Kirkuk University
College of science
Biology department
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Atmosphere

1-Stages of earth's atmosphere formation
2- Structure and composition of atmosphere
3- Layered structure of atmosphere
4-Exchange between earth and atmosphere

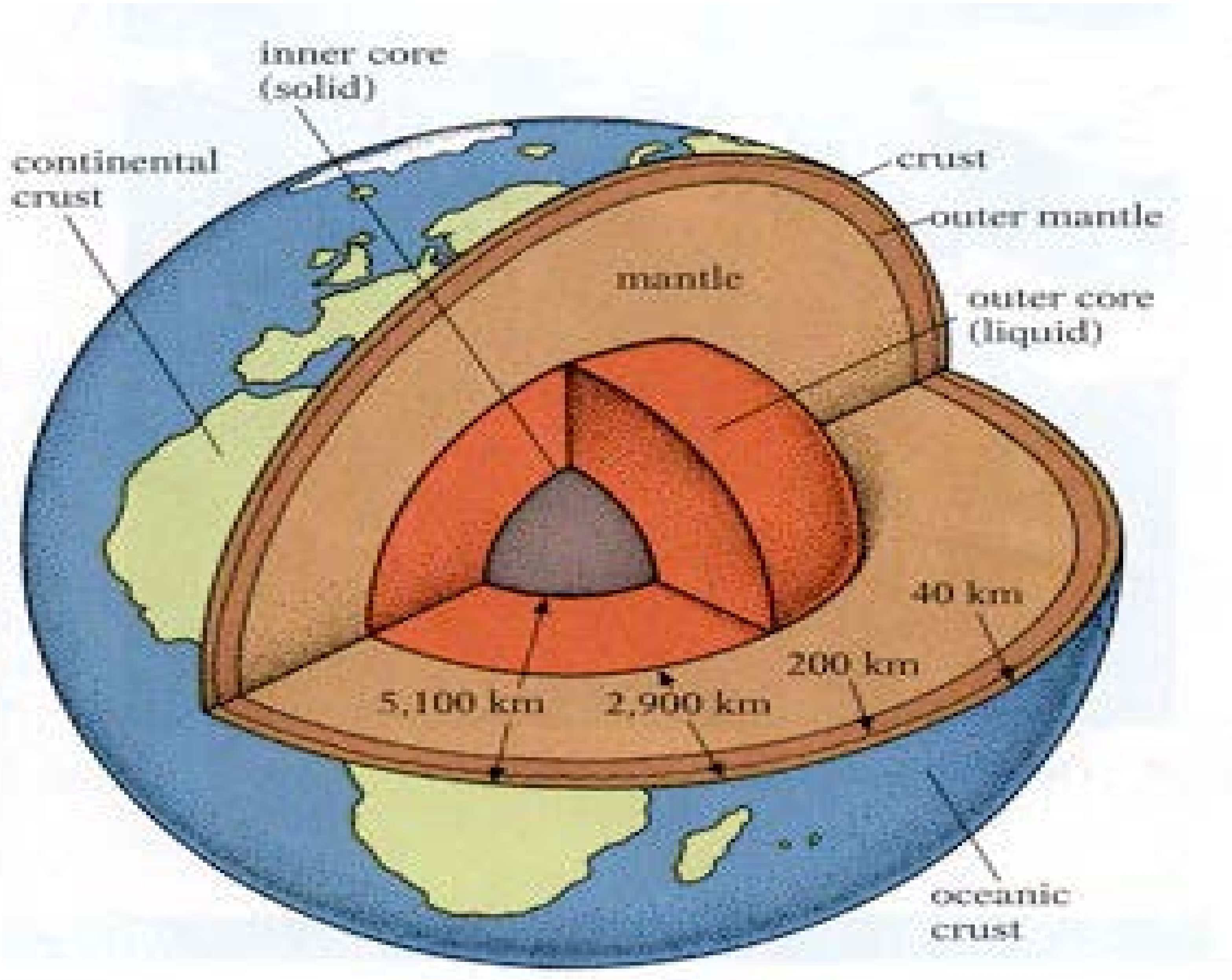
The one most widely held today is that the universe is 15 to 20 billion years old, and that the sun and its planets formed about 4.6 billion years ago from a cloud of cosmic dust and gas. Most of this material condensed into a single compact mass, the sun. Within the remainder of the dust and gas cloud, lesser centers of condensation began to form. These became the planets, of which the earth is one.

As the earth condensed, a stratification of its components took place, with the heavier materials, such as iron and nickel, moving toward the center and lighter substances becoming more concentrated nearer the surface. Among these lighter materials must have been hydrogen and helium, which formed the first atmosphere.
The earth was too small, and its gravitational field too weak, to retain this first atmosphere and eventually all the gases escaped into space.

As time passed, the components became further stratified into three distinct regions, with the dense iron and nickel accumulating in the center to form the core, the less dense silicates of iron and magnesium forming a partly molten mantle surrounding the core, and the lighter substances remaining near the surface.

As the surface of the earth cooled, the surface materials, composed primarily of the lighter silicates, solidified to form a crust. This crust is quite thin compared to the diameter of the earth —about the thickness of an eggshell compared to the diameter of an egg.

The crust solidified into massive plates resting on the molten mantle. These plates are moved about by the upwelling of new crust in some places and sinking of old crust in others.. The intense heat in the interior of the earth also tended to drive out various gases, which escaped primarily by volcanic action .These gases formed asecond atmosphere of the earth.


inner core
(solid)
continental
crust
crust
outer mantle
mantle
outer core
(liquid)
40 km
200 km
5,100 km
2,900 km
oceanic
crust

No one knows the precise composition of that atmosphere but probably it was rich in carbon dioxide and contained only traces of nitrogen and free oxygen . The most widely accepted model of the earth's early atmosphere assumes that it was made up primarily of the gases known to be produced by present-day volcanoes. These gases are H_2O, CO. CO_2, H_2S, N_2 and H_2; in such a mixture, hydrogen cyanide (HCN) and formose (H_2CO) are easily formed and would probably also present. cooling of the earths crust caused water condensation and eventually oceans were formed about 3.8 billion years ago. It is though that about 3.8 billion years ago ,an atmosphere composed of reduced gases such as CH_3 or CO_2,NH_3 or N_2 ,H_2O or H_2 had developed.

Small Organic Molecules Formed Abiotically

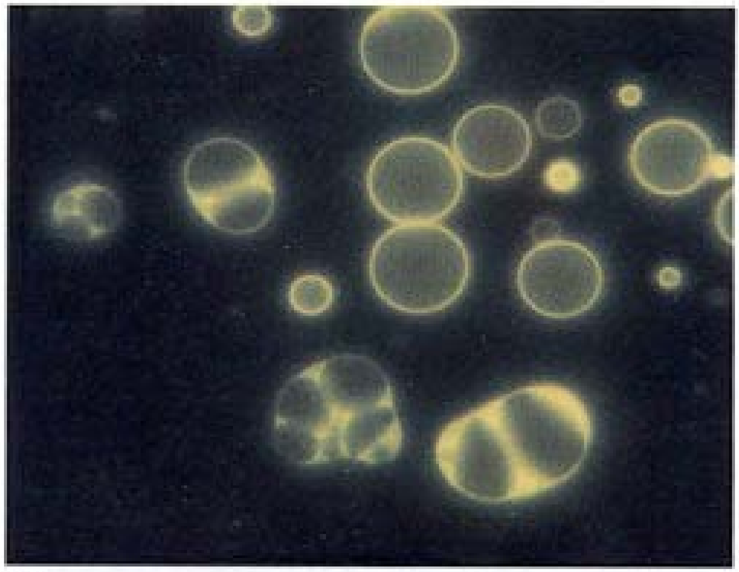
If the early earth had an oxygen-poor atmosphere, as many astronomers and geochemists believe, and the primitive seas contained a mixture of salts, CO_2, H_2S, HCN, CH_4, NH_3, formose, and N_2, how were the more complex organic molecules formed? The molecules thought to have been present in the primitive seas are thermodynamically stable; there is no tendency for these materials to react spontaneously with each other to form other compounds. Yet for life to have arisen it would seem that at the very least the critical building-block materials, particularly amino acids and the purine and pyrimidine bases, would have been necessary. How might these compounds have been formed on the primitive earth?

There are two basic hypotheses to account for the accumulation of complex organic compounds on the early earth. The first hypothesis suggests that the complex organic molecules came from asteroids and meteors striking the earth – i.e., an extraterrestrial synthesis. Many of these extraterrestrial objects are rich in complex organic molecules created during the formation of the solar system billions of years ago). Because the early atmosphere was denser than today's, incoming objects would have been slowed before striking the earth's surface. Some astronomers estimate that from 106 to 107 kilograms of complex organic molecules could have survived impact annually. It is possible, therefore, that the early earth had a vast supply of the complex molecules necessary for the evolution of life without any need to synthesize them out of simpler substances.

According to second hypothesis, complex organic molecules were generated from the small inorganic compounds already present. These molecules reacted with one another to form larger, more complex organic molecules. To do so, some external source of energy must have been acting on the mixture since these molecules are quite stable. One possible energy source would have been solar radiation, including visible light, ultraviolet (UV) light, and X rays; of these, ultraviolet light would probably have been the most important.

;. The ultraviolet radiation would have been much more intense on the early earth than it is today. A second important possibility is energy from electrical discharges, such as lightning, while a third is heat from the earth's core and the sun.

A



B

carbonaceous chondrite meteorite. (A) The golf-ball-sized fragment is part of a meteorite that fell near Murchison, Australia, in 1969. Tiny particles of organic compounds, accounting for 1-2% of the fragment's weight, are scattered throughout the stone. (B) When the organic material is extracted, some of the molecules self-assemble into vesicles. The yellow-green color is produced by the fluorescence of polycyclic aromatic hydrocarbons, a class of extremely complex organic molecules.

In **the oceans , very simple organic molecules had been assembled or accumulated in this environment that had no o2 but free o would have quickly broken down the first simple organic molecules that were necessary precursors of life .within this environment ,the first very simple living organisms were developed.**

The earliest photosynthesis reaction properly involved the oxidation of reduced gases as H2s and this reaction carried out by sulfur bacteria or cyanobacteria in area with volcanic activity

$$2H_2s + CO_2 \rightarrow CH_2o + H_2o + 2S$$

After that the photochemical reaction that splitting of water were favored

$$H_2O + CO_2 \rightarrow CH_2o + O_2$$

The availability of O2 created by this reaction dramatically changed the nature of atmosphere .O2 released by photosynthesis prior to about 2 billion years before present was bound with Fe^{+3} to form Fe_2O_3.After that about 4 billion years befor present ,O2 reduced in the oceans form deposited of SO_4^{-2}. Then O2 began to appear in the atmosphere about 400 million years ago.

58% of oxygen as Fe_2O_3

38% of oxygen as SO_4^{-2}

4% of oxygen in the atmosphere

•Eukaryotic organisms are though to have first appeared around 1.3 billion years ago

•The evolution of membrane bound chloroplast that containing photosynthesis pigments provided for more efficient photosynthesis and realese of more O_2 in to atmosphere.

•Other chemical reaction arose as nitrogen transformation

$NH_3 \rightarrow NO_2^- \rightarrow NO_3^-$

With realese of energy.

Composition of ATMOSPHERE

The primitive atmosphere was formed as a result of out gassing interior of planet.these gases are N_2, H_2O, CO_2 ,NH_3 and CH_4 with very little O_2

These gasses react to form different radicals that are very active

H_2O+ ג<240nm →**H+OH**

CO_2 ג<240nm →**CO+O**

H+H →H_2

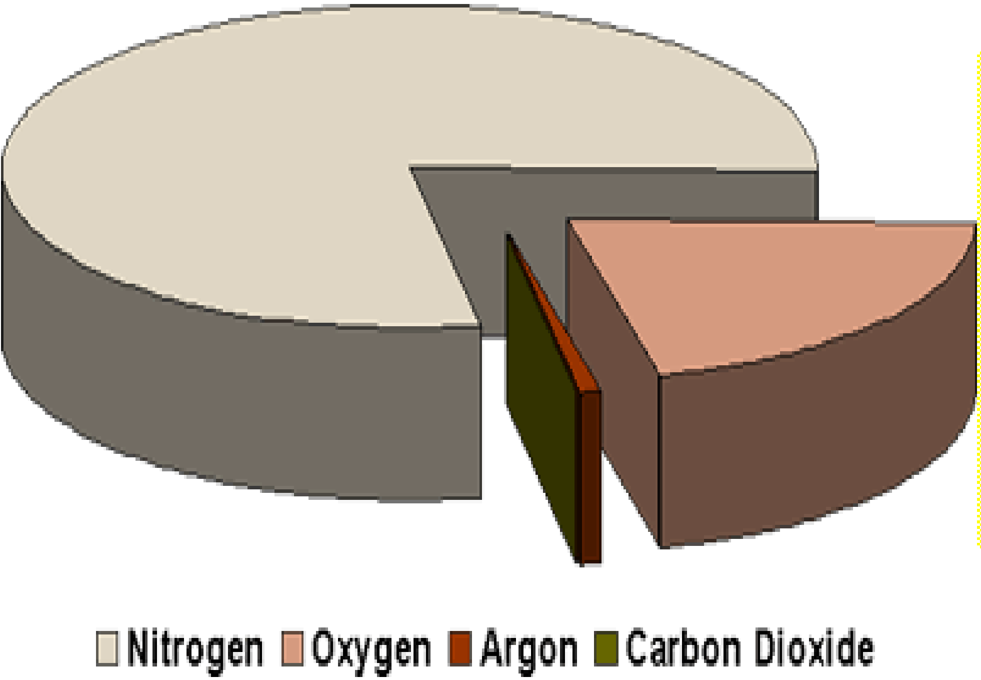
OH+OH →H_2O+O

2O →O_2

O_2+2H_2 →2H_2O

So the structure of atmosphere is complex of mixture of gases and suspended particles.This mixture dominated by N_2 and O_2 which togather formed about 99% of air dry volum.

Table 2.3 ***Average composition of the troposphere and lower stratosphere***



Gas	Proportion by Volume
nitrogen, N	78.03
oxygen, O	20.99
carbon dioxide, CO	0.03
hydrogen, H	0.01
argon, Ar	0.94

Other gases include neon , helium, ozone, methan, krypton and Xenon

Layer structure of Atmosphere

1- Troposphere

the troposphere, extends from the surface to an upper boundary, the tropopause, the height of which varies, but averages about 16 km at the equator and 8 km at the poles. Within the troposphere temperature decreases with height by an average of about 6.5°C km-1.The change in temperature lead to produce pressure and wind.Temperature decrease till reach -60C◦.

2- Stratosphere

About 50km above the surface starts from tropopause (-60C ◦) and temp. begin to increace to 0C ◦at the end of the zone.

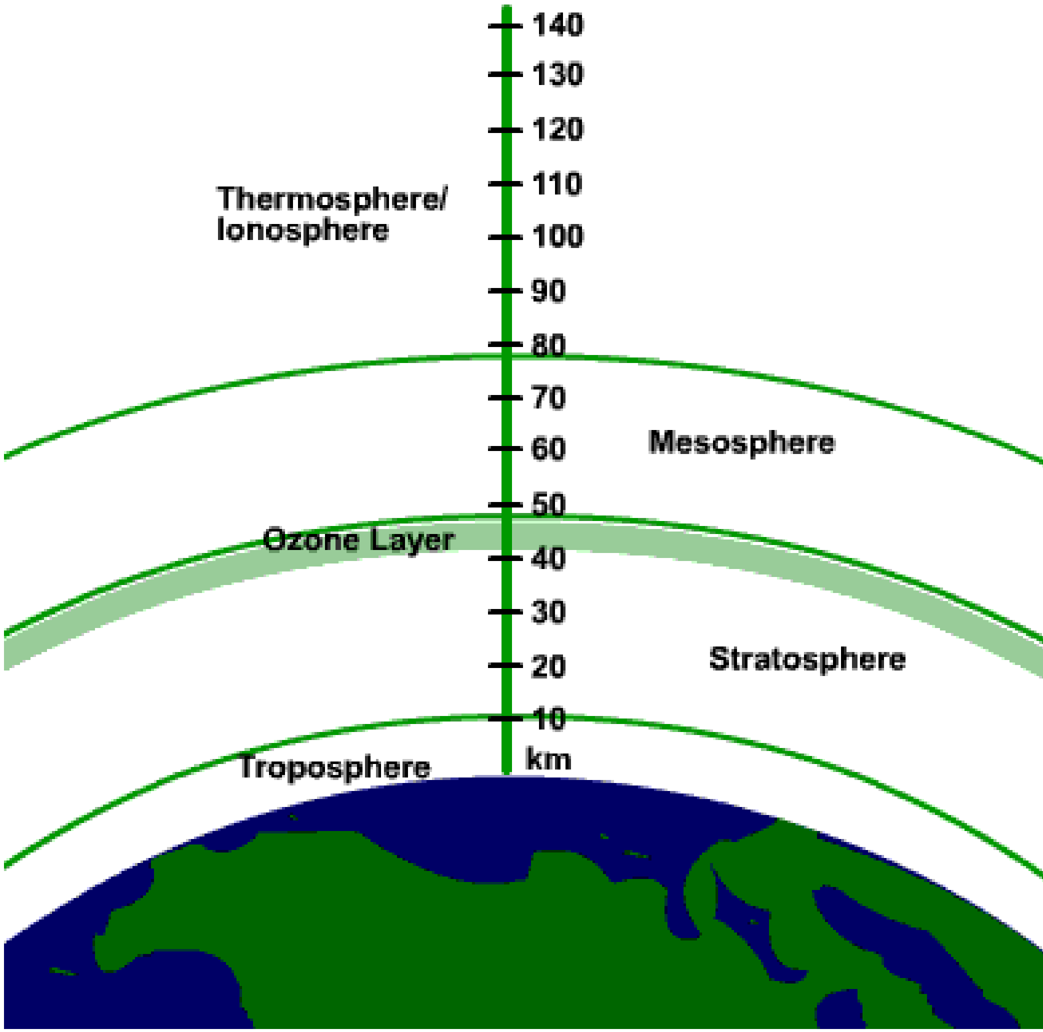
3-In the mesosphere, above the stratopause, temperature once more decreases with height, to about -90°C at the mesopause, about 80 km

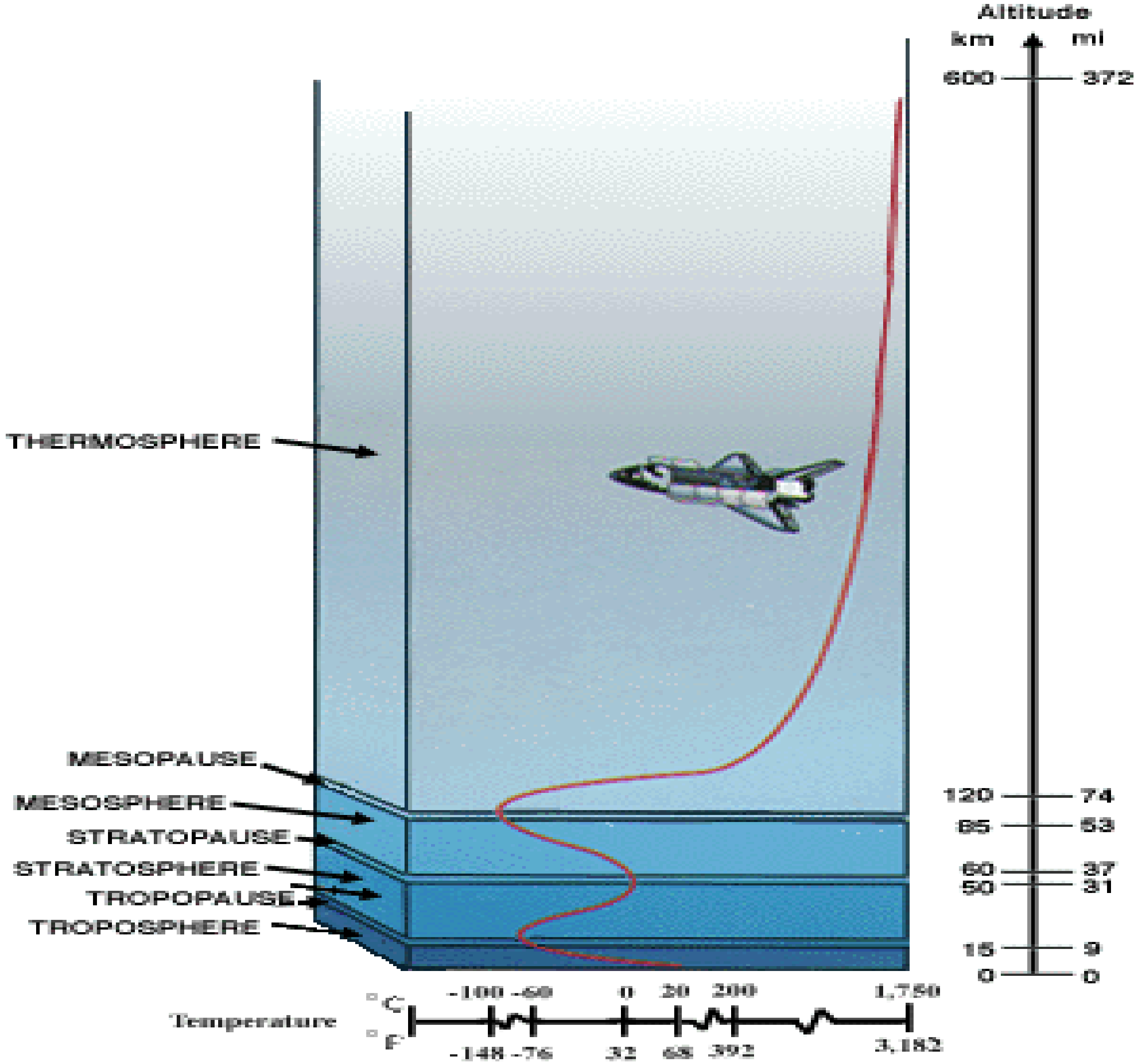
4- Thermosphere

At about 350 km the temperature may exceed 900 °C, probably because of the energy imparted by absorption of ultraviolet radiation by atomic oxygen

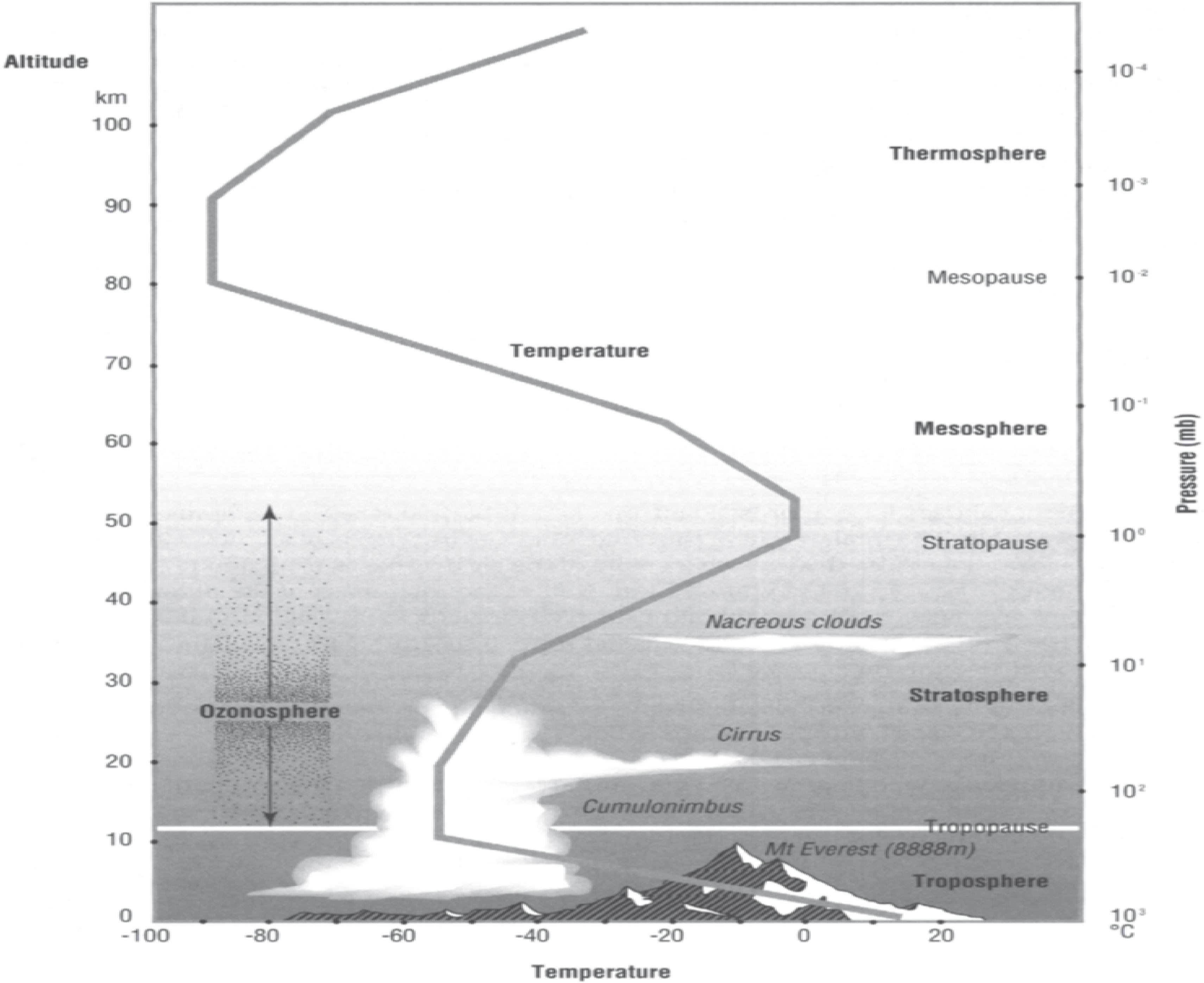
Layers of the atmosphere

There are 4 layers in the atmosphere





Altitude
km
mi
600
372
120
74
85
53
60
37
50
31
15
9
0
0
THERMOSPHERE
MESOPAUSE
MESOSPHERE
STRATOPAUSE
STRATOSPHERE
TROPOPAUSE
TROPOSPHERE
Temperature
°C
-100 -60 0 20 200 1,750
°F
-148 -76 32 68 392 3,182


Altitude
km
100
90
80
70
60
50
40
30
20
10
0
Thermosphere
Mesopause
Temperature
Mesosphere
Stratopause
Nacreous clouds
Stratosphere
Ozonosphere
Cirrus
Cumulonimbus
Tropopause
Mt Everest (8888m)
Troposphere
-100
-80
-60
-40
-20
0
20
°C
Temperature
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Pressure (mb)

Between about 30 and 60 km the density of oxygen molecules is high enough to intercept most of the incoming solar ultraviolet radiation at wavelengths below 0.29 μm. The energy imparted to them separates the molecules ($O_2 \rightarrow O + O$). Some of the oxygen atoms then combine with oxygen molecules to form ozone ($O + O_2 \rightarrow O_3$).

Ozone is unstable and may decompose either by encountering more oxygen atoms $O_3 + O \rightarrow 2O_2$) or by absorbing more ultraviolet radiation. (Ozone is, therefore, constantly forming, decomposing, and re-forming, and the process is in equilibrium above about 40 km.

The thickness of the ozone layer is often reported in Dobson units (DU). This unit was devised by G.M.B.Dobson, a British physicist who studied stratospheric ozone refers to the thickness of the layer that a gas would form. In the case of ozone, 1 Dobson unit corresponds to a thickness of 0.01 mm and the amount of ozone in the ozone layer is typically 220 –460 DU, corresponding to a layer 2.2–4.6 mm thick

Talk about ozone depletion

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Environmental prblems in the atmosphere

1- Air pollution

2-Ozone layer depletion and ozone hole

3- Global warming

4- radioactive pollution

5- Photochemical smog

Talk about green house effect

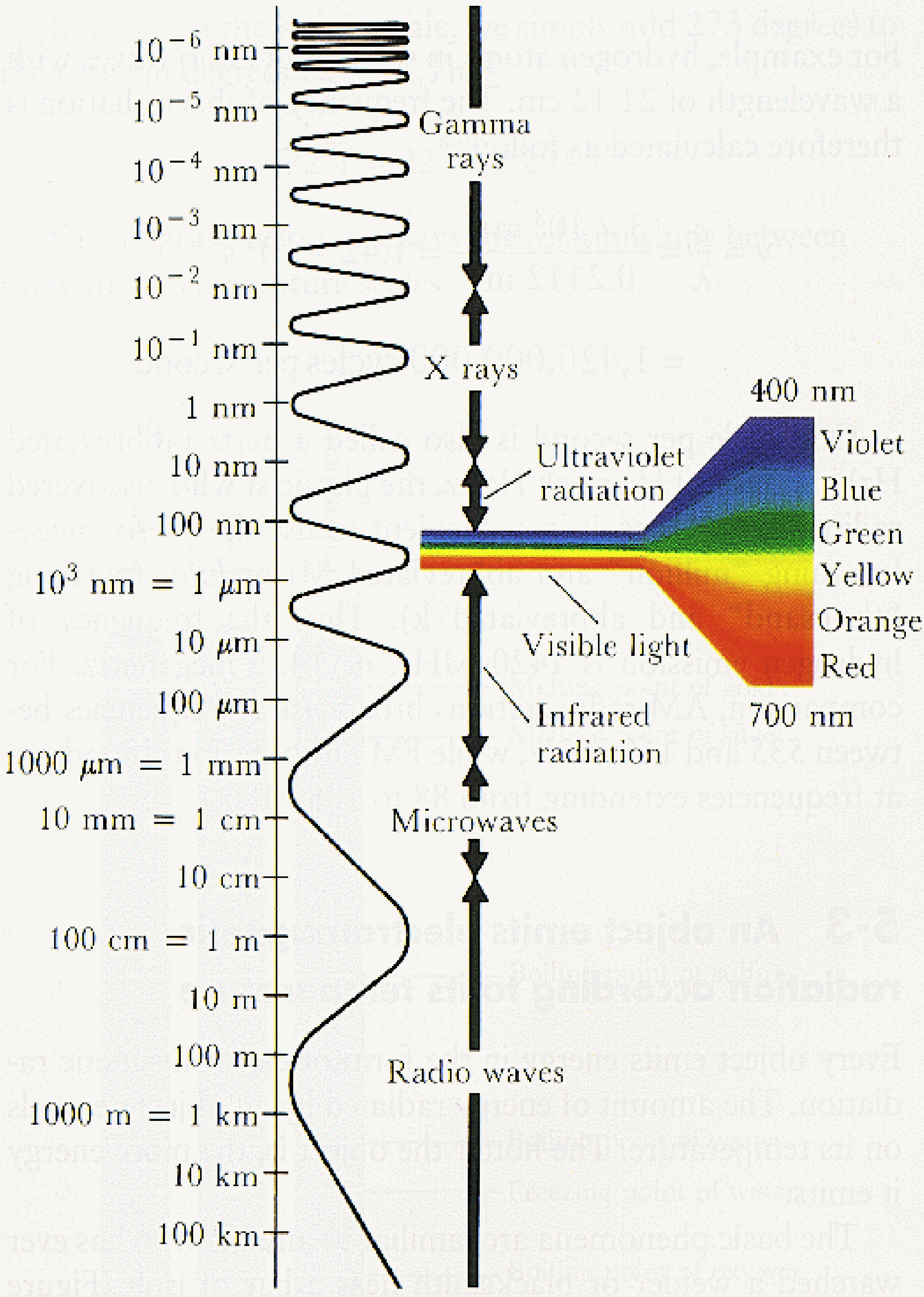
Exchange between earth and atmosphere

- There is alittle exchange between atmosphere and space ,while there is two way flow of matter between atmosphere and earth.
- Most of N_2, O_2, CO_2, H_2O enter and leave the atmosphere as part of their biogeochemical cycles in the absence of human activity so:
- Input of matter = output of matter
- Therefore over all composition of atmosphere has remain constant. The effect of human activity is the increasing the concentration of trace gases including CO_2, Co, NOx Sox ,CFC, Ch_4……..
- The energy inputs to the atmosphere arise as a result of irradiation from both sun and earth.
- from convection and conduction of thermal energy from earth surface (sensible heat) and latent heat related with the change of state of vaporation and condensation.

Solar Radiation and how the Atmosphere is Heated

The term radiation is refers to any form of energy which can travel through a vacuum. (Sound, for instance, cannot travel through a vacuum and requires a medium (like air or water)

All forms of radiation share certain properties, including traveling through a vacuum at the same speed (the so-called speed of light) and being able to be characterized as waves. The following diagram shows the various types of radiation and some of their properties .
The array of radiation, often called the electromagnetic spectrum, varies from the shortest wavelength gamma rays to the longest radio waves. Each one of these types of radiation travels through a vacuum at the same speed of light, however, each type of radiation has its own wavelength and frequency. Moreover, and this is very important, each packet of radiation carries a certain amount of energy. Specifically, the higher the frequency of the radiation (similarly, the shorter the wavelength), the greater the energy contained in the packet of radiation. The diagram below shows how we measure the wavelength of a wave:


10 −6 nm
10 −5 nm
10 −4 nm
10 −3 nm
10 −2 nm
10 −1 nm
1 nm
10 nm
100 nm
10^3 nm = 1 μm
10 μm
100 μm
1000 μm = 1 mm
10 mm = 1 cm
10 cm
100 cm = 1 m
10 m
100 m
1000 m = 1 km
10 km
100 km
Gamma rays
X rays
Ultraviolet radiation
Visible light
Infrared radiation
Microwaves
Radio waves
400 nm
Violet
Blue
Green
Yellow
Orange
Red
700 nm

Each type of gas in the Earth's atmosphere will interact with incoming solar radiation,. In particular, different gases are effective at absorbing different wavelengths of solar radiation. For instance, atomic nitrogen and oxygen are extremely efficient absorbers of gamma and x-rays, so solar gamma and x-rays are absorbed in the Earth's thermosphere. The heating that takes place in the thermosphere is the direct result of this absorption of solar gamma and x radiation.

solar ultraviolet light is absorbed by ozone in the stratosphere, and the heating of the stratosphere is the result of this direct absorption of solar energy in that region .

The sunlight that travels through the troposphere essentially unabsorbed, and reaches the surface of the Earth. This means that this sunlight warms the Earth, but also means that the sun is not directly heating the troposphere. Rather, this solar energy warms the Earth, and the Earth emits its own energy to space. Because the surface of the Earth is much cooler than the surface of the Sun, the Earth emits most of its energy at longer wavelengths (i.e., lower energy radiation). Almost all of the Earth's energy is emitted in the infrared portion of the spectrum.

There are gases in the troposphere that are efficient absorbers of the Earth's emitted infrared energy. The two most effective of these IR absorbers are water vapor and carbon dioxide. Thus, the troposphere of the Earth is warmed by the surface of the Earth, not by the Sun directly. Molecules of water vapor and carbon dioxide absorb the IR emitted by the Earth, and share this energy with other molecules in the troposphere via successive collisions. The name **greenhouse effect** is often used to describe this process, in which solar energy warms the Earth, and Earth emitted IR is absorbed to warm the troposphere. (This is sometimes called the atmospheric effect.)

Earth's troposphere was warmed by the greenhouse effect long before there were any human industrial activities to impact global climate. In fact, without the atmosphere producing any greenhouse effect, the Earth's surface would be at a temperature of approximately -15C^{o}, rather than the global average of +15C^{o}. The concern held by many scientists and environmentalists is not that there is a greenhouse effect, indeed without one the planet would be much more inhospitable. Rather, the concern is over an enhanced greenhouse effect, where CO2 produced by human industrial activities increases the magnitude of the greenhouse effect and contributes to a global warming

Talk about **Albedo and heat capacity**

Dr. Awaz B. Mohammed