

CLIMATOLOGY (TRINITY COLLEGE NABBINGO GEOGRAPHY DEPARTMENT S.6) 2020

Climatology refers to the study of the average weather conditions of the atmosphere

It involves the study of weather characteristics and other influences of the atmosphere. The scientific study of weather and atmospheric conditions is referred to as meteorology.

NB: Meteorology means the study of the physical process constantly at work in the atmosphere and it may involve daily observation and measurements of element of weather whose resultant data helps in the compilation of the climate of a given place.

Climate:

Is the average weather condition of the atmosphere at a given place studied and recorded over a long period of time ranging from 30-40 years, it constitutes the study of weather elements such as temperature, wind speed and direction, rainfall, pressure, humidity, amount of sunshine and cloud cover over a long period of time.

It covers a large area extending for hundreds of kilometers. Climatic conditions tend to remain stable over a long period of time through which minor variations occur.

In East Africa, there are different types of climate ranging from Equatorial around L. Victoria basin Tropical, semi-desert in North Eastern regions i.e. Turkana, Kotido and Montane climate around Mountains like Rwenzori.

Weather

Refers to the atmospheric conditions of a place for a short period of time i.e. one hour or a day. Weather elements are temperature, rainfall, humidity, sunshine etc.

Weather can be described as rainy, misty, foggy, sunny or windy.

Weather unlike climate affects a small area i.e. village or town. It is therefore localized, while climate covers a big area i.e. region. Weather conditions vary from time to time but climatic conditions are relatively stable and minor variations are averaged because of the long time considerations.

Qn: *Distinguish between weather and climate*

Factors that affect the climate of an area.

Relief, Refers to the morphology or shape of the land surface. Relief features e.g. Mountains and highlands influence the climate more especially rainfall and temperature

Mountainous areas like Kilimanjaro, Rwenzori, Kigezi influence the occurrence of modified equatorial climate, temperatures are reduced due to high altitude while the orographic rainfall is received on the wind ward side.

When the warm moist winds meet a highland they are forced to raise up to levels of condensation and fall back as relief rainfall.

However, when the winds descend on the leeward side they cause dry conditions since after losing moisture they become dry winds hence aridity in Ankole, Masaka, Kasese and Semliki flats.

Generally flat areas like the western and eastern rift valley, the Albert flats influence dry climate. The absence of hills to trap relief rainfall is responsible for aridity in those areas.

Latitude, Refers to the distance of a place away from the equator i.e. the distance North and South of the equator. Areas that tend to be far away from the equator generally experience cold temperatures e.g. in the temperate areas, Arctic regions and Polar Regions. However, within the tropics temperatures tend to be hot because of the overhead sun i.e. the migration of the sun within the tropics is what we refer to as the overhead. In areas of low latitudes, the hot temperatures are experienced as opposed to high latitudes where cold temperatures are experienced.

In East Africa, temperatures are hot because it lies between the tropics of 5°N and S of the equator with an average temperature of 20°C as illustrated below.

Altitude, this is the height above the sea level as a major factor determining the temperatures of a place. In the troposphere, (1st layer of atmosphere) temperatures tend to decrease with an increase in altitude. For every 150m ascended, there is a drop in temperatures by 1°C, for every 1km ascended, there is 6.5 °C drop in temperature. The fall in temperature with an increase in altitude is because of the water molecules, dusty particles and carbon dioxide all of which absorb heat and heat concentrates in the lower section of the atmosphere meaning that the lower atmosphere is warmer than the higher atmosphere.

Furthermore, temperatures tend to rise as a result of radiant heat generated by the sunrays after striking the surface meaning that the atmosphere is warmed from below rather than above.

Diagram showing radiant heat.

In East Africa, highland areas tend to experience cold temperatures e.g. Kigezi, Kenyan highlands whereas areas of low altitude e.g. along the coast, East African rift valley, the temperatures are hot.

In addition, the highland areas such as Rwenzori, Kilimanjaro, Mountain Kenya the altitude is about 5000m above the sea level. At the peaks, temperatures are below the freezing point and therefore experience snowfall and the peaks are ice-capped.

Waterbodies, large waterbodies like seas, lakes oceans are the major sources of atmospheric moisture, contributing to rainfall through the condensation of water.eg

Lake Victoria is major source of atmospheric moisture in Central **Buganda**; the Indian Ocean is the major source of atmospheric moisture along the coastal regions.

The moisture is brought in by the winds growing inland. This means that the distance from the sea may explain the climate of various parts of the East Africa. In addition, the coastal areas experience heavy rainfall as a result of land and sea breezes resulting from moist winds growing from the sea. On the other hand, areas far from the sea or major water bodies tend to be dry or semi-arid because the winds that reach them tend to have lost their moisture. This explains why much of central and Northern Tanzania are much drier than the coastal areas.

Vegetation, Much as the climate may determine the nature of the vegetation. It is also true that the natural vegetation may in turn influence climate. Swamp vegetation and other wetlands as well as forests contribute to rainfall through the process of evapo-transpiration i.e. moisture is released into the atmosphere in form of vapor which rise to higher levels, cool down, forming clouds that later comes down as rain. That is why most well vegetated areas of East Africa receive heavy rainfall compared to areas with scattered trees, thickets and shrubs, as it is the case with Karamoja.

Ocean currents, These are water currents in the oceans and may be of different temperatures, water currents of relatively warm temperatures are referred to as warm ocean currents and those of cold temperatures are known as cold ocean currents. The ocean currents influence temperatures and rainfall of the adjacent surrounding areas. Warm ocean currents raise the temperatures of the adjacent lands by the winds that grow over them and then move in land. The East African coast has hot temperatures that result into heavy rainfall because of the warm Mozambique current. On the other hand, areas that are affected by cold currents have cold temperatures and limited or no rainfall leading to arid conditions. This is evidenced by Benguela cold ocean currents that contributed to the existence of Namib cold desert in South Western Parts of Southern Africa.

Aspect, in Africa aspect may have limited or minimal effect. Aspect refers to the direction to which a slope faces particularly in reference to sunshine. It may also be referred to as the angle at which sunrays strike the surface of the earth. Within the tropics, where there

sun's over head, the influence of aspect is minimal. However, In Europe it is an important determinant in the distribution of temperatures. The influence is more pronounced in the temperate regions e.g. the south facing slopes tend to have warm temperatures than the North facing slopes

This is illustrated below.

Human activities, Man's activities have influenced climate in many parts of the world. Man has tended to modify the climate through his activities that affect temperatures and the state of the environment such activities are deforestation through lumbering, carrying out agriculture, looking for land for industrialization, These activities contribute to increased temperatures because of increased CO₂ in the environment. Through swamp reclamation, bush burning the environment is destroyed by reducing on water table some plants will be unable to access water leading to their disappearance and therefore increased CO₂ in the areas.

However, it should be noted that through man's activities on a micro scale could enhance/bring about a change positively e.g., afforestation, re-afforestation, agro-forestry, and forest conservation these cause rainfall formation through evapo-transpiration.

Man through artificial rainmaking, the area can receive rainfall through the process known as cloud seeding.

CLIMATIC TYPES

East Africa lies within the tropical latitudes but due to the contribution of factors, the region experiences a variety of climatic conditions. Different types of climate include;

True equatorial climate is experienced in South America in the Amazon basin, in the central Zaire Basin and the Guinea coastlands of Africa.

It occurs along a narrow strip of the East African coasts in Zanzibar. The high plateau of East Africa interrupts the continuity of a true equatorial climate. However, it's experienced along the Lake Victoria basin at Jinja, Mukono, Entebbe, Bukoba, Kisumu among others.

Characteristics of equatorial climate

Temperatures are generally hot and uniform departing little from 27oC

The **diurnal** range of temperature is small and sometimes attaining only 8°C while the **annual temperature** range does not exceed 2oC

Convectional rainfall is usually received during morning and evening, this is often accompanied by thunders storms and lightning for example around Lake Victoria basin at Jinja, Entebbe and Kampala in Uganda, Bukoba and Mwanza in Tanzania.

Receives heavy and well-distributed rainfall throughout the year of between 1000 – 2000mm per annum.

Characterized with a double rainfall maxima with peaks in March and November (Bi-model pattern) where the 1st rain is heavier than the later.

There is no clear marked dry season since rainfall is received throughout the year.

Constantly high humidity 80% throughout the year due to high rates of evaporation

Characterized with thick cloud cover throughout the year due to high rates of evaporation and condensation

Equatorial areas are affected by air masses that converge along the I.T.C.Z, though there may be long periods of calms and light winds.

Morning sky is clear but is gradually obscured by a rapid increasing amount by cloud and in the afternoon following the maximum heating and convectional rising rainfall in form of torrential showers, with strong thunderstorms, followed by fine evening.

Due to the hot temperatures by overhead sun they are characterized by low pressure (due to warm light winds)

Factors for the occurrence of equatorial climate

Latitude, This is the equi-angular distance from the equator, areas lying between 0 degree to 5 degrees North or South of equator below 1000m A.S.L experience an equatorial climate due to sun's isolation. At this point, the sunrays are more concentrated and strike the earth at right angles leading to hot temperatures.

Altitude, Refers to height of land above the sea level.

Areas below 1000m. A.S.L, tend to experience equatorial type of climate i.e. hot temperatures. Generally, the altitude of East Africa especially the plateau are below 1000m ASL for example Entebbe and Jinja, Kisumu, Bukoba, Kampala.

Influence of water bodies.

Presence of water bodies such as Lake Victoria cause microclimate effects through land and sea breezes, increased evaporation which leads to increased rainfall and humidity almost throughout the year around Victoria basin.

Influence of vegetation; Thick tropical forests like Mabira, Budongo encourage an equatorial type of climate through enhancing rainfall formation by evapo-transpiration,

this leads to high amount of water vapor, warm temperatures and heavy rainfall accompanied by thunderstorm.

Influence of cloud cover, Thick cloud cover along the Victoria basin ie cumulus and cumulo-nimbus prevent heat loss in the space during day and night hence sustaining a small diurnal range of temperature of 8°C and annual temperature range of 2°C a characteristic of equatorial type of climate.

The I.T.C.Z and apparent movement of the overhead sun influence insolation and rainfall pattern. The temperature and rainfall received varies with the position of the overhead sun. an overhead sun in the northern hemisphere causes hot temperature and heavy rainfall in March – June, July in North East Africa and on the other hand an overhead sun over the southern hemisphere in September to December causes hot temperatures and heavy rainfall along the Victoria basin. This results into two rainfall maxima which is a characteristic of equatorial type of climate.

Air masses or wind systems also account for the occurrence of equatorial climate. In east Africa e.g. when the South East trade winds are on shore, they bring in heavy rainfall and hot temperature hence maintain an equatorial climate particularly along the East African Coast at Mombasa and Dar-es-Salaam.

Savanna climate

It is referred to as tropical continental or Sudan type of climate or moist tropical climate. It is found on a transition zone between equatorial belt and the hot desert.

It is experienced in East and South of Guinea, Coast of West Africa, Central Africa, Brazilian Highlands, Mexican plateau e.t.c

In East Africa, it is common in central and western Uganda, Southern and western Kenya and parts of Northern Uganda.

Characteristics of Savannah climate

Hot temperatures throughout the year with the mean monthly temperatures exceeding 32°C towards the desert.

There is alternating dry and wet season a result of the apparent movement of the sun.

Maximum temperatures of up to 32°C are attained before the onset of the rain season as a result of the dry air and cloudless skies.

Receives moderate rainfall of approximately 860mm. but the rains are unreliable from year to year.

Because of limited cloud cover, there is high marked diurnal temperature range (15°C)

The annual temperature range is relatively high between 7°C -15°C.

Receives convectional rainfall alternating in a dry winter during which either the trades or stable air masses are dominant. The rains are normally short-lived and torrential.

Low humidity during dry season and relatively high during the rainy season.

FACTORS /CONDITIONS FOR THE OCCURRENCE OF SAVANNA CLIMATE

I.T.C.Z and apparent movement of the sun. The wet season occurs when the sun moves overhead bringing with it the heat equator. The I.T.C.Z and the equatorial low-pressure belt bring heavy convectional rainfall for 4-5 months. The dry season corresponds with the moving away of the I.T.C.Z resulting into little/no rainfall.

Influence of trade winds, the trade winds bring rain on certain margins particularly the East African coast at Mombasa, Dar-es Salaam but for much of the interior they are dry winds. North East trade winds for example blow from the Sahara desert bring hot dry air to Northern Kenya, Turkana land, Central Tanzania and Northern Uganda districts i.e. Gulu, Moyo, Kitgum, Kotido.

Distance from the sea/limited water bodies offers limited chances of land and sea breeze or rainfall formation and humidity. For this reason during the dry season, there is no rainfall and areas experience low humidity e.g. Gulu, Moroto, Nakapiripiriti.

Cloud cover; The limited cloud cover allows intense heating during day and at the same time during the night allows loss of heat through radiation cooling resulting into large diurnal temp range of about 15°C in Nakasongola and Northern Uganda as well as central Tanzania

Vegetation; Limited vegetation particularly towards the desert margins offers limited chances of rainfall formation through evapo-transpiration, never the less the equatorial belt favors the little rainfall formation through evapo-transpiration. Such rains are received at Gulu, Lira, and Northern Tanzania.

Latitude; this is the equi-angular distance from the equator. Savanna climate occurs in areas relatively near the equator between 5°C – 10° North or South of the equator. In this region it's because the sun rays are more concentrated and strike the earth at almost at right angles cause hot temperatures of tropical type i.e. 32°C

Altitude, refers to the height of land above sea level. Savanna climate lies below 1000m ASL and such areas experience hot temperatures above 27°C for this reason areas like Turkana in Northern Kenya, Central Tanzania experience savannah climate, Northern Uganda i.e. Kitgum, Gulu experience tropical climate.

Influence of the biotic factors such as grazing wild animals have reduced vegetation cover hence limiting chances of rain fall formation through evapotranspiration, human activities like charcoal burning, over stocking, deforestation in Moroto, Trukana region, Tsavo have

destroyed natural vegetation leading to little and unreliable rainfall, hot temperatures and limited humidity hence the occurrence of savanna climate.

Desert climate

Deserts are areas where there is a great deficit of moisture predominantly because rainfall levels are low. In some deserts, this situation is a result of hot temperatures due to high evaporation rates. Deserts are a result of aridity.

Most deserts are located in the centre on the Western part of continents approximately between latitude 15 degrees and 30 degrees north or south of the equator. In Africa, they include Kalahari and Namib Desert covering parts of Namibia and Angola, the great Sahara desert in North Africa covering Algeria, Libya, Morocco, Egypt etc. Arabian Desert covering Iran, Saudi Arabian, Atacama Desert in South America, California.

In East Africa desert like conditions are experienced in Northern Uganda, Moroto, Kaabong and Kotido in Kenya in North West around L. Turkana covered by Chalbi desert.

Characteristics of desert climate

Very hot temperatures above 40°C and absence of wet season.

Hot temperatures are experienced throughout the year.

Due to extreme temperature during day and very cold nights, there is a big diurnal range of temperature between 33 – 39°C.

There is lack of cloud cover this leads to high levels of insolation from the overhead sun and maximum cooling thus the emergences of bare rock surfaces and sandy particles

Extremely low rainfall of less than 250mm though in some cases no rainfall may be received at all in a year.

Coastal deserts such as Kalahari/Namib tend to experience fog due to cold air from cold ocean currents

There is little or no cloud cover resulting into a clear blue sky the absence of sufficient vapor from water bodies limits the formation of cumulus and other types of clouds.

Very low humidity of less than 30% due to absence of water bodies and vegetation to enhance vapor formation through evaporation and evapo-transpiration.

FACTORS FOR THE OCCURRENCE OF DESERTIFICATION (desert climate)

Rain shadow effect; produced by high mountains such as Rwenzori, Kenya, Kilimanjaro. Warm winds blow over the mountains to cause rainfall formation on the windward side, moisture becomes wasted and dry winds descend on the lee ward side. They limit humidity and rainfall formation, i.e. Kasese, Moroto etc

Location along the western coast where the ocean water is cold. Influence of cold ocean currents operates in the sense that, when the wind blows from the sea over a cool current on to a heated land aridity sets in and ultimately a desert climate is experienced, Benguela Cold Ocean current in South West Africa led to the development of Namib- Kalahari desert.

Influence of dry or drying winds like the local winds such as the trades blow over an extensive land areas i.e. North East trade winds in Turkana and Karamoja.

Cloudless skies for example in the Sahara desert allow maximum heating raising temperatures up to 40°C while at the same time during the night there is rapid cooling such conditions limit vegetation growth leading to desert climate.

Absence of water bodies in extensive landmasses accelerates the development of a desert climate e.g. in Karamoja and Turkana there are few and small water bodies like oases, this limits evaporation hence desert climate.

Latitudinal location. Hot temperatures are located between 15° – 30° North South of the equator. Namib Desert in Namibia experience maximum insolation leading to hot temperatures over 30°C during day.

Human activities like over grazing, bush burning, deforestation have accelerated the condition of hot desert and this has led to its extension in regions that never experienced before. Nakasongola, Luweero, Ankole, Semliki and Albert Flats are dry partly because of deforestation and over grazing.

Qn: Describe the causes and effects of semi-arid climate conditions in East Africa (Research 5 pages)

Source: Ssekalega Abaasi (Physical geography page 315)

Qn: a) To what extent have human activities contributed to desertification in East Africa?

b) Examine the steps taken to combat desertification in East Africa.

Group discussion

Alpine/mountain/montane climate

This is a type of climate experienced along highland areas such as Mt. Kilimanjaro in Tanzania, Rwenzori in Uganda, Mt Kenya also experienced around Drakensberg in South Africa, Atlas Mountains in North Africa etc.

Relief and altitude are the main factors that affect this type of climate in that for every 100m of ascend temperatures drop by approximately 0.6°C and a climb of 1000m temperatures drop by 6.5°C

Characteristics of alpine/ Mountain climate

The temperature at different altitudinal levels differs at the lower level 1000m ASL temperatures are hot about 25°C while as you go high it keeps dropping by 6.5°C for every 1000m of ascent.

There is a great diurnal temperature range. Days are hot over 20°C while nights are cold due to rapid radiation cooling.

There is relatively a small annual range of temperature. This is due to the fact that temperatures are quite constant on mountainous areas like Kilimanjaro and Rwenzori.

High pressure on Mountain tops, this is because pressure increases as one ascends the mountain.

Windward slope receives heavy orographic rainfall well distributed over 1500mm, this is due to the effects of warm moist winds forced to increase up on mountains.

Leeward side is characterized by hot temperatures and aridity. This is because warm moist winds lose all their moisture on windward side as they descend on the leeward side they dry not capable of producing rainfall. Hence, Kasese region lies on the leeward of mountain Rwenzori and its hot and dry.

Qn: Account for the occurrence of montane climate

WEATHER AND WEATHER ELEMENTS

Elements of weather are the components that make up the state of the atmosphere for a given place.

They are variable that are constantly referred to whenever weather is being described.

They include;

Temperature

It refers to the degree of hotness or coldness of the atmosphere may be very cold, cool, moderate, warm, hot or very hot.

The temperature of the atmosphere may be measured by an instrument known as a six's thermometer (maximum and minimum thermometer).

This is because it is important to ascertain the highest (hottest) temperature of the day and the lowest (the coldest) temperature reached during day. The maximum and

minimum temperatures are necessary to obtain the average temperatures of the day e.g. the highest + lowest

2

NB: It is also important in calculating the diurnal range of temperatures. In the tropical climate conditions diurnal range of temperature are small while in desert conditions the diurnal range is big why?

Ans: it is because; it is very hot during day and very cold during night due to low cloud cover

The instrument measuring temperature can be illustrated as below.

When the temperature rises, alcohol in the left limb of the (min) thermometer expands and alcohol in the right limb (max) vaporizes to the empty space (vacuum).

Alcohol in the left limb pushes mercury downwards the left limb freely pushing the metal index which stays at the maximum level when the temperature rises.

When the temperature falls, alcohol in the left limb condenses/liquefies. Alcohol from the right limb pushes mercury backwards to left limb, thereby pushing the metal index upwards. The end of the index in the minimum thermometer represents the minimum temperature of the day.

Rainfall (Precipitation)

Rainfall is the fall of water droplets from the clouds down to the earth's surface. It may be in form of a shower or drizzle.

In East Africa, rainfall is the main form of precipitation. The other forms of precipitation include;

Hailstones

Snow especially on the peak of Mountain Rwenzori, Kenya and Kilimanjaro,.

Rainfall results from the condensation of water vapor in the atmosphere. When the tiny water droplets forming clouds become too heavy to be held in the atmosphere, come down as rain. The amount of rainfall received in a place is measured using an instrument known as a **rain gauge**

Rainfall is measured using a rain gauge and it is made up of the outer cylinder and a funnel which is fixed in the neck of the collecting jar.

A rain gauge is sunk into the ground, the top part is visible, and it is put above 30cm in the ground to avoid splash water to get in to it.

Every day water collected is poured carefully into the measuring cylinder and the amount of rainfall is read from the scale which is measured in millimeters the rainfall received each day is recorded to obtain the total monthly rainfall

Wind: This is the moving air or Air in motion resulting from differences in atmospheric pressure. Winds tend to blow from regions of high pressure to regions of low pressure. Winds may be local or global

Global winds are referred to as air masses and play an important role in influencing climate of a given place. Local winds may also influence the micro climate of an area.

To a meteorologist wind speed, strength and direction are very important, therefore they are measured. Light winds are referred to as breezes while very strong winds are called storms.

The speed of wind is measured using an anemometer, the direction is determined by wind vane strength of wind is determined using wind sock

Diagram of the wind vane

A windvane is used to indicate wind direction. It consists of a horizontal rotating arm pivoted on a vertical shaft. The rotating arm has a tail at one end and a pointer at the other. When the wind blows, the arm swings until the pointer faces the winds. The directions, North, East, South and West are marked on arms that are rigidly fixed to the shaft. In fig 1.0, the wind is blowing from the North East.

Diagram of an Anemometer:

The speed of the wind is measured by an anemometer which consists of three or four metal cups fixed to metal arms that rotate freely on a vertical shaft. When there is wind,

the cups rotate. The stronger the wind, the faster the rotation. The number of rotations is recorded on a meter to give the speed of the wind in km/hr.

It is possible to estimate the speed of the wind without an anemometer. This is done by observing the way certain objects are moved by the wind.

Sunshine

This refers the light and heat from the sun in form of rays. Sunshine is important in that, it provides energy for a variety of physical and biological processes over the earth's surface.

Sunshine contributes to the temperature of the atmosphere. Intense sunshine may lead to hot temperatures while moderate or mild sunshine may have limited influence on temperature changes.

A meteorologist normally takes note of the number of hours of sunshine received in a given area and the intensity of solar radiation or insolation) experienced over time. The number of hours of sunshine is recorded using a sunshine recorder or Campbell stock sunshine recorder / Jordan's sunshine recorder.

SUNSHINE RECORDER

The number of hours and minutes of sunshine that a place receives each day is measured by a sunshine recorder. This is a glass sphere, which is partially surrounded by a metal frame on the inside of which is a sensitized card. This card is graduated in hours and minutes. When the sun shines, the glass sphere focuses the sun's rays onto the card and as sun moves across the sky. The rays burn a trace on the card. This only happens when the sun is shining. At the end of the day, the card is taken out and the length of trace is turned into hour and minutes, which represents the total amount of sunshine for the day.

HUMIDITY

Is the amount of water vapour in the atmosphere. It is measured through use of a hygrometer.

A hygrometer consists of two ordinary thermometers, the dry and wet bulb thermometer. The wet bulb thermometer is wrapped in a piece of muslin cloth (wick) which is dipped into a container of water. The other is called a dry bulb thermometer. This measures the actual temperatures of the surrounding air and so is not dipped in the water.

An illustration of both Wet bulb and Dry bulb thermometer

When the two thermometers are properly set, evaporation from the wet bulb thermometer will cool the thermometer and mercury will contract and hence its temperature readings will be low. The dry bulb thermometer on the other hand will measure the actual temperature of the atmosphere. Humidity is then measured as the difference in readings between the two thermometers. The real values of humidity are got by reading the difference in both temperature thermometers interpreted from given tables.

NB: At saturation where humidity is 100%, there will be no evaporation and so the reading on the two thermometers will be the same without any difference

Thus;

Where there is no difference in readings. It means that the air is at saturation (100% humidity)

Where the difference is small, the humidity is high

Where the difference is big, for example hot temperature on the dry bulb thermometer and very low temperature on the wet bulb thermometer then the humidity is low.

Research: What is meant by,

Relative humidity

Absolute humidity

ATMOSPHERIC PRESSURE

This is the force exerted by the weight of air on the earth's surface and it can be influenced by the air temperature. Since cold air is denser than warm air, it therefore exerts a greater force on the earth's surface and that is why cold regions are said to experience high atmospheric pressure. Air with moisture and impurities such as dust is denser and therefore high pressure while air in high altitude is rarified (has less impurities)

Therefore has less pressure despite the fact that it may be cold, in lower altitude, the air may have or exert high pressure because of the impurities in it despite the fact that it may be warm and therefore exerting great atmospheric pressure over the earth's surface

In highlands atmospheric pressure tends to be low generally because of the rarified nature of the air and because the column of air resting on the land surface is limited.

Atmospheric pressure is measured using the mercury aneroid barometer, however modern instruments like the barograph, which tends to record and plot the different pressures experienced at different times is used in modern weather stations.

A diagram of a Mercury aneroid Barometer

A mercury barometer is made by pouring mercury into a long glass tube a little less than 1m (39 inches) long, until it is full. Then the end of the tube is held closed whilst the tube is inverted and the end placed into a dish of mercury.

When the opening is uncovered, the level of the mercury in the tube drops down until it reaches the level of 76 centimeter above the surface of the mercury in the dish below. The atmospheric pressure on the surface of the mercury in the dish holds up the column inside the tube. The average atmospheric pressure will support the mercury column in the tube to a height of 76cm or 760mm. This amount of mercury has the same weight as a column of air about 18km high.