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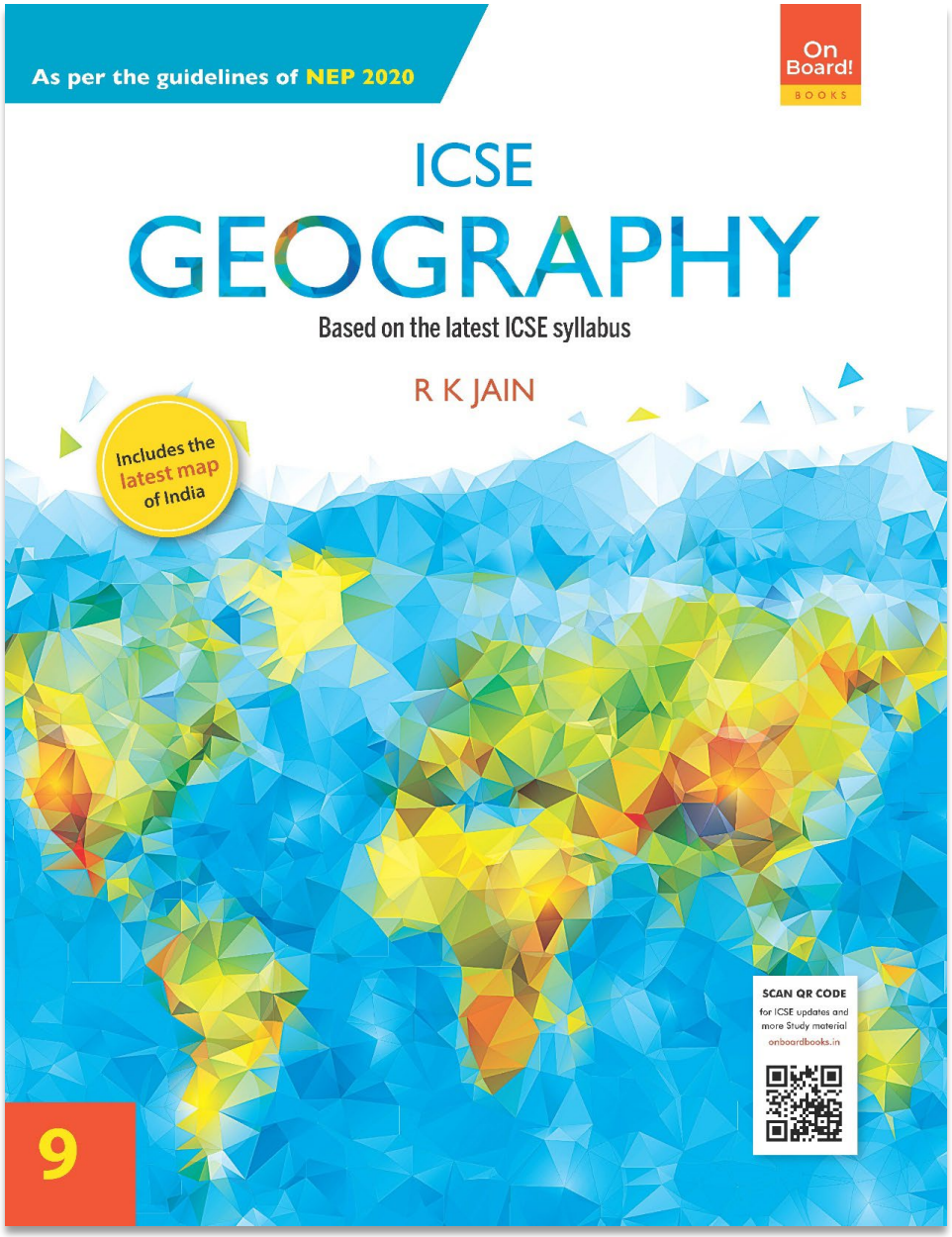
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ICSE GEOGRAPHY

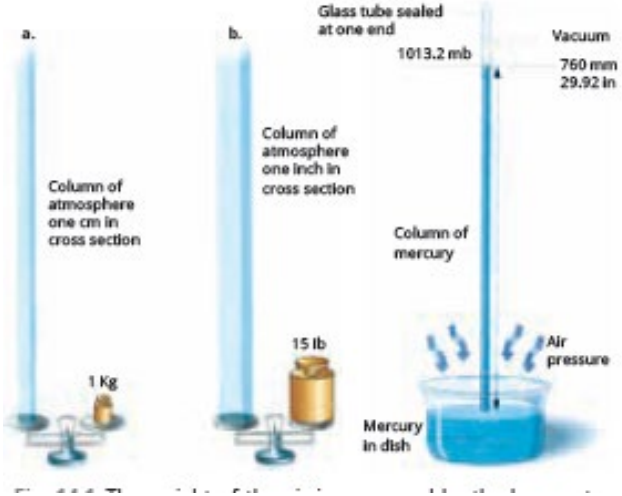
Class 9

Chapter 14: Atmospheric Pressure and Winds

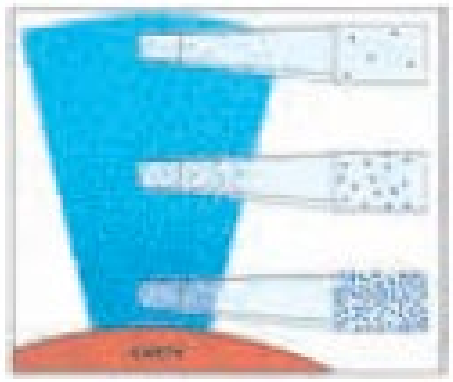
The atmosphere rests on the surface of the Earth due to the gravitational pull of the Earth. Air is a mixture of several gases and like any other matter has weight. Air exerts its weight as pressure on the surface of the Earth. This is known as the **atmospheric pressure**.

ATMOSPHERIC PRESSURE

- The atmospheric pressure is defined as the weight of the column of air at any given place and time.
- It is maximum at the sea level and its weight is 1034 grams on one square centimetre area.
- The atmospheric pressure is measured with the help of a **barometer**, which can be mercurial, aneroid, barograph, etc. The normal atmospheric pressure at the sea level is the weight of the column of mercury 76 centimetres high.
- The atmospheric pressure is measured in **millibars (**or **mb)**. One millibar is equal to the force of one gram of air over one square centimetre area. The normal pressure at the sea level is 1013 millibars.



The weight of the air is measured by the barometer

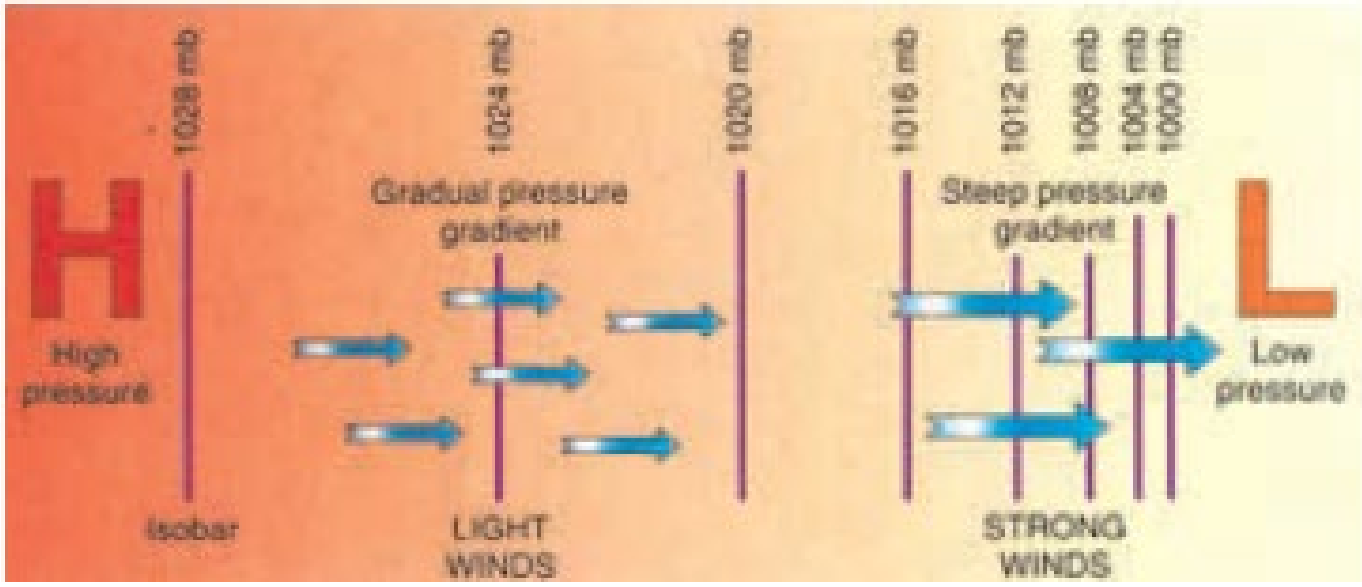


The density of air decreases with altitude

Aneroid barometer measures atmospheric pressure

The distribution of atmospheric pressure is shown with the help of **isobars** on a map. The lines joining the places having equal atmospheric pressure at the sea level are called the isobars.

- The distance between the isobars shows the rate and the direction of the changes in the pressure. It is referred to as the **pressure gradient**. There are two types of pressure systems – **high pressure** and **low pressure**.
- The atmosphere exerts considerable pressure, but we rarely feel it. One can imagine how much weight of overlying air is carried by us daily. We do not feel the weight of air because the outward pressure balances the inward pressure.



Pressure gradient determines wind speed

DISTRIBUTION OF ATMOSPHERIC PRESSURE

The general distribution of pressure on the Earth is not uniform. The atmospheric pressure belts are found more or less in regular pattern in the Southern Hemisphere than in the Northern Hemisphere.

The regularity of the pressure belts is disturbed due to the unequal distribution of land and water on the Earth. The atmospheric pressure largely depends upon air temperature which generally decreases as we move away from the equator towards the poles.

There is a low pressure belt near the **equator** due to high mean annual temperature and a high pressure belt near the **poles** due to low mean annual temperature. These two pressure belts follow the rule, i.e. the atmospheric pressure increases with decrease in temperature.

The **main pressure belts** on the Earth are as under:

1. Equatorial Low Pressure Belt.
2. Sub-Tropical High Pressure Belts in both the hemispheres.
3. Sub-Polar Low Pressure Belts in both the hemispheres.
4. Polar High Pressure Belts in both the hemispheres

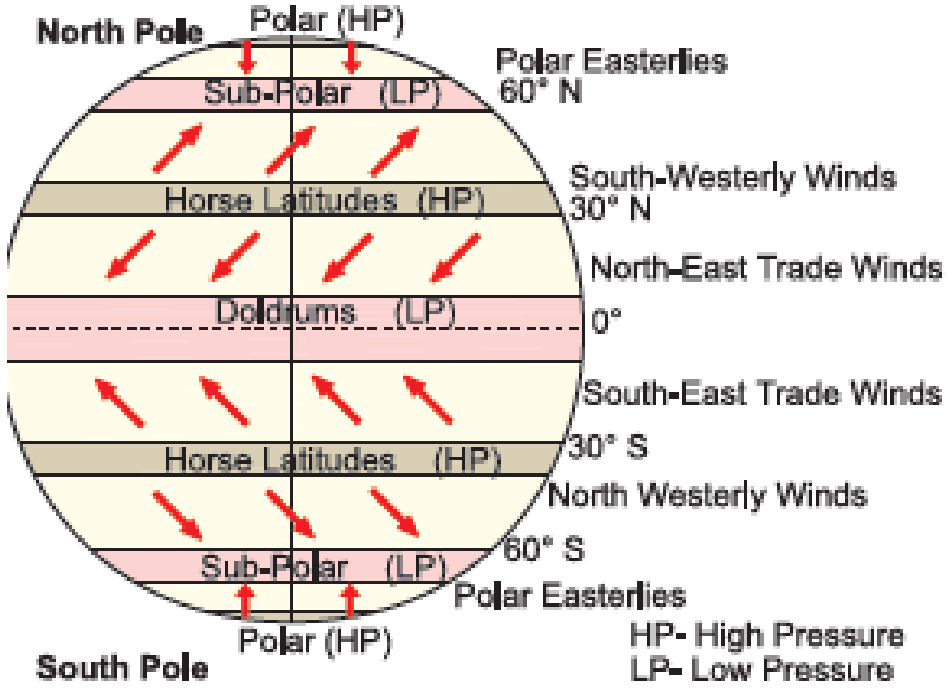
Equatorial Low Pressure Belt

- The equatorial low pressure belt extends on both sides of the equator and lies roughly between 5° N and 5° S latitudes. This low pressure belt is not stationary as there is a seasonal shift with the northward (summer solstice) and southward (winter solstice) migration of the Sun.
- This region is intensely heated by the nearly vertical rays of the Sun. The lower layers are heated due to conduction. The air becomes light and rises upwards, causing low pressure with calm conditions.

- The surface winds are generally absent as the winds approaching this belt begin to rise upwards. Thus only vertical currents are experienced in this belt. Due to extreme calm conditions, the equatorial low pressure belt is also known as the **doldrums**.
- The equatorial low pressure belt represents the zone of convergence of the Northeast and the Southeast Trade winds. They are also known as the **Inter-Tropical Convergence Zone** or **ITCZ**.

Sub-tropical High Pressure Belts

- The sub-tropical high pressure belts extend roughly between 25° and 35° latitudes in both the hemispheres. These two zones experience fairly high temperature almost throughout the year.
- The sub-tropical high pressure belts are **not of thermal origin** but are formed due to the rotation of the Earth and the subsidence of air. Thus these two belts are **dynamically induced**.



The pressure and wind belts of the world

- The warm air of the equatorial low pressure belt rises upwards and cools during its upward journey. After reaching the upper layer it starts moving towards the poles due to the Earth's rotation.

- It further cools and subsides in a zone between 25° and 35° latitudes in both the hemispheres. The descent of air results in contraction of their volume and causes the development of high pressure.
- The sub-tropical high pressure belt is characterised by anticyclonic conditions which cause atmospheric aridity. This is one of the reasons for hot deserts being found in the western parts of the continents in both the hemispheres.

The subsidence of air in this zone is due to the following two factors:

1. Cooling of air increases the density of air, which causes subsidence.
2. The eastward movement of air is due to Earth's rotation. This is also called the **Coriolis force**. The rate of deflection increases with the increasing distance from the equator.

Sub-polar Low Pressure Belts

- The sub-polar low pressure belts lie between 55° and 65° latitudes in both the hemispheres. These low pressure belts are not thermally induced.
- The sub-polar low pressure belts are more developed and regular in the Southern Hemisphere than in the Northern Hemisphere. This is due to the overdominance of oceans in the Southern Hemisphere.

Polar High Pressure Belts

- The polar high pressure belts extend for a small area around the North Pole and the South Pole. These regions experience very low temperatures (mostly below freezing point) almost throughout the year. Due to this, subsidence of air takes place, which leads to the development of high pressure.

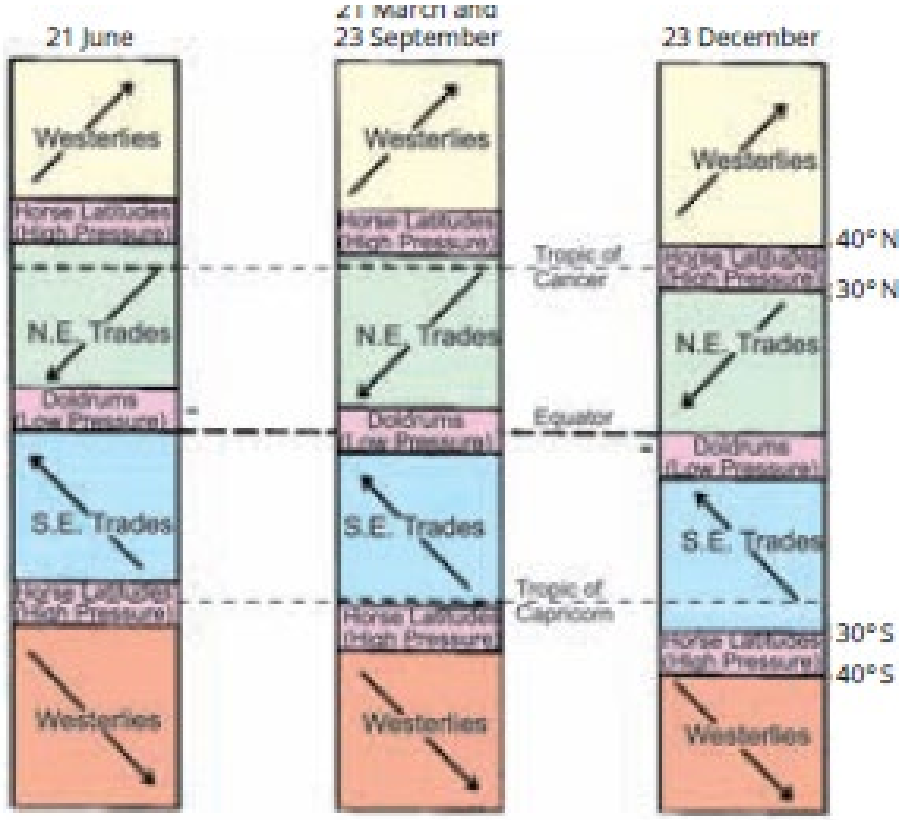
SHIFTING OF PRESSURE AND WIND BELTS

The location of the seven pressure and wind belts on the surface of the Earth should not be taken as fixed. The **main factors** responsible for the development of pressure and wind belts are:

a. the amount of insolation received by the surface of the Earth,
b. the rotation of the Earth on its axis, and
c. the revolution of the Earth around the Sun.

On 21 June (Summer Solstice), the Sun rays are vertical over the Tropic of Cancer and thus all the pressure belts, except the northern polar high pressure belt, shift northwards. **For example**, the equatorial low pressure belt lies between 0° and 10° N latitude.

On 23 December (Winter Solstice), the Sun rays are vertical over the Tropic of Capricorn and thus all the pressure belts, except the southern polar high pressure belt, shift southwards. **For example**, the equatorial low pressure belt lies between 0° latitude and 10° S latitude.



Shifting of pressure and wind belts

On 21 March and **23 September (Equinoxes)**, the Sun's rays are vertical over the equator and thus all the pressure and wind belts shift to their normal positions.

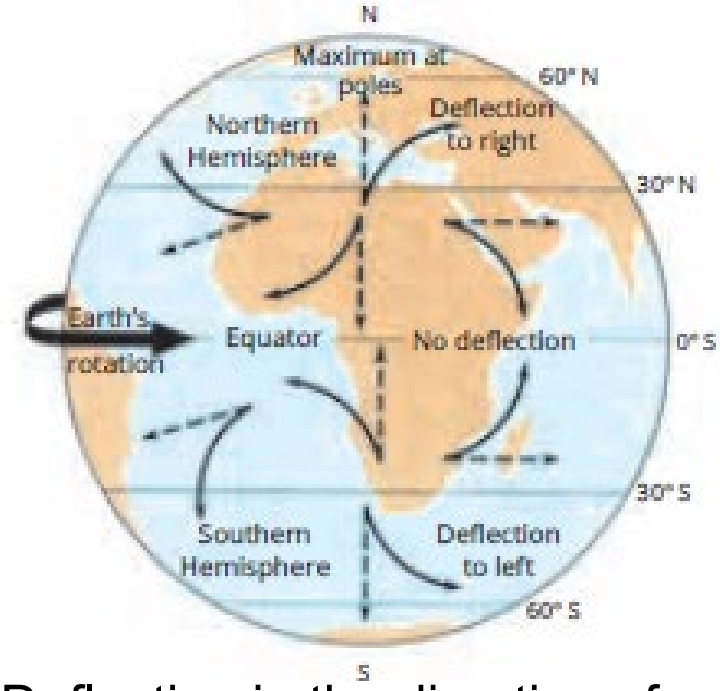
WINDS

The horizontal movement of air along the surface of the Earth is called the **wind**, while the vertical or nearly vertical movement of air is called an **air current**.

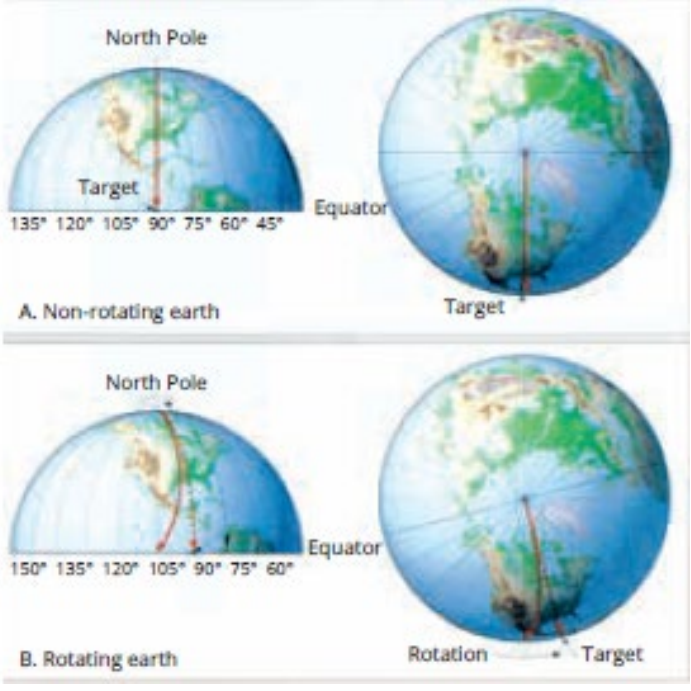
The speed and direction of the winds are determined by the following three forces:

a. The pressure gradient force
b. The Coriolis force
c. The frictional force

The force which deflects the direction of the wind is called the **Coriolis force.**
All winds are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere with respect to the rotating Earth.



Deflection in the direction of winds due to the Coriolis force



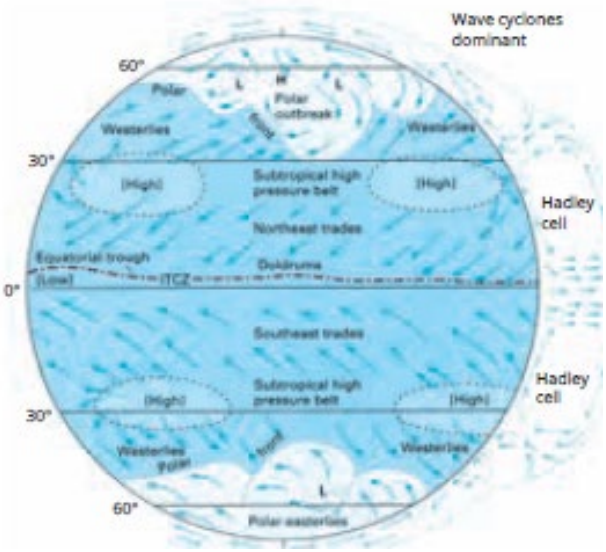
Direction of winds on a non-rotating and rotating Earth

The hill slope facing the wind is the **windward slope**, while the opposite side of the hill is called the **leeward slope**.

TYPES OF WINDS

Winds are generally classified into the following four major types:

1. Permanent winds or the Planetary winds
2. Periodic winds or the Seasonal winds
3. Local winds
4. Variable winds



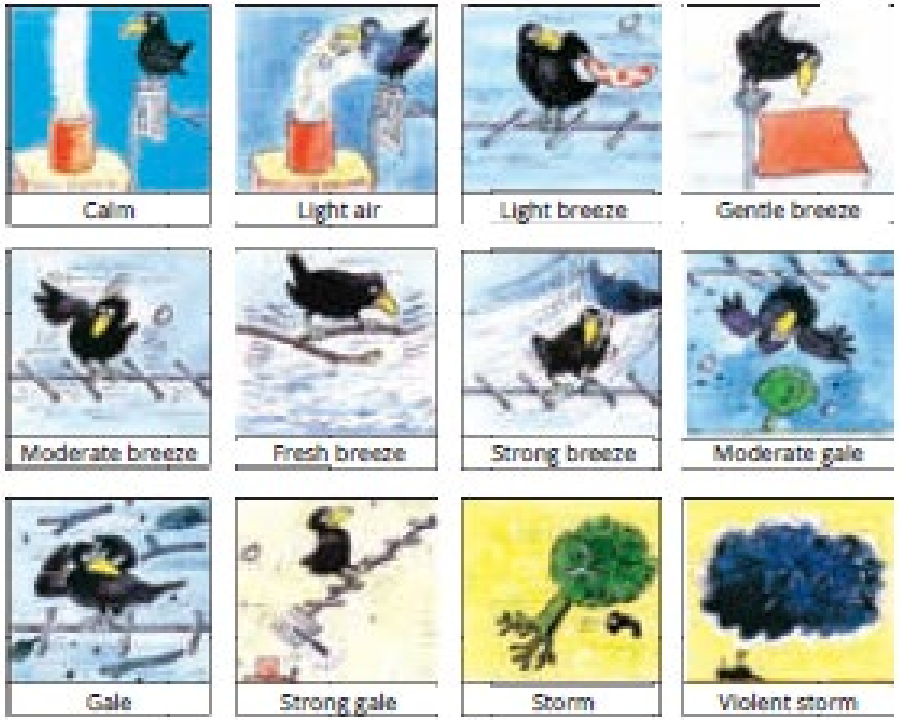
Global surface winds on an ideal Earth

PERMANENT WINDS

The winds which constantly blow in the same direction throughout the year are called the **permanent winds** or the **planetary winds** or the **prevailing winds**. Planetary winds blow over vast areas of continents and oceans. The important planetary winds are the **Trade Winds**, the **Westerlies** and the **Polar Easterlies**.

The Trade Winds

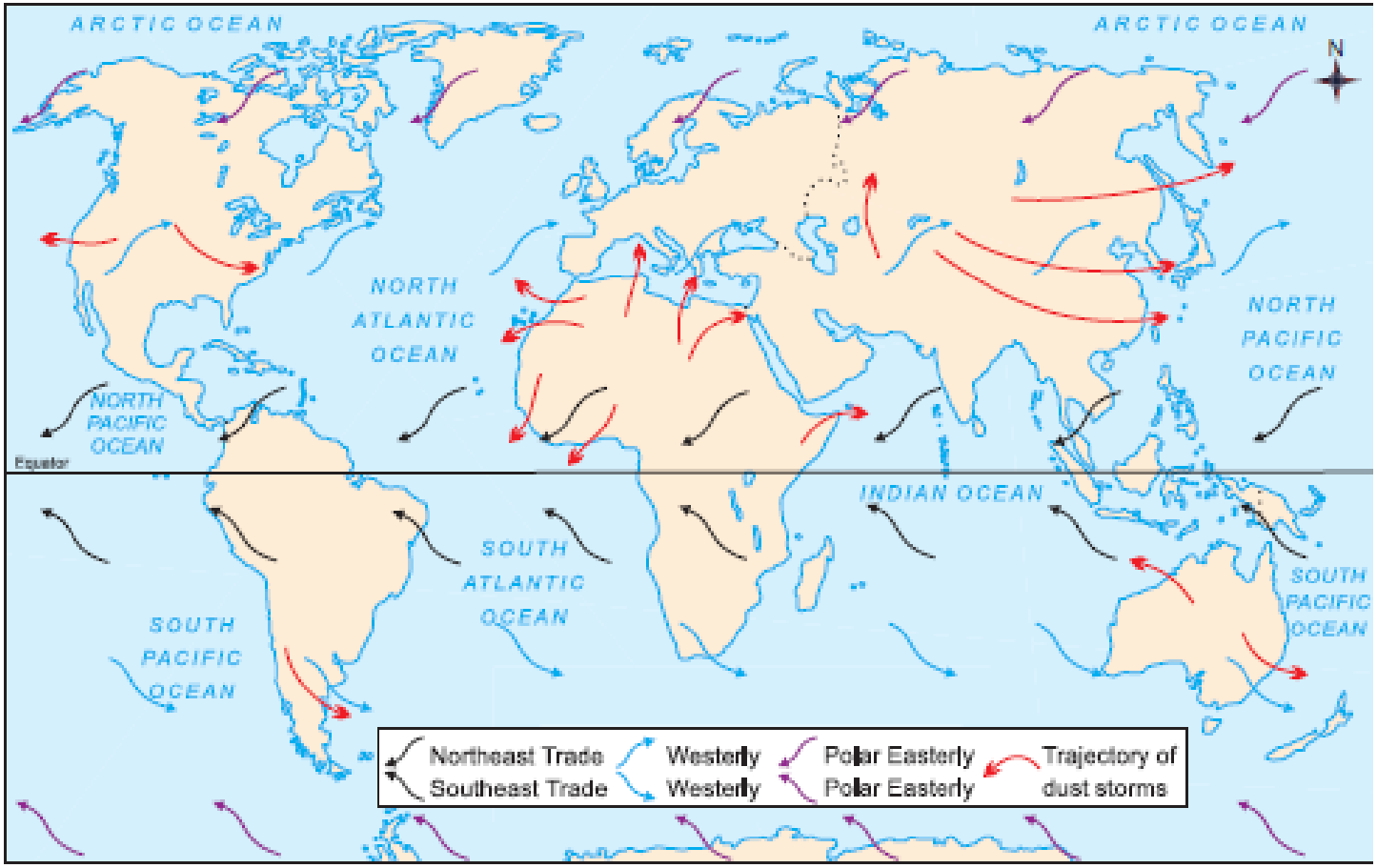
They blow with great regularity from the subtropical high pressure belt towards the equatorial low pressure belt in both the hemispheres throughout the year.



The Beaufort scale for winds

The Westerlies

These are the permanent winds blowing from the sub-tropical high pressure belt to the sub-polar low pressure belt in both the hemispheres.



World – the Permanent or the Planetary winds

The Polar Easterlies

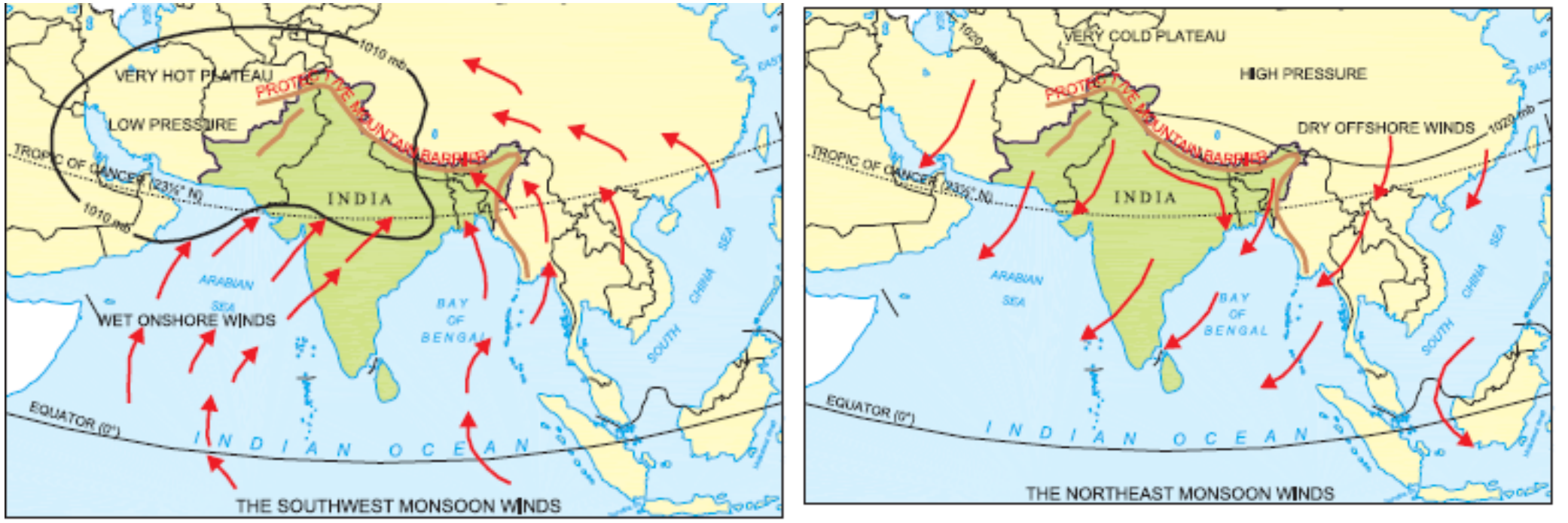
The winds which blow from the polar high pressure areas towards the sub-polar low pressure areas are known as the **Polar Easterlies** or the **Polar Winds**.

PERIODIC WINDS

The winds which change their direction periodically are called the **periodic winds** or the **seasonal winds**. In one season they blow in one direction and in another they blow in the opposite direction. These winds are caused by the unequal heating and cooling of the land and the sea. **Monsoons** are the best example of the periodic winds. Other winds included in this type are the **land breezes** and the **sea breezes**.

The Monsoon Winds

The term **monsoon** has been derived from the Arabic word **mausim** or from the Malayalam word **monsin**, both meaning **season**.



The system of Monsoon winds

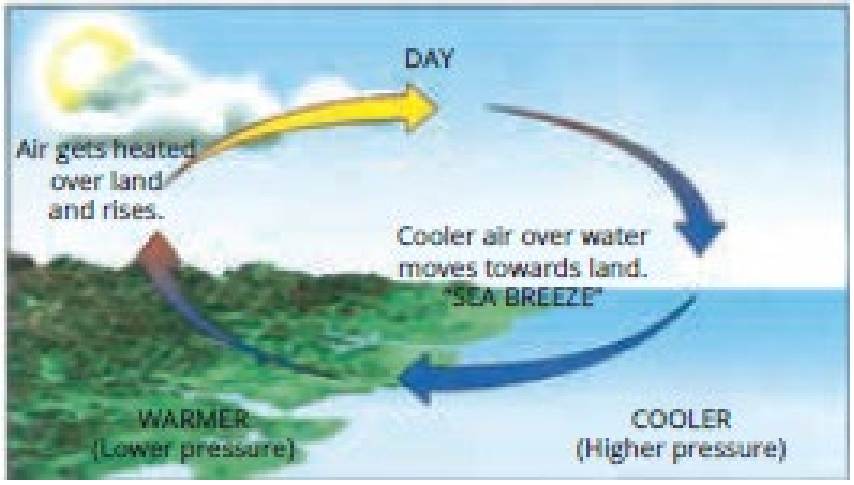
Trade winds, in both the hemispheres, meet each other near the equator. The meeting place is called the **Inter-Tropical Convergence Zone** (ITCZ).

During the summer season, the ITCZ shifts northwards due to the migration of the Sun towards the Tropic of Cancer. Thus the Southeast Trade winds cross the equator and blow from the southwest to the northeast direction under the influence of the Coriolis force. These displaced Southeast Trade winds are called the **Southwest** or the **Summer Monsoons**.

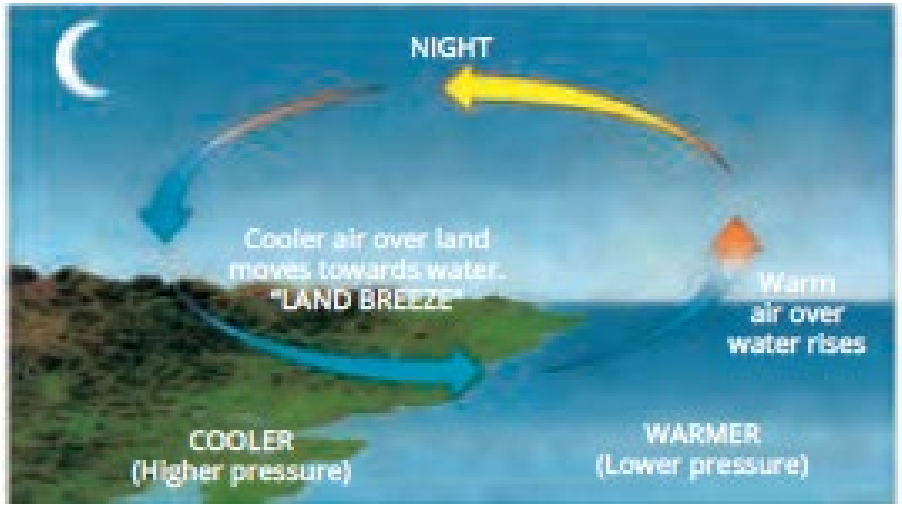
During the winter season, the sub-tropical high pressure belt and the thermal equator retreat southwards. The Trade winds in both the hemispheres are re-established. These are the **Northeast** or the **Winter Monsoons**.

The Land and Sea Breezes

The land and sea breezes are experienced in the narrow coastal areas. The sea breezes blow from sea to land during daytime and the land breezes blow from land to sea during night. These winds are caused due to the unequal heating and cooling of land and water.



Sea breezes

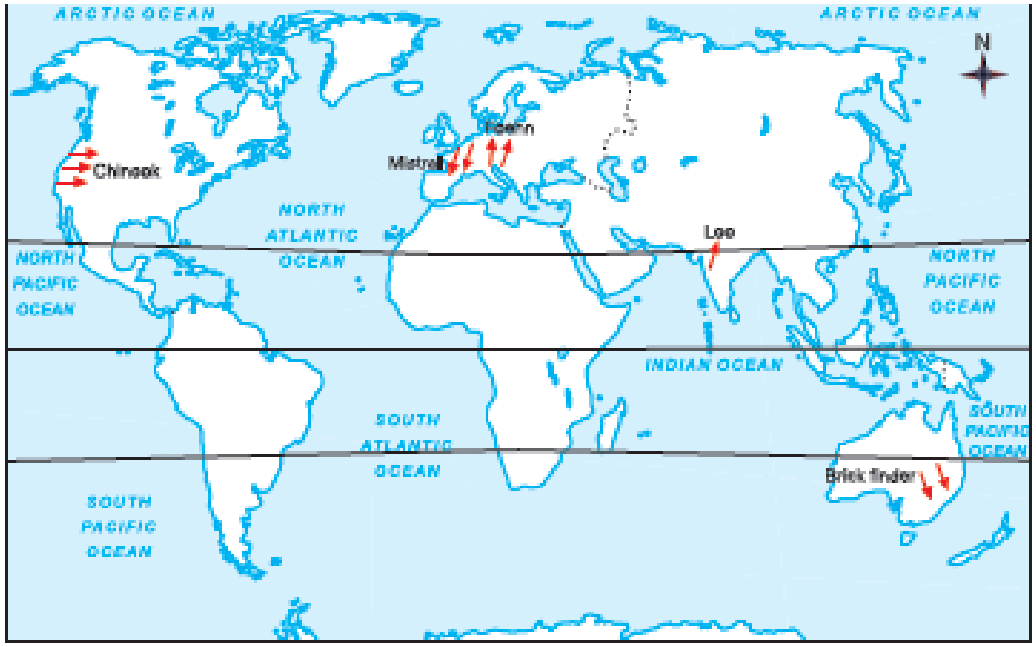


Land breezes

LOCAL WINDS

The Local winds develop due to the local variations in temperature, pressure and humidity. They affect small areas and are restricted to the lowest levels of the Troposphere. There are numerous local winds which blow in different parts of the world. They have local names like loo, chinook, foehn, mistral, etc.

1. **Loo (India)** are very hot and dry winds which blow in the plains of North India and Pakistan, in the months of May and June, usually in the afternoons. Their movement is feeble during the night hours. The temperature of the air ranges between 40 °C to 50 °C. A loo can cause **sunstroke** to the people.



World – Main types of local winds

VARIABLE WINDS

The system of circulation in the atmosphere can be disturbed by certain local conditions which cause variations in the prevailing winds. These are known as the **variable winds** or the **cyclones** and the **anticyclones**. The origin and appearance of the variable winds is quite sudden. These winds often assume the form of a terrific storm and their direction, shape, extent and scope is uncertain.

A **cyclone** represents a low pressure system at the centre surrounded by high pressure. The winds in a cyclone tend to converge towards the centre. Their movement is anticlockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

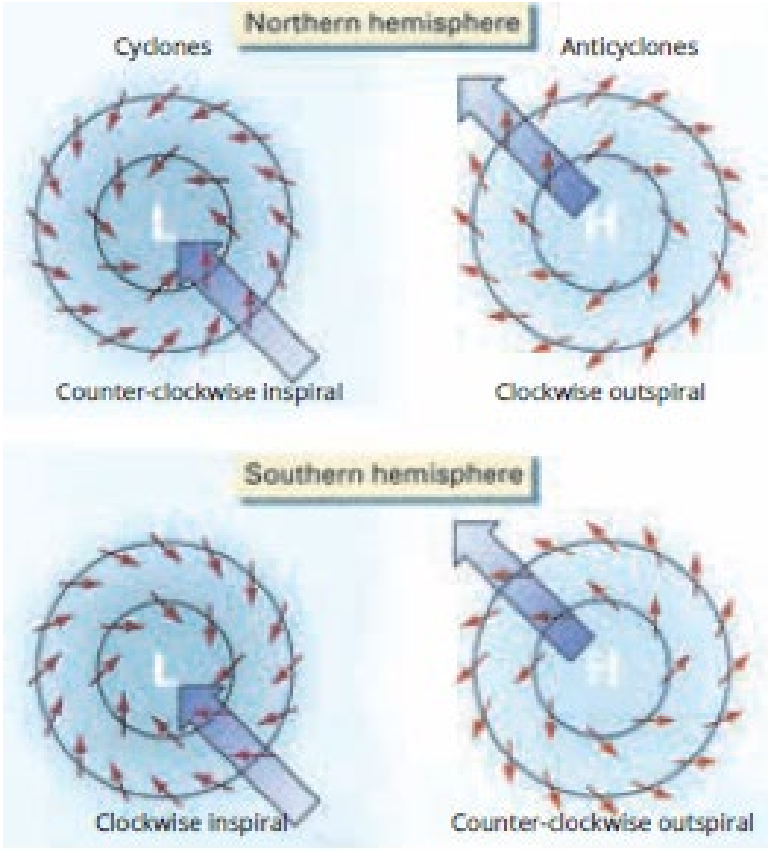
The Tropical Cyclones

The tropical cyclones are seasonal and occur in the later part of the summer season.

The Temperate Cyclones

The temperate cyclones, also called the **temperate depressions**, originate in the zone where the warm Westerlies meet the cold Polar winds. The plane along which hot and cold air masses meet is known as the **front**. Thus the temperate depressions are of **frontal origin** and have the following **characteristics**.

- They are most dominant over the North Atlantic Ocean, especially during the winter season.
- Due to their vast sizes, the winds are not circular but tend to move in an elliptical pattern.



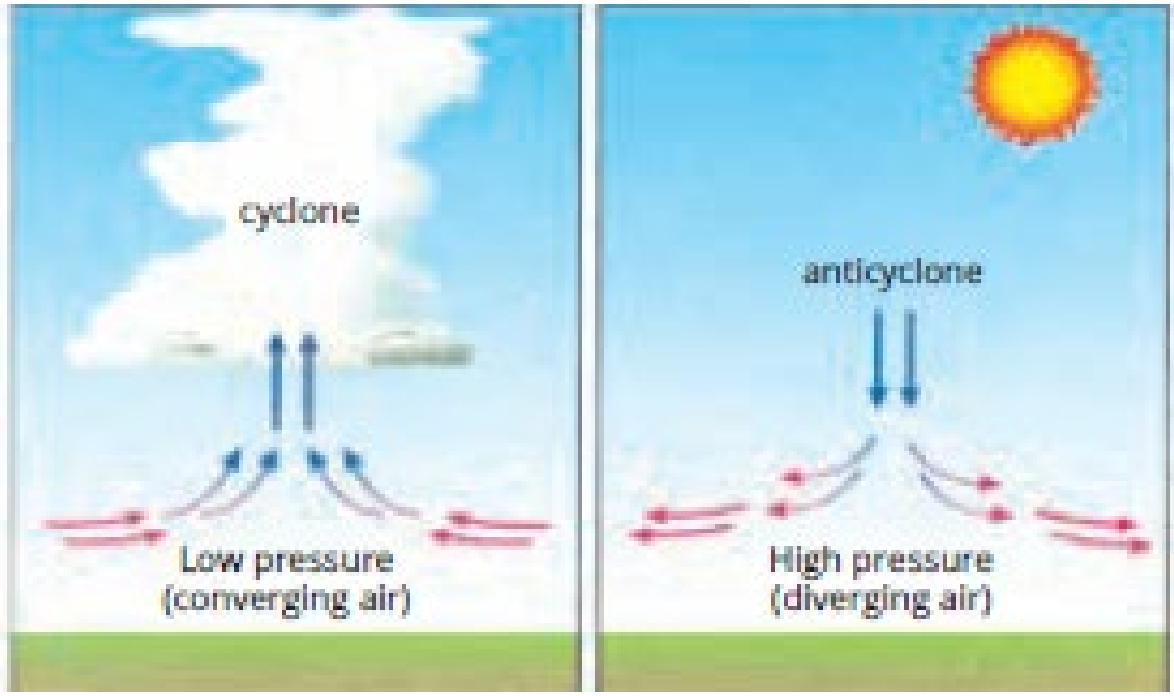
Air motion in cyclones and anticyclones

The Anticyclones

An anticyclone has a high pressure centre surrounded by low pressure on all sides. It has an oval or circular arrangement of isobars, highest value being at the centre.

It has the following **characteristics**.

- A progressive rise in the barometer indicates the approach of an anticyclone which lies between two cyclones and has no definite direction of movement.
- The winds are divergent and radiate from the high pressure centre. They are generally light and slow and never become violent.



Development of cyclone and anticyclone

- The general movement of the winds is clockwise in the Northern Hemisphere and anticlockwise in the Southern hemisphere.
- The anticyclones are often accompanied by cold and hot waves. They are associated with calm conditions and fine weather in summer, and fog and frost during the winter.

JET STREAM

A jet stream is a narrow belt of westerly winds at a high altitude (8 km to 14 km) in the troposphere. Their speed varies from about 110 km per hour in the summer season to more than 180 km per hour in the winter season. The jet streams are several hundred kilometres wide and about 2 km to 5 km deep.

On the basis of location, the jet streams are of five types.

1. **Polar Front Jet Stream** – they move in easterly direction.
2. **Subtropical Westerly Jet Stream** – they move from west to east.
3. **Tropical Easterly Jet Stream** – attached with Indian monsoons.
4. **Polar Night Jet Stream** – westerly in winters and easterly in summers.
5. **Local Jet Stream** – due to local thermal and dynamic conditions.

- The jet stream are thousands of km in length, a few hundred km in width and a few km (2 km to 5 km) in depth.

- The monsoon winds of South Asia are largely influenced and controlled by the jet streams.

THANK YOU