Pressure Belts and Types of Winds

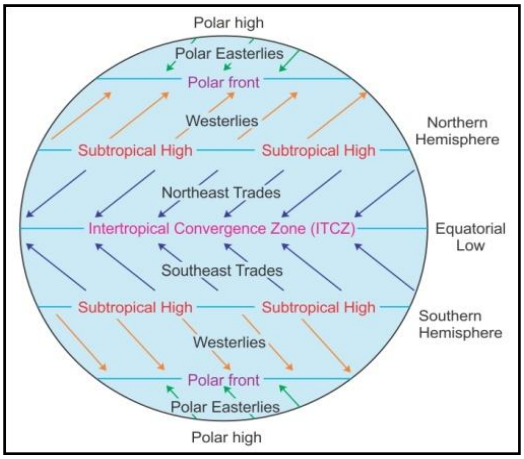
Air Pressure

- Air is a mixture of several gases present in the atmosphere. The weight exerted by air on a unit area of the Earth is known as **air pressure**. It is expressed in **millibar**.
- Atmospheric pressure produces changes in the weather.
- Winds are caused by air pressure.
- On maps, **isobar lines** join all places with the same air pressure at a given point of time. If the isobars are far apart, then the weather is calm and gentle. Closed spaced isobars denote great difference in air pressure and warm weather.
- Air pressure is measured by a **barometer**. There are two types of barometers—Fortin's barometer and aneroid barometer.
- The rate of change of atmospheric pressure between two points on the Earth's surface is known as the pressure gradient. The pressure gradient is denoted by the spacing of isobars on weather charts.
- Close spacing of isobars indicates a strong pressure gradient, while wide spaced isobars point out a weak gradient.

World's Pressure Belts

The distribution of atmospheric pressure across the latitudes is known as the global horizontal distribution of pressure. Differences in pressure conditions over the Earth result in the creation of various pressure belts. Because the Earth is spherical, different parts of the Earth get heated differently. Because the equatorial regions receive maximum sunlight, warm air rises creating low pressure conditions. Similarly, at the Poles, cold air sinks (because cold air is heavy) creating a high pressure area.

Major pressure belts of the Earth:



Main pressure belts on the Earth

Equatorial Low Pressure Belt

- This belt lies between 0°N to 5°N and 0°S to 5°S.
- Because the vertical rays of the Sun fall on the Earth, the heat is intense and the temperature is high. The air becomes warm and expands.
- The convection currents help spread the heat to the upper layers of the atmosphere also.
- This leads to the creation of a low pressure belt in the region. Winds in this pressure belt do not blow at a fast pace, and hence, this belt is known as the Belt of Calms or the Belt of Doldrums.

Sub-Tropical High Pressure Belt

- This belt is located between 30°N to 35°N and 30°S to 35°S.
- As the air at the Equator moves towards the Poles, it begins to cool and sink at about 30° North and South of the Equator. This creates areas of high air pressure.
- Because of the rotation of the Earth, air from 60°N and 60°S also descends in the Sub-Tropical Belts.
- This pressure belt is also a Belt of Calms and is called Horse Latitudes.

Circum Polar Low Pressure Belt

- This belt is located between 60°N to 65°N and 60°S to 65°S.
- It is a zone of two winds—the warm Westerly winds meet the cold Polar Easterlies. As the Westerlies are lighter, they rise over the cold polar winds creating a low pressure area.
- These belts experience stormy weather and cyclonic activity, especially during winters.

Polar High Pressure Belts

- This belt is located between 85°N to 90°N and 85°S to 90°S.
- The Polar Regions experience cold climatic conditions as the rays of the Sun are extremely slanting.
- The cold air sinks giving rise to high pressure areas.
- At places where the temperature is permanently low, air is dense and heavy. These Polar Regions have permanent ice caps.

Shifting of Pressure Belts

- The inclination of the Earth at 23 1/2° creates differences in heating of oceans and continents. The pressure conditions vary in the Northern and Southern Hemispheres.
- On 21 June, when the Sun is overhead on the Tropic of Cancer, the pressure belts shift 5° northwards. On 22 December, when the Sun shines vertically overhead on the Tropic of Capricorn, they shift 5° southwards from their original position.
- On 21 March and 23 September, when the Sun shines vertically over the Equator, the pressure belts remain balanced in both hemispheres.
- This shifting of pressure belts results in seasonal changes in climate.

World Distribution of Pressure

- The land and oceans get heated differently. Hence, there is a marked difference in pressure conditions over the land and the oceans.
- In January, the places in the Northern Hemisphere experience winter conditions. In places such as Siberia and the North Indian Plains, the temperature is low and the pressure is high.
- On the contrary, low pressure conditions exist over the Indian Ocean, North Atlantic Ocean and North Pacific Ocean. These oceans are warmer.
- The places in the Southern Hemisphere experience summer in January as there is high temperature and low pressure conditions over the continents.
- During July in the Northern Hemisphere, high pressure occurs over the oceans, and the continental landmasses experience high temperature and low pressure conditions. This is summer in the Northern Hemisphere.
- We find major seasonal fluctuations occurring during this period because of the overheating of landmasses.

Winds

Horizontal movement of air is called **winds**. Winds blow from high pressure areas to low pressure areas. The vertical movement of air is known as **air current**.
Many factors affect the direction and speed of winds. These are

Temperature: When the temperature of a place increases, the atmospheric pressure decreases. It is because an increase in temperature results in heating the air. Warm air expands. The molecules of warm air become less dense and hence exert less pressure. On the contrary, decrease in temperature makes air cool and dense. Cold air sinks creating a high pressure area in a region.

Coriolis Effect: The Earth rotates on an inclined axis. Because of the rotation, winds get deflected to their right in the Northern Hemisphere and to their south in the Southern Hemisphere.

Altitude: The atmospheric pressure decreases with the increase in altitude. Air is compressible. As the gravity of the Earth pulls the molecules and gases towards the ground, the lowest layer of air gets densest. This dense layer of air exerts the greatest pressure.

Water Vapour: Moist air exerts more pressure as it contains fewer amounts of nitrogen and oxygen. Dry air, on the other hand, exerts less pressure as it has more nitrogen and oxygen and hence is denser.
Rotation of the Earth: The rotation of the Earth causes the air at the poles to be pushed away towards the Equator. In theory, air should have been accumulated at the Equator creating a high pressure belt. However, this does not happen. On the contrary, the air gets heated at the Equator, gets warmer and rises creating a low pressure area.

Types of Winds

There are various types of winds. Winds which blow throughout the year from one latitude to the other are known as **Permanent Winds**. Certain winds reverse their direction periodically with seasons and are known as **Periodic Winds**. Some winds blow only over a small area for a specific period and have special characteristics. These winds are known as **local winds**.

Permanent Winds

There are three main permanent winds—Trade Winds, Westerlies and Polar Easterlies.

Trade Winds

Main characteristics of trade winds:

- The trade winds blow in the tropics between the sub-tropical high pressure belt and the equatorial low pressure belt between 30°N and 30°S.
- Trade winds are warm winds, and hence, they pick up moisture and bring heavy rainfall on the eastern sides of the tropical islands.
- They are deflected to the right of their course in the Northern Hemisphere and to the south in the Southern Hemisphere. Thus, in the Northern hemisphere, they become North Trade Winds, and in the Southern Hemisphere, they are called Southeast Trade Winds.
- Trade winds blow at a constant speed and are regular.
- They are associated with constant depressions and cyclones.
- The Trade Winds are also known as permanent or constant winds. The only exception is that they are replaced by the monsoon winds in the Indian and Pacific oceans.

Westerlies

Main characteristics of the Westerlies:

- They blow from Sub-Tropical High Pressure Belts to Sub-Polar Low Pressure Belts between 30° and 60°N of the Equator in the temperate latitudes.
- Because of the Coriolis Effect, they deflect to their right to become the South Westerlies in the Northern Hemisphere and deflect to their left to become the North Westerlies in the Southern Hemisphere.
- They are strong winds which are dominated by the movements of cyclones and anti-cyclones.
- They are responsible for carrying warm equatorial waters and winds to the western coasts of the temperate lands.
- Because of the shifting of the wind systems, not all the places located on the western coast of the temperate lands receive rainfall throughout the year.

Polar Easterlies

Main characteristics of the Polar Easterlies:

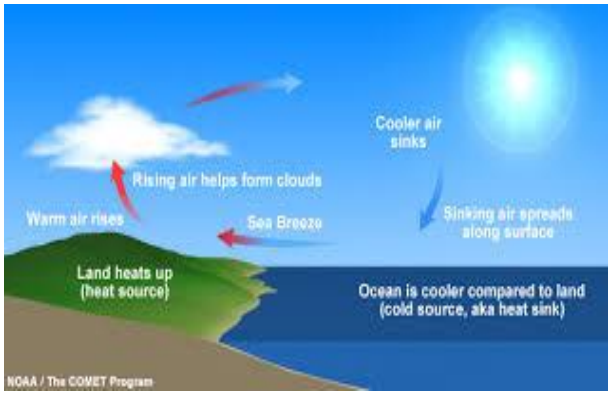
- Polar winds blow from the polar high pressure belt towards the Sub-Polar Low Pressure Belt between 60°N to 60°S. In the Northern Hemisphere, they blow from the northeast and are known as the Northeast Polar Winds. In the Southern Hemisphere, they blow from the southeast and are known as the Southeast Polar Winds.
- Because they are deflected in the west in both hemispheres by the Coriolis Effect, they are known as the Polar Easterlies.
- These are cold winds as they blow from the ice-capped regions. However, they become warm when they blow over the oceans.

Periodic Winds

Periodic winds blow at regular intervals in regular cycles. These winds cause differences in temperature and pressure in a region over which they blow.

Land and Sea Breeze

Land is a bad conductor and a good radiator of heat. Therefore, it quickly gets heated during the day. This results in building a low pressure area over the land and a high pressure area over the sea. Because winds blow from the high pressure area to the low pressure area, winds from sea blow towards the land. They are known as **sea breeze**. During the nights, the land cools down rapidly creating high pressure conditions. Thus, the **land breeze** blows from the land to the oceans.



Sea breeze and the land breeze

Summer Monsoons

- During summers, the land gets more heated than the sea. Because of high temperature, a low pressure area is created over the land.
- The reverse conditions exist in the oceans. During summers, the air is cool, and hence, a high pressure area develops. Because winds move from high pressure to low pressure areas, winds blow from the sea to the land (from the Indian Ocean to the Indian mainland) known as the summer monsoon.
- In the summer months, the landmasses of the Indian subcontinents are heated by the vertical rays of the Sun. This creates a low pressure area on the land. In the oceans, the high pressure area develops as the air is cool. So, the winds blow from the Indian Ocean northwards and in the north westward direction bringing heavy rainfall to Southeast Asia.

Winter Monsoons

- During winters, the conditions are reverse of summer. A high pressure area develops over the landmass and a low pressure area is developed over the seas.
- Because the winds blow from the land to the sea (winds move from high pressure to low pressure areas), they result in cold dry weather and hardly produce any rainfall.
- These winds can bring rainfall only when they blow over the seas to the adjoining lands. The Coromandel Coast in Tamil Nadu and the Vietnamese Coast get winter monsoon. Because these winter monsoon winds blow to the northeast, they are also known as Northeast Winter Monsoons.

Local Winds

- Local winds blow over a particular place over a certain period of time. These winds may be warm or cold depending on the area from which they blow.
- Loo is a local wind which blows in the plains of northern Indian and Pakistan during hot summer. Its temperature ranges between 45°C and 50°C, causing sunstroke in people who are directly exposed.
- Chinook is the hot local winds which blow over USA and Canada. Because of its warmth, the wind keeps the grasslands clear of any snow.
- Mistral is the local cold winds which originate over snow-capped mountains and blow towards the valleys. They are known by different names in different places. The most famous mistral is the wind which blows from the Alps over France towards the Mediterranean Sea. The winds bring down the temperature to a near freezing point.

Variable Winds

Cyclones

- Cyclones are variable winds. In low latitudes, an intense depression with low pressure conditions develop, known as tropical cyclones. These last only for few days. There are two chief types of variable winds—cyclones and anti-cyclones.
- Because of the Coriolis Effect, the cyclones blow in an anti-clockwise direction in the Northern Hemisphere and clockwise in the Southern Hemisphere.
- Cyclones are associated with turbulent weather, cloudy weather, strong winds and intense rainfall.
- A Tornado is a tropical cyclone which occurs over land. It is a funnel-shaped cloud extending downwards from the base of the thunderstorms. They may travel at a high speed of 500–800 km per hour. They are generally experienced over tropical waters in North America.
- Hurricanes and typhoons are some other tropical cyclones.
- Temperate cyclones are active over mid-latitudinal regions between 35° and 65° latitude in both hemispheres.
- Anti-cyclones represent calm weather. Winds blow gently in the clock-wise direction in the Northern Hemisphere and in the anti-clockwise direction in the Southern Hemisphere.

Jet Streams

- Jet streams are winds which blow horizontally from west to east at a high speed near the tropopause and the stratosphere. These are high-speed winds which influence the weather and climatic conditions of the region over which they blow.
- There are two types of jet streams which blow at a tropical belt of 300 north latitudes—the westerly jet stream and the easterly jet stream.
- A branch of the Westerly jet stream brings moderate to heavy rainfall followed by cold waves in the Indian subcontinent.
- The Easterly jet stream also helps the monsoon winds to blow into the greater part of India and bring monsoon showers.

Differences between cyclones and anti-cyclones

Cyclones	Anti-cyclones
It is a low pressure system with surroundings of high pressure.	It is a high pressure system with surroundings of low pressure.
It blows anti-clockwise in the Northern Hemisphere.	It blows clockwise in the Northern Hemisphere.

It blows clockwise in the Southern Hemisphere.	It blows anti-clockwise in the Southern Hemisphere.
It is associated with cloudy skies, heavy rainfall with stormy winds.	It is associated with clear skies, mild winds and dry conditions.
It can cause great damage to life and property if precautions are not taken.	The weather is settled and pleasant.

Differences between tropical cyclones and temperate cyclones

Tropical Cyclones	**Temperate Cyclones**
They originate between 8° and 20° north and south of the oceans in the tropical regions.	These are active over mid-latitudinal regions between 35° and 65° latitudes in both hemispheres.
These are produced and developed mainly over the sea.	These are produced over both land and sea.
These are limited to small areas and generally travel from east to west.	They comparatively cover a large area and generally move from west to east.
Wind is calm at the centre of tropical cyclones with no rainfall.	Wind is strong and rainfall occurs at the centre of temperate cyclones.