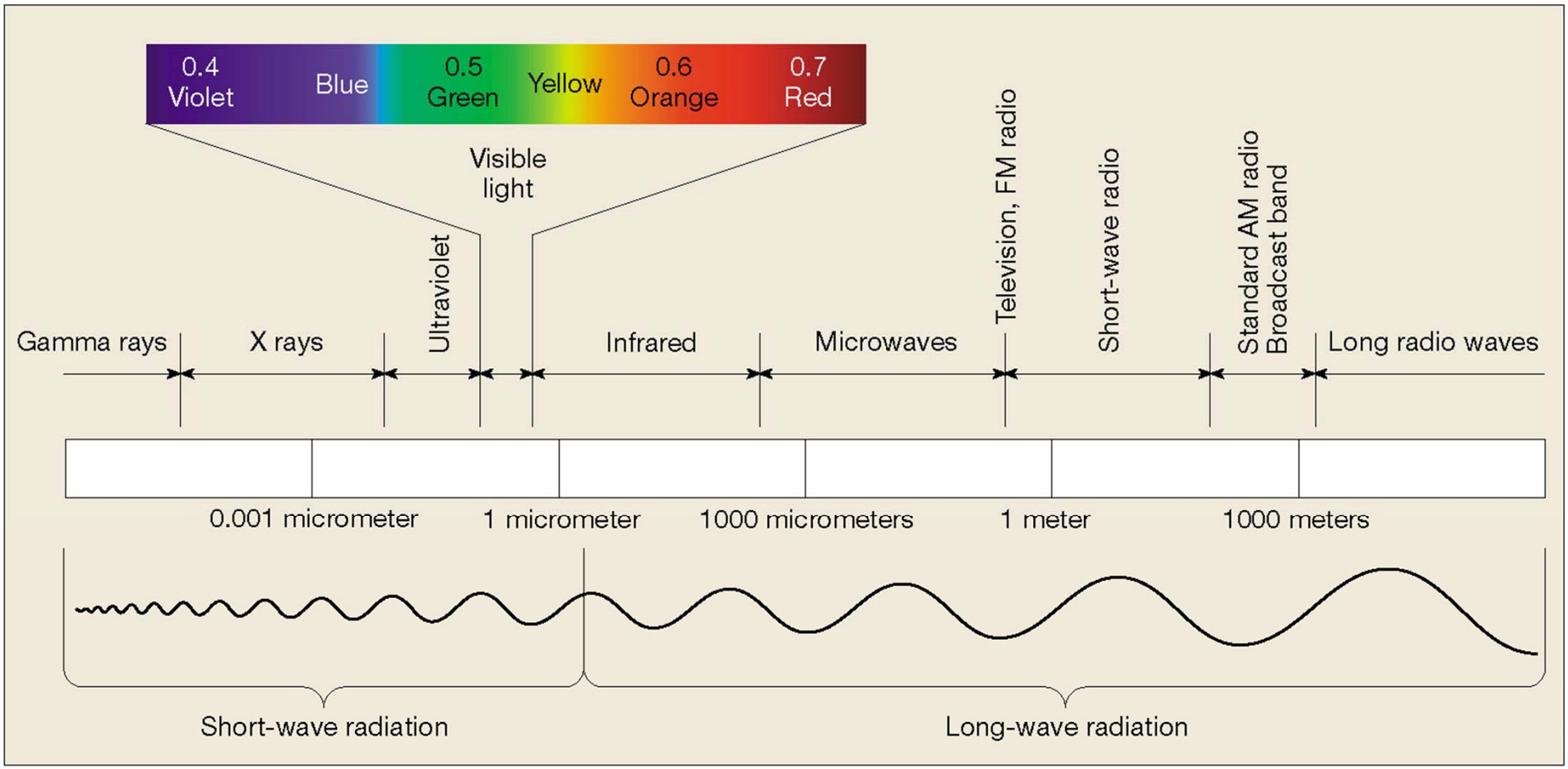
Mechanisms of Heat Transfer



Atmospheric Heating

- **Mechanisms of heat transfer**
  - **Radiation (electromagnetic radiation)**
    - **Consists of different wavelengths**
      - ***Gamma* (very short waves)**
      - ***X-rays***
      - **Ultraviolet (UV)**
      - ***Visible***
      - ***Infrared***
      - ***Microwaves and radio waves***

The Electromagnetic Spectrum



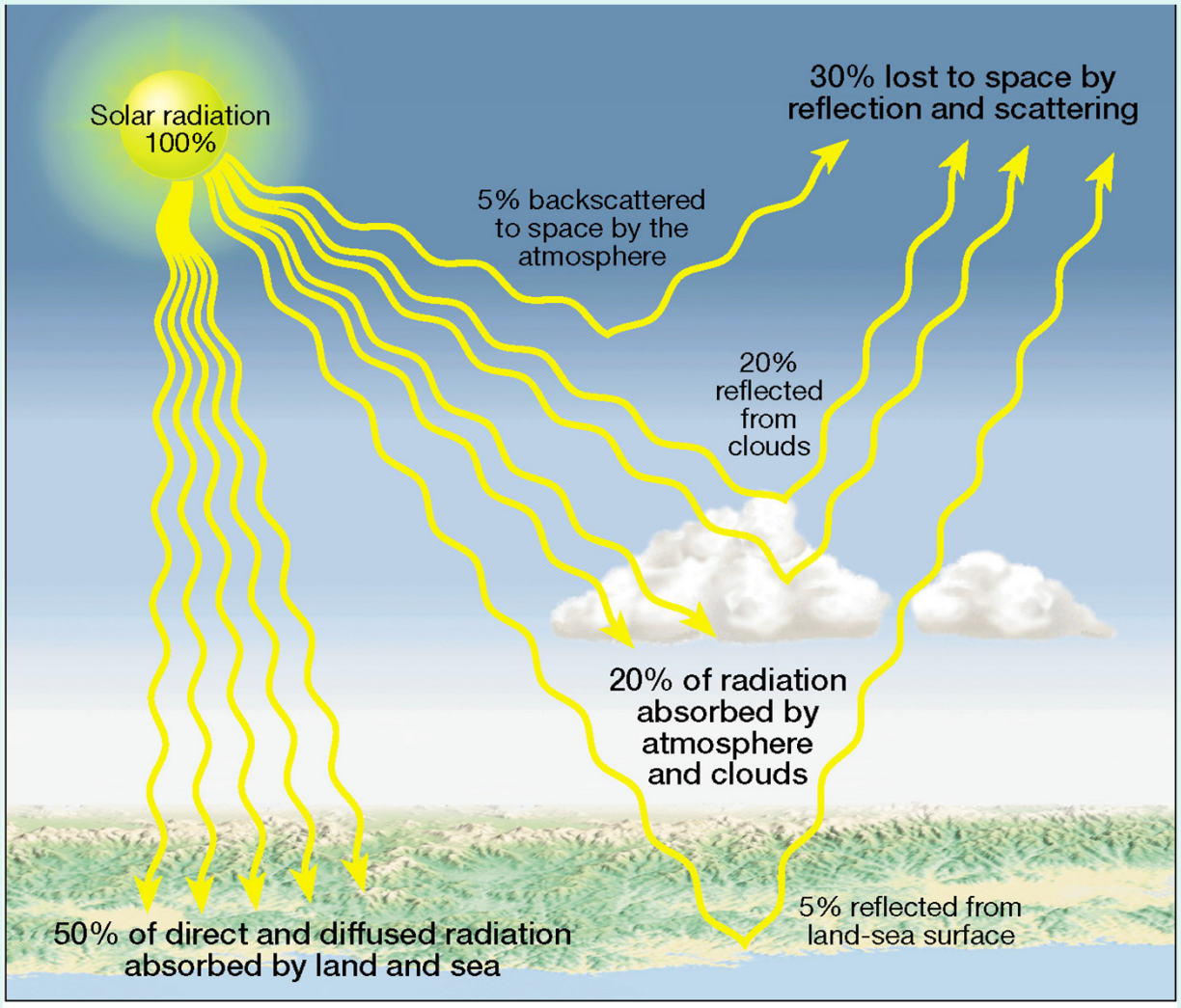
Atmospheric Heating

- **Mechanisms of heat transfer**
  - ***Radiation (electromagnetic radiation)***
    - **Governed by basic laws**
      - **Hotter objects radiate more total energy per unit area than do cooler objects**
      - **The hotter the radiating body, the shorter the wavelength of maximum radiation**
      - **Objects that are good absorbers of radiation are good emitters as well**

Atmospheric Heating

- **Incoming solar radiation**
  - **Atmosphere is largely transparent to incoming solar radiation**
  - **Most visible radiation reaches the surface**
  - **About 50% absorbed at Earth's surface**

Average Distribution of Incoming Solar Radiation

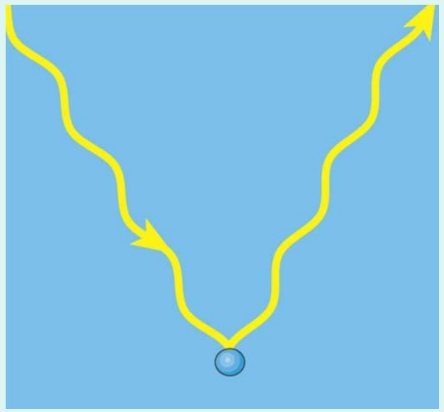


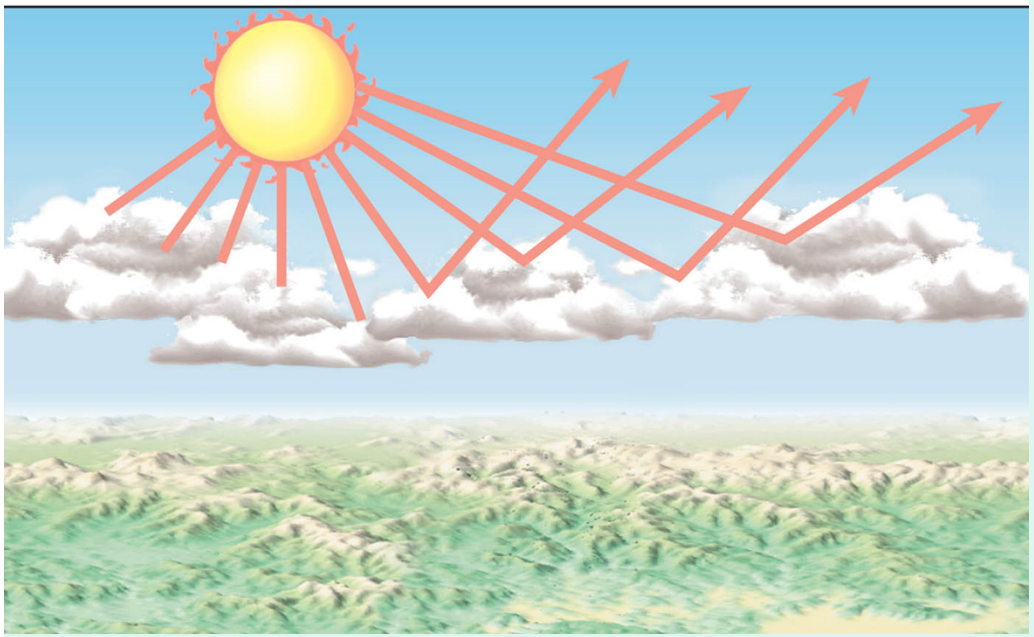
Atmospheric Heating

- **Atmospheric effects**
  - ***Reflection—Albedo*** **(percent reflected)**
  - ***Scattering***
  - ***Absorption***

Atmospheric Heating

Reflection—Albedo (percent reflected)

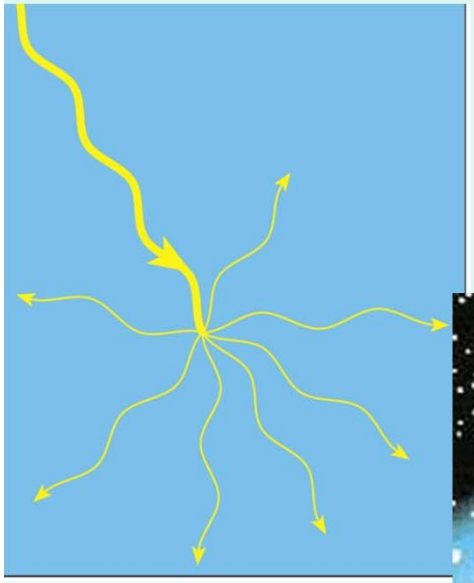


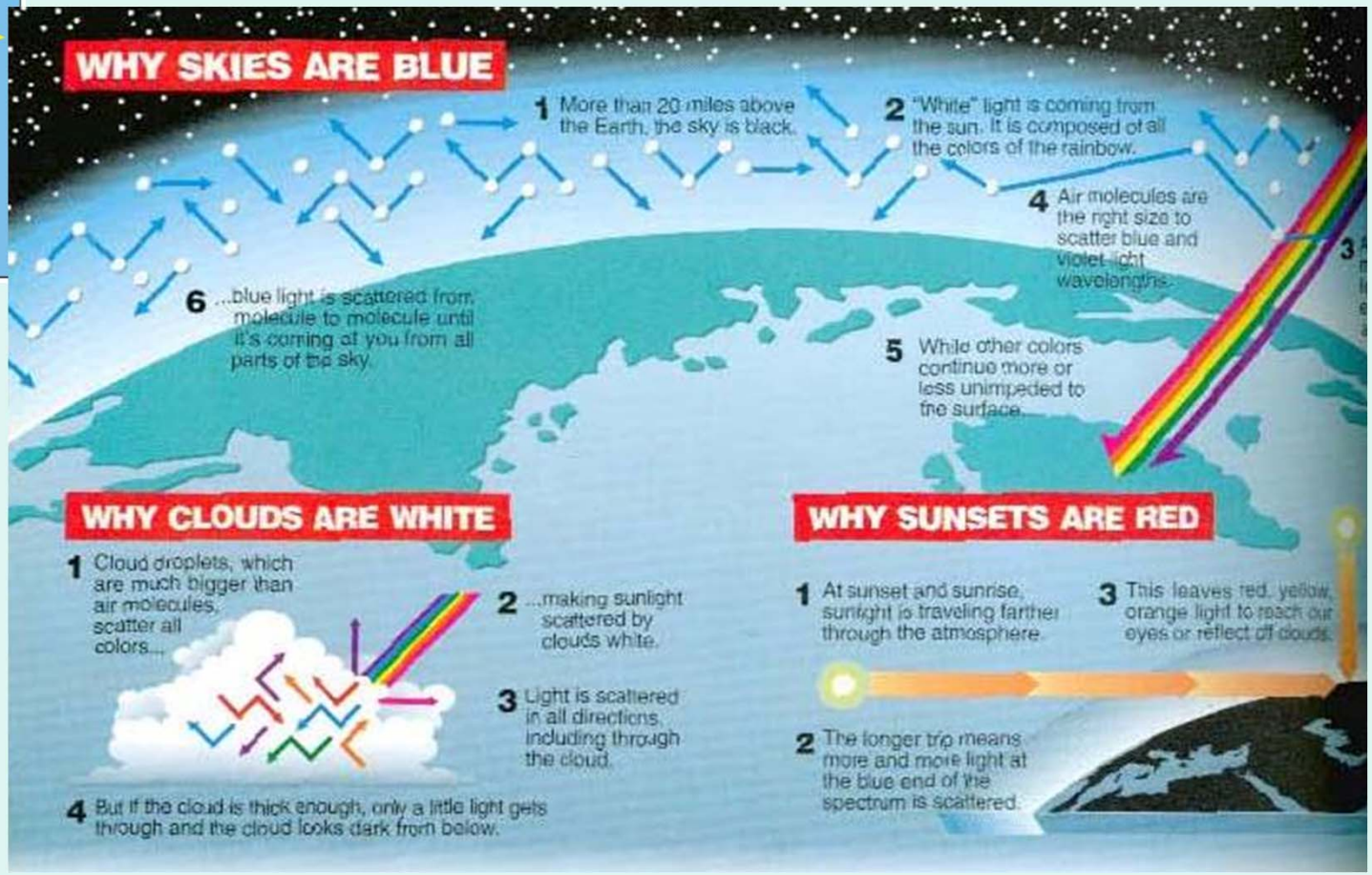


Clouds, stratus	
<150 meters thick	25–63
150–300 meters thick	45–75
300–600 meters thick	59–84
Average of all types and thickness	50–55
Concrete	17–27
Crops, green	5–25
Forest, green	5–10
Meadows, green	5–25
Ploughed field, moist	14–17
Road, blacktop	5–10
Sand, white	30–60
Snow, fresh-fallen	80–90
Snow, old	45–70
Soil, dark	5–15
Soil, light (or desert)	25–30
Water	8*

Atmospheric Heating

Scattering

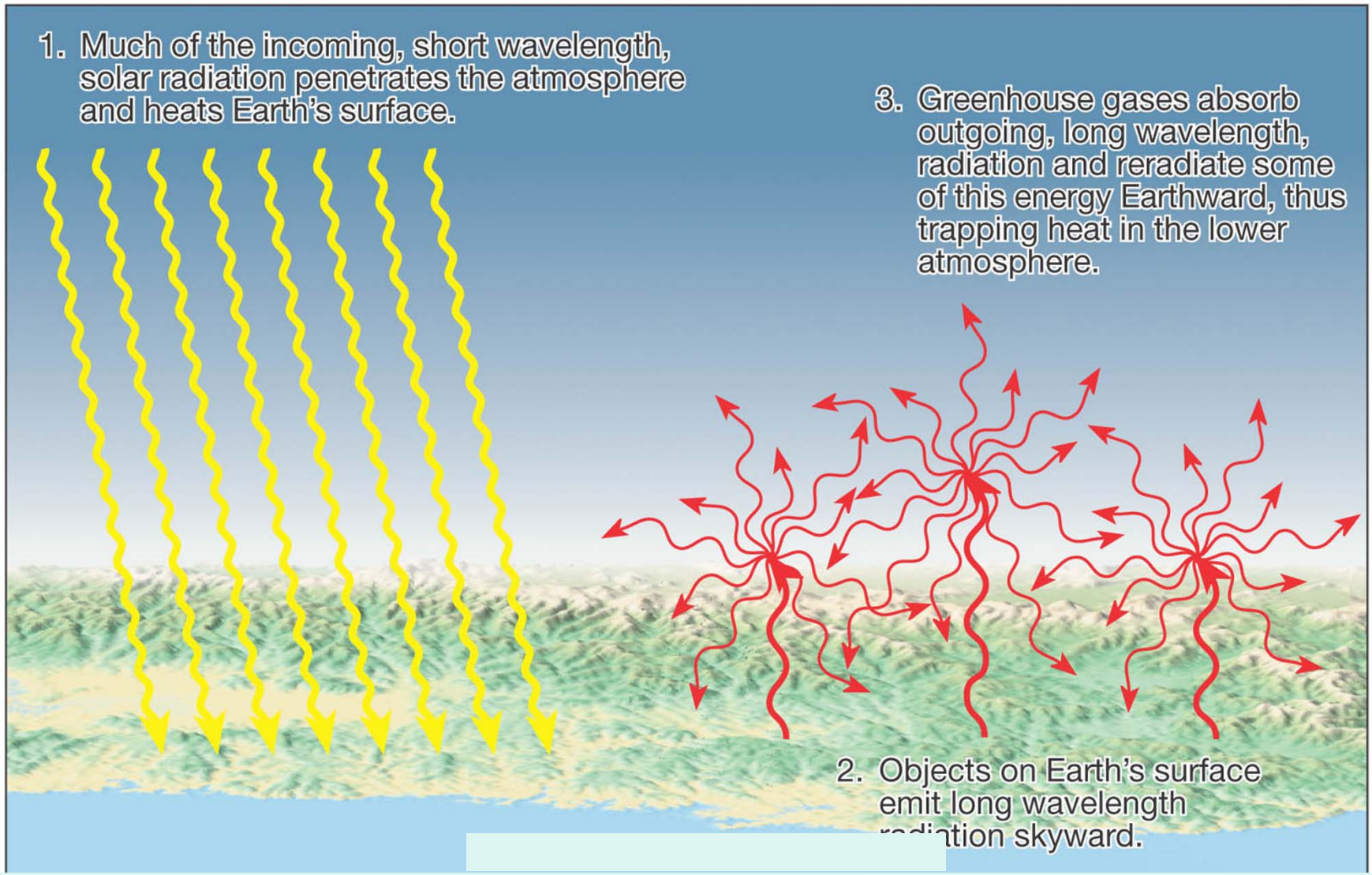




Atmospheric Heating

- **Radiation from Earth's surface**
  - **Earth re-radiates radiation *(terrestrial radiation)* at the longer wavelengths**
  - **Longer wavelength terrestrial radiation is absorbed by**
    - **Carbon dioxide and water vapor**
    - **Lower atmosphere is heated from Earth's surface**
  - **Heating of the atmosphere is termed the *greenhouse effect***

Heating of the Atmosphere

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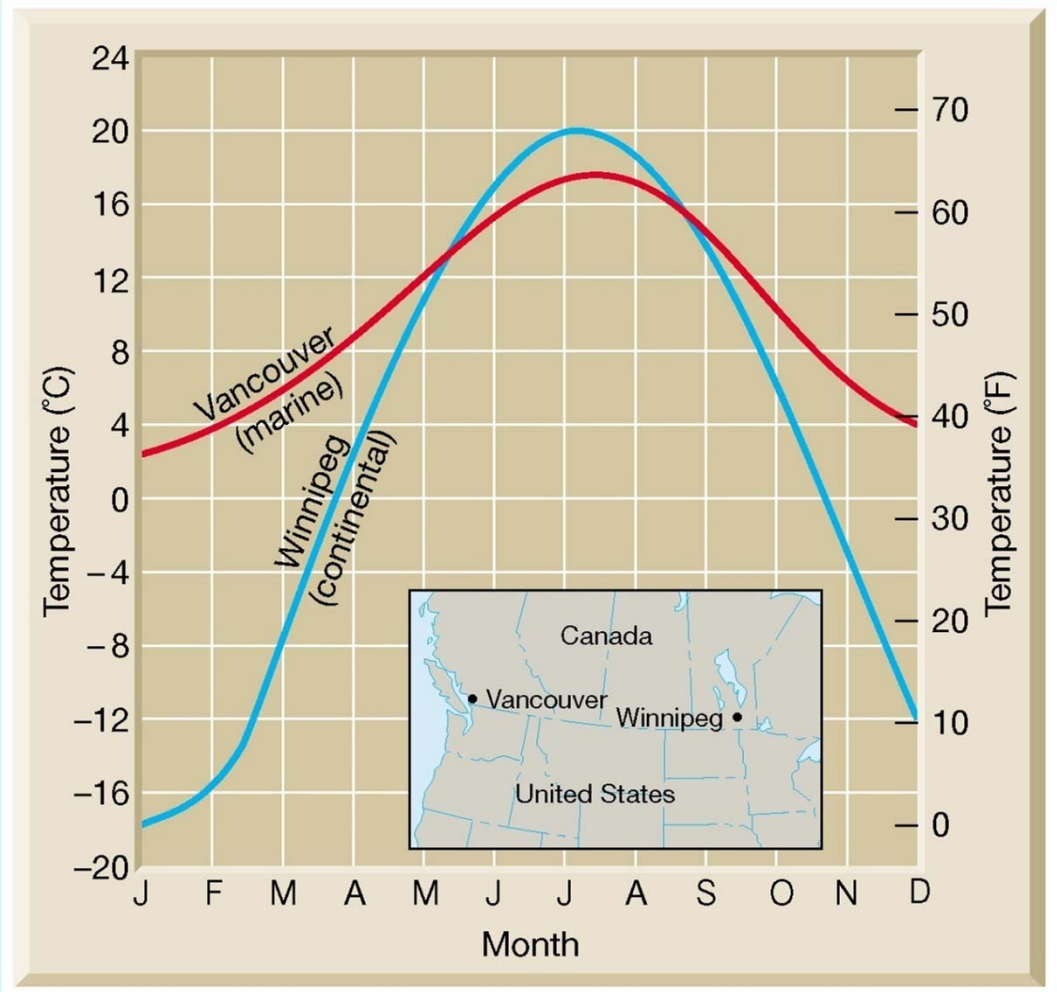
Controls of Global Temperatures

- Temperature variations
- Receipt of solar radiation is the most important control
- Other important controls
  - Differential heating of land and water
    - Land heats more rapidly than water
    - Land gets hotter than water
    - Land cools faster than water
    - Land gets cooler than water

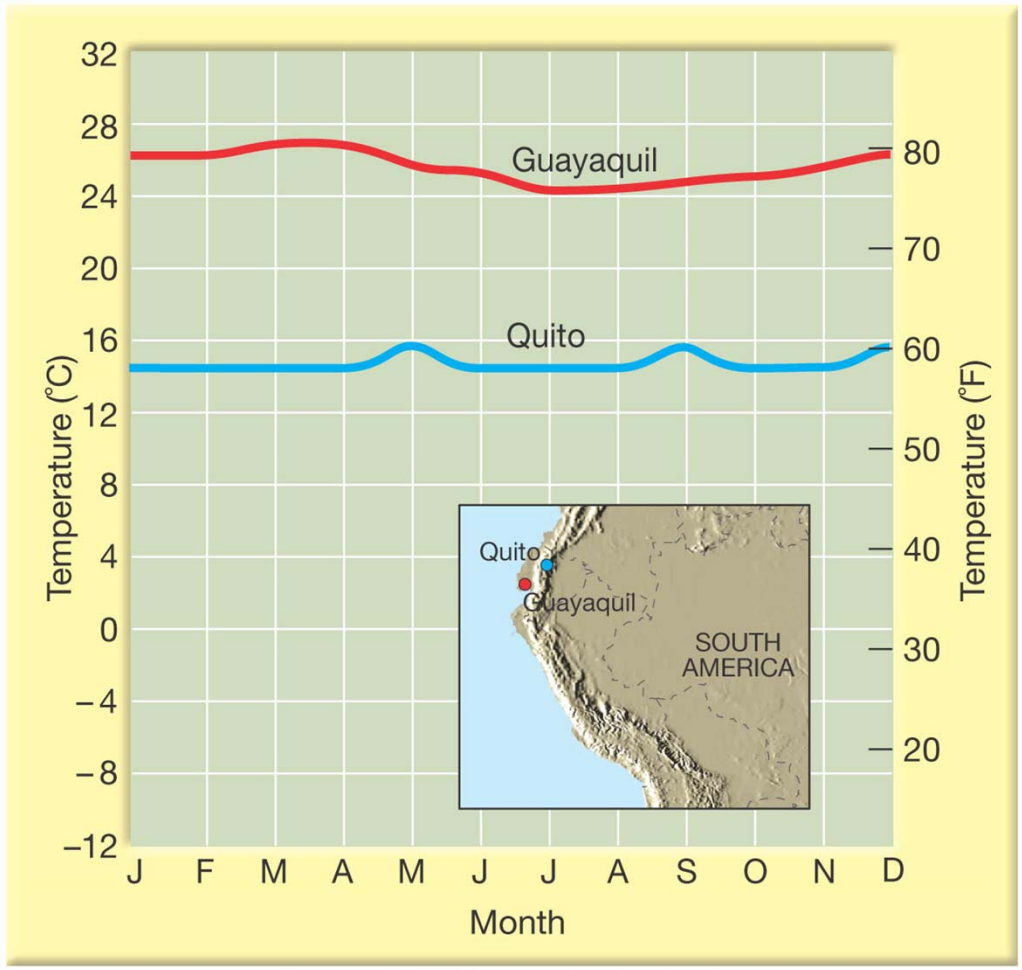
Controls of Temperature

- **Other important controls**
  - **Altitude**
  - **Geographic position**
  - **Cloud cover**
  - **Albedo**

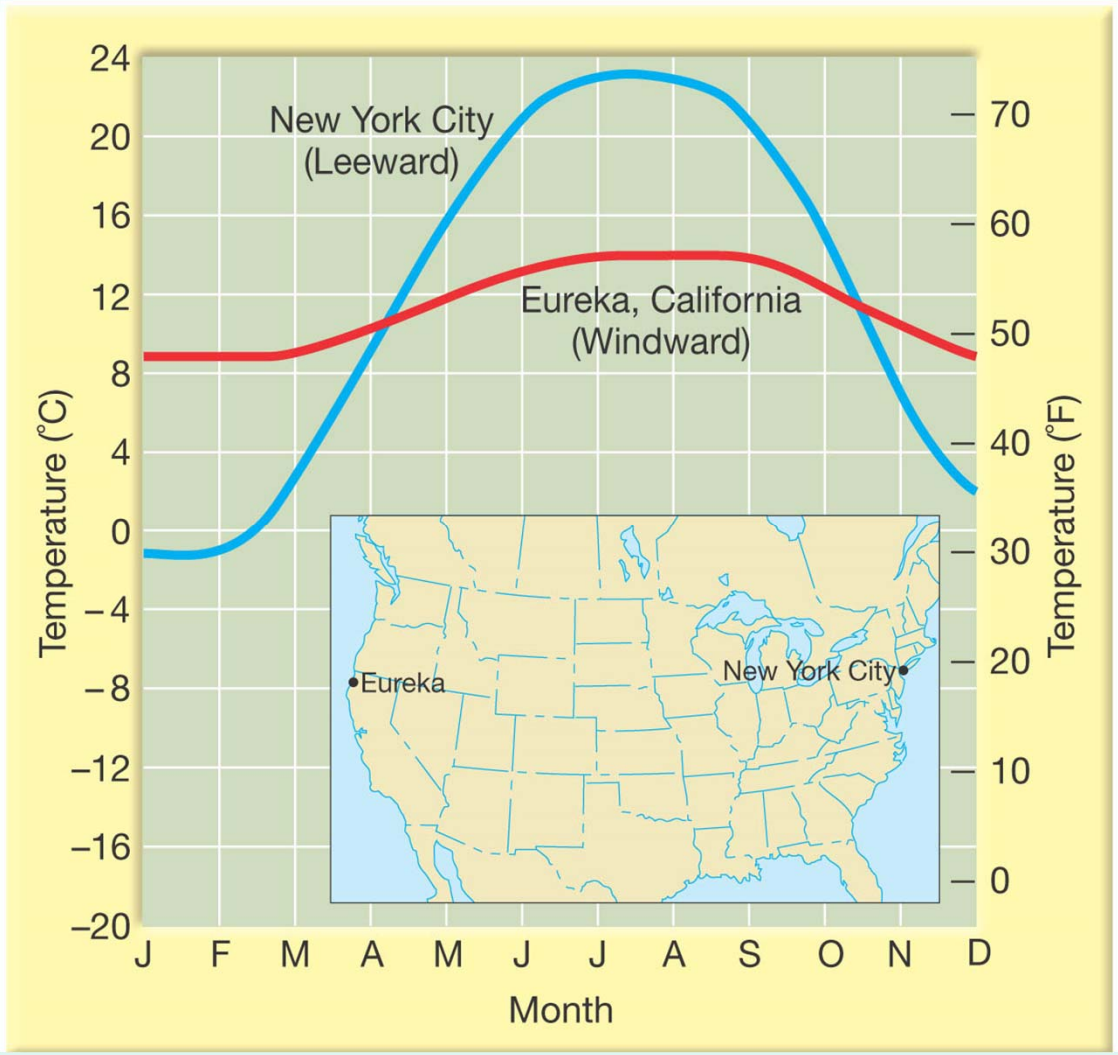
Maritime Influence on Temperature

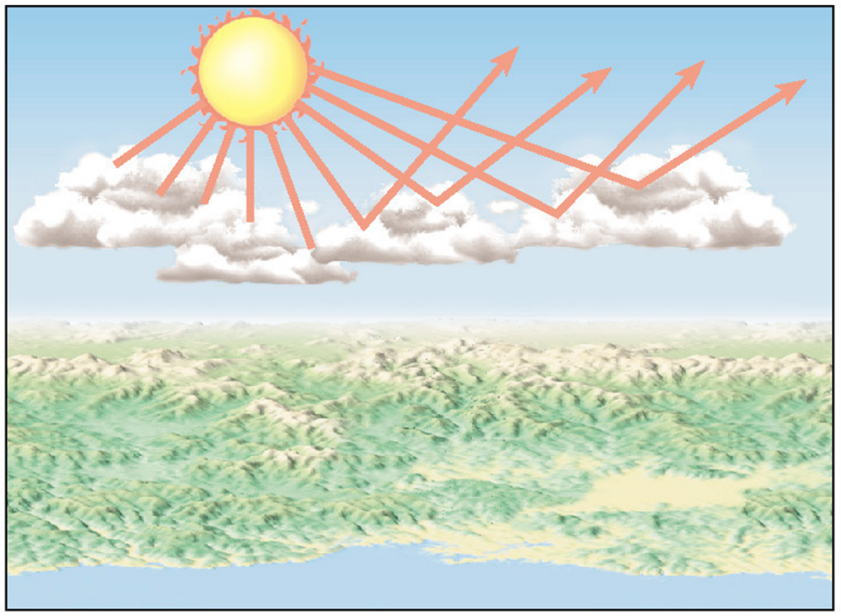


Altitude Influence on Temperature

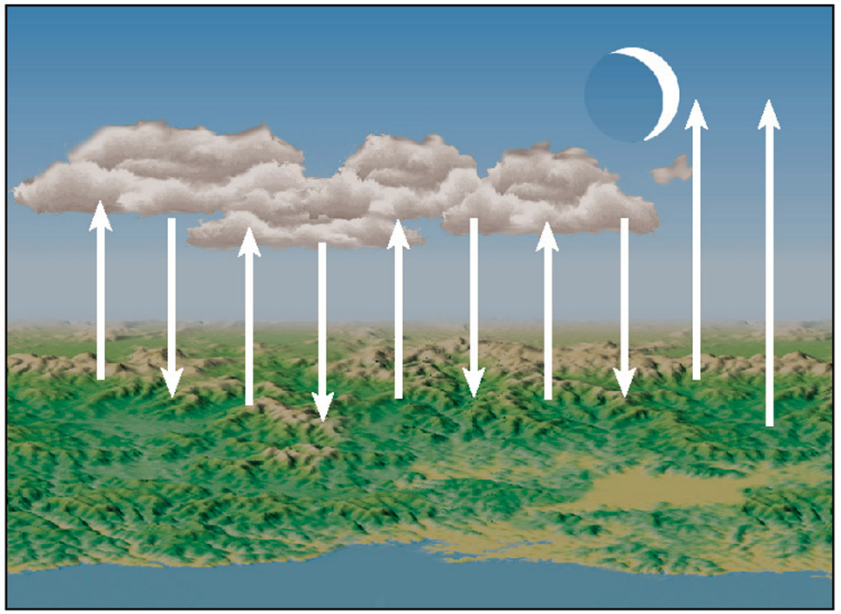


Geographic Influence on Temperature





A.



B.

Clouds Reduce the Daily Temperature Range

End of Chapter 11