UGC-NTA NET/SET/JRF-JUNE 2020

PAPER- II

GEOGRAPHY

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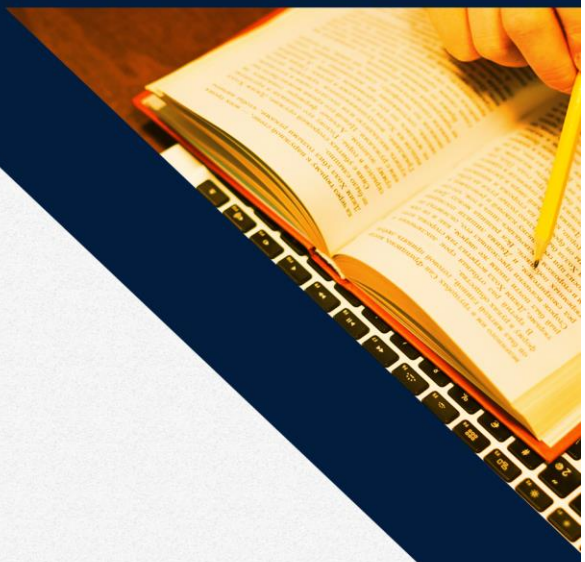
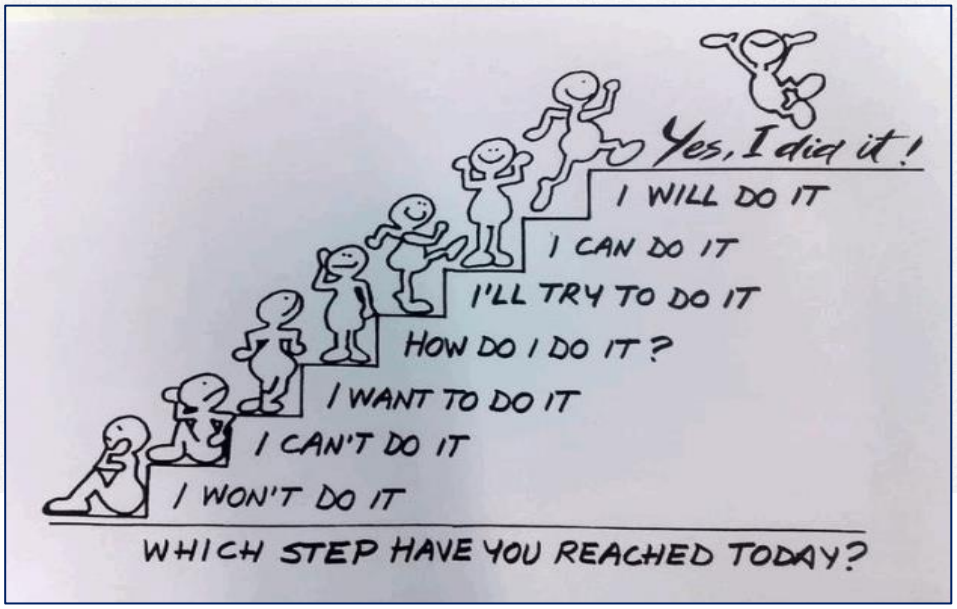




Section – 3: Key Facts and Figures

Sub Unit – 1:

Composition and structure of atmosphere

The atmosphere of Earth is the layer of gases, commonly known as air that surrounds the planet Earth and is retained by Earth's gravity. The atmosphere of Earth protects life on Earth by creating pressure allowing for liquid water to exist on the Earth's surface, absorbing ultraviolet solar radiation, warming the surface through heat retention (greenhouse effect), and reducing temperature extremes between day and night.

2.1.1 Components:

The atmosphere is made up of nitrogen (78%) and oxygen (21%). The rest of the gases combined only account for about 1% of the atmosphere. Along with all of these different gases, the atmosphere also holds many tiny, floating particles and droplets of liquid that scientists collectively call aerosols.

2.1.1.1 Major constituents of dry air, by volume:

Gas Name	Formula	Volumein %
Nitrogen	N_2	78.084
Oxygen	O_2	20.946
Argon	Ar	0.9340
Carbon dioxide)	CO_2	0.041332
Neon	Ne	0.001818
Helium	He	0.000524
Methane	CH_4	0.000187
Krypton	Kr	0.000114

2.1.2 Structure of Atmosphere:

It surrounds the earth from all sides. Generally, it **extends up to about 1600 kilometres** from the earth's surface. 97 % of the total amount of weight of the atmosphere is limited up to the height of about 30 kilometres.

2.1.2.1 Homosphere:

a)Troposphere:

It extends from Earth's surface to an average height of about 12 km (7.5 mi; 39,000 ft),although this altitude varies from about 9 km (5.6 mi; 30,000 ft) at the geographic poles to 17 km (11 mi; 56,000 ft), at the Equator, the troposphere is bounded above by the tropopause, Here the normal lapse(temperature in Earth's atmosphere falls with altitude) rate -6.4 °C/Kms.

b) Stratosphere:

The stratosphere extends from the top of the troposphere to about 50 km (31 miles i.e. Stratopause) above the ground. The infamous ozone layer is found within the stratosphere. The altitudinal range of the layer is 15 to 35 kilometers.

c) Mesosphere:

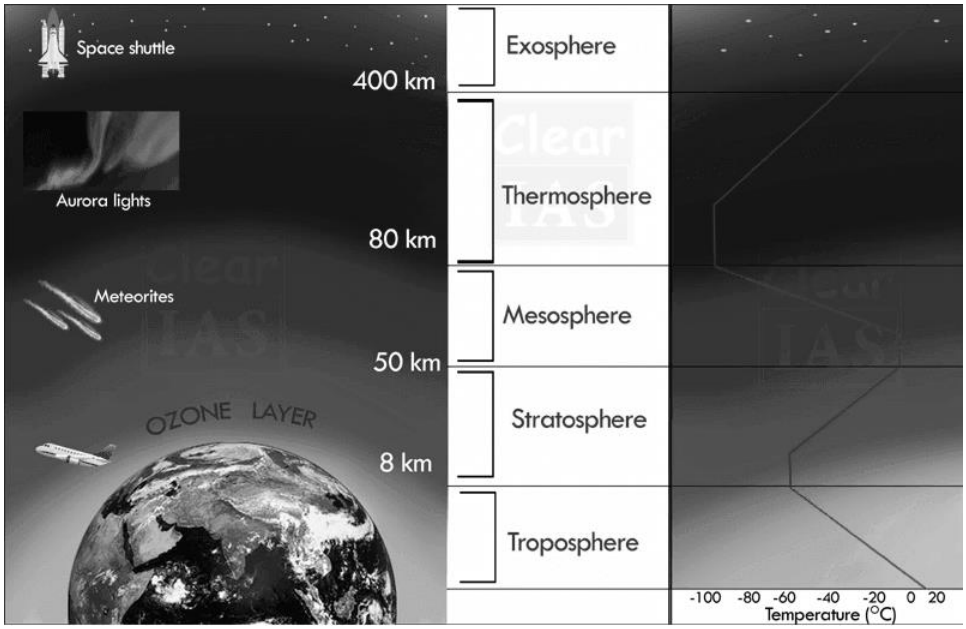
The mesosphere is the third highest layer of Earth's atmosphere, occupying the region above the stratosphere and below the thermosphere. It extends from the stratopause at an altitude of about 50 km (31 mi; 160,000 ft) to the mesopause at 80–85 km (50–53 mi; 260,000–280,000 ft) above sea level.

2.1.2.2 Hetarosphere:

d) Thermosphere:

The thermosphere is the second-highest layer of Earth's atmosphere. It extends from the mesopause (which separates it from the mesosphere) at an altitude of about 80 km (50 mi; 260,000 ft) up to the thermopause at an altitude range of 500–1000 km (310–620 mi; 1,600,000–3,300,000 ft).

This layer is completely cloudless and free of water vapor. However, non-hydrometeorological phenomena such as the aurora borealis and aurora australis are occasionally seen in the thermosphere.



Ionosphere

It is also a part of thermosphere. The layer reflects radio waves that are retransmitted from the earth and again back to the earth.
Except those layers following two layers are present-

e) Magnetosphere:

It is a region of space surrounding an astronomical object in which charged particles are manipulated or affected by that object's magnetic field.

f) Exosphere:

The exosphere, the highest layer, is extremely thin and is where the atmosphere merges into outer space. It is composed of very widely dispersed particles of hydrogen and helium.

As per scientific explanation Magnetosphere and Exosphere are not the part of the atmosphere.

Sub Unit – 2:

Temperature of atmosphere

2.2.1 Process of heating of atmosphere:

Following heads are the heating and cooling processes in the atmosphere
a. radiation
b. absorption
c. reflection
d. scattering
e. transmission
f. conduction
g. convection
h. advection (Wind)

2.2.2 Heat Budget of Earth:

Earth's heat-budget or Earth's radiation balance refers to the net flow of energy into Earth in the form of shortwave radiation and the outgoing infrared long-wave radiation into space.
This balance between incoming and outgoing heat is known as Earth's heat budget.100 units of incoming solar radiation, m34 % are scattered or reflected back to space by the atmosphere and Earth's surface.
Of these 34 units, 6 units are scattered by the air, water vapor, and aerosols in the atmosphere; 20 units are reflected by clouds; and 4 units are reflected by Earth's surface.
The 66% units of incoming solar radiation make it into Earth's atmosphere. This is equivalent to 240 watts per square meter (66% of 342 W/m^2).
The atmosphere and clouds absorb 17 units of this incoming solar radiation, leaving 51 units of solar radiation that is absorbed at Earth's surface. These incoming 51 units consist of shorter wavelength solar radiation (mostly in the visible region of the electromagnetic spectrum), which is absorbed by land, water, and vegetation.

2.2.3 Factors of distribution of temperature:

The factors are following-
a. Latitudes
b. Altitude
c. Distance from the coast
d. Nature of land and water
e. Nature of ground surface (soil)
f. Ground slope
g. Prevailing winds
h. Ocean currents

The World's Coldest : Denali or Mount McKinley, USA.
The Warmest Place in the World: Al-Aziziyah, Libya.

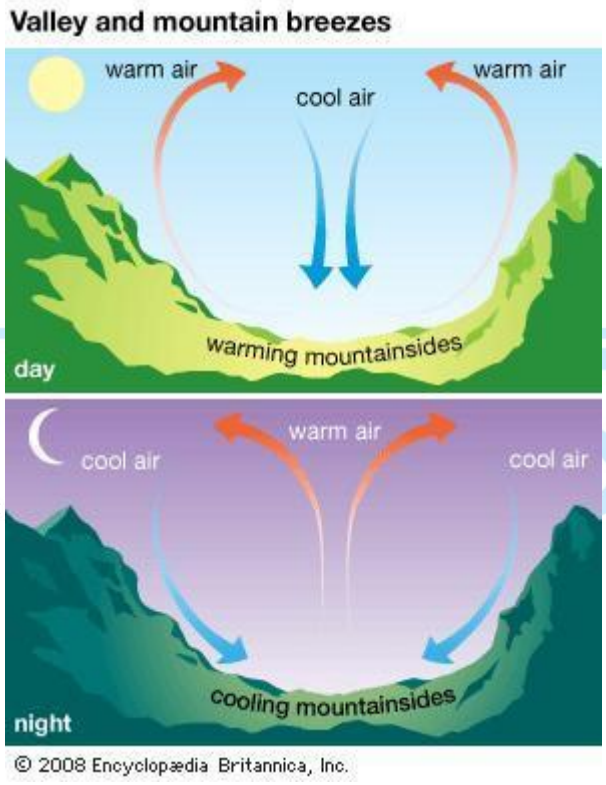
2.2.4 Vertical distribution of temperature:

Inversion of temperature-
Temperature decreases with increasing height in the troposphere but the rate of decrease varies according to seasons, duration of sunshine and location. On an average, the rate of decrease of temperature with increasing altitudes in a stationary column of air with absence of any vertical motion is 6.5°C per 1000 meters.

Ideal Conditions for Temperature Inversion:

These conditions are following:

a) Long winter nights.
b) Cloudless clear sky
c) Dry air
d) Calm atmosphere
e) Ice covered surface



2.2.5 Horizontal distribution of temperature:

The following factors are responsible for uneven distribution of temperature-
Latitude
Presence of land and water
Relief and altitude
Ocean currents
Winds
Vegetation
Nature of the slope etc.

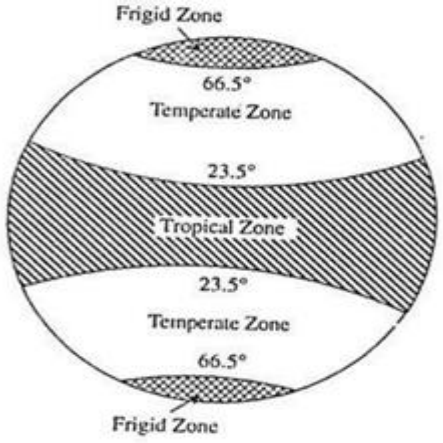
2.2.6 Regional distribution of temperature:

According to ancient Greek thinkers the globe is divided into three temperature zones on the basis of latitudes.

1.Tropical zone-Tropical zone extends between the tropics of Cancer (23°30”N) and Capricorn (23°30”S).

2.Temperate zone-Temperate zone extends between 23°30” and 66°30” latitudes in both the hemispheres.

3.Frigid zone -Frigid zone extending between 66°30” latitude and the poles in both the hemispheres is characterized by more oblique sun’s rays throughout the year resulting into exceptionally very low temperature.



Temperature zones according to the views of ancient Greek thinkers.

Sub Unit – 3:

Atmospheric pressure and circulation

2.3.1 Air pressure and atmospheric circulation:

Wind direction and related laws:

a) Low and high pressure zones:

In the Northern Hemisphere, if a person stands with his back to the wind, the atmospheric pressure is low to the left, high to the right. This is because wind travels counterclockwise around low pressure zones in the Northern Hemisphere.

It is approximately true in the higher latitudes of the Northern Hemisphere, and is reversed in the Southern Hemisphere, but the angle between the pressure gradientforce and wind is not a right angle in low latitudes.

b) Pressure Gradient Force:

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure.

c) The Coriolis effect :

All winds move towards their right in the northern hemisphere and towards their left in the southern hemisphere with respect to the rotating earth. Thus, in the northern hemisphere winds blow counter-clockwise along the centers of low pressure while clockwise in the southern hemisphere.

d) Ferrel's Law:

Because of the rotation of earth all winds are deflected to their right in the northern hemisphere and to their left in the southern.

2.3.2 Factors of air pressure:

Factors are as follow-

a. Temperature
b. Height from Sea Level
c. Moisture in Air (Humidity)
d. Gravitation of Earth
e. Rotation of Earth

2.3.3 Air pressure measuring instruments:

Barometer is an instrument used for measuring the atmospheric air pressure. Air pressure at 8 kilometers above is half of the ground.

2.3.4 Horizontal distribution of air pressure and pressure belts

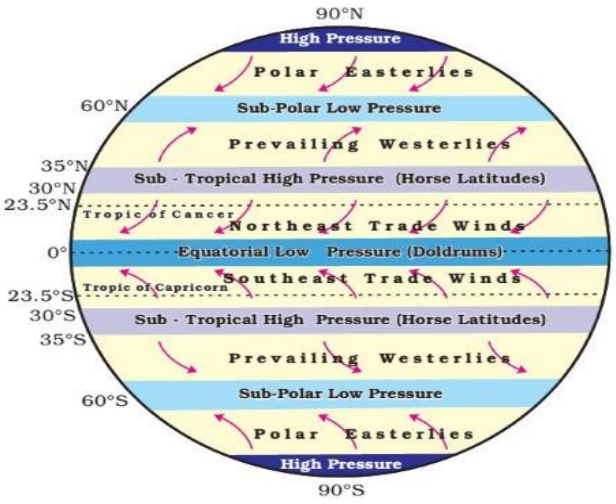
There are distinctly identifiable zones of homogeneous horizontal pressure regimes or **'pressure belts'.** On the earth's surface, there are seven pressure belts.

a. Equatorial low pressure belts

b. Subtropical high pressure belts (north and south)

c. Sub polar low pressure belts(north and south)

d. Polar high pressure belts(north and south)



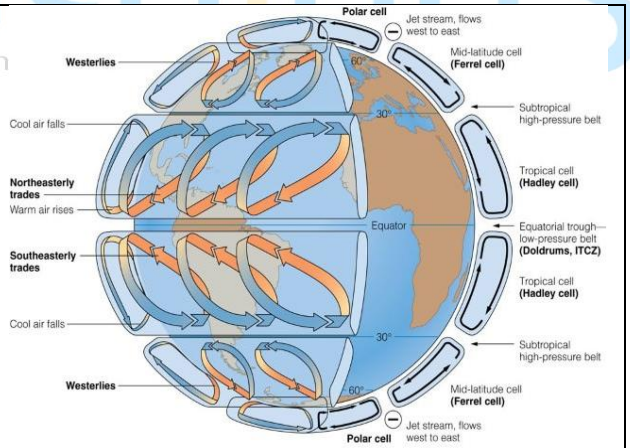
Major Pressure Belts and Wind System

2.3.5 General circulation of the atmosphere:

The concept is proposed by G. Hadley. The pattern of planetary winds depends on:

1. latitudinal variation of atmospheric heating;
2. the rotation of earth.

The wind circulation cells are:
Hadley Cells 30^0-60^0 N/S
Ferrel Cells 30^0-60^0 N/S
Polar Cells-60^0- 90^0 N/S
ITCZ:
The air at the Inter Tropical Convergence Zone (ITCZ) rises because of the convection currents caused by low pressure. Low pressure in turn occurs due to high insolation. The winds from the tropics converge at this low pressure zone. ITCZ gradually varies with the seasons, roughly corresponding with the location of the thermal equator. As the heat capacity of the oceans is greater than air over land, migration is more prominent over land. Over the oceans, where the convergence zone is better defined, the seasonal cycle is more subtle, as the convection is constrained by the distribution of ocean temperatures.



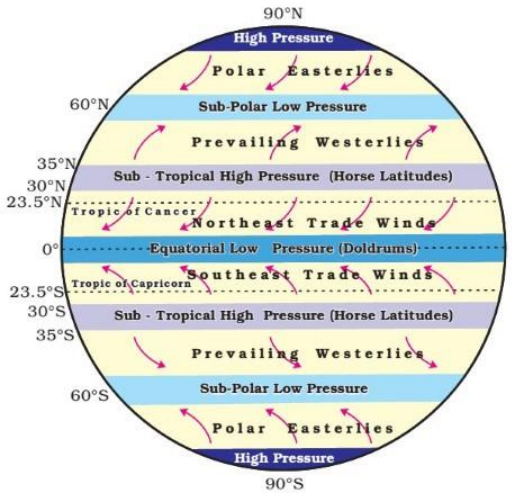
2.3.6 Classification of Winds:

Macro scale winds are on a global scale. **Meso scale** describes storms like thunderstorms. There are also winds and small circulations that only last for a few seconds. These smaller circulations are described with the term **micro scale**.

2.3.6.1 Permanent winds or Primary winds or Prevailing winds or Planetary Winds or Macro Scale winds:

a)Trade Winds (tropical easterlies):

The trade winds or easterlies are the permanent east-to-west prevailing winds that flow in the Earth's equatorial region (between 30°N and 30°S latitudes). The trade winds blow predominantly from the northeast in the Northern Hemisphere and from the southeast in the Southern Hemisphere. Trade winds have been used by captains of sailing ships to cross the world's oceans for centuries and enabled colonial expansion into the Americas and trade routes to become established across the Atlantic and Pacific oceans.



Major Pressure Belts and Wind System

b) Westerlies:

The westerlies are the winds blowing from the sub-tropical high pressure belts towards the sub polar low pressure belts. Shifting of trade wind belt towards poles is the essential for the formation of equatorial westerly.

The westerlies are developed between 40° and 65°S latitudes. These latitudes are often called Roaring Forties, Furious Fifties, and Shrieking Sixties – dreaded terms for sailors.

c)Polar easterlies:

The Polar easterlies are dry, cold prevailing winds blowing from north-east to south-west direction in Northern Hemisphere and south-east to north-west in Southern Hemisphere.They blow from the polar high-pressure areas of the sub-polar lows.

The main cause of Mediterranean, or dry summer climate, is the subtropical ridge which extends northwards during the summer and migrates south during the winter due to increasing north-south temperature differences.

2.3.6.2 Secondary Winds or Periodic Winds:

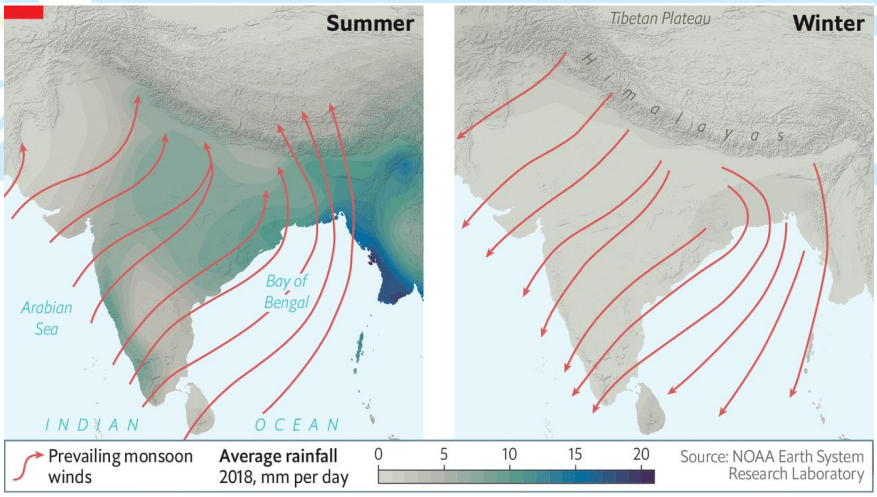
These winds change their direction with change in season.

a)Monsoons:

During summer sun rays become vertical over the tropic of cancer. That's why temperature rises enormously over the land surface which responsible to make extreme low pressure on it. Whereas high pressure is being develop over the Indian ocean due comparatively low temperature on it. Thus, moisture laden wind move from Indian ocean to land surface. It brings heavy rainfall all over India, Srilanka, Bangladesh and many more countries.

Some popular theories about Monsoon-

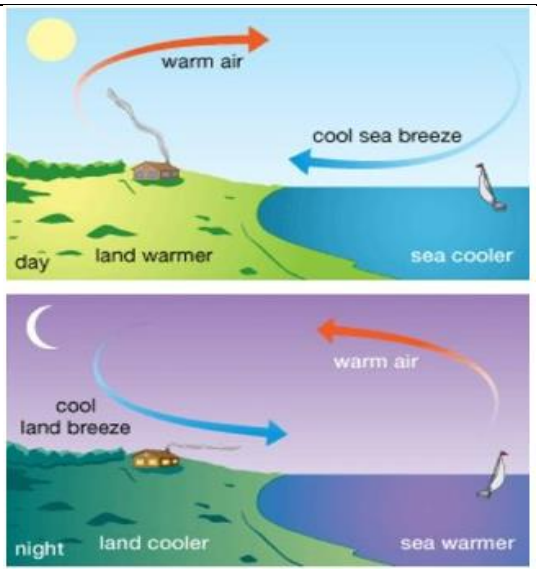
1	Hailey's Theory 1686	Alternative heating and cooling of land and sea
2	Flohn's theory 1951	Shifting of pressure belts
3	P koteswaram theory 1952 and	Thermal engine theory(monsoon and Tebet Plateau)
4	Monsoon Experiment (MONEX) 1972	



b)Land Breeze and Sea Breeze:

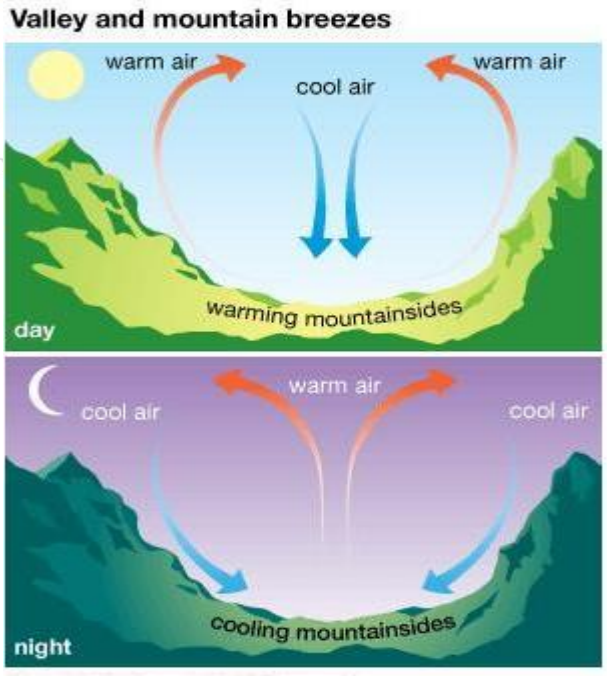
During the day the land heats up faster and becomes warmer than the sea. In the land the air rises to up and create low pressure area, whereas the sea is relatively cool and the pressure over sea is relatively high. The wind blows from the sea to the land as the sea breeze.

In the night the reversal of condition takes place. The land loses heat faster and is cooler than the sea. The pressure gradient is from the land to the sea and hence land breeze results.



c)Valley Breeze and Mountain Breeze:

In mountainous regions, during the day the slopes get heated up and air moves upslope and to fill the resulting gap the air from the valley blows up the valley.
This wind is known as the valley breeze.
During the night the slopes get cooled and the dense air descends into the valley as the mountain wind. The cool air, of the high plateaus and ice fields draining into the valley is called katabatic wind.
Another type of warm wind (katabatic wind) occurs on the leeward side of the mountain ranges. The moisture in these winds, while crossing the mountain ranges condense and precipitate. When it descends down the leeward side of the slope the dry air gets warmed up by adiabatic process. This dry air may melt the snow in a short time.



2.3.6.3Tertiary Winds or Local Winds:

Cold winds	Warm Winds
1. Pompero 2. Gregale 3. Bora 4. Tramontane 5. Mistril	1. Fohn 2. Chonook 3. Zonda 4. Loo 5. Sirocco

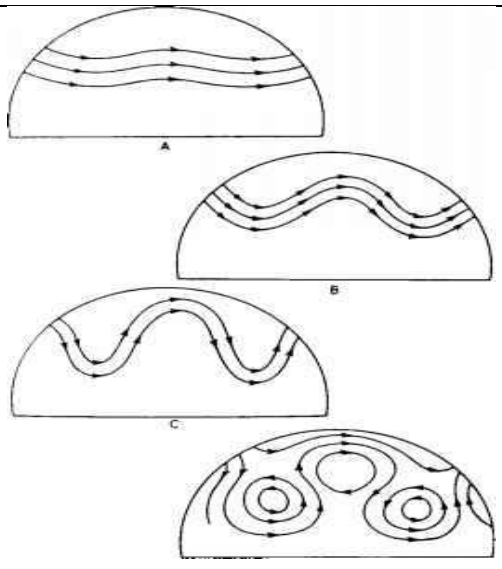
2.3.6.Jet stream

The jet stream is mainly found in the tropopause, at the transition between the troposphere (where temperature decreases with height) and the stratosphere (where temperature increases with height).

Rossby waves:

The meandering or the whirl movement of the Jet Stream is called **'Rossby Wave'.**

The geostrophic wind is the wind flow that occurs in the middle latitudes aloft in the troposphere. The winds have a more difficult time obtaining geostrophic balance in the equatorial latitudes since the Coriolis force is weak.



2.3.7 Walkar circulation and El-nino-southern oscillation (ENSO):

El Niño normally occurs around Christmas and usually lasts for a few weeks to a few months.Sometimes an extremely warm event can develop that lasts for much longer time periods. In the 1990s, strong El Niños developed in 1991 and lasted until 1995, and from fall 1997 to spring 1998.

Normal Conditions

In a normal year, a surface low pressure develops in the region of northern Australiaand Indonesia and a high pressuresystem over the coast of Peru. As a result, the trade winds over the Pacific Ocean move strongly from east to west.

Effects of El Nino:

a) The warmer waters had a devastating effect on marine life existing off the coast of Peru and Ecuador.
b) Fish catches off the coast of South America were lower than in the normal year (Because there is no upwelling).
c) Severe droughts occur in Australia, Indonesia, India and southern Africa.
d) Heavy rains in California, Ecuador, and the Gulf of Mexico.etc .

Sub Unit – 4:

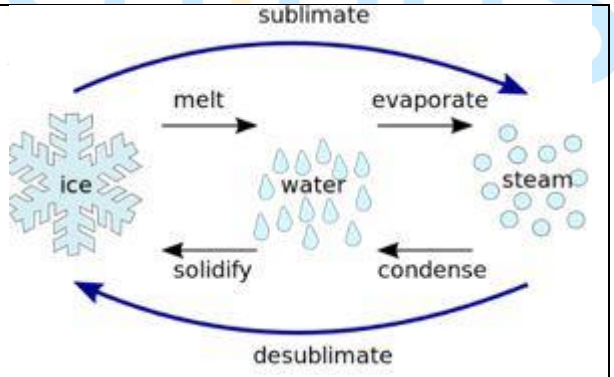
Metrological Hazards

2.4.1 Some concepts:

a) water vapor and evaporation:
As a solid, we call it ice, as a liquid, we call it water, and as a gas, we call it vapor. Vapor is really diffused water molecules that appear as fog or mist. When water is heated, the molecules in the water vibrate and some of them escape into the air, thus becoming water vapor, or the gaseous state of water. That's why we call it **evaporation**. The liquid water becomes a gas known as vapor.

b) Condensation:
Condensation is the process by which water vapor in the air is changed into liquid water. In other words, the water in the air, a gas known as water vapor, from your hot shower cooled when it met the surface of the cold mirror. This caused the water vapor to condense, or turn into its liquid form.

c) Latent heat:

The heat required to convert a solid into a liquid or vapour, or a liquid into a vapour, without change of temperature. **Sublimation** is the transition of a substance directly from the solid to the gas phase, without passing through the intermediate liquid phase. **Super cooling** is the cooling of a liquid below its freezing point without it becoming solid. The heat energy that is associated with change in state from liquid to vapor is called latent heat of vaporization. The SI unit of latent heat is Joule per Kilogram.	

d) Humidity:
Humidity is the concentration of water vapour present in air. Water vapour, the gaseous state of water, is generally invisible to the human eye. Humidity indicates the likelihood for precipitation, dew, or fog to be present. The amount of water vapour needed to achieve saturation increases as the temperature increases.

e) Humidity capacity

Humidity of the air refers to the content of water vapour present in the air at a particular time and place. The moisture retaining capacity or humidity capacity refers to the capacity of an air of certain volume at certain temperature to retain maximum amount of moisture content.

f) Absolute humidity

Absolute humidity is the measure of the actual water vapor in the air. It is expressed as grams of moisture per cubic meter of air (g/m3). The maximum absolute humidity of warm air at 30°C/86°F is approximately 30g of water vapor – 30g/m3. The maximum absolute humidity of cold air at 0°C/32°F is approximately 5g of water vapor – 5g/m3.

g) Specific humility

Specific humidity unit is the most reliable unit of measurement of humidity. This measures the weight of water vapour per unit weight of air and it is expressed as grams of water vapour per kilogram of air $g.kg^{-1}$ is the specific humidity unit.

h) Relative humidity

The relative humidity is defined as the ratio between the amount of moisture in the air at a particular temperature to the maximum moisture air can withstand at the same temperature. The relative humidity is 100% during rainy seasons.

RH= (actual vapour density/ saturation water density)x100%

i) Dew Point:

The dew point is the saturation temperature for water in air. The dew point is associated with relative humidity.

2.4.2 Stability and instability of the atmosphere:

Different forms of precipitation (dew, fog, rainfall, frost, snowfall, hailstorm etc.) depend on stability and instability of the atmosphere. The air without vertical movement is called stable air while unstable air undergoes vertical movement (both upward and downward). An airmass ascends and becomes unstable when it becomes warmer than the surrounding airmass while descending airmass becomes stable.

a) Stability:

When dry adiabatic lapse rate of an ascending dry air is higher than the normal lapse rate and if it is not saturated and does not attain dew point it becomes colder than surrounding air at certain height with the result it becomes heavier and descends. This process causes stability of atmospheric circulation due to which vertical circulation of air is resisted.

b) Instability:

atmospheric instability is caused when the rate of cooling of rising air (dry adiabatic lapse rate) is lower than the normal lapse rate. Those are two types-

1. Mechanical instability
2. Conditional instability

2.4.3 FOG:

The fog is a cloud with its base at or very near to the ground. Because of the fog and mist, the visibility becomes poor to zero.

Classification of fog

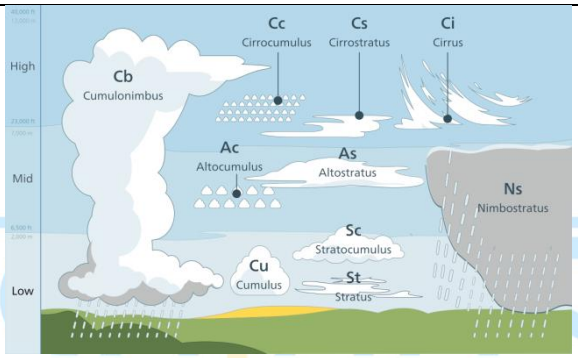
1. Radiation fog
2. Advectional fog

2.4.4 CLOUD:

Cloud is a mass of minute water droplets or tiny crystals of ice formed by the condensation of the water vapour in free air at considerable elevations. Clouds are caused mainly by the adiabatic cooling of air below its dew point.

Classification:

A combination of these four basic types can give rise to the following types of clouds:
High clouds – cirrus, cirrostratus, cirrocumulus;
Middle clouds – altostratus and altocumulus;
Low clouds – stratocumulus and nimbostratus (long duration rainfall cloud) and
Clouds with extensive vertical development – cumulus and cumulonimbus (thunderstorm cloud)



Some important terms:

a) Isoneap:average percetage of cloudiness line
b) Isohel: same duration os sunshine line
c) Isotech: equal wind speed line
d) Isotherm: equal temperature line
e) Isobar: equal pressure line.
f) Baroclinic : isobars and isotherms intersect each other.
g) Barotropic: isotherms and isobars are parallel to each other.

2.4.5 Rainfall and Precipitation:

a. Theories about rainfall-

1. Ice Crystal Precipitation Theory **by** Wegener–Bergeron–Findeisen.
2. Collision Coalescence.

b. Types of rain fall

1. Conventional rainfall:
2. Orographic rainfall
3. Cyclonic rainfall or frontal rainfall

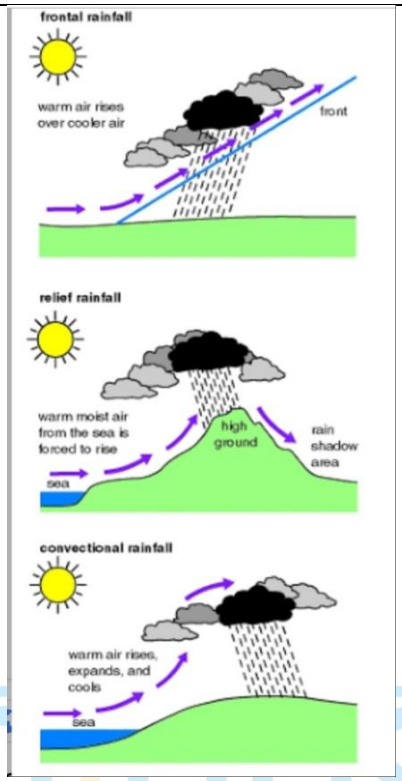
c. Lightning Formation:

The sky is filled with electric charge. In a calm sky, the positive (+) and negative (-) charges are evenly spaced throughout the atmosphere. Therefore, a calm sky has a neutral charge.

d. Rainfall regime:

The character of the seasonal distribution of rainfall at any place; the chief rainfall regimes, as defined by W. G. Kendrew, are -

a)equatorial, b) tropical, c) monsoonal, d) oceanic and e) continental westerlies, and f) Mediterranean.



e. Other forms of precipitation:

1. Rainfall: drop size more than 0.5 mm.
2. Drizzle: light rainfall; drop size less than 0.5 mm.
3. Mist: evaporation occurs before reaching the ground leading to foggy weather.
4. Snowfall: fine flakes of snow fall when the temperature is less than 0°C.
5. Sleet: frozen raindrops and refrozen melted snow; mixture of snow and rain or merely partially melted snow.
6. Hail: precipitation in the form of hard rounded pellets is known as hail; 5 mm and 50 mm.
7. Graupel: Graupel also called soft hail or snow pellets is precipitation that forms when supercooled water droplets are collected and freeze on falling snowflakes, forming 2–5 mm balls of rime. The term graupel is the German language word for sleet. Graupel is distinct from hail and ice pellets.
8. Rime: Rime ice forms when supercooled water liquid droplets freeze onto surfaces. Meteorologists distinguish between three basic types of ice forming on vertical and horizontal surfaces by deposition of supercooled water droplets. There are also intermediate formations.

These droplets, which have a diameter of about 10 μm.

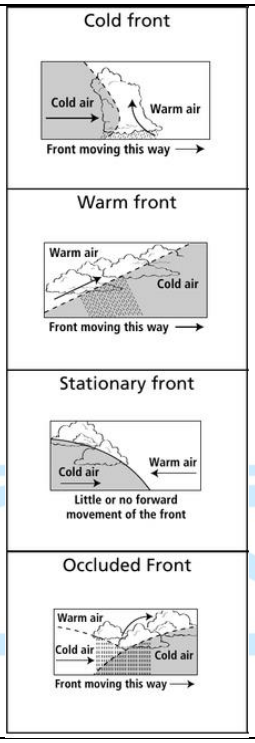
the baseline ratio of rain to snow is 1 inch of rain equals 10 inches of snow. For example, to calculate the snowfall equivalent of 3 inches of rain, multiply 3 by 10 to obtain 30 inches of snow as the baseline conversion.

9. Ice pellets are a form of precipitation consisting of small, translucent balls of ice. Ice pellets are smaller than hailstones.

2.4.6 Front genesis:

Front genesis is a meteorological process of tightening of horizontal temperature gradients to produce fronts. In the end, two types of fronts form: cold fronts and warm fronts.

1. **A cold front** is a narrow line where temperature decreases rapidly.
2. **A warm front** is a narrow line of warmer temperatures and essentially where much of the precipitation occurs. Front genesis occurs as a result of a developing baroclinicwave.
3. **Occluded front** is complex—a mixture of cold front type and warm front type weather. The formation Mid-latitude cyclones, temperate cyclones or extra-tropical cyclones are formed by occluded front.
4. Stationary front forms when a cold front or warm front stops moving. This happens when two masses of air are pushing against each other but neither is powerful enough to move the other. Winds blowing parallel to the front instead of perpendicular can help it stay in place.



Weather along a stationary front:

1. Cumulonimbus clouds are formed. Overrunning of warm air along such a front causes frontal precipitation.

2. Cyclones migrating along a stationary front can dump heavy amounts of precipitation, resulting in significant flooding along the front.

Vilhelm Bjerknes, formulated a model for a cyclone that forms as a disturbance along a zone of strong temperature contrast known as a front, which in turn constitutes a boundary between two contrasting air masses.

2.4.7 AIRMASS:

The air with distinctive characteristics in terms of temperature and humidity is called an air mass. It is a large body of air having little horizontal variation in temperature and moisture.

Characteristics:

1. They have uniform temperature and moisture content in horizontal direction but not uniform in vertical.
2. Those are characterized by their temperature and humidity properties.
3. The properties of air masses are determined by the underlying surface properties where they originate.

There are 6 major source regions of air masses on the earth's surface e.g.:

(1) Polar oceanic areas (North Atlantic Ocean between Canada and Northern Europe, and North Pacific Ocean between Siberia and Canada-during winter season),
(2) Polar and arctic continental areas (snow-converted areas of Eurasia and North America, and Arctic region-during winter season),
(3) Tropical oceanic areas (anticyclonic areas – throughout the year),
(4) Tropical continental areas (North Africa-Sahara, Asia, Mississippi Valley zone of the USA – most developed in summers),
(5) Equatorial regions (zone located between trade winds – active throughout the year), and
(6) Monsoon lands of S.E. Asia.

The International Standard Atmosphere states the density of air is 1.225 kg/m^3 at sea level in 15°C and 1.2754 kg/m^3 at 0°C for dry air. Density is affected not only by temperature and pressure but also by the amount of water vapor in the air.

Classification

Based on thermodynamic and mechanical (dynamic) modifications and some other considerations air masses are divided into 16 types as follows:

(A) Continental Polar Air Masses:

(1) Continental Polar Cold Stable Air mass (cPKs)
(2) Continental Polar Cold Unstable Air Mass (cPKu)
(3) Continental Polar Warm Stable Air Mass (cPWs)
(4) Continental Polar Warm Unstable Air Mass (cpWu)

(B) Maritime Polar Air Masses (mp):

(1) Maritime Polar Cold Stable Air Mass (mPKs)
(2) Maritime Polar Cold Unstable Air Mass (mPKu)
(3) Maritime Polar Warm Stable Air Mass (mPWs)
(4) Maritime Polar Warm Unstable Air Mass (mPWu)

(C) Continental Tropical Air Masses (cT):

(1) Continental Tropical Cold Stable Air Mass (cTKs)
(2) Continental Tropical Cold Unstable Air Mass (cTKu)
(3) Continental Tropical Warm Stable Air Mass (cTWs)
(4) Continental Tropical Warm Unstable Air Mass (cTWu)

(D) Maritime Tropical Air Masses (mT):
(1) Maritime Tropical Cold Stable Air Mass (mTKs)
(2) Maritime Tropical Cold Unstable Air Mass (mTKu)
(3) Maritime Tropical Warm Stable Air Mass (cTWs)
(4) Maritime Tropical Warm Unstable Air Mass (cTWu)
c = continental, T = tropical, m = maritime, K = cold, W = warm, u = unstable, s = stable

2.4.8 Cyclone:

A cyclone is a large scale air mass that rotates around a strong center of low atmospheric pressure. In 2014 cyclone Hudhud affects majorly in Andhra Pradesh Coasts.
The following types of cyclones are –
Tornado, b) Dust devil, c) Waterspout, d) Steam devil, e) Fire whirl etc.

A) Tropical Cyclone:

A low pressure is a winds blowing counter-clockwise around it in the Northern Hemisphere and clockwise around it in the Southern Hemisphere. A **tropical cyclone** is a cyclone which forms in the tropics. A tropical cyclone may regenerate in higher latitudes as an extra tropical depression, but it loses its identity as a tropical storm in the process. The typical lifetime of a tropical cyclone from its birth to death is about six days.

Regional names for Tropical Cyclones:

Regions	What they are called
Indian Ocean	Cyclones
Atlantic	Hurricanes
Western Pacific and South China Sea	Typhoons
Western Australia	Willy-willies

B. Haricanes:

A *hurricane* is a tropical cyclone that occurs in the Atlantic Ocean and northeastern Pacific Ocean. Their source of energy is water vapor which is evaporated from the ocean surface. Water vapor is the "fuel" for the hurricanes because it releases the "latent heat of condensation" when it condenses to form clouds and rain, warming the surrounding air. *Hurricane Matthew* was the first Category 5 Atlantic *hurricane*. *It* caused catastrophic damage and a humanitarian crisis in Haiti, as well as widespread devastation in the southeastern United States.

Category	Wind speed	Efficiency
Category 1	Winds 74 to 95 mph	Minor damage
Category 2	Winds 96 to 110 mph	Extensive damage — Can uproot trees and break windows
Category 5	Winds 111 to 129 mph	Devastating — Can break windows and doors
Category 4	Winds 130 to 156 mph	Catastrophic damage — Can tear off roofs
Category 3	Winds 157 mph or higher	The absolute worst and can level houses and destroy buildings

Beaufort number:
The Beaufort scale is an empirical measure that relates wind speed to observed conditions at sea or on land.

name of wind	wind speed		description of sea surface
	knots	kph	
calm	<1	<1	sea like a mirror
light air	1–3	1–5	ripples with appearance of scales are formed, without foam crests
light breeze	4–6	6–11	small wavelets still short but more pronounced; crests have a glassy appearance but do not break
gentle breeze	7–10	12–19	large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses
moderate breeze	11–16	20–28	small waves becoming longer; fairly frequent white horses
fresh breeze	17–21	29–38	moderate waves taking a more pronounced long form; many white horses are formed; chance of some spray
strong breeze	22–27	39–49	large waves begin to form; the white foam crests are more extensive everywhere; probably some spray
moderate gale (or near gale)	28–33	50–61	sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind; spindrift begins to be seen
fresh gale (or gale)	34–40	62–74	moderately high waves of greater length; edges of crests break into spindrift; foam is blown in well-marked streaks along the direction of the wind
strong gale	41–47	75–88	high waves; dense streaks of foam along the direction of the wind; sea begins to roll; spray affects visibility
whole gale (or storm)	48–55	89–102	very high waves with long overhanging crests; resulting foam in great patches is blown in dense white streaks along the direction of the wind; on the whole the surface of the sea takes on a white appearance; rolling of the sea becomes heavy; visibility affected
storm (or violent storm)	56–63	103–114	exceptionally high waves; small- and medium-sized ships might be for a long time lost to view behind the waves; sea is covered with long white patches of foam; everywhere the edges of the wave crests are blown into foam; visibility affected
hurricane	64 and above	117 and above	the air is filled with foam and spray; sea is completely white with driving spray; visibility very seriously affected

2.4.9 Thunderstorms:

A storm with thunder and lightning and typically also heavy rain or hail.

2.4.10 Tornedo:

Due to the Coriolis effect, the rotation direction of cyclone is clockwise in the southern and anti-clockwise in the northern hemisphere. There's an area in the middle of the these twisting winds, called the eye of cyclone, the pressure there will be extremely low. The more the low-pressure in the eye, more speed the winds around have.

2.4.11 Hail Storm:

Hail forms in strong thunderstorm clouds, particularly those with intense updrafts, high liquid water content, great vertical extent, large water droplets, and where a good portion of the cloud layer is below freezing 0 °C (32 °F). These types of strong updrafts can also indicate the presence of a tornado.

2.4.12 Heat waves:

A heat wave, or heatwave, is a period of excessively hot weather, which may be accompanied by high humidity, especially in oceanic climate countries.

2.4.13 Cold waves:

A cold wave is a weather phenomenon that is distinguished by a cooling of the air. Specifically, as used by the U.S. National Weather Service, a cold wave is a rapid fall in temperature within a 24-hour period requiring substantially increased protection to agriculture, industry, commerce, and social activities.

2.4.14 Drought:

A *drought* is an event of prolonged shortages in the water supply, whether atmospheric (below-average precipitation), surface water or ground water.

2.4.15 Cloudburst:

A **cloudburst** is an extreme amount of precipitation in a short period of time, sometimes accompanied by hail and thunder, which is capable of creating flood conditions. Cloudburst can suddenly dump large amounts of water e.g. 25 mm of precipitation corresponds to 25,000 metric tons/km^2 (1 inch corresponds to 72,300 short tons over one square mile).

2.4.16 El Nino:

See 2.3.7

2.4.17 La Nina:

La Niña means *The Little Girl* in Spanish. La Niña is also sometimes called *El Viejo*, *anti-El Niño*, or simply "*a cold event.*" La Niña episodes represent periods of below-average sea surface temperatures across the east-central Equatorial Pacific. Global climate La Niña impacts tend to be opposite those of El Niño impacts. In the tropics, ocean temperature variations in La Niña also tend to be opposite those of El Niño.

2.4.18 storm surge:

A storm surge, storm flood, tidal surge or storm tide is a **coastal flood** or **tsunami**-like phenomenon of rising water commonly associated with **low pressure** weather systems (such as **tropical cyclones** and strong **extra tropical cyclones**). The two main **meteorological** factors contributing to a storm surge are a long **fetch** of winds spiraling inward toward the storm, and a low-pressure-induced dome of water drawn up under and trailing the storm's center.

The coastal areas and off-shore islands of Bengal and adjoining Bangladesh are the most storm-surge prone, East coast of India between Paradip and Balasore in Orissa, Andhra coast between Bapatla and Kakinada holding estuaries of two major rivers Krishna and Godavari, Tamilnadu coast between Pamban and Nagapattinam, Gujarat along the west coast of India.

Sub Unit – 5:

Climatic classification

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2. 5. 1 Koppen:

A widely-used vegetation-based climate classification system, the *Koppen climate classification system*, was created by Wladimir Koppen, a German botanist, and climatologist. The classification system attempts to derive a formula to categorize vegetation zones or biomes across the globe, in accordance with their climatic boundaries.

The Köppen climate classification divides climates into five main climate groups, with each group being divided based on seasonal precipitation and temperature patterns. The five main groups are *A* (tropical), *B* (dry), *C* (temperate), *D* (continental), and *E* (polar). Each group and subgroup is represented by a letter. All climates are assigned a main group (the first letter)

In 1900, the climatic classification was a novel concept. In 1918, Koppen revised his classification system and republished, and continued revising the system until his death in 1936.

Climate Types According to Koeppen

Group	Type	Letter Code	Characteristics
A-Tropical Humid Climate	Tropical wet Tropical monsoon Tropical wet and dry	Af Am Aw	No dry season Monsoonal, short dry season Winter dry season
B-Dry Climate	Subtropical steppe Subtropical desert Mid-latitude steppe Mid-latitude desert	BSh BWh BSk BWk	Low-latitude semi arid or dry Low-latitude arid or dry Mid-latitude semi arid or dry Mid-latitude arid or dry
C-Warm temperate (Mid-latitude) Climate	Humid subtropical Mediterranean Marine west coast	Cfa Cs Cfb	No dry season , warm summer Dry hot summer No dry season , warm and cool summer
D-Cold Snow-forest Climates	Humid continental Subarctic	Df Dw	No dry season , severe winter Winter dry and very severe
E-Cold climate	Tundra Polar ice cap	ET EF	No true summer Perennial ice
H-highland	Highland	H	Highland with snow cover

2. 5. 2. Thornthwaite:

Charles Warren Thornthwaite was an American geographer and climatologist. He is best known for devising a climate classification system in 1948 that is still in use worldwide, and also for his detailed water budget computations of potential evapotranspiration.

Thornthwaite introduced the following indices in his climatic classification:

i. Precipitation effectiveness index.
ii. Thermal efficiency index.
iii. Concept of potential evapotranspiration and water balance.
iv. Moisture adequacy index.

Precipitation Effectiveness Index:

He conceived that tropical rainforest grows most rapidly and has the densest vegetation because of constantly high temperature and abundant rainfall. As such, their efficiency must be maximum in rainforests.

Humidity	P/E index	Vegetation
A (wet)	> 127	Rainforest
B (humid)	64 – 127	Forest
C (subhumid)	32 – 63	Grassland
D (semiarid)	16 – 31	Steppe
E (arid)	<16	Desert

ii. Thermal Efficiency Index:

Calculation of thermal efficiency index (TIE ratio) is similar to that of P/E ratio as indicated above, except that T (monthly temperature) replaces P (monthly precipitation).

Temperature efficiency	T/E index
A – Tropical rainforest	> 127
B – Temperate rainforest	64 - 127
C – Microthermal rainforest	32 – 63
D – Taiga	16 – 31
E – Tundra	1 – 16
F - Forest	0

iii. Concept of Potential Evapotranspiration and Water Balance:

In 1948, Tornthwaite introduced the concept of potential evapotranspiration (PET) and water balance (WB) to revise his classification of 1931. He developed the concept of thermal efficiency. According to him, thermal efficiency is PET (cm).

Thermal provinces	T/E index
A – Mega – thermal	> 44.88
B_1 to B_4 – Meso- thermal	22.4 to 44.8
C_1 to C_2 – Micro – thermal	11.2 to 22.4
D – Tundra	5.6 to 11.2
E – Frost	< 5.6

iv. Moisture Adequacy Index:

Thornthwaite revised his classification further in 1955, by introducing four more climatic criteria: moisture adequacy index (Im), thermal efficiency, humidity index (Ih,) and aridity index (la) based on PET and precipitation.

The moisture regimes according to this revised classification are

Climatic type	I_m
A – Perhumid	100 and above
B_4 – Humid	80 to 100
B_3 – Humid	60 to 80
B_2 – Humid	40 to 60
B_1 – Humid	20 to 40
C_2 – Moist subhumid	- 33.3 to 0
C_1 – Dry subhumid	- 33.3 to 0
D – Semiarid	- 66.7 to – 33.3
E – Arid	- 100 to – 66.7

Sub Unit – 6:

Climatic change

2.6.1 Air Pollution:

Cause: Most of this air pollution we cause results from the burning of fossil fuels, such as coal, oil, natural gas, and gasoline to produce electricity and power our vehicles. It produces carbon dioxide, carbon monoxide and other green house gases. At the same time it also increase amount of aerosols in atmosphere. Most of them are Polycyclic aromatic hydrocarbons (PAHs).

Effects:
a) Global temperature is rising
b) Respiratory disease of human
c) Heart disease etc.

PAN: Peroxyacytyl nitrate is a toxic chemical that is an important component of smog. It effects in the human body such as reduced respiratory function and eye irritation.

Shoot: Maximum soot is released from Thermal Power Plants. It helps to increase global temperature.

CFCs: chlorofluorocarbon basically generates from air-conditioning, refrigeration, blowing agents in foams, insulations and packing materials, propellants in aerosol cans etc.

UVI: The ultraviolet index or UV Index is an international standard measurement of the strength of sunburn-producing ultraviolet (UV) radiation at a particular place and time. The scale was developed by Canadian scientists in 1992, and then adopted and standardized by the UN's World Health Organization and World Meteorological Organization in 1994. It is primarily used in daily forecasts aimed at the general public, and is increasingly available as an hourly forecast as well.

Smog: Smog is a type of severe air pollution. Smog is primarily associated with the photochemical formation of ozone and sulfur dioxide. An erupting volcano can emit high levels of sulfur dioxide. Beijing is most worst affected by the smog calamities.

Surface ozone: Ozone is produced in the troposphere by photochemical oxidation of CO, CH_4 and non-methane volatile organic carbons (NMVOCs) in the presence of oxides of nitrogen.

CNG: to reduce carbon emission Compressed Natural Gas (Methane, Ethane etc.) is introduced in New Delhi. As a result 20% of pollution is controlled by introducing CNGs. Actually the originated hydrogen cell gives energy to move the vehicle.

Dioxins: The toxicity of other dioxins and chemicals like PCBs that act like dioxin are measured in relation to TCDD. Dioxin is formed as an unintentional by-product of many industrial processes involving chlorine such as waste incineration, chemical and pesticide manufacturing and pulp and paper bleaching.

Air Quality Index By India: The National Air Quality Index (AQI) was launched in New Delhi on September 17, 2014 under the Swachh Bharat Abhiyan. AQI will consider eight pollutants PM_{10} ie particulate matter upto 10 micrometers, $PM_{2.5}$ i.e. particulate matter 2.5 micrometers, NO_2, SO_2, CO, O_3, NH_3, and Pb

2.6.2 Global Warming:

Global warming is the increase in the average temperature of the Earth's near-surface air and the oceans ever since the mid-twentieth century. The temperature is rising day by day. Between 1880 and 2012, the global average surface temperature increased by 0.85°C. Since 1979 the rate of warming has approximately doubled.

Cause : Human activity since the Industrial Revolution has increased the amount of greenhouse gases in the atmosphere, leading to increased radioactive forcing from CO_2, methane, tropospheric ozone, CFCs, and nitrous oxide. It causes green house effect.

Effects: Ongoing effects include rising sea levels due to thermal expansion and melting of glaciers and ice sheets, and warming of the ocean surface, leading to increased temperature stratification. Other possible effects include large-scale changes in ocean circulation. Global climate change is also an effect.

Heat island (UHI) is an urban area or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities, concreit construction bitumen road etc.. It creates local low pressure zone. Wind flow is in urban region is heavier rather than rural areas.

2.6.3 Acid Rain:

Adding of carbon dioxide with rain water droplets creates slightly carbonic acid. It can damage soil property or calcium carbonate related heritages.

2.6.4 Ozone Depletion:

CFCs and halons gases are released into atmosphere. It reacts with stratospheric ozone layer and makes ozone layer thinner. UV ray from sun can easily reach to the earth surface and cause skin cancer of man and disturbs plant growth.

2.6.5 Desertification:

Cause: 'Climatic variations' and 'Human activities' can be regarded as the two main causes of desertification. Removal of the natural vegetations, agricultural activities in the vulnerable ecosystems of arid and semi-arid areas, which are thus strained beyond their capacity.

319 million hectares of Africa are vulnerable to desertification due to sand movement. The assessment is done by FAO and UNEP. They suggest that the desert is moving at an annual rate of 5 km in the semi-arid areas of West Africa.

2.6.6 Rio summit or Earth Summit or Agenda 21

Signed	3 to 14 June 1992.
Location	Rio de Janeiro, Brazil.
Core agenda	Sustainable Development

The issues addressed included:

systematic scrutiny of patterns of production — particularly the production of toxic components, such as lead in gasoline, or poisonous waste including radioactive chemicals

alternative sources of energy to replace the use of fossil fuels which delegates linked to global climate change

new reliance on public transportation systems in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smoke

the growing usage and limited supply of water.

List of Earth Summits:

1. 1972 - The United Nations Conference on the Human Environment (UNCHS) in Stockholm
2. 1982 - The 1982 Earth Summit in Nairobi (Kenya). An Earth Summit was held in Nairobi, Kenya, from 10 to 18 May 1982. The events of the time (Cold War) and the disinterest of US President Ronald Reagan (who appointed his delegated daughter Of the United States) made this summit a failure. It is not even mentioned as an official Earth Summit.
3. 1992 - The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (Brazil)
4. 2002 - The World Summit on Sustainable Development (WSSD) in Johannesburg (South Africa)
5. 2012 - The United Nations Conference on Sustainable Development (UNCSD) or Rio+20, also took place in Rio de Janeiro (Brazil)

2.6.7 Kyoto Protocol:

Signed	11 December 1997
Location	Kyoto, Japan
Effective	16 February 2005
Condition	Ratification by at least 55 states to the Convention
Expiration	In force (first commitment period expired 31 December 2012)
Signatories	84
Parties	192(European Union, Cook Islands, Niue, and all UN member states except Andorra, Canada, South Sudan, and the United States)
Depositary	Secretary-General of the United Nations
Core Agenda	Convention on Climate Change(increasing of greenhouse gases causes Global Warming.)

2.6.8 Paris Agreement:

Drafted	30 November – 12 December 2015 in Le Bourget, France
Signed	22 April 2016
Location	New York City, United States
Sealed	12 December 2015
Effective	4 November 2016
Condition	Ratification and accession by 55 UNFCCC parties, accounting for 55% of global greenhouse gas emissions
Signatories	195
Parties	185
Depositary	Secretary-General of the United Nations