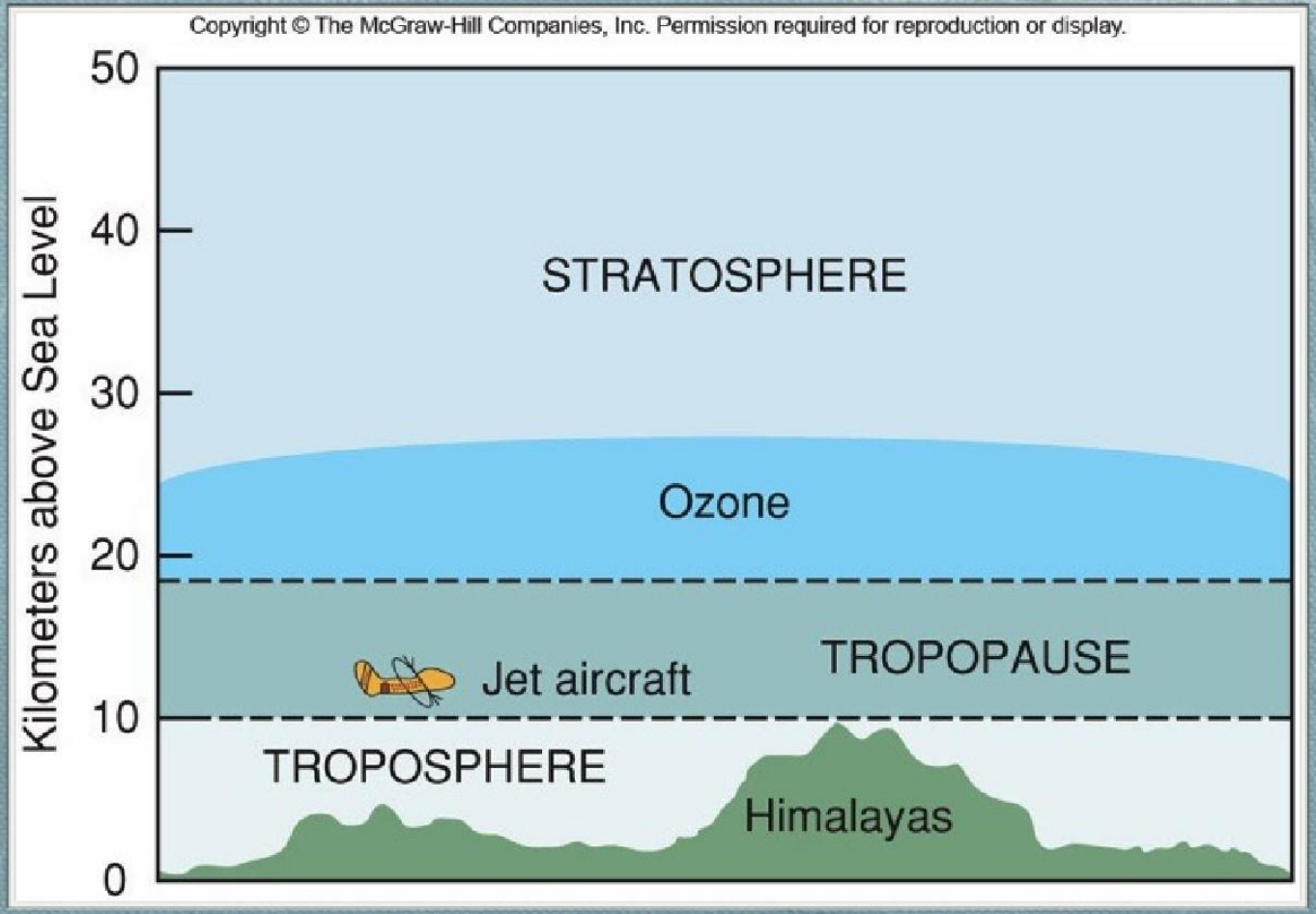
Climatology

Fourth –year /Undergraduate

Botany & Chemistry

Weather vs. Climate

- **Weather**: Atmospheric conditions at a **given time and place**
- **Climate**: Typical (long-term) weather conditions in a place
- Virtually all weather occurs in the **troposphere**
  - It is the atmospheric layer closest to the Earth's surface
  - Contains virtually all of the clouds, air, and precipitation



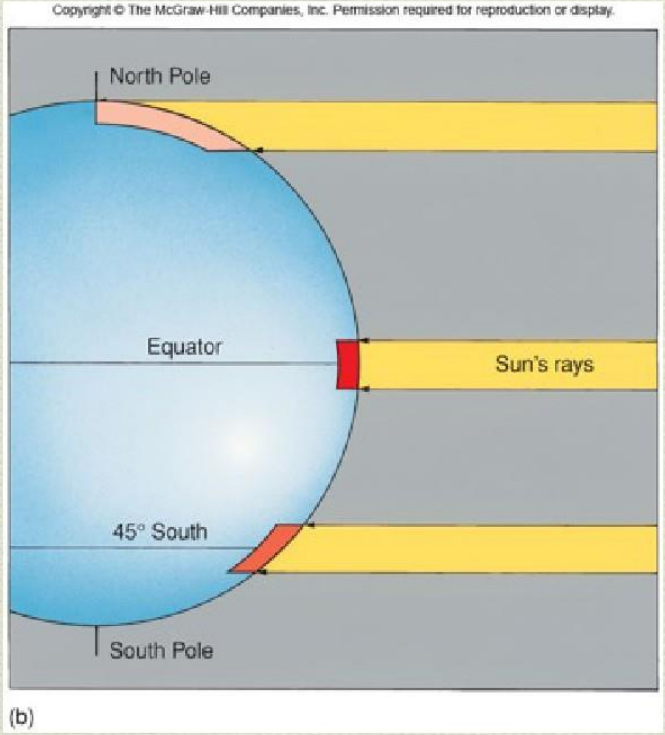
Atmospheric Layers

Air Temperature

- Varies by latitude:
  - equator=hot
  - poles=cold
  - everywhere else (temperate regions)=in between
- But why?

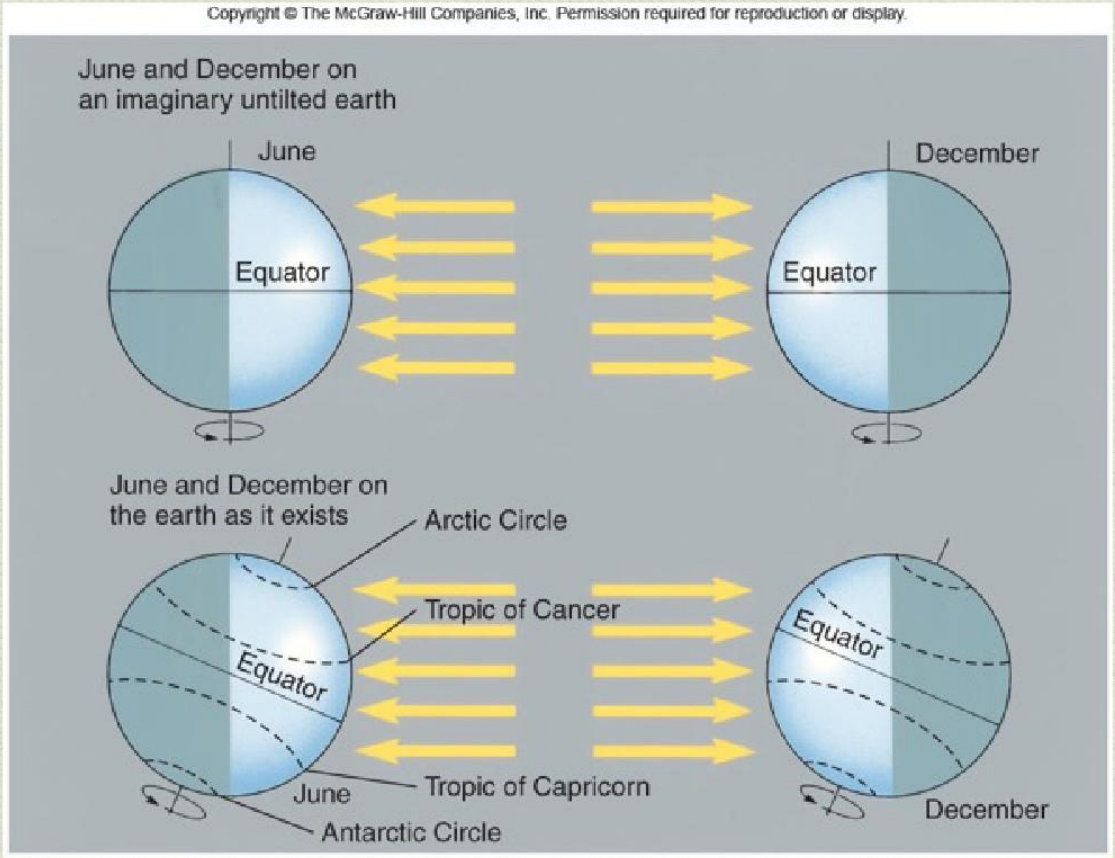
Insolation

- **In**coming **sol**ar radi**ation**: the amount of sunlight in a place
- Based on the Earth's elliptical orbit, inclination, rotation, and spherical shape
- Spherical shape: angle of incidence decreases as you approach the poles
  - same energy spread over larger area (cosine)



Insolation & Inclination

- Axis Tilt: causes seasons due to angle of incidence and length of daytime
- Summer vs. Winter...
- Arctic/Antarctic Circles
- Psychological Effects...S.A.D.



Air Temperature Modifiers

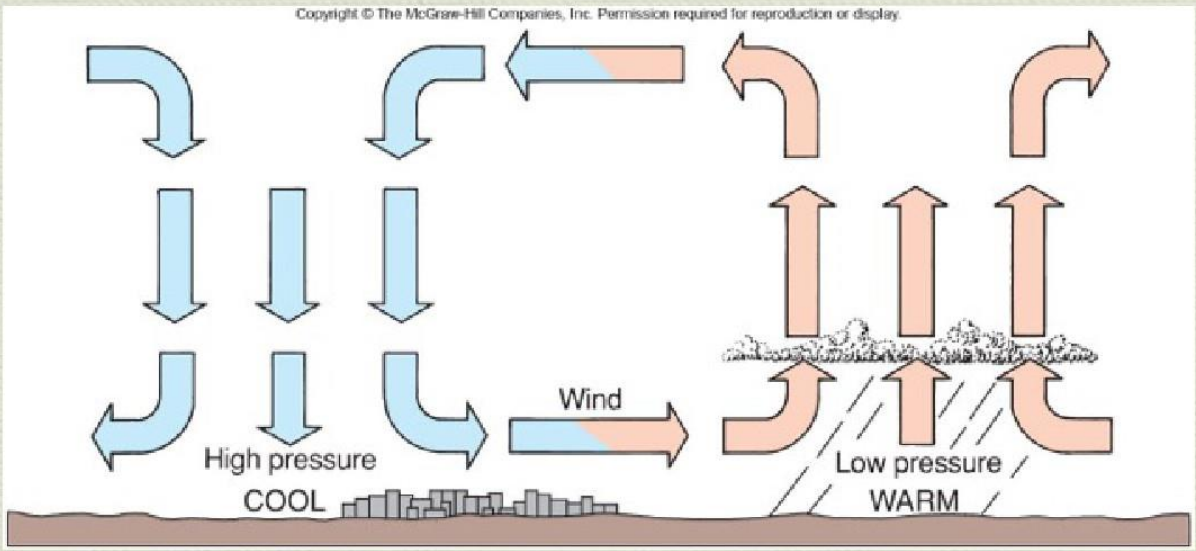
- Solar insolation
- Amount of water vapor in the air
- Cloud cover
- Physical surface features of the Earth
- Elevation
- Direction and velocity of air movement

Air Pressure

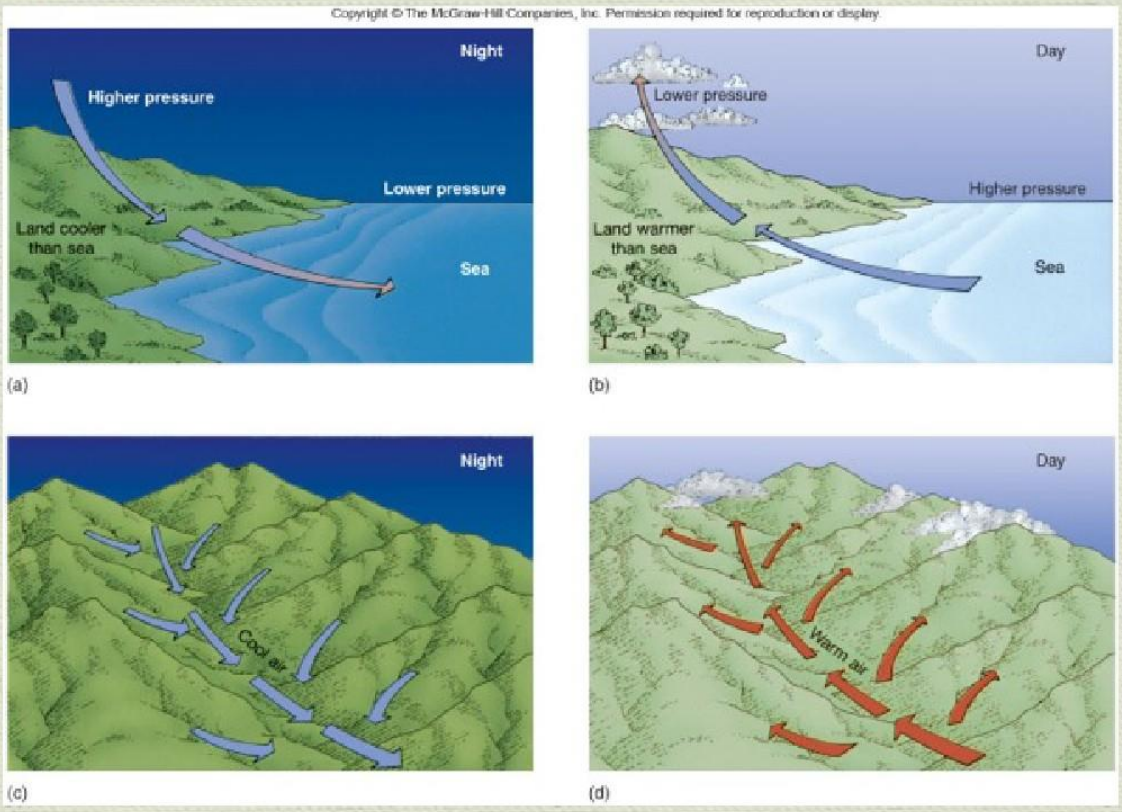
- Air pressure: force caused by weight of the air due to gravity and temperature
- Increase elevation = less air above = lower pressure
- Colder air = more dense (more air per vol.) = higher pressure
- Warmer air = less dense = lower pressure
- Winds caused by differences in air pressure...

Wind: Temperature effects

- Wind blows from higher pressure to lower pressure
- Wind speed proportional to difference in pressure
- Convection currents: warm air rises, cool air sinks



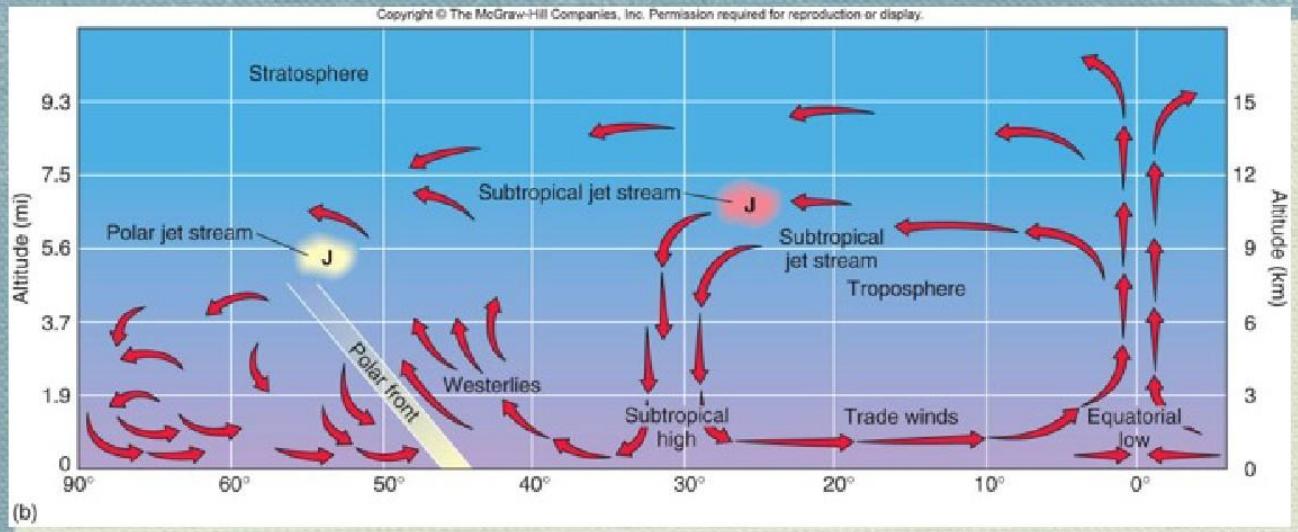
Wind: Daily localized patterns

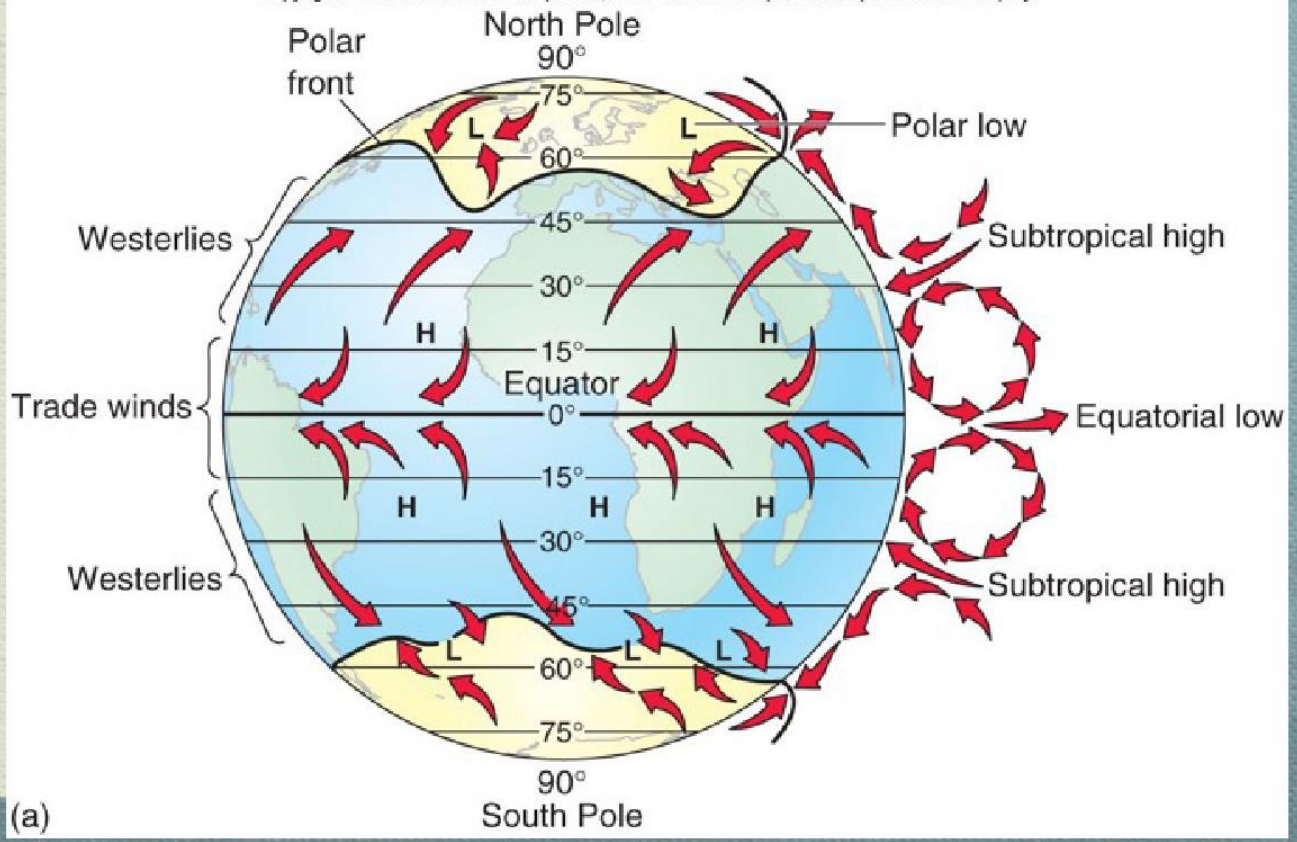


- Land/Sea breeze: sea maintains temp while land warms/cools
- Mountain/Valley breeze: valley heats up quickly, mountains cool quickly

Global Air Circulation

- Global differences in insolation cause global air pressure differences
- Equatoral lows = hotter = low pressure belt
- Subtropical highs = cooler = high pressure ridge
- Tradewinds and westerlies
- Monsoons: seasonal winds that bring wet/dry weather



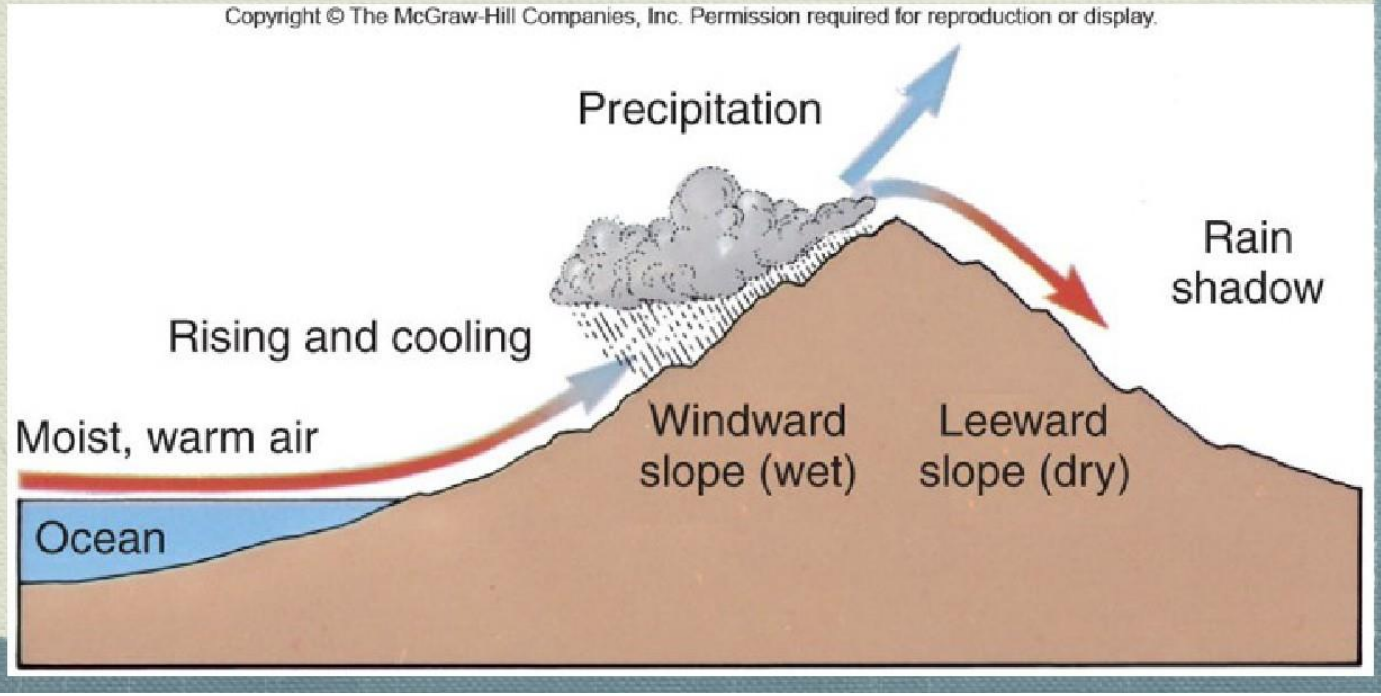


Moisture in the Atmosphere

- Rising air expands due to lower air pressure
- As air expands and rises it cools (PV=nRT)
- Cooler air can hold less water (lower saturation point)
- When temperature drops below dew point, excess water vapor condenses into droplets
- Droplets suspended by air movement form clouds
- Droplets too heavy for air resistance fall as precipitation

Types of Precipitation

- **Convectional**: warm, moisture-laden air rises and T drops below dew point (saturation temperature)
- **Orographic**: warm, moisture-laden air forced over mountains causing it to cool
- **Cyclonic**: warm front hits a cold front and the warm front moves over the cold front



Types of Precipitation

The **convectional precipitation** is prevalent in equatorial regions. In these, the warm air rises up and expands then, reaches at a cooler layer and saturates, then condenses mainly in the form of cumulus or cumulonimbus clouds. In the equatorial regions, the **precipitation** due to **convectional rainfall occurs** in the afternoon

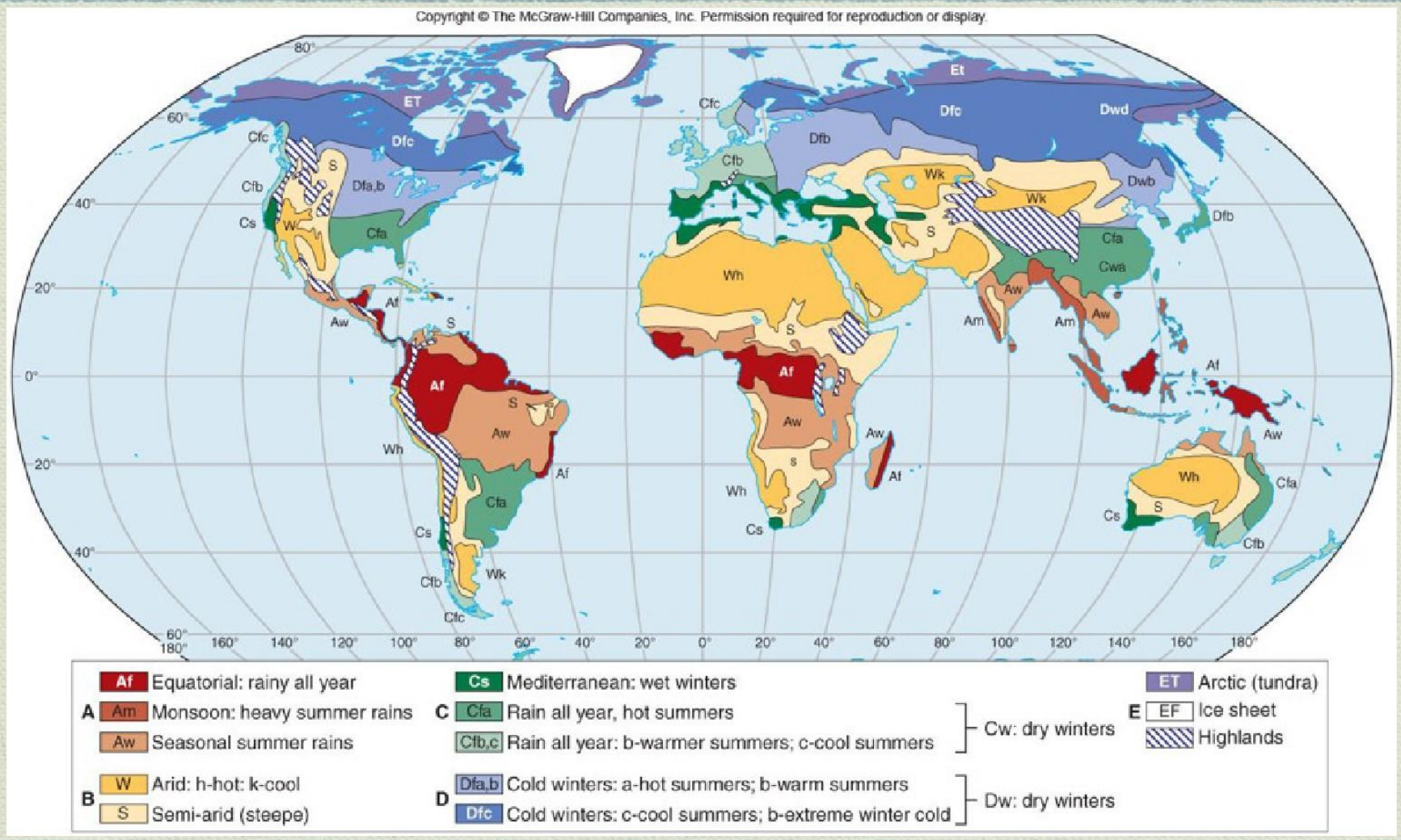
The Orographic precipitation, rain, snow, or other precipitation produced when moist air is lifted as it moves over a mountain range. As the air rises and cools, orographic clouds form and serve as the source of the precipitation, most of which falls upwind of the mountain ridge. It occurs Oceanic islands such as New Zealand

Cyclonic precipitation is caused by cyclonic activity and it occurs along the fronts of the cyclone. It is formed when two masses of air of different temperature, humidity and density meets. For example meeting of moisture laden warm tropical wind with a polar air mass. A layer separating them is called the front.

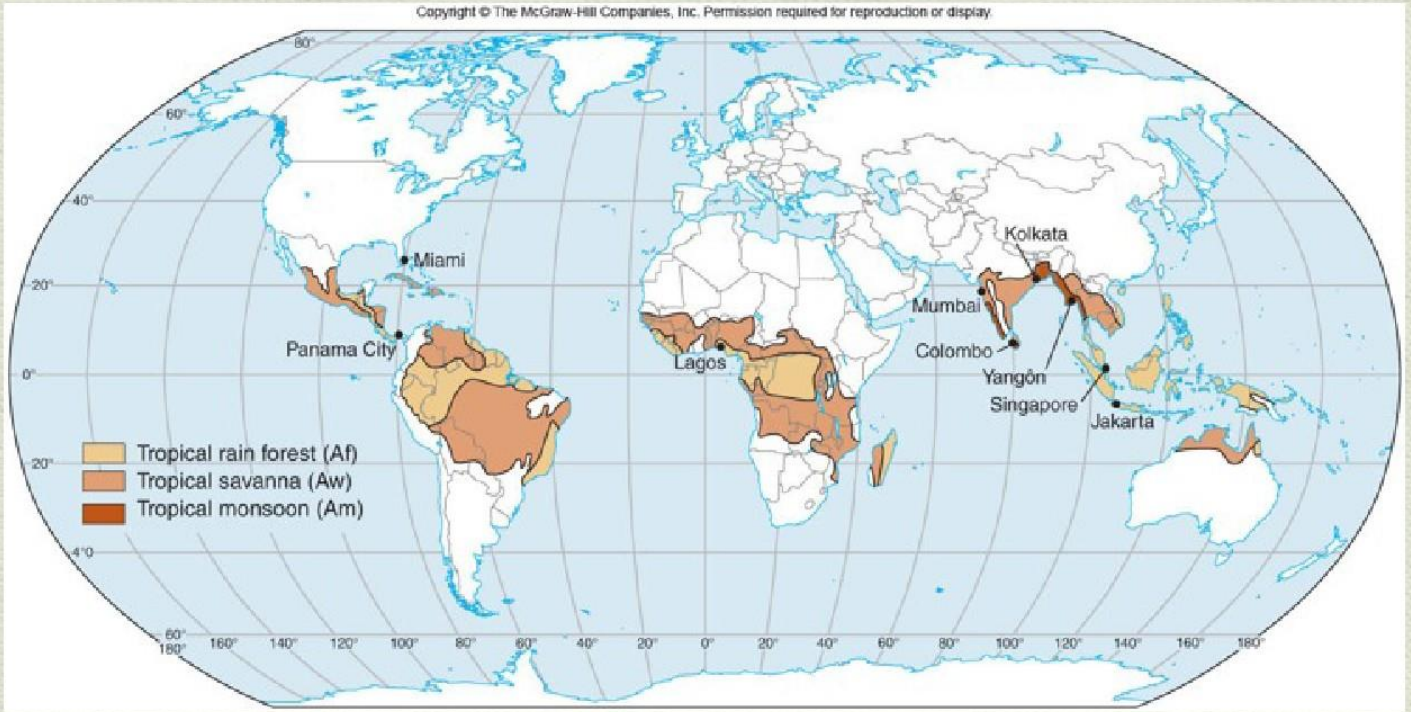
Climate Regions

- Climate: seasonal and annual weather conditions
- Primarily defined by temperature and precipitation
- Köppen system: vegetation, temperature, precipitation
  A. tropical
  B. dry
  C. mild midlatitude
  D. midlatitude with cold winters
  E. polar
  F. highland

Köppen Climate Classification

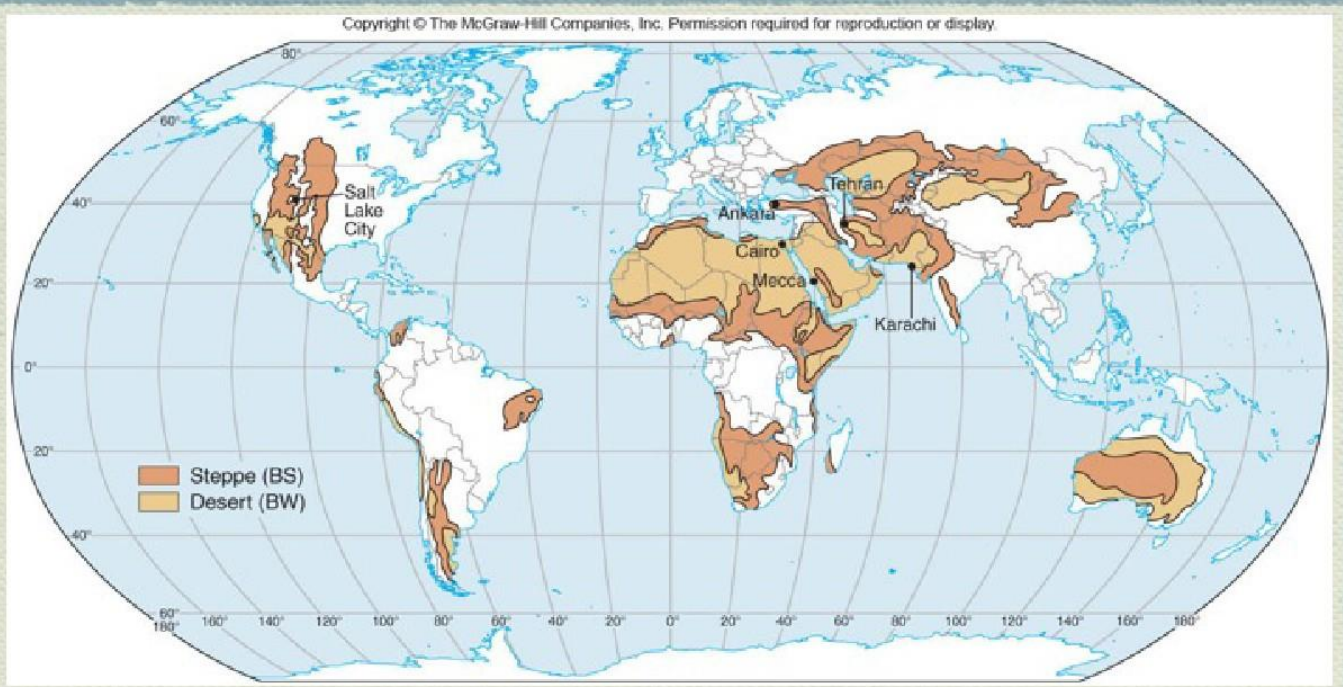


Tropical Climates



- Hot
- Humid
- Dense vegetation

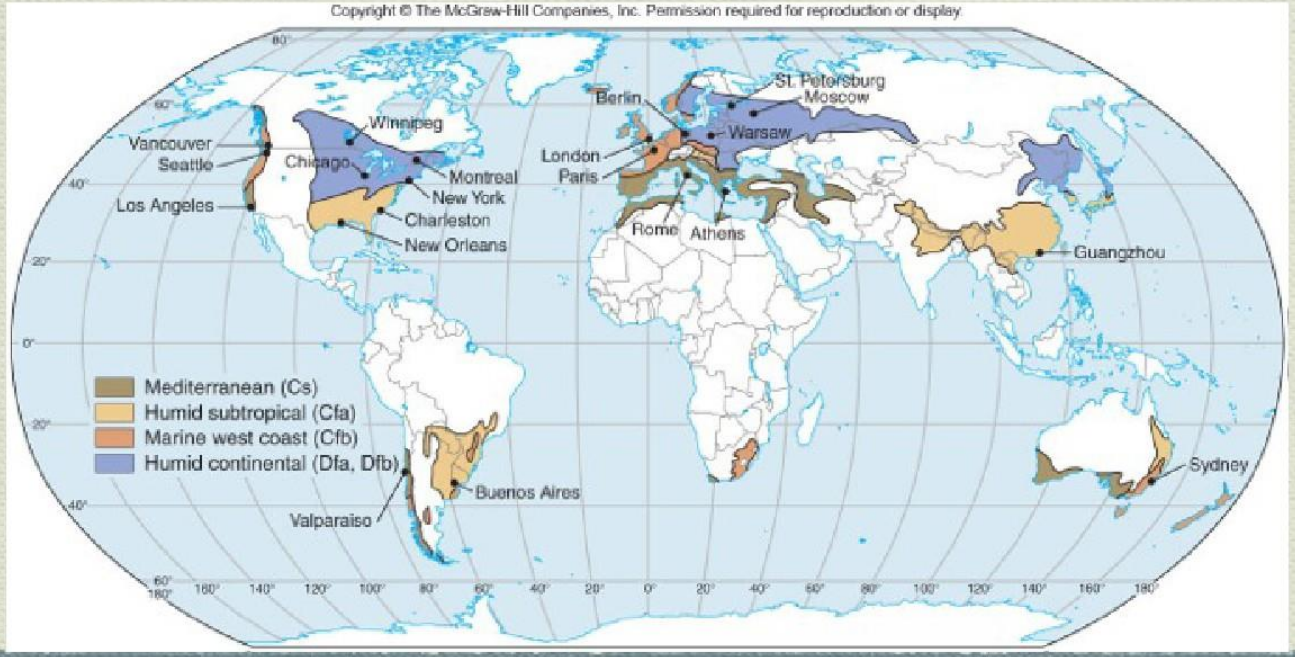
Dryland Climates



- Hot/Dry or
- Moderate (seasonal) temperature and rainfall
- Steppes: shrubs and grasses

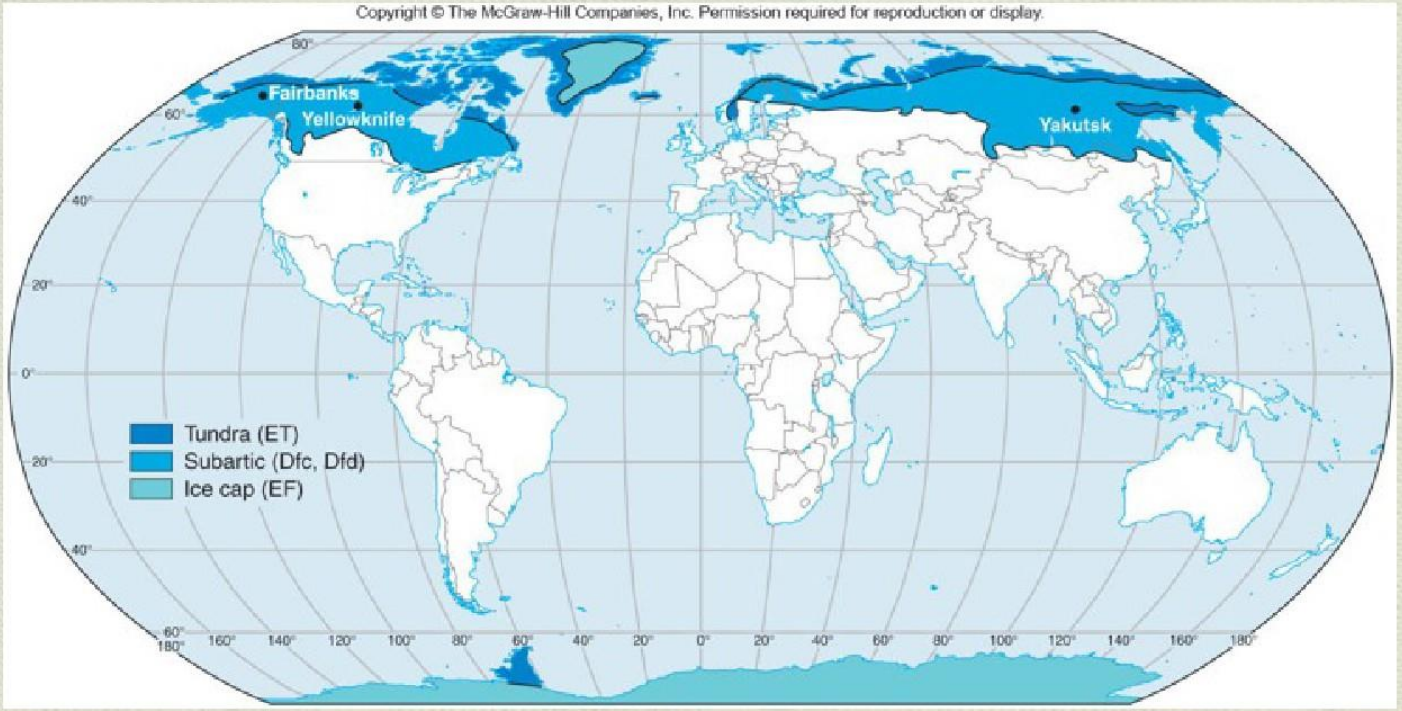
Humid Midlatitude Climates

- Warm to hot summer, cold to moderate winter
- Humid and rainy to dry summers, precipitation in winters
- Deciduous trees, shrubs, conifers

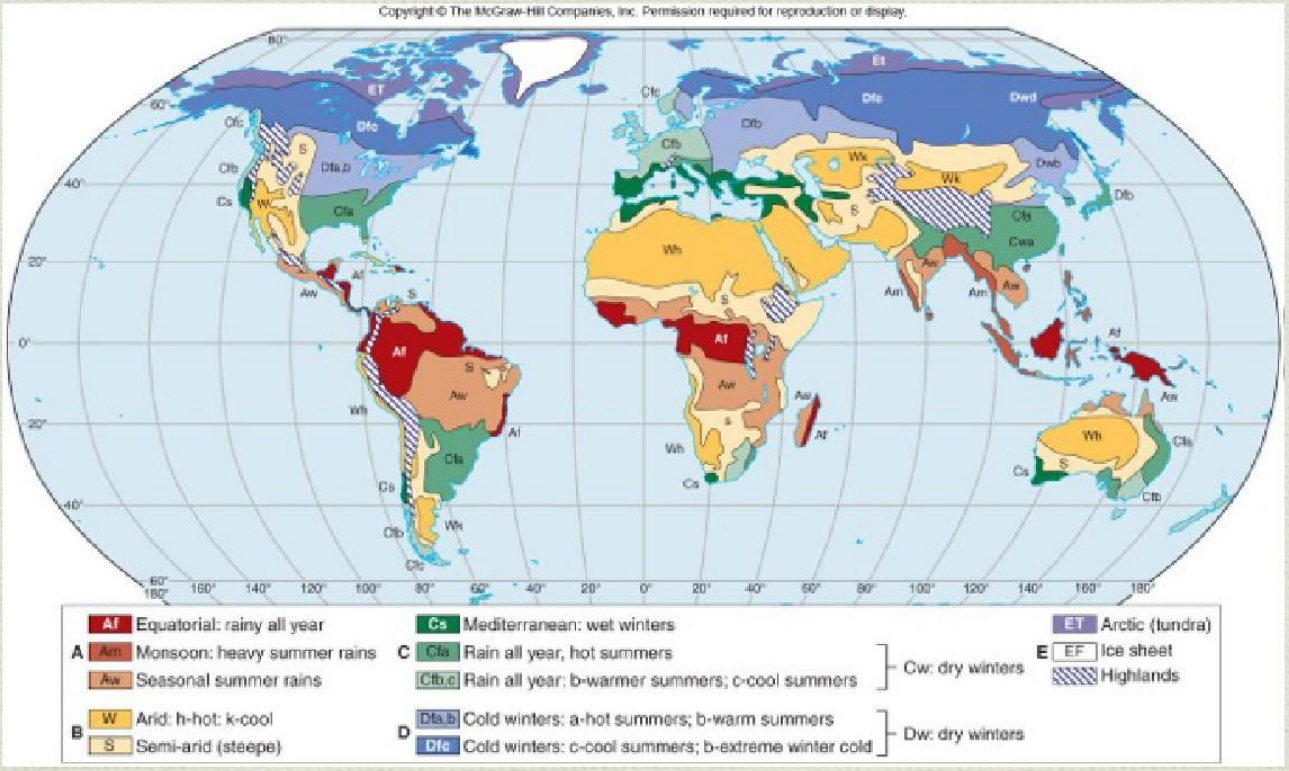


Arctic and Subarctic Climates

- Cool to very cold
- Light precipitation
- Tundra to barren



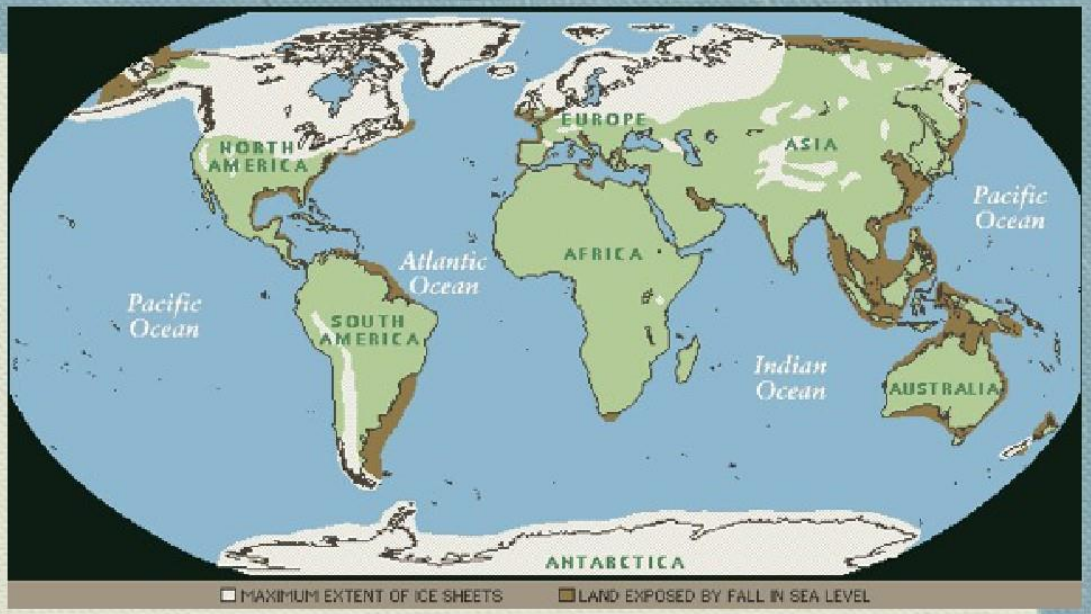
Highland Climates



- Lower temperatures
- Varied conditions depending on location and mountain features

Climate Change

- Long term (geologic time)
  - Atmospheric conditions
  - Earth's tilt
  - Elliptical orbit
- Short term (human time)
  - Volcanoes
  - Asteroids
  - Atmospheric conditions?



The atmospher is essential to all life ; the absence of a comparable combination of gases is the main factor precluding the possibility of life as we know it from other parts of the universe. Not only is the atmosphere a renewable source of essential materials for plant growth but it acts as a " filter " through which sunlight or radiant energy reaches the earth's surface and it provides, as a result, an insulating or thermostatic medium without which variations between day and night temperatures would be too extreme for the survival of any known forms of plant or animal. Further it is the agency by which water is circulated through and distributed to the biosphere.

Plants depend directly on atmosphere for certain frundamental materials, and conditions, necessary for their successful growth and reproduction. In its gaseous composition the Free Atmospher is remarkably uniform and constant so that while oxygen and carbon dioxide are essentials, their proportions do not vary significantly enough to make marked differences in plant growth or distribution. On the other hand the actual or average physical state of the atmosphere - the weather or climatic conditions - varies considerably in time and place. Since a different species of plants vary in their minimum requirements for, or in their tolerance of, particular climatic conditions, these conditions play a major role in determining where a particular plant can or cannot exist. Climatic factors[1] are the master of

\[1] Climate : is a term refers to the atmospheric factors (precipitation, humidity, temperature, light, wind and evaporation) that prevail in a region, country etc. within a year or season. It can be expected. Weather : is a term refers to combination of the above mentioned atmospheric factors in a day, hour or a moment i.e. short period of time. Weather is, usually unexpected and it changes quickly.

all environmental factors that control not only the growth of plants but also the development, distribution and densities of the vegetation of the earth.The plant cover (vegetation) of the earth is divided into number of units (Plant formations e. g. forests, grasslands, desert etc.) that are related mainly to the major climatic zones of the world

The factors of atmosphere of greatest importance are those such as light, temperature, precipitation, humidity, evaporation and wind. All of these factors are essential and all of which vary in amount or intensity from one part of the biosphere to another. All these factors, however, interact one with the other and operarte in combination to produce those atmospheric conditions which will either permit the presence of certain plants in or exclude them from a particular habitat. The condition of any one of these factors will obviously have a direct effect on that of the others; light intensity and duration will influence temperature and humidity are interrelated, humidity affect light intensity and so on

:Climatic (atmospheric factors) may be modified by the edaphic and biotic factors of any habitat. For this reason it is difficult, and in many respects unrealistic, to try to isolate the independent effect of one particular climatic factor on plant growth or function

In the following, a brief description of the climatic factors and their effects on plants will be discussed. These factors are:

Precipitation,

Temperature,

Radiation and light,

Humidity,

Wind and

Evaporation.

PRECIPITATION

Precipitation is the all forms of water whether liquid or solid that fall from the atmosphere and reach the ground. It is expressed in inches or millimeters of liquid water In all habitats except those where the supply of water is constant owing to the presence of springs, streams, ponds or other bodies of fresh water, the dependence of water content of soil is upon precipitation.

Precipitation occurs in two forms.

A- Liquid Forms : Rainfall and Dew

B - Solid Forms : Snowfall, Hail and Frost.

A- Liquid Forms Of Precipitation

1- Rainfall

Rain is the most important factor affecting growth, density and distribution of plant coverage in the different seasons of the year. Vegetation of any great region of the world is determined primarily by the amount and seasonal distribution of rainfall. Vegetations are of three types. Forests, grasslands and deserts.

Heavy annual rainfall distributed through all seasons of the year produce forests.

Heavy rainfall in summer and low rainfall in winter produce grasslands.

Low rainfall in summer and winter produce deserts

The vegetation type of any region is conditioned not only with the total amount of rain per year but also with its seasonal distribution. In desert regions, for example, in certain years strong and heavy showers may fall forming instant **torrents** as a result from **cloudburst.** This amount of water will increase greatly the annual amount of rainfall on that desert. Such rain is harmful to plant life, only it increases humidity of atmosphere for a short time.

Relative small amount of rainfall over an area distributed seasonally will be very useful to plants than relatively larger amount fall within short period. This means that the total annual rainfall in an area is only rough indicator of moisture condition for plant growth. A light rainfall usually does not affect soil moisture, for most of it will be intercepted by vegetation, if there is, and/or will evaporate quickly. That which reaches soil will wet only the surface and likewise be lost to the air. Thus, such amount of rain may, therefore, be of no significance whether except to raise the humidity temporarily and reduce transpiration for a short time.

If rain falls heavily for short periods much of it will be lost by runoff, the amount of runoff varying with:

- ❖ steepness of slope,
- ❖ nature of soil
- ❖ density and type of plant cover.

Seasonal distribution of rainfall may be of much more importance than the total amount of the year. If rainfall is uniformly distributed throughout the growing season, moisture conditions may be far more favorable with 20 - 30 inches than they would with 40 - 50 inches if the growing season is interrupted by one or more dry spells. If precipitation is regularly seasonal, the type of vegetation may be definitely. For instance, grasslands characterize those areas where rainfall in rather light and concentrated in spring and early summer. Winter rains with dry summer characterize several coastal regions, support the shrubby vegetation.

Rainfall is either

- ❖ convectional,
- ❖ orographic
- ❖ depressions.

a) Convectional Rain

Hot air with water vapour ascends as it becomes less dense. The rising air mass is called convection current. Such currents reach their climax in huge "tower" or "heap" clouds and fall in torrential thunderstorms when they mangle with cold air. Occasionally in hot desrts these cloudbursts transform dried-up water courses (wadis) into torrents that may drown travellers.

b) Orographic Rain

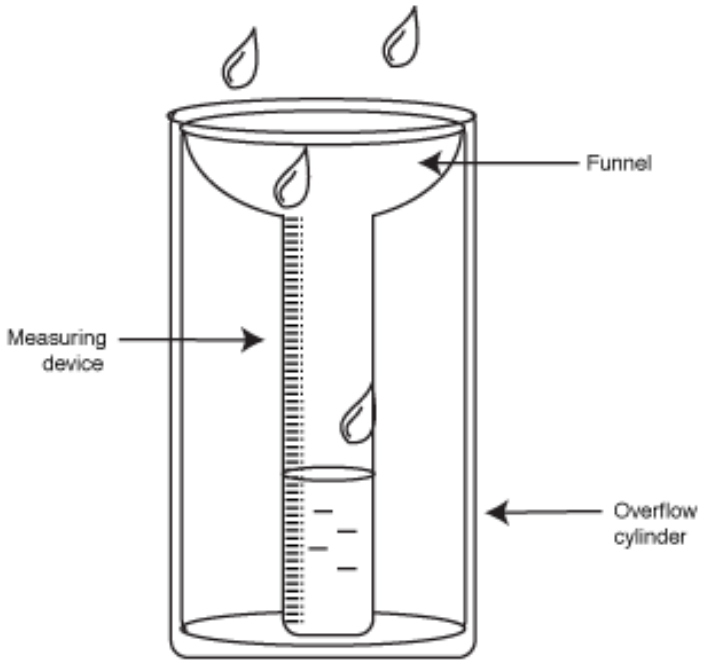
This type of rain occurs only in the mountainous countries. Orographic rains steadily from clouds caused by cooling of air as it blows up mountain side.

c) Rain From Depressions

When warm, light, moist winds ride - up over the cold, dense dry air, clouds occur in between. The warm and cold winds causing rain. These encounters between warm and cold winds are called depressions

Measurement of Rain Fall

Rainfall can be measured with the " Standard Rain Gage ". It is formed of a cylinder (8 inches in diameter and 20 inches high) which has a funnel built into the upper end that permit water it catches to run into an inner cylinder with exactly one-tenth cross sectional area. As the ratio of the outer to the inner cylinder is 10 : 1, the measurement of water collected in the tube must be divided by 10 if taken directly or it can be measured with a standard graduated stick. The purpose of the smaller inner tube is to increase the depth of water and permit for a more accurate readings. After a heavy rainfall when water from the inner tube has over flowed into the outer cylinder, firstly the inner tube is read, emptied and then the water from the outer one poured into it and the amount is recorded.



Rain gauge—rainfall measurements

2- Dew

It is formed by the condensation of water vapour of the lower layers of atmosphere on a cold surface Dew formation does not require saturated air, only it needs the presence of difference of temperatures of the surface and the air in touch with it. Dew starts to condense after sunset and may be late to midnight depending upon the temperature conditions but it stop on sunrise.

In humid areas where rainfall is high, dew is too small in amount to add diretly to the water content of soil. In these the evaporation of dew causes an increase in air humidity and thus decreases slightly the amount of water lost by evaporation from soil and transpiration from plants. However, in areas of low rainfall particular in the hot desert, dew may make an appreciable and vital contribution to rainfall. In these areas the total annual dewfall may exceed the total annual rainfall. For example, in Helwan Desert south of Cairo in Egypt it was found that the annual dewfall equal 50 mm whereas the annual rainfall rarely exceeds 30 mm. In these hot deserts, dew is considered the major source of water for xerophytic mosses, lichens, ferns and even for the ephemeral, annual and biennial flowering plants living there. In an experiment it was found that the moisture content of mosses increased by 20% during daytime nd100% during night with heavy dew.

Unlike rainfall, dewfall is more or less unchangeable and that makes it as a continuous source of water for the minute plants

especially under drought conditions.

Dew has two sources : (i) atmospheric water vapour and

(ii) water evaporates from soil by capillarity.

Measurement of dew is carried out with Leich's Plates which are formed of perforated porcelain each has a surface area of one square decimeter and thickness of one centimeter. These plates resemble the soil. Dew can be estimated by weighing these plates within certain period and the differences between the weights give you the amount of dew.

B. Solid Forms Of Precipitation

1- Snow = frozen water vapour

Snow is the atmospheric water vapour frozen in crystalline form whether in single crystals or aggregated in flakes. Snow is formed like rain but at temperature below freezing and under conditions that permit the crystals to fall before they melt. Snow is an important source of soil moisture. It does not only act as a cover to prevent evaporation but upon thawing (melting) it also enters soil directly as rain.

Snowfall = the amount of snow falling in a given time.

2 – Hail = frozen water

Hail is a frozen rain or grains of ice falling from clouds. It differs from snow being composed nearly of frozen water while snow is composed of frozen water vapour.

Hail falls usually in summer under exceptional conditions, it is of little importance to plants as a source of water. It may do serious physical damage, often stripping foliage completely from woody plants and damaging herbaceous structure beyond recovery.

3 – **Frost =** frozen dew

Frost is a state of freezing i.e temperature at or below the freezing point. It is the frozen dew but when occurs is harmful to plants

particularly the ephemerals and small seedlings.

II TEMPERATURE

Temperature is like water in its action upon plants, that it has more or less to do with nearly every function but as a working condition and not as a material. Moreover,as well as being an indirect factor on plant growth, temperature has a direct effect on practically every plant function. All the chemical processes and metabolism and also many physical processes such as diffusion, precipition and coagulation as in cell wall formation, elongation of shoots and roots etc. are dependent upon temperature and are accelerated by its increase up to an optimum.

Although there are few places in the world where temperatures are continuously too cold or too hot for life, most of the biosphere operates within a range between zero ^{0}C to 50˚C. There are some algal plants that can grow and reproduce at temperature below zero and others which can tolerate temperature as high as 70-80˚C in hot springs. Thus, temperature is not only the working condition for all organisms including plants and controls the rate of their biological activity and process but also it furnishes the energy for some of them.

The habitat plays an important part in determining the influence of temperature upon each species. A particular species has been accustomed for countless generations to certain extremes of heat and cold as well as to certain seasonal sum of temperature. Temperatures beyond these extremes check (hinder) the plant's

activity and this is usually true of the total heat available during the growing periods. These temperature adjustments become so deeply impressed in the protoplasm of a species that they result to a more or less fixed habit as regard temperature. Thus, in temperate regions, for example, low temperature in winter becomes a necessary experience to the trees of deciduous forests.

Temperature has a marked effect upon

a) seed germination,
b) growth of plants,
c) opening of flower buds,
d) fruit production i.e. upon plant reproduction.

Consequently, temperature has great influence on

A. the devlopment of individual plant
B. the development of vegetion.

Measurement of temperature is carried out with the aid of accurate standardized glass thermometer. Air temperature is usually taken in the shade with thermometer exposed to wind and away from the influence of one's body. Continuous temperature record are obtainable with thermographs. The thermometers readings are either in Centigrads (°C) or Fahrenheit (˚F). Centigrade = having hundred degrees or divided into a hundred degrees. The centigrade

therometer of 100 degrees had been constructed by Celsius (1701-1744) in which the freezing point of water is zero and the boiling-point is 100°. Fahrenheit, on the other hand, of a thermometer or thermometer scale having the freezing-point of water marked at 32° and the boiling-point at 212°. To convert degree Celsius (centigrades) to Fahrenheit, multiply by 9 and add 32. To convert degree Fahrenheit into Celsuis (or centigrade) substract 32 and mulitiply by 5

Thus:

$$^{o}C = {}^{o}F - 32 \times \frac{5}{9} \qquad {}^{o}F = {}^{o}C \times \frac{9}{5} + 32$$

$100^{o}C = 212^{o}F$ zero $^{o}C = 32^{o}F$

$122\ ^{o}F = 50\ ^{o}C$ $50\ ^{o}F = 10\ ^{o}C$

$1\ ^{o}C = 33.8\ ^{o}F$

For each species of plant there are maximum temperatures necessary for its various metabolic activities. These are called the **Cardinal Temperatures** The minimum (the" threshold" or the " base") temperature is that below which a function cannot operate; plants native to warm region e.g date palm, sorghums, melons etc. require minimum cardinal temperature of 15-18°C for growth while plants native to cold regions e.g cereals, require minimum cardinal temperature of between 2 °C and 5°C mile evergreen conifers have minimum temperature for photosynthesis Of - 3°C An increase of temperature above the ncessary minimum will be accompanied by

an increased rate of activty up to an optimum, thereafter the rate declines until a maximum temperature is reached above which activity ceases.

Plants, in general, are subjected to a considerable range of temera-ture during their period of growth. They grow only when temperature remains within certain limits and mature and die or become dormant when it falls too low or become too high.

Temperature fluctuates both daily and seasonally. The amount of heat received depends upon the angle of suns rays and their consequent absorption. The actual temerature at the surface of earth are greatly modified by **Radiation** and **Convection (** transmission).

Variation of temperature occurs with changes in Latitudes and Alti-tudes. High latitudes receives sun's rays at a greater angle than equatorial one and the absorption of heat by the atmosphere is correspondingly greater, thus leaving less for soil surface. High altitudes (mountains) receive more heat than lowlands, but as loss by radiation is so much greater, the mountainous regions are uniformly colder than plains or low lands. Although air on mountain tops is colder than that of plains yet surface temperature on soil is often considerably higher.

Winds cause temperature to rise when they blow from warmer re-gions and to fall when they come from a cooler ones.

Clouds reflect a considerable portion of the insolation from their

upper surfaces and consequently temperature at earth's surface is decreased.

plant cover (dead or alife) reduces day temperature by screening out sun's ray and increases night temperature by retarding radiation.

III RADIATION AND LIGHT

Radiation is energy moving at or near the speed of light Practically all the energy of an ecosystem originates as radiation from the sun, that is, Solar Radiation. Minor amounts of energy comes from beyond solar system e. g. volcanoes etc, but these do not contribute much to radiation provides the necessary energy to heat environment and to drive the ecosystem by means of energy storage at photosynthesis.

The solar radiation which penetrates upper atmosphere and reach the earth's surface consists of electromagnetic waves ranging in length from 300 to 10000 millimicrons or 3000 to 100,000 A°.

Light is that radiation in which violet comes at the shorter end of the wave length span and red at the the longer end. It is visible to our eyes whereas other radiations are not. Light is the effective radiation in photosynthesis and is important to considerable extent in the heating of the environment. It makes up almost half of the solar radiation reaching the earth's surface, thus it is a determining factor for plant growth and vegetation development. It is from the radient energy of light the chlorophyll absorbs certain wavelengthes which enable the chloropl A to manufacture food.

The invisible spectra are : infrared and ultraviolet.

The infrared radiation (longer wavelength) is of no value to plants and is not known to be harmful to them.

The ultraviolet radiation is of shorter wavelength than those of sunlight and it has a pronounced bad injuries effect upon plants.

Not all wavelengths are equally usable. Green light is reflected or transmittred while much more longer wavelengths, e. g red light, are much more effective in photoynthesis than the shorter lengths of yellow and blue. On the other hand, not all plant species are equaly efficient under equal illumunation. Some require certain intensities and some need certain lengths of day or season to function normally

Quality And Duration Of Light

Differences in latitude and altitudes cause variations in climate, light is a part of the climate. Thus, variations in photosynthesis and growth of plants are seen at different latitudes and altitudues. Differences in light intensity during the growing season has great effect on the plant growth.

The quality of light is modified by clouds, fogs, atmospheric water vapour etc. Water vapour in air absorbs a great deal of long wave length, particularly infrared. During winter a higher percentage of red light and a lower one of blue light reach earth than in summer. In general, the red end of spectrum permit excessive tissue and cell elongation, while the blue - violet light exerts retarding effect upon growth by keeping cell smaller.

In nature duration of light varies from 12 hours at the eqator to con-titiuous sunlight or coninuous darkness throughout the 24 hours

during a part of the year at very high latitudes.

Effects of light on plants

For each plant species there is a minimum light intensity essential for growth : this is the percentage of full day light necessary for photosynthesis to produce new food material at a rate greater than it is being used up in the process of respiration. Similarly there is an optimum intensity beyond which the rate of photosynthesis decreases and increased light intensity may be determinetal (harmful) to the plant.- Minimum and optimum requiremnts for light intensity vary from one species to another. There are those which can only grow and attain full development in light of low intensity, i. e shade - loving plants or **Sciophytes,** others which require high light intensity or sun-lovivg plants or **Heliophytes.** Most trees, all cereal crops, many grasses and herbaceous weeds are heliophytes, while a great number of mosses and ferns, together with the herbaceous and shrubby plants of woodland habitats are sciophytes.

The particular length of day essential for the production of flowers and seeds of plant is called **photoperiod$_a$** The response of plant to duration of daylight is called **photoperiodism.**

EFFECTS OF LIGHT ON PLANTS

Light has influences on :

(1) the production of chlorophyll,

(2) closing of stomata.

light is necessary for the formation of plant pigments. Plants with plastids produce chlorophyll only in light and the chlorophyll disappears in continued darkness.

Leaf undergoes the greatest modification as response to light than any organ of plant. Stems may be modified to some extent when they contain chloroplasts. Roots, not being exposed to light, show only indirect effect such as result from differences in growth due to an increased supply of photosynthate and the response to a well lightened or a moist shady habitat.

Thickness of leaf increased with light intensity. Plants grown under 1-20% light develop only one layer of palisade tissue; those under 70% have two distinct layers. Leaves that contain an excess of sponge tissues are relatively broader while those in which the palisade is preponderant are relatively thicker.

Light is the most important factor modifying stomatal movement that has a profound effect upon transpiration and respiration of plants. In nearly all plants, stomatal opening is correlated with the presence of light when other conditions for opening are favorable.

LIGHT INTENSITY

Intensity of light varies according to several factors, the most important ones are : the atmosphere, the latitude, layers of water,

suspended particles, laryers of vegetation and topography.

1 - **Effect of Atmosphere**

The intensity of light is much greater in dry than in humid climates and is very low when cloud and fog are abundant.

2 - **Effect Of Latitude**

Latitudinal variations in light intensity due to height of sun obove the horizone are very important.

3 - **Effect Of Layers Of Water**

Submerged plants are subjected to weaker illumination than terrestrial ones, for part of the light is reflected back at the water surface and of the remainder much is absorbed by the upper layers.

As light penetrates water, the intensity decreases as depth of water increases. Even in perfectly clear water only 50% of the light penetrates as deep as 18 m and at 50 m depth there may be scarcely sufficient light for feeble photosynthesis.

Light penetration through snow is sufficient to allow hardy plants (plants able to bear cold) to begin growth before the snow cover melts in spring. Photosynthesis may take place under as much as 40 cm of snow.

4 - Effect Of Suspended Particles

Solid particles dispersed in air (dust,smoke) or in water (clay, silt, plankton etc.) have screening effect.

5- Effect Of Layer Of Vegetation

Leaves transmit about 10% of the light fall on them, so that most of light penetrates through foliage passes between the leaves as sky light.

6 - Effect Of Topography

The direction and slope of land surface cause marked variations in the intensity and daily duration of insolation (light).

IV HUMIDITY

What is Humidity ?

Humidity is the mount of moisture in air in the form of vapour. It is one of the most important factors since it directly affects the rate of transpiration. The amount of water that a plant loses frequently determines whether it can or cannot grow in a given habitat.

Absolute Humidity is the actual amount of water present in air. It is expressed as grams per cubic meter of air. Warm air can hold more water vapour than cold air. In fact the capacity of air for holding invisible water vapour doubles with each increase of 20°F in temperature. In desert, the humidity is very low and water exposed quickly evaporates. Conversily, in areas of low temperature the amount of vapour that can remain in air is lessened and the air is more saturated.

Relative Humidity is the ratio expressed as a percentage of water vapour actually present in air (unit of space) at a certain temperature to the amount necessary to saturate the same unit of space under similar coditions. For example, 50% relative humidity means that the space contains one-half the amount of water vapour necessary to saturate it (100%).

The lower the relative humidity at a given temperature the more rapidly the air will take up water from transpiring leaf or from a moist soil surface.

Factors Affecting Humidity

Humidity is affected by temperature, wind, exposure, cover, evaporation and other climatic factors.

High temperature increase the capacity of air for moisture and consequently lower the relative humidity. At low temperature, air will hold less moisture and consequently its relative humidity increases. With a given amount of water vapour in air, transpiration from plants and evaporation from soil are increased with arise of plant and air temperatures.

Wind has a powerful effect upon humidity, dry winds lower the amount of air moisture by removing the moist air about plants and mixing it with dry air. This has the effect by keeping the humidity low and promoting transpiration.

Exposure, i.e the position of a slope with respect to the sun, affects humidity through the action of the sun and wind. Slopes that are exposed to sun's ray for longer time receive the most heat. Consequently, slopes with a northern exposure show somewhat lower humidities than those with southern exposure. The effect of wind is most pronounced upon those slopes exposed to prevailing dry winds.

Cover increases humidity by reducing the influence of both temperature and wind. In addition, a living cover (plants) supplies moisture to air in consequence of transpiration from plant that

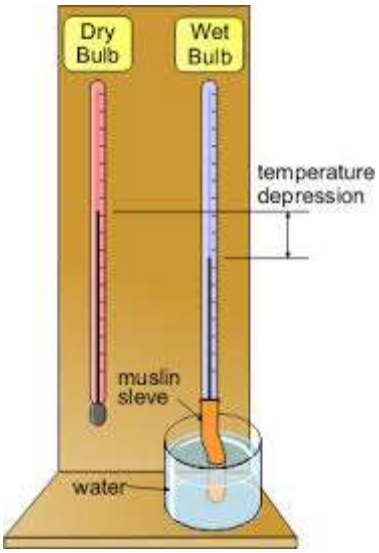
compose it

Evaporation of the surface of moist soil increases humidity. This is particularly noticeable in forests and thickets of shrubs where air is sheltered from sun and wind. In general, air near soil surface is more moist than that near the top of a cover of vegetation.

The view that atmospheric pressure influences relative humidity by changing the density of the air and hence its power to hold moisture, might not be correct as the amount of water vapour required to saturate a given area is entirely independent of the pressure of the other gases present and is determined solely by the temperature of the vapour itself. However, low air pressure does increase the rates of evaporation and transpiration through a reduction in the density of the air.

Measurement Of Humidity

Humidity is measured by means of a wet and dry bulbs **Hygrometer.** It consists of a wet-bulb thermometers set in a wooden case. The dry-bulb thermometer is an ordinary thermometer, but the wet-bulb is a thermometer covered with a clean linin cloth which is moistened with distilled water. The dry-bulb thermometer indicates the normal temperature of air while the wet bulb one gives the reduced temperature resulting from cooling due to evaporation. If air is moist, there is a little evaporation, if it is dry evaporation is rapid and the result is a marked drop (depression) is the wet bulb.



Evaporation produces a decrease in temperature depending upon the amount of moisture in air.

Tables have been prepared for almost all possible combinations of air temperatures and wet-bulbs depressions, showing the corresponding relative humidity (RH).

Saturation Deficit

Saturation deficit is the amount of water vapour that the air can take up before becoming saturated. In comparatively dry air, transpiration is rapid because the air, being unsaturated, can take up more moisture.

Saturation deficit is influenced by temperature. An apparently dry air such as that of a desert may actually contain more moisture becaule of its high temperature with the absolute humidity of the air remaining constant, its saturation deficit increase with rise in temperature and falls with the lowering of temperature. When the

temperature falls very low, some of the moisture may condense in the form of liquid water as happens in dew formation

V. WIND

Definition

Wind is a climatic factor which though not essential for plant growth yet it can exert a considerable inflence on the form of the plants. Even under conditions of plentiful soil moisture, wind may put a strain on the plant's water balance as sever as that in completely arid region. In areas exposed to high wind force, as along the sea coasts and at high altitudes, the height to which plants grow may be limited by their ability to absorb and transport water upwards rapidly enough to replace that loss by transpiration

Effects Of Wind

Wind has both a direct and indirect effects on plant life. The direct effect of strong winds is mechanical and consists in uprooting trees and breaking off branches and twigs. Strong winds also cause permanent curvature in plants on exposed places where the trees usually have an asymmetrical appearance with few branches and leaves on the windward side. Grasses and other low plants or those with well developed rhizomes are less susceptable to winds. Though winds helps in seed and fruit dissimination, yet they do much harm

in blowing fruits or blossoms from plants by preventing insects from working among flowers. It is an important agent in the distribution of weeds and spores of many diseases producing fungi. By means of whirl-winds, spores are carried high into air and over large distances. Viable spores have been caught at height of more than 11,000 feet. Wind has a beneficial effect in drying the soil in spring and milden temperature on leeward sides of large bodies of water..

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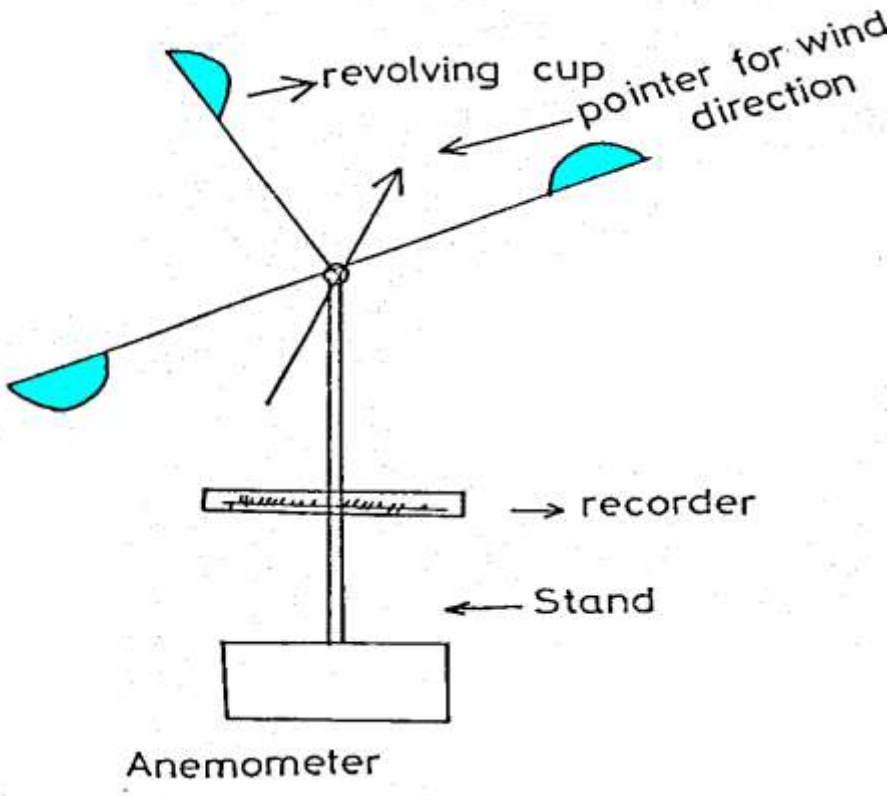
Wind velocity increases with height, above ground, thus the plants with prostrate habit with their leaves near the soil surface are safe from the drying effect of wind while the tall trees are the greatest suffers from excessive transpiration. The strong winds in the upper strata of air cause the upper shoots to dry off and inhibit growth in length. In exposed areas, therefore,. the wind action often limits the height to which tress can grow. In such- places latter trees grow to a uniform height called " **the general vegetation limit** **".** The force of wind may be modified by windbreaks, by sowing grains in furrows and by strip planting which reduce its effect, since all times a part of the soil in the field is protected by a cover of vegetation.

The indirect effect of winds is physiological. Mobilization of sand and building up of sand bodies (mounds, hummocks, hillocks and dunes) are mainly carried by winds. The arrangement of sand masses in regions of scant vegetation is also subjected to the

influence of wind. If sand movement comes slowly, vegetation may save itself from burial by growing up through sand and binding it. These are the sandbinder species, not all plants are sand - binder only the psamophytes are those species that can build sand formations

Wind movement is measured by **Rotating Anemometer.** It is composed of three half - balled cups connected together with mobile arms that move by the effect of winds. The arms are fixed on vertical stand on which there is a recorder to record wind velocity. The data are recorded as kms of wind movement per hour



VI. EVAPORATION

Definition

Evaporate means to fly off in vapour, to pass into an invisible state, to depart or to vanish. Evaporation is the act of evaporating or passing off in steam or gals. It is the process by which a substance changes into the state of vapour.

From the climatic point of view, Evaporation is an important factor. It is the desiccating power of the atmosphere that effect greatly vegetation. Evaporation Stress is affected by the other factors of the atmosphere, namely : precipitation, humidity, wind, temperature, sunshine etc.This means that the Rate of Evaporation reflects the combind effects of the other climatic factors.

In its wider mean, Evaporation is a process by which more water molecules leaves a surface, any surface, than enter it e.g. soil surface, water surface, leaf surface. etc.

Evaporation And Vegetation

As surface layers of soil, where plants grow, dry out, evaporation from these layers ceases because they form a dry barrier through which little soil water moves. At this point, major water losses from the soil takes place through the leaves of plants i.e. through transpiration. From the soil the plants take water by the roots and they lose it through leaves. Perennial xerophytes are drought

tolerant plants having long root system that penetrates deep in soil deeper than the surface layers of soil where evaporation occurs, to reach the permanent wet layer of soil from which it takes its water. Ephemerals and annuals, however, cannot grow in such a habitat with dry surface soil layers. These plants have short roots that take water from surface layers only.

Evapotranspiration is the total loss of water by evaporation from soil and transpiration from the plants constituting the vegetation of such a soil. It is measured by the use of weighed Lysimeters containing an appropriate soil cores.