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RAPID REVISION SERIES

700 High Probable Topics for UPSC Prelims 2021

(Current Affairs + Static Portion)

Part 1

Geography

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IASBABA'S

RAPID REVISION (RaRe) SERIES - UPSC 2021

RaRe Notes

DAY 3 - GEOGRAPHY

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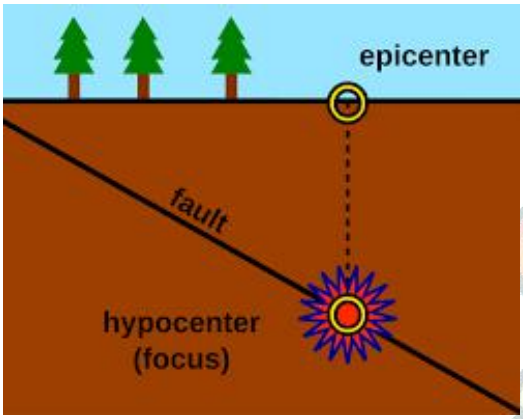
Topics Coverage:

21. Earthquakes (Basics)
22. National Center for Seismology (NCS)
23. Why the entire Himalayas are prone to high seismic activity or earthquakes?
24. Co-seismic ionospheric perturbations (CIP) and Coupled Lithosphere-Atmosphere- Ionosphere-Magnetosphere System (CLAIMs)
25. Earthquake Disaster Risk Index (EDRI) and Seismic Base Isolation
26. National Disaster Management Authority (NDMA)
27. Interior of the Earth and Classification based on physical state
28. Acidic Rocks and Basic Rocks
29. Igneous Rocks; Sedimentary Rocks and Metamorphic Rocks
30. National Geo Portal – BHUVAN and Bhuvan Panchayat V 3.0 web portal

Topic 21: Earthquake (Basics)

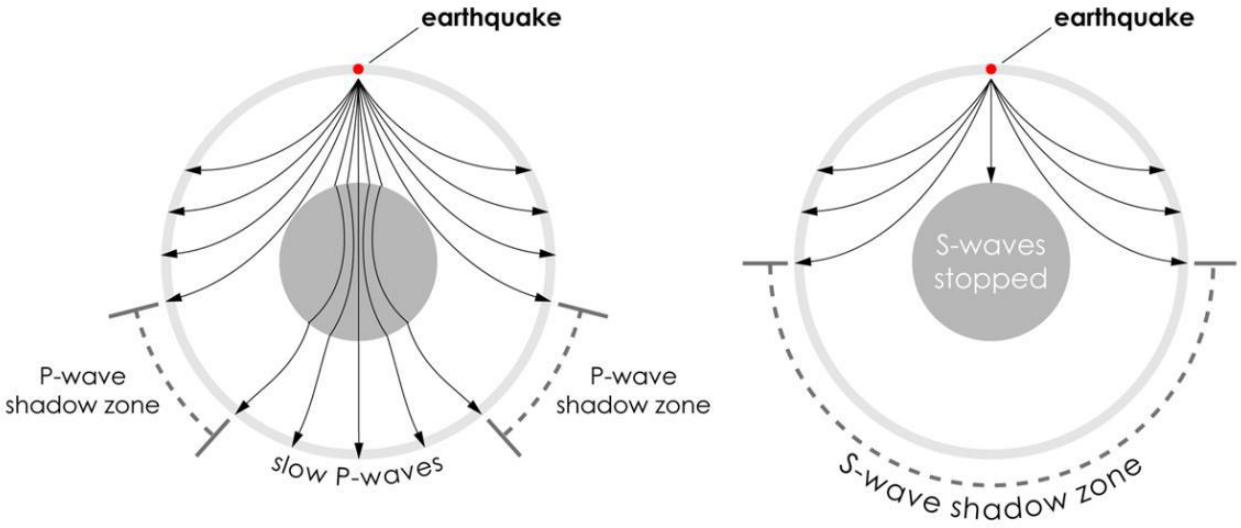
Focus or Hypocenter	The point where the energy is released is called the focus of an earthquake, alternatively, it is called the hypocentre. Earthquake waves or seismic waves originating from a point (within the body of the earth)
Epicenter	The energy waves travelling in different directions reach the surface. The point on the surface, nearest to the focus, is called epicentre. It is the first one to experience the waves. It is a point directly above the focus.



Earthquake waves

Type of wave	Propagation velocity	Path of travel
Primary waves (P – waves) Longitudinal waves/ Compressional waves	Similar to sound waves Travel in solid, liquid and gaseous media Nearly twice the speed of S waves These waves are of high frequency Velocity of P waves in Solids > Liquids >Gases	Direction of movement and direction of oscillation of the particles are the same
Secondary waves (S – waves) Transverse waves/ Shear waves	Travel only in solid media Slow in motion and not so well developed The shadow zone of S-wave is much larger than that of the P-waves	Direction of travel is at right angles to the direction of oscillation

Surface waves (R-waves) Rayleigh waves	They move along the boundaries between solid, liquid and gaseous media Intensity decreases rapidly with depth, but with low velocity they may penetrate deep into the earth's mantle over a long period of time	Surface waves are generally set up in the earth's surface Surface waves are the most destructive



Topic 22: National Center for Seismology (NCS)

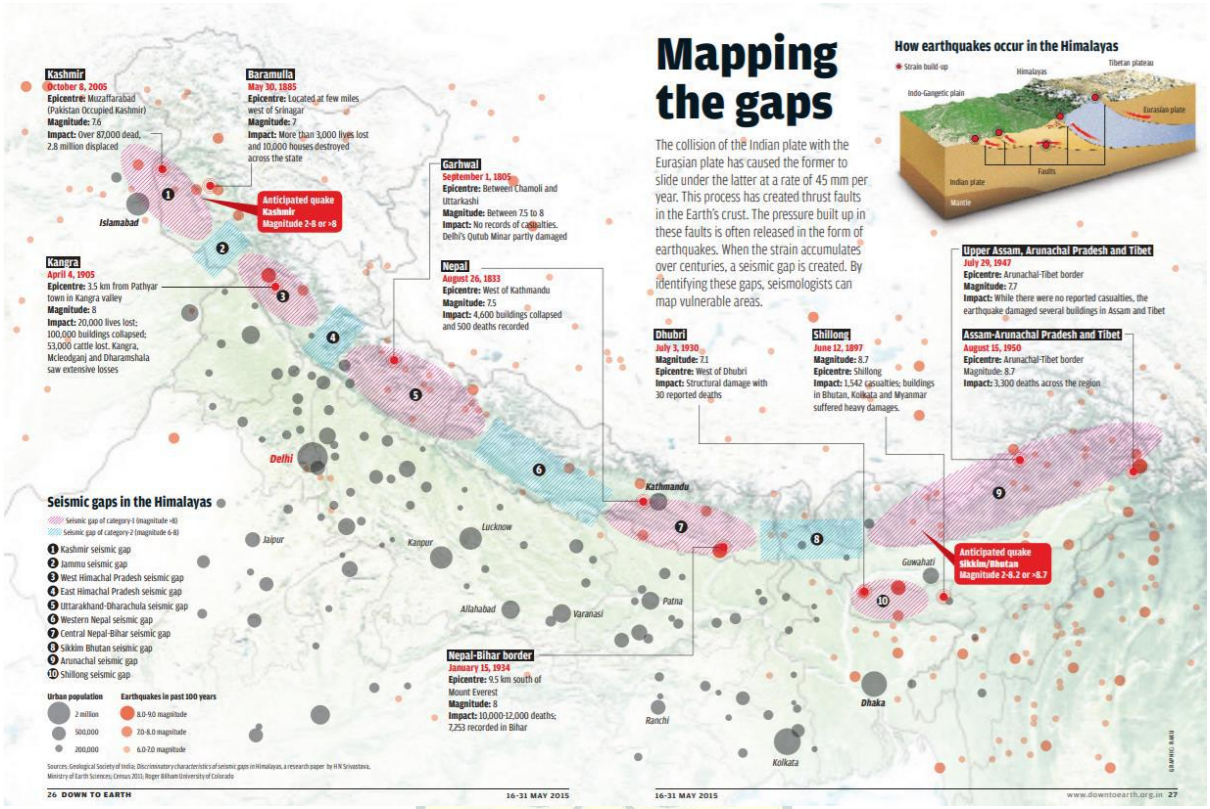
Key points:

1. Under Ministry of Earth Sciences
2. NCS is nodal agency for monitoring of earthquake activity
3. Apart from monitoring earthquake swarm and aftershock, NCS is also actively involved in the Seismic Hazard Microzonation and seismological research

Do you know?

- The history of instrumental earthquake monitoring in India dates back to 1898, when the first seismological observatory of the country was established at Alipore (Calcutta)

Topic 23: Why the entire Himalayas are prone to high seismic activity or earthquakes?



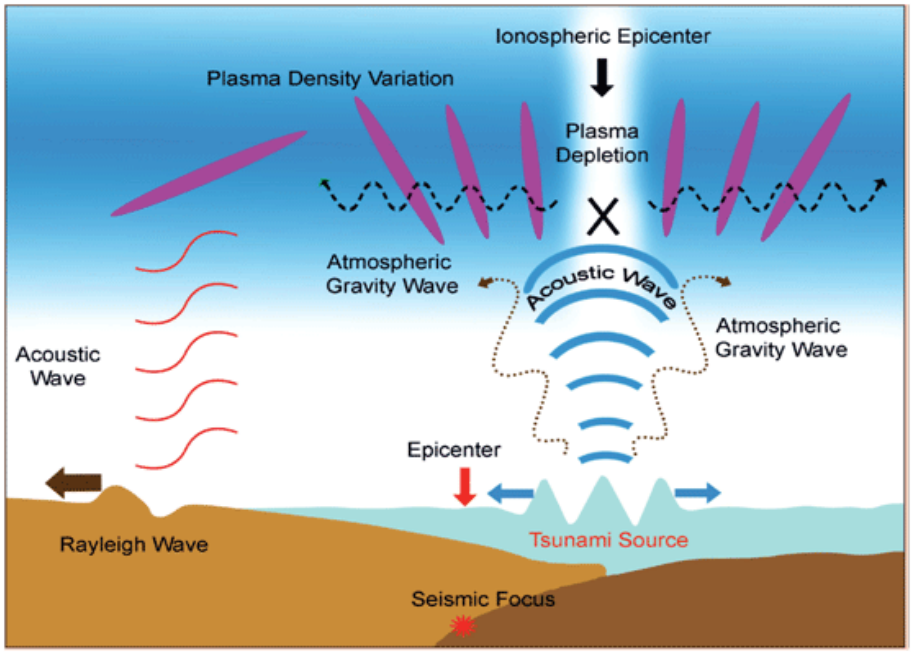
1. Himalayan belt (esp Jammu & Kashmir) is extremely vulnerable to earthquakes
2. The Himalayas are a result of the **collision of Indian plate and Eurasian tectonic** plates. And because the Indian plate moves northwards into the Eurasian plate a few centimetres every year, this has led to a **build-up of a lot of strain**, that has not been adequately released.
3. Sediments present in the mountains.

Topic 24: Co-seismic ionospheric perturbations (CIP) and Coupled Lithosphere-Atmosphere- Ionosphere-Magnetosphere System (CLAIMs)

Ionospheric based monitoring of large earthquakes

Key pointers:

- CLAIMs is an interdisciplinary program of Indian Institute of Geomagnetism funded by DST
- Main aim - The research focuses on energy transfer to the atmosphere during solid Earth processes such as earthquakes as well as tsunamis



How it works?

1. We know that earthquake produces compressional (i.e. pressure) waves
2. These pressure waves produce variations in the coupled adjacent atmosphere
3. These neutral atmospheric perturbations (called acoustic waves) propagate upwards and once these perturbations arrive at the ionospheric altitudes, they redistribute the plasma density through ion-neutral collisions and generate ionospheric perturbations termed as co-seismic ionospheric perturbations (CIP).

Various ionospheric sounding techniques can be used to study the CIP characteristics.
CIP and Total Electron Content (TEC) can be derived from derived from Global Navigation Satellite Systems (GNSS) or GPS, which can give large spatial and temporal coverage over seismic source region

Topic 25: Earthquake Disaster Risk Index (EDRI) and Seismic Base Isolation

Earthquake Disaster Risk Index (EDRI)

1. It is prepared by National Disaster Management Authority (NDMA)
2. According to EDRI, 56% area of India is vulnerable to moderate to major earthquakes where about 82% of the population live

Seismic Base Isolation or Base Isolation

- It is meant to protect a structure against earthquake forces by decoupling the superstructure from its substructure resting on a shaking ground, thereby protecting the integrity of the building (or even non-buildings such as statutes).
- The foundation in this technique comprises horizontal rubber bearings alternated by layers of steel.

Topic 26: National Disaster Management Authority (NDMA)

1. NDMA is headed by the Prime Minister
2. Apex body for disaster management in India

3. Disaster Management Act, 2005 envisaged the creation of NDMA and SDMAs (headed by respective CMs)
4. NDMA vision - To build a safer and disaster resilient India by using pro-active, technology driven, sustainable development strategy and foster culture of prevention, preparedness and mitigation.
5. NDMA is mandated to lay down the policies, plans and guidelines for Disaster Management to ensure timely and effective response to disasters.

Key points:

- The primary responsibility of Disaster management rests with the States.
- The Central Government supports the efforts of State Governments by providing logistical and financial support. It also lays down plans, policies and guidelines.
- National Executive Committee (NEC) is constituted under DM Act, 2005 to assist NDMA
- Union Home Secretary is ex-officio chairperson of NEC
- National Disaster Response Force (NDRF) - is specialized force for disaster response which works under the NDMA

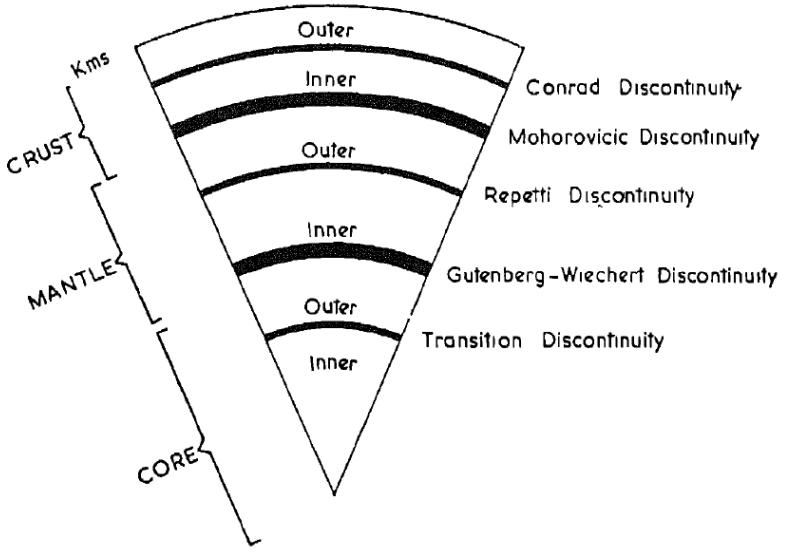
Topic 27: Interior of the Earth

Name of the layer	Structure and composition	Physical property	Average Thickness	Density of rocks
A. Crust	Outer and thinnest layer of the earth. It is composed mainly of Silica and Aluminium (SI+AL = SIAL)	Solid	5-40 Km	Light
B. Mantle (i) Upper (ii) Lower	 Lithosphere Asthenosphere Upper and lower mantle are composed mainly of Silica and Magnesium (SI + MA = SIMA)	 Solid Plastic – Semimolten	2895 Km	 Moderately light Moderately heavy
C. Core				

(i) Outer	Composed mainly of Nickel and Ferrous (Ni + Fe = Nife)	Liquid or in Plastic State	2220 Km	Heavy
(ii) Inner	Barysphere	Solid	1255 Km	Very heavy

Classification based on physical state:

1. **Lithosphere:** The top most solid layer is called lithosphere. It is up to 100 km deep including crust and some portion of upper mantle.
2. **Aesthenosphere:** It is the second plastic layer under lithosphere. It stretches from 100 km to 400km.
3. **Mesosphere:** It is an intermediate layer lying from 400km to 700km in depth.
4. **Pyrosphere:** It includes semi solid lower mantle and outer liquid crust. Because of very high temperature it gets its name. 'Pyros' means fire.
5. **Barrysphere:** It is the inner most solid core of the earth stretching from 5150km to 6371km.



Topic 28: Acidic and Basic Rocks

Acidic Rocks	Basic Rocks
These rocks contain large proportion of silica	These rocks contain lesser proportion of silica
Example - Granite, Quartz	Example - Gabbro, Basalt, Dolerite etc
Upper crust consists mostly of silicates/acidic rocks	Lower crust and the upper mantle consists basic rocks
	Earthquake foci, compressional orogenic forces which create mountains, tensional rifts which create rift valleys and fault forces which cause the displacement of the broken crustal parts – originate in the lower crust and

	the upper mantle

Topic 29: Igneous Rocks; Sedimentary Rocks and Metamorphic Rocks

Igneous Rocks	Sedimentary Rocks	Metamorphic Rocks
Formed by cooling and solidification of molten rock (Magma) from beneath earth's crust.	Formed from sediment accumulated over long periods, usually under water.	All rocks (whether igneous or sedimentary) become Metamorphic under great heat and pressure.
Normally in crystalline in structure and do not occur in strata (layers) They do not contain fossils	Layer formation and stratified Coarse and fine-grained Often contain fossils	

Topic 30: National Geo Portal – BHUVAN and Bhuvan Panchayat V 3.0 web portal

BHUVAN

- It is the national Geo-portal developed and hosted by ISRO
- It comprises of Geo-spatial data, services and tools analysis
- This software application allows the users to explore a 2D/3D representation of the surface of the Earth.

Significance of BHUVAN

Given below are the main functions which are performed by BHUVAN of ISRO:

- It can be connected to Global Positioning System(GPS) device in real-time or playback mode
- It allows one to download IRS data products and consume thematic datasets as OGC web services towards Geoprocessing
- Using BHUVAN, users can chart routes, plot areas, view terrain profile and overlay images
- It is useful for scientists as it facilitates new possibilities from the IRS geospatial data for collaborative research
- It is also beneficial for educators. One can take students virtually to an area being studied and show them the topography, surrounding areas etc.

Bhuvan Panchayat V 3.0 web portal

- Bhuvan Panchayat V 3.0 web portal was launched in 2020
- The Web Geo portal is an easy to use Geo portal developed for database visualization, data analytics, generation of automatic reports, model based products and services for the benefit of Gram Panchayat members and other stake holders. The targeted audience for this portal are Public, PRIs and different stakeholders belonging to the gram panchayats.
- ISRO launched ("Space Based Information Support for Decentralised Planning Update") SISDP project to assist Gram Panchayats at grassroot level with basic planning inputs derived from satellite data for preparing developmental plans, its implementation and monitoring the activities. SISDP phase I Project was successfully concluded in the year 2016-17.

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DAY 4 - GEOGRAPHY

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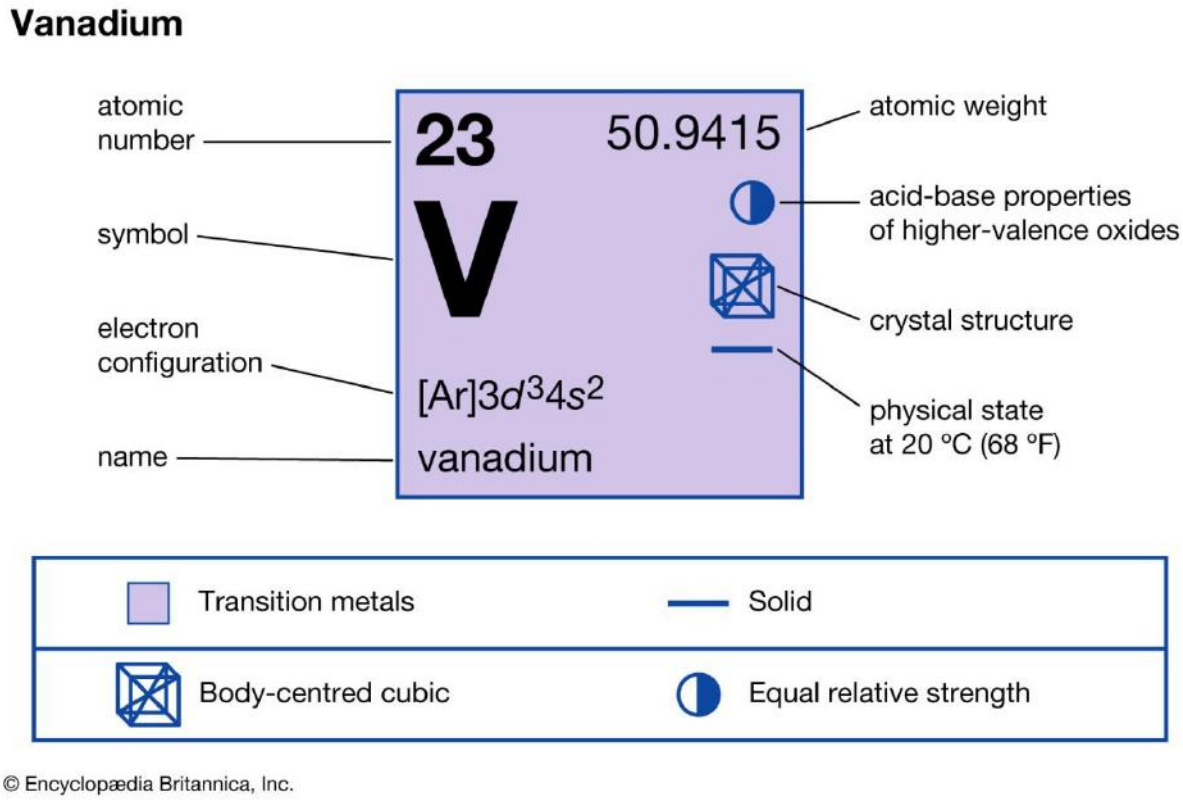
Topics Coverage:

31. Vanadium
32. Plate Tectonics Theory (Basics)
33. Volcanoes and different types
34. India and Arctic Council
35. NISAR (NASA-ISRO Synthetic Aperture Radar) satellite mission
36. Indian Antarctic Program
37. National Centre for Polar and Ocean Research (NCPOR)
38. MADICE project and SONIC project
39. Indo-Norway Integrated Ocean Initiative
40. Deep Ocean Mission

Topic 31: Vanadium

About Vanadium

1. Vanadium in its pure form is a soft, grey and ductile element primarily derived from mined iron ore, carbonaceous shale or phyllites and steel slag.
2. Vanadium rarely exists as a free element in nature but can be found in about 65 different minerals.
3. 98 percent of mined vanadium ore comes from South Africa, Russia, and China.



Applications:

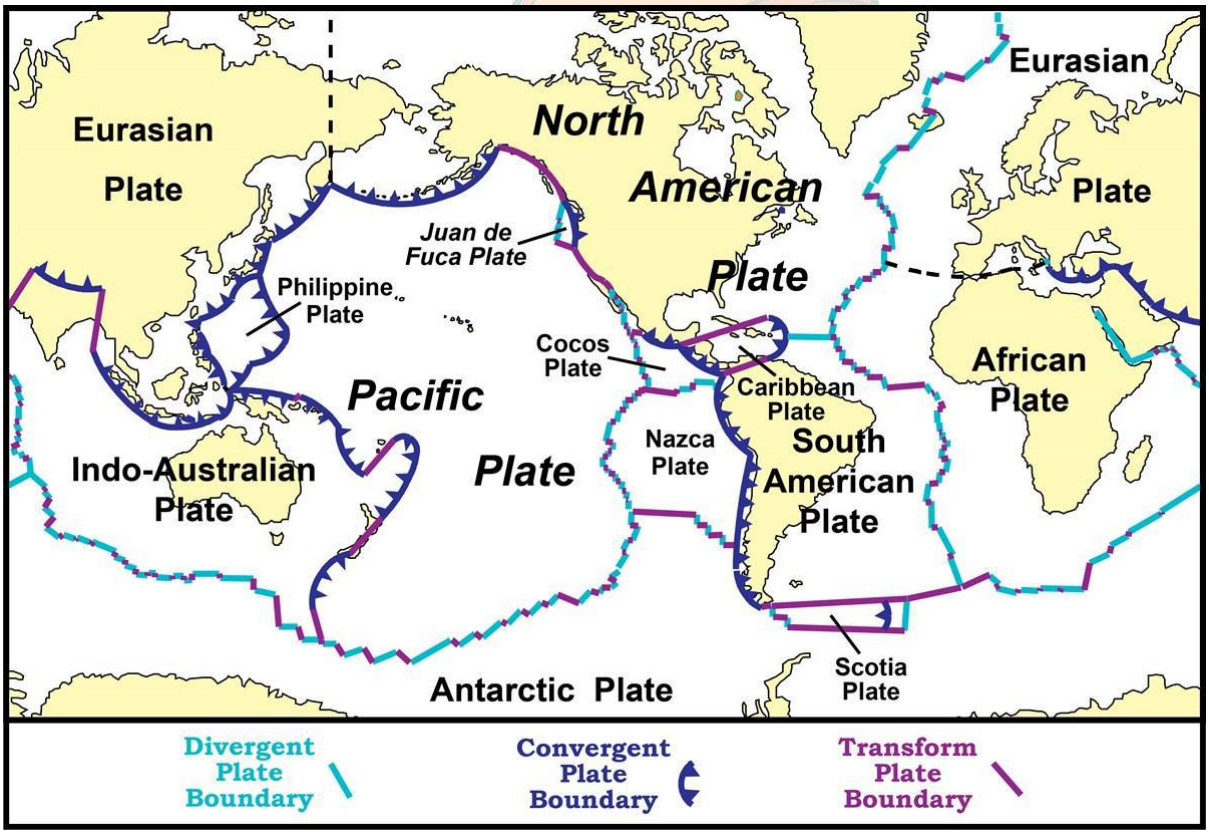
1. Vanadium is a high-value metal used in strengthening steel and titanium. Its addition improves the tensile strength of steel and of reinforcing bars used for buildings, tunnels and bridges.
2. Vanadium alloys are durable in extreme temperature and environments, and are corrosion-resistant.
3. Apart from increasing fuel-efficiency in automotive and aviation industries due to its high strength-to-weight ratio, the metal forms the integral part of vanadium redox batteries that have the least ecological impact in energy storage.

Why in news?

- Arunachal Pradesh could be India's prime producer of vanadium and hence is considered as a sleeping hydropower giant.
- The global demand for vanadium has been skyrocketing and there is deficit. The vanadium find in Arunachal Pradesh could help boost the local and national economy.

Topic 32: Plate Tectonics Theory (Basics)

Major plates	Minor plates
African Plate	Arabian plate
North American plate	Bismark plate
South American plate	Caribbean plate
Antarctica Plate	Carolina plate
Australian plate	Cocos Plate
Eurasian plate	Juan de Fuca Plate
Pacific plate	Nazca plate
	Philippines plate
	Persian Plate
	Anatolian Plate
	China plate
	Fiji plate



Most of the plates include both continental and oceanic crusts.

Three types of motion are possible between the plates:

1. Separation or divergent or constructive plate margins
2. Closing together or convergent or destructive plate margins
3. Transform or conservative plate margin

Type of Margin	Divergent	Convergent	Transform
Motion	Spreading	Subduction	Lateral sliding
Effect	Constructive (oceanic lithosphere created)	Destructive (oceanic lithosphere destroyed)	Conservative (lithosphere neither created or destroyed)
Topography	Ridge/Rift	Trench	No major effect
Volcanic activity?	Yes	Yes	No

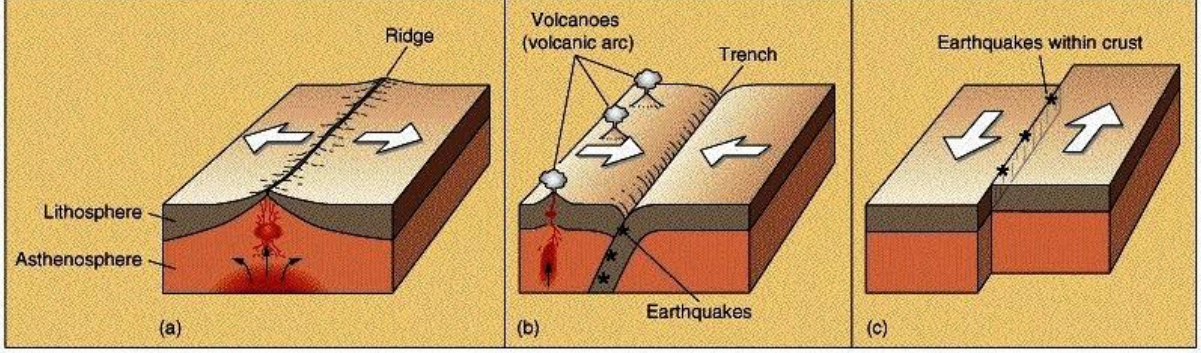
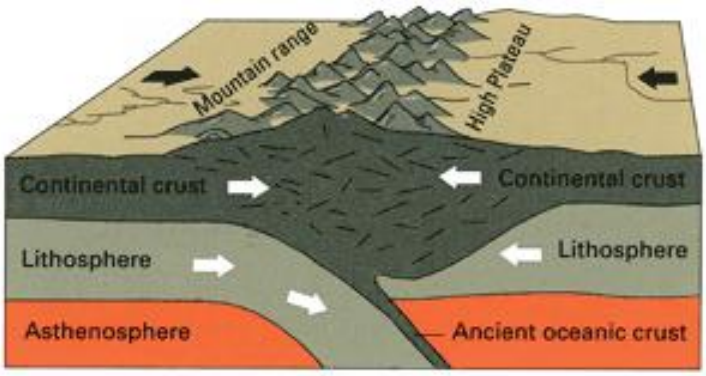
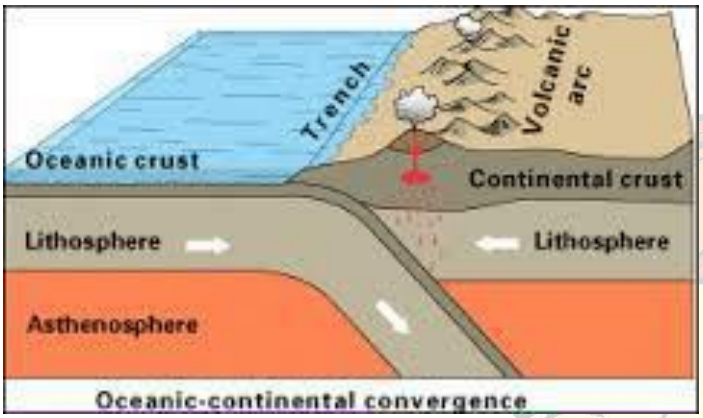


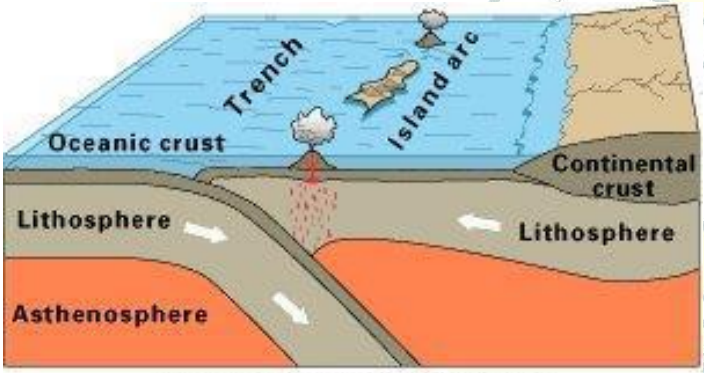
Plate boundary	Plate movement	Seafloor	Events observed	Examples
Divergent plate boundaries Ocean –ocean	Apart	Forms by seafloor spreading	Ridge forms at spreading centre. Plate area increases. Many small volcanoes and earthquakes	Mid Atlantic ridge, East Pacific rise
Divergent plate boundaries Continent - continent	Apart	New ocean basin may form as the continent splits	Continent drifts apart, ocean may intrude. Formation of rift valleys and block mountains	East African rift
Convergent plate boundary Ocean - continent	Together	Destroyed at subduction zones	Dense oceanic lithosphere plunges beneath less dense continental crust. Earthquake traces path of down moving plate as it descends into	Western South America

			asthenosphere. A trench is formed. Subducted plate partially melts and magma rises to form continental volcanoes.	
Convergent plate boundary Ocean -ocean	Together	Destroyed at subduction zone	Denser crust plunges into lighter crust and is subducted forming a curved trench and a volcanic arc.	Aleutians
Convergent plate boundary Continent-continent	Together	-- NA --	Collision between masses of gigantic continental lithosphere. Neither mass is subducted. Plate edges are compressed, folded and uplifted	Himalayas, Alps
Transform plate boundary	Past each other	Neither created nor destroyed	A transform fault is formed where plates move past each other. Strong earthquakes along the fault	San Andreas fault



Continental-continental convergence

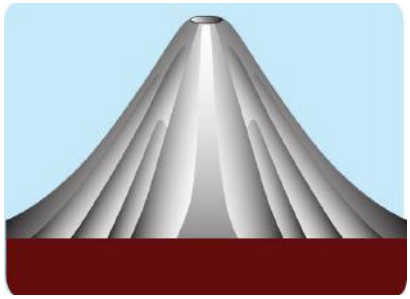




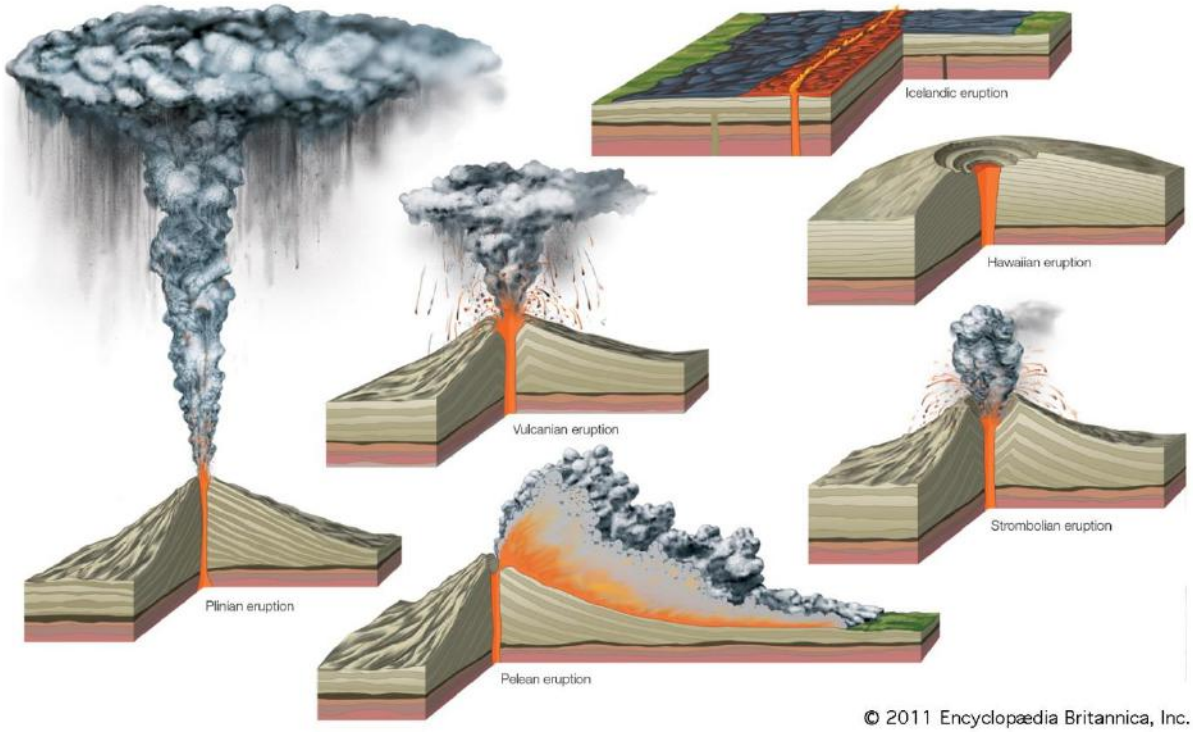
Oceanic-oceanic convergence

Topic 33: Volcanoes

Different Types:

Shield volcano 	Volcano which produces low viscosity, runny, lava and it spreads far from the source forming a volcano with gentle slopes. Most shield volcanoes are formed of fluid basaltic lava flows. Mauna Kea and Mauna Loa are shield volcanoes.
Stratovolcano 	They have relatively steep sides and are more cone-shaped than shield volcanoes. They are formed from viscous, or sticky, lava that does not flow easily. Stratovolcanoes are more likely to produce explosive eruptions due to gas building up in the viscous magma. Ex - Andesite (named after the Andes Mountains)
Dome volcano	In lava dome volacno, viscous lava is not very fluid, it cannot flow away from the vent easily when it is extruded. Instead it piles up on top of the vent forming a large, dome-shaped mass of material.
Caldera	Magma is stored beneath a volcano in a magma chamber. When a very large explosive eruption occurs which empties the magma chamber, the roof of the magma chamber can collapse forming a depression, or bowl on the surface which has very steep walls.

Types of volcanic eruptions:



Icelandic	• It flows as fissure eruption • The lava is basaltic and has less viscosity. • It flows quietly and in large quantities forming plateaus. • There is no violent activity or cone formation. • Ex. Columbia(USA), deccan plateau (India) etc.
Hawaiian	• There can be fissure , crater or caldera eruptions. • It forms small domes from which mobile lava and gases erupt. • It produces fire fountains and only minor amount of gases.
Stambolian	• They form stratocones, i.e. lava comes out and solidifies in a layered structure. • They have rhythmic to continuous explosions resulting from spasmodic gas escape. • Sometimes clots of lava are ejected producing bombs and scoria. • It can have periodic more intense activity with outpouring of lava.
Vulcanian	• They are also stratocone volcanoes. • The associated lavas are more viscous. • Sometimes the lava solidifies over the vent forming a crust resulting into gas pressure build-up leading to violent explosions. • After a long quite period eruption occurs ejecting bomb, pumice and ash.

	• Lava flows from the top of the flank after main explosive eruption. • Dark ash laden clouds, convulated, cauliflower shaped, rises to moderate heights more or less vertical depositing tephra along the flanks of volcano.
Vesuvian	• It throws extremely violent explosive gas charged magma from stratocone vent. • Eruption occurs after a long period of quite or mild activity. • Vent tend to be emptied to considerable depth. • The lava erupts in explosive spray and gas cloud reaches to great height and deposits tephra.
Pilian	• It is more violent form of visuvian eruption. • Last major phase is uprush of gas that carries clouds rapidly upward in vertical coloumn for miles. • It is narrow at base but expands outward at upper elevations. But the clouds are generally low in tephra.

Topic 34: India and Arctic Council

Background:

2007	Started with expeditions to the Arctic Ocean
2008	Opening of a research station, Himadri, at the international research base at Ny-Alesund in Svalbard, the northernmost island in the world belonging to Norway
2013	India was granted Observer Status to the Arctic Council in 2013 along with other Asian countries such as China, Japan, Singapore and South Korea.
Recently in news	India deploy open ocean mooring in the Arctic for long-term monitoring of upper ocean variables and marine meteorological parameters

About Arctic Council

- The Arctic Council is a high-level intergovernmental forum to promote cooperation, coordination, and interaction towards sustainable development and environmental protection in the Arctic.
- As part of the Arctic Council, India contributes to the international deliberations to develop effective cooperative partnerships towards a safe, stable, and secure Arctic.
- India's engagement with the Arctic dates back to 1920 with the signing of the Svalbard Treaty in Paris.
- Since July 2008, India has a permanent research station in the Arctic called Himadari at NyAlesund, Svalbard Area in Norway. It has also deployed a multi-sensor moored observatory called IndARC in the Kongsfjorden fjord since July 2014.
- The research in the Arctic region from India is coordinated, conducted, and promoted by the National Centre for Polar and Ocean Research (NCPOR), Goa.

Topic 35: NISAR (NASA-ISRO Synthetic Aperture Radar) satellite mission

Key points:

1. NASA and ISRO are collaborating on developing a satellite called NISAR.
2. NASA-ISRO Synthetic Aperture Radar, or NISAR, satellite is designed to observe and take measurements of some of the planet's most complex processes.
3. NISER aims to conduct global measurements of the cause and consequences of land surface changes using advanced radar imaging.
4. India's contributions to the Sustained Arctic Observational Network (SAON) would continue.

Significance:

- Data collected from NISAR will reveal information about the evolution and state of Earth's crust, help scientists better understand our planet's processes and changing climate, and aid future resource and hazard management. The mission is a partnership between NASA and the Indian Space Research Organization.
- NISAR's data can help people worldwide better manage natural resources and hazards, as well as providing information for scientists to better understand the effects and pace of climate change. It will also add to our understanding of our planet's hard outer layer, called its crust.

Topic 36: Indian Antarctic Program

Key points:

1. India marked four successful decades of scientific endeavour in Antarctica
2. Bharati and Maitri are India's permanent research base stations in Antarctica.
3. The Indian Antarctic Program is a multi-disciplinary, multi-institutional program under the control of the National Centre for Antarctic and Ocean Research, Ministry of Earth Sciences.
4. It was initiated in 1981 with the first Indian expedition to Antarctica.
5. The program gained global acceptance with India's signing of the Antarctic Treaty and subsequent construction of the Dakshin Gangotri Antarctic research base in 1983, superseded by the Maitri base from 1990.
6. The newest base commissioned in 2015 is Bharati, constructed out of 134 shipping containers.

Topic 37: National Centre for Polar and Ocean Research (NCPOR)

Key points:

- The National Centre for Polar and Ocean Research (NCPOR) is an important R&D institution under the Ministry of Earth Sciences.
- It conducts research in the Polar and Antarctic Ocean (Southern or Austral Ocean) realms.
- It was previously known as the National Centre for Antarctic and Ocean Research (NCAOR).
- It was established as an autonomous R&D body in 1998. It is located in Goa.

- It is the nodal agency for coordinating and implementing India's Antarctic program.
- It also maintains India's permanent stations in Antarctica, Maitri and Bharati, and also the research base in the Arctic, Himadri.

Topic 38: MADICE project and SONIC project

Key points:

1. India collaborates with Norway and Japan in Antarctic Research.
2. A major Indo-Norweigian collaborative field campaign, near Indian Maitri station, was undertaken during 2016–2019 to understand the ice shelf dynamics, mass balance and reconstruct past changes in atmospheric and sea ice dynamics under the joint project **"Mass balance, dynamics, and climate of the central Dronning Maud Land coast, East Antarctica (MADICE)".**
3. Under this project, geophysical field measurements, ice core drilling, snow core drilling, ice-sheet modelling and satellite remote sensing-based studies were conducted to understand the future Antarctic contribution to the global sea-level rise.
4. An Indo-Japanese project "Schirmacher Oasis Nippon (Japan) India Coring (SONIC)"was initiated during 2019 to reconstruct the past-climate.

Topic 39: Indo-Norway Integrated Ocean Initiative

Key points:

1. India and Norway have agreed to jointly work in the area of **marine spatial planning (MSP)** in the oceanic space for the next five years.
2. Lakshadweep and Puducherry have been identified as pilot sites for the project.
3. The two countries have decided to extend support for sustainable ocean resources utilisation to advance economic and social development in coastal areas.

Note:

- The initiative known as **Marine Spatial Planning (MSP)** will be implemented by the Ministry of Earth Sciences (MoES) through National Centre for Coastal Research (NCCR) for India.
- The MSP initiative will be implemented by MoES and the Norwegian Environment Agency.
- The World Bank and the United Nations Environment Programme (UNEP) have expressed interest in supporting MoES in conducting MSP, a societal-beneficial initiative for India's coastal regions.

Topic 40: Deep Ocean Mission

Key points:

- The Deep Ocean Mission is proposed as multi-ministerial multi-disciplinary programme with emphasis on development of deep sea technology, exploration of deep sea mineral resources and biodiversity, acquisition of a research vessel for exploration, deep sea observations, and capacity building.
- Ministry of Earth Sciences is the nodal agency for implementing the programme.

The major objectives proposed under Deep Ocean Mission are as follows:

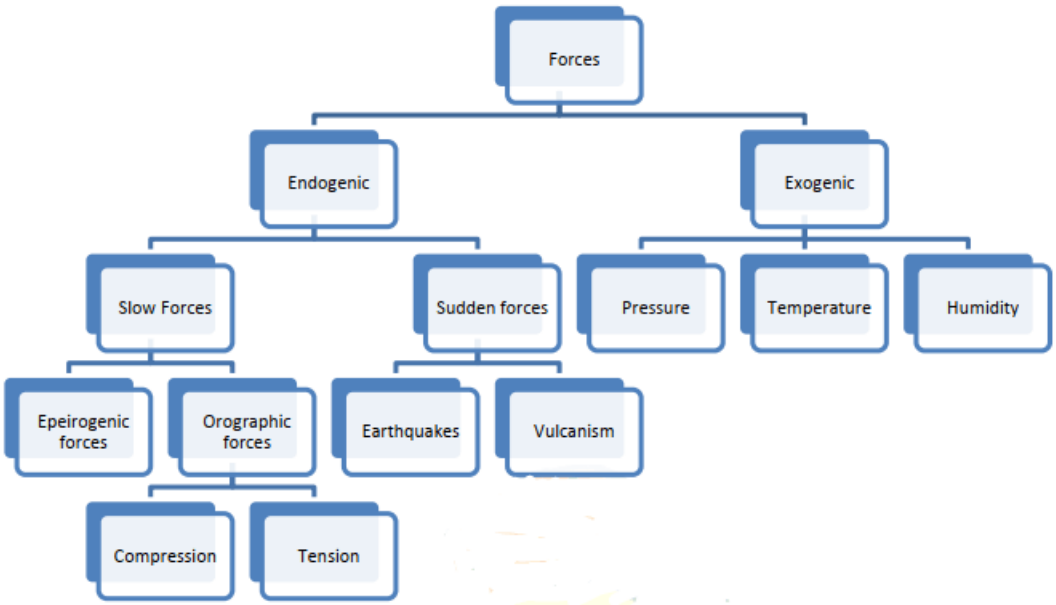
- Development of technologies for deep sea mining, underwater vehicles and underwater robotics;
- Development of ocean climate change advisory services;
- Technological innovations for exploration and conservation of deepsea biodiversity;
- Deep ocean survey and exploration;
- Proof of concept studies on energy and freshwater from the ocean; and
- Establishing advanced marine station for ocean biology

The Deep Ocean Mission is proposed to be a Central Sector Scheme and no separate allocation for States is envisaged.
Under Deep Ocean Mission, it is proposed to develop, test and demonstrate the mining technology for harvesting of polymetallic nodules.

(Important topics to revise)

- Endogenic Forces and Exogenic Forces
- Weathering
- Mass wasting
- Erosion and decomposition
- Folding and Faulting
- Horst and Graben

Forces Responsible for Geomorphic Processes



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DAY 17 - GEOGRAPHY

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Topics Coverage:

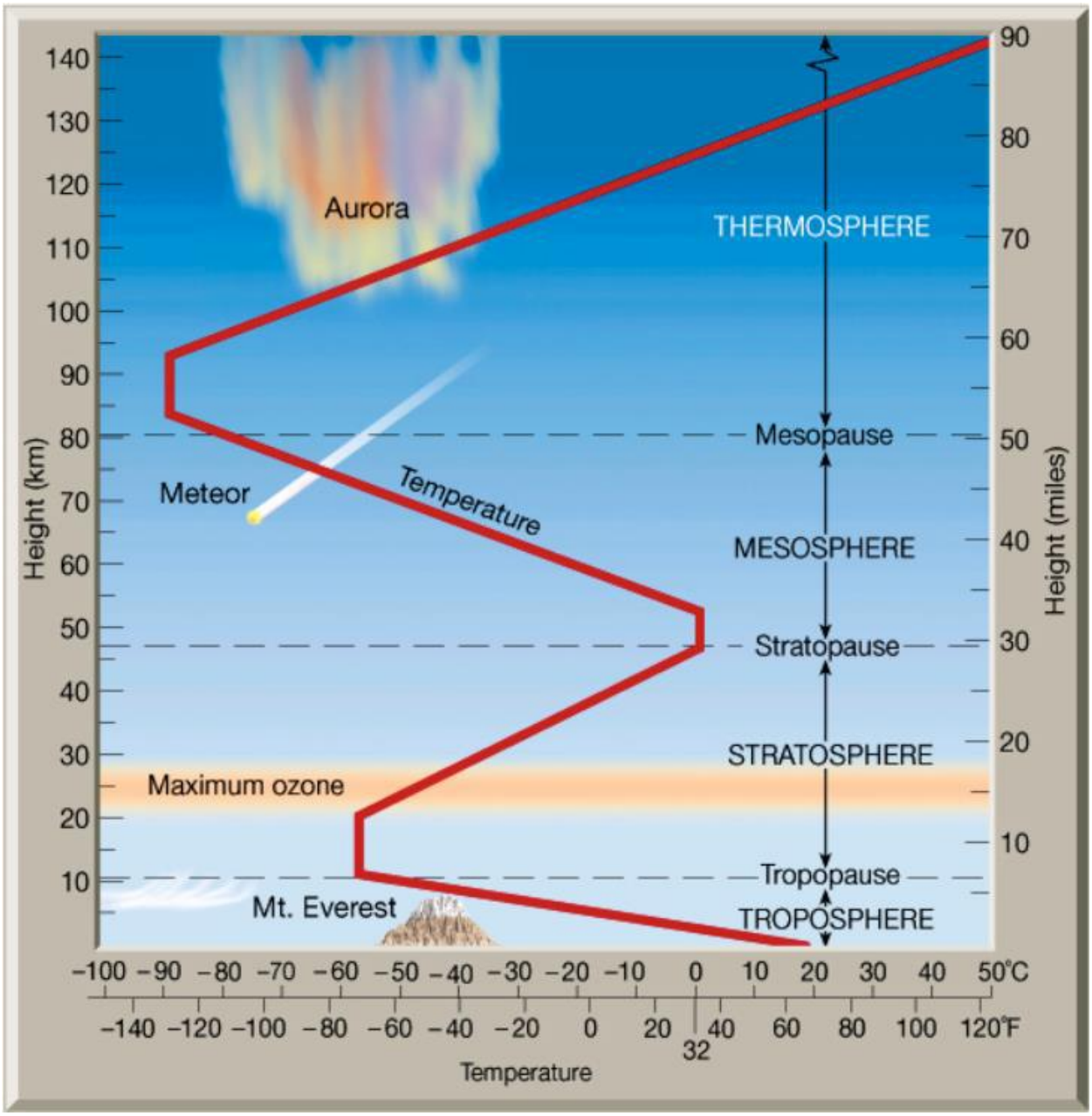
121. Structure of the Atmosphere (Basics)
122. Jet Streams
123. Polar Vortex
124. Troposphere vortex
125. Sudden Stratospheric Warming
126. Rossby Waves
127. South Atlantic Anomaly (SAA)
128. Van Allen radiation belt
129. Space Hurricanes
130. Heliosphere

Topic 121: Structure of the Atmosphere (Basics)

The structure of the atmosphere consists of 5 basic layers –

1. Troposphere
2. Stratosphere
3. Ionosphere
4. Exosphere
5. Magnetosphere

The structure of the atmosphere is highly complex but its layering in now well understood.



Layers of Atmosphere

Name	Distance	Characteristics

Troposphere	18km at equator 8km at pole	• The temperature decreases with increase in height. • The temperature is less at equator at tropopause and high at pole (at tropopause) • The source of heat in this layer is the surface of the earth. • All weather phenomenons take place in this layer.
Stratosphere	Upto 50km	• The temperature increases with increase in height. • Most conducive for flying jet aircrafts. • Contains ozonosphere. • UV is absorbed in this layer which increases the temperature.
Mesosphere	50 – 80 km	• A transition zone between stratosphere and thermosphere. • Temperature decreases with increase in height. • Meteors start burning in this layer. • The min temperature attained in atmosphere is at Mesopause. It is around – 90° C.
Thermosphere	80 – 480 km (upper limit is fixed for scientific calculations)	• It contains the layer of ions called ionosphere. • It absorbs harmful cosmic, Gama and X rays coming from the space. • The temperature increases with increase in height. • Note: Ionosphere starts from mesosphere.

Topic 122: Jet Streams

Why in news?

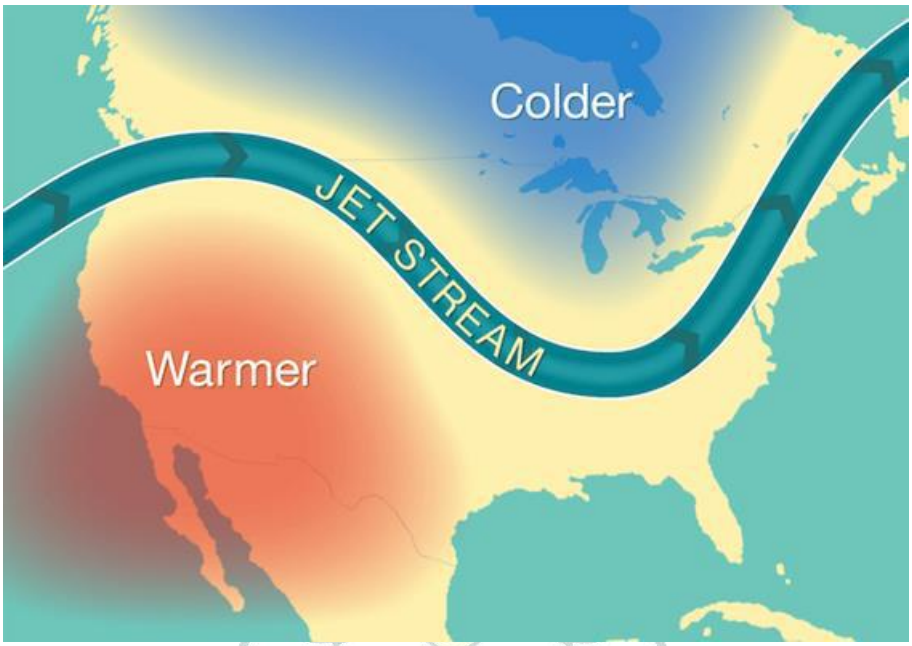
- Recently in 2020, British Airways Boeing 747 set a new subsonic record for the fastest New York to London trip while riding through a strong North Atlantic jet stream.

Key points: About Jet streams

1. They are narrow bands of strong winds that flow over thousands of kilometres from west to east.
2. Major jet streams are found near the upper levels of the atmosphere, around 9 to 16 km from the earth's surface, and can reach speeds of over 320 kph.
3. The jet streams shift to the north or south depending on the season.
4. During winters, the wind current is the strongest. They are also closer to the Equator during winter.
5. The major jet streams are the Polar Front, Subtropical, and Tropical jet streams.
6. In India, the Tropical jet stream influences the formation and duration of the summer monsoon.

How are Jet Streams caused?

1. Jet streams form when warm air masses meet cold air masses in the atmosphere.
2. So when Earth's warmer air masses meet cooler air masses, the warmer air rises up higher in the atmosphere while cooler air sinks down to replace the warm air. This movement creates an air current, or wind.
3. A jet stream is a type of air current that forms high in the atmosphere.



How Do Jet Streams Affect Air Travel?

1. Major jet streams are found near the upper levels of the atmosphere, around 9 to 16 km from the earth's surface.
2. Airplanes also fly in the mid to upper troposphere. So, if an airplane flies in a powerful jet stream and they are traveling in the same direction, the airplane can get a boost. That's why an airplane flying a route from west to east can generally make the trip faster than an airplane traveling the same route east to west.

How Do Jet Streams Affect Weather?

1. The major jet streams are the Polar Front, Subtropical, and Tropical jet streams. In India, the Tropical jet stream influences the formation and duration of the summer monsoon.
2. The fast-moving air currents in a jet stream can transport weather systems across the globe, affecting temperature and precipitation. However, if a weather system is far away from a jet stream, it might stay in one place, causing heat waves or floods.
3. Jet streams typically move storms and other weather systems from west to east. However, jet streams can move in different ways, creating bulges of winds to the north and south.
4. The jet stream is responsible for carrying the weather-altering western disturbances into North-West India.

Topic 123: Polar Vortex

Key points:

1. In the atmospheric science literature, the term "polar vortex" is most commonly used as an abbreviation for "circumpolar vortex", and refers to a planetary-scale flow that encircles the pole in middle or high latitudes.
2. In simple words, a polar vortex is a low pressure area—a wide expanse of swirling cold air—that is parked in polar regions.
3. The polar vortexes are a regular feature in the atmosphere, spinning away around the poles in both the Northern and Southern Hemispheres.
4. During winter, the polar vortex at the North Pole expands, thus sends cold air southward.
5. When the part of the polar vortex breaks off (gets disrupted) and migrates south, it brings plenty of cold air with it.
6. United States, portions of Europe and Asia may experience cold surges connected to the polar vortex.
7. Note – It is not a feature that exists at the Earth's surface.

Topic 124: Troposphere vortex

Key points:

1. They are similar to polar vortex (which happens in planet's stratosphere).
2. Troposphere vortex happens lower in the atmosphere.
3. They are also known as the jet stream, the tropospheric polar vortex functions to confine cold air near the pole.
4. Similar to polar vortex, the tropospheric polar vortex is a region of westerly (west to east) flowing winds.

Difference between Tropospheric Polar Vertex and Stratospheric Polar Vortex

Sl. No.	Tropospheric Polar Vertex	Stratospheric Polar Vortex
1.	They exist in Troposphere (happens lower in the atmosphere)	They happens in planet's stratosphere
2.	The edge of the tropospheric polar vortex typically lie within the core of the westerlies. They generally lies between 40-50 degrees latitude	They maximize at around 60° latitude, from just above the tropopause into the mesosphere
3.	Tropospheric vortex exists all year	Stratospheric polar vortex exists only from fall to spring (when there is no solar heating in polar regions) The stratospheric polar vortex strengthens during winter, and then breaks down as sunlight returns to the polar regions in spring.

Note: Both the tropospheric and stratospheric polar vortices are basic features of the earth's climatology. There existence is neither unusual nor a manifestation of major changes in the global atmospheric circulation.

Topic 125: Sudden Stratospheric Warming

Key points:

1. A sudden stratospheric warming is a significant disruption of the stratospheric polar vortex that begins with large-scale atmosphere waves (called Rossby waves) getting pushed higher into the atmosphere.
2. These waves can "break" (like waves in the ocean) on top of the polar vortex and weaken it. If waves are strong enough, the winds of the polar vortex can weaken so much that they can reverse from being westerly to easterly. This leads to cold air descending and warming rapidly, showing the sudden jump in temperature.
3. In simple words, Sudden Stratospheric Warming (SSW) occurs when there is a jump in temperatures in the stratosphere.
4. During SSW events the temperature of the stratosphere can increase by up to 50 degree Celsius within 10 days and the winds in the stratosphere can reverse from westerly to easterly.
5. Note → SSW is closely associated with polar vortex breakdown.

Effects of SSW

1. The sudden warming of Stratosphere can lead to very cold weather over Europe and Siberia, with an increased possibility of snow storms.
2. According to scientists and IMD, SSW may be one of the reasons for the rainfall in the tropics during winter days (especially over Tamil Nadu).
3. The weather in the atmospheric layers above the stratosphere — mesosphere and thermosphere — also get affected by SSW. This is a cause for concern for satellite navigation and other space-based human endeavours.
4. Recent research has conclusively shown the existence of a strong connection between SSWs and extensive changes throughout Earth's atmosphere.

Topic 126: Rossby Waves

Key points:

1. Rossby waves, also known as planetary waves, naturally occur in rotating fluids.
2. Rossby waves can be classified into two types – Oceanic Rossby Waves and Atmospheric Rossby Waves
3. Within the Earth's ocean and atmosphere, these waves form as a result of the rotation of the planet. These waves affect the planet's weather and climate.

Oceanic Rossby Waves

1. Unlike waves that break along the shore, Rossby waves are huge, undulating movements of the ocean that stretch horizontally across the planet for hundreds of kilometers in a westward direction.
2. Oceanic Rossby Waves are so large and massive that they can change Earth's climate conditions.
3. Along with rising sea levels, King Tides, and the effects of El Niño, oceanic Rossby waves contribute to high tides and coastal flooding in some regions of the world.
4. The vertical motion of Rossby waves is small along the ocean's surface and large along the deeper thermocline. Due to the small vertical movement along the ocean surface, oceanic Rossby waves are undetectable by the human eye.

Atmospheric Rossby Waves

1. They form primarily as a result of the Earth's geography.
2. Rossby waves help transfer heat from the tropics toward the poles and cold air toward the tropics in an attempt to return atmosphere to balance.
3. They also help locate the jet stream and mark out the track of surface low pressure systems.
4. The slow motion of these waves often results in fairly long, persistent weather patterns.

Topic 127 and 128: South Atlantic Anomaly (SAA) and Van Allen radiation belt

Key points: About South Atlantic Anomaly (SAA)

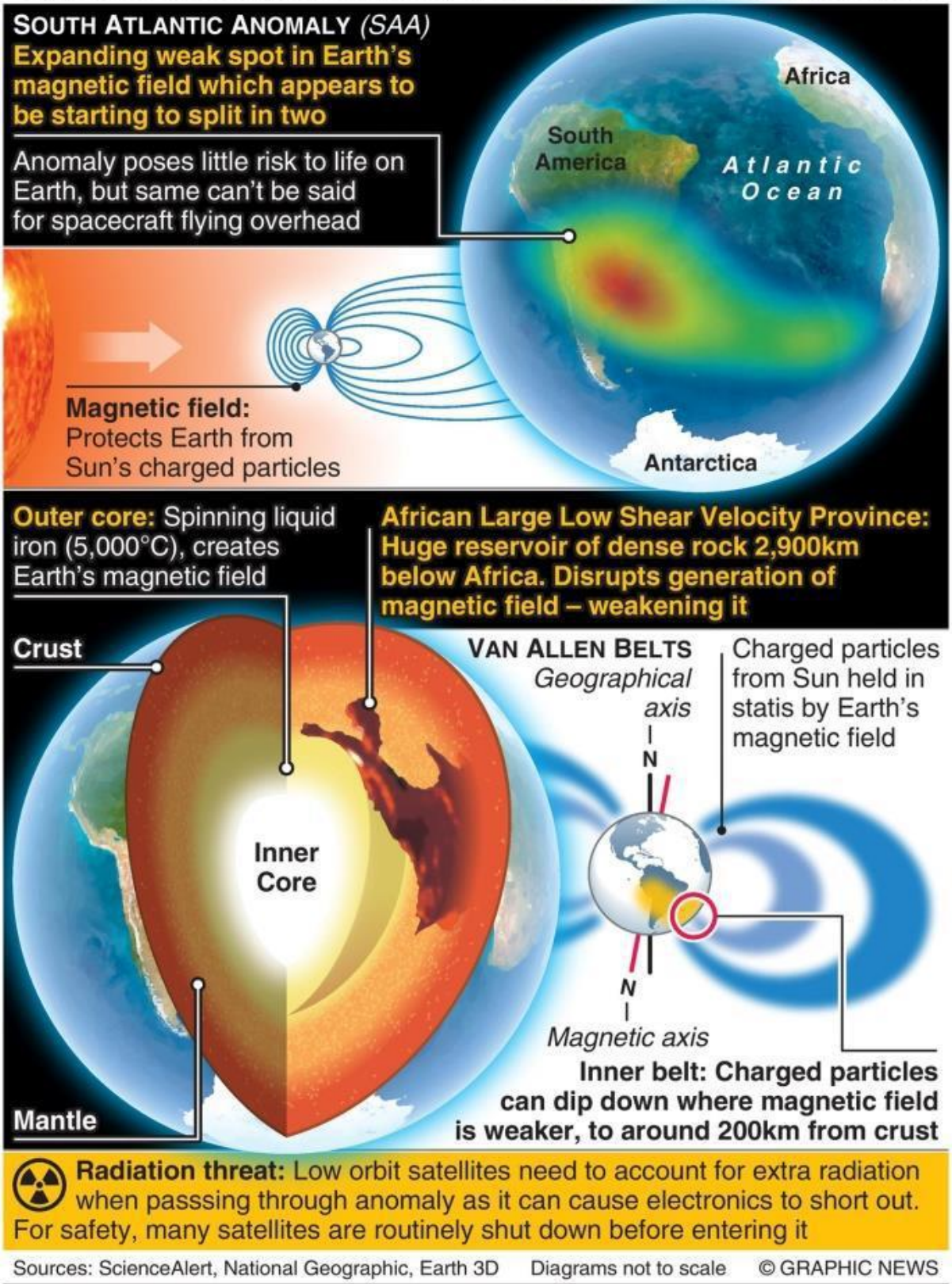
1. SAA is a stretch between Africa and South America.
2. It is an area where the Earth's inner Van Allen radiation belt comes closest to the Earth's surface
3. The SAA is the near-Earth region where the Earth's magnetic field is weakest relative to an idealized Earth-centered dipole field.
4. With the South Atlantic Anomaly widening, the weak spot is letting the harmful particle radiation from Sun come near to the surface. Not only that, this anomaly also affects satellites that pass through the area and tamper with the navigation.
5. South Atlantic Anomaly (SAA) is caused by processes in the Earth. The tilt of the magnetic axis and the molten core of the Earth both cause the dent in the magnetic field.
6. As the Earth's North Pole and South Pole are not perfectly aligned, the tilt in the axis lead to this anomaly combined with the motions on the outer layer of the molten core.

A Van Allen radiation belt

- It is a zone of energetic charged particles, most of which originate from the solar wind, that are captured by and held around a planet by that planet's magnetic field.
- Earth has two such belts and sometimes others may be temporarily created.

The "dent" in Earth's magnetic field

NASA is monitoring a strange anomaly in Earth's magnetic field – a vast region of lower magnetic intensity in the skies above the South Atlantic



Topic 129: Space Hurricanes

Why in news?

For the first time, scientists have discovered a "space hurricane" that swirled over the North Pole, in Earth's upper atmosphere.

Key points:

1. A 'space hurricane' is a swirling mass of plasma. It rains electrons instead of water.
2. Large, swirling storms called hurricanes hit frequently in the Earth's low atmosphere, but they were not known to occur in the upper atmosphere.
3. Hurricanes are characterised by a low-pressure centre (hurricane eye), strong winds and flow shears, and a spiral arrangement of towering clouds with heavy rains.
4. Hurricanes often cause loss of life and property through high winds and flooding resulting from the coastal storm surge of the ocean and the torrential rains.
5. Unlike other hurricanes, a space hurricane rains electrons into the ionosphere, causing a stunning effect: a huge, cyclone-shaped glowing green aurora below the hurricane.
6. In space, astronomers have spotted hurricanes on Mars, and Saturn, and Jupiter, which are similar to terrestrial hurricanes in the low atmosphere. There are also solar gases swirling in monstrous formations deep within the sun's atmosphere, called solar tornadoes. However, hurricanes had not been reported in the upper atmosphere of the planets in our heliosphere.

Topic 130: Heliosphere

Key points:

1. Heliosphere acts like a shield to our solar system that guards us against the rest of the galaxy from particles shot after a supernova.
2. However, it can't absorb all of the radiations and lets a quarter of these galactic rays into our solar system.
3. The particles that break through our heliosphere are still dangerous but our planet is protected by its magnetic field and atmosphere.
4. The heliosphere is the vast, bubble-like region of space that surrounds and is created by the Sun.
5. In plasma physics terms, it is the cavity formed by the Sun in the surrounding interstellar medium.

IASBABA'S

RAPID REVISION (RaRe) SERIES - UPSC 2021

RaRe Notes

DAY 18 - GEOGRAPHY

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Topics Coverage:

131. Tropical Cyclones and conditions for their formation
132. Temperate cyclones and how they are different from Tropical Cyclones
133. Factors that have led to the increased frequency of Tropical Cyclones
134. Naming of Tropical Cyclones
135. Reasons for deficient rainfall during N-E Monsoon
136. Artificial Rain
137. Western Disturbances
138. BoBBLE Experiment-Indian Monsoon
139. Karman Line
140. Heliosphere, Helio-sheath and Heliopause

Topic 131: Tropical Cyclones

Cyclones in 2020 and 2021

Amphan (May 16-21, 2020)	Bay of Bengal	West Bengal, Odisha, Bangladesh, Sri Lanka, Bhutan
Nisarga (June 1-4, 2020)	Arabian Sea	Maharashtra, Goa
Nivar (Nov 23-27, 2020)	Bay of Bengal	Sri Lanka, Andhra Pradesh, Tamil Nadu, Puducherry
Burevi (Nov 30-Dec 5, 2020)	Bay of Bengal	Sri Lanka, Tamil Nadu, Kerala
Tauktae (May 14-19, 2021)	Arabian Sea	Delhi, Kerala, Lakshadweep, Maldives, Haryana, Sindh, Sri Lanka, West India
Yaas (May 23-28, 2021)	Bay of Bengal	Andaman and Nicobar Islands, Bangladesh, East India, Nepal, Uttar Pradesh

Key points:

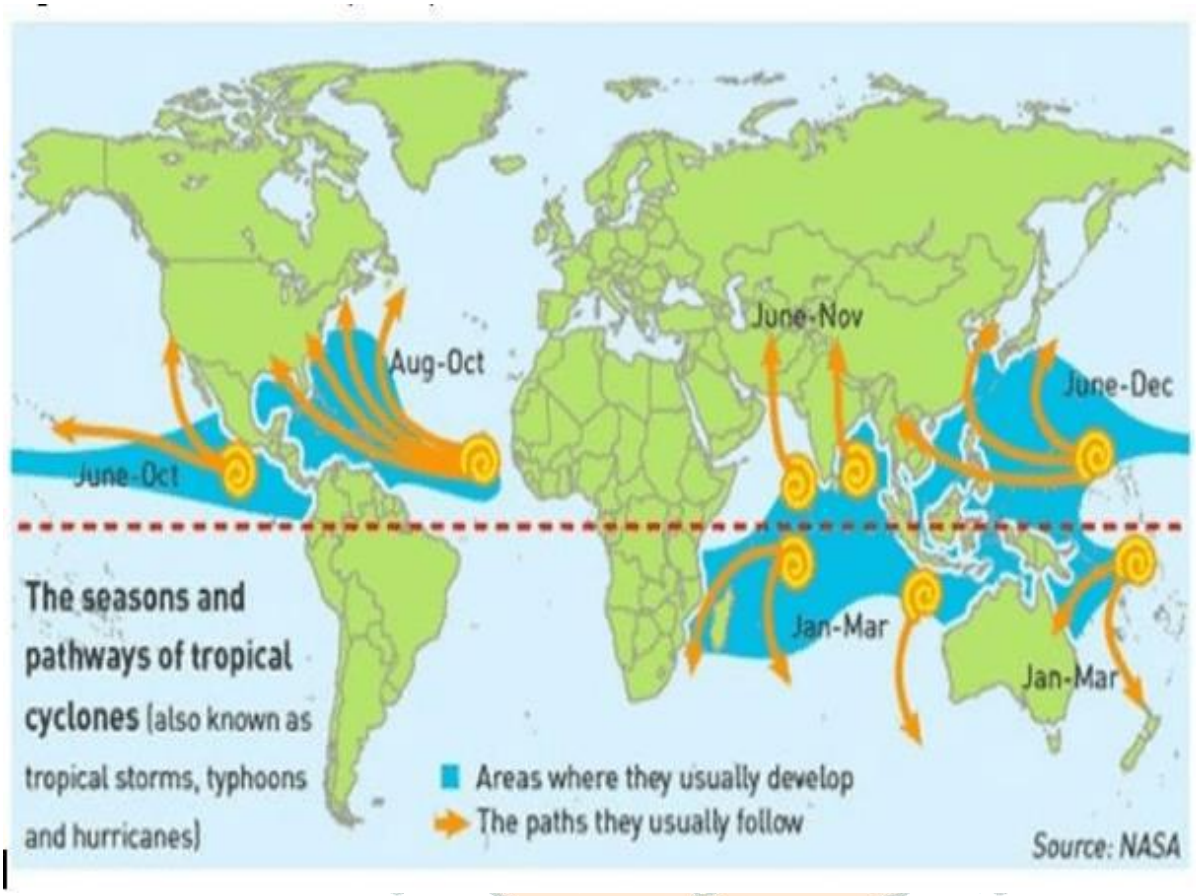
1. Cyclone is an intense low pressure area or a whirl in the atmosphere over tropical or sub-tropical waters, with organised convection (i.e. thunderstorm activity) and winds at low levels, circulating either anti-clockwise (in the northern hemisphere) or clockwise (in the southern hemisphere).
2. Tropical cyclones are violent storms that originate over oceans in tropical areas and move over to the coastal areas bringing about large scale destruction caused by violent winds, very heavy rainfall and storm surges.
3. They are known as Cyclones in the Indian Ocean, Hurricanes in the Atlantic, Typhoons in the Western Pacific and South China Sea, and Willy-willies in the Western Australia.

Tropical cyclones or hurricanes

- Such Cyclones use warm, moist air as fuel.
- Therefore, they form over warm ocean waters near the equator.
- The tropical cyclones that form over the Atlantic Ocean or the eastern Pacific Ocean are called hurricanes.
- The ones that form in the Northwest Pacific are called typhoons.
- Tropical storms that form in the Bay of Bengal or the Arabian Sea are called cyclones.

Hurricanes are categorised on the Saffir-Simpson Hurricane Wind Scale, which rates them on a scale of 1 to 5 based on wind speed.
Hurricanes that reach category three or higher are called 'major hurricanes' because of their potential to cause devastating damage to life and property.
From the centre of a cyclonic storm, pressure increases outwards. The amount of the pressure drop in the centre and the rate at which it increases outwards gives the intensity of the cyclones and the strength of winds.
Tropical cyclones require certain conditions for their formation. These are

1. A source of warm, moist air derived from tropical oceans with sea surface temperature normally near to or in excess of 27 °C
2. Winds near the ocean surface blowing from different directions converging and causing air to rise and storm clouds to form
3. Winds which do not vary greatly with height – known as low wind shear. This allows the storm clouds to rise vertically to high levels;
4. Presence of Coriolis force, provides energy to rotate or curve in anti-clockwise (in the northern hemisphere) or clockwise (in the southern hemisphere)



There are six regions that are more vulnerable to tropical cyclones:

1. **Tropical North Atlantic (Gulf of Mexico, West Indies and Caribbean Sea):** Cyclones in this region is known as Hurricane, occur mainly during August-October. Main reasons being increased sea surface temperature, convective instability, low wind shear and other thermodynamic activities. Examples- Hurricane Katrina, Florence etc.
2. **Eastern part of the tropical north pacific (Western coast of Mexico and Central America):** also known as Hurricane, usually observed during June-July. The shifting of Intertropical Convergence Zone (ITCZ) northwards and low pressure formed, aided by northwest movement of wind (due to Coriolis force) favours the formation of Tropical Cyclone in this region.
3. **Western part of tropical north pacific (The Philippines, the China Sea and areas around Japan):** The cyclones in this region are called as Typhoon, occurs during months of June-December. The presence of low vertical wind shear of less than 10 metres/second, monsoon trough and atmospheric instability favours development of tropical Typhoons.

4. **Bay of Bengal and Arabian Sea:** They are more frequent during June-September, high sea temperature along with the low pressure regions, sometimes the typhoons originating in western pacific too help in cyclone formation. Ex-Fani, Ochkhi etc
5. **Western South Pacific Ocean (regions of Samoa, Fiji Island and the east and north coast of Australia):** Occur during January-March season. They too are result of high surface temperature and low vertical wind shear that result in atmospheric instability and heavy cloudiness.
6. **The south coast of Indian Ocean (coastal regions of Madagascar):** Occurs during January-March and the westward movement of tropical depression intensified by low vertical wind shear favours cyclone formation. One dangerous recent event is the Idai Cyclone (March 2019) that resulted in more than 1300 deaths and several missing cases.

Topic 132: Temperate cyclones

Key points:

1. They are majorly dynamic in origin (Movement of air masses and coriolis force- Frontogenesis), they occur during winter seasons and are away from equator region.
2. They are largely non-destructive due to slow moving winds, but there might be damage due to flooding.
3. They can occur both on land and water.
4. They occur scattered but irregular intervals throughout the zone of westerlies.
5. They impact mainly in Northern hemisphere (due to less land availability in Southern Hemisphere).

Difference between Tropical Cyclones and Temperate Cyclones

Tropical Cyclone	Temperate cyclone
Formed in the lower latitudes – Confined to 10-30º N and S of equator.	Formed in the higher latitudes – 35 to 65 degrees N and S of equator.
Originates via formation of central low-pressure zone surrounded by high pressure zones.	Originate via merger of cold and warm fronts.
They are more intense and destructive.	Not so intense and destructive.
Due to the action of Coriolis force, they move from east to west.	They move from west to east.
They affect a smaller area.	They affect a wider area, mostly two to three continents.
Tropical Cyclone forms only on seas with temperature more than 26-27degree C and dissipate on reaching the land.	Temperate cyclones can be formed on both land and sea.
A tropical cyclone doesn't last for more than 7 days as they travel lesser distances.	A Temperate cyclone can last for a duration of 15 to 20 days.
It is characterised by cyclonic eye.	Absence of such eye.
Eye is calm and cloudless without precipitation.	Due to absence of eye, precipitation occurs even in the centre of the cyclone.
The diameter of tropical cyclone varies from 150 to 500 km and vertically from surface to about 12 km	The diameter of these cyclones may vary from **160 km to 3200 km.**

The isobar of tropical cyclones are circular in shape and pressure gradient is very steep.	Temperate cyclones isobars are V-shaped and pressure gradient is gentle.
The velocity of wind of tropical cyclone is greater – 100 to 220 kmph (during severe storms).	The velocity of wind of temperate cyclone is comparatively low – 40 to 60 kmph
Travel **about 300 to 400 miles a day.**	**Travel at about 20 to 30 miles per hour.**
Rainfall/Precipitation – Heavy but does not last beyond a few hours. If the cyclone stays at a place, the rainfall may continue for a few days.	**In a temperate cyclone, rainfall is slow and continues for many days, sometimes even weeks.**

Topic 133: Factors that have led to the increased frequency of tropical cyclones

The factors leading to increased frequency of tropical cyclones

1. Increase in frequency of tropical cyclones is specifically observed in Arabian Sea. Here winter monsoon circulations, plays an important role.
2. The interplay of global warming, climate variability and weather changes, the winter northeast monsoon circulation has been weakening over the years.
3. One important factor is the wind shear, or the change in direction and speed of the winds from bottom to the top of the atmosphere.
4. Generally, this wind shear is relatively strong in the Arabian Sea compared to the Bay of Bengal.
5. Opposing winds prevent cyclones from developing vertically, this wind shear is weakening in the Arabian Sea with increased carbon dioxide in the atmosphere.
6. Important contributors to rise in global temperatures, such as manmade black carbon particles and sulphate emissions might have increased the intensity of these cyclones in almost all oceans of tropics.
7. On the other hand burning of fossil fuels such as petrol, diesel, etc. was the main reason for climate change as it had affected the greenhouse gas cover around the earth, leading to a rise in atmospheric temperature.
8. Similarly, aerosols, greenhouse gases, volcanic activity, solar variability, and internal climate variability also add degrees to sea surface temperature, making the conducive weather conditions for tropical cyclones.
9. A La Niña (a weather pattern in the Pacific Ocean that is less damaging than El Niño) event is unfolding over the Pacific. Studies have shown that La Niña conditions change the atmospheric circulation over the north Indian Ocean and make them favourable for cyclogenesis.

Reason for coastal India to be susceptible:

India has two water bodies on both sides they are Arabian Sea and Bay of Bengal.
Bay of Bengal is more susceptible compared to Arabian Sea due to various factors like:

1. High temperature difference between land and sea.
2. Coriolis force.
3. Topographic of eastern region: absence of mountains to block.
4. Remnants of Pacific Ocean hurricane.
5. Air circulation and trade winds from north east.

6. Heat Island: Coastal regions are heavily industrialized.

Topic 134: Naming of Tropical Cyclones

Key points:

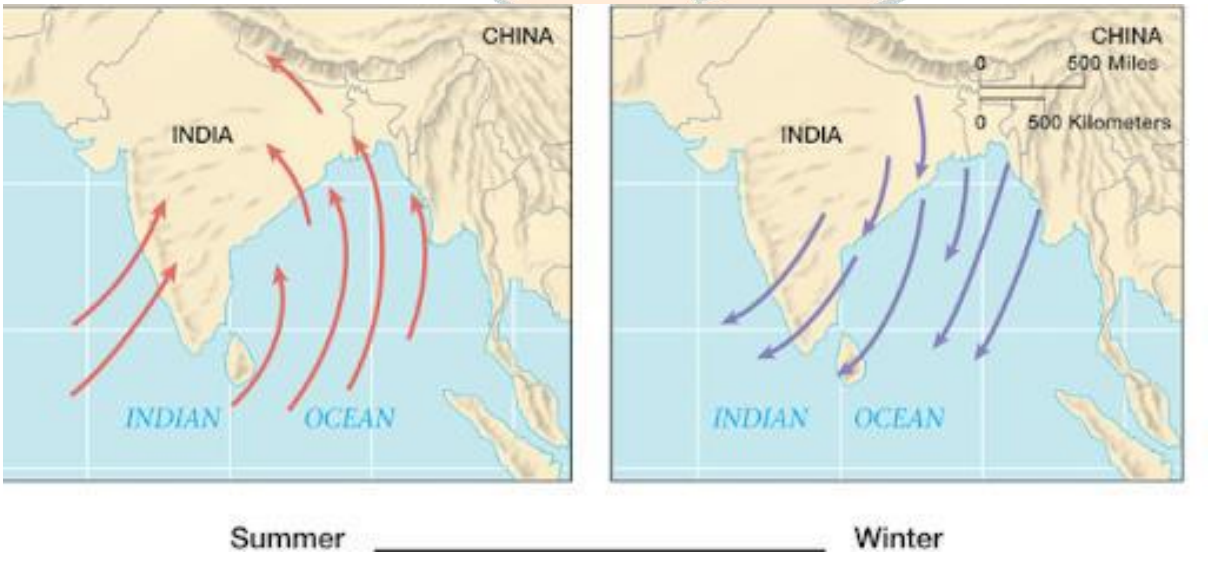
1. The tradition of naming Cyclones started with hurricanes in the Atlantic Ocean
2. In 2000, a group of nations called WMO/ESCAP (World Meteorological Organisation/United Nations Economic and Social Commission for Asia and the Pacific) was formed.
3. This comprised Bangladesh, India, the Maldives, Myanmar, Oman, Pakistan, Sri Lanka and Thailand.
4. Further, The WMO/ESCAP expanded to include five more countries in 2018 — Iran, Qatar, Saudi Arabia, United Arab Emirates and Yemen. And currently, there are 13 nations altogether.
5. Each of these nations provide their own list of names which would be clubbed to form one single list. And the subsequent cyclones will be named accordingly.

New list of Names for Tropical Cyclones

Place	List 1	List 2	List 3	List 4	List 5	List 6	List 7	List 8	List 9	List 10	List 11	List 12	List 13
Bangladesh	Nisarga	Biparjoy	Arnab	Upakul	Barshon	Rajani	Nishith	Urmi	Meghala	Samiron	Pratikul	Sarobor	Mahanisha
India	Gati	Tej	Murasu	Aag	Vyom	Jhar	Probaho	Neer	Prabhanjan	Ghurni	Ambud	Jaladhi	Vega
Iran	Nivar	Hamoon	Akvan	Sepand	Booran	Anahita	Azar	Pooyan	Arsham	Hengame	Savas	Tahamtan	Toofan
Maldives	Burevi	Midhili	Kaani	Odi	Kenau	Endheri	Riyau	Guruva	Kurangi	Kuredhi	Horangu	Thundi	Faana
Myanmar	Tauktae	Michaung	Ngamann	Kyarthit	Sapakyee	Wetwun	Mwaihout	Kywe	Pinku	Yinkaung	Linyone	Kyeekan	Bautphat
Oman	Yaas	Remal	Sail	Naseem	Muzn	Sadeem	Dima	Manjour	Rukam	Watad	Al-jarz	Rabab	Raad
Pakistan	Gulab	Asna	Sahab	Afshan	Manahil	Shujana	Parwaz	Zannata	Sarsar	Badban	Sarrab	Gulnar	Waseq
Qatar	Shaheen	Dana	Lulu	Mouj	Suhail	Sadaf	Reem	Rayhan	Anbar	Oud	Bahar	Seef	Fanar
Saudi Arabia	Jawad	Fengal	Ghazeer	Asif	Sidrah	Hareed	Faid	Kaseer	Nakheel	Haboob	Bareq	Alreem	Wabil
Sri Lanka	Asani	Shakhti	Gigum	Gagana	Verambha	Garjana	Neeba	Ninnada	Viduli	Ogha	Salitha	Rivi	Rudu
Thailand	Sitrang	Montha	Thianyot	Bulan	Phutala	Aiyara	Saming	Kraison	Matcha	Mahingsa	Phraewa	Asuri	Thara
United Arab Emirates	Mandous	Senyar	Afoor	Nahhaam	Quffal	Daaman	Deem	Gargoor	Khubb	Degl	Athmad	Boom	Saffar
Yemen	Mocha	Ditwah	Diksam	Sira	Bakhur	Ghwyzi	Hawf	Balhaf	Brom	Shuqra	Fartak	Darsah	Samhah

Topic 135: Reasons for deficient rainfall during N-E Monsoon

We know that, India's climate is affected by two seasonal winds - the northeast monsoon and the southwest monsoon.



Southwest monsoon	Northeast monsoon
Occurs between June and September Commonly known as summer monsoon	Occurs during October to December Commonly known as winter monsoon
Blows from sea to land	Blows from land to sea
Brings most of the rainfall during a year in the country (75%)	It is comparatively a small-scale monsoon
These winds cause country-wide rainfall.	These cause rainfall only in Coromandel coast including Tamil Nadu when these strike at the wetlands of the Eastern Ghats.
These blow from oceanic high pressure areas towards the low pressure areas of land.	These winds blow from land to sea as a result of reversal in the direction of wind or start of retreating monsoon season.

Key points:

1. After the complete withdrawal of the Southwest monsoon from the country takes place by mid-October, the wind pattern rapidly changes from the south-westerly to the north-easterly direction.
2. The period after the Southwest monsoon season, from October to December, is the peak time for cyclonic activity in the North Indian Ocean region — covering the Arabian Sea and the Bay of Bengal.
3. The winds associated with the formation of low pressure systems, depressions, or cyclones influence the N-E monsoon, and therefore, the rainfall.

Reasons for the deficiency of rainfall during Northeast monsoon

1. Prevailing La Niña conditions in the Pacific Ocean	While La Niña conditions enhance the rainfall associated with the Southwest monsoon, it has a negative impact on rainfall associated with the Northeast monsoon. During La Niña years, low pressure or cyclones which are formed in the Bay of Bengal remain significantly to the north of their normal position. As they lie to the north of their normal position, not much rainfall occurs over southern regions like Tamil Nadu.
2. Position of the Inter Tropical Convective Zone (ITCZ)	ITCZ position - northward and southward movements - along the equator determine the precipitation in the tropics When ITCZ is located to the north of its normal position, it contributes to the poor rainfall during the N-E monsoon season.

Topic 136: Artificial Rain

Key points:

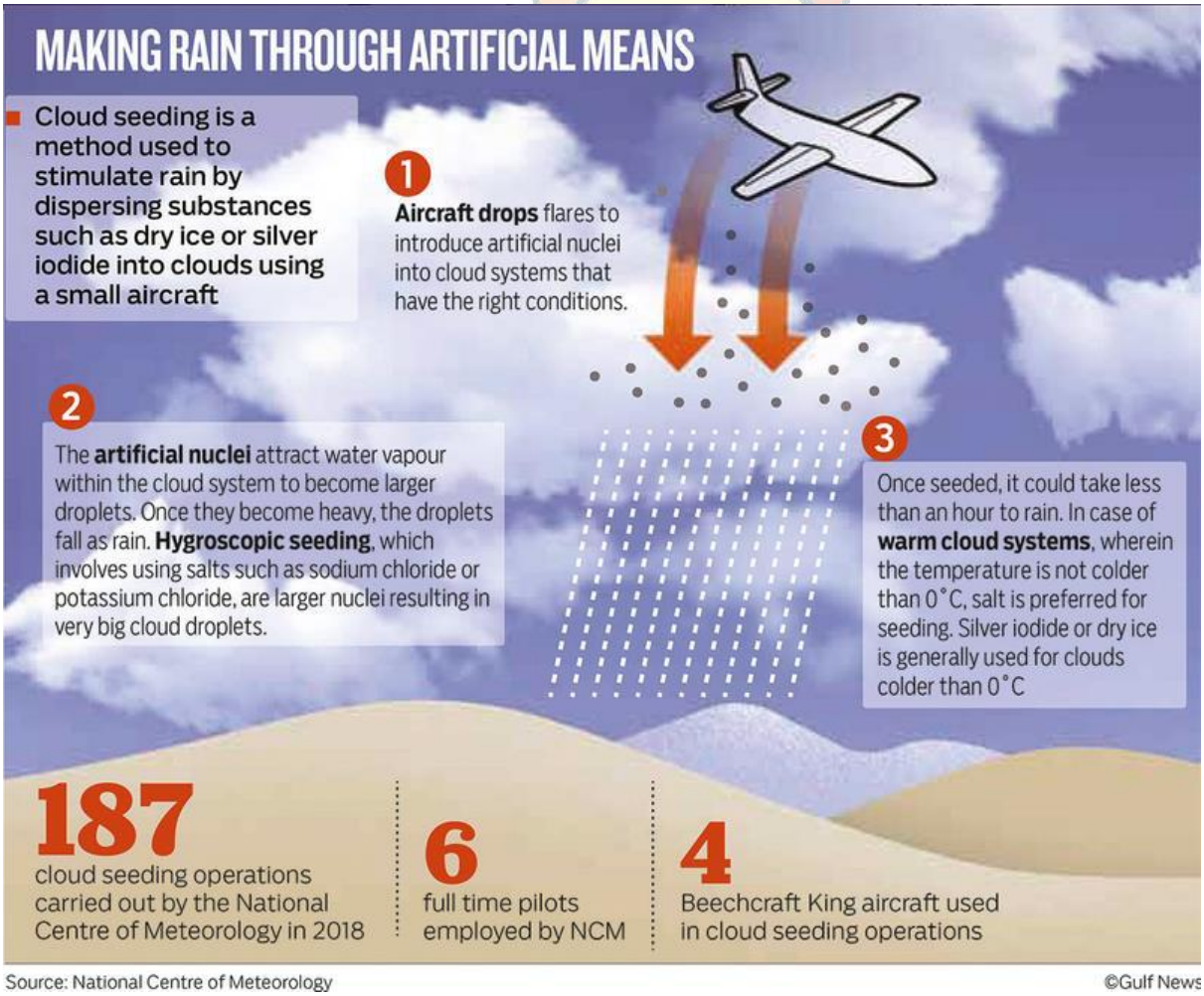
1. It's a practice of artificially inducing or increasing precipitation through clouds by adding external agents. (This process is known as Cloud Seeding.)
2. External agents or foreign particles could be Dry Ice (solid carbon dioxide), Silver Iodide, Salt powder etc.
3. During the times of drought and dryness, the temperature is so high that the mass of air is unable to reach the due point. Hence, condensation fails to take place thus leading to prolonged drought.

4. In order to hasten the condensation, the condensation nuclei are infused into the air masses, thereby speeding up the condensation and in turn precipitation.

How is artificial rain produced?

The process includes three stages, the first is agitation, second is called building-up stage and the third bombardment of chemicals.

Agitation Stage	• This process involves using chemicals to stimulate the air mass upwind of the target area to rise and form rain clouds. • These clouds are capable of absorbing water vapour from the air mass thus stimulating the condensation process in the clouds. • Chemicals like - Calcium Oxide, compound of Urea and Ammonium Nitrate or Chloride Calcium Carbonate – are used.
Building-up stage	• The cloud mass is built up using chemicals like kitchen salt, ammonium nitrate, urea and occasionally calcium chloride.
Seeding	• Chemicals such as super cool agents like silver iodide and dry ice are used to reach the most unbalanced status which eventually leads to the formulation of droplets and make them fall as raindrops.



Topic 137: Western Disturbances

Key points:

1. A western disturbance (WD) is an extra-tropical storm which originates in the Mediterranean region
2. It brings sudden winter rain to the northern parts of the Indian subcontinent.
3. It is a non-monsoonal precipitation pattern driven by the westerlies.
4. The moisture in these storms usually originates over the Mediterranean Sea, the Caspian Sea and the Black Sea.
5. Extra-tropical storms are a global phenomenon with moisture usually carried in the upper atmosphere, unlike their tropical counterparts where the moisture is carried in the lower atmosphere.
6. In the case of the Indian subcontinent, moisture is sometimes shed as rain when the storm system encounters the Himalayas.
7. Western disturbances are more frequent and stronger in winter season.
8. Western disturbances are important for the development of the Rabi crop, which includes the locally important staple wheat.

Role of Jet streams:

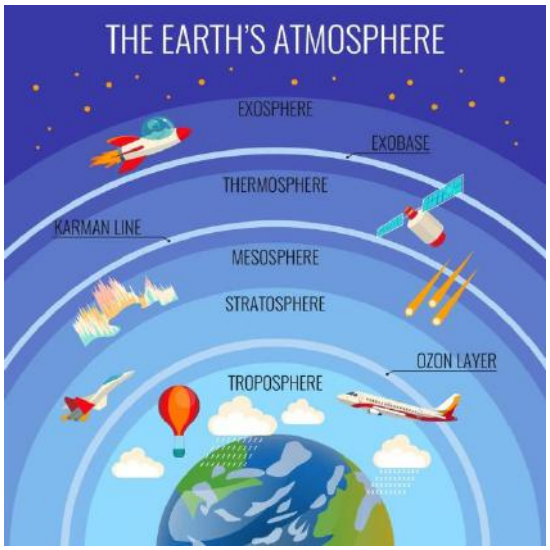
1. Westerly jet stream blows at a very high speed during winter over the sub-tropical zone. This jet stream is bifurcated by the Himalayan ranges and Tibetan Plateau.
2. The northern branch of this jet stream blows along the northern edge of the Tibetan Plateau.
3. The southern branch blows to the south of the Himalayan ranges along 25° north latitude.
4. Meteorologists believe that southern branch of jet stream exercises a significant influence on the winter weather conditions in India.
5. The upper jet is responsible for steering of the western depressions [Western Disturbances] from the Mediterranean Sea.

Topic 138: BoBBLE Experiment-Indian Monsoon

Key points:

1. BoBBLE → Bay of Bengal Boundary Layer Experiment
2. It is a joint India-UK project → funded by Union Ministry of Earth Sciences and the Natural Environment Research Council of UK
3. Aim is to create a blueprint for accurate prediction of monsoon, tropical cyclones and other weather related forecasts
4. Understand the role of thermodynamic surface and mixed layer processes in the monsoon
5. Understand the role of large-scale ocean structure, ocean dynamics and ocean biogeochemistry in the monsoon.

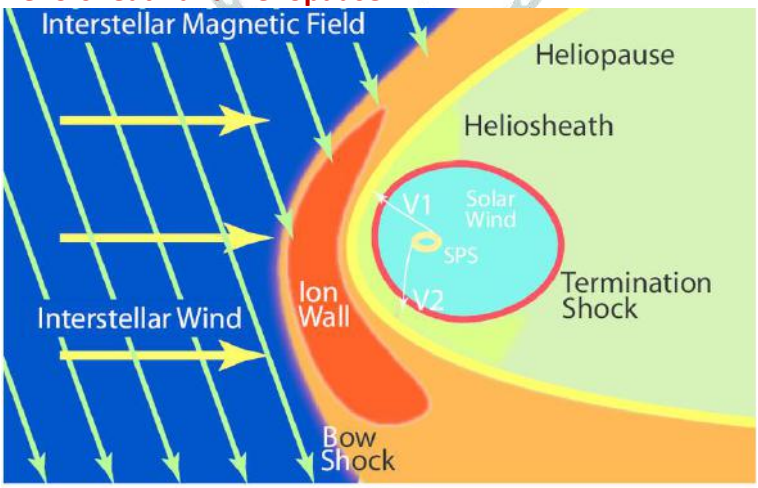
Topic 139: Karman Line



Key points:

1. The Karman line is the altitude where space begins (internationally recognized boundary of space).
2. It commonly represents the border between the Earth's atmosphere and outer space.
3. The line is named after Theodore von Kármán (1881–1963), a Hungarian American engineer and physicist, who was active primarily in aeronautics and astronautics.
4. It is an imaginary boundary 100 kilometers (62 miles) above mean sea level. In theory, once this 100 km line is crossed, the atmosphere becomes too thin to provide enough lift for conventional aircraft to maintain flight.
5. At this altitude, a conventional plane would need to reach orbital velocity or risk falling back to Earth.

Topic 140: Heliosphere, Helio-sheath and Heliopause



Key points:

Heliosphere	• The solar wind, emanating from the Sun, creates a bubble that extends far past the orbits of the planets. This bubble is the heliosphere. • It is shaped like a long wind sock as it moves with the Sun through interstellar space.

Helio-sheath	• The helio-sheath is the outer region of the heliosphere, just beyond the termination shock, the point where the solar wind slows abruptly, becoming denser and hotter. • The solar wind piles up as it presses outward against the approaching wind in interstellar space.
Heliopause	• The boundary between solar wind and interstellar wind is the heliopause, where the pressure of the two winds are in balance. • This balance in pressure causes the solar wind to turn back and flow down the tail of the heliosphere.

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RaRe Notes

DAY 31 - GEOGRAPHY

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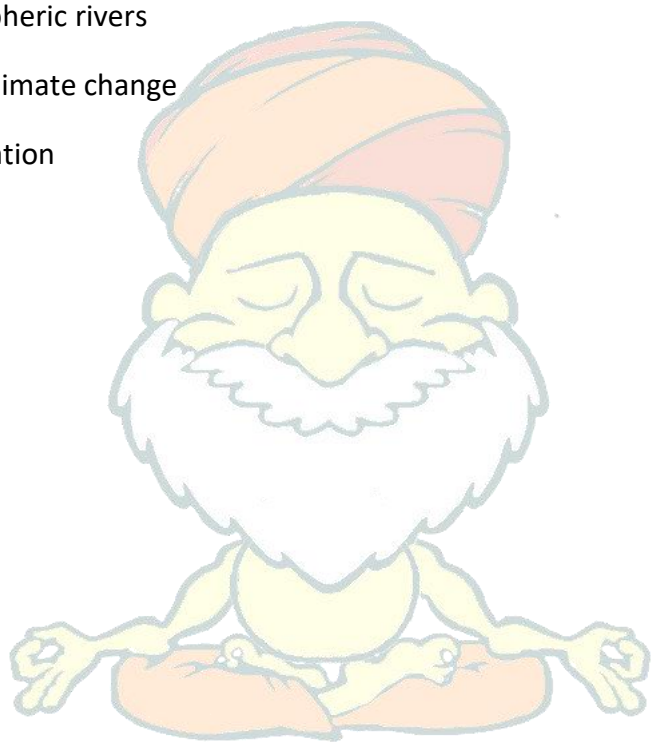
Index



221. Kelp Forests

In News: Satellite imagery shows that the area covered by kelp forests off the coast of Northern California has dropped by more than 95 percent.

- Also, Tasmanian Kelps – lost due to ocean warming.
- Sea urchins can destroy entire kelp forests by moving in herds whereas Sea otters play a key role in stabilizing Sea urchin populations so that kelp forests may thrive. So if the population of Sea otters decreases for any reason (discharge of waste into sea) then Sea Urchin population increases which threatens kelp forests.

About Kelp Forests

- Kelp Forests are underwater ecosystems formed in shallow water by the dense growth of several different species known as kelps.
- **Kelps are actually extremely large brown algae**, although they look like plants.
- They thrive in cold, nutrient-rich waters.
- Kelp attaches to the seafloor and eventually grows to the water's surface and relies on sunlight to generate food and energy.
- Kelps live further from the tropics than coral reefs, mangrove forests, and warm-water seagrass beds, so kelp forests do not overlap with those systems.
- They even grow under sea ice.
- Kelp forests have been observed throughout the Arctic and Canadian Arctic alone represents 10 percent of the world's coastlines.

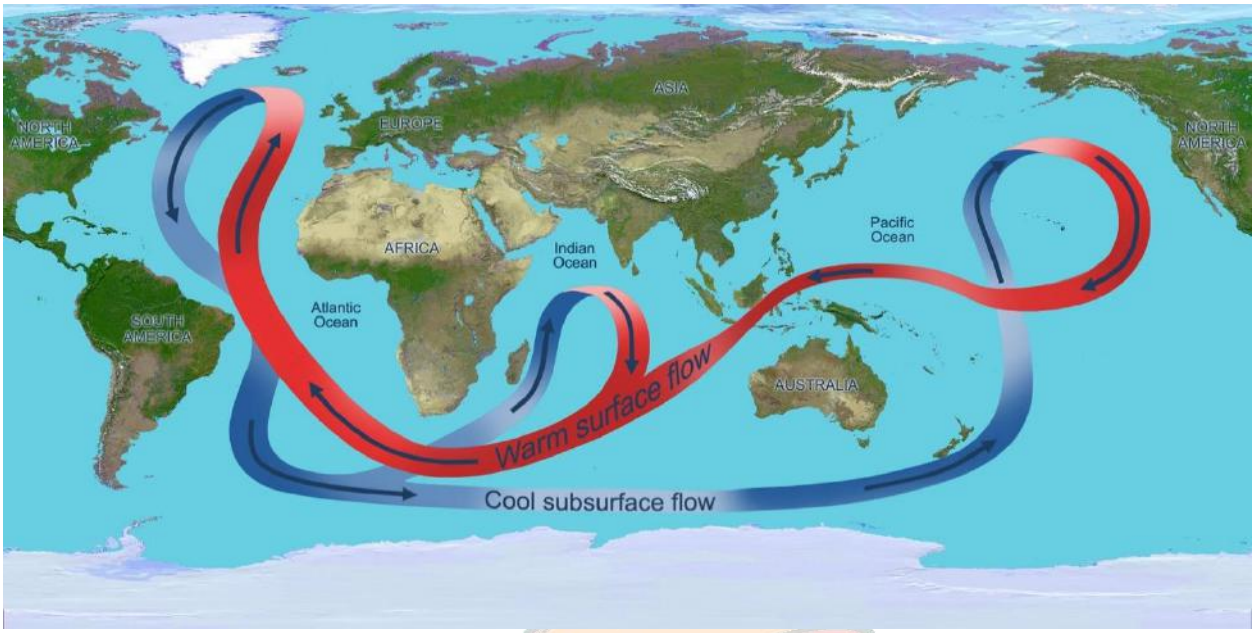
Ecological Role

- Kelp serves as an ecosystem foundation: feeding and sheltering diverse ocean species. Many fish species use kelp forests as **nurseries for their young.**
- Seabirds and marine mammals like sea lions, sea otters and even grey whales use them as **shelter from predators and storms.**
- Kelp forests also reduce coastal erosion and serve as a buffer against strong storm-born waves.
- Since climate change will likely heighten the severity of weather events like storms, kelp forests provides protection to coastal communities

Threats

- Destructive fishing practices, coastal pollution and accidental damage caused by boat entanglement are known to negatively affect kelp forests.
- Climate change could lead to declines of underwater kelp forests through impacts on their micro biome.
- It was predicted that ocean warming and acidification can change microbes on the kelp surface, leading to disease and potentially putting fisheries at risk.

222. Atlantic meridional overturning circulation.



In News: For thousands of years, Atlantic Meridional Overturning Circulation (AMOC) has remained stable but in the last 15 years, signs show that **AMOC may be slowing,** which could have drastic consequences on the global climate.

- However, the rising temperatures in the Indian Ocean can help to boost the AMOC and delay slow down.

Atlantic Meridional Overturning Circulation (AMOC)

- It is **one of the Earth's largest water circulation systems** where ocean currents move warm, salty water from the tropics to regions further north, such as western Europe and sends colder water south.
  - As warm water flows northwards in the Atlantic, it cools, while evaporation increases its salt content.
  - Low temperature and high salt content increases the density of the water, causing it to sink deep into the ocean.
  - The deep cold dense water slowly spreads southward.
  - Eventually, it gets pulled back to the surface and warms again, and the circulation is complete.
  - This continual mixing of the oceans and the distribution of heat and energy around the planet contributes to the global climate.
- Atlantic Meridional Overturning Current (AMOC) **ensures the oceans are continually mixed, and heat and energy are distributed around Earth.**
- It is sometimes referred to as the **"Atlantic conveyor belt"**

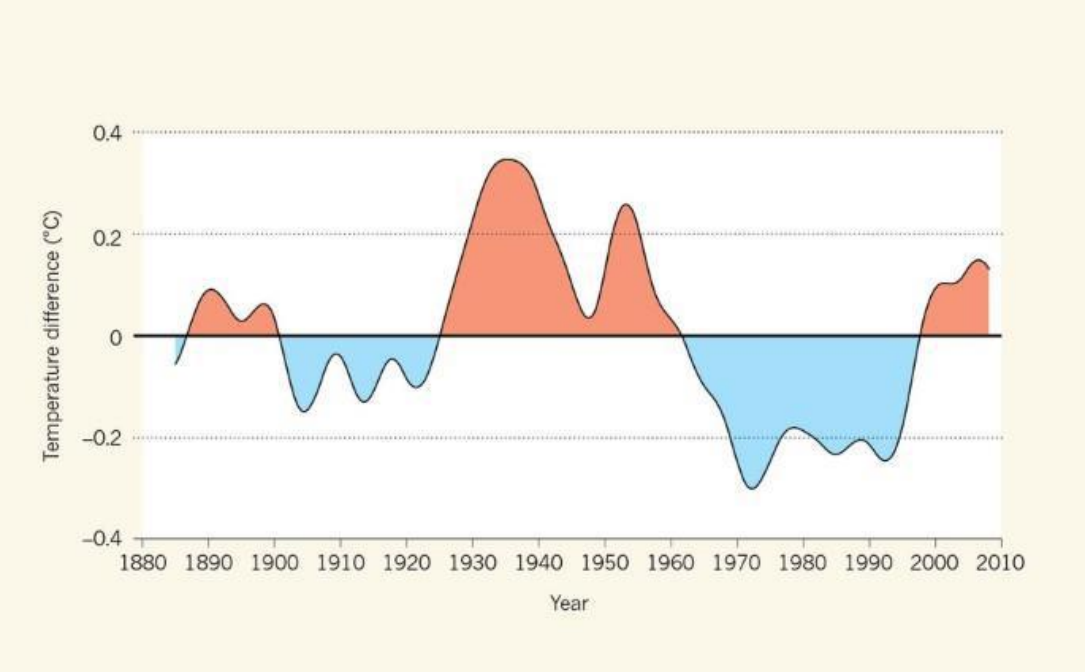
How Indian Ocean temperature rise is helping AMOC?

- Warming in the Indian Ocean generates additional precipitation, which, in turn, draws more air from other parts of the world, including the Atlantic.
- With so much precipitation in the Indian Ocean, there will be less precipitation in the Atlantic Ocean.

- Lesser precipitation leads to higher salinity in the waters of the tropical portion of the Atlantic — because there won't be as much rainwater to dilute it.
- This saltier water in the Atlantic, as it comes north via AMOC, will get cold much quicker than usual and sink faster.
- The above process would act as a jump start for AMOC, intensifying the circulation.
- But if other tropical ocean's warming, especially the Pacific's, catches up with the Indian Ocean, the advantage of intensification for AMOC may stop.
- Moreover, it isn't clear whether the slowdown of AMOC is caused by global warming alone or it is a short-term anomaly related to natural ocean variability.
- Slow down of AMOC had taken place 15,000 to 17,000 years ago which caused harsh winters in Europe, with more storms or a drier Sahel in Africa due to the downward shift of the tropical rain belt.

223. Decadal Swing

In News: A recent study showed that Atlantic multi decadal Variability (AMV) can cause changes in world's weather.



- Atlantic multidecadal variability (AMV) describes **alternating swings in sea surface temperature in the North Atlantic Ocean** that occur with a characteristic timescale of several decades
- Conventional wisdom holds that AMV is driven mainly by **internal processes** in the Atlantic climate system — in particular, by naturally occurring changes in atmospheric and ocean circulation
- However, in the recent years, some researchers have suggested a possible implication of **external drivers** (including volcanos, solar variability, anthropogenic aerosols emission). Both internal and external drivers are likely important for the AMV and they are not mutually exclusive.
- Understanding the mechanisms that underlie AMV is crucial for developing models **to predict future climate.**

The Atlantic Multidecadal Variability (AMV) is particularly important while affecting several components of

the climate, even in Europe and in the Mediterranean region as it leads to

- Drier condition over the Mediterranean basin
- Wetter condition over Northern Europe
- Rainfall variability over Sahel, Arctic sea-ice and Greenland ice sheet
- Increased Atlantic hurricanes frequency etc.

224. Particle Laden Atmospheric Rivers

In News: For the first time scientists mapped Godzilla – the atmospheric river that comes from Sahara to Caribbean coasts of US

Atmospheric rivers

- **Atmospheric rivers** are relatively long, narrow regions in the atmosphere – like rivers in the sky – that transport most of the water vapor outside of the tropics.
- Atmospheric rivers are a key feature in the global water cycle and are closely tied to both water supply and flood risks
- When the **atmospheric rivers** make landfall, they often release this water vapor in the form of rain or snow.
- The concept of atmospheric rivers is only about 20 years old.

Particle laden Atmospheric Rivers

- Atmospheric rivers also include global transport of dust, soot, and other airborne particles, collectively known as aerosols, by jets of winds in the atmosphere.
- Research has shown that these atmospheric rivers tend to move large amounts of aerosols in a limited number of extreme events instead of in a steady stream throughout the year.
    - A few major events a year can transport between 40% to 100% of the aerosols moved by the atmosphere
- Regions including the Sahara, Patagonia, Asian deserts and Namibia are big sources of **dust** aerosol atmospheric rivers.
- Areas like the eastern U.S., the southern Amazon and Africa, and northern India tend to produce atmospheric rivers dominated by **soot** resulting from wildfires and the burning of fossil fuels.
- Gaining a better understanding of how these particles are transported around the globe is important because certain aerosols can
    - Nourish rainforest soil
    - Help or hinder cloud formation and thus impacting storms
    - Affect air quality – which can impact human health
    - Reduce visibility
    - Move plant pathogens that can affect crop

225. Cryptocurrency and Climate change

In News: Bitcoin and other cryptocurrencies have been criticised for its impact on the environment

- Tim Berners-Lee, credited as the inventor of the World Wide Web, has gone so far as to describe "Bitcoin mining" as "one of the most fundamentally pointless ways of using energy."

What is Bitcoin mining?

- Cryptocurrencies are built on a network of millions of computers that process transactions on a blockchain – an encrypted digital ledger that maintains a record of every single transaction. nothing ever escapes this ledger.
- Every time a full block is mined i.e. a certain number of transactions are processed, fresh tokens are created and those that run the machines are rewarded proportionately to their computing power.
- Bitcoin is one such digital token which was envisioned as a decentralised system to rival banks.

Bitcoin mining and its impact on nature

- Everyone wants to mine as much cryptocurrency as they can. There are millions of people running mining machines across the world.
- The business model will only work when the cost of producing a Bitcoin is lesser than the value of the Bitcoin.
- Thus miners prefer cheap electricity, generated from fossil fuels, to run their machines. which is perhaps why instead of being spread evenly across the world, 70% of Bitcoin mining was reportedly concentrated in China.
- The use of coal for generating electricity, however, results in carbon dioxide and other harmful emissions.

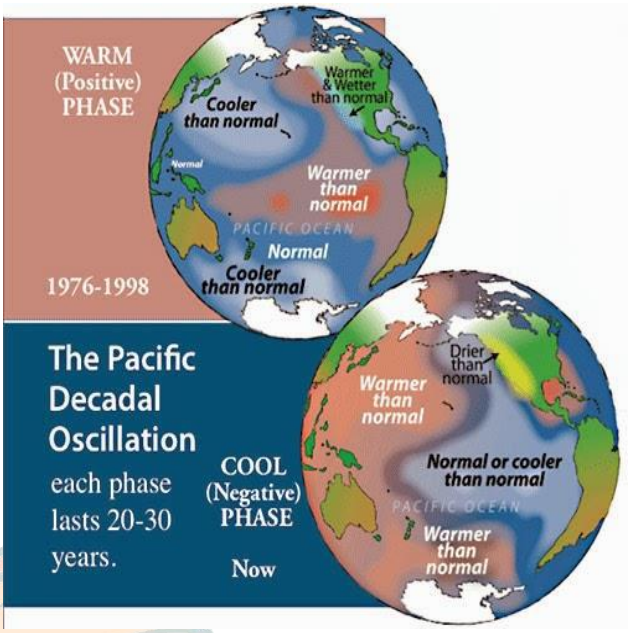
Do You Know?

- Bitcoin mining is estimated to consume more energy than several countries, including Kazakhstan and the Netherlands.
- Each Mastercard transaction is estimated to use just 0.0006 kWh (kilowatt hours), whilst every Bitcoin transaction consumes 980 kWh, enough to power an average Canadian home for more than three weeks.
- The continued adoption of Bitcoin under present conditions could push global warming above 2°C within three decades.

Despite these issues, UN experts believe that cryptocurrencies and the technology that powers them (blockchain) can play an important role in sustainable development, and actually improving our stewardship of the environment.

- One of the most useful aspects of cryptocurrencies, as far as the UN is concerned, is **transparency**.
- Because the technology is **resistant to tampering and fraud**, it can provide a trusted and transparent record of transactions. This is particularly important in regions with weak institutions and high levels of corruption.
- The **World Food Programme (WFP),** the largest UN agency delivering humanitarian cash, has found that blockchain can help to ensure that cash gets to those who need it most.
- A pilot programme in Pakistan showed that it was possible for WFP to get cash directly to beneficiaries, securely and quickly, without the need to go through a local bank.

226. Pacific decadal oscillation



- PDO is a long-term ocean fluctuation of the Pacific Ocean, which waxes and wanes approximately every 20 to 30 years.
- Just like El Nino/La Nina in the tropical Pacific, PDO has a signature for a longer time (on decadal scale) in the sea surface temperatures and its interaction with the atmosphere
- **Warm or positive phase:** the west Pacific becomes cooler and part of the eastern ocean warms.
- **Cool or negative phase:** East pacific becomes cooler and west pacific becomes warmer.

PDO and El Nino/La Nina

- PDO is a pattern of Pacific climate variability similar to **El Nino-Southern Oscillation (ENSO)** in character, but which varies over a much longer time scale.
- The PDO can remain in the same phase for 20 to 30 years, while ENSO cycles typically only last 6 to 18 months.
- Also, El Niño and La Niña are a pattern that can be thought of as lying on top of the large scale temperature distribution determined by the Pacific Decadal Oscillation.
- If both ENSO and the PDO are in the same phase, it is believed that El Niño/La Nina impacts may be magnified.
- Conversely, if ENSO and the PDO are out of phase, it has been proposed that they may offset one another, preventing "true" ENSO impacts from occurring.

PDO and Climate

- PDO phase can have significant implications for the global climate, **affecting Pacific and Atlantic hurricane activity, droughts** and **flooding** around the Pacific basin, the productivity of marine ecosystems, and global land temperature patterns.
- The change in location of the cold and warm water masses can also alter the path of the jet stream.

PDO and drying of North East India

- Northeast India, one of the wettest places on the Earth has been experiencing rapid drying, especially in the last 30 years.
- Some places which used to get as high as 3,000 mm of rain during the monsoon season have seen a drop of about 25-30%.This decreasing monsoon rainfall is associated with natural changes in the subtropical Pacific Ocean.
- Researchers studied the rainfall and sea surface temperature data for the period 1901-2014.

- Their results show out that the reduction in rainfall during a major part of the last 114 years may be associated with global man-made factors, while the trend during the last 36 years is associated with natural phenomena.
- Only about 7% of the rainfall in this region is associated with local moisture recycling, which means that anthropogenic activities can affect only this small percentage.
- So the rapid drying is a part of inter-decadal variability of monsoonal rainfall which is strongly associated with the PDO

227. Brown ocean effect

- Tropical cyclones need the fuel of warm ocean water to develop and thrive. That's why they usually fizzle out after landfall.
- However, if conditions are right, recent study revealed that tropical cyclones can maintain or intensify while over land.
- The Brown Ocean Effect is not a case of dirty ocean water, but it does involve dirt (i.e. soil). It's a case where very warm and saturated **soil can imitate the moist, warm ocean water environment.**
- This serves as fuel for either maintaining or intensifying a tropical cyclone once it's over land which is atypical of most landfalling tropical systems.
- The following conditions were necessary for an effective Brown Ocean environment:
    - The **lower levels of the atmosphere** should be very similar to the warm, tropical environment the tropical cyclone came from with little temperature variation.
    - **Abundant soil moisture** is needed along or near the path of the inland tropical cyclone. This ample moisture evaporates and eventually condenses into water droplets. This phase change is known as condensation which releases a lot of heat into the atmosphere called "latent heat" which is power fuel for tropical systems.
    - **The latent heat** has to be at a certain level (at least 70 watts per square meter)

Origin of the study of Brown Ocean Effect

- The tropical cyclone that encouraged research regarding this phenomenon was Tropical Storm Erin in 2007. Unlike most landfalling systems, it strengthened when it was well inland across Oklahoma, USA. It actually formed an eye.
- Other storms influenced by the Brown Ocean Effect were Tropical Storm Bill in 2015 and Tropical Storm Alberto of 2018 (USA).
- This rare phenomenon extends the life of landfalling tropical cyclones, and there are cases of this happening outside of the U.S including China and Australia.

228. Steam Devil

- It is a **small, weak whirlwind over water** (or sometimes wet land) that has drawn fog into the vortex, thus rendering it visible.
- Typically, it is associated with steam fog (Arctic sea smoke), a type of fog that develops in very cold air above a relatively warm body of water or very wet land.
- Smaller ones can form over ponds, hot springs, and geysers when the air is very cold.

- Larger ones can form over large lakes and oceans during cold air outbreaks while the water is still relatively warm, and can be an important mechanism in vertically transporting moisture.
- Steam devils have only been reported and studied since the 1970s.
- Their usual shape is close to a small drinking fountain and are usually vertical, about 1600 feet high and can be as wide as 160 to 600 feet in diameter.
- Typically, the core of a steam devil is about 10% of its spinning column width and just like the core of a dust devil is clear, the center of a steam devil is clear at the core.
- Steam devils **rotate with a cyclonic direction of motion**, but not very fast or powerfully, usually just a few rotations per minute, and sometimes apparently not at all.
- Steam devils are a **rare and short-lived phenomenon,** typically surviving no more than three or four minutes.

Formation

- When Cold air comes across a fairly warm water body (with substantial temperature difference), it produces warm moist air (commonly known as steam fog) due to evaporation.
- As the warm moist air rises up in the air, it creates low pressure system which is surrounded by high pressure system.
- The condition so created is akin to cyclonic like environment, thus causing whirlwhind.
- This whirl wind pulls up the fog near to its vortex resulting in the formation of vertical column of fog.
- The vertical column moves around along with the whirlwind thus causing steam devil (refer video for better explanation)

229. Marine Heat Waves (MHW)

In News: Scientists have observed unusually high sea surface temperatures (SSTs) in the Pacific Ocean around the western coast of the United States. This marine heatwave (MHW), covering an area of roughly 6.5 million square kilometres, can affect marine life and lead to droughts in the surrounding regions

- During an MHW, the average temperatures of the ocean surface up to a depth of 300 feet or more increase by 5-7 degrees Celsius above normal.
- Heatwaves can happen in summer and also in winter, where they are known as "winter warm-spells".
- MHWs can be caused by **locally** formed heat fluxes between the atmosphere and the ocean or due to **large-scale drivers of the Earth's climate** like the El Niño Southern Oscillation (ENSO).
- One of the possible reasons for the current MHW in the Pacific is unusually slow wind speeds. It was also a reason behind the intensification of extremely severe Cyclone Fani, which hit the eastern Indian coast in May 2019.
- MHWs are also increasing in frequency due to climate change. MHWs increased by 54 per cent in the last 30 years.

Impact of Marine Heat Waves:

- **Fish Species:** Marine heatwaves affect ecosystem structure, by supporting certain species and suppressing others. For example, after the 2011 marine heatwave in Western Australia the fish communities had a much more "tropical" nature than previously and switched from kelp forests to seaweed turfs.
- **Economy**: Marine heatwaves can cause economic losses through impacts on fisheries and aquaculture.
- **Corals**: Temperature-sensitive species such as corals are especially vulnerable to MHWs. Corals evolved over millions of years to adjust to gradual changes in sea temperatures and are now being subjected to unusually high temperatures over extended periods of time

230. Winter Snowmelt

In News: More snow is melting during winter across the West which has worried climate experts.

- Particularly in cold mountain environments, **snow accumulates over the winter** — it grows and grows — and gets to a point where it reaches a maximum depth, before **melt starts in the spring**
- But the new research found that melt before April 1 (before Spring) has increased at almost half of more than 600 stations in western North America, by an average of 3.5% per decade.
- Snow melt is increasing in all cold season months — from October to March.
- As a result, the distinction between winter and spring (historically 1st April) is becoming increasingly blurred.
- Increased winter snowmelt can be attributed to global warming and climate change.

Implications

1. Water System

- Snowy mountains act like water towers, reserving water up high until it melts, making it available to lower elevations that need it during the summer, like a natural drip irrigation system. Entire water infrastructure is built on this premise.
- More winter snowmelt is effectively shifting the timing of water entering the system, turning that natural drip irrigation system on more frequently in the winter, shifting it away from the summer.
- This is a big concern for water resource management and drought prediction in the West, which depends heavily on late winter snowpack levels in March and April.

2. Flash Floods & Soil Ecosystem

Wetter soils in the winter also have ecological implications.

- One, the wet soils have no more capacity to soak up additional water during spring melt or rainstorms, which can increase flash flooding.
- Wetter winter soils also keep microbes awake and unfrozen during a time they might otherwise lay dormant. This affects the timing of nutrient availability, water quality and can increase carbon dioxide emissions.

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RAPID REVISION (RaRe) SERIES - UPSC 2021

RaRe Notes

DAY 32 - GEOGRAPHY

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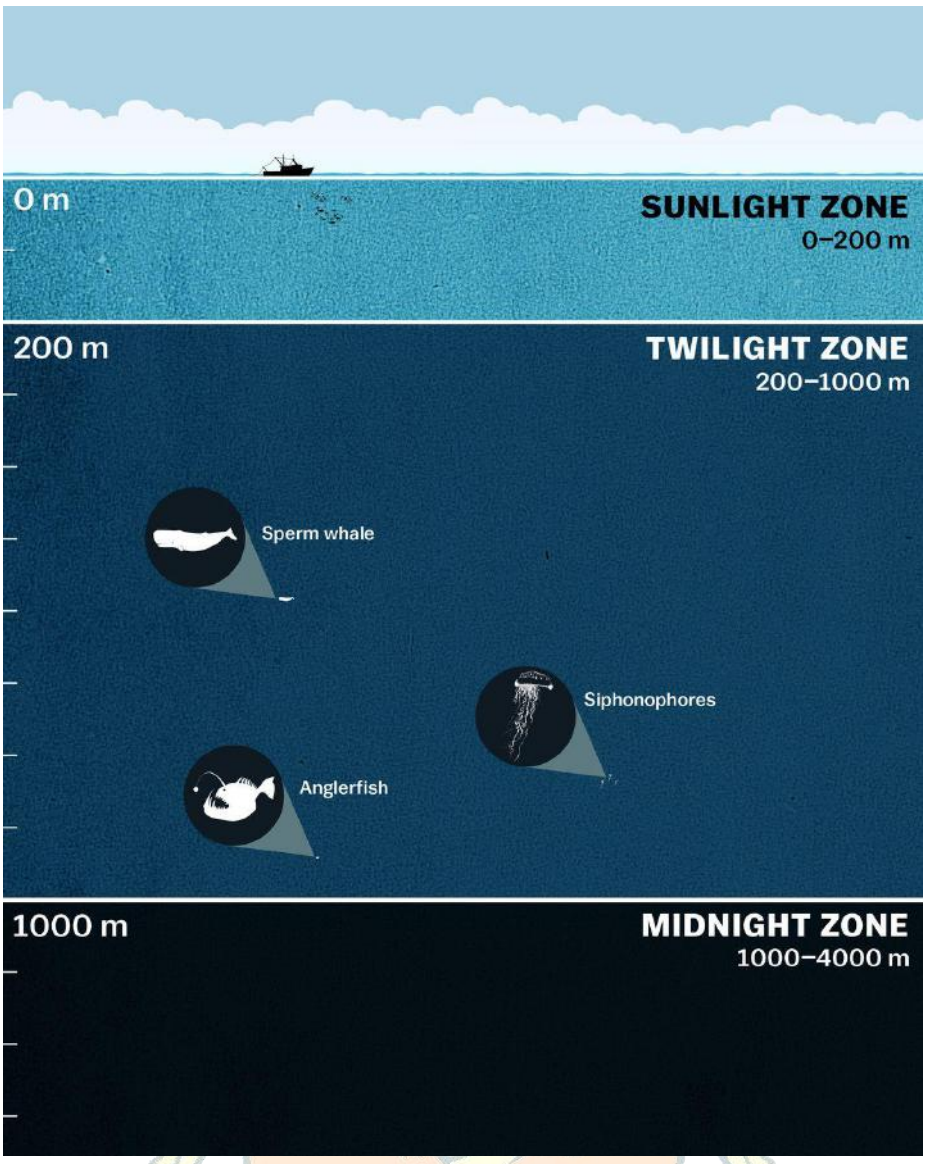
Index

231. Ocean Twilight Zone

In News: A Mesobot is providing deeper insight into the vast mid-ocean region - "twilight zone."



About Twilight Zone

- The ocean twilight zone is a layer of water that stretches around the globe. It lies 200 to 1,000 meters (about 650 to 3,300 feet) below the ocean surface, just beyond the reach of sunlight.
- It begins at the depth where only 1% of incident light reaches and ends where there is no light.
- Also known as the midwater or mesopelagic, the twilight zone is cold and its light is dim, but with **flashes of bioluminescence**—light produced by living organisms.
- The region teems with life. Recent studies suggest that the **biomass of fish in the twilight zone may be ten times greater** than previously thought—more than in all the rest of the ocean combined.
- It's remote. It's deep. It's dark. It's elusive. As a result, the twilight zone is one of the more poorly understood ecosystems of the Earth

Importance of Twilight Zone

1. Climate Regulation

- Whilst mesopelagic fish usually inhabit between 200 and 1 000 metres below the surface of the ocean, they rise nearer to the surface shortly before sunset to feed before travelling back down again to hide from predators.
- Through this act they contribute to the **"biological pump",** which takes carbon out of the air and brings it down to the deep ocean.
- This is just one of the ways in which oceans take in and store carbon dioxide from the atmosphere.
- Without this pump, the atmospheric concentration of CO_2 would be twice its current value

2. Economic Potential

- Several recent studies have estimated that mesopelagic fish are the largest vertebrate group in the world in terms of biomass.
- This has attracted the attention of the fishing industry looking into using these resources as an alternative source of fishmeal and oils.

232. Coccolithophores

In News: The National Centre for Polar and Ocean Research (NCPOR) has carried out the study of Coccolithophores (microscopic ancient marine algae) and found that there is a decrease in the concentration of oceanic calcium carbonate (CaCO3) in the southern Indian ocean.

- This decrease in $CaCO_3$ is attributed to the increase in the concentration of another **single-celled algae known as diatoms**. This, in turn, will affect the growth and skeleton structure of coccolithophores, with potential significance for the world ocean ecosystem.

About Coccolithophores

- Coccolithophores are single-celled algae living in the upper layers of the world's oceans.
- They have been playing a key role in marine ecosystems and the global carbon cycle for millions of years.
- They **calcify marine phytoplankton** that produce up to 40% of open ocean calcium carbonate and are responsible for 20% of the global net marine primary productivity.
- They **build exoskeletons** from individual $CaCO_3$ plates consisting of chalk and seashells.
- Though carbon dioxide (CO_2) is produced during the formation of these plates, coccolithophores help in removing it from the atmosphere and ocean by consuming it during photosynthesis.
- At equilibrium, coccolithophores **absorb more carbon dioxide than they produce**, which is beneficial for the ocean ecosystem.

NCPOR Study

- The study revealed that abundance and diversity enrichment of coccolithophores in the southern Indian Ocean is highly dependent on time and influenced by various environmental factors such as silicate concentrations, calcium carbonate concentration, diatom abundance, light intensity and availability of macro and possibly micronutrient concentrations.
- The study revealed that the reduction of coccolithophore diversity in the early summer and late summer periods is due to an increase in the presence of **diatom algae**, which occurs after sea ice breakdown with climate change and ocean acidification.

- Diatoms increase the silicate concentration in the waters and which in turn decreases $CaCO_3$ and reduces coccolithophores diversity.
- The study also analysed the maximum coccolithophore diversity during mid-summer in the Subtropical Zone and Sub-Antarctic Zone, which is controlled by elevated silicate, low temperature, and low salinity conditions.
- The results of the study point to **climate change as a major reason** for the altered coccolithophore calcification rate.
- Different environmental factors and the ability of the species to adapt to those environmental changes would ultimately determine the future coccolithophore calcite production.

National Centre for Polar and Ocean Research (NCPOR)

- It was established as an autonomous Research and Development Institution of the **Ministry of Earth Sciences** on the 25th May 1998.
- Earlier known as National Centre for Antarctic and Ocean Research (NCAOR), NCPOR is India's premier R&D institution responsible for the country's **research activities in the Polar and Southern Ocean realms.**
- It is the nodal agency for planning, promotion, coordination and execution of the entire gamut of polar and southern ocean scientific research in the country as well as for the associated logistics activities.

Its responsibilities include:

- Management and upkeep of the Indian Antarctic Research Bases "**Maitri**" and "**Bharati**", and the Indian Arctic base "**Himadri**".
- Management of the Ministry's Ocean Research Vehicle (**ORV) Sagar Kanya** as well as the other research vessels chartered by the Ministry.
- Playing a **facilitator role** in the scientific research activities being undertaken by several national institutions and organizations in Antarctica, the Arctic and in the Indian Ocean sector of the Southern Ocean.
- Playing a lead role in the **geoscientific surveys** of the country's Exclusive Economic Zone (EEZ) and its extended continental shelf beyond 200m, deep-sea drilling in the Arabian Sea basin, exploration for ocean non-living resources such as gas hydrates and multi-metal sulphides in mid-ocean ridges.

233. Genome Mapping in Indian Ocean

In News: National Institute of Oceanography (constituent laboratories of CSIR) launching the first-of-its-kind project of Genome Mapping in the Indian Ocean.

- A team of scientists and researchers from the NIO on board its research vessel **Sindhu Sadhana** will spend 90 days traversing the course of over **10,000 nautical miles** in the Indian Ocean on the research project to **reveal the internal working of the body of the ocean at a cellular level.**
- Indian Ocean is the third largest water body in the world, covering about 20% of the Earth's water surface.

About the Project

- **Objective**:
  - To gather samples for genome mapping of microorganisms in the Indian Ocean.
  - To understand the biochemistry and the response of the ocean to climate change, nutrient stress and increasing pollution.
- **Project Cost & Duration**: Rs. 25 crore and will take three years to complete.
- **Genome Collection:**
  - The researchers will collect samples from various stretches of the ocean at an average depth of about 5 km.
  - Just like gene mapping is carried out on blood samples collected from humans, the scientists will map these in the bacteria, microbes found in the ocean.
  - The mapping of the Deoxyribose Nucleic Acid (DNA) and Ribonucleic Acid (RNA) will show the nutrients present in them, and also those lacking in different parts of the ocean.
- **Studying Trace Elements:**
  - Trace metals like **cadmium or copper** are supplied to oceans via continental run-offs, atmospheric deposition, hydrothermal activities and continental shelf interaction. They are essential for ocean productivity.
  - Scientists will try to understand the **interactions of trace metals with marine biota** for having a holistic understanding about nutrient cycling and productivity of the oceans.
  - Apart from their reactions on marine life, **isotopic forms of trace metals can be utilised to track the movement of water masses** responsible for ocean circulation and as tools to study the biological, geochemical and ecosystem processes and food web analyse.

Genome

- A genome is the complete set of DNA (or RNA in RNA viruses) of an organism.
- Each genome contains all of the information needed to build and maintain that organism.
- In humans, a copy of the entire genome contains more than 3 billion DNA base pairs**.**

Genome Mapping

- It describes the methods used to identify the locus of a gene and the distances between genes. Gene mapping can also describe the distances between different sites within a gene.
- Taking inspiration from the Human Genome Project, the Department of Biotechnology (DBT) initiated the ambitious "Genome India Project" (GIP) in January 2020. The GIP aims to collect 10,000 genetic samples from citizens across India, to build a reference genome.

Benefits of Genome Mapping in Indian Ocean

- Better understanding of the marine Ecosystem
- Understanding Factors Causing Change
- Identifying Mineral Concentration
- Biotechnology Application
- Better understanding about **nutrient cycling and productivity** of the oceans.
- Optimization of Conservation Efforts

234. Translocation of Corals in Mumbai

In News: The **National Institute of Oceanography** will carry out the translocation of 18 coral colonies from the coast of Mumbai for the Mumbai Coastal Road Project

Corals

- Corals exhibit characteristics of plants, but are **marine animals** that are related to jellyfish and anemones.
- They are made up of **genetically identical organisms called polyps,** which are tiny, soft-bodied organisms.
- The corals have a symbiotic relationship with algae called the zooxanthellae.
- These algae live inside the coral polyp's body and provide the coral with food. The polyps, in turn, provide a home and carbon dioxide for the algae.
- These algae are responsible for the variety of colours of corals.
- There are 2 types of corals:
    - **Stony,** shallow-water corals—the kind that build reefs.
    - **Soft corals** and deep water corals that live in dark cold waters

Coral Reefs

- They are large underwater structures composed of the skeletons of colonial marine invertebrates called coral.
- Corals extract calcium carbonate from seawater to create a hard, durable exoskeleton that protects their soft, sac-like bodies.
- These exoskeleton remains of millions of corals pile up with time to form coral reefs.
- In India, they are under **Schedule I of the Wildlife Protection Act (WPA), 1972.**
- Coral reefs cover less than 1% of the ocean floor but they are among the most productive and diverse ecosystems on Earth.
- They are referred to as "the rainforests of the sea" for their biodiversity,
- Coral reefs also act as **'wave breaks'** between the sea and the coastline and minimise the impact of sea erosion
- When corals become stressed due to any changes, including pollution or global warming, they can expel algae and get **bleached**, meaning the 'death' of the coral reef.
- Dead coral reefs support cryptic organisms like hidden sea creatures, including fishes, snails, tiny crabs and worms, who hide under its rubble to save themselves from predation

Coral Translocation:

- The translocation of corals is at a **nascent stage along the Indian coastline.** It is difficult and has **not been very successful in India.**
- Transplanted corals are **more susceptible to storm surges and bleaching from warming ocean waters.**
- Experts are of the view that for a high survival rate, it is important to translocate corals in a place with similar environmental characteristics such as depth, current flow, amount of light, and pressure.

Biorock Technology

- Biorock, also known as Seacrete or Seament, refers to the substance formed by electro-accumulation of minerals dissolved in seawater.
- The technology is contemplated in the wake of failure of translocation.
- The technology works by passing a small amount of electrical current through structures (steel) lowered in sea.
- Due to electric current flowing between them, calcium ions and carbonate ions in sea combine to form calcium carbonate and adhere to the structures
- The formed material is similar to coral structures
- Coral larvae adhere to the CaCO3 and grow quickly
- Biorock projects **can be powered by a wide range of electrical sources** including renewable energy like windmills, photovoltaic solar panels and tidal current generators
- The calcification (conversion into calcium carbonate) has started in Gulf of Kachchh but real success will come when attached and new organisms (corals) start to grow faster.
- India has four major coral reefs areas: Andaman and Nicobar Islands, Lakshadweep, Gulf of Mannar and the Gulf of Kachchh

235. MARPOL

- The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes.
- The Protocol of 1978 was adopted in response to a number of tanker accidents in 1976–1977.
- It is one of the most important international marine environmental conventions.
- It was developed by the IMO with an objective to minimize pollution of the oceans and seas, including dumping, oil and air pollution.
- The Convention includes regulations aimed at preventing and minimizing pollution from ships – both accidental pollution and that from routine operations – and currently includes six technical Annexes.
- India is a signatory to MARPOL.
- It has six annexes (I to VI) and it deals with prevention of
  1) Pollution from ships by Oil
  2) Noxious liquid substances
  3) Dangerous goods in packaged form
  4) Sewage
  5) Garbage and
  6) Air pollution from ships respectively

International Maritime Organization (IMO)

- It is a **specialized agency of the United Nations (UN).**

- It was established following agreement at a UN conference held in Geneva in 1948 and came into existence ten years later, meeting for the first time in 1959.
- It is a global **standard-setting** authority with responsibility to improve the safety and security of international shipping and prevention of marine and atmospheric pollution by ships.
- The IMO is **not** responsible for enforcing its policies. There is **no enforcement mechanism** to implement the policies of the IMO.
- Its main role is to create a **regulatory framework** for the shipping industry that is fair and effective, universally adopted and universally implemented.
- It is also involved in legal matters, including liability and compensation issues and the facilitation of international maritime traffic.

236. Boreal Summer Intra Seasonal Oscillation (BSISO)

In News: Indian National Centre for Ocean Information Services (INCOIS) has found a better way to forecast waves based on Boreal Summer Intra Seasonal Oscillation (BSISO)

About BSISO

- The BSISO of the Asian summer monsoon (ASM) is one of the most prominent sources of short-term climate variability in the global monsoon system.
- It is the movement of convection (heat) from the Indian Ocean to the western Pacific Ocean roughly every 10-50 days during the monsoon (June-September).
- Compared with the related Madden-Julian Oscillation (MJO) it is more complex in nature, with prominent northward propagation and variability extending much further from the equator.
- It represents the monsoon's 'active' and 'break' periods, in which weeks of heavy rainfall give way to brilliant sunshine before starting all over again.
- The active phase also enhances monsoon winds and hence the surface waves.

Why predict BSISO behaviour?

- Some phases of boreal summer intraseasonal oscillation or BSISO induce high wave activity in the north Indian Ocean and the Arabian Sea, the researchers claimed.
- Wave forecast advisories based on the BSISO would be more useful for efficient coastal and marine management.
- This finding has a great significance in developing seasonal and climate forecast service for waves and coastal erosion for India.

BSISO and ENSO:

- El-Nino comes with dryness in the western pacific – therefore weakening the propagation of BSISO
- La-Nina provides moist environment – which is conducive for convection current

237. Methane Eating Microbes

In News: Scientists are worrying why the methane the seeps out of the ocean floors do not reach the surfaces.

Methane

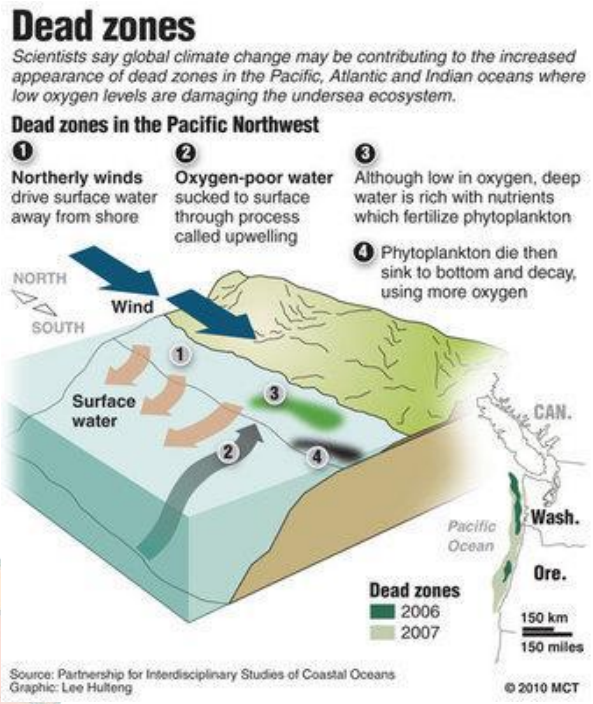
- Methane is a strong greenhouse gas that plays a key role in Earth's climate. Anytime we use natural gas, whether we light up our kitchen stove or barbeque, we are using methane.
- **Only three sources on Earth produce methane naturally:**
    - Volcanoes
    - Subsurface water-rock interactions
    - Microbes.
- Between these three sources, most is generated by microbes, which have deposited hundreds of gigatons of methane into the deep seafloor.
- At seafloor methane seeps, it percolates upwards toward the open ocean, and microbial communities consume the majority of this methane before it reaches the atmosphere.
- Over the years, researchers are finding more and more methane beneath the seafloor, yet very little ever leaves the oceans and gets into the atmosphere. Where is the rest going?. The answer lies in microbes present in carbonate rocks

Microbes in Carbonate Rocks

- **Seafloor carbonate rocks** are common, but in select locations, they form unusual chimney-like structures
    - These chimneys reach 12 to 60 inches in height and are found in groups along the seafloor resembling a stand of trees.
- Unlike many other types of rocks, these carbonate rocks are porous, creating channels that are home to a very dense community of methane-consuming microbes.
- Scientists discovered the microbes living in such carbonates rocks consume methane 50 times faster than microbes in the sediment
- The micro-environments within the carbonates may contain more methane than the sediment due to its porous nature.
- Carbonates have channels that are constantly irrigating the microbes with fresh methane and other nutrients allowing them to consume methane faster.
- In sediment, the supply of methane is often limited because it diffuses through smaller, winding channels between mineral grains.

238. Dead Zones

In News: An analysis of sediment cores from the Bering Sea has revealed a recurring relationship between warmer climates and abrupt episodes of low-oxygen "dead zones" in the subarctic North Pacific Ocean over the past 1.2 million years.



Dead Zones

- Dead zones are **hypoxic (low-oxygen) areas** in the world's oceans and large lakes.
- In these zones very few or no organism survive. The regions facing such a situation essentially become **biological desert.**
- **Causes of Hypoxia**
    - **Natural Cause:** In the summer, northerly summer winds work together with the Earth's rotation to push oxygenated surface water offshore and this coastal water is replaced by low-oxygen but nutrient-rich waters from the depths of the continental shelf by a process known as **upwelling.** Once this nutrient-rich water reaches the ocean's sunlit layers, it fertilizes blooms of phytoplankton.
    - **Eutrophication** i.e the process by which extra nutrients are added to the water bodies, stimulating an overgrowth of algae, which then sinks and decomposes in the water. The decomposition process consumes oxygen and depletes the supply available to healthy marine life
- Historically, many of these sites were naturally occurring. However, in the 1970s, oceanographers began noting increased instances and expanses of dead zones.
- These occur near inhabited coastlines, where aquatic life is most concentrated.
- The vast middle portions of the oceans, which naturally have little life, are not considered "dead zones".
- Severe hypoxia that would destroy ecosystems, food sources, and economies

How to detect a Hypoxia?

- Sediments are deposited and build up on the seafloor.
- The activity of organisms usually disrupts and mixes them as they accumulate.
- But if hypoxia has killed those organisms, an orderly pattern of layers is preserved.
- Thus, scientists can find a record of past hypoxic events in the form of these layered or "laminated" sediments in cores drilled from the seafloor.
- Recent Research raise concerns about whether climate change and ocean warming will lead to a tipping point that would trigger widespread hypoxia in the North Pacific Ocean

239. Heat from Below -Atlantification

In News: The heat from the Atlantic has hindered ice growth in the Barents and Kara Seas for years.

Atlantification: Marine researchers refer to the increasing influx of warm Atlantic water masses into the Arctic Ocean as Atlantification

How it leads to fragility of ice:

- Atlantic heat results in complete melting of sea ice in summer.
- In the following winter the sea releases large amounts of heat into the atmosphere.
- As a result, the sea freezes so rapidly that it compensates for the summertime ice losses
- If new ice does form, it's significantly thinner than before
- Young, thin sea ice conducts heat significantly better than thick ice thereby leading to fragility.

Atlantic & Arctic Ocean

- The warm water masses that flow from the North Atlantic into the Arctic Ocean are responsible for slowing or even preventing ice growth in the Barents and Kara Seas. If new ice does form, it's significantly thinner than before
- If Atlantification persists to this extent, and the winter temperatures in the Arctic continue to rise, in the long term we will also see changes in the regions of the Arctic Ocean further east.
- In that case, the ice cover in the Arctic Ocean will decline and become thinner and more fragile than it already is.

240. Places in News

	Places in News	
1	**Pantanal, Brazil** 	• Situated in Brazil, it is the world's largest wetland and biggest tropical wetlands • Vegetation compacted under the **marshy flood water** • Ramsar and a UNESCO World Heritage Site • Natural region encompassing the world's largest tropical wetland area, and the world's largest flooded grasslands. • Extends into **Bolivia and Paraguay** • Rich with **tapirs, pumas, capybaras** and **jaguars.**
2	**Coral Triangle, West Pacific Ocean**	• It is described as world's epicenter of marine diversity. • It houses nearly 600 different species of reef-building corals.

		• It is one of 3 mega ecological complexes on Earth, together with Congo Basin and Amazon Rainforest. • It is a vast ocean expanse that geographically spreads across 6 countries in Asia and the Pacific: 1.Indonesia, 2.Malaysia, 3.Philippines, 4.Papua New Guinea, 5.Solomon Islands, and 6.Timor Leste (the "CT6" countries)
3	**Pointe d'Esny region** 	• **In News**: Mauritius has declared a state of environmental emergency after a grounded ship off its coast is said to be leaking tonnes of crude oil in the Pointe d'Esny region. **Pointe d'Esny:** • It is a Ramsar site and the largest remaining wetland in Mauritius. • The Ile aux Aigrettes Nature Reserve. • Blue Bay Marine Area. • Mahebourg Fishing Reserves all lie close to the region

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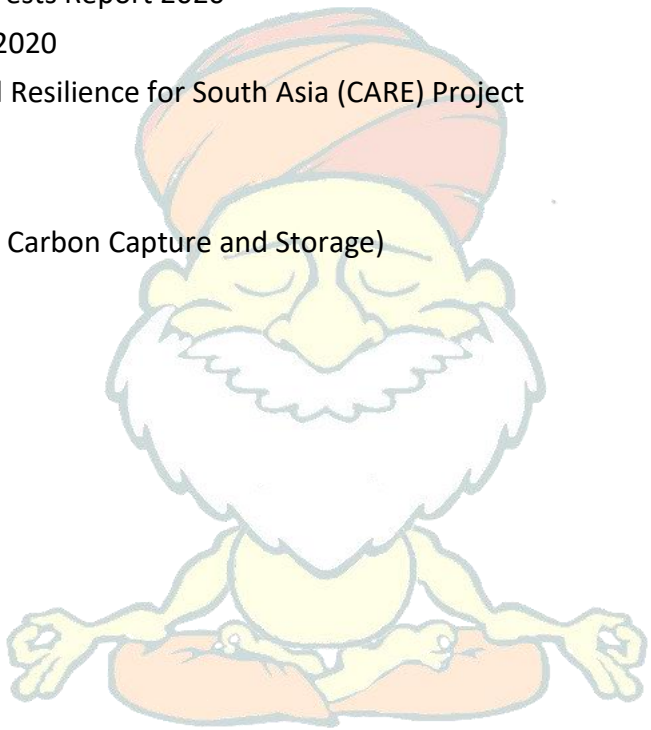
Index



321. Discrete Auroras of Mars

Context: UAE's Hope spacecraft has captured images of glowing atmospheric lights in the Mars night sky, known as discrete auroras.

Auroras on Earth:

- An Aurora is **a display of light in the sky predominantly seen in the high latitude regions** (Arctic and Antarctic). It is **also known as a Polar light.**
- Auroras are caused when charged particles ejected from the Sun's surface - called the solar wind - enter the Earth's atmosphere.
- The typical aurora is caused by collisions between charged particles from space with the oxygen and nitrogen in Earth's upper atmosphere.
- The electrons - which come from the Earth's magnetosphere, the region of space controlled by Earth's magnetic field - transfer their energy to the oxygen and nitrogen atoms and molecules, making them "excited".
- When a large number of electrons come from the magnetosphere to bombard the atmosphere, the **oxygen and nitrogen can emit enough light for the eye to detect, giving us beautiful auroral displays.**
- They commonly occur at high northern and southern latitudes, less frequent at mid-latitudes, and seldom seen near the equator.
- While **usually a milky greenish color**, auroras can also show red, blue, violet, pink, and white. These colors appear in a variety of continuously changing shapes.
- Auroras are **not just something that happens on Earth.** If a planet has an atmosphere and magnetic field, they probably have auroras.

Discrete Auroras of Mars:

- Unlike auroras on Earth, which are seen only near the north and south poles, **Discrete Auroras (DA) on Mars are seen all around** the planet at night time.
- These DAs are traced out where **energetic particles excite the atmosphere** after being funneled down by a patchy network of crustal **magnetic fields that originate from minerals** on the surface of Mars.

Martian Auroras are Different:

- Unlike Earth, which has a strong magnetic field, the **Martian magnetic field has largely died out.** This is because the molten iron at the interior of the planet - which produces magnetism - has cooled.
- However, the **Martian crust**, which hardened billions of years ago when the magnetic field still existed, **retains some magnetism.**
- So, in contrast with Earth, which acts like one single bar magnet, **magnetism on Mars is unevenly distributed**, with fields strewn across the planet and differing in direction and strength.
- These disjointed fields channel the solar wind to different parts of the Martian atmosphere, creating "discrete" auroras over the entire surface of the planet as charged particles interact with atoms and molecules in the sky– as they do on Earth.

Why Study Martian auroras?

- Studying Martian auroras is important for scientists, for it can offer clues as to why the Red Planet lost its magnetic field and thick atmosphere– among the essential requirements for sustaining life.
- With the information gathered during the UAE's Mars mission, scientists will have a better understanding of the climate dynamics of different layers of Mars' atmosphere

Other Mars Missions

- **NASA's Mars 2020 Mission (Perseverance Rover)**: The mission is designed to better understand the geology of Mars and seek signs of ancient life.
- **Tianwen-1 by China:** It was launched in 2019 to conduct scientific investigations into the planet's soil, geological structure, environment, atmosphere and water.
- **India's Mangalyaan:** It was launched from the Satish Dhawan Space Centre in Andhra Pradesh by Indian Space Research Organisation in November 2013.

322. National Clean Air Program (NCAP)

- It is a government programme launched by the **Union Ministry of Environment, Forests and Climate Change** in 2019.
- It is the **first-ever effort in the country to frame a national framework for air quality management with a time-bound reduction target.**
- The programme is a pollution control initiative with a major goal of reducing the concentration of coarse and fine particulate matter in the atmosphere by at least 20% by the year 2024 keeping 2017 as the base year for the comparison of concentration.
- The programme aims:
  - To expand the national air quality monitoring network.
  - To build capacity for air pollution management
  - To raise public awareness about the hazards of air pollution
- The NCAP also aims to have a feasible plan for the prevention, management and control of air pollution.
- At the national level, the implementation of the programme will be done by an **apex committee at the Environment Ministry level.**
  - At the state level, committees at the Chief Secretary level will oversee the implementation of the scheme.
- The NCAP is a joint collaboration between: Ministry of Road Transport and Highways; Ministry of New and Renewable Energy; Ministry of Petroleum and Natural Gas; Ministry of Heavy Industry; Ministry of Health; Ministry of Housing and Urban Affairs; Ministry of Agriculture; Central Pollution Control Board and NITI Aayog
- The programme also ropes in academia, philanthropic foundations, civil society, etc.
- **The plan includes 102 non-attainment cities,** across 23 states and Union territories, which were identified by the Central Pollution Control Board (CPCB) on the basis of their ambient air quality data between 2011 and 2015.

- The Smart Cities Mission of the Central Government will also be leveraged to start clean air programmes for the 43 smart cities among the 102 cities.

Major Initiatives under NCAP

- Augmenting Air quality monitoring network
- Air Quality Management Plan for the cities chosen.
- Indoor Air Pollution Monitoring & Management
- Air Quality Forecasting System: AQFS is a state of the art modelling system which will forecasts the following day's air quality.
- National Emission Inventory – this is an inventory of the quantity of pollutants discharged into the air.
- Setting up Air Information Centre- An Air Information Center will be responsible for data analysis, interpretation, dissemination including through GIS platform.
- Technology Assessment Cell- TAC will evaluate the technologies having significance in reference to prevention, control and abatement of pollution.
- International cooperation including the sharing of best practices with respect to abatement of air pollution.

National Ambient Air Quality Standards

National Ambient Air Quality Standards are the standards for ambient air quality with reference to various identified pollutant notified by the **Central Pollution Control Board** under the Air (Prevention and Control of Pollution) Act, 1981.

List of pollutants under NAAQS: PM10, PM2.5, SO2, NO2, CO, NH3, Ozone, Lead, Benzene, Benzo-Pyrene, Arsenic and Nickel.

323. CAMPA (Compensatory Afforestation Management and Planning Authority.

- Whenever forest land is diverted for non-forest purposes, it is mandatory under the **Forest (Conservation) Act, 1980** that an equivalent area of non-forest land has to be taken up for compensatory afforestation. In addition to this**, funds for raising the forest** are also to be imposed on whomsoever is undertaking the diversion.
- At the time of submission of project proposal to apply for forest clearance, the applicant must attach an undertaking stating that they will **bear the cost of compensatory afforestation** as per existing rules & scheme.
- The forest department must also provide details regarding the area identified for afforestation. It is only after this, that the proposal goes to higher authorities for recommendations and approval.

SC directed creation of Compensatory Afforestation Fund

- In TN Godhavarman Vs Union of India, 2002 case the Supreme Court (SC) ordered that a Compensatory Afforestation Fund had to be created in which all the contributions towards compensatory afforestation and net present value of land had to be deposited.

- Therefore, **Compensatory afforestation Fund (CAF)** means that every time forest land is diverted for non-forest purposes such as mining or industry, the user agency pays to this fund certain amount for planting forests over an equal area of non-forest land, or when such land is not available, twice the area of degraded forest land.

Creation of CAMPA

- In April 2004, Ministry of Environment and Forests constituted ***ad-hoc*** Compensatory Afforestation Fund Management and Planning Authority (CAMPA) to overlook and manage the CAF as directed by the SC.
- The authority was termed as the 'custodian' of the fund.
- Further in 2009, the government ordered that State CAMPAs had to be set up to boost compensatory afforestation at state level and also manage Green India Fund.

Compensatory Afforestation Fund Act, 2016 (CAF)

- Despite all these efforts, CAG report in 2013 revealed that the CAMPA funds remained unutilised. The report stated that between 2006 and 2012, CAF with ad hoc CAMPA grew from ₹ 1,200 crores to ₹ 23,607 crores.
- To compensate the loss of forest area and to maintain the sustainability, the Government of India came up with a well-defined Act, known as CAMPA (Compensatory Afforestation Fund Management and Planning Authority).
- The law establishes the National Compensatory Afforestation Fund under the Public Account of India, and a State Compensatory Afforestation Fund under the Public Account of each state.
- The payments made for compensatory afforestation, net present value and others related to the project will be deposited in the fund.
- The National Fund will receive 10% of these funds, and the State Funds will receive the remaining 90%.
- The funds can be used for the treatment of catchment areas, assisted natural generation, forest management, wildlife protection and management, relocation of villages from protected areas, managing human-wildlife conflicts, training and awareness generation, supply of wood saving devices, and allied activities.
- After the 2018 notification rules, ₹ 54,685 crores were brought to the control of central government fund from the ad hoc CAMPA. Of this, MoEF handed over ₹ 47,436 crore rupees to various states to take up afforestation and conservation activities as per the provisions of CAF Act and Rules.

Do You Know?

- In April 2019, the Ministry of Environment notified that states which have a forest land of **more than 75% of their geographical area need not provide non-forest** land for compensatory afforestation. Instead, land can be taken up in states with lesser forest cover.
- Further, it was also notified that the minimum area of compensatory land should be five hectares if the land is not contiguous to a forest.
- As per 2019 State of Forest India report, states with more than 75% forest cover include the North Eastern states of Arunachal Pradesh (79%), Manipur (75%), Meghalaya (76%), Mizoram (85%), Nagaland (75%), and Andaman and Nicobar Islands (81%) and Lakshadweep (90%).

- In terms of Recorded Forest Area, Manipur, Sikkim and Andaman and Nicobar Islands have more than 75% area categorised as forests.

324. Aerosol Radiative Forcings

Aerosol

- Aerosols are defined as a combination of liquid or solid particles suspended in a gaseous or liquid environment.
- In the atmosphere, these particles are mainly situated in the low layers of the atmosphere (< 1.5 km) since aerosol sources are located on the terrestrial surface.
- However, certain aerosols can still be found in the stratosphere, especially volcanic aerosols ejected into the high altitude layers.
- The origin of atmospheric aerosols is either natural or the result of anthropogenic activities.
    - Natural sources of aerosols include sea salt generated from breaking waves, mineral dust blown from the surface by wind, and volcanoes.
    - Anthropogenic aerosols include sulfate, nitrate, and carbonaceous aerosols, and are mainly from fossil fuel combustion sources.
- The atmospheric aerosols play a key role in the regional/global climate system through scattering and absorption of incoming solar radiation (Reflect more energy from the sun back to space)
- Aerosols have important impacts on **air quality and human health** (e.g. aerosols can cause damage to heart and lungs).
- Aerosols serve as nuclei for cloud droplets or ice crystals in ice clouds.

Aerosols & Himalayas

- The transport of light-absorbing carbonaceous aerosols and dust from the polluted Indo-Gangetic Plain and desert areas over the Himalayas constitutes a major climatic issue due to severe impacts on atmospheric warming and glacier retreat.
- This heating over the Himalayas facilitates the "elevated-heat pump" that strengthens the temperature gradient between land and ocean and modifies the atmospheric circulation and the monsoon rainfall.

Aerosols Radiative Forcing in Trans- Himalayas

- Recently, a study by the Aryabhatta Research Institute of Observational Sciences (ARIES) has found that radiative forcing of aerosols i.e. effect of anthropogenic aerosols is much higher over the high altitudes of western trans-Himalayas.
    - ARIES, Nainital is an autonomous research institute under the Department of Science and Technology (DST), Ministry of Science and Technology.
- The study analyzed the variability of aerosol optical, physical and radiative properties from January 2008 to December 2018 and the role of fine and coarse particles in Aerosol Radiative Forcing (ARF) assessment.
- The Research shows - ARF of aerosols in Himalayas is leading to heating rates of **0.04 to 0.13 degrees Celsius per day.**
- ARF is the effect of anthropogenic aerosols on the radiative fluxes at the top of the atmosphere and at the surface and on the absorption of radiation within the atmosphere.

325. State of the World's Forests Report 2020

Context: Recently, **United Nations Environment Programme (UNEP) and Food and Agriculture Organization (FAO)** has jointly released a report titled The State of the World's Forests (SOFO) 2020.

- The report examines the contributions of forests, and of the people who use and manage them, to the conservation and sustainable use of biodiversity.

Key Findings of the Report

- The world's total forest area was 4.06 billion hectares (bha**),** which was 31 per cent of the total land area. This area was **equivalent to 0.52 ha per person.**
- The largest proportion of the world's forests were **tropical** (45 per cent), followed by boreal, temperate and subtropical.
- More than **54 per cent of the world's forests were in only five countries —** the Russian Federation, Brazil, Canada, the United States of America and China.
- Forests provide habitats for 80% of amphibian species, 75% of bird species and 68% of mammal species. About 60% of all vascular plants are found in tropical forests
- **Forest area has declined** all across the world in the past three decades. The world lost 178 mha of forest since 1990**,** an area the size of Libya
- **The rate of forest loss** has also declined due to the growth of sustainable management. The rate of forest loss in 2015-2020 declined to an estimated 10 million hectares (mha), down from 12 million hectares (mha) in 2010-2015.
    - Agricultural expansion continues to be the main driver of deforestation and forest fragmentation and the associated loss of forest biodiversity.
- The **area of naturally regenerating forests worldwide decreased since 1990, but the area of planted forests increased by 123 mha.**
- The world is not on track to meet the target set out in UN Strategic Plan for Forests to increase forest area by 3% worldwide by 2030.
- **Forest-Specialist index,** developed by **World Wildlife Fund,** has fell by 53% between 1970 and 2014 which highlights the increased risk of species becoming vulnerable to extinction

326. Emissions Gap Report 2020

Context: **United Nations Environment Programme** (UNEP)'s Emissions Gap Report 2020 has been published recently.

- The annual report from UNEP measures the gap between anticipated emissions and levels consistent with the **Paris Agreement** goals of limiting global warming this century to well below 2°C and pursuing 1.5°C.

Key Findings

- GHG emissions continued to increase (1.4% per year since 2010 on average and rapid increase of 2.6% in 2019 due to forest fires**)** and reached a **record high of 59.1 GtCO2e in 2019**.
- Fossil carbon dioxide (CO_2) emissions (from fossil fuels and carbonates) dominate total GHG emissions. Fossil CO_2 emissions reached a record **38.0 $GtCO_2$ in 2019.**

- **G20 countries account for bulk of emissions**: Top four emitters - China, US, EU+UK and India contributed 55% of the total GHG emissions in the last decade.
    - The **top seven emitters** (including the Russian Federation, Japan and international transport) have contributed to 65%, with G20 members accounting for 78%.
- **Around two thirds of global emissions** are linked to the **private household activities**.
- The emissions of the richest 1 per cent of the global population account for more than twice the combined share of the poorest 50 per cent.
- COVID-19 crisis offers only a short-term reduction in global emissions and will not contribute significantly to emissions reductions by 2030.
- **Current NDCs** would lead to a temperature increase of at least 3°C by the end of the century.
    - The levels of ambition in the Paris Agreement still must be roughly **tripled for the 2°C pathway** and **increased at least fivefold for the** 1.5°C Pathway.

United Nations Environment Programme

- The UNEP is a leading global environmental authority established on **5th june 1972.**
- **Functions:** It sets the global environmental agenda**,** promotes the sustainable development within the **UN system,** and serves as an authoritative advocate for global environment protection.
- **Major Reports:** Emission Gap Report, Global Environment Outlook, Frontiers, Invest into Healthy Planet.
- **Major Campaigns:** Beat Pollution, UN75, World Environment Day, Wild for Life.
- **Headquarters:** Nairobi, Kenya.

327. Climate Adaptation and Resilience for South Asia (CARE) Project

Context: CARE Project was recently approved by The World Bank Board of Executive Directors approved a $39.5 million to bolster climate action **in South Asia.**

About Climate Adaptation and Resilience for South Asia (CARE)

- **Objective**: To build resilience to climate threats and disasters by sharing regional data and knowledge.
- It will help in **developing regional standards and guidelines** for infrastructure, and promoting climate resilient policies and investments.
- The project will help develop a **public platform to inform climate planning** and investments, and fund technology to support resilience in South Asia.
- It will fund a public domain platform known as **Regional Resilience Data and Analytics Service**, with information about weather hazards, climate variability, and sector-specific data to help policymakers assess climate risks.
- It will also assess climate impacts in districts across Bangladesh, Nepal, and Pakistan to support agriculture, livestock, water, and transport.
- The $39.5 million CARE project includes a $36 million grant from the **International Development Association** and $3.5 million from the Program for Asia Resilience to Climate Change.

- CARE will work with two regional organizations,
  - Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)
  - Asian Disaster Preparedness Center (ADPC).

Regional Integrated Multi-Hazard Early Warning System (RIMES)

- RIMES is an **international and intergovernmental institution,** owned and managed by its Member States, for the generation and application of early warning information.
- It was established after the aftermath of the 2004 Indian Ocean tsunami **on 30 April 2009**, and was **registered with the United Nations on 1 July 2009.**
- RIMES operates from its **regional early warning center** located at the campus of the Asian Institute of Technology in Pathumthani, **Thailand.**
- It is owned and managed by a **Council** comprising of 48 Members and Collaborating States (including India)

328. Drying Deltas

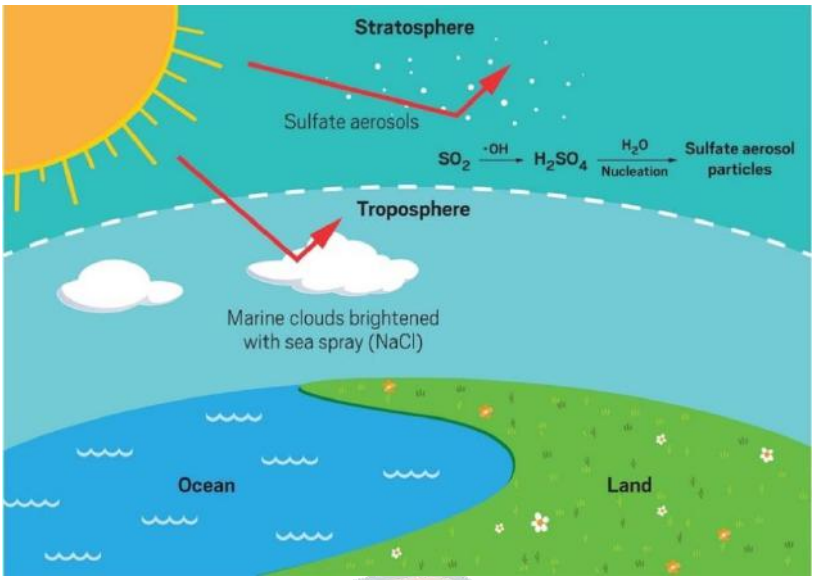
Context: Muskrats are a bellwether for a drying delta

- The muskrat has lived for thousands of years in Peace-Athabasca Delta. one of Earth's largest freshwater deltas in northeastern Alberta, Canada
  - This delta lies within Canada's Wood Buffalo National Park which is one of the largest protected land in North America and a World Heritage Site
  - The park is in danger from threats related to governance as well as hydropower and oil sands development upstream of the delta.
  - Previous research has implicated climate change as a driver of long-term drying in the delta and hydroelectric dams on the Peace River as a cause of reduced flooding.
- New research focused on muskrat population dynamics in the Peace-Athabasca Delta demonstrates the vulnerability of even this most protected landscape to human-driven changes to water systems and the global climate.

- Muskrat (Ondatra zibethicus) populations have always followed a **boom-and-bust cycle**.
- Their numbers crash in dry years and peak after major floods.
- But in recent decades **the booms --** and the area of the delta inhabited by muskrats during wet years -- **have been shrinking**.
- Muskrats depend heavily on floodwaters, rivers and streams to travel and disperse beyond their natal ponds.
- Muskrats population is therefore an indicator of human impacts at the local, regional and global level

329. Solar geo-engineering

Context: Climatologists from the University of Liège have found that Injecting Sulphur into the stratosphere can reduce solar radiation and stop the Greenland ice cap from melting.



- The Greenland ice sheet will lose mass at an accelerated rate throughout the 21st century, with a direct link between anthropogenic greenhouse gas emissions and the extent of Greenland's mass loss.
- To combat this phenomenon, and therefore global warming, new ideas like Solar geoengineering are gaining traction.
- Solar geoengineering is a climate intervention that consists of artificially reducing solar radiation above the ice caps and thus limiting the melting of the ice.
- The idea is to **inject Sulphur into the stratosphere**, a stable meteorological zone located between 8 and 15 km above sea level in the atmosphere.
- The sulphur will then act as a sort of mirror that will reflect part of the solar radiation back into space.
- This reduces the amount of **sunshine on earth**, similar to what happens during volcanic eruptions.
    - In 1991, the **eruption of Pinatubo** (Philippines) injected millions of tones of Sulphur dioxide into the stratosphere, causing a drop in global temperatures of around 0.5°C. This observation led to the development of solar geoengineering scenarios.
- It possible to locally reduce the melting of the **Greenland ice sheet by 6% through such solar geo-engineering technique.**
- However, this type of intervention is not without risk since it could have a significant impact on the ozone layer and on water cycles and precipitation, accentuating the disparities between wet and dry regions.

330. BECCS (Bio-energy with Carbon Capture and Storage)

Context: Bioenergy with Carbon Capture and Storage (BECCS) has been considered inevitable to achieve the 2°C or 1.5°C climate goal.

About Bio-energy with Carbon Capture and Storage

- BECC is a process of extracting bioenergy from biomass, then capturing and storing the carbon to a geological reservoir.
- It is a negative emission technology since the biomass is produced by plants through photosynthesis that can uptake the carbon dioxide from atmosphere.

- To achieve the 2°C or 1.5°C climate goal, large-scale deployment of BECCS was assumed to be prominent in many previous studies
- The **IPCC Fifth Assessment Report** by the Intergovernmental Panel on Climate Change (IPCC), suggests a potential range of negative emissions from BECCS of **0 to 22 Giga Tones per year.**
- However, BECC is not without challenges as there is concerns on the challenges brought to water and land resources to grow the bioenergy crop
- Therefore, comprehensive assessments of the BECCS potential that consider both potential benefits and adverse effects are necessary for simultaneously achieving the multiple sustainable development goals on climate, water, land, etc.

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RaRe Notes

DAY 46 - GEOGRAPHY

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Index

331. Darkening of the seas

Context: Research conducted to learn more about the effects of deforestation on the coastal environment by studying material that flowed into rivers from various settings in a Central American rainforest and tracking its progress into the sea off the coast of Belize

- Belize is caribbean country located on the northeastern coast of Central America, home to the world's second largest barrier reef.

Key Findings of Research

- The flow of **dissolved organic material,** such as soil, from land to the oceans plays an important role in the global carbon and nutrient cycles.
- Changing how land is used can alter the type and amount of material being transported, with widespread implications for ecosystems.
- Like many countries in the region, **Belize is experiencing a rapid rate of deforestation** due to increasing need for agricultural and urban land. This is changing the colour and composition of natural material washing into nearby rivers
- Research findings showed that significantly **more coloured material** is entering the rivers from land used for farming, compared to naturally forested sites
- The material accumulated as it continued its journey along the river, suggesting that it is **less likely to decompose**. In other words, the material was not accessible to the micro-organisms who break down natural matter and convert it into carbon dioxide.
- When the material reaches the coast, its **coloured nature means that it absorbs light** and **can darken the sea**, potentially affecting marine life such as seagrass and corals which need light to grow.
- This phenomenon is not limited to Belize but is observable for other coastal developing nations where deforestation is ongoing but there are no integrated conservation plans

332. Medicanes

Context: Research shows that human-induced climate change may increase Medicanes

About

- Extra tropical storms in the Mediterranean Sea are known as 'Medicanes' or 'Mediterranean Hurricanes'
- Medicane is a combination of the two words "Mediterranean" and "hurricane." Although it is not official terminology, the name separates the regional differences that these storms have, compared to tropical storms, cyclones or hurricanes.
- A medicane is more of a tropical stormlike cyclone.
- They form when a non-tropical storm feeds off the warm waters of the Mediterranean.
- The storm can then begin to strengthen and develop tropical storm characteristics.
- The area that typically experiences a medicane is central Mediterranean countries like Greece, Italy or Turkey, for example.

Difference of Medicanes with other systems

- Medicanes occur more in colder waters than tropical cyclones, hurricanes and typhoons. Hence, the cores of these storms are also cold, as compared to the warm cores of tropical cyclones.
- Warmer cores tend to carry more moisture (hence rainfall), are bigger in size and have swifter winds.
- The rare event of an extra tropical cyclone becoming a tropical cyclone happens because of warmer-than-usual waters in the Mediterranean Sea. They are short-lived and very rare
- Medicanes, however, do not typically progress into anything more severe.
- The odds of a medicane developing into a major hurricane-strength system are extremely small

- There is not a classified system with categories for medicanes.

333. Ammonia (NH3)

Context: Recently, Ammonia gas leaked at the Indian Farmers Fertilizer Cooperative Limited (IFFCO) unit at Prayagraj, Uttar Pradesh.

About Ammonia

- Ammonia (NH3) is a **colourless highly reactive and soluble alkaline gas.**
- Ammonia **occurs naturally in the environment**. A small amount of ammonia is generated when **lightning strikes** and reaches earth in rainfall. But most ammonia is produced by bacteria in water and soil as an end product of plant and animal waste **decomposition.**
- Ammonia is found in relatively low nontoxic concentrations in soil, air, and water and provides a **source of nitrogen for plants**.
- In soils and water ammonia will go through many complex biochemical transformations. These transformations constitute what is commonly known as the **nitrogen cycle.** It adversely affects ecosystems at higher concentrations.
- It is **stored in liquid form under high pressure** or in gaseous form at low temperature.
- It is **naturally present in the body** and secreted by the kidneys to neutralise excess acid.
- It is used as an **industrial chemical in the production** of fertilisers, plastics, synthetic fibres, dyes and other products.
- It is critical in the **manufacturing of fertilizers**, because ammonia is a building block for ammonium nitrate (NH4NO3) that is used in agriculture as a high-nitrogen fertilizer.

Ammonia in Water

- Water reacts with ammonia to form ammonium(NH4+) and hydroxide ions (OH-)

$$NH_3\,(aq) + H_2O\,(l) \rightleftharpoons NH_3 \cdot H_2O\,(aq) \rightleftharpoons NH_4^+\,(aq) + OH^-\,(aq)$$

(ammonia in water) (ammonia + water) (ammonia in water)

- **Ammonia (NH3) is toxic** to aquatic organisms but ammonium (NH4+) is non-toxic.
- There exists an equilibrium in water between the toxic ammonia and the non-toxic ammonium. This equilibrium is affected by water temperature and pH (acidity).
- Warm water will contain more toxic ammonia then cooler water (think Global Warming)
- Also, water contaminated with fertilizer ammonia should not be allowed to enter any storm drains, rivers, drainage ditches, wetlands or lakes.

Ammonia in Air and Soil

- After a release of ammonia the vapors will dissipate reacting with the moisture in the air to form ammonium and eventually return to earth in rainfall.
- Ammonium then **quickly binds to the negatively charged soil organic** matter and soil clays.
- Ammonium rarely accumulates in soil because bacteria will rapidly convert the ammonium that is not taken up by **plant roots into nitrates (nitrification).**
- Nitrates can also be absorbed by roots or may leach through the soil profile.

- Since ammonium is soil bound, unless the soil is washed away by rainfall events the contamination will likely stay put horizontally but leach vertically as nitrates through the root zone.

Sources of NH3 emissions:

- The largest source of NH3 emissions is agriculture, including animal husbandry and NH3-based fertilizer applications.
- Other sources of NH3 include industrial processes, vehicular emissions, volatilization from soils and oceans, **decomposition of organic waste, forest fires, animal and human waste**, nitrogen fixation processes.

Green Ammonia

- Green ammonia refers to ammonia, which has been **produced through a process that is 100% renewable and carbon-free.**
- It uses renewable energy **instead of natural gas or coal for producing hydrogen**; hence, is an effective way to reduce greenhouse emissions.

334. Global methane assessment

Context: Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions" was published by the United Nations Environment Program in association with the Climate and Clean Air Coalition

About Methane (CH4)

- Methane is the simplest hydrocarbon, consisting of one carbon atom and four hydrogen atoms (CH4).
- It is flammable, and is used as a fuel worldwide.
- Methane is produced by the breakdown or decay of organic material.
- Methane can be introduced into the atmosphere by
    - Natural processes – such as the decay of plant material in wetlands, the seepage of gas from underground deposits or the digestion of food by cattle
    - Human activities – such as oil and gas production, rice farming or waste management
- Methane is a powerful greenhouse gas that is **84 times more potent than carbon**
- Methane is a **short-lived climate pollutant** (SLCP) with an atmospheric lifetime of roughly a decade.
- Methane contributes to the formation of **ground-level ozone**, a dangerous air pollutant.
- Methane's reduction can result in **rapid reductions** in climate forcing and ozone pollution.

Key findings of the report

- Methane is **second only to carbon dioxide** in driving climate change.
- Methane's atmospheric concentration has more than doubled since pre-industrial times
- **Methane in the atmosphere reached record levels last year** even though CO2 levels dropped during the pandemic.
- **Reduction** of anthropogenic emissions **by 45%** would prevent a rise in global warming by up to **0.3 degrees Celsius by 2045**.

Reducing Methane Emissions:

- Reducing food waste and loss
- Improving **livestock management**
- Eco-friendly harness of fossil fuels

Climate and Clean Air Coalition

- Launched in 2019, it is a **voluntary partnership** of governments, intergovernmental organizations, businesses, scientific institutions and civil society organizations committed to protecting the climate and improving air quality through actions **to reduce short-lived climate pollutants. India is a member** of the coalition.

United Nations Environment Programme (UNEP)

- Headquartered in Nairobi, Kenya, UNEP is a leading global environmental authority **established on 5th june 1972.**
- It sets the global environmental agenda, promotes the sustainable development within the UN system, and serves as an authoritative advocate for global environment protection.
- Major Reports: Emission Gap Report, Global Environment Outlook, Frontiers, Invest into Healthy Planet.
- Major Campaigns: Beat Pollution, UN75, World Environment Day, Wild for Life.

335. Adaptation gap report, 2020

Context: United Nations Environment Programme (UNEP) released Fifth edition of Adaptation Gap Report, 2020

Basics

- **Adaptation** is the process of **adjustment to actual or expected climate and its effects**. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities.
  - Paris Agreement on Climate Change requires its signatories to implement adaptation measures through national plans, climate information systems, early warning, protective measures and investments in a green future.
- **Adaptation Gap** is defined as the **difference between actually implemented adaptation and a societally set goal**, determined largely by preferences related to tolerated climate change impacts, and reflecting resource limitations and competing priorities.
- **Adaptation Costs** include Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transaction costs.
- **Adaptation Finance:** It refers to the flow of funds to developing countries to help them tide over the damages caused by weather events from climate change.
- **Adaptation Finance gap:** It is the difference between Adaptation Cost and Adaptation Finance

Key Highlights of Report

- 72% of countries have adopted at least one national-level adaptation planning instrument.
- Annual cost of adaptation to the effects of climate change for developing countries is estimated to at least quadruple by 2050 ($500 billion).
- The ever-increasing **adaptation cost has outpaced the growth in adaptation finance.**
  - Adaptation costs is higher in developed countries but burden of adaptation is greater for developing countries in relation to their gross domestic product.
- COVID-19 pandemic has impacted adaptation efforts but its effect is not yet quantified.

Key suggestions

- Significant scaling up and incentivizing for both public and private adaptation finance is required to narrow the gap.
- Nature-based solutions (NbS) must become a priority.

336. Climate Change Performance Index (CCPI)

Context: India ranked 10th in CCPI 2021 (last year ninth position). It is second time in a row that India has continued to remain in the top 10.

About Climate Change Performance Index (CCPI):

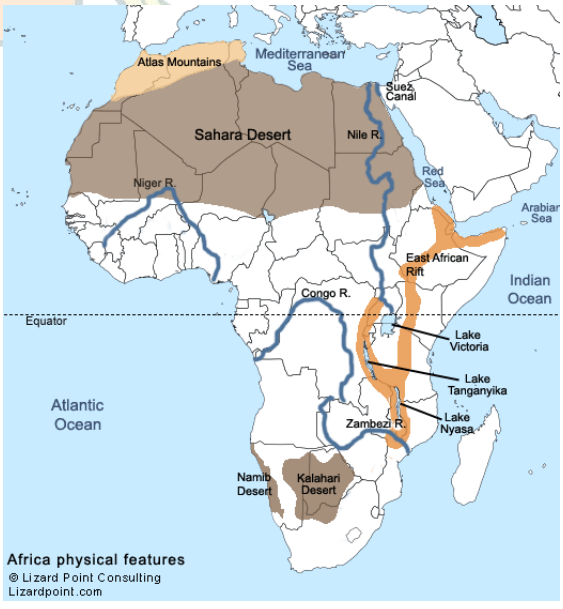
- It is an independent monitoring tool for tracking the climate protection performance of 57 countries and the European Union. These countries together **generate 90%+ of global greenhouse gas emissions.**
- **Published by:** Germanwatch, the New Climate Institute and the Climate Action Network annually since 2005.
- CCPI aims to **enhance transparency** in international climate politics and enables comparison of climate protection efforts and progress made by individual countries.
- The CCPI looks at four categories, with 14 indicators:
  - Greenhouse Gas Emissions (40% of the overall score),
  - Renewable Energy (20%)
  - Energy Use (20%)
  - Climate Policy (20%)

CCPI 2021:

- Top three ranks were empty as no country had met the criteria to get placed high enough on the index.
- Only two G20 nations, the United Kingdom and India are among the high rankers in CCPI 2021, which covers the year 2020.
- Six other G20 nations including the USA, Canada, South Korea, Russia, Australia and Saudi Arabia are ranked at the bottom of the index.
- This is the second time in a row that the USA (ranked last), which is the largest historical polluter, is ranked at the bottom.
- China, which is the biggest current emitter of greenhouse gases, is ranked at the 33rd position on the CCPI 2021 report.

337. East African rift valley

- It is an active continental rift zone in East Africa.
- The rift is a developing **divergent tectonic plate boundary** where the African Plate is in the process of splitting into two tectonic plates, called the **Somali Plate** and the **Nubian Plate,** at a rate of 6–7 mm (0.24–0.28 in) per year
- The rifting started in the **Afar region** in northern Ethiopia at around 30 million years ago and propagating southwards towards Zimbabwe.
- Rifting is followed by **flood basalt volcanism** in some places that spread around the rift creating plateaus and highlands (Ethiopian Highlands, Kenya Dome).
- The EAR transects through Ethiopia, Kenya, Uganda, Rwanda, Burundi, Zambia, Tanzania, Malawi and Mozambique.
- EAR **consists of two branches.**



- **The Eastern Rift Valley: A**lso known as **Gregory Rift,** it extends along Jordan River, to Kenya through the Shire River valley and Mozambique Plain.
- **The Western Rift Valley**: Extends northward from the northern end of Lake Nyasa (Lake Malawi) in a great arc that includes Lakes Rukwa, Tanganyika, Kivu, Edward, and Albert.

Note that ***Narmada and Tapti Rift Valleys*** *(fault zones) are formed from a mechanism different from the one explained above. They are formed due to the bending of the northern part of the Indian plate during the formation of Himalayas.*

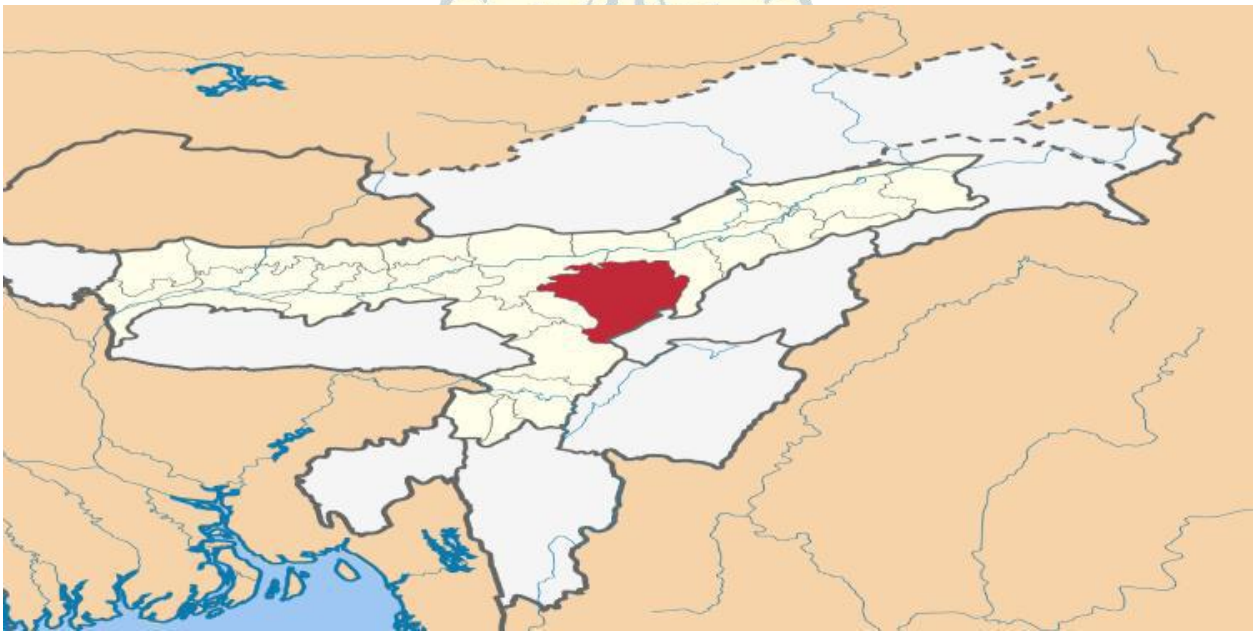
338. Wular lake

Context: Wular lake gets Rs 700 crores for rejuvenation

About Wular Lake

- Wular Lake is the **deepest and second largest fresh water lake in India.**
- The lake basin was formed as a result of **tectonic activity** and is fed by the Jhelum River.
- It lies at the north end of the Valley of Kashmir,
- The Tulbul Project is at the mouth of Wular Lake

339. Karbi Anglong plateau



- **Karbi Anglong plateau** is an extension of the Indian peninsular plateau in the Assam.
- It is pear-shaped and has an area of about 7000 km2
- It has been subjected to extreme weathering and denudation and as a result, resistant sandstones of the Surma series which underlie them have contributed to the characteristic rugged topography with a number of hills purely of relic type.
- To the south lie the young folded ranges of North Cachar Hills and to the surrounding lowlands on all sides. The plateau has developed a radial drainage pattern.
- However, the central part still remains high with the Rengma Range reigning the east-central landscape.
- The highest peak is **Dambusho** (1363m) lies in this region.

- Due to variation in the topography, this hill zone experiences different climates in different parts.
- The process of soil formation in Karbi Anglong is generally slow on a foundation of Precambrian gneiss rock. The soil cover is shallow over the hill slopes with a thin surface layer of humus and is liable to erosion. Usually, these soils are red loam.

340. Mount Sinabung

Context: Mount Sinabung of Indonesia erupted and sent a cloud of hot ash as high as 3 km

- Mount Sinabung volcano is located in North Sumatra, Indonesia.
- This mountain sits on the Sunda Arc of the subduction zone of the Indo-Australian plate under the Eurasian plate.
- It is a pleistocene-to-holocene era **stratovolcano**, and it had been dormant for about 400 years until 29 August 2010.
- This volcano is among the 120 other active volcanoes in the country that are located on the Ring of Fire, which is an arc of volcanoes and fault lines that is encircling the Pacific Ocean
- It is the only volcano that is currently on level 4 alert and is considered, by global experts, to be highly dangerous.