SPACE DYNAMIC

WEATHER AND CLIMATE

(a) Difference between weather and climate

There is a slight difference between weather and climate. Weather refers to as the actual state of atmosphere and climate refers to the average state of atmosphere.

By definition:

Weather is the condition of the atmosphere with regard to its elements for a certain place and at specific moment. It is the daily atmospheric condition of a place at particular time. It is the condition of being hot, windy, cold, foggy, or cloudy. Weather changes from time to time and from place to place. The condition of the atmosphere is determined by the elements of weather which are:

- Temperature
- Humidity
- Atmospheric pressure
- Clouds
- Precipitation and
- Winds

Climate is the average atmospheric condition over a long period of time over 30 to 40 years within a specific geographical area.

Factors that influence weather and climate

Weather and climate are influenced by the factors like;

-Temperature
-Precipitation
-Humidity
-Pressure

-Winds

-Cloud cover

-Sunshine

-Altitude and

-Ocean currents.

Measuring and recording the elements of weather and climate is done at a weather station.

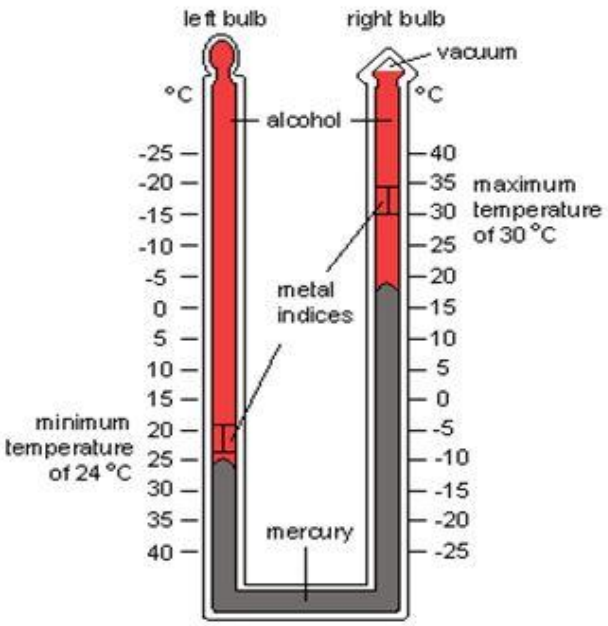
WEATHER STATION is a place that is set aside for the purpose of observing measuring and recording weather elements.

Element of weather

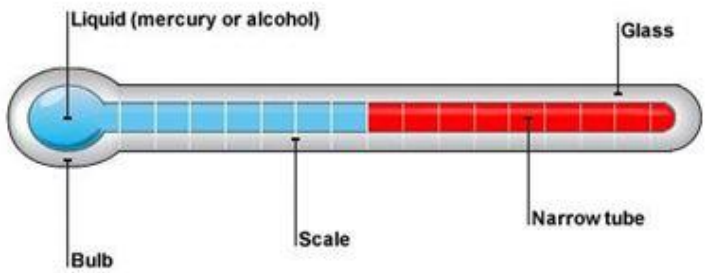
1. TEMPERATURE

Temperature is the degree of a heat of a body. It is a measure or degree of hotness of an object or place .Temperature is measured by an instrument called thermometer. The lines joining all places

with equal temperature are called isothems



Six's thermometer



Minimum thrmometer

RECORDING TEMPERATURE

1. The mean (or overage) daily temperature is obtained by adding the daily maximum and the daily minimum temperature and dividing the sum by two.

$$\frac{\text{max temperature} + \text{min temperature}}{2}$$

2. The daily range of temperature is obtained by substracting the daily maximum temperature by the daily minimum temperature which is,

daily max temp – daily minimum temperature

3. The mean (or average) monthly temperature is obtained by dividing the sum of daily mean temperature of a month by the number of days in that particular month

4. The monthly range of temperature is obtained by subtracting the lowest daily temperature of a month from the highest mean daily temperature of that particular month.

5. The mean(or average) annual temperature is obtained by dividing the sum of the monthly mean temperatures of the particular year by 12.

6. The mean annual range of temperature is obtained by substracting the lowest mean monthly temperature of a year from the highest mean monthy temperature of that same year.

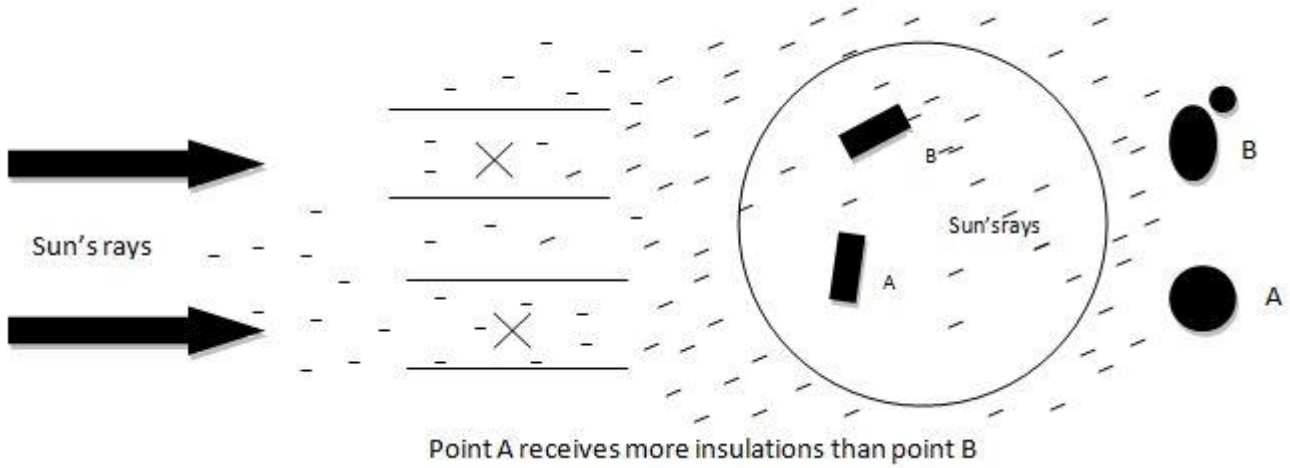
FACTORS AFFECTING INSOLATION OR TEMPERATURE OF A PLACE

Factors that influence the amount of insolation received any point and therefore its radiation balance and heat budget vary considerably over time and space.They include the following.

(a) Seasons and angle of incidence

The earth as a planet moves along its orbit throughout the year under this movement inclination of the earth varies and the angle of which the sun rays strikes the earth's surface changes with seasons.

Also the distance of the earth from the sun varies from month to month.At spring and autumn equinoxes.(21th March and 23rd September) the angle of incidence at the equator is 90º making an area to have high temperature throughout the year.Temperature is distributed equally in both hemispheres.At the summer and winter solsctice (21th June and 22nd December) due to earth tilting the sun is overhead at the tropics where the hemisphere experience summer will receive maximum insolation.The angle of incidence is the most important factor which influences the amount of insolation of a place on the earth's surface.

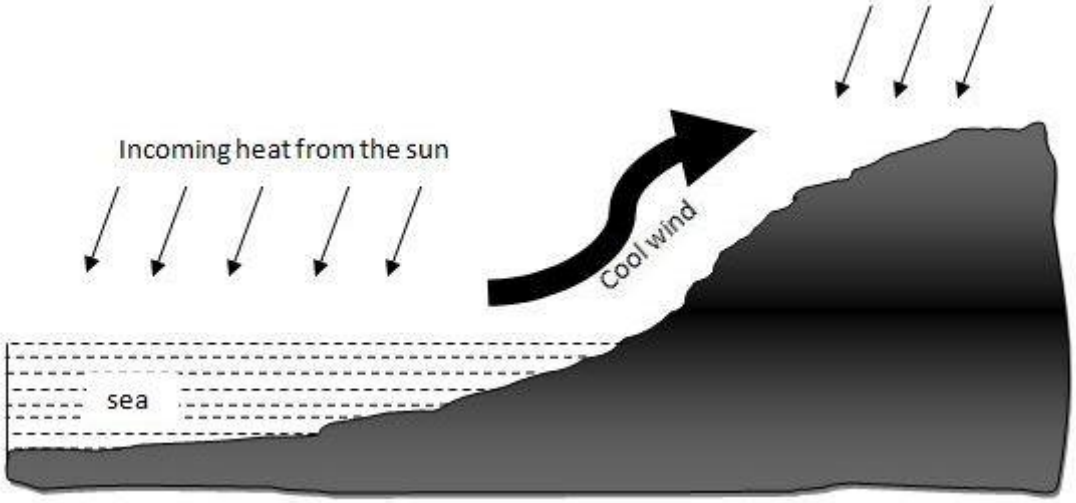


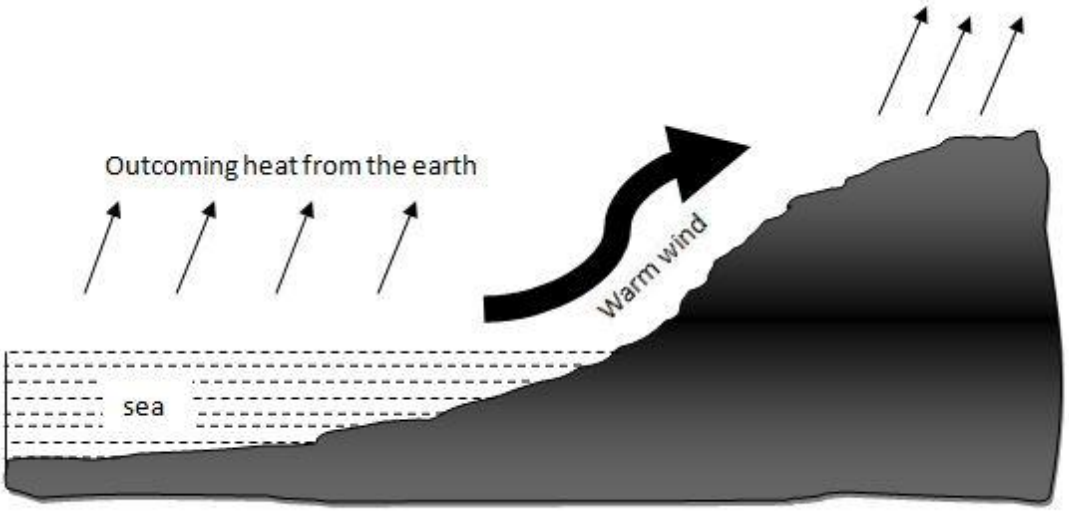
(b)Distance from the sea

There is often a considerable differences between temperature of land and water surface. The reason for this is that land surface heats and cool more slowly than the sea.

Due to this summer temperature in coastal areas are lower than in continental interior. Likewise winter temperature will be higher in coastal areas than in continental interior if the winds blow towards the shore

During the day and during night the situation is related to land and sea breeze. Areas whose temperatures are greatly affected by the sea are reffered to as maritime .The greater distance from the sea the colder the winter it will be and the warmer the summer develops.

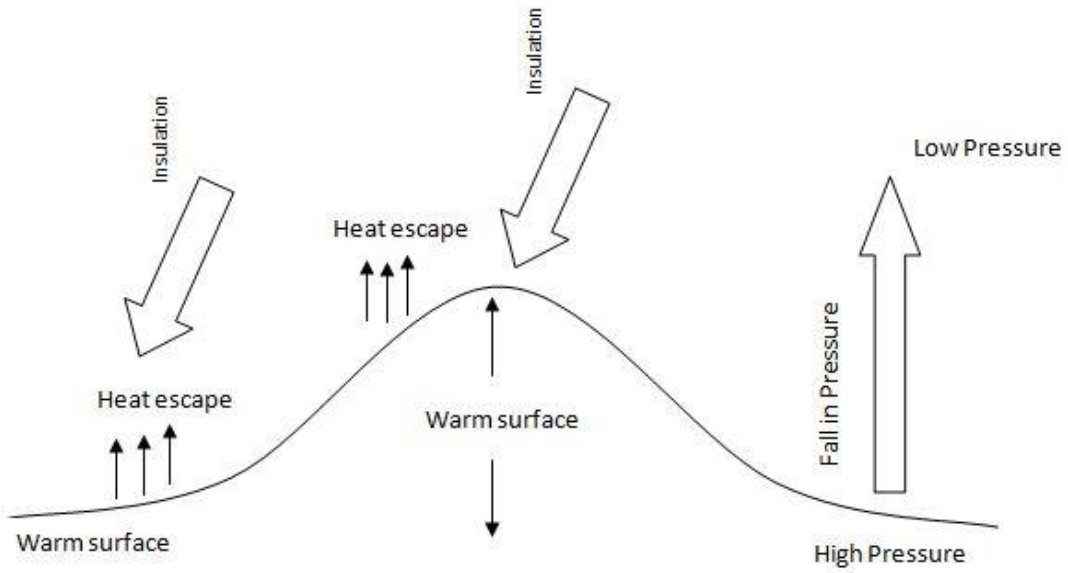




(c)Altitude

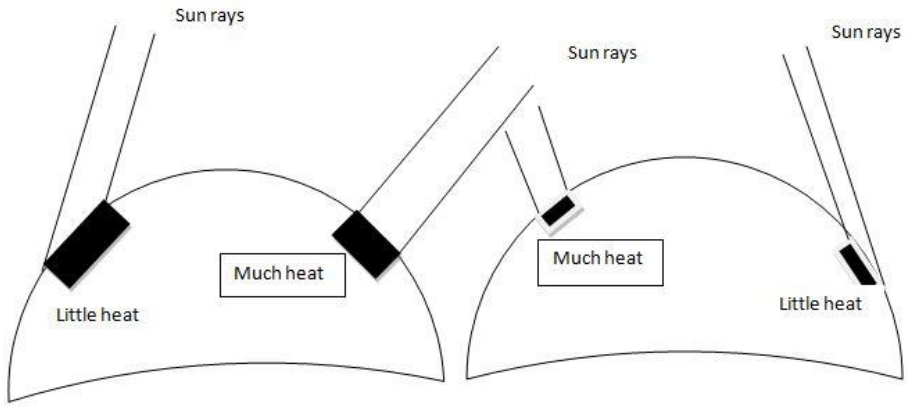
The rate at which temperature decreases with increasing altitude is called lapse rate. Normally air temperature decreases with increasing height at a rate of 0.6ºc R.r 100 meters.This is because when earth surface is heated it passes its heat on air making atmosphere being heated from below and not directly from the sun.This affect temperature because the higher you go the cooler it becomes. Altitude explains why highlands in the tropics are ever cold e.g Mt. Kilimanjaro in

Tanzania.



(d) Aspect

This refers to the direction in which a slope falls.Some slopes are exposed to the sun than others.The atmosphere of the north facing slopes of highlands in the northern hemisphere also called ubac are cooler than the slopes facing south adret.The same thing appears in the southern hemisphere

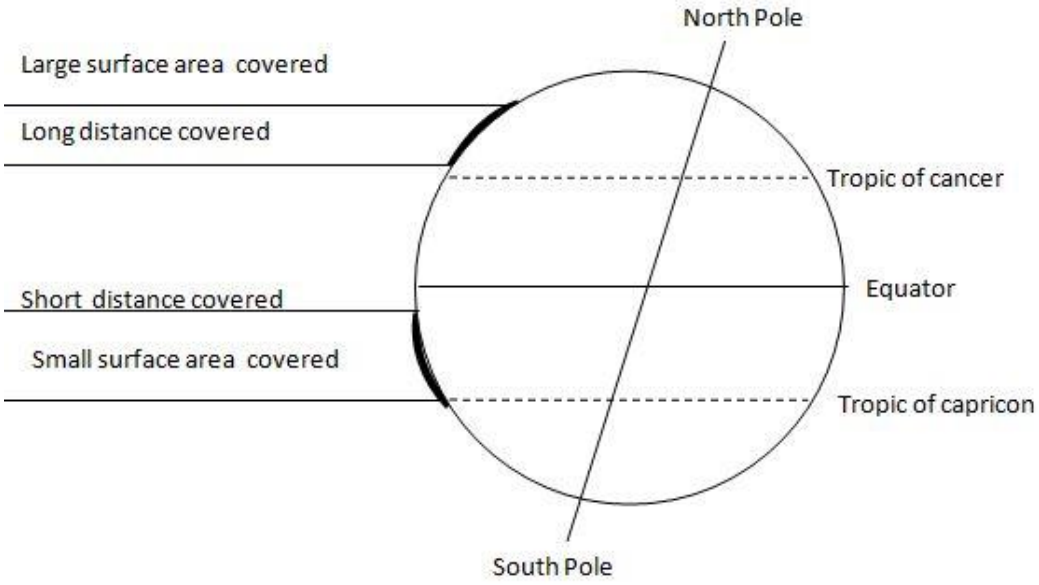


(e) Latitude

It is the angular distance from the equator to the poles. It determines both the length of day throughout the year and the intensity and possible duration of sunlight received.

As one moves pole wards from the equator he experiences gradual progressive decrease in temperature. This is because the sun strikes the equator more intensity than it does in the poles two observations can explain this phenomenon.
(i)At the equator the beam of light strike the earth's surface covering a smaller surface area than in the poles where the same beam of light covers a larger surface area.

(ii)At the equator the beam of light strike travels a short distance hence experiencing less atmospheric effects like absorption reflection and scattering.At the poles the beam of light travels a longer distance and it experiences more effects in the atmosphere.



(f) Cloud cover

The atmosphere of areas covered with heavy clouds is cooler than that of areas with clear skies.This is because clouds prevent insolation to reach sand sea surface.

(g) Length of day and night

Insolation is only received during day light hours and reaches its peak at noon .The longer the period of solar insolation the greater the quantity of radiation received at a given place on the earth's surface.There are no seasonal variations at the equator where days and nights are of equal

length throughout the year.In contrast polar regions receive no insolation during part of winter when there is continuous darkness but may received up to 24 hours of insolation during parts of the summer when the sun never sinks below the horizon .This occurs in the lands of the midnight sun

(f) Prevailing winds.

Temperature of the wind is affected by the temperature of it's area of origin and of the surface over which it blows normal winds blowing from the sea during winter warms the atmosphere of the land near the sea while winds blowing from the sea during summer cools the atmosphere of the coast

(g)Ocean currents

Warm ocean currents carry warm water pole wards and rise the air temperature of the maritime environments where they follow while cold ocean currents carry cold water to the equator and so lower the temperature of the coast areas.

<u>Factors affecting the flow of ocean Currents</u>

Ocean currents – this is the horizontal movement of mass water in a defined direction .The movement is due to density variation at various depths governent by the temperature and salinity .The meeting of two currents converging upon one another causes sinking of water which counter balances with ascending masses.

- Salinity differences

Density of ocean water is caused by amount of salts the more salt in an ocean the denser the water will be.Denser water sinks in water with low density which causes the formation of ocean currents.

- Temperature

Temperature causes differences in water density which causes ocean water to move. The cold water is denser than warm water, this tends to make polar cold water sink to the bottom then flow downwards towards the equator while the warmer less denser water at the tropic moves on

the surface towards the poles .After being cooled it sinks again and moves towards the equator hence the ocean current.

- Prevailing winds

When wind blows over ocean surface it pushes water surface and forms the ocean current .Prevailing winds therefore cause the water to move to the direction they blowing to winds cause drift currents. An example of drift currents is the north Atlantic drift which is caused by the westerly winds in the Atlantic ocean.

- Rotation of the earth

This causes the current flow to be affected as they are deflected or pushed according to Ferrell's law. Ferrell's law slates that"Anything moving freely in the northern hemisphere will be deflected to its right while in the southern hemisphere it will be indirectly though the winds where in the northern hemisphere ocean current are deflected to their right while in the southern hemisphere to their left ".

- Shape of landmasses

The flow of ocean water can also be directed by the landmass.The ocean currents are turned from their straight course by the shape of adjacent landmass or coast line.

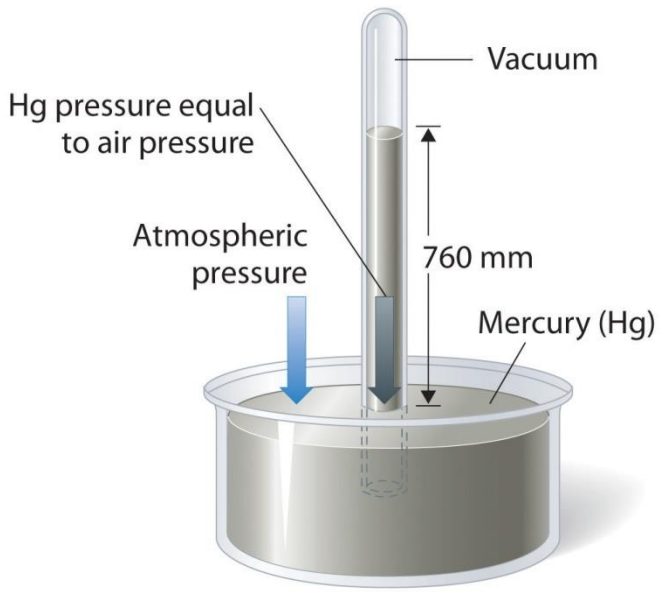
What is a temperature anomaly ?
The term temperature anomaly is used specifically to describe temperature differences from a mean .It shows the difference between the mean temperature of a place and the mean temperature of other places with the same latitude in the same month.
For example:An area which has a mean January temperature of 4ºc, which is 20ºc higher than the average for other location laying at 58 degree latitude north.such anomalies result primary from the ueven heating and cooling rates of land and sea and are intensified by the horizontal transfer of energy by ocean currents and prevailing winds.

2. ATMOSPHERIC PRESSURE

Air has weight and therefore it exerts the pressure called atmospheric pressure on the earth surface.Pressure varies with the temperature and altitude, and an instrument which measure pressure is called barometer.

There are two types of mercury
(i)barometer
(ii)aneroid barometer

The lines which join all places with equal pressure are called bars.Thus pressure varies from one place to another it is not the same in one or all the regions.



FACTOR INFLUENCING VARIATION IN ATMOSPHERIC PRESSURE

- Temperature

As temperature decrease pressure rises at the same height due to low temperature cold air tend to sink, thus inducing high pressure to develop But as temperature increases hot air tends to rise making it possible for low pressure to develop over the area.

- Altitude

Usually pressure of the atmosphere decrease with increasing height. Pressure is therefore lower at the mountain top than at the sea level.This is because at the sea level air has to support a greater height than it does on the top of mountain.Thus there is less force or weight of air at the mountain top than at the sea level.

- Revoluation of the Earth

The earth revolution causes seasons where some seasons are warm while others are cold .Revolution of the earth affects the position of the low pressure belt i.e doldrum. Normally doldrum moves northwards and southwards of the equator depending on the seasons.

Earth rotation as a ball causes formation of subtropical high-pressure belt around 35º north and south of the equator where air sinks down and gets compressed .Due to this compression the sinking of air is heated up and rises again. The same situation takes place around circumpolar or temperature belt around 60º north and south of the equator.These are the areas where the warm subtropical air rises over the cold polar air expands and gets cooler.This situation result into Depression cyclonic or frontal.

PLANETARY PRESSURE BELTS

THE WORLD PRESSURE BELTS

These can be analyzed according to temperatures:

(i)Equatorial low pressure belt / equatorinally trough

This is called doldrum it is located around 5º north and south of the equator.The air here rises due to high temperature it is a wind a convergence zone. This means winds meet there and it is called intertropical convergence zone (ITCZ)

(ii)Subtropic high pressure belt (Horse latitudes)

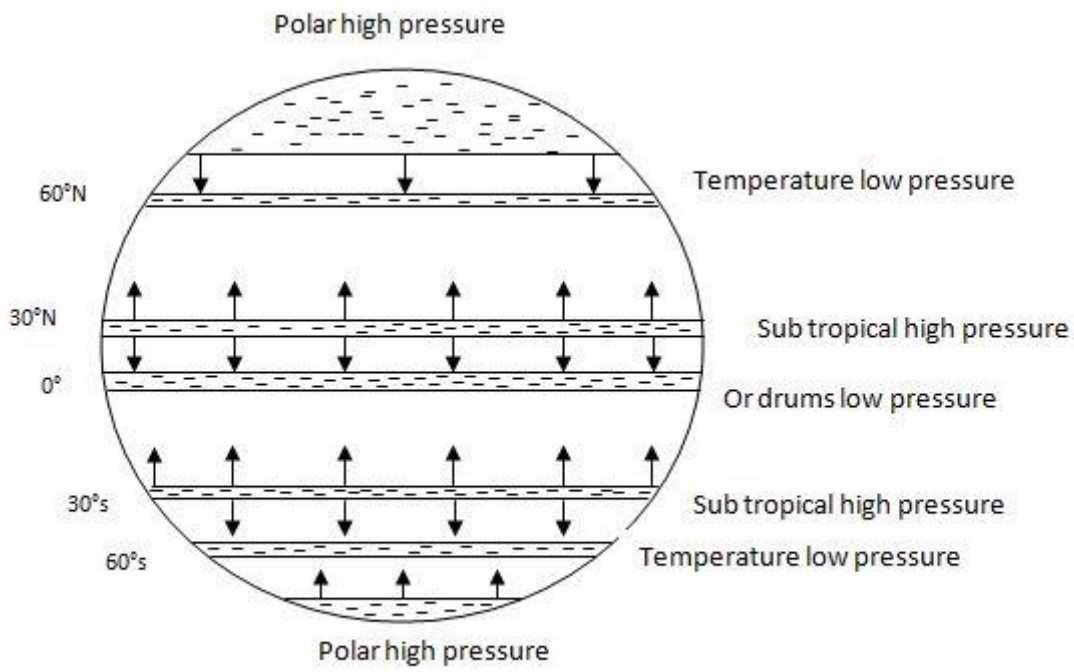
This is located at 30º north and south of the equator with descending air current due to heat of temperature. High pressure is attributed by accumulation of cold air which moves from the equator towards poles.This belt is also referred to as the "horse belt".

(iii)Temperature low pressure belt (sub polar low temperature belts)

This is found at 60º north and south of the equator. It is also known as cyclonic activities zone or zone of convergence. Existance of low pressure is mainly dynamic rather than a result of temperature change.

(iv) Polar high-pressure belt

This is confined at 90º north and south of the equator. Pressure is permanently high due to low temperature attributed by a dense descending air from the temperature low pressure belt.



Pressure and wind pattern on the uniform earth surface

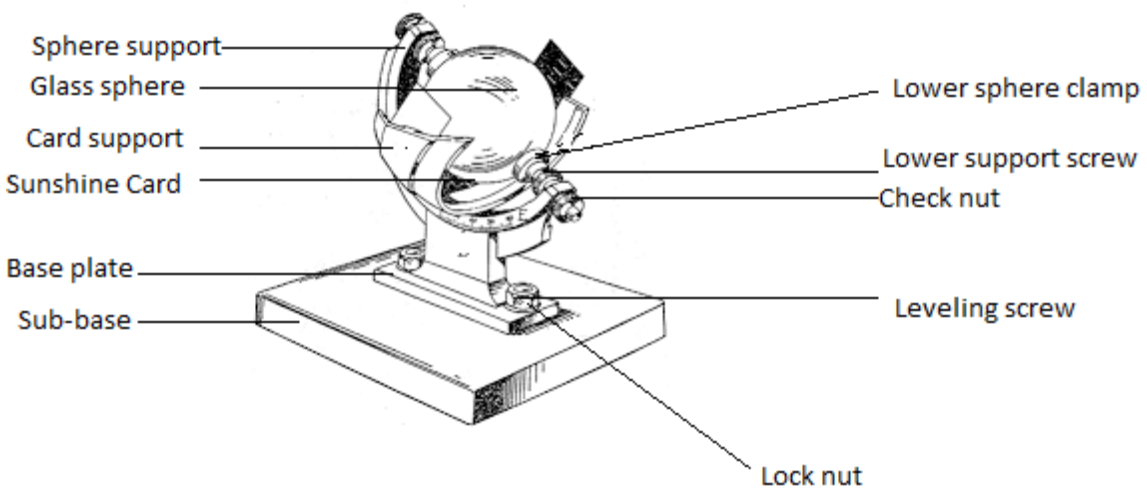
3. SUNSHINE

This is another element of weather. The duration of sunshine is party of a function of latitude. For the hours of light (that is possible sunshine) vary with these season in different latitudes.It is also a function of daytime cloudiness .

MEASUREMENT AND RECORDING OF SUNSHINE

The duration of bright sunshine is measured by means of campbell stokes recorder, a solid sphere of glass 10cm in diameter. This form the rays of sunshine onto a sensitized card graduated in hours and so burn a line during the time the sun is shinning .Faint sun,light sun, near dawn or dusk or when the sun is partially abscured is not recorded .Tables of sunshine data are prepared from these record, in the form of either absolute solution in hours per day or as percentage of possible sunshine per day or month. When means figures has been obtained over the requisite number of years, the value for each state can be plotted, and lines of equal mean duration of sunshine isohels can be interpolated.

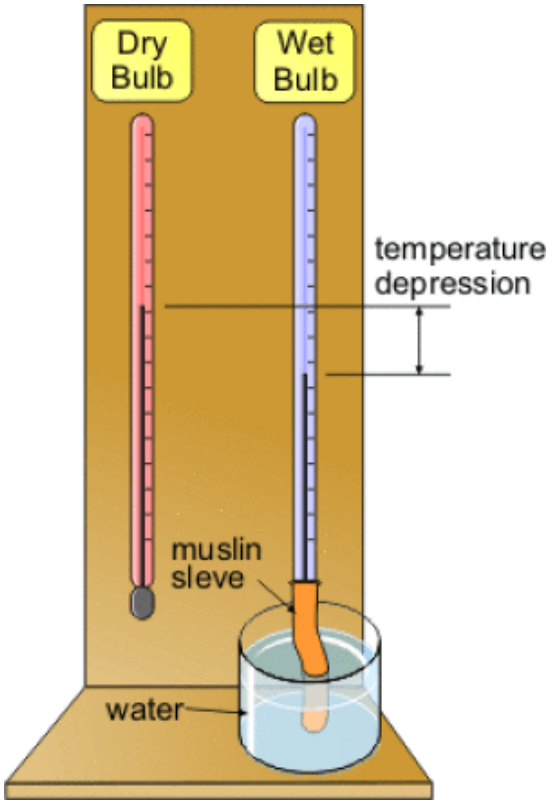
SunShine recorder



4. HUMIDITY

This is refered to as the atmospheric moister .The moister is obtained from various sources such as oceans, lakes,seas, dams,ponds and rivers. It is of high importance as far as weather as climate

is concerned. Air absorbs water through the process of evaparation which result in water changing from its liquid state to gaseous state,the gaseous state is called water vapour. The amount of water vapour in the air is called humidity and it is measured by an instrument called hydrometer placed in the Stevenson screen.



FACTOR INFLUENCING HUMIDITY

-Air pressure

When air is compressed, it warms up and its density becomes lower .Thus at low altitude where pressure is high air will absorb more moister. At high altitude where pressure is lower air expands and cools and its capacity to absorb moister is reduced.

-Latitude

Humidity higher in lower latitudes than in higher latitude because there is greater rate of evaporation at lower latitudes due to high

temperature.Likewise the mount of moister in the air is higher in summer .

-Temperature

Arise in temperature lowers relative humidity if the amount of moister

remains constant because when air is heated it expands .The volume increase and therefore distribution of water vapour per unit.Volume became less.The air will have a greater capacity of holding more water vapour if air is cooled it contracts and decrease in volume making the space which moister can occupy become less .That is why if air continues to cool it will reach saturation and it gets rid of excess water vapour through condensation .

-Moisture supply

If the supply of moisture increases the air will have more of it ,they making absolute humidity to be higher .If the temperature if the air increases it will absorb even more moisture .This situation makes all places which are near large water bodies to be humid especially if the temperature is high causing a lot of evaporation. Areas that are far away from large water bodies such as deserts center has little water vapour the air has high capacity of holding moisture.

IMPORTANCE OF WATER VAPOUR IN THE ATMOSPHERE

- Evaporation forms precipitation ,which provides fresh water plants and animals.
- It absorbs both incoming and radiated energy from the sun.
- It conveys Latent heat into the atmosphere

The amount of water vapour the atmosphere can hold depends upon the temperature of the air the higher the temperature of the air the higher the capacity of it to hold water .

COMMON WAYS OF STATING WATER VAPOUR (HUMIDITY)

(I) Absolute humidity

This is the actual amount of water vapour in a specific volume of atmosphere i.e the mass of water vapour per cubic unit of air and it is normally expressed in g/m^3

(II) Relative humidity

This is the proportion of water vapour present in the air compared to the maximum amount of

water vapour, possible at the same temperature and it is usually expressed in percentage.Normally saturated air has relative humidity 100%.

5. PRECIPITATION

This refers to water that falls on the earth in liquid or solid forms.Some common forms of precipitation are rain, snow, sleet and hail.

Rain

This is most common form of precipitation spread every where and it is liquid form.It forms when tiny water droplets merge together around the nuclei to form rain drops.After becoming heavy enough they fall down to the earth surface as rain.Rainfall is measured by an instrument called rain gauge and the lines which join all places with equal rainfall are called isohyets.

Snow

This is refered to as solid precipitation, which forms when air cools to below the dew point or freezing point and fall down as ice while falling the ice crystals may join together to form snow flake.

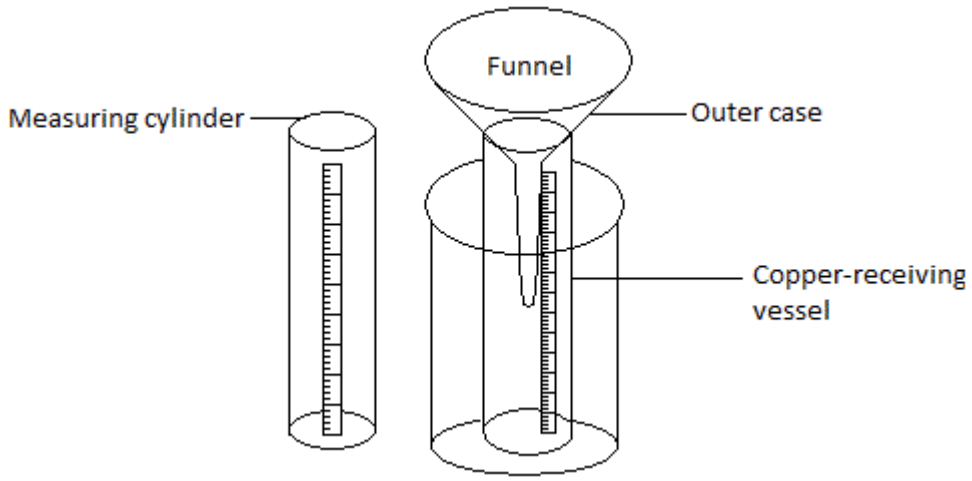
Sleet

This is a frozen or partly frozen rain droplet; it so often referred to as frozen rain. It is hazardous as it may destroy crops, bring down power lines and tree branches

Hail

This is caused by super cooling of water particles in a convectional up shaft .This super cooling forms the hail stones .These stone vary in size depending on the intensity of cooling by that convectional cewent. It is more hazardous than sleet. Hail can cause coderable damage to property and plants some hail stones weight up to 2.5 Kilogram which may hit the ground at speed of up to 160 km/hr.

All forms of precipitation result from rising and cooling of air to below the dew point where condensation begins.The visible effect here is clouds in order for precipitation to occur the small droplets of water in clouds must join together in drops too large to remain or be sustained in the atmosphere thus they prefer to fall down on the earth surface as precipitation.



CAUSES OF RISING OF AIR

When air rises there is less pressure on it at the new altitude.As a result the temperature of the rising air is lowered and cools causing that air to descend and become warm. The rate of cooling or heating that results from this vertical movement of air (ascending deslending) is called adiabatic rate.

For saturated air the rate of temperature change is 0.6ºc per 100 meters, which forms unsaturated air rate is 1ºc per 100 meters and it is called dry adiabatic rate.

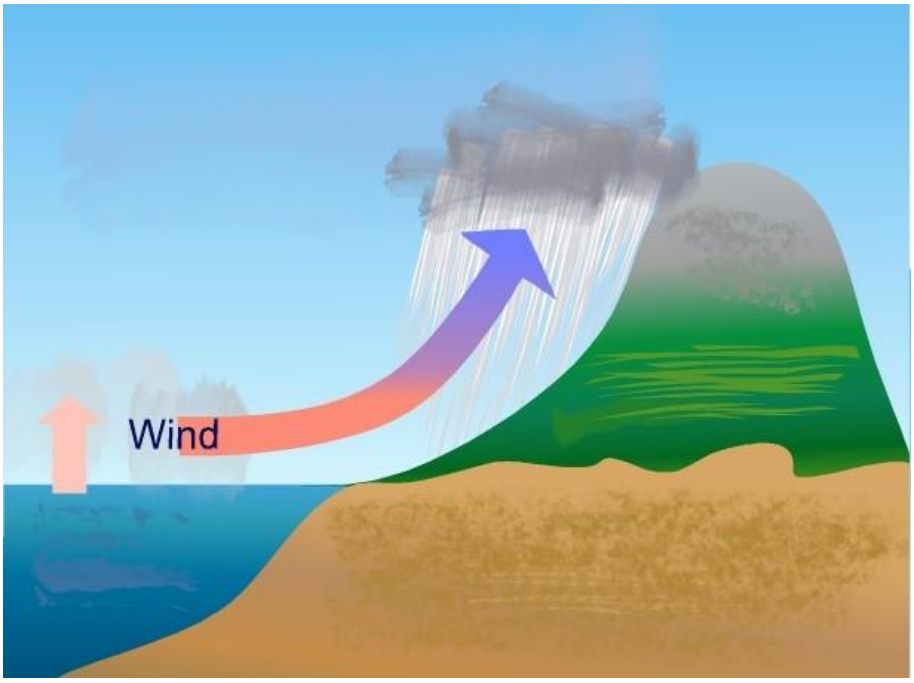
CAUSES OF AIR RISING FOR PRECIPITATION

The causes of air rising are also known as the types of rainfall or the factors that influence rainfall. The factors include relief convection and the water bodies.

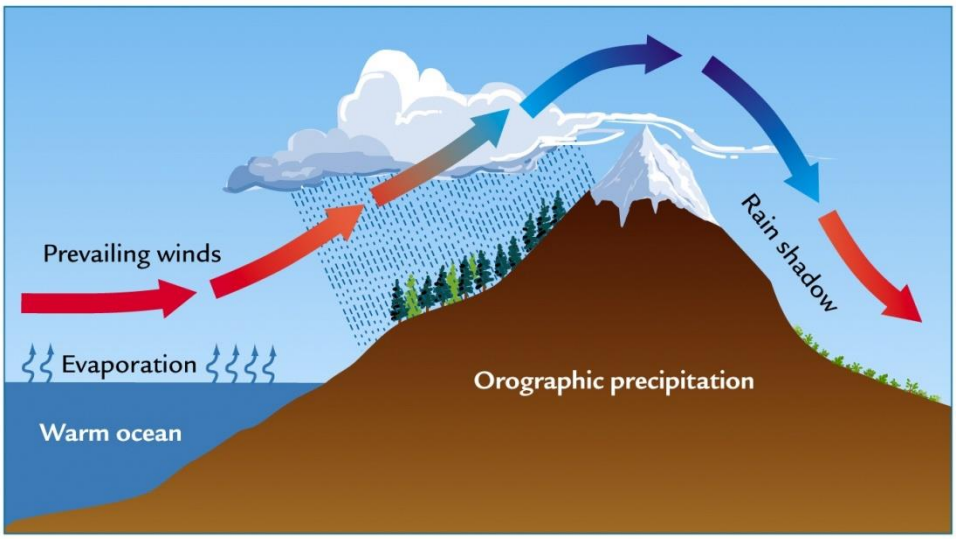
(i) Orographic or relief cause

Orographic cause of air rising forms orographic or relief rainfall.It forms when air is forced to ascend as a result of relief features such as mountains or plateaus. Where moist air reaches the

mountain precipitation forms and it is called windward side while the other pass away from windward form the leeward side or rain shadow.

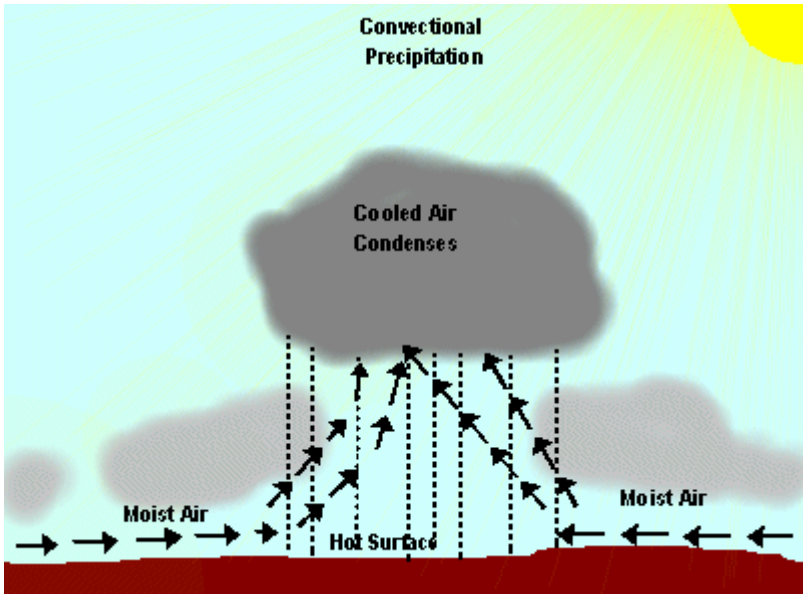


When moist air is forced to rise over a mountain range,clouds and rain often occur.



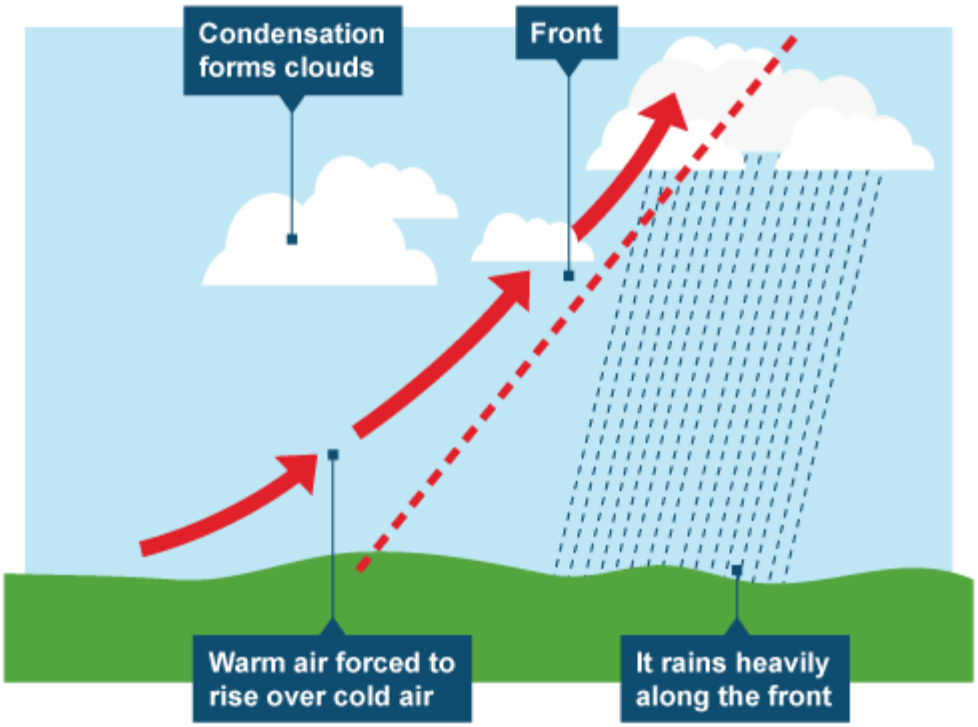
(ii) convectional cause

Here air is forced to rise as a result of intense heating the surface air is heated and vertical upshaft to air occur this process is called convection and it forms convectional rains it is common in summer or hot seasons.



(iii) Frontal or cyclonic cause

Where two bodies of air masses coming from different directions and with different characteristics in terms of temperature and moisture content meet, the warmer air will be forced to rise and condense to form precipitation. The point where these two winds or air meet is called front hence frontal of cyclonic rainfall.



Warm air is forced to rise when it is under cut by colder air,clouds and sometimes Rain.

Importance of precipitation

i. It may lower temperature

ii. It supplies water to streams and rivers

iii. It is a source of water watering crops

iv. It absorbs solar radiations

IMPACTS OF PRECIPITATION.

Impacts of precipitation can be categorized into positive and negative.

(i) Development of water bodies: precipitation encourages the development of water bodies such as rivers and lakes. These are important for irrigation, hydroelectric power generation ,transport, supply of H_2O for domestic and industrial use and fishing.

ii) Cleaning the atmosphere. The falling drops collect the dust particles and deposit them on the surface, keeping the atmosphere clean or less polluted.

(iii) Temperature regulation: -precipitation especially rainfall, regulates the temperature such that the atmosphere attains moderate weather condition rather than extremes.

(iv) Soil development precipitation also plays an instrumental role in soil development. It encourages the weathering of rocks and the decomposition of organic matter. Where there is high precipitation chemical decomposition takes place effectively.

(v) Encouraging plant growth: precipitation supplies water the surface, which used by plant for growth. This has advantage in the development of Agriculture since where is effective plant growth there is positive agricultural development.

(vi)Soil erosion:this takes place when rainfall is very heavy. Erosion is more pronounced in the areas where the surface is bare and sloppy Erosion destroys vegetation, houses, transport systems etc.

(vii) Outbreak of diseases :when there is precipitation water born disease such as dysentery. Typhoid, diarrhea and cholera, as well malaria are very common

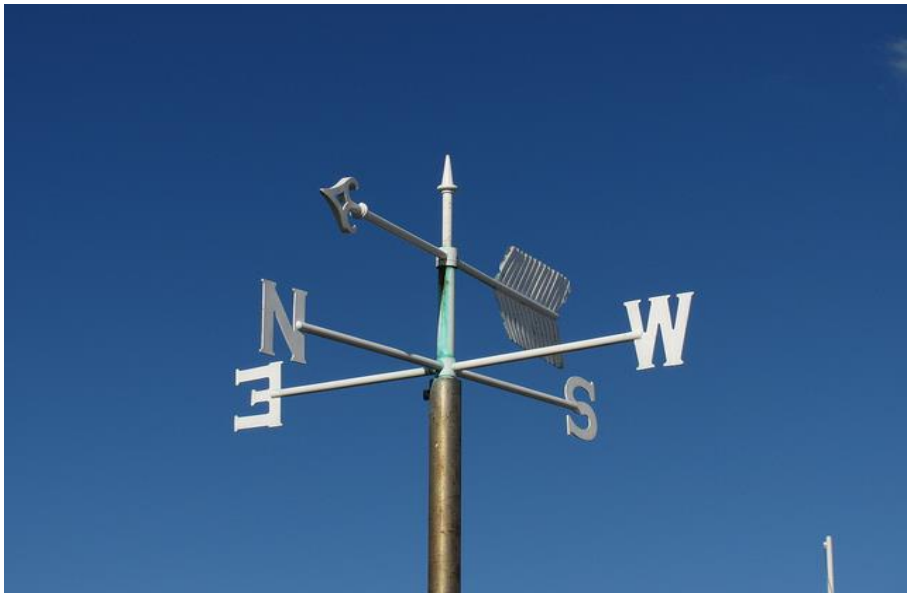
(viii) Floods: Heavy precipitation leads to the occurrence of floods, which in turn destroy crops, houses,kill animals and people etc.

(ix) Mass – wasting (mass movement) takes place as result of the disturbances caused by precipitation on the weathered rock particles. Mass movement can destroy crops, kill people and animals and destroy electricity supply networks as well as causing a lot of damage.

(x) Water pollution is caused by surface run – off cover land Flow and foods, which collect various waste materials and empty them in the water bodies like rivers. Dams and natural lakes. Some of the pollutants are deleterious charmatul to human health.

6. WINDS

A wind is air in motion which always move from high pressure to low pressure belts.Wind speed is measured by an instrument called anemometer while wind direction is measured by wind vane. During wind movement it causes some balances such as temperature balance，humidity balance and pressure balance.



FACTORS WHICH ACCOUNT FOR DIRECTION AND STRENGTH OF WIND

1. Pressure gradient

Variation of pressure from one place to another due to variation in pressure causes wind to develop and move from high – pressure belt to low- pressure belt: the larger the pressure gradient the greater the winds speed.

2. Coriolis force

This is the force due to earth rotation: It obeys the Ferrell's law which state that"Any object moving freely in the northern hemisphere is deflected to its right while southern hemisphere is deflected to its left". This force is called Coriolis force and the resultant wind is called geostrophic wind.

3. Friction

This is common especially up to 900 meters above the sea level due to mountains and big valleys, which may reduce the speed and change the direction of winds. The influence of friction stronger on sand surface than on water.

4. centrifugal force

This is the force due to earth curvature and this force acts outward when an air stream moves on a curved course as in a pressure system with closed or curved isobars is subjected to centrifugal force acting outwards from the center of curvature.

WIND SYSTEMS

Wind systems are related to pressure belts these winds are called prevailing winds and they are deflected according to ferrell's law prevailing winds are those which blow more frequently than other wind in a particular region. Among these winds are trade winds westerly and polar.

(i)Trade winds

These winds meet at the doldrum they are noted for their constancy of force and direction.They are terrible tropical storms which occur at certain season. At the equatorial belt the air is heated and rises to be replaced by air moving in (winds) from north and south.These form north east trade winds and south east trade winds which obey ferrell's law.

(ii)Westerly winds

These blow across latitude 35º and 60º to the polar front these winds are characterized by constant strength and direction in the southern hemisphere while in the northern hemisphere and masses disrupt much of their strength .These winds include north west and south west westerly

(iii)Polar winds

These winds are of solid air they are more pronounced in the southern hemisphere and irregular in the northern hemisphere due to interruption by mountains.

(iv)Monsoon winds

These are seasonal winds if the pressure of a large continent is high the wind will blow out of it to the sea where pressure is low These are called "offshore winds".

These winds are common during winter in Asia as inland temperature is very low while sea temperature is still warm and less dense.If the pressure over a large continent is low than winds blow into it from the sea where pressure is higher.These winds are called "onshare winds" and they are common in Asia during summer.

(v)The upper air movement

Prevailing winds are normally surface winds not very far from the earth's surface. These systems of wind are of high speed and high altitude approximately 1000 to 12000 meters above the sea level within these winds are narrow bands of extremely fast moving air known as "jet streams"

JET STREAMS

Evidences of strong winds in the upper troposphere first came when first world war, several interwar ballons blown off- course were observed travelling at speed in eccess of 200 km per hour. Pilots in the second world war, flying at height above 8km found east ward flights much faster and their return westward journey much slower than expected. The explanation was to and to be a belt of upper air westernizes the Rossby wave which form a compute pattern around the globe.

FIVE MAIN JET STREAMS ARE

There are five recognizable jet streams, two are particularly significant with a third having seasonal importance

i. Polar front jet stream (PEJS)

This occurs in middle latitudes between 40 and 60 degrees and a height of 9000 – 12000 meter more or less at the tropopause in the hemisphere. The winds form the division between the

ferrell's and polar cells which is the boundary between warm tropical and cold polar air these winds are responsible for giving fine or wet weather on the earth's surface.

ii) Sub tropical set stream (STJS)

This occurs at about 12000 meters and 25 to 30 degrees from the equator and form the boundary between the Hadley and Ferrell cell in effect vortex associated with the mid-latitude cell. They have lower velocity compared to PFJS but follow the west-east pattern.

iii) Equatorial Easterlies set stream (EEJS)

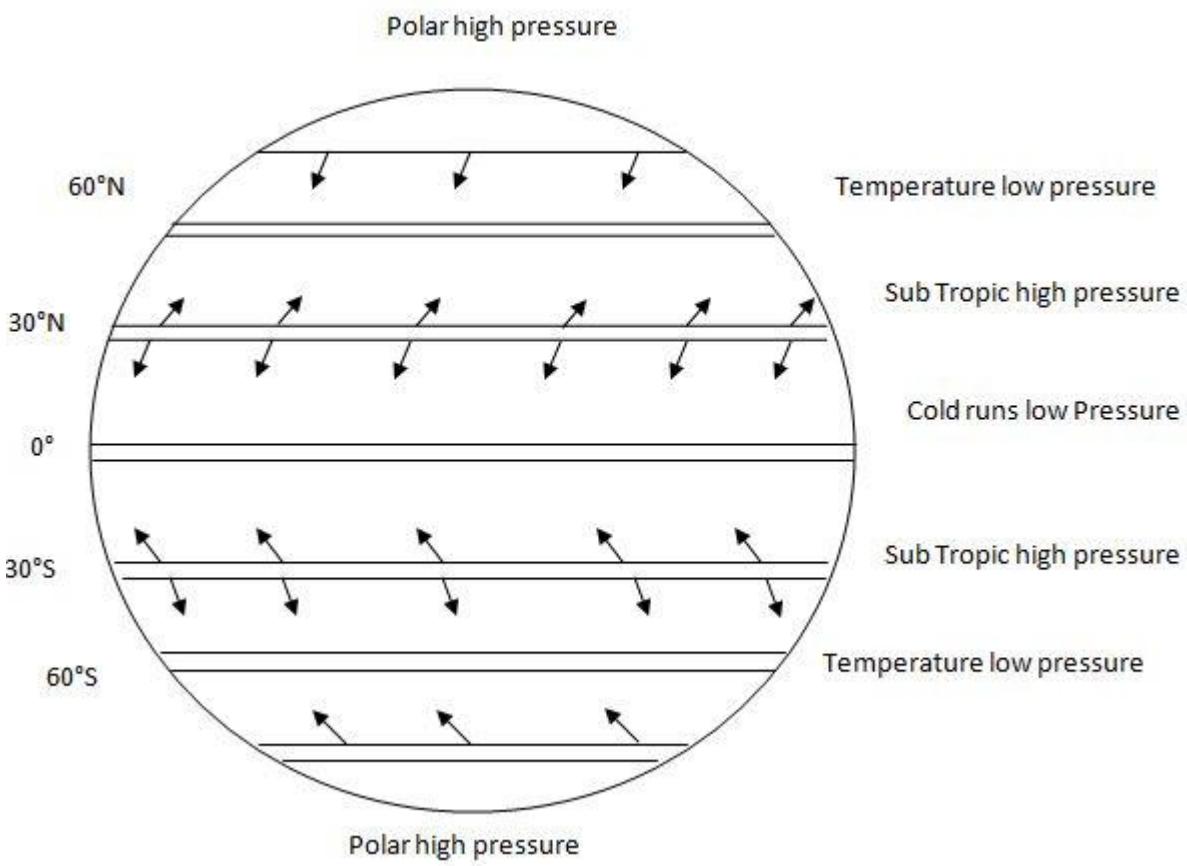
This is more seasonal being associated with the summer monsoon of the Indian sub continent.

iv) Arctic set streams (AJS)

This has been traced across Alaska and Canada at about 7600 meters.

v) Polar night set stream (PNJS).

This is recently discovered above the Aretic circle in the lower Stratosphere.



LOCAL WINDS.

Local winds are controlled by the surrounded"terrain"or environment they are not controlled by planetary system of the winds they are rather diurnal than seasonal. There winds do affect animals, plants and movement of industrial pollutants.

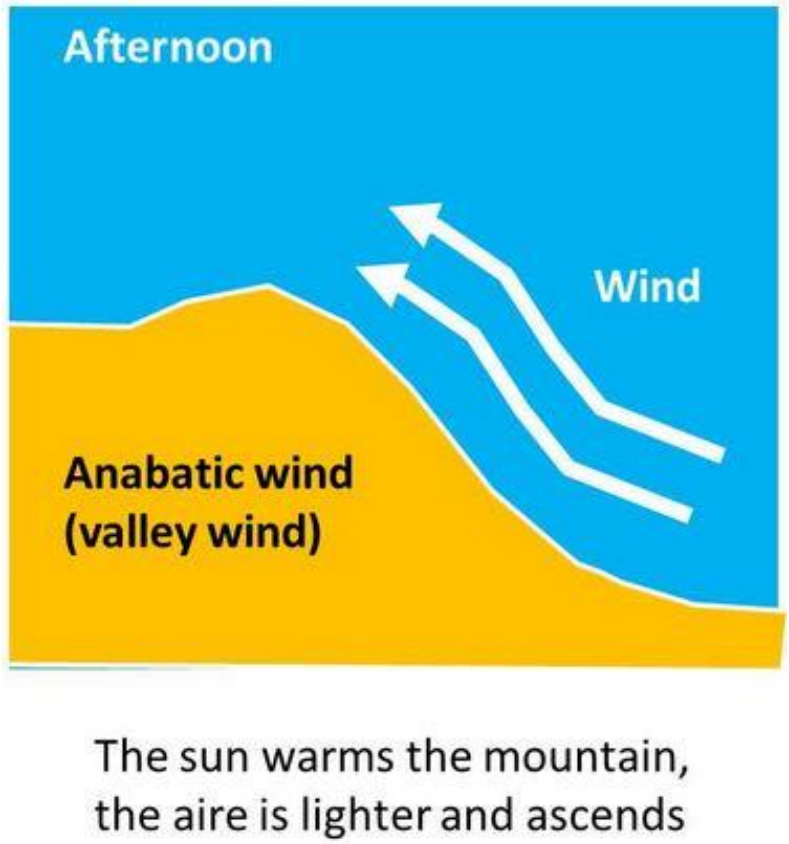
LOCAL WINDS INCLUDE THE FOLLOWING

1) Anabatic and Katabatic

i)Anabatatic winds

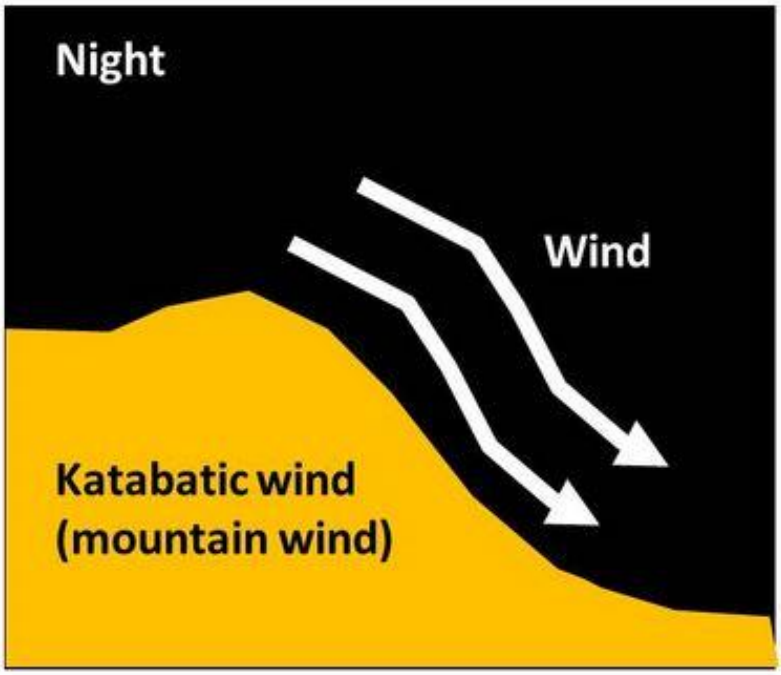
These are cold local winds which blow from, the valley button up to the hilltops. They blow in the afternoon especially in summer. During the day

the slopes exruince. Low pressure due to direct sun rays which make them hot and winds move from button upwards. They further condense and come down causing the become foggy**. There winds are called Anabatic winds.**



ii)Katabatic winds.

These are cold local winds which blow down from hilltops they occur during the night where air is rapidly cooled by terrestrial radiation on the upper slopes. During the night the valley slopes become very cold as they lose the heat rapidly, hence high pressure on them. Due to convectional currents the valley buttom becomes warm creating low pressure. Winds sink down through the valley slopes and rise up from the valley buttom . These winds are called Katabolic winds.

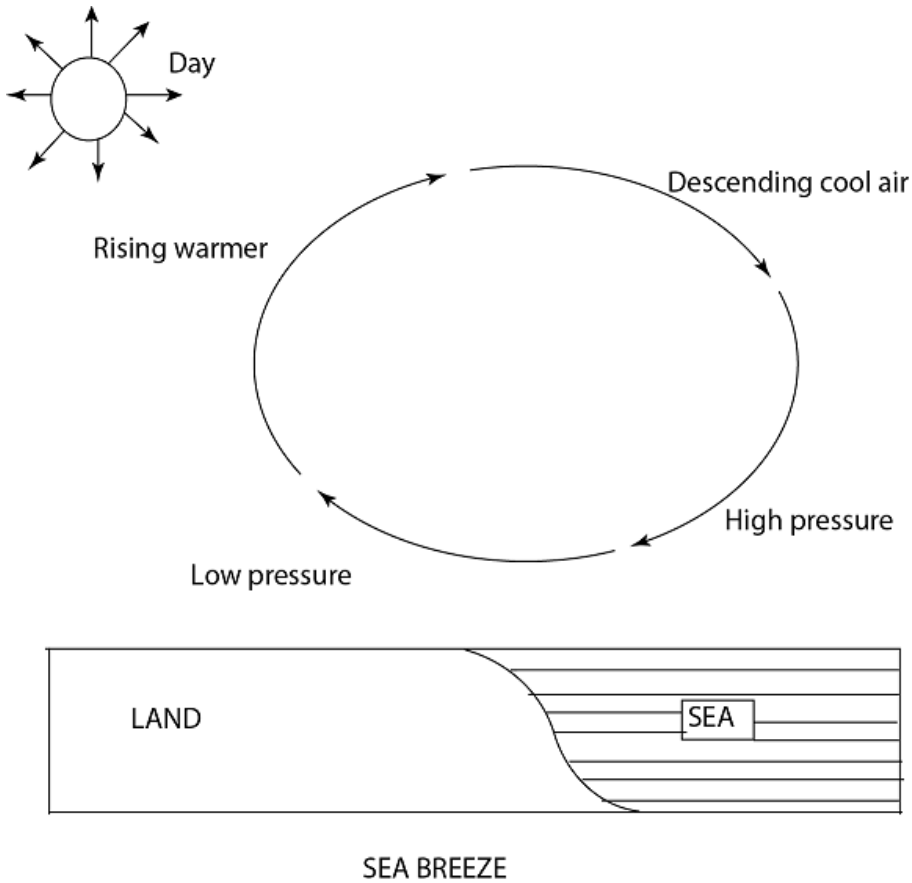


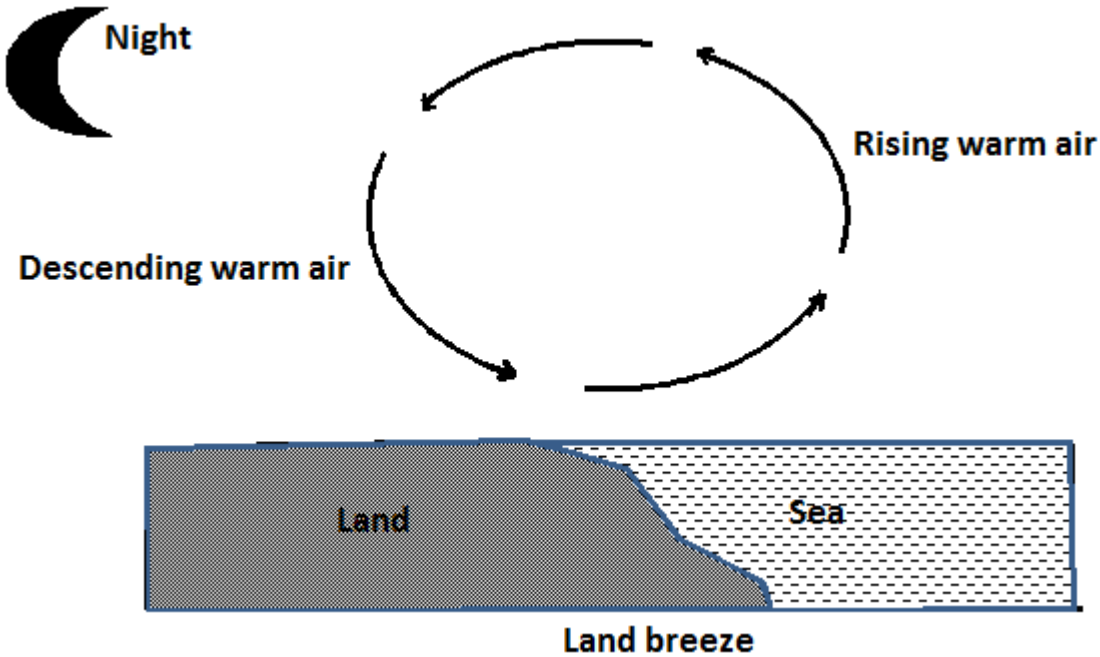
The mountain cools down, the air becomes heavier so it descends.

2) Land and sea braze.

During the day land becomes warm more rapidly than the sea. Thus winds tend to move from the sea (high pressure) to the land (low pressure).This situation is called sea breeze. During the night the land cools more rapidly than the sea. Thus wind tends to move from land to the sea, this action is called land breeze.

Day


Day
Descending cool air
Rising warmer
High pressure
Low pressure
LAND
SEA
SEA BREEZE

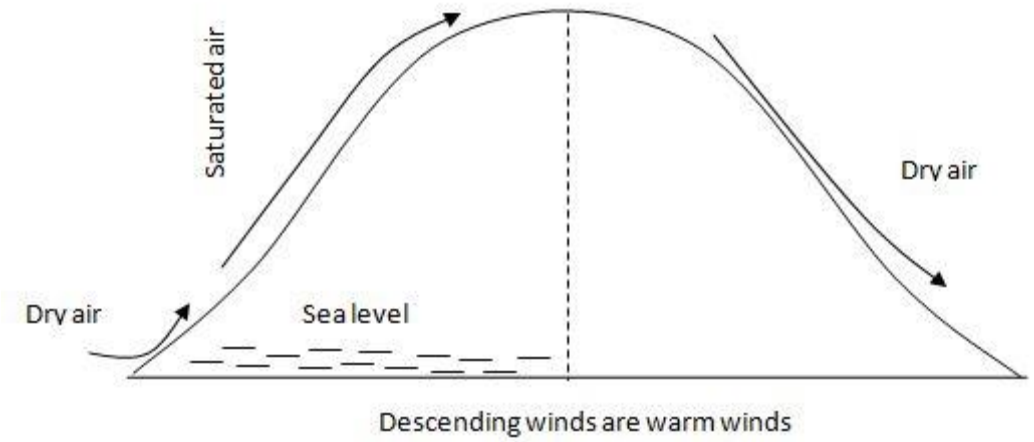

Night
Rising warm air
Descending warm air
Land
Sea
Land breeze

3) Descending winds:

These winds are mostly warm and they are called Fohn. The name Fohn is

common in Alps Mountains of Switzerland.Where during winter the Fohn winds descend from the Swiss Alps into Switzerland.

- During the same period cold winds blow from France south ward torwards Mediterranean Sea. These winds are called "Mistral" but in USA the same winds are called "chinook". This situation occurs mostly in the leeward side of the mountain. Some local winds blow from the high pressure over the Sahara during spring. These winds are warm, dusty and dry because they originate from the desert which is dry.



The Harmattan.

These are NE winds which blow from the Sahara across West Africa between November and March. These winds are dry and dusty because they originate from the desert. The winds blow during winter towards the Gulf of Guinea where the land is cold while over Mediterranean sea pressure is low because the sea is much warmer than the land.

Berg winds:

These are the winds which originate from the plateau of South Africa during winter. At this time the high pressure lies over the plateau and it is a region of descending air the winds blow out toward the South SE and SW.Those winds are warm because of being compressed by the increasing atmospheric pressure.

4) **Adiabatic cooling and warming:**

This is the change of heat per unit area. It occurs when air is heated on the ground which makes it to rise as it raises it becomes cool and sinks down. This is adiabatic cooling and heating.

AIR MASSES

Air mass is a large volume .of air whose temperature and humidity are fairly uniform and covers all extensive areas such as desert and ocean surfaces moving horizontally at different levels.

- Characteristics of air mass normally come from the region where the air masses were formed. These characteristics are retained by the air mass may be warm, dry or moist.

CLASSIFICATION OF AIR MASSES.

Air masses are classified on the basis of the source regions trajectry and characteristics of both temperature and humidity. On the basis of temperature they can be categorized as polar and tropical air masses. By combining temperature and humidity four main categories can be distinguished as follows.

i)Tropical continental.(Tc or CT).

They originate over the continents in the low latitudes such as in the desert. They tend to be warm and dry. But near the equatorial there is tropical equatorial continental air mass, which consists reasonable amount of moisture. Enough to cause precipitation. A good example is tropical continental air mass over the Sahara desert, which is called the Harmattan.

ii) **Tropical maritime (Tm or mT).**

These originate in the trade wind belts and subtropical oceans near the equator they are refered to as Equatorial air masses (E) these are warm and moist such that they to yield heavy precipitation, thunderstorms etc because of being unstable. A good example is tropical maritime air masses which originate from Atlantic

iii)**Polar continental (Pc or cP):**

These originate from the cold land surface like the Arctic and Antarctic regions, including

central Asia,northern Canada where they develop in winter. These air masses are very cold, dry and stable such that they prevent the formation of rain showers.

iv)Polar maritime (Pm or mP).

These originate over the oceans 50º North and south of the equator they are cool, moist and unstable. They yield heavy precipitation as they move in land in middle latitudes and high latitudes.

CYCLONES, ANTICYCLONES AND DEPRESSIONS

i) What are weather cyclones, anticyclones and depressions?

ii) Explain the Formation of these aspects

iii) Explain the weather associated with them.

CYCLONES

These are areas of Low- pressure system, which originates on temperature Latitude between 20^{0} - 60^{0} north and south of the equator cyclones occur all over the oceans except in northern Atlantic ocean. The isobars that represent a cyclone on a map are closely spaced and they form a circular shape. Strong wind spirals or tends to move towards the center clockwise in the southern hemisphere and anticlockwise in the northern hemisphere. They also tend to rush upward with strong force called vortex which surround the center of the cynodes.

IMPORTANCE OF CYCLONES:

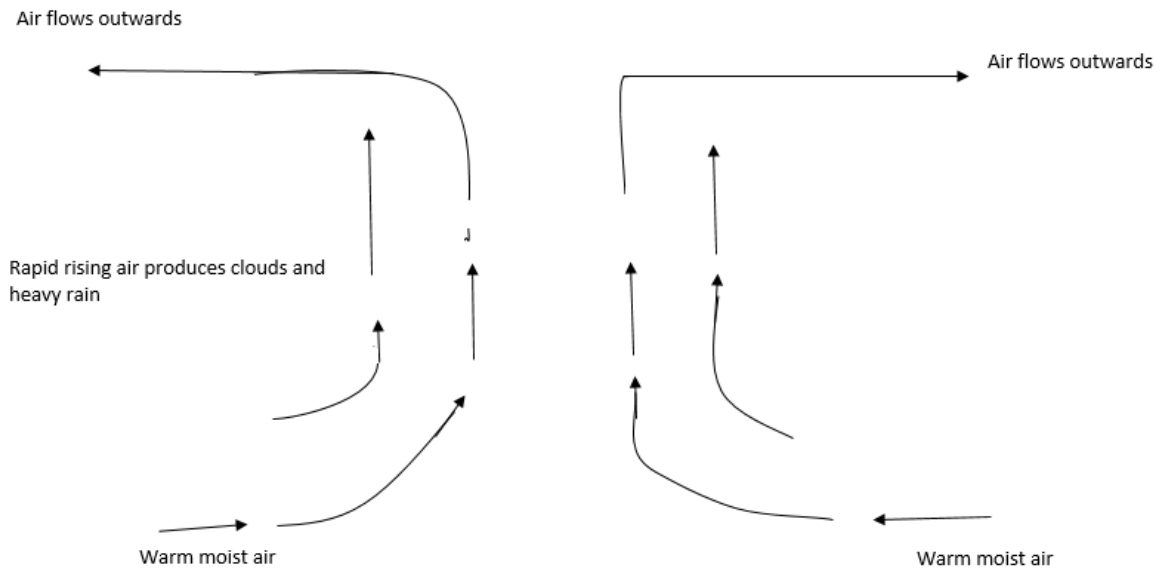
The rapid rising air gives to torrential rainfall and the strong blowing wind causes considerable damage to property such as crops and buildings.

FORMATION OF CYCLONES. (Required conditions)

) Abundant source of warm moist air of temperature about 27ºc to the sea surface

ii) Air must blow in ward and rise rapidly to great height to give clouds of great vertical extent, capable of providing torrential rainfall.

- A Tropical cyclone develops where the air mass brought by to northern and southern trade winds meet that is along the inter – tropical front. They form; over the oceans as the air masses which have traveled over the oceans have warm moist lower air while the upper layer of air masses tends to be cool and dry. When two such air masses meet one is lifted up over the other the rising air cools its moisture condenses to provide rainfall (torrential). Tropical cyclones move in a westerly direction on reaching laid they gradually die act because the supply of warm moist air is cut off.



Warm sea surface of temperature 27ºc

WEATHER ASSOCIATED WITH TROPICAL CYCLONES

Before the tropical cyclones arrive

i)Air becomes very still

ii) Temperature and humidity rises.

iii) Thick clouds appear or develop

iv) Winds blow violently

v) Dense clouds and torrential rainfall reduces visibility to a few meters

Examples of tropical Cyclones are tornadoes, Hurricanes and typhoons.

TORNADO

This is a small cyclone that appears as a black funnel cloud, hanging from high clouds. Its color is a result of the moisture and debris being carried by wind at a speed of up to 400km/ hr on the ground. It covers a small area of about 90 – 500 meters in diameters

- The origin mechanism of tornadoes is not properly understood however they are commonly and mostly associated with the condition provided by the meeting of cold, dry and hot moist air.

- Thus they are associated with cold front originated where turbulence along there fronts is greatest. Most occur in the USA and are concentrated in the central state of OKLAHOMA.

HURRICANES

These occur in West Indies islands in the Caribbean. The wind is generally very slow.

They have similar characteristics with typhoons but the only difference is intensity duration and locality

- Weather associated with hurricanes:

.Calm dense clouds and stormy weather

. Rainless/ dry weather.

TYPHOONS:

Typhoons occur in China. They are most frequent from July to October and violence is common.

They have very steep gradient and cover an area of 30 to 300 kilometers in diameter. They occur around 20°- 60° north and south of the equator.

- Weather associated with typhoons

- Over cast sky

- Torrential rain accompanied by thunder and lighting
- Very destructive to both human and property. For example 50000 people were killed in 1922 on the coast of china.

ANTICYCLONE

This is an area of high pressure which when shown on the isoline map, has an oval circular shape of closed isobar.

Note that, the highest pressure is near the centre. An anticyclone develops in a region where the air is descending and the winds associated with it blow outwards in a clockwise direction in the Northern hemisphere and anticlockwise in the southern hemisphere in West Africa during the dry season anticyclone cover the Sahara and they are associated with the Harmattan.

WEATHER CONDITION ASSOCIATED WITH ANTICYCLONES.

Anticyclones are associated with the fire weather, calm air and high temperature in summer but low in winter and clear skies. During winter intense cooling of the lower atmosphere may results in thick Fog.

DEPRESSION

These are large areas of low pressure due to meeting of warm equatorial and cold polar air. They are oval or circular shared on maps with closed isobars. Air of depression circulates anticlockwise direction in the Northern hemisphere and a clockwise in the southern hemisphere where they blow towards the center.

- Depressions mainly develop in temperature latitudes when humid tropical air meets with cold polar air especially around; latitude 60º north and south of the equator where westerly winds meet with polar winds. The

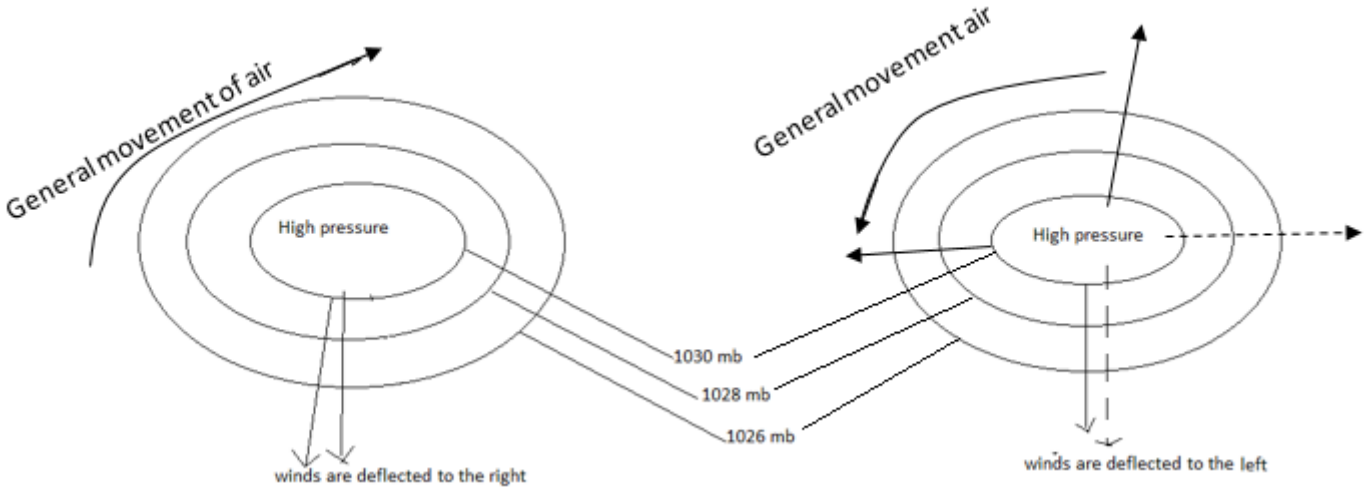
zone or boundary where these winds meet or converge is called "polar front" it is in this zone where depressions form.

- Depression are rarely stationary and they move in a general e.g. sterly direction. Some are small: others are large, but all of them are associated with unsettled weather usually with overcast skies and periods of continuous rain.

- The rain is caused by the uplifting of the warm moist tropical air by the cool drier polar air, as they meet or converge at the polar front. Such rain is called “depression Rain" and it is generally lighter than convectional rain and has longer duration up to several days.

WEATHER ASSOCIATED WITH DEPRESSION.

Depressions are associated with clear sky except the circus clouds which are little bit high, winds blow from the south east, after a definite time, a clouds cover develops and heavy rain occurs and the warm front then passes, when the rain stops wind direction changes and start blowing from south west. Temperature rises and there occurs more humid air.



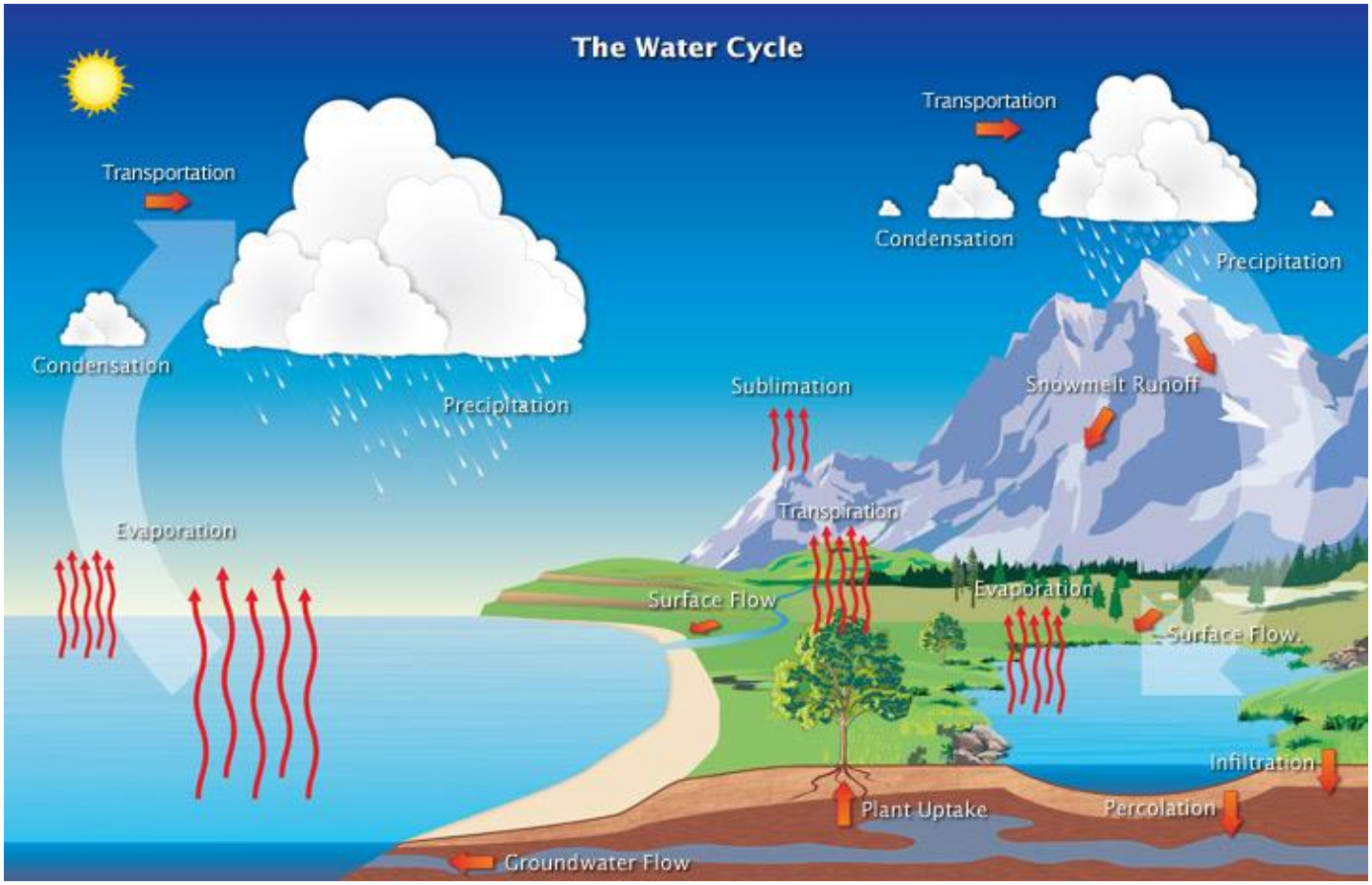
HYDROLOGICAL CYCLE (WATER CYCLE)

Hydrological cycle (water cycle) refers to the endless circulation of water from the surface (rivers, lakes, oceans and vegetation) into the atmosphere through evaporation or transpiration and then back to the surface as rain, snow, hail or another form of precipitation. The processes involved in hydrological include evaporation or transpiration condensation after cooling and later

precipitation the combined process of evaporation and transpiration is known as evapo – transportation

At first water, gets into the atmosphere as water vapour through evaporation from the surface or transpiration from parts.

Later as most air rises, it cools through expansion, leading to condunsation through condensation water droplets or drops are formed which later fall onto the surface as precipitation. As waterfalls onto the surface, some of the water in filtrates and percolates into the ground to form underground water. Some flow on the surface as surface run – off (overland flow) or stream flow into the oceans or lakes. Some is evaporated back into the atmosphere to drive forth the process of hydrological cycle. In the process of hydrological cycle ,insolation is very important since it provides the energy that facilitates evaporation process.



The diagram above shows the process which lead to the formation of precipitation which are part and parcel of the hydrological cycle. These processes include evaporation or evapo-transpiration cooling condensation and precipitation

CONDENSATION.

Condensation is the process through which the atmospheric water vapor is converted into liquid as a result of cooling. If the temperature is below the freezing point condensation can be skipped.The process in which water vapor changes directly into solid state without passing through liquid state is called "sublimation". The term also applied when the change takes place from solid state to water vapor without passing through the liquid state when the temperature are extremely high.

WAYS IN WHICH AIR COOLS:

There are several ways through which cooling in the air takes place and these can be identified as follows.

i)Direction radiation of heat energy from the surface leads to the cooling of the air, since heat energy is lost into the atmosphere. The loss of heat energy makes the surface become cold hence influences the temperature of air above it.

ii)Horizontal air movement over the cold surface (advection) may also lead to the cooling effect.

iii) Also cooling can take place when warm air mass meets with cold air mass on mixing along the the front,the temperature of warm air declines, leading to cooling.

iv)Another way through which air tends to cool is by the ascent.The ascending air cools adiabatically as result air mass expension.

CONDITION FOR CONDENSATION TO OCCUR

Condensation is determined by several factors that include cooling, presence of microscopic particles and presence of water vapor.

i)Atmospheric cooling.

The cooling of the atmosphere occurs through various ways which include contact with the cold surfaces mixing of air masses or through mechanical uplift.

ii)Existence of water vapor

When the air saturated, any additional moisture in the atmosphere leads to Condensation.

iii)Presence e of microscopic particles in the atmosphere. These act as condensation nuclei which provide the starting point for condensation. Water vapor molecules tend to collect around the particles to form water droplets when the particles are absent, condensation takes place with difficulty unless the atmosphere is super saturated.

COMMON FORMS OF CONDENSATION.

Condensation manifests in various form namely

- Dew
- Frost
- Clouds
- Fog.

Dew

Dew consists of water droplets condensed and deposited on the cold solid surfaces. It usually Forms during long nights with clear skies having little or no wind when the atmosphere is relatively moist.When the sky is clear there occurs high rate of outgoing radiation, which in turn leads to the cooling of surface.

Frost

Is the term used of mean dew that becomes frozen. The condition that favor its formation are the same those. For formation of dew except the condensation occurs under freezing point.Desert and semi-deserts are places where dew and frost common occurs at night, since these areas can sometimes experience low night temperature as low below O^0C.

fog and mist.

Fog and mist are clouds at ground level, which result from moisture condensation and they may extend far in the atmosphere. of and Mist differ in visibility.

Mist forms where moist air cools below dew point. Condensation takes place but the resultant water droplets remain suspended in kilometers. On the other hand Fog is like mist and forms in the same way but it is much denser as it reduces visibility to less than a kilometer. There are various types of fog depending on their mode of formation.

TYPES OF FOG

i)**Advection Fog**:

Refers to Fog caused by the cooling of warm moist air. Transported over the cold surface. Also, advection Fog can be caused by the cold air passing over a warmer sea surface than mixes with the warm air prevailing there.

ii)**Radiation Fog**

This occurs when land surface is suddenly cooled by radiation where the air upon it becomes chilled which results into condensation. It common in hilly areas.

iii)**Frontal Fog**

This forms due to passage of warm air over cold air. The warm air is therefore chilled to form Fog.It forms at the Front of depression.

iv)**Upslope or expansion Fog chill Fog**

Refers to the Fog formed when the air-mass moves upslope leading to adiabatic cooling due to air mass expansion. It forms simple low sheet cloud which may envelop the hills like, what happens on the hills of western. Britain when moist air is moving on land

v) **Steam Fog**

Is the type advection Fog formed when a cold air- mass passes over much warmer water surface such that water appears to "steam" In latitude it is referred to as ice-Fog. Where the moisture in the air is converted into ice crystals, steam Fog is rare and does not last for a long period of time.

vi)**Sea Fog**

Is formed when the sea air cools over the cold ocean currents. It differs from the steam Fog,in

that the sea Fog does not appear as steam but just as normal Fog. Also in steam Fog, the moving air is cold and stable and warms over the warm water surface.

vii)**Smog Fog**

This is Fog plus smoke and industrial pollutant like CO_2, CO and SO_2 it is usually yellowish in color and acidic in smell,smog is common in big cities e.g. Ruhr industrial area in Germany. Fog has major environmental hazards particularly on transportation.

viii)**Rime**

When a Fog composed of super cooled droplets is driven by slight wind against prominent objects such as telegraph poles, wires and trees the drops freeze on them as rime. The temperature of both droplets and the

objects is below freezing point. The rime has the white, opaque appearance. This is a common feature on the mountains of Britain.

CLOUDS AND CLOUDS FORMATION

Cloud is another element of weather. It is defined as a mass of water vapour which hangs in the sky. Clouds are a form of condensation which consists of water droplets or of tiny ice bar tides floating at various levels from the ground to the very high altitudes. At 12000m above the sea level.

- Mist and Fog are made of water droplets and in this repast they are types of cloud, but they form near the surface.

- The clouds give hint on the type of weather that is likely to occur through their shape, height and and nature of movement. Thus they are carefully studied by meteorologists in order to prepare weather forecast and various precautionary information on the impeding weather phenomena. On the map cloud cover can be represented by using the lines.

CLASSIFICATION OF CLOUDS

There are many different types of clouds, but they are often difficult to distinguish as they form constantly changes. The general classification of clouds was proposed by LUKE HOWARD in

1803 this classification is based on form appearance and height and he used four Latin words *cirrus, cumulus, stratus* and *nimbus.*

- High clouds (6,000 to 12,000m)
- Middle clouds (2,100 to 6,000m)
- Low clouds (below 2,100m)

a) High clouds 6,000 – 1,200m (consists of cirrus which start with cirro.)

i) Cirrus is composed of small ice crystals, wispy, fibrous or feather. Its a appearance is min bands or patches.

ii) Cirrocumulus – is composed of ice crystals:" globular or ripple like in appearance looks like ripples or wavy structures in the sand on a sea shore) Forming a thin cloud.

iii) Cirrostratus- it looks like a thin white, almost transparent sheet that gives the sun and moon haloes.

b) Middle clouds below 2,100 - 6,000m (consists of clouds whose names start with alto)

i) Altocumulus – is composed of water droplets in layers or patches globular or bumpy. Looking with Flattened based arranged in line or waves. This indicates fair weather.

ii) Altostratus – is composed of water droplets forming sheets of grey or water looking clouds, partly or totally covering the sky.

c) Low clouds below 2100m.

i) Stratocumulus: is a large globular mass: bumpy – looking soft and grey in appearance forming pronounces regular patten. It is in fact darker, lower and a heavier type of actocumulus cloud. It always allows the penetration of some our rays called crepuscular rays.

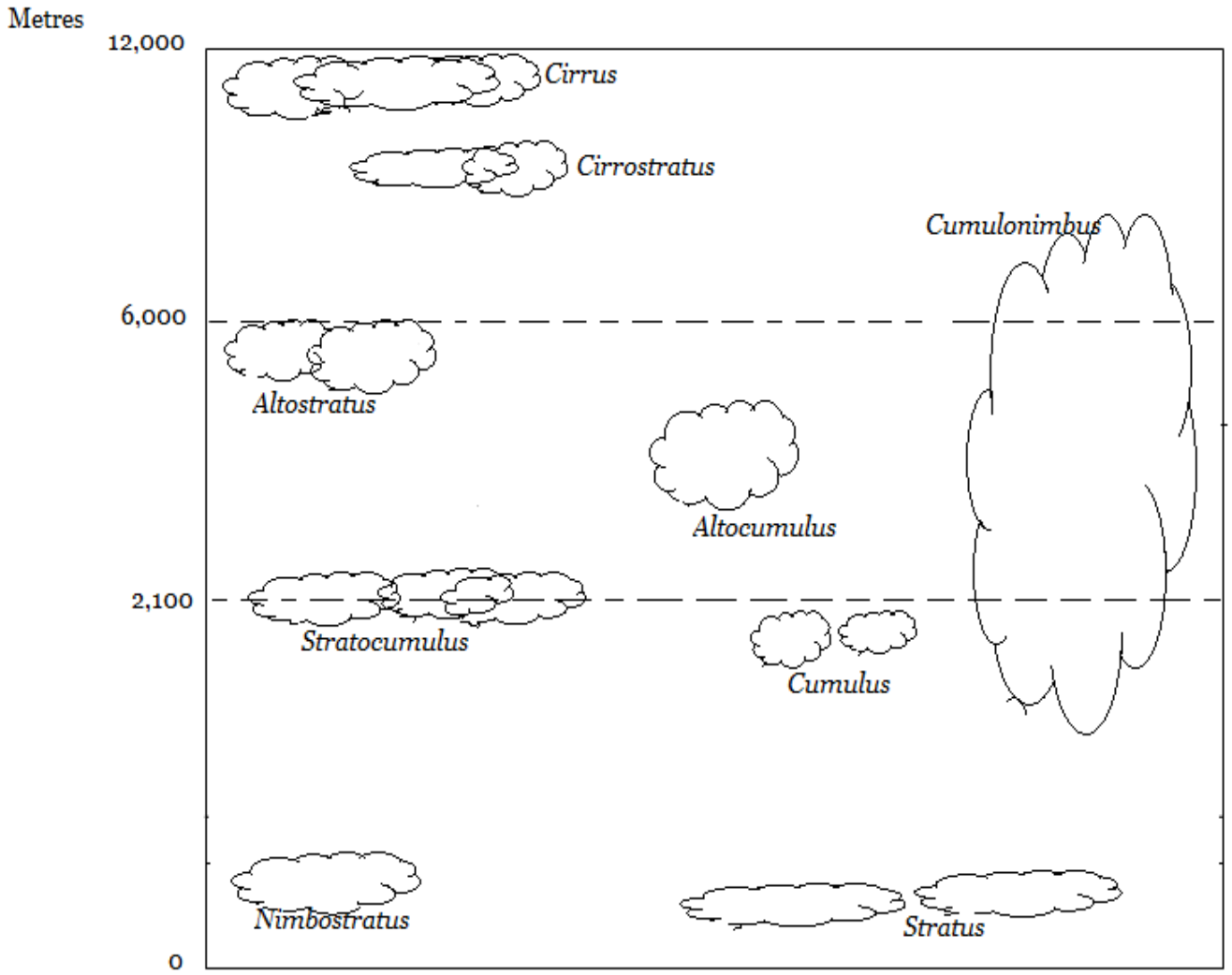
ii) Stratus – is fog- like low cloud forming a uniform layer: brings dull weather and often carom paled by drizzle.

iii) Nimbostratus – Dark grey and rainy – looking dense and shape less often gives continuous rain clouds of great vertical extent.

iv) Cumulus: round topped and flat based forming a whitish grey globular mass consisting of individual cloud units.

v) Cumulonimbus – is a lowering cloud which is usually white or black appearing as globular mass whose rounded tops often spread out forming an anvil structure. It is associated with convection rain lighting and thunder. This cloud is sometimes called "thunder head".

NB: - Cirrus and curriform clouds occupy high level and form high clouds; clouds that start with acto are found in the middle level constituting middle clouds. Nimbus is the term that applies to rain bearing clouds; stratus applies to clouds that form layers or uniform cover and cumulus is the term used for clouds that occur in a massive nature.



Clouds at different levels and extent

Clouds at different levels and extent

The Amount of cloud cover is estimated in oktas; one oktas represents one – eighth of the sky covered with clouds.

WEATHER CHANGES

ATMOSPHERIC STABILITY AND INSTABILITY

Atmospheric stability

The state of stability is when a rising parcel of unsaturated air cools more rapidly than the air surrounding it. If there is nothing to force the parcel of air to rise such as mountains or fronts it

will sink back to its starting points. The air is described as stable because dew point may not have been reached and the only clouds which might have developed would show flat topped cumulus which do not produce precipitation. Stability is often linked with anticyclones.

- Absolutely stable is experienced when the ELR is less than the SALR (Saturated Adiabatic Lapse Rate). During absolute stability even the saturated air, which is usually buoyant (light), tends to cool faster that the surrounding air and keeps on sinking rather than rising. Stability is also called stable Equilibrium.

Atmospheric instability:

Conditions of instability arise in on hot days when localized heating of the ground warms the adjacent air by conduction creating,a higher lapse rate.

The resultant parcel of rising unsaturated air cools less rapidly than the surrounding air. In this case the environmental lapse rate lies to the left of the Dry Adiabatic Lapse Rate, the rising air remains warmer and lighter than the surrounding air.

Should it be sufficiently moist and if dew point is reached, then the upward movement may be accelerated to produce towering cumulus or cumulonimbus type clouds. Thunderstorms are likely and saturated air following the release of latent heat,will cool at the saturated Adiabatic lapse rate.

CONDITIONAL INSTABILITY.

This type of instability occurs when the ELR is Lower than the DALR but higher than the SALR. It is the most common of the three conditions.

The rising air is stable in its lower layers and being cooler than the surrounding air would normally sink back again.

However if the mechanism which initially triggered the up lift remains, then the air will be cooled to its dew point. Beyond this point cooling a slower SALR and the parcel may become warmer than the surrounding air. It will now continue to raise freely even if the uplifting mechanism is removed as it is now in an unstable state.

Instability is conditional upon the air being forced to rise in the first place, and later becoming saturated so that condensation occurs. The associated weather is usually fine in areas at altitudes below condensation level but clouds and showery in those above.

- What to note is that

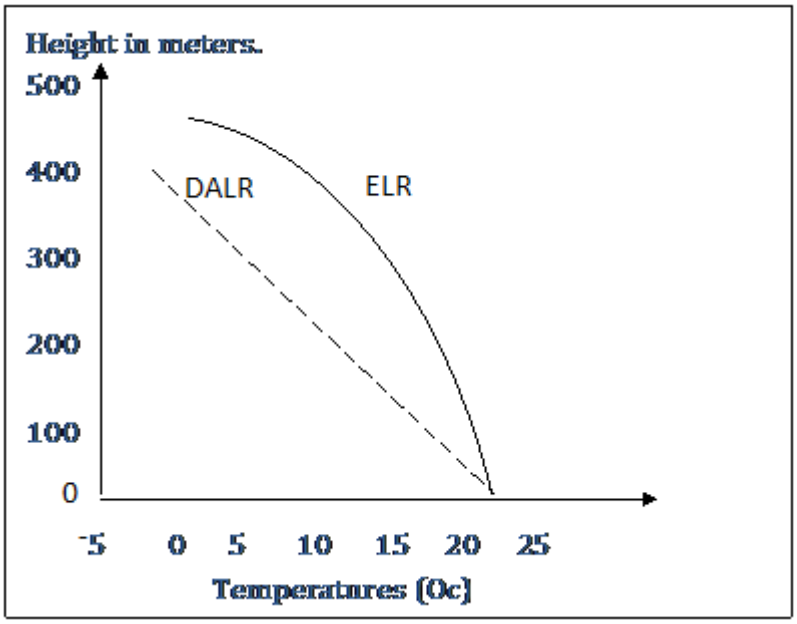
Unstable air mass is regarded to be either conditional or potential.It can be conditional if after it has reached dew point it cools very slowly to retain warmness that the surrounding and forced to rise higher and higher.

- It is regarded to be potential if the condition air is forced to rise above cold air mass. Atmospheric instability is associated with relative fall in temperature, high humidity (dampness) heavy clouds, sand, heavy rainfall.

These conditions can be summarized as follows:

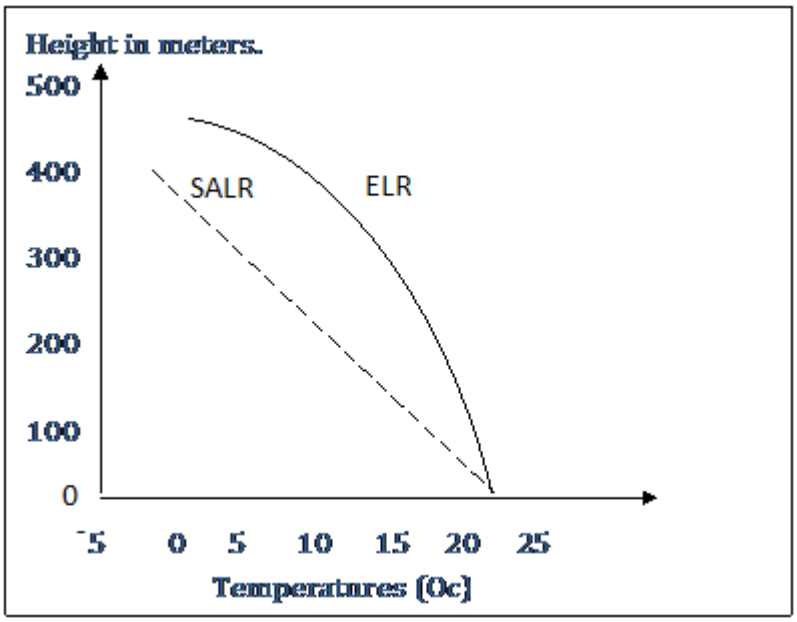
Stability when	ELR< DALR or (DALR> ELR)
Absolute stability when	ELR< SALR or (SALR >ELR)
Neutral Equilibrium when	ELR = DALR or (DALR =ELR)
Absolute instability when	ELR > DALR or (DALR < ELR)
Condition instability when	ELR is between DALR and SALR.

- Diagrams representing atmospheric stability and instability.



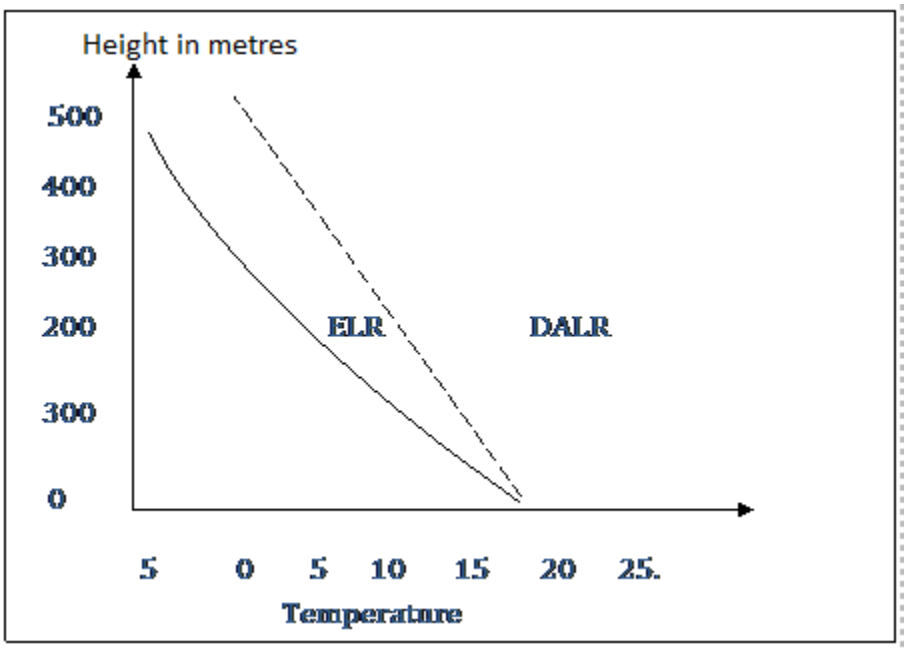
In diagram above.

The line for DALR is below the line for ELR. Indicating that the DALR is greater than the ELR and therefore the air is cooling faster than the ELR leading at atmospheric stability. In this case there is no vertical air – mass movement since the cold dense air mass tends to sink down to the surface.



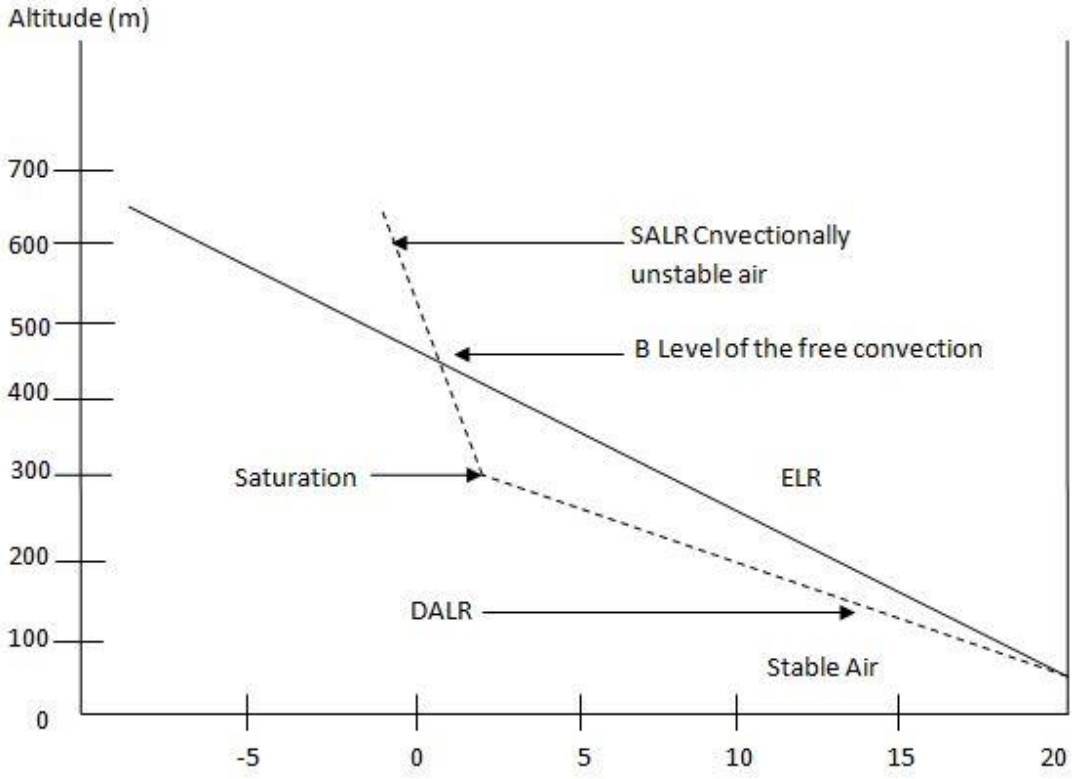
In the diagram above:

the line for SALR is below the line for ELR indicating that the SALR is greater than the ELR and therefore the saturated air is cooling faster than the ELR Leading to atmospheric stability. Also in this case the vertical air-mass movement is limited, since the denser air mass tends to sink down to the surface.



In the diagram above, the ELR is below the line for DALR indicating that the ELR is greater that the DALR and therefore the dry pocket of air is cooling at a lower rate than the ELR, Leading atmospheric instability.

Also in this case, the vertical air – mass movement is pronounced since the pocket air mass tends to rise because of buoyancy or lightness. Under this situation, these can be condensation, freezing and precipitation in the atmosphere. Storms also develop, affecting the earth's surface and its various features.



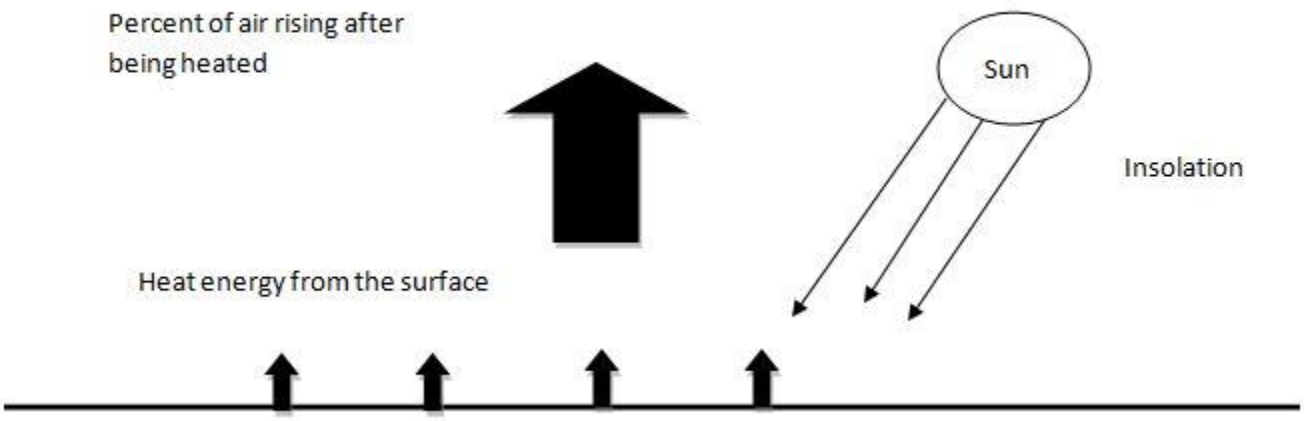
In the above diagram:

One can find that before condensation is the lower altitude, the air is dry and DALR is greater than the ELR. The atmosphere experiences stability. As air is forced to rise the cooling process leads to condensation which saturates the air. The saturated air becomes warm due to the addition of moisture which has latent heat. It then starts rising spontaneously while cooling at the SALR, which is lower than the ELR. This situation manifests the attainment of a state conditional instability.

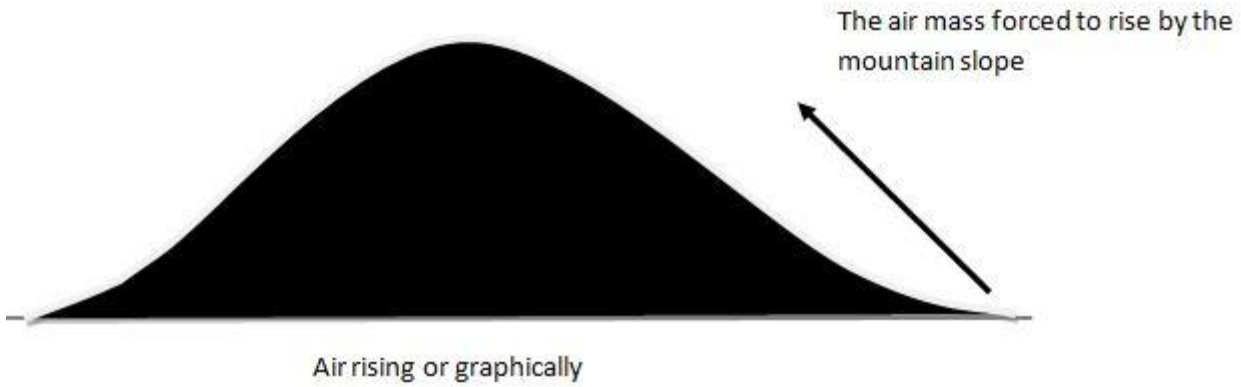
CAUSES OF AIR – MASS ASCENT.

Pockets of air are forced to rise several ways, which include;

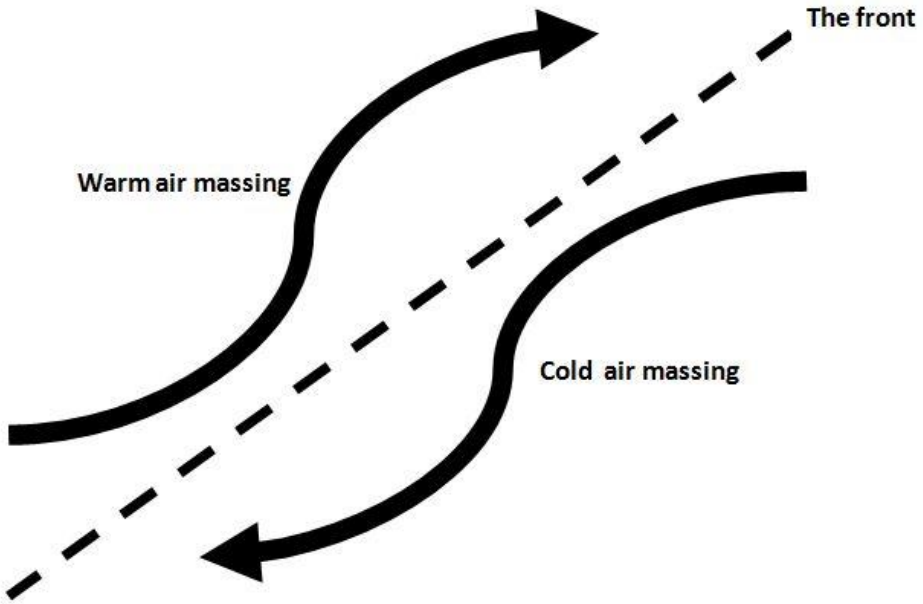
i) When the air- mass is heated or warmed by conduction, air rises in conduction the heat energy which is reflected from the earth's surface warms the air resting above; then vertical convectional currents sets up. This phenomenon leads to the formation of convectional rain and it is common in the equatorial and tropical areas. The convection rain falls in the afternoon and is usually accompanied by rainfall and thunder.



ii) The pocket of air can rise after being forced mechanically to rise up the slope incase the wind blows against the mountain side. The air mass that rises cools leading to condensation and later the formation of orographic rain, which is common in mountain areas like Kilimanjaro, Uluguru, Rungwe, Meru and Usambara in Tanzania.



iii) The third way involves the situation where one air – mass, usually warm is forced by another mass of air which is usually cold. The warm air rises above the cold air creating a zone of contact in between them called front. In most cases of raising air a vertical element is introduced which is a form of convergent rotation. Under this situation a depression is usually created, which is associated with law pressure formation of clouds and rainfall formation.



It should be noted that when the air-mass is warm, it tends to expand and it always lighter, such that it keeps on rising above.

TYPES OF TEMPERATURE INVERSIONS

a) According to the causes, temperature inversions can be categorized into four types namely :

- Subsidence inversions
- Advection inversions
- Radiation (nocturnal) inversion
- Frontal inversion

i)Subsidence Inversion is formed where the air is descending in the high pressure zones. The sinking of the air leads to compression, which in turn causes temporary inversion at a higher level in the atmosphere. This type of inversion is also called high inversion and usually last a long time.

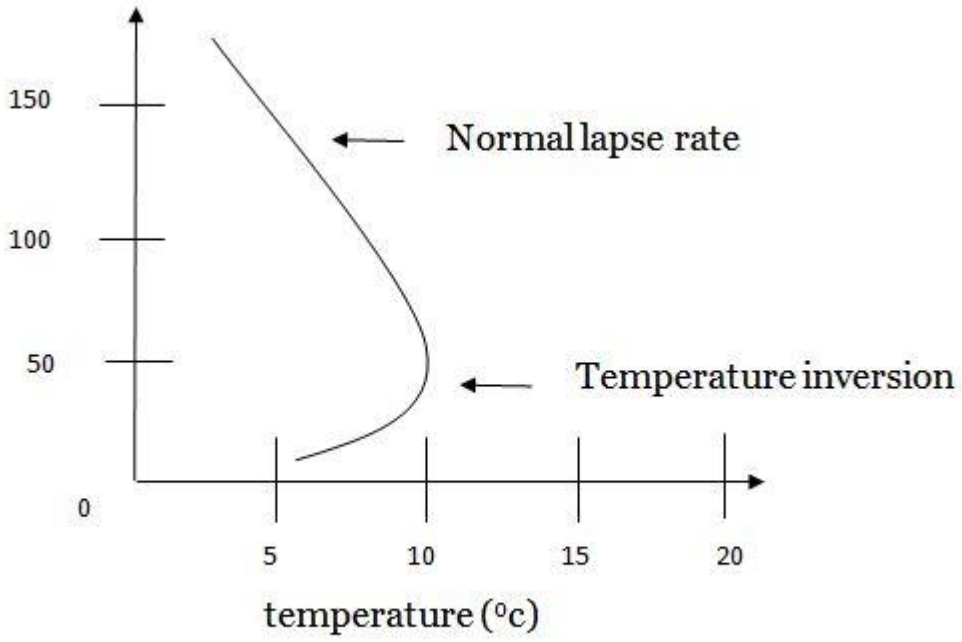
ii) Advection inversion is caused by a warm air mass advancing across the cold surface. The lower portion gets cold while the upper part remain warm this can happen over the colder sea in summer or over the land mass in winter.

iii)Radiation (nocturnal) inversion is the type of inversion that occurs during night when the land is very cold because of having lost most of the heat energy through radiation. Nocturnal inversion occurs exclusively over the land as the ground can cool much more quickly after sunset, than the sea. It is also called ground level inversion as it is near the surface. This type of inversion disappears when the sun rises in the Morning.

vi) Frontal inversion which occurs as a result of the formation of warm and cold front due to meeting of two air masses. The warm air rises over the cold air mass keeping the atmosphere above warm while near the surface.

b) According to the level of occurrence:According to level of occurrence temperature inversion can be classified as ground level and high level inversions.

i.Ground level inversion is the type of inversion that takes place near the surface of the earth due to cooling, caused by the lose of radiant energy into the space. The air near the surface tends to be cooler than the air above it. Since it is in contact with the cold surface. It takes place at night and disappears in the morning when the sun arises Nocturnal inversion is good.Example;



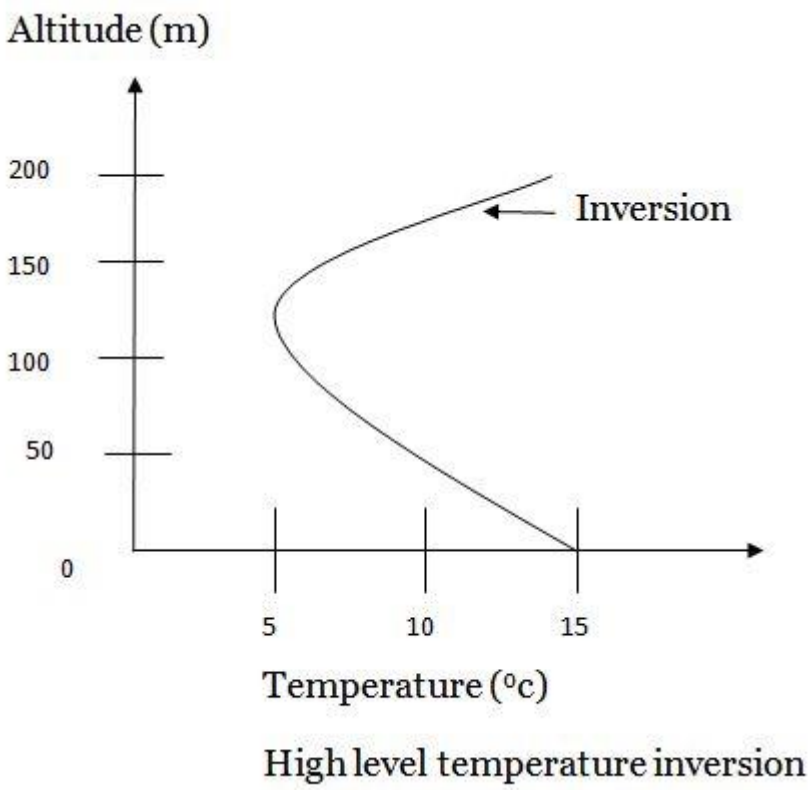
Ground level inversion

The above hypothetical diagram indicates that temperature inversion takes place near the ground level due to the influence of surface radiation such that as one moves from 0 to 45 meters above the sea level will experience the rise in temperature. After 45 meters of altitude the temperature starts decreasing at a normal lapse rate.

ii.High level temperature inversion

Takes place at upper levels of the atmosphere for example, after 145 meters above the sea level . It can be caused by air subsidence presence of water vapour or a layer of Carbon dioxide and Ozone. It is usually last longer than

the ground level temperature inversion.



iii.The above hypothetical diagram illustrates that from 0 to 145 meters is above the sea level the temperature decreases with altitude at a normal lapse and after 145 meters it tends to increase with increase in altitude(temperature inversion occurs).

ATMOSPHERE

This is the this layer of gases held on the earth by the gravitation attraction.

Composition of atmosphere

Describe and explain the composition of the atmosphere atmosphere is composed of the following;

i. Mixture of various gases these included oxygen 21% nitrogen 78% Argon 0.09% and Carbon dioxide 0.03%others include neon, xenon, krypton helium and others in minute percentages

ii. Dust particle dust particles may be natural or artificial where natural dust particles are those caused by wind and volcanic eruption while arterial dust particles are those derived from industrial pollution

iii. Water vapour this is colourless, odourless gas in form of water which makes up a perfect mixture with gases. The degree at which water vapour is present in the atmosphere in termed as humidity water vapour condenses in term of rain snow, mist excess water vapour brings about capitation in form of rain snow, sleet and hail when water vapors is present in the atmosphere in small quantity extreme dryness of air many cause occur of hot desert.

THE STRUCTURE OF ATMOSPHERE

Atmosphere is divided into layers according to temperature these lases are

i. Homosphere and

ii. Heterosphere

A. HOMOSPHERE

This is the lower part of atmosphere running from 0-80km above the sea level. This layer has there sub layers which are Troposphere Stratosphere and Mesosphere.

1. Troposphere

This is the lowest part of homosphere found between 0-9miles or 0-15km above sea level, the layer is composed of gases water vapour and dust. All processes of rain formation take place in this zone and temperature decreases with altitude at a normal lapse rate. The lapse rate in Troprosphere is 0.6 ºC per 100 metres which is equivalent to 6.5ºC per 1000 metres rise. The lapse the result of the fact that the earth's surface is warmed by incoming solar rotation which in turn heats the air next to it by conduction, convection and radiation. The tropopause which forms the upper limit to earth's climate and weather is marked by an isothermal layer where temperature remains constants at -80ºC.

2. Stratosphere

This is the second part of homosphere lying above tropopause between 48 kilometres above the sea level. Much of the zone layer is concentrate within this zone particularly15 to 50 kilometres above the earth’s surface. Sometimes the term ozonesphere is used to refer the layer where there is concentration of ozone gases. Temperature remains unchanged with increasing height at tropopause but later it start to increase with height the lower stratosphere cover about 15 to25 kilometre from the earth's surface this is the layer in which temperature remain constant. This steady is case in temperature (temperature inversion) is caused by concentration zone (O_3) this gas absorbs incoming ultra violet (UV) radiations from sun. The stratopause which marks the upper limit of this zone is other isothermal layer where temperature does not change with increasing height.

3. Mesosphere

This is the third part of homosphere lying above stratopause between 48 to 80 kilometers above the sea level where temperature decreases with altitude up to -100ºC at 80 kilometers above the sea level. Temperature falls rapidly if there is no water vapour, clouds, dust particles or ozone to absorb incoming radiations. Thus this layer experiences the atmosphere lowest temperature and strongest wind. The mesopause like the tropopause and stratopause which is the upper limit of this zone records the minimum temperature that may fall to -100ºC and thus shows no further changes in temperature.

B. HETEROSPHERE

This is is the second zone of atmosphere where temperature increases with altitude from -100ºC at 80 kilometres to about 500ºC at 8o-5,000 kilometres above the sea level. The increase of temperature is assumed to be so because of lack of water vapour and dust particles zone. The upper part of this zone is called Ionosphere which is sometimes divided into exosphere and thermosphere. In the thermosphere temperature rises rapidly with height perhaps to reach 1500 ºC . This is due to an increasing proportion of atomic oxygen in the atmosphere which like ozone layer absorbs incoming Ultra Violet radiations.

TEMPERATURE INVERSION

Temperature inversion refers to the increase in temperature with height above the earth's surface. This phenomenon is a reverse of the normal lapse rate in the atmosphere; it is the exceptional lapse rate. This situation of increase in temperature with altitude is what called reverse lapse rate or abnormal lapse. In temperature inversion it means that, temperature in the air far above the ground.

CAUSES OF TEMPERATURE INVERSION

I. Presence of ozone layer in the atmosphere

Ozone in the atmosphere absorbs energy from the sun especially ultra violet(UV) rays. The reaction between these rays and ozone gives out heat whit warms the atmosphere from the ground surface.

II. Formation of fronts

This takes place when two air masses of different temperature meets. On meeting the warm air rises above the cold air. Under this situation two fronts are formed such that the warm front is above and the cold air leading to temperature inversion.

III. Air subsidence

When there is high pressure air tends to descend or sink down. The downward of air leads to compression or friction between molecules thus creating warm condition in the level.

IV.Atmosphere components

Water vapour and dust particles at a higher level, keep the atmosphere warmer than near the surface since it preserves energy from the sun for a longtime which leads to temperature inversion.

V. Advection

When the mass of warm air passes over the cold surface its lower part is cooled by the cold surface leaving the upper portion warm because of being far away from the influence of this cold surface.

VI. Radiation

Radiation of infra red energy from the earth's surface makes the ground cool very quickly. The cold surface cools the air immediately above leaving the other layer far above warm. For example; during clear settled weather, as radiation of heat takes place during the night the air on hill - slopes is rapidly cooled and thus dense air drawn down wards filling valleys or basins with cold air possibly at temperature bellow freezing point, when the upper slope are markedly warmer.

VII. Water vapour

Water vapour at higher altitudes keeps the atmosphere warmer than air the surface since it preserves heat energy for a long time. This also causes temperature inversion.

EFFECTS OF TEMPERATURE INVERSION

1. The warmer layer of air above the cold air may lead to increase in atmosphere stability and vertical air mixing as such the temperature is always calm with no precipitation. But when inversion occurs due to the development of precipitation and formation of cyclonic storm.

2. Temperature inversion leads to the formation of fog and smog. Smog is common in the industrialized areas with a of smoke which is produced from industries. The smoke so produced mixes with fog to from smog.

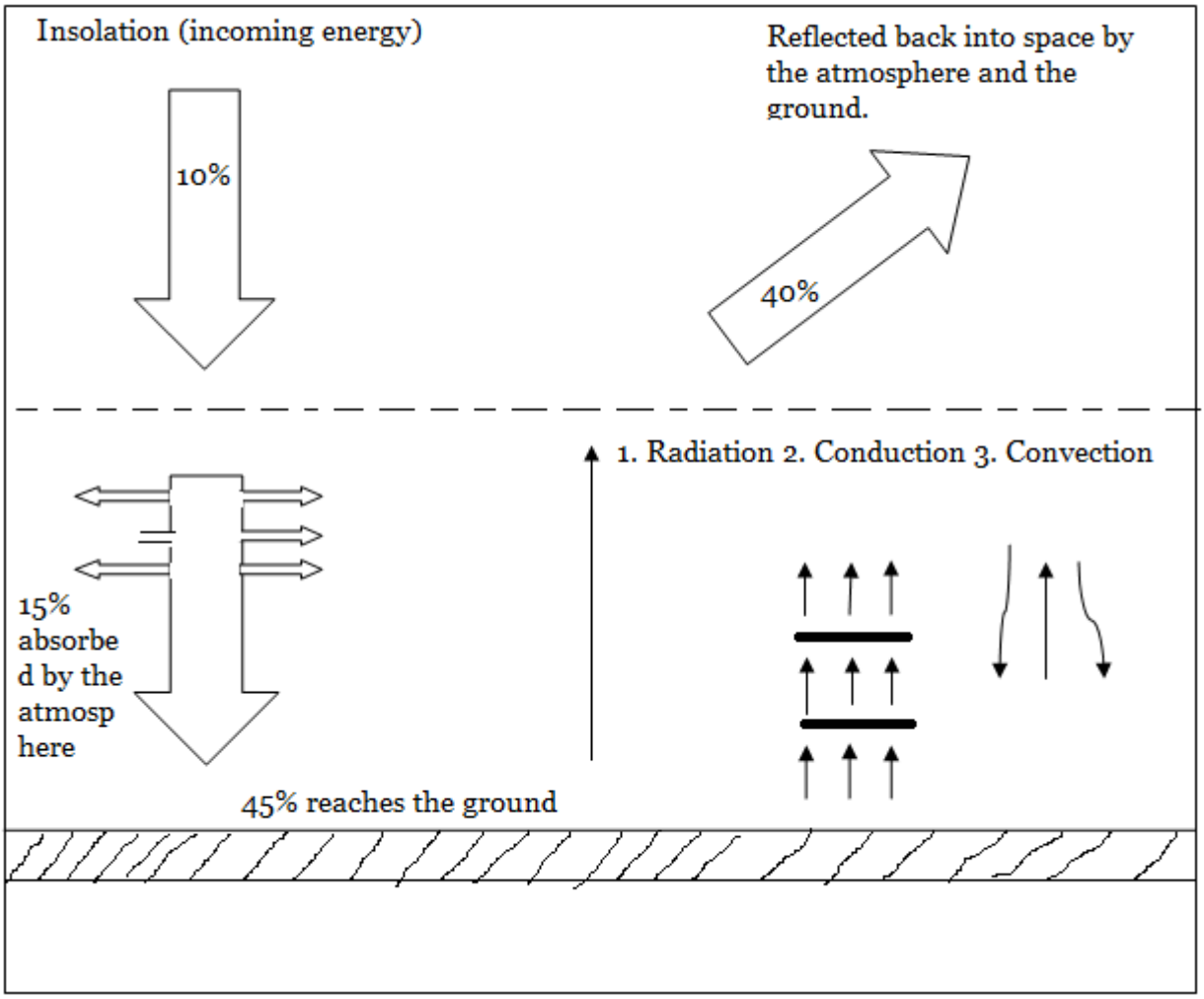
3. Air pollution takes place when there is temperature inversion.The air is polluted because of the sinking of particles which are hanging in the atmosphere due to the fact that the warm air above the cold air is less dense and thus not capable of holding the particles since they are denser than the warm air. The sinking down of air to the lower atmosphere level causes air pollution which affect human health, animal and plants. It can cause itching of body, inflammation of eyes and coughing.

THE HEAT BUDGET

The sun's energy is called insolation or solar radiation which turns into heat energy at the earth surface. Insolation travels through space from the sun inform of waves and interact with outer edge of atmosphere before reaching the earth's surface. Total amount of solar radiation released from the sun is 100% since the earth is neither warming up nor cooling down, there be a balance between incoming insolation and outgoing terrestrial radiation. The atmospheric condition therefore reduces the amount of solar insolation through three processes;

1. By absorption: About 15% of total solar radiation is absorbed in the atmosphere by the atmosphere components. The greater absorbers are water vapour, dust particles and clouds.
2. By reflection: Certain amount of solar radiation is reflected back into the space by clouds, dust particles and ground. The amount of insolation reflected depends on the surface but the average

reflection amounts to 40% of total insolation.



ALBEDO

Albedo refers to the percentage expression of the ratio between coming radiations and the amount reflected. Clouds and to a less extent, the earth surface are the principal reflectors of the incoming radiations back into space. The albedo varies with cloud type from 30-40% in thin clouds, to 50-70% in thicker stratus and 90% in cumulonimbus where only 10%

insolation reaches the atmosphere below the cloud level. Albedo also varies over different land surface from less than 10% over oceans and dark soil, for 15% over coniferous forest and urban areas 25% over grass land and deciduous forests 40% over light coloured deserts to 85% over reflecting fresh snow. This reduces possibility at ice meet and disappears on mountain tops like Kilimanjaro.

THE OZONE LAYER

The ozone layer is found within the stratosphere and it sometimes re-termed as a shield of life. The layer is highly concerned with human and all other earth life and it sets in at an altitude of about 15km and even upward to about 55 kilometers. This layer serves as a shield protecting the troposphere and the earth surface from most violent rays or radiation from the sun. If these rays were to reach the earth directly, all bacteria exposed would be destroyed and animal tissues would be damaged.Destruction of this layer by some scientific discoveries has made the intensity of ultra violet rays reaching the earth surface to increase causing global warming. If this situation is left to continue, it will cause suffering particularly cancer , crop reduction in yield and killing of organisms on land, water and air.

FUNCTION OF ATMOSPHERE

1. It is an insulator: It moderates temperature during night winter.

2. It is a filter: It filters solar insolation through ozone layer and provides a layer through which meteors are burnt into gases.

3. It is a scientific field where radio, radar, television and other communication including air transport and telephones are done.

4. It has hydrological function where rainfall is formed.

5. It support its life through breathing in animals and respiration in plants.

CLIMATOLOGY

Climatology is the study of climate that deals with spatial distribution atmospheric phenomena. It mainly deals with definition and description of different climates in their geographical settings.

Meteorology is the study of weather. It is a scientific study of the physical process constantly at work in the atmosphere. It is highly applied in the forecasting of the future trend of the weather.

It is a branch of Science which deals with the conditions of or within the atmosphere surrounding the earth.

Climatology and meteorology are the studies or the sciences which are concerned with the study of atmosphere and its elements like weather and climate.

CLASSIFICATION OF CLIMATES

By studying the weather, the atmospheric conditions prevailing at a given time in a specific place or area; it is possible to make generalization about the climate of that place or area basing on the average normal condition over a period of time usually 35 years. In seeking a sense of order; the Geographers try to group together those parts of world that have similar measurable climatic characteristics in temperature, rainfall distribution winds, etc.

Classification of climate is done in different systems.

- Greek's classification system.
- Germany climatologist classification system.
- Koepen's temperature zones classification system.
- Miller's classification system.

GREEK CLASSIFICATION SYSTEM

The early Greeks divided the world into three zones based upon a simple temperature description. A classification of climate by Greek is based on temperature control of the climate and they completely ignored precipitation. Under this approach climate is divided into:

i) Tropical climate where the amount of temperature is high.

ii) Temperate climate where the temperature is moderate i.e between the tropical and polar temperature condition.

iii) Polar climate where the temperature is extremely Low.

KOPPEN'S CLASSIFICATION SYSTEM

In 1918 Koppen advanced the modern classification of climate. To support his claim that natural vegetation boundaries were determined by climate, he selected as his basis what he considered were appropriate temperature and seasonal precipitation values.

The classification of climate by this approach is based on the duration above or below the value belt. By this approach climate is classified into the following belts;

- Tropical belt
  The climate having 12 months with temperature above 20°C.

- Sub- tropical belt
  The climate having 4-11 months with temperature above 20°C.

- Temperature belt
  The climate having 4 – 12 months with temperature ranging from 10°C– 20 ^{o}C.

- Cold belt
  This involves those areas having 12 months with the temperature ranging from 10°C to 20°C.

- Polar belt
  The climate having 12 months with temperature below 10°C.

CLASSIFICATION BY GERMANY CLIMATOLOGIST

According to Germany climatologist, climate divided into the following types;

- Hot zone climate
  The climate with temperature isotherm of 20°C annually.

- Cold zone climate
  The climate with annual temperature isotherm of 10°C or below.

- Temperature zone
  The climate with temperature isotherm in between 10°C – 20°C.

MILLER'S CLASSIFICATION SYSTEM

In Britain, in the 1930s, Miller proposed a relatively simple classification based upon five latitudinal temperature zones which he determined by using just three temperature figures. This is the most popular method of climate classification today because it combines both maps of temperatures, showing temperature by means of isotherms and map of rainfall showing rainfall by means of isohyets. It shows a close relationship to vegetation zones and this it is easier to use and convenience.

- The structure of climate classification is as follows;

- Hot zone - With temperature above 20°C.
- Warm zone - With temperature ranging from 10°C – 20°C.
- Cool zone - With temperature of 10°C.
- Cold zone -With temperature near to 0°C .
- Arctic zone -With temperature near to 0°C and below.

CLIMATIC FEATURES

- Dry warm summers with offshore trade winds.
- A concentrated rainfall in winter with offshore westerly.
- Bright sunny weather with hot dry summer and wet mild winter.
- Presence of local winds around the Mediterranean Sea e.g. morocco and Muscat.
- Annual range of temperature is high about 11°C
- Rainfall is moderate about 838 mm and normally falls during winter and it is cyclonic rain type.
- Summer temperature is about 21°C and winter is 10°C, hence high range of temperature.

VEGETATION

Evergreen coniferous forest, Mediterranean bushes and grasses semi arid shrubs as well as grasses, evergreen Mediterranean forests.

ECONOMIC ACTIVITIES:

Crop cultivation due to high rain fall and moderate temperature, Animal rearing i.e. transhumance (pastoralism) orchard farming with different kind of fruits and vegetable (market gardening).

EQUATORIAL CLIMATE

This type of climate occurs as a belt around the world at about 5º North and South of the Equator but it is also found around 5º-10º North and South in some places. The continuity of this climate however is interrupted in several places by mountains such as Andes of South America and the East Africa high lands.

DISTRIBUTION OF EQUATORIAL CLIMATE

Zaire and Congo basin, Amazon basin, East Indies, South Ivory Coast, and Western Coast Nigeria, Eastern Coast, Malaysia and North eastern Australia.

PROBLEMS OF CLIMATE CLASSIFICATION

Classification of climate poses more difficulties since there is no clear boundary due to the fact that climates are Transitional. Thus all classifications have weaknesses, non is perfect because;

- *They do not show transition zones between climates, and after the division lines are purely arbitrary.*

- They do not allow for mesoscale variation such as the lake and district or microscale variation (local variation).

- They can be criticized for being either too simplistic (miller) or too complex.

- They ignore human influence and climatic change both in the long term and the short term.

- Most tend to be based upon temperature and precipitation figures, and neglect recent studies in heat and water budget, air mass movement and the transfer of energy.

- All suffer from the fact that some areas still lack the necessary climatic data to enable them to be categorized accurately.

GENERAL CLASSIFICATION OF CLIMATE

A: **MEDITERRANEAN CLIMATE**

The warm temperature Western margin or the Mediterranean climate is confined in the Western margin of continental landmasses between latitude 30º-40º North and South of the equator.

Areas involved

Central Chile, California, Cape Town, Southern Austria, South West Australia, San Francisco, and parts of Morocco.

CLIMATE CHANGE

It has been noted that a certain area experience a certain climatic condition. Therefore any deviation from the expected condition denotes for a climatic change. There are several evidences of climatic change. These include; rocks are found today in areas which seems to have a different climatic condition under which they formed, fossil landscape, sea level changes, shifting of vegetation belts Sahara, etc.

CAUSES OF CLIMATE CHANGE

For the factors or causes of historical climatic change, refer to the theories which explain the ice ages.

Note: However today the world is experiencing the so called “Global warming” Scientists have reached a consensus on this point of global warming as a published by the International Panel on climate change (IPCC).

Global warming may refer to the world wide increase in the lower atmospheric and terrestrial temperature. This may be as a result of increase in the concentration of one or more greenhouse gases (GHG) as well as the Ozone layer depletion. Global warming is mainly theory asserts that the increasing levels of GHG will progressively trap more of the Earth's heat, gradually warming the global climate as much as 3 to 9 degrees. However the reasons which have been put forward to explain the scenario are related to those activities which pump the GHG into the atmosphere. Therefore man through different activities carried out for his triggers off climate change.

The Marjory include;

CFC's and Halons: Scientists first suggested in 1974 that the worldwide use of CFC's and halons could be destroying the Ozone layer.

In 1982, British scientist for the first time documented the existence of a large hole in the ozone layer over the Antarctica that had been theoretically predicted earlier. In this case the emitted CFC's and halon react with the ozone in the stratosphere to be depleted which formally absorbed some incoming radiation. CFC's is emitted from coolants in air conditioners and refrigerators, propellants in aerosol spray cans, cleaners for electronic parts such as computer chips, production and burning of plastic foam products.

Fossil fuel burning: Like coal burning in industries before the introduction of alternative energy source; this could emit large amounts of GHG such as carbon dioxide and methane into the atmosphere. The industrial revolution sparked off the extraction of the coal to run the machines or industries which had sprung up. The perpetual burning meant continuous emission of carbon dioxide and sulphur hence contributing through the greenhouse effect.

Deforestation: This involve the clearing of vegetation and burning of grassland for either establishment of settlement/industries or agricultural activities. This results into the accumulation of carbon dioxide which would have been taken up by plants.

Cultivation of rice: This is couple with the release of methane gas into the atmosphere.

Livestock farming: Animals like cattle produce methane gas due to their microbial fermentative reaction. Therefore the dumping of cow dung will release too much methane as it decomposes. Animal husbandry is thought to be responsible for much of the increase.

Ozone layer depletion: The chemical reactions which take place between the GHG may break down or deplete the ozone layer. This makes it thinner or drill a hole making it easier for more insolation to pass through to reach surface. Therefore the more insolution reaching the Earth's surface, the more the temperature will increase hence climate change.

Industrialization: Some industries emit GHG into the atmosphere to change the climate through the greenhouse effect as well as reacting with the ozone layer.

Transportation: Automobile emit carbon dioxide during the combustion of fuel in the engine which act as GHG to contribute the global warming.

EFFECTS OF CLIMATIC CHANGE

The effects we feel or observe are rarely, if ever, the effects of a single factor, they are combined impacts of the whole of factors (pollutants) acting over the total life span, and frequently the effects are synergistic. For instance both plant and animals may be so stressed by climatic change and become vulnerable to other environmental factors such as attack by parasites and diseases.

Given the complexity of this situation, it is extremely difficult to determine the effect of any particular factor. Nevertheless some significant progress has been made to link climate change and some effects, these may include;

Soils: Higher temperatures could reduce the water holding capacities and increase soil moisture deficits. It should be noted that climate change will alter the chemical, biological and physical properties of the soils. The expected temperature raise and related prolonged droughts will increase the rate of soil organic matter decomposition thus accelerating land and soil degradation. This will escalate soil fertility depletion result into low productivity. On the other hand, the anticipated floods in highland areas will accelerate run off and soil erosion.

Flora and fauna: Higher temperatures and increased water deficits could mean loss of several species. This is because the exiting flora and fauna cannot adjust drastically to acclimatize to the new climatic conditions.

For instance the increasing temperature may affect the aquatic animals like fish which are used to cool/cold environment. In which addition to that, the change in climate will change in the quality of the different habitats and consequently all the flora and fauna in them. The habitats may include; wetlands, forests, etc.

Agriculture: Agricultural activities which entirely depend on rainfall will be hit by climate change such as prolonged drought, unreliable rainfall are evident in some areas. Droughts lower the productive capacity of rain –fed agriculture hence reducing the agro exports, increasing food prices, nutritional deficiencies and destabilize the macro economies. Cereals will be hit by dry seasons hence a reduction in the production of crops. For instance according to NAPA (2007), in the Lake Victoria basin in Tanzania, maize productivity is estimated to reduce by 17% due to the anticipated climate variability manifesting in form of temperature raise and reduction in rainfall.

The increase in the number of pest and diseases due to climate change is a set-back in the agricultural activities.

Coastal regions: Rise in sea level, increase in height of storms result into more flooding especially around estuaries. Flooding affects housing, industry, farming, transport and wildlife. Flooding increases the susceptibility of water borne diseases along lake shores, coastlines, and other places liable to flooding. For instance in Uganda the outbreaks of malaria, bilharzia, and other water borne diseases were reported to as often occurring during and immediately after floods, (Ugandan NAPA 2007), According to the Tanzania NAPA (2007), Malaria prevalence has been reported tom occur in areas where it was not commonly found in the previous decade for example in some parts of Kagera, Musoma, Mwanza in Tanzania; Kisumu and Kiisi in Kenya. In addition to the even the ice caps for instance on the Kilimanjaro Mountain has tremendously reduced as a result of accelerated ice melt.

It is also anticipated to accelerate the popular ice cap melt too. During the century, sea level rose about 15 cm (6 inches) due to melting of ice and expansion of warmer waters. Models predict that sea level may rise as much as 59 cm (23 inches) during the Century, threatening coastal communities, wetlands, and coral fees. Arctic sea ice is melting. The summer thickness of sea ice is about half of what it was is 1950. Glacier and permafrost are melting for instance over the past 100 years, mountain glacier in all areas of the world have decreased in size and so has the amount of permafrost in the Arctic.

Water: Water is most likely to become scarce due to the increased rates of evaporation as well as the variation in the rainfall pattern in some areas. The anticipated climate variability in form of long droughts will worsen the availability of and accessibility to clean water particularly the poor or those who depend on rivers, streams, boreholes. This is because such source may be dried out or lowering of water levels, in springs, rivers, underground aquifers. Communities will veer to any available water irrespective of its quality hence pausing a danger for water borne diseases, harden the production of hydroelectric power, limit water transport. For instance the declining water levels of lake Victoria in 2002 to 2004 left many boat landing sites and harbours high and dry thus affecting water transport

negatively; the extension of the Owen falls dam (Kiira and Nalubaale) opened in 2000 appears to have been designed to operate with conditions of high average water levels seen between 1960 1990 basing on the inability of the power plant to operate at full capacity during the low water levels of 2002. In Tanzania, the power cut off was extreme also as the mega like Kidatu could not operate at full capacity. This was portrayed through a more than 12 hours cut off.

Tourism: It predominately depends on the beautiful glamorous natural features like mountains, habitats and associated flora and fauna. Climate change will distort the natural environment to as well affect the tourism sector negatively. To make matters worse, floods may destroy the roads to access the distant tourist sites. This is because most of the tourists attraction sites are located in the remote areas of which their roads are impassable during the rainy season. Since the rainfall pattern is unreliable and unpredictable, this will impede the movement of the tourists to such sites. The scenario will ultimately slump the economies which depend on tourism.

Climate change will affect all the different sectors of a country and ultimately the micro economical status of the greatly affected areas or countries more so the developing countries. This is because they may not be robust enough to cope up with the changes hence rendering them variability and change.

Strategies to address Climate change.

It is responsibility for all people at a household or community level, NGO's, government, regional groupings, and the international community at large to strive to reverse the situation. This is because everyone contributes to the existence of the problem though the magnitude of contribution differs. To make matters worse, the effects cut across i.e affects all. However it may be difficult to reverse the situation but the efforts should revolve around strategies to adapt to the climate changes as well as reducing the emission of GHG.

Some of the avenues to fight climate change may include,

Renewable energy sources: Countries should adopt the use of renewable energy resources such as solar, nuclear, biogas, geothermal, etc which are environmentally benign.

In this case they should advocate against the use of fossil fuel such as coal, petroleum and natural gas which emit the GHG.

Afforestation: people should indulge in the policies which encourage the plantation of trees such as agro-forestry. This is because they act as carbon sink to minimize the amount of the carbon dioxide in the atmosphere.

Ambient standards: The International community should agree on the maximum amount of GHG to be emitted by a source point like an industry. In the extreme cases where the GHG can't be curtailed, the strategy may be inevitable.

Use of ethanol or gasohol: The vehicles and other automobiles may replace petroleum with the use of ethanol and gasohol Biomass from sugar cane can be used for the production of ethanol which replace the usage of fossil fuel (petroleum inclusive) this will minimize the GHG which could be emitted the combustion.

Abatement policies: Countries should be stringent on those who emit more than the ambient standards. Abatement policies my involve the pay or cost to cater for the damage caused by the extra emissions the cost as disincentives to pollution.

Comply to the relevant Conventions: signatories should implement accordingly. For instance the 1985 Vienna Convention on the protection of the ozone layer Depletion. The convention requires parties to take concern to the assessment of the cause, effects of ozone layer depletion as well as

transmission of information and exchange of information and Technology to reduce ozone layer depletion.

Note; the convention was amended in Montreal 1987 to become the protocol on substance that deplete the ozone layer. It was later revised in 1990 in London and Stockholm in 1991.

It represents a much more significant agreement than the convention.

It sets a firm target for reducing and eventually elimination of consumption and production of a range of ozone depleting substances. It recognizes the equity of treatment of all Nations that produce ozone depleting substance including the developing countries which produce less.

The protocol also deals with the problem of non- parties by banning trade in ozone depleting with those states to control the use.

- Produce less ozone depleting substances. This is attained through technological transfer.
- Restrict the importation of ozone depletion substances through identifying and monitoring mechanism. For instance Revenue authorities like TRA, URA jointly work with the Environment authorities like NEMA, NEMC in Uganda and Tanzania respectively. In this case, the environmental authorities specify the ozone depleting substances while the revenue authorities escalate the taxes to narrow down the importation.
- Research and education of the stake-holders about the substances. This will also increase on the number of technical officers to ease the monitoring.
- International cooperation through the sharing and transfer of information.
- Establishment of incentives like subsidy to encourage the use of substitutes and disincentives to prohibit the of ozone depleting substance through taxation.

There are very many key players toward the adaptation to the climate change and chopping of GHG emissions.