



BREEZE

INDIAN METEOROLOGICAL SOCIETY CHENNAI CHAPTER NEWSLETTER

STATEMENT ON CLIMATE FOR THE STATE
OF TAMIL NADU -2025 - HIGHLIGHTS

SOUTHWEST MONSOON- 2025:
OPERATIONAL INSIGHTS INTO
RAINFALL VARIABILITY AND EXTREME
EVENTS OVER SOUTH PENINSULAR
INDIA

CHANGING SKIES: NORTHEAST
MONSOON 2025 AND THE OUTLOOK
FOR 2026

REVERSAL OF RELATION BETWEEN
LOCATION OF APRIL SUB-TROPICAL 500 HPA
RIDGE OVER PENINSULAR INDIA AND THE
SUBSEQUENT SOUTHWEST MONSOON
RAINFALL OVER INDIA

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“BREEZE NEWSLETTER,VOL. NO.25, ISSUE NOS. 1 & 2, DEC 2025”

From the Chairperson's Desk...



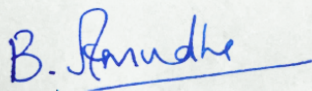
Dear esteemed members,

I am delighted to bring forth the IMS Newsletter Breeze, Vol.25 (Issue Nos. 1 & 2) with a variety of 9 articles contributed by enthusiastic members. As is customary, articles on southwest and northeast monsoon – 2025 provide the salient aspects of the monsoons. For the first time, a summary of the Annual Climate Statement of Tamil Nadu for 2025 has been included which documents the changing temperature and rainfall scenario of the State.

Breeze has a different flavour with a creative quiz, a poem and an update on a book written by a veteran of IMD, Chennai. A senior member of IMS Chennai Chapter has contributed a review article of the urban heat island effect throwing light on traditional practices followed in our country. Impacts of climate change on engineering and manufacturing of equipments are emphasized by an Industry expert member of IMSCC in his article.

My sincere thanks to all the authors of the articles for their valuable contributions. I thank the young and enterprising technical team of Smt. Sruthi and Shri. Vikash for their help in bringing out such a pleasing and professional flipbook of Breeze.

The term of the Local Council of 2024-26 will end in May 2026. I sincerely thank all the members for their support and cooperation during our tenure. The formal taking over of the new Local Council members for 2026-28 is awaited.



With best regards

B. Amudha

Chairperson, IMSCC, 2024-26

March 2026

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Life Membership details of IMS Chennai Chapter (as on March 2026) : 203

The members list is available in <https://imetsociety.org/members-list/>

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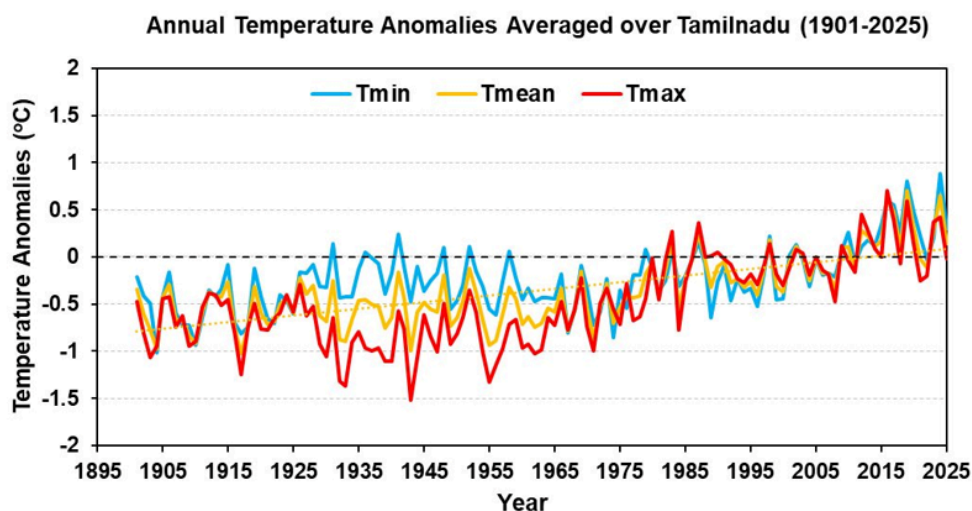
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Statement on Climate for the State of Tamil Nadu -2025 - Highlights

The “**Statement on Climate for the State of Tamil Nadu: 2025**” has been prepared by the Regional Meteorological Centre (RMC), Chennai. The report presents a comprehensive assessment of the **monthly, seasonal, and annual climate conditions** over Tamil Nadu during the year 2025, along with a comparison against the long-term climatology. Complete Report will be made available in the link: <https://mausam.imd.gov.in/chennai/>. A brief update on the report is presented here.

The analysis in the report is based on observational datasets of temperature and rainfall obtained from IMD’s network of meteorological stations. The anomalies in temperature are computed with respect to the **Long Period Average (LPA) for the base period 1991–2020**, while rainfall departures are calculated relative to the **LPA for the period 1971–2020**. The report also includes an assessment of long-term trends based on historical data spanning the period **1901–2025**.

This report provides an overview of the **temperature and rainfall characteristics during 2025**, including seasonal variations, departures from normal and long-term trends. It also highlights significant weather events observed during the year. The report is intended to enhance understanding of the ongoing climate variability and change over Tamil Nadu.

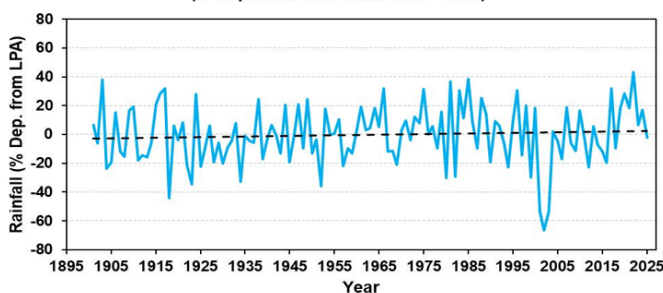


Annual maximum, minimum and mean land surface air temperature anomalies averaged over the State of Tamil Nadu for the period 1901-2025. The anomalies were computed with respect to the base period of 1991-2020. The dotted yellow line indicates the linear trend in the annual mean temperature time series

Highlights of the report are:

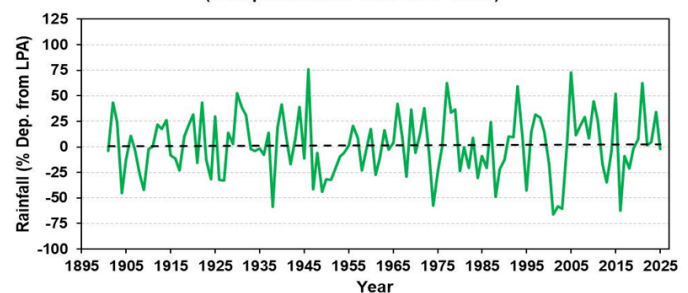
- Tamil Nadu experienced generally above-normal temperatures during 2025, consistent with the long-term warming trend observed over the state.
- Annual maximum, minimum, and mean temperatures showed increasing trends during 1901–2025, with stronger warming observed in minimum temperatures.
- The state recorded 1% deficient Southwest Monsoon rainfall and 3% deficient Northeast Monsoon rainfall compared to the Long Period Average (1971–2020). However, summer rainfall was about 97% above normal.
- Long-term rainfall analysis indicates an overall decreasing tendency in both Southwest and Northeast Monsoon rainfall over Tamil Nadu, with considerable district-level variability.
- During the Southwest Monsoon season, Coimbatore showed the highest increasing rainfall trend, while Nilgiris recorded the steepest decreasing trend.
- In the Northeast Monsoon season, most districts showed non-significant rainfall trends due to high inter-annual variability.
- Madurai (Airport) recorded the highest maximum temperature of 41.5°C, while Salem recorded the lowest minimum temperature of 15.9°C during 2025.
- The highest one-day rainfall was recorded at Karaikal (194.3 mm) on 30 November 2025.
- Overall, the climate conditions during 2025 reflected the combined influence of long-term warming, monsoon variability, and regional climate fluctuations over Tamil Nadu.

Southwest Monsoon Season Rainfall Averaged over Tamilnadu
(% Departure from LPA: 1971 - 2020)



Seasonal departure of southwest monsoon rainfall averaged over Tamil Nadu expressed as the percentage from Long Period Average (LPA) computed for the base period of 1971-2020

Northeast Monsoon Season Rainfall Averaged over Tamilnadu
(% Departure from LPA: 1971 - 2020)



Seasonal departure of northeast monsoon rainfall averaged over Tamil Nadu expressed as the percentage from Long Period Average (LPA) computed for the base period of 1971-2020.

Southwest Monsoon- 2025: Operational Insights into Rainfall Variability and Extreme Events over South Peninsular India

- Dr. Arvind Kumar, Sc.-D,
India Meteorological Department, RMC Chennai

Understanding the Changing Behaviour of the Monsoon through Synoptic Systems, Climate Drivers and Operational Forecasting

The Southwest Monsoon remains the backbone of India's agriculture, water resources, and economy. Every year, its onset, progress, intensity, and withdrawal are closely monitored not only by meteorologists but also by farmers, disaster managers, water-resource planners, and the general public. For a country where agriculture, water resources, hydropower generation, and even day-to-day life depend heavily on seasonal rainfall, the arrival and behaviour of the monsoon always remain a subject of great interest. Every year, meteorologists closely monitor the progression of the monsoon from the Andaman Sea towards Kerala and further across the Indian subcontinent. Yet, despite decades of scientific advancement, the monsoon continues to surprise forecasters with its dynamic and multi-scale variability.

The Southwest Monsoon 2025 over South Peninsular India presented several interesting features. The season was

characterised by near-normal onset conditions, multiple low-pressure systems originating over the Bay of Bengal, strong intra-seasonal rainfall fluctuations, and a number of intense rainfall episodes over different parts of South India. The season also highlighted the growing importance of integrating synoptic analysis, sub-seasonal oscillations, and climate-scale drivers for improving operational forecasting.

Monsoon Onset and Progression

The onset of Southwest Monsoon over Kerala during 2025 occurred around the normal climatological date of 1 June. Unlike some previous years where the monsoon either advanced rapidly or remained delayed for prolonged periods, the progression during 2025 was relatively stable and climatologically aligned. The monsoon covered most parts of South Peninsular India by the middle of June and advanced over the entire country by the end of June. Figure 1 illustrates the interannual variability in the advance of Southwest Monsoon during 2020–2025. Considerable year-to-year differences are visible in the onset over Kerala, advance over Tamil Nadu, and all-India coverage, highlighting the

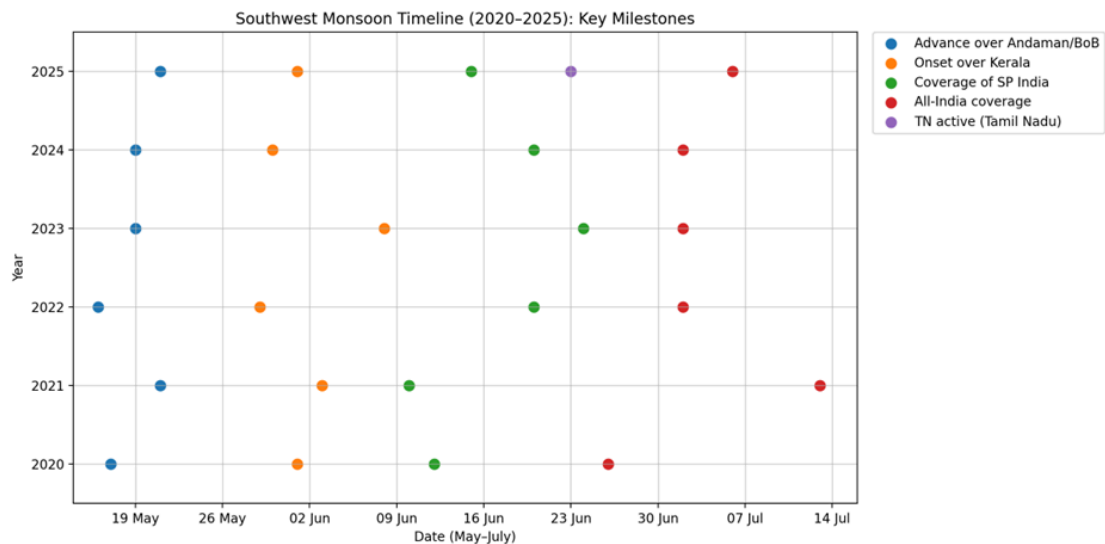


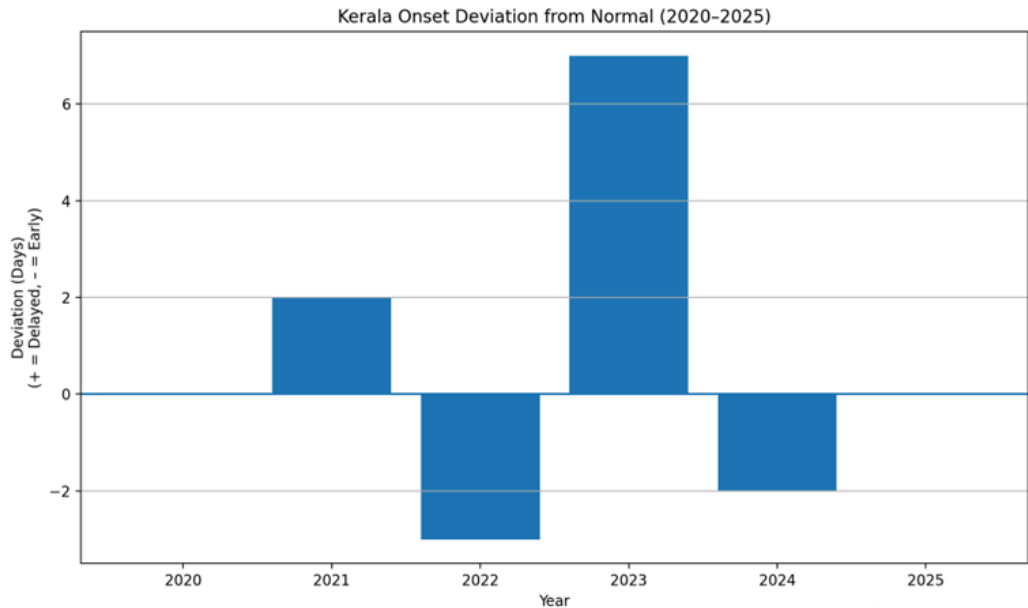
Fig. 1: Interannual Variability in Southwest Monsoon Advance (2020–2025)

dynamic nature of monsoon progression.

When compared with the previous five years, the onset behaviour clearly reflected the year-to-year variability associated with monsoon dynamics. For instance, the years 2022 and 2024 experienced relatively early onset over Kerala, whereas 2021 and 2023 witnessed delayed onset conditions. However, an important operational lesson observed during recent years is that early onset does not necessarily

guarantee early withdrawal, nor does delayed onset always imply weak monsoon conditions later in the season. Figure 2 shows the deviation in Southwest Monsoon onset dates over Kerala from the climatological normal during 2020–2025. The figure clearly demonstrates the variability in onset behaviour during recent years.

The withdrawal phase during 2025 also remained slightly delayed compared to climatology, with withdrawal from the entire country occurring during mid-



*Normal onset date used: 1 June (IMD climatology)

Fig. 2: Kerala Onset Deviation from Normal (2020–2025)

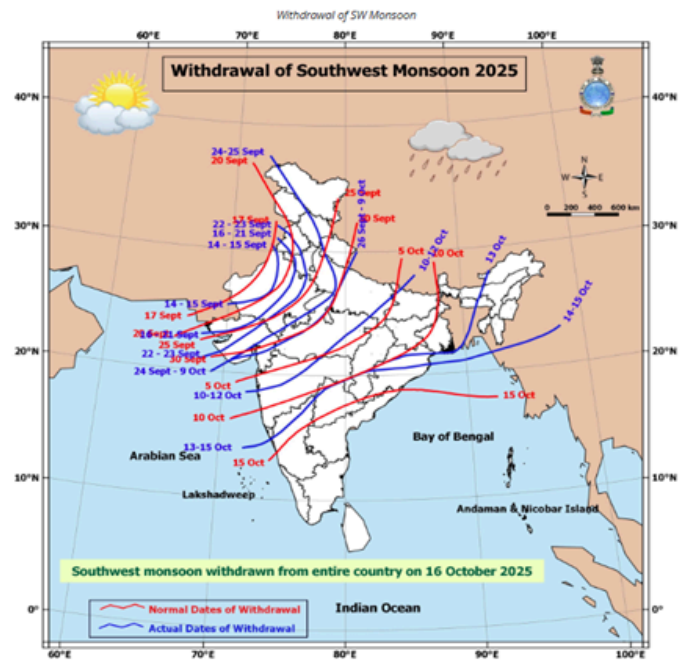
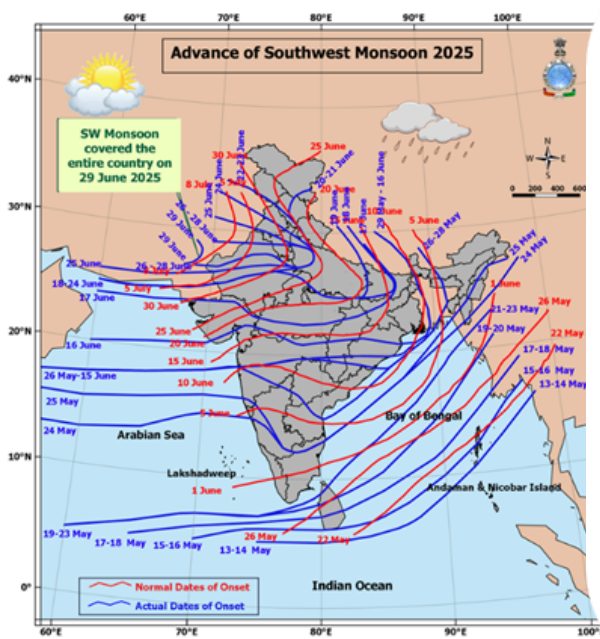


Fig. 3 & 4

October. Such delayed withdrawal has increasingly become a recurring feature during recent monsoon seasons. Figures 3 and 4 depict the advance and withdrawal phases of Southwest Monsoon 2025 respectively. The monsoon progressed steadily during June and withdrawal occurred slightly later than normal, consistent with recent seasonal trends.

One of the most significant features of Southwest Monsoon 2025 was the active synoptic activity over the Bay of Bengal. Multiple low-pressure areas (LPAs), well-marked low-pressure areas (WMLPAs), and depressions developed during the season and played a dominant role in modulating rainfall distribution over South Peninsular India.

Most of these systems originated over the Bay of Bengal and moved westward or west-northwestward across Odisha, Andhra Pradesh, Telangana, central

India, and further towards Gujarat and Rajasthan. Such tracks are climatologically important because they strongly influence rainfall activity over interior peninsular regions. The synoptic activity gradually intensified from July onwards and reached its peak during August and September. Two notable depressions formed during 18–19 August and 26–27 September respectively. These systems significantly enhanced rainfall activity over Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, and adjoining regions.

The interaction between the monsoon trough, offshore trough, and synoptic systems further amplified rainfall over the Western Ghats during active phases of the monsoon. These synoptic systems not only influenced rainfall intensity but also contributed significantly to the intra-seasonal variability observed during the season.

Intra-Seasonal Rainfall Variability

Another remarkable feature of Southwest Monsoon 2025 was the strong intra-seasonal variability in rainfall distribution. While June rainfall over Tamil Nadu remained above normal, July experienced a significant rainfall deficit. However, the monsoon revived strongly during August, leading to widespread excess rainfall conditions over several districts. Figure 5 presents the seasonal rainfall departure from normal over different meteorological sub-divisions of South Peninsular India. Telangana and North Interior Karnataka recorded significantly excess rainfall, whereas Kerala and Lakshadweep experienced deficient rainfall conditions.

August 2025 was particularly active from a rainfall perspective. Many districts recorded excess and large excess rainfall categories. Several heavy to very heavy rainfall events occurred over the Nilgiris, Chennai, coastal Tamil

Nadu, and adjoining areas. One of the most notable events was the intense cloudburst-like rainfall episode over Chennai during the end of August.

In contrast, September exhibited mixed rainfall conditions. While some districts continued to receive excess rainfall, a few regions such as Ramanathapuram and Tiruppur experienced deficient rainfall conditions. Such contrasting spatial distribution once again demonstrated the complex nature of monsoon rainfall variability over South Peninsular India.

Role of Large-Scale Climate Drivers

The behaviour of the Southwest Monsoon is not controlled solely by regional synoptic systems. Large-scale climate drivers also influence monsoon variability at seasonal and intra-seasonal time scales. During Southwest Monsoon 2025, ENSO conditions largely remained neutral. Therefore, strong El Niño or

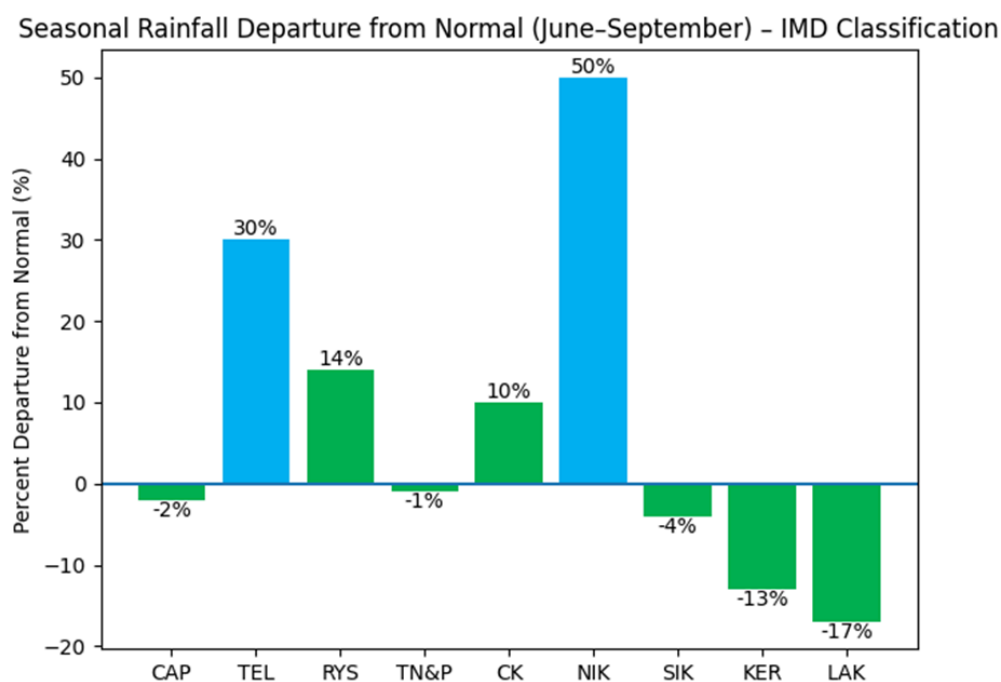


Fig. 5: Seasonal Rainfall Departure from Normal (June-September)

La Niña forcing was absent during the season. However, the Indian Ocean Dipole (IOD), which remained neutral during the early monsoon phase, gradually transitioned towards negative conditions by September. Such evolution may have contributed to some of the observed rainfall variability during the latter part of the season.

The Madden–Julian Oscillation (MJO) also played an important role in

modulating convection and rainfall activity. Different MJO phases influenced the development of convective systems and active-break cycles during the monsoon season. Operationally, it was clearly observed that periods of enhanced convection associated with favourable MJO phases often coincided with active rainfall spells over South India.

Extreme Rainfall Events and Operational Challenges

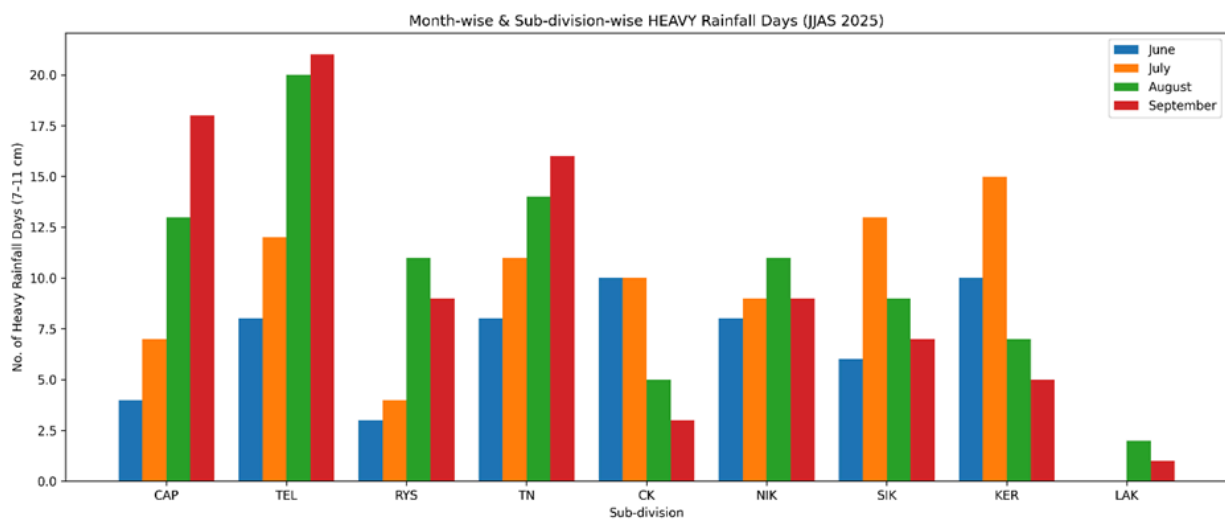


Fig. 6: Month-wise and Sub-division-wise Heavy Rainfall Days during SW monsoon-2025

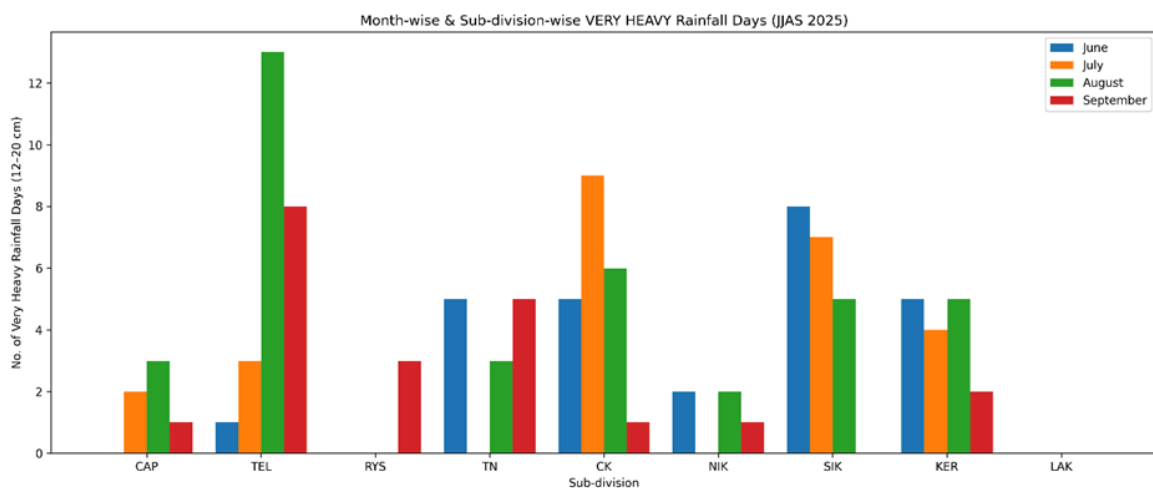


Fig. 7: Month-wise and Sub-division-wise Very Heavy Rainfall Days during SW monsoon-2025

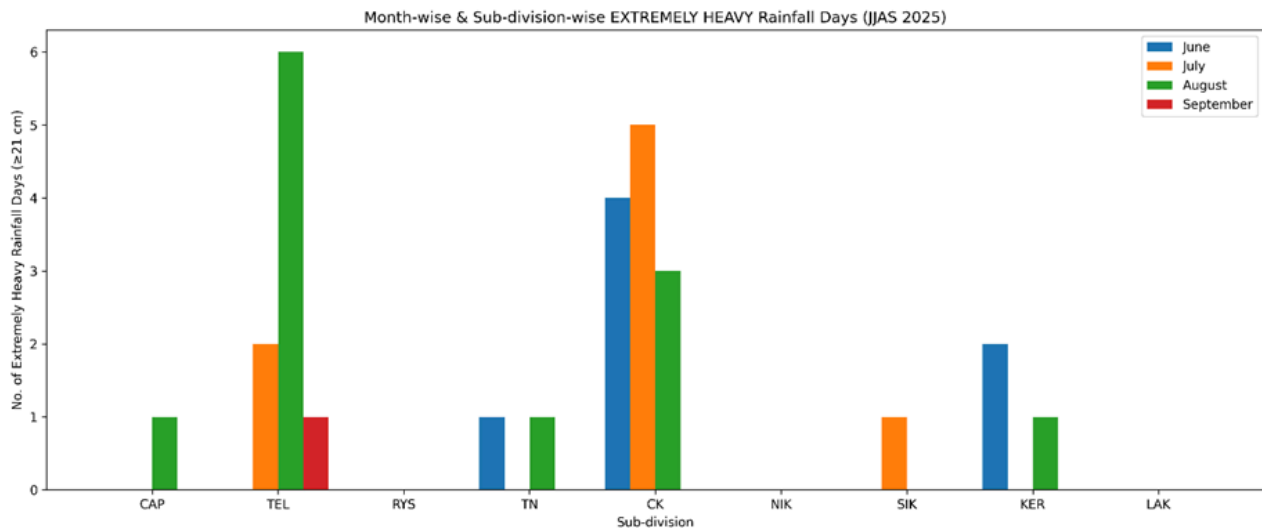


Fig. 8: Month-wise and Sub-division-wise Extremely Heavy Rainfall Days during SW monsoon-2025

The increasing frequency of extreme rainfall events continues to remain a major forecasting challenge. Southwest Monsoon 2025 witnessed several intense rainfall episodes associated with synoptic interactions and local mesoscale processes.

Urban flooding during heavy rainfall spells over Chennai highlighted the need for high-resolution forecasting systems and improved impact-based warning dissemination. Similarly, intense rainfall over hilly regions such as the Nilgiris once again demonstrated the vulnerability of orographic regions during active monsoon phases. Such events reinforce the importance of integrating radar observations, satellite monitoring, numerical weather prediction models, and real-time synoptic analysis into operational forecasting systems. Figures 6–8 indicate the month-wise distribution of heavy, very heavy, and extremely heavy rainfall days across different sub-divisions.

Telangana and Coastal Karnataka witnessed a comparatively larger number of intense rainfall events during active monsoon phases, particularly during August and September.

Figure 9 highlights the sub-division-wise distribution of extremely heavy rainfall events (≥ 21 cm). Telangana recorded the highest number of such events during the season, emphasizing the increasing occurrence of high-impact rainfall episodes over South Peninsular India. Operational forecasting during the season required continuous monitoring of Doppler Weather Radar products, satellite-derived cloud-top temperatures, low-level wind fields, moisture transport, and numerical weather prediction model guidance.

Lessons for Future Forecasting

The Southwest Monsoon 2025 once again highlighted that monsoon forecasting requires a true multi-scale approach. Synoptic systems, intra-seasonal oscillations, and climate-scale

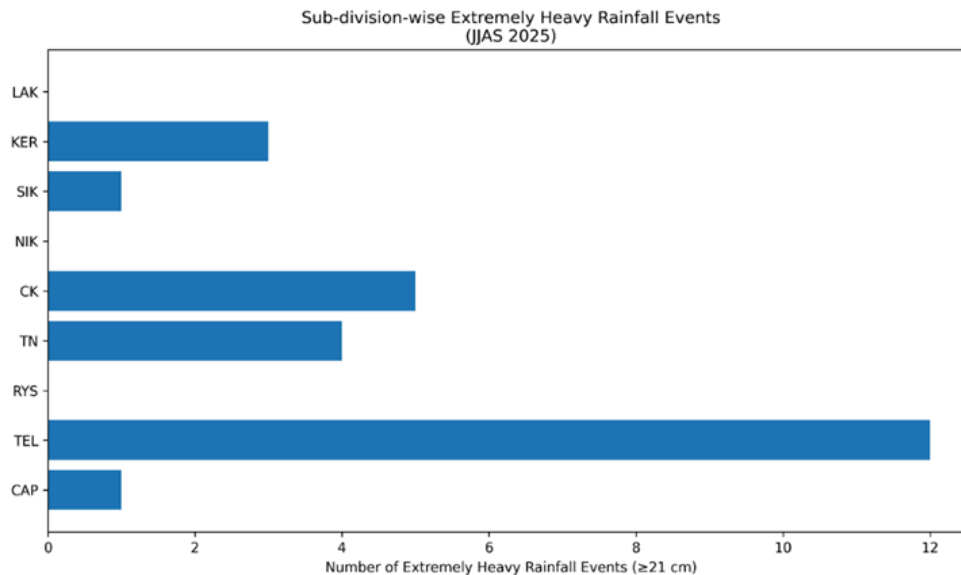


Fig. 9: Number of Extremely Heavy Rainfall Events (≥ 21 cm)

drivers all interact simultaneously to shape rainfall variability over India.

Some important operational lessons emerging from the season include:

- Continuous monitoring of Bay of Bengal synoptic systems remains critical for short-range rainfall forecasting.
- Forecast skill improves significantly when MJO and sub-seasonal variability are incorporated into operational analysis.
- Extreme rainfall prediction requires high-resolution observational and modelling systems.
- Impact-based forecasting must be strengthened further for urban flooding, agriculture, water management, and disaster preparedness.

The Way Forward

Future improvements in monsoon forecasting over South Peninsular India will depend on stronger integration between observational systems,

numerical weather prediction models, climate diagnostics, and decision-support services.

The growing availability of Doppler Weather Radars, satellite products, high-resolution numerical models, and extended-range forecast systems provides new opportunities for improving forecast skill. However, scientific understanding alone is not sufficient. Effective communication of weather information to stakeholders and the public remains equally important.

As climate variability and extreme weather events continue to increase, operational meteorology must evolve towards a more integrated and impact-oriented forecasting framework. Although a single season cannot directly establish climate change trends, the increasing frequency of short-duration

As climate variability and extreme weather events continue to increase, operational meteorology must evolve towards a more integrated and impact-

oriented forecasting framework. Although a single season cannot directly establish climate change trends, the increasing frequency of short-duration intense rainfall events over urban and hilly regions remains an important area of scientific concern.

The Southwest Monsoon 2025 served as yet another reminder that the Indian monsoon is not merely a seasonal weather phenomenon—it is a highly dynamic atmospheric system influenced by processes operating from local to global scales. Understanding these interactions remains one of the greatest scientific and operational challenges in meteorology.

Acknowledgement

The valuable inputs provided by the Investigation and Development Unit (IDU), RMC Chennai, and the Meteorological Centres of all subdivisions of the southern peninsula for the analysis are duly acknowledged.

Changing Skies: Northeast Monsoon 2025 and the Outlook for 2026

- Dr. V.R.Durai, Sc.-F,
India Meteorological Department, RMC Chennai

The Northeast Monsoon (NEM), spanning October to December, is a crucial climatic phenomenon for southern India—particularly Tamil Nadu, where it contributes nearly half of the annual rainfall. The 2025 season presented a dynamic mix of active phases, climatic influences, and impactful weather events, underlining its importance for water security and agriculture.

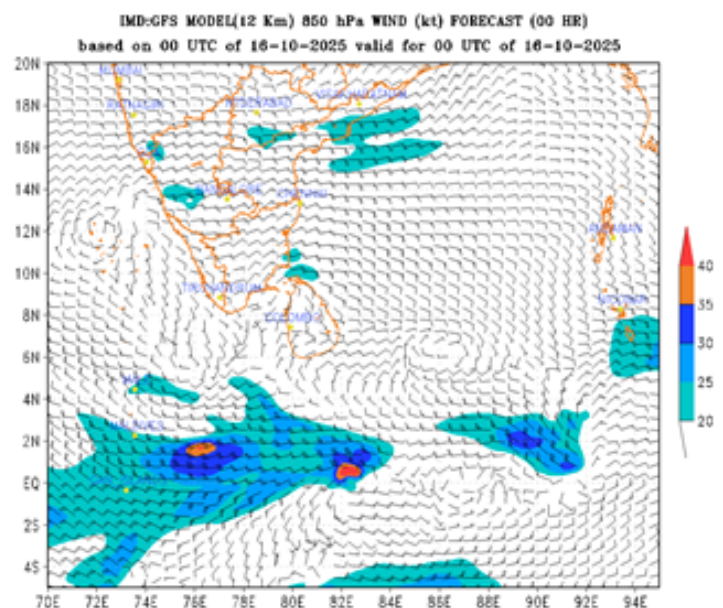
Onset and Early Activity

In 2025, the Southwest Monsoon withdrew from the country on 16 October, marking the simultaneous onset of the Northeast Monsoon over Tamil Nadu, Puducherry, Coastal Andhra Pradesh, and adjoining regions. The establishment of easterly and northeasterly winds over the southern peninsula and the Bay of Bengal signaled the transition.

The monsoon became active almost immediately, with widespread rainfall observed across Tamil Nadu and nearby regions. October emerged as the most active month, with favourable atmospheric conditions including upper air cyclonic circulations and enhanced moisture flow.

Rainfall Distribution and Trends

The season exhibited notable spatial and temporal variability: Above-normal rainfall was recorded over Tamil Nadu and Coastal Andhra Pradesh, particularly during October. Kerala and South Interior Karnataka experienced heavy rainfall spells associated with low-pressure systems. Rainfall activity declined significantly during November and December. Tamil Nadu and Puducherry witnessed the highest monsoon activity, with 25 active to vigorous rainfall days, compared to fewer active days in other subdivisions. The region also recorded a high number of heavy rainfall events, including extremely heavy rainfall on several occasions.



Climatic Drivers

Large-scale climatic factors played a key role in shaping the monsoon:

ENSO Conditions:



A weak La Niña prevailed, gradually transitioning toward neutral conditions. Such conditions typically support normal to above-normal rainfall over South India.

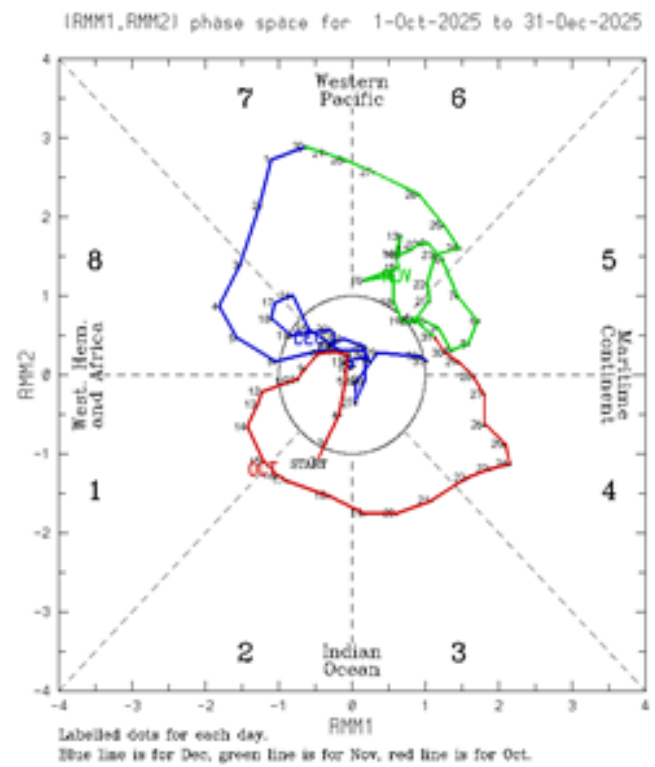
Indian Ocean Dipole (IOD):



Neutral IOD conditions persisted, indicating minimal deviation from average rainfall patterns.

Sea Surface Temperatures (SSTs): Warmer-than-normal SSTs in the Bay of Bengal enhanced moisture availability.

Madden-Julian Oscillation (MJO):



Copyright Commonwealth of Australia Bureau of Meteorology

The MJO is an eastward-moving pulse of clouds and rainfall along the equator, recurring every 30–60 days and divided into eight phases. It is monitored using RMM1 and RMM2 indices, which combine cloud and wind information.

- Inside the circle → Weak MJO
- Outside the circle → Strong MJO

During October 2025, the MJO remained mainly in Phases 2 and 3, which are favourable for enhanced Northeast Monsoon rainfall over South India. Active MJO phases contributed to enhanced rainfall episodes during certain periods.

Synoptic Weather Systems

The 2025 monsoon was significantly influenced by synoptic systems over the Bay of Bengal. Multiple low-pressure

systems and cyclonic circulations developed, intensifying rainfall across the southern peninsula.

Notable systems included:

- **Severe Cyclonic Storm Montha (25–29 October 2025)**
- **Cyclonic Storm Ditwah**

(26 November–2 December 2025)

These systems enhanced moisture transport and led to episodic heavy rainfall, with some areas experiencing localized flooding.

Impacts on Society and Economy

The Northeast Monsoon continues to be the lifeline of Tamil Nadu:

Positive impacts:

- Improved groundwater levels
- Support for Rabi (rice) cultivation
- Enhanced drinking water availability

Negative impacts:

- Urban flooding in several districts
- Temporary disruptions to transport and infrastructure

Withdrawal and Conclusion

The monsoon withdrew on 19 January 2026, marking the end of significant rainfall activity over the region.

In summary, the Northeast Monsoon 2025 was characterized by:

- An active onset and strong October phase
- Declining rainfall in later months
- Strong influence of synoptic systems and ocean-atmosphere interactions

Despite its variability, the season played a vital role in sustaining agriculture and water resources across South India, reinforcing the enduring importance of the Northeast Monsoon.

Looking Ahead:

As attention turns to the future, the outlook for the **2026 Northeast Monsoon** suggests a more uncertain scenario.

Possible Influence of El Niño

There are indications that **El Niño conditions** may develop during 2026.

El Niño events are generally associated with:

- Reduced rainfall over South India
- Higher temperatures

If these conditions strengthen, they could affect the performance of the monsoon.

Warmer Oceans, Stronger Extremes

The Bay of Bengal is expected to remain warm in 2026 as well.

While warmer waters can increase moisture availability, they can also lead to:

- Short, intense rainfall events
- Increased chances of extreme weather

This means rainfall may become **less frequent but more intense**, posing new challenges.

A More Variable Monsoon

Recent trends suggest that monsoon patterns are becoming:

- Less predictable
- More uneven in distribution

For 2026, this could mean:

- A slightly delayed/irregular onset
- A few periods of heavy rainfall
- Longer dry spells between rain events

Even if total rainfall is near normal, its distribution may not be ideal.

Implications for the Future

The changing nature of the Northeast Monsoon has important consequences.

For Agriculture

Farmers may face uncertainty in rainfall timing, affecting crop planning.

For Cities

Heavy rainfall in short periods can increase the risk of flooding.

For Water Management

Irregular rainfall makes it difficult to store and manage water efficiently.

Adapting to Changing Skies

As the monsoon becomes more variable, adaptation becomes essential.

Key steps include:

- Developing better urban drainage infrastructure
- Promoting water conservation and storage
- Encouraging climate-resilient farming practices

These measures can help reduce risks and make better use of available rainfall.

Conclusion: A Monsoon in Transition

The Northeast Monsoon 2025 was a season that highlighted both reliability and change. It delivered essential rainfall but also showed signs of increasing variability.

Looking ahead to 2026, the possibility of El Niño and warmer oceans suggests that uncertainty may continue. Rainfall patterns are likely to become more uneven, with intense short spells and longer dry periods.

In many ways, the Northeast Monsoon is entering a **new phase – one shaped by changing climate conditions**. Understanding these changes and preparing for them will be key to ensuring water security and sustainability in the years ahead.

Reversal of relation between location of April subtropical 500 hPa ridge over Peninsular India and the subsequent southwest monsoon rainfall over India

-Dr. Y.E.A. Raj
Sci-F & DDGM (Retired), RMC Chennai

1. Most of the IMS members must be familiar with the legacy and history of Long Range Forecasting (LRF) of Indian South west Monsoon Rainfall (ISMR, Jun-Sep rainfall over entire India) carried out by the India Meteorological Department (IMD). In the late 1970's the transposition of April 500 hPa Subtropical Ridge (STR) over India emerged as an important predictor. Fig 1 presents the normal April 500 hPa wind distribution over India. As shown the STR is located along 14°N with westerlies to the north and easterlies to the south. The latitudinal position of the Apr STR at 75°E exhibited good correlation with the subsequent monsoon rainfall as shown in a few studies published in the 1970s and 80s. Banerjee, Sen P N & Raman CRV 's paper in 1978 in Mausam was perhaps the first detailed paper bringing out this relation and they used the data from 1950-75 for development and verification of the statistical model based on this predictor. Subsequently this was used as the leading predictor in IMD's LRF of ISMR as detailed in the 1982 paper by Thapliyal. It was also taken as one of the 16 predictors based on which a power regression model was developed

and the details were presented in the 1991 paper by Gowardikar et al. The relation between STR and ISMR was positive in that a northern position of the ridge favoured good subsequent ISMR and a southern position favoured poor rainfall. During the period 1971-84 the STR was well aligned with IMR pre-indicating correctly the occurrence of deficient rainfall in the years 1972, 79 and 82 and also the good monsoon years of 1975, 80 and 83.

2. However, under all accounts the correlation coefficient (CC) between STR and ISMR decreased in the 1980's and then further in the 1990's. In the 2006 Current Science paper by Rajeevan et al which described the dual stage forecasts for ISMR, the STR was not included as a predictor.

3. This is the background and the author had the curiosity to investigate how the STR has been related to ISMR in the most recent period. Has the relation decreased or completely disappeared? This we wanted to find out and took the STR data for the 25 year period 2000-24 from NCEP Reanalysis2 website.

There could be an error of upto 0.25° N in the visual estimation of the latitudinal position of the ridge position. The ISMR data was taken as the percentage of Long Period average (LPA). Figs 2a and 2b present the STR and ISMR data during 2000-24. Fig.3 presents the scatter diagram. The CC between the two time series was computed and was obtained as -0.49 with a t value of 2.7 which is significant at 2% LS. Thus the relation has turned from positive to significantly negative.

4. In Table 1a is presented the statistics of both STR and ISMR. During 2020-24 STR has a mean value of 14.5° N (at 75° E) and a standard deviation (SD) of 2.0° . ISMR has a mean of just 96% and SD of 8.7%. Thus during this near-quarter century period ISMR rainfall has been deficient by 4 % from the LPA. In Table 1b presents the conditional means of ISMR (also expressed as the anomaly from the short term mean value of 96%) given STR and vice -versa for various intervals which has been done to obtain a smoother profile.

This is also graphically presented in Figs 4a & 4b., from which the presence of negative relation is much more obvious. When STR is very much north in the interval at $18-20^{\circ}$ N the IMR is 86.5% and is 9.5% lower than the short period average. During the 5 years when the ISMR is less than 90% of LPA, the STR is in the range of $15.2-18.8^{\circ}$ N. During the 5 years when ISMR is 105- 110 % of LPA

which could be characterised as slight excess, the STR is at 13.2° N, nearly 1.3° south of its normal position.

Fig.5a displays the Apr 500 hPa wind flow for the year 2009 when ISMR was deficient by as much as 22 % . STR position is at 16° N well north of the normal position. Fig. 5b presents the flow for the year 2020 and the STR position is at 12.5° N well south of its normal position. But the ISMR was 109% of LPA so close to an excess rainfall category. The ridge positions during these two extreme years also point to the negative nature of the relationship.

5. Thus the reality is that the relation between STR and ISMR has not just decreased or disappeared but has turned sign to become significantly negative with southern (northern) location associated with good (poor) ISMR. The sample we have used is small but adequate. During the period when the relation was positive it could also be backed by a convincing physical reasoning. In winter and summer when the upper tropospheric westerlies are strong and penetrate in to the lower latitudes of Indian subcontinent it was considered to be an unfavourable factor for the subsequent south west monsoon. Whereas weak westerlies and winter jet stream shifting towards the northern latitudes are considered favourable for monsoon.

The older positive relation of STR fitted perfectly with this conceptual model. The recent negative relation goes against the conceptual model and so it will be difficult to include it as a predictor despite the significant negative CC that it is now displaying with ISMR.

6. For the year 2025 the ISMR was excess by 8%. The STR was not that well defined. It was along 20°N over the Saudi Arabaian region at 60° E but over India at 75° E its latitudinal positin was south of Comorin at about 6° N (Fig. 5c) again manifesting the negative relation with ISMR.

7. Why the relation between STR and ISMR which was considered very important and stable in the 1970-80's has completely changed sign in the 21-st century is another important scientific question . Can we assign any physical explanation to such a change? Can this type of change in relation happen to the well established relation between say ISMR and El Nino or Southern Oscillation also? These are hypothetical questions but are worth pondering over.

Table 1a Mean and Standard deviation of STR and ISMR 2020-24

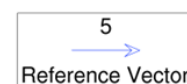
	Mean	SD
STR °N	14.5	2.0
ISMR % of LPA	96	8.5

STR- Latitudinal position at 75° E

Table 1b Conditional means of ISMR given STR and STR given ISMR, 2020-24

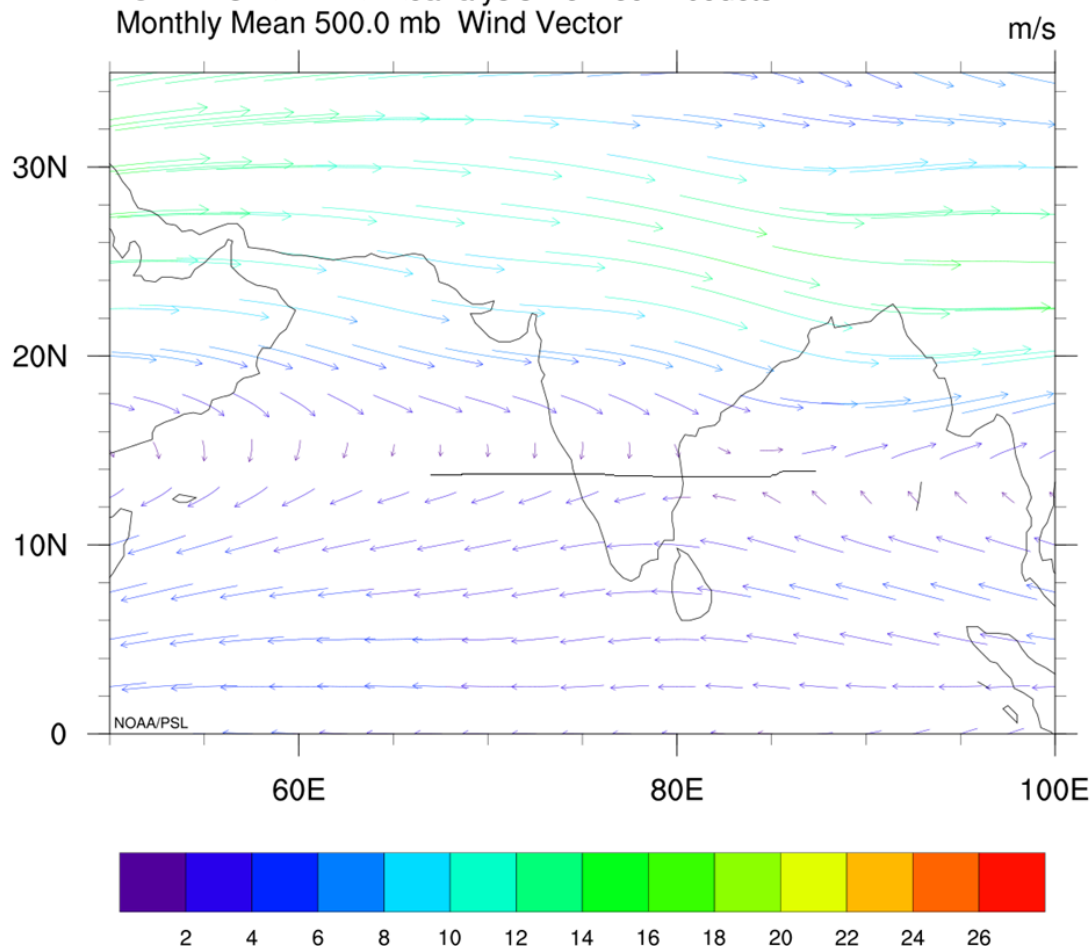
STR at 75 E Lat ° N	ISMR % of LPA	Anomaly from value of 96%	n No. of years		ISMR % of LPA	Lat °N	n
10-12	100.0	4	2		75-80	16	1
12-14	102.0	2	7		80-85	18.8	1
14-16	96.0	0	8		85-90	15.2	3

STR at 75 E Lat ° N	ISMR % of LPA	Anomaly from value of 96%	<i>n</i> No. of years		ISMR % of LPA	Lat °N	<i>n</i>
16-18	94.2	-1.8	6		90-95	15	5
18-20	86.5	-9.5	2		95-100	13.8	5
					100-105	14.1	4
					105-110	13.2	5
					110-115	15.0	1



Apr (1981-2010 Climatology)

NCEP-DOE AMIP-II Reanalysis Derived Products
Monthly Mean 500.0 mb Wind Vector



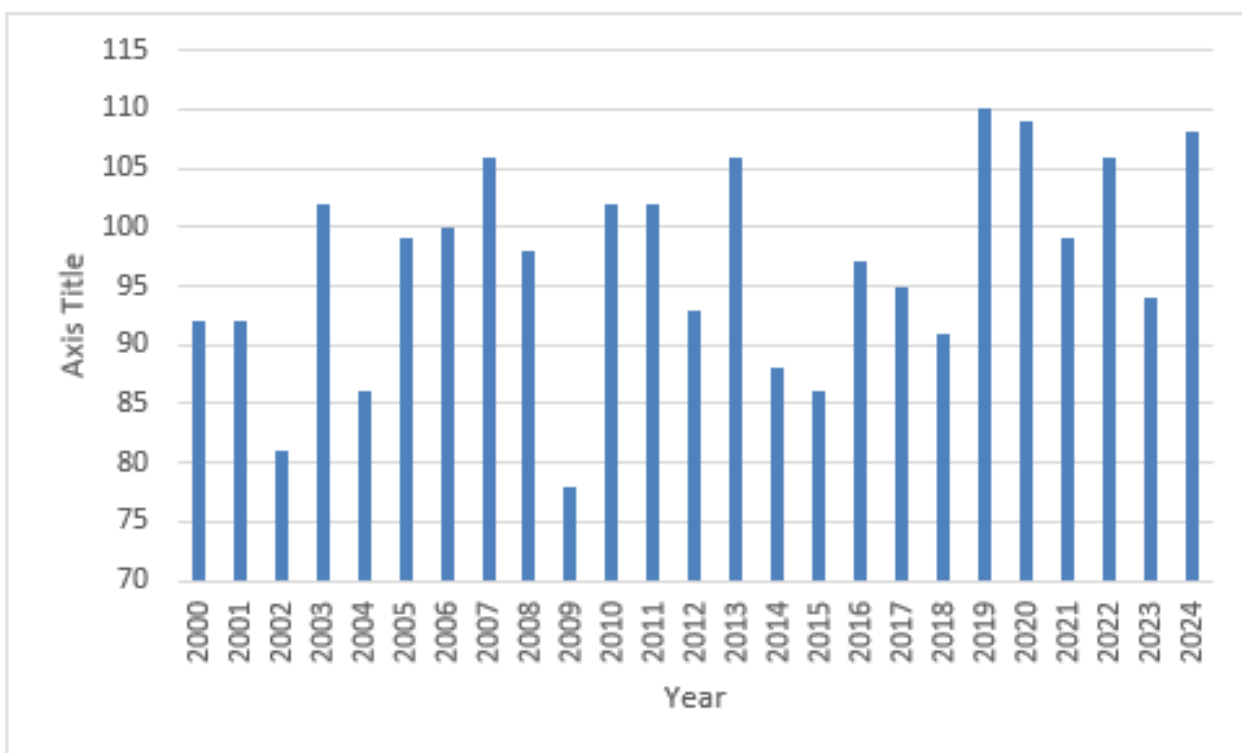
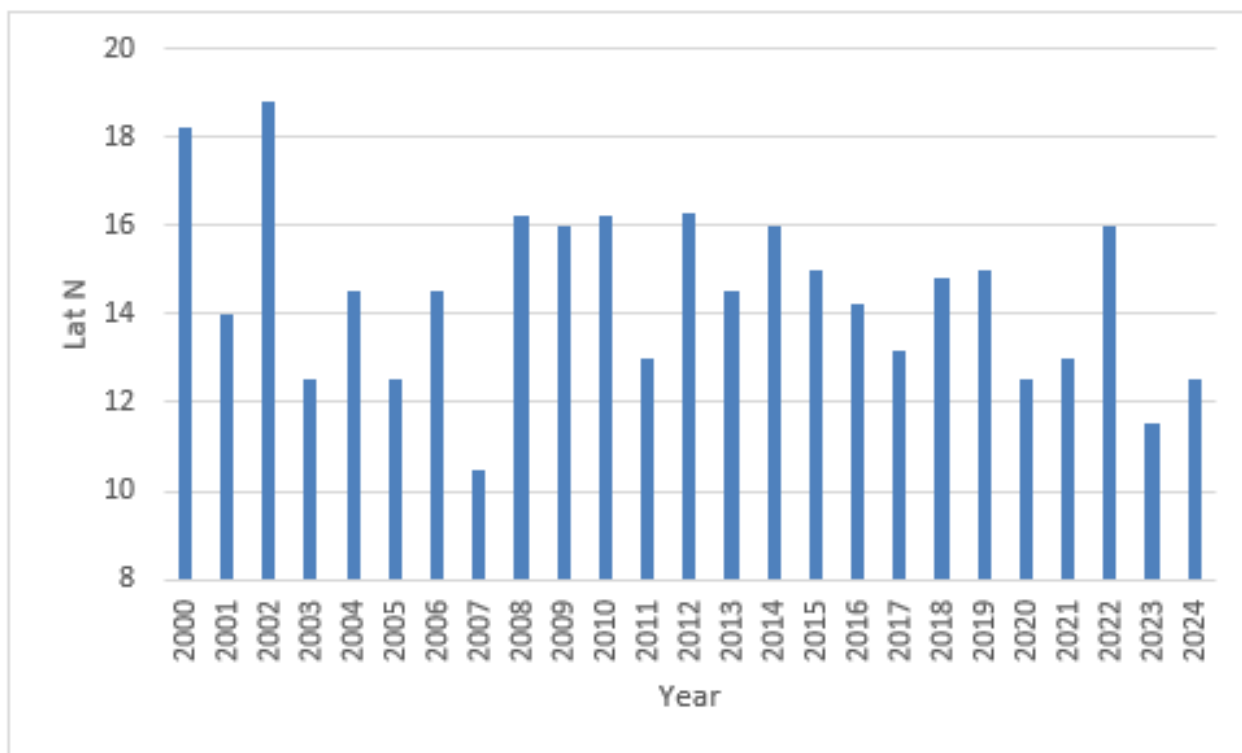


Fig. 2a & 2b Variation of STR (°N) & ISMR (% of LPA). 2020-24
(For all figures - STR- Latitudinal position at 75°E)

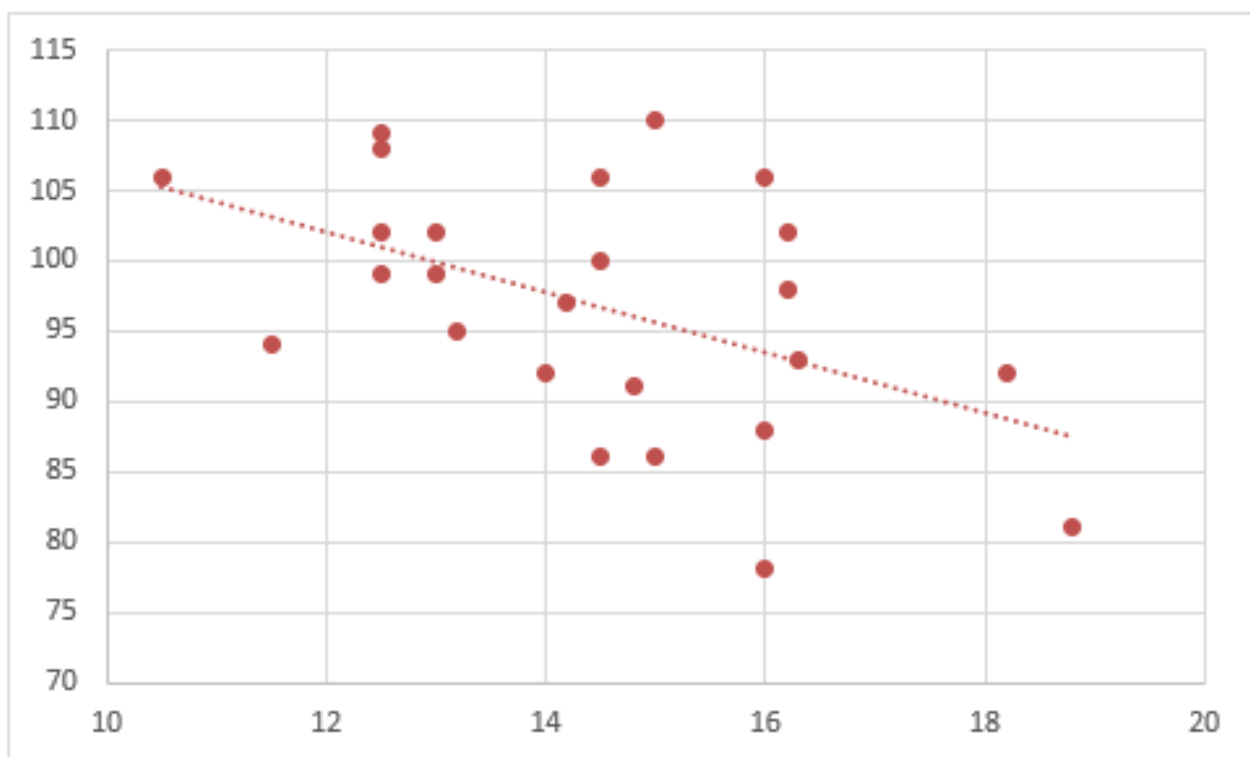
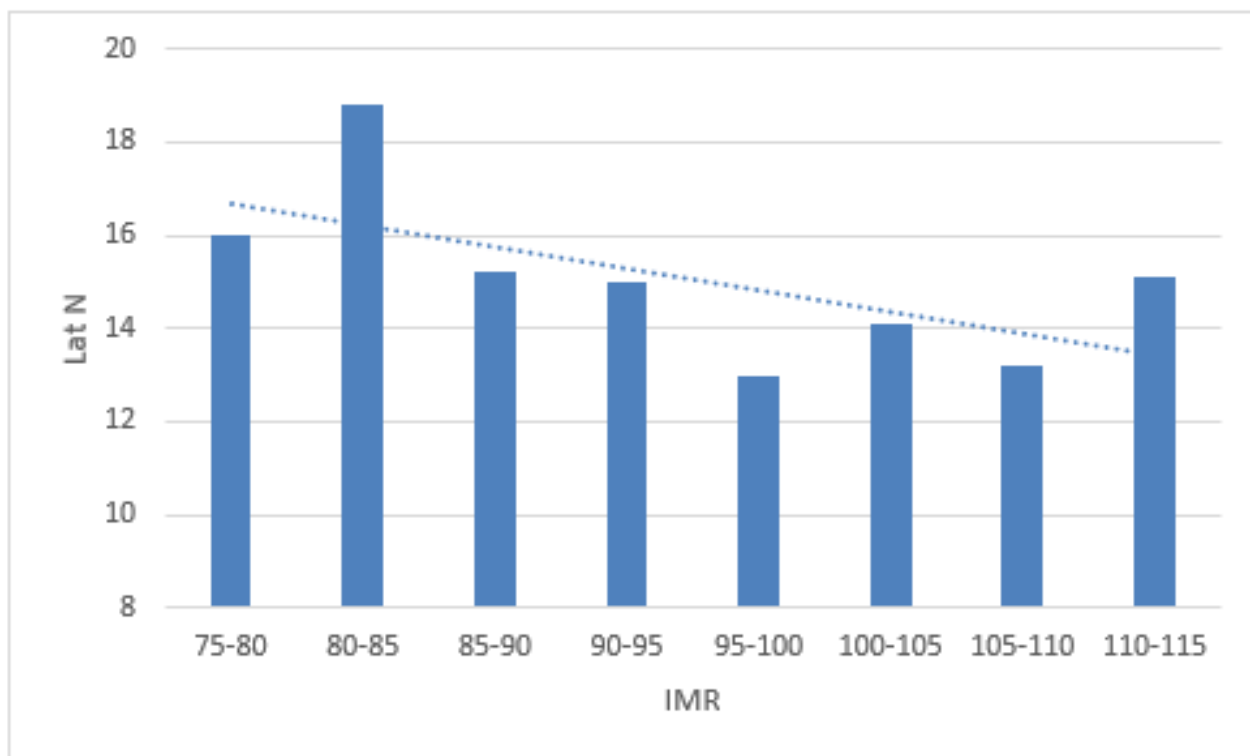


Fig3. Scatter diagram STR (°N) (x-axis) & ISMR in % (y-axis)



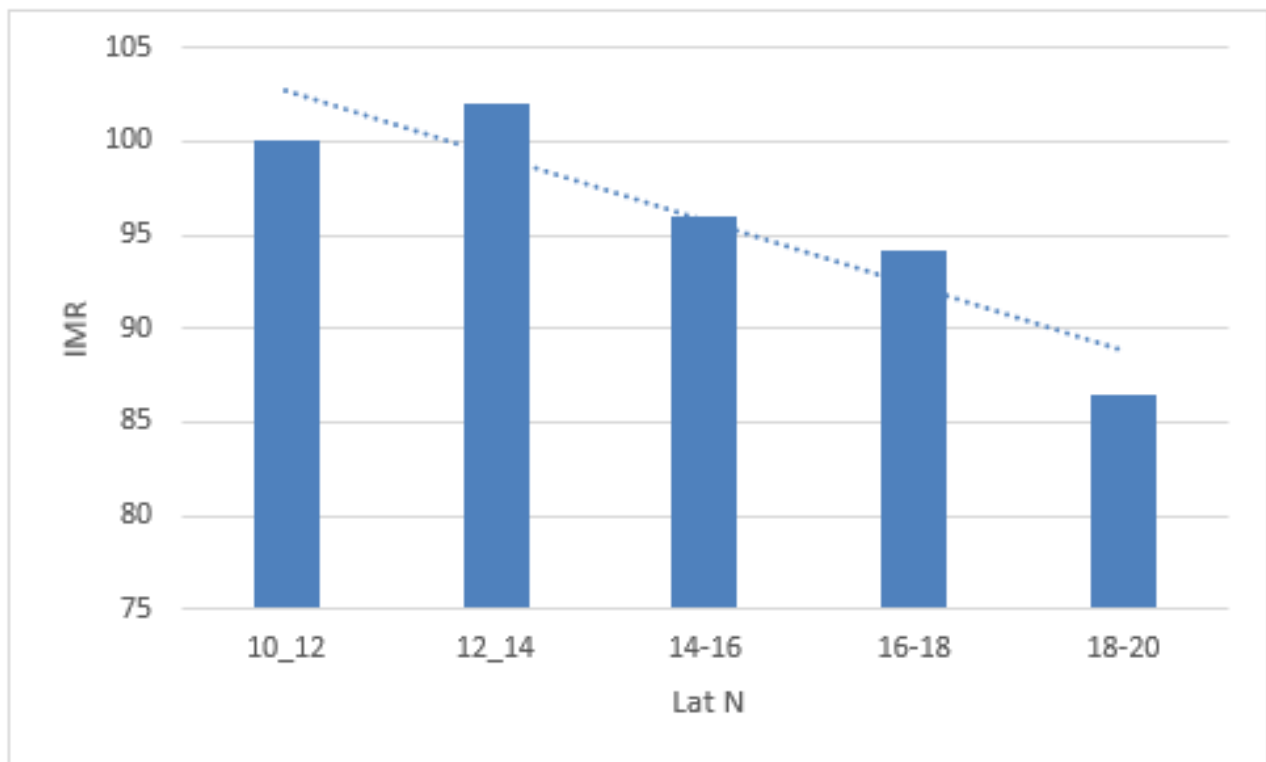


Fig.4. Conditional means of ISMR given STR and STR given ISMR

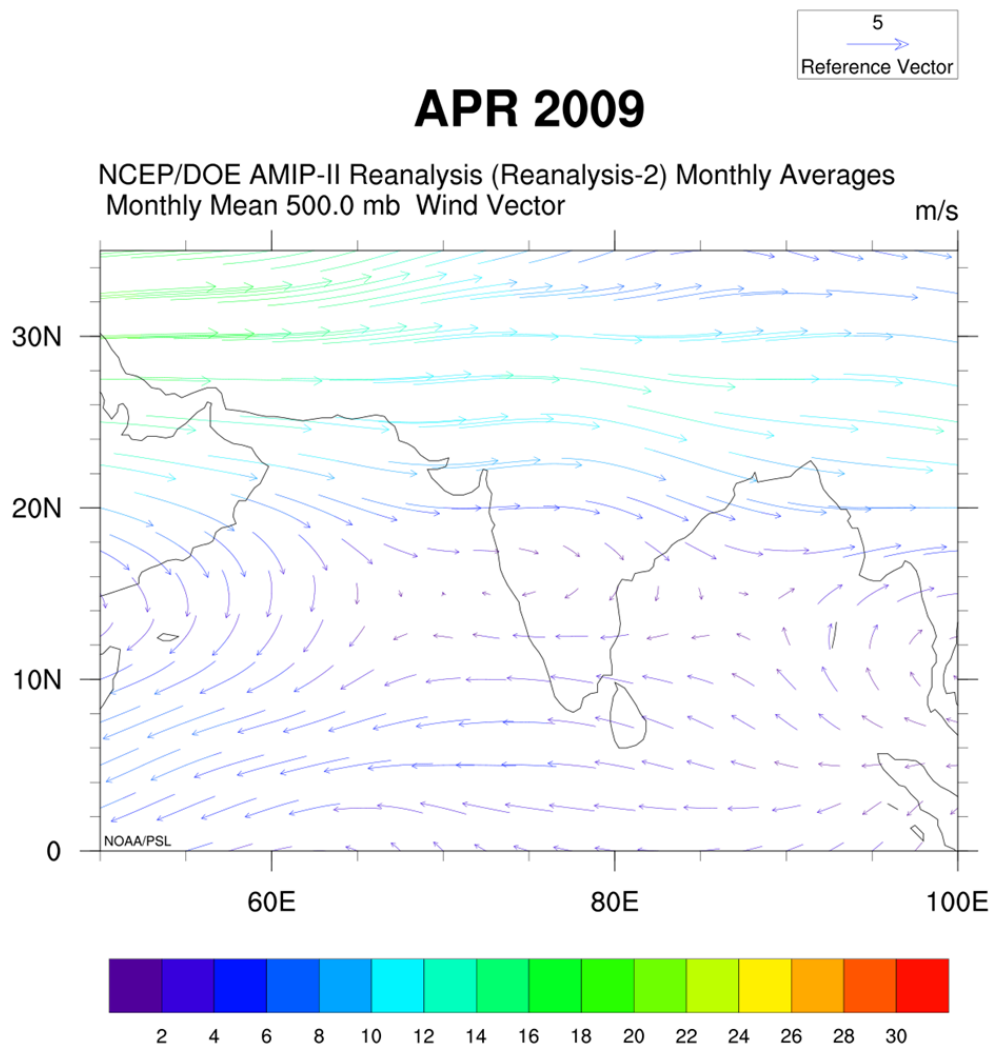
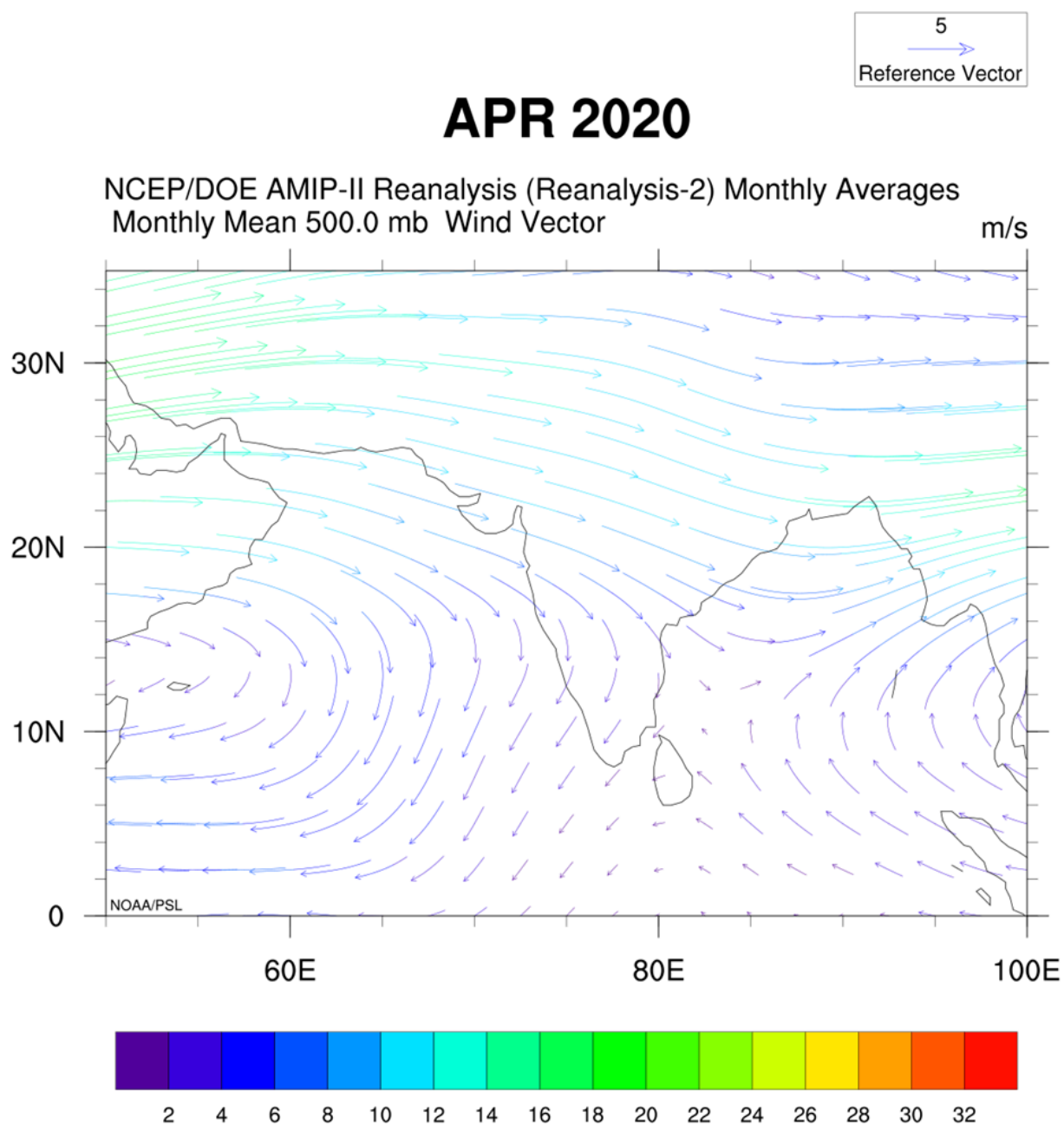
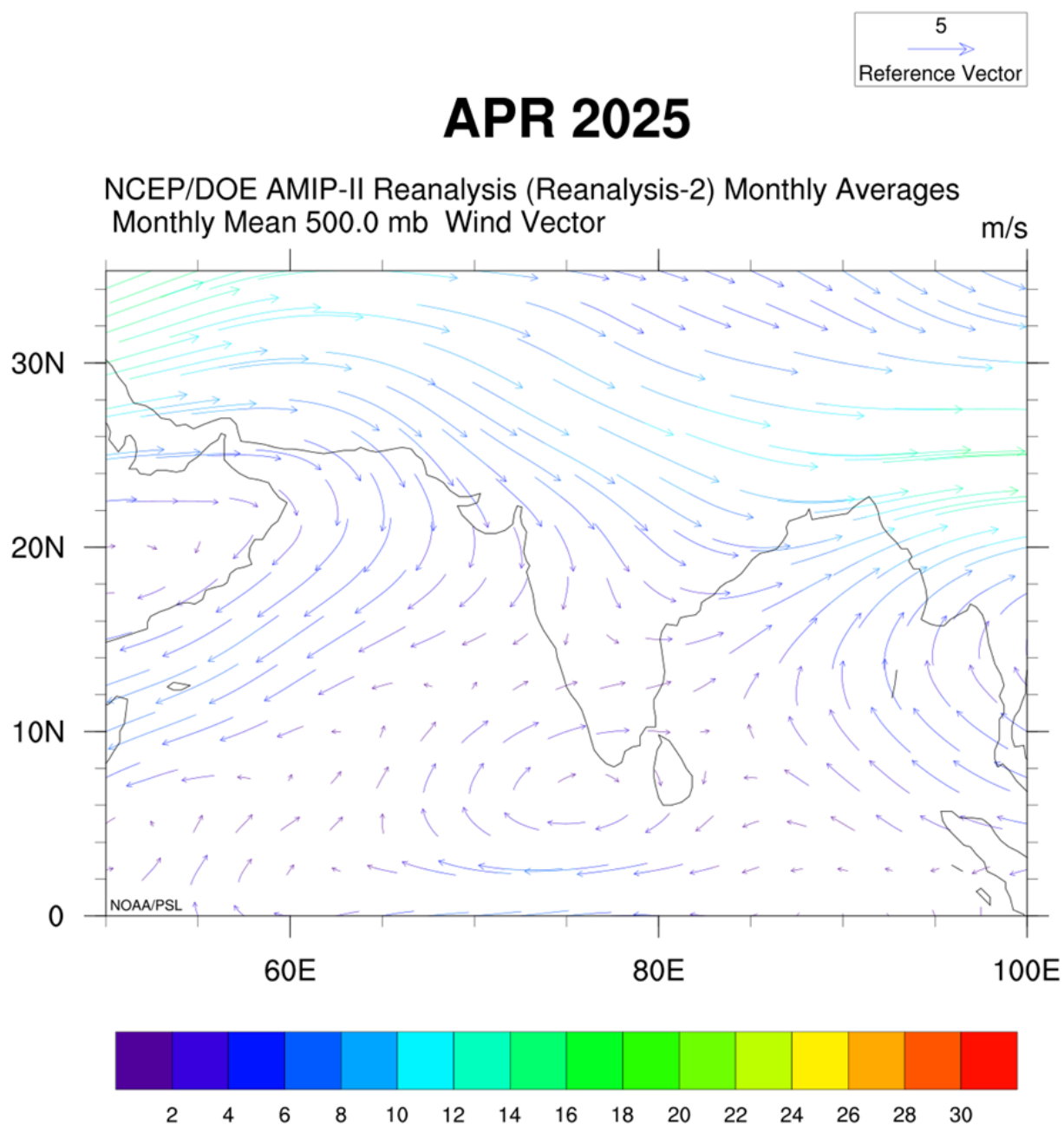


Fig.5a

**Fig.5b**

**Fig.5c**

Review of the Urban Heat Island Effect and NDVI Analysis in Indian Cities

- **Shri G.V. Kumar**
Meteorologist(Retired), Bengaluru

An integrated analysis of the Urban Heat Island (UHI) effect in Indian cities, combining chronological climate observations with remote sensing methodologies, particularly Normalized Difference Vegetation Index (NDVI) is presented. A review of studies conducted between 2010 and 2024 on land-use change assessments, temperature variation studies, satellite-based vegetation monitoring, and recent climate observations is attempted. The intensification of UHI impacts across major Indian metropolitan regions is highlighted with environmental, health, and urban-planning implications while identifying mitigation strategies for modern scientific research and use of traditional architectural practices.

1. Introduction

The Urban Heat Island (UHI) effect represents one of the most significant climatic impacts of urbanization, characterized by elevated temperatures

in urban areas compared to their rural surroundings. This phenomenon results from a complex interplay of anthropogenic activities, land-use modifications, and infrastructural development that fundamentally alter the thermal properties of urban landscapes.

Indian metropolitan cities, particularly Bengaluru, Chennai, and Mysuru, have experienced progressive intensification of UHI effects over recent decades, driven by rapid urbanization, population growth, and expanding built environments. The relationship between urban vegetation and surface temperature has emerged as a critical factor in understanding and mitigating UHI intensity, with the Normalized Difference Vegetation Index (NDVI) serving as a key remote sensing tool for quantifying this relationship.

The early findings from studies around 2010, mid-term analyses, and recent high-resolution climate observations from 2021–2024, integrating remote sensing data, particularly NDVI measurements, with ground-based climate monitoring to provide a comprehensive understanding of UHI dynamics in Indian cities are presented.

2. NDVI Methodology and Remote Sensing Approach

2.1 Understanding NDVI

The NDVI is a standardized remote sensing metric that quantifies vegetation health and density by measuring the difference between near-infrared (NIR) and visible red light reflected by vegetation. The NDVI formula is expressed as: $NDVI = (NIR - Red) / (NIR + Red)$

NDVI values range from -1 to +1, where higher values (0.6 to 0.9) indicate dense, healthy vegetation, moderate values (0.2 to 0.5) suggest sparse or stressed vegetation, and low or negative values indicate bare soil, water, or built-up areas. This index exploits the unique spectral signature of healthy vegetation, which strongly absorbs red light for photosynthesis while reflecting near-infrared radiation.

2.2 Satellite Platforms and Data Sources

Multiple satellite systems have been deployed for NDVI and Land Surface Temperature (LST) analysis in Indian urban studies:

- Landsat Program (TM, ETM+, OLI sensors): Provides consistent 30-meter resolution multispectral imagery with thermal bands for LST retrieval, forming the backbone of long-term urban monitoring studies
- Sentinel-2: Offers enhanced spatial resolution (10-20 meters) and improved temporal frequency for contemporary vegetation monitoring

- MODIS (Moderate Resolution Imaging Spectroradiometer): Enables daily observations at coarser resolution, suitable for large-scale regional assessments
- Indian Remote Sensing Satellites (IRS series): Provides complementary data with varied spatial and spectral resolutions

2.3 Integration with Land Surface Temperature

A strong inverse correlation exists between NDVI and Land Surface Temperature viz. areas with high NDVI (dense vegetation) exhibit significantly lower surface temperatures, while areas with low NDVI (urban built-up regions) show elevated temperatures. Vegetated areas can be 2-4°C cooler than adjacent built-up zones.

3. Early Evidence of UHI in Indian Cities (2010 Era)

Key findings from the study during 2010 indicate that urban cores were consistently 1.5°C to 4°C warmer than surrounding rural zones, with the greatest temperature differentials observed during night time hours. The nocturnal intensification reflects the thermal mass properties of urban infrastructure, which absorbs solar radiation during the day and releases it slowly at night, preventing urban areas from cooling as rapidly as vegetated or rural landscapes. The inverse relationship between NDVI and surface temperature was clearly established,

with correlation coefficients typically exceeding -0.7, indicating that areas with higher vegetation density consistently exhibited lower surface temperatures. Analysis of historical satellite imagery documented substantial urban expansion between 1973 and 2010, characterized by significant loss of green cover and a corresponding increase in built-up areas, directly contributing to worsening UHI intensity.

4. Continued Urbanization and Land Surface Transformation (2010–2020)

The decade 2010 to 2020 witnessed accelerated urban development across Indian cities. Research during this period showed robust correlations between urbanization patterns, ecosystem degradation, and rising temperatures at both ambient and surface levels. Bengaluru experienced particularly rapid infrastructural growth during this period, characterized by significant encroachment on wetlands, lakes, and other natural ecosystems. NDVI-based analyses revealed progressive fragmentation and reduction of vegetated patches, with remaining green spaces becoming increasingly isolated within the urban matrix. Despite an overall trend of vegetation loss, specific vegetated areas maintained their role as critical cooling zones within the urban environment.

Studies identified several key green spaces that demonstrated measurable cooling effects: Lalbagh Botanical Garden, Cubbon Park, the Indian Institute

of Science (IISc) campus, and Mysore Zoo all exhibited surface temperatures 2°C to 4°C lower than surrounding built-up areas. These findings reinforced the importance of preserving and expanding urban green spaces, leading to increased calls for integrating urban forestry, conservation planning, and climate-responsive architecture into city development frameworks.

5. Recent Climatic Trends and UHI Intensification (2021–2024)

Recent studies from 2021 to 2024 using improved higher resolution satellite data document unprecedented changes in climatic patterns and accelerated UHI intensification across Indian metropolitan regions.

In April 2024, Bengaluru recorded a temperature of 37.6°C, marking its second-highest temperature on record, accompanied by unusually warm nights reaching 24.5°C. The city also experienced its wettest year on record in 2022, with total annual rainfall reaching 169 cm, indicating increasing climatic variability and extremes. A comprehensive 2022 land-use study reported a 51.8% increase in built-up area between 1973 and 2022, accompanied by a devastating 26.2% decline in green spaces and water bodies.

NDVI analysis during this period revealed not only continued decline in overall vegetation cover but also degradation in the health and density of remaining vegetated areas.

Time-series NDVI data showed declining trends even in protected green spaces, suggesting that remaining urban vegetation faces increasing stress from heat, water scarcity, and pollution.

UHI conditions get intensified through multiple mechanisms: reduced evapotranspiration from vegetation loss decreases natural cooling; increased impervious surfaces enhance heat absorption and storage; disrupted local microclimates alter wind patterns and humidity levels; and heightened heat-related health risks affect vulnerable populations. Additional consequences include elevated energy consumption for cooling, contributing to greenhouse gas emissions, and biodiversity loss as urban habitats become increasingly inhospitable. Despite overall degradation, key vegetated zones such as IISc campus, Gandhi Krishi Vignana Kendra (GKVK), and Mysore Zoo continue to function as temperature-moderating buffers, though their effectiveness may be diminishing.

6. Discussion

6.1 The Vegetation-Temperature Nexus

The studies reveal an increasingly strong and well-documented link between rapid urban expansion, vegetation loss, and UHI severity. The NDVI-LST relationship demonstrates that vegetation plays a multifaceted role in urban cooling: evapotranspiration removes heat from the environment through latent heat flux;

shading reduces direct solar radiation absorption by surfaces; increased surface albedo from vegetated areas reflects more solar radiation; and modified air circulation patterns enhance natural ventilation. These cooling mechanisms are most effective in areas with high vegetation density and connectivity, suggesting that not just the total amount but also the spatial configuration of urban green space matters significantly.

6.2 Urban Design and Material Considerations

Modern building materials and urban design approaches significantly contribute to heat accumulation. Concrete, asphalt, and metal surfaces exhibit high thermal mass and low albedo, absorbing substantial solar radiation during the day and releasing it slowly at night. The proliferation of compact architectural forms with limited natural ventilation, combined with widespread use of air conditioning that rejects heat to the outdoor environment, creates positive feedback loops that intensify UHI effects. In contrast, areas with high vegetation density demonstrate significant cooling effects, with surface temperatures 2-4°C lower than adjacent built-up zones and potential air temperature reductions of 1-2°C extending beyond the vegetated area itself.

6.3 Lessons from Traditional Architecture

Traditional Indian architectural practices, developed over centuries in response to local climatic conditions, offer valuable guidance for climate-adaptive urban design. Terracotta roof tiles provided thermal mass with lower conductivity than modern materials. Exposed brick walls have natural thermal regulation properties. Verandahs along with covered walkways provide shading while maintaining air circulation. Traditional methods represent time-tested strategies that can be adapted and integrated into contemporary urban planning and architectural practice.

7. Mitigation Strategies and Recommendations

Based on the integrated analysis of NDVI-temperature relationships and historical urban development patterns, this review identifies several priority strategies for UHI mitigation which are : Urban Green Infrastructure Expansion, Sustainable Building Design, Strategies for incorporating natural ventilation and passive cooling methods, Water Body Restoration, Policy Interventions by integrating UHI considerations into city master plans and development codes. Monitoring and Research has to be done by establishing urban climate monitoring networks. Regular NDVI and LST assessments must be done using satellite data and develop city-specific UHI models for scenario planning.

8. Conclusion

The intensification of the Urban Heat Island effect in Indian cities over the past decades is exemplified and seen that the pattern is repeated across Indian metropolitan regions, with profound implications for urban climate, public health, energy consumption, and environmental sustainability. The strong inverse correlation between NDVI and land surface temperature, demonstrated across multiple studies and time periods, underscores the critical importance of urban vegetation in moderating thermal extremes. As climate change intensifies background warming and extreme heat events become more frequent, the cooling services provided by urban green infrastructure will become increasingly vital for maintaining liveable urban environments.

There is an urgent need for nature-based solutions, sustainable building design, comprehensive policy interventions, and citizen-based climate monitoring. Integrating UHI considerations into city master plans. Future research should focus on developing localized UHI models, assessing the effectiveness of different mitigation strategies in Indian urban contexts, understanding the social dimensions of heat vulnerability, and establishing long-term monitoring programs that integrate ground-based measurements with satellite observations.

Impact of climate change on Engineers and Manufacturing Industry

- Er. N Prakash,
Director, Vahyu Techno Engineers Pvt.Ltd, Chennai

Climate change is one of the most pressing issues facing the global economy today and its implications are particularly significant for the manufacturing industry.

Climate change also forces Engineers to evolve past traditional design methods, prioritizing climate-resilient infrastructure, strict environmental regulations and sustainable materials. It reshapes nearly every discipline, demanding continuous adaptation, proactive risk assessment, innovative and eco-friendly technological solutions.

Climate change will have an impact on both industrial raw material supplies and processes. Although the greatest effect will most likely be via global market development, climate change can have notable impacts to those industrial sectors whose raw materials are heavily dependent on weather and other changes in the natural environment.

The industrial sector emits 25% of global carbon dioxide (CO₂) emissions. Including construction inputs such as cement, steel and iron, as well as petrochemicals such as plastics and

ammonia, the sector includes many high emitting activities known to be hard to decarbonise.

As the global economy accelerates its efforts to meet the goal of Net-Zero emissions by 2050, the industrials sector will have both a crucial role in decarbonising the global economy and face substantial transition risks. Growing policy pressures, risk of legal and reputational damage, and technological innovations will reduce the market share of conventional producers with less carbon-intensive alternatives.

Relying on stable climate conditions to enable effective operations in complex supply chains, the industrials sector is also at risk from the physical impacts of climate change such as storms, droughts, and wildfires that will make current industrial practices more difficult or risky.

Global warming significantly exceeds natural climate fluctuations. As a consequence, various weather phenomena have been altered in their frequency, intensity, and regional distribution. In recent years, numerous extreme events have caused widespread



damage to communities, with total losses amounting to billions of dollars, a large share of which is associated with severe wind events.

While the description and projection of wind-related phenomena under climate change originate primarily from the fields of meteorology and climate science, the interpretation of these findings for structural design and safety requires the expertise of Engineers.

According to the World Meteorological Organization's State of the Global Climate 2023, the year 2023 was the warmest year on record, with global near-surface temperature about $1.55^{\circ}\text{C} + 0.13^{\circ}\text{C}$ above the 1850–1900 baseline World Meteorological Organization, 2024.

However, this record was exceeded immediately the year after with 2024 reported by the WMO as $1.45^{\circ}\text{C} + 0.12^{\circ}\text{C}$ above the 1850–1900 baseline.

The climate crises has serious health consequences, the WHO warned in its recent COP24 report. Direct health impacts include an increase in respiratory and cardiovascular disease and injuries or death due to extreme weather events. Climate change also causes indirect effects on health, such as food and water insecurity, the spread of climate sensitive infectious diseases and population displacement.

Impact of climate change on Manufacturing Industry

The manufacturing industry is a cornerstone of the global economy,

contributing significantly to GDP and employment. According to the World Bank, manufacturing accounted for approximately 16% of the global GDP, employing over 500 million people worldwide.

This sector encompasses a wide range of activities, from Heavy industries like steel and automotive production to high tech manufacturing such as electronics and pharmaceuticals.

However, the industry is at a critical juncture as it faces the dual pressure of climate change and need for sustainability. The increasing frequency of climate-related disruptions is forcing manufacturers to reassess their operations, supply chains and long term strategies.

Extreme weather conditions:

Rising temperatures have a direct impact on labour productivity, particularly in industries that rely heavily on outdoor work or non-climate-

controlled environments. Studies have shown that as temperatures rise, worker efficiency declines, leading to reduced output and increased health risks.

For example, research from the National Bureau of Economic Research indicates that labour productivity in hot weather can drop by as much as 20% (Burke et al., 2023). In manufacturing settings, this can translate to significant losses in output. Moreover, prolonged exposure to extreme heat can lead to heat related illnesses, increasing absenteeism and healthcare costs for employers.

In regions where temperatures are expected to rise significantly, such as South Asia, the impact on labour productivity could be severe. The world bank projects that by 2050, heat stress in South Asia could result in labour productivity losses equivalent to 4-6% of working hours, with economic losses estimated \$150 billion annually (Sizzling Cities: Planning for Urban Heat Resilience in South Asia,2023)



The primary impacts on Engineers and responsibilities vary by engineering discipline:

Climate change impacts every engineering discipline and architecture, driving massive shifts in how professionals mitigate emissions and adapt to extreme weather. The greatest shared challenge is redesigning infrastructure to survive higher temperatures, volatile weather, and stricter carbon regulations, while simultaneously advancing decarbonisation tech across all global industries.

The localized impacts vary significantly by engineering field:

1. Energy & Power

- **Solar & Wind:** Rising ambient temperatures directly degrade the output efficiency of solar panels. Wind and solar operators must heavily integrate energy storage and AI-driven grid balancing to mitigate the intermittency caused by extreme weather and shifting atmospheric wind streams.
- **Thermal:** Thermal power engineers face increased pressure to reduce greenhouse gas emissions through Carbon Capture and Storage (CCS) and fuel-switching to green hydrogen.
- **Petroleum:** Engineers are challenged with stricter emission regulations, transitioning to biofuels, and

managing infrastructure exposed to increased risks from coastal flooding and intense storms.

2. Infrastructure & Environment

- **Civil & Architects:** Higher temperatures and increased UV exposure accelerate the degradation and corrosion of structural materials (like concrete and asphalt). Civil engineers and architects must update building codes, adopt low-carbon concrete alternatives, and design for resilience against sea-level rise and flooding.
- **Environment:** Environmental engineers lead the charge in mitigating climate damage. They design water-purification systems to combat drought and develop waste-to-resource strategies for the circular economy. Air pollution is a major area they have to focus in industrial sectors.

3. Industry & Manufacturing

- **Chemical:** The chemicals sector is highly energy-intensive. Chemical engineers are central to developing green chemistry processes, bio plastics, and zero-waste manufacturing to sever the industry's reliance on fossil fuels.
- **Air Conditioning & Refrigeration (HVAC):** Rising global heat gradients mean HVAC engineers must handle unprecedented cooling loads.

They are redesigning cooling systems to be hyper-energy-efficient and phasing out high Global Warming Potential (GWP) refrigerants.

- **Textile & Leather:** These industries face severe scrutiny for water usage, chemical pollution, and carbon footprints. Engineers in these fields are pioneering closed-loop water recycling, bio-based synthetic dyes, and sustainable tanning methods.

4. Transport & Communications

- **Aerospace:** Hotter temperatures reduce air density, directly limiting aircraft lift and payload capacities. Aerospace engineers are focused on developing Sustainable Aviation Fuels (SAF), hybrid-electric

propulsion systems, and optimized flight paths to reduce atmospheric warming.

- **Marine:** Sea-level rise and extreme storms increase risks for port infrastructure and shipping. However, melting Arctic ice is also forcing marine engineers to design specialized, ice-capable vessels to navigate emerging Northern shipping routes.
- **Electrical, Communication & Electronics:** Extreme weather and temperature swings threaten the stability of power grids and telecommunication networks. Electrical and electronics engineers must develop heat-resistant hardware, smart micro grids, and resilient fiber optic/satellite networks to maintain continuous operation.



Meteorological Scientists role:

Meteorological scientists support engineers by providing high-resolution climate models, extreme weather projections, and historical weather data. This information enables engineers to design climate-resilient infrastructure, develop sustainable renewable energy systems, and establish effective early-warning systems to protect communities from severe climate impacts.

Key collaborative areas include:**Climate Modelling & Risk Analysis:**

Meteorologists supply localized climate projections (e.g., temperature shifts, sea-level rise). Engineers use these datasets to design structures—such as bridges, seawalls, and storm water systems—that can withstand future environmental conditions.

Renewable Energy Integration: By providing precise wind and solar resource assessments, meteorologists help engineers optimize the placement and efficiency of renewable energy grids and predict power generation fluctuations.

Extreme Weather Preparedness:

Meteorologists track and predict severe events like hurricanes and floods. Engineers rely on this data to build early-warning networks, reinforce vulnerable infrastructure, and develop emergency response protocols.

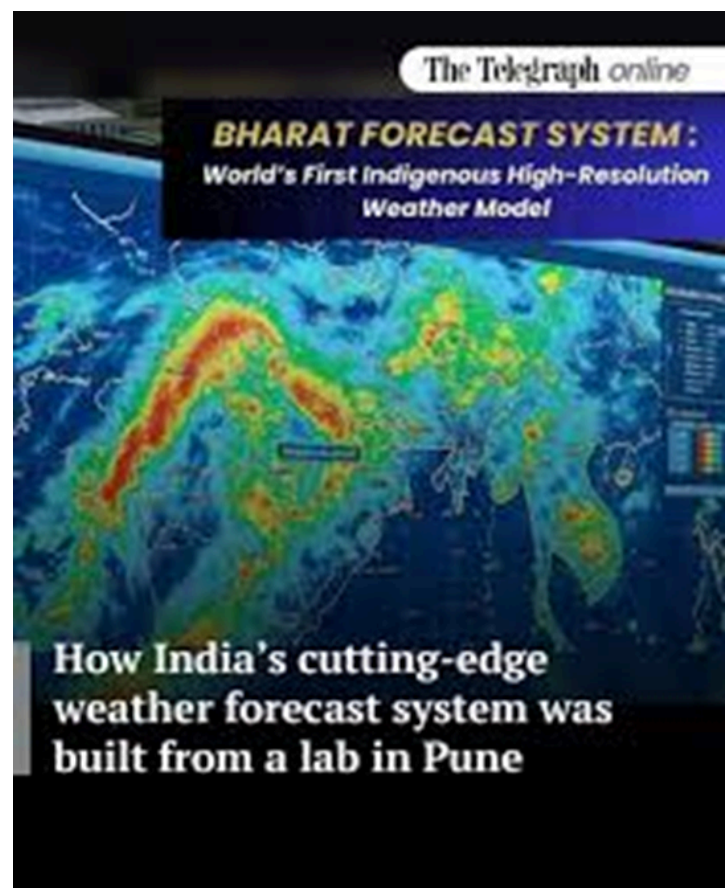
Water Resource Management:

Meteorological data on precipitation patterns and drought cycles helps

engineers design dams, reservoirs, and agricultural irrigation systems that secure water supplies in shifting climates.

Low carbon transition in industry and productivity

The low-carbon transition opens up significant possibilities for the electrification of industrial processes. If energy-intensive industries such as steel, aluminium and base chemicals that currently emit significant amounts of CO₂ can be electrified, benefiting from cheaper energy from renewables, the result will be a different energy and industrial production map, no longer tied to fossil fuel access. Countries such as Chile, Brazil, Australia, Saudi Arabia, UAE, Mauritania, Namibia and Kazakhstan are already developing landmark projects



through pilot investments across green hydrogen, green ammonia, green steel and low-carbon aluminium that could see them become strong players and early leaders in low-carbon industries.

Climate Change Performance Index (CCPI)

The Climate Change Performance Index (CCPI) 2026 has placed India at 23rd place among the countries who have adopted substantial measures to mitigate climate change. The report has ranked India at the 23rd position from its previous position of 10th rank in 2025.

To rank various countries, the report looked at the four specific categories and their benchmark limits: GHG emissions (40%), renewable energy (20%), energy use (20%) and climate policy (20%)

The index follows the directives led by the Paris Agreement, established with the goal to limit global warming to well below 2 °C or even to 1.5° C.

Government initiative and commitment in India:

The Government of India launched National Action Plan on Climate Change (NAPCC) on 30th June, 2008 outlining eight National Missions on Climate Change. These include:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency

- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Eco-system
- National Mission for a green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

Engineer's role and innovation:

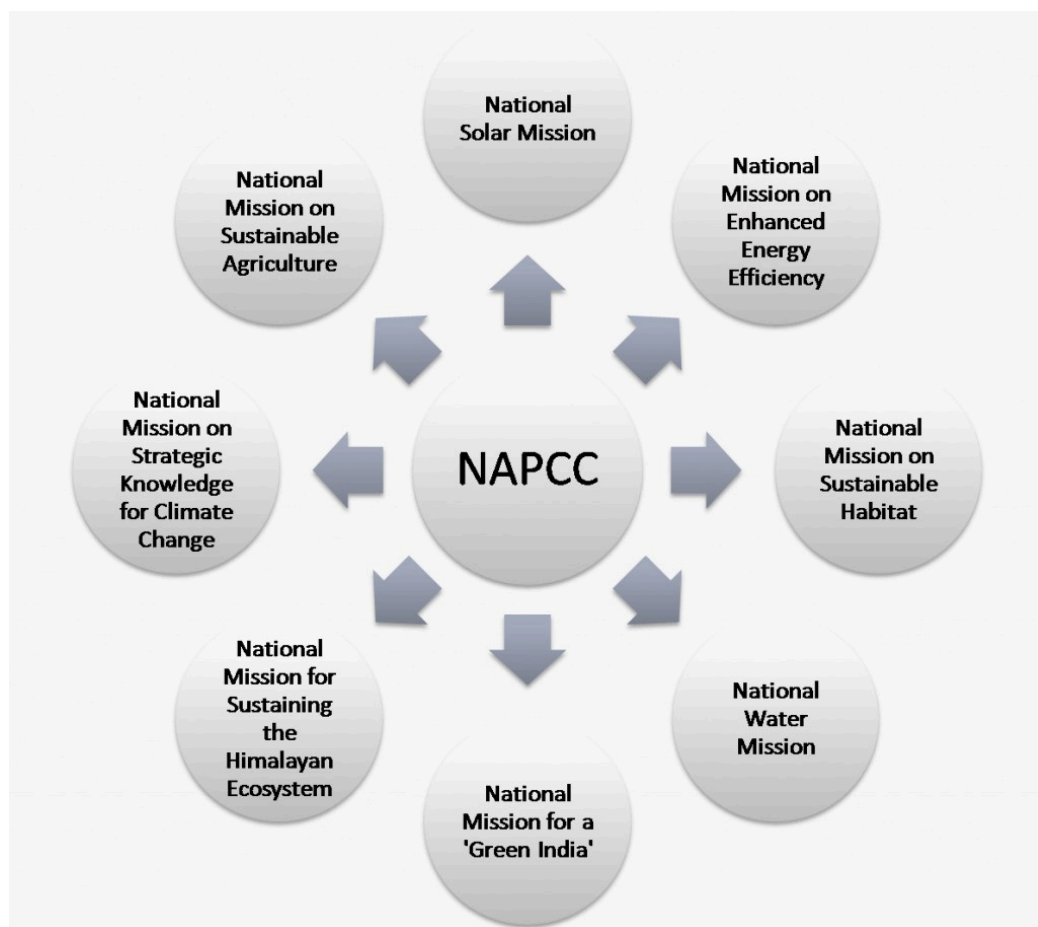
Climate change serves as a catalyst for innovation in manufacturing processes. Companies are increasingly investing in sustainable technologies that reduce their carbon footprint and enhance operational efficiency. E.g. Manufacturers are turning to renewable energy sources, such as solar and wind power to reduce reliance on the fossil fuels and lower emissions.

Advancements in Energy-efficient technologies can significantly reduce energy consumption in manufacturing processes. New focus to adopt smart manufacturing technologies such as the internet of Things (IoT) and Artificial intelligence (AI) allows manufacturing companies to optimise production processes, minimise waste and improve efficiency.

Conclusion:

Climate change is a global societal crises that is causing devastating consequences. Its cost have been projected as high as US \$23 trillion in reduced global economic output, according to Swiss Re, a reinsurance company. Multifaceted collective efforts are necessary to address the crises.

Engineers, Scientists, Technologies and Industry leaders should play major roles in creating a greener planet, protecting environment and a sustainable world.



Source : <https://drreddysfoundation.org/>

Cracking the Code: A Day in the Life of a Weather Detective (Meteorologist)

-Ms. Menaka Gandhi.J
Scientific Assistant, RMC Chennai

Imagine a **Meteorologist** receive the following message:

METAR VOMM 150600Z

To most of the people, the above message looks as a collection of letters and numbers. To a Meteorologist, it tells a story about the atmosphere at Chennai airport. Weather forecasting can be compared to science, mathematics, and computer modelling. Just as detectives solve mysteries using fingerprints, footprints, and witness statements, Meteorologists gather evidence from weather stations, satellites, radars, and numerical models. Decoding the clues into forecast is challenging.

Why is Weather Information Coded?

Imagine if every Weather station in the World reported observations in lengthy sentences every hour.

Communication would be slow and inconsistent. Meteorologists use standardized codes developed by the World Meteorological Organization (WMO).

Doctors diagnose patients by examining body temperature, pulse rate, blood pressure, and oxygen levels.

Meteorologists examine:

- Temperature
- Humidity

- Atmospheric pressure
- Wind speed and direction
- Cloud cover
- Rainfall

Every Meteorologist needs tools like Surface Weather Stations, Radars, Satellites, AWS for forecasting.

One of the most important clues in Tropical Meteorology is the **Inter Tropical Convergence Zone (ITCZ)**.

The ITCZ is a region where winds from the Northern and Southern Hemispheres converge. As these winds meet, warm moist air rises, leading to cloud formation and rainfall.

Experienced Meteorologists rarely rely on a single clue. They continuously monitor several atmospheric features such as Monsoon Trough, Low Pressure areas, Wind Discontinuities, Jet Streams, Western Disturbances, Sea Breeze and Land Breeze, MJO, El Nino and La Nina.

From Clues to Forecasts

Meteorologists are often called weather forecasters, but they are also detectives. Every day, they gather clues from weather stations, satellites, radars, and computer models to solve one big mystery: "What will the atmosphere do next?"

Are you ready to put your weather wisdom to the test? Test your skills with these clues!

Before you begin... The **Answer key** has been placed at the end of this article for your convenience. Please attempt all questions first and refer to the answers only after completing the quiz.

Good luck, and enjoy decoding the atmosphere's secrets!

Clue 1: The Secret Message

You receive the following coded report:

METAR VOMM 150600Z 22012KT

What does it represent?

- A. A train timetable
- B. A secret military code
- C. A weather observation report
- D. A flight ticket number

Clue 2: The Patient's Health Report

A doctor checks: Temperature, Pulse, Blood pressure.

A Meteorologist checks:

- A. Mobile battery percentage
- B. Temperature, humidity, pressure, and wind
- C. Vehicle speed
- D. Internet signal strength

Clue 3: The CCTV Camera

Which tool acts like a CCTV camera for storms?

- A. Thermometer
- B. Barometer
- C. Weather Radar
- D. Rain Gauge

Clue 4: The Bird's-Eye View

Which tool gives meteorologists a view of clouds from space?

- A. Compass
- B. Satellite
- C. Stopwatch
- D. Wind Vane

Clue 5: Where the winds meet

Imagine a marketplace where people are moving toward a common location from different directions.

What atmospheric feature behaves similarly?

- A. Sea Breeze
- B. Jet Stream
- C. ITCZ
- D. Western Disturbance

Clue 6: The Rainfall Highway

Which feature is often called the "rainfall highway" during the Indian monsoon?

- A. Monsoon Trough
- B. El Nino
- C. Sea Breeze
- D. MJO

Clue 7: Atmospheric Magnet

What attracts surrounding winds and often produces widespread rainfall?

- A. High Pressure Area
- B. Low Pressure Area
- C. Heat Wave
- D. Fog

Clue 8: Traffic Junction in the Sky

When winds from different directions meet, meteorologists call it:

- A. Wind Discontinuity
- B. Jet Stream
- C. Monsoon Burst
- D. Heat Dome

Clue 9: Expressway above Us

Which feature acts like a high-speed expressway in the atmosphere?

- A. ITCZ
- B. Jet Stream
- C. Rain Gauge
- D. Sea Breeze

Clue 10: The Long-Distance Traveller

Which weather system begins near the Mediterranean region and influences northern India's weather?

- A. Cyclone
- B. Tornado
- C. Western Disturbance
- D. Sea Breeze

Clue 11: Chennai's Daily Breath

Which local phenomenon frequently affects weather along the Tamil Nadu coast?

- A. Blizzard
- B. Sea Breeze and Land Breeze
- C. Dust Storm
- D. Avalanche

Clue 12: The Travelling Pulse

Which atmospheric phenomenon circles the tropics and influences rainfall patterns?

- A. MJO
- B. Fog
- C. Hailstorm
- D. Heat Wave

Clue 13: The Ocean's Secret Signal

Which global climate patterns influence seasonal rainfall across the world?

- A. El Niño and La Niña
- B. Sea Breeze and Land Breeze
- C. Fog and Mist
- D. Dew and Frost

Final Challenge

A meteorologist observes:

- ✓ Falling pressure
- ✓ Increasing humidity
- ✓ Thunderstorm clouds on radar
- ✓ Strong wind convergence

What is the most likely forecast?

- A. Clear skies
- B. Stable weather
- C. Thunderstorms and rainfall
- D. Snowfall

Answer Key:

Clue 1: Answer: **C** Meteorologists use coded weather bulletins to quickly communicate observations around the world.

Clue 2: Answer: **B** These are the atmosphere's vital signs.

Clue 3: Answer: **C** Radar allows meteorologists to monitor thunderstorms and rainfall in real time.

Clue 4: Answer: **B** Satellites help track cyclones, cloud systems, and moisture patterns over land and ocean.

Clue 5: Answer: **C** The Intertropical Convergence Zone (ITCZ) forms where winds from both hemispheres converge.

Clue 6: Answer: **A** The position of the monsoon trough strongly influences rainfall distribution across India.

Clue 7: Answer: **B** Low-pressure systems draw air inward, encouraging cloud formation and rainfall.

Clue 8: Answer: **A** Wind convergence can trigger thunderstorms and heavy rainfall.

Clue 9: Answer: **B** Jet streams guide weather systems and influence monsoon behaviour.

Clue 10: Answer: **C** Western disturbances bring rain and snowfall to northern India.

Clue 11: Answer: **B** Sea breeze circulation can trigger afternoon thunderstorms and moderate temperatures.

Clue 12: Answer: **A** The Madden–Julian Oscillation (MJO) is a moving pulse of tropical convection.

Clue 13: Answer: **A** These ocean-atmosphere interactions can significantly affect monsoon rainfall.

Final Challenge: Answer: **C**

Congratulations!

Your Weather Detective Score

11–13 Correct: Master Weather Detective

8–10 Correct: Senior Forecaster

5–7 Correct: Junior Meteorologist

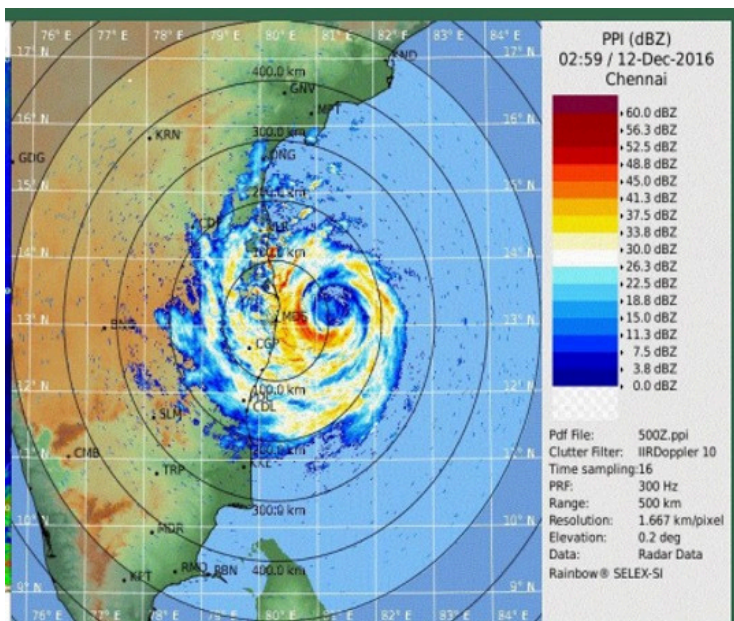
0–4 Correct: Keep Watching the Sky

A common misconception is that forecasts are generated entirely by computers. In reality, forecasting is a partnership between advanced numerical models and human expertise. Weather models perform billions of calculations every day, simulating atmospheric behaviour. Meteorologists then compare model outputs with real-world observations, identify inconsistencies, and apply scientific understanding to produce forecasts and warnings. Hours later, when rainfall occurs exactly where it was predicted, it is not magic. It is the result of systematically decoding the atmosphere's messages.

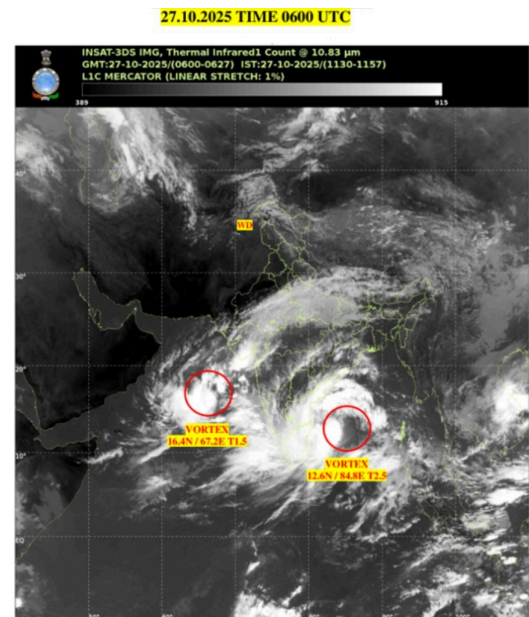
Conclusion

Every weather bulletin is a coded letter from the sky. By decoding weather bulletins and tracking clues such as the ITCZ, monsoon troughs, low-pressure areas, jet streams, western disturbances, sea breezes, and global climate signals, meteorologists transform atmospheric mysteries into actionable forecasts.

The next time you read a weather forecast, remember that behind every prediction lies a fascinating investigation across the vast and ever-changing sky.



**Very Severe Cyclonic Storm Vardah – DWR Chennai –
12-Dec-2016**



**INSAT – 3DS satellite image
27-Oct-2025**

Book Review by the Editor:

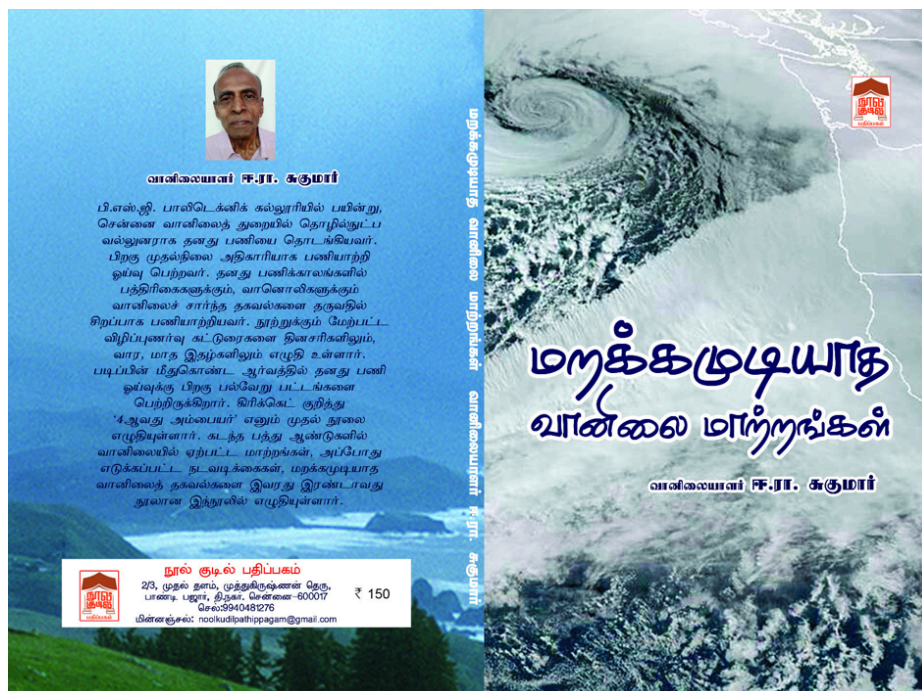
மறக்க முடியாத வானிலை மாற்றங்கள் – வானிலையாளர்
: ஈ. ரா. சுகுமார்

Marakka Mudiyaatha Vaanilai Matrangal

- A book by Shri. E.R.Sukumar, Meteorologist(Retired), IMD, Chennai

Shri. E.R.Sukumar (LM-1903) is an enthusiastic writer with wide experience in weather forecasting. He served in Area Cyclone Warning Centre and in Aerodrome Meteorological Office, Chennai. With over three decades of operational knowledge about the vagaries of weather and the associated challenges in weather prediction, he has been publishing articles in Tamil newspapers to create awareness on the science of weather forecasting among the public. Very frequently, he gives talks in All India Radio as an initiative to popularise meteorology.

The book “**Marakka Mudiyaatha Vaanilai Matrangal**” was released in December 2025 in Regional Meteorological Centre, Chennai during the 8th Meeting of the IMD Pensioners Association, Chennai with the initiative of Shri. N. Marikrishnan (IMS LM-918), Meteorologist (Retired). The book published by Nool Kudil Pathippagam, Chennai and priced at Rs.150/- is a collection of articles written by Shri. E.R.Sukumar during 2010-2024. Topics like Seasons of India, Heat Waves, Cold Waves, Natural Disasters, cyclones, cyclone warning procedures, practices followed in dissemination of weather information, Port Warning symbols and their meanings, southwest monsoon, northeast monsoon, technological advancements in IMD that have led to providing enhanced meteorological services have been highlighted in the book.



நூல் வெளியீடு...



சென்னை வானிலை ஆய்வு மையத்தில் நடைபெற்ற நிகழ்ச்சியில், ஓய்வு பெற்ற வானிலையாளர் ஈ.ரா.சுருமார் எழுதி நூல் குடில் பதிப்பகம் வெளியிட்ட 'மறக்க முடியாத வானிலை மாற்றங்கள்' நூலை வெளியிட்ட வானிலை ஆய்வு மைய தென்மண்டல இயக்குநர் ப.அமுதா, அகில இந்திய ஓய்வுதியர்கள் சங்கத்தின் தமிழ்நாடு தலைவர் துரைபாண்டி, அகில இந்திய வானொலி நிலைய திகழ்ச்சி அதிகாரி சரவணன், பதிப்பாளர் இராம.மெய்யப்பன்.



Book release function held in RMC Chennai IMD Pensioners Association Meeting on 20 Dec 2025. Coverage in Dinamani Daily Tamil newspaper

Reminiscing his journey in IMD, Shri. E.R.Sukumar speaks about the close-knit bond he had with IMD colleagues and how he was inspired by the experts who carved a niche of their own while motivating the younger and promising officers who worked with them. Shri. Sukumar has endeavoured to create a meaningful impact through his articles in popularising meteorology. The book written in lucid Tamil will help general public to understand terminologies used in weather forecasting.

An Ode to Humans

**-Dr. Rajasri Sen Jaiswal, Professor of Physics,
Gopalan College of Engineering and Management, Bangalore**

Cover me with my green robe.

Dig my heart not!

Let the icy crown be on my head,

To soothe the equator hot.

Thou art given my tender heart

To live and let live.

Why churn my swelling blood

Under the ocean deep?

Thou art given soothing soil

With gifted food and gems;

Then, why thou fly to Moon and Sun,

The cosmic world to strain?

With spades on my heart, and landing on sky,

Thou made me drift and dagger;

Losing icy crown and churning blood,

Hath made my heart pump slower.

Fire balls "ll shower with thunderous roar from heaven;

Billowy oceans, angry volcanoes "ll engulf you all again.

*Scientific Lecture on "Weather Radar Networks" - 09 January, 2025
by Dr. V. Chandrasekar, Distinguished Professor, CSU, USA*



National Science Day - 28th Feb, 2025 & IMS Newsletter Launch- BREEZE Dec 2024.



IMS Membership

To learn about the procedure for becoming a member of the Indian Meteorological Society (IMS) Chennai Chapter, please visit:

<https://imetsociety.org/become-member/>

New Members of IMS Chennai Chapter (Joined after the 2024-26 Council took over):

- Dr. B. Prabhu Dass Batvari
- Dr. D. Surendran
- Mr. J Beno Jones
- Dr. Ribu Cherian
- Dr. R I Sujith
- Dr. Somnath De
- Ms Sreelakshmi S
- Ms. Menaka Gandhi J
- Sruthi S
- Dhivya S
- Ms. Veenus Venugopal
- Dr. Satheesh Kumar Shekatam
- Mr. Anush Raghuraman
- Dr. C. S. Goldie Sheila Jesolit
- Dr. K. Rangesh
- Ms. E Devadarshini
- Ms. Deepa R. V.

Support Our Society

Your generous donations help us in our ongoing efforts to enhance the understanding of meteorology, support educational activities, and contribute to the overall development of the scientific community. Every contribution makes a difference, no matter how big or small. Help us in our mission to foster knowledge and innovation.

If you'd like to contribute or need more information on how to support our initiatives, feel free to contact any of our council members. They are available to assist you with any inquiries related to donations, sponsorship, and ways to get involved.

We deeply appreciate your support in contributing to the Indian Meteorological Society. Together, we can make a significant impact!

Reach out to us:

ims.chennai6@gmail.com