AIR MASSES

An air mass is a large body of air whose physical properties, especially humidity and temperature, are more or less uniform horizontally for hundreds of kilometres. When the air remains over a homogeneous area for sufficiently long time, it acquires the characteristics of the area. The homogenous region can be the vast ocean surface on vast plains. The homogenous surfaces, over which air masses from, are called the source regions.

The air masses are classified according to the source region. There are five major source regions. These are:

- Warm Tropical and Subtropical Oceans
- Subtropical Hot deserts
- Relatively cold high latitude oceans
- Permanently ice-covered continents in the arctic and Antarctica
- Very cold snow-covered continents in high latitudes

Accordingly, the following Types of air-masses are recognised:

- Marine tropical
- Continental tropical
- Maritime Polar
- Continental Polar
- Continental Arctic

Tropical air masses are warm, and polar air masses are cold.

Fronts

A front is a weather system, a boundary that separates two different types of air. One type of air is usually denser than the other, with different temperatures and different levels of humidity. This clashing of air types causes weather: rain, snow, cold days, hot days, and windy days.

There are four major types of fronts

1. Cold fronts often come with thunderstorms or other types of extreme weather. They usually move from west to east. Cold fronts move faster than warm fronts because cold air is denser, meaning there are more molecules of material in cold air than in warm air.

Strong, powerful cold fronts often take over warm air that might be nearly motionless in the atmosphere. Cold, dense air squeezes its way through the warmer, less-dense air, and lifts the warm air. Because air is lifted instead of being pressed down, the movement of a cold front through a warm

front is usually called a low-pressure system. Low-pressure systems often cause severe rainfall or thunderstorms.


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2. Warm fronts usually show up on the tail end of precipitation and fog. As they overtake cold air masses, warm fronts move slowly, usually from north to south. Because warm fronts aren't as dense or powerful as cold fronts, they bring more moderate and long-lasting weather patterns. Warm fronts are often associated with high-pressure systems, where warm air is pressed close to the ground. High-pressure systems usually indicate calm, clear weather.

3. Stationary fronts are those fronts where air masses are not moving against each other. There is no movement of the actual temperature gradient, but there is still convergence and force lifting.

4. Occluded fronts are produced when an air mass is fully lifted above the land surface by fast-moving air mass coming from behind. For example, a fast-moving cold front catches and overtakes a slower-moving warm front. A Cyclone will decrease its intensity once occlusion occurs. The weather becomes clear, calm and stable as warm air is forced upward between the two cold air masses.

Tropical Cyclones

Tropical cyclones are closed air circulation around a low-pressure centre. This wind movement is caused by atmospheric disturbances coupled with the earth's 'rotation. They are associated with destructive and violent disturbances like heavy squalls and torrential rainfall and lightning.

Ideal Conditions:

- High Sea Surface temperature above **27 °C**.
- The **regular supply of warm and moist air** which gets further enhanced in the presence of Warm currents
- High relative humidity of around 50 to 60 percent in the mid-troposphere.
- **Presence of Coriolis Force:** The Coriolis force is zero, at the equator but it increases with latitude. A Coriolis force exceeding 10-5 /second in magnitude occurs above 5° latitude. This magnitude is strong enough to help the development of a cyclonic vortex.
- The cold currents lower the surface temperatures of the eastern parts of the tropical oceans making them unfit for the breeding of such storms.
- The small variation in vertical speed of wind: The depth of warm water (26-27°C) should extend for 60-70 m from surface of the ocean/sea so that there is no mixing of the cooler water below with, the warmer water which is near the surface.
- **Upper air Divergence**: A well- developed divergence in the troposphere is necessary so that a low pressure get maintained at the centre.

Characteristics of Tropical Cyclones:

- A Symmetrical elliptical shapes and steep pressure gradient.
- Region of influence expands over 80 km to 350 km.
- Wind velocity is more in poleward margins than at the centre, and also its speed is moreover the oceans compared to that over landmasses.

- The wind velocity may range upto 250 km per hour.
- These cyclones start with a westward movement near the equator but turn northwards around 20° latitude due to Coriolis forces. Then it further turns north-eastwards around 25° latitude hence follow a parabolic path.
- They are anti-clockwise in the northern hemisphere and clockwise in the southern hemisphere.
- There exist an anticyclone between two cyclones.
- The cyclones can be either tropical or temperate/extra-tropical as per their area of origin, and principal tracks followed.

Structure of Tropical Cyclones:

Horizontal Structure

Eye:

- it lies at the centre of the cyclone.
- The diameter of this core varies from 10 to 50 km.
- The wind speed in this region is minimum.
- Temperature is high due to the descending air currents, and also the sky is clear.

Eyewall:

- it surrounds the eye.
- It is characterised by winds of maximum velocities.
- A continuous ring of cumulonimbus clouds moves vertically. Therefore, it has the heaviest precipitation.

Spiral Bands:

- Two spiral bands are located outside the eyewall.
- A few km wide, they are also known as Rainbands or Feeder Bands.
- They rotate at speeds ranging from 20 km to 55 km.
- These regions are marked by high winds and precipitation.

Vertical Structure

- The lowest layer, known as the inflow layer, extends up to 3 km and is responsible for driving the storm.
- The middle layer extends from 3 km to 7 km. Here the main cyclonic storm takes place.
- The outflow layer lies above the range of 7 km-12 Km. The movement of air in this region is anticyclonic in nature.


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Significance of Cyclones

- The Cyclones levels down the inequalities of pressure and wind movement over the globe.
- They play an important role in the complex process of heat exchange between various latitudinal zones.
- Cyclones have an effect over the phenomenon of precipitation, more so in the mid-latitude regions, by lifting up the moist air from oceans and carrying it into the surrounding landmasses.

Formation of Tropical Cyclones

Origin

- They are of thermal origin and develop over tropical seas during Early Summer (April- May) and Late Summers (August to mid-November).
- Due to the Coriolis force, local convectional currents acquire a whirling motion.
- Under favourable conditions, multiple thunderstorms merge and create an intense low-pressure system.

Early-stage

- In the thunderstorm, the air is uplifted as it is warm and light. At a certain height, the temperature of the air falls, and moisture in the air undergoes condensation, thus making the air warmer. It becomes much lighter and is further uplifted.
- Space is filled with fresh moisture-laden air. The air from surroundings rushes in and undergoes deflection due to Coriolis force creating a cyclonic vortex (spiralling air column. Similar to a tornado).
- Due to centripetal acceleration, the air in the vortex is forced to form a region of calmness called an eye at the centre of the cyclone. Thus The inner surface of the vortex forms the eyewall.
- Upwards moving winds thus loses its moisture and becomes cold and dense. So it descends to the surface at the edges of the cyclone.
- The storm will reach a mature stage If the ocean can supply more moisture.

Mature stage

- At this stage, the spiralling winds create multiple convective cells with successive calm and violent regions.
- The regions formation are known as rain bands below where intense rainfall occurs.
- Cloud formation is dense at the centre. The cloud size decreases from centre to periphery.
- Rain bands are mostly formed of cumulonimbus clouds. The ones at the periphery are made up of nimbostratus and cumulus clouds.
- The dry air flowing along the dense central overcast descends at the eye and the periphery region.

Regional Names for Tropical Cyclones

- Indian Ocean: Cyclones
- Atlantic Region: Hurricanes
- Western Pacific and the South China Sea: Typhoons
- Western Australia: Willy-willies