Solar Energy, Seasons and the Atmosphere

- **The Solar System, Sun, and Earth**
- **Solar Energy: From Sun to Earth**
- **The Seasons**
- **Atmospheric Composition, Temperature, and Function**
- **Variable Atmospheric Components**

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**

Solar Energy: From Sun to Earth

- Solar Wind
- Electromagnetic Spectrum of Radiant Energy
- Incoming Energy at the Top of the Atmosphere
  - Solar constant
  - Uneven distribution of insolation
  - Global net radiation

The Electromagnetic Spectrum

- Sun radiates shortwave energy
- Shorter wavelengths have higher energy
- Earth radiates longwave energy

INSOLATION:

SOLAR RADIATION INTERCEPTED BY THE EARTH

REACHES EARTH AT A HORIZONTAL PLANE

DIFFERENCES IN THE ANGLE OF SOLAR RAYS AT EACH LATITUDE RESULT IN AN *UNEVEN* DISTRIBUTION OF INSOLATION AND HEATING

Distribution of Insolation

- Tropics receive more concentrated insolation due to the Earth's curvature
- Tropics receive 2.5x more than poles

The Seasons

- Seasonality
- Reasons for Seasons
  - Revolution
  - Rotation
  - Tilt of Earth's axis
  - Axial parallelism
- Annual March of the Seasons
  - Seasonal observations

Seasonality

- Seasonal changes
  - Sun's altitude – angle above horizon
  - Declination – location of the subsolar point
  - Daylength

Factors That Influence Seasonal Change

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

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 1675 kmph (1041 mph)

Reasons for Seasons

- Tilt of Earth's axis
  - Axis is tilted 23.5° from plane of ecliptic
- Axial parallelism
  - Axis maintains alignment during orbit around the Sun
  - North pole points toward the North Star (Polaris)
- Sphericity

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

THE SOLSTICES

DENOTE THE EXTREMES OF DAYLENGTH

DECEMBER 12 AND JUNE 21 ARE TERMED THE SOLSTICES --

THE SPECIFIC POINTS IN TIME AT WHICH THE SUN'S DECLINATION IS AT:

ITS FARTHEST POINT NORTH - THE TROPIC OF CANCER - 23.5*N OR . . .

ITS FARTHEST POINT SOUTH - THE TROPIC OF CAPRICORN AT 23.5*S

WINTER SOLSTICE:

DECEMBER 21: NORTH POLE IS EXCLUDED FROM SUNLIGHT AND SOUTH POLE IS IN TOTAL DAYLIGHT

THE SUBSOLAR POINT IS 23.5*S

THE NORTHERN HEMISPHERE IS TILTED AWAY FROM THE DIRECT RAYS OF THE SUN --

LOWER ANGLE AND MORE DIFFUSE PATTERN OF INSOLATION

SUMMER SOLSTICE

JUNE 21: SOUTH POLE IS EXCLUDED FROM SUNLIGHT AND NORTH POLE IS IN TOTAL DAYLIGHT

THE SUBSOLAR POINT SHIFTS TO 23.5*N

THE SOUTHERN HEMISPHERE IS TILTED AWAY FROM THE DIRECT RAYS OF THE SUN

VERNAL EQUINOX:

MARCH 21 OR 22:

WHEN THE SUN'S DECLINATION CROSSES THE EQUATORIAL PARALLEL AND ALL PLACES ON EARTH EXPERIENCE DAYS AND NIGHTS OF EQUAL LENGTH

THE SUN RISES AT THE NORTH POLE AND SETS AT THE SOUTH POLE

AUTUMNAL EQUINOX:

SEPTEMBER 22 OR 23:

THE SUN'S DECLINATION CROSSES THE EQUATORIAL PARALLEL AND ALL PLACES ON EARTH EXPERIENCE DAYS AND NIGHTS OF EQUAL LENGTH

THE SUN RISES AT THE SOUTH POLE AND SETS AT THE NORTH POLE

Atmospheric Composition, Temperature, and Function

- Atmospheric Profile
- Atmospheric Composition Criterion
- Atmospheric Temperature Criterion
- Atmospheric Function Criterion

Atmospheric Profile

- Atmosphere extends to 32,000 km (20,000 mi) from surface
- Exosphere begins at 480 km (300 mi)
- Three criteria to examine atmosphere
  - Composition
  - Temperature
  - Function

Atmospheric Composition

- Heterosphere – outer atmosphere
  - 80 km (50 mi) outwards
  - Layers of gases sorted by gravity
- Homosphere – inner atmosphere
  - Surface to 80 km (50 mi)
  - Gases evenly blended

Atmospheric Temperature

- Thermosphere
  - Roughly same as heterosphere
  - 80 km (50 mi) outwards
- Mesosphere
  - 50 to 80 km (30 to 50 mi)
- Stratosphere
  - 18 to 50 km (11 to 31 mi)

Atmospheric Temperature

- Troposphere
  - Surface to 18 km (11 mi)
  - 90% of mass of atmosphere
  - Normal lapse rate – average cooling at rate of 6.4 C°/km (3.5 F°/1000 ft)
  - Environmental lapse rate – actual local lapse rate

Atmospheric Function

- Ionosphere
  - Absorbs cosmic rays, gamma rays, X-rays, some UV rays
- Ozonosphere
  - Part of stratosphere
  - Ozone (O_3) absorbs UV energy and converts it to heat energy
  - Chlorine from CFCs destroys O_3

Variable Atmospheric Components

- Natural Sources
- Natural Factors That Affect Air Pollution
- Anthropogenic Pollution
- Benefits of the Clean Air Act

Natural Factors That Affect Air Pollution

- Winds
- Local and regional landscapes
- Temperature inversion

Anthropogenic Pollution

- Carbon monoxide
- Photochemical smog
- Industrial smog and sulfur oxides
- Particulates