Week 9 Notes

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May 2021

Contents

1 Biogeochemistry

1.1 Carbon

1.1.1 The Global Carbon Cycle

In Figure 1

- Boxes represent carbon pools
  - A carbon pool is a specific area in the ecosystem where carbon can exist.
  - Pools with a higher number store more carbon mass, the largest being Rock Components and Fossil Fuels. However, there are no arrows coming off of these, so the largest pool that is active is Ocean Waters.

- Arrows represent Fluxes.
  - Fluxes represent processes that cause movement of carbon from one pool to another.
  - Fluxes with a higher number transfer more carbon mass. The largest being photosynthesis.

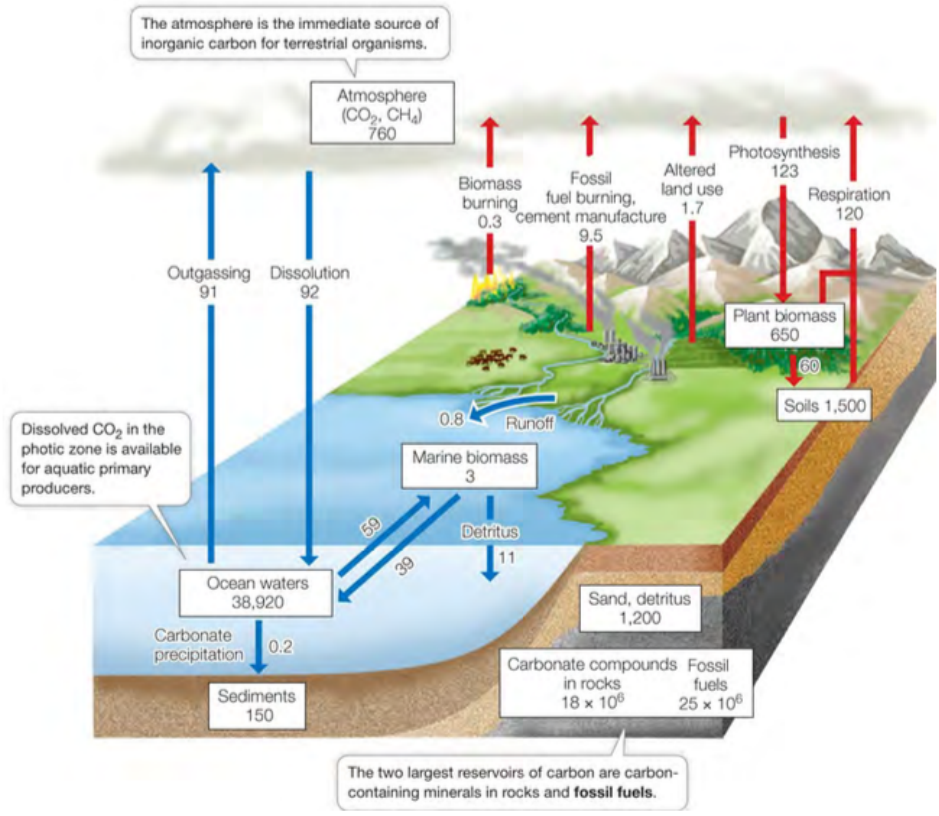

Figure 1: The Global Carbon Cycle

1.1.2 Atmospheric CO_2 Levels

Questions: in Figure 2

- What process drives the overall increase in CO_2 levels?
  - Anthropogenic greenhouse emissions: fossil fuels.
- What process drives the annual oscillation in CO_2 levels?
  - Global photosynthesis absorbs more CO_2 than Respiration creates when plants are growing, i.e., May to September.
  - Global photosynthesis absorbs less CO_2 than Respiration creates when plants are not growing.

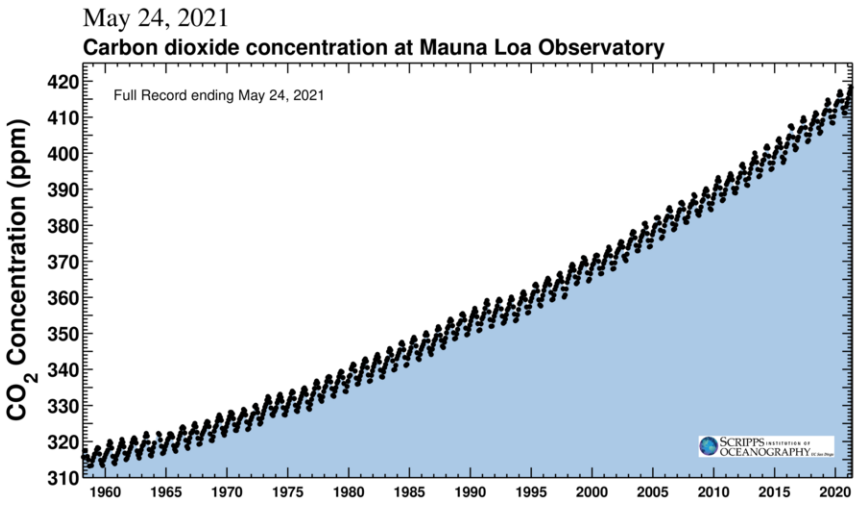

Figure 2: The Keeling Curve

- Highly seasonal, highly productive ecosystems like boreal forests will experience the most oscillation of CO_2 levels, because the carbon they absorb in Spring and Summer is not offset enough by the Southern hemisphere's Fall and Winter.
  - Global CO_2 level oscillations are mainly driven by the boreal forest.
  - Locations such as Mauna Loa or the South Pole will also see oscillations, although these are actually residual effects of the boreal forest.
  - Locations that are not highly seasonal or highly productive will not be able to contribute to global CO_2 level oscillations.

Ocean Acidification Example

- Higher Acidity (lower pH) and warming of ocean bleaches coral.
- Coral have an mutualistic relationship with zooxanthellae.
  - Coral get sugar from photosynthesis of zooxanthellae.
  - Zooxanthellae gets place to live, and nutrients from coral.
  - Also obligate relationship for coral. Coral can not survive without the relationship.
- Higher acidity or warming of the ocean acts as a stressor, killing zooxanthellae.
- Without the presence of zooxanthellae, the coral will lose its color (Coral Bleaching) and eventually die if prolonged. If conditions improve after bleaching but before death, the coral can recover by recruiting new zooxanthellae.

1.2 Water and Nitrogen

1.2.1 The Global Hydrological Cycle

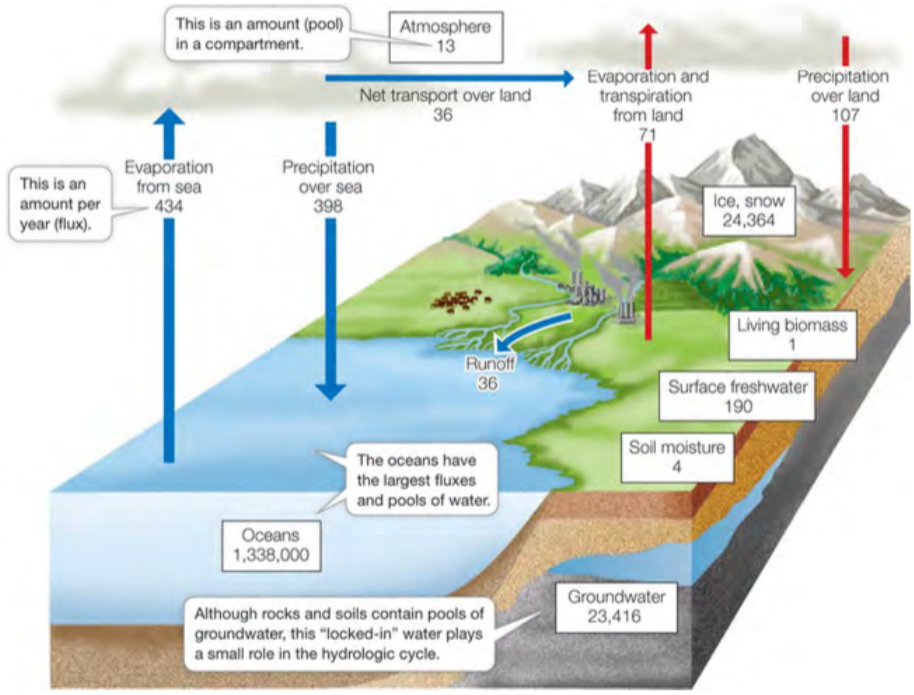

Figure 3: The Global Hydrological Cycle

In Figure 3: The Global Hydrological Cycle

- Fluxes are processes by which water moves from one pool to another.
  - Evaporation
  - Transpiration
  - Rain
- Pools are locations that store water.
  - Oceans
  - Lakes
  - Groundwater
- Largest
  - Flux: Evaporation from oceans
  - Pool: Oceans

- Anthropogenic Fluxes
  - Groundwater does not naturally connect to the rest of the hydrological cycle.
  - Humans can, through irrigation and aquifers, access groundwater and thus connect it to the cycle.

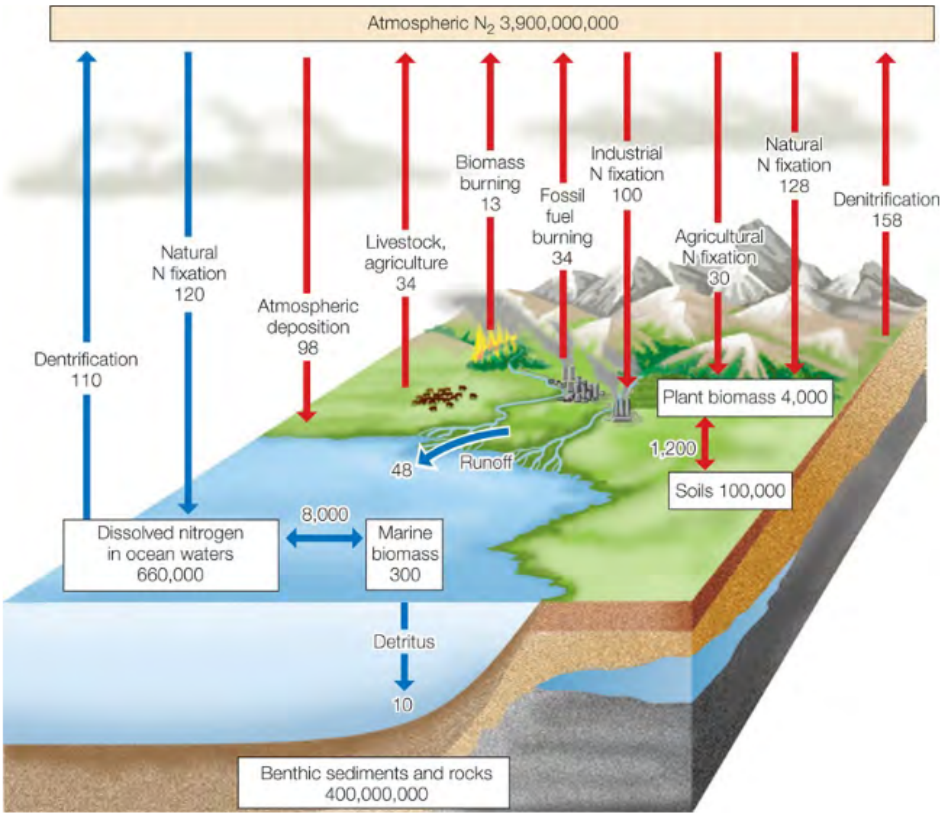

Figure 4: The Global Nitrogen Cycle

In Figure 4: The Global Nitrogen Cycle

- Largest
  - Flux: Denitrification - gaseous loss of nitrogen from the soil converting into N_2 gas in the atmosphere.
  - Pool: Atmospheric N_2
- Anthropogenic fluxes
  - Agricultural/Industrial Nitrogen fixation
  - Fossil fuels, biomass burning, livestock

1.3 Linking Cycles

1.3.1 Runoff

- Runoff as a flux: being dissolved in water adds that compound to the water cycle, helping to move it around. All 3 cycles experience runoff.
- Watersheds: Patterns of runoff across land.

The gulf of Mexico Dead Zone

- Cause
  - Large portion of the Midwest is one watershed, runs off into the Gulf of Mexico.
  - Chemical runoff: Municipal waste (poo), fertilizer (also poo)
  - Nitrogen is often a limiting resource, so the nitrogen runoff from fertilizer and other poo causes an algal bloom.
  - When the algae die, the decomposition of their bodies uses all of the oxygen in the water column.
  - Low oxygen levels in water column along the coast of the Gulf of Mexico.
- Reducing the Dead Zone
  - Hurricanes/windstorms mix up water and infuse oxygen.
- Impacts of Dead Zone
  - Female fish in hypoxic locations have lower fecundity/smaller ovaries.
  - Male fish have smaller testes and lower sperm production.

1.3.2 How the Carbon cycle connects to the Nitrogen Cycle

- Photosynthesis takes CO_2 out of the atmosphere and turns it into sugars.
- *Rubisco* is the protein that actually picks up the CO_2 from the atmosphere.
- *Rubisco* is made up of a lot of nitrogen.
- Plants require lots of nitrogen to capture CO_2.

2 Energy and Trophics

2.1 Ecosystem Energy

2.2 Trophic Roles and Interactions

3 History of Life

3.1 Precambrian to Paleozoic

3.2 Mesozoic to Cenozoic