Objectives, Measurement of Air Pressure, Distribution of Air Pressure, Pressure Belt

The air around us exerts pressure. But we do not feel the weight of the atmosphere because we have air inside us which exerts an equal outward pressure that balances the inward pressure of the atmosphere. Atmospheric pressure is important to us as it is related to winds and helps to determine the weather conditions of a place.

Objectives

The major objectives of this chapter are:

- To give reasons for the decrease of air pressure with increase in altitude
- To explain the relationship between the spacing of isobar and pressure gradient
- To establish relationship between the temperature and the existence of equatorial low pressure and the polar high pressure
- To give reasons for the existence of sub-tropical high pressure and sub-polar low-pressure belts
- To explain the distribution of atmospheric pressure with the help of isobar maps of the world for the months of January and July
- To establish the relationship between pressure gradient and speed of winds
- To explain the influence of Coriolis effect on the direction of winds in both the hemispheres
- To distinguish between planetary and monsoon winds, land and sea breezes, valley and mountain breezes, and temperate and tropical cyclones
- To describe the characteristics of important local winds

Measurement of Air Pressure

- The atmosphere is held on the earth by the gravitational pull of the earth. The weight of the column of air at a given place and time is called air pressure or atmospheric pressure. Atmospheric pressure is measured by an instrument called barometer.
- Atmospheric pressure is measured as force per unit area. The unit used for measuring pressure is called millibar. One millibar is equal to the force of one gram per square centimetre approximately. A pressure of 1000 millibars is equal to the weight of 1.053 kilograms per square centimetre at sea level. It is equal to the weight of a column of mercury which is 76 centimetre high. The international standard pressure unit is the pascal, a force of one Newton per square meter. In practice atmospheric pressure is expressed in kilopascal. One kilopascal or kPa equals 1000 pascal or Pa.

- The mean atmospheric pressure at sea level is 1013.25 millibars. However, the actual pressure at a given place and at a given time fluctuates and it generally ranges between 950 and 1050 millibars

Distribution of Air Pressure

Distribution of atmospheric pressure on the surface of the earth is not uniform. It varies both vertically and horizontally.

Vertical Distribution

Air is a mixture of various gases. As it compresses, its density increases. The higher the density of air, the greater is the air pressure and vice versa. The mass of air above in the column of air compresses the air under it hence its lower layers are denser than the upper layers. The columnar distribution of atmospheric pressure is known as vertical distribution of pressure. Air pressure decreases with increase in altitude, but it does not always decrease at the same rate. Dense components of atmosphere are found in its lowest parts near the mean sea level. Temperature of the air, amount of water vapour present in the air, and gravitational pull of the earth determine the air pressure of a given place at a given time. Since these factors are variable with change in height, there is a variation in the rate of decrease in air pressure with increase in altitude. The normal rate of decrease in air pressure is 34 millibars per every 300 metres increase in altitude. In high mountainous areas rice takes more time to cook because low pressure reduces the boiling point of water. Breathing problem such as faintness and nose bleedings are also faced by many trekkers from outside in hilly areas because of low pressure conditions in which the air is thin and it has low amount of oxygen content.

Horizontal Distribution

The distribution of atmospheric pressure over the globe is known as horizontal distribution of pressure. It is shown on maps with the help of isobars. An isobar is a line connecting points that have equal values of pressure. The spacing of isobars expresses the rate and direction of change in air pressure. This charge in air pressure is referred to pressure gradient. It is the ratio between pressure difference and the actual horizontal distance between two points. Close spacing of isobars expresses steep pressure gradient while wide spacing indicates gentle pressure gradient.

The factors responsible for variation in the horizontal distribution of pressure are:

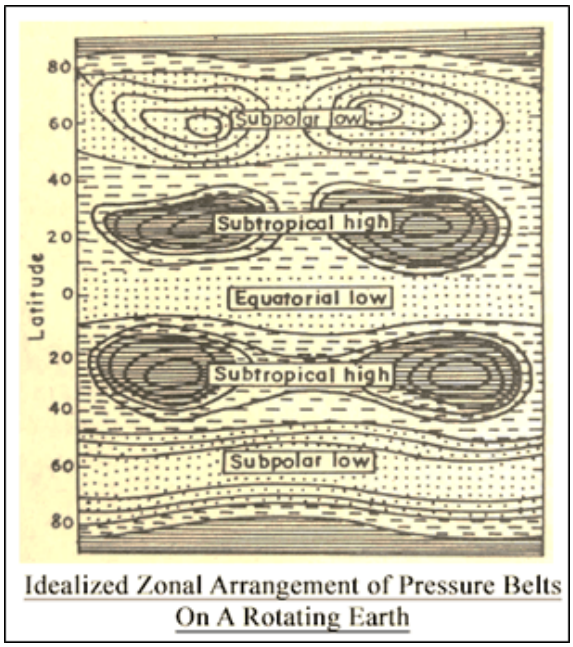
- **Air Temperature**: There is an inverse relationship between air temperature and air pressure. The higher the air temperature, the lower is the air pressure. The fundamental rule about gases is that when they are heated, they become less dense and expand in volume and rise. Hence, air pressure is low in equatorial regions and it is higher in polar regions. Along the equator lies a belt of low pressure known as the equatorial low or doldrums. Low air pressure in equatorial regions is due to the fact that hot air ascends there with gradual decrease in temperature causing thinness of air on the surface. In polar region, cold air is very dense hence it descends, and pressure increases. However, pressure does not increase latitudinally in a regular manner from equator to the poles. Instead, there are regions of high pressure in subtropics and regions of low pressure in the subpolar areas.
- **The Earth's Rotation**: The earth's rotation generates centrifugal force. This results in the deflection of air from its original place, causing decrease of pressure. It is believed that the low-pressure belts of the sub-polar regions and the high-pressure belts of the sub-tropical regions

are created as a result of the earth's rotation. The earth's rotation causes convergence and divergence of moving air. Areas of convergence experience low pressure while those of divergence have high pressure.

- **Pressure of Water Vapour**: Air with higher quantity of water vapour has lower pressure and vice-versa. In winter the continents are relatively cool and tend to develop high pressure centres but in summer they stay warmer than the oceans and tend to be dominated by low pressure. On the other hand, the oceans are associated with low pressure in winter and high pressure in summer.

Pressure Belt

The horizontal distribution of air pressure across the latitudes is characterised by high- or low-pressure belts. This is, however, a theoretical model because pressure belts are not always found as such on the earth. These pressure belts are:



Idealized Zonal Arrangement of Pressure Belts On A Rotating Earth

- **The Equatorial Low-Pressure Belt**: The sun shines almost vertically on the equator throughout the year. As a result, the air gets warm and rises over the equatorial region and produce equatorial low pressure. This belt extends from equator to 10°N and 10°S latitudes. Due to

excessive heating horizontal movement of air is absent here. Therefore, this belt is called doldrums due to virtual absence of surface winds. These are the regions of convergence because the winds flowing from sub-tropical high-pressure belts converge here. This belt is also known as the Inter Tropical Convergence Zone (ITCZ) .

- **The Sub-Tropical High-Pressure Belts**: The sub-tropical high-pressure belts extend from the tropics to about 35º latitudes in both the hemispheres. It is known as the north sub-tropical high-pressure belt and the south sub-tropical high-pressure belt in the northern and southern hemisphere, respectively. The existence of these pressure belts is due to the fact that the uprising air of the equatorial region is deflected towards poles due to the earth's rotation. After becoming cold and heavy, it descends in these regions and get piled up which results in high pressure. Calm conditions with feeble and variable winds are found here. In olden days vessels with cargo of horses passing through these belts found difficulty in sailing under these calm conditions. They used to throw the horses in the sea in order to make the vessels lighter. Henceforth these belts or latitudes are also called horse latitudes.
- **The Sub-Polar Low-Pressure Belts**: The sub-polar low-pressure belts extend between 45ºN and the Arctic Circle in the northern hemisphere and between 45°S and the Antarctic Circle in the southern hemisphere. They are known as the north sub-polar low and the south sub-polar low-pressure belts, respectively. Winds coming from the sub-tropical and the polar high belts converge here to produce cyclonic storms.
- **The Polar High-Pressure Belts**: In polar regions, sun rays are always slanting resulting in low temperatures. Due to low temperature, air compresses and its density increases.
    - Hence, high pressure is found here. This is called the north polar high-pressure belt in northern hemisphere and south polar high-pressure belt in the southern hemisphere.
    - In reality, the location of these pressure belts is not permanent. They shift northward in July and southward in January, following the changing position of the sun's direct rays as they migrate between the Tropics of Cancer and Capricorn. With the shifting of thermal equator northwards in summer and southwards in winter, there is also a slight shift in pressure belts towards north and south of their annual average location.