

Climate of India

Indian Climate is a monsoon type, mainly found in South-East Asia and South Asia. Though the Climate of India is a monsoon type, Indian Climate experiences certain regional variations. These include regional variations in Precipitation and its amount and temperature-

- **Regional Variations in Precipitation and its Amount:** The Himalayan regions experience snow while other parts of the country experience rain. Jaisalmer (Rajasthan) receives 9cm of Rainfall. At the same time, Mawsynram and Cherrapunji (Meghalaya) receive Rainfall over 1080 cm.
- **Regional Variations in Temperature:** Indian Climate experience a temperature variation. Drass (Ladakh) has a temperature down to -45°C while at the same time, Chennai experiences a temperature of 20°C or 22°C . Also, Tawang (Arunachal Pradesh) can have a temperature of 19°C , and Churu (Rajasthan) has a temperature of 50°C simultaneously.

Despite such variations, the Climate of India is characteristic and rhythmic monsoons. The characteristics of atmospheric conditions and their components reflect the different seasons of a region's year.

Factors Determining the Indian Climate

The Climate of India is the tropical monsoon climate type with regional variations in temperature, Precipitation, and amount of Rainfall because of the large geographical area. The factors related to relief, location, winds, and air pressure determine India's Climate. These are explained as under-

Latitude

The sun rays received by the earth surface is determined by the Latitude. There is a gradual decrease in the temperature from the equator to the poles. Also, India experiences two different types of climates i.e., the Tropical climate and the Subtropical climate. The two climatic conditions is experienced because of the passage of the Tropic of Cancer that divides India into two regions.

Altitude

On moving from the surface to places with higher altitudes, there is a decrease in the density of the air and temperature. Indian topography includes a variation in the landscapes thus, it experiences a variation in the climatic conditions throughout. Along with this, the weather patterns are also influenced by the presence of huge mountains as these mountains hamper the flow of wind and act as a barrier.

Pressure and Wind system

It influences the distribution of rainfall and temperature of an area. The significant components of the pressure and wind system include- cyclones, upper air circulation, winds at the surface, and pressure.

Distance from the Sea and Relief

Sea influences the climate of the coastal areas. There are extreme climatic conditions in the interior land while the climate in the coastal areas is moderate.

The relief also impacts the climate of India. All the physical features that affect the regional climate including temperature, air pressure, wind pressure, speed, and distribution of the rainfall.

Indian Monsoon

The world is divided into different climatic zones on the basis of different climatic parameters like humidity, precipitation, temperature, etc. Because of the similar climatic pattern in southeast and southern Asia and India, India is positioned in the monsoonal climatic region.

- There is an annual seasonal reversal of wind in India. During the summer season, the winds travel from sea to land. In contrast to this, the direction of the wind gets reversed in winter (it flows from ground to sea).
- Whole of India experiences monsoons with regional variations of rainfall, wind pattern, wetness and dryness degree, and temperature.
- However, one can understand the patterns of monsoon in India by studying it in comparison to the world, especially the monsoon patterns of South Asia is easy to understand.
- In India, the monsoon in winter is northeast while it is southwest during summer.

The factors responsible for the formation and pattern of the Indian Monsoon are as follows-

- **Differential heating and cooling of land and water** – Because of heat, the land gets heated up much faster as compared to the surface of the sea. The difference in their temperature results in an intense low pressure at the continental areas. This allows the wind to blow in the direction from sea to land and its reverse happens during winters.
- **ITCZ** – Indian monsoon is highly influenced by the visible movement of ITCZ. During the summer season, the monsoon gets shifted to the north and Ganga plains. This shift creates a Monsoon trough (intense low pressure) characterized by heavy rainfall.
- During summer, Tibetan plateaus' intense heating results in the formation of strong vertical air currents with low pressure.
- Jet Streams: The easterly jet streams are present in the peninsular plateau while the western one lies in the north of the Himalayas.
- East of Madagascar, the Southern Indian Ocean's high-pressure area has a significant influence on the Monsoon in India.
- **El Niño/La Niña** – The monsoon winds' intensity towards Asia is highly affected by the non-continuous change of pressure conditions in the Pacific Ocean.

The Onset of the Monsoon Affecting Climate of India

In the sub-continent, the low-pressure area is created because of the difference in the water and land heat at the beginning of the summer season. Because of the creation of the low pressure center, it attracts the Southeast trade winds. Because of the ITCZ presence, the Southeast trade winds cross the Equator. Along with this, the wind is deflected to east by 40-60 degree towards the Indian sub-continent which further enters as the South-west monsoon winds in the

sub-continent. At the June beginning, the monsoon sets over Kerala which further proceeds in the direction of inland.

Monsoon Burst

There is a sudden rise of rainfall at the arrival of monsoon. This remains the same for a few days. After sometime, the pre-monsoon showers appears with the burst in the monsoon. Easterly Jet streams causes the monsoon burst.

The monsoon winds in India is divided into two branches: Arabian Sea branch and the Bay of Bengal Branch. The branch of the Bay of Bengal carries the moisture from the sea and reaches to Assam while the one at the Arabian Sea branch moves and stretches to Mumbai by moving through the west coast. The Arabian Sea branch is further divided into the following:

- The western coast is hit by the first branch perpendicularly along Kerala and Karnataka.
- The second branch enters from the Mumbai coast after entering the Ganga Plains, it travels through the mainland crossing of the Chotanagpur Plateau.
- The third branch passes parallelly through Aravali range after entering the Kachchi peninsula

The Bay of Bengal branch, enters the Indian region from the south and southeast direction (deflected from the east), splits into two branches due to the presence of the Himalayas. One of these branch crosses the plains and enters the Punjab Plains, after this another branch enters the Brahmaputra plains. This branch entering the Brahmaputra results into huge amount of Rainfall in the northeast region. Both of these branches at last meets in the northwestern part at the Ganga plains which experiences a huge amount of Rainfall.

Break in the Monsoon

In the period of the southwest 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 the Monsoon trough (and ITCZ) in the northern part, which reduces the frequency of moisture-laden winds in the mainland. Along with this, the parallel path of winds on the west coast restricts the regional Rainfall for a period of a few weeks.

Retreating Monsoon

The Monsoon began to withdraw from the northwestern Indian states by early September and completely by mid-october from the northern half of India and rapidly withdrew from the southern peninsula. At the same time, the Monsoon starts from other parts of the country by early December.

Different Types of Climate in India

The Indian sub-continent has large latitudinal dimensions. Thus, it experiences varying climatic conditions from the north to the south of the country. This includes four seasons:

- Winter Season (the cold weather season)
- Summer Season (the hot weather season)
- Rainy Season (southwest Monsoon)
- The Retreating monsoon season

Winter Season

Cold, dry winds from the north of the Himalayas, especially from central and western Asia, come into contact with the trade winds at the surface over the north and northwestern regions of the country. The Indian weather pattern is greatly influenced by the Jet Streams blowing over the upper troposphere. In winter, the Jet Streams travels south of the Himalayas over the Ganga plain, and other branch blows north of the Tibetan plateau.

- **Jet Streams** – The westward wind at the high altitude of the troposphere is called a Jet stream. It has the characteristics of flowing in a meandering path at high speed.
- The western cyclonic disturbance is brought by the westerly Jet Stream. It originates in the Mediterranean Sea, and moves towards the Indian northwestern parts. It is characterized by increased night temperatures and brings winter rainfall which aids the cultivation of Rabi crops.

Summer Season

At the beginning of the summer season, the wind gets reversed as atmospheric as well as the surface level.

- The Inter-tropical Convergence Zone (ITCZ): The zone where low-pressure troughs at the southeast and northeast part trade winds converge is called Inter-tropical Convergence Zone. Later, the Converged wind shifts in the north direction according to the apparent sun movements. It lies parallel and south of the Himalayan region.
- The Easterly Jetstream flows in the south of the Peninsular region. It navigates the depressions/ tropical cycles into the country.

Rainy Season

Because of the increasing temperature, the low-pressure conditions get intensified over the northwestern plains. By early June, winds of the Southern Hemisphere get attracted by the low pressure. The Monsoon approaches the landmasses into two branches:

- Bay of Bengal branch
- Arabian Sea branch

Retreating Monsoon

The sun moves in the direction of the southern latitudes in September. As a result of this, the Ganga plains' low-pressure center eventually becomes weak. The weak and low pressure center is replaced by a high-pressure center. The monsoon from west India gets retreats, and eventually, the low-pressure center is completely eliminated from the land in the month of December. During this period, low pressure is experienced in the Bay of Bengal.

October Heat

The land area experiences a rise in humidity and temperature when the Southwest Monsoon retreats. During this time, the weather becomes oppression. This phenomenon is known as October Heat.

The interior of Tamil Nadu along with the Southeast coast experiences heavy rainfall during October and November.

Impact of Global Phenomenon on Indian Monsoon

The Indian monsoon is greatly influenced by the pressure conditions in the southern Pacific Ocean. Usually, there is high pressure in the Southwestern- East Pacific. Along with this, it experiences winds that flow to the South-West Pacific Ocean through this region. The reversal of this condition, i.e., the low pressure in the southeast Pacific Ocean, creates a phenomenon called Southern Oscillation (SO).

- **El Nino** – the cold current is temporarily replaced by El Nino. Also, the frequency varies from 2 to 5 years.
- **ENSO** (El Nino Southern Oscillation) is a phenomenon in which the pressure changes in the Pacific Ocean caused by El Nino.
- **Indian Ocean Dipole** - The phenomenon that is associated with irregular patterns of pressure in the equatorial region in the South of the Indian Ocean.

The phenomenon of the Indian Ocean Dipole is further into the following two categories-

- **Positive Indian Ocean Dipole**- In this phenomenon, the Western Indian Ocean is the low-pressure area while the eastern India experiences the high pressure. As a result of this, the wind gets a shift from sumatra to Madagascar. An additional push is experienced by the Monsoon winds that tend it to enter Northern Hemisphere. As a result of this push, Indian Sub-continent gets excessive rainfall.
- **Negative Indian Ocean Dipole**- Madagascar is a high pressure area, the wind in the southern hemisphere (western Indian Ocean) moves to the west of Australia (Eastern Indian Ocean). The movement of wind hampers the South-east trade winds. As a result of this obstruction, the wind entering the North Indian Ocean have low intensity. Eventually, the Indian Sub-continent experiences poor monsoon.

Koppen's Classification of the Indian Climate

The world is classified into different regions on the basis of climatic conditions. However, the most acceptable classification is Koeppen's Climatic Classification. This type of classification was developed on the basis of several factors and is considered to be an empirical one throughout the globe.

The Koeppen Climate Classification was put forward by Koeppen in 1981. Based on the vegetational distribution, Koeppen-related climate and vegetation. This classification has the following characteristics-

- The Av. Precipitation and temperature are taken into account for connecting the derived values along with the distribution of rainfall.
- Small and capital letters were used by Koppen to classify the climate into different types and groups.
- He recognized 5 climatic groups. Among these only 1 takes precipitation into account while 4 takes temperature as the classification factor.

- These 5 groups of climate are further separated into different types on the basis of seasonality, regional precipitation characteristics, and temperature.
- The climatic groups are indicated by the letters A, C, D, and E (for humid climates) and B (for dry climates) while the climatic types are recognized as s (summer dry season), w (winter dry season), m (monsoon climate), and f (no dry season).

Here is a table showing the division of India into eight climatic regions based on Koppen's Climate scheme-

Climate Type	Code	Climatic Regions of India
Tropical Savanna	Aw	South of the Tropic of Cancer and most of the peninsular plateaus
Tropical monsoon with short dry season	Amw	South of Goa, West Coast of India
Tropical moist	AS	Tamil Nadu's Coromandel coast
Semi Arid steppe	BShw	Punjab, parts of Rajasthan, and North-western Gujarat
Hot desert	Bwhw	Extreme western Rajasthan
Monsoon with dry winters	CWG	Most of north-east India, northern Madhya Pradesh, Eastern Rajasthan, and Ganga plain
Cold humid winter with short summer	Dfc	Arunachal Pradesh
Polar type	E	Uttarakhand, Himachal Pradesh, and Jammu & Kashmir