Climate refers to the sum total of weather conditions and variations over a large area for a long period of time (more than thirty years).

Weather refers to the state of the atmosphere over an area at any point of time. The elements of weather and climate are the same, i.e. temperature, atmospheric pressure, wind, humidity and precipitation.

The climate of India is described as the 'monsoon' type. This type of climate is found mainly in the south and the Southeast Asia. Despite an overall unity in the general pattern, there are perceptible regional variations in climatic conditions within the country.

Let us take two important elements – temperature and precipitation, and examine how they vary from place to place and season to season.

In summer, the mercury occasionally touches 50°C in some parts of the Rajasthan desert, whereas it may be around 20°C in Pahalgam in Jammu and Kashmir. On a winter night, temperature at Drass in Jammu and Kashmir may be as low as minus 45°C. Tiruvananthapuram, on the other hand, may have a temperature of 20°C.

Need to Know?

The word monsson is derived from the Arabic word 'mausim' which literally mean season. 'Monsoon' refers to the seasonal reversal in the wind direction during a year.

Need to Know?

In certain places there is a wide difference between day and night temperatures. In the Thar Desert the day temperature may rise to 50°C, and drop down to near 15°C the same night. On the other hand, there is hardly any difference in day and night temperatures in the Andaman and Nicobar islands or in Kerala.

PRECIPITATION VARIATION

There are variations not only in the form and types of precipitation but also in its amount and the seasonal distribution. While precipitation is mostly in the form of snowfall in the upper parts of Himalayas, it rains over the rest of the country. The annual precipitation varies from over 400 cm in Meghalaya to less than 10 cm in Ladakh and western Rajasthan. Most parts of the country receive rainfall from June to September. But some parts like the Tamil Nadu coast get most of its rain during October and November.

In general, coastal areas experience less contrasts in temperature conditions. Seasonal contrasts are more in the interior of the country. There is decrease in rainfall generally from east to west in the Northern Plains. These variations have given rise to variety in lives of people – in terms of the food they eat, the clothes they wear and also the kind of houses they live in.

CLIMATIC CONTROLS

The climate of a place is determined by the interplay of various factors such as location, altitude, distance from the sea, pressure and winds and upper air circulation.

- (i) Due to the curvature of the earth, the amount of solar energy received varies according to latitude. As a result, air temperature decreases from the equator towards the poles.
- (ii) As one goes from the surface of the earth to higher altitudes, the atmosphere becomes less dense and temperature decreases. The hills are therefore cooler during summers.

- (iii) The pressure and wind system of any area depend on the latitude and altitude of the place. Thus it influences the temperature and rainfall pattern.
- (iv)The sea exerts a moderating influence on climate. As the distance from the sea increases its moderating influence decreases and the people experience extreme weather conditions. This condition is known as continentality.
- (v) Ocean currents along with onshore winds affect the climate of the coastal areas.
- (vi)Relief too plays a major role in determining the climate of a place. High mountains act as barriers for cold or hot winds, they may also cause precipitation if they are high enough and lie in the path of rain-bearing winds. The leeward side of mountains remains dry.

FACTORS AFFECTING INDIA'S CLIMATE

- Latitude: The Tropic of Cancer passes through the middle of the country from the Rann of Kuchchh in the west to Mizoram in the east. Almost half of the country, lying south of the Tropic of Cancer, belongs to the tropical area. All the remaining area, north of the Tropic, lies in the sub-tropics. Therefore, India's climate has characteristics of tropical as well as subtropical climates.
- 2. Altitude: India has mountains to the north, which have an average height of about 6,000 metres. India also has a vast coastal area where the maximum elevation is about 30 metres. The Himalayas prevent the cold winds from Central Asia from entering the subcontinent. It is because of these mountains that this subcontinent experiences comparatively milder winters as compared to central Asia.
- **3. Pressure and Winds:** The climate and associated weather conditions in India are governed by the following atmospheric conditions:
 - Pressure and surface winds;
 - Upper air circulation; and
 - Western cyclonic disturbances and tropical cyclones.

India lies in the region of north easterly winds. These winds originate from the subtropical high-pressure belt of the northern hemisphere. They blow south, get deflected to the right due to the Coriolis force, and move on towards Need to Know?

Coriolis Force

An apparent force caused by the earth's rotation. The Coriolis force is responsible for deflecting winds towards the right in the northern hemisphere and towards the left in the southern hemisphere. This is also known as 'Ferrel's Law'.

the equatorial low-pressure area. Generally, these winds carry very little moisture as they originate and blow over land. Therefore, they bring little or no rain. Hence, India should have been an arid land, but, it is not so.

The pressure and wind conditions over India are unique. During winter, there is a high-pressure area north of the Himalayas. Cold dry winds blow from this region to the low-pressure areas over the oceans to the south. In summer, a low-pressure area develops over interior Asia as well as over northwestern India. This causes a complete reversal of the direction of winds during summer. Air moves from the high-pressure area over the southern Indian Ocean, in a south-easterly direction, crosses the equator, and turns right towards the low-pressure areas over the Indian subcontinent. These are known as the Southwest Monsoon winds. These winds blow over the warm oceans, gather moisture and bring widespread rainfall over the mainland of India.

4. Jet Streams: The upper air circulation in this region is dominated by a westerly flow. An important component of this flow is the jet stream.

These jet streams are located approximately over 27°-30° north latitude, therefore, they are known as subtropical westerly jet streams. Over India, these jet streams blow south of the Himalayas, all through the year except in summer. The western cyclonic disturbances experienced in the north and north-western parts of the country are brought in by this westerly flow. In summer, the subtropical westerly jet stream moves north of the Himalayas with the apparent movement of the sun. An easterly jet stream, called the tropical easterly jet stream blows over peninsular India, approximately over 14°N during the summer months. Need to Know?

The **western cyclonic disturbances** are weather phenomena of the winder months brought in by the westerly flow from the Mediterranean region. They usually influence the weather of the north and northwestern regions of India. Tropical cyclones occur during the monsoon as well as in October-November, and are part of the easterly flow. These disturbances affect the coastal regions of the country.

THE INDIAN MONSOON

The climate of India is strongly influenced by monsoon winds. The sailors who came to India in historic times were one of the first to have noticed the phenomenon of the monsoon. They benefited from the reversal of the wind system as they came by sailing ships at the mercy of winds. The Arabs, who had also come to India as traders named this seasonal reversal of the wind system `monsoon'.

The monsoons are experienced in the tropical area roughly between 20° N and 20° S. To understand the mechanism of the monsoons, the following facts are important.

- 1. The differential heating and cooling of land and water creates low pressure on the landmass of India while the seas around experience comparatively high pressure.
- The shift of the position of Inter Tropical Convergence Zone (ITCZ) in summer, over the Ganga plain (this is the equatorial trough normally positioned about 5°N of the equator – also known as the monsoontrough during the monsoon season).
- 3. The presence of the high-pressure area, east of Madagascar, approximately at 20°S over the Indian Ocean. The intensity and position of this high-pressure area affects the Indian Monsoon.
- 4. The Tibetan plateau gets intensely heated during summer, which results in strong vertical air currents and the formation of high pressure over the plateau at about 9 km above sea level.
- 5. The movement of the westerly jet stream to the north of the Himalayas and the presence of the tropical easterly jet stream over the Indian peninsula during summer.

It has also been noticed that changes in the pressure conditions over the southern oceans also affect the monsoons. Normally when the tropical eastern south Pacific Ocean experiences high pressure, the tropical eastern Indian Ocean experiences low pressure.

There is a reversal in the pressure conditions and the eastern Pacific has lower pressure in comparison to the eastern Indian Ocean. This periodic change in pressure conditions is known as the **Southern Oscillation or SO.**

ENSO: The difference in pressure over Tahiti (Pacific Ocean, 18°S/149°W) and Darwin in northern Australia (Indian Ocean, 12°30′S/131°E) is computed to predict the intensity of the monsoons. If the pressure differences were negative, it would mean below average and late monsoons. A feature connected with the SO is the El Nino, a warm ocean current that flows past the Peruvian Coast, in place of the cold Peruvian current, every 2 to 5 years. The changes in pressure conditions are connected to the El Nino. Hence, the phenomenon is referred to as ENSO.

Need to Know?	Need to Know?
Inter Tropical Convergence Zone The Inter Tropical Convergence zone (ITCZ), is a broad trough of low pressure in equatorial latitudes. This is where the northeast and the southeast trade winds converge. This convergence zone lies more or less parallel to the equator but moves north or south with the apparent movement of the sun.	EL Nino: This is a name given to the periodic development of a warm ocean current along the coast of Peru as a temporary replacement of the cold Peruvian current. 'EL Nino' is a Spanish word meaning 'the child', and refers to the baby Christ, as this current starts flowing during Christmas. The presence of the EL Nino leads to an increase in sea-surface temperatures and weakening of the trade winds in the region.

THE ONSET OF THE MONSOON AND WITHDRAWAL

The Monsoon, unlike the trades, are not steady winds but are pulsating in nature, affected by different atmospheric conditions encountered by it, on its way over the warm tropical seas. The duration of the monsoon is between 100-200 days from early June to mid-September. The monsoon arrives at the southern tip of the Indian peninsula generally by the first week of June. Subsequently, it divided into two the Arabian Sea branch and the Bay of Bengal branch. The Arabian Sea branch reaches Mumbai about ten days later on approximately the 10th of June. The Bay of Bengal branch arrives is Assam in the first week of June. The lofty mountains cause the monsoon winds to deflect towards the west over the Ganga Plains. By mid-June the Arabian Sea branch of the monsoon arrives over Saurashtra-Kuchchh and the central part of the country. The Arabian Sea and the Bay of Begal branches of the monsoon merge over the northwestern part of the Ganga plains. Delhi generally receives the monsoon showers from the Bay of Bengal branch by the end of June. By the first week of July, western Uttar Pradesh, Punjab, Haryana and eastern Rajasthan experience the monsoon. By mid-July, the monsoon reaches Himachal Pradesh and the rest of the country.

Withdrawal or the retreat of the monsoon is a more gradual process. The withdrawal of the monsoon begins in northwestern states of India by early September. By mid-October, it withdraws completely from the northern half of the peninsula. The withdrawal from the southern half of the peninsula is fairly rapid. By early December, the monsoon has withdrawn from the rest of the country.

THE SEASONS

There were 4 main seasons are identified in India:-

- (i) Cold weather season December to February
- (ii) Hot weather season March to May.
- (iii) Advancing monsoon season June to September
- (iv) Retreating monsoon season October and November

1. The Cold Weather Season (Winter):

(i) The cold weather season begins from mid-November in

northern India and stays till February.

- (ii) December and January are the coldest months in the northern part of India. The temperature decreases as one moves from south to the north.
- (iii) Days are warm and the nights are cold. Frost is common in the north and the higher slopes of the Himalayas experience snowfall.
- (iv)The northeast trade winds prevail over the country. They blow from land to sea and hence, for most part of the country, it is a dry season.

- (v) In the northern part of the country, a feeble high-pressure region develops, with light winds moving outwards from this area.
- (vi)The weather is normally marked by clear sky, low temperatures and low humidity and feeble variable winds.
- (vii)Inflow of cyclonic disturbances from the west and the northwest. These low pressure systems originate over the Mediterranean Sea and western Asia and move into India, along with the westerly flow. They cause the much needed winter rains over the plains and snowfall in the mountains. Locally known as 'mawat' are of immense importance for the cultivation of 'rabi' crops.
- (viii) The northeast trade winds cause fair amount of rainfall in Chennai or the Coromandel Coast in winter.

2. Hot Weather Season (Summer):

- (i) Due to the apparent movement of the sun, the global heat belt shifts northward. As such, from March to May, it is hot weather season in India.
- (ii) Temperature increases from south to north. In peninsular India, temperatures remain lower.
- (iii) High temperature between 38°C and 48°C in the plains.
- (iv)Local dust storms accompanied with light rains.
- (v) Hot dry winds, 'loo' is common in May and June.
- (vi)Kerala and Karnataka coast receives pre-monsoon showers. (Mango showers)
- (vii) West Bengal and Assam are affected by northwesterly winds. (Kalbaisakhi)

3. Advancing Monsoon (The Rainy Season):

By early June, the low-pressure condition over the northern plains intensifies. It attracts, the trade winds of the southern hemisphere. These south-east trade winds originate over the warm subtropical areas of the southern oceans. They cross the equator and blow in a southwesterly direction entering the Indian peninsula as the south-west monsoon. As these winds blow over warm oceans, they bring abundant moisture to the subcontinent. These winds are strong and blow at an average velocity of 30 km per hour.

The inflow of the south-west monsoon into India brings about a total change in the weather. Early in the season, the windward side of the Western Ghats receives very heavy rainfall, more than 250 cm. The Deccan Plateau and parts of Madhya Pradesh also receive some amount of rain in spite of lying in the rain shadow area. The maximum rainfall of this season is received in the north-eastern part of the country.

Mawsynram in the southern ranges of the Khasi Hills receives the highest average rainfall in the world. Rainfall in the Ganga valley decreases from the east to the west. Rajasthan and parts of Gujarat get scanty rainfall.

Breaks in Monsoon: Another phenomenon associated with the monsoon is its tendency to have 'breaks' in rainfall. Thus, it has wet and dry spells. In other words, the monsoon rains take place only for a few days at a time. They are interspersed with rainless intervals. These breaks in monsoon are related to the movement of the monsoon trough.

For various reasons, the trough and its axis keep on moving northward or southward, which determines the spatial distribution of rainfall. When the axis of the monsoon trough lies over the plains, rainfall is good in these parts. On the other hand, whenever the axis shifts closer to the Himalayas, there are longer dry spells in the plains, and widespread rain occur in the mountainous catchment areas of the Himalayan rivers. These heavy rain bring in their wake, devastating floods causing damage to life and property in the plains.

The frequency and intensity of tropical depressions too, determine the amount and duration of monsoon rains. These depressions form at the head of the Bay of Bengal and cross over to the mainland. The depressions follow the axis of the "monsoon trough of low pressure". The monsoon is known for its uncertainties. The alternation of dry and wet spells vary in intensity, frequency and duration. While it causes heavy floods one part, it may be responsible for droughts in the other. It is often irregular in its arrival and its retreat. Hence, it sometimes disturbs the farming schedule of millions of farmers all over the country.

4. Retreating Monsoon (The Transition Season): During October-November, with the apparent movement of the sun towards the south, the monsoon trough or the low-pressure trough over the northern plains becomes weaker. This is gradually replaced by a high-pressure system. The south-west monsoon winds weaken and start withdrawing gradually. By the beginning of October, the monsoon withdraws from the Northern Plains.

The months of October-November form a period of transition from hot rainy season to dry winter conditions. The retreat of the monsoon is marked by clear skies and rise in deltas of the Godavari, the Krishna and the Kaveri are frequently struck by cyclones.



VAGARIES OF THE MONSOONS IN INDIA

At times the monsoons come in full swing, or it may fail altogether. Thus, causing the twin probelms of floods and famines.

The alternation of dry and wet spells keeps on varying in intensity, frequency and in duration.

Implications of vagaries of the monsoons:

- (i) Due to the late arrival the crops dry up.
- (ii) Due to excessive rains floods are caused, leading to destruction.
- (iii) The amount of rain may vary causing drought conditions.
- (iv) Sometimes the monsoons come early, normal or late.
- (v) The monsoons may retreat early, normal or late.

DISTRIBUTION OF PRECIPITATION IN THE COUNTRY

Areas of Heavy rainfall: Areas which get rainfall of 200 cms and above are Assam, The Ganga Delta, the Western Ghats and the Western Coastal regions and the mountainous regions of Himachal Pradesh. **Areas of Moderate Rainfall:** Areas which get annual rainfall between 100cms to 200cms are Madhya Pradesh, Orissa, Chotanagpur, Western Bengal, Bihar, Eastern U.P, North-Eastern Punjab, Eastern parts of Tamil Nadu and Eastern slopes of Western Ghats receive moderate rainfall.

Areas with Low Rainfall: Areas receiving annual rainfall between 50cms to 100cms are the Deccan Plateau, Western U.P., South-Eastern Punajb, Eastern Rajasthan and parts of Kashmir get low rainfall. **Areas with Scanty Rainfall:** Areas which get less than 50cms rainfall annually are western Rajasthan, Kutch, Southeastern parts of Haryana, Northeastern Kashmir get scanty rainfall.

Consequences of the Uneven Precipitation in India:

- (i) If there is too much rain in certain areas they cause floods and havoc all around. Many grown up crops, villages, railway lines are washed away resulting in great loss of men and money.
- (ii) If there are not sufficient rains even then people are doomed because of drought and hunger Many people begin to starve and die of hunger, Standing crops dry away thereby bringing doomed to the farmers.

Uneven distribution rainfall is due to:

(A) Relief/Orography (B) Wind direction (C) Location (D) Low pressure axis.

Relief/Orography largely governs the distribution of rainfall. For instance, the windward side of the Western Ghats registers a rainfall of 250cms. On the other hand, the leeward side of this ghat is hardly able to receive 50cms.

Again, the heavy rainfall in the northeastern states can be attributed to their hilly ranges and the eastern Himalayas.

Western Rajasthan gets scanty rain because the Arabian Sea branch of the monsoon blows parallel to the Aravallis.

Rainfall in the north decreases from east to west Kolkata situated near the sea receives about 120 cm, Patna 102 cm, Allahabad 91 cm, and Delhi 56 cm.

MONSOON AS A UNIFYING BOND

- 1. There is great diversity in the climatic conditions due to location, extent and relief features.
- 2. But these diversities are subdued by the monsoons, which prevails over the whole country.
- 3. These monsoons are active for just three to four months and rest of the year India remains almost thirsty.
- 4. This water scarcity is felt all over the country.
- 5. Thus the arrival of the monsoons is most welcome; it changes the Indian landscape, gives impetus to agricultural activities, the total life of the Indian people revolves around the monsoons, including festivals.