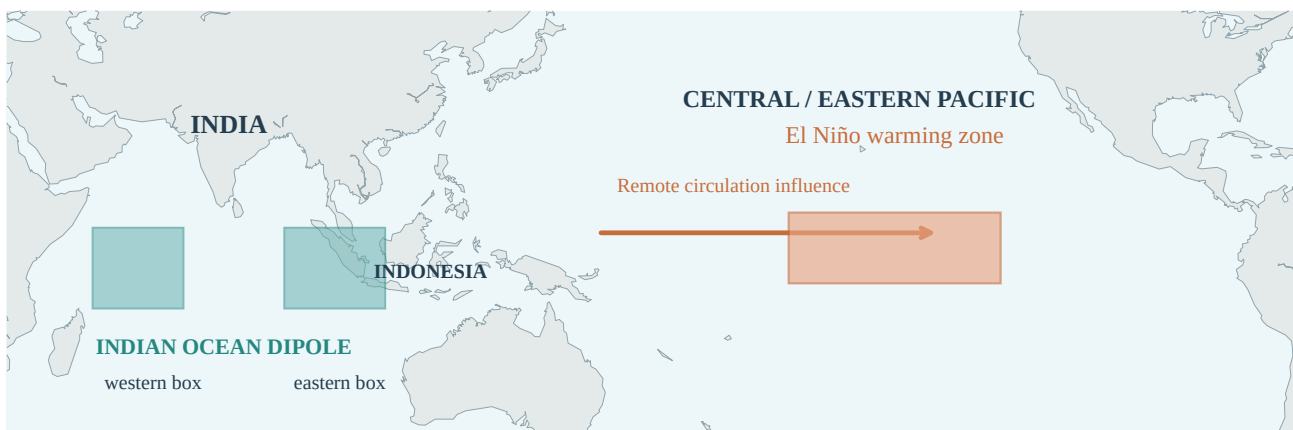


India's Monsoons: Ocean and Atmospheric Influences

How Pacific and Indian Ocean conditions, moving tropical weather systems and cyclones affect rainfall across India

India's monsoon rainfall changes substantially from year to year. Some years bring widespread, persistent rain; others have long dry periods interrupted by local downpours. These differences are not controlled by one ocean temperature or one weather system. They emerge from interactions between the tropical Pacific, Indian Ocean, the atmosphere and disturbances that develop close to India.

The map locates the two major ocean temperature patterns discussed here. The **El Niño–Southern Oscillation (ENSO)** begins in the equatorial Pacific. The **Indian Ocean Dipole (IOD)** concerns the temperature contrast between the western and eastern Indian Ocean. Their effects can reach India's monsoon region through large-scale changes in winds and rising air. [3][9]



Broad monitoring regions and atmospheric influence. Shaded ocean areas mark the relevant tropical regions, not a particular day's ocean-temperature forecast.

India has two major rainy seasons

	Southwest monsoon	Northeast monsoon
Season	June–September	October–December
Rainfall focus	Most of India	Mainly Tamil Nadu and nearby southeast-coast regions
El Niño tendency	Higher risk of below-normal national rainfall	Historical tendency toward wetter southeast-Indian conditions, with many exceptions

Central point A climate pattern changes the *odds* of rain. It does not guarantee the rainfall in a particular city, month or season.

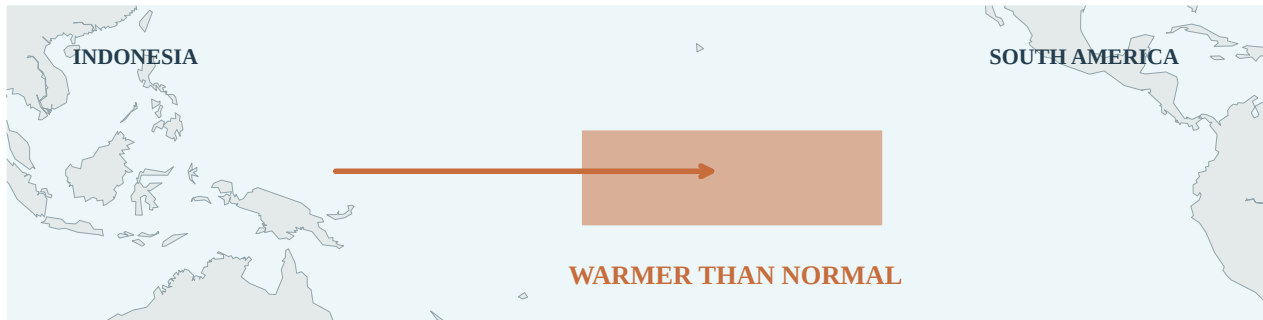
1. El Niño and La Niña: changes across the Pacific

Normally, easterly trade winds push warm surface water towards Indonesia and allow cooler water to rise in the eastern equatorial Pacific. During **El Niño**, the trade winds weaken and the central/eastern equatorial Pacific becomes warmer than usual. During **La Niña**, trade winds generally strengthen and the same region is cooler than usual. These are changes relative to the normal temperature, not warming or cooling of the whole Pacific.

[3]

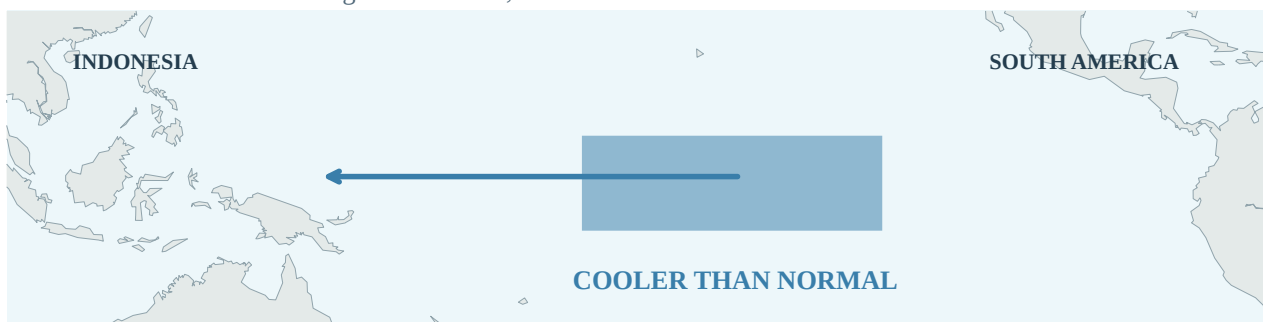
EL NIÑO

Trade winds weaken; unusually warm surface waters spread east



LA NIÑA

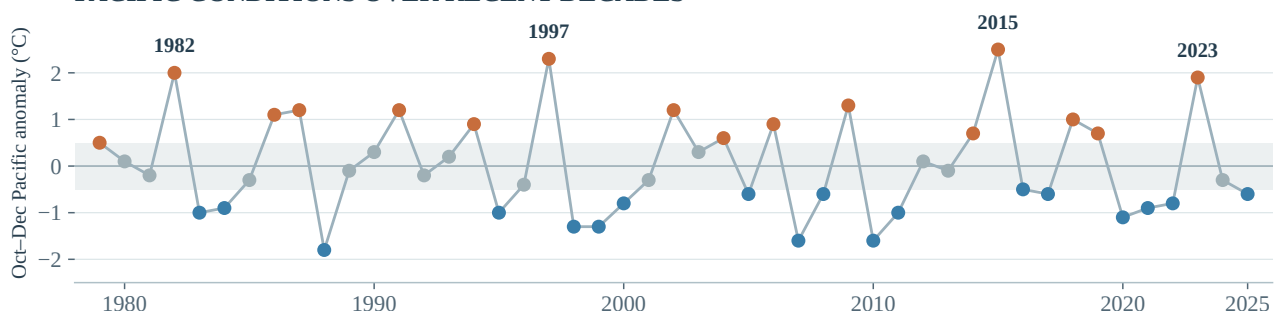
Stronger trade winds; central/eastern Pacific waters are cooler



Simplified maps using actual coastlines. The coloured area represents a central/eastern Pacific sea-surface temperature anomaly. The arrows show the broad trade-wind response.

These ocean changes modify the **Walker circulation**: the tropical overturning system in which air rises over active thunderstorms, flows aloft and sinks elsewhere. Such adjustments can reach the Indian Ocean and affect how favourable the atmosphere is for monsoon rainfall. ENSO episodes commonly develop over months, often become strongest around November–January, and vary considerably in duration and intensity. [3]

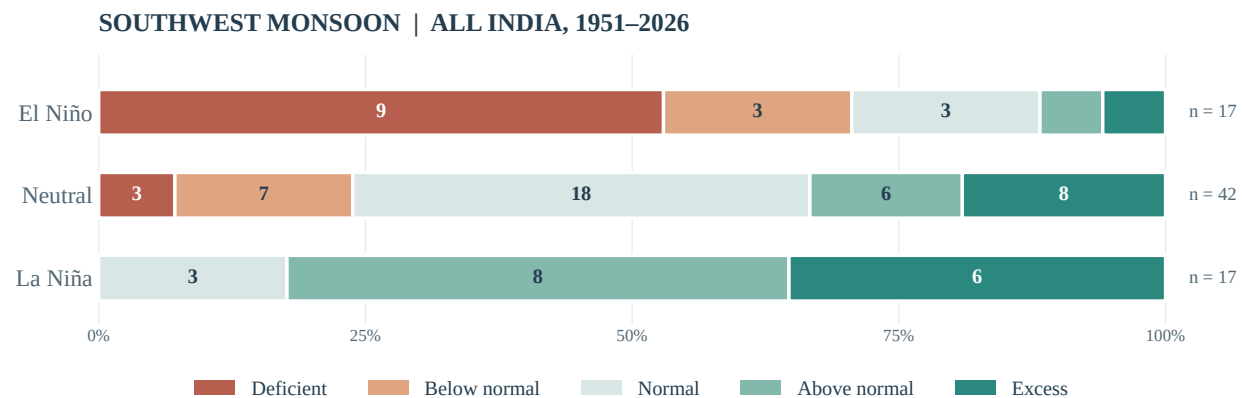
PACIFIC CONDITIONS OVER RECENT DECADES



Actual October–December Pacific ONI values, 1979–2025. Orange points indicate warmer-than-normal phases and blue points cooler-than-normal phases. Seasonal values are not, by themselves, a formal classification of a sustained ENSO event. [3]

2. The southwest monsoon: June to September

Across India, El Niño tends to weaken the atmospheric circulation supporting the southwest monsoon. But the relationship is not absolute: rainfall also depends on Indian Ocean conditions and on where monsoon lows, troughs and rain bands form. The following comparison covers **76 completed southwest monsoon seasons, 1951–2026**. [1][3]



The printed figures are numbers of seasons (not millimetres). The bars show the proportion of national rainfall outcomes within El Niño, neutral and La Niña phases, using July–September ONI to group years. IMD’s all-India categories use a narrower range for “normal” than its regional rainfall categories.

El Niño (17 summers)

9 deficient, 3 below normal, 3 normal, 1 above normal, 1 excess.

Mean departure from normal: –9.1%.

La Niña (17 summers)

0 deficient, 0 below normal, 3 normal, 8 above normal, 6 excess.

Mean departure from normal: +8.2%.

2026: a recent example of a deficient southwest monsoon

India received **759.4 mm** from June through September 2026 compared with an all-India normal of **868.6 mm**. That is **12.6% below normal**, officially a deficient season in IMD’s all-India classification. The July–September 2026 ONI was approximately **+2.2 °C**, so 2026 is included in the El Niño group above. [3][12]

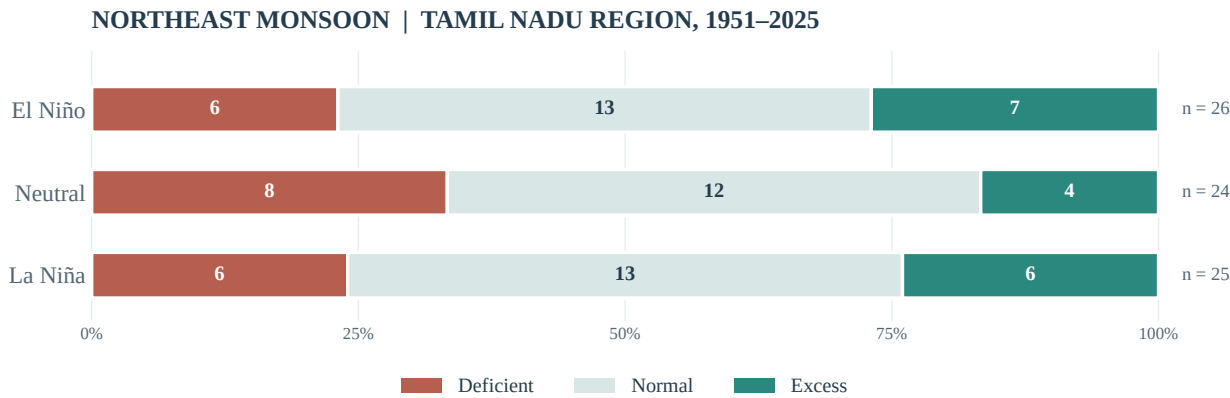


All-India rainfall. A countrywide deficit does not mean that every state or district experienced below-normal rain.

What the record says El Niño substantially raises the risk of a weak Indian summer monsoon; La Niña has historically favoured normal-to-wet national monsoon seasons.

3. The northeast monsoon: October to December

The northeast monsoon is especially important for **Tamil Nadu and the southeastern coast**, including Chennai. Easterly waves, low-pressure areas, depressions and occasional cyclones carry rain from the Bay of Bengal. In contrast with India’s summer monsoon, research has often found a **positive El Niño–rainfall relationship** in southeast India, especially around November. Yet individual seasons can be very different. [5][6]



October–December rainfall outcomes for the Tamil Nadu–Puducherry–Karaikal IMD subdivision, 1951–2025. El Niño: 26 seasons; neutral: 24; La Niña: 25. Categories here are regional: deficient below 81% of normal, normal about 81–119%, and excess above 119%. The 2026 season is not yet complete. [2][3]

El Niño (26 seasons)

6 deficient, 13 normal, 7 excess.

La Niña (25 seasons)

6 deficient, 13 normal, 6 excess.

The counts overlap substantially. Earlier decades showed a clearer positive ENSO–northeast monsoon association, whereas recent decades have not shown a reliable consistent relationship. The strength of El Niño alone is therefore **not a dependable forecast** of Tamil Nadu’s seasonal rainfall. [5][6][11]

Three seasons that illustrate the difference

Year	Pacific state	Rainfall in the Tamil Nadu meteorological subdivision
2015	Strong El Niño	About 51% above normal ; exceptionally wet, including damaging Chennai flooding.
2020	La Niña	Approximately 8% above normal ; close to normal overall.
2023	Strong El Niño	Approximately 4% above normal regionally, yet extreme floods occurred in some districts.

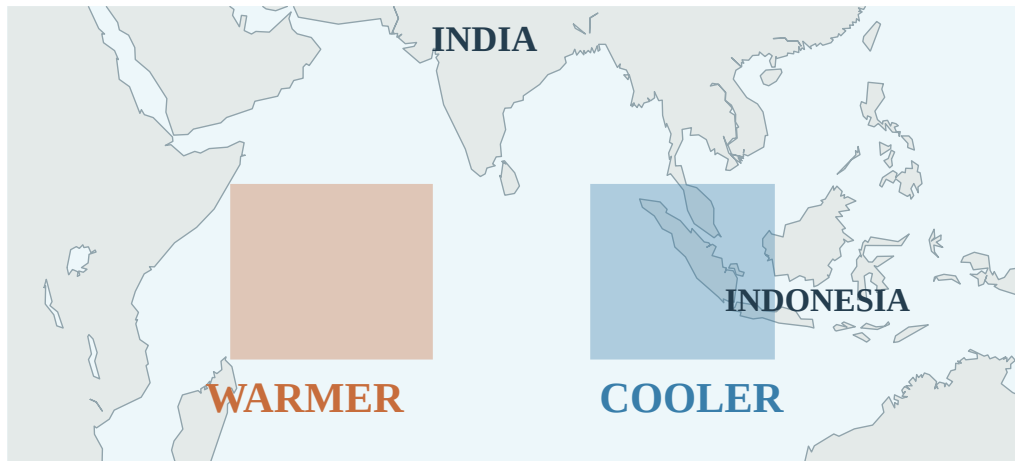
Regional rainfall departures are compared with the same 1971–2020 reference normal. A regional seasonal average can conceal extreme local events. [2]

Rainfall is not just cyclones A wet northeast monsoon can occur without many named cyclones: repeated easterly waves and depressions may deliver very heavy rain.

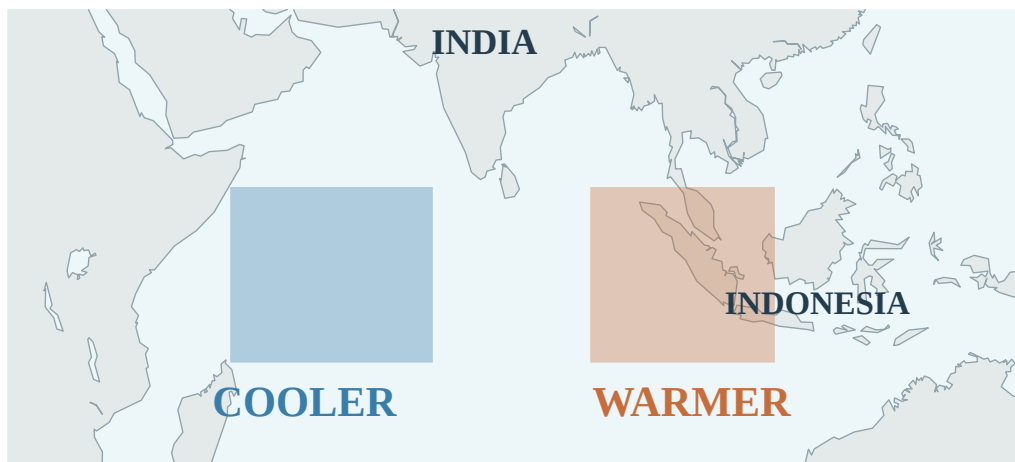
4. The Indian Ocean Dipole: an east–west contrast

The **Indian Ocean Dipole (IOD)** describes a difference in sea-surface temperatures between the western Indian Ocean near East Africa and the eastern Indian Ocean near Indonesia. When the west is relatively warmer and the east cooler, it is called a **positive IOD**; the opposite arrangement is a **negative IOD**. The contrast changes where warm, moist air rises and where rainfall is favoured. [9]

POSITIVE IOD — WEST WARMER



NEGATIVE IOD — EAST WARMER



The contrasting ocean-temperature regions in positive and negative IOD conditions. Each panel shows a broad pattern rather than observed temperatures for a specific year.

A positive IOD can sometimes improve the conditions for India's **southwest monsoon** and offset part of El Niño's drying influence. A negative IOD can instead favour wetter conditions near Indonesia and change the flow of moisture towards India. For the northeast monsoon, the IOD also influences Bay of Bengal winds and rain-producing systems, but the resulting rainfall response is more complicated and depends on other circulation patterns. [9][7]

Think of the IOD as an additional influence The Pacific and Indian Ocean patterns can reinforce one another or partly oppose one another in the same year.

5. The Madden–Julian Oscillation: moving areas of rain

The **Madden–Julian Oscillation (MJO)** is a large-scale pattern of tropical clouds, thunderstorms, pressure and winds that generally travels **eastwards** from the Indian Ocean towards Indonesia and the Pacific. It is an *atmospheric* phenomenon, not an ocean current. Its active and quiet regions can alter the chances of rainfall on time scales of roughly a few weeks; a complete cycle often takes around **30–60 days**. [8][10]

THE MOVING MJO RAIN BELT

Green shading: rainfall and thunderstorms are more likely **INSIDE** the shaded region.

1. OVER THE INDIAN OCEAN



2. SHIFTS EAST TOWARD INDONESIA



3. MOVES INTO THE WESTERN PACIFIC



For India: Rain can increase when the active zone reaches the region or strengthens nearby monsoon systems. When the active zone is out over the ocean, the extra showers mainly occur there—not across all of India.

The green area shows where *enhanced rainfall is more likely*, not a forecast that all of India will receive showers. The zone travels eastward through the tropics; each panel is a conceptual stage, not an exact weather map. [8]

Does an active MJO over the Indian Ocean mean more rain in India? Not automatically. When the shaded zone is mainly over the ocean, extra thunderstorms are favoured *over that ocean region*. India's rainfall can increase if the active MJO reaches nearby waters or strengthens the monsoon trough, moisture transport or low-pressure systems affecting the country. [8]

How ENSO, the IOD and the MJO work together

HOW THE DRIVERS ACT TOGETHER

ENSO	SEASONS	Changes the broad tropical circulation
IOD	MONTHS	Shifts Indian Ocean heat and rainfall
MJO	WEEKS	Brings moving wetter and drier spells
Local systems	DAYS	Lows, depressions and cyclones decide where rain falls

The key distinction is time scale: the larger ocean patterns set seasonal conditions; the MJO affects the timing of wetter and drier spells; local disturbances govern actual storms and rainfall at a particular place.

A strong El Niño can make the national summer monsoon less favourable, but an active MJO or a positive IOD can still support short periods of heavy rain. Likewise, a seemingly favourable northeast-monsoon season may turn dry if local rain-bearing systems fail to form or move away from the coast.

Two examples of the combined influence

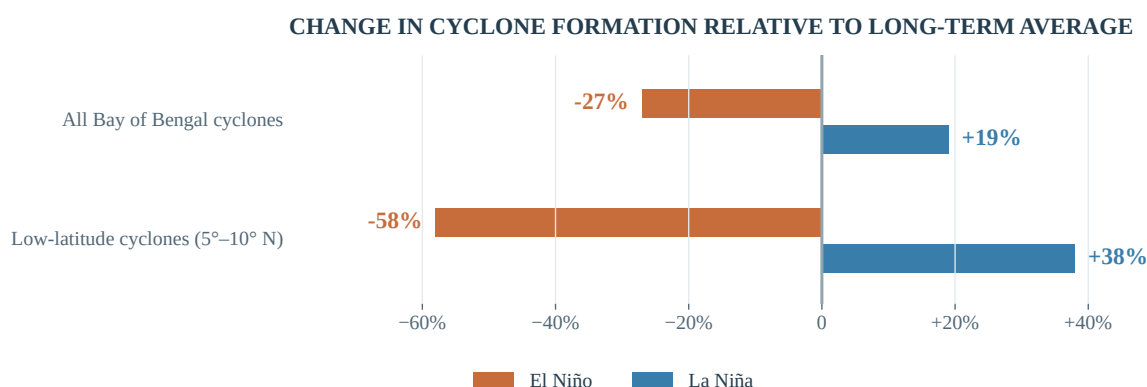
A dry seasonal background can contain a very wet week. During an El Niño summer, the large-scale circulation may favour less rain over India. But when the MJO passes through an active phase, it can encourage strong showers and the development of low-pressure systems. The season may finish below normal despite those intense episodes.

A favourable season need not bring rain to every district. Even if Pacific and Indian Ocean conditions favour the northeast monsoon, rainfall depends on where easterly waves and depressions develop and how they travel. A storm offshore or a change in its path can produce major local differences.

Useful perspective ENSO and the IOD help explain seasonal differences; the MJO helps explain wetter and drier spells; local weather systems ultimately determine when and where rain falls.

6. Bay of Bengal cyclones: why the numbers can change

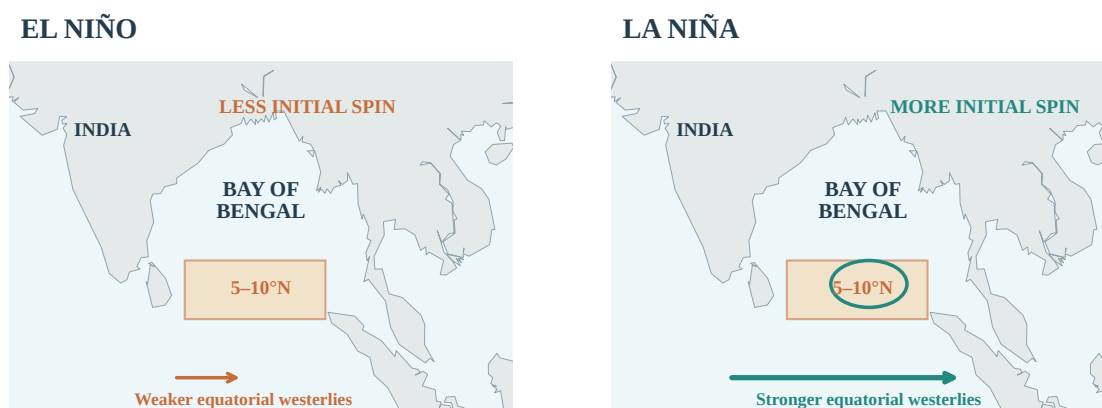
A study of post-monsoon (October–December) Bay of Bengal cyclones during **1979–2020** found fewer storms during El Niño and more during La Niña. Its strongest result concerned storms forming between **5°N and 10°N**: these low-latitude cyclones were much less common during El Niño. [7]



Relative changes in the study's average cyclone frequency. Negative bars mean fewer cyclones than the long-term average; positive bars mean more. All four percentages are from Roose and colleagues (2022). [7]

What changes physically?

Cyclones need warm sea water, moist air, favourable winds and **enough initial rotation**, called *vorticity*. During El Niño, near-equatorial **westerly winds over the Indian Ocean often weaken**; this reduces the low-level rotation available to help a developing storm spin up in the southern Bay of Bengal. La Niña more often supports stronger equatorial westerlies and greater low-level rotation. [7]



The mechanism is reduced atmospheric rotation, not weaker ocean currents. Fewer cyclones overall do not guarantee fewer landfalls near Chennai: even one storm or depression can cause flooding.

7. El Niño, warmer years and the 2026–27 outlook

Why can the year after El Niño be exceptionally warm?

Global air temperature often responds to an El Niño with a **lag of several months**. The strong 2015–16 event was followed by record global warmth in **2016**; the 2023–24 El Niño was followed by the record global warmth observed in **2024**. However, this is not a fixed calendar rule. Long-term greenhouse warming and local weather also matter, and a globally hot year does *not* imply that Tamil Nadu must experience its hottest summer. [13][14]

What was known by October 2026?

NOAA's **8 October 2026** assessment reported a strengthening El Niño and a strong-to-very-strong event likely through **January–March 2027**. It placed an **83% probability** on an October–December Relative Oceanic Niño Index (RONI) of at least **+2.5°C**. This is a probability about the upcoming seasonal peak, not a measured final peak. The phrase *super El Niño* is informal. [4]

The **2026 southwest monsoon is complete and was deficient**, as documented earlier. The **2026 northeast monsoon is still underway** at the time of this article; IMD's early-season outlook called for broadly near-normal rainfall across the relevant southern region, with variation between locations. The El Niño peak is relevant but cannot, by itself, settle the rainfall outcome. [11][12]

Four important conclusions

- 1 Southwest monsoon:** El Niño is associated with a much greater historical risk of below-normal all-India June–September rainfall.
- 2 Northeast monsoon:** El Niño has sometimes favoured October–December rain in Tamil Nadu, but the link is not stable enough for a reliable stand-alone forecast.
- 3 IOD and MJO:** Indian Ocean temperature contrasts and travelling atmospheric rain patterns can reinforce or offset the ENSO background.
- 4 Cyclones and heat:** El Niño can reduce southern Bay cyclone formation and raise the risk of unusually warm global conditions later, but neither outcome is guaranteed locally.

Scientific sources

- [1] IMD Pune: [All-India monthly rainfall archive](#) and national monsoon classifications.
- [2] IMD Pune: [Tamil Nadu–Puducherry–Karaikal rainfall archive](#).
- [3] NOAA CPC: [Oceanic Niño Index \(ERSSTv6\)](#), historical series.
- [4] NOAA CPC: [ENSO Diagnostic Discussion](#), 8 October 2026.
- [5] De and Mukhopadhyay (1999): [ENSO and northeast monsoon rainfall](#), *MAUSAM*.
- [6] Sengupta et al. (2019): [Northeast winter monsoon](#), *Journal of Climate*.
- [7] Roose et al. (2022): [ENSO influence on Bay of Bengal cyclogenesis confined to low latitudes](#), *npj Climate and Atmospheric Science*.
- [8] Australian Bureau of Meteorology: [Madden–Julian Oscillation explainer](#).
- [9] ISRO/NRSC NICES: [ENSO, IOD and the Indian summer monsoon](#).
- [10] IMD Pune: [Monsoon and MJO background](#).
- [11] [Report of IMD's northeast-monsoon 2026 outlook](#), 2 October 2026.
- [12] IITM Monsoon Online: [June–September 2026 national rainfall](#).
- [13] NASA: [2016 global temperature assessment](#).
- [14] WMO: [2024 global temperature assessment](#).