## MARINE HEATWAVES – ENVIRONMENT

NEWS: Scientists have found that the **marine heatwaves (MHWs) affected 96%** of the ocean surface in 2023, raising fears of a **permanent temperature shift** that could disrupt **life in oceans and on land**.

WHAT'S IN THE NEWS?

### What are Marine Heatwaves (MHWs)?

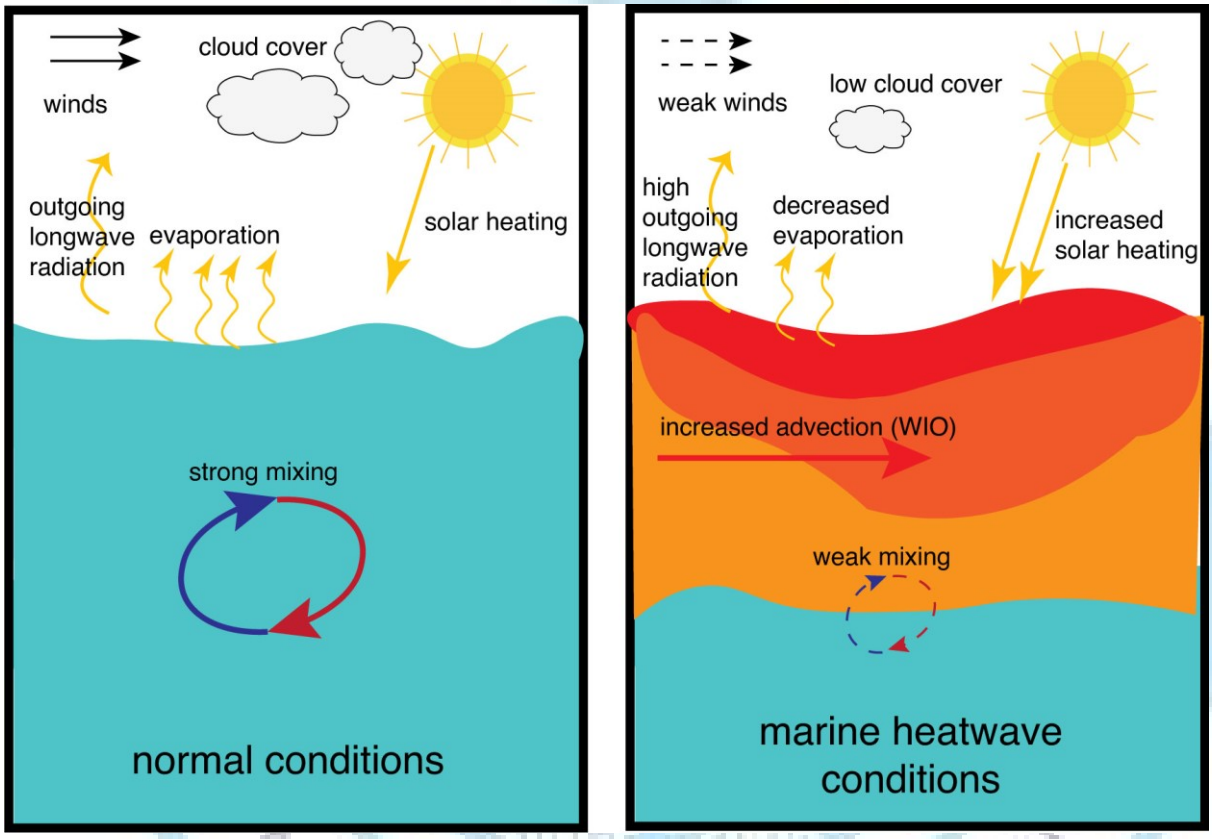
- **Definition**: Marine Heatwaves (MHWs) are prolonged periods of unusually high sea surface temperatures (SSTs), typically **3–4°C above normal**, persisting **for at least 5 consecutive days** in a specific ocean region.
- **Duration**: They can last **weeks, months, or even years**, depending on oceanic and atmospheric conditions.
- **Global Significance**: MHWs are considered **"extreme weather events"** in the marine environment, similar in severity to heatwaves on land.

### Key Causes of Marine Heatwaves

1. **Global Warming and Ocean Heat Storage**
    - Oceans absorb **over 90% of excess heat** from greenhouse gas emissions.
    - This leads to **thermal stratification** and long-term warming, increasing the likelihood of MHWs.
2. **El Niño and Pacific Decadal Oscillation (PDO)**
    - **El Niño** disrupts normal ocean currents and weakens **upwelling**, trapping heat in surface waters.
    - **PDO**, a longer-term Pacific temperature fluctuation, amplifies El Niño effects, creating more intense and widespread MHWs.
3. **Reduced Cloud Cover**
    - Fewer clouds result in **greater solar radiation** reaching the ocean surface.
    - This was a factor in the **2023 Atlantic marine heatwave**, which reached record SSTs.
4. **Changing Ocean Currents**
    - Altered oceanic circulation (e.g., weakened **Gulf Stream**) leads to **uneven heat distribution**, warming specific regions like the **US East Coast**, also influencing **hurricanes** and **regional sea-level rise**.
5. **Human-Induced Feedback Loops**

- **Arctic ice melt** exposes darker water, reducing albedo and **increasing heat absorption**.
- Coral bleaching reduces **carbon sequestration**, reinforcing global warming.

6. **Anthropogenic Factors**
    - **Greenhouse gas emissions**, **pollution**, and **unsustainable ocean use** (e.g., overfishing) further destabilize marine thermal balance.




**Projected Trends**

- The **average global ocean temperature has increased by 1.5°C** over the past century.
- By **2100**, MHWs are projected to become **up to 50 times more frequent** than during the pre-industrial era.
- Intensity and geographical coverage of MHWs are also expected to **increase significantly**, affecting even deeper waters.

**Impacts of Marine Heatwaves**

**Climatic Impacts**

- MHWs **intensify tropical storms and hurricanes** by heating ocean surfaces which fuels cyclonic energy.

- They **disrupt precipitation patterns**, aggravating **droughts, floods, and wildfires**.
- **Example**: **Hurricane Ian (2022)** in Florida was intensified by record-warm Gulf waters.

**Economic Impacts**

- **Aquaculture is vulnerable**, as farmed species like fish and shellfish require stable temperatures.
- **Fisheries suffer** due to migration of target species to cooler waters.
- **Examples**:
    - Declines in **lobster and snow crab** in the Northwest Atlantic.
    - Collapse of **scallop populations** in Western Australia.

**Ecological Impacts**

- MHWs lead to **mass mortality of marine invertebrates**, coral bleaching, and kelp forest degradation.
- They **disrupt food chains**, alter wildlife behavior (e.g., **whales moving into fishing zones**, risking entanglement).
- They **encourage invasive species**, displacing native biodiversity.
- **Example**: The **2011 MHW off Western Australia** caused ecosystem collapse across hundreds of kilometers.

**Compounding Environmental Stressors**

- MHWs often co-occur with:
    - **Ocean acidification** – reduces shell-building capacity in marine organisms.
    - **Deoxygenation** – limits habitable zones for fish.
    - **Overfishing** – weakens ecosystem resilience.
- Together, these create **multi-dimensional stress** on marine habitats.

**Prevention and Mitigation Strategies**

1. **Enhance Ocean Monitoring and Climate Forecasting**
    - Expand **satellite and in-situ monitoring systems**.
    - Improve **high-resolution ocean models** to better predict onset and duration of MHWs.
2. **Protect and Restore Marine Ecosystems**

- Safeguard **coral reefs, mangroves, seagrasses, and salt marshes** through conservation and restoration.
- Establish and expand **Marine Protected Areas (MPAs)** to build ecosystem resilience.

3. **Promote Sustainable Aquaculture and Fisheries**
    - Shift towards **heat-tolerant species** and **low-impact feed** in aquaculture.
    - Develop **early warning systems** to support fishing communities during MHW events.
4. **Reduce Local Stressors on Oceans**
    - Combat **marine pollution** through international frameworks like the **UN Plastic Treaty**.
    - Promote **sustainable agriculture** to prevent nutrient runoff into oceans.
    - Explore **geoengineering** like reflective surface films or **artificial upwelling** to cool ocean surfaces (experimental).
5. **Accelerate Climate Action to Reduce Emissions**
    - Transition to **renewable energy**, implement **carbon pricing**, and decarbonize industries.
    - Enforce emission-cutting goals under the **Paris Agreement** to limit global warming and related MHWs.
6. **Strengthen International Cooperation**
    - Support **climate finance and technology transfer** to vulnerable nations.
    - Enforce **UNCLOS** and ocean-related frameworks.
    - Advance science-driven policies through the **UN Decade of Ocean Science (2021–2030)**.

**Conclusion**

- Marine Heatwaves are a **growing climate crisis** threatening **marine biodiversity**, **coastal livelihoods**, and **global climate systems**.
- They represent a **symptom of unchecked climate change**, exacerbated by local pressures and delayed global action.
- Tackling MHWs requires a **multi-pronged approach**: rapid emission reductions, ecosystem protection, technological innovation, and **robust global ocean governance**.

- Without urgent interventions, MHWs will become **longer, more frequent, and more destructive**, causing irreversible damage to **life under water** and **human societies**.

Source: https://epaper.thehindu.com/ccidist-ws/th/th_international/issues/141399/OPS/GHGEMELBU.1.png?cropFromPage=true