

# Weather /Climate Manual for Agriculture

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## **SOME USEFUL DEFINITIONS**

**WATER VAPOR** - It is the gaseous state of water and it's often invisible to the human eye.

**DEW POINT** - It refers to the temperature that air needs to be cooled (at constant pressure) to reach a relative humidity of 100%. At this point, the air is fully saturated and cannot hold any more water vapor. When the air temperature matches the dew point, the air is as saturated as it can be without condensation forming.

**DOWNPOUR** - It is the sudden and unexpected heavy fall of rain.

**RAINFALL AMOUNT** - It is the amount of precipitation in the form of rain (water droplets from the clouds) that descends onto the surface of the Earth, either on land or waters.

**MIST** - It is a cloud of tiny water droplets suspended in the atmosphere at or near the Earth's surface that limits visibility (to a lesser extent than fog; strictly with visibility remaining above 1km).

**FOG** - It is a thick cloud of tiny water droplets suspended in the atmosphere at or near the Earth's surface which obscures or restricts visibility (to a greater extent than mist; strictly reducing visibility to below 1km).

**DEW** - It is a water in the form of droplets that appears on thin exposed objects in the morning or evening due to condensation. As the exposed surface cools by radiating its heat, atmospheric moisture condenses at a rate greater than that at which it can evaporate, resulting in the formation of water droplets.

**AEROSOL** - It is a suspension of tiny particles or droplets in air such as dust or fumes.

**EVAPORATION** - It is the process of turning liquid into a gas.

**CONDENSATION** - It is the process where water vapor becomes liquid. It is actually the reverse of evaporation.

**CONCENTRATION** - It refers to the amount of substance in a defined space.

**SATURATION** - It is a physical and chemical state where a system can take no more.

**CESSATION OF RAINFALL** - This is a period that is characterized by the end of rainfall in a year, this also means the scanty few days of rainfall which may occasionally occur.

**ONSET OF RAINFALL** - It can be described as the possible start of rainfall in a year.

**CLIMATE ZONE** - These are areas with distinct climates. These zones might correspond to weather patterns, latitude, or communities of plants and animals. Climate zones can even help farmers and

gardeners understand which plants will grow best in their area. So, in Ghana our agro-ecological zones help farmers to know the kind of crop to plant at a specific geographical location and what to expect at a particular time of the year in respect to the climate.

**PROBABILITY** - Chance of a weather occurring.

**VISIBILITY** - How far ahead one can see.

**PRECIPITATION** - Weather in the form of Rain, snow, hail, drizzle, showers.

**THUNDERSTORM** - Series of thunder usually accompanied by rain or hail

**ISOLATED** - The weather is expected over few areas. Usually less than a quarter of the area

**SCATTERED** - More than a quarter of the area will be affected by the weather but less than half.

**WIDESPREAD** - The weather is expected over more areas, usually more than half of the area under consideration.

**INTERMITTENT** - A weather that is expected to occur in aggregates (not continuous) but could last for a long period of time.

**OCCASIONAL** - The weather is expected to occur some times within the day.

**GUST** - It is an occasional increase in wind speed

**PREVAILING WEATHER** - The weather that is dominating an area at a time.

**SLIGHT, MODERATE, HEAVY** - Tells the intensity of the weather. The least is slight, followed by moderate and the highest is heavy.

**SQUALL** - A line of intense thunder.

**DRY** - Less amount of moisture in the atmosphere.

**MOSTLY CLOUDY** - More cloud than sun.

**FEW CLOUDS** - More sun than clouds.

**CLEAR SKY** - No cloud in the sky

**OVERCAST** - Entire sky covered with cloud

**FAIR WEATHER** - Weather void of rain, thunder

**UNSTABLE ATMOSPHERE** - Atmosphere favourable for cloud formation and/or precipitation.

**HAZE** - Weather that causes obscuration in a relatively dry atmosphere.

**STRONG/WEAK** - used to describe the intensity of a weather condition.

**PARTLY CLOUDY** - An atmosphere with cloud and sun existing together.

**WINDY** - Strong winds persisting for a period of time.

**STORM** - rain that comes with strong winds.

**PERIODIC** - Weather condition that will occur during some times within the day.

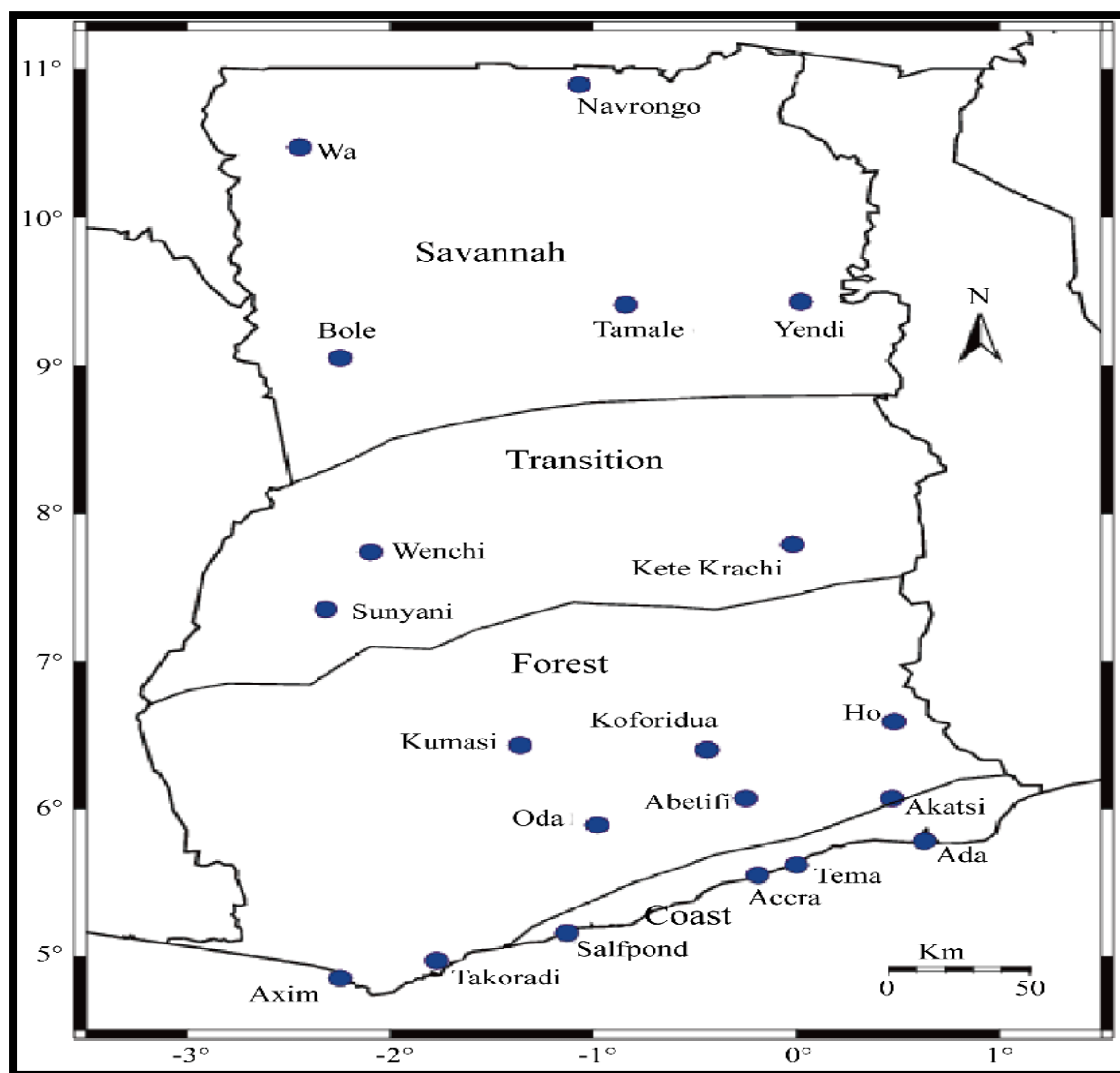
**CLIMATE VARIABILITY** - It refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scale beyond that of the individual weather events.

**AGROMETEOROLOGY** - It is an abbreviated form of agricultural meteorology, puts the science of meteorology to the service of agriculture, in its various forms and facets, to help with the sensible use of land, to accelerate the production of food, and to avoid the irreversible abuse of land resources

**AGROCLIMATOLOGY** - It is the study of climate and its effect on agriculture. It mainly deals with the interaction between climatological and hydrological factors. Its main aim is to apply climatological information for the purpose of improving farming practices and increasing agricultural productivity both in terms of quantity and quality. Even though agrometeorology and agroclimatology deal with almost similar fields, they differ in their approach as agrometeorology mainly deals with weather forecasting dealing with daily problems, while the agroclimatology deals with the use of mean data as a guide to long range planning.

**SYNOPTIC WEATHER STATIONS** - They collect meteorological information at synoptic time 00h00, 06h00, 12h00, 18h00(UTC) and at intermediate synoptic hours 03h00, 09h00, 15h00, 21h00(UTC). The instruments used for gathering the information at the stations are the anemometer, wind vane, pressure sensor, thermometer, hygrometer and rain gauge. The purpose of the synoptic observations includes mapping large scale weather systems (in real time and for climatology) and also to provide the basis needed for proper analysis and verification of operational weather models.

## THE VARIOUS SYNOPTIC STATIONS IN GHANA



## **THE ATMOSPHERE**

Our planet's atmosphere is a layer of gases that surrounds it and is held in place by gravity and its own weight. Gases like Nitrogen (78%), oxygen (21) and other percent gases, make up the atmosphere. The Atmosphere shields life on Earth from harmful ultraviolet (UV) radiation, insulates the planet to maintain a comfortable temperature, and limits the extremes of day and night.

The atmosphere is made of four layers namely; Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere in their respective increase other of height.

### **TROPOSPHERE**

The lowest layer of the atmosphere, the troposphere, is located about 9 km above Earth's surface and contains the majority of the atmosphere's mass (about 75–80%).

- The majority of weather-related activities occur in the troposphere.
- We are located in this layer, which also contains all other living things.
- The majority of the gases in the atmosphere are found in the troposphere.
- In this layer, temperature falls with height.

### **STRATOSPHERE**

Most of the ozone in the atmosphere is found in this second layer, which is the second layer of the atmospheric. The temperature rises vertically in this layer. The UV light from the sun is absorbed by the ozone in this layer, preventing it from reaching the Earth's surface.

From the tropopause, it spreads out by around 10 to 30 kilometers (layer between the troposphere and the stratosphere).

### **MESOSPHERE**

Between 30 and 50 km above the stratosphere, this layer of the atmosphere is relatively large.

At the mesopause, temperatures drop with height to a minimum of roughly -90 degrees Celsius (layer separating the mesosphere and the thermosphere).

### **THERMOSPHERE**

Due to the sun's powerful ultraviolet and x-ray light being absorbed, the thermosphere is a layer of the atmosphere where temperature rises with height. It is located between 50 and 400 kilometers above the mesopause.

## EXOSPHERE

This layer of the atmosphere is the bottom one and is primarily made up of oxygen and hydrogen atoms. It is located above the thermosphere at a distance of around 400 km.

### A DIAGRAM SHOWING THE LAYERS OF THE ATMOSPHERE

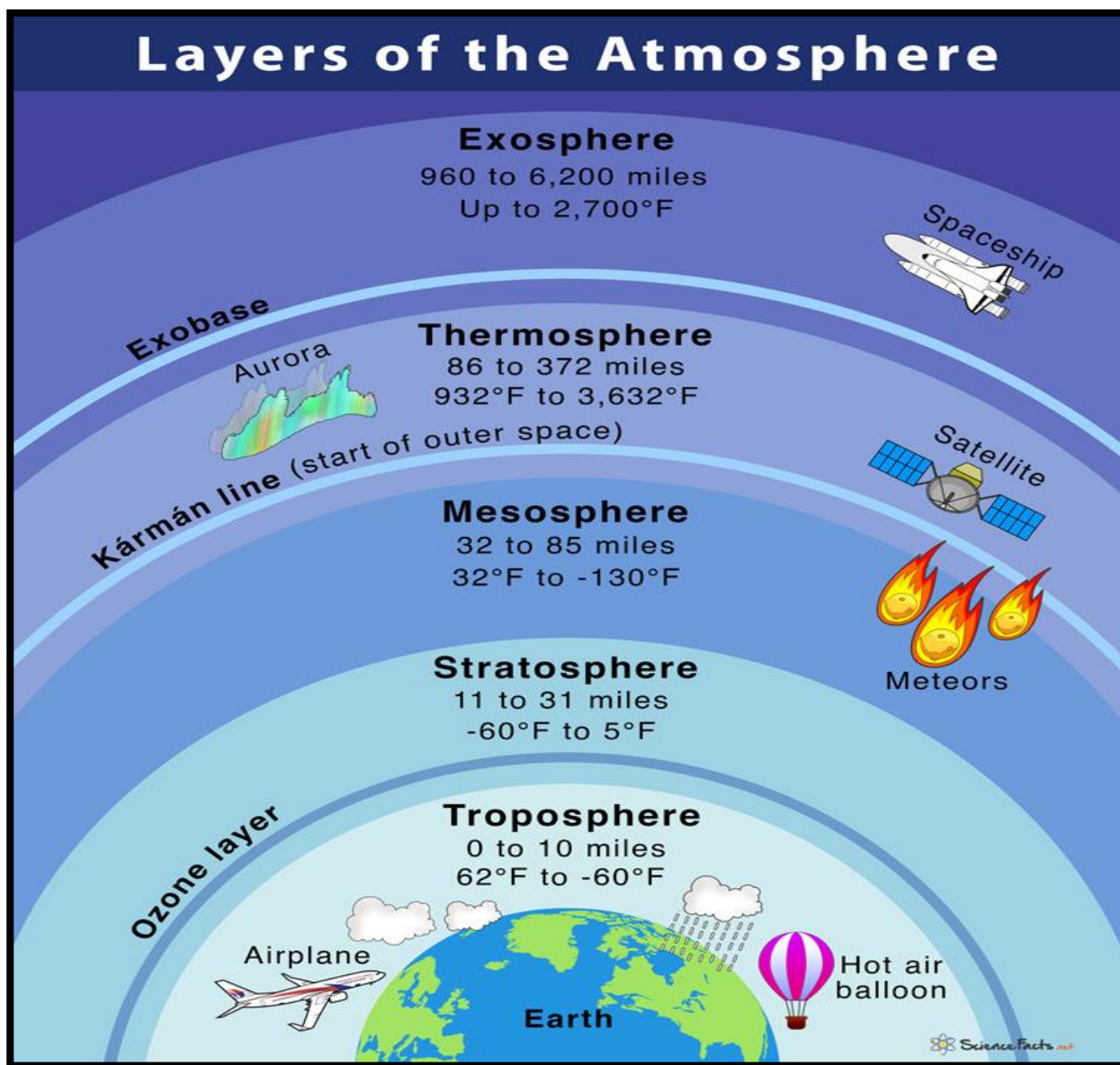


Figure 2: The layers of the atmosphere.

## **THE WEATHER**

We shall focus on the troposphere, which is where the majority of our weather-related activities occur, from the upper layers of the atmosphere. The variety of activities that take place daily in our atmosphere make up the weather. Because of the dynamic nature of the atmosphere, the weather varies across the globe and changes over the course of a few minutes, hours, days, and weeks.

Air temperature, atmospheric pressure, humidity, precipitation, solar radiation, wind, and cloudiness are just a few of the variables that make up the weather.

A meteorologist measures and examines these meteorological variables in order to forecast or anticipate the weather. The type of air mass affects weather as well.

### **AIR MASSES**

Air masses are generally a parcel of air with uniform temperature and humidity moving in the same direction. An air mass is known based on their source of origin

#### **TYPES OF AIR MASSES**

- Tropical continental air mass
- Tropical maritime air mass
- Polar continental air mass
- Polar maritime air mass
- Arctic maritime air mass
- Returning polar maritime air mass

Because we are taking of our weather and climate our concentration will on tropical continental and tropical maritime. These are the two types of air masses that have impact on our climate.

#### **PROPERTIES OF AN AIR MASS**

All air masses have the following properties:

- Temperature
- Moisture content
- Stability
- Weather
- Visibility
- Change of lapse rate

## **TROPICAL CONTINENTAL**

This particular air mass is primarily responsible for the country's dry season, often known as the Harmattan season. It is accompanied by a great deal of dust, which causes the atmosphere to become quite dry. Visibility is also moderate to poor, and the temperature rises quickly with a steady atmosphere. The Sahara Desert in North Africa is where these air masses originated.

## **TROPICAL MARITIME**

This kind of air mass blows across the nation from the sea. It typically comes with chilly temperatures, an unstable atmosphere, good visibility, and moist, rainy weather.

## **WHAT IS WEATHER**

Weather refers to the state of the atmosphere at a particular place. Weather can also be referred to as the short-term changes in the atmosphere.

## **WHAT IS CLIMATE**

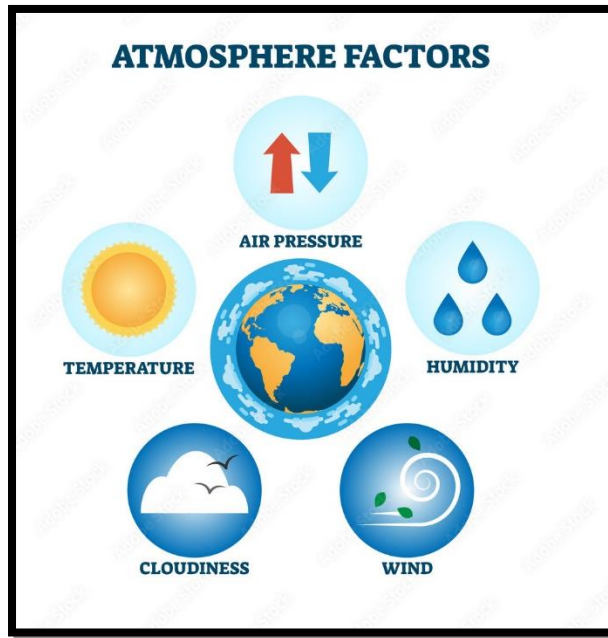
Climate refers to the long-term state of the atmosphere at a particular place at a particular time. Climate describes what the weather is like over a long period of time in a specific area.

## **DIFFERENCES BETWEEN WEATHER AND CLIMATE**

<b>WEATHER</b>	<b>CLIMATE</b>
1.Weather refers to the short-term changes in the atmosphere.	1.Climate refers to the long-term state of the atmosphere.
2. Weather affects only a small geographical area.	2. Climate affects a large geographical area.
3. Weather is what you get.	3. Climate is what you expect to happen in some years to come.

## **WHAT CAUSES WEATHER**

Weather is made up to 6 main components namely temperature, atmospheric pressure, cloud formation, wind, humidity and precipitation. The atmosphere is dynamic so is the weather and any slightest change in any of the aforementioned components can change the pattern of the weather.



*Figure 3: An Image Showing the Variations of Temperature*

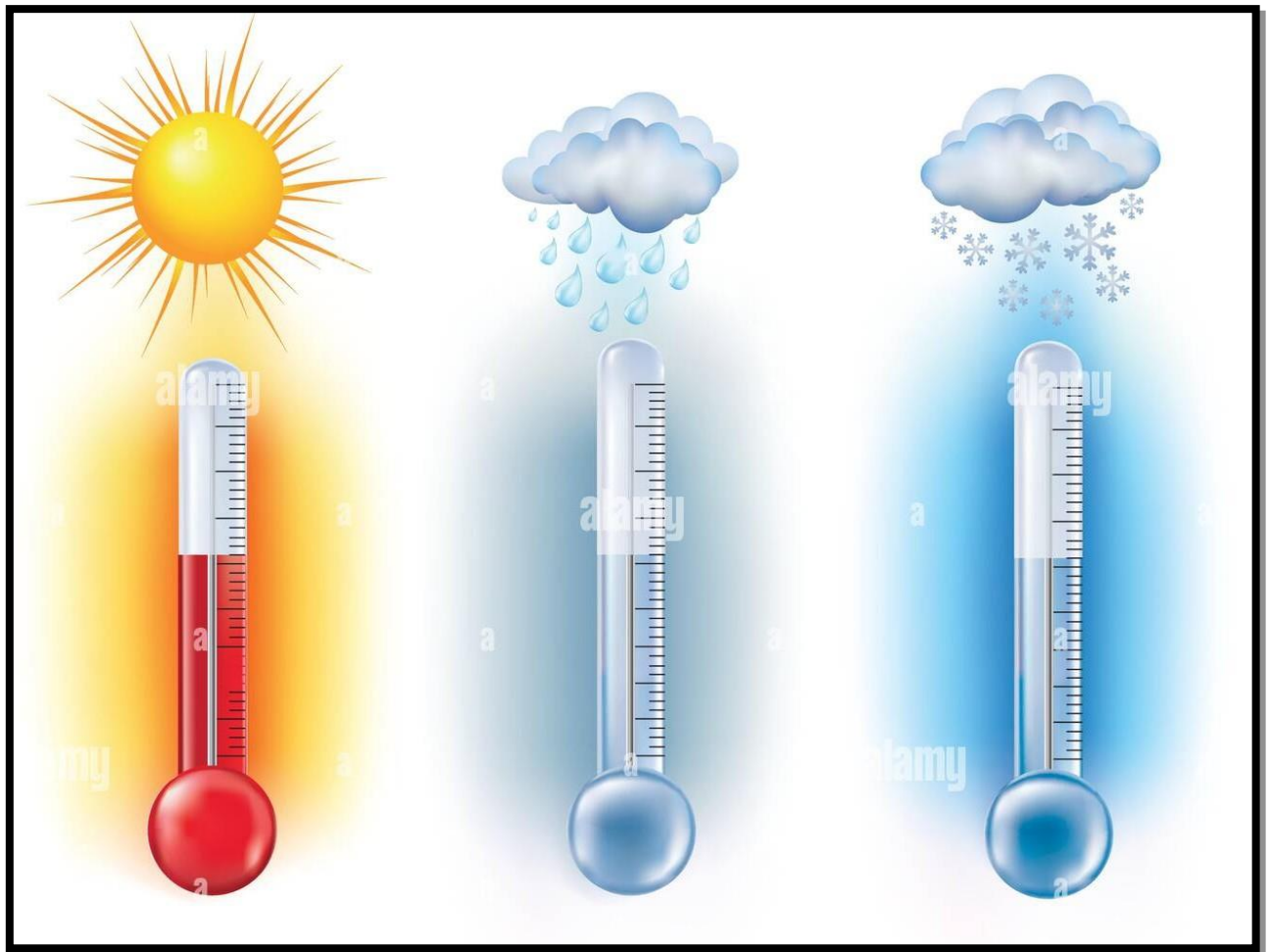
For instance, we could be experiencing a fair and clear weather in the morning but in the afternoon, there can be heavy rains with thundering and lightening. The weather keeps on changing due to smallest change in any of the weather components. These weather components are measured, analyzed and forecasted by meteorologist to give awareness to the general public to know the state of the atmosphere.

## **COMPONENTS OF WEATHER**

### **1. TEMPERATURE**

Temperature is the main parameter which determines or defines the stability of the atmosphere. Temperature basically describes how hot or cold a body or an object is. Temperature decreases with altitude in the troposphere. The atmosphere absorbs energy from the sun and this makes the air at the surface rise and then cool and condense. It then forms clouds and later fall as rain.

Since air mass brings about the weather change, the temperature of the air mass will determine the kind of weather we will be experiencing.



*Figure 4: The above showing the Atmosphere Factors.*

## 2. **ATMOSPHERIC PRESSURE**

This is an indicator of the weather. Atmospheric pressure generally refers to the weight of the air. Air masses move from high pressure zone to a low-pressure zone.

### **LOW PRESSURE SYSTEM**

Low pressure systems are normally found in the 1012mb to 1000mb isobars. For low pressure zones, the winds move inward in a circular motion from a high-pressure zone and it normally rotates in an anticlockwise direction in the Northern hemisphere. In low pressure systems, the air is lighter than the surrounding air masses and so rises causing an unstable environment. This rising air makes water vapor in the air condense and form clouds which fall as rain. This is what causes active weather like the rains, winds(whirlwind,) and severe weather conditions such as cyclones, tornadoes, hurricanes, typhoons. It is also associated with clouds and precipitation that minimize temperature change throughout the day.

### **HIGH PRESSURE SYSTEM**

High pressure means the air is heavy and it sinks. Sinking air makes the environment very stable. Under high pressure, you can expect sunny skies and calm weather. High pressure systems lead to anticyclones where the winds rotate in the clockwise direction. The winds blow out of the system to a low-pressure system. High pressure systems have descending air/winds which reduces the formation of clouds and leads to light winds and settled weather conditions. High pressures are mostly from 1016mb to 1050mb isobars.

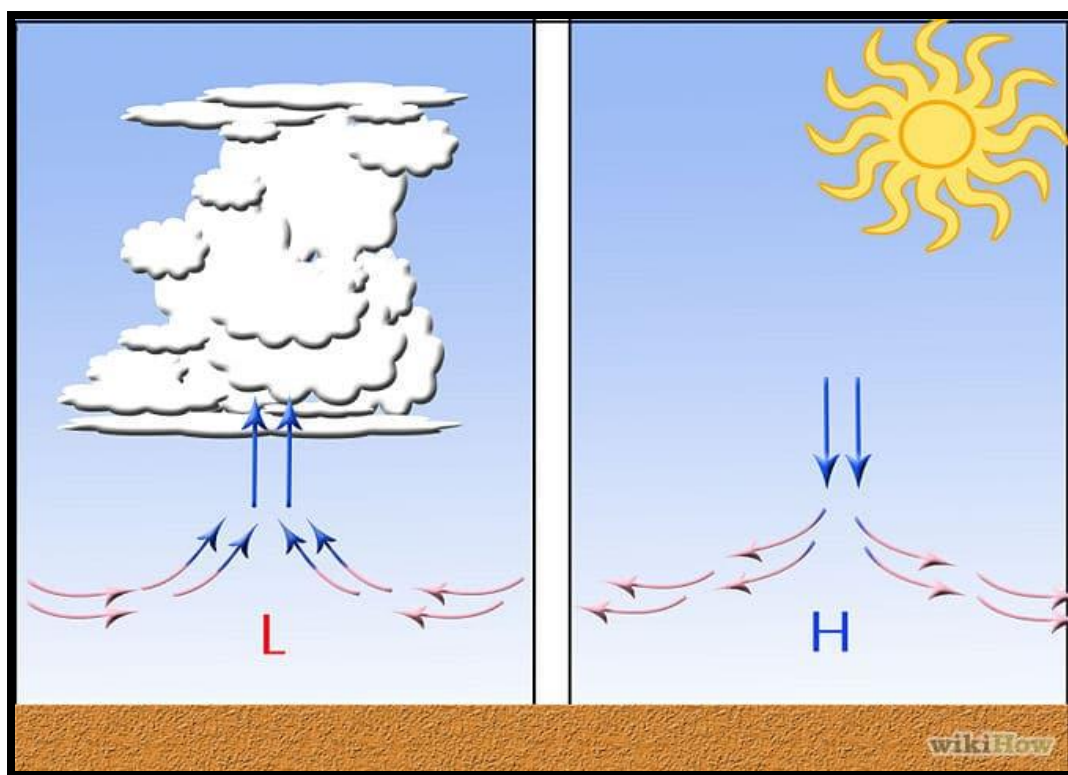


Figure 5: The above image shows Low Pressure System and High-Pressure System respectively.

## **HUMIDITY**

Humidity is the measure of the amount of water vapor present in the atmosphere. Water can be solid(ice), liquid(water) or gas(vapor). The vapor components make up to about 99% of all the water held in the atmosphere. Humidity has an important influence on our atmosphere affecting water vapor and rainfall.

When there's a lot of water vapor present in the atmosphere (air), humidity is high and the higher the humidity, the wetter it feels outside. Humidity is greatly influenced by temperature so the more water evaporates in a given area, the more water vapor rises into the atmosphere (air), and the higher the humidity of that area. Hot places or areas tend to be more humid than cool places because heat causes water to evaporate faster. For instance, a fixed quantity of water vapor will result in higher humidity in cool air and it will be in warm air. Plus, as the temperature increases so does the amount of water vapor required to reach saturation.

Humidity is measured in three main ways or methods; absolute, relative and specific humidity.

### **ABSOLUTE HUMIDITY (A.H)**

Absolute humidity refers to the concentration (amount) of water vapor in the air, regardless of temperature. This on scientific terms is the most accurate measurement of humidity since the amount of water vapor in the air directly determine humidity. It is measured in grams of moisture per cubic meter of air ( $\text{g/m}^3$ ).

### **RELATIVE HUMIDITY (R.H)**

Relative humidity refers to the concentration (amount) of water vapor in the air, compared to how much it could hold at that temperature. Its value is expressed in percentage (%). For instance, R.H of 50% means the air is holding one half of the water vapor it can hold while a R.H of 100% means the air is totally saturated with water vapor and can't hold any more water (it has reached the dew point). This also means that (100% R.H) the air is so moist that a mist or dew could form.

The higher the temperature the more water vapor air can hold. However, a R.H of 0% means that the air is totally dry but R.H of 0% is impossible in the atmosphere we find ourselves in (i.e. the troposphere) because air always contain Sr amount of water vapor. R.H is metric most commonly used in weather reports, as it's an indicator of the likelihood of precipitation, dew, mist and fog.

### **SPECIFIC HUMIDITY (S.H)**

Specific humidity refers to the ratio of the mass of water vapor to the mass of moist air. S.H is used for very precise calculations.

**NOTE:** The method of reporting humidity is considered "relative" because it doesn't actually measure how much water vapor is in the air relative to how much that volume of air can hold. So, the closer the dew point is to 100%, the more humid the air feels. The instrument used in measuring humidity is the hygrometer.

### 3. CLOUD FORMATION

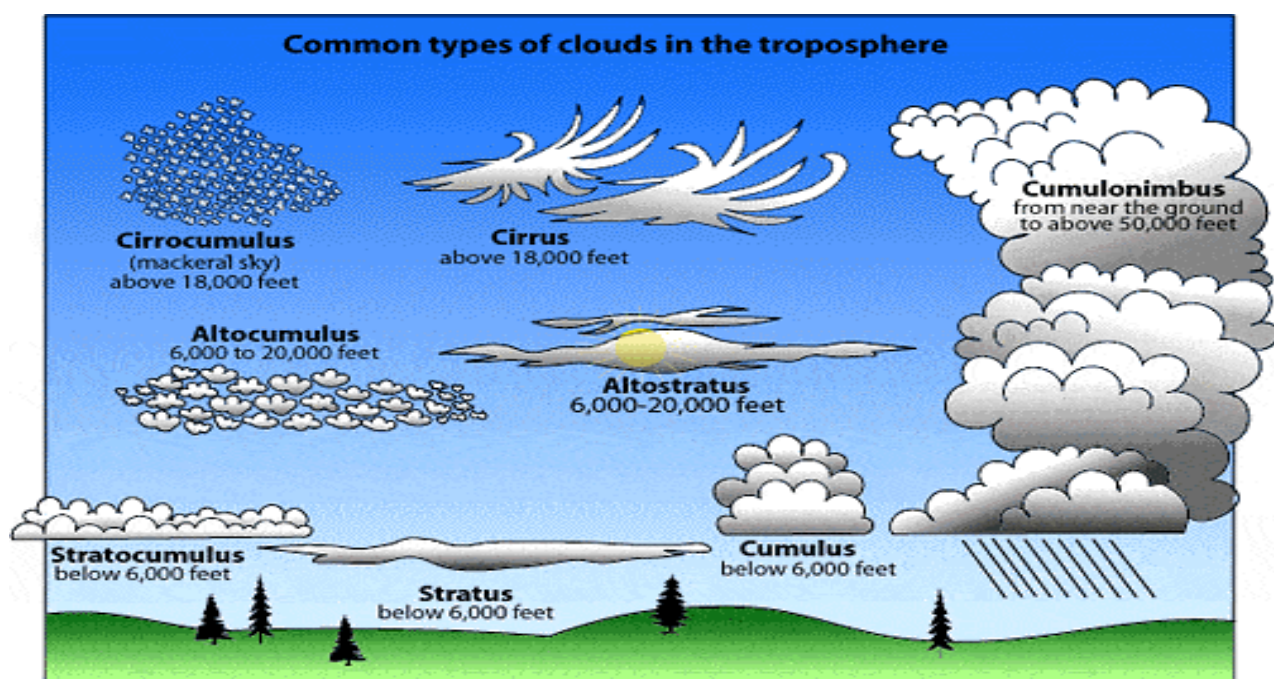


Figure 6: The image shows the various types of clouds at their various height

Clouds are made up of water droplets or ice crystals that are so small and light and are able to stay up in the air. Clouds are made in different ways but same process of lifting of air;

- some clouds form when air warms up near the Earth's surface and rises. Heated by the sun, the ground heats the air just above it. Then warm air starts to rise because when warm, it is lighter and less dense than the surrounding air.

As it rises, its pressure and temperature drops causing water vapor to condense. Eventually, enough moisture will condense out of the air to form a cloud. Several types of clouds form in this way including cumulus, cumulonimbus, mammatus and stratocumulus clouds

- some also form when wind blows into the side of a mountain range or other terrain and is forced upwards, higher in the atmosphere. This process can also happen without a mountain range, just when air travels over land that slopes upward and is forced to rise.

The air cools as it rises and eventually clouds forms. Most clouds that are formed are lenticular stratus clouds but other clouds such as cumulus clouds can be formed above mountains too as air is warmed at the ground and rises.

- clouds are also formed when air is forced upwards at areas of low pressure. Winds meet and converge at the center of a low-pressure system and have nowhere to go but up. All types of clouds are formed by these processes especially altocumulus, altostratus, cirrocumulus, stratocumulus and stratus clouds.
- We also have the weather fronts, where two large air masses of air collide at the Earth's surface, this form clouds by causing the air to rise. For the weather fronts we have warm and cold fronts;
- At a warm front, a warm air mass slide over a cold air mass, the warm air is pushed upward forming many different types of clouds, from low stratus clouds to a mid-level altocumulus and altostratus clouds to high cirrus, cirrocumulus and cirrostratus clouds. Clouds that produce rains like nimbostratus and cumulonimbus are also common at warm fronts.
- At cold front where a heavy cold air mass pushes a warm air mass upward, cumulus clouds are common. They often grow into cumulonimbus clouds, which produces thunderstorms. Nimbostratus, stratocumulus and stratus clouds can also form at a cold front.

#### 4. **PRECIPITATION**

Precipitation is any liquid or frozen water that forms in the atmosphere and falls to the Earth. It comes in many forms like rain, sleet, hails and snow. It forms in the clouds when water vapor condenses into bigger and bigger droplets of water. Then when the drops are heavy enough, they fall to the Earth like any of the above forms.

##### **FORMATION OF PRECIPITATION**

When water vapor condenses into increasing-sized droplets of water, precipitation develops in the clouds. The drips hit the Earth when they are heavy enough.

Water droplets may freeze to create ice in clouds if the temperature is lower, as it would be at higher altitudes. Depending on the cloud's internal temperature and the Earth's surface temperature, these ice

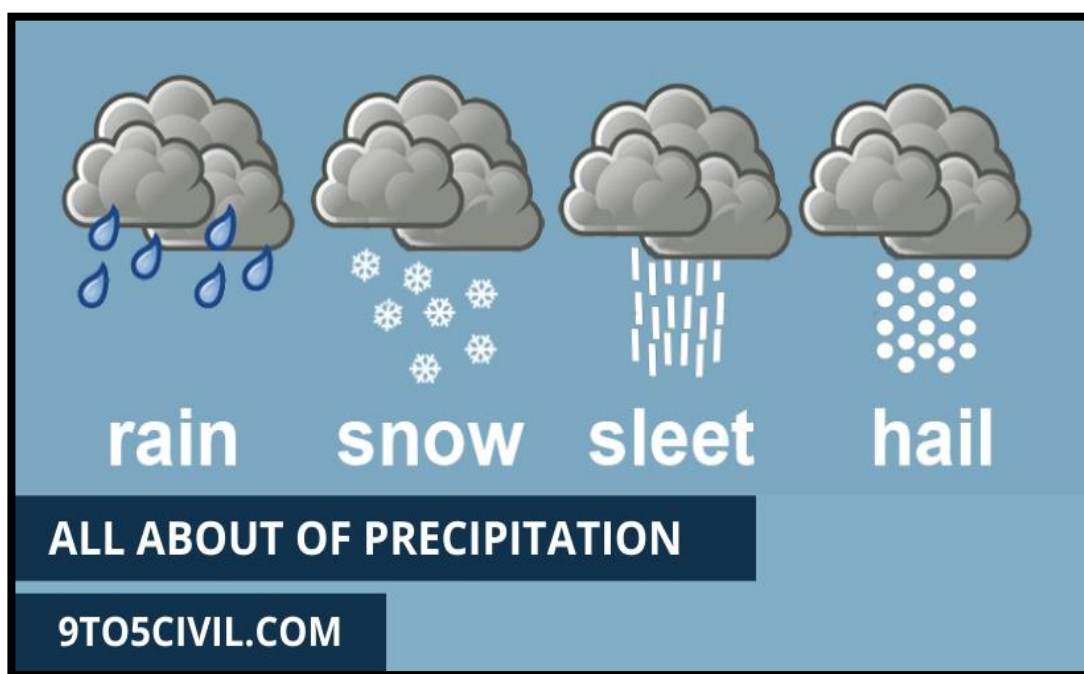
crystals subsequently descend to the Earth as snow, hail, or rain. Most rain actually starts as snow in the clouds, high up. Raindrops form as snowflakes pass through warmer air.

Precipitation requires smoke or dust particles in the atmosphere. These "condensation nuclei" serve as a surface on which water vapor can condense. This encourages water droplets to congregate and enlarge until they are large enough to fall to the ground.

Even if the water came from the ocean, precipitation is always fresh water. This is so because water does not cause sea salt to evaporate. However, occasionally, airborne toxins can pollute water droplets before they fall to the ground. Acid rain is the term for the precipitation that arises from this.

Although it does not directly injure people, acid rain can increase the acidity of lakes and streams.

Because plants and animals frequently cannot adjust to the acidity, this damages aquatic ecosystem.



*Figure 7: The above image shows the various types of precipitation we have.*

## 5. **WINDS**



*Figure 8: The image shows the direction and force of a wind.*

Wind is the movement of air caused by the uneven heating of the Earth by the sun and the Earth's own rotation. It cannot be seen or held but its force can be felt. Wind is a great equalizer of the atmosphere; transporting heat, moisture, pollutants and dust to a great distance around the globe. Winds occur because of the horizontal and vertical differences (gradients) in atmospheric pressure, the distribution of winds is closely related to that of pressure. Near the Earth's surface, winds generally flow around regions of relatively low and high pressure - cyclones and anticyclones respectively. Winds play a significant role in determining and controlling climate and weather.

## **WEST AFRICAN MONSOON**

The West African monsoon is a major wind system that impacts parts of West Africa between latitudes 9° and 20° N. It is distinguished by winds that blow southwesterly in the summer and northeasterly in the winter. The West African monsoon is the surface harmattan and southwesterly wind alternation. Only south westerlies occur farther south, but north easterlies are constantly present farther north.

The West African summer monsoon is characterized by a large-scale inflow of warm, very humid, conditionally and convectively unstable air streams from the equatorial Atlantic across the entire sub region from March to October/November. It is generally a period of widespread and prolonged precipitation.

The West African winter monsoon is a similar large-scale flow but in the reverse direction i.e. from land to the ocean from the subtropical (Sahara) high-pressure system. Unlike the summer component, the winter monsoon is a period of near total dryness. It is also the period of the harmattan

The West African monsoon winds have a significant influence on Ghana's tropical climate. The seasons and height hide the temperature variations, which are generally warm. The northern region of the country usually experiences just one rainy season, which lasts from May until September. There are two rainy seasons in Southern Ghana: a main one from April to July and a lesser one from September to November.

## **WEATHER PATTERNS IN GHANA**

In the wetter center and south of Ghana, rains usually fall in April, may, and June, with a brief respite from July to August. There is then a shorter rainy season in September, October and first half of November. In the more desert-like north, the rains arrive from March to September. But thanks to the dry earth, when the rain does fall it can cause terrible flooding and block roads in the north.

How can it be raining on one spot, but not be raining on a spot that is a couple meters away? This is because the rain has stop somewhere. The cloud producing the rain is not infinite. It covers a specific area, so it won't be raining outside it. Logic would suggest that you are at the edge of a rain-bearing cloud. Everything has an end to it.

## **CLIMATE TYPES ACROSS THE WORLD**

There are approximately five main climate types on Earth:

- Tropical
- Dry
- Temperate
- Continental
- Polar

**A: Tropical.** In this hot and humid zone, the average temperatures are greater than 64°F (18°C) year-round and there is more than 59 inches of precipitation each year.

**B: Dry.** These climate zones are so dry because moisture is rapidly evaporated from the air and there is very little precipitation.

**C: Temperate.** In this zone, there are typically warm and humid summers with thunderstorms and mild winters.

**D. Continental.** These regions have warm to cool summers and very cold winters. In the winter, this zone can experience snowstorms, strong winds, and very cold temperatures—sometimes falling below -22°F (-30°C)!

**E: Polar.** In the polar climate zones, it's extremely cold. Even in summer, the temperatures here never go higher than 50°F (10°C)!

### **THE CLIMATE TYPE IN GHANA**

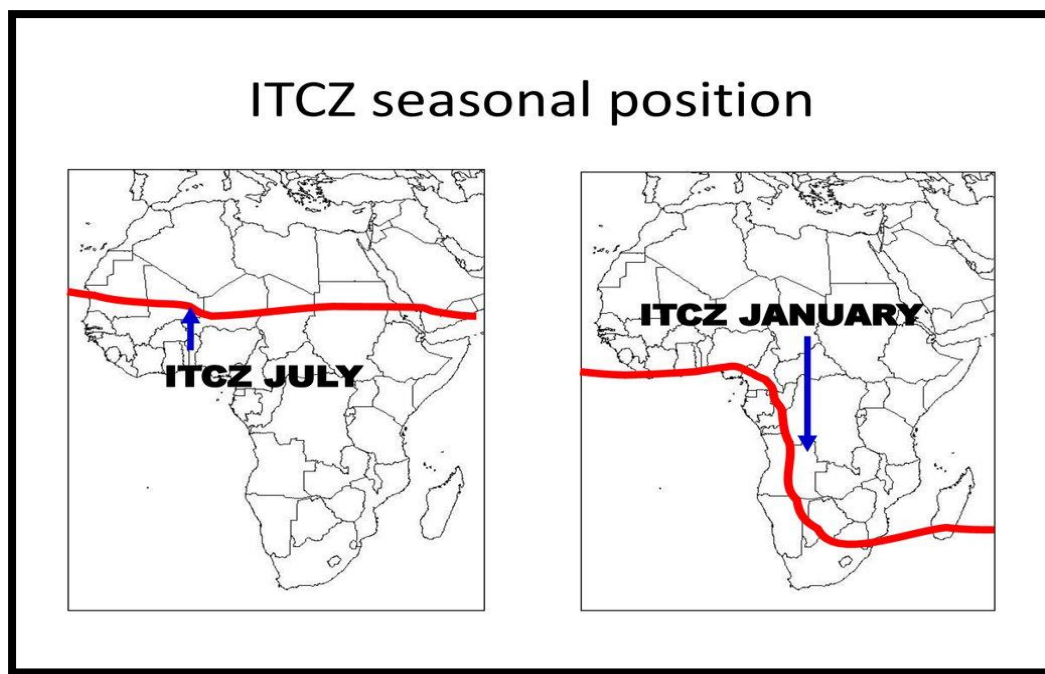
The West African monsoon winds have a significant impact on Ghana's tropical climate. The seasons and elevation hide the fluctuating temperatures, which are generally warm.

### **INTER-TROPICAL CONVERGENCE ZONE (ITCZ)**

The ITCZ appears as a band of clouds consisting of showers with occasional thunderstorms that encircles the globe near the equator. It is also a narrow zone where trade winds of two hemispheres collide (meet) which causes erratic weather patterns with stagnant calms. It is caused by the convergence of northeast and southeast trade winds (tropical continental and tropical maritime winds respectively) in the area encircling Earth near the equator.

It is basically a low pressure belt encircling Earth near the equator. It's a zone between the northern and southern hemispheres where winds blowing equator-ward from the mid latitude and winds flowing

poleward from the tropics meet. It shifts from north and east seasonally according to the movement of the sun. It is generally characterized by convective activities which generates often vigorous thunderstorms over large areas. It's is most active over continental land masses by day and relatively less active over the ocean.



## **PRESSURE AND MEAN SEA LEVEL PRESSURE**

**Pressure** is “cumulative force per unit area” due to millions of gas molecules which are bouncing off the “sides” of any container. However, Earth’s atmosphere has no “container” but is a 360-degree shell completely surrounding the globe. So net force of gas molecules appears as surface “pressure”. The average force is called a BAR and daily variations due to ripples in force are in “millibars”.

**Absolute pressure** - The actual pressure at a given position is called the absolute pressure, and it is measured relative to absolute vacuum (i.e., absolute zero pressure).

**Gage pressure** - Gage pressure is the pressure relative to the atmospheric pressure. In other words, how much above or below is the pressure with respect to the atmospheric pressure.

**Vacuum pressure** - Pressures below atmospheric pressure is called vacuum pressures and are measured by vacuum gages that indicate the difference between the atmospheric pressure and the absolute pressure.

**Atmospheric pressure** - The atmospheric pressure is the pressure that an area experiences due to the force exerted by the atmosphere. The atmospheric pressure at mean sea level, either directly measured or, most commonly, empirically determined from the observed station pressure.

In regions where the earth's surface is above sea level, it is standard observational practice to reduce the observed surface pressure to the value that would exist at a point at sea level directly below if air of a temperature corresponding to that actually present at the surface were present all the way down to sea level.

In actual practice, the mean temperature for the preceding 12 hours is employed, rather than the current temperature. This "reduction of pressure to sea level" is responsible for many anomalies in the pressure field in mountainous areas on the surface synoptic chart.

### **Mean sea level pressure -**

This is the pressure reading most commonly used by meteorologists to track weather systems at the surface. Like altimeter setting, it is a "reduced" pressure which uses observed conditions rather than "standard" conditions to remove the effects of elevation from pressure readings.

This reduction estimates the pressure that would exist at sea level at a point directly below the station using a temperature profile based on temperatures that actually exist at the station. In practice the temperature used in the reduction is a mean temperature for the preceding twelve hours.

Mean sea level pressure should be used with caution at high elevations as temperatures can have a very profound effect on the reduced pressures, sometimes giving rise to fictitious pressure patterns and anomalous mean sea level pressure values.

## **SEASONS**

Ghana is located in the tropics and we are strongly influenced by the West Africa Monsoon winds (WAM). Our season is basically dependent on the position of the ITCZ and from the diagram above we can notice that it is beneath the country or is at the coast in January and by July it is above the country. Ghana has two seasons; dry season (the harmattan) and wet season (rainy).

### **THE RAINY (WET) SEASON**

The northern part of the country usually records one main rainy season which begins in March and ends in November. Squalls usually occur in the northern part of Ghana during March and April which is followed by occasional rain until August, September, and somewhere mid-October when the rainfall reaches its peak. The northern part has a relatively shorter rainy season of about six months, and therefore only one cropping season.

In the southern part of Ghana, there is a prolonged rainy season as a result creating two cropping seasons in most places. The southern part experiences the major and the minor rainy seasons. The major rainy season starts from April and ends in July then they experience some little dryness in August. Heavy rainfall is usually observed and recorded in June to July where most parts of the southern part get flooded and causes a lot of destruction and damages to properties and there is sometimes loss of life. The minor rainy season starts from September to mid-November. The minor rainy season doesn't usually cause flooding compared to the major rainy season.

In short, the rainy season lasts from March to mid-October in the north, from April to October in the central belt and from April to November in the south.

### **THE DRY (HARMATTAN) SEASON**

The dry season starts from mid-November to March in Ghana. The harmattan wind blows from the Sahara from mid-November or early December through to March. During this period, there are more dust in the atmosphere with less humidity. Visibility is very bad in the harmattan season. The northern part of Ghana experiences more of the harmattan than the southern part of Ghana due to their closeness to the Sahara Desert.

## **CLIMATE AND AGRICULTURE**

Agriculture is an economic activity that produce food necessary for human livelihood and it is highly dependent upon weather and climate; however, agriculture is also likely to be very vulnerable to climate variability and change. Climate variability and climate change are the main causes of stress on food production and availability. Depending on the level of development, roughly 20 to 80 percent of the inter-annual variability of yields is caused by the change in weather and 5 to 10 percent of national agricultural production is lost annually due to weather variability. Chronic losses and indirect negative effect such as diseases, pests and so on exceed by far the effects of extreme climate events. In fact, production losses due to pest, diseases and weeds are estimated at 26 to 30 percent for sugar beet, barley, soybean, wheat and cotton, and about 35 to 40 percent for maize, potatoes and rice respectively. However, post-harvest losses are also of the same order of magnitude. At the same time, climate should be considered as a "resource" and not merely as a hazard. If resources are to be used in a sustainable way, they must be assessed in quantitative terms and properly managed.

Solar radiation, rainfall and temperature conditions are the primary production potential and together with mineral nutrition and management they influence the attainable production. The main factors determining the availability of agricultural products at the local level (farm, village) are environmental conditions and management. The environment covers biophysical factors (i.e. weather, climate, pests, soil, water, land availability, etc.) while management involves decisions taken by the farmers themselves. Decisions related to these management practices can be made in response to the weather to optimize the production or minimize the risk of farming systems. Climate information is generally used for for planning the crop season and for making strategic decisions such as defining the crop, the variety, planting date, total water demand for irrigation and other weather informations on the other hand is used for operational decision as in knowing the exact date to plant based on soil water content, whether to make an application, anticipated harvest (in case of forecast of rainfall), irrigation management and others.

Exploiting climate information and serviced for decision-makers, the agriculture sector will be better placed to provide food for a more highly populated and increasing urban world. In today's constantly changing environment, farmers need accessible as well as executable climate services to adequately manage climate risks and exploit climate resources, so as to take advantage of favorable weather and minimize problems due to unfavorable weather conditions.

The main factors that have the strongest influence on crop production and need to be considered are in particular, those that influence crop growth and development. The two most important elements are temperature and water availability; in both situations daily and seasonal variations are common and

temporal and spatial quantity are crucial. The agroclimate zones help with the planning of agriculture on a regional or national scale and should include adaptation that may be necessary due to climate variability and climate change. Weather and climate information amassed through observation, data and diagnostics can be used to assist farmers with planning their activities.

## AGRO-ECOLOGICAL ZONES IN GHANA

An agro-ecological zone is a land resource mapping unit defined in terms of climate, landforms and soils, and/or landcover, and having a specific range of potentials and constraints for land use. But agro-ecological zoning refers to the division of an area of land into smaller units which have similar characteristics related to land suitability, potential production and environmental impact.

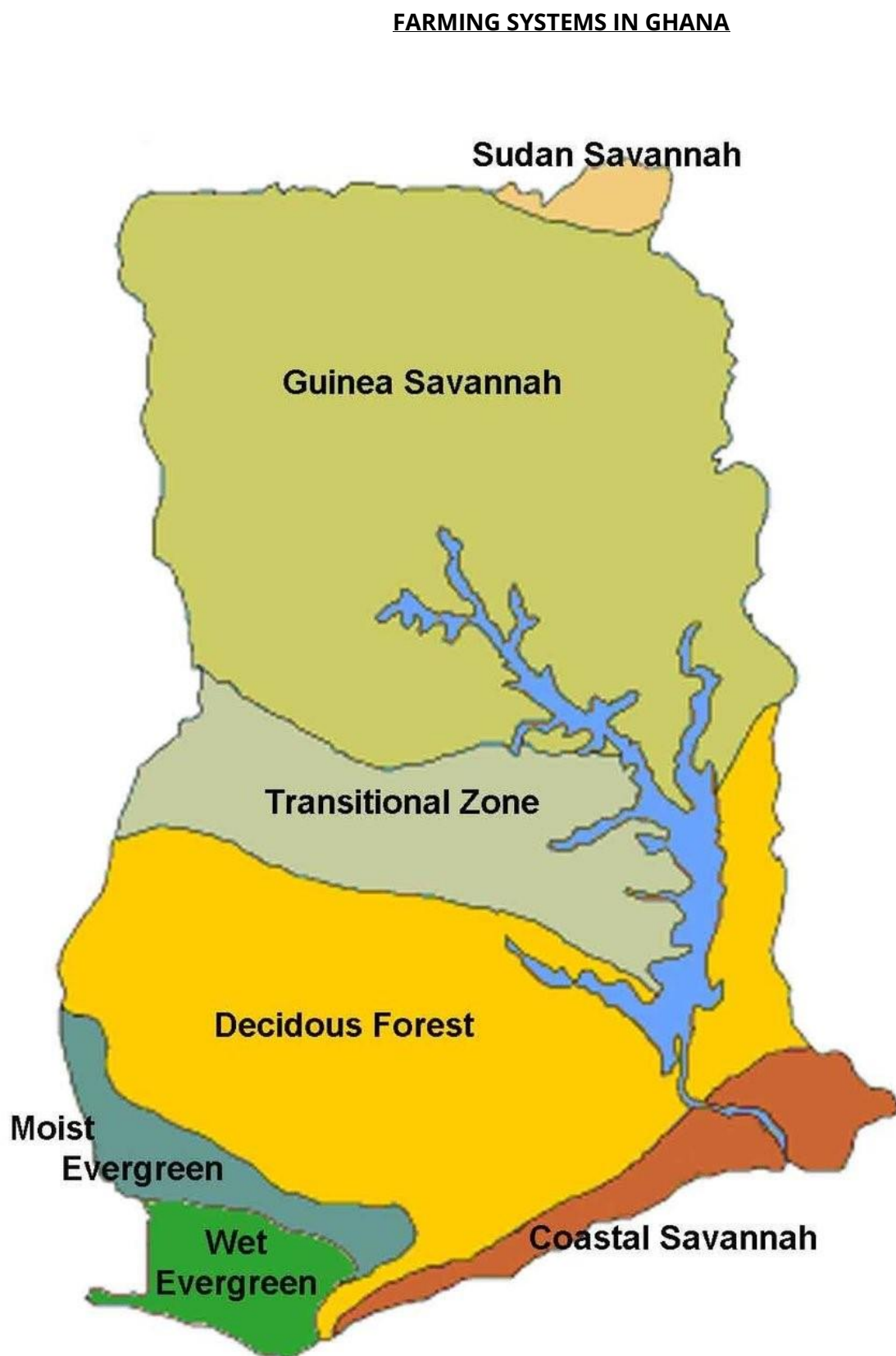
Ghana is divided into six (6) ecological zones namely; Sudan Savannah, Guinea Savannah, Transition Zone, Deciduous Forest, Evergreen (moist and wet evergreen) or Rainforest and Coastal Savannah.

The Guinea Savannah zone covers the whole of Upper West and Northern regions. It also occupies parts of Upper East region and the northern part of Brong Ahafo and Volta region. This zone has a single rainfall season lasting from May to October and it records an annual rainfall of about 1000mm. The Sudan Savannah also spreads from north-eastern part of Upper East region with an annual rainfall between 500mm to 700mm. The Transition Zone falls within the middle portion of Brong Ahafo region, northern part of both Ashanti and Eastern regions and the western part of the Volta region.

This zone experiences two rainy seasons, recording an annual rainfall of about 1200mm. The Deciduous Forest cuts across the northern part of Western region through southern Brong Ahafo, Ashanti and Eastern regions. It also spreads to the Volta region and most part of the Central region. It also experiences a double rainy season with an annual rainfall of about 1400mm been recorded.

Most parts of the Western region are within the Evergreen Zone. It also captures a small part of Central region. This zone records the most annual rainfall of about 2000mm; having the same rainfall pattern as Transition Zone and Deciduous Forest. The Coastal Savannah also stretches from Central region through to Greater Accra to Volta regions. It has a single rainy season and records an annual rainfall of about 600mm.

*Figure 9: shows the various agro-ecological zones in Ghana*



The farming systems represent the combination of cropping and livestock activities and the resources available (pedoclimatic conditions) to the farmers to raise them for their production purposes.

The philosophy behind this approach is to secure a judicious mix of cropping system with associated enterprises like animal husbandry suited to the given pedo/agro climatic conditions in accord with the socio-economic status of farmers in order to bring prosperity to the farm. In Ghana, there are about seven (7) different farming systems practiced by farmers and some other households. These are arable farming, mixed farming, subsistence cultivation, shifting cultivation, plantation farming, pastoral/livestock cultivating and nomadic cultivating.

**Arable farming -** is a crop production system that include different variety of crops from foliage crops. In this system, the land must neither be too wet or dry and it is practiced on gently slope or flat lands with deep and fertile soil under a warm climate. Some crops that are cultivated include vegetables, plantain, cassava, grains and so on.

**Mixed farming -** is a farming method in which farmers grow crops and raise livestock on the same piece of land. This can be practiced in a region with great precipitation or water system offices.

**Plantation farming** - is when one type of crop is cultivated on a large plot of land for commercial purposes. Some crops practiced with is system are coconut, plantain, palm nuts, avocados, cassava and so on.

**Shifting cultivation** - in this system, the farmers cultivate on a piece of land for like two to three seasons then abandon the land when soil loss it's fertility and plant on a different land for the previous land to heal.

**Nomadic cultivating -** this is similar to pastoral/livestock cultivating but this system, livestock are herded in order to seek for fresh pastures on which they graze and for water. Animals such as cow, sheep, goats, camel, ponies and jackasses are normally seen by herdsmen.

**Subsistence cultivation -** it is the practice of growing crops or livestock or both sufficient for one's own use and not for trade or business.

**Pastoral/livestock cultivating -** in this system, animals are the only produce and not crops. This system can be used for commercial purpose or household purpose. Animals raise are the rabbits, grass cutter, poultry, goats and so on.

## **EFFECT OF WEATHER AND CLIMATE CHANGES ON AGRICULTURE**

### **IMPACT ON CROP PRODUCTION**

Crop yields may be significantly impacted by changes in temperature, atmospheric carbon dioxide (CO<sub>2</sub>), and the frequency and severity of extreme weather. Depending on the crop's ideal temperature for growth and reproduction, an increase in temperature will have different effects on different crops. The types of crops that are traditionally cultivated there may benefit from warming in some areas, or farmers may be able to switch to crops that are now grown in warmer regions.

Conversely, production will decrease if the higher temperature exceeds the crop's optimal temperature.

### **IMPACT ON LIVESTOCK**

Animals may be impacted by climatic changes both directly and indirectly.

1. High temperatures, which are expected to become more frequent as a result of climate change, might seriously endanger livestock.

2011 saw approximately \$1 billion in heat-related losses for agricultural producers as a result of exposure to high temperature occurrences. Animals are impacted by heat stress both directly and indirectly. Heat stress over time can lower fertility, decrease milk production, and make people more susceptible to illness.

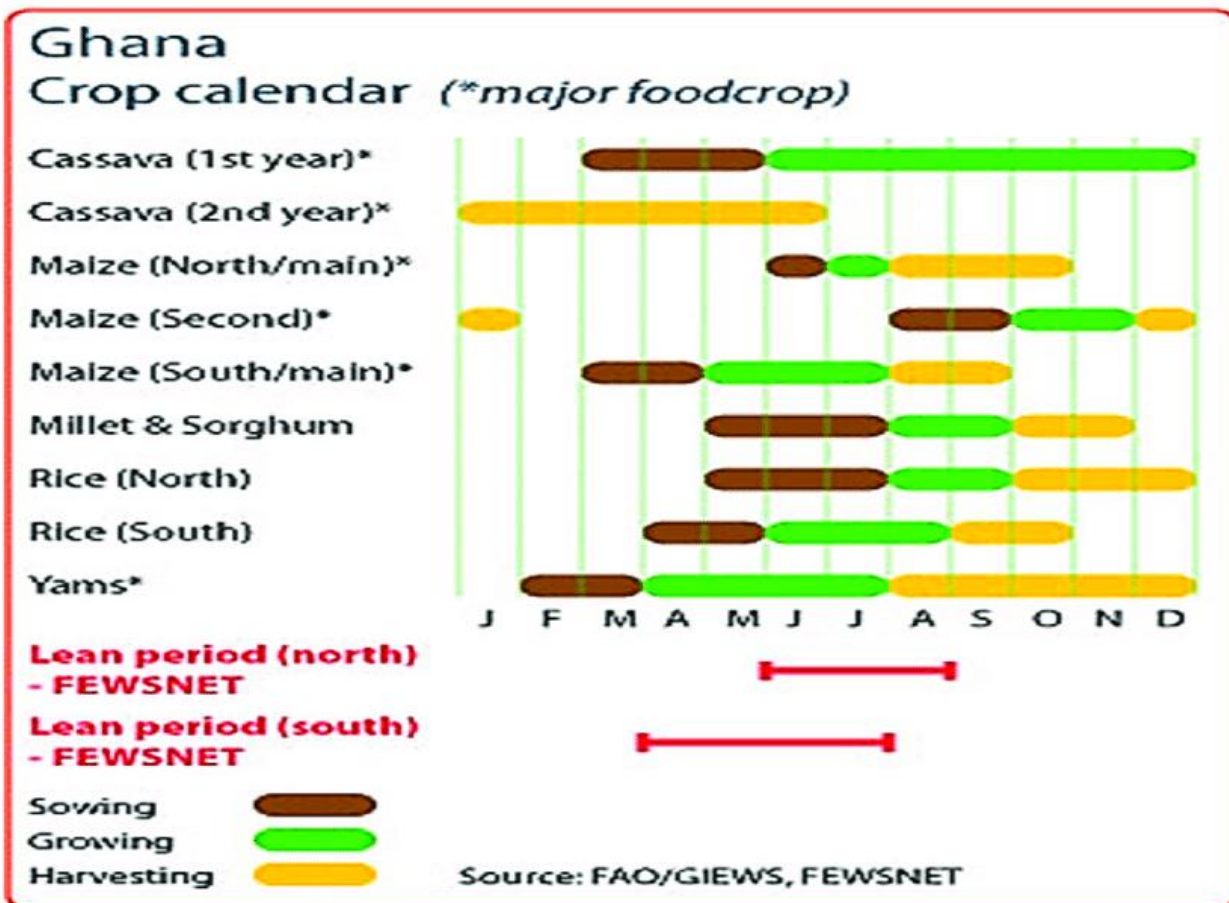
2. A drought might put pasture and feed supplies at danger.

The amount of high-quality fodder available to grazing livestock is decreased by drought.

Due to hotter summers and less precipitation, certain locations may endure longer and more severe droughts. Changes in agricultural production brought on by drought could also cause issues for animals that depend on grains.

3. The prevalence of illnesses and parasites that afflict livestock may rise as a result of climate change. Winters that are warmer and spring that arrive earlier may make it easier for some parasites and pathogens to survive. Increased rainfall may encourage the growth of diseases that require moisture.

## CROP CALENDAR IN GHANA



## **GROWING SEASON IN GHANA**

The time of year when crops and other plants effectively develop is known as a growth season. A growth season's length varies depending on where you live. A growth season of at least 90 days is required for most crops.

The growing season might span the entire year in tropical areas where it is warm all year long. However, a wet season might stop the growing season in some tropical regions. Crops cannot be grown at this time due to the flooding. This kind of irregular growing season is typical of coffee, which grows in tropical environments. Coffee is harvested all year long in Colombia.

Heavy downpours frequently cut short the coffee-growing season in Indonesia.

Sometimes the climate is too dry for crops to flourish in other tropical regions. The Sahel, a tropical region of northern Africa, frequently endures dry spells. The Sahel is a region that lies between the savanna in the south and the Sahara Desert in the north. The likelihood of a successful harvest in the Sahel is quite unclear due to dramatic weather patterns.

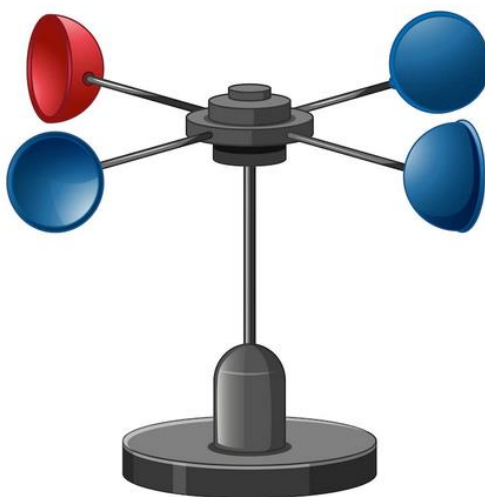
The length of the growing season in temperate countries, which have chilly winters and mild summers, is mostly influenced by temperature. The length of some growth seasons might reach eight months. Such extended growing seasons are common in Europe and the majority of America. The length of the growing season decreases with distance from the Equator. The growth season might be as short as two months in areas close to the polar regions.

The growing season can be identified in two ways. The growing season in temperate countries is typically determined by the average number of days between the final spring frost and the first severe fall frost. The typical number of days that the temperature rises high enough for a specific crop to sprout and grow can also be used to calculate the growing season. The crop determines how much to measure. The temperature must be at least 20 degrees Celsius for rice to grow (68 degrees Fahrenheit). However, at just 5 degrees Celsius, wheat will sprout (40 degrees Fahrenheit).

## **SOME METEOROLOGICAL INSTRUMENTS**

### **1. ANEMOMETER**

The instrument used to gauge wind direction and speed is called an anemometer. In weather stations, it is a typical instrument. The measurement unit for anemometer is m/s, km/hr, mph and knots.



### **1. BAROMETER**

Barometer is an instrument used for measuring atmospheric pressure. The unit measured in is the millibar (mb).



### 1. **HYGROMETER**

A hygrometer is a device that gauges the moisture content of soil, air, or restricted spaces. Instruments used to measure humidity typically rely on measurements of other values, such as temperature, pressure, mass, and changes in a substance's mechanical or electrical properties as a result of absorbing moisture.



### 4. **THERMOMETER**



Devices that measure temperature or a temperature gradient are known as thermometers (the degree of hotness or coldness of an object). Two crucial components make up a thermometer:

(1) a temperature sensor that changes in response to changes in temperature, such as the bulb of a mercury-in-glass thermometer or the pyrometric sensor in an infrared thermometer; and (2) a way to translate this change into a numerical value (e.g. the visible scale that is marked on a mercury-in-glass thermometer or the digital readout on an infrared model).

## 5. **RAIN GAUGE**

A rain gauge, also referred to by the names udometer, pluviometer, pluviometer, ombrometer, and hyetometer, is a tool that hydrologists and meteorologists use to collect and measure the amount of liquid precipitation over a certain region over time. It is used to calculate the amount of rainfall by measuring the depth of the precipitation (often measured in mm) that falls over a given area.



## 6. **SUNSHINE RECORDER**

A sunlight recorder is a tool that captures the quantity of sunshine present in a specific area or time period. The outcomes offer details about a region's temperature as well as its weather and climate. In addition to other disciplines, meteorology, science, agriculture, and tourism all benefit from this knowledge.

## 7. **EVAPORATING PAN**

During observations to estimate the amount of evaporation at a certain place, water is kept in an evaporation pan. These pans come in a variety of sizes and shapes, with circles and squares being the most popular.



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