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THEMATIC #2 CURRENT AFFAIRS

for IAS PRELIMS 2024

GEOGRAPHY

THEME # 1

GEO ATMOSPHERIC PHENOMENON

- WINDS
- JET STREAMS
- CYCLONE
- THUNDERSTORMS
- CLOUDS & PRECIPITATION
- GEO-CLIMATIC PHENOMENON
- IMPACT OF CLIMATE CHANGE

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Content

THEMATIC CURRENT AFFAIRS

UPSC CSE Prelims exam requires a candidate to link and interlink Current Affairs with the syllabus and the static concepts.

It's important to note that simply compiling current affairs won't suffice; it's crucial to learn how to utilize and link them effectively.

To aid in this process, we have categorized the entire UPSC prelims syllabus into actionable and easy-to-understand themes, and current affairs have been blended into these themes.

Thematic Current Affairs will help you in:

- Division of entire syllabus- theme wise
- Revision of concepts and current affairs together
- developing the skill to interlink theory and contemporary developments
- Concise and precise information for quick coverage

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Prelims Sampoorna 2024

UPSC CSE Current Affairs

1

Winds

Brushing Basics (Wind)

- **Definition:** Wind is the **movement of air** caused by the **uneven heating** of the Earth by the sun.
- Differences in **atmospheric pressure** generate winds.
  - **Low Pressure System:** At the Equator, the sun warms the water and land more than it does the rest of the globe. Warm equatorial air rises higher into the atmosphere and migrates toward the poles. This is a low-pressure system.
  - **High Pressure System:** At the same time, cooler, denser air moves over Earth's surface toward the Equator to replace the heated air. This is a high-pressure system. ***Winds generally blow from high-pressure areas to low-pressure areas.***
- **Front:** The boundary between these two areas is called a front. The complex relationships between fronts cause **different types of wind and weather patterns.**
- **Prevailing winds** are winds that blow from a single direction over a specific area of the Earth.
- **Convergence zones:** Areas where prevailing winds meet are called convergence zones. Generally, prevailing winds blow east-west rather than north-south. This happens because Earth's rotation generates what is known as the **Coriolis effect.**
- **Coriolis effect**: The Coriolis effect makes wind systems twist counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

Wind Zones

The Earth contains five major wind zones: polar easterlies, westerlies, horse latitudes, trade winds, and the doldrums.

Polar Easterlies

- Polar easterlies are dry, cold prevailing winds that blow from the east.
- They emanate from the polar highs, areas of high pressure around the North and South Poles.
- Polar easterlies flow to low-pressure areas in sub-polar regions.

Westerlies

- Westerlies are prevailing winds that blow from the west at midlatitudes.
- They are fed by polar easterlies and winds from the high-pressure horse latitudes, which sandwich them on either side.

- The strongest westerlies blow through the "Roaring Forties," a wind zone between 40 and 50 degrees latitude in the Southern Hemisphere.

Horse Latitudes

- The horse latitudes are a narrow zone of warm, dry climates between westerlies and the trade winds. Horse latitudes are about 30 and 35 degrees north and south.
- Many deserts, from the rainless Atacama of South America to the arid Kalahari of Africa, are part of the horse latitudes.
- The prevailing winds at the horse latitudes vary, but are usually light. Even strong winds are often short in duration.

Trade Winds

- Trade winds are the powerful prevailing winds that blow from the east across the tropics.
- Most tropical storms, including hurricanes, cyclones, and typhoons, develop as trade winds. Differences in air pressure over the ocean cause these storms to develop. As the dense, moist winds of the storm encounter the drier winds of the coast, the storm can increase in intensity.

Doldrums

- **Intertropical convergence zone (ITCZ):** The place where trade winds of the two hemispheres meet is called the intertropical convergence zone (ITCZ). The area around the ITCZ is called the doldrums.

1. LOCAL AND PERIODIC WINDS

BACKDROP

The direction of periodic winds changes with the change of seasons. Monsoon winds are the most important periodic winds.

Classification of Winds:

- There are majorly three **Types of Winds** that exist in the world. The winds are categorized or classified under the following categories:

Planetary winds/ Permanent Winds	Periodic Winds	Local Winds
◉ Trade Winds ◉ The Westerlies ◉ The Easterlies	◉ Monsoons ◉ Mountain and valley breeze	◉ Loo ◉ Mistral ◉ Foehn ◉ Sirocco ◉ Bora ◉ Chinook

About Monsoon

- Monsoon can be defined as the **change in the direction of winds and currents** in a region which leads to the **formation of clouds** and hence **precipitation.**
- Monsoon is a **seasonal phenomenon.**
- The monsoon winds generally blow from cold to warm regions. The monsoon in Asia can be classified into
  - Southwest Monsoon
  - Northeast Monsoon
- India receives **Southwest monsoon** winds in summer and Northeast monsoon during winter.
- The Southwest monsoon arises because of the formation of an intense low-pressure system over the Tibetan plateau.
- During the Summer times, the **Thar desert and central India along with Tibetan Plateau** gets heated up which causes a **low pressure** to be formed over northern and central India.
- Due to the low pressure, the moist water vapor-rich air moves towards central and northern India.
- This moisture-rich air moves toward the Himalayas.
- The Mighty Mountains act as a barrier and block the paths of these winds. As these winds rise the temperature decreases and cause cloud formation and precipitation.
- **Factors** that influence the onset of the Southwest Monsoon are mostly:
  - intense low-pressure formation over the Tibetan Plateau
  - permanent high-pressure cells in the South of the Indian Ocean
  - subtropical jet stream
  - African Easterly Jet
  - Inter- Tropical Convergence Zone

List of Major Local Winds and their Type or Nature:

Alizé	Maritime wet, fresh northerly wind across west central Africa
Bora	northeasterly from eastern Europe to northeastern Italy
Cape Doctor	dry south-easterly wind that blows on the South African coast in summer
Chinook	warm dry westerly off the Rocky Mountains
Diablo	hot, dry, offshore wind from the northeast in the San Francisco bay
Etesian	northerly across Greece and Turkey
Elephanta	strong southerly or southeasterly wind on the Malabar coast of India
Föhn	warm dry southerly off the northern side of the Alps and the North Italy
Fremantle Doctor	afternoon sea breeze from the Indian Ocean which cools Perth, Western Australia during summer

Harmattan	dry northerly wind across central Africa
Kali Andhi	Violent dust squalls that occur before monsoon in the northwestern parts of the Indo-Gangetic Plain region of the Indian Subcontinent.
Karaburan	a Spring and winter Katabatic wind of central Asia
Khamsin	South-easterly wind from North Africa to the eastern Mediterranean
Loo	Hot wind which blows over plains of India and Pakistan.
Maestro	cold northerly in the Adriatic sea
Mistral	cold northerly from central France and the Alps to Mediterranean
Monsoon	mainly south-westerly winds combined with heavy rain in various areas close to the equator
Nor'easter	strong storm with winds from the northeast on the north eastern coast of the United States (particularly New England states) and the east coast of Canada (Atlantic Canada))
Nor'wester	wind that brings rain to the West Coast, and warm dry winds to the East Coast of New Zealand's South Island, caused by the moist prevailing winds being uplifted over the Southern Alps, often accompanied by a distinctive arched cloud pattern
Pampero	very strong wind which blows in the Pampa(Argentina)
Passat	medium strong, constant blowing wind at sea in tropical areas
Rashabar (black wind)	a strong wind in the Kurdistan Region of Iraq, particularly in Sulaimaniya
Simoom	strong, dry, desert wind that blows in the Sahara, Israel, Jordan, Syria, and the desert of Arabia
Shamal	a summer northwesterly wind blowing over Iraq and the Persian Gulf states
Zonda	eastern slope of the Andes in Argentina

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2

Jet Streams

1. POLAR VORTEX AND COLD WAVES

BACKDROP

Polar vortices have been in the news ever since the **northern hemisphere** saw its coldest period during the winter season in 1990s.

- The same cold spell had come once again in 2020 when the United States of **America, Canada, and Russia** experienced one of the coldest winters on record.

What is a Polar Vortex?

- The stratospheric polar vortex is a **large-scale region of air** that is contained by a **strong west-to-east jet stream** that circles the polar region. This jet stream is usually referred to as the **polar night jet**.
- The polar vortex extends from the tropopause (the dividing line between the stratosphere and troposphere) through the stratosphere and into the **mesosphere (above 50 km**). Low values of ozone and cold temperatures are associated with the air inside the vortex.
- It is described as a whirling cone of low pressure over the poles that are strongest in the winter months due to the increased temperature contrast between the Polar Regions and the mid-latitudes, such as the US.
- Often when the **polar vortex is strong, temperatures** are mild in the mid-latitudes across the Eastern US and Northern Eurasia; **and when the vortex is weak, temperatures** tend to be cold across the Eastern US and northern Europe and Asia.

What is Strong Polar Vortex?

- Strong is the more common state of the **polar vortex**. When the polar vortex is strong, this creates strong low pressure in the Arctic region.
- Because of the pressure difference between the **Arctic and mid-latitudes**, air flows into low pressure and this confine the cold air to **high latitudes closer to the Arctic**.

- Therefore it is often mild across the Eastern US, Europe and East Asia during winters when the polar vortex is strong. During strong polar vortex, the air flow is fast and in a direction **from west to east.**
- Low pressure in the Arctic region is referred to as the positive phase of the **Arctic Oscillation (AO)**, which is also known as the **North Atlantic Oscillation (NAO).**

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3

Cyclone

BUILDING BASICS (CYCLONES)

About Cyclones

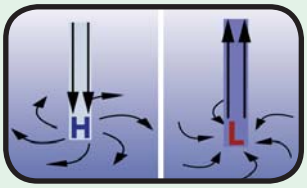
- In meteorological terms, a cyclone is a **wind system** that rotates inwards (**counter-clockwise in the Northern Hemisphere and clockwise in the Southern**) around a **strong low-pressure centre.**
- Simply put, inward-spiralling winds that rotate about a low-pressure zone is known as a cyclone.
- Generally, when winds rise above 118 kmph, it is known as a cyclone.

Stages of formation of a cyclone

- **Creating low-pressure zone: Warm, moist air** over the ocean rises due to less density. This air rises up and away from the ocean surface, leaving less air near the surface, creating a **low-pressure zone.**
- **Formation of cycle:** Due to the surrounding high-pressure areas, air flows into this low-pressure area and eventually warms up, forming a cycle.
- **Formation of cloud and wind system:** Now, this cycle makes the warm air above the ocean rise and cool the water below to generate clouds. With the constant heating and evaporating process, the entire cloud and wind system spins and grows.

Low Pressure Area (L)

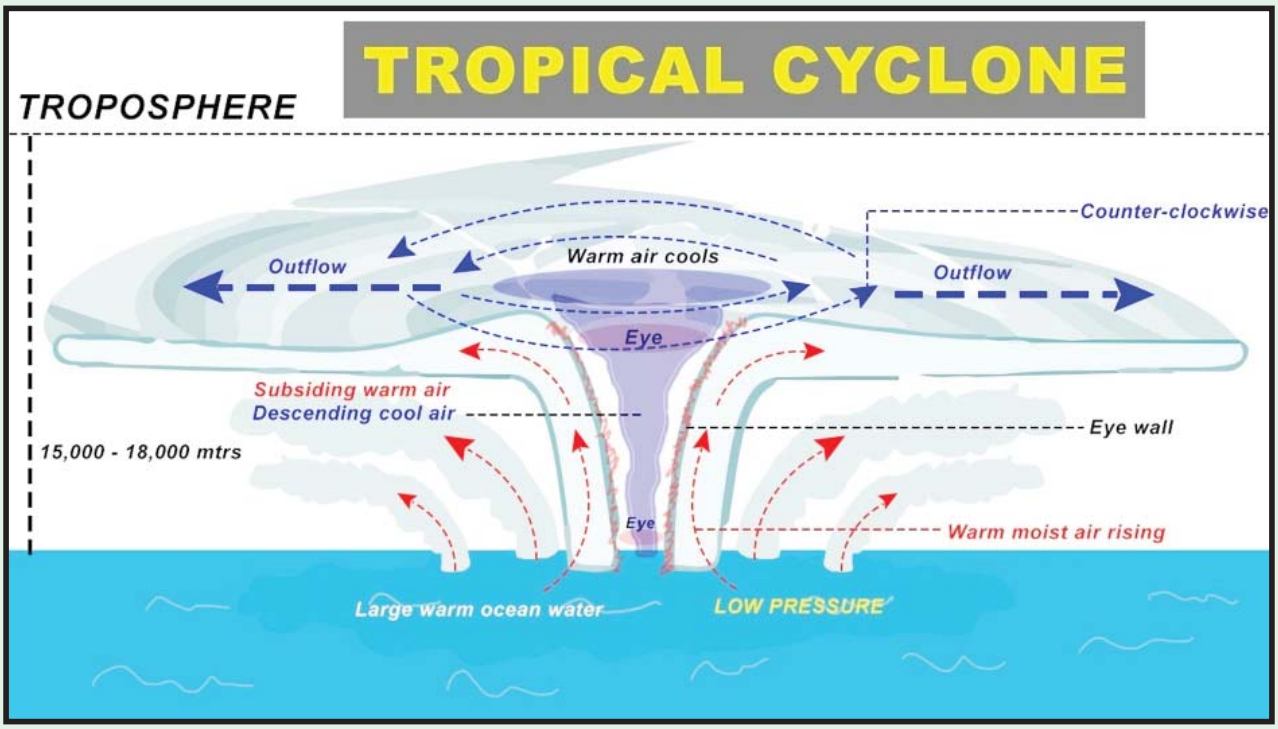
A low is an area where air pressure is lower than it is in the areas surrounding it.



- **Eye formation:** With more speed, cyclone eye formation takes place in the centre. This zone signifies the lowest air pressure and is calm and clear. The high-pressure air from above flows down into this region.

Factors responsible for cyclone formation:

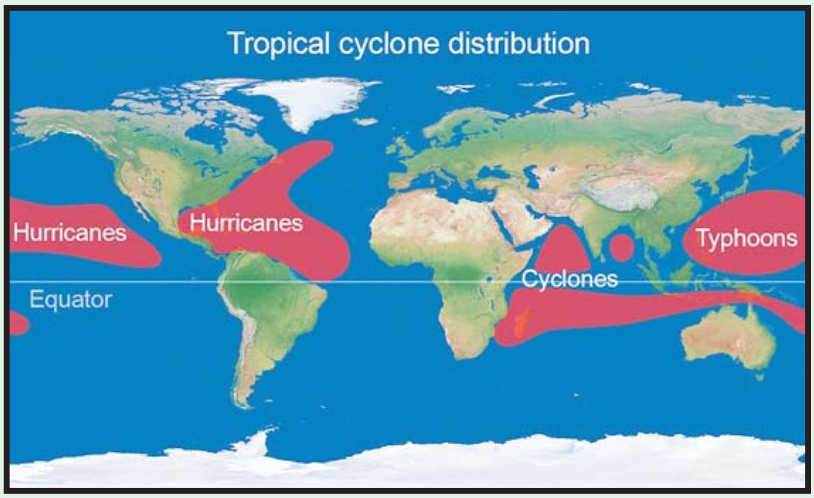
- Warm temperature at sea surfaces
- Coriolis force impact area that forms a low-pressure zone



- Atmospheric instability
- Increased humidity in the lower to middle levels of the troposphere
- Low vertical wind shear
- Pre-existing low-level disturbance or focus

Commonly used names:

Depending on its location and strength, a tropical cyclone is referred to by **different names,** including hurricane, typhoon, tropical storm, cyclonic storm, tropical depression, and simply cyclone.



- **North Atlantic (including Caribbean and Gulf of Mexico):** Hurricanes
- **Eastern and Central North Pacific:** Hurricanes
- **Western Northern Pacific:** Typhoons
- **Arabian Sea/Northern Indian Ocean:** Tropical Cyclones
- **South Indian Ocean:** Tropical Cyclones/Willy-Willy for southwest Australia
- **Coral Sea/South Pacific:** Tropical Cyclone

Category	Wind Speed in Km/h
1	120-150
2	150-180
3	180-210
4	210-250
5	250 and above

1. CYCLONES IN BAY OF BENGAL & ARABIAN SEA

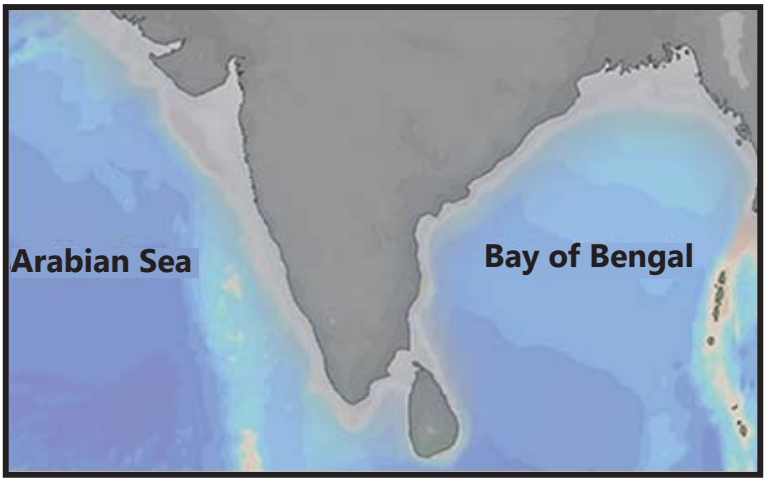
BACKDROP

A report highlighted the increasing **occurrence of Cyclones** in the **Arabian Sea** as compared to the Bay of Bengal over several years due to climate change.

The Geographic Location

- The **Arabian Sea** and the **Bay of Bengal** are both a part of the **Indian Ocean**, which extends on the west along the **African coast and Madagascar** up to the **Arabian Peninsula** and the **Gulf of Oman**, down to the **North Indian Ocean** below India, along the **Andaman Sea**, and goes all the way to the **Australian coast.**

	Arabian Sea (west coast of India)	Bay of Bengal (eastern side of India)
Island	The group of islands in the Arabian Sea is called Lakshadweep and Minicoy.	The group of islands in the Bay of Bengal is called the Andaman and Nicobar Islands.
Area	The total area of Lakshadweep Islands is 32 sq km.	The geographical area of Andaman and Nicobar Islands is 8,249 km.
Features	The Lakshadweep Islands and Minicoy Islands are made up of coral deposits.	The Andaman and Nicobar Islands consist of sea mountains, volcanic mountains (Barren Island), and coral deposits.
Vegetation	Vegetation is not so much in the Lakshadweep islands.	The Andaman and Nicobar Islands receive convective rainfall and have an equatorial type of vegetation (evergreen forest)



What is the general trend of cyclones?

- Generally, India gets 5 cyclones on an average in a year.
  - 4 in the Bay of Bengal
  - 1 in the Arabian Sea

Bay of Bengal vs. Arabian Sea:

Factors affecting cyclones in the Bay of Bengal	Factors affecting cyclones over the Arabian Sea
⦿ The Bay of Bengal is fed by a **constant source of freshwater** in the form of giant rivers like the **Ganga and the Brahmaputra.** ⦿ The river water that empties into the Bay of Bengal warms up at the surface and rises up as moisture. ⦿ This makes it difficult for the warm layers of water to mix properly with the cooler layers of water below, keeping the surface always warm and ready to feed any potential cyclone over it. ⦿ Furthermore, because of the shape of the land around the Bay of Bengal, the winds are slower and weaker over the ocean, ready to spin.	⦿ Conversely, the northern, central, and western parts of the **Arabian Sea** have much cooler temperatures. ⦿ The mountains in **east Africa** direct winds toward the Arabian Peninsula, dissipating heat much more efficiently throughout the Arabian Sea. ⦿ As a result, this region is not favourable to feed potential cyclones, and about half the cyclones that move into this area typically lose energy and dissipate. ⦿ However, this year, the sea surface temperatures continue to remain abnormally high, **in the 30°C's, feeding cyclonic conditions.**

Cyclone Hazard Zone in India

⦿ As per the **Indian Meteorological Department**, 13 coastal regions and Union Territories in India are prone to a cyclone.

⦿ This happens because of the long coastline of 8041 Km, which is exposed to nearly 10% of the world's tropical cyclones. For that cause, both the coasts of India experience cyclonic storms often.

⦿ **Vulnerable states-** West Bengal, Andhra Pradesh, Tamil Nadu, Odisha, Puducherry (UT), Maharashtra, Gujarat

2. BOMB CYCLONE

BACKDROP

In December 2022, large parts of the United States and Canada were under the grips of 'bomb cyclone' that has caused dozens of deaths.

What is Bomb Cyclone?

⦿ **A bomb cyclone is a winter cyclone.** It occurs through the process known as **Bombogenesis.**

➤ **The word "Bombogenesis" is a combination of cyclogenesis which describes the formation of a cyclone or storm and bomb, which is self-explanatory.**

- Bomb cyclones are often associated with atmospheric rivers and are also called **"explosive cyclogenesis"** or a **"weather bomb".**
- A bomb cyclone occurs **when a mid-latitude cyclone rapidly intensifies or quickly drops in atmospheric pressure, marking the strengthening of the storm.**
- It occurs when a storm's central barometric pressure drops **at least 24 millibars in 24 hours.**
  - **A millibar is a way of measuring pressure. The lower the pressure, the more powerful the storm.**
- Some storms have intensified as rapidly as **60 millibars in 24 hours.** A few bomb cyclones even develop **"eyes," similar to the centre of a hurricane.**

Atmospheric rivers

- Bomb cyclones are often associated with atmospheric rivers and typically form in winter when cold and warm air masses collide.
- Atmospheric rivers are storms akin to rivers in the sky that dump massive amounts of rain and can cause flooding, trigger mudslides and result in loss of life and enormous property damage.

In which region does a Bomb Cyclone occur?

- There are four active regions which are hot spots for **Bomb Cyclone**:
  - The Northwest Pacific
  - The Northern region of the Atlantic Ocean
  - The Southwest Pacific
  - The Southern region of the Atlantic Ocean.

Bomb Cyclone	Hurricanes
Cold air is an essential ingredient for bomb cyclones	Cold air rapidly weakens hurricanes
Bomb cyclones form during winter	Hurricanes form from late spring to early fall.
Bomb cyclones form at higher latitudes	Hurricanes form in tropical waters

3. IMPACT OF CYCLONE ON MONSOON'S ONSET

BACKDROP

As the effect of **Global warming**, the occurrence of cyclones in **Indian Ocean** and typhoons in **North-western Pacific Ocean** is changing, which has a significant impact on **onset and withdrawal of monsoon** in India.

Changing scenario:

- Against the conventional pattern of occurrence of cyclones usually **post-monsoon (October-November)** has shifted to **pre-monsoon times (April-May).**
- This unusual occurrence of cyclones either in **Arabian Sea or Bay of Bengal** affects the monsoon showers over Indian subcontinent.
- The course of monsoon usually is affected by the **three tropical oceans – Indian, Atlantic, and Pacific**.

About Monsoon:

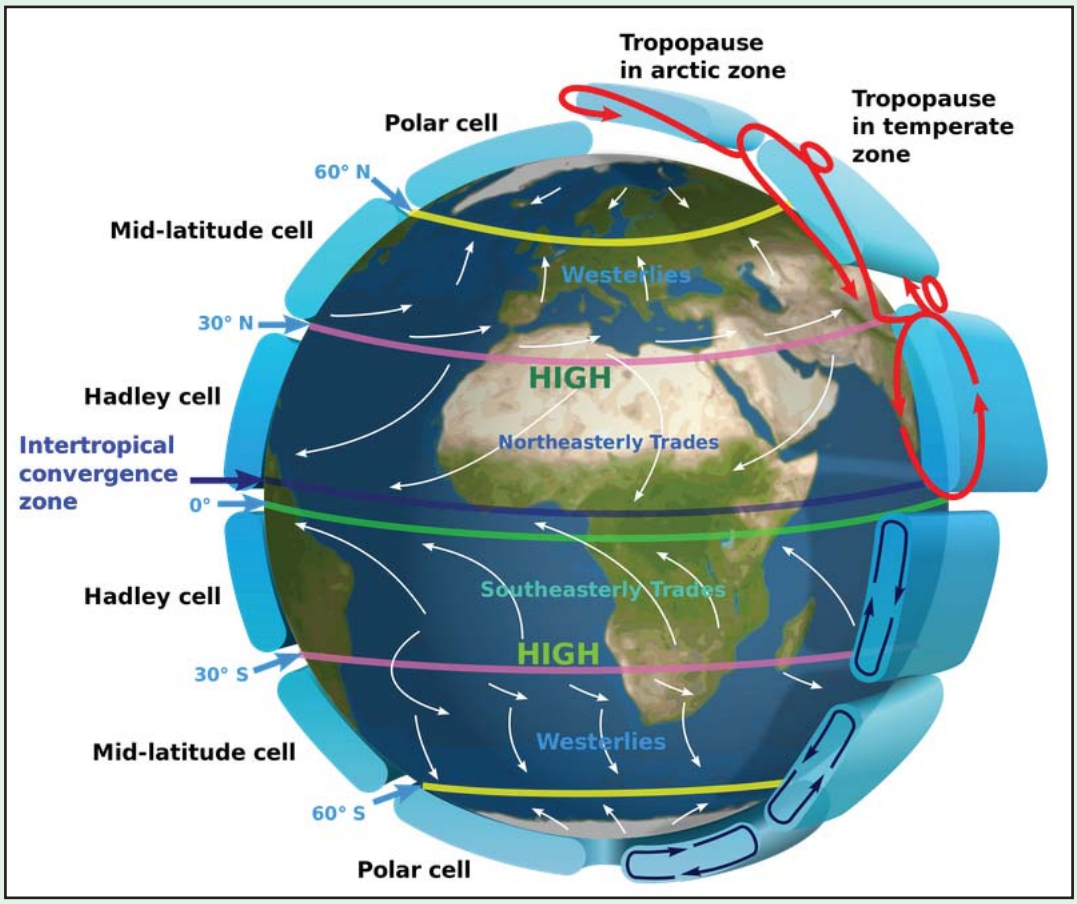
- The "monsoon" climate is related to the **seasonal reversal** of wind direction.
- The monsoons are a seasonal wind pattern that travels from **the sea to the land in the summer** and from **the sea to the land in the winter**.
- The Indian subcontinent, central-western Africa, Southeast Asia, and a few other regions all have monsoons, but the winds are highest in the Indian subcontinent.

Onset of the Monsoon:

- In **April and May**, when the sun shines vertically over the **Tropic of Cancer**, the huge continent to the north of the Indian Ocean gets exceedingly hot.
- This causes an **intense low-pressure system** to build in the north western section of the subcontinent.
- Because the pressure in the Indian Ocean to the south of the landmass is high due to the slow heating of water, the low-pressure cell attracts southeast trades over the Equator.
- These factors help the **ITCZ** to move northward.
- The southwest monsoon can be considered as a continuation of the southeast trades deflected towards the Indian subcontinent after crossing the Equator.
- These winds cross the Equator between **40°E and 60°E longitudes**.
- The southwest monsoon arrives on the Kerala coast on June 1st and sweeps fast through Mumbai and Kolkata from June 10th to June 13th.
- By **mid-July, the southwest monsoon** has engulfed the whole subcontinent.

Intertropical convergence zone (ITCZ)

- Near the equator, from about 5° north and 5° south, the northeast trade winds and southeast trade winds converge in a low pressure zone known as the **intertropical convergence zone (ITCZ).**
- The position of the ITCZ varies seasonally because it follows the Sun; it moves north in the Northern Hemisphere summer and south in the **Northern Hemisphere winter.**
- As a result, the ITCZ is responsible for the wet and dry seasons in the tropics.



How position of cyclone affects Monsoonal winds?

- **For Cyclones in North Indian Ocean**:
- Since the circulation of winds around the cyclones is in the **anticlockwise direction**, the location of the cyclone is critical as far as the cyclone's impact on the **transition of the monsoon trough** is concerned.
- The monsoon trough is a **low-pressure region t**hat is a characteristic feature of the monsoons.
  - **For example**, if a cyclone lies further north in the Bay of Bengal, the back-winds blowing from the southwest to the northeast can pull the **monsoon trough forward**, and assist in the monsoon's onset.
- **South-westerly winds** over the **Arabian Sea** are positive for onset as they bring large quantities of moisture onto the Indian subcontinent.
- On the other hand, **south-westerly winds** over the Bay of Bengal are **bad news for the monsoon**.

Monsoon Trough:

- A trough is a belt of **low pressure** extending to large area. This trough seen during monsoon period, hence known as Monsoon trough.
- Monsoon trough is a part of the **Inter Tropical Convergence Zone (ITCZ)** where the northern hemisphere and southern hemisphere winds meet.
- This is normally shown as a line connecting the **location of monsoon** low pressure areas.
- These troughs run across continents during peak monsoon periods.

4. SUNDARBANS IS CYCLONE CAPITAL OF INDIA: IMD

BACKDROP

West Bengal's South 24 Parganas district, within which the larger share of the Sundarbans is located, is impacted by cyclones the most frequently among Indian districts, found a recent study.

About Sundarbans

- The Sunderbans forest sprawls over 10,000 sq km covering India and neighbouring Bangladesh, of which 40% lies in India.
- It is located in the south-west of Bangladesh between the river **Baleswar** in the East and the **Harinbanga** in the West, adjoining to the **Bay of Bengal.**
  - In India, it is confined to the southern tip of West Bengal and spreads over two districts – **South 24 Parganas** and **North 24 Parganas.**
- The Sundarban Delta has 102 islands, of which 54 are inhabited. The rest constitute the world's largest mangrove forest.
- Sundarbans has got the world's largest coastal mangrove forest (an area of about 10,000 km^2, shared between India (4,000 km^2) and Bangladesh (6,000 km^2).
- The Sundarbans is a **UNESCO world heritage site** and a critical wetland.

- This IMD study clearly indicates that Sunderbans within the coastal area of South 24 Paraganas is one of the most-affected parts of the country.
- The unique analysis of cyclone return and vulnerability was modelled on the United States National

Oceanic and Atmospheric Administration (NOAA) technical memorandum regarding the national hurricane risk analysis.

- The finding is in sync with the developments during the last three years when Sunderbans was impacted by one major cyclone after another — from Bulbul in 2019, Amphan in 2020, Yaas and Jawad in 2021. In 2009, Cyclone Aila had devastated the region.
- The region in south Bengal was ravaged by nine severe cyclones during the period, the highest in the country. Srikakulam and Ganjam districts followed with six and five intense cyclonic storms respectively.
- A composite map of the northern Bay of Bengal coastline shows that, between 1877 and 2016, the highest strike intensities were concentrated in West Bengal and northern Odisha. The median landfall location shifted east-ward from northern Odisha toward the West Bengal / Bangladesh border area (Sundarban).
- During 1877-2016, the total cyclonic strikes in the Sundarban region varied between categories either 27 to 31 or 32 to 37 — the highest categories.

5. DVORAK TECHNIQUE

BACKDROP

The American meteorologist **Vernon Dvorak** passed away at the age of 100. He was best credited for developing the **Dvorak technique** in the early 1970s.

Dvorak Technique:

- **About:**
  - **A statistical method** for estimating the intensity of **tropical cyclones (TCs) (hurricanes, cyclones and typhoons)** from interpretation of satellite imagery.
  - It uses regular Infrared and **Visible imagery**. It is based on a **"measurement" of the cyclone's convective cloud pattern** and a set of rules.
- **Benefits**:
  - It helps forecasters to do pattern recognition from the observed structure of the storm, locate its eye and estimate the intensity of the storm,
  - It is the Dvorak technique which gives the best estimates of the cyclone intensity — a vital component while issuing weather warnings.
- **Advancements:**
  - The Dvorak technique, said to be one of the greatest meteorological innovations, has undergone several advancements since its inception.
  - The technique has been upgraded multiple times since then, and after a recent software update, it has been named the **Advanced Dvorak Technique (ADT)**, coined by the National Hurricane Centre of the **National Oceanic and Atmospheric Administration (NOAA).**
  - The updated technique would improve the tropical storm forecasts by many folds as they would have access to sharper and detailed images than ever before.

6. NOAA PREDICTS ABOVE-AVERAGE ATLANTIC HURRICANE SEASON

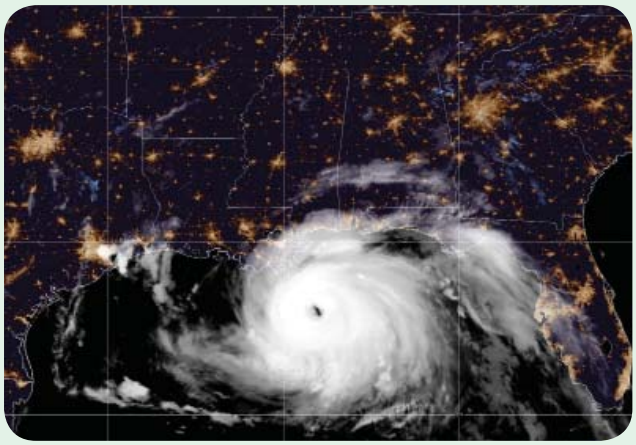
BACKDROP

The **North Atlantic Ocean hurricane season** is not typically very active in November, but the 2022 season witnessed more active season.

When is the Atlantic hurricane season? (The normal season)

- The Atlantic hurricane season officially runs from June 1 to November 30 each year.
- This six-month period was chosen because it accounts for about **97% of all Atlantic tropical storms and hurricanes.**

Important Weather System



- A tropical cyclone is a **rotating low-pressure weather system** that has organized thunderstorms but no fronts (a boundary separating two air masses of different densities).
  - **Tropical depressions:** Tropical cyclones with maximum sustained surface winds of less than 39 miles per hour (mph) are called **tropical depressions**.
  - **Tropical Storms:** Tropical cyclones with maximum sustained winds of 39 mph or higher are called **tropical storms.**
  - **Hurricane:** When a storm's maximum sustained winds reach 74 mph, it is called a **hurricane**.
- Hurricanes are large, swirling storms.
- Hurricanes originate in the Atlantic basin, which includes the **Atlantic Ocean, Caribbean Sea, and Gulf of Mexico, the eastern North Pacific Ocean**, and, less frequently, the **central North Pacific Ocean**.

Atlantic Hurricane

- An **Atlantic hurricane** or tropical storm is a **tropical cyclone** that majorly covers the **Atlantic Ocean, Caribbean Sea and the Gulf of Mexico**.
- **Formation:** Hurricanes need three main ingredients to form:
- warm sea surface temperatures
- minimal to no wind shear
- an area of organized, long-lasting thunderstorms

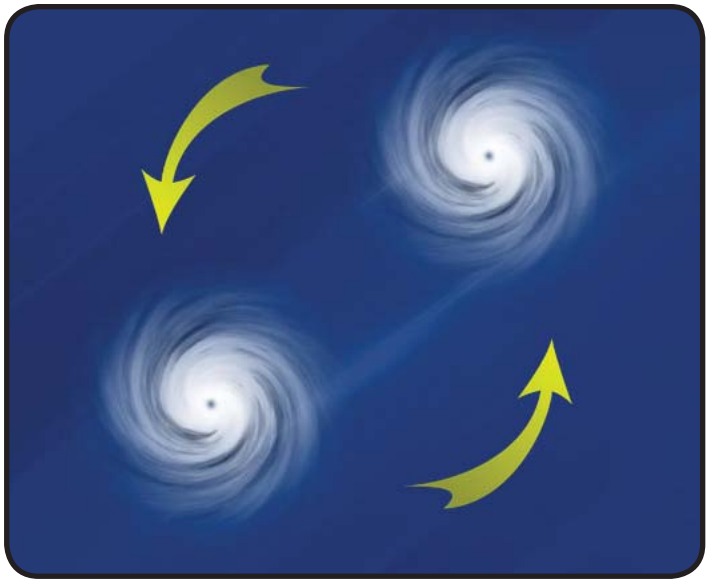
7. FUJIWHARA EFFECT

BACKDROP

With typhoon Hinnamnor and another tropical storm called Gardo, meteorologists observed a phenomenon called the **Fujiwhara Effect.**

- Typhoon Hinnamnor, known in the Philippines as Super Typhoon Henry, was a very large and powerful tropical cyclone in Pacific Ocean that impacted Japan and South Korea.

What is the Fujiwhara Effect?



- The Fujiwhara effect happens when two **tropical systems** come near, then orbit each other, or possibly merge into one system.
- These two storms formed around the same time in the same ocean region with their centres or eyes at a distance of less than 1,400 km, with intensity that could vary between a depression (wind speed under 63 km per hour) and a super typhoon (wind speed over 209 km per hour).
- The term "Fujiwhara effect" refers to the interaction between the two tropical weather systems.
- It is named for **Sakuhei Fujiwhara**, a Japanese meteorologist who first described the effect in 1921.
- **Impact:**
  - The interaction could lead to changes in the track and intensity of either or both storm systems.
  - In rare cases, the two systems could merge, especially when they are of similar size and intensity, to form a bigger storm.

8. AZORES HIGH

BACKDROP

According to a new study, an extremely large **'Azores High'** (a subtropical weather phenomenon) has resulted in abnormally dry conditions across the **western Mediterranean**, including the Iberian Peninsula, primarily occupied by Spain and Portugal.

What is Azores High?

- The Azores High is also known as the **Bermuda High**.

- It is a **subtropical high pressure system** that extends over the eastern subtropical North Atlantic and Western Europe during winter.
- It is associated **with anticyclonic winds** in the subtropical North Atlantic.
- It is formed by **dry air** aloft descending the subtropics and coincides with the downward branch of the **Hadley Circulation.**
- The researchers showed that the **Azores High expansion** is **driven by external climate forces** and that the only external forcing that produces this signal in the industrial era is atmospheric greenhouse gas concentrations.

Azores

- Azores are mostly known as weather makers or weather causers.
- They can be seen in the middle of Atlantic.
- The nine major Azores islands – São Miguel, Santa Maria, Terceira, Graciosa, São Jorge, Pico, Faial, Flores and Corvo.

9. MAJOR CYCLONES

Cyclonic storm Asani

BACKDROP

Severe Cyclonic Storm Asani was a strong tropical cyclone that made landfall in India (Andhra Pradesh coast).

About Cyclone Asani:

- Asani was formed in the North Indian Ocean region.
- **Naming:** The name Cyclone Asani has been given by Sri Lanka. It means 'wrath' in Sinhalese.
- Asani triggered a spell of rain in the coastal region of West Bengal, Karnataka, and Odisha. It also impacted regions of Bangladesh and Myanmar.
- Cyclone Asani has weakened into a deep depression with a wind speed of **55-65 kmph** gusting to **75 kmph.**
- **Gulab, Titli, Hudhud, Helen, and Lehar** — these five cyclones have made landfall over Andhra Pradesh in the last 10 years.

Cyclone Mandous

BACKDROP

Cyclone Mandous impacted the Tamil Nadu and Puducherry coasts in December 2022.

What is Cyclone Mandous?

- The name, 'Mandous', was suggested by the United Arab Emirates (UAE) in 2020 as a member of the World Meteorological Organisation (WMO).
- It was a slow-moving cyclone that absorbs a lot of moisture and gains strength in the form of wind speeds. It intensified into a severe cyclonic storm.

Nomenclature of Cyclones:

- Cyclones that form in every ocean basin across the world are named by the **regional specialised meteorological centres (RSMCs) and Tropical Cyclone Warning Centres (TCWCs).**
- There are six RSMCs in the world, including the **India Meteorological Department (IMD), and five TCWCs.**
- In 2000, a group of nations called WMO/ESCAP (World Meteorological Organisation/United Nations Economic and Social Commission for Asia and the Pacific), which comprised Bangladesh, India, the Maldives, Myanmar, Oman, Pakistan, Sri Lanka and Thailand, decided to start naming cyclones in the region. After each country sent in suggestions, the WMO/ESCAP Panel on Tropical Cyclones (PTC) finalised the list.
- The WMO/ESCAP expanded to include five more countries in 2018 — **Iran, Qatar, Saudi Arabia, United Arab Emirates and Yemen.**

Other Major Cyclones

- **Biparjoy** (Saffir-Simpson scale: category 3)
- **Mocha** (Saffir-Simpson scale: category 5)

- **Sitrang** (2022)
  - **Region**: Bay of Bengal
  - **Saffir-Simpson scale:** tropical storm
- **Jawad:** December 2021
  - **Region**: Bay of Bengal
  - **Saffir-Simpson scale:** tropical storm
- **Gulab (October 2021)**
  - **Region:** Arabian Sea
  - **Saffir-Simpson scale:** category 1
- **Yaas:** May 2021
  - **Region:** Bay of Bengal
  - **Saffir-Simpson scale:** tropical storm
- **Tauktae:** May 2021
  - **Region:** Arabian Sea
  - **Saffir-Simpson scale:** category 4

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4

Thunderstorms

1. DERECHO TURNS THE SKY GREEN IN THE US

BACKDROP

States of Nebraska, Minnesota and Illinois in the US were hit by a storm system called a 'Derecho'.

About Derecho:

- A derecho is a **large, possibly harmful weather phenomenon** that is characterized **by broad, persistent straight-line winds** linked to a rapidly moving cluster of severe thunderstorms.
- The word comes from the Spanish word '**la derecha'** meaning **'straight'.** Straight storms are those where thunderstorms do not change unlike a hurricane.
- This **long-lasting, direct storm** is associated with a **fast-moving rain belt or thunderstorm**.
- These storms travel hundreds of miles and occupy a large area.
- As it is a **warmer climate**, Derecho usually - not always - occurs during the summer from May, and hits hard in **June and July.**
- However, they are rare compared to other storm systems such as **hurricanes or hurricanes**.

Types of Derecho:

- **Progressive:** A progressive derecho is associated with a short line of thunderstorms that may travel for hundreds of miles along a relatively narrow path. It is a summer phenomenon.
- **Serial:** A serial derecho, on the other hand, has an extensive squall line wide and long sweeping across a large area. It usually occurs during spring or fall.
- **Hybrid:** Hybrid ones have the features of both progressive and serial derechos.

Classification:

- For a storm to be classified as a derecho it must have **wind gusts of at least 93 km per hour.**
- The Wind damage swath extending more than 400 km.
- The time gap between successive wind damage events should not be more than three hours.

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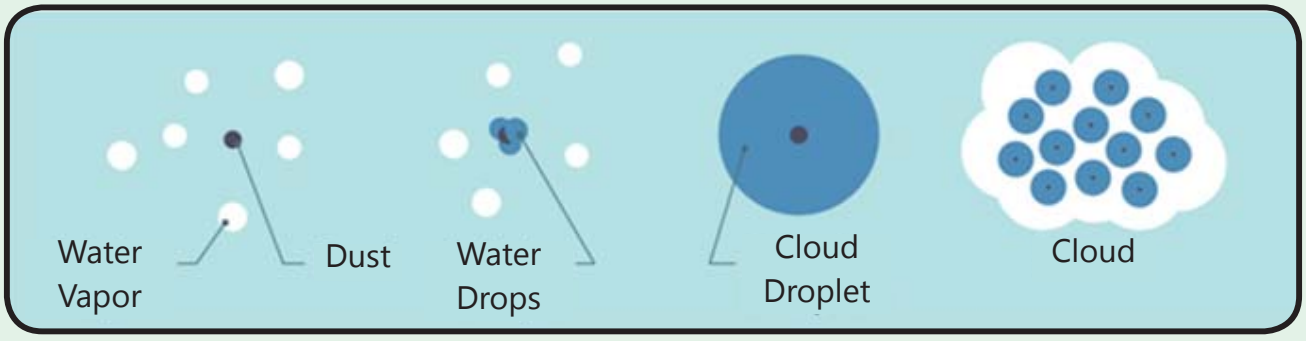
5

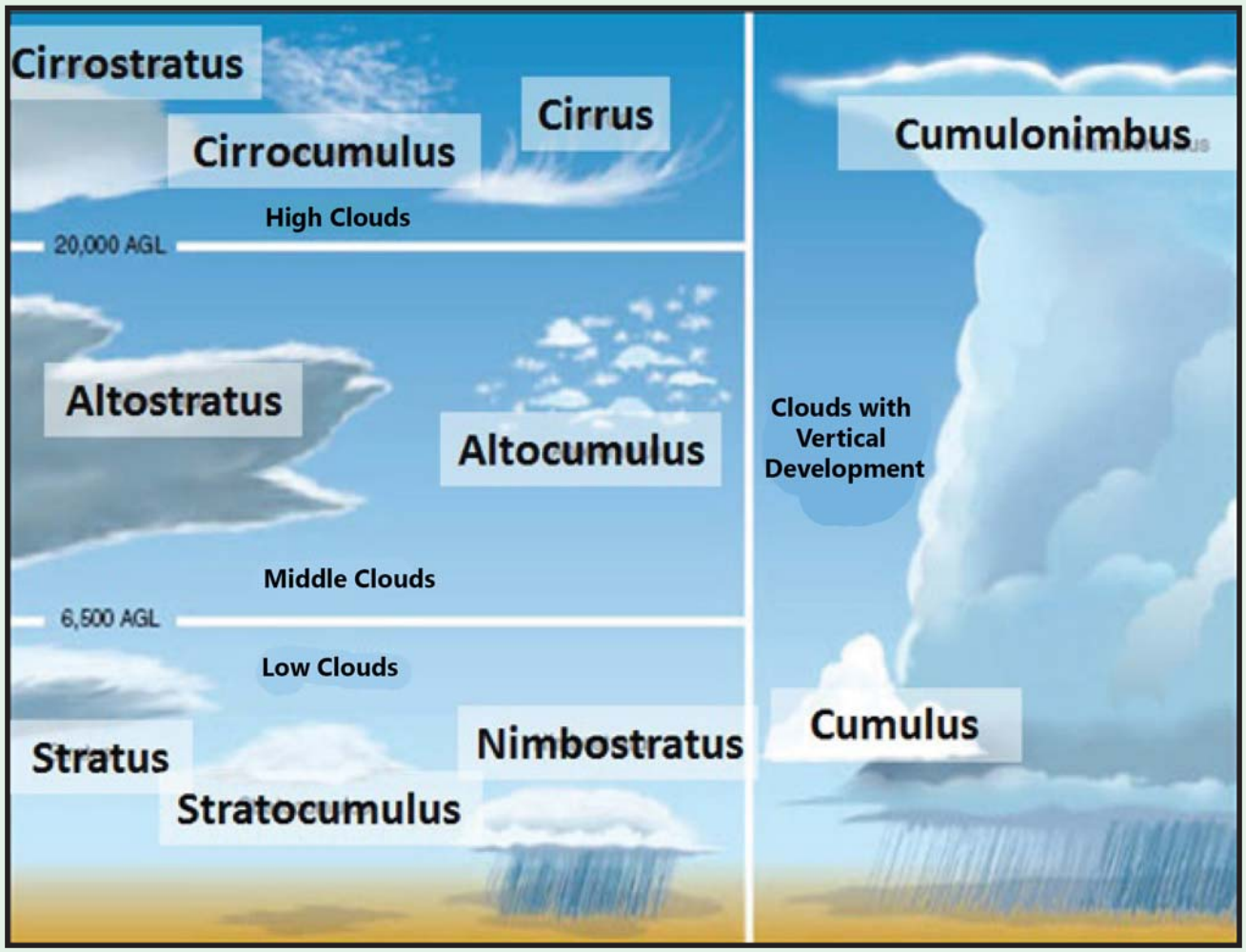
Clouds and Precipitation

Building Basics (Cloud)

- A cloud is defined as 'a visible **aggregate of minute droplets** of water or particles of ice or a mixture of both floating in the free air'.
- Each droplet has a diameter of about a hundredth of a millimeter and each cubic meter of air will contain 100 million droplets.
- Because the droplets are so small, they can remain in liquid form in temperatures of -30 °C. If so, they are called **supercooled droplets**.
- Clouds at higher and extremely cold levels in the atmosphere are composed of **ice crystals** - these can be about a tenth of a millimeter long.
- Clouds form when the invisible water vapor in the air condenses into **visible water droplets or ice crystals.**
- **Saturation:** For this to happen, the parcel of air must be saturated, i.e. unable to hold all the water it contains in vapor form, so it starts to condense into a liquid or solid form.
- There are two ways by which saturation is reached.
  - By increasing the water content in the air, e.g. through evaporation, to a point where the air can hold no more.
  - By cooling the air so that it reaches its dew point - this is the temperature at which condensation occurs, and is unable to 'hold' any more water.



Different types of clouds



1. RAINBOW CLOUDS

BACKDROP

Recently, an unusually-shaped **rainbow cloud** appeared over China.

- The cloud in question resembles a **pileus cloud**, and the phenomenon of bright colours appearing on a cloud is called **cloud iridescence.**

What is a pileus cloud?

- A pileus cloud is usually **formed over a cumulus or cumulonimbus cloud**.
- It is formed when the **base cloud pushes a moist current of air upwards** and the water vapour from the current condenses to somewhat resemble wave-like crests, or umbrellas.
- A pileus cloud is **transient in nature** and lasts barely for a few minutes, making it difficult, and at the same time, exciting, to spot.

Cloud iridescence:

- **Cloud iridescence or Irisation** is an **optical phenomenon** that mostly occurs in wave-like clouds, including
  - Pileus and Altocumulus lenticularis.
- Iridescence in clouds means the **appearance of colours on clouds**, which can either be in the form of parallel bands like in a rainbow, or mingled in patches.
- In ancient Greek mythology, Iris is the goddess of rainbow.
- "Irisation", the phenomenon of rainbow-like colours in clouds, is derived from her name.
- Iridescence of clouds is a **photometeor – an optical phenomenon produced by the reflection, refraction, diffraction or interference of sunlight.**

2. CLOUDBURSTS

BACKDROP

At least **26 cloudbursts** occurred in the Himalayan region since 2021.

What is Cloudburst?

- A cloudburst is an **extreme downpour** in a short period of time. It may be accompanied with hail and thunder.
- According to the **Indian Meteorological Department (IMD),** an unexpected precipitation exceeding 100mm (or 10 cm) per hour over a geographical region of approximately 20 to 30 square km is a cloudburst.
- **Orographic lift:** These clouds usually cause rain, thunder and lightning. This upward movement of clouds is also known as **'orographic lift'.** Due to these unstable clouds, heavy rainfall may occur over a small area.
  - The upward movement of clouds provides the required energy for a cloudburst.
  - It usually happens at 1,000-2,500 metres above the sea level.
- **Mini cloudburst:** Some scientists term rainfall between 50 and 100 mm within two hours as a 'mini cloudburst'.

3. ATMOSPHERIC RIVER STORMS

BACKDROP

Atmospheric river storms can drive devastating floods — and climate change is making them stronger.

About:

- Atmospheric rivers are **long, narrow bands of moisture** in the atmosphere that extend from the tropics to higher latitudes.
- These rivers in the sky can transport 15 times the volume of the **Mississippi River.**
- **Impact:** When that moisture reaches the coast and moves inland, it rises over the mountains, generating rain and snowfall. It can trigger other disasters, such as extreme flooding and debris flows.
- **Region:** Atmospheric rivers occur globally, affecting the west coasts of the world's major land masses, including **Portugal, Western Europe, Chile and South Africa.**
  - So-called "**Pineapple Express**" storms that carry moisture from Hawaii to the United States West Coast are just one of their many flavours.

Impact of climate change

- Atmospheric rivers are predicted to grow longer, wetter and wider in a warming climate.
- Greenhouse gases trap heat in the atmosphere, warming the planet.
  - This causes more water to evaporate from **oceans and lakes, and increased moisture in the air makes storm systems grow stronger.**
- In dry conditions, atmospheric rivers can replenish water supplies and quench dangerous wildfires. In wet conditions, they can cause damaging floods and debris flows, wreaking havoc on local economies.

*****

6

Geo-Climatic Phenomenon

1. TRIPLE DIP' LA NINA AND ITS IMPACT ON INDIA'S MONSOON

BACKDROP

Australia's Bureau of Meteorology (BOM) predicted that a third consecutive event of **La Niña** could be underway.

What is La Niña?

- La Niña involves the large-scale cooling of the ocean surface temperatures in the central and eastern equatorial Pacific Ocean coupled with changes in the tropical atmospheric circulation (winds), pressure, and rainfall.
- It usually has the opposite impact on weather and climate as El Niño.

El Niño is a climate pattern that describes the unusual warming of surface waters in the **eastern tropical Pacific Ocean.**

El Nino-Southern Oscillation (ENSO):

- ENSO is the interaction between the atmosphere and ocean in the tropical Pacific.
- It is a series of linked weather and ocean-related phenomena.

- La Niña is characterized by **lower-than-normal air pressure** over the western Pacific.
- These low-pressure zones contribute to increased rainfall.
- La Niña years are associated with above-average trade winds, pushing the warmer waters towards Asia and drawing in cooler than normal water temps to the equatorial pacific.
- **Causes:** La Niña is caused by a build-up of cooler-than-normal waters in the tropical Pacific, the area of the Pacific Ocean between **the Tropic of Cancer and the Tropic of Capricorn.**
- **Effects:** La Niña affects; patterns of rainfall, atmospheric pressure and global atmospheric circulations.

What does a triple La Niña mean?

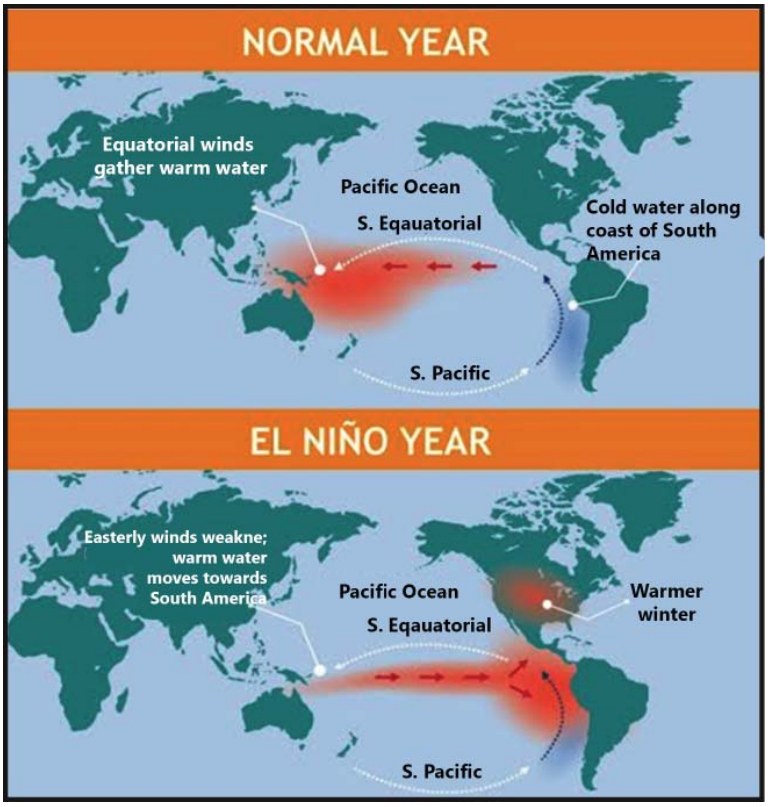
- A triple La Niña or a 'triple dip' La Niña is a rare occurrence, lasting for three years in a row. It has happened only twice since 1950.
- On the contrary, the occurrence of two consecutive La Niña winters in the Northern Hemisphere is common.

2. EL NIÑO IS COMING

BACKDROP

As per the prediction of most forecast models, the climate system's biggest player – **El Niño** – will return for the first time in nearly four years.

El Nino:



- El Niño is one side of the climatic coin called the **El Niño-Southern Oscillation (ENSO).** It's the heads to **La Niña's tails.**
- It is classified as a **periodic fluctuation** in **sea surface temperature (SST)** across the central and eastern tropical Pacific oceans.
- It is triggered by a warming of the eastern equatorial Pacific Ocean
- El Niño occurs **every 2-7 years** and can last anywhere between **nine months and two years**.
- El Niño is the warm phase of the **El Niño Southern Oscillation (commonly called ENSO)** and is associated with a band of warm ocean water that develops in the central and east-central equatorial Pacific **(between approximately the International Date Line and 120°W**), including off the Pacific coast of South America.

La Nina is the opposite of El Nino and is characterised by cooler currents in the equatorial eastern Pacific.

El Nino Southern Oscillation (ENSO):

- The combined phases of **La Nina and El Nino** are termed **El Nino-Southern Oscillation (ENSO).**
- The phenomenon affects **rainfall patterns, global atmospheric circulation, and atmospheric pressure across the planet.**

How El Niño affects the planet?

- **Wet and dry areas:** Warm water affects air currents that leave areas wetter or drier than usual.
- **Storms:** It can ramp up storms in some areas, like the southern U.S. while tending to tamp down Atlantic hurricane activity.

- **Impact on marine life:** El Niño can also wreak havoc on the many marine ecosystems that support the world's fishing industries, including coral reefs and seagrass meadows.
- **Extreme ocean warming:** Specifically, El Niño tends to trigger intense and widespread periods of extreme ocean warming known as marine heat waves.
  - Global ocean temperatures are already at record highs, so El Niño-induced marine heat waves could push many **sensitive fisheries to a breaking point.**

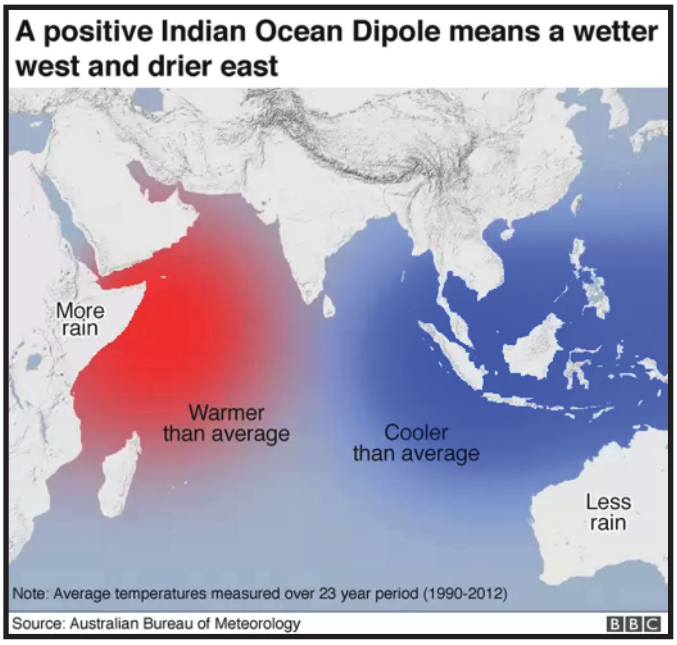
In the **Bay of Bengal east of India**, interactions between El Niño and a tropical airflow pattern known as the **Walker Circulation** elevate the risk for marine heat waves.

3. INDIAN OCEAN DIPOLE (IOD)

BACKDROP

With **the El Nino phenomenon** almost certain to affect the Indian monsoon this year, high hopes are pinned on the development of a positive I**ndian Ocean Dipole (IOD**) and its ability to counterbalance the El Nino effect.

About Indian Ocean Dipole:



- The IOD is an ocean-atmosphere interaction very similar to the El Nino fluctuations in the Pacific Ocean, playing out, as the name shows, in the Indian Ocean.
- It is also a much weaker system than El Nino, and thus has relatively limited impacts.
- A positive IOD helps rainfall along the **African coastline** and also over the Indian sub-continent while suppressing rainfall over Indonesia, Southeast Asia and Australia.
- The impacts are opposite during a **negative IOD event.**
- IOD, sometimes referred to as the **Indian Nino, is** a similar phenomenon, playing out in the relatively smaller area of the **Indian Ocean between the Indonesian and Malaysian coastline in the east and the African coastline near Somalia in the west.**

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7

Impact of Climate Change

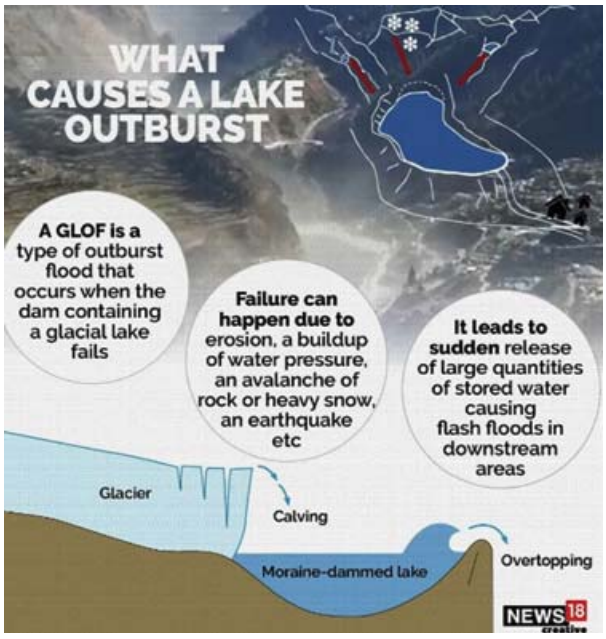
1. GLACIAL LAKE OUTBURST

BACKDROP

Glacial lake outburst floods (GLOFs) represent a major hazard and can result in significant loss of life.

What is a GLOF?

- GLOF is the term scientists use to describe the incident when the water levels of glacial lakes breach their boundaries, causing large amounts of water to flow into nearby streams and rivers.
- These also create flash floods.
- Experts attribute GLOFs to climate change and the increase of anthropogenic footprints on glaciers.
- GLOFs are not a recent phenomenon, but they remain a persistent threat to downstream communities and infrastructure besides flora and fauna.



2. HEAT WAVES IN INDIA

BACKDROP

There were instances of frequent heatwave in India that has forced millions of people indoors, with air conditioner sales nearly doubling seen in several years.

What are heatwaves?

- The **India Meteorological Department** qualitatively describes heatwave as a condition of air temperature which becomes fatal to the human body when exposed.
- Quantitatively, it is defined based on the temperature thresholds over a region in terms of actual temperature or its departure from normal.
- **Declaration:**
  - **Heatwave:** A heatwave is declared when an area logs a maximum temperature **of 45 degree Celsius**.
  - **Severe heatwave:** A severe heatwave is declared if the maximum temperature crosses **47 degrees**.
- For coastal regions, heat wave may be described provided actual maximum temperature is **37 degrees or more.**

The General Occurrence:

- **Months:** Heat waves usually occur in the months of **March to June** and in some rare cases even in July.
  - The peak month of the heat wave over India is May.
- **Regions:** Heat waves generally occur over plains of **northwest India, Central, East and north Peninsular India.**
  - It covers **Punjab, Haryana, Delhi, Uttar Pradesh, Bihar, Jharkhand, West Bengal, Odisha, Madhya Pradesh, Rajasthan, Gujarat, parts of Maharashtra and Karnataka, Andhra Pradesh and Telangana.**
- Sometimes it occurs over **Tamil Nadu and Kerala** also.

Different standards on heatwaves:

Several countries have adopted their own standards on heatwaves:

- **United States:** The US National Weather Service defines a heatwave as a spell of "abnormally and uncomfortably hot and unusually humid weather" over two days or more.
- **Denmark:** A heatwave occurs when the mean of the highest recorded temperature measured over three consecutive days exceeds 28°C (82.4°F).
- **Australia:** In Adelaide, Australia, a heatwave is defined as five straight days with temperatures at or above 35°C (95°F), or three consecutive days at or over 40°C (104°F).

Wet Bulb Temperature:

- This heatwave has also brought the **wet bulb temperature** concept into mainstream conversation.
- In simpler terms, wet bulb temperature tells us at what level our bodies will be unable to cool themselves down by sweating.
- In this case, the threat of a heat stroke rises dramatically.
- **Wet bulb temperature** combines heat and humidity to indicate how much evaporation can be absorbed into the air.
- It measures the lowest temperatures that our bodies can reach when we are in hotter environments, by sweating.

3. HEAT DOME IN NORTHERN AMERICA

BACKDROP

The temperatures reported from the Pacific north-west and some parts of Canada are part of a "historic" heat wave, a result of a phenomenon referred to as a "heat dome".

About Heat Dome

- A heat dome occurs when the atmosphere traps hot ocean air like a lid or cap. A heat dome typically lasts for weeks.
- There are two things that contribute to a heat dome:
  - Atmospheric pressure
  - Rising sea temperatures
- High pressure way up in the atmosphere can trap heat, leading to an increase in temperatures at ground level.
- This effect is fuelled by heat rising from the ocean, creating an amplification loop.
- The high pressure in the atmosphere acts like a dome and prevents the heat from dissipating. As the air gets hotter, everything gets hotter and hotter.
- A heat dome is created when strong high-pressure atmospheric conditions combine with weather patterns like La Niña.

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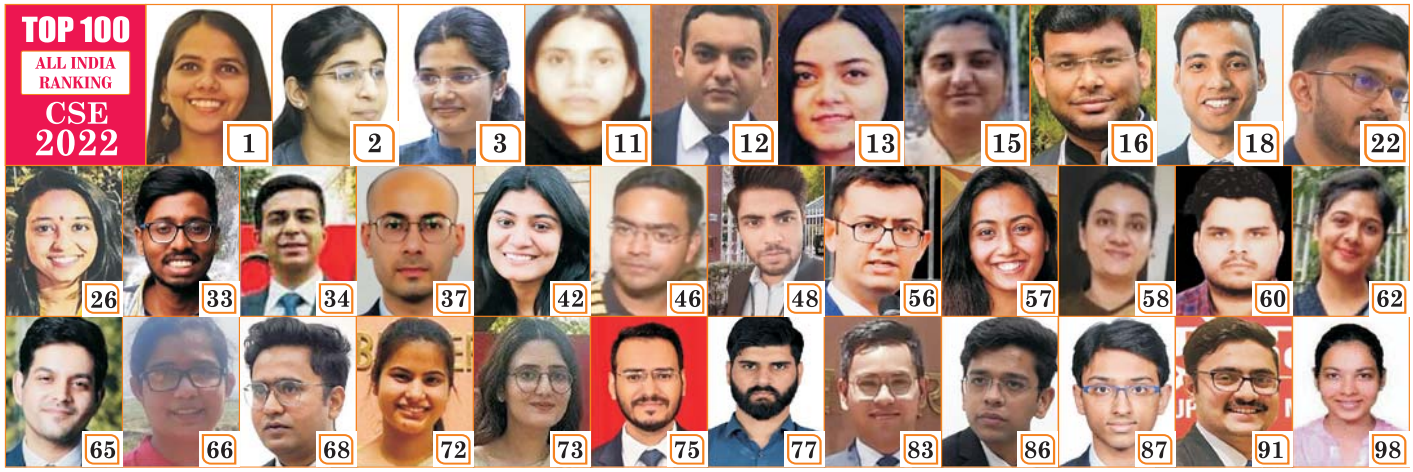
CSE RESULTS



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