ARCTIC SEA ICE & INDIAN MONSOON : GEOGRAPHY

NEWS : *How changes in the level of Arctic sea ice can change monsoon patterns in India*

WHAT'S IN THE NEWS ?

Unpredictable, erratic rainfall has become the norm for the Indian monsoon. New research reveals that less sea ice in the central Arctic leads to lower rain in western and peninsular India but more rain in central and northern India

Impact of Arctic Sea Ice on the Indian Monsoon:

Introduction to the Indian Monsoon:

- The Indian monsoon is crucial for agriculture and water resources in India, but in recent years, its pattern has become erratic, with unpredictable rainfall leading to frequent droughts and floods.
- While climate change is a major driver of these variations, other climatic factors also play a role in this unpredictability.
- A recent study, conducted by Juhi Yadav and colleagues from India's National Centre for Polar and Ocean Research (NCPOR) and South Korea's Korea Polar Research Institute, explores how seasonal variations in Arctic sea ice levels affect the Indian Summer Monsoon Rainfall (ISMR).

The Mechanics of the Indian Summer Monsoon (ISMR):

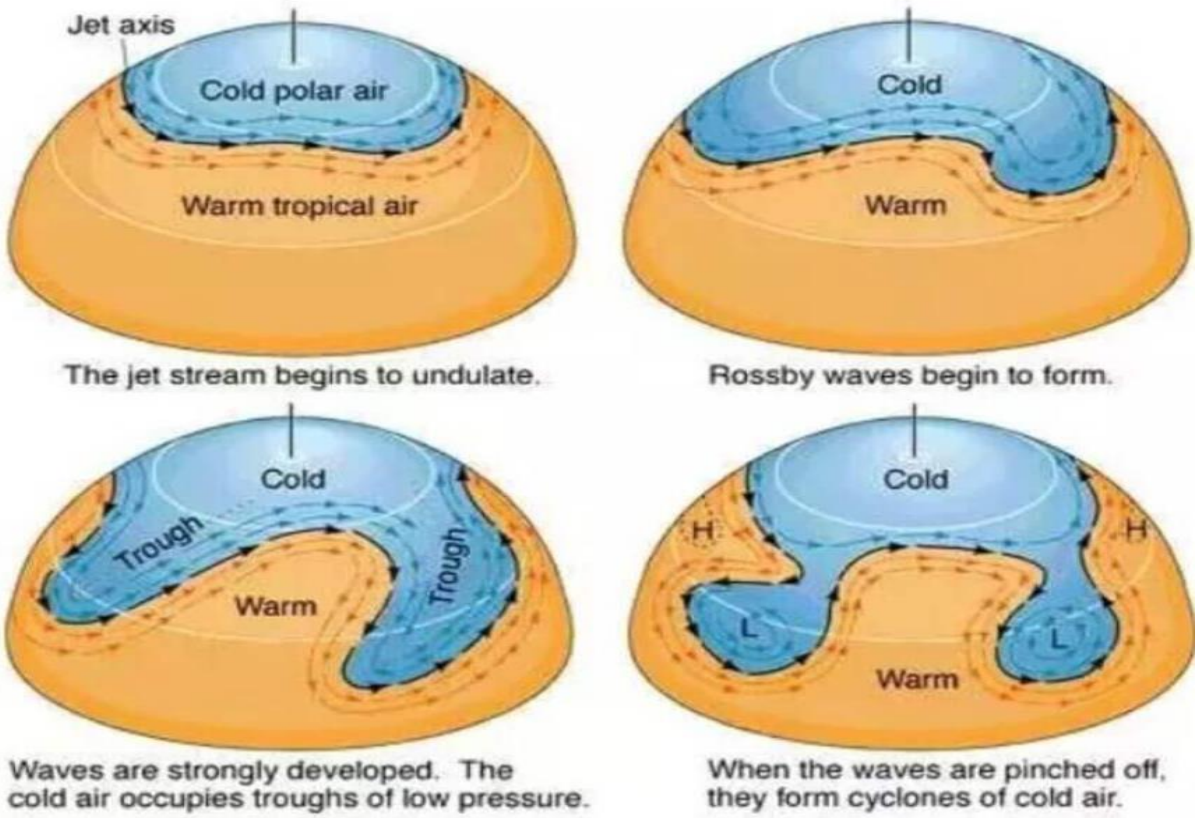
- **Active Period**: The ISMR is active from July to September and is one of the largest and most influential monsoon systems globally, bringing substantial rainfall to India.
- **Formation Process**: The ISMR is driven by the difference in heating between the Central Asian and Indian landmass and the surrounding oceans. As the land heats up faster, it creates a low-pressure system that pulls in moisture-laden winds from the Indian Ocean.
    - These winds split into two branches: one bringing rain to India's western coast via the Arabian Sea, and the other bringing rainfall to the eastern and northeastern regions via the Bay of Bengal.
- **Complex Influences**: The ISMR is influenced by a combination of ocean surface temperatures, atmospheric pressure gradients, and global wave patterns like the Circum-global Teleconnection (CGT), which affect mid-latitude atmospheric circulation.

Key Findings of the Study:

1. **Impact of Central Arctic Sea Ice Decline**:
    - **Effect on Rainfall**: Reduced sea ice in the central Arctic affects rainfall distribution in India. It leads to less rainfall in western and peninsular India, while central and northern regions experience more rainfall.
2. **Impact of Barents-Kara Sea Ice Decline**:

- **Delayed Monsoon Onset**: When sea ice levels in the Barents-Kara Sea region are low, the onset of the Indian monsoon is delayed. This delay also increases the unpredictability of rainfall patterns across India.

Atmospheric Systems Influencing Monsoon Patterns:



1. **Rossby Waves and Their Effect**:
   - **How They Form**: When Arctic sea ice decreases, heat transfer from the ocean to the atmosphere triggers cyclonic circulation at lower latitudes. This strengthens **Rossby waves**, large-scale atmospheric waves that modulate weather patterns globally.
   - **Impact on Indian Monsoon**: These enhanced Rossby waves can influence the Indian monsoon by intensifying high-pressure systems over northwest India and creating low-pressure systems over the Mediterranean. This alters the subtropical easterly jet over India, impacting rainfall patterns.
   - **Result**: Rossby waves lead to an anomalous high-pressure system over Central Asia, which can result in increased rainfall over western and peninsular India.
2. **Barents-Kara Sea Ice Decline**:
   - **Atmospheric Circulation Changes**: The reduction in sea ice in this region triggers high pressure over southwest China, leading to a **positive Arctic Oscillation**. Additionally, anticyclonic circulation develops over northwest Europe, disrupting atmospheric stability in subtropical Asia and India.

- **Impact on Rainfall**: This disruption results in higher rainfall over northeastern India but drier conditions in central and northwest India.

The Role of Climate Change:

- **Accelerated Sea Ice Loss**: Climate change has intensified the decline in Arctic sea ice, exacerbating the variability and unpredictability of the Indian monsoon.
- **Global Impact**: As Arctic sea ice continues to decline, it contributes to more frequent and severe weather events in India, including droughts, excessive rainfall, and flooding.
- **Increased Risk**: The loss of sea ice also contributes to more frequent and severe droughts in some parts of India while causing excessive rainfall and flooding in other regions, making it difficult for India to predict and prepare for monsoon variability.

Conclusion:

- The study underscores the intricate relationship between declining Arctic sea ice and the Indian monsoon. The far-reaching effects of sea ice loss on the global climate, particularly on India's weather systems, highlight the importance of understanding these connections.
- Given the rising influence of climate change, there is a growing need for more extensive research on how Arctic sea ice affects the Indian monsoon, alongside better forecasting models to improve India's climate resilience and preparedness for future monsoon variations.

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