



**Class VII<sup>th</sup> NEW NCERT**  
**Chapter-2**

# Understanding the Weather

*A change in the weather is sufficient to create the world and oneself anew.*

*Marcel Proust, French novelist*



Fig. 2.1

## The Big Questions ?

1. How can we measure and monitor the weather around us?
2. How do weather predictions help us prepare for events like heavy rain, storms, drought and heat waves?



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## Weather and its Elements

You wake up one winter morning and shiver. You reach for thick clothes to keep yourself warm. In the summer, you choose clothes that keep you cool and comfortable. You are responding to your body's signals; your body is sensing the weather.

### What is weather?

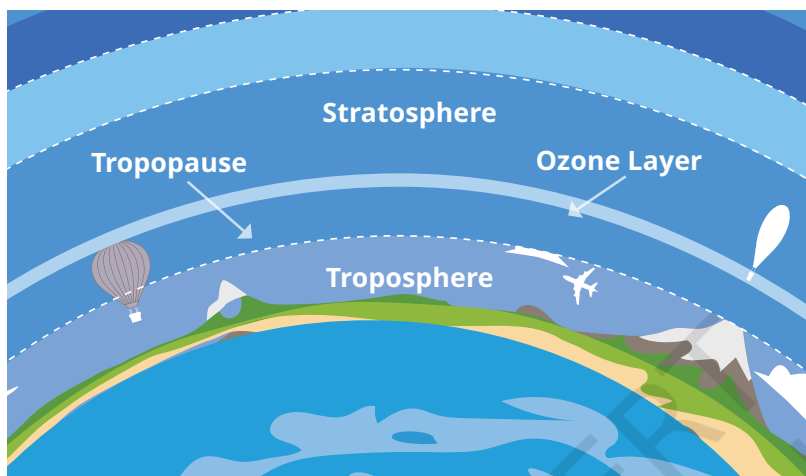


Fig. 2.2

**Weather** is a state of the Earth's atmosphere at a particular time and place. But what is an atmosphere? In simple terms, it is the layer of gases that surround some planets—in the case of our Earth, we call these gases 'air'. The Earth's atmosphere may be compared to a cake

with several layers. The layer closest to the surface of the Earth is called the 'troposphere', and that is where all land-based plants and animals (including humans!) live and breathe. It is also where almost all weather phenomena, which we will explore in this chapter, take place. The troposphere extends to a height of 6 to 18 kilometres from the ground; it is less thick at the poles (where the cold air contracts) and thicker in the tropical zone (where the warmer air expands). You will study more about the other layers in your Science classes.

We use many words to describe the weather—hot, cold, rainy, cloudy, humid, snowy, windy, and so on. They describe the different ways in which we experience the elements of weather.

### LET'S EXPLORE

What are some of the words in your local language that you use to describe the weather? Hot, cold, warm, chilly, crisp, pleasant, and so on, are commonly used terms in English.



The **elements of weather** are:

- **Temperature:** How hot or cold the atmosphere is.
- **Precipitation:** Any form of water, such as rain, snow, **sleet** or **hail**, that falls from the sky.
- **Atmospheric Pressure:** The weight of the air above us, felt on the Earth's surface.
- **Wind:** The movement of air, including its speed and direction.
- **Humidity:** The amount of **water vapour** in the air.



### THINK ABOUT IT

Let us imagine that Krishnan from Chennai is speaking with Amir in Kashmir. Krishnan tells Amir that it has become chilly in Chennai after it rained the previous night. Amir asks him how cold it is. How will Krishnan explain to Amir how cold it is? After all, what is cold for Krishnan may be quite pleasant for Amir!

As you can see, it would be difficult for Krishnan to convey his sense of chilliness to Amir unless there is a commonly agreed way to measure the temperature. It is the same with other elements of the weather. In this chapter, we will learn how we measure the weather using common standards.

### LET'S EXPLORE

What do you think could be some other reasons to measure the weather more precisely? (Hint: Think how knowing the weather a few hours or a few days in advance would help you plan some activities.)

From early times, humans have closely observed Nature and learnt to read her signals to **forecast** the weather. Observing birds flying low, ants carrying eggs, squirrels gathering nuts, frogs croaking loudly, or even the opening and closing of pine cones, provided valuable information about coming rain or storms. This knowledge has been passed down from generation to generation. Even today, in many parts of India, people use traditional ways to predict the weather, especially the arrival of the monsoon.

#### Sleet:

Frozen or partly frozen rain.

#### Hail:

Small, hard balls of ice that fall from the sky like rain.

#### Water vapour:

Water vapour is water in gaseous instead of liquid form.



#### Forecast:

To predict or find out in advance (in our case, the weather).

## Observing Nature's clues



*Fig. 2.3.1. Ants shifting their eggs to higher ground is a natural behaviour that indicates an expected change in the weather, especially heavy rain.*

*Fig. 2.3.2. A frog croaking in a forest of the Western Ghats, in expectation of rain.*



**Meteorology:** Meteorology is the systematic study of weather and its evolution. This study is the basis for weather forecasting.



*Fig. 2.3.3. The opening and closing of pine cones are natural mechanisms driven by environmental humidity. Pine cones close in humid conditions to protect their seeds, and open in dry conditions to release them, ensuring they spread in favourable weather.*

### LET'S EXPLORE



Talk to elders in your neighbourhood and ask them how they predict the weather. What signs do they observe? Document any sayings in your regional language that refer to weather prediction.

In the last few centuries, scientists have worked out methods to measure and monitor the elements of the weather with great precision. Based on those inputs, **meteorologists** try to predict how the weather will behave in a particular region after a few hours or a few days, or even a few weeks. How do they do it? Do they just look up at the sky and guess? No, they've got some cool gadgets, a few of which we will now look at.

# Weather Instruments

## a) Temperature

### LET'S REMEMBER



In your Grade 6 Science textbook, *Curiosity*, you read about different types of thermometers used for measuring the temperature—the clinical thermometer and the laboratory thermometer. You also learnt about temperature scales. One of them is the Celsius scale; another is the Fahrenheit scale. If, for instance, we have a cool temperature of 15 degrees Celsius (noted as 15°C), it is the same as 59 degrees Fahrenheit (noted as 59°F).



Fig. 2.4.1. Snow melts quickly when it's warm.



Fig. 2.4.2. Cloudy weather—it's getting cold.



Fig. 2.4.3. In winter, coconut oil turns solid.



Fig. 2.4.4. Curd takes longer to set in cold weather.

**Ambient:**  
Of the immediate surroundings.

**Statistics:**  
The technique of gathering and analysing information or data in order to be able to detect patterns, understand events or make predictions.

There are several types of thermometers. Some simply measure the **ambient** temperature; others record the maximum and minimum temperatures during a day. Thermometers often use a coloured liquid which expands when the temperature increases. However, more and more, digital thermometers are preferred as they are more precise and can record more data.

Indeed, temperature recordings can be used to collect some useful **statistics**, including:

- **Range of temperature** or the maximum temperature minus the minimum temperature during a particular period of time (usually 24 hours).
- **Mean daily temperature** or the maximum temperature plus the minimum temperature of the day divided by two.

### DON'T MISS OUT

- The **India Meteorological Department** was set up in 1875. Its motto is *ādityāt jāyate vṛiṣhti*, which means, “From the sun arises rain.” The phrase comes from the ancient text *Manusmṛiti*, and the complete sentence reads, “From the sun arises rain, from rain comes food, and from food, living beings originate.”
- Can you think of a reason why rain arises from the sun?



Fig. 2.5

### LET'S EXPLORE

- Here's a chart of the temperatures of a city in Madhya Pradesh. What is the maximum temperature recorded in the week shown here? What is the minimum? Calculate the range.

Date	Maximum Temperature (in °C)	Minimum Temperature (in °C)
28.02.2025	29	16
01.03.2025	30	15
02.03.2025	31	17
03.03.2025	32	18
04.03.2025	30	17
05.03.2025	28	14
06.03.2025	29	15

→ Remember the conversation between Krishnan and Amir? If Krishnan said it was 20°C in Chennai and he was feeling a little cold, he and Amir would have a measure they could understand. What do you think Amir's reaction to Krishnan's statement might be?

## b) Precipitation

If the news says that a particular place received 30 mm of rainfall in a day, what does it mean? How is rainfall measured?

The amount of rainfall is measured with the help of an instrument called a **rain gauge** (Fig. 2.6). When it rains, the water falls into a funnel and is collected in a cylinder. A scale is attached to the cylinder to measure the depth of rainwater collected. For example, when the height of the water collected is 5 mm, we say that the area received 5 mm of rainfall.

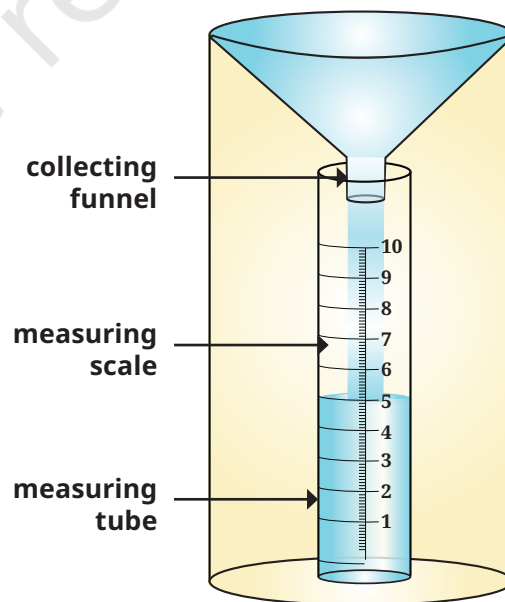


Fig. 2.6. Rain gauge

## LET'S EXPLORE



Make a rain gauge as shown in the diagram above. Place the rain gauge in an open area, away from objects that might obstruct rain. Ensure that the rain gauge is on a flat surface and will not tilt or topple with the wind. Using the measuring scale, record the amount of rainwater collected at the same time every day, for a month. (If there is snow, allow it to melt before taking the measurement.) Calculate the average rainfall for every week in that month and comment on the variation from week to week.

### c) Atmospheric pressure

Our bodies are quite aware of temperature and rainfall. But you may also have experienced that the weather sometimes feels 'heavy', as before a thunderstorm. This is related to atmospheric pressure, which is the pressure exerted by the weight of the air above and around us.

The atmospheric pressure is higher near the sea coast and lower as we go higher up into the mountains. When you climb a mountain, the air gets thinner than in the plain below. As a result, the air pressure is lower, and there is less oxygen available for

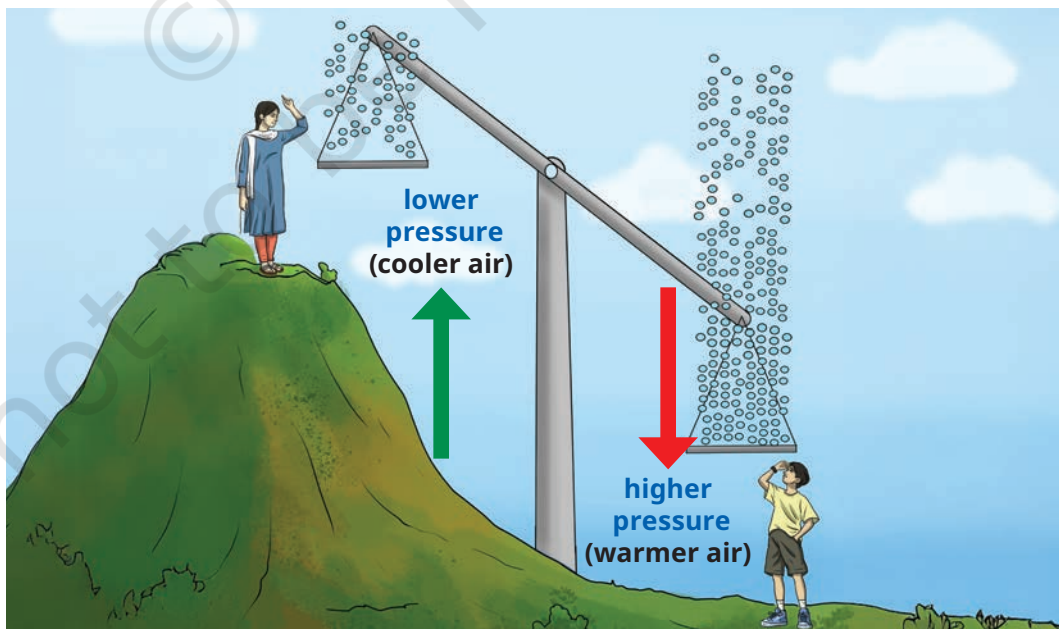


Fig. 2.7

your lungs to take in. With less oxygen getting into your blood, your body has to work harder to keep you moving! That's why people sometimes feel breathless, dizzy or tired at high altitudes.

This does not mean that the atmospheric pressure is always high in the plains below or on the coast. In fact, it sometimes drops dramatically, resulting in what meteorologists call a 'depression' or 'low-pressure system', which can sometimes develop into a storm or even a cyclone.



### THINK ABOUT IT

Why do you think it would be important to measure atmospheric pressure? Who are the people most likely to use such measurements?

The instrument used to measure atmospheric pressure is called a **barometer**. As with thermometers, there are several types of barometers. The unit they display is generally the **millibar** (abbreviated as mb). The normal atmospheric pressure at the sea coast is around 1013 mb; a pressure below 1000 mb indicates a depression.



### THINK ABOUT IT

People who journey to places at a high altitude are advised to make pauses on the way to allow the body to **acclimatise**. Our army personnel serve in high-altitude places like Khardung la in Ladakh, which is over 5600 metres above sea level. It is hard to imagine how they live and work in places where the oxygen level is so low—the atmospheric pressure there is generally about 650 millibars!



Fig. 2.8

**Acclimatise:**  
Adjust to a new climate or new condition

## d) Wind

Wind is the movement of air from areas of high pressure to areas of low pressure. Speed and direction are two important factors when we describe the wind.



### THINK ABOUT IT

Have you seen seeds like these flying in the wind? What would happen to the seeds if there was no wind?



Fig. 2.9

The wind is an important element of the weather. Its direction and speed help in weather forecasting. Besides, air pilots and sailors need to be aware of wind data, as the wind has a great influence on flying or sailing. Farmers also use the wind direction to predict where rain might come from. Also, a greater wind speed will cause the soil to dry faster.

So, how do we measure this direction and speed? A wind vane (or weather vane) has a rotating arm with a pointer at one end and a tail at the other. When the wind blows, the tail is pushed, and the pointer turns in the direction of the wind. It responds even to a light breeze.



Fig. 2.10. Left: Wind vane on the tarmac. Right: Anemometer

This wind vane on the tarmac is called a ‘wind sock’. It gives pilots an indication of the direction of the wind during take-off and landing. Similar socks are used in industries that release ash or gases.

The simplest instrument to measure the wind direction and speed is the **anemometer**. It has three or four metal cups that rotate on a vertical shaft when the wind blows—the stronger the wind, the faster the rotation. A meter attached at the bottom counts how many times the anemometer spins in a certain period of time and calculates the wind speed in kilometres per hour (km/h).

### e) Humidity

Humidity is the last element of the weather on our list. It refers to the amount of water vapour present in the air. It also depends on factors like temperature, wind, pressure and location.

#### LET'S EXPLORE

Where do you think humidity is likely to be more, Kochi or Jaipur? You might guess that Kochi has higher humidity than Jaipur because it is located near the sea. But how will we know for sure? If we had to compare the humidity level between Kochi and Mangaluru, how would we do it? Discuss with your classmates.



We can answer these questions more precisely by learning how to measure humidity.

Before we move forward, we need to remember our Science lesson from Grade 6 about the states of water. This will help us to understand how humidity is measured.

### LET'S REMEMBER



- When water evaporates, it causes a cooling effect.
- If the amount of water in the air is already high (more humidity), water evaporates slowly. That is typically the case on a rainy day.

Humidity of the air is measured as **relative humidity**: air that would contain absolutely no water vapour (which is impossible in natural conditions) is rated at 0%, while air saturated with water vapour will have a humidity of 100%. In practice, dry weather has a relative humidity range between 20% and 40%, while humid weather usually falls between 60% and 80% relative humidity.



### THINK ABOUT IT

If the humidity in Delhi is at 52% while in Kochi it is 84%, in which of the two places are wet clothes likely to dry faster? And where are you likely to sweat more, assuming the temperature is the same in both places?

But how do we measure such numbers? This is done through an instrument called a **hygrometer**. Again, there are several types of hygrometers, depending on the principle they are based on. The measurement of humidity is of great importance in many industrial processes, such as food processing. Museums also monitor humidity as they need to maintain a dry environment to preserve their exhibit.

## Weather Stations

As you can see, we need several instruments to measure the weather at a particular place and time. A weather station brings all these instruments together, making it easy to measure and track the weather. Readings of all the measurements are taken at regular intervals, which helps in mapping and forecasting the weather.



Fig. 2.11

### An automated weather station

An **Automated Weather Station (AWS)** is a self-operating system that uses various sensors to measure and record weather data, such as temperature, humidity, wind speed and direction, precipitation, and atmospheric pressure. Such stations are widely used in fields like agriculture, aviation, navigation, environmental monitoring, and so on, providing accurate and timely weather information without the need for human intervention.

#### DON'T MISS OUT



In 2023, the National Disaster Management Authority set up an AWS at a glacial lake of Sikkim at an altitude of more than 4800 metres above sea level. The AWS provides early information about upcoming weather conditions.

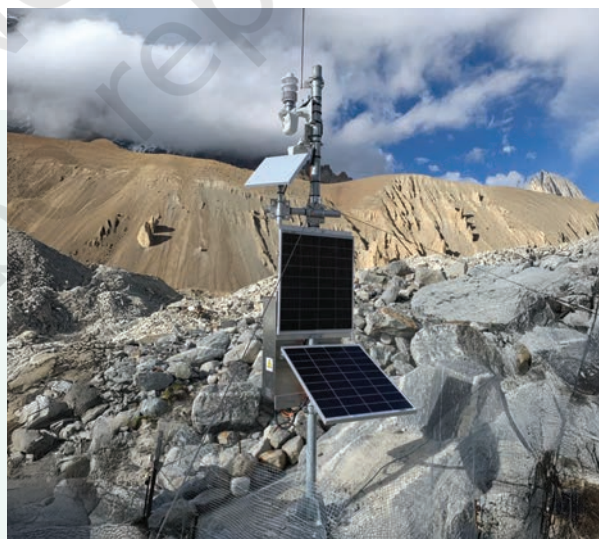


Fig. 2.12. AWS at a glacial lake of Sikkim

## Predicting the Weather

Meteorologists collect data using these instruments over long periods of time. They study the data and use scientific

methods to try and predict the weather. Such predictions are very important nowadays, as climate change makes extreme weather, such as droughts, floods, cyclones, etc., more frequent.

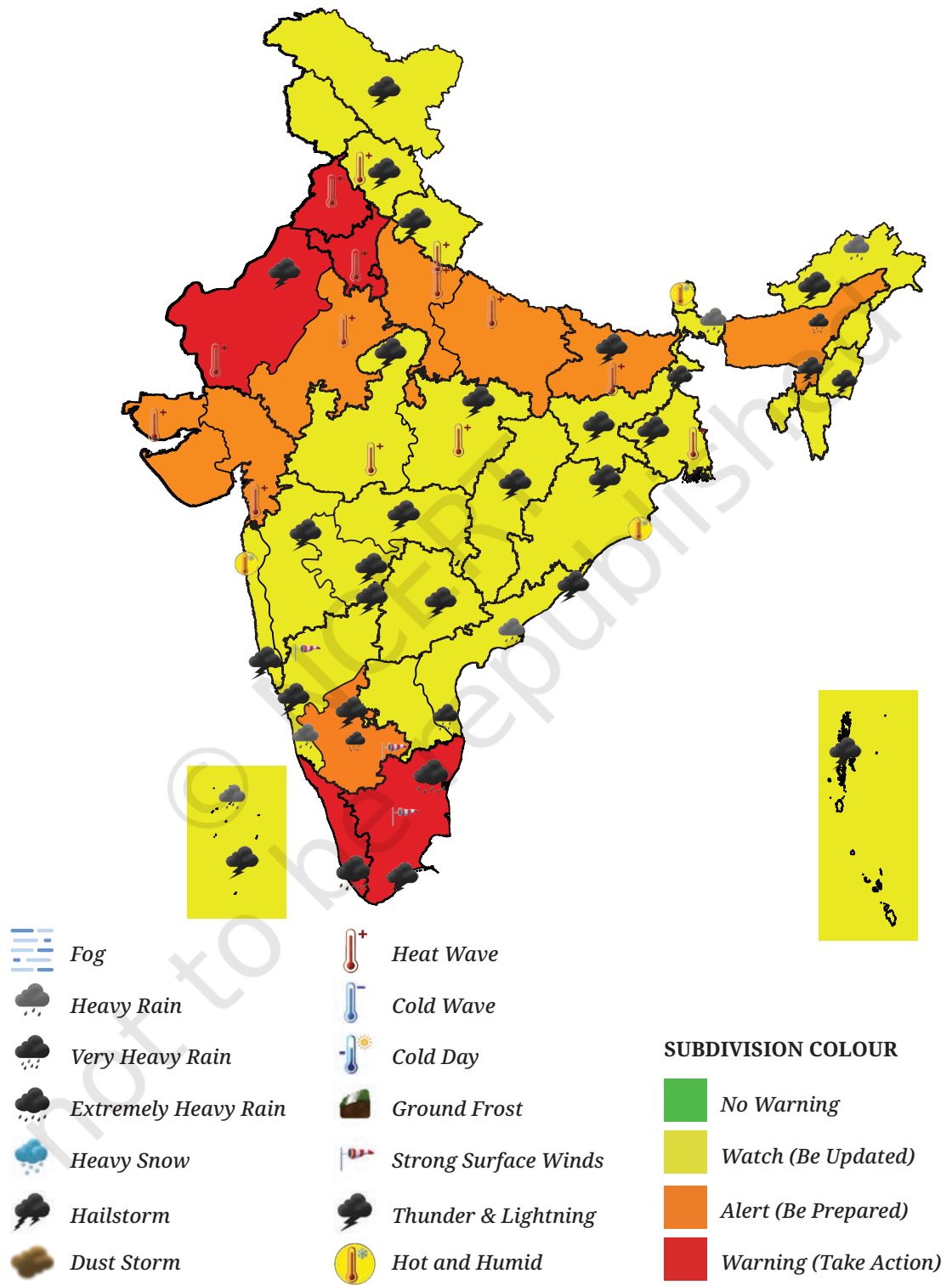


Fig. 2.13. India: weather warning for India on 19 May 2024

Accurate predictions help us to be ready for such events. They also enable local governments to mobilise resources and prepare for any disasters. For example, if stormy weather is expected at sea, fishermen are warned about venturing out in their boats, or an entire coastal area might have to be evacuated if a cyclone is expected.

### LET'S EXPLORE

Discuss, in pairs, different situations in which weather predictions are helpful. Make a list, and after you have completed it, share it and discuss it with the pair sitting next to you. How many different categories of situations have you been able to identify?

Look carefully at the map of India above. This map was issued by the India Meteorological Department on 19 May 2024. Study the icons and connect them to the conditions shown on the map.

### LET'S EXPLORE

- What do you observe happening on that day? What are the various weather conditions that the IMD is alerting people to?
- Which states have warning signs?
- Which parts of India are likely to be free from severe weather?
- Which states are likely to face heat wave conditions?
- What are the causes for warning in Tripura and Lakshadweep?

### Before we move on ...

- Temperature, humidity, precipitation, wind and atmospheric pressure together define the weather at a particular place.
- The condition of these elements is measured using special instruments. Data collected from these help us to monitor and predict the weather.



- In different times or situations, one of the elements is dominant — for example, rainfall in July, the temperature in May and December, atmospheric pressure when a cyclone is moving, and wind when a loo (strong, hot and dusty winds that blow in north India in summers) is blowing, or forest fires are spreading.
- Weather is closely linked to climate. We will discuss this in the next chapter.

## Questions and activities

1. Match the instrument with the weather element it measures.

Instrument used		Element of the Weather	
(1)	Hygrometer	(a)	Precipitation
(2)	Anemometer	(b)	Atmospheric pressure
(3)	Barometer	(c)	Wind direction and speed
(4)	Thermometer	(d)	Humidity
(5)	Rain gauge	(e)	Temperature

2. Jyotsna is deciding what clothes to pack for her school trip to Mumbai in June. She looks at the weather forecast, which predicts 29°C and 84% humidity. What would be your advice to her?
3. Imagine that a small group of students is setting up a rain gauge.

Here are some options for the site.

1. The school vegetable garden.
2. The terrace of the school building.
3. Open ground with elevated platform.
4. Compound wall of school.
5. Verandah of the school laboratory.

Discuss in your group and finalise the site. Write down the reasons for your decision.

4. Below is a chart taken from IMD, Jammu and Kashmir. Looking at the data available, write a short script to report the weather conditions in different parts of Jammu and Kashmir on the date shown. (Hint: Cover the temperature range, maximum and minimum temperatures, humidity, precipitation, etc.)

**DAILY WEATHER PARAMETERS**  
**Jammu & Kashmir (EVENING)**  
**DATE: 01-02-2024**

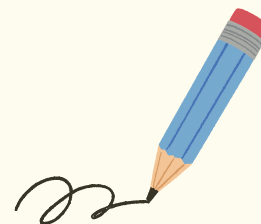
Station	max temperature of date			min temperature of date			from 0830 to 1730 hrs (mm/cm)		24 hrs R/F ending 0830 of date (mm/cm)		relative humidity	
	ACT (°C)	NOR (°C)	DEP (°C)	ACT (°C)	NOR (°C)	DEP (°C)	R/F (mm)	S/N (cm)	R/F	S/N	0830 (%)	1730 (%)
	SRINAGAR	6.5	8.9	-2.4	0.2	-0.7	0.9	TR	0.0	13.4	2.4	89
QAZIGUND	3.2	8.5	-5.3	-0.4	-2.1	1.7	11.8	10.0	36.2	22.0	97	90
PAHALGAM	1.1	5.6	-4.5	-4.1	-6.1	2.0	6.0	8.0	19.4	23.0	96	96
KUPWARA	5.1	8.5	-3.4	-0.7	-2.3	1.6	0.5	0.0	21.9	10.0	97	94
KUKERNAG	2.6	6.6	-4.0	-1.4	-2.4	1.0	12.0	8.0	35.2	30.0	96	97
GULMARG	-2.6	1.4	-4.0	-7.6	-7.6	0.0	8.2	6.35	35.2	35.0	76	100
MUZAFARABAD	8.5	-	-	5.6	-	-	-	-	25.8	-	93	-

**Note: ACT means actual; NOR means normal; DEP is departure from normal; R/F is rainfall; S/N is snowfall; TR means trace amount.**

# Noodles

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\*'Noodles' is our abbreviation for 'Notes and Doodles'!





**Class IX<sup>th</sup> NEW NCERT**  
**Chapter-4**



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# 4

## CLIMATE

In the last two chapters you have read about the landforms and the drainage of our country. These are the two of the three basic elements that one learns about the natural environment of any area. In this chapter you will learn about the third, that is, the atmospheric conditions that prevail over our country. Why do we wear woollens in December or why it is hot and uncomfortable in the month of May, and why it rains in June - July? The answers to all these questions can be found out by studying about the climate of India.

**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. You may have observed that the weather conditions fluctuate very often even within a day. But there is some common pattern over a few weeks or months, i.e. days are cool or hot, windy or calm, cloudy or bright, and wet or dry. On the basis of the generalised monthly atmospheric conditions, the year is divided into seasons such as winter, summer or rainy seasons.

The world is divided into a number of climatic regions. Do you know what type of climate India has and why it is so? We will learn about it in this chapter.

### Do You Know?

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

The climate of India is described as the 'monsoon' type. In Asia, this type of climate is found mainly in the south and the southeast. 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. Thiruvananthapuram, on the other hand, may have a temperature of 22°C.

### Do You 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.

Let us now look at precipitation. 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 gets a large portion 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.

### Find out

Why the houses in Rajasthan have thick walls and flat roofs?

- Why is it that the houses in the Tarai region and in Goa and Mangalore have sloping roofs?
- Why houses in Assam are built on stilts?

## CLIMATIC CONTROLS

There are six major controls of the climate of any place. They are: **latitude, altitude, pressure and wind system, distance from the sea** (continentality), **ocean currents and relief features**.

Due to the curvature of the earth, the amount of solar energy received varies according to **latitude**. As a result, air temperature generally decreases from the equator towards the poles. 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. 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. 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 (i.e. very hot during summers and very cold during winters). **Ocean currents** along with onshore winds affect the climate of the coastal areas. For example, any coastal area with warm or cold currents flowing past it, will be warmed or cooled if the winds are onshore.

### Find out

- Why most of the world's deserts are located in the western margins of continents in the subtropics?

Finally, **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 relatively dry.

## FACTORS AFFECTING INDIA'S CLIMATE

### Latitude

The Tropic of Cancer passes through the middle of the country from the Rann of Kutch 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.

### 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.**

### 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 southwards, get deflected to the right due to the Coriolis force, and move towards the equatorial low-pressure area. Generally, these winds carry 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. Let us see why?

**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 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.

## THE SEASONS

The monsoon type of climate is characterised by a distinct seasonal pattern. The weather conditions greatly change from one season to the other. These changes are particularly noticeable in the interior parts of the country. The coastal areas do not experience much variation in temperature though there is variation in rainfall pattern. How many seasons are experienced in your place? Four main seasons can be identified in India – the cold weather season, the hot weather season, the

advancing monsoon and the retreating monsoon with some regional variations.

### The Cold Weather Season (Winter)

The cold weather season begins from mid-November in northern India and stays till February. December and January are the coldest months in the northern part of India. The temperature decreases from south to the north. The average temperature of Chennai, on the eastern coast, is between 24°–25° Celsius, while in the northern plains, it ranges between 10°C and 15° Celsius. Days are warm and nights are cold. Frost is common in the north and the higher slopes of the Himalayas experience snowfall.

During this season, 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. Some amount of rainfall occurs on the Tamil Nadu coast from these winds as, here they blow from sea to land.

In the northern part of the country, a feeble high-pressure region develops, with light winds moving outwards from this area. Influenced by the relief, these winds blow through the Ganga valley from the west and the northwest. The weather is normally marked by clear sky, low temperatures and low humidity and feeble, variable winds.

A characteristic feature of the cold weather season over the northern plains is the 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. Although the total amount of winter rainfall locally known as 'mahawat' is small, they are of immense importance for the cultivation of 'rabi' crops.

The peninsular region does not have a well-defined cold season. There is hardly any noticeable seasonal change in temperature pattern during winters due to the moderating influence of the sea.



Figure 4.1 : Advancing Monsoon

## The Hot Weather Season (Summer)

Due to the apparent northward movement of the sun, the global heat belt shifts northwards. As such, from March to May, it is hot weather season in India. The influence of the shifting of the heat belt can be seen clearly from temperature recordings taken during March-May at different latitudes. In March, the highest temperature is about 38° Celsius, recorded on the Deccan plateau. In April, temperatures in Gujarat and Madhya Pradesh are around 42° Celsius. In May, temperature of 45° Celsius is common in the northwestern parts of the country. In peninsular India, temperatures remain lower due to the moderating influence of the oceans.

The summer months experience rising temperature and falling air pressure in the northern part of the country. Towards the end of May, an elongated low-pressure area develops in the region extending from the Thar Desert in the northwest to Patna and Chotanagpur plateau in the east and southeast. Circulation of air begins to set in around this trough.

A striking feature of the hot weather season is the 'loo'. These are strong, gusty, hot, dry winds blowing during the day over the north and northwestern India. Sometimes they even continue until late in the evening. Direct exposure to these winds may even prove to be fatal. Dust storms are very common during the month of May in northern India. These storms bring temporary relief as they lower the temperature and may bring light rain and cool breeze. This is also the season for localised thunderstorms, associated with violent winds, torrential downpours, often accompanied by hail. In West Bengal, these storms are known as the 'Kaal Baisakhi'.

Towards the close of the summer season, pre-monsoon showers are common especially, in Kerala and Karnataka. They help in the early ripening of mangoes, and are often referred to as 'mango showers'.

## 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 south-westerly 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. With the exception of the extreme north-west, the monsoon winds cover the country in about a month.

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.

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 rains bring in



Figure 4.2 : Retreating Monsoon

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 in 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.

### Retreating/Post Monsoons (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

#### Do You Know?

Mawsynram, the wettest place on the earth is also reputed for its stalagmite and stalactite caves.

temperature. While day temperatures are high, nights are cool and pleasant. The land is still moist. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive during the day. This is commonly known as ‘October heat’. In the second half of October, the mercury begins to fall rapidly in northern India.

The low-pressure conditions, over north-western India, get transferred to the Bay of Bengal by early November. This shift is associated with the occurrence of cyclonic depressions, which originate over the Andaman Sea. These cyclones generally cross the eastern coasts of India cause heavy and widespread rain. These tropical cyclones are often very destructive. The thickly populated deltas of the Godavari, the Krishna and the Kaveri are frequently struck by cyclones, which cause great damage to life and property. Sometimes, these cyclones arrive at the coasts of Odisha, West Bengal and Bangladesh. The bulk of the rainfall of the Coromandel Coast is derived from depressions and cyclones.

### DISTRIBUTION OF RAINFALL

Parts of western coast and northeastern India receive over about 400 cm of rainfall annually. However, it is less than 60 cm in western Rajasthan and adjoining parts of Gujarat, Haryana and Punjab. Rainfall is equally low in the interior of the Deccan plateau, and east of the Sahyadris. Why do these regions receive low rainfall? A third area of low precipitation is around Leh in Jammu and Kashmir. The rest of the country receives moderate rainfall. Snowfall is restricted to the Himalayan region.

Owing to the nature of monsoons, the annual rainfall is highly variable from year to year. Variability is high in the regions of low rainfall, such as parts of Rajasthan, Gujarat and the leeward side of the Western Ghats. As such, while areas of high rainfall are liable to be affected by floods, areas of low rainfall are drought-prone (Figure 4.3).

### MONSOON AS A UNIFYING BOND

You have already known the way the Himalayas protect the subcontinent from extremely cold winds from central Asia. This enables northern India to have uniformly higher temperatures compared to other areas on the same latitudes. Similarly, the Peninsular plateau, under the influence of the sea from three sides, has moderate temperatures. Despite such

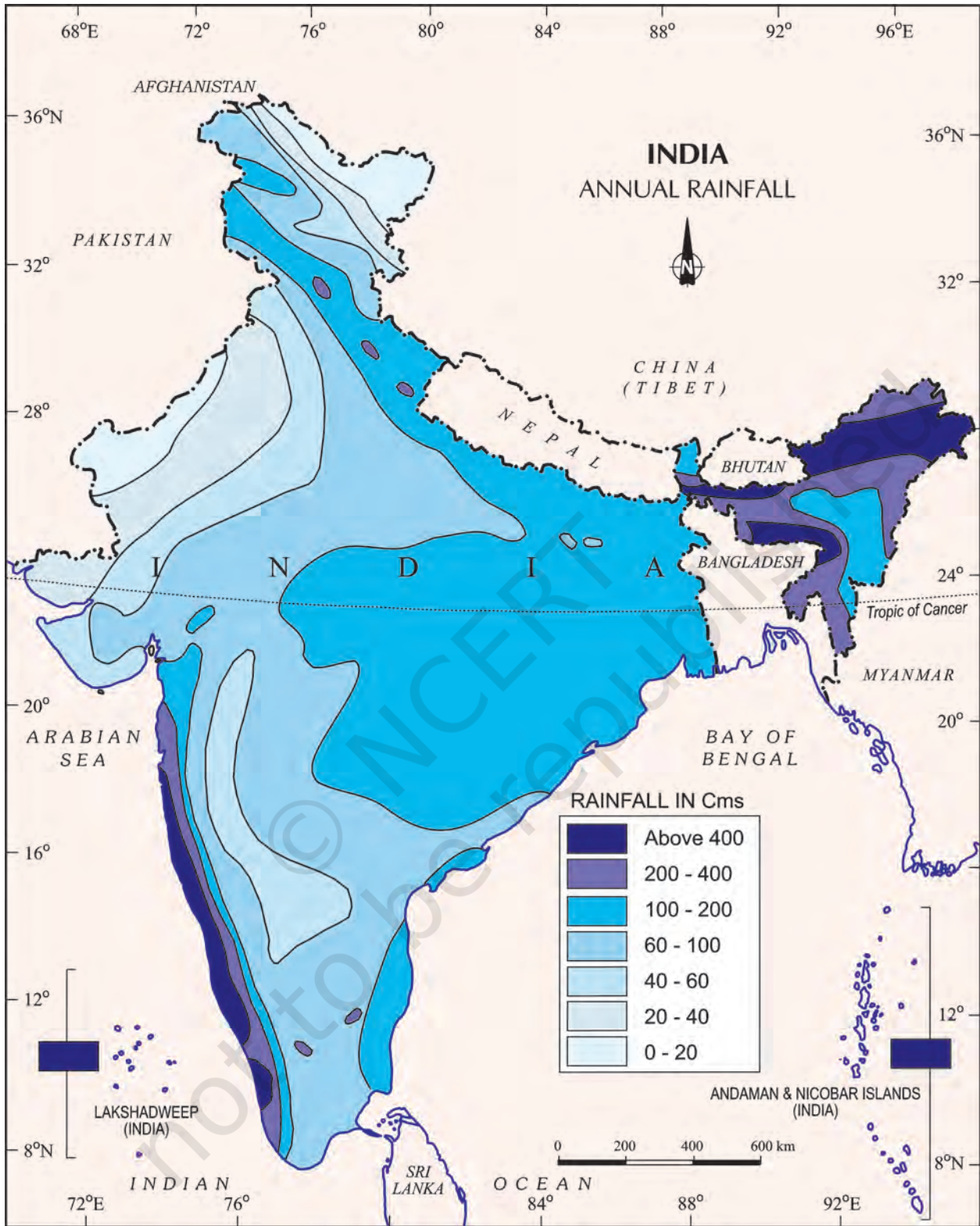


Figure 4.3 : Annual Rainfall

# Devastated by deluge

## Haze hazard on road Chennai submerged

### Hint of an early summer

Tuesday: 28.4 °C

HT Correspondent  
New Delhi, January 31

THE MERCURY is soaring, paving the way for what could be an early onset of summer; the weatherman has said. It may touch 30 degrees Celsius within a couple of days in Delhi.

The mercury settled at 28.4 degrees Celsius on Tuesday, nearly six degrees above the average, breaking a decade-old record.

## A day Mumbai won't forget

SORAB Ghaswalla  
Mumbai, December 30

JULY 26, 2005 started off as just another soggy day in Mumbai. But, the rainfall was one of the heaviest Mumbai had seen over the past century. As citizens went about their morning chores, they had no inkling that by dusk the city would be swamped.

By sunset, 435 residents had either drowned in their houses or vehicles as rain-water started rising with alarming rapidity. By night, the city and its people were defeated. No transport, no electricity and no place to go. Mumbai was on its knees.

The weather bureau had predicted just another "normal" rainy day for the city. But it poured 944.2 m.m. (three feet of rain) over 24 hours, the highest in 100 years.

Before 26/7, Mumbaiites, used to about 15 cm of rain, would tease, "What's a Mumbai monsoon without some days of disruption?" On 26/7, the joke was on them.

### FOG CHECK

Flight operations at Delhi Airport was normal with the runway visibility at 1,500 metres. However, thick fog in the NCR made driving difficult in the early hours.

**DELATED:** 17 incoming trains: departure of six trains was rescheduled.  
Poorva Express from Howrah, Sampurna Kranti Express from Patna and Rajdhani Special from Mumbai.

**RESCHEDULED:** Kashi Vishwanath from New Delhi to Varanasi, Lichchivi Express from New Delhi to Muzaffarpur, Bhupeneshwar Raj from New Delhi to Seldah, Sultanpur Express from Delhi to Sultanpur and Janta Express from Delhi to Howrah.

### Cold comfort for New Year revellers

G.C. Shekhar  
Chennai, December 30

IF 2004 was the year of the tsunami, 2005 turned out to be the year of rains and floods in Tamil Nadu. Unlike the tsunami, which affected a belt of six coastal districts in Tamil Nadu and Pondicherry, the floods wreaked havoc across the state.

In five furious spells, the last two being cyclones that weakened before hitting the coast, the rain gods lashed Tamil Nadu from October to December with almost every district drenched and drowned.

Chennai, which was lauded as an alternative to Bangalore, found itself floating on water on three occasions. The rains and floods killed 350

people. Fields were inundated, crops damaged, roads looked like backwaters. And this was the city that cried for water in summers.

The rains showed up the state's failure to literally tap the resources as 90 tmc of water flowed into the sea. Irrigation tanks and reservoirs were breached. The suburbs were the worst hit as many localities remained under water from October to December.

When the relief efforts began, that brought calamity of another order. Rush for rations resulted in one of the most avoidable tragedies as 48 people were killed in stampedes outside two relief centres.

This was one rain cloud

### Fog is in, get ready for disruptions

A thin blanket of fog enveloped the city in the early hours of Friday. Visibility was reduced to 500 metres in most areas. There

## Freezing Kashmir

RASHID Ahmad

Srinagar

HT Correspondent

New Delhi, January 11

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The rain picked up at about 1 p.m. Initially, nobody paid attention. The enormity of the situation hit Mumbaiites at about 5 p.m. By then, many were dead and the low-lying areas of Kuria, Ghatkopar, Andheri, Dadar, Juhu and Kalina were flooded.

DELHIITES, SHIVERING from the northwesterly onslaught, finally got some respite with the temperatures rising on Wednesday. The city experienced a high of 23 degree Celsius (1 degree above normal) despite a partly cloudy sky in some parts. The minimum was also healthy at 14 degree Celsius that was two degrees below normal.

As expected, fresh western disturbances over the northwestern region of the country cranked up the minimum temperature in the city that had almost dropped to

below 0 degree Celsius on Saturday at 0.2 degree Celsius. The minimum temperature remained over 6 degree C below normal for the next two days. Things were slightly better on Wednesday. At least, the wind had lost its sting. Last three days were very cold, despite the sunshine," said Kanchari Jha, a Delhi resident.

For Thursday, the Met department forecasts a minimum temperature of 6 degree Celsius.

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## After 2 days of biting cold, sun shines

### Expect a ballistic winter after western winds are in

HT Correspondent  
New Delhi, November 30

ACROSS NORTH India, it's a winter of woes. Amritsar is icy with a minimum temperature of 5°C. Snowfall, of up to 78 cm, has blanketed Srinagar. In Delhi, it's still a pleasant nip. This mild wintry condition, however, will definitely not last, says the Met.

In a day or two, winds from Afghanistan, known as western disturbances, will lash the Capital. Conditions are perfect for harsh winter ahead, said Met officials, who have declared "official winter" in Delhi from Thursday.

"Wednesday's morning mist, moisture in the air, low night temperature and the cold winds that hit the city by evening are enough indications for the weather department to declare the onset of winter a day in advance," an official said.

Winter may have been delayed in much of north India by about a fortnight, but it has set in on time in Delhi, he added.

In vast swathes of north India, the past week has been colder than average. "Winter trying to make up for the lost time," the weatherman added in a lighter vein. With temperatures consistently below the average for this year, there is a spectre of this year's winter being colder than usual.

In the ski resort of Gulmarg, there's heavy snow. Night temperature dipped four degrees past normal and Churu in Rajasthan has become bitterly cold. But Delhi continues to be comfortable. Night temperature on Wednesday hovered around 10°C.

"The western disturbances are unpredictable. They might hit Delhi within the next 72 hours or may not for another week. But it is time to get your woollens out. Temperatures will drop progressively in the days to come," said Delhi Met chief R.D. Singh. With mornings getting misty, the dreaded fog may not be far behind. And with pollution levels at a five-year high, the fog this time may be worse.

Delhi has been colder this fortnight compared to the same period last year. The temperature pattern is similar to the record-

### So, it's officially winter in the Capital

#### Delhi

**Max: 25°C, Min: 8** In a day or two, winds from Afghanistan — western disturbances — will lash the Capital. Winter declared from Dec 1.

#### Srinagar

**Max: 8°C, Min: -3** It's a sea of snow there. Like much of Kashmir, it is experiencing sub-zero temperatures and bitterly cold weather.

#### Amritsar

**Max: 21°C, Min: 5** The great plains are extremely cold. The coming days will be worse with expected sub-zero temperatures.

#### Shimla

**Max: 10°C, Min: -4** The Himachal capital is blanketed in heavy snow. Higher reaches are even colder.

breaking winter of 2003 — the worst in 40 years.

The Met office says it cannot forecast so far ahead in future. "It may not be record breaking winter, but it will definitely be chillier than an average winter," said a weather official.

The official pointed out that snowfall in Kashmir and Shimla has been heavier and earlier than usual. The temperature in Shimla dropped two degrees below normal. Sander nagar at 4.3 °C was cold too.

Northerly cold winds have struck Rajasthan, affecting normal life last night with Churu and Sriganganagar shivering at 5°C each, about two-three degrees below normal. Nights in Jodhpur, Bikaner, Ajmer and Jaipur divisions have become harsh.

### Activity

- On the basis of the news items above, find out the names of places and the seasons described.
- Compare the rainfall description of Chennai and Mumbai and explain the reasons for the difference.
- Evaluate flood as a disaster with the help of a case study.

moderating influences, there are great variations in the temperature conditions. Nevertheless, the unifying influence of the monsoon on the Indian subcontinent is quite perceptible. **The seasonal alteration of the wind systems and the associated weather conditions provide a rhythmic cycle of seasons.** Even the uncertainties of rain and uneven distribution are very much typical of the monsoons. The Indian landscape, its animal and plant life, its

entire agricultural calendar and the life of the people, including their festivities, revolve around this phenomenon. **Year after year, people of India from north to south and from east to west, eagerly await the arrival of the monsoon.** These monsoon winds bind the whole country by providing water to set the agricultural activities in motion. The river valleys which carry this water also unite as a single river valley unit.

## EXERCISE

1. Choose the correct answer from the four alternatives given below.
  - (i) Which one of the following places receives the highest rainfall in the world?
    - (a) Silchar
    - (c) Cherrapunji
    - (b) Mawsynram
    - (d) Guwahati
  - (ii) The wind blowing in the northern plains in summers is known as:
    - (a) *Kaal Baisakhi*
    - (c) Trade Winds
    - (b) *Loo*
    - (d) None of the above
  - (iii) Monsoon arrives in India approximately in:
    - (a) Early May
    - (c) Early June
    - (b) Early July
    - (d) Early August
  - (iv) Which one of the following characterises the cold weather season in India?
    - (a) Warm days and warm nights
    - (b) Warm days and cold nights
    - (c) Cool days and cold nights
    - (d) Cold days and warm nights
2. Answer the following questions briefly.
  - (i) What are the controls affecting the climate of India?
  - (ii) Why does India have a monsoon type of climate?
  - (iii) Which part of India does experience the highest diurnal range of temperature and why?
  - (iv) Which winds account for rainfall along the Malabar coast?
  - (v) Define monsoons. What do you understand by “break” in monsoon?
  - (vi) Why is the monsoon considered a unifying bond?
3. Why does the rainfall decrease from the east to the west in Northern India.

4. Give reasons as to why.
  - (i) Seasonal reversal of wind direction takes place over the Indian subcontinent?
  - (ii) The bulk of rainfall in India is concentrated over a few months.
  - (iii) The Tamil Nadu coast receives winter rainfall.
  - (iv) The delta region of the eastern coast is frequently struck by cyclones.
  - (v) Parts of Rajasthan, Gujarat and the leeward side of the Western Ghats are drought-prone.
5. Describe the regional variations in the climatic conditions of India with the help of suitable examples.
6. Give an account of weather conditions and characteristics of the cold season.
7. Give the characteristics and effects of the monsoon rainfall in India.

### MAP SKILLS

On an outline map of India, show the following.

- (i) Areas receiving rainfall over 400 cm.
- (ii) Areas receiving less than 20 cm of rainfall.
- (iii) The direction of the south-west monsoon over India.

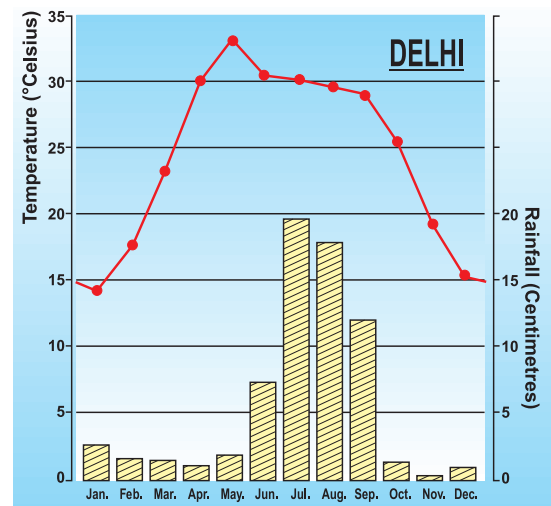
### PROJECT/ACTIVITY

- (i) Find out which songs, dances, festivals and special food preparations are associated with certain seasons in your region. Do they have some commonality with other regions of India?
- (ii) Collect photographs of typical rural houses, and clothing of people from different regions of India. Examine whether they reflect any relationship with the climatic condition and relief of the area.

### FOR DOING IT YOURSELF

1. In Table-I, the average mean monthly temperatures and amounts of rainfall of 10 representative stations have been given. It is for you to study on your own and convert them into 'temperature and rainfall' graphs. A glance at these visual representations will help you to grasp instantly the similarities and differences between them. One such graph (Figure 1) is already prepared for you. See if you can arrive at some broad generalisations about our diverse climatic conditions. We hope you are in for a great joy of learning. Do the following activities.
2. Re-arrange the 10 stations in two different sequences:

Figure 1 : Temperature and Rainfall of Delhi



- (i) According to their distance from the equator.  
(ii) According to their altitude above mean sealevel.
3. (i) Name two rainiest stations.  
(ii) Name two driest stations.  
(iii) Two stations with most equable climate.  
(iv) Two stations with most extreme climate.  
(v) Two stations influenced by retreating monsoons.  
(vi) The two hottest stations in the months of  
(a) February      (b) April      (c) May      (d) June

**Table I**

Stations	Latitude	Altitude (Metres)	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Rainfall
Temperature (°C) Bengaluru Rainfall (cm)	12°58'N	909	20.5 0.7	22.7 0.9	25.2 1.1	27.1 4.5	26.7 10.7	24.2 7.1	23.0 11.1	23.0 13.7	23.1 16.4	22.9 15.3	18.9 6.1	20.2 1.3	88.9
Temperature (°C) Mumbai Rainfall (cm)	19° N	11	24.4 0.2	24.4 0.2	26.7 -	28.3 -	30.0 1.8	28.9 50.6	27.2 61.0	27.2 36.9	27.2 26.9	27.8 4.8	27.2 1.0	25.0 -	183.4
Temperature (°C) Kolkata Rainfall (cm)	22°34' N	6	19.6 1.2	22.0 2.8	27.1 3.4	30.1 5.1	30.4 13.4	29.9 29.0	28.9 33.1	28.7 33.4	28.9 25.3	27.6 12.7	23.4 2.7	19.7 0.4	162.5
Temperature (°C) Delhi Rainfall (cm)	29° N	219	14.4 2.5	16.7 1.5	23.3 1.3	30.0 1.0	33.3 1.8	33.3 7.4	30.0 19.3	29.4 17.8	28.9 11.9	25.6 1.3	19.4 0.2	15.6 1.0	67.0
Temperature (°C) Jodhpur Rainfall (cm)	26°18' N	224	16.8 0.5	19.2 0.6	26.6 0.3	29.8 0.3	33.3 1.0	33.9 3.1	31.3 10.8	29.0 13.1	20.1 5.7	27.0 0.8	20.1 0.2	14.9 0.2	36.6
Temperature (°C) Chennai Rainfall (cm)	13°4' N	7	24.5 4.6	25.7 1.3	27.7 1.3	30.4 1.8	33.0 3.8	32.5 4.5	31.0 8.7	30.2 11.3	29.8 11.9	28.0 30.6	25.9 35.0	24.7 13.9	128.6
Temperature (°C) Nagpur Rainfall (cm)	21°9' N	312	21.5 1.1	23.9 2.3	28.3 1.7	32.7 1.6	35.5 2.1	32.0 22.2	27.7 37.6	27.3 28.6	27.9 18.5	26.7 5.5	23.1 2.0	20.7 1.0	124.2
Temperature (°C) Shillong Rainfall (cm)	24°34' N	1461	9.8 1.4	11.3 2.9	15.9 5.6	18.5 14.6	19.2 29.5	20.5 47.6	21.1 35.9	20.9 34.3	20.0 30.2	17.2 18.8	13.3 3.8	10.4 0.6	225.3
Temperature (°C) Thiruvananthapuram Rainfall (cm)	8°29' N	61	26.7 2.3	27.3 2.1	28.3 3.7	28.7 10.6	28.6 20.8	26.6 35.6	26.2 22.3	2.6.2 14.6	26.5 13.8	26.7 27.3	26.6 20.6	26.5 7.5	181.2
Temperature (°C) Leh 34° N Rainfall (cm)	34°N	3506	-8.5 1.0	-7.2 0.8	-0.6 0.8	6.1 0.5	10.0 0.5	14.4 0.5	17.2 1.3	16.1 1.3	12.2 0.8	6.1 0.5	0.0 -	-5.6 0.5	8.5

4. Now find out
- (i) Why are Thiruvananthapuram and Shillong rainier in June than in July?
  - (ii) Why is July rainier in Mumbai than in Thiruvananthapuram?
  - (iii) Why are southwest monsoons less rainy in Chennai?
  - (iv) Why is Shillong rainier than Kolkata?
  - (v) Why is Kolkata rainier in July than in June unlike Shillong which is rainier in June than in July?
  - (vi) Why does Delhi receive more rain than Jodhpur?
5. Now think why
- Thiruvananthapuram has equable climate?
  - Chennai has more rains only after the fury of monsoon is over in most parts of the country?
  - Jodhpur has a hot desert type of climate?
  - Leh has moderate precipitation almost throughout the year?
  - while in Delhi and Jodhpur most of the rain is confined to nearly three months, in Thiruvananthapuram and Shillong it is almost nine months of the year?

In spite of these facts see carefully if there are strong evidences to conclude that the monsoons still provide a very strong framework lending overall climatic unity to the whole country.



**Class XI<sup>th</sup> NEW NCERT**  
**Chapter-4**

# UNIT III

## ***CLIMATE AND VEGETATION***

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*This unit deals with*

- *Weather and climate – spatial and temporal distribution of temperature, pressure, winds and rainfall; Indian monsoons: mechanism, onset and variability – spatial and temporal; climatic types*
- *Natural vegetation – forest types and distribution; wild life conservation; biosphere reserves*

# CLIMATE

## CHAPTER

# 4



11094CH04

**W**e drink more water during summers. Your uniform during the summer is different from the winters. Why do you wear lighter clothes during summers and heavy woollen clothes during winters in north India? In southern India, woollen clothes are not required. In northeastern states, winters are mild except in the hills. There are variations in weather conditions during different seasons. These changes occur due to the changes in the elements of weather (temperature, pressure, wind direction and velocity, humidity and precipitation, etc.).

Weather is the momentary state of the atmosphere while climate refers to the average of the weather conditions over a longer period of time. Weather changes quickly, may be within a day or week but climate changes imperceptively and may be noted after 50 years or even more.

You have already studied about the monsoon in your earlier classes. You are also aware of the meaning of the word, “monsoon”. Monsoon connotes the climate associated with seasonal reversal in the direction of winds. India has hot monsoonal climate which is the prevalent climate in south and southeast Asia.

### UNITY AND DIVERSITY IN THE MONSOON CLIMATE

The monsoon regime emphasises the unity of India with the rest of southeast Asian region. This view of broad unity of the monsoon type of climate should not, however, lead one to ignore its regional variations which differentiate

the weather and climate of different regions of India. For example, the climate of Kerala and Tamil Nadu in the south are so different from that of Uttar Pradesh and Bihar in the north, and yet all of these have a monsoon type of climate. The climate of India has many regional variations expressed in the pattern of winds, temperature and rainfall, rhythm of seasons and the degree of wetness or dryness. These regional diversities may be described as sub-types of monsoon climate. Let us take a closer look at these regional variations in temperature, winds and rainfall.

While in the summer the mercury occasionally touches 55° C in the western Rajasthan, it drops down to as low as minus 45° C in winter around Leh. Churu in Rajasthan may record a temperature of 50° C or more on a June day while the mercury hardly touches 19° C in Tawang (Arunachal Pradesh) on the same day. On a December night, temperature in Drass (Ladakh) may drop down to minus 45° C while Thiruvananthapuram or Chennai on the same night records 20° C or 22° C. These examples confirm that there are seasonal variations in temperature from place to place and from region to region in India. Not only this, if we take only a single place and record the temperature for just one day, variations are no less striking. In Kerala and in the Andaman Islands, the difference between day and night temperatures may be hardly seven or eight degree Celsius. But in the Thar desert, if the day temperature is around 50° C, at night, it may drop down considerably upto 15° -20° C.

Now, let us see the regional variations in precipitation. While snowfall occurs in the Himalayas, it only rains over the rest of the country. Similarly, variations are noticeable not only in the type of precipitation but also in its amount. **While Cherrapunji and Mawsynram in the Khasi Hills of Meghalaya receive rainfall over 1,080 cm in a year, Jaisalmer in Rajasthan rarely gets more than 9 cm of rainfall during the same period.**

**Tura situated in the Garo Hills of Meghalaya may receive an amount of rainfall in a single day which is equal to 10 years of rainfall at Jaisalmer.** While the annual precipitation is less than 10 cm in the north-west Himalayas and the western deserts, it exceeds 400 cm in Meghalaya.

**The Ganga delta and the coastal plains of Odisha are hit by strong rain-bearing storms almost every third or fifth day in July and August while the Coromandal coast, a thousand km to the south, goes generally dry during these months. Most parts of the country get rainfall during June-September, but on the coastal areas of Tamil Nadu, it rains in the beginning of the winter season.**

In spite of these differences and variations, the climate of India is monsoonal in rhythm and character.

#### FACTORS DETERMINING THE CLIMATE OF INDIA

India's climate is controlled by a number of factors.

**Latitude :** You already know the latitudinal and longitudinal extent of the land of India. You also know that the Tropic of Cancer passes through the central part of India in east-west direction. Thus, **northern part of the India lies in sub-tropical and temperate zone and the part lying south of the Tropic of Cancer falls in the tropical zone.** The tropical zone being **nearer to the equator, experiences high temperatures throughout the year with small daily and annual range.** Area north of the **Tropic of Cancer being away from the equator, experiences extreme climate with high daily and annual range of temperature.**

**The Himalayan Mountains :** **The lofty Himalayas in the north along with its extensions act as an effective climatic divide.** The towering mountain chain provides an invincible shield to protect the subcontinent from the cold northern winds. **These cold and chilly winds originate near the Arctic circle and blow across central and eastern Asia. The Himalayas also trap the monsoon winds, forcing them to shed their moisture within the subcontinent.**

**Distribution of Land and Water :** India is flanked by the Indian Ocean on three sides in the south and girdled by a high and continuous mountain-wall in the north. **As compared to the landmass, water heats up or cools down slowly. This differential heating of land and sea creates different air pressure zones in different seasons in and around the Indian subcontinent.** Difference in air pressure causes reversal in the direction of monsoon winds.

**Distance from the Sea :** With a long coastline, large coastal areas have an equable climate. **Areas in the interior of India are far away from the moderating influence of the sea. Such areas have extremes of climate. That is why, the people of Mumbai and the Konkan coast have hardly any idea of extremes of temperature and the seasonal rhythm of weather.** On the other hand, the seasonal contrasts in weather at places in the interior of the country **such as Delhi, Kanpur and Amritsar affect the entire sphere of life.**

**Altitude :** Temperature decreases with height. **Due to thin air, places in the mountains are cooler than places on the plains. For example, Agra and Darjiling are located on the same latitude, but temperature of January in Agra is 16° C whereas it is only 4° C in Darjiling.**

**Relief :** The **physiography or relief of India also affects the temperature, air pressure, direction and speed of wind and the amount and distribution of rainfall.** The windward sides

### Inter Tropical Convergence Zone (ITCZ)

The Inter Tropical Convergence Zone (ITCZ) is a low pressure zone located at the equator where trade winds converge, and so, it is a zone where air tends to ascend. In July, the ITCZ is located around 20° N-25° N latitudes (over the Gangetic plain), sometimes called the monsoon trough. This monsoon trough encourages the development of thermal low over north and northwest India. Due to the shift of ITCZ, the trade winds of the southern hemisphere cross the equator between 40° and 60° E longitudes and start blowing from southwest to northeast due to the Coriolis force. It becomes southwest monsoon. In winter, the ITCZ moves southward, and so the reversal of winds from northeast to south and southwest, takes place. They are called northeast monsoons.

of Western Ghats and Assam receive **high rainfall during June-September** whereas the **southern plateau remains dry due to its leeward situation along the Western Ghats.**

### THE NATURE OF INDIAN MONSOON

Monsoon is a familiar though a little known climatic phenomenon. Despite the observations spread over centuries, **the monsoon continues to puzzle the scientists.** Many attempts have been made to discover the exact nature and causation of monsoon, **but so far, no single theory has been able to explain the monsoon fully.** A real breakthrough has come recently when it was studied at the global rather than **at regional level.**

Systematic studies of the causes of rainfall in the South Asian region help to understand the causes and salient features of the monsoon, particularly some of its important aspects, such as:

- (i) The onset of the monsoon.
- (ii) Break in the monsoon.

### Onset of the Monsoon

Towards the end of the nineteenth century, it was believed that the **differential heating of land and sea during the summer months is the mechanism which sets the stage for the monsoon winds to drift towards the subcontinent.** During April and May when the sun shines vertically over the Tropic of Cancer, the large landmass in the north of Indian ocean

gets intensely heated. This **causes the formation of an intense low pressure in the northwestern part of the subcontinent.** Since the pressure in the Indian Ocean in the south of the landmass is high as water gets heated slowly, **the low pressure cell attracts the southeast trades across the Equator.** These conditions **help in the northward shift in the position of the ITCZ.** The southwest monsoon may thus, be seen as a continuation of the **southeast trades deflected towards the Indian subcontinent after crossing the Equator.** These winds cross the Equator between 40° E and 60° E longitudes.



Figure 4.1 : Onset of Monsoon

The shift in the position of the ITCZ is also related to the phenomenon of the withdrawal of the westerly jet stream from its position over the north Indian plain, south of the Himalayas. The easterly jet stream sets in along 15° N latitude only after the western jet stream has withdrawn itself from the region. This easterly jet stream is held responsible for the burst of the monsoon in India.

*Entry of Monsoon into India* : The southwest monsoon sets in over the Kerala coast by 1st June and moves swiftly to reach Mumbai and Kolkata between 10th and 13th June. By mid-July, southwest monsoon engulfs the entire subcontinent (Figure 4.2)

### Break in the Monsoon

During the south-west monsoon period after having rains for a few days, if rain fails to occur for one or more weeks, it is known as break in the monsoon. These dry spells are quite common during the rainy season. These breaks in the different regions are due to different reasons:

- (i) In northern India rains are likely to fail if the rain-bearing storms are not very frequent along the monsoon trough or the ITCZ over this region.
- (ii) Over the west coast the dry spells are associated with days when winds blow parallel to the coast.

### THE RHYTHM OF SEASONS

The climatic conditions of India can best be described in terms of an annual cycle of seasons. The meteorologists recognise the following four seasons :

- (i) the cold weather season
- (ii) the hot weather season
- (iii) the southwest monsoon season
- (iv) the retreating monsoon season.

### The Cold Weather Season

*Temperature* : Usually, the cold weather season sets in by mid-November in northern India. December and January are the coldest months in the northern plain. The mean daily temperature remains below 21° C over most parts of northern India. The night temperature may be quite low, sometimes going below freezing point in Punjab and Rajasthan.

There are three main reasons for the excessive cold in north India during this season :

- (i) States like Punjab, Haryana and Rajasthan being far away from the moderating influence of sea experience continental climate.
- (ii) The snowfall in the nearby Himalayan ranges creates cold wave situation; and
- (iii) Around February, the cold winds coming from the Caspian Sea and Turkmenistan

### El-Nino and the Indian Monsoon

El-Nino is a complex weather system that appears once every three to seven years, bringing drought, floods and other weather extremes to different parts of the world.

The system involves oceanic and atmospheric phenomena with the appearance of warm currents off the coast of Peru in the Eastern Pacific and affects weather in many places including India. El-Nino is merely an extension of the warm equatorial current which gets replaced temporarily by cold Peruvian current or Humbolt current (locate these currents in your atlas). This current increases the temperature of water on the Peruvian coast by 10° C. This results in:

- (i) the distortion of equatorial atmospheric circulation;
- (ii) irregularities in the evaporation of sea water;
- (iii) reduction in the amount of planktons which further reduces the number of fish in the sea.

The word El-Nino means 'Child Christ' because this current appears around Christmas in December. December is a summer month in Peru (Southern Hemisphere).

El-Nino is used in India for forecasting long range monsoon rainfall. In 1990-91, there was a wild El-Nino event and the onset of southwest monsoon was delayed over most parts of the country ranging from five to twelve days.

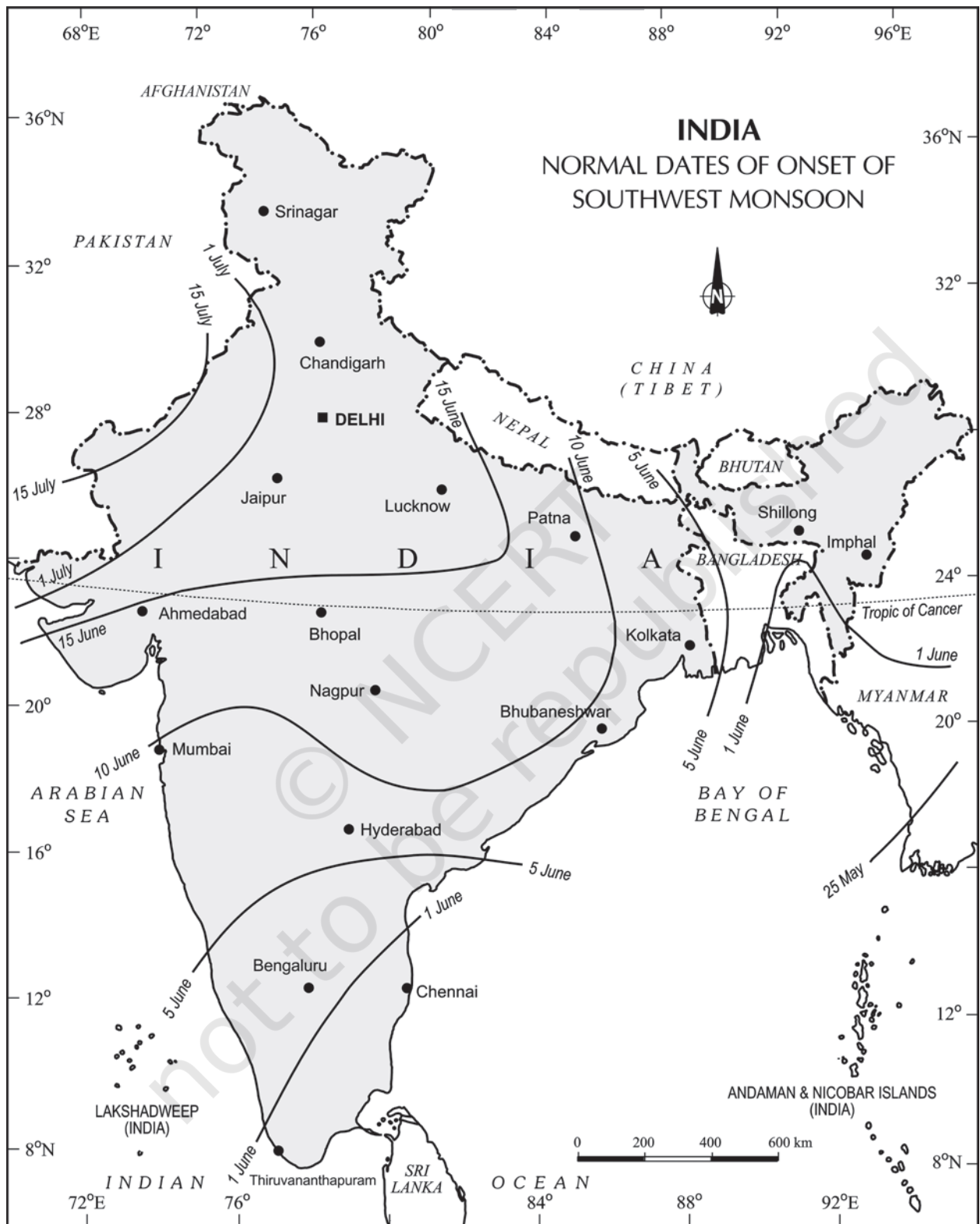


Figure 4.2 : India : Normal Dates of Onset of the Southwest Monsoon

bring cold wave along with frost and fog over the northwestern parts of India.

#### Understanding the Monsoon

Attempts have been made to understand the nature and mechanism of the monsoon on the basis of data collected on land, oceans and in the upper atmosphere. The intensity of southwest monsoon winds of southern oscillation can be measured, among others, by measuring the difference in pressure between Tahiti (roughly 20° S and 140° W) in French Polynesia in East Pacific and port Darwin (12° 30'S and 131° E) in northern Australia. Indian Meteorological Department (IMD) can forecast the possible behaviour of monsoons on the basis of 16 indicators.

The Peninsular region of India, however, does not have any well-defined cold weather season. There is hardly any seasonal change in the distribution pattern of the temperature in coastal areas because of moderating influence of the sea and the proximity to equator. For example, the mean maximum temperature for January at Thiruvananthapuram is as high as 21° C, and for June, it is 29.5° C. Temperatures at the hills of Western Ghats remain comparatively low.

**Pressure and Winds :** By the end of December (22nd December), the sun shines vertically over the Tropic of Capricorn in the southern hemisphere. The weather in this season is characterised by feeble high pressure conditions over the northern plain. In south India, the air pressure is slightly lower. The isobars of 1019 mb and 1013 mb pass through northwest India and far south, respectively.

As a result, winds start blowing from northwestern high pressure zone to the low air pressure zone over the Indian Ocean in the south.

Due to low pressure gradient, the light winds with a low velocity of about 3-5 km per hour begin to blow outwards. By and large, the topography of the region influences the wind direction. They are westerly or northwesterly down the Ganga Valley. They become northerly in the Ganga-Brahmaputra delta. Free from the influence of topography, they are clearly northeasterly over the Bay of Bengal.

During the winters, the weather in India is pleasant. The pleasant weather conditions, however, at intervals, get disturbed by shallow cyclonic depressions originating over the east Mediterranean Sea and travelling eastwards across West Asia, Iran, Afghanistan and Pakistan before they reach the northwestern parts of India. On their way, the moisture content gets augmented from the Caspian Sea in the north and the Persian Gulf in the south. What is the role of Westerly Jet Streams in steering these depressions in India?

**Rainfall :** Winter monsoons do not cause rainfall as they move from land to the sea. It is because firstly, they have little humidity; and secondly, due to anti cyclonic circulation on land, the possibility of rainfall from them reduces. So, most parts of India do not have rainfall in the winter season. However, there are some exceptions to it:

- (i) In northwestern India, some weak temperate cyclones from the Mediterranean sea cause rainfall in Punjab, Haryana, Delhi and western Uttar Pradesh. Although the amount is meagre, it is highly beneficial for rabi crops. The precipitation is in the form of snowfall in the lower Himalayas. It is this snow that sustains the flow of water in the Himalayan rivers during the summer months. The precipitation goes on decreasing from west to east in the plains and from north to south in the mountains. The average winter rainfall in Delhi is around 53 mm. In Punjab and Bihar, rainfall remains

between 25 mm and 18 mm respectively.

- (ii) Central parts of India and northern parts of southern Peninsula also get winter rainfall occasionally.
- (iii) Arunachal Pradesh and Assam in the northeastern parts of India also have rains between 25 mm and 50 mm during these winter months.
- (iv) During October and November, northeast monsoon while crossing over the Bay of Bengal, picks up moisture and causes torrential rainfall over the Tamil Nadu coast, southern Andhra Pradesh, southeast Karnataka and southeast Kerala.

### The Hot Weather Season

*Temperature:* With the apparent northward movement of the sun towards the Tropic of Cancer in March, temperatures start rising in north India. April, May and June are the months of summer in north India. In most parts of India, temperatures recorded are between 30°-32° C. In March, the highest day temperature of about 38° C occurs in the Deccan Plateau while in April, temperature ranging between 38° C and 43° C are found in Gujarat and Madhya Pradesh. In May, the heat belt moves further north, and in the north-western part of India, temperatures around 48° C are not uncommon.

The hot weather season in south India is mild and not so intense as found in north India. The Peninsular situation of south India with moderating effect of the oceans keeps the temperatures lower than that prevailing in north India. So, temperatures remain between 26° C and 32° C. Due to altitude, the temperatures in the hills of Western Ghats remain below 25° C. In the coastal regions, the north-south extent of isotherms parallel to the coast confirms that temperature does not decrease from north to

south rather it increases from the coast to the interior. The mean daily minimum temperature during the summer months also remains quite high and rarely goes below 26° C.

*Pressure and Winds :* The summer months are a period of excessive heat and falling air pressure in the northern half of the country. Because of the heating of the subcontinent, the ITCZ moves northwards occupying a position centred at 25° N in July. Roughly, this elongated low pressure monsoon trough extends over the Thar desert in the north-west to Patna and Chotanagpur plateau in the east-southeast. The location of the ITCZ attracts a surface circulation of the winds which are southwesterly on the west coast as well as along the coast of West Bengal and Bangladesh. They are easterly or south-easterly over north Bengal and Bihar. It has been discussed earlier that these currents of southwesterly monsoon are in reality 'displaced' equatorial easterlies. The influx of these winds by mid-June brings about a change in the weather towards the rainy season.

In the heart of the ITCZ in the northwest, the dry and hot winds known as 'Loo', blow in the afternoon, and very often, they continue to well into midnight. Dust storms in the evening are very common during May in Punjab, Haryana, Eastern Rajasthan and Uttar Pradesh. These temporary storms bring a welcome respite from the oppressing heat since they bring with them light rains and a pleasant cool breeze. Occasionally, the moisture-laden winds are attracted towards the periphery of the trough. A sudden contact between dry and moist air masses gives rise to local storms of great intensity. These local storms are associated with violent winds, torrential rains and even hailstorms.

### Some Famous Local Storms of Hot Weather Season

- (i) **Mango Shower** : Towards the end of summer, there are pre-monsoon showers which are a common phenomena in Kerala and coastal areas of Karnataka. Locally, they are known as mango showers since they help in the early ripening of mangoes.
- (ii) **Blossom Shower** : With this shower, coffee flowers blossom in Kerala and nearby areas.
- (iii) **Nor Westers** : These are dreaded evening thunderstorms in Bengal and Assam. Their notorious nature can be understood from the local nomenclature of '**Kalbaisakhi**', a calamity of the month of **Baisakh**. These showers are **useful for tea, jute and rice cultivation**. In Assam, these storms are known as '**Bardoisila**'.
- (iv) **Loo** : Hot, dry and oppressing winds blowing in the Northern plains from Punjab to Bihar with higher intensity between Delhi and Patna.

### THE SOUTHWEST MONSOON SEASON

As a result of rapid increase of temperature in May over the **northwestern plains**, the **low pressure conditions over there get further intensified**. By early June, they are **powerful enough to attract the trade winds of Southern Hemisphere coming from the Indian Ocean**. These southeast trade winds cross the equator and enter the Bay of Bengal and the Arabian Sea, only to be caught up in the air circulation over India. **Passing over the equatorial warm currents, they bring with them moisture in abundance**. After crossing the equator, they follow a southwesterly direction. That is why they are known as southwest monsoons.

**The rain in the southwest monsoon season begins rather abruptly**. One result of the first rain is that it brings down the temperature substantially. This sudden **onset of the moisture-laden winds associated with violent thunder and lightning**, is often

termed as the **"break" or "burst" of the monsoons**. The monsoon may burst in the first week of June in the coastal areas of Kerala, Karnataka, Goa and Maharashtra **while in the interior parts of the country, it may be delayed to the first week of July**. The day temperature registers a decline of  $5^{\circ}\text{C}$  to  $8^{\circ}\text{C}$  between mid-June and mid-July.

As these **winds approach the land, their southwesterly direction is modified by the relief and thermal low pressure** over the northwest India. **The monsoon approaches the landmass in two branches:**

- (i) The Arabian Sea branch
- (ii) The Bay of Bengal branch.

### Monsoon Winds of the Arabian Sea

The monsoon winds originating over the Arabian Sea **further split into three branches:**

- (i) Its one branch is obstructed by the Western Ghats. These winds climb the slopes of the Western Ghats from 900-1200 m. Soon, they become cool, and as a result, the **windward side of the Sahyadris and Western Coastal Plain receive very heavy rainfall ranging between 250 cm and 400 cm**. After crossing the Western Ghats, these winds descend and get heated up. This reduces humidity in the winds. **As a result, these winds cause little rainfall east of the Western Ghats. This region of low rainfall is known as the rain-shadow area**. Find out the rainfall at Kozhikode, Mangalore, Pune and Bengaluru and note the difference.
- (ii) **Another branch** of the Arabian sea monsoon **strikes the coast north of Mumbai. Moving along the Narmada and Tapi river valleys, these winds cause rainfall in extensive areas of central India**. The Chotanagpur plateau gets 15 cm rainfall from this part of the branch. Thereafter, **they enter the Ganga plains and mingle with the Bay of Bengal branch**.
- (iii) A **third branch** of this monsoon **wind strikes the Saurashtra Peninsula and the Kachchh**. It then passes over west

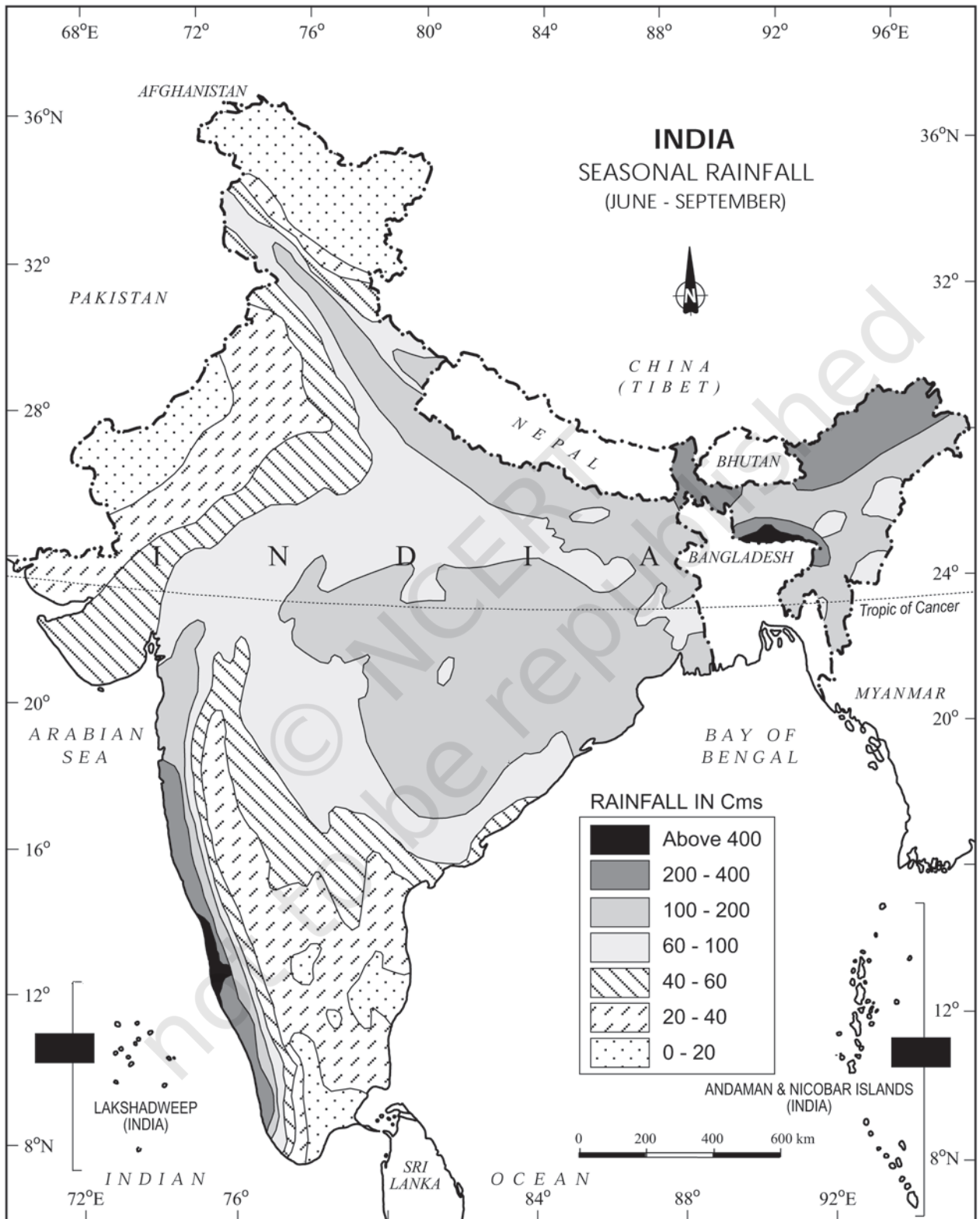


Figure 4.3 : India : Seasonal Rainfall (June-September)

Rajasthan and along the Aravalis, causing only a scanty rainfall. In Punjab and Haryana, it too joins the Bay of Bengal branch. These two branches, reinforced by each other, cause rains in the western Himalayas.

### Monsoon Winds of the Bay of Bengal

The Bay of Bengal branch strikes the coast of Myanmar and part of southeast Bangladesh. But the Arakan Hills along the coast of Myanmar deflect a big portion of this branch towards the Indian subcontinent. The monsoon, therefore, enters West Bengal and Bangladesh from south and southeast instead of from the south-westerly direction. From here, this branch splits into two under the influence of the Himalayas and the thermal low is northwest India. Its one branch moves westward along the Ganga plains reaching as far as the Punjab plains. The other branch moves up the Brahmaputra valley in the north and the northeast, causing widespread rains. Its sub-branch strikes the Garo and Khasi hills of Meghalaya. Mawsynram, located on the crest of Khasi hills, receives the highest average annual rainfall in the world.

Here it is important to know why the Tamil Nadu coast remains dry during this season. There are two factors responsible for it:

- (i) The Tamil Nadu coast is situated parallel to the Bay of Bengal branch of southwest monsoon.
- (ii) It lies in the rainshadow area of the Arabian Sea branch of the south-west monsoon.

### Season of Retreating Monsoon

The months of October and November are known for retreating monsoons. By the end of September, the southwest monsoon becomes weak as the low pressure trough of the Ganga plain starts moving southward in response to the southward march of the sun. The monsoon retreats from the western

Rajasthan by the first week of September. It withdraws from Rajasthan, Gujarat, Western Ganga plain and the Central Highlands by the end of the month. By the beginning of October, the low pressure covers northern parts of the Bay of Bengal and by early November, it moves over Karnataka and Tamil Nadu. By the middle of December, the centre of low pressure is completely removed from the Peninsula.

The retreating southwest monsoon season is marked by clear skies and rise in temperature. The land is still moist. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive. This is commonly known as the 'October heat'. In the second half of October, the mercury begins to fall rapidly, particularly in northern India. The weather in the retreating monsoon is dry in north India but it is associated with rain in the eastern part of the Peninsula. Here, October and November are the rainiest months of the year.

The widespread rain in this season is associated with the passage of cyclonic depressions which originate over the Andaman Sea and manage to cross the eastern coast of the southern Peninsula. These tropical cyclones are very destructive. The thickly populated deltas of the Godavari, Krishna and Kaveri are their preferred targets. Every year cyclones bring disaster here. A few cyclonic storms also strike the coast of West Bengal, Bangladesh and Myanmar. A bulk of the rainfall of the Coromondal coast is derived from these depressions and cyclones. Such cyclonic storms are less frequent in the Arabian Sea.

### TRADITIONAL INDIAN SEASONS

In the Indian tradition, a year is divided into six two-monthly seasons. This cycle of seasons, which the common people in north and central India follow is based on their practical experience and age-old perception of weather phenomena. However, this system does not match with the seasons of south India where there is little variation in the seasons.

Seasons	Months (According to the Indian Calendar)	Months (According to the Gregorian Calendar)
Vasanta	Chaitra-Vaisakha	March-April
Grishma	Jyaistha-Asadha	May-June
Varsha	Sravana-Bhadra	July-August
Sharada	Asvina-Kartika	September-October
Hemanta	Margashirsa-Pausa	November-December
Shishira	Magha-Phalgun	January-February

### Distribution of Rainfall

The average annual rainfall in India is about 125 cm, but it has great spatial variations.

**Areas of High Rainfall :** The highest rainfall occurs along the west coast, on the Western Ghats, as well as in the sub-Himalayan areas in the northeast and the hills of Meghalaya. Here the rainfall exceeds 200 cm. In some parts of Khasi and Jaintia hills, the rainfall exceeds 1,000 cm. In the Brahmaputra valley and the adjoining hills, the rainfall is less than 200 cm.

**Areas of Medium Rainfall :** Rainfall between 100-200 cm is received in the southern parts of Gujarat, east Tamil Nadu, northeastern Peninsula covering Odisha, Jharkhand, Bihar, eastern Madhya Pradesh, northern Ganga plain along the sub-Himalayas and the Cachar Valley and Manipur.

**Areas of Low Rainfall :** Western Uttar Pradesh, Delhi, Haryana, Punjab, Jammu and Kashmir, eastern Rajasthan, Gujarat and Deccan Plateau receive rainfall between 50-100 cm.

**Areas of Inadequate Rainfall:** Parts of the Peninsula, especially in Andhra Pradesh, Karnataka and Maharashtra, Ladakh and most of western Rajasthan receive rainfall below 50 cm.

Snowfall is restricted to the Himalayan region.

Identify the pattern of rainfall after consulting the rainfall map.

### Monsoons and the Economic Life in India

- Monsoon is that axis around which revolves the entire agricultural cycle of India. It is because about 64 per cent people of India depend on agriculture for their livelihood and agriculture itself is based on southwest monsoon.

- Except Himalayas all the parts of the country have temperature above the threshold level to grow the crops or plants throughout the year.
- Regional variations in monsoon climate help in growing various types of crops.
- Variability of rainfall brings droughts or floods every year in some parts of the country.
- Agricultural prosperity of India depends very much on timely and adequately distributed rainfall. If it fails, agriculture is adversely affected particularly in those regions where means of irrigation are not developed.
- Sudden monsoon burst creates problem of soil erosion over large areas in India.
- Winter rainfall by temperate cyclones in north India is highly beneficial for rabi crops.
- Regional climatic variation in India is reflected in the vast variety of food, clothes and house types.

### GLOBAL WARMING

You know that change is the law of nature. Climate has also witnessed change in the past at the global as well as at local levels. It is changing even now but the change is imperceptible. A number of geological evidences suggest that once upon a time, large part of the earth was under ice cover. Now you might have read or heard the debate on global warming. Besides the natural causes, human activities such as large scale industrialisation and presence of polluting gas in the atmosphere are also important factors responsible for global warming. You might have heard about the "green house effect" while discussing global warming.

The temperature of the world is significantly increasing. Carbon dioxide produced by human activities is a major source of concern. This gas, released to the atmosphere in large quantities by burning of fossil fuel, is increasing gradually. Other gases like methane, chlorofluorocarbons, and nitrous oxide which are present in much smaller concentrations in the atmosphere, together with carbon dioxide are known as

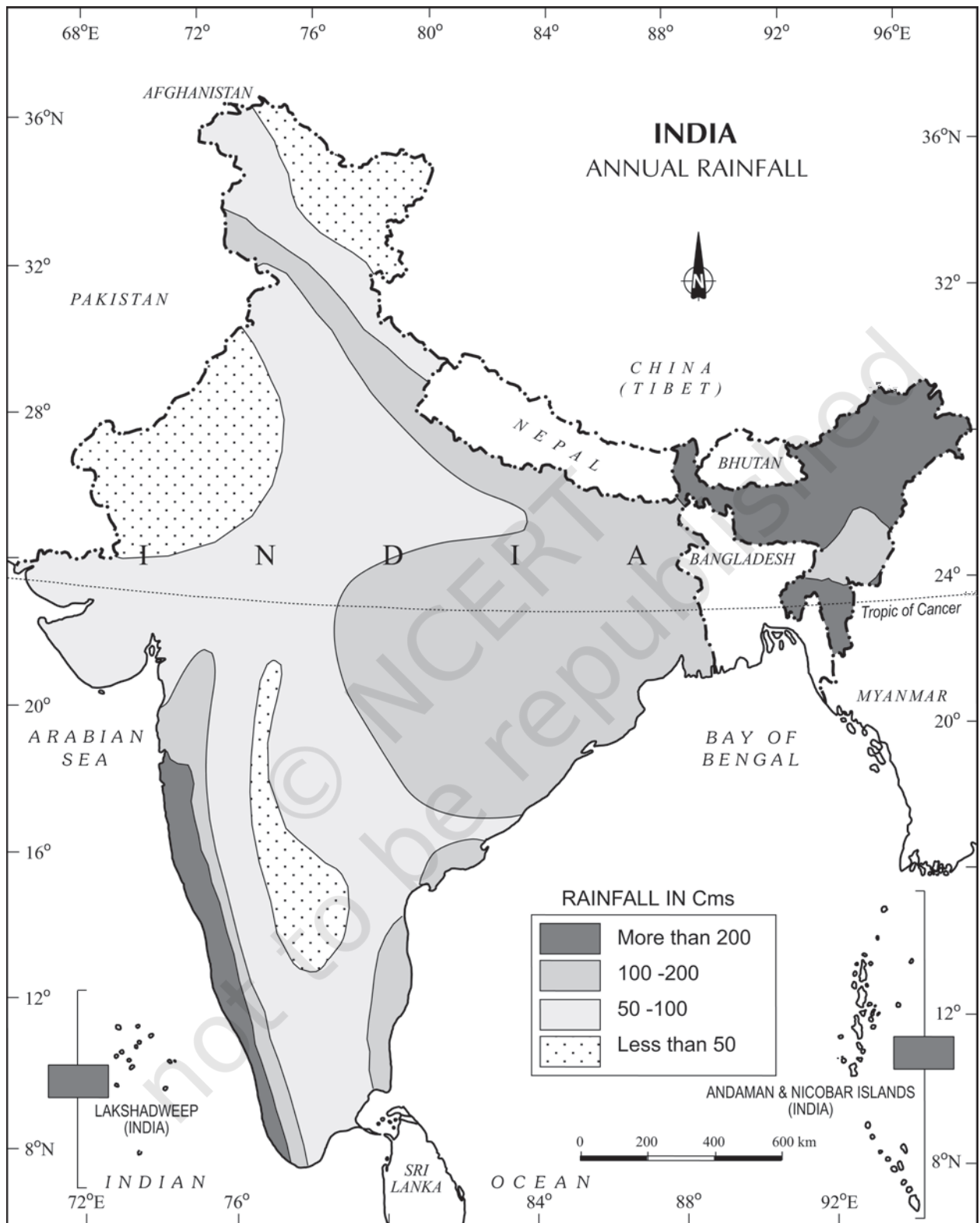


Figure 4.4 : India : Annual Rainfall

green house gases. These gases are better absorbers of long wave radiations than carbon dioxide, and so, are more effective at enhancing the green house effect. These gases have been contributing to global warming. It is said that due to global warming the polar ice caps and mountain glaciers would melt and the amount of water in the oceans would increase.

The mean annual surface temperature of the earth in the past 150 years has increased. It is projected that by the year 2,100, global temperature will increase by about 2° C. This rise in temperature will cause many other

changes: one of these is a rise in sea level, as a result of melting of glaciers and sea-ice due to warming. According to the current prediction, on an average, the sea level will rise 48 cm by the end of twenty first century. This would increase the incidence of annual flooding. Climatic change would promote insect-borne diseases like malaria, and lead to shift in climatic boundaries, making some regions wetter and others drier. Agricultural pattern would shift and human population as well as the ecosystem would experience change. What would happen to the Indian sea coasts if the sea level rises 50 cm above the present one?

### EXERCISES

1. Choose the right answer from the four alternatives given below.
  - (i) What causes rainfall on the coastal areas of Tamil Nadu in the beginning of winters?
 

(a) South-West monsoon	(c) North-Eastern monsoon
(b) Temperate cyclones	(d) Local air circulation
  - (ii) What is the proportion of area of India which receives annual rainfall less than 75 cm?
 

(a) Half	(c) Two-third
(b) One-third	(d) Three-fourth
  - (iii) Which one of the following is not a fact regarding South India?
    - (a) Diurnal range of temperature is less here.
    - (b) Annual range of temperature is less here.
    - (c) Temperatures here are high throughout the year.
    - (d) Extreme climatic conditions are found here.
  - (iv) Which one of the following phenomenon happens when the sun shines vertically over the Tropic of Capricorn in the southern hemisphere?
    - (a) High pressure develops over North-western India due to low temperatures.
    - (b) Low pressure develops over North-western India due to high temperatures.
    - (c) No changes in temperature and pressure occur in north-western India.
    - (d) 'Loo' blows in the North-western India.

2. Answer the following questions in about 30 words.
  - (i) What is the Inter-Tropical Convergence Zone?
  - (ii) What is meant by 'bursting of monsoon'? Name the place of India which gets the highest rainfall.
  - (iii) Which type(s) of cyclones cause rainfall in north-western India during winter? Where do they originate?
3. Answer the following questions in not more than 125 words.
  - (i) Notwithstanding the broad climatic unity, the climate of India has many regional variations. Elaborate this statement giving suitable examples.
  - (ii) How many distinct seasons are found in India as per the Indian Meteorological Department? Discuss the weather conditions associated with any one season in detail.

**Project/Activity**

On the outline map of India, show the following:

- (i) Areas of winter rain
- (ii) Wind direction during the summer season
- (iii) Areas having less than 15° C temperature in January
- (iv) Isohyte of 100 cm.