CHAPTER 10 WEATHER AND CLIMATE

Objectives

After studying this chapter, students should be able to:

(i) define the terms 'weather' and 'climate'.

(ii) state the elements of weather.

(iii) describe the measurement and recording of weather elements.

(iv) list and describe the factors that affect the climate of a place.

(v) state the importance of weather and climate on the environment and human activities.

Weather and climate are terms that are often used when the state of the atmosphere is being discussed. Weather is the condition of the lower part of the atmosphere of any given place observed over a short period of time. Changes in the state of weather are caused by changes in one or more elements of weather. A slight change in one of the elements can bring about drastic changes in the weather even within few minutes. These elements include temperature, air pressure, wind speed and direction, humidity, cloud cover and sunshine duration. Climate can be regarded as the average weather condition of a place over a long period of time ranging from thirty-five years and above. Since climate cover long time periods, climatic variations are much slower than that of changes in the weather. Both weather and climate deals with the state of the atmosphere over a given time period for a particular place.

10.1 Attributes of Weather and Climate

The major attributes or characteristics of weather and climate include:

(i) Variability: This refers to changes that occur in the state of the atmosphere. In this respect, both weather and climate are subject to constant changes mainly due to the effect of human activities and the relief of the surrounding areas.

(ii) Duration of change: This has to do with the time period under which changes occur in the state of the atmosphere. In this wise, changes in weather occur within a small time period while climatic changes occur over a long period of time.

(iii) Scale of occurrence: This refers to the area where weather and climate occur. Weather and climate could be localized or extend over large areas (towns, cities etc.). Weather changes occur within a small area while climatic changes are usually large in dimension covering large areas of the Earth.

(iv) Atmospheric dimension: This refers to the part of the atmosphere where weather and climates occur. Weather usually occur within the lower troposphere while climate covers the entire atmosphere.

10.2 Elements of Weather

The elements of weather determine the state of the weather and they include:

(i) Temperature

(ii) Relative humidity

(iii) Rainfall or precipitation

(iv) Atmospheric pressure

(v) Wind

(vi) Cloud cover

(vii) Sunshine
(viii) Visibility

1. Temperature

This is the degree of hotness or coldness of a body or matter *e.g.* air. It is usually measured by a thermometer and is measured directly as sensible heat. Hence, it is possible to determine the temperature of a place by looking at whether the heat within the air is hot or cold. Through the thermometer, it is possible to measure the temperature. The thermometer is in form of a narrow glass tube filled with mercury and alcohol. The instrument works on an established principle that mercury expands when heated and contracts when cooled. On most thermometers, temperatures are marked or graduated in two ways using two measuring units – degree Fahrenheit and degree Celsius. In Fahrenheit, the freezing point of a thermometer is 32^0F while the boiling point is 212^0F. Degree Celsius scale has a freezing point of 0^0C while the boiling point is 100^0C. However, for the sake of scientific purpose and accuracy, the degree Celsius is often preferred. However, both measurement scales could be used at the same time for expressing temperature. It is also possible to convert from one unit to the other using some established formulas.

To convert from degree Fahrenheit to degree Celsius, the formula is used: $^0C = \frac{5}{9}(^0F - 32)$ while to convert from degree Celsius to degree Fahrenheit, the following formula: $^0F = \frac{9}{5}(^0C + 32)$ is used.

For example, to convert 86^0F to ^{0}C, we have

$$C = \frac{5}{9}(^0F - 32)$$

$$= \frac{5}{9}(86 - 32)$$

$$= \frac{5}{9}(54^6) = 5 \times 6$$

$$= 30^0C$$

To convert 25^0C to ^{0}F, we have

$$C = \left(\frac{9}{5} \times \frac{25}{1}\right) + 32$$

$$= 9(5) + 32$$

$$= 9 \times 5 + 32$$

$$= 45 + 32$$

$$= 77^0F$$

Both the two measurement units can be used when measuring thermometer. The thermometer was invented by an Italian scientist Galileo Galili. The instrument tries to capture two types of temperature: maximum and minimum temperatures. The maximum temperature refers to the highest temperature reached during the day and is measured by a maximum (mercury) thermometer while the minimum temperature is the lowest temperature reached during the day and is measured with a minimum (alcohol) thermometer. The two thermometers may be in the form of separate thermometers or joined together as U-shaped glass tube called the Six's thermometer.

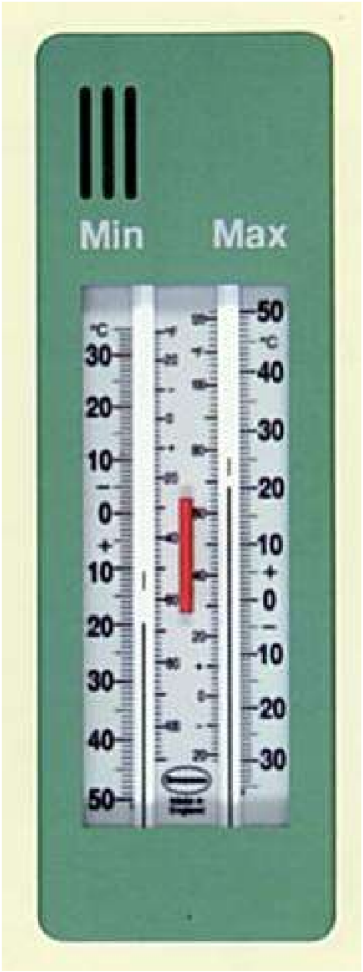

Fig.10.1: Maximum and minimum thermometers

The maximum thermometer measures the maximum temperature which is determined when the temperature of the air rises. The mercury in the glass tube expands and pushes a metal indicator up the tube. When the temperature falls, the mercury contracts leaving the indicator behind. The maximum temperature is obtained by reading the scale at the end of the index which is contact with the mercury.

Similarly, the minimum temperature can be measured. This is done when the temperature falls and in response to this, the alcohol in the thermometer contracts and drags the metal index by its surface tension down the glass bulb. When the temperature rises again, the alcohol flows past the index leaving it where it is. The minimum temperature is obtained by reading the scale at the end of the index farthest from the bulb. The thermometer is then reset using a magnet in preparation for the next 24 hours reading.

The mean temperature (the average of the two temperatures) can be obtained by adding both the maximum and minimum temperature and then divide by 2. The diurnal or daily range of temperatures are averaged for a month to obtain the mean monthly temperature. The monthly means are further averaged to obtain the mean annual temperature. The difference between the hottest and the coldest month gives the annual range of temperature.

Temperature recordings (readings) are represented by graphs and maps. On a graph, it appears as a simple curve. Because temperatures are continuous, they are better represented by lines or curves and should not be represented by a histogram or bar graphs. On a map, temperature shown in form of lines joining places or areas with equal temperatures are called **ISOTHERMS**.

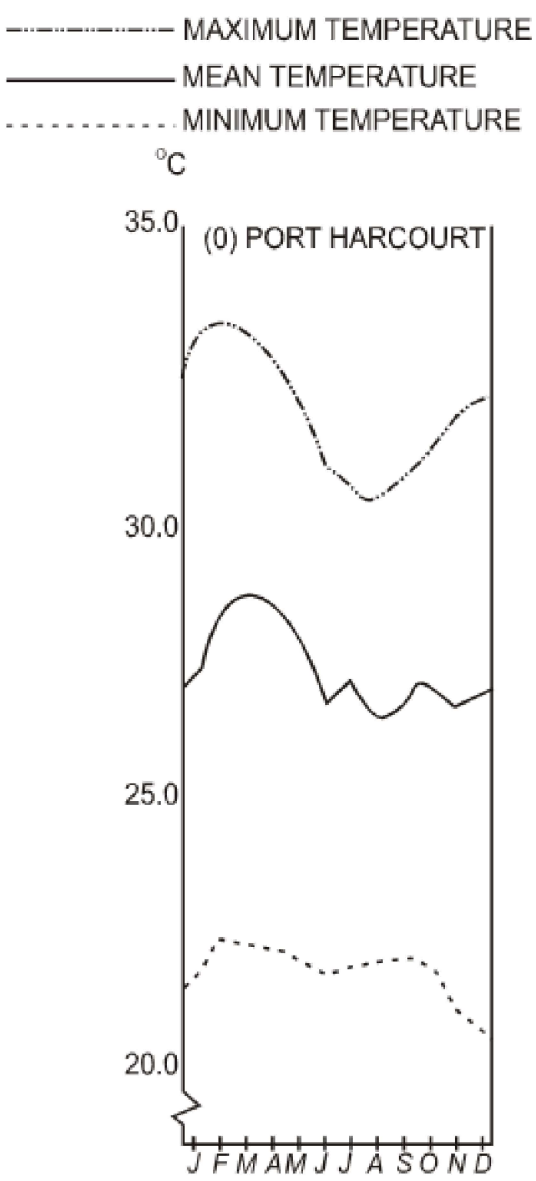

Fig. 10.2: Representation of temperature using line graph

Importance of Temperature

1. It influences the amount of water vapour present in the air and thereby determine the moisture-carrying capacity of the air.
2. Temperature determines the rate of evaporation and condensation.
3. It determines the degree of stability of the atmosphere.
4. It affects the nature and types of cloud formation.
5. It influences the formation of precipitation.

In measuring temperature, there is the need to ensure that damages to the thermometers are avoided. For this reason, emphasis is often placed on the measurement of shade temperatures. In this respect, precautions ought to be taken to ensure that the intensity of the sun' radiant heat is excluded. In order to achieve this, the Stevenson's screen was devised. The screen was invented by a British scientist called Stevenson in the 19th century. The Stevenson's screen is a standard weather shelter or receptacle. It consists of a white wooden box raised about five feet above the ground. It is structured in the form of silts in order to lift it above the ground. The roof of the box is in form of double layers with enough space to allow enough air space that will exclude much of the direct rays of the sun. The sides of the box are shaped in the form of layers or as a direct resemblance of

venetian blinds that will allow free circulation of air. One side of the screen is hinged such that it can serve as a door which can be opened and closed in order to allow people to have access to the instruments whenever readings are about to be taken. The floor of the screen is equally louvred. The Stevenson screen houses the maximum and minimum thermometers, dry and wet bulb thermometer. Larger ones may contain self-recording thermograms and hydrograms.

In recording temperature, the maximum temperature is entered in the column for the previous day while the minimum temperature is recorded in the column for the current day in order to allow for their respective period of probable occurrence.

Fig.10.3: A Stevenson screen

2. Humidity

This is the degree of wetness or dryness of the air. It is determined by the amount of water vapour of moisture content that is present in the air. It varies greatly from one place to the other, and at different times of the day. The humidity at any given time can be expressed as absolute humidity which is the amount of moisture or water vapour present in a given volume of air. In addition, there may be the need to determine the relationship between the actual amount of water vapour in the air and the amount of vapour that the air will hold at a particular temperature. This led to the use of relative humidity as a measure of humidity in a particular place. Relative humidity refers to the percentage of water vapour the air can hold in relation to the actual amount of vapour in the air. Thus, a relative humidity of 70 percent at a temperature of 35^0C means that the air is holding seven-tenths of the water vapour it can hold at 35^0C. When the relative humidity is 100%, the air is said to be saturated. The temperature at which this occurs is called the **DEW-POINT TEMPERATURE**. Further cooling of the air

after reaching the dew-point temperature will cause the water vapour in the air to condense into clouds and form rain. The relative humidity is measured by an instrument called a hygrometer.

Fig.10.4: Hygrometer

It consists of two thermometers: the dry bulb thermometer and the wet bulb thermometers. The dry bulb thermometer is a normal thermometer. The wet bulb thermometer has its bulb wrapped around a piece of muslin or wick which is dipped into a container of water. When the air is not saturated, water evaporates from the muslin and this cools the wet-bulb causing the mercury to contract. The dry-bulb is similarly affected and so shows a normal reading. The difference between the readings of the two thermometers is known as **WET-BULB DEPRESSION**.

With this value known, the relative humidity can be read from a table. For example, if the dry-bulb thermometer reads 30^0C and the wet-bulb reads 24.5^0C, then the wet bulb depression is 30^0C – 24.5^0C = 5.5^0C. From the table, the corresponding temperature (in this case, the dry-bulb temperature of 30^0C and wet-bulb depression of 5.5^0C in first column), the relative humidity is 64%. On a map, lines connecting places or areas with equal amount of humidity are known as **ISOHUMES**. Note that a large difference in wet bulb depression indicates a low relative humidity while a small difference shows a high relative humidity. If both have the same reading, then the relative humidity is 100%, hence, the air is saturated.

3. Precipitation

This is a collective term that covers every form of moisture that falls from the air to the ground. Examples include rain, snow, hail, sleet, mist *etc.* Whether high in the atmosphere or close to the ground, as soon as the air is sufficiently cooled below dew point, tiny water droplets will condense around and produce atmospheric dust particles known as **HYGROSCOPIC NUCLEI** which gives rise to different form of precipitation. At this juncture, it is necessary to state that fog, cloud and dew that result directly from condensation are excluded as precipitation because they do not fall to the ground surface but are suspended or float about in the air and maybe dissipated when isolation is high. However, due, moisture may be directly deposited on leaves, roof tops and other elevated surfaces.

Forms of Precipitation

(i) Rain: This is formed when tiny water droplets in the air coalesce with other tiny droplets to form larger droplets. They later fall to the ground under gravity as liquid water or rain.

(ii) Snow: These are common in the higher latitudes and altitudes. Here, condensation may take place in the atmosphere below dew-point. When this happens, the water droplets freeze into ice flakes and fall under gravity as snow.

(iii) Hail: This occurs when water droplets freeze into ice pellets as they are rapidly carried into the cooler regions of the atmosphere. As they are tossed up and down by strong up draughts of air in storm clouds in which they are embedded, drops of water freeze around the ice pellets. Eventually, they fall to the ground as hailstones or simple hail.

(iv) Sleet: This is a mixture of frozen rain drops and ice pellets that freeze and refreeze as they fall through the air. It also forms when snow melts as it falls and then refreezes. They eventually reach the ground as both rain and ice.

Forms of Condensation

(i) Mist and Fog: When water condenses close to the ground without giving rise to rain or snow, the resulting cloud that is formed is called a **MIST** or **FOG**. In other words, mist and fog are tiny droplets that float about in the air close to the ground. The difference between the two lies in the fact that a fog is thicker than a mist with visibility much reduced than in a mist.

(ii) Dew: When condensation occurs at ground level, some water droplets are deposited directly on the leaves of trees, roofs and other exposed surfaces to form dew.

Types of Rainfall

There are several types of precipitation since precipitation is largely dependent on the nature of the prevailing winds blowing over a particular area. Precipitation varies seasonally in many regions according to the movement of the sun and the accompanying movement of the rain belts. On the basis of the mode of uplift of the air, three types of rainfall can be identified namely:

(i) Convectional or Thunder Rainfall

(ii) Orographic or Relief Rainfall

(iii) Frontal or Cyclonic Rainfall

(i) Conventional Rainfall: This rainfall occurs when the Earth's surface is heated by the process of conduction which causes the moisture laden air to rise. As the vapour rises, it becomes cooled as a result of expansion. When the saturation point is reached, the water vapour then condenses into great cumulonimbus clouds which yield torrential downpour. This type of rainfall is copious (plenty) and brief lasting few minutes or hours and is usually accompanied by strong winds, thunder and lightning. This rainfall is common in places that are intensely heated either during the day as in the tropics or in summer as in the temperate regions. Thunder rainfall may become localized such that some places may experience it while nearby areas may not experience it.

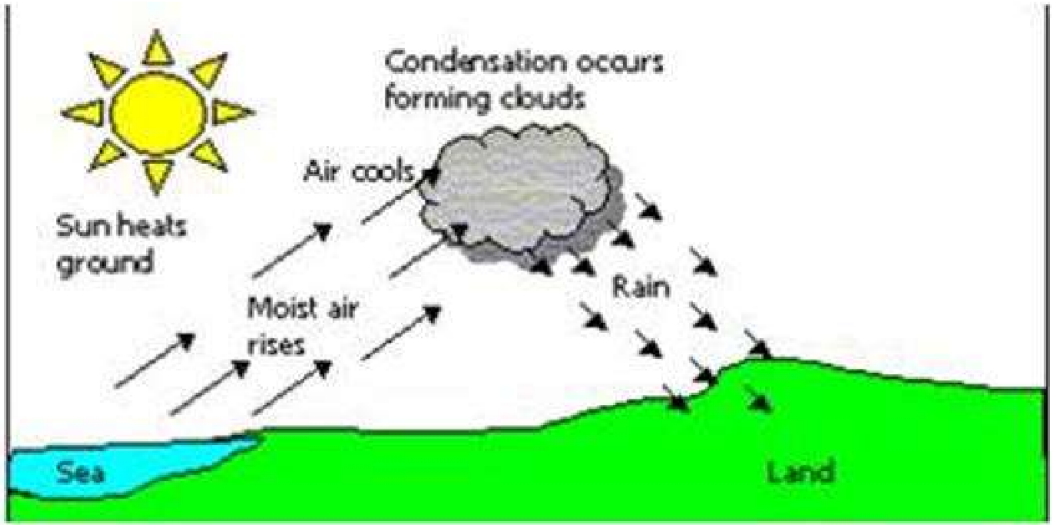

Fig. 10.5: Convectional Rainfall

(ii) Orographic or Relief Rainfall: This occurs when moisture-laden on-shore winds are forced to ascend a highland barrier such as hills, mountains *etc.* As the air is compelled to rise over the windward side of the mountain barrier, it is cooled by expansion until it becomes saturated. Condensation then takes place and clouds are formed which eventually give rise to rain. On descending the mountain, the air is compressed and warmed. Consequently, its relative humidity falls and any available moisture in the air is evaporated. The leeward side of the mountain thus experiences no rainfall. It is usually dry and is called the rain-shadow area.

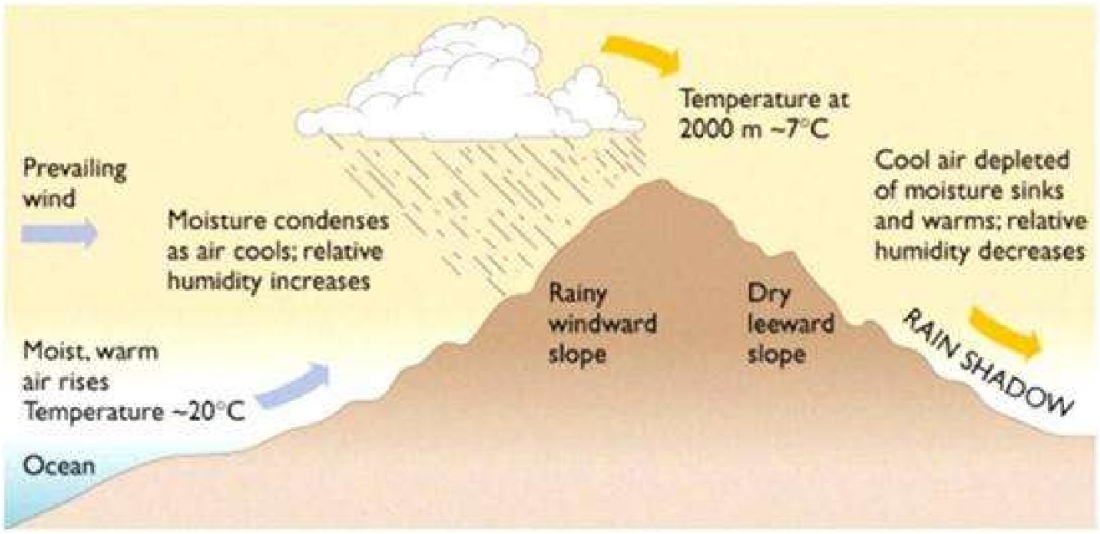

Fig. 10.6: Orographic or Relief Rain

(iii) Frontal or Cyclonic Rainfall: This occurs when two air masses of differing moisture and temperature characteristics meet. When such air masses converge the colder, denser air which remains close to the ground, forces the warm, lighter air to rise up. As it ascends, it is cooled by expansion until it reaches the point of saturation. When condensation takes place leading to cloud formation and giving off light shower called frontal, cyclonic or depression rainfall. This type of rainfall is common in temperate regions.

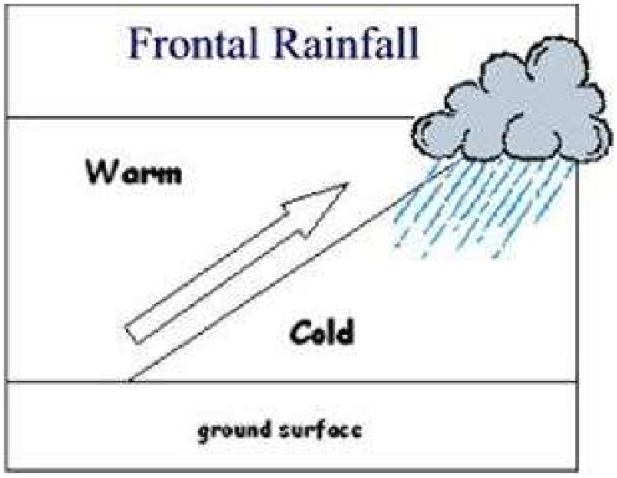

Fig. 10.7: Cyclonic or Frontal Rain

Measurement and Recording of Precipitation

The purpose of measuring precipitation is to determine the amount of rain, snow, hail or sleet that falls at a place during a period of 24hours. Precipitation is measured with a rain guage. It consists of a metal cylinder with a jar inside in which rain falls each day it is collected. The rain water is made to enter the glass jar through a funnel in order to reduce evaporation. To prevent rain splash from the ground getting into the funnel, the rainguage is buried in the ground with the top of the funnel about 30cm above the ground level. The rain that falls into the glass jar is emptied everyday and measured with a measuring cylinder, graduated so that the depth of rainfall can be read off directly to obtain the depth of rain. If the form of precipitation being measured is snow, hail or sleet, it is first melted before it is measured. Precipitation amount is expressed in millimeters and centimeters.

For effectiveness, rain gauges are usually kept in open space fall from buildings, trees and houses so as to prevent splashes or human interference.

Fig.10.8: Rainguage and measuring cylinder

Importance of Rainfall

(i) It is useful in the planning of military and strategic operations.

(ii) It serves as a basis for sea and air navigation as it is considered whenever this means of transport is administered.

(iii) It is useful in planning and executing agricultural activities especially crop cultivation, animal husbandry *etc.*

(iv) It is considered in the planning of social activities and events.

4. Air Pressure

Air is found in large quantities in the atmosphere and they have weight since they are made up of a number of mixed gases. They exert their weight on the Earth's surface. Air pressure varies from place to place and from time to time depending on the temperature of the air and the altitude. Atmospheric pressure is measured with an instrument called **BAROMETER**. There are two types of barometer: Fortin or ordinary mercury barometer and the Aneroid barometer. There is a third type which is a variant of the first, that is, Fortin barometer and is called altimeter, but it is mostly used in aircrafts and high altitude activities such as mountaineering or mountain climbing. Air pressure is measured in millibars (mb). The units are applicable only to air pressure.

The instrument used for measuring atmospheric pressure called aneroid barometer comprises a small metal container with the air inside pumped out so that there is little or no pressure inside. When atmospheric pressure rises, it forces the top lid of the box to collapse inside. The increase in pressure is conveyed to a graduated scale by a system of levers. When the pressure falls, a spring inside the box pushes the lid up and this can be read off the revolving dial. Lines that connect equal areas of atmospheric pressure on map are called **ISOBARS**. In temperature regions, pressure changes are very rapid especially when it comes to the formation of cyclones and anticyclones. Under normal circumstances, pressure during these events varies between 950mb and 1100mb.

When recording pressure readings, care has to be taken to ensure accuracy since pressure readings vary with a number of factors, especially altitude. It is a fact that as one ascends there is less air above and so the weight is less and more importantly the barometer is sensitive to gravitational forces at different latitudes. Since

mercury is known to increase with temperature, it becomes essential that necessary corrections be made with respect to altitude, latitude and temperature, have to be made for the recording of atmospheric pressure to be easy and effective. To ensure a continuous record of pressure changes, a self-recording **BAROGRAM** is used.

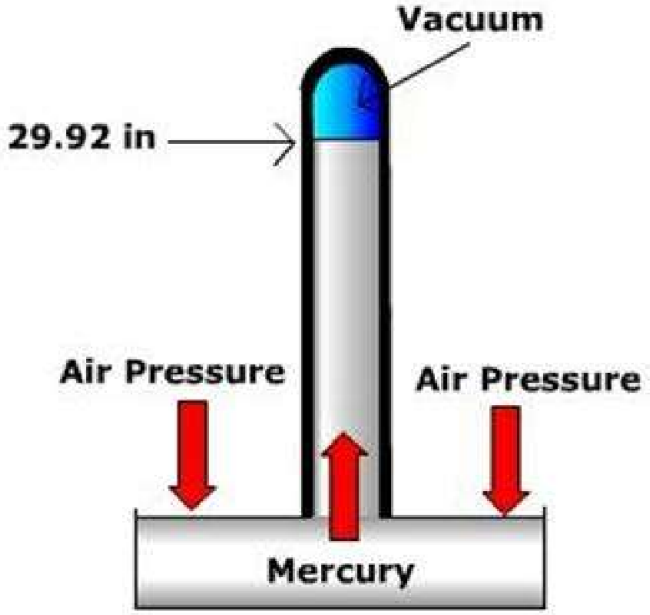

Fig.10.9: Principle of the mercury barometer

Fig.10.10: Aneroid barometer

5. Wind

This is air in motion. It has both speed and direction. The movement of air is affected by changes in temperature, pressure and the movement of wind itself. Two aspects of winds are usually measured: wind speed and wind direction.

Wind speed is measured with a cup anemometer. It consists of three or four semi-circular cups attached to the ends of two horizontal spokes mounted on a high vertical spindle about which they rotate. When the wind blows, the horizontal arms bearing the cups rotate. The rotational movement of the cup operates a meter which records the speed of the wind in metres per second (m/s) or kilometres per hour (km/hr). Wind speed is sometimes expressed in Knots (1 knot = 1.85km/hr).

Wind direction is measured with a wind vane. It is made up of two parts. One part consists of a rotating indicator in the form of an arrow or vane, pivoted on a vertical shaft. The other part compare with the four compass points attached to the ends of the spokes and fixed to the spindle bearing the indicator. As the wind blows, it strikes the indicator on both of its flat sides, causing it to point towards the downstream direction of the wind. For effectiveness, a wind vane should be located in an exposed position that is away from obstructions such as tall buildings and trees.

Winds are named from the direction they blow; an east wind (or easterly) is one that blows from the northwest to the southeast. Lines on a map connecting areas with equal wind speed are called **ISOTACHS**.

Fig. 10.11: Cup type anemometer

Fig. 10.12: Wind vane

6. Cloud Cover

Clouds are masses of tiny water droplets or ice crystals in the air that are too light to fall to the ground. They are produced by the condensation of water vapour on particles of dust, smoke and salt collectively called **HYGROSCOPIC NUCLEI**. These microscopic dust particles are absolutely necessary for condensation to occur.

Changes in cloud cover can bring about significant changes in the weather. For example, a dense cloud cover can reduce insolation receipts as much as 95% and at the same time yield considerable rainfall. The form, height

and movement of clouds can present a lot of information on present sky conditions and the coming weather.

Cloud cover is measured in terms of the proportion of the sky that is covered. It is expressed in eights or oktas. For example, $\frac{2}{8}$ is one quarter covered, $\frac{4}{8}$ is half covered, $\frac{6}{8}$ is three-quarter covered and $\frac{8}{8}$ is completely covered or overcast. The records taken can be plotted and lines connecting areas or equal cloudiness are called **ISONEPHS**.

7. Sunshine Duration

This simply refers to the duration of sunshine at a place. It varies with latitude and season. In many parts of the world such as the tropics and the deserts. The sun shines for many hours in a day while in other parts like the temperate regions, the sun shines only a few hours in a day. Sunshine duration is also low during the rainy season due to high cloud cover and high during the dry season when the sky is relatively clear of clouds.

The direction of sunshine is measured with an instrument called sun dial while the duration and intensity of sunshine is measured by an instrument called **CAMPBELL STOOKE SUNSHINE RECORDER**. It consists of a glass sphere having about 100millimeters in diameter and a sensitized card that is graduated in 2hours. The glass sphere concentrates the sun's rays on a point on the sensitized graduated card. When the intensity of the sun is sufficiently high, the card is scorched. The number of sunshine hours can be read directly from a line scorched on the card. On maps, lines that run though places with the same amount of sunshine intensity and duration are called **ISOHELS**.

Sunshine is an important weather element in that it is the major source of radiant energy that maintains life on the Earth, *e.g.* photosynthesis and evaporation.

Fig. 10.13: Sunshine Recorder

8. Visibility

This refers to the horizontal distance within which an observer can see without hindrance lying along his line of observation. Visibility is a function of the amount of dust particles and moisture in the air. It is affected by severe weather conditions such as thunderstorm or a dust storm. The element is of particular concern to aircraft pilots in the West African region during the harmattan when the north-easterly winds fill the air with dust particles. Other limiting factors are haze, mist and fog. Visibility considerations are important for activities such as aircraft operations, road traffic, shipping and recreation. Visibility is simply expressed in terms of meters or kilometers in horizontal distance.

10.5 Impacts of Weather and Climate on Physical and Human Activities

A. Impacts on the Physical Environment

1. Certain aspects of the weather and climate have serious impacts on the environment such as: excessive precipitation which causes flooding, landslides, mudflows, overflow of river banks, siltation of reservoirs, and soil and gully erosion.
2. Excessive wind speeds from tropical storms such as hurricanes, tornadoes, typhoons, etc can generate gale force winds that have cause tsunamis with their destructive tendencies.
3. Drought resulting from climatic anomalies have been known to disorganize and dislocate societies, causing environmental degradation and hydrological problems.
4. The El Nino phenomenon which is climatic in origin has been associated with intense disruption of fishery and agricultural activities in the regions where they occur.
5. Weather and climate problems are not affecting man adversely through such environmental problems like acid rain, ozone hole, global warming and air pollution.
6. Incidences of heat waves have caused severe impacts on biospheric processes.
7. Lightning and thunder strikes have caused forest fires that also led to loss of lives and environmental degradation.

B. Impacts on Human Activities

1. Air pollution is inimical to human and animal health and detrimental to vegetation and corrodes cultural features like national monuments, paintwork of cars and buildings.
2. Excessive precipitation and high wind speeds cause destruction of lives and property, destruction of farm crops and building.
3. Reduced visibility resulting from fog, smog and hazy conditions can cause traffic accidents, air crashes and economic loss due to cancellation of flights.
4. Clear Air Turbulence (CAT) in aviation has been known to cause plane crashes.
5. Climate determines the type and nature of agriculture, *e.g.* irrigation, dry farming, *etc.*
6. High humidity causes sultry conditions, human discomfort and reduced activity and productivity.
7. Incidences of heat waves have cause death of people.
8. Lightning strikes have caused forest fires that also led to loss of lives and property.

Factors Affecting Climate

Factors that affect the climate of a place are:

1. Latitude

Latitude affects the climate of a place in three main ways. First, it determines the angle of the mid-day sun. In general, the higher the angle, the higher the amount of radiation received from the Sun. Within the tropics, and especially at the equatorial region, the angle is always high and consequently, the amount of energy received from the sun is high all through the year.

Latitude also affects the distance travelled by the rays of the Sun before they strike the Earth's surface. As a ray of light travels through the Earth's atmosphere, some of its energy is absorbed by atmospheric clouds, water vapour and dust particles, thereby reducing its intensity at the Earth's surface. As we can see from Fig.10.14, the distance travelled by solar rays increases as we move polewards.

Finally, latitude determines the area of surface warmed by the solar rays. Observing the area of the Earth's surface that is warmed by the solar rays as they arrive at the surface. As one moves away from the equator to the tropics such as warmed. The effect of this is that higher latitudes with larger surface areas will require extra energy to stay at the same temperature with the lower latitudes.

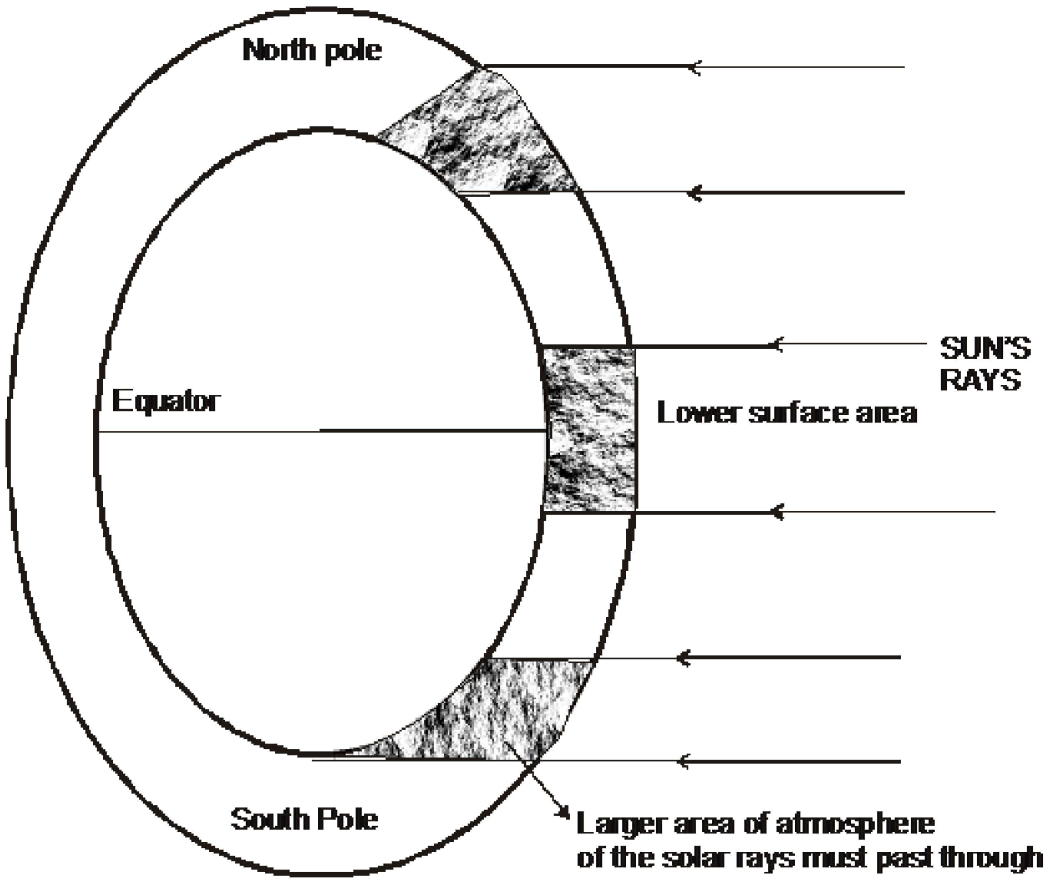

Fig.10.14: Effects of latitude on distance travelled by sun's rays

2. Altitude and relief

Places nearer the Earth's surface are in general warmer than those higher up. This can be explained by the fact the atmosphere is heated from below, which also explains the saying: "The higher you go, the cooler it becomes." The rate of decrease of temperature with elevation is known as the environmental or normal lapse rate. Generally, temperatures drop by 6.5^{o}C for every 1000 meters of ascent.

Elevation also has two other effects on climate. Highlands and mountains create relief or orographic rainfall on the windward side of the feature and rain-shadow effect on the leeward side as described earlier. Some highland areas in West Africa where elevation has the effect of lowering the temperature of the towns include Jos Plateau, Mambilla and Adamawa Highlands, Fouta Djallon and Guinea Highlands.

3. Distance from the sea

The distance of a place from the sea determines its range of temperature. The Sun's heat is absorbed more quickly by land surfaces than by water bodies. The land also loses heat much faster than water bodies. Therefore, during the summer, the land readily absorbs heat and attains the maximum temperature faster than nearby water bodies. In winter, land surfaces also easily lose their heat and attain the minimum temperature before nearby water bodies. This accounts for the warmer summers and colder winters, and consequently, greater temperature ranges of continental interior locations relative to maritime regions. This influence of distance from the sea on climate is sometimes called continentality.

4. Ocean currents

Coastal locations that are washed by warm and cold currents are affected by such currents if the winds are on-shore. Ocean currents like the Gulf Stream and the North Atlantic Drift warm the coasts of Western Europe, keeping their ports free of ice during the winter season. Other locations in the same latitudes but washed by cold currents such as northeast Canada that is washed by the cold Labrador Current are frozen for several months of the year. The upwellings of cold waters on the western sides of continents are partly responsible for the arid conditions experienced in these areas.

5. Prevailing winds

Winds result from thermal differences occurring from the seasonal movement of the overhead Sun and from a shifting of the pressure belts. Whichever is the cause, the winds transport heat and moisture to the areas where they blow. Depending on their source, winds blowing out of a desert or warm ocean surface will transport heat and moisture respectively to the adjacent regions. Those moving out of a cold region or over a cold current will bring coldness. Hence, the prevailing wind system of a place determines its temperature and precipitation patterns.

6. Slope and aspect

The effects of these are more noticeable in temperate latitudes where the altitude of the Sun is low in the sky. In the northern hemisphere, a mountain range with an east-west alignment like the Alps experiences greater insolation and consequently higher temperatures on their south-facing slopes than their northern sides. In the southern hemisphere, the reverse is observed.

7. Vegetation

The natural vegetation of a region affects the climate of the region by allowing or preventing sunlight from reaching the ground. For example, the thick foliage of forested jungles cuts off the incoming insolation, preventing much of the sunlight from reaching the floors of the jungle. In consequence, the shade temperature of a forested area is lower than that of open spaces in the same latitudes.

Also, during the day, trees lose water by evapo-transpiration so that the air above the trees is cooled. Mist and fog may form, all tending to lower the temperature of the area.

Summary

In this chapter, students have learnt that:

- weather refers to state or condition of the atmosphere at any given time.
- climate is the average state of the atmosphere over a long period of time, usually 35 years.
- elements of weather and climate include temperature, rainfall, humidity, wind, pressure sunlight, *etc.*
- attributes of weather and climate include: variability , scale of occurrence, atmospheric dimension.
- Weather elements can be measured with instruments as follows: rain – rainguage, Temperature – Thermometer; Humidity – Hygrometer; Wind Speed – Cup anemometer; Wind direction - wind vane, Air pressure – Barometer; Sunshine duration – Sun – dial, etc

Revision Questions

Objective Questions

1. Which of the following pairs is not correct in the measurement of weather elements? (a) Rainfall with rain gauge (b) Humidity with hydrometer (c) Pressure with anemometer (d) Temperature with

thermometer (e) Wind direction with wind vane.

2. Air pressure at sea levels is higher than at the top of mountain because the air at sea level (a) Originates from the sea (b) has a greater weight (c) consists of a lesser mixture of gases (d) has a lesser weight (e) Consists of a greater mixture of gas.
3. Diurnal range of temperature is the
   a. Average of the highest and the longest month temperature
   b. Difference between the maximum and the minimum temperature for a year.
   c. Average of the minimum and the maximum daily temperature.
   d. Differences between the maximum and the minimum temperature for a month.
   e. Difference between the highest and the lowest temperature for a day (WAEC 1989)
4. A rain guage is kept in an open place in the observatory because (a) It is much more easily accessible to the observer (b) Rain drops get into the funnel without any obstruction (c) rain falls more heavily in the open space (d) rain drops are deflected by the wind in an open place (e) the funnel is easily filled with rain water (1990).
5. A fog is most likely to develop when a
   (a) Cold dry wind blows over a cold current
   (b) Warm moist wind blows over a cold current
   (c) Cold dry wind blows over a warm current
   (d) Warm moist wind blows over a warm current
6. Humidity is the amount of
   (a) Cloud cover in the sky
   (b) Water vapour in the atmosphere
   (c) Moisture needed to cause condensation
   (d) Moist in the atmosphere
7. Convectional rains are most common in
   (a) Equatorial regions and tropical monsoon climates
   (b) Polar region and Mediterranean climates
   (c) Temperature region
   (d) Temperate and Mediterranean regions (2007)
8. Which of the following is not a form of precipitation?
   (a) Hail (b) Dust (c) Dew (d) Snow (2010)
9. Visibility usually decreases when a
   (a) Cold, dry wind blows over a cold current
   (b) Body of fresh water mingles with salty water
   (c) Warm wind blows over a warm current
   (d) Warm, dry wind rises over a high mountain
   (e) Blow towards the horse latitudes. (1996)
10. The energy received from the sun at a particular place is called
   (a) Insolation (b) Convection (c) Conduction (d) heat wave (e) Advection (1997)

Answers

1. C 2. B 3. E 4. B 5. A 6. B 7. A 8. B 9. C 10. A

Essay Questions

1a. Name the three types of rain

b. With the aid of relevant diagrams, describe the formation and characteristics of any two types named in (a) above

2a. Distinguish between weather and climate

b. Identify and describe any four elements of weather

c. Mention three uses of rainfall data to man. (1999)

4. Use the climatic data in the table below to answer the following questions.

3. Use the climatic data in the table below to answer the following questions.

MONTH	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Rainfall in MM	18	17	20	39	48	90	112	90	56	47	30	25
Temp. in $0^{o}C$	21	21	20	17	15	12	12	13	14	18	18	20

Table I – Climate data for station x.

(a) Plot a combined rainfall and temperature graph for station X

(b) Calculate the

(i) annual temperature range

(ii) mean annual temp. for the station

(c) What climatic type does the station represent? (2000)

4. (a) Name the instruments used in measuring the following weather elements.

(i) pressure (ii) Sunshine (iii) rainfall (iv) wind speed

(b) Explain how wind speed is measured and recorded. (2008)

5. (a) What are the attributes of weather and climate.

(b) State the importance of weather and climate on physical and human activities.