GEOGRAPHY

THE WEATHER

WEATHER

* WEATHER is the state of the atmosphere at any given time and place.
* The three most important gases in the atmosphere are the ozone, water vapor and carbon dioxide.
* These gases protect us from scorching heat and powerful solar radiation.
* The atmospheric layer is constantly destroyed by human activities such as deforestation and industrialization.

THE EARTH'S ATMOSPHERE

The Earth's atmosphere consists of four layers. These layers are: troposphere, stratosphere, mesosphere and thermosphere.

When we talk about the weather, we are actually talking about the changes that occur in the troposphere. The troposphere is the bottom-most layer of the atmosphere. It is often thickest at the Equator and thins towards the Poles. 75% of the gases found in the atmosphere are found in the troposphere. Above the troposphere is the stratosphere. This layer can reach a height of about 50km. An important gas called ozone is found in great abundance in the stratosphere. The mesosphere is the layer above the stratosphere. It is located at an altitude of between 50km to 80km above sea level. The last atmospheric layer is the thermosphere. It can stretch from 80km to 480km from the Earth's surface. Look at Figure 3.1. Can you tell how high temperatures can reach?

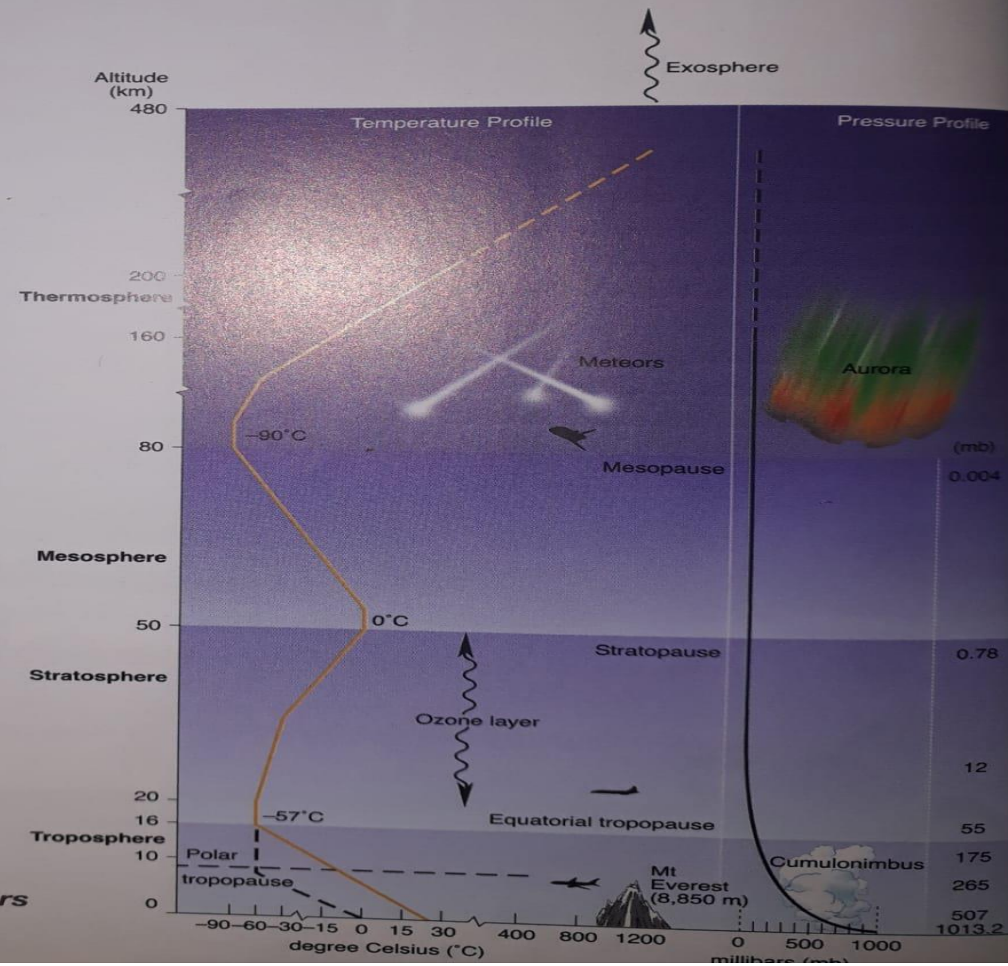

Figure 3.1 ***Various layers of the atmosphere***

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Solar Radiation And The Weather

The Earth's weather is also affected by the amount of solar energy. Look at Figure 3.2. You will begin to see how solar radiation is distributed throughout the atmospheric layer. Only an average of about 46% of the Earth's solar radiation is absorbed by the ground. Where did the rest of the solar energy go to?

From Figure 3.2, you can see that most of the radiation is reflected and scattered back into space by clouds and gases and absorbed by vapour, ozone and dust particles. This outgoing terrestrial radiation plays an important part in our weather.

All the incoming solar radiation that reaches the Earth and is absorbed by the Earth is changed into heat energy to keep us warm and for other living things to live and grow. This exchange of incoming solar radiation and outgoing terrestrial radiation set in motion the circulation of air in the atmosphere, thereby affecting us.

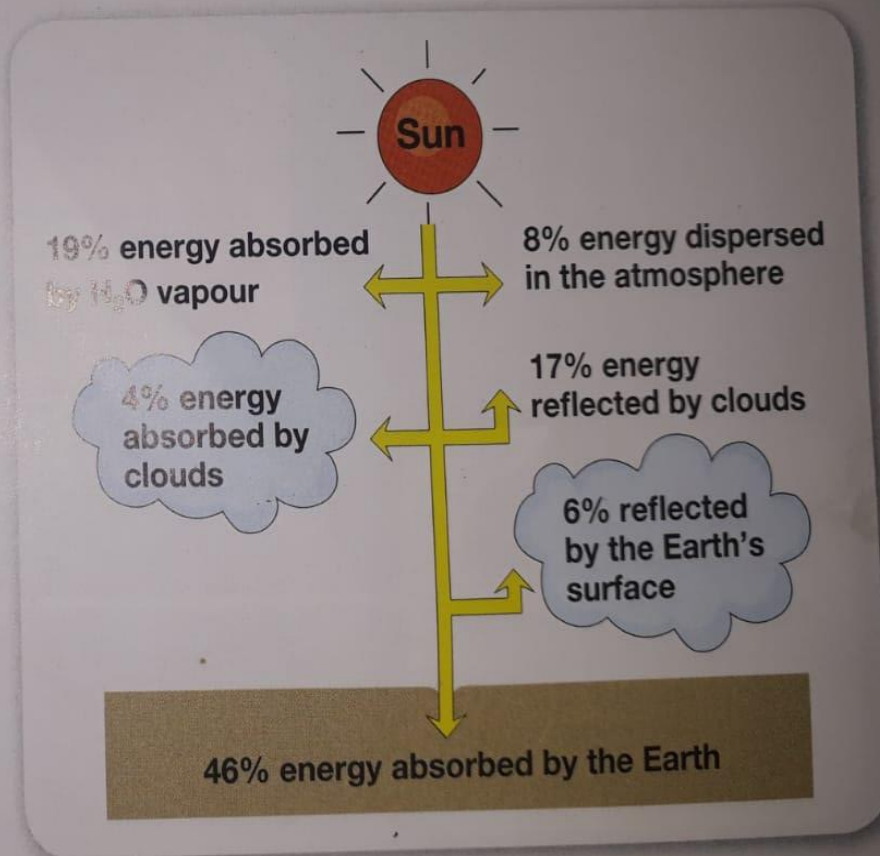


Figure 3.2 Heat balance of the Earth

TEMPERATURE

Temperature

The temperature of a place affects what we wear; it also influences the way we design our buildings. For example, in countries that experience heavy snow falls, the houses are designed with steeper roofs to prevent the accumulation of snow that may cause the roofs to collapse.

Temperature is the degree of hotness or coldness in the atmosphere. It is measured in degree Celsius (°C) or degree Fahrenheit (°F). The temperature of a place depends on how much heat the air absorbs from the ground below it. The sun heats the ground first, after which the heat is transferred back to the air above by means of radiation, conduction and convection (Figure 3.3).

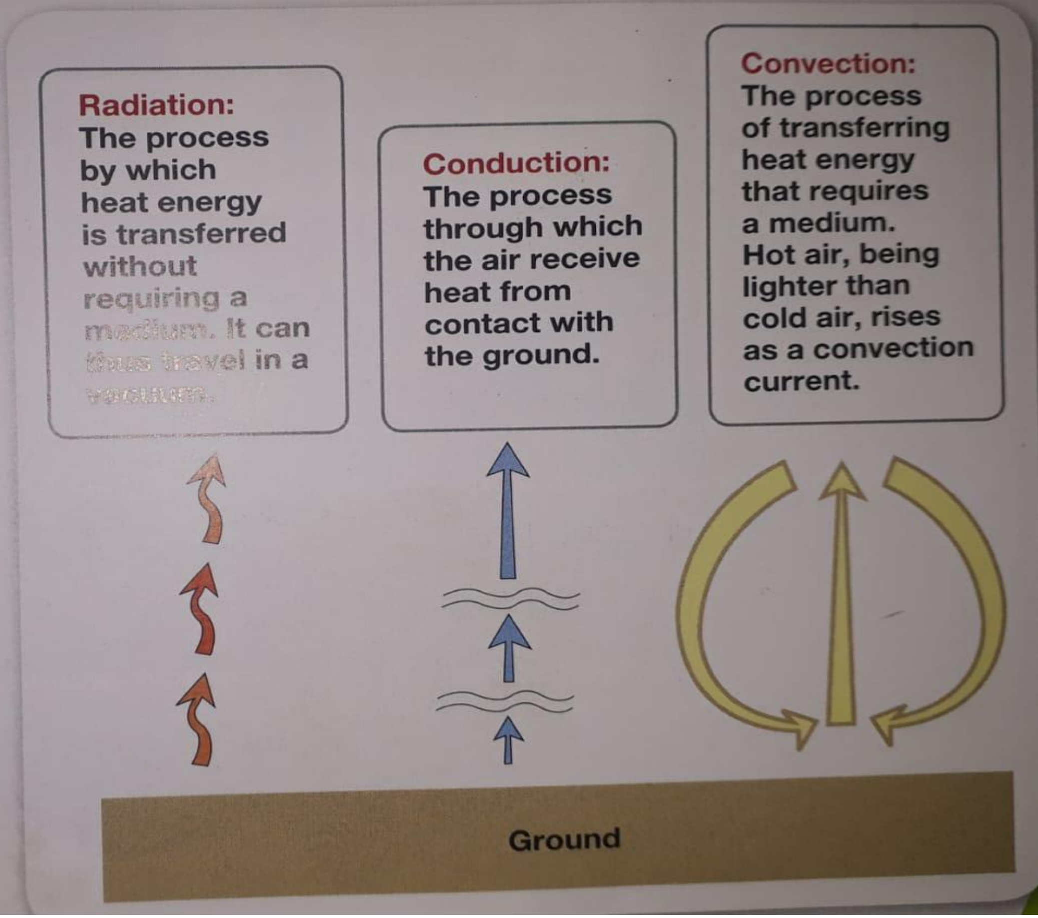


***Figure 3.3** Processes by which heat is transferred from the ground to the air above it*

FACTORS INFLUENCING TEMPERATURE

Distance from the sea

In Figure 3.7, places such as Berlin, Warsaw and London are located on the same latitude. However these cities do not experience the same temperatures. Why are temperatures in Warsaw and Berlin lower than temperatures experienced in London?

You will soon notice that Berlin is further inland and away from the sea while London is closer to the sea. Consequently, London does not have freezing winters compared to those experienced in Berlin. What can you tell about summer temperatures in Berlin and London? Do you notice a difference too? Why do you think this is the case?

Temp (°C)	London	Berlin	Warsaw
January	4	–1	–3
July	17	18	19

Figure 3.7 The temperatures of the three cities are influenced by their distances near the sea

The sea is a major factor for the difference in temperatures between Moscow and London. This is because the sea heats up and cools slowly compared to the land. Places nearer the sea will not feel extreme changes as a result. The sea moderates the temperatures of places near the sea. This influence is known as the maritime influence.

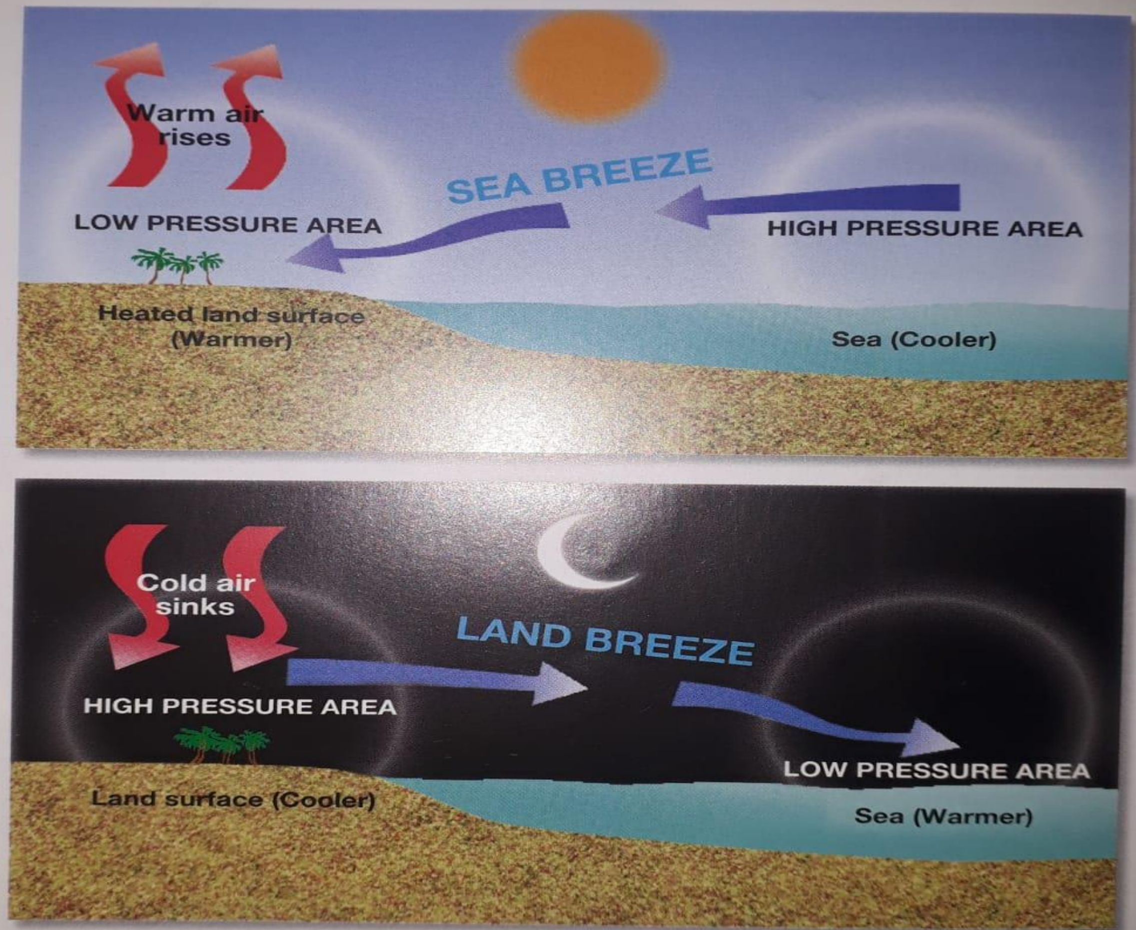


Figure 3.8 *Sea and land breezes*

Places further inland, however, will experience extremes in temperatures. These areas are under continental influence. In other words, they are not affected by the moderating effect of the sea and they experience a large difference between summer and winter temperatures.

Latitude

Study Figure 3.5 again. What can you tell about the temperatures of places nearer the Equator? What can you tell about temperatures as you move towards the north and south poles?

You would have observed that places nearer the Equator will experience higher temperatures and are hot all year round. Places closer to the poles experience greater variations in temperatures throughout the year. All these differences in temperatures can be easily explained by studying Figure 3.6 below. It shows how the sun's rays strike the Earth's surface at different latitudes.

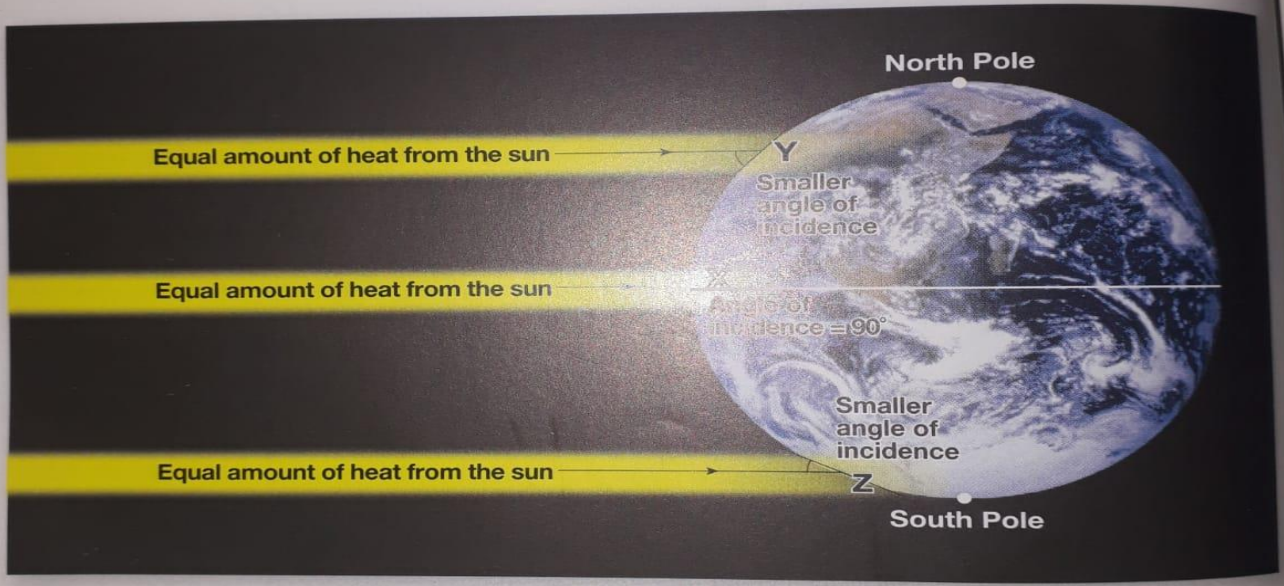


Figure 3.6 The angle of incidence at various latitudes

The same amount of heat from the sun reaches the Earth but at different angles. At the Equator, the sun's rays hit the Earth's surface at an angle of 90°. The same amount of heat is concentrated over a small area (marked 'X').

In higher latitudes, the angle of incidence (angle at which the sun's rays strike the Earth's surface) is lower. Most of the time the sun's rays strike the Earth's surface at an oblique angle. The same amount of heat is now spread over a larger area or diffused. As a result the heat is less concentrated, lowering the temperatures of places in higher latitudes (area Y and area Z).

Ocean currents

Ocean currents are flows of surface water in the ocean. They are set in motion by prevailing winds blowing over the water surface.

Ocean currents originating from the warm waters of the equatorial regions are called warm ocean currents. Those originating from the cold waters of the polar regions are called cold ocean currents.

We can therefore conclude that a warm ocean current raises the temperatures of the coastal areas especially so when onshore wind blows over it. A cold ocean current lowers the temperatures of the coastal areas, particularly so when an onshore wind blows over it.

Altitude

In mountainous regions of the world, trees tend not to grow beyond a certain height. Imagine that you are climbing Mt Kilimanjaro (5,895m) in Africa. As you climb, you will notice that there is an abundance of grass at the foot of the mountain. Animals thrive well here because average temperatures are between 30°C and 32°C throughout the year. You will also find that you have no difficulty breathing.

However as you climb up to about 2,000m above the sea, the vegetation begins to change to that of a temperate forest. The leaves of trees in temperate forests are broad but the trees tend to shed their leaves when there is not enough moisture. Further up at about 4,000m, you will see more boreal forests where the trees have needle-like leaves and are green all year round. At the same time, you may have difficulty breathing. Beyond 5,000m, hardly anything grows.

Can you think of any places in the Caribbean with high mountains? Places like the Blue Mountains of Jamaica and the Northern Range Mountains of Trinidad show a change in vegetation with ascent. At the base of many Caribbean mountains, you may see secondary vegetation, further up, tropical rainforests and at the top, elfin woodlands.

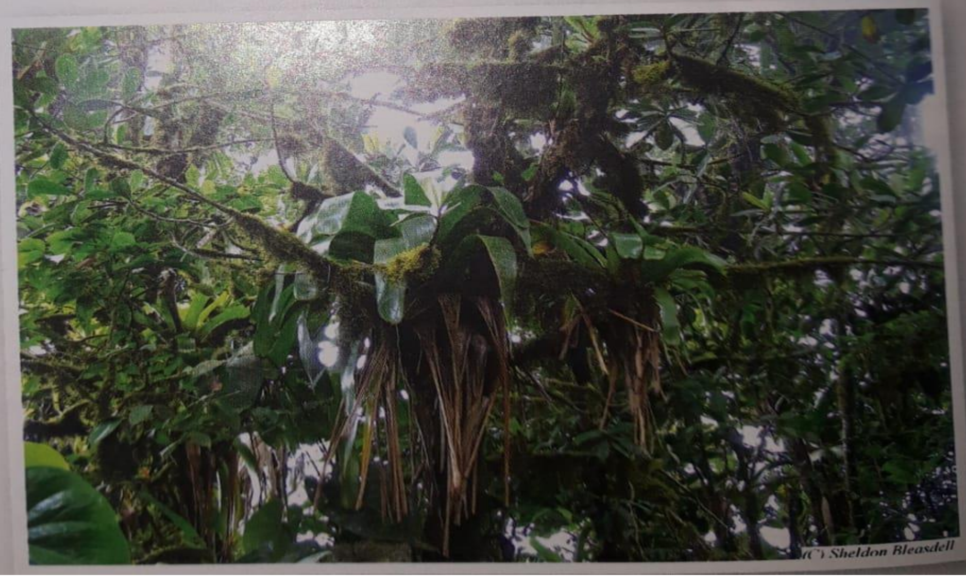


Figure 3.11 *Elfin woodland is adapted to high moisture availability on the highest peak in Trinidad's Northern Range Cerro del Aripo*

This observation tells us that as you climb higher up, vegetation responds to the changes in temperatures and moisture. The higher you climb, the colder it will be. Temperature falls at an average of 6.4°C per 1,000m ascent. This drop in temperature is known as the environmental lapse rate.

As we have already learnt, the Earth's surface is covered by a layer of air called the atmosphere. The air is warmed by the heat from the ground through convection, radiation and conduction. It is much warmer at the ground, allowing more vegetation to grow. It is in this layer of air just above the ground that most of the gases of the atmosphere and dust particles all concentrate at. This is because of the Earth's gravity which pulls everything towards the Earth's surface. Hence, most of the sun's heat is absorbed at or near to sea level where the air is concentrated. The atmosphere is also warmed by the Earth's surface.

At higher altitudes, there is less water vapour, gas and dust particles. Therefore, there are less gases to absorb the sun's heat. Temperatures are also lower as you climb higher.

Cloud cover and humidity

Clouds are formed from the condensation of water vapour present in the atmosphere. A thick cloud cover will reflect some of the incoming solar radiation and cools the land in the day. Therefore the amount of cloud cover present over a place can affect the temperature of the place.

Guyana and the Sahara Desert are places located within the tropics. Both experience high temperatures. However, the temperatures in Guyana remain constant with little or no fluctuations compared to temperatures experienced in the Sahara Desert. Figure 3.12 explains how the presence of clouds can moderate the temperatures of a place.

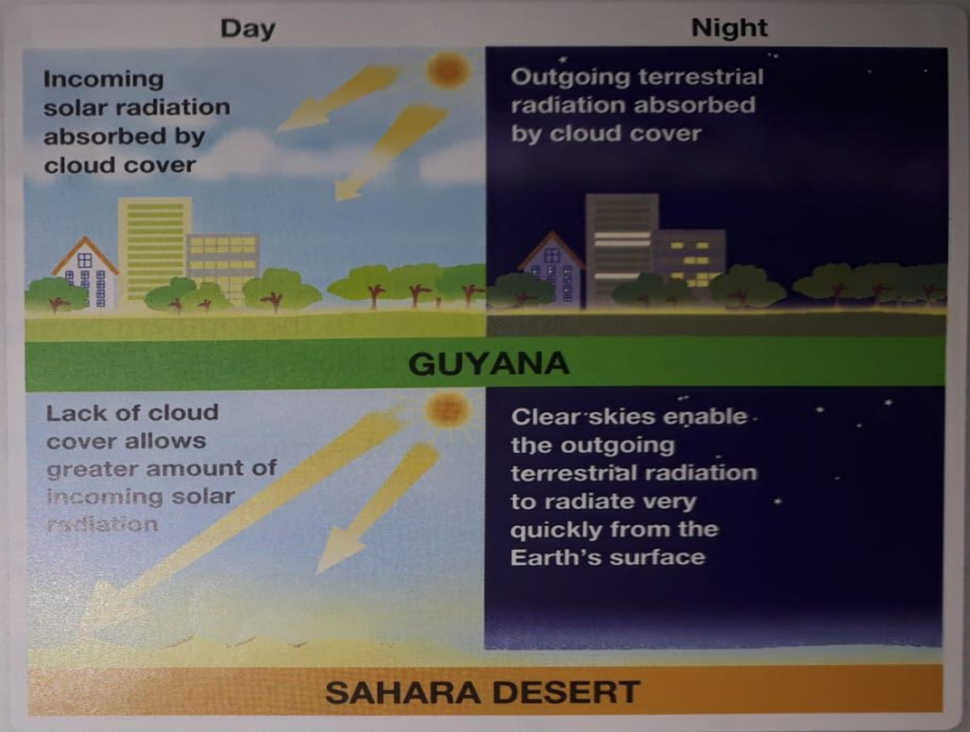


Figure 3.12 *The effects of cloud cover in Guyana and the Sahara Desert*

When there is high humidity (presence of moisture in the environment), there is greater cloud cover. The lower the humidity; the lesser the cloud cover. You can see from Figure 3.12 that the Sahara Desert has little or no moisture present most of the time. As a result, the humidity is low with little or no cloud cover at all. Day time temperatures in the Sahara can be very hot and reaches beyond 30°C easily. However at night, the absence of cloud cover causes heat to escape resulting in extremely low temperatures in the night.

Microclimatic factors

So far we have examined how temperatures are affected on a large or global scale by the latitude, altitude, nearness from the sea, cloud cover and ocean currents. Temperatures can change on a small (local) scale too. These factors responsible for the local variations (microclimate) are called microclimatic factors.

One such microclimatic factor is aspect. It refers to the direction in which a slope faces in relation to the sun. This influence is more obvious in higher latitudes where the angle of the sun is more oblique.

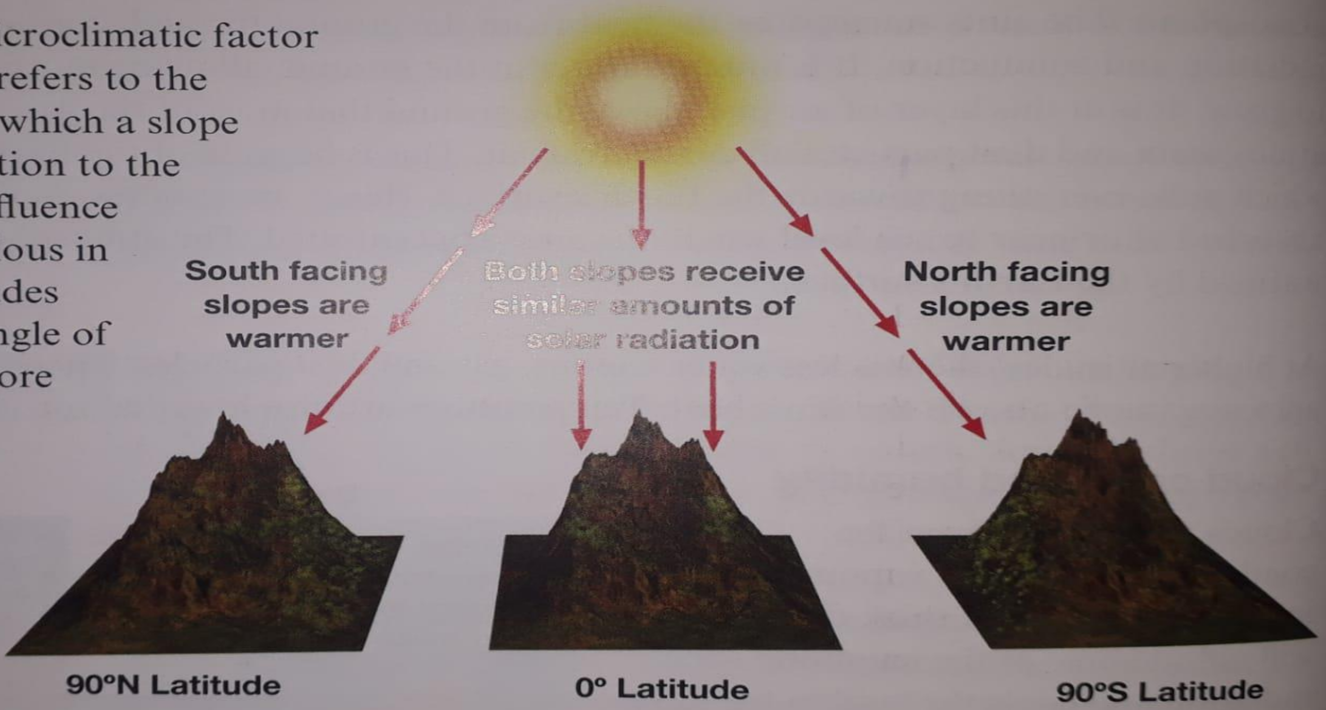
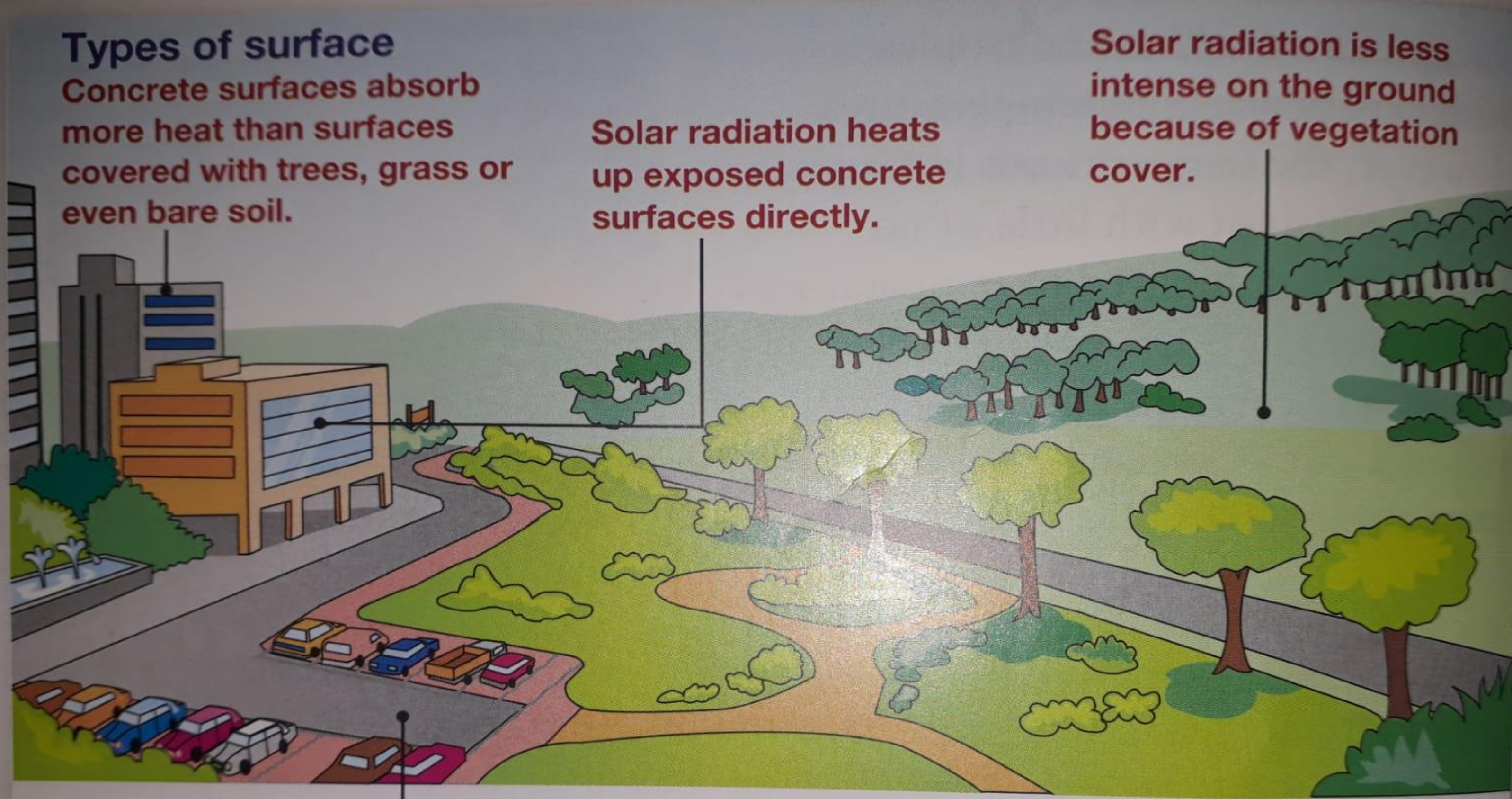


Figure 3.13
Aspect

In the northern hemisphere, slopes that are south facing are usually warmer than the north facing slopes. In the southern hemisphere, slopes that are north facing are warmer than the south facing slopes.



Urban vs rural

Concrete buildings and asphalt roads in urban areas absorb and retain heat better than soil and trees do. The high density of high-rise buildings in cities also traps the heat radiated from concrete surfaces during the night. As a result, air temperature in cities is typically higher than that in the surrounding rural areas.

Figure 3.14 *The land surface of an area affects temperatures*

An area with more vegetation tends to be cooler than a concrete surface. This is because the trees and other plants in a forest will reduce the amount of incoming solar radiation absorbed by the ground. The evaporation of moisture on the surface of the leaves, twigs and branches and transpiration through the stomata of the leaves also cool the surroundings.

Concrete surfaces and buildings in an urban area absorb heat in the day and release it slowly at night. The dust particles reduce the amount of radiation escaping to space.

MEASURING AIR TEMPERATURES

Air temperatures can be read using an instrument called the maximum and minimum thermometer. This instrument is placed in a Stevenson Screen which protects the thermometers from the direct rays of the sun and allows the shade temperature of the air to be measured. The Stevenson Screen is a wooden box whose sides are painted white and allows free entry of air. The box is attached to a stand approximately 1.2 metres (4 feet) above the ground. Figure 3.15b shows how the maximum and minimum thermometer works.

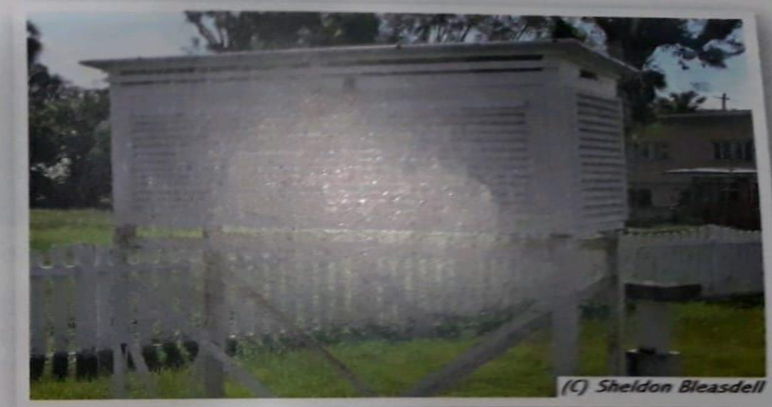


Figure 3.15a A Stevenson Screen

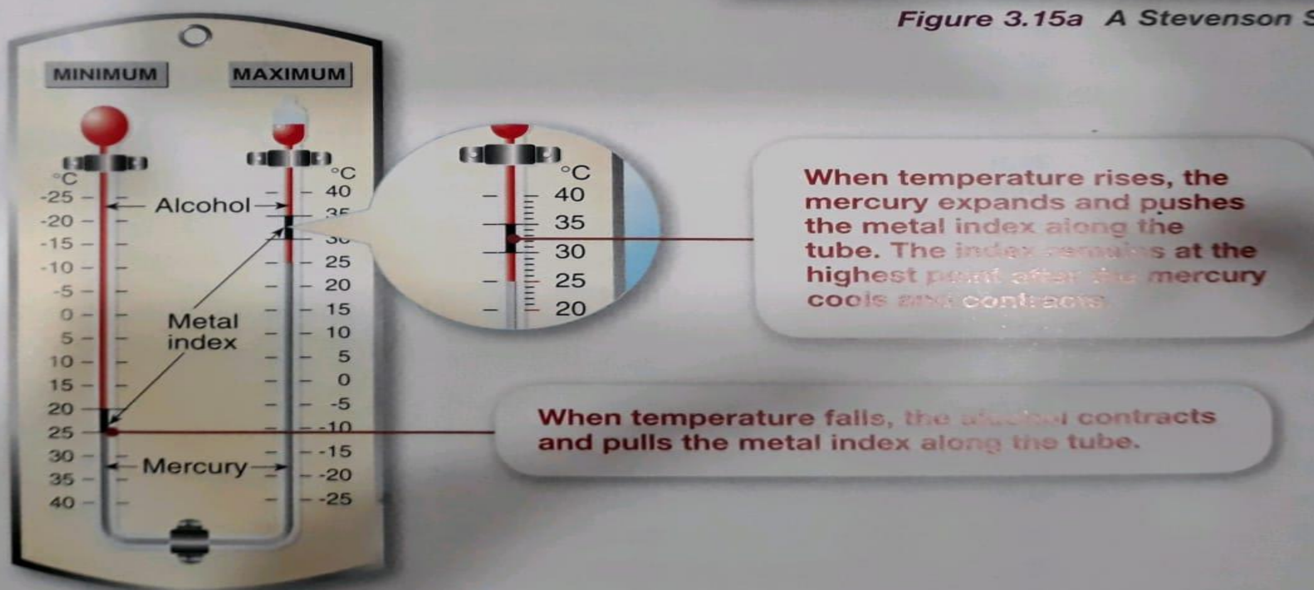


Figure 3.15b A maximum and minimum thermometer

DIURNAL RANGE

Calculating diurnal range of temperature and average daily temperature

Information of air temperatures helps farmers to take note about how their crops are doing. It also helps those of you who live in the city to plan better for the next day.

The difference between the maximum temperature and the minimum with little cloud cover temperature of any one day is called the diurnal range of temperature. Places such as the hot deserts will experience a great diurnal range while places along the equatorial regions will have a small diurnal range of temperature. Try the following activity with your friend.

Activity

Singapore

Ain Salah, Algeria

Time	Hourly temperature reading (°C)	Hourly temperature reading (°C)
midnight	27.0	28.0
1 am	27.6	26.2
2 am	27.2	24.5
3 am	27.0	23.7
4 am	27.0	22.1
5 am	26.9	20.8
6 am	26.9	22.0
7 am	25.8	24.3
8 am	27.1	26.3
9 am	28.4	28.5
10 am	31.0	30.4
11 am	30.7	32.7
noon	31.3	35.1
1 pm	31.2	38.2
2 pm	29.9	41.5
3 pm	30.0	44.5
4 pm	30.1	45.0
5 pm	28.7	44.5
6 pm	28.3	43.5
7 pm	26.0	41.2
8 pm	27.8	38.6
9 pm	27.7	35.4
10 pm	27.6	32.2
11 pm	27.3	30.5

1. Study the table carefully. Work out the diurnal range of temperature for the two places.
2. What are the advantages and disadvantages of living in a place which has a small diurnal range of temperature?
3. How do you think a large diurnal range of temperature would affec the daily lives of people living in a hot desert?

***Table 3.16** 24-hour temperatu readings for a day in Singapo and Ain Salah, Algeria (in west Sahara Desert)*

AVERAGE DAILY TEMPERATURE

Mean (Average) daily temperature 1

The average of the maximum and minimum temperatures for any one day:

$$\frac{\text{Maximum temperature} + \text{Minimum temperature}}{2}$$

The second way is to record the temperatures taken at every hour of the day over a 24-hour period. Then take the average of the hourly temperature readings by adding them up and divide the sum by 24.

Mean (Average) daily temperature 2

The average of all the 24-hourly temperature readings for a particular day:

$$\frac{\text{Sum of 24-hourly temperature readings}}{24}$$

ACTIVITY

Time	Hourly temperature reading (°C)
midnight	27.7
1 am	26.1
2 am	25.6
3 am	25.2
4 am	25.3
5 am	25.7
6 am	25.5
7 am	26.6
8 am	27.9
9 am	29.2
10 am	30.0
11 am	30.6
noon	30.6
1 pm	29.9
2 pm	31.2
3 pm	31.8
4 pm	31.3
5 pm	30.7
6 pm	29.5
7 pm	28.5
8 pm	28.2
9 pm	28.2
10 pm	28.1
11 pm	28.3

Table 3.17 Table for the 24-hour temperature readings for 1 July 1998 in Singapore

MEAN MONTHLY TEMPERATURE

The average of all the mean daily temperatures in a particular month:

$$\frac{\text{Sum of all the mean daily temperatures in the month}}{\text{Total number of days in that month}}$$

MEAN ANNUAL TEMPERATURE

The mean annual temperature for a particular year can be calculated by adding up the mean monthly temperatures for all the months in that year and dividing the sum by the total number of months.

The average of mean annual temperatures of at least 30 years of a particular weather station will give a good representation of what the climate of a place is.

READING A LINE GRAPH

All temperature data can be plotted on a line graph. The figure below shows Port of Spain's (Trinidad) temperature for 2005.

Month	Temp (°C)
Jan	25.5
Feb	25.8
Mar	26.3
Apr	27.2
May	27.5
Jun	26.9
Jul	26.9
Aug	27.1
Sep	27.1
Oct	26.9
Nov	26.9
Dec	25.8

Figure 3.20 Temperature line graph of Port of Spain, Trinidad

It is important to know how to read the line graph. When you are analysing the line graph, you must take note of the following:

- Are the temperatures fluctuating? Do the temperatures remain unchanged?
- Are there variations in the temperatures? How large or small are the variations?
- Which period of the year does the country experience high temperatures? How high is the temperature? Is there a range?
- Which period of the year does the country experience low temperatures? How low is the temperature? Is there a range?
- What is the annual temperature range?

These are terms to describe the mean annual temperature:

- Temperature that is below 10°C is low.
- Temperature ranges from 10°C to 20°C is considered moderate.
- Temperature that is greater than 20°C is high.

WEATHER SYMBOLS

Weather symbols

Information on the weather is obtained daily by meteorologists. The amount of information is very large and it is important that information on weather elements is recorded accurately on weather maps. Weather symbols are used to represent the information on a weather map.

Some symbols are used to represent weather elements such as air temperature, air pressure and speed of wind. Figure 3.21 shows the important weather symbols that are commonly used to represent the information on weather maps. You will need to understand and interpret these symbols in order to understand the information on weather maps.

Total cloud cover

No cloud	⅛ or less cover	¼ cloud cover	⅜ cloud cover	½ cloud cover	⅝ cloud cover	¾ cloud cover	⅞ cloud cover	No blue sky	Sky obscured

Main cloud types

Group	Cloud type with symbols		
High level (6,000–12,000m)	Cirrus	Cirrostratus	Cirrocumulus
Medium level (2,000–6,000m)	Altocumulus	Altostratus	Nimbostratus
Low level (under 2,000m)	Stratus	Small Cumulus	Stratocumulus
Vertical development	Large Cumulus	Cumulonimbus	

Rainfall

•	Light and intermittent
• •	Light and continuous
	Moderate and intermittent
	Moderate and continuous
	Heavy and intermittent
	Heavy and continuous
▽	Showers
△	Hail
	Drizzle
	Thunderstorm
	Thunderstorm with hail
	Fog — Mist — Haze

Note:
Continuous rainfall – symbols horizontal
Intermittent rainfall – symbols only vertically aligned

Wind strength

Symbol	Speed (knots)	Speed (km/hr)	Symbol	Speed (knots)	Speed (km/hr)
	Calm	Calm		35	65
	< 5	< 9		40	74
	5	9		45	83
	10	19		50	93
	15	28		55	102
	20	37		60	111
	25	46		65	120
	30	56		70	130

Note: Each half feather = 9km/hr (5 knots)
A whole feather = 19km/hr (10 knots)
A shaded triangle = 93km/hr (50 knots)

Eye of tropical disturbance with wind speeds below 119km/hr

Eye of hurricane with wind speeds over 119km/hr

Fronts

Symbol	System
	Cold front
	Warm front
	Quasi-stationary front
	Intertropical Convergence Zone (narrow zone, one area of activity)
	Intertropical Convergence Zone (wide zone, two areas of activity)

Figure 3.21 Weather symbols

WEATHER MAPS

Weather maps show the atmospheric conditions of a region or a place at a particular time of the day. A weather map usually shows several station weather plots or station models and each station weather plot has many weather symbols to describe the various weather elements of the station. By studying the weather plots on a weather map, you will be able to get a 'big' picture of the atmospheric conditions of the particular region represented on the map.

Figure 3.22 shows an example of a station weather plot. It has several weather symbols to provide important information about the atmospheric conditions of Trinidad, the area where the station weather plot is located.

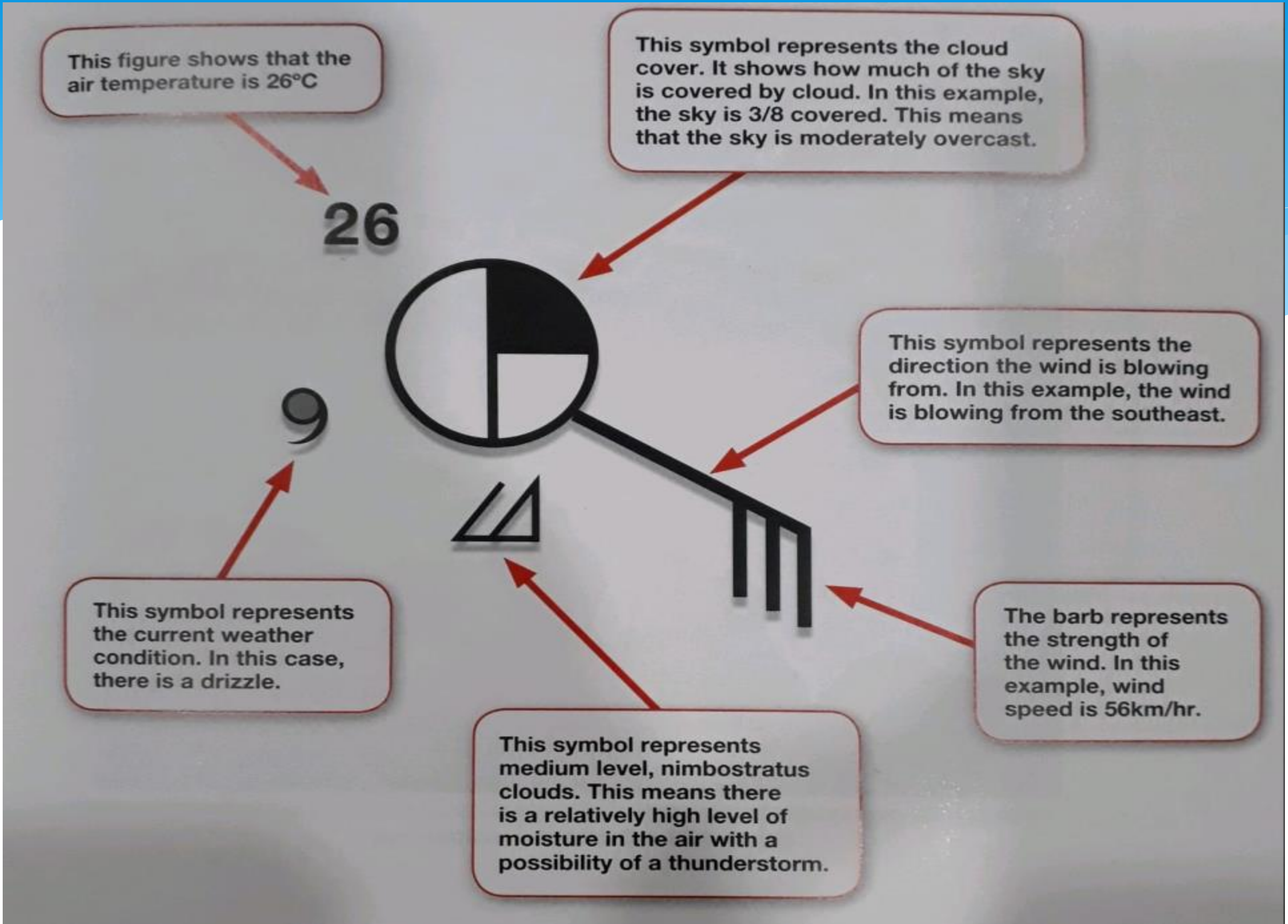


Figure 3.22 A station weather plot and what the symbols mean

ISOBARS

Figure 3.23 shows a Caribbean weather map. Can you describe the weather conditions represented by the weather plots? There is a hurricane affecting a particular region. Can you identify where? The flowing lines on the map are isobars and they represent the air's (atmospheric) pressure. Each of these lines has a value. For example, '1,012' depicts an atmospheric pressure of 1,012mb. This is interpreted as an area of higher air pressure. The centre of the hurricane is an area of low air pressure. The air pressure at the centre is 926mb.

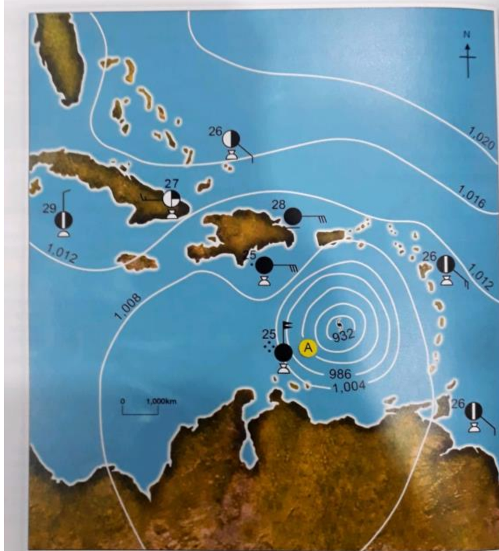


Figure 3.23 A Caribbean weather map

ACTIVITY

Study Figure 3.23 on the previous page and answer the following questions.

1. What is the air temperature of Caicos Islands as shown by the station weather plot?

   a) 24°C
   b) 26°C
   c) 28°C
   d) 31°C

2. What is the air pressure at A?

   a) 932 millibars
   b) 946 millibars
   c) 968 millibars
   d) 986 millibars

3. What is the cloud cover over Dominican Republic as shown by the station weather plot?

   a) No clouds
   b) 4/8ths skycover
   c) 6/8ths skycover
   d) Completely overcast

4. What is the direction of the wind blowing over Dominican Republic as shown by the station weather plot?

   a) Wind from the east
   b) Wind from west
   c) Wind from southeast
   d) Wind from northwest

5. Describe the weather conditions of the area 100km west of the hurricane.