Recap

- ✓ Atmosphere
- ✓ Temperature inversion
  - Normally, air temperature decreases with an increase in altitude, but during an inversion warmer air is held above cooler air
- ✓ Different layers of atmosphere

Thermosphere (or) Ionosphere

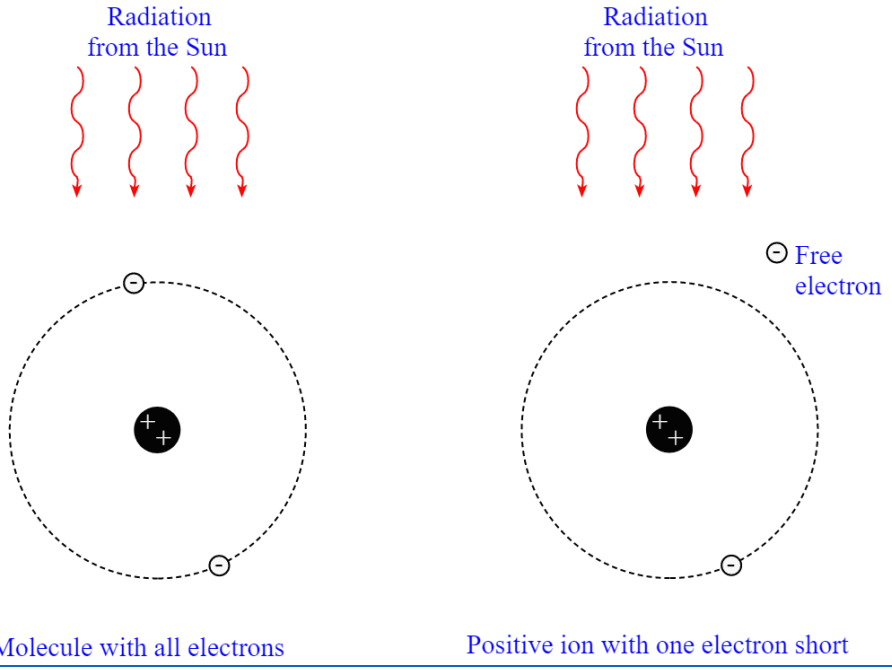
- ✓ The ionosphere is very thin, but it is where aurora take place
  - Charged particles from space collide with atoms and molecules in the thermosphere, exciting them into higher states of energy.
  - The atoms shed this excess energy by emitting photons of light, which we see as the colorful **Aurora Borealis** and **Aurora Australis**.

- ✓ It's responsible for absorbing the most energetic photons from the Sun
- ✓ Also responsible for reflecting radio waves, thereby making long-distance radio communication possible

- ✓ In thermosphere the space shuttles fly and the International Space Station orbits Earth.

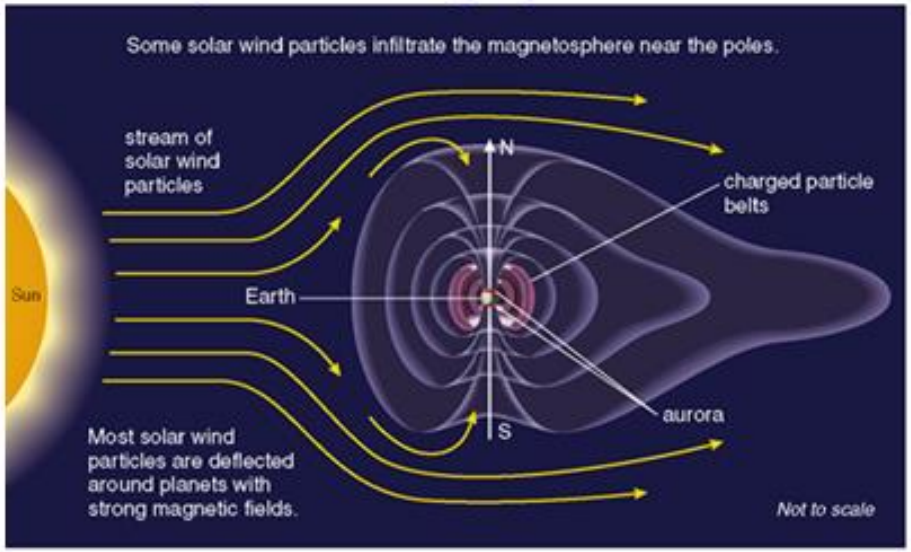
Ionosphere

- ✓ The region of the atmosphere above 80 km
- ✓ Energetic solar radiation knocks off electrons from molecules and atoms, turning them into ions with a positive charge.
- ✓ Ionosphere is a series of regions in parts of the mesosphere and thermosphere where high-energy radiation from the Sun has knocked electrons loose from their parent atoms and molecules.



The Role of the Magnetic Field of Earth

- ✓ Another important characteristics of the Earth is its magnetic fields, which shield us from the bombardment of the high-energy charged particles, mostly from the Sun.
  - Without magnetic field, the high energy particles of solar wind can strip much of the Earth's atmosphere by breaking the bonds between the atoms in the air molecules
  - $N_2 \rightarrow N + N$
  - $O_2 \rightarrow O + O$
  - $H_2O \rightarrow H + H + O$
- ✓ The lighter gases then higher probability of acquiring velocity higher than escape velocity and escape from Earth!



Atmospheric Gases

- ✓ Nitrogen, oxygen, argon, water vapor, carbon dioxide, and most other gases are invisible.
- ✓ Clouds are not gas, but condensed vapor in the form of liquid droplets.
- ✓ Ground based smog, which is visible, contains reactants of nitrogen and ozone.
- ✓ Composition of Atmosphere
  - Nitrogen – 78%
  - Oxygen – 21%
  - Carbon Dioxide – 0.038%
  - Other gases make up the rest
- ✓ % of CO_2 is very low but its very important for Photosynthesis
- ✓ CO_2 also helps in the heat balance

Ozone – is the primary ingredient of smog!

Atmospheric Gases

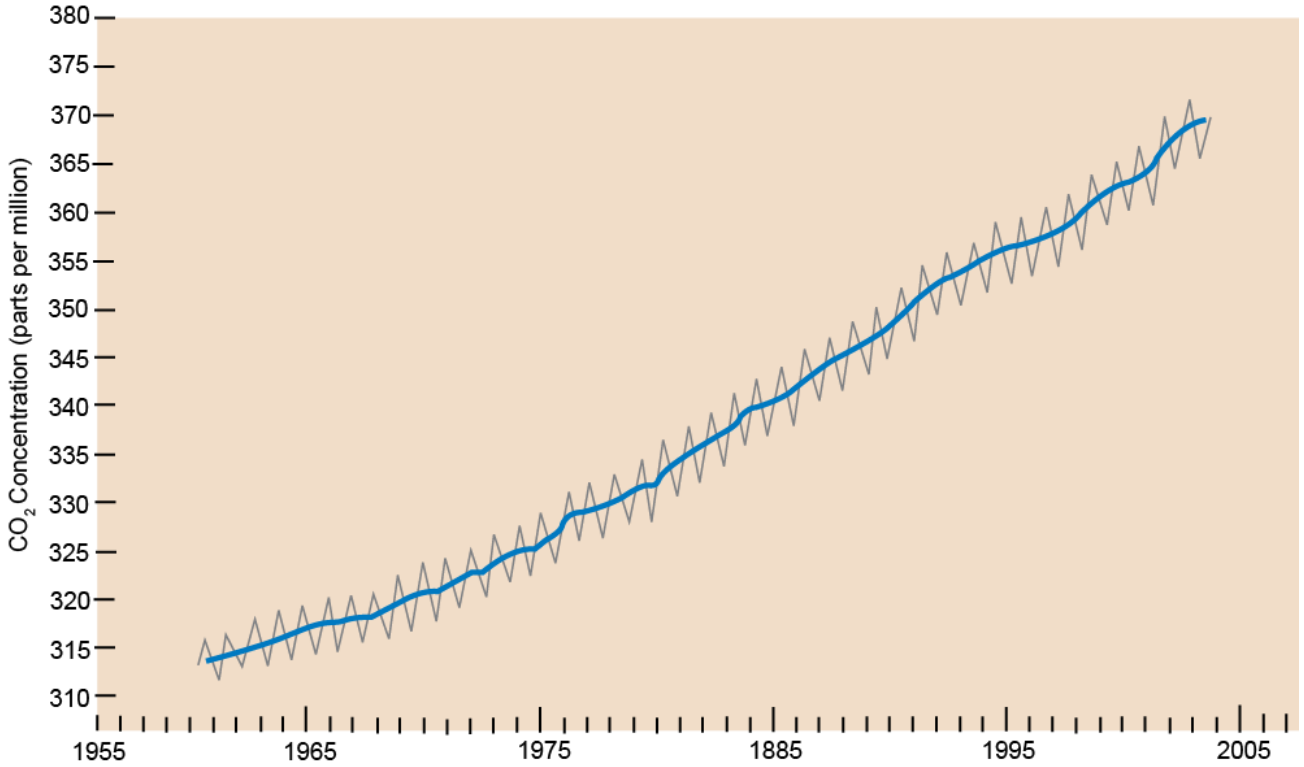
- ✓ Water vapor also present in the atmosphere and in the range of 0.1 % - 5 % (based on temperature, precipitation, rate of evaporation)

- ✓ On average 3 % of water vapor is present in air
  - 3rd most abundant constituent of air

- ✓ At ambient condition
  - <1 % of water vapor at 0 °C (even at freezing point water gets evaporated)
  - ~5 % of water vapor at 35 °C

- ✓ The basic composition of air always same (if we exclude the role of pollution). This is due to constant circulation of air in troposphere

Variable & Increasing Gases

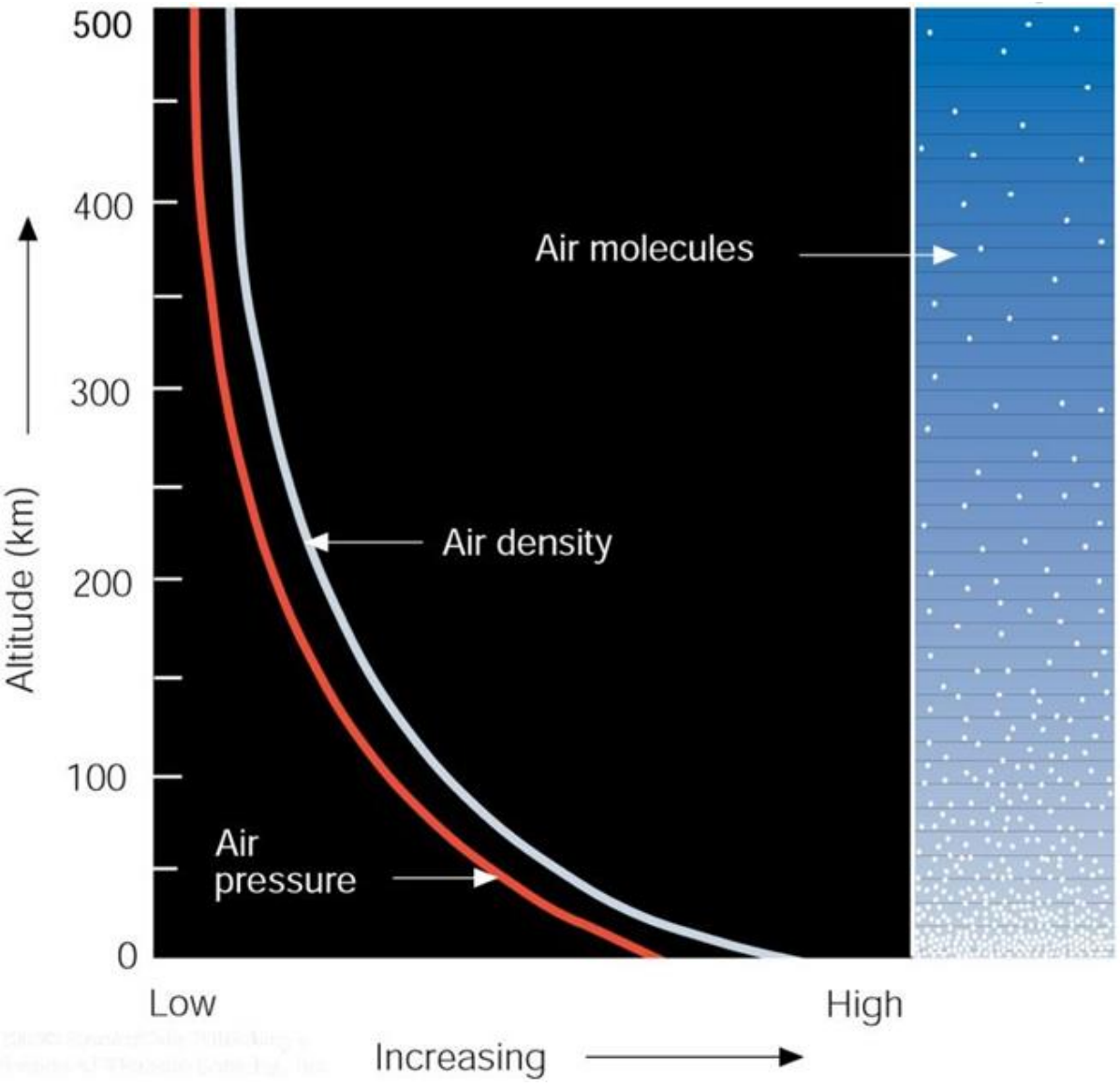


- ✓ Nitrogen and oxygen concentrations experience little change, but carbon dioxide, methane, nitrous oxides, and chlorofluorocarbons are greenhouse gases experiencing discernible increases in concentration. CO_2 has risen more than 18% since 1958.
- ✓ Fossil fuels are the biggest problem!

Aerosols & Pollutants

- ✓ Human and natural activities displace tiny soil, salt, and ash particles as suspended aerosols, as well as sulfur and nitrogen oxides, and hydrocarbons as pollutants.

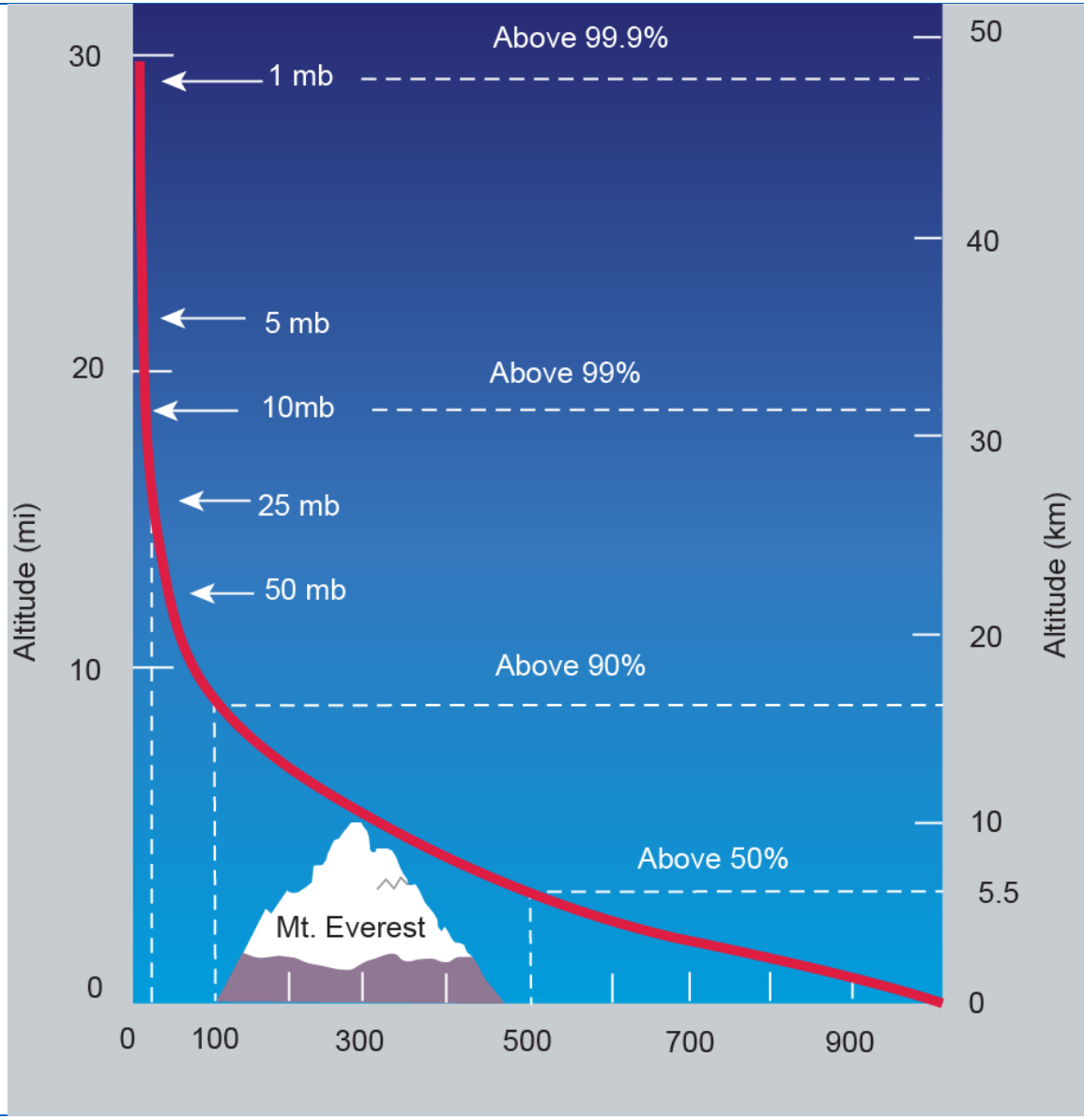
Pressure & Density



- ✓ The amount of force exerted Over an area of surface is called Air pressure!
- ✓ Air Density is The number of air Molecules in a given Space (volume)
- ✓ Gravity pulls gases toward earth's surface, and the whole column of gases weighs
  - 14.7 psi at sea level
  - 1013.25 mbar
  - 1,01,325 Pa
  - 1 atm
  - 760 torr

Vertical Pressure Profile

- ✓ Atmospheric pressure decreases rapidly with height.
- ✓ Climbing to an altitude of only 5.5 km where the pressure is 500 mb (milli bar), would put you above one-half of the atmosphere's molecules.



Ecosystems

- ✓ Environment has been divided into small sections or functional groups for easy studies – Ecosystems

- ✓ An ecosystem is a community of living organisms in conjunction with the non-living components of their environment, interacting as a system
  - Forest
  - Desert
  - Grassland
  - Marsh
  - Pond
  - Field

- ✓ All the ecosystems are self-contained and self-sustaining

Producers and Consumers

- ✓ Ecosystems are sustained by the energy that flows through them

- ✓ **Producers**: Produce their own food
  - Plants
  - Cyanobacteria (blue-green algae)
- ✓ **Consumers**: Consume plants or other creatures to obtain the nutrients and energy they need
  - Divided into four main groups
    - **Herbivores**: feed directly on producers – deer, cows, mice, and grasshoppers
    - **Carnivores**: eat other animals – spiders, frogs, hawks, and all cats (lions, tigers and domestic cats)
    - **Omnivores**: feed on both plants and animals – Rats, Raccoons, Bears, and most humans
    - **Decomposers**: feed on detritus – a freshly dead or partly decomposed remains of plants and animals – Bacteria, Fungi, Earthworms, many insects

Flow of energy through ecosystems

- ✓ **Energy**: The ability to do work or bring about change

  (or) Energy is the capacity to make something happen

  - Kinetic energy
  - Potential energy

- ✓ Energy exits in many forms including Light, Heat, Electrical energy, Nuclear energy and Chemical energy

- ✓ **Energy Transformations:**
  - Stars convert nuclear energy into light and heat
  - Plants convert light energy into chemical energy
  - Animals convert chemical energy into energy of motion

But none of the transformations are 100% efficient

Flow of energy through ecosystems

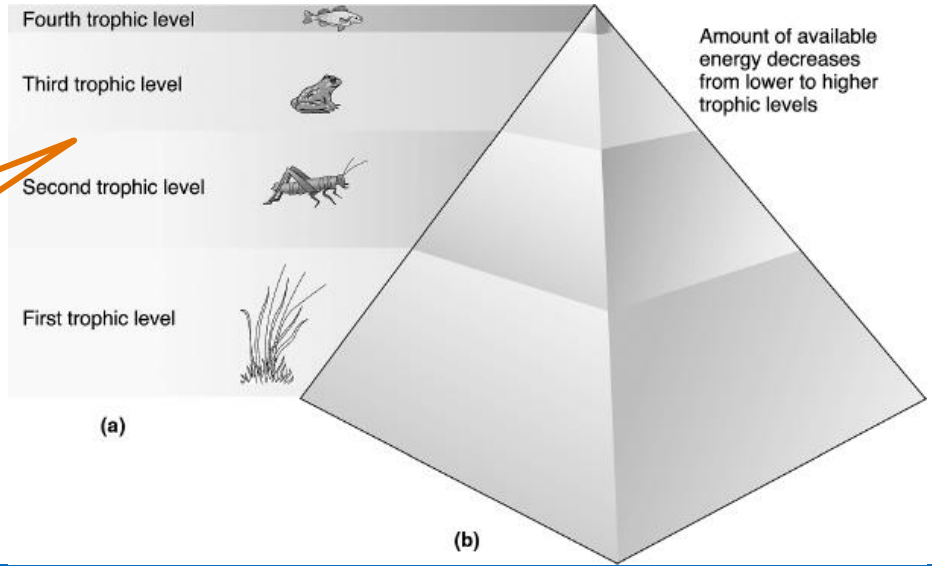
- ✓ First law of thermodynamics
  - Energy can be neither created nor destroyed. It can only be transformed from one form to another
- ✓ Second law of thermodynamics
  - when energy changes from one form to another form, or matter moves freely, entropy (disorder) in a closed system increases.
  - During energy is transferred or transformed, more and more of it is wasted.
- ✓ Most of the inefficient energy conversions lead to release heat
  - Gasoline engine is only 10% efficient

Food chains and Tropic levels

- ✓ Green plants are the only organism that can take energy from the sun and use the process of photosynthesis to store some of that energy in chemicals bonds in the form of sugars, starches and other large molecules.
- ✓ Ecosystem has innumerable feeding pathways or food chains through which energy flows.
  - Grasshoppers eat green leaves
  - Frogs eat Grasshoppers
  - Fish eats Frogs

Each step in the chain is called **Tropic level**

Human beings belong to 2nd and 3rd tropic level



Food chains and Tropic levels

- ✓ Going from one tropic level to the next, an estimated **90%** of the energy that was present at the lower level is lost
- ✓ Second tropic level (herbivores) is only **10%** of the energy at the first tropic level (producers)
- ✓ Third tropic level (carnivores) is only **1%** of the energy at the first tropic level (producers)
- ✓ Due to these mass requirements, food chains rarely go beyond tropic levels

Nutrient cycles

- ✓ All the living being to exist requires constant supply of both **Energy** and **Nutrients**
- ✓ Energy flows endlessly from producers to consumers
- ✓ Light energy from Sun comes as the waste energy that can't be reused by Sun itself
- ✓ In contrary, Nutrients are continually recycled and reused.
- ✓ Living beings die, their tissues are broken down and vital chemicals are returned to soil, water and atmosphere

Nutrient cycles

- ✓ Tissues of living organism shows more than 95% of the mass of the tissues is made from just 6 of Earth's 92 naturally occurring elements
  - Carbon
  - Hydrogen
  - Oxygen
  - Nitrogen
  - Sulfur
  - Phosphorous

Also Building blocks for the manufacture of Carbohydrates, Proteins and Fats

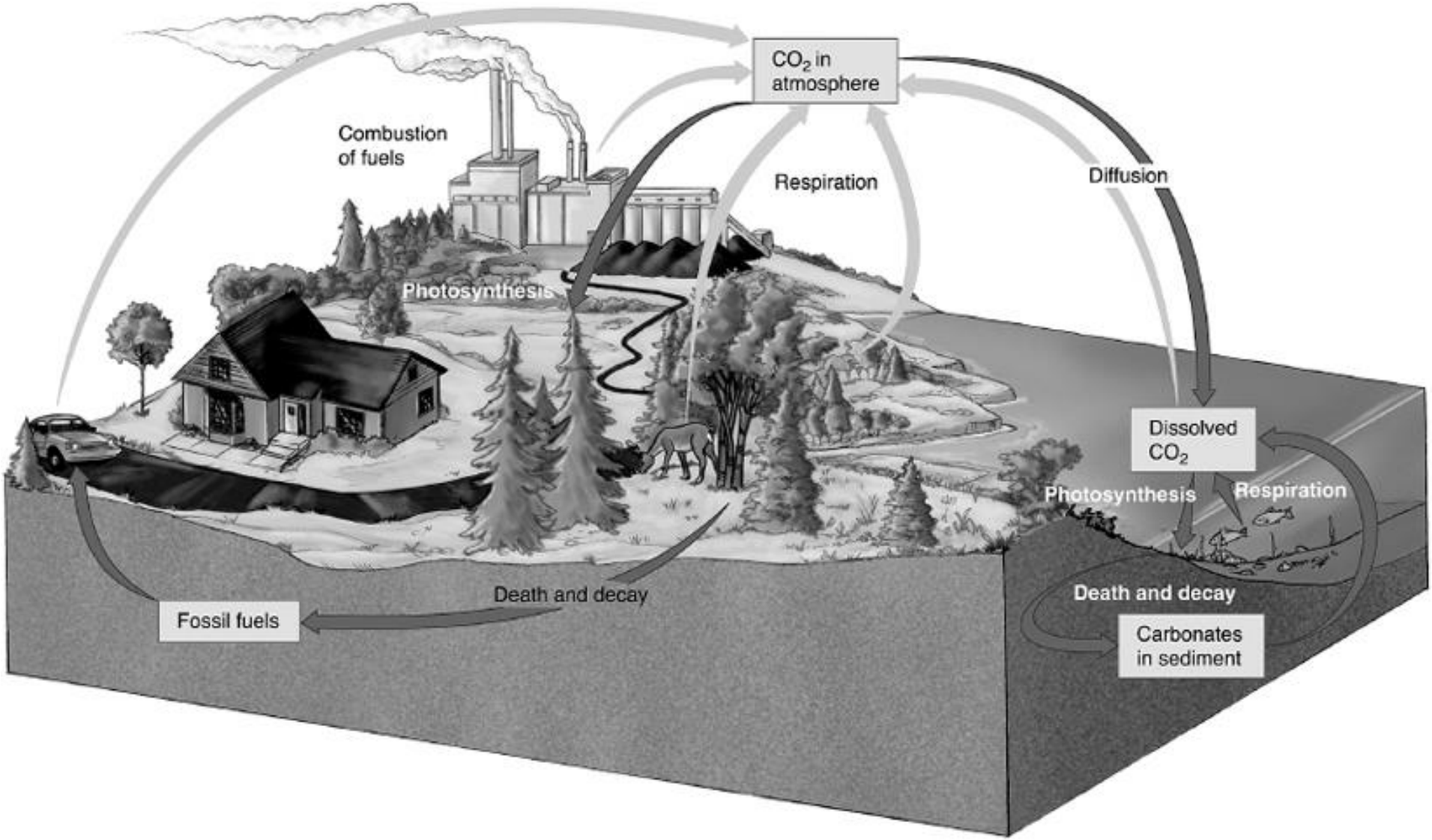
Plants composed of Carbohydrates & Animals composed of Proteins primarily

- ✓ Other main elements for rest 5% are
  - Iron (Fe) – Mostly in Hemoglobin
  - Magnesium (Mg) – Mostly Chlorophyll
  - Calcium (Ca) – Bones and Cartilage
- ✓ Other elements (trace quantities): 16 elements, like Cu, Zn, Na, K
- ✓ All these elements are flowed through Trophic levels

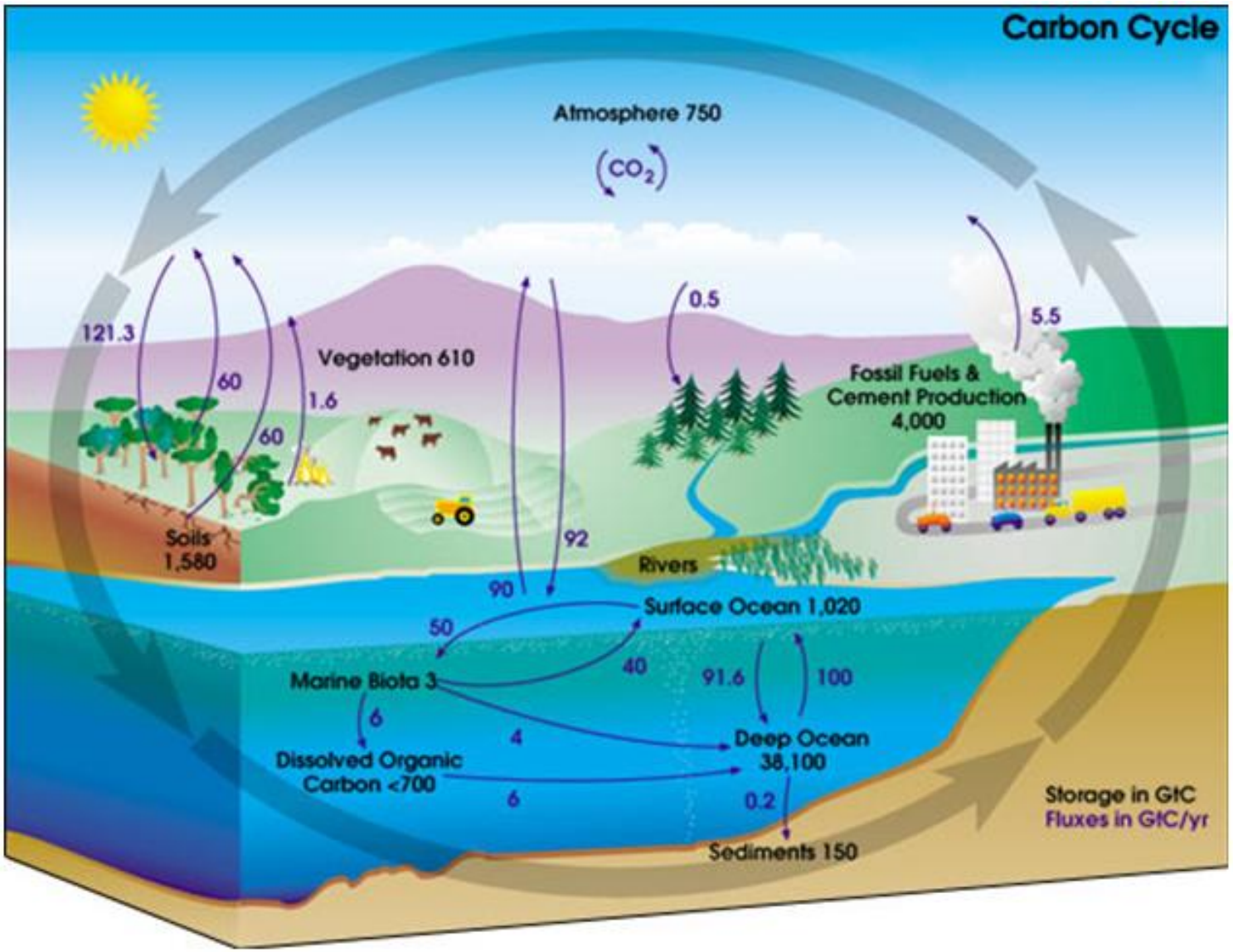
Carbon Cycle

- ✓ Carbon is exchanged between the active pools due to various processes –
  - photosynthesis
  - respiration between the land and the atmosphere
  - diffusion between the ocean and the atmosphere

Carbon Cycle



Carbon Cycle



GtC ~ 3.67 Giga tons of CO_2

Carbon Cycle