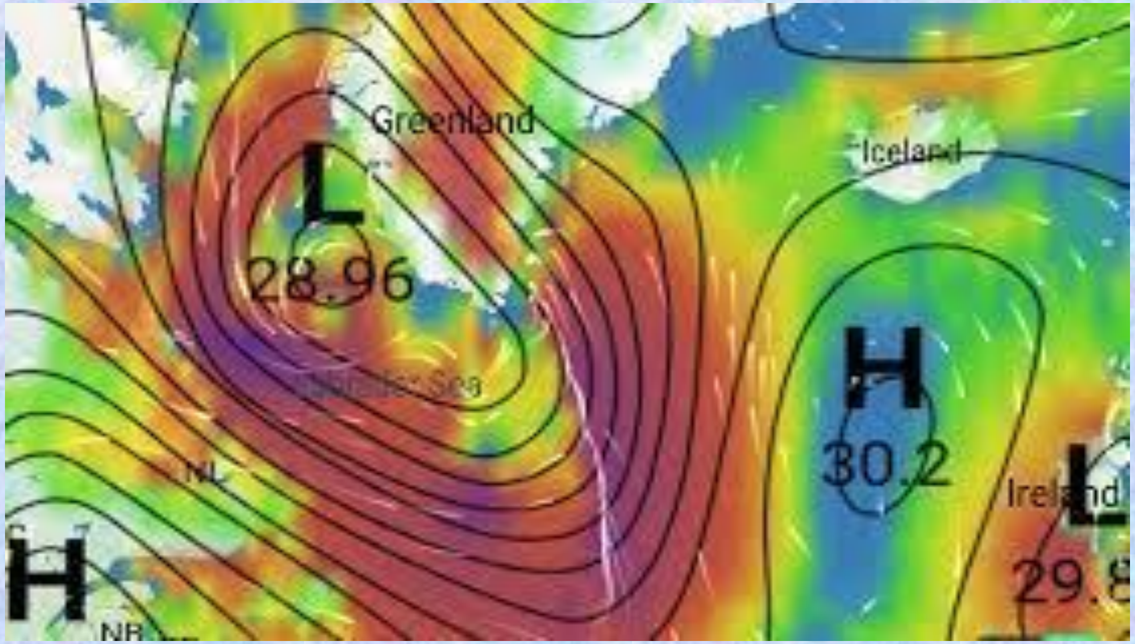
Global Pressure Belts and Wind System



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Pressure System

Air expands when heated and gets compressed when cooled. This results in variations in the atmospheric pressure.

The differences in atmospheric pressure causes the movement of air from high pressure to low pressure, setting the air in motion.

Air in horizontal motion is wind. The wind redistributes the heat and moisture across latitudes, thereby, maintaining a constant temperature for the planet as a whole.

The vertical rising of moist air forms clouds and bring precipitation.

Atmospheric or Air Pressure

Since air has mass, it also has weight. The pressure of air at a given place is defined as a force exerted in all directions by virtue of the weight of all the air above it.

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 various units.

Measurement of Air Pressure

Atmospheric pressure is the weight of the column of air at any given place and time. It is measured by means of an instrument called **barometer**.

The units used by meteorologists for this purpose are called **millibars (mb).**

One millibar is equal to the force of one gram on a square centimeter. A pressure of **1000 millibars** is **equal** to the **weight** of **1.053 kilograms per square centimeter**.

The normal pressure at sea level is taken to be about ***76 centimeters (1013.25 millibars).***

Vertical Variation of Pressure

In the lower atmosphere the pressure decreases rapidly with height.

At the height of Mt. Everest, the air pressure is about two-thirds less than what it is at the sea level.

The decrease in pressure with altitude, however, is not constant. Since the factors controlling air density – temperature, amount of water vapour and gravity are variable, there is no simple relationship between altitude and pressure.

In general, the atmospheric pressure decreases on an average at the rate of about 34 millibars every 300 metres of height.

Vertical Variation of Pressure

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.

Due to gravity the air at the surface is denser and hence has higher pressure. Since air pressure is proportional to **density as well as temperature**, it follows that a change in either temperature or density will cause a corresponding change in the pressure.

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.

A rising pressure indicates fine, settled weather, while a falling pressure indicates unstable and cloudy weather.

Horizontal Distribution of Pressure

- Small differences in pressure are highly significant in terms of the wind direction and 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 spacing of isobars expresses the rate and direction of pressure changes and is referred to as **pressure gradient.**

Horizontal Distribution of Pressure

- Close spacing of isobars indicates a steep or strong pressure gradient, while wide spacing suggests weak gradient.

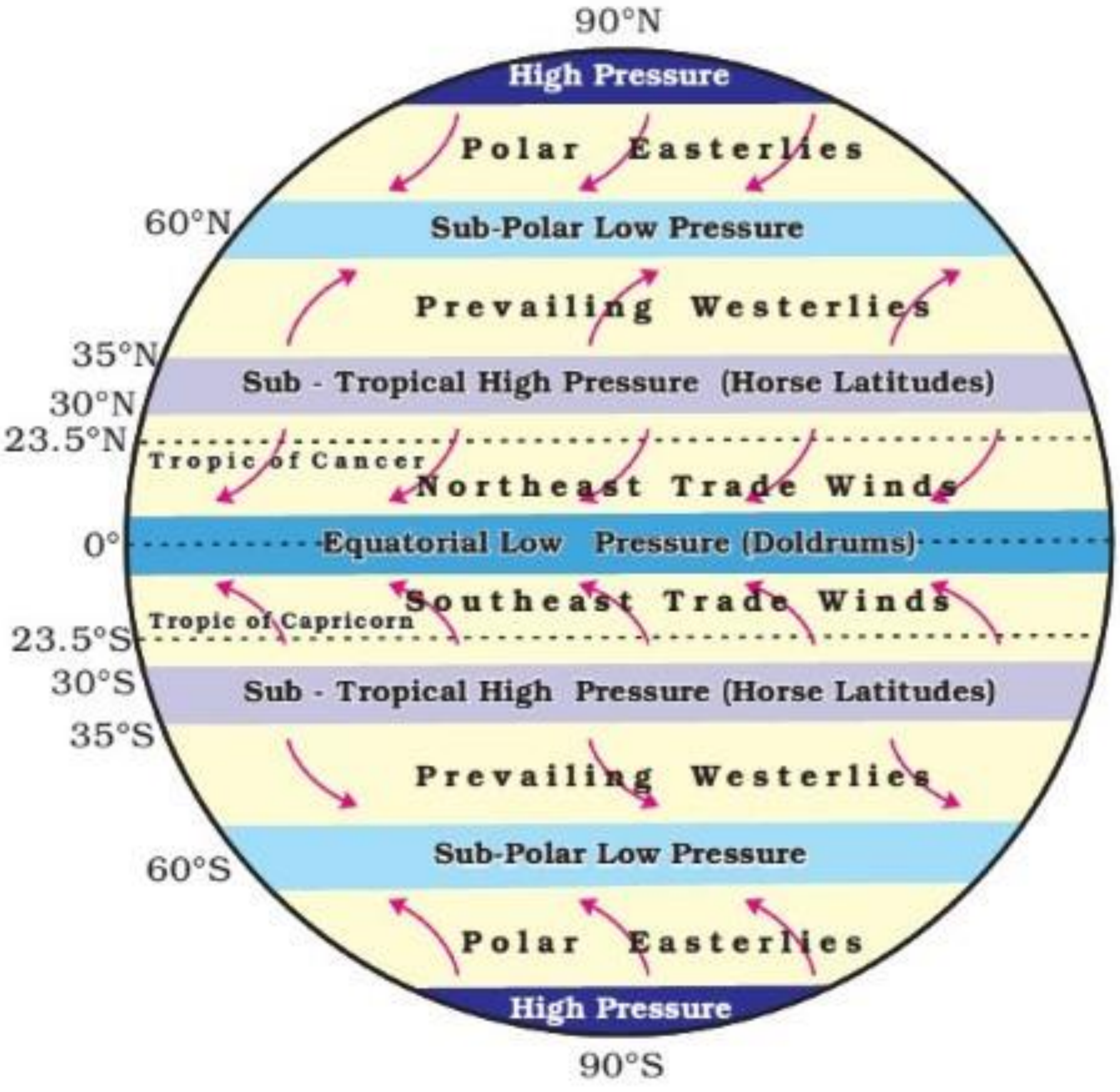
- The pressure gradient may thus be defined as the decrease in pressure per unit distance in the direction in which the pressure decreases most rapidly.

There are distinctly identifiable zones of homogeneous horizontal pressure regimes or **‘pressure belts’.** On the earth’s surface, there are in all seven pressure belts.

The major pressure belts are:

- **equatorial low,**
- **the sub-tropical highs,**
- **the sub-polar lows, and**
- **the polar highs.**

The distribution of atmospheric pressure across the latitudes is termed global horizontal distribution of pressure. Its main feature is its zonal character known as pressure belts.



Major Pressure Belts and Wind System

Closed Isobars or Closed Pressure centers

- 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.

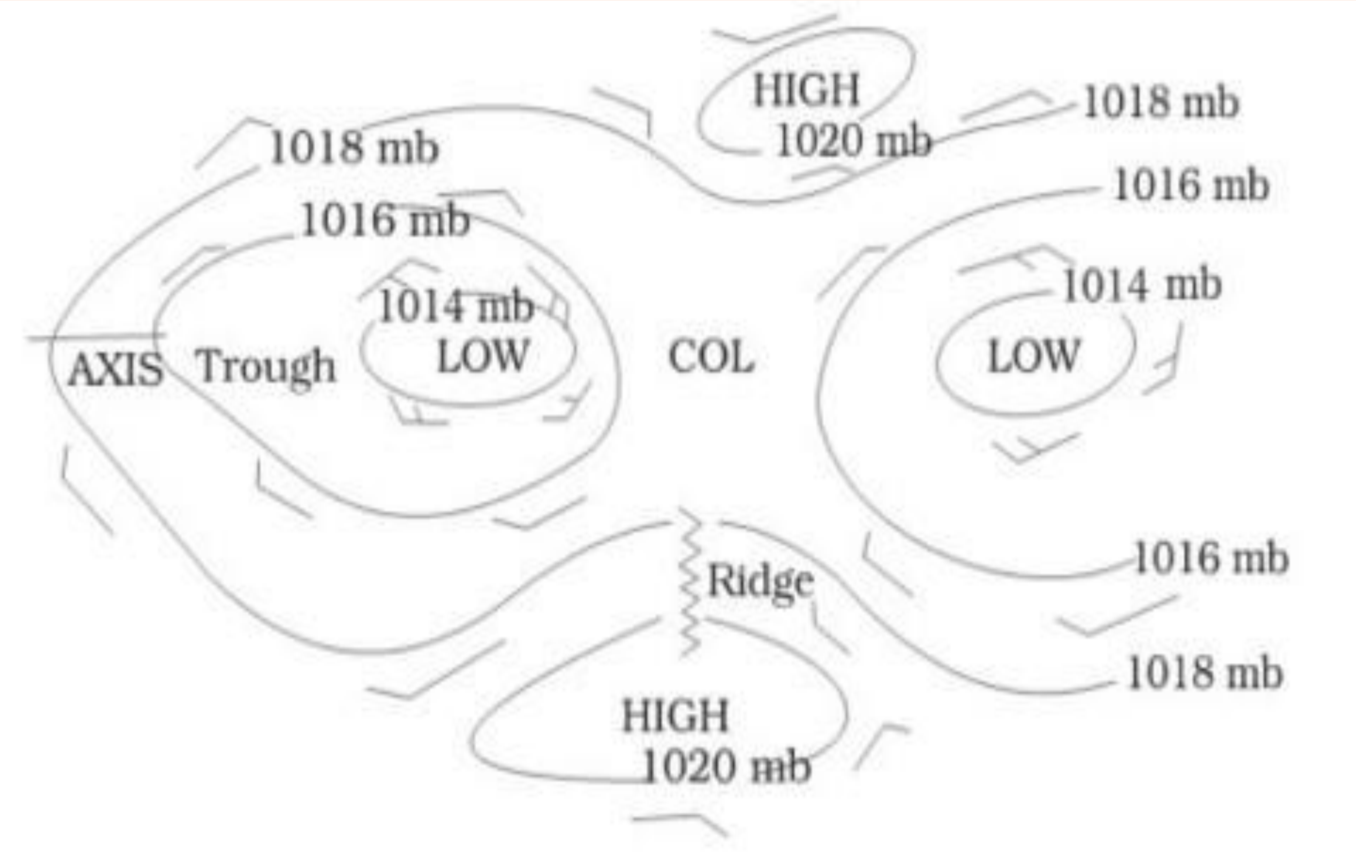


Fig.: Pressure centers and isobars

World Distribution of Sea Level Pressure

The atmosphere exerts a pressure of **1034 gm per square cm** at sea level. This amount of pressure is exerted by the atmosphere at sea level on all animals, plants, rocks, etc.

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** 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.

Equatorial Low Pressure Belt or ‘Doldrums’

Lies between 5°N and 5°S latitudes.

Width may vary between 5°N and 5°S and 20°N and 20°S.

This belt happens to be the **zone of convergence of trade winds** from two hemispheres from sub-tropical high pressure belts.

This belt is also called the **Doldrums**, because of the **extremely calm air movements.**

Due to the vertical rays of the sun here, there is intense heating.

The air, therefore, expands and rises as convection current causing low pressure to develop here.

Climate in Equatorial Low-Pressure Belt

This belt is characterized by **extremely low pressure** with **calm conditions**.

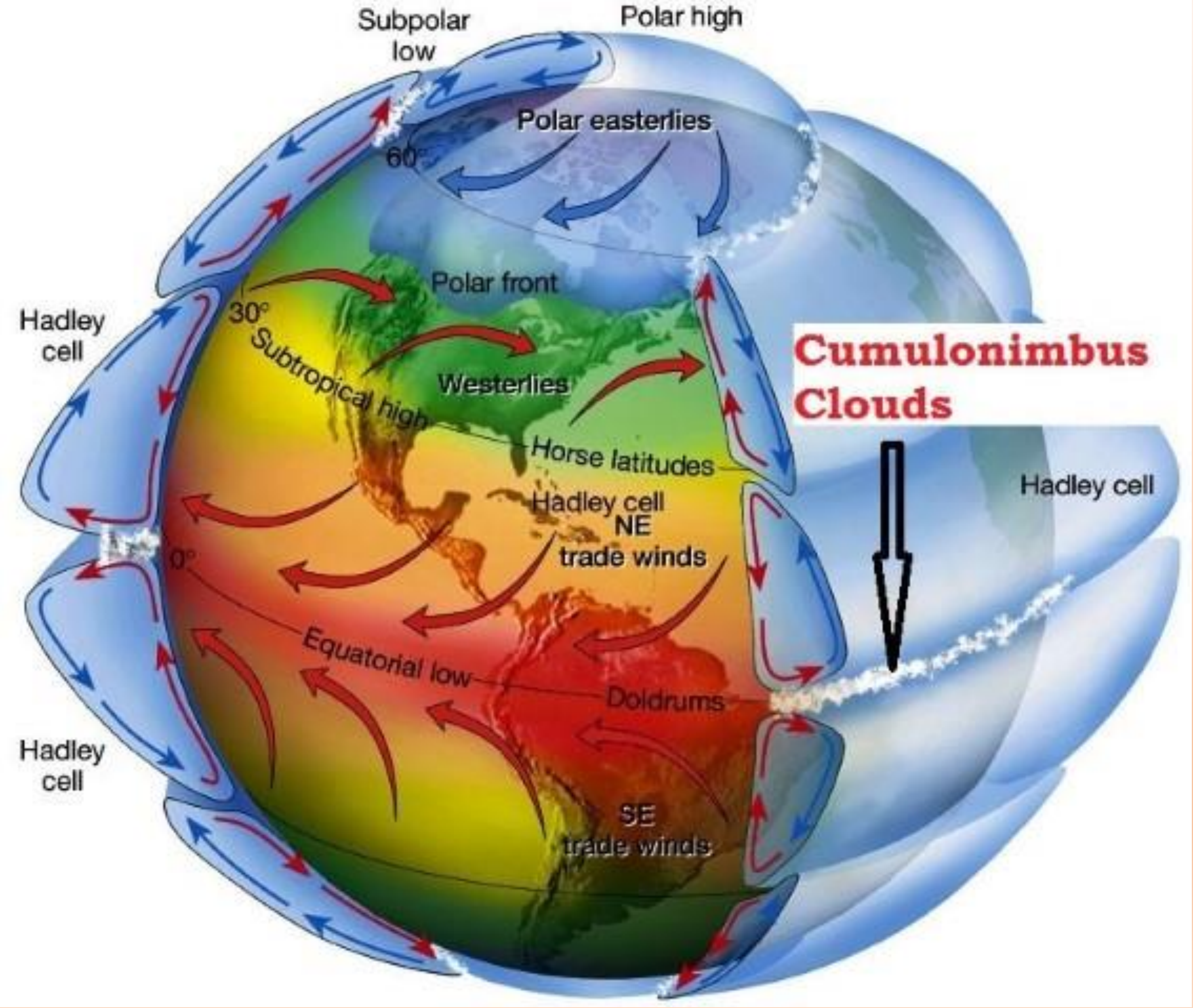
This is because of the **absence of Surface winds** since winds approaching this belt begin to rise near its margin. Thus, **only vertical currents are found**.

As the larger part of the low pressure belt passes along the oceans, the winds obtain huge amount of moisture.

Climate in Equatorial Low-Pressure Belt

Vertical winds (convection) carrying moisture form **cumulonimbus clouds** and lead to **thunderstorms (convectional rainfall).**

Inspite of high temperatures, cyclones are not formed at the equator because of 'zero' coriolis force. (we will see more later)



Sub-Tropical High Pressure Belt or Horse Latitudes

The sub-tropical highs extend from near the tropics to about **35°N and S.**

After saturation (complete loss of moisture) at the ITCZ, the air moving away from equatorial low pressure belt in the upper troposphere becomes dry and cold.

This dry and cold wind subsides at 30°N and S.

So the high pressure along this belt is due to **subsidence of air coming from the equatorial region** which descends after becoming heavy.

The high pressure is also due to the blocking effect of air at upper levels because of the **Coriolis force.**

Climate in **Sub-Tropical High Pressure Belt**

The **subsiding air is warm and dry, therefore, most of the deserts are present along this belt, in both hemispheres**.

A calm condition **(anticyclonic)** with feeble winds is created in this high pressure belt.

The descending air currents feed the winds blowing towards adjoining low pressure belts.

This belt is **frequently invaded by tropical and extra-tropical disturbances**.

Climate in **Sub-Tropical High Pressure Belt**

The corresponding latitudes of sub-tropical high pressure belt are called **horse latitudes.**

In early days, the sailing vessels with cargo of horses found it difficult to sail under calm conditions of this high pressure belt.

They used to throw horses into the sea when fodder ran out. Hence the name horse latitudes.

This belt is **frequently invaded by tropical and extra-tropical disturbances**.

Sub-Polar Low Pressure Belt

•Located between **45°N and S latitudes** and the **Arctic and the Antarctic circles (66.5° N and S latitudes).**

Owning to low temperatures in these latitudes the sub polar low pressure belts are not very well pronounced year long.

•On long-term mean climatic maps, the sub polar low-pressure belts of the northern hemisphere are grouped into two centers of atmospheric activity: the **Iceland low** and the **Aleutian depression (Aleutian low).**

The area of contrast between cold and warm air masses produces **polar jet streams** which encircles the earth at 60 degrees latitudes and is focused in these low pressure areas.

Polar High Pressure Belt

The polar highs are small in area and extend around the poles.

They lie around poles between 80 – 90° N and S latitudes.

The air from sub-polar low pressure belts after saturation becomes dry. This dry air becomes cold while moving towards poles through upper troposphere.

The cold air (heavy) on reaching poles subsides creating a high pressure belt at the surface of earth.

The lowest temperatures are found over the poles.

Shifting Of Pressure Belts

If the earth had not been inclined towards the sun, the pressure belts, as described above, would have been as they are. But it is not so, because the earth is inclined 23 1/2° towards the sun.

On account of this inclination, differences in heating of the continents, oceans, and pressure conditions in January and July vary greatly. January represents winter season and July, summer season in the Northern Hemisphere.

Opposite conditions prevail in the Southern Hemisphere. When the sun is overhead on the Tropic of Cancer (21 June) the pressure belts shift 5° northward and when it shines vertically overhead on Tropic of Capricorn (22 December), they shift 5° southward from their original position.

The shifting of the pressure belts causes seasonal changes in the climate, especially between latitudes 30° and 40° in both hemispheres.

Shifting Of Pressure Belts

In this region, the Mediterranean type of climate is experienced because of the shifting of permanent belts southwards and northwards with the overhead position of the sun.

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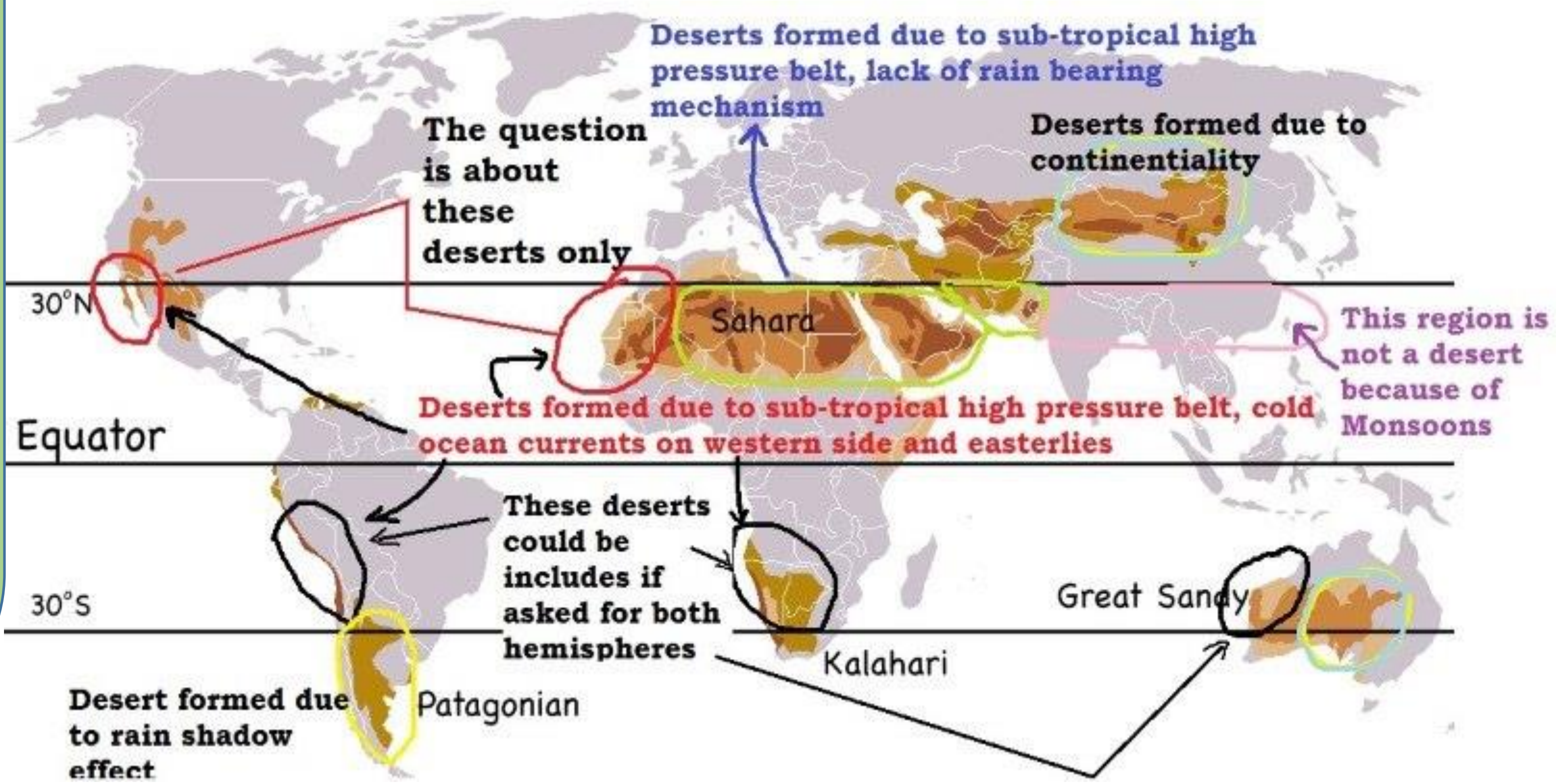
During winters Westerlies prevail and cause rain. During summers dry Trade Winds blow offshore and are unable to give rainfall in these regions.

When the sun shines vertically over the Equator on 21st March and 23rd September (the Equinoxes), the pressure belts remain balanced in both the hemispheres.

Pressure belts in July

In the northern hemisphere, during summer, with the apparent northward shift of the sun, the thermal equator (belt of highest temperature) is located north of the geographical equator.

The pressure belts shift slightly north of their annual average locations.



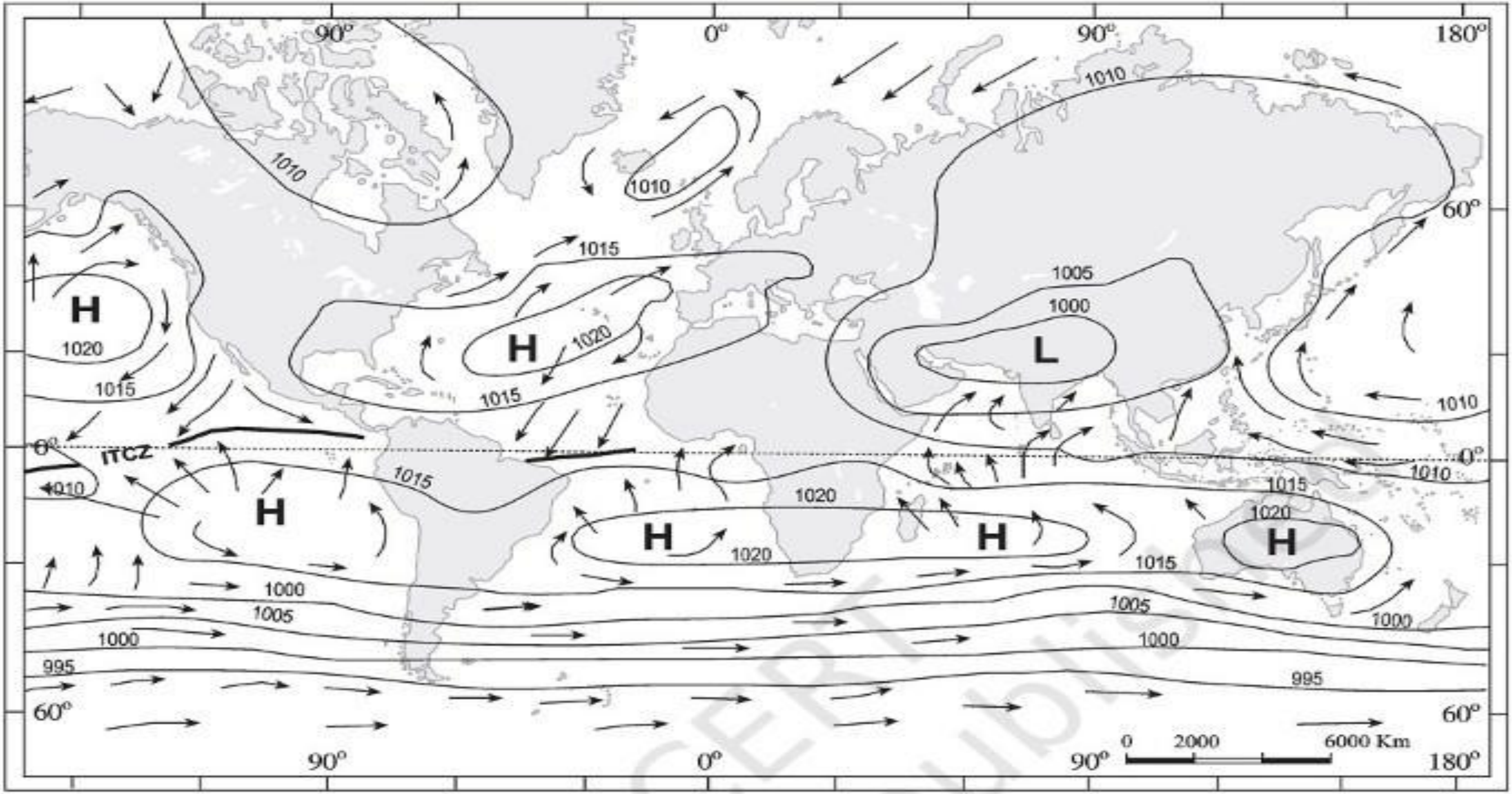


Figure 10.3 : Distribution of pressure (in millibars) — July

Pressure belts in January

During winter, these conditions are completely reversed and the pressure belts shift south of their annual mean locations. Opposite conditions prevail in the southern hemisphere. The amount of shift is, however, less in the southern hemisphere due to predominance of water.

Similarly, distribution of continents and oceans have a marked influence over the distribution of pressure. In winter, the continents are cooler than the oceans and tend to develop high pressure centres, whereas in summer, they are relatively warmer and develop low pressure. It is just the reverse with the oceans.

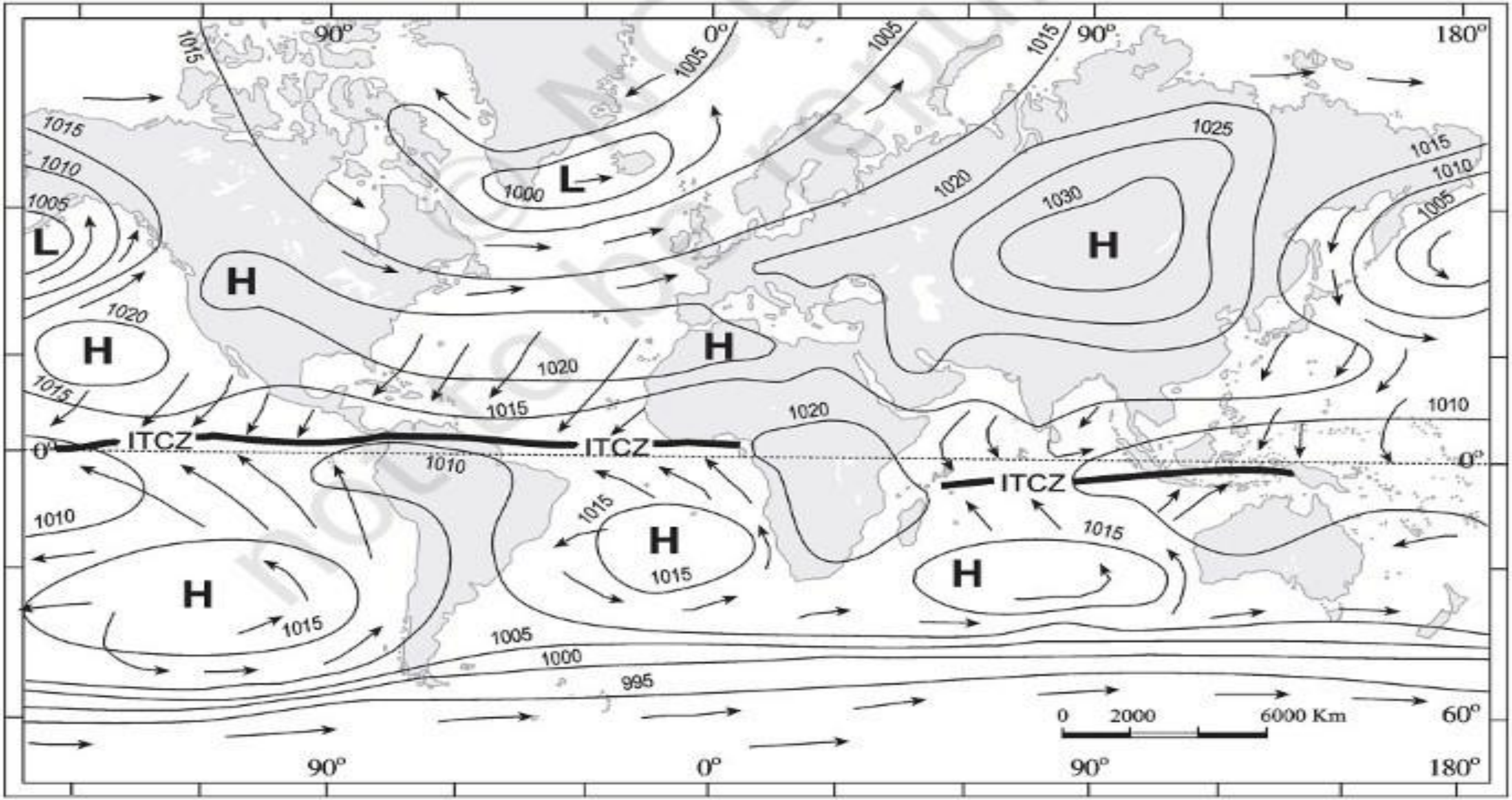


Figure 10.2 : Distribution of pressure (in millibars) — January

Thank You