

### Freak weather offshoot of climate change: Experts

Intermittent showers in Hyderabad have bewildered Meteorological officials, while climate change experts said it is increasingly becoming difficult to predict future weather events in the country. For the last two years, we have noticed that the weather systems are behaving in a peculiar way resulting in unusual weather events.

After observing such unforeseen situations like extreme summer in the country, sudden hailstorm in Chevella region of Ranga Reddy district, cloudbursts in Uttarakhand and early onset of southwest monsoon and a late retreat, experts say that weather systems are behaving in a peculiar way.

Ongole received 341 mm rainfall in one day, which is more than one-third of the state's total annual rainfall. The heavy showers across the state have damaged several acres of crops, particularly cotton. But in a good news, 75% of the around 80,000 tanks in Andhra Pradesh are full now.

*(adapted from Oct 25, 2013 Times of India)*

- Collect similar newspaper reports.

Are these indicators of some change or just a variation that happen once in a long time? Invite some meteorological officials or college faculty to discuss these developments.

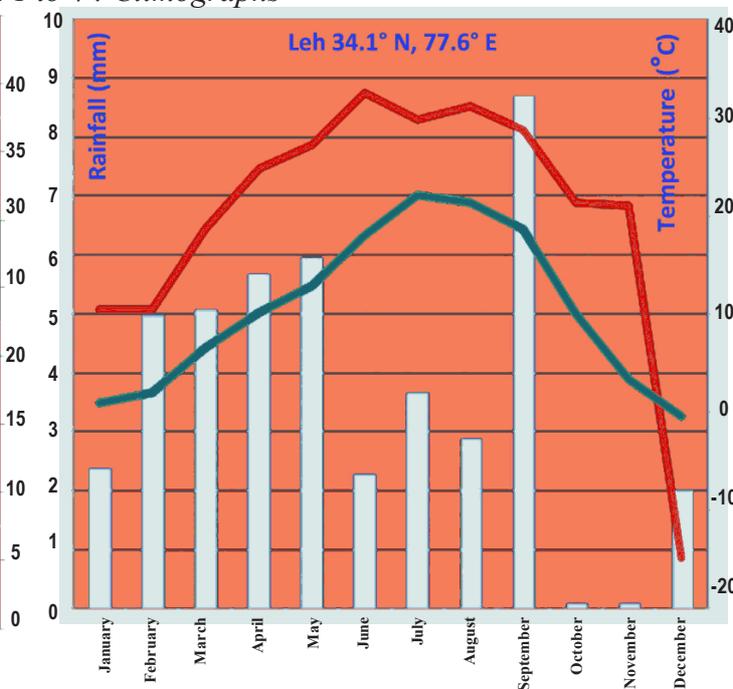
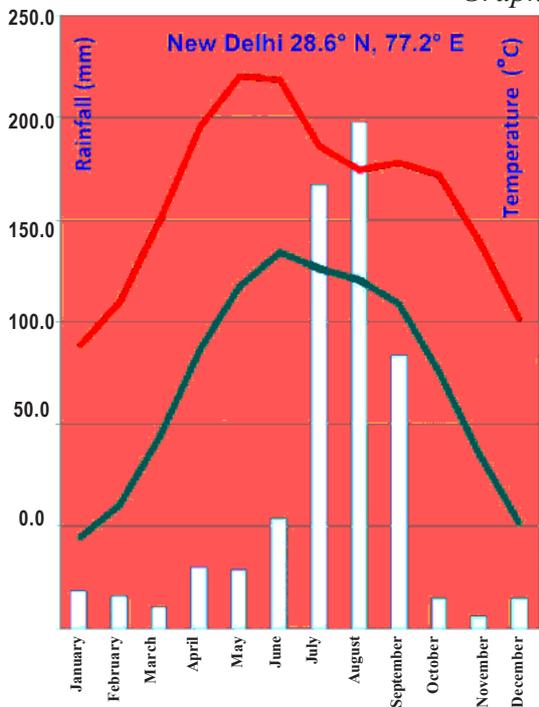
### Climate and Weather

The state of atmospheric conditions over an area at a particular time refers to weather. These weather conditions fluctuate very often even in a short period. Climate refers to such conditions over a large area and follows a similar general pattern over many years. What have been the general conditions, year after year, over thirty years or more, gives us the climate. There are variations from year to year but a basic pattern remains the same. On the basis of these generalised conditions, the year is divided into seasons. The elements of weather and climate are: temperature, atmospheric pressure, wind, humidity, and precipitation. The pattern of these for a place can be shown using pictures called climographs or climatographs. Climographs show average monthly values of maximum temperature, minimum temperature, and rainfall for a given place.

## Climographs of a few places in India.

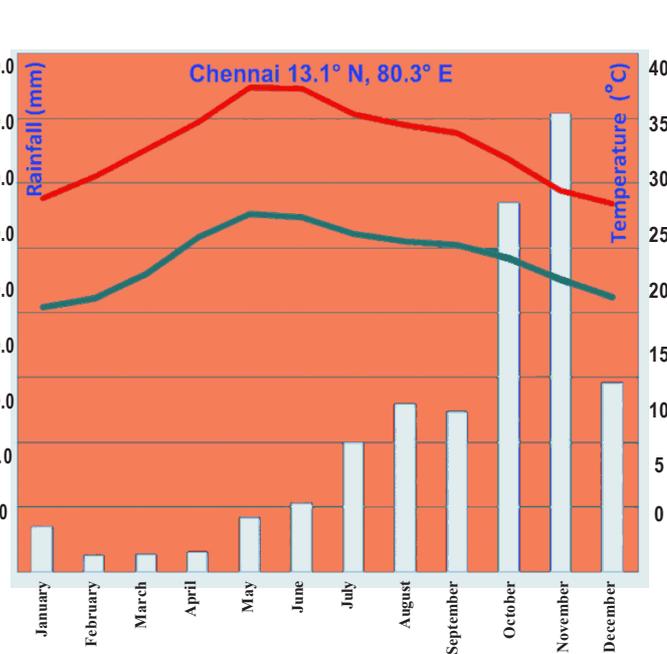
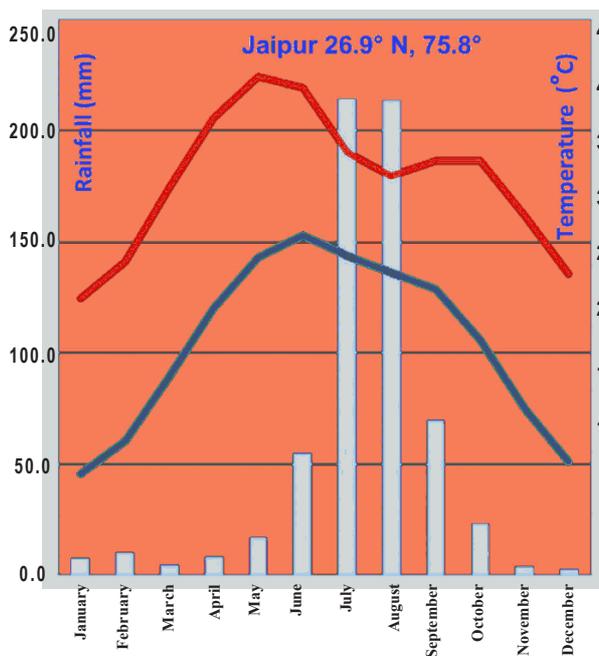
The climographs below show that temperature and rainfall vary in different parts of the country. Refer to your atlas and identify the relief region where these places are located. Also, read the graphs below and fill the table on following page.

Graph 1 to 4 : Climographs



— Mean Maximum Temperature (°C)  
— Mean Minimum Temperature (°C)

— Mean Rainfall (mm)



All Graphs Courtesy: The Indian Institute of Geographical Studies.(CC)2013

Place	Relief region	Range of maximum temperature, during the year	Range of minimum temperature, during the year	Name the wettest month and the rainfall (mm) for that month	Name the driest month and the rainfall (mm) for that month
Jaipur					
Leh					
New Delhi					
Chennai					

Range of Temperature: From highest value to lowest value

- What are the warmest and coldest months in Leh?
- From the range of temperatures in the above table say whether Jaipur is, in general, hotter than Leh. Explain your answer.
- Compare the climate of Delhi and Chennai. How are they different?
- Read carefully the rainfall pattern for Leh. In what ways is this different from the others? From your atlas can you find out some other places in the world that have similar rainfall pattern.
- Identify the wet months for Chennai. How is this different from Jaipur?

## Factors influencing climate and weather

It is observed that for some places (e.g. Chennai) there is not much difference in the temperature across months. Some places (e.g. Delhi) have wide differences in temperature across the months. India experiences wide variations in temperature. The northern portion is bounded by the Himalayas whereas southern peninsula is surrounded by seas. Some places are far from the coasts; they are inland. Some places are at high altitude, whereas others are on the plains. The factors that affect climate are called climatic controls. These include:

1. Latitude
2. Land-water relationship
3. Relief
4. Upper air circulation

### 1. Latitude or distance from the equator

The average temperatures for the year drop as you go further away from the equator. For this reason, we divide the regions on Earth as:

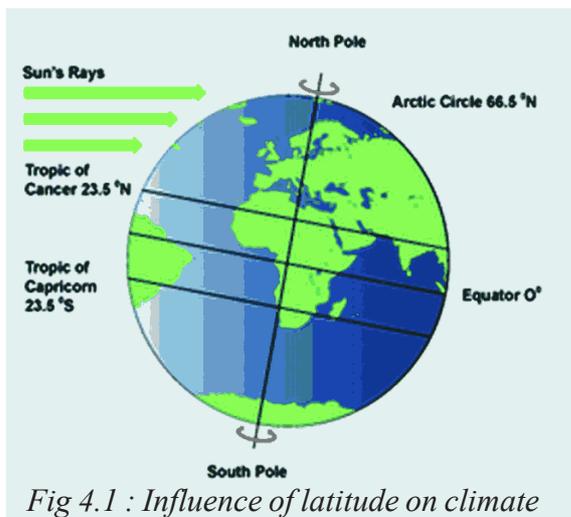
- Tropical, as those close to the Equator;
- Polar, as those close to the poles;
- Temperate, as those in between these two extremes.

If we compare the climate of, say, Indonesia and Japan, we can understand the

differences. The reason for these differences is the differential heating of Earth that you have read in earlier classes. Intensity of temperature depends on the latitude.

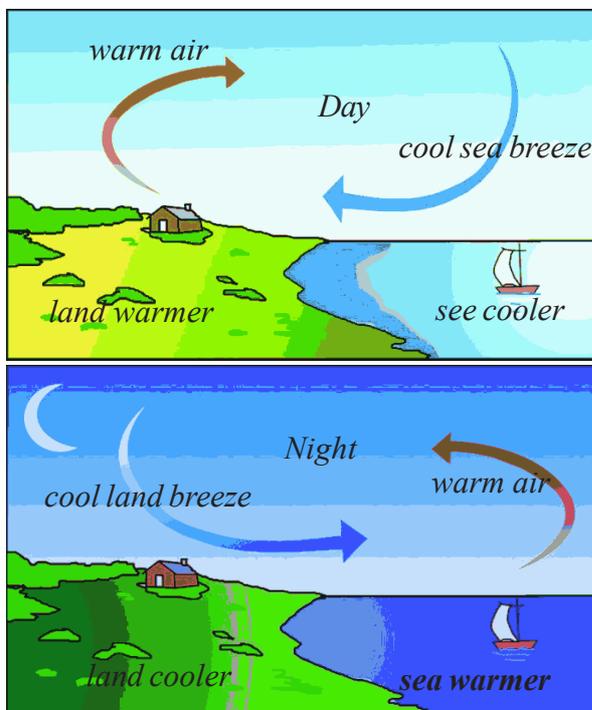
- Using a globe recall and discuss what you may have read earlier. How does the angle of sun vary at different latitudes? What impact does this have?

The temperature of the atmosphere at a particular place near the Earth's surface depends upon the insolation (heat from sun rays) received at that location. This is more intense in the low latitudes than in the high latitudes. As we move away from the equator towards the poles, the average annual temperature decreases.



In India the southern part lies in the tropical belt closer to the equator. Therefore this region has higher average temperature than the northern part. This is one reason for the climate of Kanyakumari being entirely different from Bhopal or Delhi. India is situated roughly between 8° and 37° N latitudes and the country is divided into almost two equal parts by the Tropic of Cancer. The part south of the Tropic of Cancer lies in the tropical zone. The part north of the Tropic of Cancer lies in the temperate zone.

### Land water relationship



Look at a map of India showing land cover and water bodies, and you will see another important factor which has an influence on climate: the land and water relationship. The amount of sunlight that is first absorbed and then radiated back or directly reflected depends on the nature of the surface. Darker areas, such as heavily vegetated regions, tend to be good absorbers; lighter areas, such as snow and ice-covered regions, tend to be good reflectors. The ocean absorbs and loses heat more slowly than land. This affects climate in many ways. One of this is the formation of land and sea breezes. Using Fig 4.2 explain how this happens. Recall from class IX the connection between pressure and direction of wind.

A large part of southern India, because of its long coast line, comes under the moderating influence of the sea. As such, the difference between the temperature of day and night and that of summer and winter is not much. This is known as equable climate. If we compare similar places on the same latitude and altitude we can appreciate the effect of the sea.

### Relief

You have learnt that temperature decreases as altitude increases. Hence, hills and mountains will have lower temperature than locations on the plain. Therefore, relief or altitude of a region influences the climate of the area. You would have heard about several hill stations of the Himalayan region like Shimla, Gulmarg, Nainital and Darjeeling as places that have a cool climate even during the peak summer months. Similarly Kodaikanal and Udagamandalam (Ooty) have cooler climate, compared to places near the coast.

- In your atlas, compare the temperatures of Mumbai and Nagpur for winter and summer months. How are they similar or different? How does it explain distance from the sea?
- With the help of the climographs can you explain the differences in temperature for Jaipur and Chennai.

- Are Shimla and Delhi located on very different latitudes? Check with your atlas. Is Shimla cooler than Delhi during summer?
- Why does Darjeeling have pleasant weather as compared to Kolkata during summer season?

### Upper atmospheric circulation

In the northern hemisphere, subtropical high pressure belt gives rise to permanent winds. They blow toward the equatorial low pressure belt by reflecting towards the west and are called trade winds. The German word 'trade' means 'track' and stands for blowing steadily in the same direction and in a constant course. India lies in the belt of *dry north-east trade winds*.

The climate of India is also affected by the movement of *upper air currents* known as 'jet streams'. These are fast flowing air currents in a narrow belt in the upper atmosphere, above 12,000 m. The speed varies from about 110 km/h in summer to about 184 km/h in winter. An easterly jet stream develops at about 25°N. A jet stream causes the neighbouring atmosphere to cool. This cooling effect of the easterly jet stream causes rain from clouds already found over this latitude (25°N).

### Seasons: Winter

The temperature in the Indian land mass considerably reduces from mid-November and this cold season continues till February. January is usually the coldest month-day temperature sometimes drops below 10°C in several parts of the country. However, the cold weather is more pronounced in northern India. South

India, especially the coastal areas, enjoy a moderate climate as temperature remains well above 20°C.

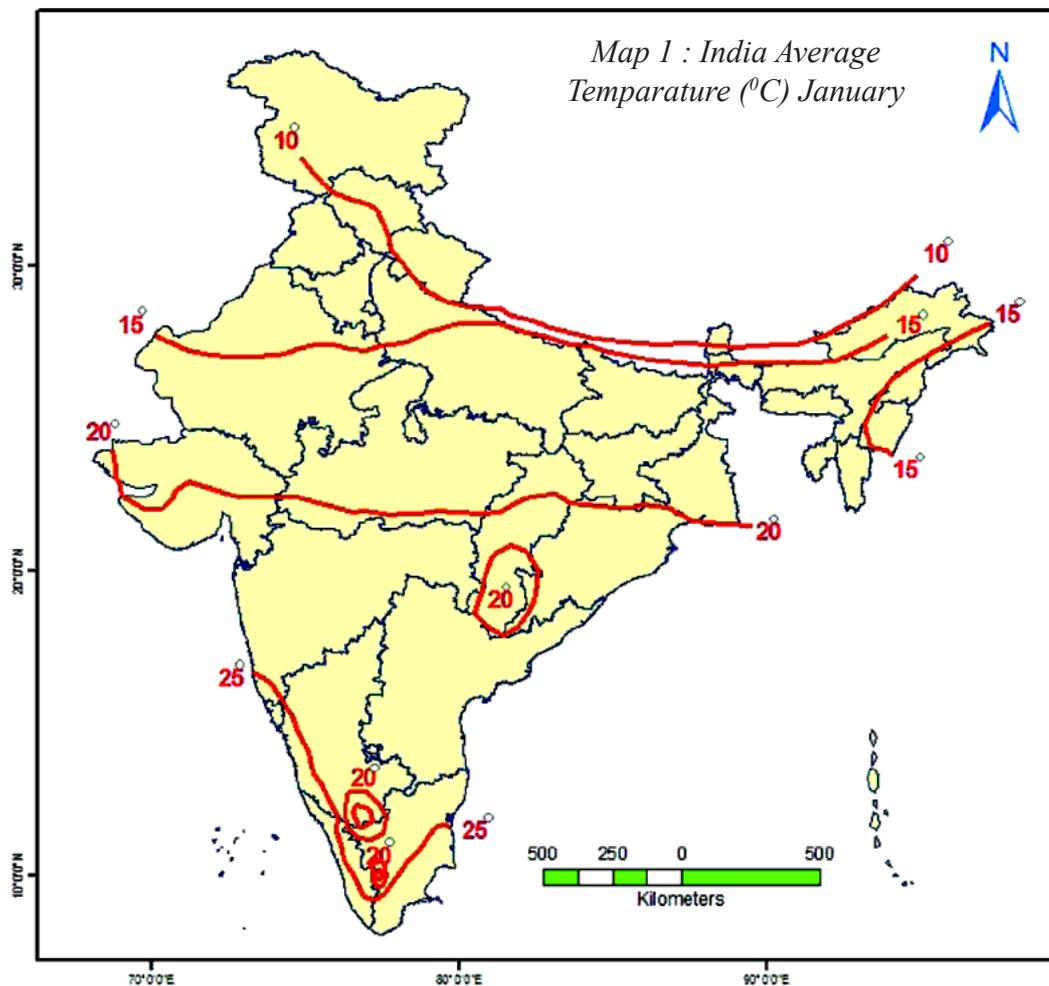
- What would be the range for the average temperature in A P for January?
- Using your atlas find some places located on 15°C.
- Close to the line showing places where average temperature is 25°C, there's a small circle of places on 20°C. How is this possible?

The lines in map 1 below indicate places that have the same average temperature for January.

During winter, the weather is generally pleasant with clear sky, low humidity and cool breeze. Cyclone depressions coming from Mediterranean Sea called Western Disturbances cause low to moderate rainfall over northern India. This rainfall

is boon to wheat crop which is generally cultivated in 'Rabi' season.

India lies in the trade wind belt of Northern Hemisphere – north-east trades blow over India from land to sea and are therefore dry. However, some amount of rainfall occurs on the Coramandel coast of Tamil Nadu from these winds, as they pick up moisture from the Bay of Bengal while crossing it.



## Summer

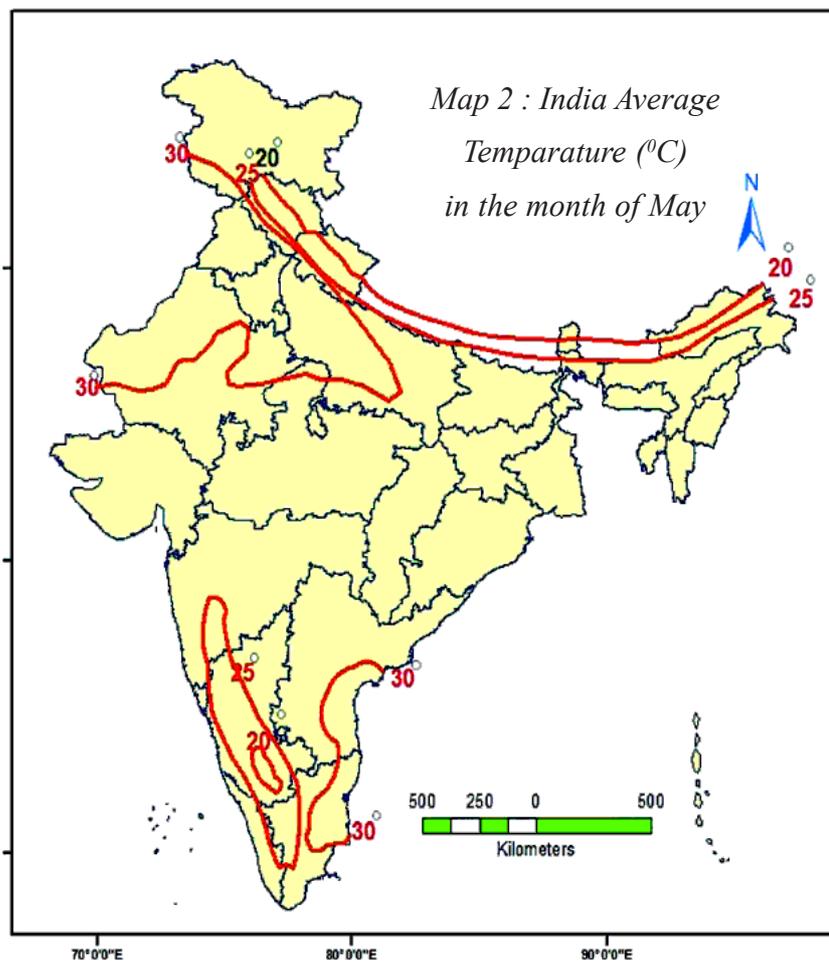
During the hot season, as we move from southern to northern part of the country, the average temperature increases. Starting in April, the temperature rises and slowly the maximum day temperature exceeds  $37^{\circ}\text{C}$  in northern plains of India. By mid-May, day temperature may touch  $41^{\circ}\text{C}$  to  $42^{\circ}\text{C}$  in many parts of the country, especially in the north-west plains and central India. Even minimum temperature does not go below  $20^{\circ}\text{C}$ . The northern plain experiences dry and hot winds called 'Loo'.

Towards the end of the summer season, pre-monsoon showers ('bursting monsoon') are common in the Deccan Plateau. These help in the early ripening of mangoes and other plantation crops in peninsular India. Hence they are locally known as mango showers in Andhra Pradesh.

## Advancing monsoon

The climate of India is strongly influenced by the monsoon winds. The sailors who came to India during olden days noticed the regular periodic reversal of winds. They used these winds to sail towards the Indian coast. Arab traders named this seasonal reversal of wind system 'monsoon'.

The monsoon forms in the tropical area approximately between  $20^{\circ}\text{N}$  and  $20^{\circ}\text{S}$  latitudes. The south-east monsoon winds from the southern hemisphere carry moisture as they flow over the Indian Ocean and towards the equatorial low pressure zones. After crossing the equator, these winds deflect towards the low pressure formed in the Indian sub-continent. The heating of land creates low pressure on the land mass of Indian sub-continent, especially over central India and the Gangetic



- From the climographs (Graph 1-4), note the approximate average temperature for May for the four places and mark them on the above map.

plain. Together with this, the Tibetan plateau gets intensely heated and causes strong vertical air currents and the formation of low pressure over the plateau at above 9 kms altitude.

They then flow as the southwest monsoon. The Indian peninsula divides them into two branches - the Arabian Sea branch and the Bay of Bengal branch. The Bay of Bengal branch strikes the Bengal coast and the southern face of the Shillong plateau. Then it gets deflected and flows westward along the Gangetic valley. The Arabian Sea branch arrives at the west coast of India and moves north ward. Both the branches reach India by the beginning of June, which is known as “onset of monsoon”. They gradually spread over the entire country in four to five weeks. The bulk of the annual rainfall in India is received from south-west monsoon. The amount of rainfall is very high along the west coast due to the Western ghats, and in north-east India due to the high peaked hills. Tamil Nadu coast (Coromandel), however, remains mostly dry during this season as it is in the rain shadow area of the Arabian Sea branch and is parallel to the Bay of Bengal branch.

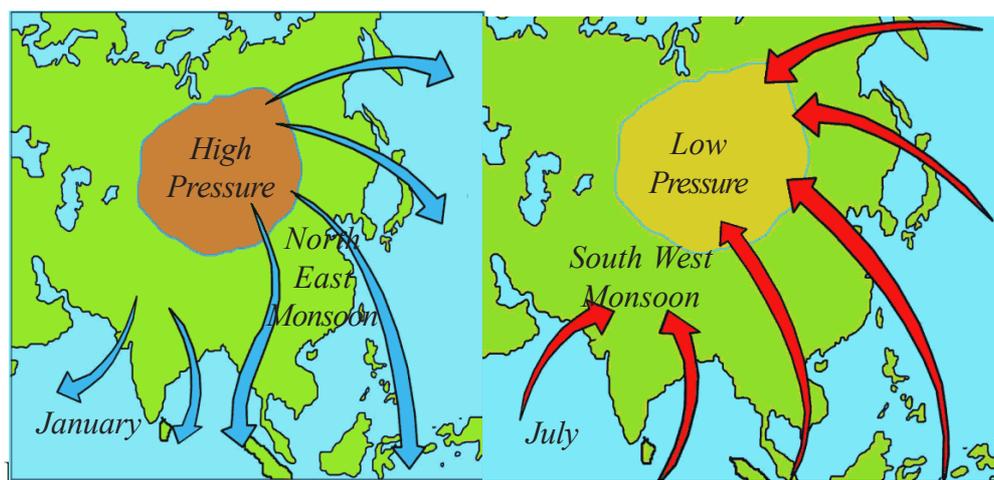
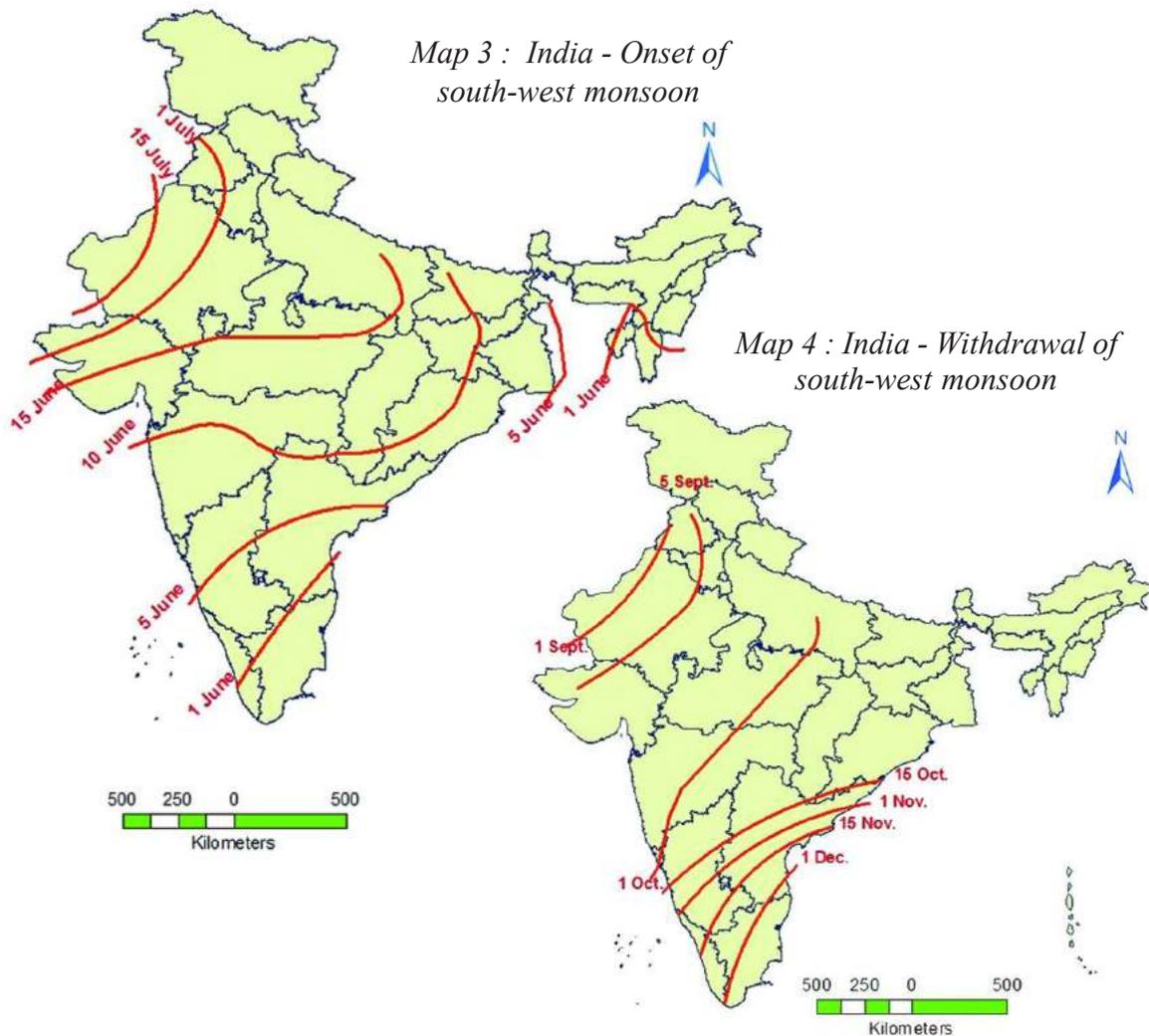


Fig 4.3 : Pressure and monsoon wind

October - November is a period of transition from a hot wet conditions to dry winter condition (Fig 4.7). The retreat of the monsoons 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 “October heat”.

The low pressure conditions which once prevailed over north-western India move far South to the centre of the Bay of Bengal by early November. During this period cyclonic depressions are common which originate over the Andaman area. These tropical cyclones are often very destructive. The thickly populated deltas of the Godavari, Krishna and Cauveri are their targets. No year is ever found disaster free. Occasionally, these tropical cyclones visit Sundarbans and Bangladesh too. Bulk of the rainfall of the Coromandel Coast is derived from depressions and cyclones.



In the Indian tradition, a year is divided into six two-monthly seasons. This cycle of seasons that the people in north and central India follow is based on their practical experience and age-old perception of weather phenomena. There is a slight variation in the timing of the seasons between northern and southern India.

### Traditional Indian Seasons

Seasons	Months According to the Indian (lunar) calendar	Months According to the Western (solar) calendar
Vasantha	Chaitra – Vaishakha	March – April
Grishma	Jyestha – Ashadha	May – June
Varsha	Sraavana – Bhadra	July – August
Sharad	Aswayuja – Karthika	September – October
Hemanta	Margashira – Pushya	November – December
Shishira	Magha – Phalguna	January – February

## Global Warming and Climate Change

As Earth started to take shape from a fire ball to a planet, many gases were released. These gases did not escape into outer space because of the Earth's gravitational pull. It still holds them back. The result? A thin layer of gases surrounds Earth and provides us several important benefits. For example: the oxygen that we breathe, the ozone that protects us from harmful ultraviolet rays from the sun, the nitrogen that our plants use to make proteins that we need, the medium through which fresh water is circulated, and keep us warm (look at the image from Class IX Chapter 4).

Keeping us warm is one of the most important things that the atmosphere does for us. It is like a light, but effective, blanket enveloping Earth. You will recall from Class IX that the atmosphere traps a lot of the solar energy that reaches Earth by preventing it from totally escaping back into space. This is called Green house effect. This is important and vital for life to survive on this planet. If it did not have this atmosphere, earth would be very cold indeed.

However, since the 19<sup>th</sup> century the planet has been warming up very rapidly. There is an increasing concern about this. Why this concern? After all, Earth has been through many cycles of warming and cooling (in fact, freezing!). So what is so special about it now?

Earlier cycles of cooling and warming happened over very long periods of time. This allowed much of the life on Earth the time to adapt to the changes. The problem now is that the heating is much more rapid and could lead to catastrophic changes. Much of the warming that has been occurring since the Industrial Revolution is because of human activities. Hence, the current global warming trend is called AGW (Anthropogenic Global Warming; anthropogenic means caused by humans).

More recently, scientists are discovering large volumes of methane under the frozen tundras of the far northern latitudes (mainly in the vast expanses of northern Russia). As global temperature increases, the ice in the tundra melts more. The methane that is trapped under the ice escapes into the atmosphere, increasing the global temperatures. In turn, this causes even more ice to melt, releasing even more methane, and so on. Methane is said to be even more powerful than carbon dioxide as a greenhouse gas.

### AGW and climate change

AGW is causing many changes in the distribution of heat in the Earth system. Remember how atmospheric and oceanic circulations keep re-distributing the heat in the world? AGW disturbs this system and the re-distribution system. The disturbance itself is not so much of a problem. It is the rapidity with which it is happening.

When the redistribution system is disrupted, weather and climate patterns

change. Long-term changes (climatic changes) happen from accumulations of short-term changes (weather changes).

An international effort to form an agreement whereby all countries try to reduce their emission of greenhouse gases has so far not been achieved. An international organization called Inter-governmental Panel on Climate Change (IPCC) was formed to address this issue. It has held many conferences to work out a treaty among the nations of the world to reduce AGW and try to slow down the process of climate change. None of these have been successful. The latest attempt was made at the IPCC conference in Warsaw (Poland), in 2013. This has also failed to achieve any agreement.

Broadly, the disagreements are between the ‘developed’ countries (mainly industrialised, economically more advanced countries of the West) and ‘developing’ countries (countries that are not as industrialised). Developed countries want developing countries to cut down on burning coal and other activities that add greenhouse gases to the atmosphere. Developing countries argue that developed countries developed precisely by burning fossil fuels in their development. Developing countries say that their economic development will be seriously damaged if they don’t burn fossil fuels (mainly coal), and that developed countries should do their fair share of work to help find alternatives that can help the developing countries to progress.

Most scientists from around the world agree on this much: AGW is real, it is happening, and it is leading to rapid and drastic climate change. They warn that severe weather and other changes will increase in the coming years and threaten life as we know it.

One of the human activities that contribute to global warming is deforestation. Discuss with your teacher and your classmates and try to answer the questions on the right in a few sentences.

- What is deforestation?
- Does deforestation happen only in forest areas? How about in your local area, even if there are no forests?
- How does deforestation affect global warming? (You will need to recall your study of photosynthesis in your science class.)
- What are some other ways in which human action contributes to global warming?

### Impact of climate change on India

Though a rise of 2° C in average temperature may appear to be small, it would result in a rise of one meter in sea levels by early next century. This would affect large portions of our coastal areas and millions of people would have to be shifted. They would lose their livelihood.

Nearly 200 squatter families living in Nonadanga in east Kolkata for the past few years are in the process of being evicted by the Kolkata Metropolitan Development Authority (KMDA). Many of the families came to Kolkata in search of work, after the Aila super-cyclone ravaged Sundarbans in 2009.

On March 30, the slum was bulldozed amid heavy police presence and some hutments were set on fire. The recurrent thunderstorms over the past few days has meant sleepless and soiled nights for nearly 700 people who have been rendered homeless. They work as house helps, rickshaw pullers and construction labourers.

The other effect would be on rainfall. This is likely to be more erratic and lead to greater imbalances: some places are likely to receive excess rainfall whereas others would get less than normal. Hence droughts and floods are expected to increase. This would greatly affect the agriculture pattern and people's livelihood.

Imagine how one would cope with a situation, if millions of people were affected. Where would you find land for resettlement? What jobs would they do?

The faster melting of Himalayan glaciers would disturb the livelihood of fresh water fisher folk as their natural habitat of fish is affected. Similarly freak weather conditions that you read about are likely to increase. Climate change is something that happens at a global level. Therefore, it affects all of us.



*Fig 4.8 : Impact of Aila : (left) broken embankment, (below) repairing embankment*



## Key words

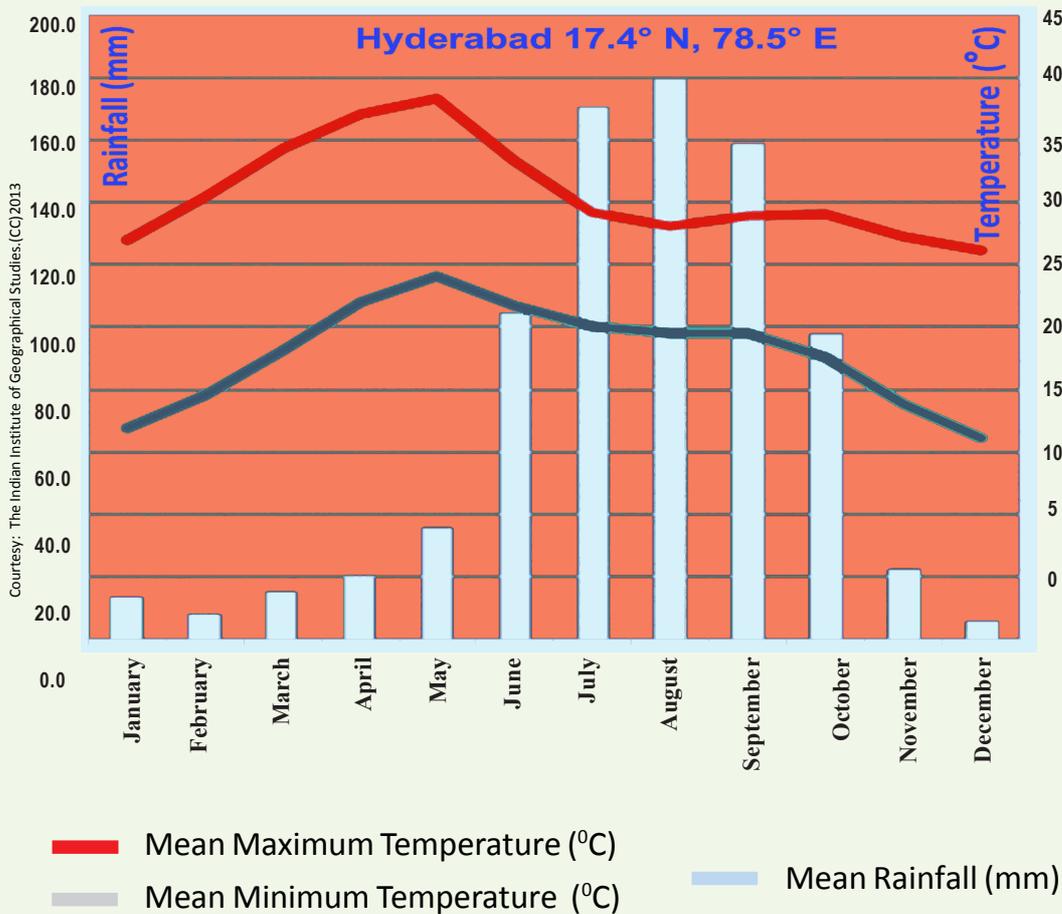
Climograph  
Jet Streams

Weather  
Pressure Zone

Monsoon  
Global warming  
Insolation

## Improve your learning

- 1) Read the following statements and mark if it is an example of weather or climate
  - a) During the last few years many glaciers have melted in Himalayas
  - b) During the last few decades drought in Vidarbaha region has increased
- 2) Match the following. Use maps if you cannot locate the places. (There could be multiple correct answers)
  - a) Trivandrum is farther from the equator and temperature would be lower in winter
  - b) Gangtok is closer to the equator but not close to the seas and has low rainfall
  - c) Anantapur is closer to sea, and climate has big impact of the seas
3. Describe India's climate controls.
4. Write a short note on factors influencing climatic variations in hilly areas and deserts.
5. How are human activities contributing to global warming?
6. What are disagreements between 'developed' and 'developing' countries about AGW?
7. How is climate change causing global warming? Suggest measures to minimise the influence of the global warming.
8. On an outline map of India, show the following:
  - (i) Areas recorded with more than 40°C annual mean temperature
  - (ii) Areas recorded with annual mean temperature less than 10°C
  - (iii) The direction of the south-west monsoon over India.
9. Observe the following climograph and answer the following questions.
  - A. Which month received highest rainfall?
  - B. Which months experience highest and lowest temperature?
  - C. Why is the maximum amount of rainfall between June and October?
  - D. Why is the temperature high between March and May?
  - E. Identify relief conditions causing variation in temperature and rainfall.



## Project

Collect proverbs/ sayings that are related to climate and weather in your region.

- A Rainbow in the morning is the Sailor's Warning.
- A Rainbow at night is the Sailor's delight.
- When the dew is on the grass rain will never come to pass.