



## Early Monsoon Onset 2025

**For Prelims:** [India Meteorological Department](#), [Southwest monsoon](#), [Westerly winds](#), [Madden-Julian Oscillation](#), [Somali jet](#)

**For Mains:** Factors influencing the onset of the southwest monsoon over India.

[Source:IE](#)

### Why in News?

The [India Meteorological Department \(IMD\)](#) declared the [southwest monsoon](#) onset over Kerala earlier than usual. This early arrival is significant as the monsoon provides over **70% of India's annual rainfall**, crucial for agriculture and the economy. The last early onset before 2025 was in **2009**.

### What are the Criteria for Declaring the Onset of the Monsoon?

- **Essential criteria:** IMD declares monsoon onset anytime after May 10 based on key criteria:
  - **Rainfall Criteria:** After 10th May, if **60% of 14 designated weather stations in Kerala and surrounding areas** (e.g., Thiruvananthapuram, Kochi, Mangalore) record  $\geq 2.5$  mm rainfall for two consecutive days, onset can be considered on the second day.
  - **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 up to 600 hectoPascals or hPa, which is the unit for measuring **atmospheric pressure**, and wind speeds must range between 15-20 knots (27-37km/hr) at 925 hPa.
  - **Outgoing Longwave Radiation (OLR):** The [INSAT](#)-derived **OLR value**, which measures the energy emitted to space by the Earth's surface, oceans, and atmosphere, should be below **200 watts per square meter ( $W/m^2$ )** in the region between 5°N and 10°N latitude and 70°E and 75°E longitude, indicating sufficient atmospheric heat conducive to rainfall.
- Once these conditions are met on two consecutive days, IMD declares the monsoon onset.

### What Factors Caused the Early Monsoon Onset 2025?

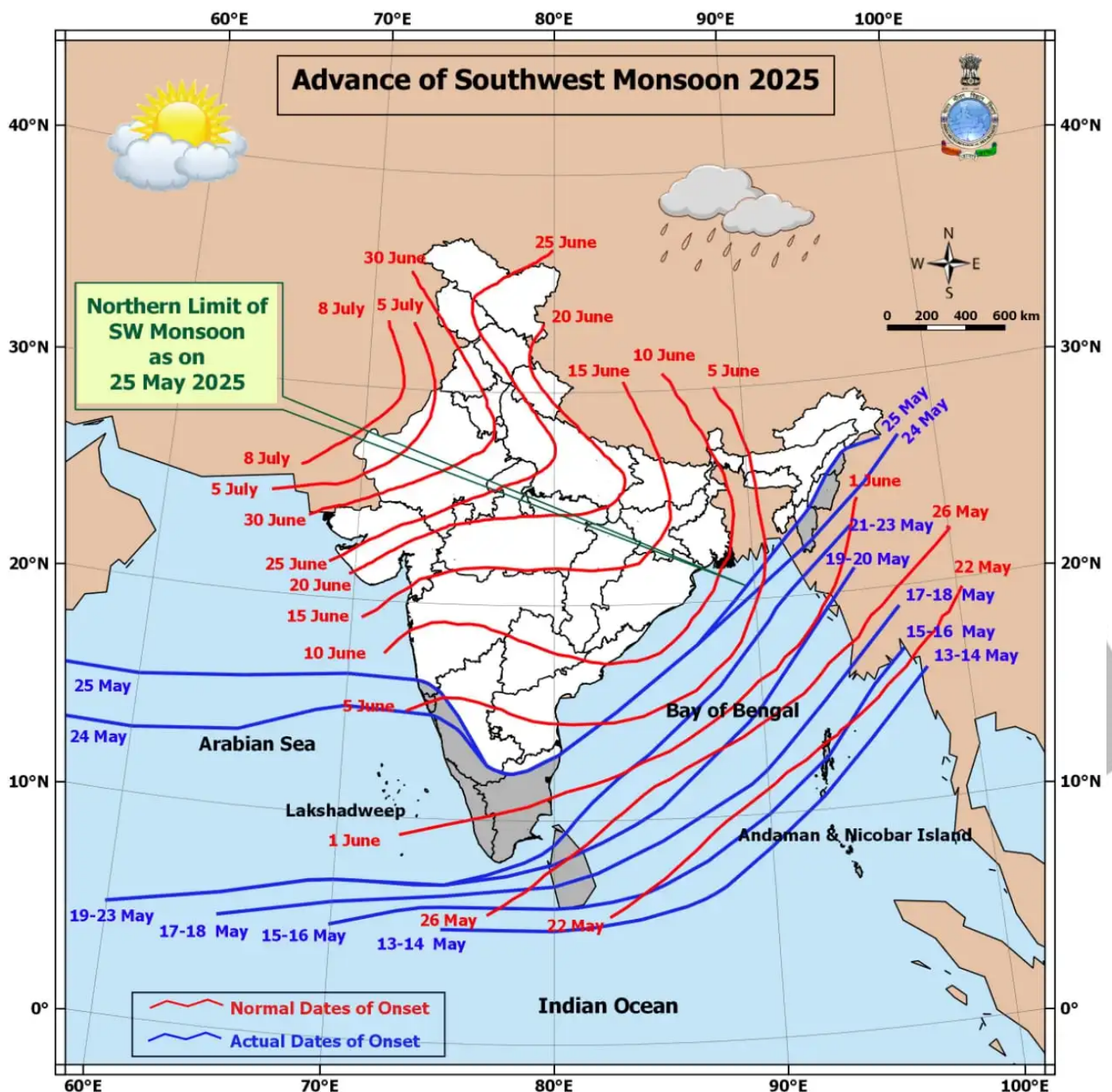
- **Madden-Julian Oscillation (MJO):** The [MJO](#) is a transient **eastward-moving system of winds, clouds, and pressure** disturbances that travels around the equator.
  - It was identified in 1971 by Roland Madden and Paul Julian, scientists at the National Centre for Atmospheric Research in Colorado.
  - The MJO typically travels eastward at 4–8 m/s, and completes one global cycle in 30–60 days, though sometimes it takes up to 90 days.
  - It **influences weather in tropical regions**, especially between 30°N and 30°S, which includes India.
  - MJO has two distinct phases: an **active phase**, which brings enhanced convection and increased rainfall, and a **suppressed phase**, which leads to reduced convection and drier

conditions.

- It can trigger cyclones and cause brief but intense rainfall spells, even during dry periods.

- **Mascarene High:** The IMD describes the **Mascarene High** as a high-pressure area found around the **Mascarene Islands (in the south Indian Ocean)** during the monsoon period.
  - The variation in the intensity of high pressure is responsible for heavy rains along India's west coast.
- **Convection:** An increase in the **convective activity**, that is, the vertical transport of heat and moisture in the atmosphere, also brings rainfall.
- **Somali Jet:** It is a low-level, inter-hemispheric cross-equatorial wind band originating **near Mauritius and north Madagascar**.
  - During May, after crossing the east coast of Africa, it reaches the Arabian Sea and the west coast of India. A strong **Somali jet** is associated with the strengthening of monsoon winds.
- **Heat-low:** As the Sun moves northward, a low-pressure zone forms over the Arabian Sea and Pakistan, acting like a **suction pump to draw moist air** along the monsoon trough, boosting monsoon rainfall.
- **Monsoon Trough:** It is an **elongated low-pressure area** extending from the heat low to the north Bay of Bengal. The north-south swinging of this trough causes rainfall during the **June-September period across the core monsoon zone**.
- **Cyclonic Monsoon Vortex:** It is also known as a **Monsoon Onset Vortex (MOV)**, is a **synoptic-scale cyclonic circulation** that forms over the Arabian Sea during the Indian summer monsoon.
  - These vortices can intensify into tropical cyclones and play a crucial role in the onset and advance of the monsoon.
- **Pressure gradients:** It is the rate of change of pressure over a given distance. It also supports the strong monsoon onset.





## Other Factors Influencing Monsoon

- **Monsoon low:** It is a type of **low-pressure area (LPA)** characterized by the lowest pressure at its center with winds blowing anticlockwise in the **Northern Hemisphere**.
  - It causes air to converge and rise, leading to cloud formation and rainfall. During the monsoon season, these **LPAs are known as monsoon lows and can intensify into monsoon depressions**, which are the main rain-bearing systems of the southwest monsoon over India.
- **Tibetan High:** It is a warm anticyclone **located over the Tibetan Plateau** in the middle to upper troposphere during the monsoon season.
  - It produces an outflow of easterly winds that form a jet stream near Chennai. The position of this Easterly Jetstream influences the **monsoon rainfall pattern over India**.

## How are Rainfall alerts Categorised?

| Alert Colour | Rainfall Category (24 hrs) | Weather Description      | Advisory / Action                                                                          |
|--------------|----------------------------|--------------------------|--------------------------------------------------------------------------------------------|
| Green        | Less than 64 mm            | Light rain               | <b>No advisory:</b> Weather is generally safe; no action needed.                           |
| Yellow       | 64.5 – 115.5 mm            | Moderate rain            | <b>Be aware:</b> Minor disruptions possible; stay informed and updated.                    |
| Orange       | 115.6 – 204.4 mm           | Heavy to very heavy rain | <b>Be prepared:</b> Likely disruptions in transport, power; take necessary precautions.    |
| Red          | 204.5 mm and above         | Extremely heavy rain     | <b>Take action:</b> High risk to life and property; follow emergency measures immediately. |

## What is the Impact of Early Onset of Monsoon?

- **Boost to Kharif Crop Sowing:** Early monsoon facilitates **timely sowing** of major **Kharif crops** like rice, maize, millets, toor, and moong, ensuring **higher productivity**.
- **Vegetable and Mushroom Cultivation:** Pre-monsoon rains benefit **vegetable farmers** (e.g., tomatoes, okra, beans) and **mushroom growers** by creating a **cool, moist environment** favorable for cultivation.
- **Water Resource Management:** Early rainfall **recharges groundwater**, fills reservoirs, and **improves irrigation**, essential for both agriculture and **hydropower generation**.
- **Increased Spoilage & Inflation Pressure:** **Unanticipated rains** have led to **farm-level spoilage**, pushing up **vegetable prices** in cities like Mumbai.
- **Weather Extremes and Flood Risks:** **Heavy downpours, lightning, and gusty winds** in parts of Kerala, Karnataka, and Maharashtra raise concerns over **localized flooding and damage to standing crops**.
- **Enhanced Export Potential:** Increased crop production could **improve farm incomes, boost agri-exports**, and support **India's GDP growth**.

## Why do Cyclones not occur in India during the Peak Monsoon Months?

- **Conditions Required for Cyclone Formation:** **Tropical cyclogenesis** (cyclone formation) requires a combination of the following environmental factors:
  - Warm ocean waters with temperatures of **at least 26.5°C**, extending to a depth of 50 meters or more.
  - High humidity in the **mid-troposphere, around 5 km altitude**, to support cloud development.
  - **Low vertical wind shear**, meaning there should be minimal difference in wind speed and direction between the surface and the upper atmosphere, allowing the system to remain vertically aligned.
  - **A pre-existing low-pressure** disturbance near the surface to initiate cyclonic rotation.
- **Atmospheric Conditions During Monsoon:** Despite **warm seas and high moisture** (both crucial for cyclone formation) India rarely experiences cyclones during July and August, the peak monsoon months.
  - This is primarily due to unfavorable atmospheric conditions, especially strong **vertical wind shear that prevents cyclones** from developing and sustaining.

- Westerly winds peak at **20-25 knots between 900 and 800 hPa**, while easterly winds reach 60-80 knots at 150-100 hPa over peninsular India.
  - This results in **high vertical wind shear**, disrupting cyclone formation and making conditions unfavorable for tropical cyclogenesis during these months.

# MONSOON



*Monsoons are seasonal winds that reverse their direction with the change of season.*

## Origin of Monsoon

- ⌚ Thermal Concept
- ⌚ Dynamic Concept

## Thermal Concept by Halley

### Monsoon result of:

- ▶ Heterogenous character of globe (Unequal distribution of land and water)
- ▶ Differential seasonal heating and cooling of continents and oceans

## South-West (Summer) Monsoon

- ⌚ Sun shines over Tropic of Cancer
- ⌚ Brings low-pressure centres (Near Baykal Lake and Peshawar) due to High temperature

## Dynamic Concept by Flohn

- ⌚ Monsoon originated due to shifting of pressure and wind belts
- ⌚ Intertropical Convergence (ITC) formed due to convergence of NE and SE trade winds near equator
- ⌚ Northern and Southern branches of the ITC, known as NITC and SITC respectively, create a belt of doldrums marked by equatorial westerlies

## South-West (Summer) Monsoon

- ⌚ Sun shines over Tropic of Cancer
- ⌚ NITC extended up to 30° N latitude covering south and SE-Asia and establishes Equatorial westerlies
- ⌚ It brings atmospheric depressions (cyclones) with heavy rainfall

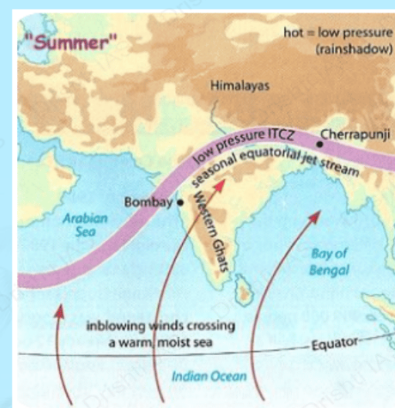
## North-East (Winter) Monsoon

- ⌚ Sun shines over Tropic of Capricorn
- ⌚ Due to Southward shifting of Sun, pressure and wind belts also shifts
- ⌚ Western cyclonic disturbances (from Mediterranean Sea) enter India from west in winter due to Westerly Jet stream
- ⌚ Northeast trade winds reestablished over south and SE Asia
- ⌚ These NE trades become winter monsoons called Retreating Monsoon and rains in Andhra and Tamil Region

- ⌚ Low temperature in Southern hemisphere brings High pressure centre over Australia and Indian Ocean
- ⌚ Winds Blow from high (ocean) to low pressure in Asia (land)
- ⌚ Ferrel's law and Coriolis force turn these wind in south-westerly (SW) direction
- ⌚ They bring moisture from Indian oceans to Indian subcontinent yielding heavy rainfall

## North-East (Winter) Monsoon

- ⌚ Sun shines over Tropic of Capricorn
- ⌚ Brings High Pressure centers (near Baykal Lake and Peshawar) due to low temperatures
- ⌚ High temperature in Southern hemisphere brings Low pressure centre over Australia and Indian Ocean
- ⌚ Winds Blow from high (land) to low pressure (ocean) in north-easterly (NE) direction called Retreating Monsoon



# What is the Impact of Climate Change on Indian Monsoon?

- **Increasing Extreme Rainfall Events:** Rising trend in both the frequency and magnitude of extreme rainfall events during the monsoon season, particularly over central India. This is attributed to **climate change combined with natural variability**.
  - Alongside more extreme events, there is a decreasing trend in moderate rainfall occurrences during the monsoon season over central India.
- **Overall Monsoon Rainfall Decline:** Over the last 50 years, summer monsoon precipitation (June to September) over India has declined by approximately 6%, with significant reductions noted over the Indo-Gangetic Plains and the Western Ghats.
- **Increase in Heavy Rainfall Frequency:** Central India has experienced about a 75% increase in the frequency of daily extreme precipitation events, defined as rainfall exceeding 150 mm per day.
- **Warming Atmosphere and Moisture Capacity:** The Earth's rising temperature due to anthropogenic greenhouse gas emissions increases the atmosphere's capacity to hold moisture.
  - According to the **Clausius-Clapeyron Relation principle**, the moisture-holding capacity of air increases by approximately 7% for every 1°C rise in temperature.
  - As the atmosphere holds more moisture, heavy rainfall events are expected to become more frequent and intense under changing climate conditions.

## Withdrawal of Monsoon

- The withdrawal of monsoon is defined as the **gradual retreat of the southwest (SW) monsoon** from different parts of India. It marks the end of the rainy season and is characterized by:
  - Cessation of rainfall for at least **5 consecutive days**.
  - Change in wind patterns, especially a shift from **southwesterly to northeasterly directions**.
  - Reduction in **atmospheric moisture** as seen in satellite water vapour imagery and tephigrams.
  - Formation of **anticyclonic circulation** in the lower troposphere (850 hPa and below).

### **Drishti Mains Question:**

Discuss the atmospheric and oceanic factors responsible for the early onset of the southwest monsoon.

## UPSC Civil Services Examination, Previous Year Question (PYQ)

### **Prelims:**

**Q. With reference to 'Indian Ocean Dipole (IOD)' sometimes mentioned in the news while forecasting Indian monsoon, which of the following statements is/are correct? (2017)**

1. The IOD phenomenon is characterized by a difference in sea surface temperature between tropical Western Indian Ocean and tropical Eastern Pacific Ocean.
2. An IOD phenomenon can influence an El Nino's impact on the monsoon.

**Select the correct answer using the code given below:**

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2

(d) Neither 1 nor 2

**Ans: (b)**

**Mains:**

**Q.** How far do you agree that the behavior of the Indian monsoon has been changing due to humanizing landscape? Discuss. **(2015)**

PDF Refernece URL: <https://www.drishtiias.com/printpdf/early-monsoon-onset-2025>

