S.S. COLLEGE, JEHANABAD
(GEOGRAPHY DEPARTMENT)

B.A. PART - 1 (PHYSICAL GEOGRAPHY : PAPER - 1)

TOPIC : COMPOSITION AND STRUCTURE OF ATMOSPHERE

- **Prof. KUMARI NISHA RANI**

COMPOSITION AND STRUCTURE OF ATMOSPHERE

We all know that earth is a unique planet due to the presence of life. The air is one among the necessary conditions for the existence of life on this planet. The air is a mixture of several gases and it encompasses the earth from all sides. The air surrounding the earth is called the atmosphere.

- Atmosphere is the air surrounding the earth.
- The atmosphere is a mixture of different gases. It contains life-giving gases like Oxygen for humans and animals and carbon dioxide for plants.
- It envelops the earth all round and is held in place by the gravity of the earth.
- It helps in stopping the ultraviolet rays harmful to the life and maintains the suitable temperature necessary for life.
- Generally, atmosphere extends up to about 1600 km from the earth's surface. However, 99 % of the total mass of the atmosphere is confined to the height of 32 km from the earth's surface.

COMPOSITION OF ATMOSPHERE

Main gases of the atmosphere are nitrogen, oxygen, water vapour, carbon dioxide, methane, nitrous oxide, and ozone. These gases are extremely important to the health of the Earth's biosphere.

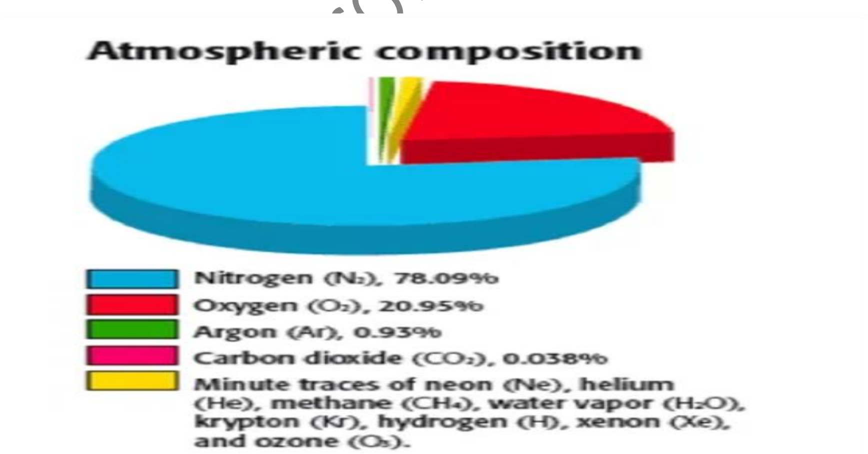
Nitrogen and oxygen are the main components of the atmosphere by volume. Together these two gases make up approximately 99% of the atmosphere. Both of these gases have very important associations with life.

Nitrogen is removed from the atmosphere and deposited at the Earth's surface mainly by specialized nitrogen-fixing bacteria, and by way of lightning through precipitation.

The addition of this nitrogen to the Earth's surface soils and various water bodies supplies much-needed nutrition for plant growth. Nitrogen returns to the atmosphere primarily through biomass combustion and denitrification.

Oxygen is exchanged between the atmosphere and life through the processes of photosynthesis and respiration. Photosynthesis produces oxygen when carbon dioxide and water are chemically converted into glucose with the help of sunlight.

In respiration, oxygen is combined with glucose to release energy for metabolism. The products of this reaction are water and carbon dioxide.



The water vapour varies in concentration in the atmosphere both spatially and temporally. The highest concentrations of water vapour are found near the equator over the oceans and tropical rain forests.

Cold polar areas and subtropical continental deserts are locations where the volume of water vapour can approach zero percent. Water vapour has several very important functional roles on our planet. It redistributes heat energy on the Earth through latent heat energy exchange.

The condensation of water vapour creates precipitation that falls to the Earth's surface providing needed fresh water for plants and animals. It helps to warm the Earth's atmosphere through the greenhouse effect.

The fifth most abundant gas in the atmosphere is carbon dioxide. The volume of this gas has increased by over 35% in the last three hundred years. This increase is primarily due to human-induced burning from fossil fuels, deforestation, and other forms of land-use change.

Carbon dioxide is an important greenhouse gas. The human-caused increase in its concentration in the atmosphere has strengthened the greenhouse effect and has definitely contributed to global warming over the last 100 years.

Carbon dioxide is also naturally exchanged between the atmosphere and life through the processes of photosynthesis and respiration.

Methane is a very strong greenhouse gas. Since 1750 (since the industrial revolution), methane concentrations in the atmosphere have increased by more than 150%.

The primary sources for the additional methane added to the atmosphere are; rice cultivation; domestic grazing animals; termites; landfills; coal mining; and, oil and gas extraction.

The average concentration of the greenhouse gas nitrous oxide is now increasing at a rate of 0.2 to 0.3% per year.

Concentrations of ozone gas are found in two different regions of the Earth's atmosphere. The majority of the ozone (about 97%) found in the atmosphere is concentrated in the stratosphere at an altitude of 15 to 55 kilometres above the Earth's surface.

This stratospheric ozone provides an important service to life on the Earth as it absorbs harmful ultraviolet radiation. In recent years, levels of stratospheric ozone have been decreasing due to the build-up of human-created chlorofluorocarbons in the atmosphere.

Ozone is also highly concentrated at the Earth's surface in and around cities. Most of this ozone is created as a by-product of human-created photochemical smog.

STRUCTURE OF THE ATMOSPHERE

It surrounds the earth from all sides. Generally, it extends up to about 1600 kilometres from the earth's surface. 97 % of the total amount of weight of the atmosphere is limited up to the height of about 30 kilometres.

The atmosphere can be divided into five layers according to the variation of temperature and density:

(a) Troposphere,

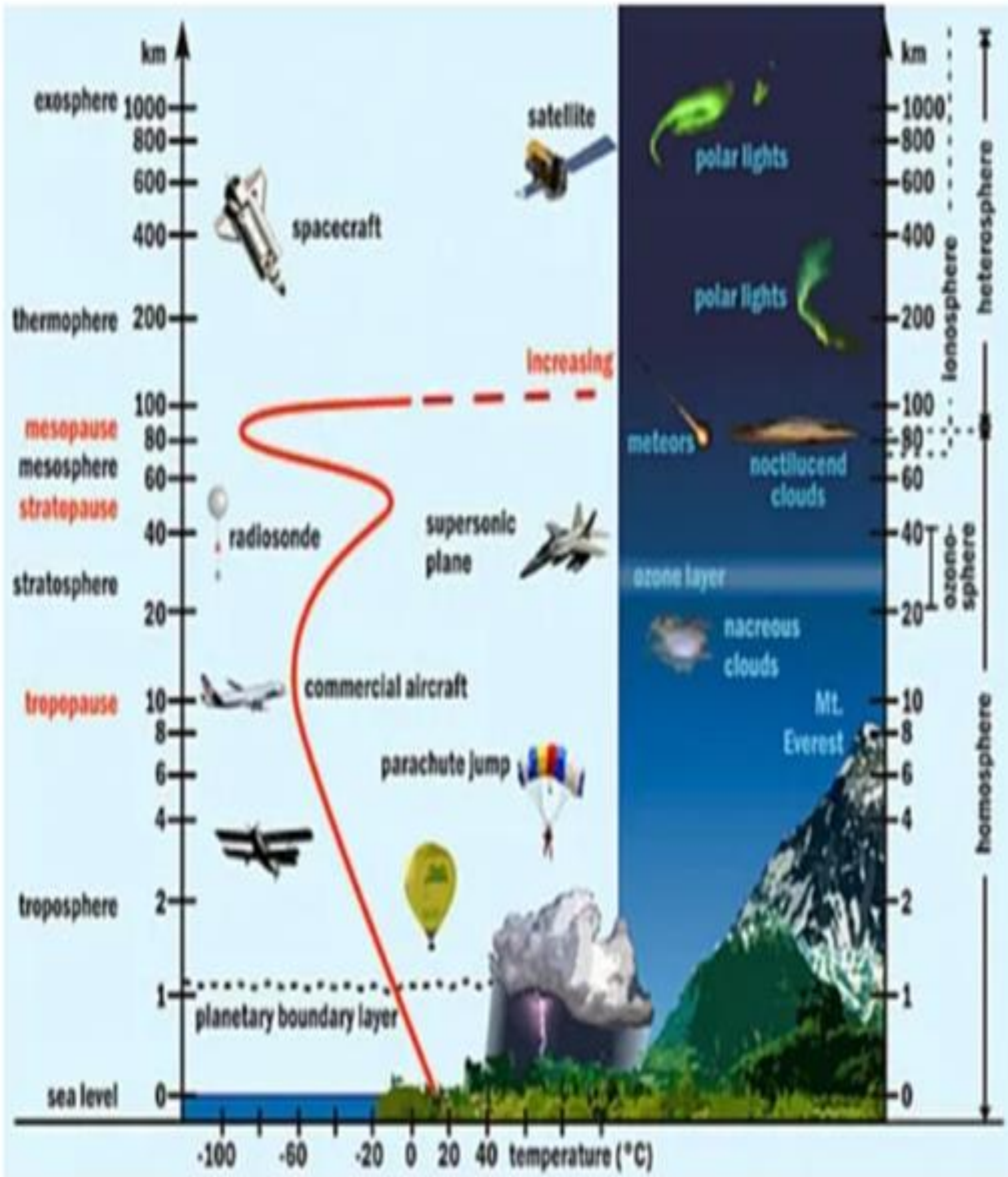
(b) Stratosphere,

(c) Mesosphere,

(d) Ionosphere and

(e) Exosphere

Salient features of different layers of Atmosphere given below:



a) Troposphere:

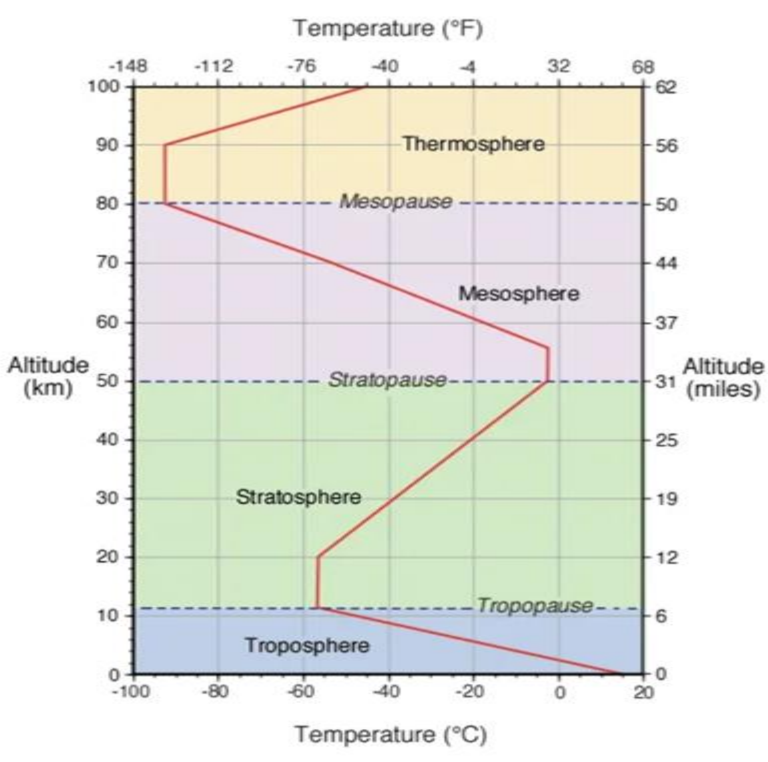
This is the lowest layer of the atmosphere.

The height of this layer is about 18 km on the equator and 8 km on the poles. The main reason of higher height at the equator is due to the presence of hot convection currents that push the gases upward.

This is the most important layer of the atmosphere because all kinds of weather changes take place only in this layer. Due to these changes development of living world take place on the earth. The air never remains static in this layer. Therefore, this layer is called changing sphere or troposphere.

The environmental temperature decreases with increasing height of the atmosphere. It decreases at the rate of 10C at the height of 165 meters. This is called Normal lapse rate.

The upper limit of the troposphere is called tropopause. After this, temperature increases. This is a transitional zone. In this zone, characteristics of both the troposphere and ionosphere are found.



(b) Stratosphere

This layer is above the troposphere.

This layer is spread up to the height of 50 km from the Earth's surface. Its average extent is 40 km.

The temperature remains almost the same in the lower part of this layer up to the height of 20 km. After this, the temperature increases slowly with the increase in the height. The temperature increases due to the presence of ozone gas in the upper part of this layer.

Weather-related incidents do not take place in this layer. The air blows horizontally here. Therefore, this layer is considered ideal for flying aircraft. The lower portion of the stratosphere is also influenced by the polar jet stream and subtropical jet stream. In the first 9 kilometres of the stratosphere, the temperature remains constant with height.

A zone with constant temperature in the atmosphere is called an isothermal layer. From an altitude of 20 to 50 kilometres, temperature increases with an increase in altitude. The higher temperatures found in this region of the stratosphere occurs because of a localized concentration of ozone gas molecules.

(c) Mesosphere

It is the third layer of the atmosphere spreading over stratosphere.

It spreads up to the height of 80 km from the surface of the earth. Its extent is 30 km.

Temperature goes on decreasing and drops up to – 1000C.

'Meteors' or falling stars occur in this layer.

(d) Ionosphere

This is the fourth layer of the atmosphere. It is located above the mesosphere.

This layer spreads up to the height of 400 km from the surface of the earth. The width of this layer is about 300 km.

The temperature starts increasing again with increasing height in this layer.

Electrically charged currents flow in the air in this sphere. Radio waves are reflected back on the earth from this sphere and due to this radio broadcasting has become possible. The ionosphere is a region of the atmosphere that is ionized by solar radiation. It is responsible for auroras. During daytime hours, it stretches from 50 to 1,000 km and includes the mesosphere, thermosphere, and parts of the exosphere.

However, ionization in the mesosphere largely ceases during the night, so auroras are normally seen only in the thermosphere and lower exosphere. The ionosphere forms the inner edge of the magnetosphere. It has practical importance because it influences, for example, radio propagation on Earth.

(e) Exosphere:

This is the last layer of the atmosphere located above ionosphere and extends to beyond 400 km above the earth.

Gases are very sparse in this sphere due to the lack of gravitational force. Therefore, the density of air is very less here.

The last atmospheric layer has an altitude greater than 80 kilometres and is called the thermosphere. Temperatures in this layer can be greater than 1200° C.

These high temperatures are generated from the absorption of intense solar radiation by oxygen molecules (O2). While these temperatures seem extreme, the amount of heat energy involved is very small.

The amount of heat stored in a substance is controlled in part by its mass. The air in the thermosphere is extremely thin with individual gas molecules being separated from each other by large distances.

Consequently, measuring the temperature of thermosphere with a thermometer is a very difficult process.

Homosphere and Heterosphere

The homosphere and heterosphere are defined by whether the atmospheric gases are well mixed. The surface-based homosphere includes the troposphere, stratosphere, mesosphere, and the lowest part of the thermosphere, where the chemical composition of the atmosphere does not depend on molecular weight because the gases are mixed by turbulence.

This relatively homogeneous layer ends at the turbopause found at about 100 km, which places it about 20 km above the mesopause.

Above this altitude lies the heterosphere, which includes the exosphere and most of the thermosphere. Here, the chemical composition varies with altitude.

This is because the distance that particles can move without colliding with one another is large compared with the size of motions that cause mixing.

This allows the gases to stratify by molecular weight, with the heavier ones, such as oxygen and nitrogen, present only near the bottom of the heterosphere. The upper part of the heterosphere is composed almost completely of hydrogen, the lightest element.

-------------------------*--------------*------------*