Class-ix

Subject-Geography

Chapter14-Atmospheric pressure and winds (part-1)

Atmospheric Pressure and Winds

If we consider the atmosphere as an ocean of air, we live at the bottom of this ocean of air. The atmosphere exerts pressure because air has weight but we don't feel the enormous pressure of air. It is because we are supported by an equal pressure of air on all sides of our bodies and the air inside us exerts an equal amount of outward pressure balancing the inward pressure of the atmosphere.

The pressure exerted by the weight of vertical column of air per unit of area is called atmospheric pressure.

- Atmosphere surrounding the Earth is a mixture of gases. It is bound by the Earth due to gravity, which does not allow air to escape to outer space.
- Atmospheric pressure is not the same everywhere.
- Air pressure decreases with increase in altitude. So, the mountain climbers often experience some physiological disturbances like weakness, nose bleeding, ear bleeding, etc.
- The atmospheric pressure is maximum at the sea level. It exerts pressure of 1.03 kg per sq. cm at the sea level.

MEASUREMENT OF ATMOSPHERIC PRESSURE

Atmospheric pressure is measured with the help of an instrument called barometer invented by the scientist Galileo and his assistant Torricelli in 1643. Barometers are of four types:

1. Simple Barometer or Mercury Barometer
2. Aneroid Barometer
3. Altimeter
4. Forteins Barometer

1. Simple Barometer or Mercury Barometer

- The ordinary mercury barometer consists of a long glass tube about 1000 mm in length. It is sealed at the upper end and open at the lower end. The open end of the tube is inverted into a container filled with mercury.
- The surface of mercury is exposed to the air. The air exerts pressure on mercury. The mercury in the tube settles at about 760 mm above the level of the mercury in the container when it is placed at the sea level.
- When the air pressure increases, the mercury column rises above 760 mm which indicates high pressure and when the air pressure decreases, the mercury in the column drops indicating low pressure. See Fig. 15.1.

2. Aneroid Barometer

- This barometer does not contain any liquid so it is portable, convenient and suitable for outdoor measurements.
- It consists of a hollow metal container, partly emptied of air to form almost a vacuum. It has a thin flexible lid on one side.
- The lid springs inward when the pressure increases outside the box and springs outwards when the pressure decreases. These movements are registered on an indicator placed against a circular dial. Thus, atmospheric pressure can be read on the dial in millibars. See Fig. 15.2.

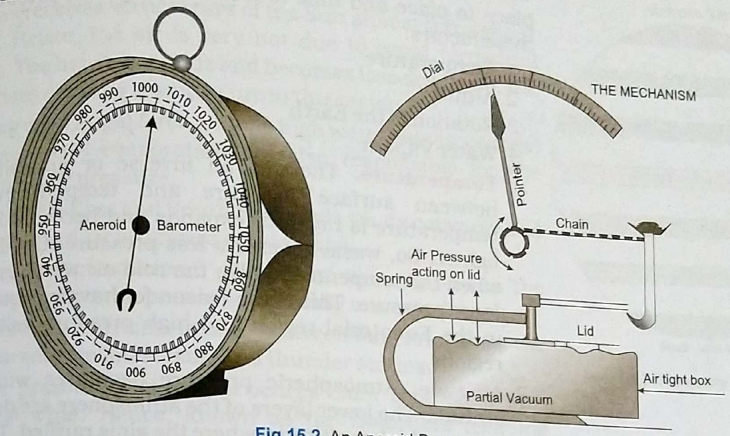

Fig.15.2 An Aneroid Barometer

3. Altimeter

- It is a modified type of Aneroid Barometer used in aeroplanes to find out their flying height. It has a dial showing altitude on the basis of average decrease in atmospheric pressure at an approximate rate of 1 inch drop in mercury reading for every 900 ft of ascent.
- It gives reading in feet for height instead of inches of millibars. It is also used by surveyors on land.

4. Forteins Barometer

- It is an improved type of cistern barometer. It is capable of reading accurate atmospheric pressure but it is not easy to transport and this is one of its disadvantages.

BAROGRAM

It is a continuous record of changes of atmospheric pressure as measured by an aneroid barometer, indicated by a curve drawn on scaled paper.

Barograph. It is a self recording barometer (usually an aneroid barometer). A continuous record (barogram) of atmospheric pressure is traced on a moving drum.

ISOBAR

- Isobar is an imaginary line drawn on a map or a weather chart, joining places having equal atmospheric pressure, supposing these places to be at the sea level.

Did you know?

Mercury barometer is a standard instrument for measuring atmospheric pressure. Pressure is read in centimetres or inches of mercury.

Millibars. The unit of measurement of atmospheric pressure is a bar. One bar is divided into 1000 millibars. Millibars are known as hectopascals.

Standard sea level pressure is 76 cm or 29.92 inches on the mercury scale.

One atmospheric pressure (76 cm of mercury) is equivalent to 1013 mb.

- When the isobars are far apart, there is little variation of atmospheric pressure and when the isobars are close to one another, there is a great difference of atmospheric pressure over smaller area. It indicates stormy weather.
- Thus, the spacing of isobars indicates the pressure gradient.

FACTORS AFFECTING AIR PRESSURE

The atmospheric pressure is not the same everywhere. It varies from place to place and time to time. Atmospheric pressure depends on these factors:

1. Temperature
2. Altitude
3. Rotation of the Earth
4. Water Vapour

1. Temperature. There is an inverse or opposite relationship between surface pressure and temperature. When the temperature is high, air expands and becomes less dense and lighter. So, warm air exerts less pressure. On the other hand, when the temperature falls, the cold air which is denser exerts more pressure. This is the reason for having a low pressure belt in the Equatorial region and high pressure belts in the Polar regions.

2. Altitude. Atmospheric pressure decreases with increase in altitude. The lower layers of the atmosphere are denser than the layers at higher altitude, where the air is rarified. This is because the atmosphere is highly compressible. The overlying layers exert pressure on low-lying layers. The heavier gas molecules remain closer to the surface due to gravity.

3. Rotation of the Earth. The rotation of the Earth causes bulk of air to swing from the Poles towards the Equator. Polar Regions have high pressure belts due to extremely cold conditions. The air sinking down at the Polar region expands and its pressure decreases. Thus, the low pressure belts are formed along 60° N and 60° S latitudes.

4. Water Vapour. The air with water vapour or the humid air is lighter than dry air because water vapour present in the air displaces an equal volume of dry air (nitrogen and oxygen), thus making the air lighter. Water vapour has latent heat also which makes the air lighter.

MAJOR PRESSURE BELTS

The horizontal distribution of atmospheric pressure varies from place to place. It is due to the variation in temperature and the rotation of the Earth.

Unequal heating of the Earth and the atmosphere. Due to the spherical shape of the Earth, different parts get heated unequally.

(a) At the Equator. Equatorial regions receive intense heat throughout the year. Heated air being lighter rises forming low pressure area.

(b) At the Poles. Polar regions are very cold. The cold air being heavy, sinks forming a high pressure area.

Bulk of air swings from the Polar Regions towards the Equator forming low pressure belts along 60° N and 60° S latitudes. There are four major pressure belts following latitudinal pattern because the temperature distribution follows latitudes. There is a pattern of alternate high and low pressure belts over the Earth.

1. Equatorial low pressure belt or Doldrums (5° N to 5° S):

- This belt extends up to 5° N and 5° S of the Equator.
- This region receives vertical rays of the Sun almost throughout the year. Hence, the air is very hot due to rapid terrestrial radiation. The hot air expands and becomes less dense. So, the light air rises creating low pressure in this region.
- The strong centrifugal force and the high water vapour content due to excessive evaporation are also responsible for the formation of low pressure.
- Here the North-East and South East trade winds converge and the movement of air is upward in this region.
- The ascending convectional air current rises up and in the upper troposphere; it spreads horizontally towards the poles.
- The ascending currents lead to convectional rainfall in the afternoon with violent squalls and thunder storms.
- This low pressure region experiences calm conditions with very little wind. Hence, known as the Doldrums meaning "dull". Sailors avoid the Doldrums because of lack of regular winds in this region. See Fig. 15.3.

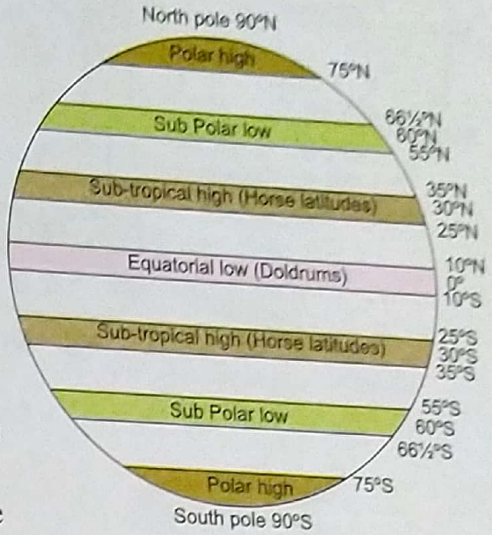

Fig. 15.3 Pressure belts of the World

2. Sub Tropical High Pressure Belt (30° N to 35° N and 30° S to 35° S)

- This belt extends from 30° N to 35° N and 30° S to 35° S of the Equator.
- Air that rises at the Equatorial region, reaches the higher level of troposphere where it cools down and spreads.
- Due to rotation of the Earth, it gets deflected away from the Equator to the North and South.
- It gets cooled and sinks down to the surface at 30° N and S of the Equator. This causes an increase in air pressure.
- The air rising from 60° N and 60° S is forced to descend in this sub tropical belt due to the effect of rotation of the Earth, thus adding to pre-existing high pressure in this region.
- This sub tropical high pressure belt is the region of calm winds. It is referred to as the "Horse latitude".
- The descending dry air cannot bring rain, so on land it is the belt of hot deserts, widest in Africa and Asia where there is most of the land in this belt.

3. Sub Polar Low Pressure Belt (60° N to 65° N and 60° S to 65° S)

- This belt extends from 60° N to 65° N and 60° S to 65° S of the Equator.
- These belts should actually be high pressure belts due to very cold air over here but there is a low pressure belt which is created mainly due to the effect of rotation of the Earth that swings the bulk of air from the poles towards the Equator.

Knowledge Booster

The Horse latitudes

Years ago, the horse merchants used to carry horses along with passengers and other cargo in the ships across the Atlantic Ocean. As soon as the ships used to reach the Sub tropical high pressure belt, it was difficult for the captains to proceed further due to calm conditions prevailing over there and the weight of the cargo. They considered throwing the horses into the sea as a solution to reduce the load and proceed. They were unaware of the fact that the excess load was felt due to the descending air exerting pressure over this belt.

- The cold sinking air at the poles expands and their pressure decreases forming low pressure belts surrounding the two Polar regions.
- These belts are the areas of convergence of westerlies and polar winds with cyclonic activities and storminess, especially in winter season. See Fig. 15.4.

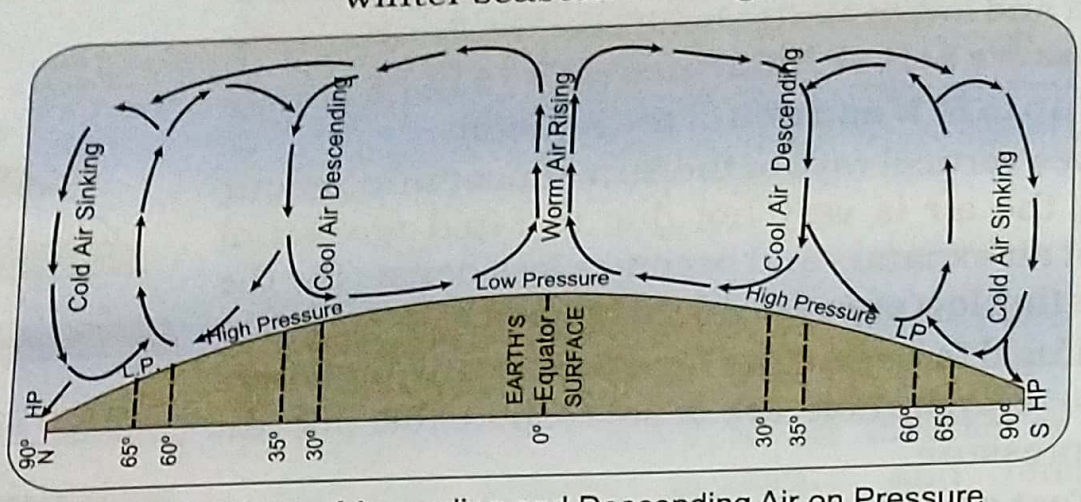

Fig. 15.4 Effects of Ascending and Descending Air on Pressure

4. Polar High Pressure Belt (80°N to 90°N and 80°S to 90°S)

- These belts extend from 80°N to 90°N and 80°S to 90°S of the Equator.
- Due to extremely cold temperature throughout the year, the region develops a belt of dense, heavy sinking air causing high pressure.
- Due to the rotation of the Earth, a strong centripetal force is caused which contributes to the high pressure over here.

Home Work

- What is meant by atmospheric pressure?what is the normal atmospheric pressure ?
- Why there is low pressure belt near the equator?
- Explain the factors affecting the atmospheric pressure.
- Define isobar.
- How the subtropical high pressure belt is developed?
- Draw a labelled diagram of major pressure belts of the world.