Physical Geography

GEOGRAPHY 1710

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Chapter 2

Solar Energy to Earth and the Seasons

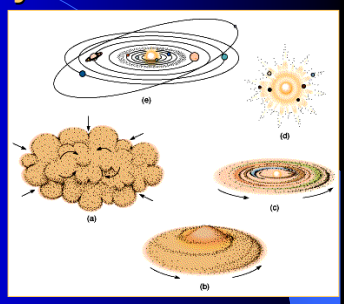
Solar System Formation and Structure

- Gravity
  - Mutual attracting force exerted by mass on all other objects
- Planetesimal hypothesis
  - Chamberlin and Moulton postulate that the materials now composing the Sun, planets, and satellites, at one time existed as a spiral nebula, or as a great spiral swarm of discrete particles, each particle in elliptic motion about the central nucleus.

http://www.worldwideschool.org/library/books/sci/astronomy/TheEvolutionOfTheStarsAndTheFormationOfTheEarth/chap2.html

The Origin of the Solar System

- Condensation and collapse of interstellar material
- Flattening and rotation of cloud
- Accretion of planetesimals
- Birth of Sun



Dimensions and distances

- Speed of light
  - 299,792 kmps (186,282 mps)
    - speed of sound at sea level = 340.29 mps
  - Universe is 12 billion light-years across
    - It is the distance that light can travel in one year.
    - One light-year is equal to 9,500,000,000,000 kilometers.
  - Milky Way Galaxy 100,000 ly across
  - Our Solar System 11 light-hours across
  - Moon is 1.28 light-seconds away

Milky Way Galaxy

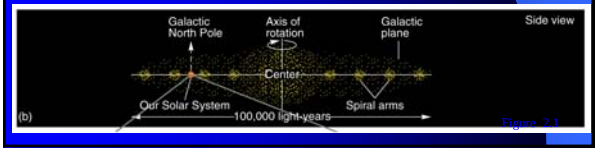


Figure 21

Dimensions and distances

- Earth's orbit
  - Average distance from Earth to the Sun is 150,000,000 km (93,000,000 mi)
  - Perihelion – closest at January 3
    - 147,255,000 km (91,500,000 mi)
  - Aphelion – farthest at July 4
    - 152,083,000 km (94,500,000 mi)
  - Earth is 8 minutes 20 seconds from the Sun
  - Plane of Earth's orbit is the plane of the ecliptic

Our Solar System

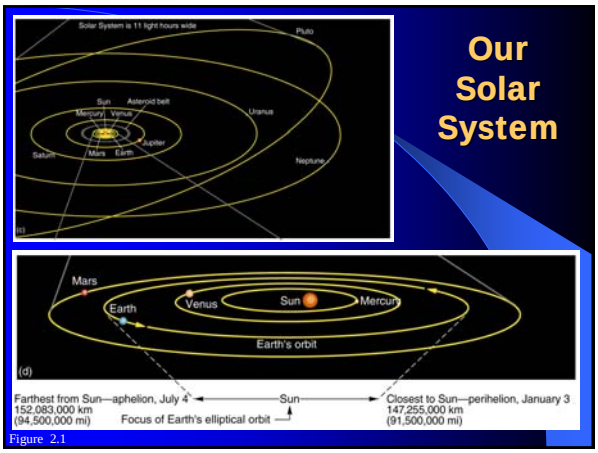
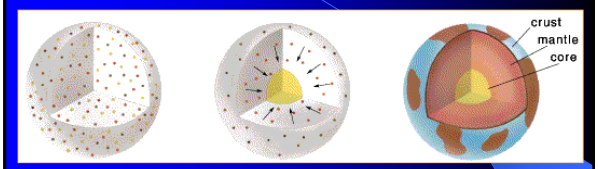


Figure 2.1

The Differentiation of Early Earth



Perhaps the most significant event in Earth history, the 'settling' of material according to density resulted in a layered Earth. This concentric arrangement of material led to the formation of continents, oceans, and the atmosphere.

The Electromagnetic Spectrum

- Sun radiates short-wave energy
- Shorter wavelengths have higher energy
- Earth radiates long-wave energy

The Electromagnetic Spectrum

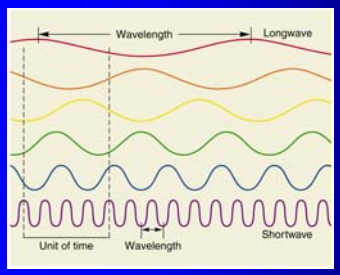


Figure 2.5

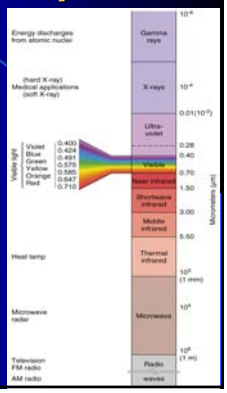


Figure 2.6

Earth's Energy Budget

Figure 2.8

Distribution of Insolation

- Insolation-Direct or diffused shortwave solar radiation that is received in the Earth's atmosphere or at its surface.
- Tropics receive more concentrated insolation due to the Earth's curvature
- Tropics receive 2.5X more than poles

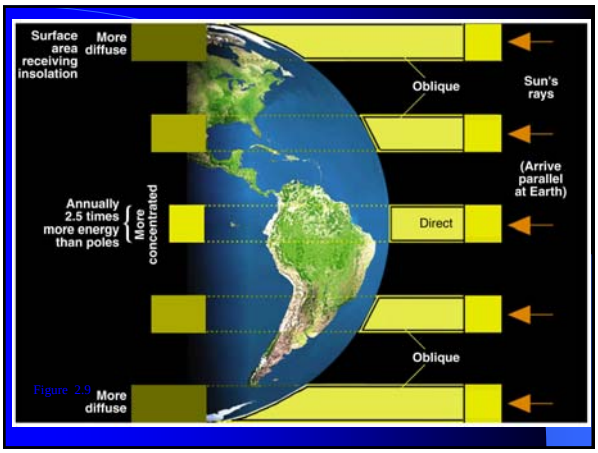


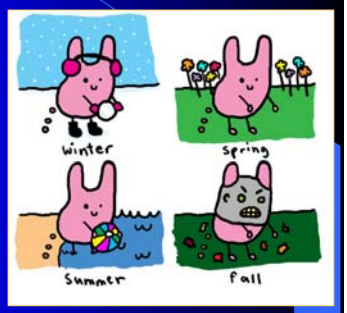
Figure 2.9

Seasonality

- Seasonal changes
  - Sun's altitude – angle above horizon
  - Declination – Location (latitude) on the Earth where the location of the sun on a particular day is directly overhead at solar noon. This location is somewhere between 23.5° North and 23.5° South depending on the time of the year.
  - Daylength

Reasons for Seasons

- Revolution
- Rotation
- Tilt of Earth's axis
- Axial parallelism
- Sphericity



http://www.nataliedee.com/

Reasons for Seasons

- Revolution
  - Earth revolves around the Sun
  - Voyage takes one year
  - Earth's speed is 107,280 kmph (66,660 mph)
- Rotation
  - Earth rotates on its axis once every 24 hours
  - Rotational velocity at equator is 1674 kmph (1041 mph)

Revolution and Rotation

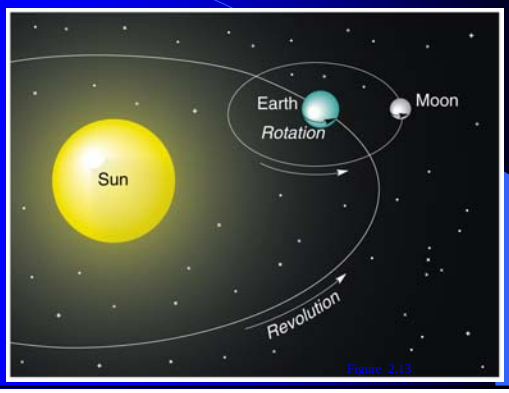
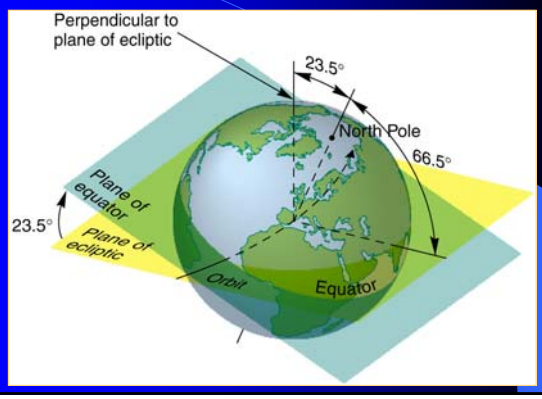


Figure 2.13

Reasons for Seasons

- Tilt of Earth's axis
  - Axis is tilted 23.5° from plane of ecliptic
- Axial parallelism - refers to the fact that the axis of the earth remains parallel to it's previous position as the earth revolves around the sun. This means that the earth's axis always points in the same direction.
  - Axis maintains alignment during orbit around the Sun
  - North pole points toward the North Star (Polaris)
- Sphericity - the roundness of a 3-dimensional object

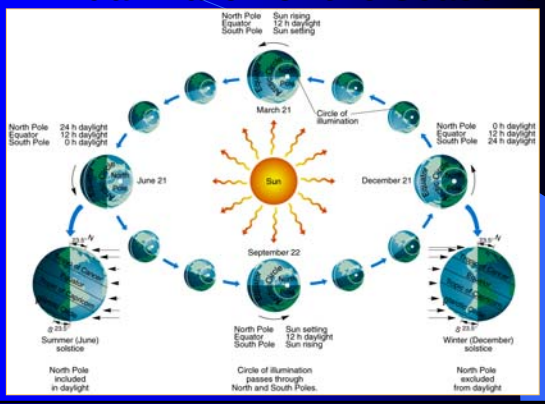
Axial Tilt and Parallelism



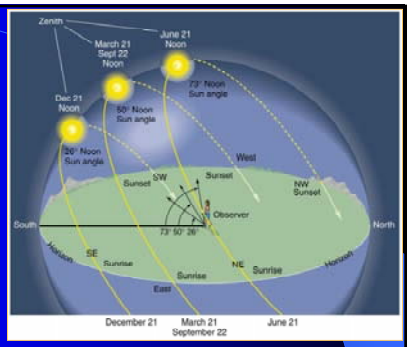
Annual March of the Seasons

- Winter solstice – December 21 or 22
  - Subsolar point Tropic of Capricorn
- Spring equinox – March 20 or 21
  - Subsolar point Equator
- Summer solstice – June 20 or 21
  - Subsolar point Tropic of Cancer
- Fall equinox – September 22 or 23
  - Subsolar point Equator

Annual March of the Seasons



Season Sun Angles



Seasonal observations at 40° N latitude for the December solstice, March equinox, June solstice, and September equinox. The Sun's altitude increases from 26° in December to 73° above the horizon in June—a difference of 47°. Note the changing position of sunrise and sunset along the horizon during the year.