Decoding the Early Monsoon

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Decoding the Early Monsoon: Atmospheric and Oceanic Influences in 2025

Context

The **southwest monsoon** is crucial for India, as it accounts for **over 70% of the country's annual rainfall** and sustains its **agriculture-dependent economy**. Its timely onset and progression affect **Kharif crop production, water availability**, and the overall **economic outlook**. The **India Meteorological Department (IMD)** officially declared the onset of the **2025 southwest monsoon over Kerala on May 24**, which is **eight days earlier** than the normal date of **June 1**. This early onset signals the beginning of the **June–September monsoon season**.

Monsoon Onset Declaration: Criteria and Procedure

The **IMD** uses specific meteorological parameters to declare the onset of the southwest monsoon, typically after **May 10** each year.

Key Criteria for Onset

1. **Rainfall Criterion**
    - At least **60% of 14 designated stations** in southern India (e.g., **Thiruvananthapuram, Kochi, Mangaluru**) must report **≥2.5 mm rainfall for two consecutive days**.
2. **Wind Field Condition**
    - Dominance of **westerly winds** up to the **600 hPa pressure level**.
    - Wind speed at **925 hPa** should be between **15–20 knots** (**27–37 km/h**).
3. **Outgoing Longwave Radiation (OLR)**

- OLR values should be **below 200 W/m²**, indicating high cloud cover and active convection.

4. **Final Declaration**
   - IMD declares monsoon onset **on the second day after all conditions are fulfilled**.

2025 Onset Coverage

The 2025 onset covered:

- **Kerala**
- **Lakshadweep**
- **Mahe (Puducherry)**
- Parts of the **Arabian Sea**
- **Southern Karnataka**
- **Mizoram**
- Parts of the **Bay of Bengal**

This widespread coverage highlights a **strong and early start** to the season.

Why Did Monsoon Arrive Early in 2025?

The early onset was influenced by **favourable oceanic and atmospheric conditions**:

1. Low-Pressure Systems and Trough Formation

- A **low-pressure area over the Arabian Sea** and a **trough over Vidarbha** enhanced **moisture inflow** and triggered **strong convection**, hastening monsoon arrival.

2. Madden-Julian Oscillation (MJO)

- MJO is an **eastward-moving ocean-atmosphere phenomenon**.
- Involves **disturbances in clouds, winds, and pressure**.
- Travels around the globe in **30–60 days** at **4–8 m/s**.
- In a **favourable phase**, it enhances **monsoon rainfall** over India.

3. Mascarene High

- A **high-pressure zone** near the **Mascarene Islands** (south Indian Ocean).
- Affects the **strength of monsoon winds**, especially over **India's west coast**.
- **Strong Mascarene High** results in **heavier rainfall** in coastal areas.

4. Increased Convective Activity

- Vertical movement of **heat and moisture** in the atmosphere enhances **rainfall potential**.
- Example: A **convective system over Haryana** moved to **Delhi**, causing rainfall.

5. Somali Jet Stream

- A **cross-equatorial low-level jet** originating near **Mauritius and Madagascar**.
- Strengthens by **May**, reaching **India's west coast** via the **Arabian Sea**.
- Plays a vital role in enhancing **monsoon winds** and **moisture transport**.

6. Heat Low and Moisture Suction Effect

- A **heat low** develops over **Pakistan and northwest India** due to summer heating.
- Acts as a **suction pump**, drawing in **moist air** from the Arabian Sea.

- Intensifies rainfall over **central and northern India**.

7. Monsoon Trough Dynamics

- The **monsoon trough** is an **elongated low-pressure area** from **northwest India to north Bay of Bengal**.
- Its **oscillating position** governs **rainfall distribution** across the monsoon zone.

8. Monsoon Onset Vortex

- A **cyclonic system** in the **southeastern Arabian Sea**.
- Triggers initial **burst of monsoon** over Kerala and nearby regions.