Atmosphere and Climate

Atmosphere and Climate

The Earth is surrounded by a thick layer of air known as the atmosphere. This atmosphere plays a vital role in making life possible on our planet. It provides the air we breathe, protects us from harmful solar radiation, and helps regulate the Earth's temperature. Without the atmosphere, the Earth would be too hot during the day and too cold at night.

Climate refers to the average weather conditions of a place over a long period of time. It influences natural vegetation, wildlife, human activities, and patterns of settlement. The atmosphere and climate together control weather phenomena such as rainfall, winds, storms, and seasons.

Understanding the atmosphere and climate is important because they directly affect our daily lives, agriculture, water resources, and the overall environment. In this chapter, we will learn about the composition and structure of the atmosphere, the factors affecting climate, and the relationship between atmosphere, weather, and human life.

STRUCTURE AND COMPOSITION OF ATMOSPHERE

The atmosphere is a thick blanket of gases that surrounds the Earth and extends hundreds of kilometers into space. It is held close to the Earth by gravity.

Structure of the atmosphere

The atmosphere is not uniform. Based on temperature changes with height, it is divided into five distinct layers. These distinct layers are called Troposphere, Stratosphere, Mesosphere, Thermosphere (lonosphere), and Exosphere.

Troposphere

The troposphere extends from 8 km near the poles to 18 km near the equator. The word 'tropo' means mixing, which refers to the continuous mixing of gases in this layer, giving its name.

The troposphere contains nearly 75 per cent mass of the atmosphere and all essential gases, such as water vapour and primary greenhouse gases. All weather phenomena such as precipitation, storms, and lightning, occur in this layer. This is the layer where all life forms exist, making it the most important layer for sustaining life on Earth.

In this layer, the temperature decreases with altitude at an average rate of 1 degree Celsius for every 165 m . This is known as the lapse rate.

Importance:

This layer supports life and controls weather and climate. Most living organisms depend directly on this layers.

Stratosphere

The layer above the troposphere is called the stratosphere. The stratosphere has a cold lower section and a warmer upper section forming two distinct layers. The name 'Strato' means 'layer'. It extends up to about 50 km above the Earth's surface. The boundary between the troposphere and stratosphere is known as the tropopause.

Since the Stratosphere contains very little moisture and dust and has minimal air turbulence, it is ideal for flying airplanes.

The ozone layer, located in the stratosphere, protects us from harmful UltraViolet (UV) rays. As altitude increases within the stratosphere, the temperature also rises.

Importance:

It protects life on Earth by preventing harmful solar radiation. By filtering UV radiation, the stratosphere protects crops, forests, plankton and marine ecosystems which are essential for food chains and oxygen production.

Mesosphere

The layer that lies above the stratosphere is called the mesosphere. It roughly extends up to 80 km from the Earth's surface. This layer lies between two layers above and two layers below it which is why it is called the mesosphere. Meso means middle.

The boundary between the stratosphere and mesosphere is termed the stratopause.

As meteorites enter this layer, they burn up due to friction with gaseous particles. Meteorites appear to us as shooting stars, but they are not actual stars.

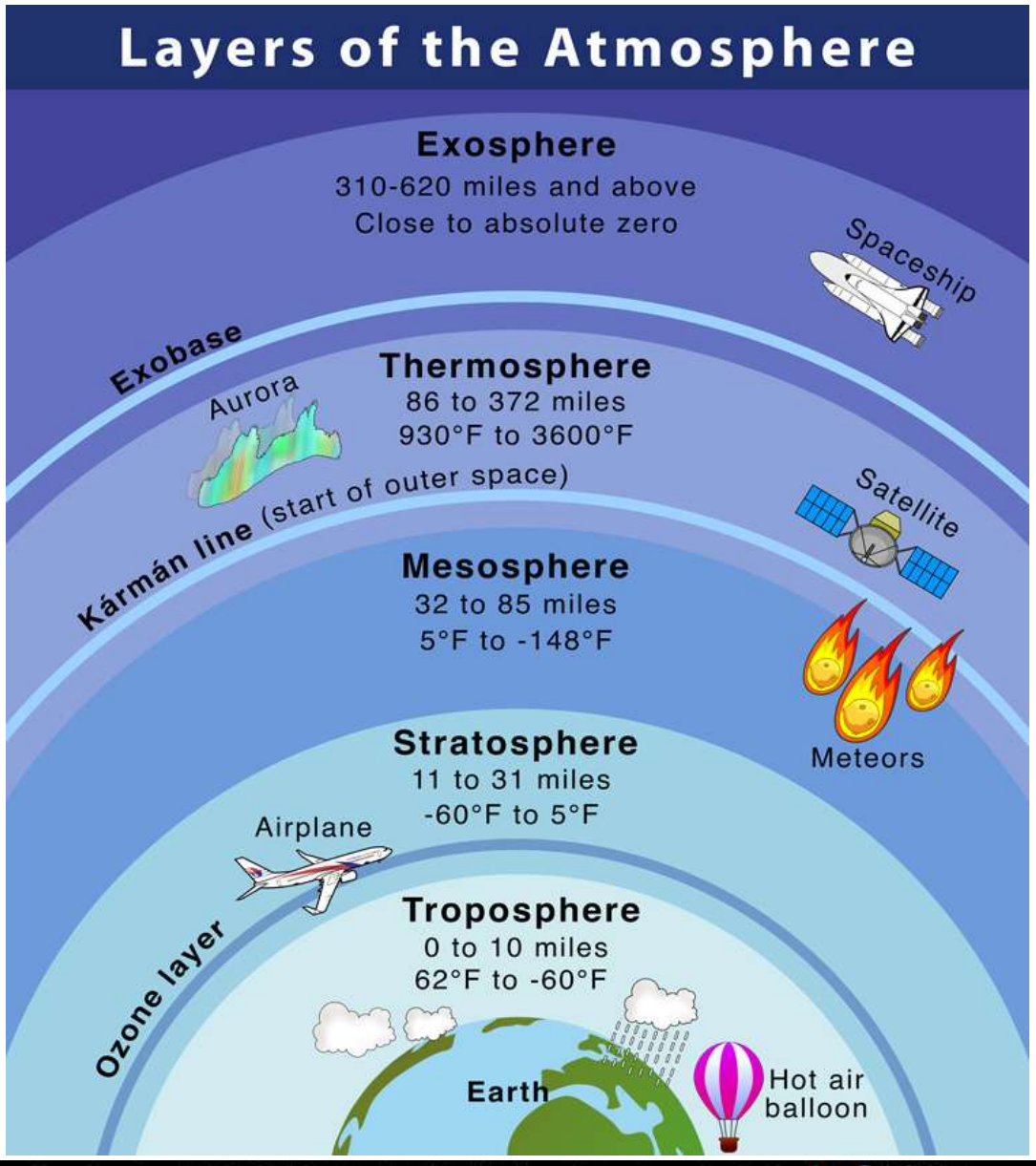
Importance:

It protects Earth from falling meteoroids. It helps maintaining energy balance by absorbing and redistributing heat from both below and above.

Ionosphere

This layer is also known as the thermosphere, and it roughly extends up to 450 km . The name ionosphere comes from the fact that the atoms of gases in these layers get converted into ions due to solar radiation.

In the thermosphere, as we go upward, the temperature rises and reaches up to 2000 degree Celsius It is the hottest layer of the atmosphere. This layer helps in satellite communication and radio transmission.



Importance:

It is essential for long-distance communication. The thermosphere acts as Earth's radiation shield and communication layer, playing a vital role in protecting life and supporting technology.

Exosphere :

The exosphere is the outermost layer of the atmosphere, which ultimately merges with space. It lacks dust, oxygen, nitrogen, and water vapour. However, traces of hydrogen and helium are found here.

Importance:

Many communication, weather and naviagation satellites orbit in the exosphere, enabling GPS (Global Positioning System), television, internet and weather forecasting, acts as the transition zone between Earth's atmosphere and outer space.

Composition of the atmosphere

The atmosphere is a mixture of different gases, water vapour, and dust particles that surrounds the Earth. These components are essential for sustaining life, regulating temperature, and supporting natural processes like respiration, combustion, and rainfall. The proportion of gases in the atmosphere remains almost constant up to a height of about 90 km .

Major Gases of the Atmosphere

1. **Nitrogen 78 %**
   - Largest component of the atmosphere
   - Does not support respiration or burning directly
   - Reduces the intensity of oxygen and prevents rapid combustion
   - Essential for plant growth (nitrogen cycle)

   Importance:

   Nitrogen-enriched soil leads to better crop yields making it vital for agriculture and food production.
2. **Oxygen 21%**
   - Second most abundant gas
   - Essential for respiration in humans and animals
   - Supports combustion
   - Needed for oxidation processes

   Importance:

   Without oxygen, life on Earth would not be possible. It is also necessary for burning and combustion, which is important for cooking industries, and energy production.
3. **Argon 0.93%**
   - Chemically inactive gas
   - Does not take part in biological processes
   - Used in electric bulbs and welding

   Importance:

   It maintains balance in the atmosphere and prevents unwanted chemical reactions. It is also used to protect food, wine and historical documents from oxidation.
4. **Carbon Dioxide (0.04%)**
   - Present in very small quantity but extremely important
   - Used by plants for photosynthesis
   - Helps in maintaining Earth's temperature through the greenhouse effect
   - Released by respiration and buming of fuels

   Importance:

   It supports plant life and helps regulate global temperature. It dissolves in water to form carbonic acid, which influences ocean pH and marine life.

   Other Components of the Atmosphere

(i) Water Vapour

- Amount varies from place to place
- Responsible for humidity
- Forms clouds, rain, fog, and dew
- Absorbs heat and moderates temperature

Importance:

It plays a crucial role in weather and climate. It also plays a central role in the hydrogical cycle, moving water between oceans, atmosphere and land

(ii) Dust Particles

- Includes smoke, pollen, salt, and soil particles
- Help in the condensation of water vapour
- Cause colourful sunsets and sunrises

Importance:

Dust particles are necessary for rainfall formation. Dust blown from deserts carries minerals and nutrients to occans and soils, enriching ecosystems and supporting plant and marine life.

(iii) Ozone (Trace Amount)

- Found mainly in the stratosphere
- Absorbs harmful ultraviolet (UV) rays

Importance:

It protects living organisms from skin cancer and genetic damage. The ozone layer absorbs most of the Sun's Ultra violet radiations, which can cause skin cancer, cataracts, and damage to plants and marine life.

Conclusion

The atmosphere is a carefully balanced mixture of gases, water vapour, and dust particles. Each component has a specific role in supporting life, controlling climate, and maintaining environmental balance. Even gases present in very small amounts are extremely important for the survival of living organisms on Earth.

➢ **KEY LEARNINGS**

- The atmosphere is a thick blanket of gases that surrounds the Earth and extends hundreds of kilometres into space.
- The troposphere contains nearly 75 per cent mass of the atmosphere and all essential gases such as water vapour and primary greenhouse gases.
- The atmosphere is a mixture of different gases, water vapour, and dust particles that surrounds the Earth.
- Without oxygen, life on Earth would not be possible.
- The ozone layer absorbs most of the Sun's Ultraviolet radiations, which can cause skin cancer, cataracts, and damage to plants and marine life.

ELEMENTS OF WEATHER AND CLIMATE

Weather refers to the day-to-day conditions of the atmosphere at a particular place, while climate is the average of weather conditions over a long period of time. Weather and climate are controlled by certain basic elements known as the elements of weather and climate. These elements help us understand atmospheric conditions and their impact on human life and the environment.

1. Temperature

Temperature is a fundamental element of both weather and climate. It refers to the degree of hotness or coldness of the air. Its variations help scientists understand both immediate weather conditions and long-term climate trends.

It is measured using a thermometer. It is expressed in degrees Celsius. It affects air pressure, winds, and rainfall. High temperature leads to expansion of air, while low temperature causes contraction.

There are different types of thermometers used to measure temperature. Some thermometers show the current air temperature, while others are designed to record the highest (maximum) and lowest (minimum) temperatures over a day.

Most traditional thermometers contain a colored liquid (usually alcohol or mercury) that expands when heated and contracts when cooled to indicate temperature changes. However, digital thermometers are becoming popular because they are fast, more accurate and can store more data.

These temperature readings can also help us calculate important statistics such as:

- Temperature Range: This is the difference between the maximum and minimum temperatures recorded over a period, usually 24 hours.
- Mean Daily Temperature: This is the average temperature of the day, calculated by adding the day's maximum and minimum temperatures and dividing by two. Mean = Maximum + Minimum /2

2. Atmospheric Pressure

Our bodies are very sensitive to changes in weather, especially temperature and rainfall, but another important factor that affects how the weather feels is atmospheric pressure. Atmospheric pressure is the force exerted by the weight of the air above us pressing down on the Earth's surface. Although we don't see air, it has weight, and this weight pushes down all around us.

Atmospheric pressure is generally higher at places close to sea level, such as coastal areas, because the above is denser and heavier. As you move to higher altitudes, like when climbing a mountain, the air becomes thinner, meaning there are fewer air molecules pressing down. This causes the atmospheric pressure to drop. Because of the thinner air, there is also less oxygen available, which makes breathing harder. This is why at high altitudes, people may feel tired, dizzy, or short of breath; their bodies have to work harder to get enough oxygen.

Atmospheric pressure doesn't just change with altitude. It also changes with weather conditions. Sometimes, the pressure falls suddenly over a region, forming what meteorologists call a low-pressure system or a depression. These low-pressure areas often bring unstable weather, including clouds, rain, and strong winds. When the low-pressure system intensifies, it can develop into a storm or even a cyclone, which are powerful and dangerous weather events.

In contrast, regions of high pressure usually bring clear skies and calm weather because the air is heavier and sinks, preventing clouds from forming. Understanding these pressure systems helps meteorologists predict weather changes and warn us about approaching storms.

So, atmospheric pressure plays a vital role in shaping the weather we experience every day and can directly affect how we feel physically, especially in extreme conditions.

The device used to measure atmospheric pressure is known as a barometer. Similar to thermometers, barometers come in different types. They usually show pressure readings in millibars (mb). At sea level, the average atmospheric pressure is about 1013 mb or 1 ATM. When the pressure falls below 1000 millibars, it usually signifies the presence of depression or low-pressure system.

3. Wind

Wind is essentially air in motion, moving from areas where the air pressure is high to places where the pressure is lower. This movement happens because nature always tries to balance pressure differences. The greater the difference in pressure between two areas, the stronger the wind tends to be.

Speed and Direction

The two main features of wind are its speed and direction. Wind speed tells us how fast the air is moving, usually measured in kilometers per hour or meters per second Wind direction shows the direction from which the wind is blowing • for example, a north wind means the wind is coming from the north.

Why is Wind Important?

Wind affects many aspects of our daily life and the environment:

- Weather Forecasting: Meteorologists study wind patterns to predict weather changes. For example, a shift in wind direction can indicate that a storm or rain is approaching.
- Aviation and Sailing: Pilots and sailors must understand wind conditions to navigate safely and efficiently. Strong winds can affect the speed and course of airplanes and boats.
- Agriculture: Farmers watch the wind to forecast rain or dry spells. Wind can also influence the evaporation of water from soil, affecting irrigation needs.
- Environmental Impact: Wind helps disperse seeds and pollen, aiding plant reproduction. It can also spread pollutants or wildfire smoke over large distances.

Measuring Wind: Wind Vanes and Anemometers

A wind vane shows the direction of the wind. It has a pointer and a tail mounted on a rotating axis. When the wind blows, the tail catches the breeze and turns the pointer towards the source of the wind. This tool helps us know exactly where the wind is coming from.

To measure how fast the wind is blowing, an anemometer is used. This instrument usually has cups or blades that spin faster as the wind speed increases. The speed of rotation is converted into wind speed readings.

4. Humidity

Humidity is the final weather element we will explore. It describes how much water vapour is present per unit of air. The level of humidity can vary based on several factors, including temperature, wind, air pressure, and the geographical location of a place.
To answer such questions accurately, we need to understand how humidity is measured.

The humidity in the air is measured using a scale called relative humidity, which tells us how much moisture the air is holding compared to how much it could hold at that temperature. If the air had no moisture at all (which almost never happens in nature), its relative humidity would be 0 % On the other hand, if the air is completely full of water vapour, it is said to have 100 % relative humidity, meaning it can't hold any more moisture. In everyday conditions, dry weather usually means the relative humidity is between 20 % and 0 %, while humid weather, when the air feels sticky and moist, falls between 60 % and 80 %

So how are these humidity levels measured? This is done using an instrument known as a hygrometer. There are different types of hygrometers, each working on a different principle. Measuring humidity is very important in various fields, for example, in food processing industries, where the right moisture levels must be maintained. Even museums carefully track humidity to keep the air dry and protect valuable artefacts from damage.

5. Precipitation

When the news reports that a place received 30 millimetres (mm) of rainfall in a day, it means that 30 mm of rainwater fell and collected on the ground in that area. To understand it better, imagine if there were no drains or slopes, then the rain would form a layer 30 mm deep on the flat ground. That's about as thick as three 10 coins stacked together.

But how do we know how much it rained? We use a special instrument called a rain gauge. A rain gauge is a simple tool used by weather scientists to measure rainfall. It has a wide funnel at the top, which catches the rain and directs it into a cylinder or container. This container has markings or a scale on it so that we can read how much rain has collected.

Let's say the water collected in the container rises to the 15 mm mark. That means the area got 15 mm of rain during that time. If it rises to 30 mm , then it received 30 mm of rainfall.

Rainfall is usually measured over a 24 -hour period, and the results help farmers, weather forecasters, and disaster management teams prepare for floods, droughts, or crop planning. Even in your city, regular rainfall records help the local government manage water supply and drainage systems.

SEASONS AND MONSOON IN INDIA

A distinct seasonality is a prominent character of the monsoon type of climate. The weather changes also occur from one season to the other and are obvious to anyone observing it, especially in the interiors of India. Not much difference in temperature can be seen in the coastal areas but a distinct pattern is seen in the rainfall that occurs here.

India experiences four main seasons :

1. Hot Weather Season
2. Cold Weather Season
3. Advancing Monsoon Season
4. Retreating Monsoon Season.

1. **Hot Weather Season (Summer) :** The sun's northward movement causes the global heat belt to shift northwards. This causes the hot weather season in India from March to May. The effect of the shifting of heat belt can be seen clearly from the temperature recordings during March-May at different stations that are located at various latitudes. The temperature is around 42° C in April in Gujarat and Madhya Pradesh. The temperature of 48∘ C is common around May in northwestern regions of

   In north India, rising temperature and falling air pressure occur in the summer months. An extended low pressure area develops in north India by the end of May. This low pressure area extends from the Thar Desert in the northwest to Patna and Chhotanagpur plateau in the east to southwest. Around this trough the circulation of air begins to set in.

A unique feature of the hot weather season in India is the loo. The loo are strong, hot and dry winds that blow during the day in summer, over northern and northwestern India. They may even continue till midnight. Many people suffer from heat strokes or other fatal consequences when they are exposed to these hot winds. During May the areas experience dust storms in the evening. These dust storms bring some relief from the intense, oppressive heat for a brief time.

They are accompanied by light drizzle and cool breeze. In some areas locally formed thunderstorms along with violent winds, torrential rainfall with hailstorms may also occur.

When the summer season is about to reach an end, Kerala and Karnataka experience pre-monsoon showers. These showers are vital in aiding the ripening of the mango crop; hence they have earned the name of mango showers.

2. **Cold Weather Season (Winter) :** By mid-November the cold weather season sets in north India. It prevails in the area till February. The coldest months of these seasons are December and January. The temperature at this time decreases from south to north. The mean temperature is between $24^{\circ}3$ and$25^{\circ\circ}$C in Chennai but in the northern plains the temperature is between10°C and15°C. The days are mostly warm but the nights are cold. In the higher regions frost is a common occurrence.

   In the winter season, the northeast trade winds prevail over the country. Blowing from land to sea, they cause most of India to experience a dry season. However, the coasts of Tamil Nadu receive most of its rains from these winds as they reach here from sea to land.

   In north India, a weak high pressure area is developed. Light winds blow outwards from this region. They are affected by the relief. These winds blow through the Ganga valley from west and northwest. The fine weather in this season is marked by clear sky, low temperature and low humidity.

   The inflow of depression from west and northwest is the prominent characteristic feature of the cold weather season over the north Indian Plains. Known as the Western Disturbances, these low pressure systems originate over the Mediterranean Sea and Western Asia. They are brought in by the westerly jet stream. The vital winter rain required by the land is caused by these low pressure systems. The winter rain falls over the plains and the Himalayas experience snowfall. This meagre rainfall is important for the rabi crops and is known locally as 'mahawat'.

   The peninsular region has no particular winter season. There is not much seasonal change in the distribution pattern of temperature due to the influence of the sea.

3. **Advancing Monsoon-Rainy season :** The intensity of the low pressure conditions over the northwestern plains is increased by first week of June. They are strong enough to attract the trade winds of the Southern Hemisphere. These ocean-originating southeast trade winds move over the Indian Ocean and cross the Equator to follow the south-westerly direction. As they pass over the equatorial warm currents they carry a lot of moisture in them.

   The monsoons are pulsating winds as compared to the steady trade winds. These strong winds tend to blow at an average speed of 30 km per hour. They blow all over the country in a month's time, leaving only the extreme northwest. Violent thunder and the lightning that mark the sudden approach of these moisture rich winds bring on what is popularly known as the breaking of the monsoon. The southwest monsoon that flows into India bring about a major change in its weather.

   The Indian Peninsula divides the monsoons into two branches :

   (i) The Arabian Sea Branch

   (ii) The Bay of Bengal Branch

➢ **Characteristics of the Arabian Sea Branch**

- The Arabian Sea branch reaches Mumbai by 10th June.
- The Western Ghats pose an obstruction to this branch of monsoon.
- Heavy rains occur on the windward side of the Sahyadris.
- This monsoon branch crosses the Ghats and reaches the Deccan Plateau and Madhya Pradesh, where it causes some rainfall.
- Delhi receives rainfall by the 29 th of June.
- As this branch passes over western Rajasthan it causes scanty rainfall.
- This branch meets the Bay of Bengal branch in Punjab and Haryana to cause rains in the western Himalayas by first week of July.


INDIA
ADVANCING MONSOON
68°E
72°
76°
80°
84°
88°
92°
96°E
36°N
32°
28°
24°
20°
16°
12°
8°N
PAKISTAN
CHINA (TIBET)
NEPAL
BHUTAN
BANGLADESH
MYANMAR
I N D I A
Srinagar
Chandigarh
DELHI
Jaipur
Lucknow
Patna
Shillong
Imphal
Ahmedabad
Bhopal
Kolkata
Nagpur
Bhubaneswar
Mumbai
Hyderabad
Bengaluru
Chennai
Tropic of Cancer
1 July
15 June
10 June
5 June
1 June
21 May
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
SRI LANKA
LAKSHADWEEP (INDIA)
ANDAMAN & NICOBAR ISLANDS (INDIA)
0 200 400 600 km


INDIA
RETREATING MONSOON
68°E
72°
76°
80°
84°
88°
92°
96°E
36°N
32°
28°
24°
20°
16°
12°
8°N
PAKISTAN
CHINA (TIBET)
ARUNACHAL PRADESH
ASSAM
BANGLADESH
MYANMAR
I N D I A
Srinagar
Chandigarh
DELHI
Jaipur
Lucknow
Patna
Shillong
Imphal
Ahmedabad
Bhopal
Kolkata
Nagpur
Bhubaneswar
Mumbai
Hyderabad
Bengaluru
Chennai
Tropic of Cancer
15 Sept.
1 Oct.
15 Oct.
1 Nov.
15 Nov.
1 Dec.
15 Dec.
1 Jan.
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
SRI LANKA
LAKSHADWEEP (INDIA)
ANDAMAN & NICOBAR ISLANDS (INDIA)
0 200 400 600 km

Local Winds and their Impacts

Local winds are winds that blow over a small area due to differences in temperature and air pressure caused by local features such as mountains, deserts, and water bodies. They are usually seasonal or occur at specific times of the day and can significantly affect the climate and daily life of a region. For example, the Loo is a hot, dry summer wind that blows over northern India and Pakistan, raising temperatures and sometimes causing heatstroke and crop damage. The Chinook wind, which blows down the eastern slopes of the Rocky Mountains in North America, is a warm, dry wind that rapidly melts snow and benefits agriculture but may cause discomfort such as headaches. In Europe, the Foehn wind produces similar warming effects in the Alps. Coastal areas experience sea breezes during the day and land breezes at night, which help moderate temperatures and sometimes bring rainfall. Overall, local winds can have both positive impacts, such as improving farming conditions and regulating temperature, and negative impacts, such as health problems, drought, and damage to crops.

Mawsynram, located on the crest of the southern range of Khasi Hills, receives the highest average annual rainfall in the world. Cherrapunji, located 16 km east of Mawsynram holds some other rainfall records.

Cherrapunji is one of the wettest places on earth and established a world record of an incredible 1032 inches of rain in 1861. It continues to record an average rainfall of 450 inches in the monsoon months of July to September.

Cherrapunji is surrounded by groves of orange and banana trees. This little town has a lively weekly market and is famous for its delicious orange-flavour honey.

The heaviest rainfall in the world is recorded in the nearby village of Mawsynram with an annual average of 479 inches. The excessive rainfall is due to a situation on an ampitheatre relief and on the windward side of the monsoon.

➢ **Characteristics of the Bay of Bengal Branch**

- This branch of monsoon is naturally directed towards parts of southeast Bangladesh and coastal Myanmar, to be deflected later.
- This deflection occurs due to the Arakan Hills along Myanmar's coast. Here a major part of this monsoon branch enters West Bengal and Bangladesh from south and southeast.
- Low temperature in northwest India causes the branch to split into two • one of which moves westward and the other moves to the north and northeast India.
- The westward branch reaches the Punjab Plains along the Ganga Plains, while the other branch moves up the Brahmaputra valley to cause heavy and widespread rains in northeastern India.

The relief of our country determines the distribution of rainfall from the southwest monsoon. So we observe that the Western Ghats receive a rainfall of over 250 cm . On the other hand, less than 50 cm of rain is recorded on the leeward side of the Ghats. Similarly, the hills and mountain ranges cause heavy rainfall in the northeastern states. The Northern Plains experience decreased rainfall as one moves westward. At this time of the season Kolkata receives 120 cm of rain while Patna, Prayagraj and Delhi receive 102 cm,91 cm and 56 cm of rainfall respectively. The increasing distance from the sea causes the decline in the rainfall.

The monsoon tends to have 'breaks' in its rainfall which causes wet and dry spells. This means that monsoon rains occur only a few days at a time. Rainless, dry spells occur in between. This phenomenon is due to the frequent and strong tropical depression. Formed at the head of the Bay of Bengal, they cross over the mainland. The depressions follow the axis of the monsoon trough of the low pressure. Due to different causes the trough and its axis keep moving to the north or south which in turn decides on the spatial distribution of rainfall. When the axis of the monsoon trough is over the plains, the region receives ample rainfall. But if there is a shift in the axis and it moves closer to the Himalayas, then an increase in dry spells is observed and these dry spells also last longer than other times. Widespread rainfall occurs in the mountainous catchment areas of the Himalayan rivers. These heavy rainfalls herald floods that devastate the lands leading to huge loss of life and property in the plain regions.

Uncertainty and changes are characteristics of the monsoons. The alternation of dry and wet spells varies in intensity, frequency and in durations. They bring heavy rains in one part and cause droughts in other areas. Their irregular arrival and retreat disrupt the farming schedule of most of the Indian farmers.

4. **Retreating Monsoon (Transition Season) :** The monsoon trough of low pressure grows weaker by October November. It is then slowly replaced by high pressure. The monsoon's outreach is rendered unsustainable and the gradual withdrawal begins. This is known as the 'retreat of monsoon'. By the time October begins the monsoons withdraw from the Northern Plains.

The period of transition from hot and rainy to dry and cold season occurs in the months of October-November. Clear skies and rising temperature are prominent marks of retreating monsoon. During the daytime the temperature remains high but nights are pleasant and cool. The land remains moist. High temperature and humidity cause the daytime weather to become rather oppressive. Known as October Heat, this phenomenon of early October is replaced in late October by low temperature especially in Northern India.

The northwestern India's low pressure conditions move to the Bay of Bengal area by early November. This shift is caused due to cyclonic depressions that occur with their origins over the Andaman Sea. Those depressions that are able to cross the eastern coasts of India cause heavy rains. The destructive tropical cyclones strike the thickly populated area in the Godavari, Krishna and Kaveri deltas. Loss of lives and properties are on a large scale. These cyclones may also arrive in Odisha, West Bengal and Bangladesh coasts. Most of the rainfall of the Coromandal Coast is a consequence of the depressions and cyclones.

Distribution of Precipitation

India receives an annual rainfall of over 400 cm over parts of western coast and northeastern India. However, in western Rajasthan and parts of Punjab, Haryana and Gujarat only 60 cm rain is recorded. Low rainfall is also recorded in the interiors of the Deccan Plateau in the east of the Sahyadris. Around Leh in Jammu and Kashmir we can once again observe low precipitation.

The rest of India gets moderate rainfall while snowfall is restricted to the Himalayan region.

Due to the vagaries of the monsoon, the annual rainfall is bound to vary from year to year. Regions of low rainfall have high variability. These regions include parts of Rajasthan, Gujarat and the leeward sides of Western Ghats. Thus, areas that receive high rainfall are prone to floods while areas having low rainfall suffer from droughts.

Monsoons A Unifying Bond

The Himalayas are protective barriers that stop the cold winds from entering the subcontinent. This allows even the areas of northern India which lie on the same latitude to experience uniform high temperature. In the same way the influence of the sea from three sides makes for moderate temperature on the peninsular plateau. Even though these moderating influences exist there are some great differences in the temperature conditions. Even then the monsoon as a unifying bond is an obvious fact. The seasonal alternation of the wind systems and the associated weather conditions provide a rhythmic cycle of season. The uncertainties of rain and the uneven distribution are a prominent character of the monsoons. The monsoon has a profound influence on India's festivals, lifestyle of people, the agricultural routine, animal and plant life and the Indian landscape too. The monsoon is a unifying factor as it influences the occupation followed by a large percentage of Indian population-agriculture. The summer monsoon is vital to India's agriculture. The timing and amount of the rains can mean the difference between a successful harvest and widespread crop failure and famine. Other than this, monsoons have a profound impact on the culture of India. The very essence of folk life style, dances, music, festivals, paintings and literature come under the monsoon's influence. For centuries the Indians from north to south, from east to west have waited for the monsoon to arrive eagerly. But how much prosperity or devastation they bring is another matter to discuss.

➢ **KEY LEARNINGS**

- India experiences four main seasons, i.e., Hot weather season, Cold weather season, Advancing monsoon season and Retreating monsoon season.
- Hot weather season is from March to May with rising temperature and falling air pressure.
- Loo are strong hot, dusty and dry winds that blow during the day in summer over northern and north-western part of India.
- Cold weather season sets in north India in mid-November and prevails till February.

- In the winter season, north-east trade winds prevail over the country, and blowing from land to sea, they cause most parts of India to experience a dry season.
- South-east trade winds cross the equator and blow in a south-westerly direction entering the Indian peninsula as the south west monsoon, bringing abundant moisture to the subcontinent.
- The months of October-November form a period of transition (Retreating monsoon season) from hot rainy season to dry winter conditions.
- The bulk of rainfall of the Coromandel Coast is derived from depression and cyclones.

➢ **CLIMATE CHANGE**

Climate change is one of the most important environmental issues facing the world today. Its change is the long-term change in Earth's average temperature and weather patterns, mainly caused by human activities such as burning fossil fuels and deforestation, which increase greenhouse gases in the atmosphere.

1. **Burning fossil fuels**
   Coal, oil, and natural gas burned for electricity, transport, and industry release greenhouse gases like carbon dioxide (CO_2). These gases trap heat in the atmosphere.

2. **Deforestation**
   Trees absorb CO_2. When forests are cut down or burned, that stored carbon is released, and fewer trees remain to absorb future emissions.

3. **Industrial and agricultural activities**
   Factories emit greenhouse gases, and farming produces methane (from livestock) and nitrous oxide (from fertilisers), both are very powerful heat-trapping gases

4. **Waste and overconsumption**
   Landfills emit methane, and producing goods at large scales increases energy use and emissions.

Effects of Climate Change

1. Rising global temperatures
   Average temperatures are increasing, leading to hotter days and more frequent heatwaves.
2. Melting ice and rising sea levels
   Glaciers and polar ice caps are melting, causing sea levels to rise and threatening coastal cities and islands.
3. More extreme weather
   Climate change increases the intensity and frequency of storms, floods, droughts, and wildfires.
4. Harm to ecosystems and wildlife
   Many plants and animals struggle to adapt quickly enough, leading to habitat loss and species extinction.
5. Impacts on humans
   • Food and water shortages
   • Health problems (heat stress, spread of diseases)
   • Economic losses and climate-driven migration
   • Thus we find that Climate change affects every part of life on Earth-nature, economies, and human health. The good news is that reducing emissions, protecting forests, and switching to renewable energy can slow its impacts.

FLOODS

Floods are inundations of land with water caused by rains, rivers overflowing their banks, increase in reservoirs of water, winds, cyclones, tsunami, melting of glaciers and sea tides. Sometimes rivers breach or burst their banks. There may also be a dam burst or a thunderstorm or a tsunami may cause floods. Such a violent splash of water is called flash flood. The area drained by the waters of the river is called drainage basin. The flattish area alongside river channels covered by water during floods is called flood plain. The area in the upper course of the river which catches rainfall and feeds the river is called catchment area. A stream or a smaller river joining the main river is called a tributary. The point from where river begins its course is called origin. A point or a place where the river joins the sea is called its mouth. The high relief feature that separates two drainage basins is called water divide. The surface flow of water is called run off. These terms are very essential to learn in order to understand the anatomy of floods.

Onset Type

Floods are regarded as 'slow movements' in terms of their origin but not in terms of their happening. Most floods are preceded by heavy rainfall and melting of snow over several days. During this period even an ordinary person gets an idea of flooding. This period is known as 'probability' period. During the probability period prior to onset of flood there is persistence or intensity of rain and rapid flow or heavy runoff. The floodplains first receive the release of extra water that the channel cannot hold. Even the dam bursts regarded as major hazards have a probability period when a breach or a crack in the reservoir walls may have been noticed. Globally dissemination of statistical information collected from flood-prone streams and areas has revealed that there is a probability of occurring floods once during a ten year period. In between this period there may be milder floods every two years. Even floods occurring on account of cyclones or tsunami, and producing storm surges, have a certain probability period.

The Central Water Commission (CWC) has about 132 forecasting stations in the country which cover almost all the interstate flood prone rivers. Over 6000 forecasts are issued annually. In most cases the discharge of rivers is within permissible limits. The period of peak flow depicted in the given hydrograph may indicate possible flooding above this level which also serves a warning on T.V. screen and computer networks for flood control personnel in the area to which the hydrograph pertains.

The probability period discussed before allows sufficient time for media and administrative authorities to issue warnings and begin evacuation process much in advance. Almost all major river systems and canals have water level gauges fixed at strategic points which indicate the water level at a particular period of time. The Flood/Irrigation Departments of the Government or field units of Central Water Commission (CWC) use various other methods to forecast floods and issue warnings. They use hydrographs or charts to show lag-time between heavy rainfall and peak discharge as shown in the figure. [The interval between heavy rainfall and flooding is called lag-time in the present context.]

- **Vulnerability**

  - Settlements in low lying areas of flood plain (known as peneplain) at the mouth of the river or the stream or on steep slopes where rush of water may put the structures at risk.
  - Houses built on stilts near the mouth of a river.
  - Industries and multistoreyed housing projects in flood plains have in recent studies been found not only vulnerable but are regarded as the cause of floods. It is because surfaced roads, drains, covered areas, parking lots prevent water from seeping underground. The hydrographs are also used to depict these variations.

- **Typical Effects**

  - **Panic :** This is almost common to most hazards. Most persons having weak physique, old people, children, pregnant mothers die more on account of panic.
  - **Disease :** Floods mix-up wastes and waste water. In India most floods come during rainy season when it is very warm. Decomposition of organic matter on a vast scale leads to spread of diseases such as epidemics, viral infections, malaria and diarrhoea.
  - **Physical damage :** In India crops are raised in flood plains. They are still standing during rainy season when floods come. The sediments transported by floods cause the most damage to standing crops. Houses at risk, dam bursts on account of pressure, landslides, houses on stilts, animals and animal shelters all become victims of heavy rush of water during floods.
  - **Soil erosion :** While in flood plains rivers generally do deposition work, severe floods cause heavy rush of water and consequently do the work of erosion. Even in areas of deposition soil characteristics are changed, especially due to non-degradable materials washed out by floods.

➢ **Main Mitigation Strategies : Non-Structural Mitigation**

- **Mapping :** Most major rivers, their flood plains, their basins and water divides are now fully mapped. A wide-variety of computer data-base is also available. This information is often made use of by flood control personnel to good advantage.
- **Land-Use Control :** This will reduce the danger to life and property when water inundates the floodplains and the coastal areas. No major develop-ment should be permitted in areas which are subjected to flooding. Important facilities like hospitals should be located in safer and elevated areas.
- **Flood Forecasting and Warning :** Better facilities for forecasting and warning help in reducing the impact of floods.

➢ **Structural Mitigation**

- **Straightening of channels :** In straight channels water flows speedily during floods. Meanders are open to floods. Artificial straightening is the main strategy to control floods.
- **Dikes and levees :** These are artificial embankments to divert the flood of water in particular direction.
- **Stream behaviour :** The behaviour of a stream river is an important aspect of study in hydrography or the science of charting rivers and other water bodies. Engineering structures are then built to divert the course of water where no major risk is posed. This also involves non-structural strategy of zoning and separate flood-tracts are earmarked.
- **Flood proofing :** These measures include the following :
  (i) artificial reservoirs in flood prone area with sluice gates to divert flood water into a certain direction.
  (ii) sand bags to block flow of water in a certain direction.
- Constructing platforms and elevations : During the Indus Valley Civilisation houses were constructed on elevated platforms as a safety measure against floods. In many Nordic countries which are below the sea level such raised platforms are constructed even today. Settlements are founded on these platforms.

CARBON FOOTPRINT

Human activities have greatly increased the amount of greenhouse gases in the atmosphere. One important way to understand this impact is through the concept of carbon footprint. Reducing our carbon footprint is essential to control climate change and protect the environment for future generations.

Meaning of Carbon Footprint

A carbon footprint is the total amount of greenhouse gases, mainly carbon dioxide (CO_2), released into the atmosphere due to human activities.

In simple words, a carbon footprint shows how much we contribute to air pollution and global warming through our daily actions.

➢ **Sources of Carbon Footprint**

Carbon footprints are created from various activities at individual, community, and national levels.
Major sources include:

- Burning of fossil fuels (coal, petroleum, natural gas)
- Transportation (cars, buses, airplanes)
- Electricity generation in thermal power plants
- Industries and factories
- Deforestation
- Use of household appliances like air conditioners and refrigerators
- Agriculture and livestock farming

- **Types of Carbon Footprint**

  Carbon footprint can be classified into two main types:

  Direct Carbon Footprint

  This includes emissions from activities we directly control,such as:

  - Driving vehicles
  - Using LPG or petrol
  - Burning fuels at home

- **Indirect Carbon Footprint**

  This includes emissions produced during the manufacturing and transportation of goods and services we use, such as:

  - Clothes
  - Food products
  - Electronic items

- **Effects of High Carbon Footprint**

  An increase in carbon footprint leads to serious environmental problems such as:

  - Global warming
  - Climate change
  - Melting of glaciers and polar ice
  - Rise in sea level
  - Increase in extreme weather events
  - Loss of biodiversity
  - Health problems due to air pollution.

- **Ways to Reduce Carbon Footprint**

  Reducing carbon footprint is a shared responsibility.

  Steps individuals can take:

  - Use public transport, cycling, or walking
  - Save electricity and use energy-efficient appliances
  - Switch to renewable energy sources
  - Reduce, reuse, and recycle materials
  - Avoid unnecessary use of plastic
  - Plant more trees
  - Consume local and seasonal products

- **Role of Students in Reducing Carbon Footprint**

  Students can play an important role in environmental protection by:

  - Spreading awareness
  - Practicing energy conservation at home
  - Participating in tree plantation drives
  - Supporting eco-friendly habits at home and school