Impact of Arctic Sea ice on Indian Monsoon

Why in news?

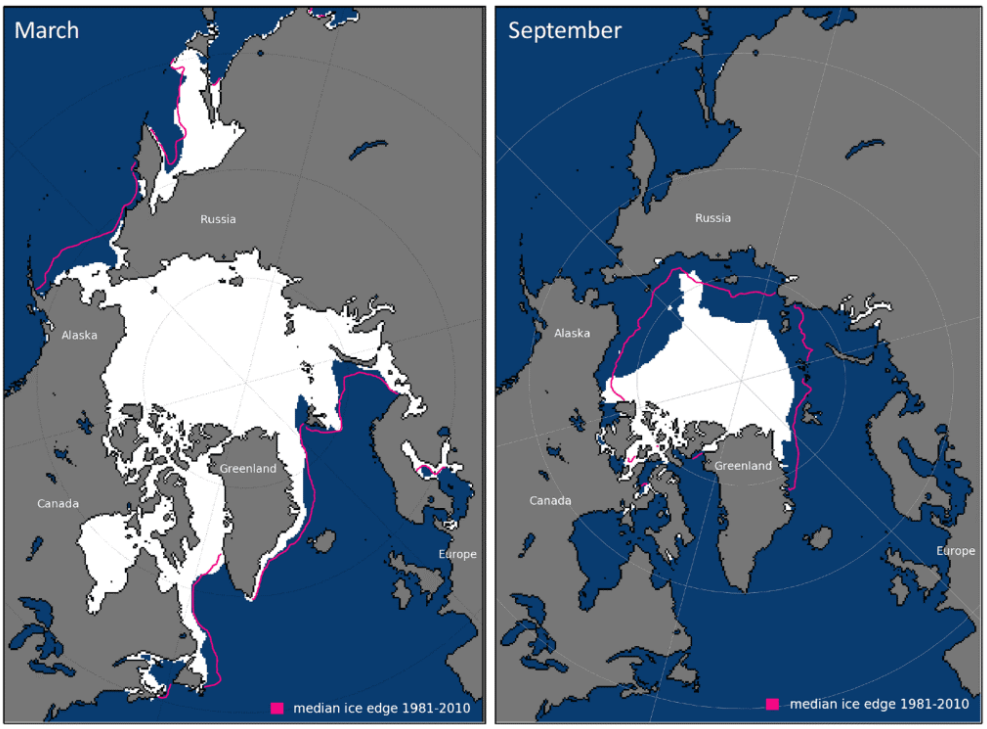
New research reveals that changing Arctic Sea level has significant impact on monsoon patterns.

What is the Arctic Sea ice?

- **Sea ice** - It is sea water that freezes from the ocean surface down to several feet below, is an integral part of the Arctic Ocean.
- **Importance of sea ice** - Sea ice helps in
  - Regulating Earth's climate
  - Influencing global weather patterns
  - Affecting ocean circulations
- **The Arctic ice** – It is the sea ice cover of the Arctic Ocean and its vicinity.

***Arctic Circle** is the line of latitude around Earth, at approximately 66°30′ N.*

  - **During the dark winter months** – Sea ice essentially covers the entire Arctic Ocean
  - **In summer** – Some of this ice melts because of warmer temperatures and long hours of sunlight.



What is Arctic sea ice change?

- **Arctic Minimum** - Arctic Sea ice reaches its minimum each September and reaches the maximum extent in March.
- **Declining Arctic minimum** – The *Arctic is warming faster* than anywhere else on the planet.
- As a result, sea ice in the Arctic Ocean is decreasing.
- Shrinking September Arctic Sea ice – It is now decking at a rate of 12.2% per decade, compared to its average extent during the period from 1981 to 2010.

- **Impact on Monsoon** - Arctic Sea ice levels affect atmospheric circulations that in

turn influence the Indian Summer Monsoon Rainfall (ISMR).

- Due to the climate change, sea ice concentration (SIC) in the central Arctic Sea is reducing, which is affecting ISMR.
- Less central Arctic sea ice leads to lower rain in western and peninsular India but more rain in central and northern India.
- Lower sea ice levels in the upper latitudes, particularly in the Barents-Kara Sea region delay the monsoon's onset and render it more unpredictable.

Barents-Kara Sea region *encompassing the Hudson Bay, the Gulf of St. Lawrence and the Sea of Okhotsk.*

What is the Indian Summer Monsoon Rainfall (ISMR)?

- **Occurrences** – It occurs over the Indian subcontinent, from July
- **Determining factors** - The *surface temperatures* of the Indian, the Atlantic, and the Pacific Oceans affect the ISMR.

The circum-global teleconnection (CGT), *a large-scale atmospheric wave flowing at the mid-latitudes, seemed to significantly influence the monsoon as well.*

- **Pressure gradient** - In summer months, *sunlight warms the Central Asian and Indian landmass* more and faster than the surrounding ocean.
- This creates a low pressure band at the Tropic of Cancer called the *intertropical convergence zone*.
- **Wind movement** - Trade winds blowing from the southeast are subsequently deflected towards the Indian landmass *due to the Coriolis force and the low pressure* after they cross the equator.
- **Rainfall** - As they blow over the Arabian Sea, the winds pick up moisture and deposit that as rain over India.
- **Branches** - Over the landmass itself, this southwest monsoon splits into two.
    - **Arabian Sea arm** - It brings rain to the west coast.
    - **Bay of Bengal arm** – It brings rain to India's eastern and northeastern parts.
- These two arms finally converge over Punjab and Himachal Pradesh as the Arabian Sea arm moves inward and the Bay of Bengal arm moves along the Himalaya.

To know more about Monsoon, Click here

How increase in Central Arctic sea ice influence ISMR?

- **Cyclones formations** – Higher SIC triggers a *cyclonic circulation at lower latitudes*, the heat transferred from the ocean to the atmosphere which in turn strengthens the Rossby waves.

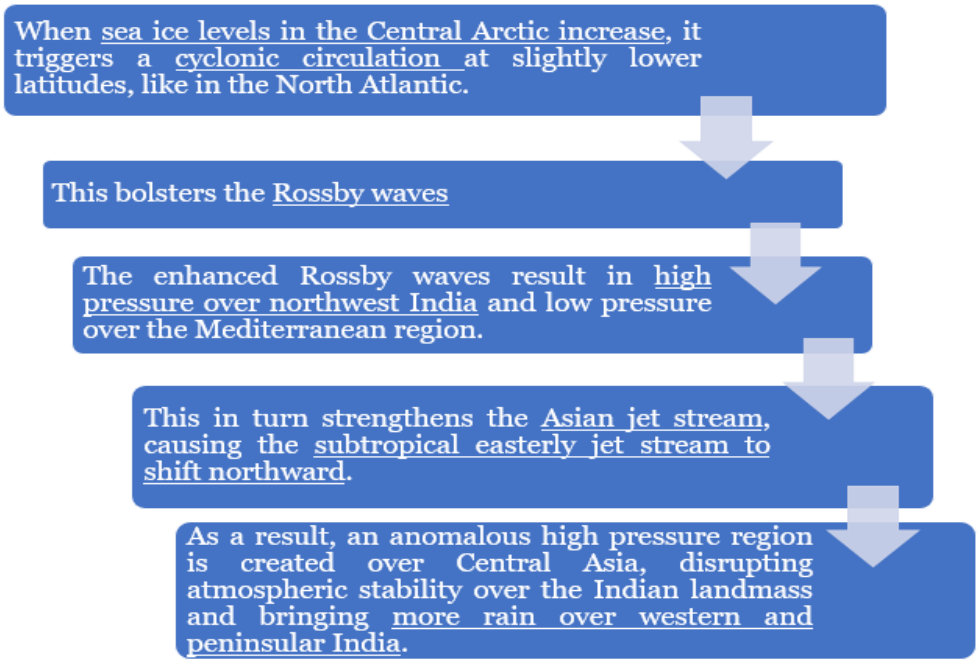
Rossby waves *are fast-flowing streams of air high in the atmosphere created by*

the earth's rotation and differences in temperature and weather systems that move west to east.

- This enhanced Rossby waves creates
  - **High Pressure over** – Northwestern India
  - **Low pressure over** – Mediterranean region
- **Strengthening of Asian Jet Stream** – It is a narrow band over the Caspian Sea which causes the subtropical easterly jet stream to shift northwards.

*The **Subtropical Easterly Jet Stream** (STEJ) is a high-altitude wind pattern that flows from east to west over the Indian subcontinent during the summer months.*

- It results in high pressure region over Central Asia disrupting atmospheric stability over Indian landmass.
- **Rainfall in India** – As a result, *Western and Peninsular India receives more rainfall*.



How lower Arctic sea ice impacts ISMR?

- High pressure over China – Low sea ice over the Barents-Kara Sea region *triggers a series of air currents* that produce an anomalous *high pressure over southwest China*.
- This correlates with a ***positive Arctic Oscillation***, a high pressure over the northern Atlantic and Pacific oceans along with a weakening of the CGT, which connects weather events in different parts of the world.
- **Anticyclones formation** – As sea ice levels decrease in the region, heat rises from the Barents-Kara sea, creating an anticyclonic circulation (calm, clear skies) over northwest Europe.
- This disturbs the upper atmospheric region over subtropical Asia and India.
- **Rainfall in India** - This instability, coupled with high surface temperature of the Arabian Sea and the moisture picked up from the surrounding water bodies promotes

high rainfall over northeastern India.

- It leaves the central and northwest regions of the country without much rainfall.

References

1. The Hindu | Arctic Sea ice can change monsoon patterns
2. NSIDC | Polar Sea ice