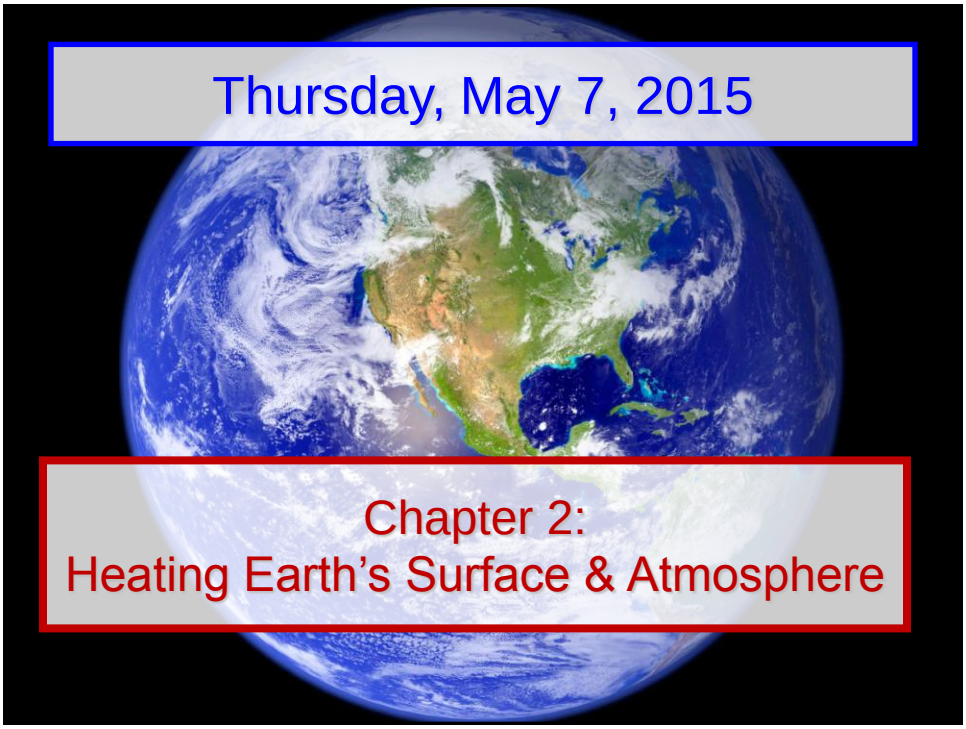
Thursday, May 7, 2015



Chapter 2:
Heating Earth's Surface & Atmosphere

Chapter 2

- **Lines of the Earth**
- **Earth – Sun Relationships**
- **Energy and Heat Transfers**
- **Insolation**
- **Heat Budgets**

Lines of the Earth:
The Earth-Sun Relationship

Earth's Motions

Rotation vs. Revolution

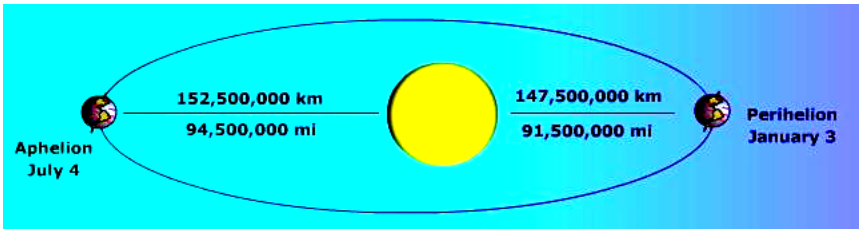
Rotation:
The spinning of the earth on its axis.
- Duration: 24 hours (1 day)
- Keyword: Axis

Revolution:
The traveling of the earth around the sun.
- Duration: 365 ¼ Days (1 year)
  (leap year every 4 years – Feb. 29)
- Keyword: Orbit

Perihelion vs. Aphelion

Perihelion:
Point closest to the sun in the earths orbit
- Distance: 91.5 Million miles
- Date: January 3

Aphelion:
Point farthest from the sun in the earths orbit
- Distance: 94.5 Million miles
- Date: July 4



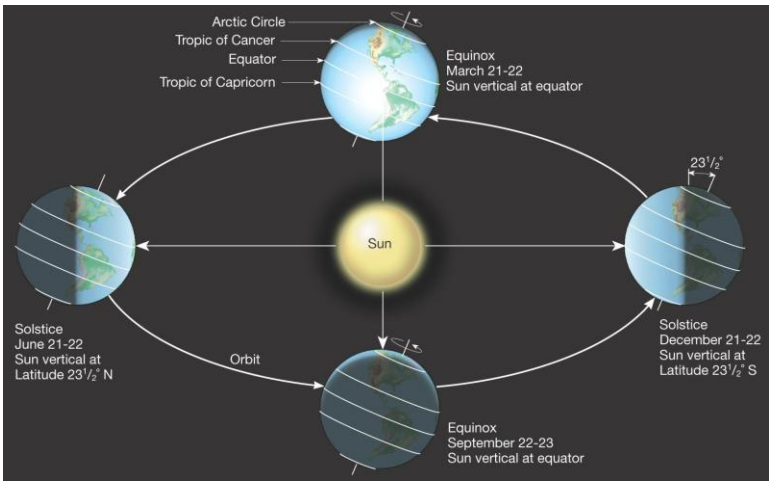
The Seasons

	Northern Hemisphere	Southern Hemisphere
Spring	**March, April, May**	**September, October, November**
Summer	**June, July, August**	**December, January, February**
Fall	**September, October, November**	**March, April, May**
Winter	**December, January, February**	**June, July, August**

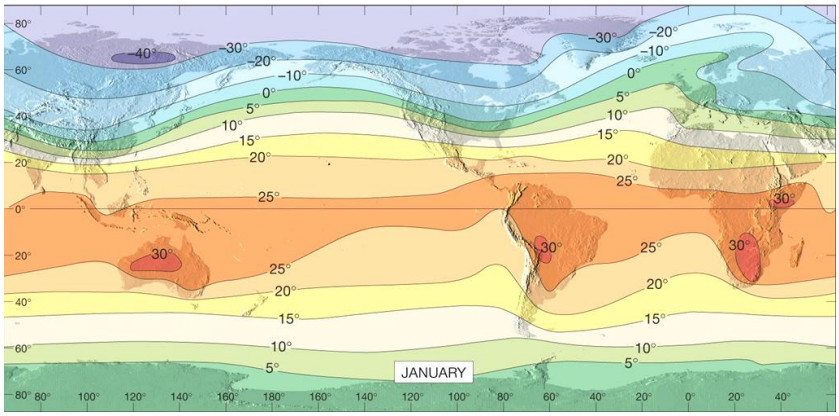
Earth-Sun Relationship

- **Yearly Changes:**
  - Seasons: *Why they occur?*
  - Winter and Summer **Solstice**
  - Spring and Fall **Equinox**
  - January and July Earth Temperature Patterns
- **Tilt of the Earth**
  - **23.5°**
  - Always points in the same direction in space
- **Sun Angle Changes**
  - **Longest and Shortest Day** (Northern Hemisphere)
  - **12 Hours of Day/Night** everywhere on Earth

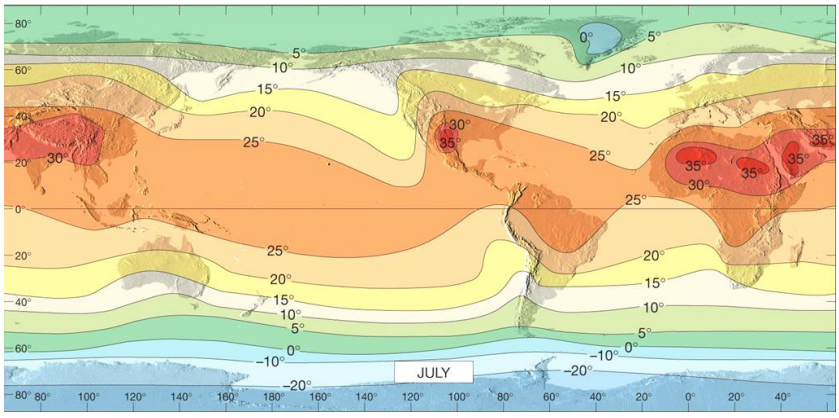
Earth-Sun Relationship: Seasons



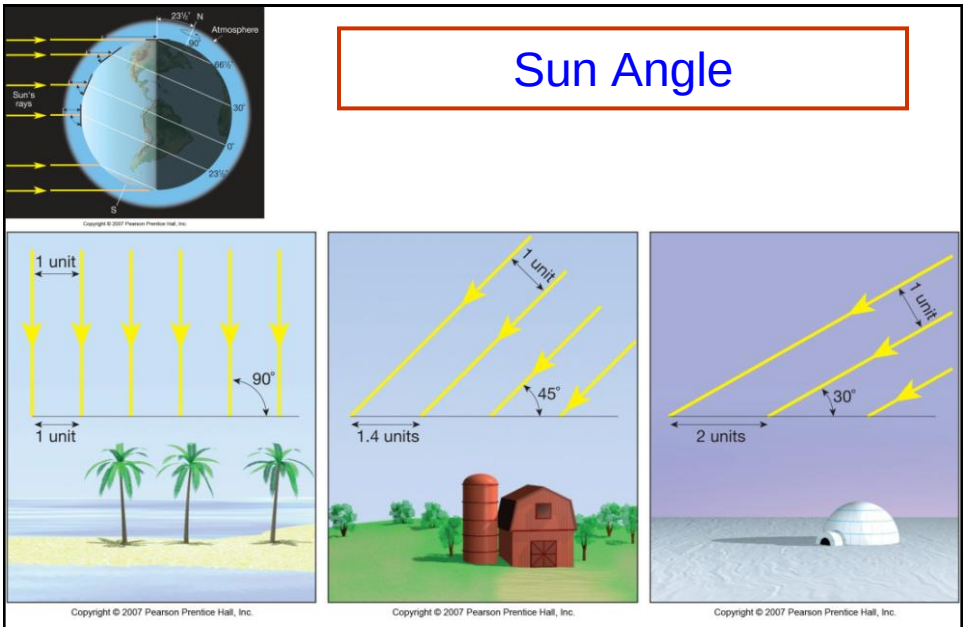
World Temperature: January



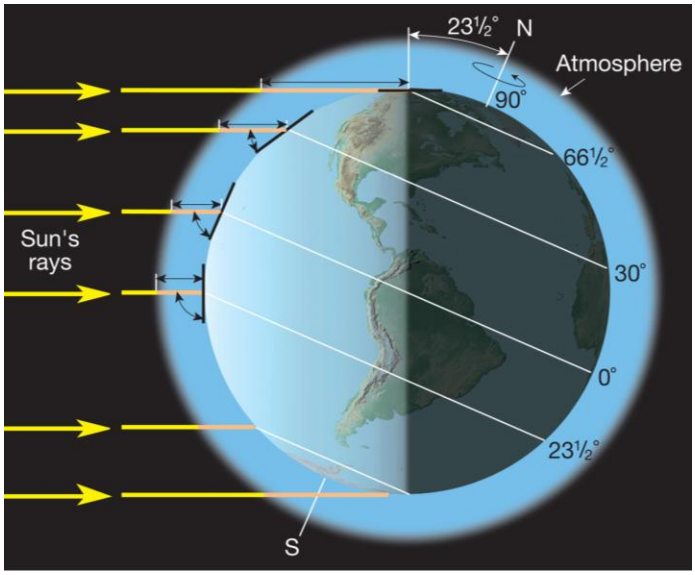
World Temperature: July



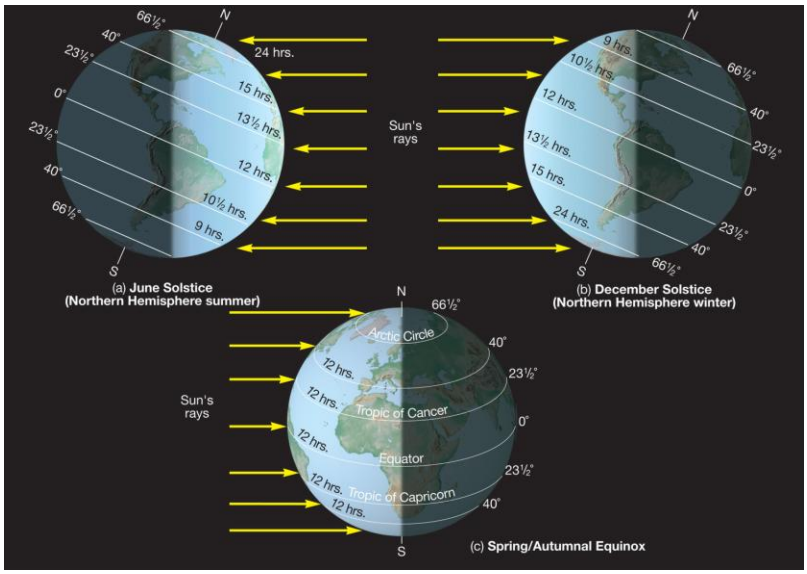
Sun Angle



Axial Tilt

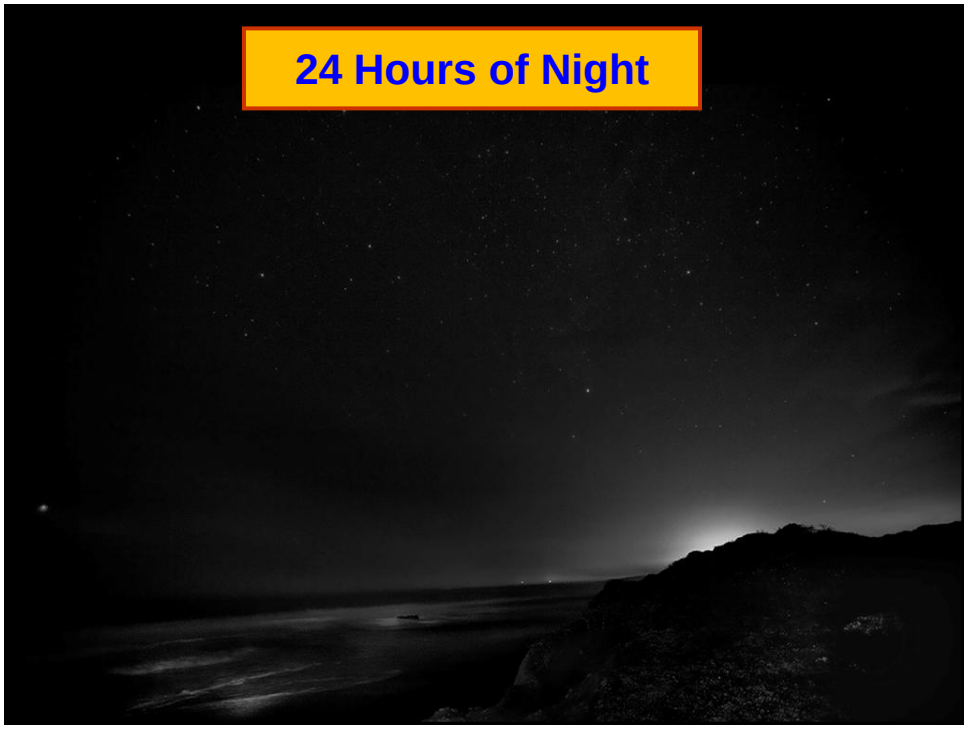


Seasons and Axial Tilt

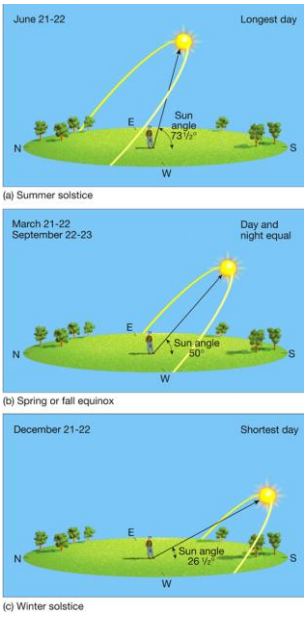


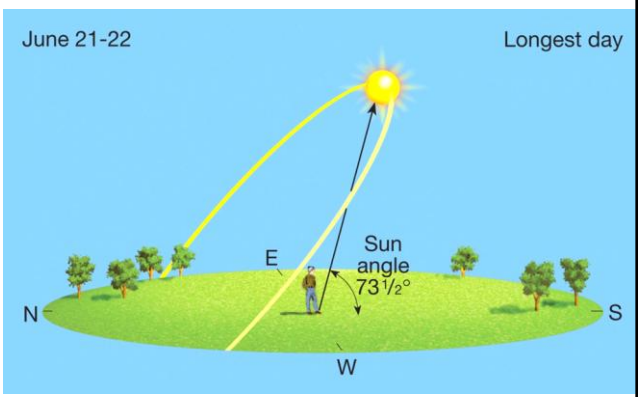
24 Hours of Daylight

24 Hours of Night



Sun Angle



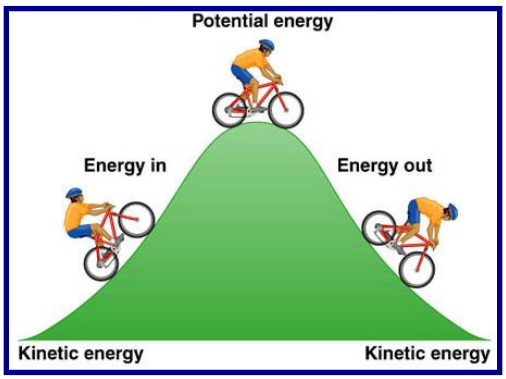


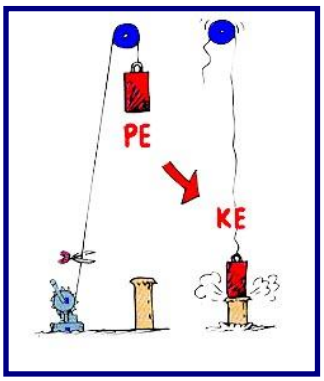
Lines of the Earth

Lines	Location
Latitude (*E-W*)	*0-90°* N/S
North Pole	90°N
Arctic Circle	66.5°N
Tropic of Cancer	23.5°N
Equator	0°
Tropic of Capricorn	23.5°S
Antarctic Circle	66.5°S
South Pole	90°S
Longitude (N-S)	*0-180°* E/W
Prime Meridian	0°
International Date Line	180°

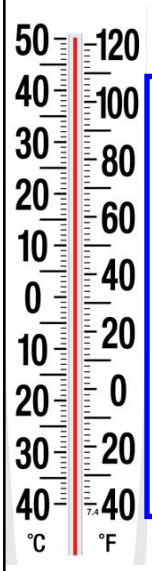
Forms of Energy

Energy: The capacity to do work
Kinetic Energy: Energy due to motion
Potential Energy: Energy that **CAN BE** put into motion





Temperature

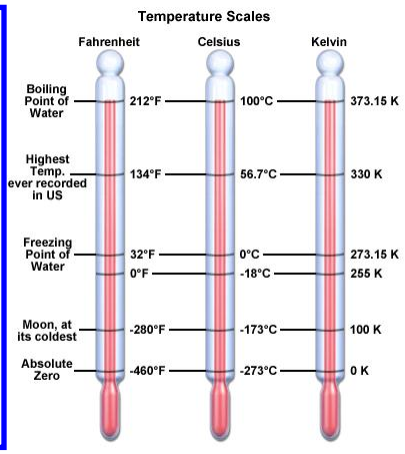


Temperature: A measure of the average kinetic energy of the atoms or molecules

or

A quantity the describes how warm or cold an object is with respect to the standard scale

US = **Fahrenheit**
World (Science) = **Celsius** and **Kelvin**



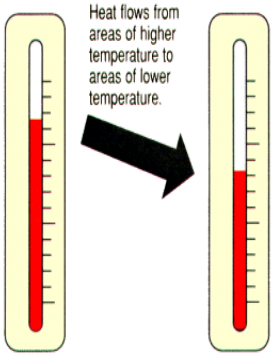
Heat

Heat: The transfer of energy into or out of an object because of temperature differences between it and another medium

Temperature **ALWAYS** flows **DOWNHILL.**

This means that heat always flows from a region of greater temperature into a region of lesser temperature

A thing does not HAVE HEAT, heat is a flow of energy



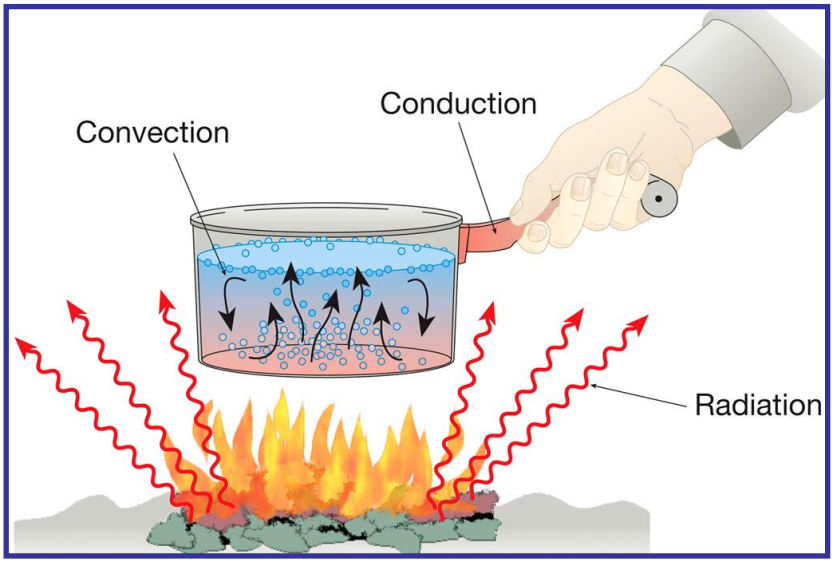
Mechanisms of Heat Transfer

The flow of heat energy
can occur in three ways:

- Conduction
- Convection
- Radiation

All three can operate simultaneously

Mechanisms of Heat Transfer



Conduction

The transfer of heat through electron and molecular collisions from one molecule to another.

or

Heat moving directly by contact
This is how Solids (Earth) moves heat

The ability of substances to conduct heat varies considerably.

Good conductors: Metals

Poor conductors (Insulators): Air

Convection

Heat transfer that involves the actual movement or circulation of a substance

It takes place in fluids and gasses (the oceans and the atmosphere) where the material is able to flow

Convective Circulation: This is where material heated in lower areas, expands and rises, only to cool off and eventually condense and fall.

This is true for a pot of boiling water and for the lowest portion of the atmosphere (the Troposphere)

Convection

Convective Circulation:

This occurs in the atmosphere when air is heated by the surface (usually land).

It warms and expands

which allows it to rise.

These **Thermals** are what hang gliders use to stay aloft.

Air Movement:

Convection = ↑ and ↓

Advection = ← and → (wind)

Radiation

Radiant heat transfer requires NO medium. This is how solar energy travels across the vacuum of space, from the sun to the earth.

Earth's Energy Budget

- **Energy In – it all comes from the SUN**
  The energy from the sun is what heats up the Earth
- **As Energy arrives at the Earth, the Earth heats up**
  The sun's energy warms both the Earth's atmosphere and surface.
- **Energy Out – Heat leaving the Earth**
  The Earth ***MUST*** remove the heat gained from the sun every day! If not, we would continue to heat up forever, resulting in total loss of life on the planet.
- **A Balance must be maintained**
  - If we get in more energy than we give off… we will continuously heat up
  - If we give off more energy than we get in… we will continuously cool down
  - THEREFORE… to maintain a near normal constant temperature, we must get heat from the sun and lose it back out to space every day

INSOLATION: What Happens?

IN*coming*
SOL*ar*
***radi*ATION**

3 things can happen when radiation strikes an object:

- energy is ABSORBED (absorption)
- energy is TRANSMITTED (transmission)
- energy is BOUNCED OFF (reflected or scattered)

INSOLATION

INSOLATION:

IN = Incoming
SOL = Solar
ATION = Radiation

Insolation is the total amount of incoming solar radiation that the Earth receives.

INSOLATION

The amount of energy entering the Earths atmosphere, (*and ultimately reaching the surface*) changes from day to day as well as from place to place. We will be working with average values of Insolation.

The surface of the Earth is also a factor in how much energy (Insolation) it actually receives. The reflectivity of the surface is very important in determining how much energy that strikes it that it can actually "keep."

This measure of reflectivity is called ALBEDO.

Albedo

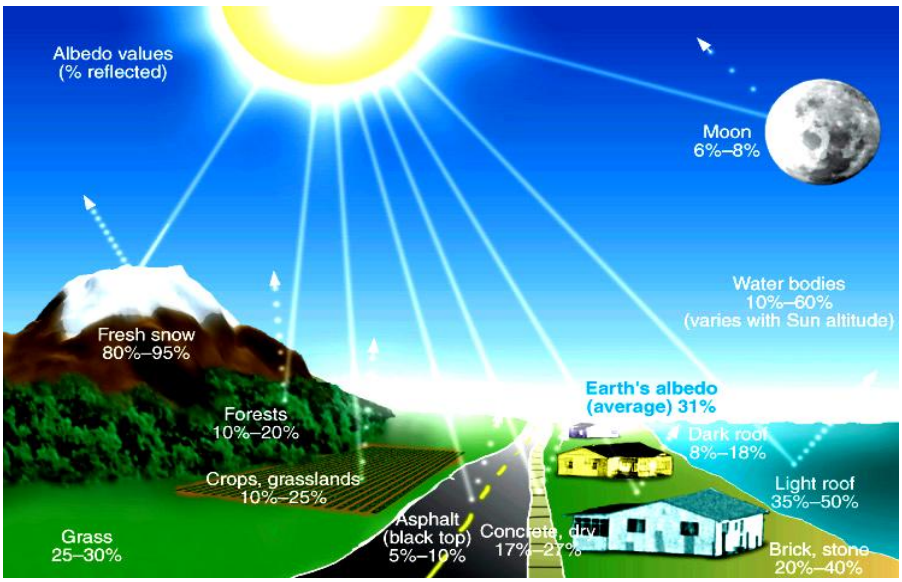
Albedo is the measure of reflectivity of a surface.

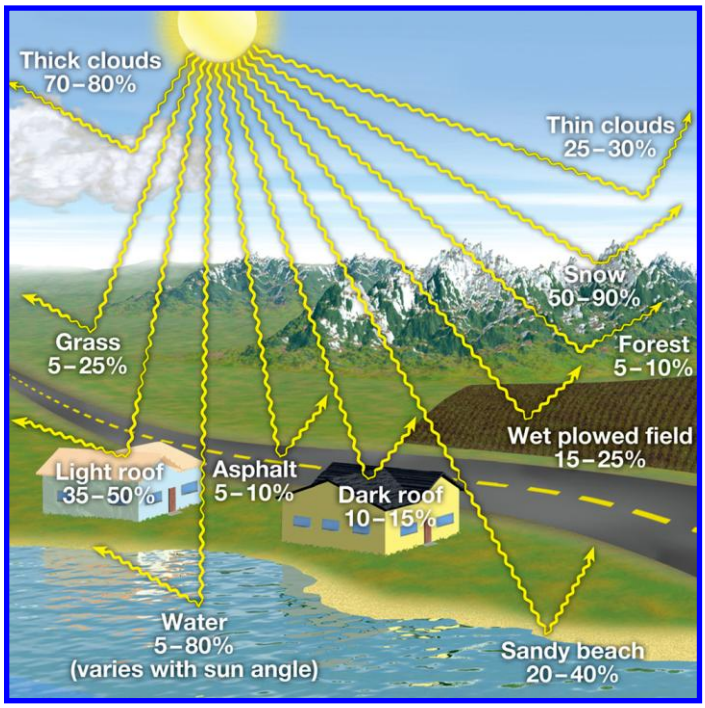
The MORE reflective a surface, the less energy it will "keep" and the HIGHER the albedo. Albedo is the percentage of Insolation that a surface reflects.

High Reflectivity = High Albedo

Low Reflectivity = Low Albedo

Common Surface Albedos





Albedo

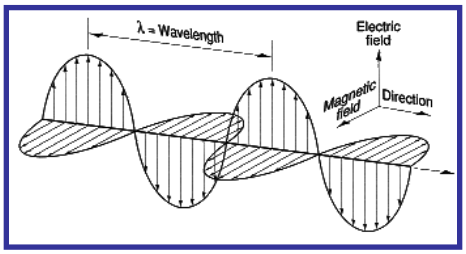
Common Surface Albedos

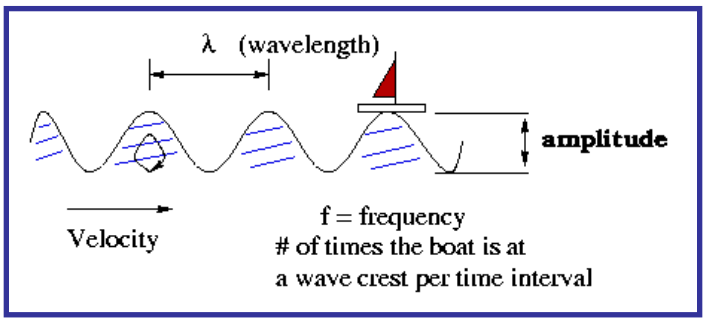
TYPE OF SURFACE	ALBEDO (% reflected)
Fresh Snow	.80 - .95 (80% - 95%)
Water	.10 - .60
Concrete	.17 - .27
Forests	.10 - .20
Dry Plowed Field	.05 - .20
Asphalt Pavement	.05 - .10
Dark Colored Roof	.08 - .18
Light Colored Roof	.35 - .50

Radiation

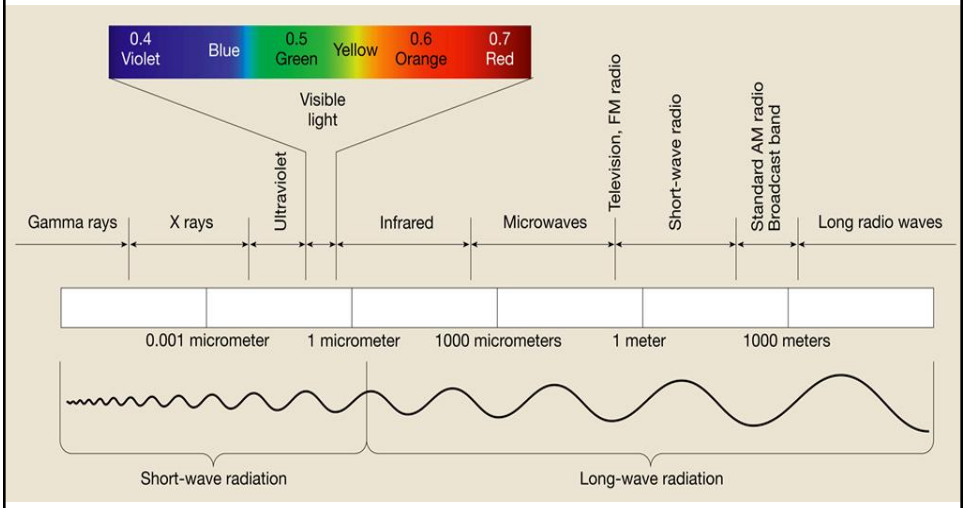
- **Electromagnetic Radiation**
  - Wavelengths
    - Short / Long
    - Ultraviolet, Visible / Infrared
- **Laws of Radiation**
  - All Objects Emit
    - Hotter - More Radiation
    - Hotter - Shorter Waves
    - Absorb Well - Emit Well

Radiation



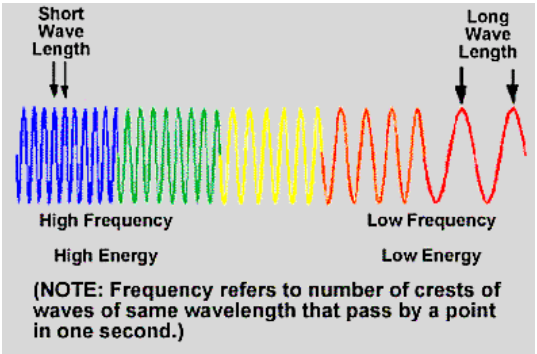


Radiation



SHORT-WAVE LONG-WAVE

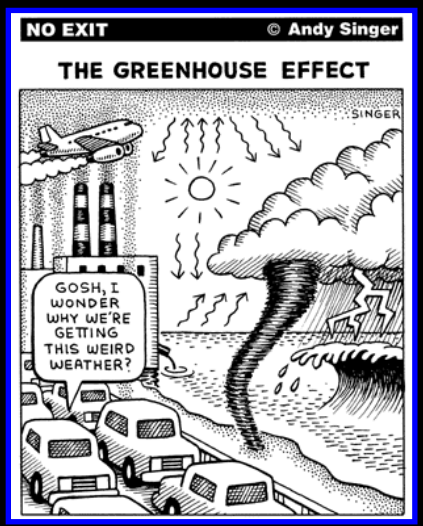
Visible Light: Color Spectrum

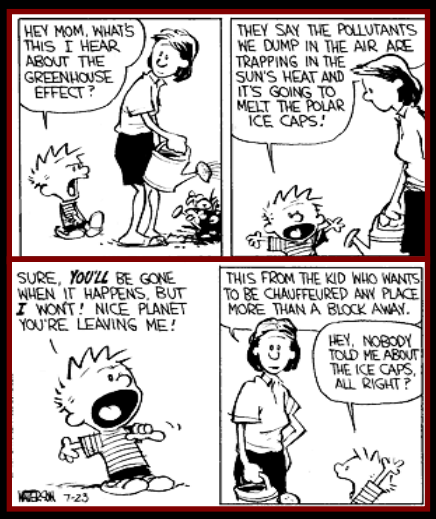


Heating the Atmosphere

- **Heating from the sun - top-down (shortwave)**
  - Absorbing incoming shortwave radiation
  - Thermosphere / Stratosphere
    - Thermosphere (Shortwave: Gamma-rays, X-rays, etc.)
    - Stratospheric Ozone (Ultraviolet UV-radiation)
- **Heating from the bottom-up (long-wave)**
  - Absorbing long-wave terrestrial radiation
  - CO_2 and H_2O
  - Environmental Lapse Rate
  - Convection cells

The Greenhouse Effect

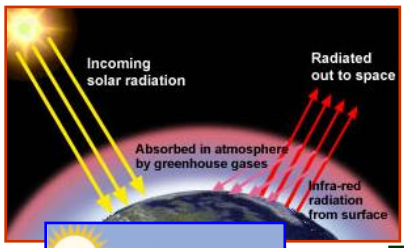


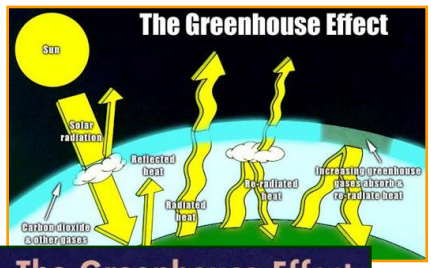


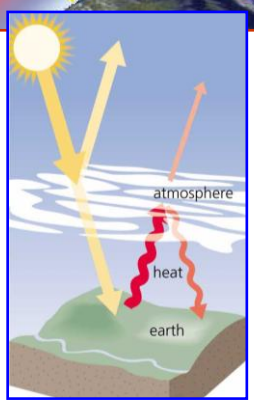
The Greenhouse Effect

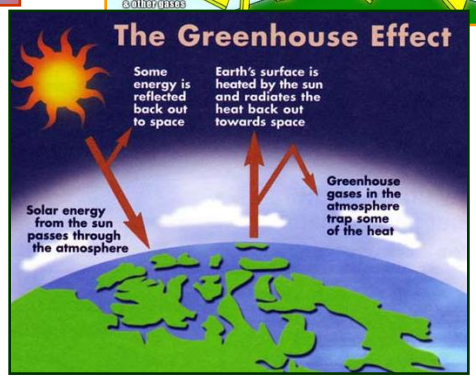
- Sun = Energy In (Shortwave)
- Shortwave passes through Greenhouse gasses in the Atmosphere
- Energy heats Earth's Surface
- Earth reradiates heat as Long Wave radiation
- Long Wave radiation is absorbed by Greenhouse gasses in the atmosphere
- This energy is then reradiated:
  - Some is sent out to space
  - Some is sent back to the Earth
  - The Earth therefore is warmer than it normally would be
    - ❖ One way to remember this is that it is like a credit card with a cashback bonus!

The Greenhouse Effect









The Role of Clouds in Heating Earth

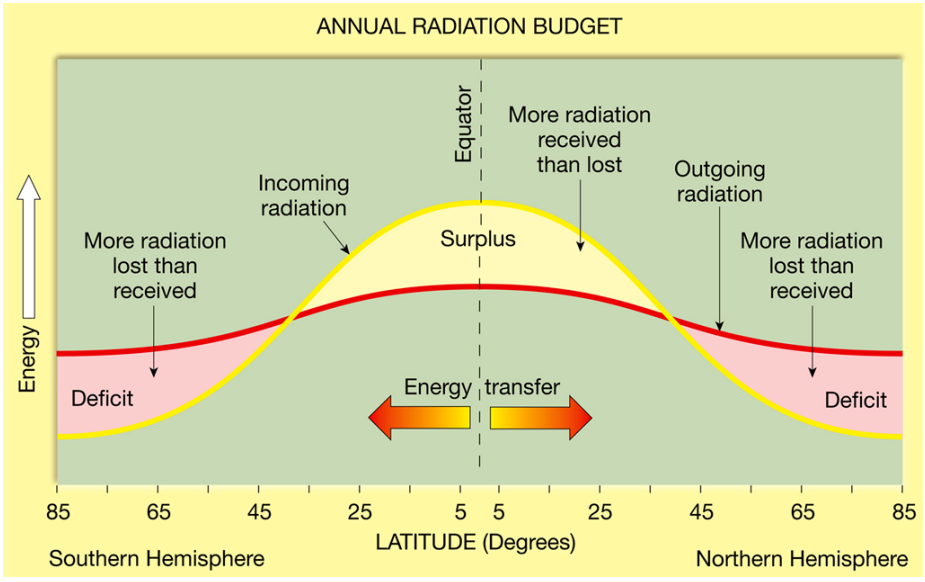
Day:

- Clouds block (reflect or absorb) sunlight
  - Preventing light from reaching surface
  - Cooler temperatures

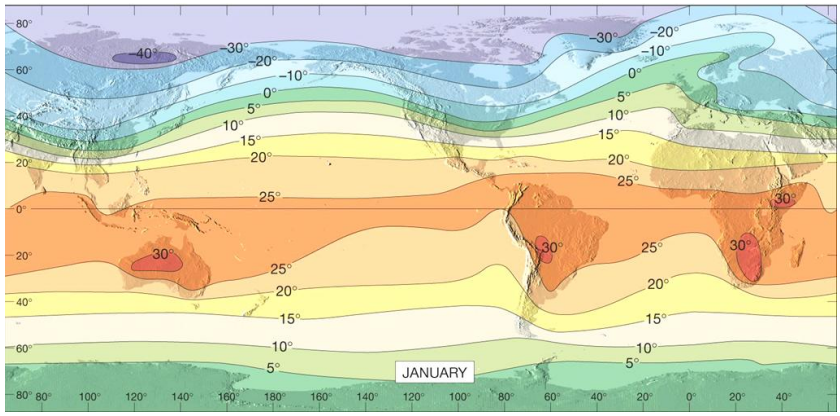
Night:

- Clouds act like an insulator
- Preventing thermal escape
  - Energy never leaves atmosphere
  - Warmer temperatures

Latitudinal Heat Transfer



World Temperature: January



World Temperature: July