

Earlier Chapter 9 described the uneven distribution of temperature over the surface of the earth. Air expands when heated and gets compressed when cooled. This results in variations in the atmospheric pressure. The result is that it causes the movement of air from high pressure to low pressure, setting the air in motion. You already know that air in horizontal motion is wind. Atmospheric pressure also determines when the air will rise or sink. The wind redistributes the heat and moisture across the planet, thereby, maintaining a constant temperature for the planet as a whole. The vertical rising of moist air cools it down to form the clouds and bring precipitation. This chapter has been devoted to explain the causes of pressure differences, the forces that control the atmospheric circulation, the turbulent pattern of wind, the formation of air masses, the disturbed weather when air masses interact with each other and the phenomenon of violent tropical storms.

ATMOSPHERIC PRESSURE

Do you realise that our body is subjected to a lot of air pressure. As one moves up the air gets varied and one feels breathless.

The weight of a column of air contained in a unit area from the mean sea level to the top of the atmosphere is called the *atmospheric pressure*. The atmospheric pressure is expressed in units of millibar. At sea level the average atmospheric pressure is 1,013.2 millibar. Due to gravity the air at the surface is denser and hence has higher pressure. Air

ATMOSPHERIC CIRCULATION AND WEATHER SYSTEMS

pressure is measured with the help of a mercury barometer or the aneroid barometer. Consult your book, *Practical Work in Geography — Part I* (NCERT, 2006) and learn about these instruments. The pressure decreases with height. At any elevation it varies from place to place and its variation is the primary cause of air motion, i.e. wind which moves from high pressure areas to low pressure areas.

Vertical Variation of Pressure

In the lower atmosphere the pressure decreases rapidly with height. The decrease amounts to about 1 mb for each 10 m increase in elevation. It does not always decrease at the same rate. Table 10.1 gives the average pressure and temperature at selected levels of elevation for a standard atmosphere.

Table 10.1 : Standard Pressure and Temperature at Selected Levels

| Level | Pressure in mb | Temperature °C |
|-----------|----------------|----------------|
| Sea Level | 1,013.25 | 15.2 |
| 1 km | 898.76 | 8.7 |
| 5 km | 540.48 | -17.3 |
| 10 km | 265.00 | -49.7 |

The vertical pressure gradient force is much larger than that of the horizontal pressure gradient. But, it is generally balanced by a nearly equal but opposite gravitational force. Hence, we do not experience strong upward winds.

Horizontal Distribution of Pressure

Small differences in pressure are highly significant in terms of the wind direction and

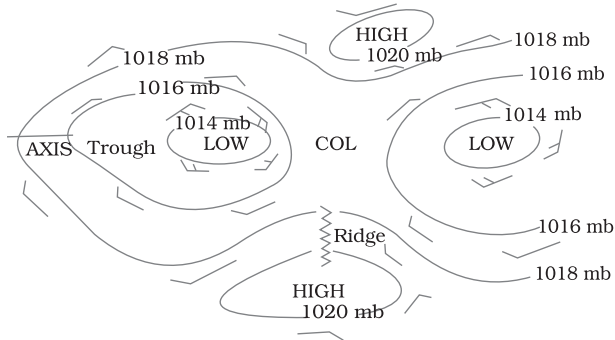


Figure 10.1 : Isobars, pressure and wind systems in Northern Hemisphere

velocity. Horizontal distribution of pressure is studied by drawing isobars at constant levels. Isobars are lines connecting places having equal pressure. In order to eliminate the effect of altitude on pressure, it is measured at any station after being reduced to sea level for

purposes of comparison. The sea level pressure distribution is shown on weather maps.

Figure 10.1 shows the patterns of isobars corresponding to pressure systems. Low-pressure system is enclosed by one or more isobars with the lowest pressure in the centre. High-pressure system is also enclosed by one or more isobars with the highest pressure in the centre.

World Distribution of Sea Level Pressure

The world distribution of sea level pressure in January and July has been shown in Figures 10.2 and 10.3. Near the equator the sea level pressure is low and the area is known as *equatorial low*. Along 30° N and 30° S are found the high-pressure areas known as the *subtropical highs*. Further pole wards along 60° N and 60° S, the low-pressure belts are termed as the *sub polar lows*. Near the poles the pressure is high and it is known as the *polar high*. These pressure belts are not permanent

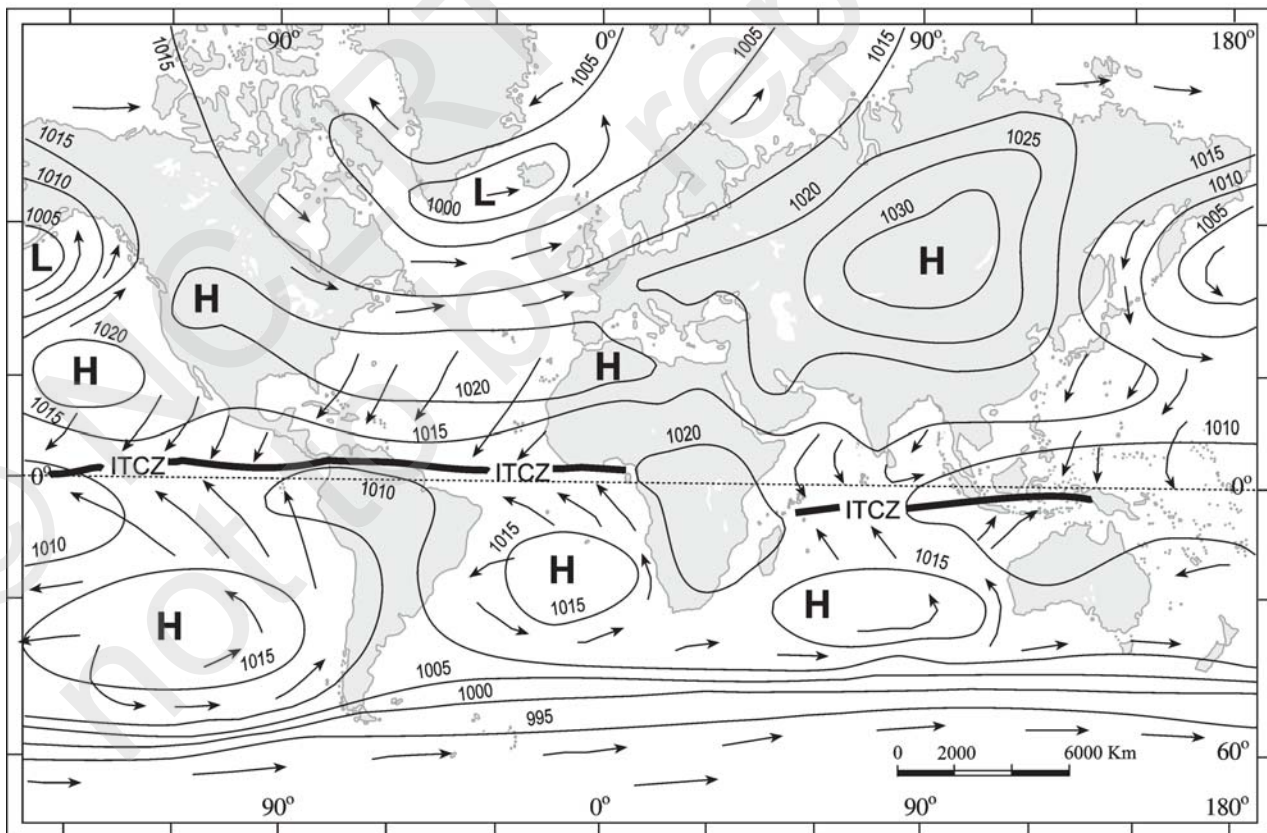


Figure 10.2 : Distribution of pressure (in millibars) — January

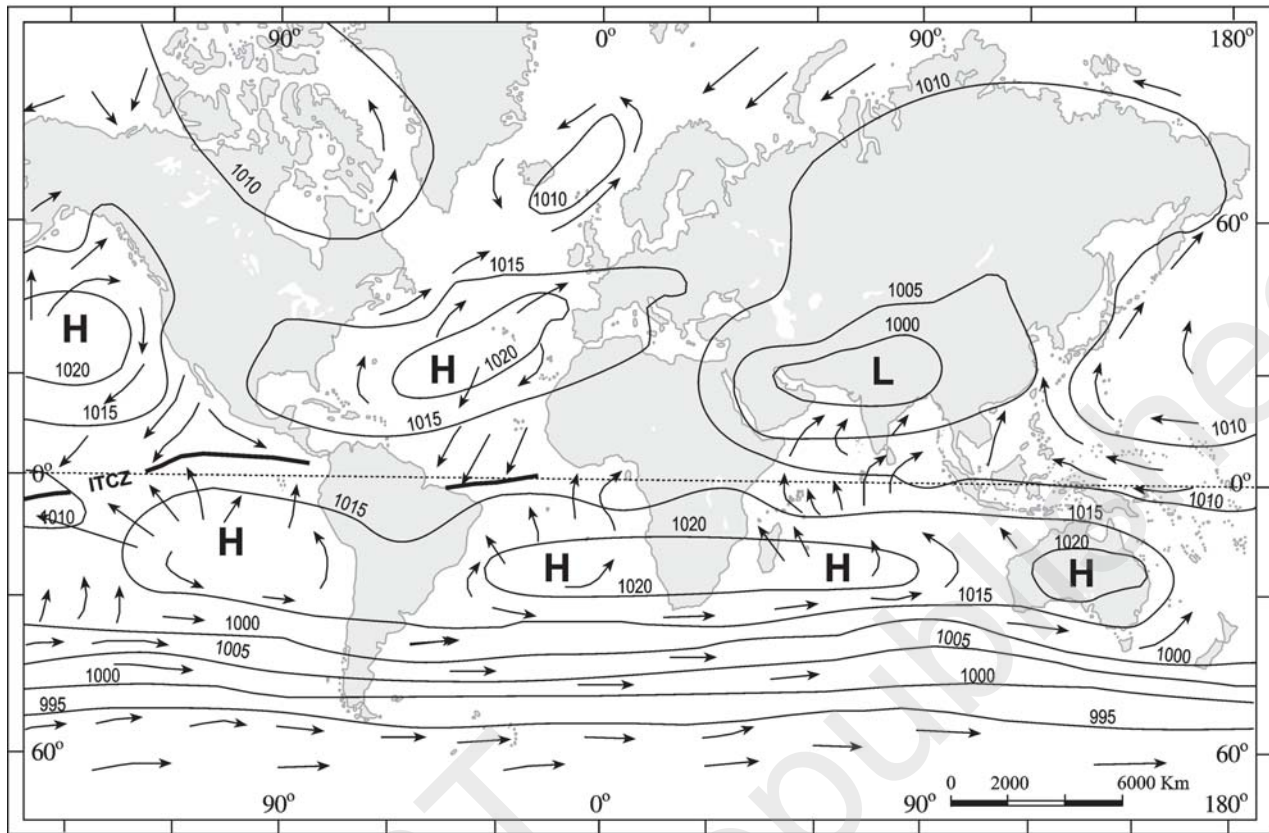


Figure 10.3 : Distribution of pressure (in millibars) — July

in nature. They oscillate with the apparent movement of the sun. In the northern hemisphere in winter they move southwards and in the summer northwards.

Forces Affecting the Velocity and Direction of Wind

You already know that the air is set in motion due to the differences in atmospheric pressure. The air in motion is called wind. The wind blows from high pressure to low pressure. The wind at the surface experiences friction. In addition, rotation of the earth also affects the wind movement. The force exerted by the rotation of the earth is known as the Coriolis force. Thus, the horizontal winds near the earth surface respond to the combined effect of three forces – the pressure gradient force, the frictional force and the Coriolis force. In addition, the gravitational force acts downward.

Pressure Gradient Force

The differences in atmospheric pressure produces a force. The rate of change of pressure with respect to distance is the pressure gradient. The pressure gradient is strong where the isobars are close to each other and is weak where the isobars are apart.

Frictional Force

It affects the speed of the wind. It is greatest at the surface and its influence generally extends upto an elevation of 1 - 3 km. Over the sea surface the friction is minimal.

Coriolis Force

The rotation of the earth about its axis affects the direction of the wind. This force is called the Coriolis force after the French physicist who described it in 1844. It deflects the wind to the right direction in the northern hemisphere and

to the left in the southern hemisphere. The deflection is more when the wind velocity is high. The Coriolis force is directly proportional to the angle of latitude. It is maximum at the poles and is absent at the equator.

The Coriolis force acts perpendicular to the pressure gradient force. The pressure gradient force is perpendicular to an isobar. The higher the pressure gradient force, the more is the velocity of the wind and the larger is the deflection in the direction of wind. As a result of these two forces operating perpendicular to each other, in the low-pressure areas the wind blows around it. At the equator, the Coriolis force is zero and the wind blows perpendicular to the isobars. The low pressure gets filled instead of getting intensified. That is the reason why tropical cyclones are not formed near the equator.

Pressure and Wind

The velocity and direction of the wind are the net result of the wind generating forces. The winds in the upper atmosphere, 2 - 3 km above the surface, are free from frictional effect of the surface and are controlled mainly by the pressure gradient and the Coriolis force. When isobars are straight and when there is no friction, the pressure gradient force is balanced by the Coriolis force and the resultant wind blows parallel to the isobar. This wind is known as the geostrophic wind (Figure 10.4).

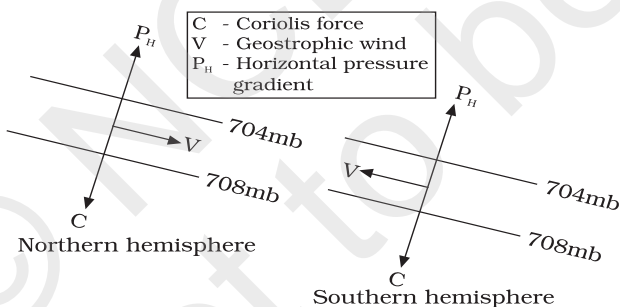


Figure 10.4 : Geostrophic Wind

The wind circulation around a low is called *cyclonic circulation*. Around a high it is called *anti cyclonic circulation*. The direction of winds around such systems changes according to their location in different hemispheres (Table 10.2).

The wind circulation at the earth's surface around low and high on many occasions is closely related to the wind circulation at higher level. Generally, over low pressure area the air will converge and rise. Over high pressure area the air will subside from above and diverge at the surface (Figure 10.5). Apart from convergence, some eddies, convection currents, orographic uplift and uplift along fronts cause the rising of air, which is essential for the formation of clouds and precipitation.

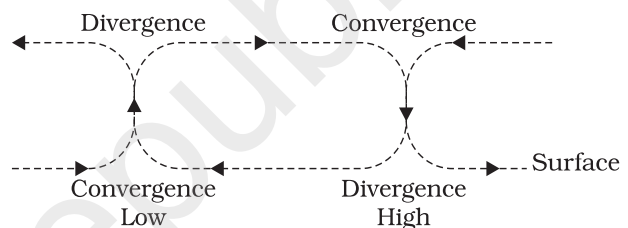


Figure 10.5 : Convergence and divergence of winds

General circulation of the atmosphere

The pattern of planetary winds largely depends on : (i) latitudinal variation of atmospheric heating; (ii) emergence of pressure belts; (iii) the migration of belts following apparent path of the sun; (iv) the distribution of continents and oceans; (v) the rotation of earth. The pattern of the movement of the planetary winds is called the general circulation of the atmosphere. The general circulation of the atmosphere also sets in motion the ocean water circulation which influences the earth's

Table 10.2 : Pattern of Wind Direction in Cyclones and Anticyclones

| Pressure System | Pressure Condition at the Centre | Pattern of Wind Direction | |
|-----------------|----------------------------------|---------------------------|---------------------|
| | | Northern Hemisphere | Southern Hemisphere |
| Cyclone | Low | Anticlockwise | Clockwise |
| Anticyclone | High | Clockwise | Anticlockwise |

