Early Monsoon Arrival

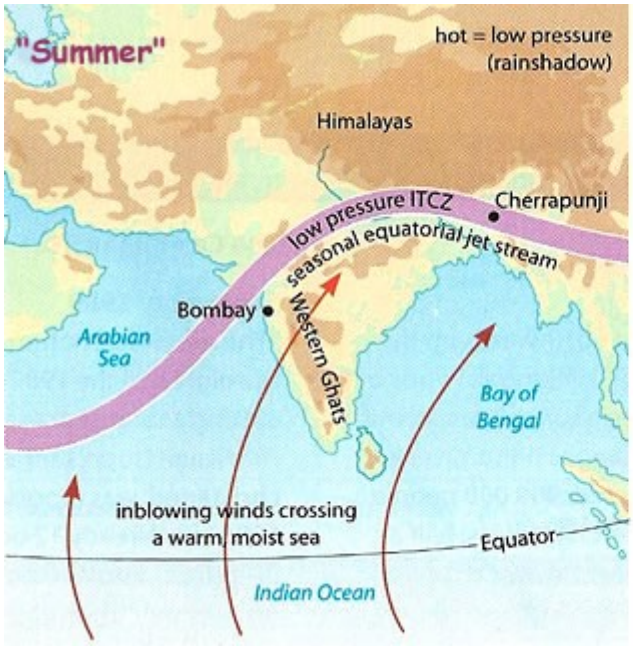
> Mains Syllabus: GS I - Important Geophysical phenomena such as earthquakes, Tsunami, Volcanic activity, cyclone etc.,

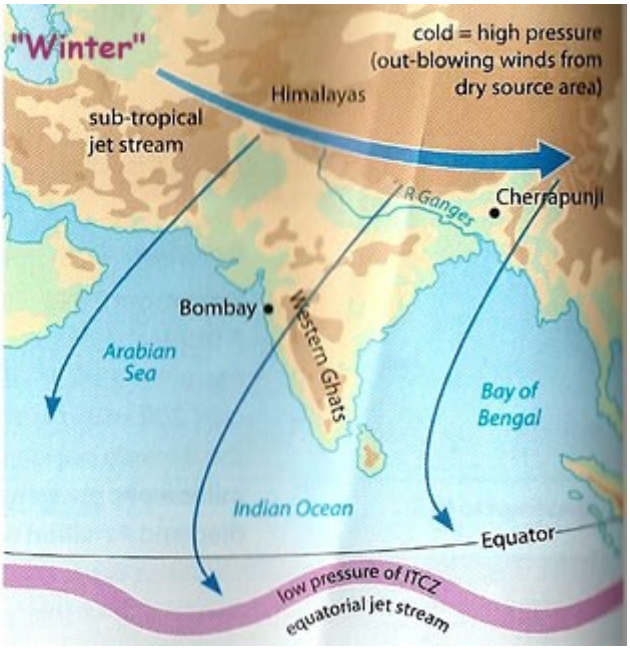
Why in the News?

India Meteorological Department said the southwest monsoon set in over Kerala on May 24, a week ahead of its normal onset.

What are the various theories on monsoon onset?

- **Different Theories & No Consensus** - There are many theories as to the science of monsoon onset , but there is no consensus on a complete understanding of the processes leading to the onset of monsoon.
- **Monsoon Factors** - The onset of the monsoon is a complex phenomenon influenced by multiple atmospheric, oceanic, and terrestrial factors.
- **Tracking the Trough** - The march of the trough is watched carefully from its origin in the northwestern tropical Pacific into the Andaman Sea and the Bay of Bengal.
- **Classical (Thermal) Theory** - Proposed by Sir Edmund Halley (1686), It attributes the monsoon to the differential heating of land and sea.
- During summer, the Asian landmass heats up much faster than the surrounding oceans, creating a low-pressure area over the land and a high-pressure area over the ocean.
    - **Limitations** - This theory cannot explain the sudden burst of monsoon, regional variations, or the intricacies of monsoon onset and withdrawal.

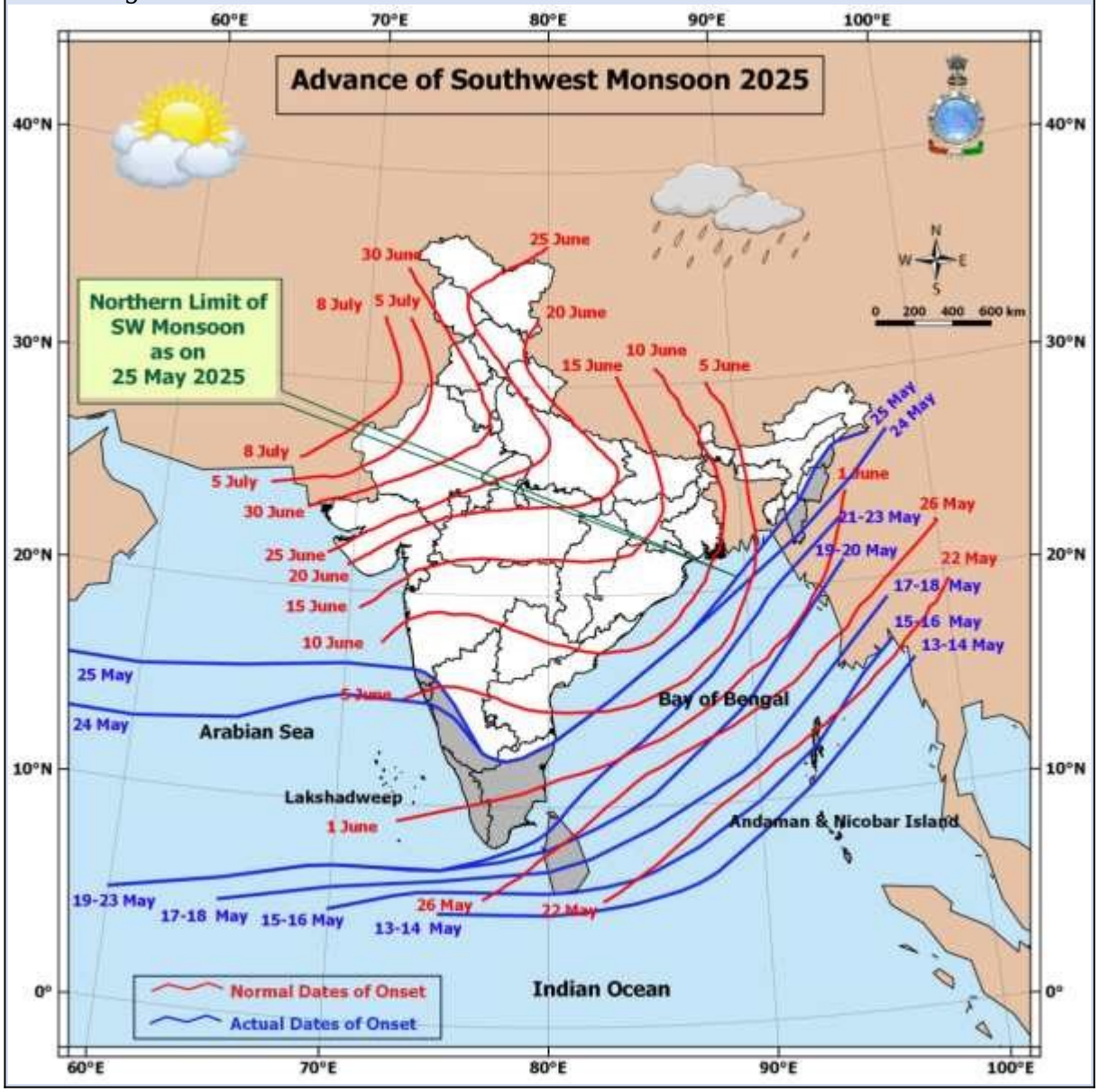




- **Dynamic Theory** - Developed by Flohn (1951) , this theory focuses on the seasonal migration of planetary wind and pressure belts.
- The Inter-Tropical Convergence Zone (ITCZ), where trade winds from both hemispheres meet, shifts northward during the northern summer.
- The monsoon is seen as a result of this shift, with the equatorial westerlies (southwest monsoon) moving towards the Indian subcontinent as the ITCZ migrates.
- **Jet Stream Theory** - Modern research has highlighted the role of upper atmospheric circulation, particularly the jet streams.
- The subtropical westerly jet shifts northward in summer due to heating of the Tibetan Plateau, allowing the monsoon trough to develop over India.
- This theory helps explain the timing and sudden onset ("burst") of the monsoon over the Indian subcontinent.
- **Orographic and Surface Moist Static Energy (SMSE) Theory** - Recent studies using Atmospheric General Circulation Models (AGCMs) suggest that orography (mountains) and surface moist static energy play crucial roles in monsoon onset.
- The onset occurs when the SMSE crosses a threshold value and there is large-scale upward motion in the mid-troposphere.
- The presence and configuration of the Himalayas and Tibetan Plateau are particularly important in modulating the onset and strength of the monsoon.
- **Sea Surface Temperature (SST)** - Warmer SSTs near the equator and the Indian subcontinent increase atmospheric instability, favoring monsoon onset.

IMD’s Meteorological Criteria on Monsoon Onset

• **Rainfall** - At least 60% of 14 southern meteorological stations record ≥2.5 mm rainfall for two consecutive days.
• **Wind field** - Westerly winds blow from West to East in the 30 to 60 degree latitudes, both in the northern and southern hemispheres.
• For the onset, the depth of westerly winds should be maintained at upto 600 hectoPascals or hPa wind speeds must range between 15-20 knots (27-37km/hr) at 925 hPa.
• **Outgoing Longwave Radiation (OLR)** – Its value falls below 200 W/m^2, indicating dense cloud cover and active convection.



This year, there has been a simultaneous onset over the entire Lakshadweep, Mahe (Puducherry), many parts of the Arabian Sea and the Bay of Bengal, along with monsoon winds reaching parts of southern Karnataka and Mizoram in northeast India.

What is the relation between past and present early onsets?

- **Earliest Onset** - Since 1975, the earliest monsoon onset over Kerala occurred on May 19, 1990, 13 days ahead of schedule.

- **Previous Onset** – Before to this year's onset, It happened in 2009 with the early arrival occurred at May 23.
- **Unusual El Nino 2009** - 2008 was about 0.5°C warmer than the pre-industrial baseline and 2009 was a mild El Niño year.
- The summer of 2009 was noted to be warm across the tropical Pacific, which is unusual for an El Niño year and 2009 had a severe monsoon drought.

In an El Niño year, the east is expected to be warming in the summer and the west to be cooling.

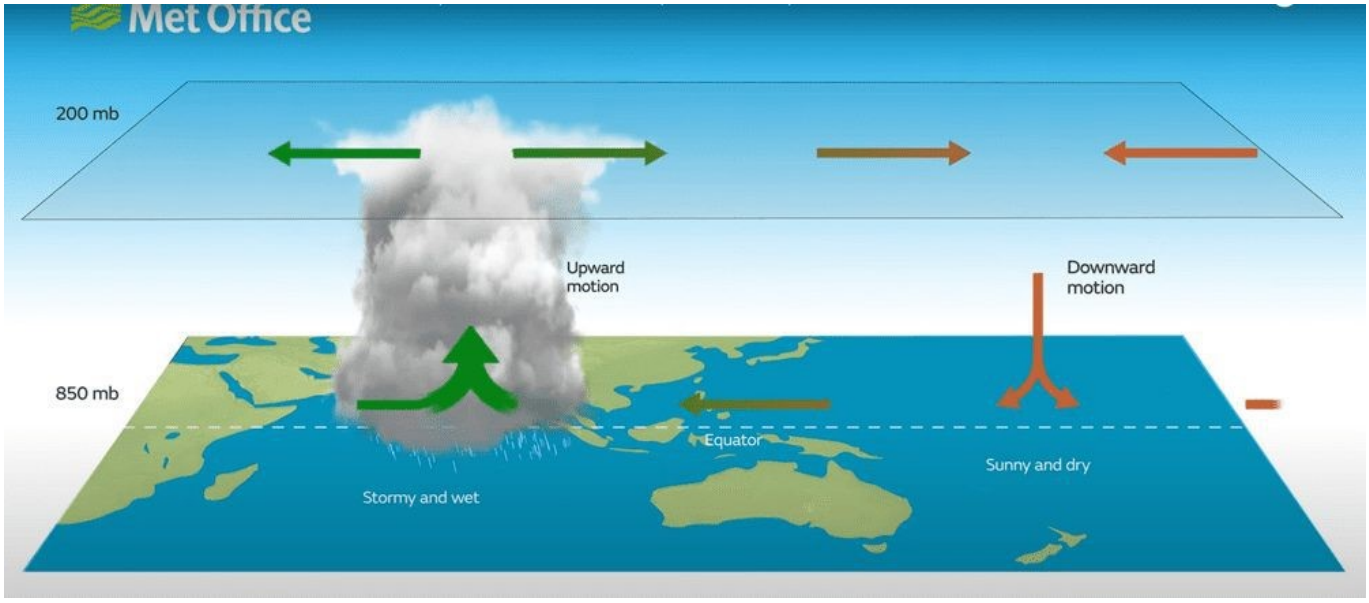
- **Current Global Warming Rate** - Global warming thus far in 2025 is already over 1.2°C with a strong El Niño in 2023, and a failed La Niña in 2024.
- **2024 Anomaly** - An unusual sea surface temperature anomaly pattern in the tropical Pacific occurred in 2024, with warm anomalies in the far east and far west but cooler anomalies in the centre.

What are the factors affecting monsoon arrival in India?

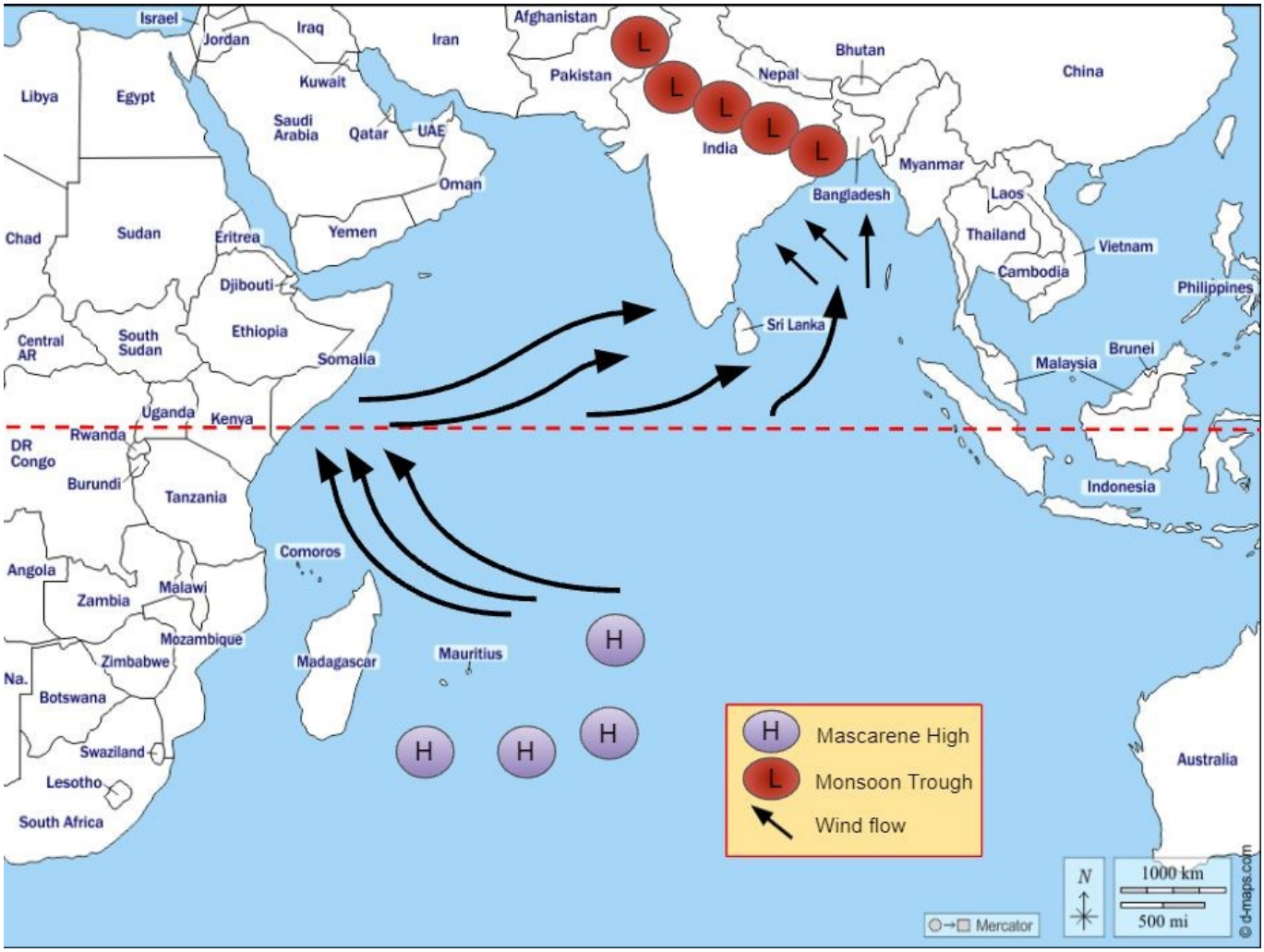
- Many external factors are now playing into the arrival of the monsoon trough to Kerala.
- **Pre-monsoon cyclone** - More cyclones are occurring late into the pre-monsoon cyclone season, that is, close to the monsoon onset and some pulls the trough forward to deliver an early onset.

The pre-monsoon cyclone season in the North Indian Ocean, particularly the Bay of Bengal, typically occurs between April and May, characterized by the formation and intensification of tropical cyclones.

- **Pacific Typhoons** - They also pull moisture away from the Indian Ocean during the onset phase to delay the onset.
- **Madden-Julian Oscillation (MJO)** - The MJO is a significant, eastward-moving atmospheric disturbance originating in the Indian Ocean.
- When in a favorable phase, it enhances cloud formation, wind patterns, and rainfall over India, often accelerating monsoon onset.



- **Mascarene High** - This is a high-pressure system near the Mascarene Islands (south Indian Ocean).
- Its intensity influences the strength and direction of monsoon winds toward India, with a stronger Mascarene High promoting robust monsoon flow and early arrival.



- **Somali Jet**- It is a low-level, cross-equatorial wind originating near Mauritius and Madagascar.

- A strong Somali jet intensifies the southwest monsoon winds, aiding in the timely or early onset over Kerala.

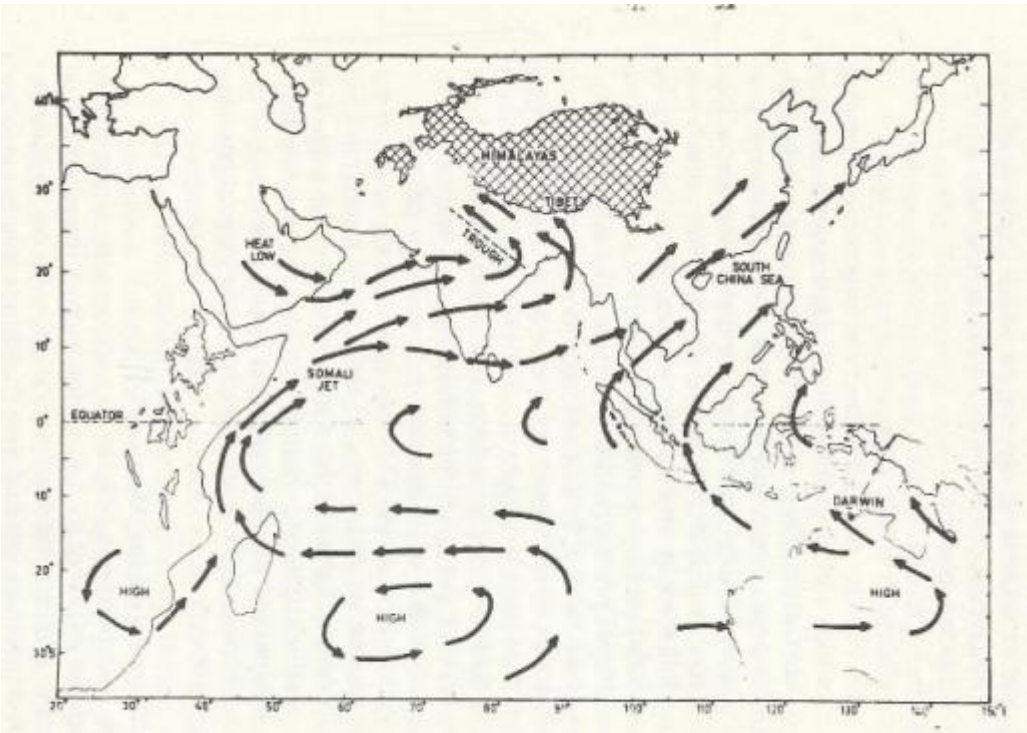


Figure 2.6. The Summer Monsoon. Low level winds.

What are the implications of early onset of monsoon?

- **Agricultural Impact** - Early rains can benefit farmers by enabling earlier sowing of summer (kharif) crops such as rice, cotton, and soybeans, potentially leading to a longer growing season and higher yields.
- However, if the early onset is followed by a prolonged dry spell or "break" in rainfall, it can damage newly sown crops or disrupt the cropping cycle, causing losses for farmers.
- **Relief from Heatwaves** - Early monsoon rains provide immediate relief from extreme heat, lowering temperatures and reducing the impact of heatwaves in affected regions.
- **Water Resource Replenishment** - Reservoirs, groundwater, and other water bodies benefit from early rainfall, improving water availability for irrigation, drinking, and industrial use.
- **Risk of Urban Flooding** - Intense early rainfall can overwhelm drainage systems, leading to waterlogging, flash floods, and disruptions in cities unprepared for early rains.
- **Economic Impacts** - The monsoon's timing is a critical economic indicator for India, influencing food prices, rural incomes, and overall economic stability.

What lies ahead?

- As India continues to grapple with the growing impacts of climate change, understanding the evolving behaviour of the monsoon is more critical than ever.
- Disaster response plans need to be activated ahead of the planned schedule.
- Early monsoon preparedness activities like dredging drainage network needs to be

fastened.

- Health advisories on vector control to prevent outbreaks of diseases like dengue, malaria, and chikungunya, which spike during the monsoon can be released ahead.
- Timely advisories to farmers regarding sowing schedules, crop selection, and protection measures in light of the altered rainfall pattern needs to be issued.

Reference

1. The Hindu | Why has the monsoon come early this year?
2. The Indian Express | Early Monsoon Onset

To Practice Mains Question Click Here.