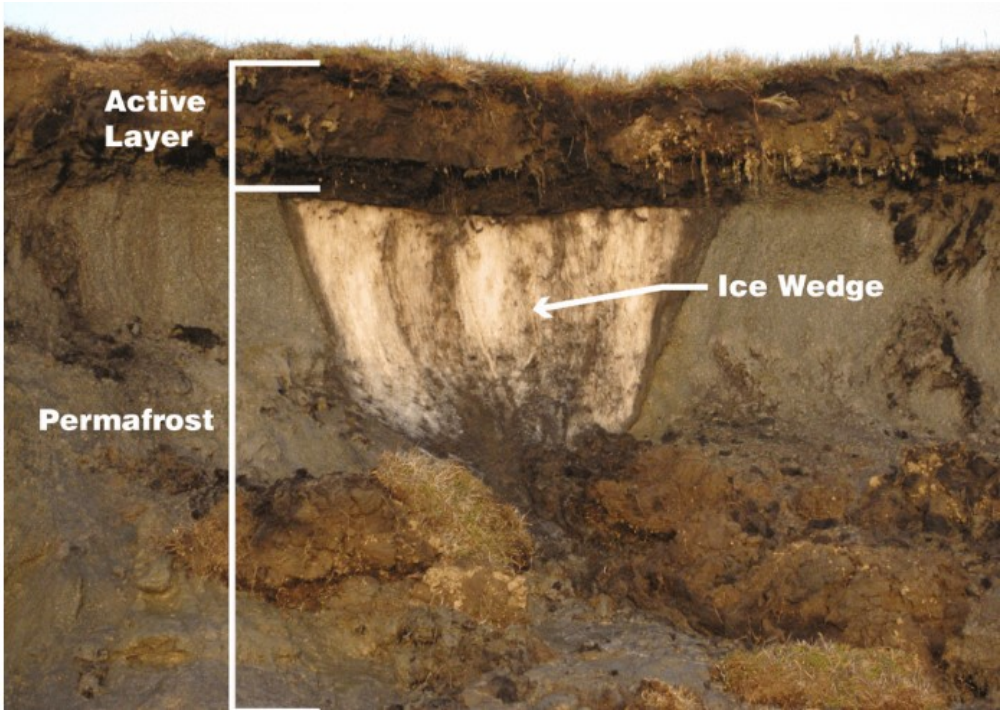
UPSC Daily Current Affairs | Prelim Bits 23-08-2024

Toxic mercury in Arctic's permafrost

As the Arctic's permafrost thaws in a warming climate, an enormous amount of toxic mercury is being released into the environment.

- **Permafrost** – They are any ground that remains completely frozen 32°F (0°C) or colder—for at least two years straight.
- Permafrost is made of a combination of soil, rocks and sand that are held together by ice.
- These are most common in regions with high mountains and in Earth's higher latitudes—near the North and South Poles.



- **Active layer** – It is the top layer of the permafrost that does not stay frozen all year.
- It thaws during the warm summer months and freezes again in the fall.
- **Permafrost Thawing** - As Earth's climate warms, the ice inside the permafrost melts, leaving behind water and soil.
- **Mercury Bomb** - A significant amount of total mercury (THg) is liberated from permafrost during glacial erosion in Arctic.
- Abrupt thawing events can rapidly mobilise metres-thick deposits of

sediment, potentially releasing large mercury.

- The mercury content was generally higher in sediment, with finer rather than coarser grains
- **Thaw slumps** – It is a type of landslide that occurs in the terrestrial Arctic's permafrost region.
- Thaw slumps adjacent rivers around the arctic region - Mackenzie river, Yukon and Koyukuk rivers, elevate suspended particulate mercury contents downstream.
- Most mercury eroded from the banks during river migration is redeposited with sediments.
- **Arctic Mercury** - Mercury is a global environmental contaminant with both natural sources and sources associated with human activities.
- Much of the mercury contaminating the Arctic is a result of transport by ***air and ocean pathways*** from sources outside of the Arctic.
- Over ***98%*** of atmospheric mercury is emitted outside the region and is transported to the Arctic via long-range air and ocean transport.
- **Impact** - People and wildlife living in the Arctic are some of the most exposed human populations globally to mercury.
- Mercury is a ***neurotoxin*** that can cause serious harm to the brain and nervous system, particularly when it accumulates in the food chain.
- Many indigenous communities, including Alaskan communities, rely on subsistence fishing and have disproportionately elevated blood mercury levels linked to dietary exposure.

References

Down to Earth |Toxic mercury trapped in Arctic's permafrost

Kodaikanal Tower Tunnel Telescope

Scientists have discovered a new method to explore the Sun's secrets by studying magnetic fields at different layers of its atmosphere using data from the Kodaikanal Tower Tunnel Telescope.

Aspect	Details
Origins and Evolution	• Established in 1899 as the Madras Observatory and later renamed as Kodaikanal Solar Observatory.
Location	• Tamil Nadu
Operator	• Indian Institute of Astrophysics (IIA)

Significance and Legacy	• One of the oldest solar observatories globally. • Maintains a 1250-year collection of solar observations. • Plays a crucial role in tracking the Sun's activity over time. • Known for the discovery of the ***Evershed Effect in 1909.***
Primary Use	• Observations and measurements of the Sun's magnetic fields • Tracks the Sun's magnetic field and its evolution. • Observes solar activity cycles, with the 25th cycle expected to peak in 2024-2025. • Provides data on sunspots, solar flares, and coronal mass ejections (CMEs).
Environment	• Situated at an altitude of 2,500 meters. • Ideal for solar observations with over 220 days of clear skies. • Low dust pollution and low atmospheric turbulence enhance observation quality.
Telescope Infrastructure	• Houses 7 telescopes for solar observations. • Key telescopes include Spectro Heliogram Telescope, Twin Telescope, Kodai Tower Tunnel Telescope, H-Alpha Telescope, and others. • The 8-inch telescope is used for night sky observations.
Telescope Type	• Coelostat-based telescope system with a 3-mirror setup.
Mirror Configuration	• **Primary Mirror (M1) -** Tracks the Sun. • **Secondary Mirror (M2)-**Redirects sunlight downwards. • **Tertiary Mirror (M3)-** Makes the beam horizontal.
Focusing System	• Achromatic doublet (38cm aperture, f/96) focuses the Sun's image.
Image Scale	• 5.5 arcsec per mm.
Key Spectral Lines Used	• **Hydrogen-alpha (Hα) line-** 6562.8 Å • **Calcium II line-** 8662 Å
Purpose of Spectral Lines	• Inference of magnetic field stratification at different atmospheric heights.
Strategic and Geopolitical Importance	• Studying solar eruptions critical to protect satellites, power grids, and communication networks. • Helps predict and prepare for space weather events that could have global impacts.

References

1. PIB | Kodaikanal Tower Tunnel Telescope
2. India Today | Kodaikanal Tower Tunnel Telescope

Island of Madeira

Wildfires in Madeira have endangered world-heritage forests and stranded tourists, with nearly 6% of the island's total area burned.

Aspect	Details
Location	• Madeira is a Portuguese island located in the North Atlantic Ocean, part of the Madeira Archipelago. • It comprises the volcanic islands of Madeira, Desertas, and the Porto Santo. • The Portuguese archipelago of Madeira is located to the west of Morocco and to the southwest of the Portuguese capital of Lisbon.
Region	• Iberian Peninsula (Spain and Portugal).
Capital	• Funchal.

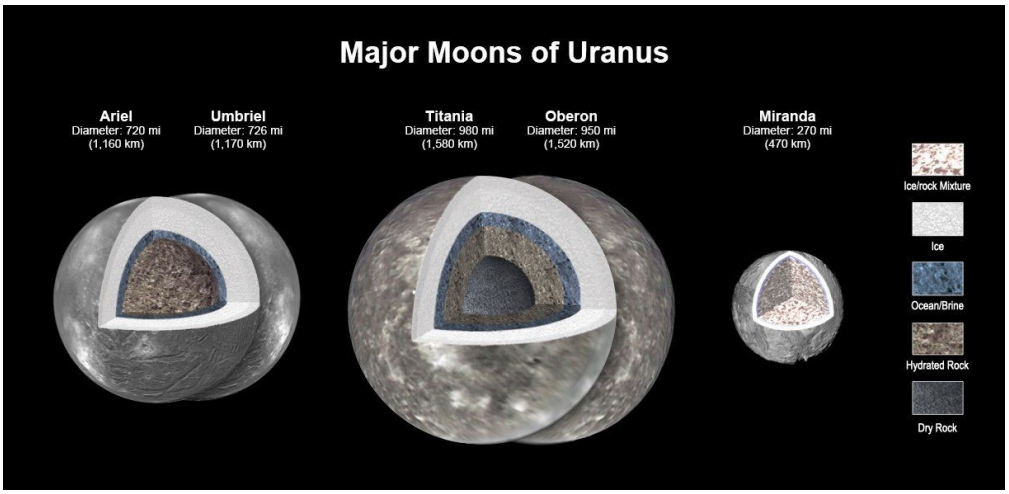
Geography	• Madeira is the top of a massive, submerged shield volcano rising about 6 km from the ocean floor.
Area	• Madeira is the largest and most populous island of the Madeira Archipelago.
Tourism	• A highly popular tourist destination, known for its landscapes, wine, and mild climate.
Natural Heritage	• Home to the largest surviving laurel forests (Laurus nobilis) in the world, a UNESCO World Heritage Site.

Reference

Down to Earth | Island of Madeira

Underground Ocean on Ariel

The scientists using the James Webb Space Telescope have detected carbon dioxide ice on Uranus' moon Ariel, marking a key discovery in the search for water in the solar system.



- Scientists working on the “Moons of Uranus” project has been closely studying 4 specific moons orbiting Uranus in order to find traces of ammonia, organic molecules, water, or carbon dioxide ice.
- They found that carbon dioxide ice was present on the surface of Uranus’ moon called Ariel.
- **Potential Underground Ocean-** The presence of ***carbon dioxide ice*** on Ariel suggests there may be a ***liquid ocean beneath its surface.***
- **Possible Chemical Processes-** The underground ocean may be releasing carbon dioxide through chemical processes, which then escapes to the surface via ice cracks.
- Another theory suggests that Uranus' magnetic field could be ***breaking***

down molecules to generate carbon dioxide.

- **Additional Findings-** Carbon monoxide and traces of carbonates were also found on Ariel's surface. Carbonates are typically formed when water interacts with rocks.
- **Significance-** Underground oceans are considered important in the ***search for extra-terrestrial life***, as they may harbour or sustain life.

Ariel
• Ariel, second nearest of the five major moons of Uranus. • **Size-** It has a diameter of about 1,158 kilometres. • It the fourth-largest of Uranus' moons. • **Discovery-** It was discovered in 1851 by William Lassell • Other major discovery on Ariel was conducted by the Voyager 2 spacecraft in January, 1986. • **Voyager 2-** The primary source of information about Ariel comes from the Voyager 2 flyby in 1986. • The spacecraft provided detailed images and data about its surface and features. • **Surface-** Ariel's surface is characterized by a mix of bright, young surfaces and older, heavily cratered areas. • **Internal Structure-** The moon is composed mainly of water ice and rocky material, with its internal structure possibly consisting of a silicate core surrounded by an icy mantle. • **Magnetic Field-** Ariel does not have a significant magnetic field of its own.

References

1. India Express | underground ocean on Uranus' moon
2. Brittanica | Ariel

JUICE probe

European scientists were due to attempt a first in orbital gymnastics tapping into the gravity of the earth.

- **JUICE probe-** The Jupiter Icy Moons Explorer (JUICE) probe.
- It is a ***European Space Agency (ESA) mission*** designed to explore Jupiter and its 3 large moons i.e. ***Callisto, Europa, and Ganymede.***
- **Launched in -** April, 2023, aboard an Ariane 5 rocket from the Guiana Space Centre.
- **Goals**
    - **Exploring the moons -** Create detailed maps of the moons' surfaces,

analyze the water bodies beneath them, and characterize them as planetary objects and potential habitats
    - **Studying Jupiter -** Monitor Jupiter's magnetic, radiation, and plasma environment, and understand its origin, history, and evolution
    - **Searching for life -** Investigate the possibility of life in space by studying the moons' subsurface oceans, which are believed to have conditions that could support life.

Gravity assist

- It is a technique where a spacecraft brushes past a planet or moon, using its ***gravity to alter speed or trajectory***.
- Scientists will tapping into the gravity of the earth to guide the JUICE probe towards Jupiter in the ***first-ever double slingshot manoeuvre.***
- In a novel double manoeuvre, the JUICE probe will first use the gravity of the moon to swing towards the earth on exactly the right trajectory.
- If successful, it will put JUICE on course to reach Jupiter and its 3 large ocean-bearing moons - Callisto, Europa and Ganymede in 2031 with the help of three further single gravity assists
    - Venus in 2025, and then
    - The earth again in 2026 and 2029.

References

1. The Hindu | Juice Probe
2. ESA | Juice spacecraft specs