NORTHEAST MONSOON 2025

DETAILED OUTLOOK

Hemachander R
Ph: 8939412147
Mail ID:hemachanderraja@gmail.com

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North East Monsoon 2025

Introduction

The Northeast Monsoon, also known as the Post-Monsoon or Retreating Monsoon, occurs when cold, dry winds from the Siberian high-pressure system pick up moisture over the South China Sea and reach southeastern India as moisture-laden easterlies or northeasterly winds**.**

ENSO

The El Niño-Southern Oscillation (ENSO) refers to the cyclical climate pattern involving fluctuations between El Niño and La Niña phases, significantly influencing global temperatures, precipitation, and ecosystems. Occurring in the Equatorial Pacific Ocean, ENSO results from natural interactions between the ocean and atmosphere, affecting sea surface temperatures, precipitation, air pressure, and atmospheric and oceanic circulation patterns (NOAA, 2021).

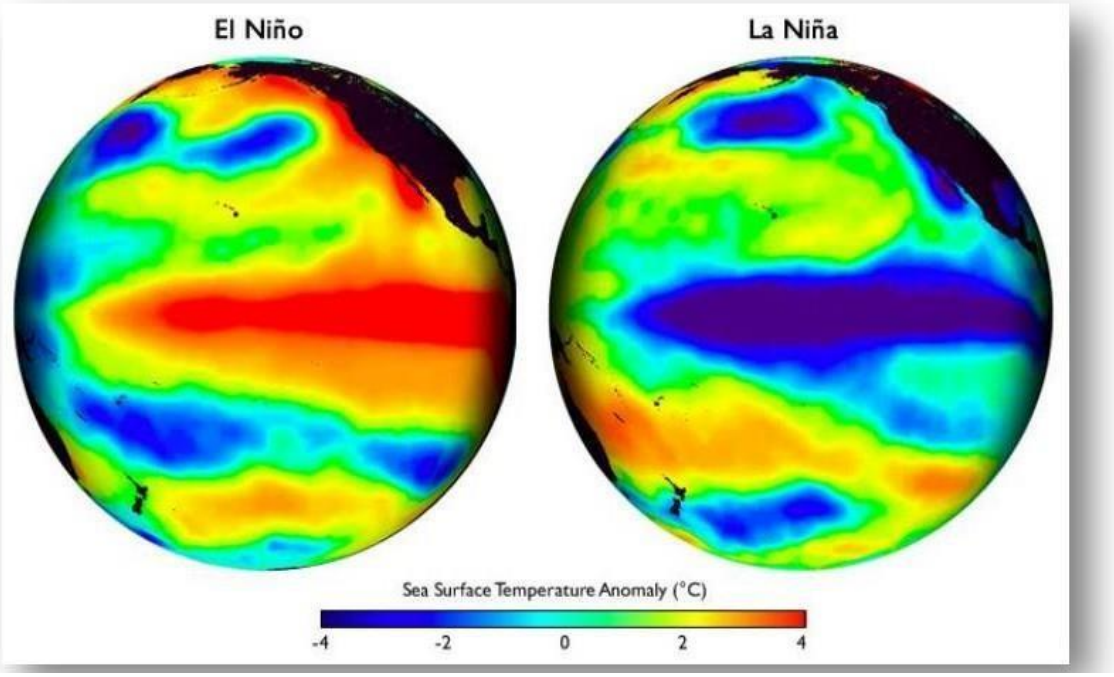


Figure 1: ENSO pattern – El Nino & LA Nina

Key Takeaways:

- **ENSO Conditions:** Weak La Niña conditions are projected to prevail in the Pacific base state throughout October, November, and December 2025.
- **Indian Ocean Dipole (IOD):** A strongly negative IOD is anticipated to persist until November 2025, transitioning to a negative-neutral state by January 2026.
- **Sea Surface Temperatures:** The South China Sea and West Pacific Ocean are currently the warmest globally, with sea surface temperatures of 30–31°C. The Bay of Bengal is recording temperatures of 28–29°C.
- **Madden-Julian Oscillation (MJO):** Standing wave conditions associated with the MJO are likely to dominate over the East Indian Ocean and Maritime Continent, influencing regional weather patterns.
- **Rainfall in Tamil Nadu:** Tamil Nadu is anticipated to receive excess monsoon rainfall, ranging between 54 cm and 60 cm, representing a 20% to 35% increase above the normal of 45 cm.
- **Regional Rainfall Distribution:**
    - North Coastal Districts: Districts such as **Chennai, Thiruvallur, Kanchipuram, Chengalpet, Villupuram, Puducherry, Cuddalore, Mayiladuthurai, Nagapattinam, Thiruvarur, and Thanjavur** are expected to experience above-normal to excess rainfall, with a high likelihood of cyclone activity in November and December.
    - North and Central Interior Districts: **Above-normal rainfall is anticipated in north interior and parts of central interior Tamil Nadu.** Western and Southern Tamil Nadu**:** Normal rainfall is expected, with isolated pockets potentially receiving below-normal precipitation.
- **Extended Southwest Monsoon**: An extended Southwest Monsoon may lead to enhanced rainfall activity in **Western Ghats districts, including Kanyakumari, Tirunelveli, Coimbatore, and Nilgiris, during October 2025.**

1. EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION ISSUED BY CLIMATE PREDICTION CENTER/NCEP/NWS

ENSO Alert System Status: La Niña Watch

Synopsis: ENSO-neutral is most likely through the late Northern Hemisphere summer 2025 (56% chance in September-October). Thereafter, a brief period of La Niña conditions is favored in the fall and early winter 2025-26 before reverting to ENSO-neutral.

During the past month, ENSO-neutral continued, with near-average sea surface temperatures (SSTs) established across most of the equatorial Pacific Ocean. With the exception of the easternmost Niño-1+2 index (+0.8°C), the latest weekly Niño SST index values ranged from -0.3°C to +0.0°C. Subsurface temperature anomalies in the eastern Pacific Ocean became weakly negative over the past month, with below-average temperatures generally observed between 25- and 200-meters. Low-level wind anomalies were easterly over the east-central and eastern tropical Pacific, while upper-level wind anomalies were westerly over the west-central and eastern tropical Pacific. Convection remained enhanced over a small region of Indonesia and was suppressed over the western tropical Pacific. Collectively, the coupled ocean-atmosphere system in the tropical Pacific reflected ENSO-neutral.

The IRI predictions indicate ENSO-neutral is most likely to persist through the Northern Hemisphere winter 2025-26. However, similar to last month, the North American Multi-Model Ensemble favors La Niña conditions for a short duration during the Northern Hemisphere fall and early winter. Based on this guidance and recent changes in the tropical Pacific, the forecast team narrowly favors La Niña thresholds being reached in three overlapping, 3-month seasons (Niño-3.4 index ≤ -0.5°C during September-November, October-December, and November-January).

In summary, ENSO-neutral is most likely through the late Northern Hemisphere summer 2025 (56% chance in August-October). Thereafter, **a brief period of La Niña conditions is favored in the fall and early winter 2025-26 before reverting to ENSO-neutral.**

This discussion is a consolidated effort of the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Weather Service, and their funded institutions. Oceanic and atmospheric conditions are updated weekly on the Climate Prediction Center website (El Niño/La Niña Current Conditions and Expert Discussions). A probabilistic strength forecast is available here.

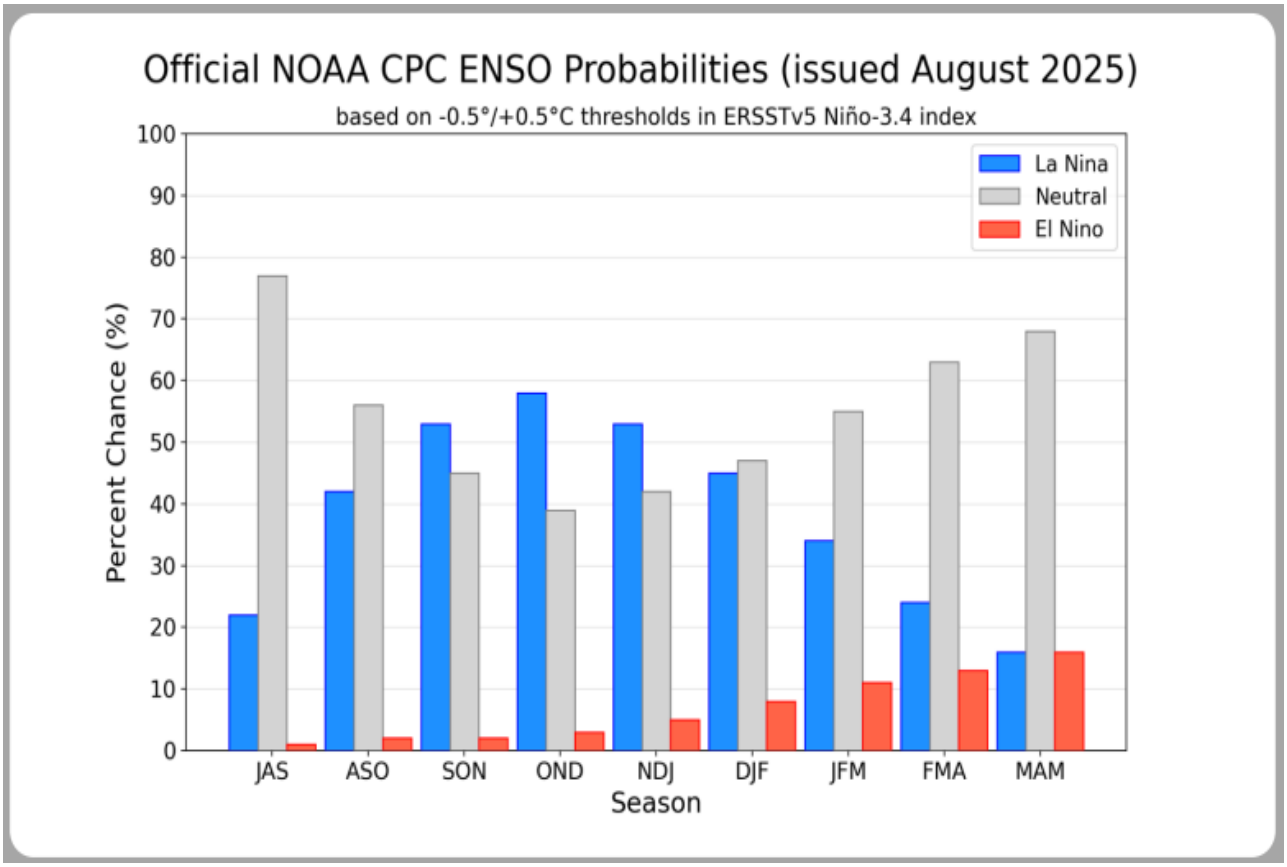


Figure 2: ENSO Probabilistic forecast issued by CPC

2. **Indian Ocean Dipole - (IOD)**

As of September 7th, the recent weekly IOD index dropped to −1.27 °C and has remained below the negative threshold for the seventh week in a row. In another 10 days, a negative IOD event is most likely to be announced. The IOD forecast of most of the multi-models remains negative IOD conditions until November. Negative Neutral conditions till January.

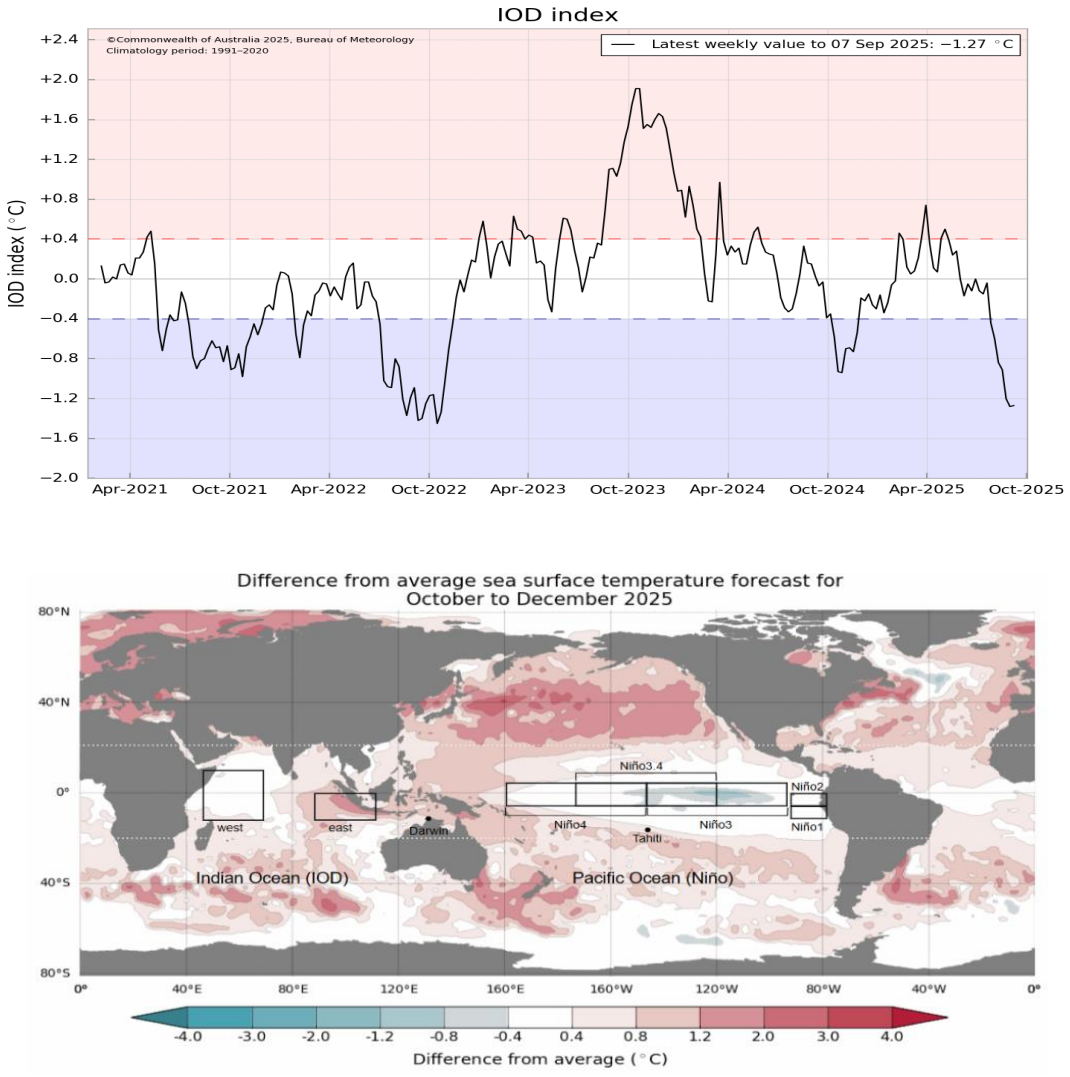


Figure 3: IOD index & ENSO forecast

3. Global warming

Global warming is significantly influencing weather patterns worldwide, with notable impacts expected on the Northeast monsoon from October 2025 to January 2026. It is likely to contribute to extreme rainfall events occurring over short periods, rapid intensification of cyclones upon reaching land, prolonged monsoon activity, and unseasonal rainfall activity during winter.

4. Sea surface temperature - (SST)

The majority of the western Indian Ocean is showing cooling trend, with an average sea surface temperature of 25-26°©. The average sea surface temperature (SST) for the Bay of Bengal was also observed to be 29°C; but, in recent years, it has been closer to 30/31°C. With 30 to 31°C, the South China Sea and the West Pacific Ocean are still the world's warmest regions.

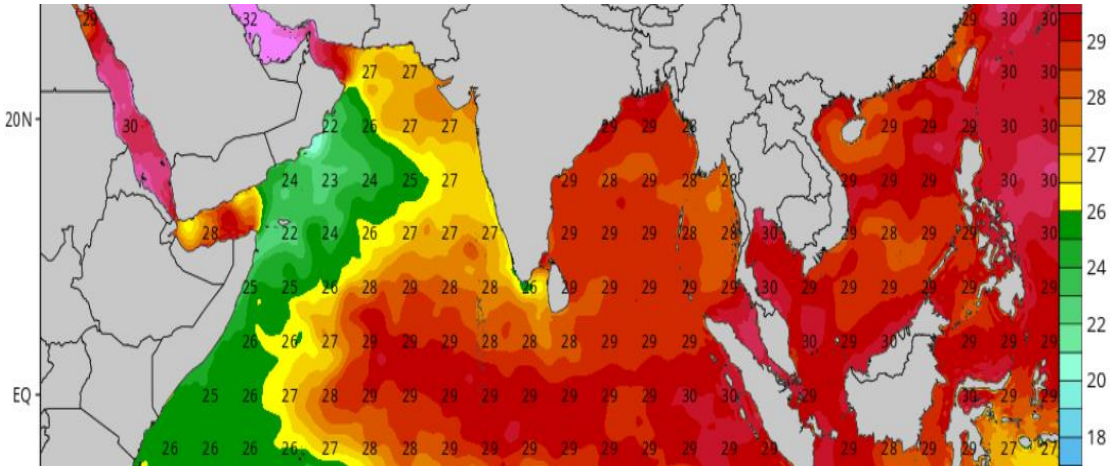


Figure 4: SST analysis of Indian Ocean

However, 26.5°© is enough to host the Cyclonic storm. Bay of Bengal current temperature is 28/29°© and it expected to increase a bit in upcoming few weeks especially before peak period of Northeast monsoon.

5. Planetary Waves:

Planetary waves are large-scale, vertically propagating disturbances in the atmosphere, characterized by fluctuations in pressure, temperature, winds, and atmospheric composition. Planetary waves also play a critical role in mediating interactions between the stratosphere and troposphere, influencing weather patterns.

a. Madden-Julian Oscillation (MJO):

Recent observations of planetary wave activity, particularly the Madden-Julian Oscillation, indicate prolonged durations and slower propagation during phases 4 (Maritime Continent) and 5 (Western Pacific Ocean). Suppressive conditions have been noted in phases 1 (Africa) and 2 (West Indian Ocean), particularly during the Southwest monsoon Neutral (ENSO) and Indian Ocean Dipole (IOD) conditions. Consequently, a La Niña - NIOD pattern is expected to emerge, with a quasi-stationary standing wave pattern gradually forming over the Maritime Continent and adjacent East Indian Ocean.

b. Equatorial Rossby Waves:

Equatorial Rossby waves are eastward-to-westward propagating waves along the equator, generating disturbances on both sides of the equatorial region. Given the current negative IOD state, frequent occurrences of Equatorial Rossby waves are anticipated in the East Indian Ocean, contributing to enhanced atmospheric disturbances at the South Bay of Bengal.

c. Kelvin Waves:

Kelvin waves, another type of planetary wave, propagate from west to east and are associated with intense thunderstorm activity. A strong Kelvin wave influence is expected to enhance thunderstorm-related rainfall during October, particularly supporting increased precipitation during the early Northeast Monsoon period

6. **Analog years**:

Historical data from 1984, 2005, 2020, and 2021 show weak La Niña and negative Indian Ocean Dipole (IOD) conditions, selected for their clear representation of impacts on regional climate patterns. However, each La Niña and negative IOD event varies, with many negative IOD years exhibiting weaker intensity. During such years, certain regions may experience below-average rainfall despite the broader climatic trends.

Over the past six years (2020–2025), five years have been characterized by La Niña conditions. A similar pattern was observed during the period from 1970 to 1975, marking a notable recurrence within the last century.

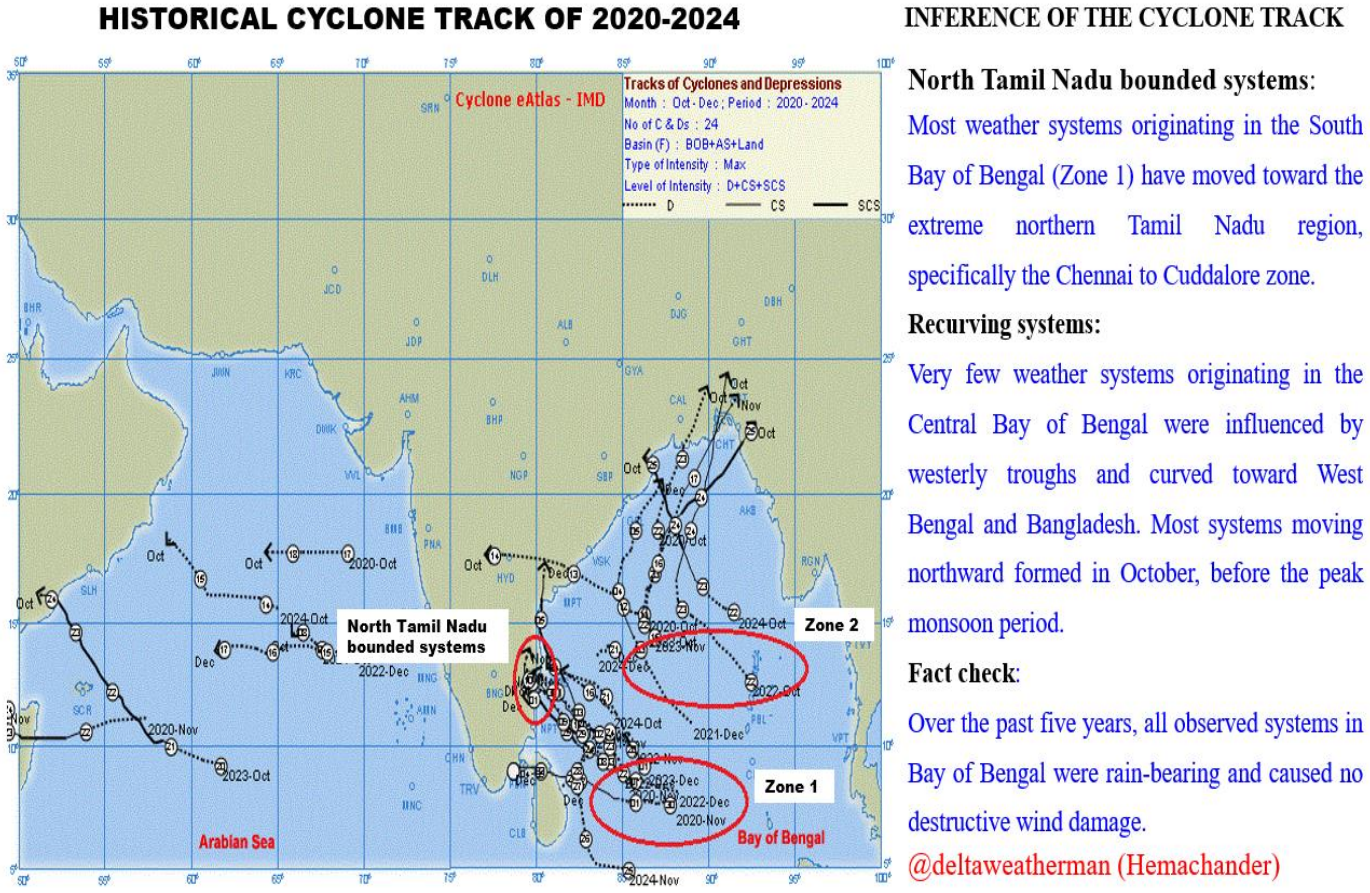


Figure 4: The Depression/cyclone tracks of last five years (2020-2024)

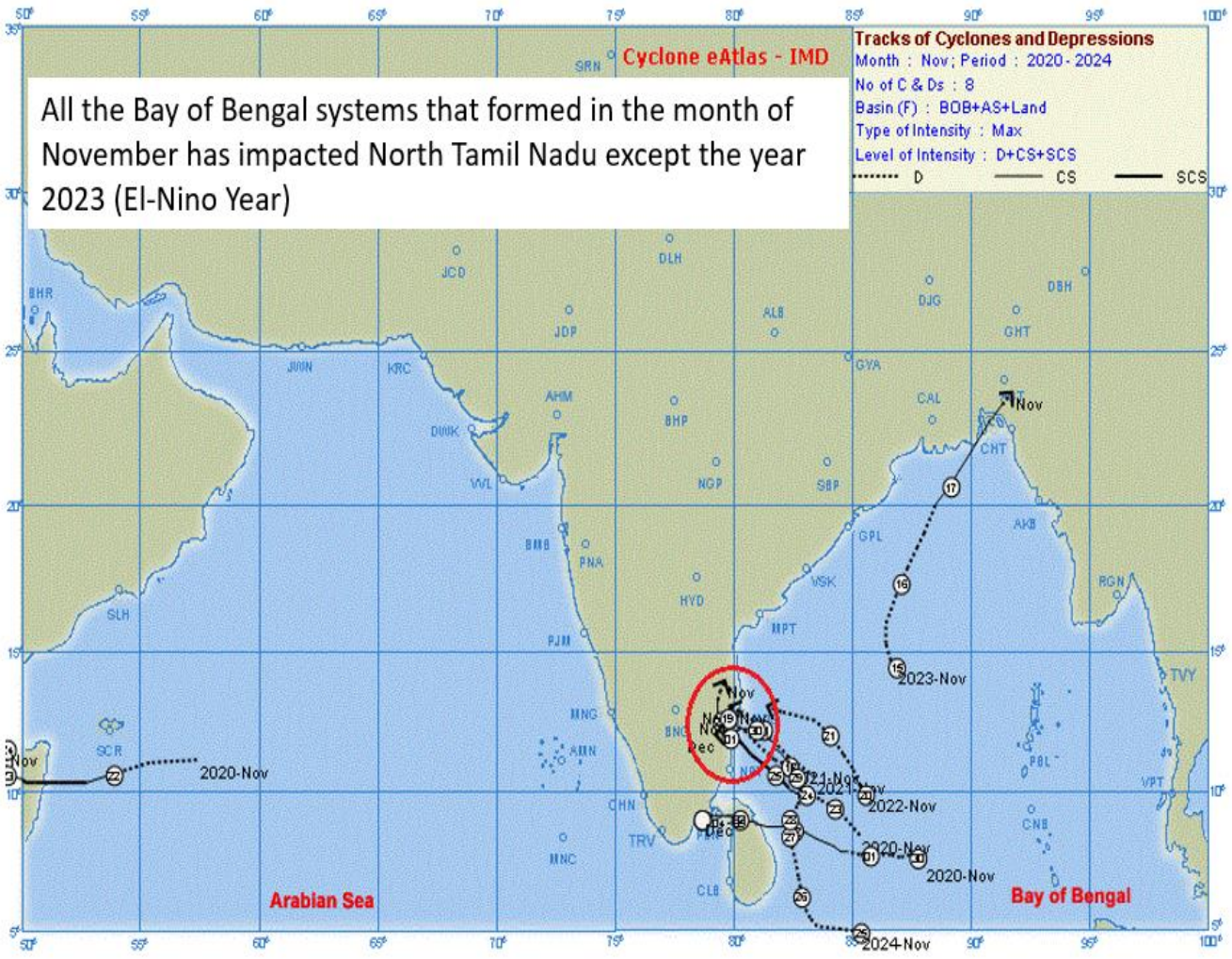
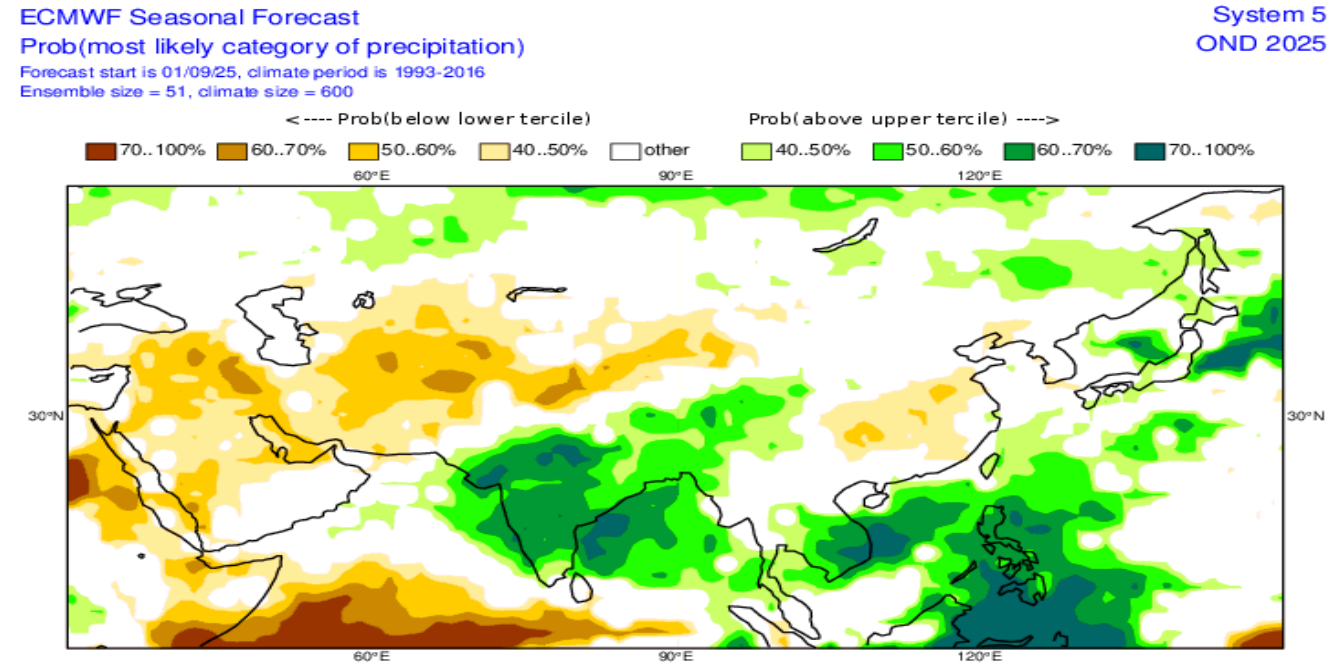


Figure:5 The November month Depression/cyclone tracks of the last five years (2020-2024)

7. Numerical Models output:

Numerical multi-models output clearly shows the convective phase over South China Sea and suppressive phase over Arabian sea also representing the La-Nina and NIOD signature pattern.



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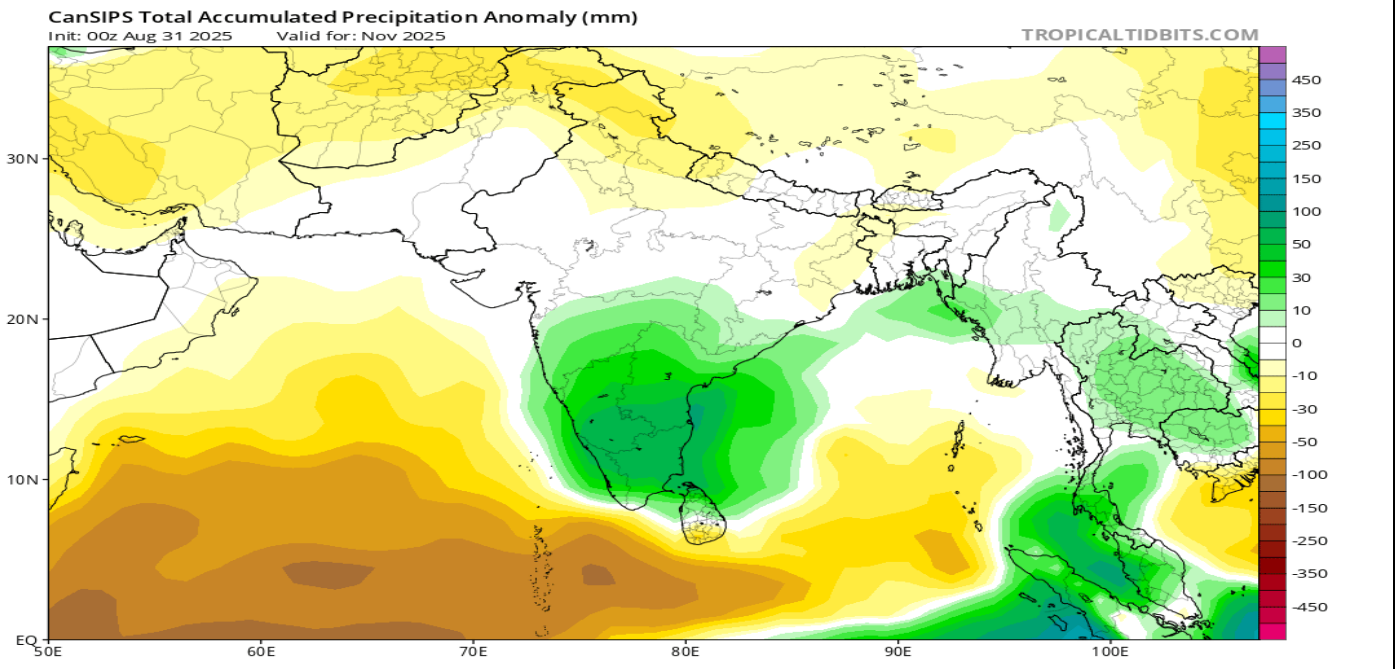

Figure 6: Seasonal forecast outlook for Oct, Nov, Dec 2025

8. Conclusive Statement of Outlook

Based on the analysis, the Northeast Monsoon of 2025 is expected to be significantly active, with a high likelihood of Excess & Cyclonic rainfall activity.

Key points include:

- **Frequent Low-Pressure Systems**: The central South Bay of Bengal is anticipated to experience consecutive low-pressure system formations, leading to system-driven rainfall, including low-pressure areas, depressions, or cyclonic storms.
- **Equatorial Rossby Wave Influence:** Frequent Equatorial Rossby waves are likely to trigger low-latitude system formation.
- **Suppressed Activity in West Indian Ocean and Africa:** Phases 1 and 2 of suppression over the West Indian Ocean and Africa will minimize the influence of Easterly Waves, pull-effect rains, and Western Disturbances.
- **High-Pressure Impact in Southern Asia:** A dominant high-pressure area over Southern Asia, reinforced by the Indo-Pacific and Indo-Arabian Ridges, is expected to restrict the northward movement of weather systems.
- **Cyclone Characteristics:** Cyclones during this period are predicted to be primarily rain-bearing rather than wind-destructive.
- **Regional Impact in Tamil Nadu:** North coastal Tamil Nadu districts, including Chennai, Thiruvallur, Kanchipuram, Chengalpet, Villupuram, Puducherry, Cuddalore, Mayiladuthurai, Karaikal, Nagapattinam, Thiruvarur, and Thanjavur, are likely to experience short-duration extreme rainfall and potential cyclone impacts.
- **Rainfall Distribution:** Tamil Nadu is projected to receive excess monsoon rainfall, ranging between 53 and 60 cm. North coastal areas are expected to see surplus rainfall, while southern and western interior districts may receive normal to slightly above normal rainfall.

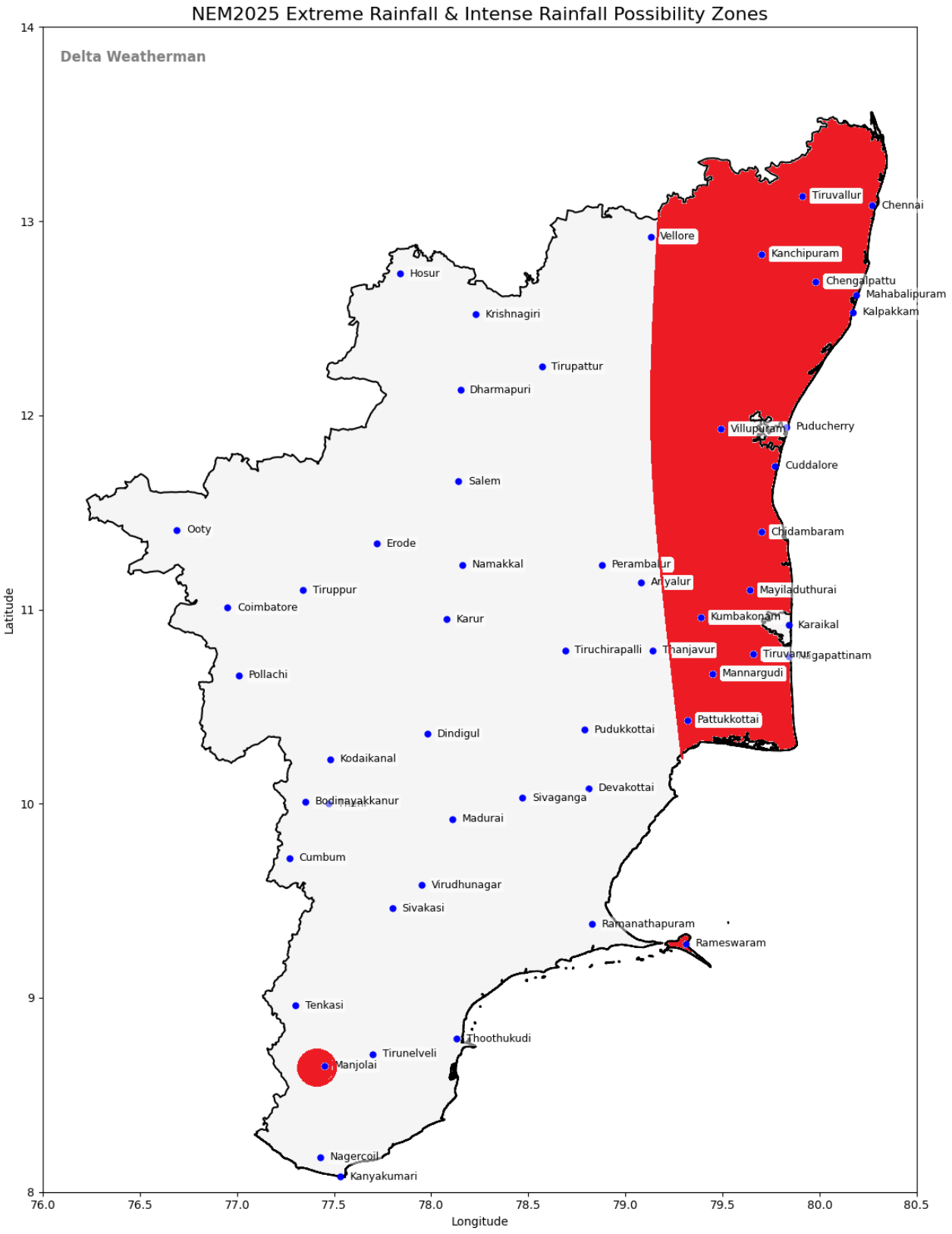

Figure 7: Extreme Rainfall & Intense Rainfall Possibility Zone

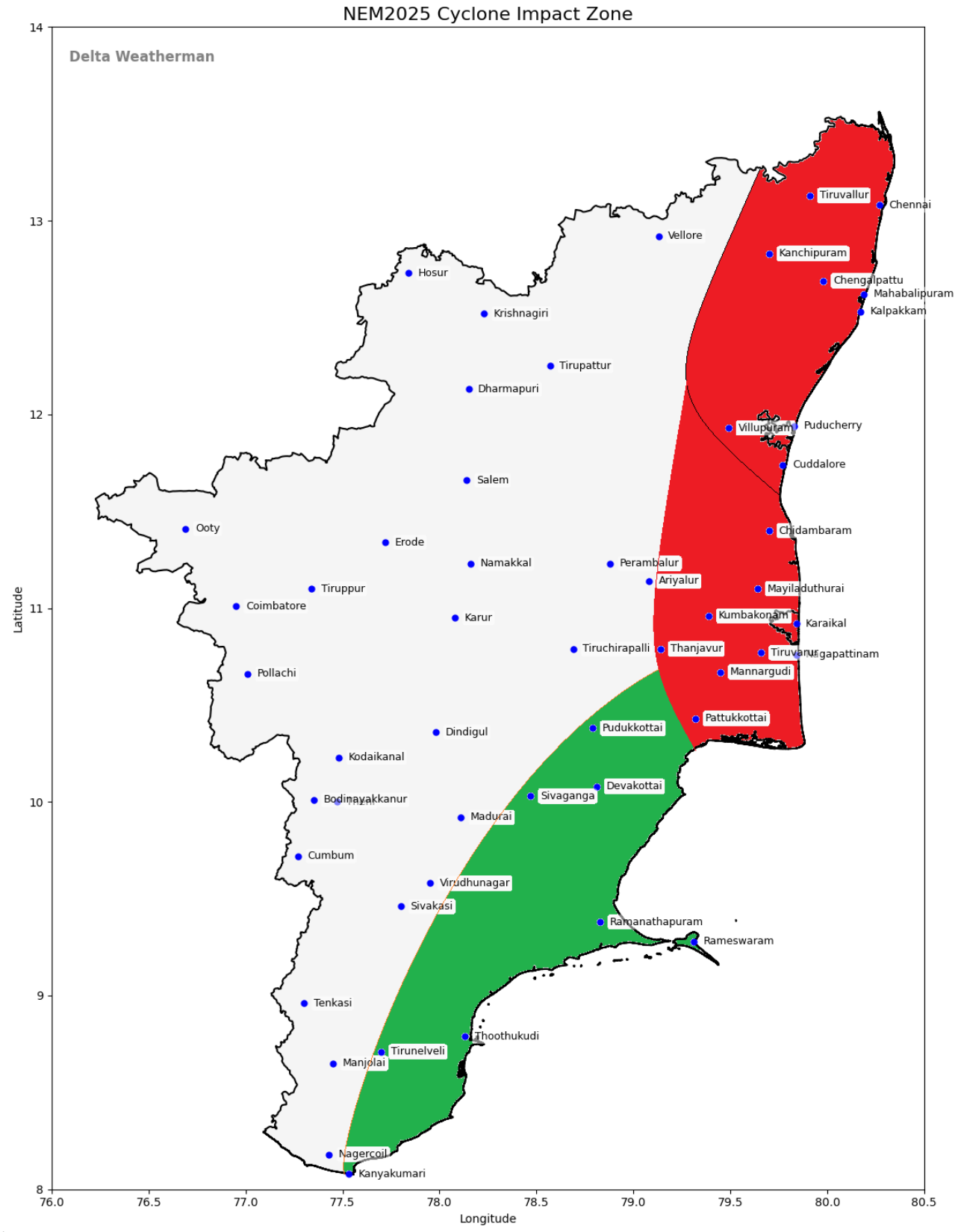

Figure 8: Cyclone Impact Zone

Impacts expected during vigorous monsoon conditions:

- **Extreme Rainfall and Flooding:** Short-term extreme rainfall events are likely to cause heavy waterlogging and flash flooding in low-lying areas of North coastal Tamil Nadu, with continuous heavy rainfall episodes potentially triggering riverine floods.
- **Infrastructure Damage:** Temporary tents and kuccha houses are at high risk of severe damage due to intense rainfall and flooding.
- **Power Disruptions:** Widespread disruption of electricity supply is anticipated due to extreme weather conditions.
- **Traffic Disruptions:** Heavy rainfall is expected to cause significant traffic congestion and disruptions in affected areas.
- **Environmental Damage:** Damage to trees, including uprooting, is likely to occur due to strong winds and heavy rains.
- **Agricultural Impacts:** Extensive crop damage and waterlogging in farms are expected, threatening agricultural productivity.
- **Regional Variability:** Districts in Western and Southern Tamil Nadu should prepare for potentially normal to above normal monsoon rains, leading to uneven rainfall distribution.

Suggested Topics for Results Discussion:

1. Disaster Preparedness and Response: Strategies to enhance early warning systems, evacuation plans, and emergency response for flash floods and riverine flooding.

2. Agricultural Adaptation Measures: Approaches to mitigate crop losses, such as flood-resistant crops or improved drainage systems for farms.

3. Infrastructure Resilience: Investments in strengthening temporary shelters, kuccha houses, and critical infrastructure to withstand extreme weather.

4. Urban Planning for Flood Mitigation: Urban design solutions to reduce waterlogging and improve drainage in low-lying areas.

5. Economic Impacts and Recovery: Assessing the economic toll of infrastructure damage, power outages, and traffic disruptions, along with recovery strategies.

6. Environmental Conservation: Measures to protect trees and ecosystems from the impacts of heavy rainfall and strong winds.

7. Community Awareness and Education: Programs to educate communities on preparing for extreme weather events and adapting to changing monsoon patterns.

8. Regional Water Management: Balancing flood risks in North coastal areas with potential water scarcity in Western and Southern districts due to poor monsoon rains.

9. Challenges in Agriculture.

- North coastal Tamil Nadu and the Delta districts are likely to experience short-duration extreme rainfall events. Therefore, farmers should select crop varieties resilient to both excessive and intense rainfall. These abnormal rain patterns are expected to severely impact crops in the short term.
- Tamil Nadu is projected to encounter foggy and misty weather from November to January, increasing the risk of diseases and insect infestations in paddy crops. Additionally, the development of La Niña may lead to unseasonal rainfall during winter, potentially affecting paddy harvests in January and February.

Suggested recommendations:

To prepare for extreme rainfall and monsoon conditions, the following measures should be implemented:

1. **Identify and Prepare Low-Lying Areas:** Map out low-lying areas prone to flooding and ensure temporary shelters are established and equipped to provide safe refuge during extreme rainfall events.
2. **Maintain Drainage Systems:** Prior to the monsoon season, thoroughly inspect and maintain drainage systems in urban areas and agricultural fields to ensure they are free of blockages and capable of handling heavy water flow.
3. **Ensure Clear Drainage Channels:** Maintain clean and unobstructed drainage channels to facilitate the safe and efficient disposal of excess runoff water, minimizing flood risks
4. **Alert and Protect Vulnerable Communities:** Identify and warn residents living in vulnerable structures about potential risks, advising them to relocate to safer areas or shelters during extreme weather events.
5. **Implement Effective Water Management:** Adopt robust water management strategies to address both deficient monsoon rains and flood conditions, ensuring efficient water storage, distribution, and flood mitigation measures.

These steps will enhance preparedness and reduce the impact of extreme rainfall and monsoon-related challenges.

Reference

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ECMWF Long range forecast models