AIRMASS

- A large body of air having little horizontal variation in temperature and moisture is called an airmass.
- Airmass acquires its properties by remaining stationary over a homogenous region for long period. The homogenous regions can be the vast ocean surface or vast plains.
- Another prerequisite for the development of an air mass is large scale subsidence over the source region.
- The air masses extend through many latitudes and cover thousands of square kilometres.
- Air masses are not necessarily confined to their source regions and they do move to other regions. This migration causes an abrupt change in the temperature and humidity conditions where the air masses move.

CLASSIFICATION OF AIRMASS

Air masses are normally classified depending on the temperature and humidity characteristics of their source regions. Air masses, based on their humidity content are considered to be either continental (dry) or maritime (moist). Further, based on their temperature, air masses are tropical (warm), polar (cold) and arctic (extremely cold).

<table>
<thead>
<tr>
<th>AIR MASSES</th>
<th>SOURCE REGION</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continental Arctic (cA)</td>
<td>Greenland, Antarctica, Highest latitudes of Asia and North America</td>
<td>Very cold and very dry, extremely stable, very little cloud cover.</td>
</tr>
<tr>
<td>Continental Polar (cP)</td>
<td>High latitudes, continental interiors</td>
<td>Cold and dry, very stable, very little cloud cover</td>
</tr>
<tr>
<td>Maritime Polar (mP)</td>
<td>High-latitude oceans. Eg. Bering Sea and Norwegian sea</td>
<td>Cold, moist and cloudy, somewhat unstable</td>
</tr>
<tr>
<td>Continental Tropics (cT)</td>
<td>Low-latitude deserts</td>
<td>Hot and dry, very unstable</td>
</tr>
<tr>
<td>Maritime Tropics (mT)</td>
<td>Subtropical oceans</td>
<td>Warm and humid</td>
</tr>
</tbody>
</table>

EFFECTS ON CLIMATE

- A hot, dry air mass can cause drought, which can stress and kill trees, and increase the risk of devastating wildfires thereby increasing global warming.
- Ozone depleting substances will get transported to upper atmosphere through Polar front.
- Maritime air masses produce moist weather as they occur over oceans. In contrast, continental air masses produce hot and dry weather.
• Maritime tropical air mass produces the warm, humid conditions. For eg. Florida and the Caribbean.
• Continental tropical air masses produce hot, dry conditions. For eg. Southwest U.S. and Mexico.
• In the winter, cold, dry air masses tend to dominate the central and eastern United States as cold winds blow from the northwestern Canadian prairies.
• Airmasses result in cyclonic conditions especially along the polar front.

FRONTS
• The boundary zone of convergence separating the two air masses of contrasting temperature and humidity characteristics is called fronts.
• The fronts occur in middle latitudes and are characterized by steep gradient in temperature and pressure.
• They bring abrupt changes in temperature and cause the air to rise to form clouds and cause precipitation.
• The passage of a front over a place is normally accompanied by an abrupt change in temperature, shift in the wind speed and direction, change in the humidity and a change in the cloud cover.
• Front separating the tropical and the polar air masses is called Polar front. They influence temperate cyclone formations.

TYPES
• A cold front occurs when a wedge of cold air advances towards the warm air ahead of it (a front in which cold air is replacing warm air at the surface). Cold fronts tend to move faster than all other types of fronts. Cold fronts tend to be associated with the most violent weather among all types of fronts.
• A warm front occurs when a warmer air mass moves towards a colder air (a front in which warm air replaces cooler air at the surface). Warm fronts tend to move slowly. Warm fronts are typically less violent than cold fronts.
• Stationary front - a front that does not move or barely moves.
• Cold fronts move faster than warm fronts, and they can catch up to and overtake their related warm front. When they do, an occluded front is formed (warm air
will be uplifted from the surface). Occluded fronts are indicative of mature storm systems.

**EXTRATROPICAL/TEMPERATE CYCLONE**

- Extra-tropical cyclones are very large weather systems which form along a front in the middle latitudes between 35° and 65° in both hemispheres.
- They are generally, extensive having a vertical thickness ranging from 9 to 11 km and a diameter of about 1,000 km.
- These systems and very often provide extensive precipitation over a very large region.
- The general direction of movement of temperate cyclones is from west to east with under the influence of westerly flow in mid-latitudes (westerlies and polar jet streams).
- Jet stream plays a major role in temperate cyclone formation. It influences the path of temperate cyclones.
- The temperate cyclones occur mostly in winter, late autumn and spring. During summer, all the paths of temperate cyclones shift northwards and there are only few temperate cyclone over sub-tropics and the warm temperate zone, although a high concentration of storms occurs over Bering Strait, USA and Russian Arctic and sub-Arctic zone.

**POLAR FRONT THEORY**

According to polar front theory, the highs and lows of the westerly wind belts result from the interactions and alternations of two contrasting types of air masses, one originating in the polar regions and the other in the subtropics. Cold air from polar highs moves equatorwards and is deflected westward, forming the northeast and southeast polar winds. Warmer air from the subtropical highs moves poleward and, by eastward deflection, forms the westerly winds. The contact between these contrasting air masses is the polar front. Eddies, or waves, develop along this contact and the front becomes highly irregular, consisting of interlocking tongues of the two types of air masses setting in motion an anticlockwise cyclonic circulation. This cyclonic circulation leads to a well-developed extra tropical cyclone, with a warm front and a cold front. There are pockets of warm air or warm sector wedged between the forward and the rear cold air or cold sector. The warm air glides over the cold air and a sequence of clouds appear over the sky ahead of the warm front and cause precipitation. The cold front approaches the warm air from behind and pushes the warm air up. As a result, cumulus clouds develop along the cold front. The cold front moves faster than the warm front ultimately overtaking the warm front. The warm air is completely lifted up and the front is occluded and the cyclone dissipates.
STAGES OF FORMATION

(a) **FIRST STAGE:** This involves the convergence of two air masses of contrasting physical properties and directions. Initially, the air masses (warm and cold) move parallel to each other and a stationary front is formed. This is called initial stage.

(b) **SECOND STAGE:** It is also called as ‘incipient stage’ during which the warm and cold air masses penetrate into the territories of each other and thus a wave-like front is formed.

(c) **THIRD STAGE:** It is the mature stage when the cyclone is fully developed and isobars become almost circular.

(d) **FOURTH STAGE:** Warm sector is narrowed in extent due to the advancement of cold front than warm front, as cold front comes nearer to warm front.

(e) **FIFTH STAGE:** Starts with the occlusion of cyclone when the advancing cold front finally overtakes the warm front and an occluded front is formed.

(f) **SIXTH STAGE:** Warm sector completely disappears, occluded front is eliminated and ultimately cyclone dies out.

DISTRIBUTION OF TEMPERATE CYCLONES

- **USA** and **Canada**
- The belt extending from **Iceland to Barents Sea** and continuing over Russia and Siberia
- Winter storms over **Baltic Sea**
- **Mediterranean basin** extending up to Russia and even up to India in winters (called **western disturbances**) and the Antarctic frontal zone.
- **East China**

WEATHER CHANGES

- At any particular place, the passage of the extratropical cyclones which generally moves eastward with either a northward or a southward component provides a reasonable predictable sequence of changing sky conditions.
- With the approach of a warm front, cloud cover deepens and increases accompanied by light to moderate precipitation. With the passage of the warm front, warmer, sunny and relatively cloud-free conditions prevail. These clear, warm and sunny conditions, which occur when the warm sector air overlies the place, may persist for a day or two.
• With the approach of the **cold front**, fast moving band of clouds, chiefly of the cumuliform type and intense short-lived precipitation in the form of rain and snow are seen. The **rear of the cold front** brings very cold and absolutely cloud-free conditions.

**BOMB CYCLONE**

**Bombogenesis**, a **popular term** used by meteorologists, occurs when a **midlatitude cyclone rapidly intensifies**, dropping at least 24 millibars over 24 hours. A millibar measures atmospheric pressure. This can happen when a **cold air mass collides with a warm air mass**, such as air over warm ocean waters. The formation of this **rapidly strengthening weather system** is a process called bombogenesis, which creates what is known as a **bomb cyclone**. It can bring **frigid and freezing rains**, and **snowfall** in affected regions. It is also sometimes called as **winter storm**.

**DIFFERENCE BETWEEN TEMPERATE AND TROPICAL CYCLONES**

<table>
<thead>
<tr>
<th>TEMPERATE CYCLONE</th>
<th>TROPICAL CYCLONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much larger</td>
<td>Relatively smaller</td>
</tr>
<tr>
<td>Form in temperate zones</td>
<td>Form in tropical regions</td>
</tr>
<tr>
<td>Form over both land and sea</td>
<td>Form only over sea</td>
</tr>
<tr>
<td>Produced in winter</td>
<td>Produced in late summer and autumn</td>
</tr>
<tr>
<td>More regular in their formation</td>
<td>Vary greatly from year to year</td>
</tr>
<tr>
<td>Derive their energy from air mass temperature contrast</td>
<td>Derive their energy from latent heat of condensation</td>
</tr>
<tr>
<td>Wind speed is 10-20 ms⁻¹</td>
<td>Wind speed is over 30 ms⁻¹</td>
</tr>
<tr>
<td>Continuous rainfall for many days</td>
<td>Violent and Torrential rainfall for few hours to few days</td>
</tr>
<tr>
<td>Rate of movement is faster</td>
<td>Slower movement</td>
</tr>
<tr>
<td>Generally moves west to east</td>
<td>Generally moves east to west</td>
</tr>
</tbody>
</table>

**PREVIOUS YEAR QUESTION (MAINS)**

1. Discuss the concept of air mass and explain its role in macro-climatic changes.
   
   (2016)

**MODEL QUESTION (PRELIMS)**

1. The term ‘Bomb cyclone’ is sometimes seen in the news in the context of
   (a) cyclones that burst, wreaking havoc over coastal areas.
   (b) cyclones that recurve in tropical latitudes.
   (c) cyclones that cause supersonic sound while moving.
   (d) cyclones that intensify rapidly in temperate latitudes.
MODEL QUESTIONS (MAINS)

1. Discuss the origin, movements and characteristics of air masses and explain their role in influencing world climates.

2. What is polar front and how does cyclone develop along this front? How are these cyclones different from cyclones that form over tropical latitudes?