

CLIMATE OF INDIA

Climate and Weather

- Climate is defined as the total average weather conditions over a region for a greater number of years.
- Weather is defined as characteristics of the atmosphere at a particular point of time.
- The climate and weather have the same components of measure; the observation period differs for both the terms and the climate reflects the general characteristics of the atmosphere of a particular region or area.
- The characteristics of atmospheric conditions, along with their components, reflect the different seasons of a year of a region.
- The Tropic of cancer divides the country into two equal halves.
- The area located to the south of Tropic of cancer experiences high temperature and no severe cold season throughout the year whereas, the areas to the north of this parallel enjoys subtropical climate.
- When the altitude increases, the temperature decreases. Temperature decreases at the rate of 6.5°C for every 1000 metres of ascent.
- Distance from the sea does not cause only temperature and pressure variations but also affects the amount of rainfall.
- Air near the coast has more moisture and greater potential to produce precipitation.
- Areas of central and north India experience much seasonal variation in temperature due to the absence of influence of seas.
- A large area of India, especially the peninsular region, is not very far from the sea and this entire area has a clear maritime influence on climate.
- The most dominant factor which affects the climate of India is the monsoon winds.
- The climate of southeast India is also influenced by northeast monsoon.
- The meteorologists recognize the four distinct seasons in India. They are:
 - Winter or cold weather season (January - February)
 - Pre-Monsoon or summer or hot weather season (March - May)
 - Southwest monsoon or rainy season (June - September)
 - Northeast monsoon season (October - December)
- Mawsynram, the place which receives highest rainfall (1141 cm) in the world. It is located in Meghalaya.
- The average annual rainfall of India is 118 cm.

Factors which Influence the Indian Climate

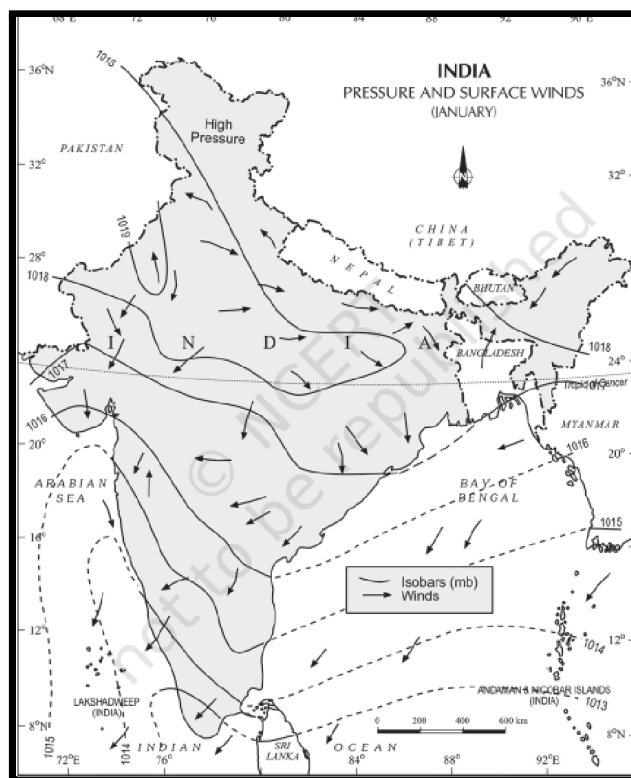
- **Latitude** – latitude determines the amount of sun rays that a surface receives. The air temperature decreases from the equator to poles. As the tropic of cancer cuts India almost equally half, India experiences both Tropical and Sub-Tropical climate.
- **Altitude** – the temperature decreases from the surface to higher altitudes as the density of air decreases. As India has a diversity of landscapes from coastal areas to huge mountains led to different climate patterns in different areas of the country. The huge mountains also influence the weather pattern by acting as a wind barrier.

- **Pressure and Wind system** – the distribution of temperature and rainfall depends on the pressure and wind system of an area. The major pressure and wind components are – Pressure and surface winds, Upper air circulation and the cyclones.
- **Distance from the sea** – Sea influences the climate in the coastal areas, thus coastal areas have moderating climate and the interior lands have an extreme climate.
- **Relief** – the physical features have a great influence on climate with the parameters of temperature, air pressure, wind direction and speed and finally the rainfall distribution.

Weather Mechanism

Winter Season

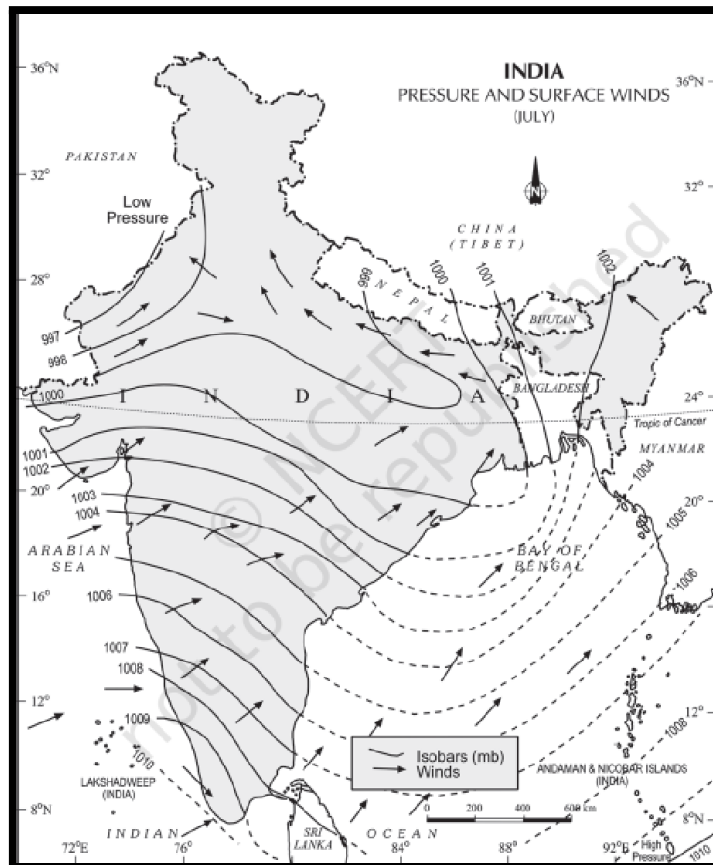
- **Cold dry winds** from the north of Himalayas, especially from central and western Asia comes into contact with the trade winds at the surface over the north and north-western regions of the country.
- Jet Streams blows over the upper troposphere have a great influence on the weather pattern in India. In winter the Jet Streams travels south of the Himalayas over the Ganga plain, and another branch blows north of Tibetan plateau.
- **Jet Streams** – it is the **high-altitude** westward wind in the troposphere. It has the characteristics of flowing in a meandering path at high speed.
- The westerly Jet Stream brought in the **western cyclonic disturbance**, which originates in the Mediterranean Sea to the north-western part of India. It is characterised with increased night temperatures and brings winter rainfall which aids the cultivation of Rabi crops.



Summer Season

- At the start of summer, the **wind circulation reverses** in both at the surface and atmosphere level.

- The Inter-tropical Convergence Zone (ITCZ) – which is **the low-pressure trough** in which the north-east and south-east **trade winds converge**. It shifts northwards with the apparent movement of the sun and lies south of Himalayas and parallel to it.
- In the southern part of the Peninsula, Easterly Jetstream flows which steers the tropical cyclones/depressions into India.



Indian Monsoon

- Based on different parameters like Temperature, Precipitation, Humidity, etc., the planet is divided into different climatic regions. E.g., Equatorial climate, Siberian, etc.
- India is placed in the **monsoon type climatic region** as it is the climatic pattern in the south and south-east Asia.
- Monsoon type of climate is well described as the seasonal reversal of winds in a year. In summer the winds travel from sea to land, and in winter the phenomenon is reversed, i.e., from land to sea.
- The monsoon is experienced all over the country, but the regional variation is experienced in terms of rainfall, wind pattern, temperature, the degree of wetness and dryness.
- In summer the country experiences south-west monsoon, and in winter it is the north-east monsoon.
- The various factors which are responsible for the formation and pattern of Indian Monsoon are:
 - o **Differential heating and cooling of land and water** – in summer the land gets heated up faster than the sea, thus creates an intense low pressure in the continental area and the winds from high-pressure seas blows towards the land. It is vice-versa in the

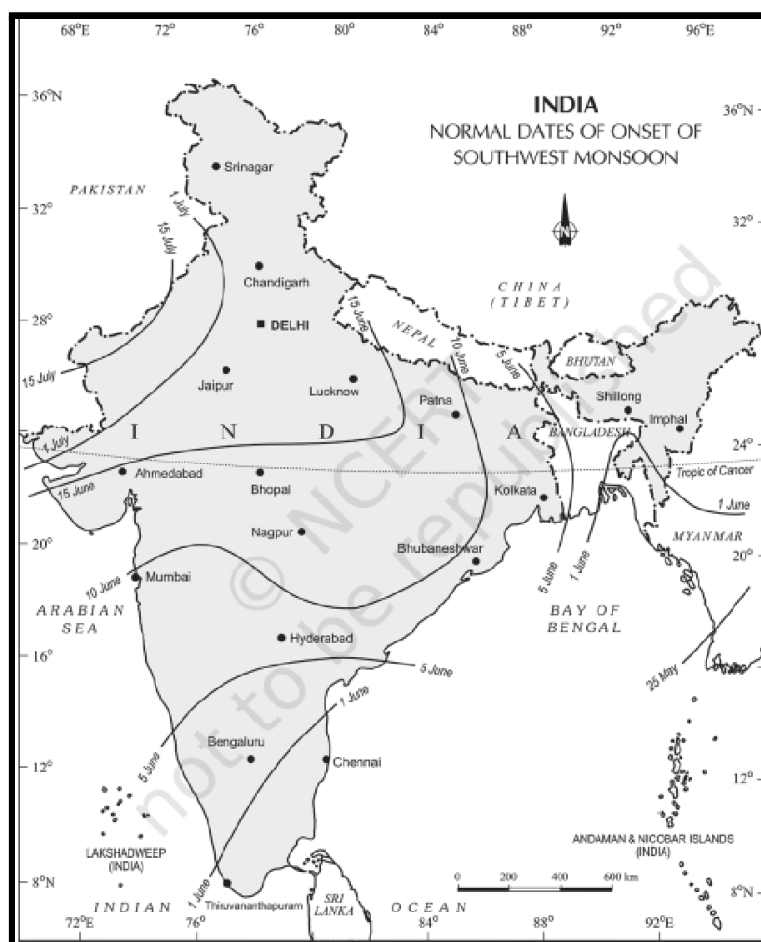
winter season.

- o **ITCZ** – apparent movement of ITCZ with the movement of the sun has greater influence over the Indian monsoon. During summer it shifts northwards and places at Ganga plains, thus creating an intense low pressure called **Monsoon trough** – this region is characterized with high rainfall.
- o Intense heating of Tibetan plateau during summer creates strong vertical air currents and low pressure.
- o The presence of jet streams: Westerly Jet Streams to the north of Himalayas and Easterly Jet in the peninsular plateau.
- o The high-pressure area in the Southern Indian Ocean (east of Madagascar) has a great impact over Indian monsoon.
- o **El NINO/LA NINA** – infrequent change of pressure condition in the Pacific Ocean affects the intensity of monsoon winds towards Asia.

The Onset of the Monsoon

- Due to differential heating of land and water, at the start of summer, the low-pressure area is created in the sub-continent, especially in the north-western part of the country.
- The south-east trade winds get attracted to this low-pressure centre and also due to the presence of ITCZ it crosses the equator and deflects towards the Indian Sub-continent between 40 to 60 degree east and enters India as South-west Monsoon winds.
- By 1st June the south-west monsoon sets in over Kerala and progresses further towards the inland.
- **Monsoon Burst** – at the time of arrival of monsoon the **rainfall increases suddenly and persists** for few days after the pre-monsoon showers are called Burst of the monsoon. The monsoon burst is caused due to Easterly Jet Streams.
- The monsoon winds split into **two branches: Arabian Sea branch and the Bay of Bengal Branch**. The Arabian Sea branch goes through the west coast and reaches Mumbai, while the Bay of Bengal branch reached Assam carrying moisture from the sea.
- The Arabian Sea branch further splits into three branches:
 - o The first branch hits the western coast perpendicularly along the states of Kerala and Karnataka.
 - o The second branch enters the Mumbai coast and travels through the mainland crossing Chotanagpur Plateau before entering into the Ganga Plains.
 - o The third branch enters the Kachchh peninsula and passes through Aravali range parallelly thus providing Scanty Rainfall.
- The Bay of Bengal branch after entering into India from the south and south-east direction (deflected from the east) splits into two branches due to the presence of Himalayas.
 - o One branch enters the Punjab Plains after crossing through the plains, and another branch enters the Brahmaputra plains and provides a significant amount of rainfall in the north-east region.
- Both the meets at the Ganga plains in the north-western part and receives a significant amount of rainfall.
- **Western coast receives through Orographic rainfall** as the moist bearing winds raise in the Western Ghats and provide plenty of rainfall in short duration of time.

- As the Eastern Ghats lies parallel to the Bay of Bengal Branch of Monsoon winds, it doesn't receive much rainfall through the south-west Monsoon winds especially in the south-eastern coast and also due to its location in the rain-shadow region. Thus, the **eastern coast remains dry during summer**.
- This branch, after hitting the north-east, provides Orographic rainfall and deflects towards the western part the country along the Ganga plains **due to the position of the Himalayas** which obstructs the northward movement of the winds.
- The rainfall decreases from east to west on the eastern side and from west to east on the west coast of the country.
- **Break in the monsoon** – In the period of the south-west monsoon, there will be a break in the rainfall for a few days or weeks. The main reason for this break is the fluctuation of Monsoon trough (and ITCZ) in the northern part and reduces the frequency of moisture-laden winds in the mainland. Also due to parallel path of winds in the west coast curbs the rainfall in that region for few weeks.



Retreating Monsoon

- By the month of September, the sunsets to move towards the southern latitudes. Thus, the low-pressure centre along the Ganga plains becomes weak and gradually replaced by high pressure.
- The monsoon retreats from the western part of the country, thus gradually by the month of December, the low-pressure centre is completely removed from the land area, and north of

the Bay of Bengal experiences the low pressure.

- **October Heat** – when the south-west monsoon retreats the land area is characterised with high temperature and humidity with the clear sky; thus, the weather becomes oppressive, and this condition is called as October Heat.
- The south-east coast of the country and the interior Tamil Nadu gets heavy rainfall in October and November both from North-East monsoon and the tropical cyclones which passes through the eastern coast.



Impact Of Global Phenomenon on Indian Monsoon

El Nino Southern Oscillation (ENSO)

- The pressure conditions in the southern Pacific Ocean have a great impact on Indian Monsoon.

- Usually, the South-East Pacific Ocean experiences High pressure and winds from this region flow to the South-West Pacific Ocean, which experiences a low-pressure area.
- The reversal of this condition, i.e., **the low pressure in the south-east Pacific Ocean creates a phenomenon called Southern Oscillation (SO).**

El Nino

- El Nino is a phenomenon in which the Peruvian current (Cold Current) is replaced by a warm ocean current, thus creating a low-pressure area in the South-East Pacific Ocean. It is a temporary replacement of the cold current, and the frequency will vary from 2 to 5 years.

Indian Ocean Dipole (IOD)

- It is a phenomenon associated with **irregular pressure pattern in the Southern Indian Ocean in the equatorial area.**
- This phenomenon can be categorised into two:
 - o **Positive Indian Ocean Dipole** – in this the high pressure lies in the eastern Indian Ocean and the low-pressure area in the western Indian Ocean; thus, the winds move from Sumatra region to Madagascar. This aids the monsoon winds by giving the additional push to enter into Northern Hemisphere, which results in surplus rainfall in the Indian Sub-continent.
 - o **Negative Indian Ocean Dipole** – the winds from high-pressure Madagascar area (Western Indian Ocean) in the southern hemisphere flows towards the Eastern Indian Ocean (west of Australia) thus obstructs the Monsoon winds (South-east trade winds) which reduce the intensity of winds entering the North Indian Ocean and subsequently poor monsoon in the Indian Sub-Continent.

Koeppen's Classification

- The climatic classification of world regions is developed by various scientists, but Koeppen's climatic classification of the world is an empirical one and was developed considering various factors.
- It was developed by him in the year 1884.
- In this classification, he related vegetation and climate by demarcating the regions based on the distribution of vegetation.
- Average temperature and precipitation is taken for making the relationship with the distribution of rainfall and the derived values are used for climate classification.
- For the designation of groups and types of climate, he used capital and small alphabets.
- Five major Climatic groups are recognised by Koeppen in which four of them are based on temperature, and one group is based on Precipitation.
- The climatic groups are sub-divided into climatic types based on temperature and precipitation characteristics of a region and its seasonality.
- The climatic groups are indicated by the letters A, C, D, E (for humid climates) and B (for dry climates). The climatic types are indicated by f (no dry season), m (monsoon climate), w (winter dry season), s (summer dry season).

Climatic Groups

<i>Group</i>	<i>Characteristics</i>
A - Tropical	Average temperature of the coldest month is 18° C or higher
B - Dry Climates	Potential evaporation exceeds precipitation
C - Warm Temperate	The average temperature of the coldest month of the (Mid-latitude) climates years is higher than minus 3°C but below 18°C
D - Cold Snow Forest Climates	The average temperature of the coldest month is minus 3° C or below
E - Cold Climates	Average temperature for all months is below 10° C
H - High Land	Cold due to elevation

Climatic Types

<i>Group</i>	<i>Type</i>	<i>Letter Code</i>	<i>Characteristics</i>
A-Tropical Humid Climate	Tropical wet	Af	No dry season
	Tropical monsoon	Am	Monsoonal, short dry season
	Tropical wet and dry	Aw	Winter dry season
B-Dry Climate	Subtropical steppe	BSh	Low-latitude semi arid or dry
	Subtropical desert	BWh	Low-latitude arid or dry
	Mid-latitude steppe	BSk	Mid-latitude semi arid or dry
	Mid-latitude desert	BWk	Mid-latitude arid or dry
C-Warm temperate (Mid-latitude) Climates	Humid subtropical	Cfa	No dry season, warm summer
	Mediterranean	Cs	Dry hot summer
	Marine west coast	Cfb	No dry season, warm and cool summer
D-Cold Snow-forest Climates	Humid continental	Df	No dry season, severe winter
	Subarctic	Dw	Winter dry and very severe
E-Cold Climates	Tundra	ET	No true summer
	Polar ice cap	EF	Perennial ice
H-Highland	Highland	H	Highland with snow cover