ENERGY IN THE BIOSPHERE

How Does Energy Enter the Biosphere?

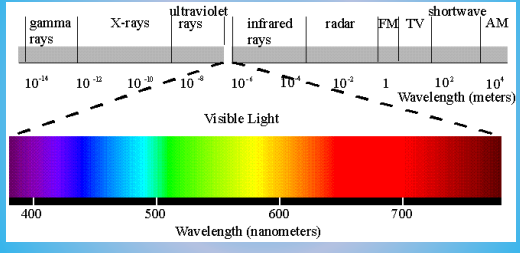
The Sun!!

- Is the ultimate energy source on Earth
- Releases electromagnetic radiation (thermal energy) to the earth which is used to power Earth's climate system and sustain life

Radiation

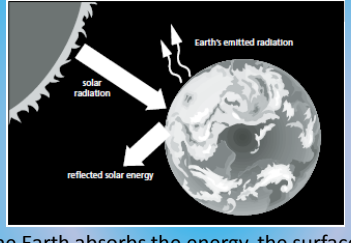
- The emission of energy as waves.
- The waves release energy only when they interact with matter.
- As there are no particles in outer space (vacuum) it is the only way the sun's energy can reach the biosphere

- Radiant energy can be reflected or absorbed
- Any substance at a higher temperature than it surroundings will release radiant energy



- Solar radiation consists of many different wavelengths of energy which act differently as they enter the atmosphere

Incoming and Outgoing Radiation

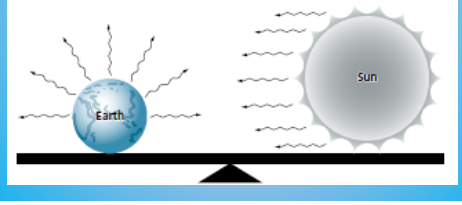


- As the Earth absorbs the energy, the surface gains thermal energy and its temperature rises.
- The warm surface then releases energy back out through different wave lengths in the form of infrared radiation.

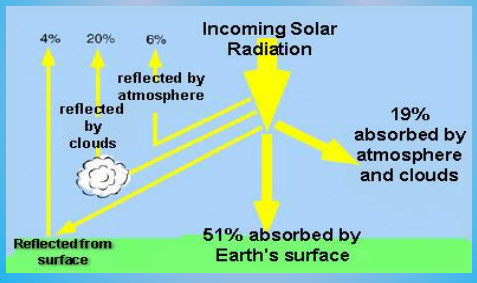
Global Energy Balance

- Earth maintains an energy temperature balance by radiating as much energy into space as it absorbs from the Sun.
- This balance is known as the **radiation budget**.

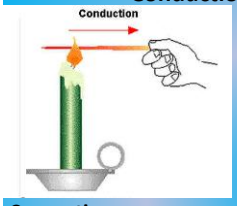
Radiation Budget = Total incoming energy – Total outgoing energy



- Of the solar energy entering the Biosphere:
  - 51% is absorbed by oceans and land
  - 45% is absorbed, reflected & scattered by the atmosphere
  - 4% is reflected by the Earth's surface



Conduction and Convection



Conduction

- Is the transfer of thermal energy through **direct contact** between the particles of a substance.
- Usually takes place in solids since the molecules in these substances are **closer together.**

Convection

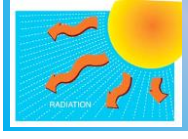
- Is the transfer of thermal energy through the **movement of particles** from one location to another.
- Usually takes place in fluids (liquids) or gases.
- Warm particles **rise** and cool particles **fall** causing a **current**

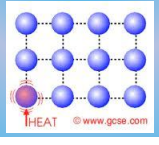
A Summary of Thermal Energy Transfer on Earth:

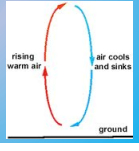
a) The Earth's land or water surface heats up as it absorbs energy in the form of solar **radiation.**

b) Energetic molecules on the surface of the land & water collide with gas molecules in the atmosphere transferring energy to them by **conduction.**

c) This thermal energy is transferred to surrounding cooler air or water causing **convection currents** in air and water.







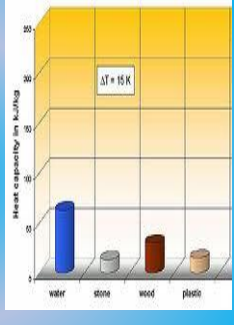
Heat Sink

- an object that absorbs energy & becomes warmer

- A good heat sink has a high **Specific Heat Capacity**
  = The amount of heat (J) required to raise the temperature of 1 g of a substance by 1°C
  = amount of heat it can hold

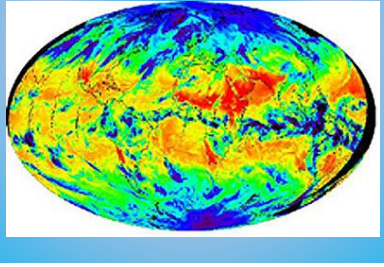
- Water is a better heat sink than dry land
  = can hold a lot of heat!
- Reasons:
  a) solar radiation penetrates water
  = energy is spread through the water, not just concentrated on the surface
  b) due to convection currents, water has a high heat capacity
  = dry land heats and cools faster

ie.) a sandy beach on a hot summer day

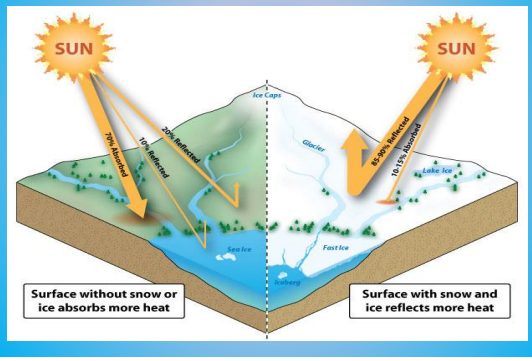


EFFECTS OF SPECIFIC HEAT CAPACITY ON THE BIOSPHERE

- Different specific heat capacities of the Earth's different surfaces (sand, water, forests, etc) affect how much they heat up the air and water around them.

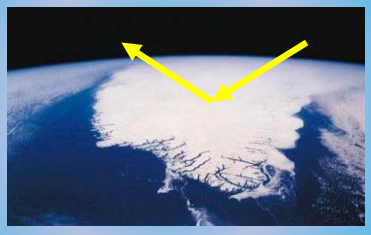


- The Earth's surface color affects how much radiation is absorbed or reflected



Albedo = Reflectivity

- Ability of a substance's surface to reflect solar energy
- Light, shiny colors = high albedo!
  eg. Snow, ice, clouds & suspended particles (e.g. volcanic ash)



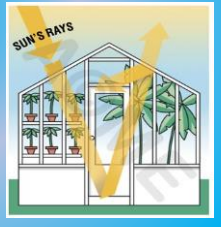
- When light is reflected back to space, it can have a global **cooling effect**.
- What prevents too much heat being reflected?

The Greenhouse Effect

Most greenhouses look like a small glass house. Greenhouses are used to grow plants, especially in the winter.

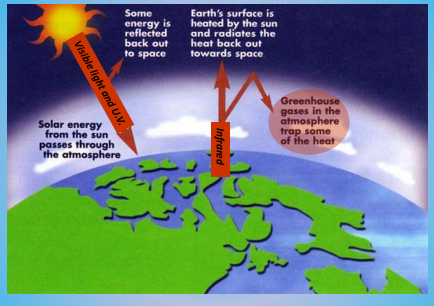
Greenhouses work by trapping heat from the sun.

The glass panels of the greenhouse let in light but keep heat from escaping. This causes the greenhouse to heat up, much like the inside of a car parked in sunlight, and keeps the plants warm enough to live in the winter.



The Natural Greenhouse Effect

- Greenhouse gases in our atmosphere **trap** in heat radiated from earth.



- Without the greenhouse effect, Earth would be covered completely with ice with a global climate similar to Mars instead of a global average of 15°C.