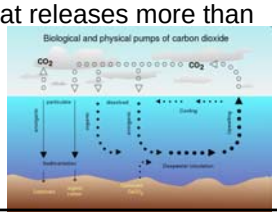
Ecological framework, part II
&
Earth Systems

Carbon Cycle

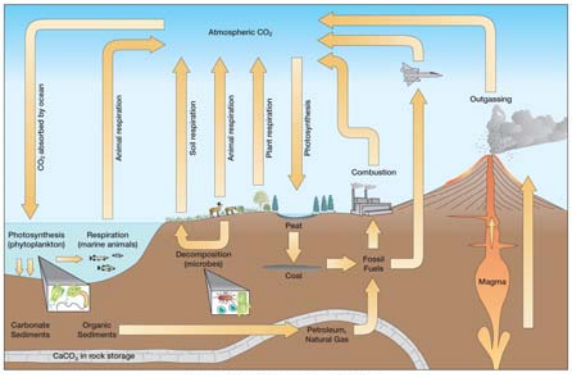
- Carbon (C) moves through several reservoirs: atmosphere ($C0_2$), lithosphere (rocks and fossil fuels), hydrosphere, and biosphere (plants, animals, and soil)
  - Fourth most abundant element in universe
  - Most carbon on earth, about 65,500 billion metric tons, stored in rocks (not including fossil fuels)


Sinks and sources

- Sinks: anything that absorbs and stores more than it releases (i.e. reservoir)
  - Takes it out of a cycle
  - Oceans for dissolved carbon
  - Forests/plants
- Sources: anything that releases more than absorbs
  - Puts it in the cycle
  - Fossil fuels
  - Farming



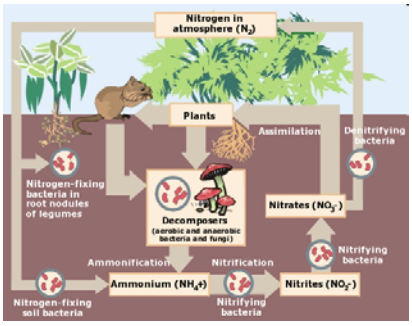
Carbon cycle



Nitrogen Cycle

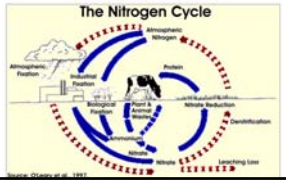
- Primarily two reservoirs: atmosphere and biosphere
- 78% of the atmosphere is Nitrogen (N_2). Other forms of nitrogen exist in living or dead organic matter
  - The amount of nitrogen in the atmosphere is one million times larger than the total nitrogen contained in living organisms
- Essential for plant growth

Nitrogen Cycle



Nitrogen cycle

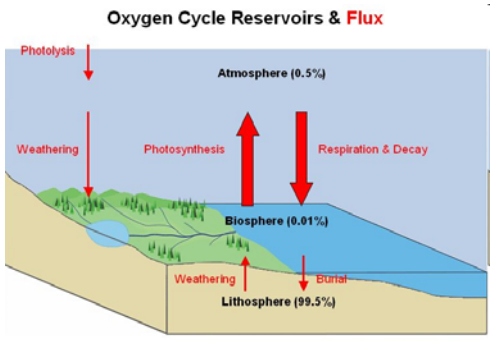
- Moves from atmosphere to soil through lightning, rain, and bacteria fixation (primary transfer)
- Used by plants for growth, eaten by animals
- Returned to cycle by decomposers



Oxygen Cycle

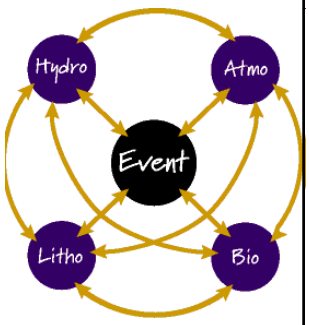
- Oxygen (O) moves through all reservoirs: atmosphere, biosphere, hydrosphere, and lithosphere
  - Largest reservoir is in the lithosphere (99.5%)
- Essential for life on earth

Oxygen Cycle



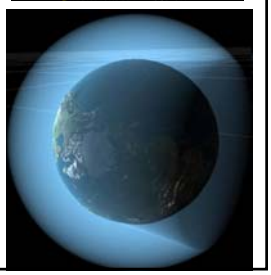
Earth system science

- Embraces chemistry, physics, biology, mathematics and applied sciences in the holistic study of earth
- Four basic parts of earth



1. Atmosphere

- Study of everything from the ground upwards until reach outer space
  - Includes weather, climate, and storms
- "Life-giving gaseous

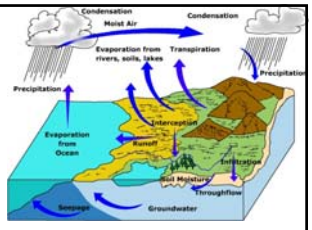


2. Biosphere

- All living things and the supporting factors
  - Soil
  - Plants
  - Animals

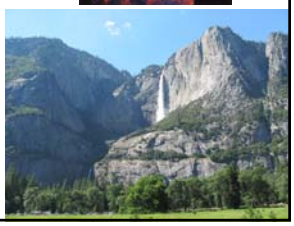
3. Hydrosphere

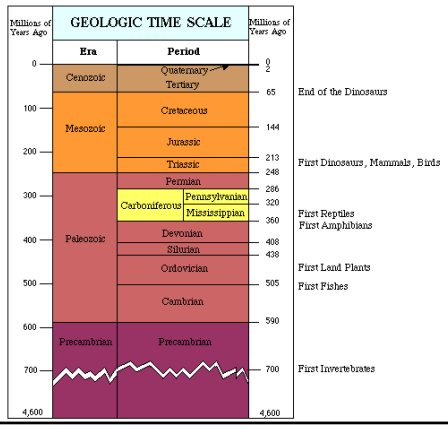
- All water on earth
  - Rivers, lakes, oceans, glaciers, clouds, snow



4. Lithosphere

- Solid Earth – surface of earth
  - Hills and valleys
  - Mountains
  - Beaches





Gaia Hypothesis

- Introduced in 1965 by J. Lovelock
  - Refined with additions by L. Margulis

*"The Gaia hypothesis says that the temperature, oxidation state, acidity, and certain aspects of the rocks and waters are kept constant, and that this homeostasis is maintained by active feedback processes operated **automatically and unconsciously by the biota**."*
- James Lovelock, The Ages of Gaia

Gaia

- The earth is considered a living organism
  - Processes are regulated to keep organism running
  - Not centered on humans – small part of whole
  - Thought is that humans can modify one of the systems to such an extent that earth cannot cope.
- Controversial hypothesis

Some evidence

- Biotic activities replenish gases in the atmosphere (hydrogen and methane)
- Carbon dioxide would be more abundant if there was no life

Importance

- Theory suggests that the abiotic and biotic environment is made up of many complex interrelationships
- Some complex interrelationships are delicate and may be altered by human activity to a breaking point

http://www.physicalgeography.net/fundamentals/5d.html

Where we stand today

- The model that life **influences** planetary processes (i.e., it has a substantial effect on abiotic processes) has become known as the **weak Gaia hypothesis**. This model is widely supported.
- The original Gaia hypothesis, that life **controls** planetary processes (i.e., life created Earth's system), has become known as the **strong Gaia hypothesis**. It is not widely accepted.

http://www.globalchange.umich.edu/globalchange1/current/lectures/Gaia/

Tragedy of the Commons

- G. Hardin (1968) – biologist
- Published two years before Earth Day
- Widely criticized
  - Use of word “commons”
  - Privatization of lands
- Sustainability
- Discussed overexploitation
  - What was being overused in 1968?