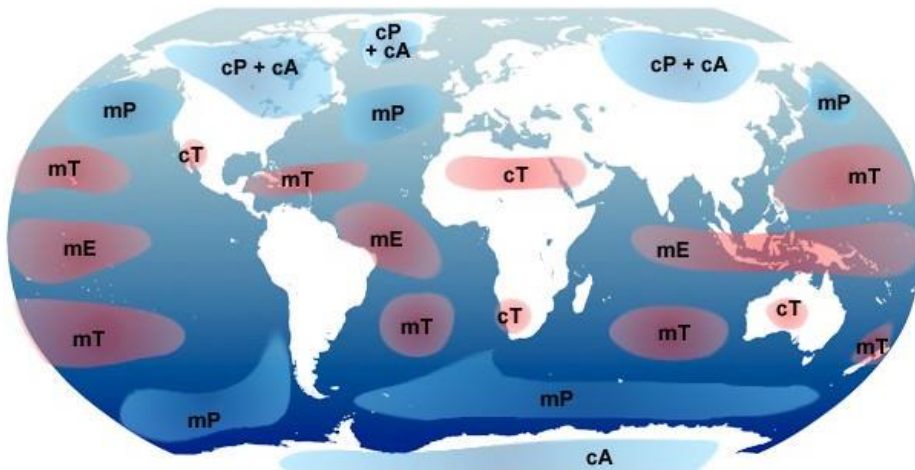


AIR MASSES AND CYCLONES

For HPAS PRELIMS AND MAINS

AIR MASS

- A **large body of air** having **little horizontal variation in temperature and moisture** is known as **Air Mass**.
- When air remains over a homogenous area for a sufficiently longer time, it acquires the characteristics of the area. These are known as **Source Regions**.



SOURCE REGIONS

- Source Region **imparts heat and moisture characteristics** to the overlying air mass.
- These homogenous regions can be the vast ocean surface or vast plains and plateaus which have homogenous temperature and moisture across long distances.
- The main source regions are in the high pressure belts in the **sub tropics (giving rise to tropical hot air masses)** and around **the poles (the source for polar cold air masses)**.
- Areas with **high pressure but little pressure difference or pressure gradient** are ideal source regions.
- There are no major source regions in the mid-latitudes as these regions are dominated by cyclonic and other disturbances.
- There are five major source regions. These are:
 - ✓ **Warm tropical and subtropical oceans** (warm and moist air masses);
 - ✓ The **subtropical hot deserts** (hot & dry air masses);
 - ✓ The relatively **cold high latitude oceans** (cool and moist air masses);

- ✓ The very cold **snow covered continents in high latitudes** (cold and dry air masses);
- ✓ **Permanently ice covered continents in the Arctic and Antarctica** (cold and dry air masses).

TYPES OF AIRMASSES

- Characteristics of an air mass are not very important for the source region but they are

important for the regions these masses travel to.

- For ex., air mass over Siberia is not cold for Siberia. This air mass might be cold air mass for the warmer regions down south. This air mass might even be a warm air mass if it travels to the arctic region.
- Thus, a **cold air mass** is one which is **colder than the underlying surface**.
- A **warm air mass** is one which is **warmer than the underlying surface**.
- Air masses are classified into various classes and denoted by following letters:
 - ✓ **c** : continental (dry) air mass
 - ✓ **m** : maritime (moist) air mass
 - ✓ **T** : tropical (warm)
 - ✓ **P** : polar (cold)
 - ✓ **A** : Arctic or Antarctic (cold)
 - ✓ **E** : Equatorial (warm and moist)

CONTINENTAL POLAR AIR MASS (cP)

- These air masses are characterized by **dry, cold and stable conditions**.

- Source regions of these air masses are the **Arctic basin, northern North America, Eurasia, and Antarctica.**
- These are also known as **Continental Arctic (cA)** air masses.

MARITIME POLAR AIR MASS (mP)

- These are actually those continental polar air masses which have moved over the warmer oceans, got heated up and have collected moisture.
- The **source region** of these air masses are the **oceans between 40° and 60° latitudes.**
- The conditions over the source regions are cool, moist, and unstable. These are the regions which cannot lie stagnant for long.
- The weather during winters is characterized by high humidity, overcast skies and occasional fog and precipitation.
- During summer, the weather is clear, fair and stable.

CONTINENTAL TROPICAL AIR MASS (cT)

- The **source-regions** of the air masses include **tropical and sub-tropical deserts of Sahara in Africa, and of West Asia and Australia.**
- These air masses are **dry, hot and stable** and do not extend beyond the source.
- They are dry throughout the year.

MARITIME TROPICAL AIR MASS (mT)

- The **source regions** of these air masses include the **oceans in tropics and sub-tropics such as Mexican Gulf, the Pacific and the Atlantic oceans.**
- These air masses are **warm, humid and unstable.**
- The weather during winter has mild temperatures, overcast skies with fog.
- During summer, the weather is characterized by high temperatures, high humidity, cumulous clouds and convectional rainfall.

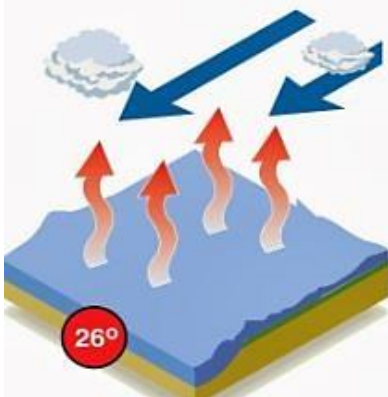
TROPICAL & TEMPERATE CYCLONES

- A cyclone is a large scale air mass rotating around a strong centre of low atmospheric pressure
- A sufficiently low pressure region can create a pressure gradient strong enough to provoke violent winds and strong convection around the low pressure centre.
- Cyclones can be classified on the basis of their origin into **tropical** and **extra tropical cyclones**.

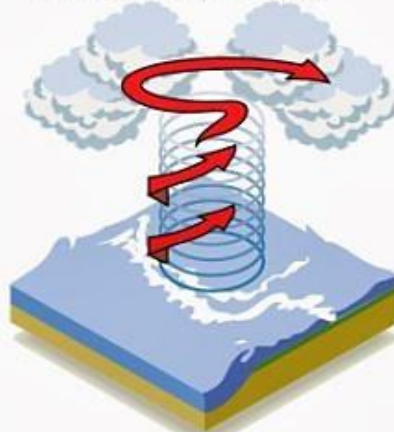
- A roughly **circular area of comparatively light winds and fair weather** found at the centre of a severe tropical cyclone is known as **Eye of the cyclone**.
- The eye is the region of **lowest surface pressure and warmest temperatures** as **air descends at the centre**.
- The eye is surrounded by the **“eye wall”**, the roughly circular ring of deep convection, **where winds blow the fastest**.
- Tropical cyclones have a compact size, ranging from **80 km to 2000 km in diameter**.
- The **latent heat of evaporation** released by the

High humidity and ocean temperatures of over 26°C are major contributing factors

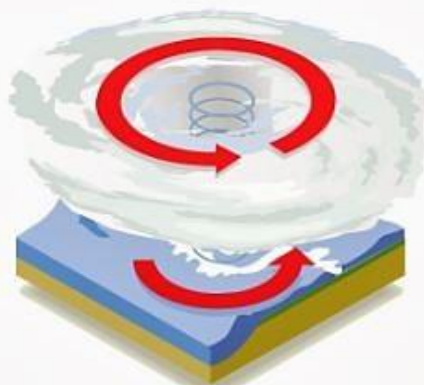
Water evaporates from the ocean surface and comes into contact with a **mass of cold air, forming clouds**



A **column of low pressure** develops at the centre. **Winds form** around the column



As pressure in the central column (the eye) weakens, the **speed of the wind around it increases**



TROPICAL CYCLONES

- Tropical cyclones are **strong low pressure centres that originate over oceans in tropical areas** and move over to the coastal areas bringing about large scale destruction due to violent winds, very heavy rainfall (torrential rainfall) and storm surge.
- Conditions favourable for tropical cyclone formation:
 - ✓ Large sea surface with temperature higher than 27° C.
 - ✓ Presence of the Coriolis force to create a cyclonic vortex (hence they **do not form at Equator because Coriolis force is zero**).
 - ✓ Small variations in the vertical wind speed.
 - ✓ A pre-existing weak low-pressure area or low-level-cyclonic circulation.
 - ✓ Upper divergence above the sea level system.

condensation of moist rising air over oceans is the **driving engine for tropical cyclones**.

- These cyclones cannot sustain over land because the latent heat of evaporation is not available. Therefore, they dissipate after they make landfall.
- Tropical cyclonic systems move in a parabolic path towards west. Then they get deflected by the Coriolis force.
- They are most commonly formed over:
 - ✓ **South-east Caribbean** region where they are called **hurricanes**.
 - ✓ **Philippines islands, eastern China and Japan** where they are called **typhoons**.
 - ✓ **Bay of Bengal and Arabian Sea** where they are called **cyclones**.
 - ✓ Around **south-east African coast and Madagascar-Mauritius islands**.
 - ✓ **North-west Australia** where they are known as **Willy Willy**.

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- Wind circulation is **anti-clockwise in northern hemisphere** and **clockwise in southern hemisphere**.
- These low pressure systems are responsible for cyclonic rainfall, thunderstorms and storm surges along the coasts where they make contact with land.
- These cyclones can be predicted in advance.

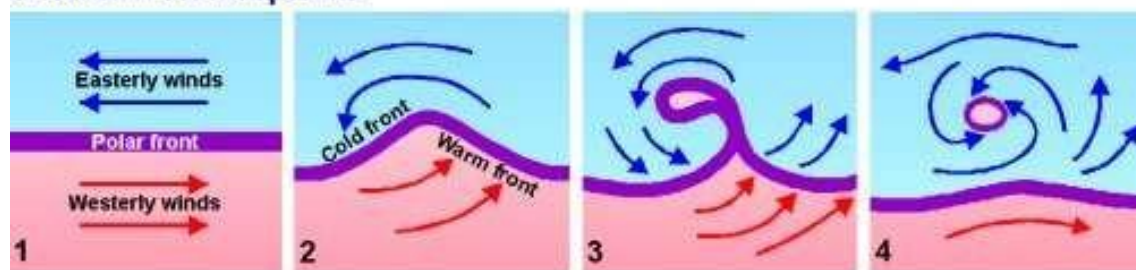
TEMPERATE CYCLONES

- The low pressure systems developing in the **mid and high latitude (35° latitude and 65° latitude in both hemispheres)**, beyond the tropics are called the **Temperate Cyclones or Extra Tropical Cyclones or Mid-Latitude Cyclones or Frontal Cyclones or Wave Cyclones**.
- They are most commonly formed at the polar fronts where warm and moist air masses meet cold and dry air masses from poles.
- Such conditions occur over **sub-tropical high, sub-polar low pressure belts and along the Tropopause**.
- The cold air pushes the warm air upwards from underneath. Thus a void is created because of lessening of pressure.
- The surrounding air rushed in to occupy this void and coupled with the Earth's rotation, a cyclone is formed which advances with the westerlies (Jet Streams).
- These cyclones are actually the formation and occlusion of stationary, cold and warm fronts that we discussed earlier.
- The temperate cyclones **occur mostly in winter, late autumn and spring**. They are generally associated with rainstorms and cloudy weather.
- The temperate cyclones are asymmetrical and shaped like an inverted 'V'. They stretch over large areas ranging from 500 km to over 2500 km.
- They have a height of 8 to 11 km.
- The approach of a temperate cyclone is marked by fall in temperature and pressure and a halo around the Sun and the moon, and a thin veil of cirrus clouds.
- A light drizzle follows which turns into a heavy downpour. These conditions change with the arrival of the warm front which halts the fall in mercury level and the rising temperature.
- Rainfall stops and clear weather prevails until the cold front of an anticyclonic character arrives which causes a fall in temperature, brings cloudiness and rainfall with thunder. After this, once again clear weather is established.
- Since these cyclones move with the westerlies (Jet Streams), they are oriented east-west.
- If the storm front is east-west, the centre moves swiftly eastwards.
- These cyclones can cover long distances under the influence of westerlies.
- The western disturbances arriving in North West India during winters are remnants of such cyclones.

COMPARISON OF TROPICAL & TEMPERATE CYCLONES

	Tropical Cyclones	Temperate Cyclones
Origin	Thermal origin.	Dynamic Origin – movement of air masses and Coriolis force.
Formation	Only on seas with temperature more than 25°C. Dissipate on landfall.	Form on both land and seas.
Latitude	Between 5° to 30° N & S.	Between 35° to 65° N & S.
Fronts	Absent.	Forms because of front formation.
Size	Smaller in size. Avg. diameter is 100 km to 500 km.	Larger in size. Avg. diameter between 300 km to 2000 km.
Shape	Elliptical & funnel shaped.	Inverted V.
Frequency	Seasonal. Frequent in late summers. (Aug to Oct)	Irregular but more frequent in winters.
Lifetime	4 to 7 days.	2 to 3 weeks.
Rainfall	Heavy rainfall for short duration.	Slow rainfall, can continue for a few days.
Intensity	Great wind speeds (100 – 250 kmph)	Relatively low wind speeds (30 – 150 kmph)
Calm Region	Calm centre with no rainfall.	No calm region where winds and rains are absent.
Driving Force	Driven from latent heat of condensation released by moist air.	Driven because of contrasting airmasses converging.
Destruction	Greater destruction due to winds, storm surges and torrential rains	Less destruction due to winds but more destruction due to flooding.
Influence on India	Both coasts effected. But east coast is the hot spot.	Bring rains to North – West India. The associated instability is called ‘Western Disturbances’.

Northern Hemisphere



Southern Hemisphere

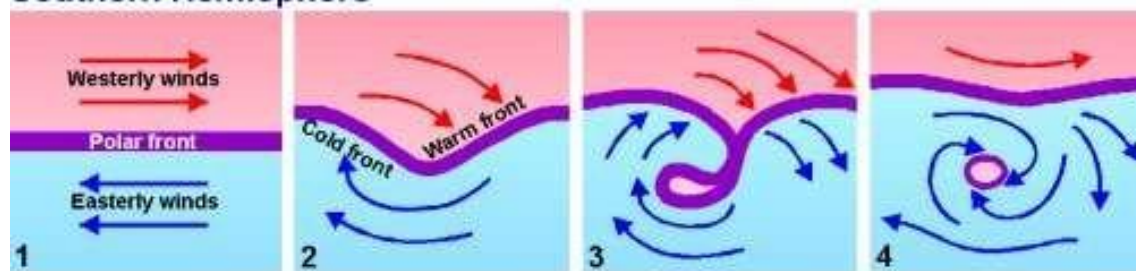
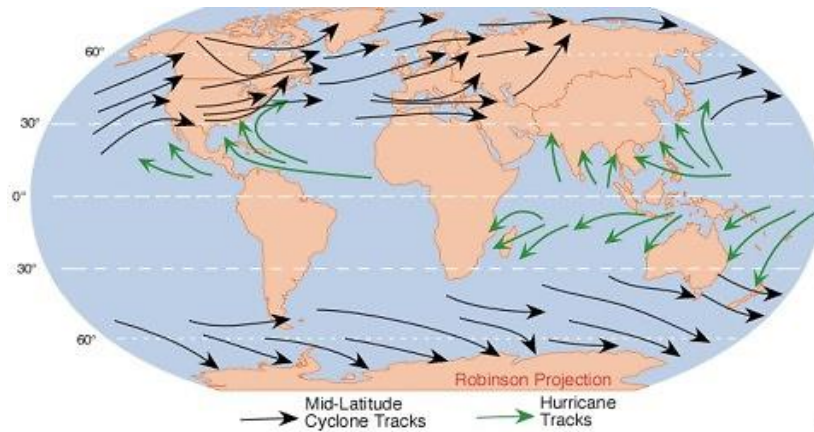


Figure 2 – Temperate Cyclone and Fronts

Path

Tropical Cyclones move east to west under trade winds. They turn north at 20° latitude and west at 30° latitude. Temperate Cyclones move west to east under westerlies.



PRACTICE QUESTIONS:

Question 1: Which of the following are the features of the low pressure region along the equator?

1. High temperature
2. High humidity
3. High Coriolis force
4. Air Convergence

Select the correct answer using the codes given below:

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 1, 2 and 4 only
- (d) 1, 2, 3 and 4

Answer: C

Question 2: Which of the statements below are incorrect regarding cyclones?

- (a) Tropical cyclones are generally smaller in dimension than temperate cyclones.

(b) Tropical cyclones originate only on warm water bodies while temperate cyclones are formed only on colder water bodies.

(c) Tropical cyclones move faster than temperate cyclones.

(d) Tropical cyclones move under trade winds and temperate cyclones move under westerly winds.

Answer: B

Question 3: Willy is:

(a) a type of tree grown in temperate regions

(b) a wind that blows in a desert

(c) a tropical cyclone of the north-west Australia

(d) a kind of common fish found near Laccadives Islands

Answer: C

Question 4: In the South Atlantic and South-Eastern Pacific regions in tropical latitudes, cyclone does not originate. What is the reason?

(a) Sea surface temperatures are low

(b) Inter-Tropical Convergence Zone seldom occurs

(c) Coriolis force is too weak

(d) Absence of land in those regions

Answer: A

Question 5: Consider the following statement about tropical cyclone.

1. It is characterised by a low-pressure centre.

2. In this, counterclockwise wind flow in the Northern Hemisphere and clockwise wind flow in the Southern Hemisphere.

3. It is warm core storm system.

Which of the above statement are correct?

(a) 1 and 2

(b) 1 and 3

(c) 2 and 3

(d) All of these

Answer: D

MAINS QUESTION

Question 1: Discuss the concept of air mass and explain its role in macro-climatic changes. (8 Marks, 120 Words).

Question 2: Write a short note on formation of temperate cyclone. (4 Marks, 60 words).