KSCSTE - INSTITUTE FOR CLIMATE CHANGE STUDIES (ICCS)

A Research Organization under the Kerala State Council for Science Technology and Environment (KSCSTE), Govt. of Kerala

STATEMENT ON CLIMATE FOR THE STATE OF KERALA: 2025

HIGHLIGHTS

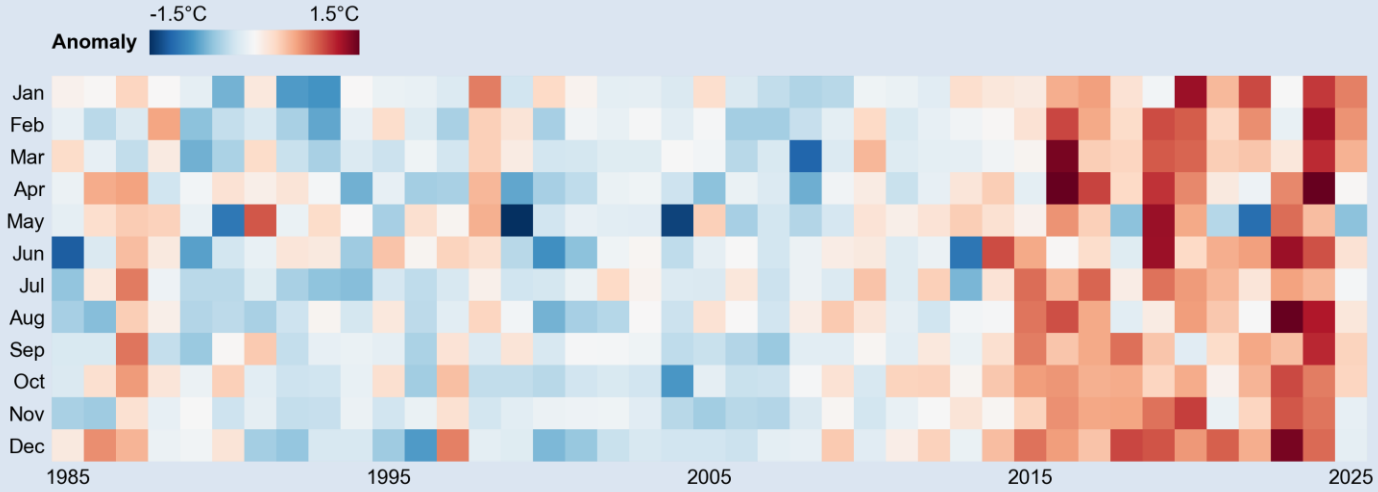
The state-averaged annual mean land surface air temperature in Kerala during 2025 was 25.82°C, which is +0.22°C above the Long Period Average (LPA, 1991–2020). This makes 2025 the 13th warmest year on record for the state since 1901. While warmer than the long-term average, it was significantly cooler than the record-breaking warmth of 2024 (+0.99°C, the warmest year on record for the state since 1901).

Unlike the previous year, which saw consistent record-breaking heat, 2025 witnessed mixed seasonal patterns in mean temperatures. Consistent with the long-term warming trend, the winter season was significantly warmer than average (+0.63°C anomaly), ranking as the 5th warmest winter on record since 1901. However, the other seasons remained close to their LPA: summer (-0.03°C anomaly, near normal), monsoon (+0.2°C anomaly), and post-monsoon (+0.16°C anomaly).

The state averaged annual maximum and minimum temperatures during 2025 were warmer than average (1991-2020) with anomalies of +0.13°C (14th warmest) and +0.31°C (10th warmest) respectively. While no month set a new all-time record, the early part of the year remained historically warm. January and March recorded the 5th warmest mean temperatures since 1901, with anomalies of +0.61°C and +0.52°C respectively. Similarly, regarding maximum temperatures, February stood out as the 5th warmest on record (+0.77°C anomaly), and September ranked as the 8th warmest (+0.55°C anomaly) since 1901. In terms of minimum temperatures, January (+1.11°C anomaly) stood 5th warmest since 1901 while March recorded the 4th warmest since 1901 (+0.78°C anomaly).

Kerala received 2925.7 mm of annual rainfall in 2025, which is a departure of +1.2% from the LPA (1971-2020). Both monsoon seasons continue to show decreasing trends over the 1901-2025 period. The southwest monsoon rainfall recorded a departure of -13% of LPA, while the northeast monsoon shows a departure of -21% of LPA.

The coastal waters of Kerala remained persistently warm, with annual mean anomalies of +0.47°C (North Kerala) and +0.42°C (South Kerala) above the LPA. While cooler than the record-breaking 2024, the long-term trend (1982–2025) shows a significant warming rate of ~0.02°C per year. The strongest warming was recorded during the pre-monsoon season (MAM), with North Kerala registering a high anomaly of +0.89°C. August and December were the only months to record negative SST anomalies.



Monthly mean surface air temperature anomalies over Kerala compared to the 1991–2020 reference period

Introduction

The Institute for Climate Change Studies (ICCS), Kottayam is a Research and Development institution under the Kerala State Council for Science Technology and Environment (KSCSTE), Government of Kerala. The Centre is envisioned for integrated research, technical support, and capacity building in all aspects of Climate change issues and integrate development policies, plans and programs at state level. Last year, as part of its state level climate monitoring activities, ICCS had issued annual climate statement for the state of Kerala for the year 2024 in line with national level annual statement being issued regularly by India Meteorological Department (IMD) for the country. Now, ICCS has prepared annual climate statement for the year 2025 and presented here. The present statement contains, important information about the monthly, seasonal, and annual state averaged temperature and rainfall for the year 2025 vis a vis the same during the last 125 years. The rainfall and temperature data used for the preparation of this report were provided by IMD.

Temperatures

The monthly and seasonal maximum, minimum and mean temperature anomalies averaged over the State of Kerala are given in the **Fig.1**. The anomalies were computed based on the Long Period Average (LPA) for the period 1991-2020. The state-averaged annual mean land surface air temperature in Kerala during 2025 was 25.82°C, which is +0.22°C above the Long Period Average (LPA, 1991–2020). This makes 2025 the 13th warmest year on record for the state since 1901. Although warmer than the long-term average, it was significantly cooler than the record-breaking warmth of 2024, which remains the warmest year on record with an anomaly of +0.99°C, for the state since 1901.

Unlike the previous year, which saw consistent record-breaking heat, 2025 witnessed mixed seasonal patterns in mean temperatures. Consistent with the long-term warming trend, the winter season was significantly warmer than average (+0.63°C anomaly), ranking as the 5th warmest winter

on record since 1901. However, the other seasons remained close to their LPA: summer (+0.04°C anomaly, near normal), monsoon (+0.2°C anomaly), and post-monsoon (+0.16°C anomaly). It is also important to note that 8 of the ten warmest years on record occurred in the recent decade (2016–2025), with the recent decade (2016–2025) remaining the warmest decade on record. Consequently, the annual mean temperature of Kerala during the past decade (2011–2020/2016–2025) was the highest on record, with a decadal average annual mean temperature anomaly of 0.35°C / 0.56°C. A significant increasing trend of 1.15°C/100 years is observed in the state averaged annual mean temperature during 1901-2025 (**Fig.2**).

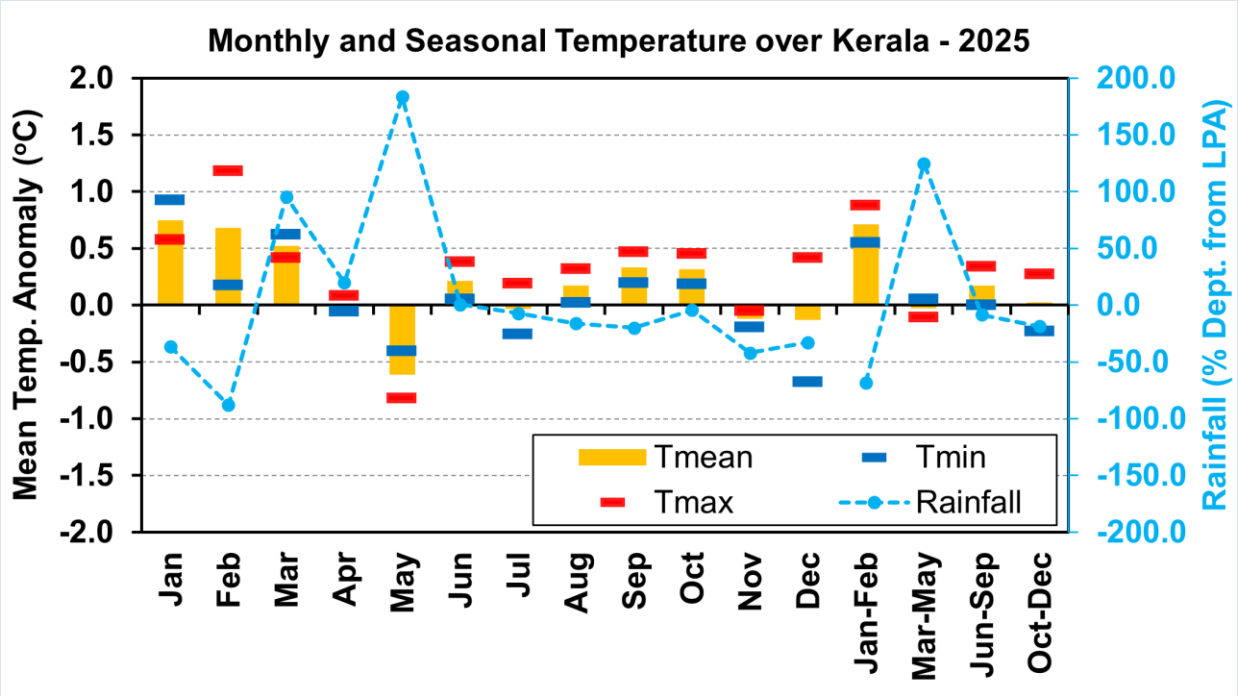


Fig.1. Monthly and Seasonal Maximum, Minimum and Mean Temperature anomalies (°C) averaged over Kerala during 2025. Monthly and seasonal Rainfall anomalies (% departure) averaged over Kerala during 2025 is also depicted. The anomalies were computed from Long Period Average (LPA) for the base period of 1991-2020 (Temperature), and 1971-2020 (Rainfall).

A notable feature of 2025 was the exceptional weather during May, which deviated significantly from the warming trend observed in the earlier months. The month witnessed an early onset of the southwest monsoon (around May 24th), resulting in a massive rainfall excess of 172% above the Long Period Average. This intense pre-monsoon and early monsoon activity brought a sharp cooling effect, resulting in a negative mean temperature anomaly of -0.59°C for the month. This was driven primarily by a significant drop in daytime temperatures, with the maximum temperature anomaly falling to -0.88°C, marking a distinct break from the heat experienced during the rest of the summer season.

The state averaged annual maximum and minimum temperatures during 2025 were warmer than average (1991-2020) with anomalies of +0.13°C (14th warmest) and +0.31°C (10th warmest) respectively (Fig.2). While no month set a new all-time record, the early part of the year remained historically warm. January and March both recorded the 5th warmest mean temperatures since 1901,

with anomalies each of +61°C. Similarly, regarding maximum temperatures, February stood out as the 5th warmest on record (+0.77°C anomaly) and September ranked as the 8th warmest (+0.55°C anomaly) since 1901. In terms of minimum temperatures, January (+1.11°C anomaly) stood 5th warmest since 1901 while March recorded the 4th warmest since 1901 (+0.78°C anomaly). During the period 1901-2025, the state averaged maximum temperature showed a significant increasing trend (1.77°C/100 years) and the state averaged minimum temperature showed a relatively lower increasing trend (0.53°C/100 years). As seen in the Fig.2, the anomalies of annual maximum temperature were more negative than that of annual minimum temperatures till late 1980's. Thereafter, the role was reversed. This is mainly because of the observed faster increasing trend in the maximum temperatures compared to that in the minimum temperatures. This has also resulted in the increased annual state averaged diurnal variation (not shown here) in recent decades.

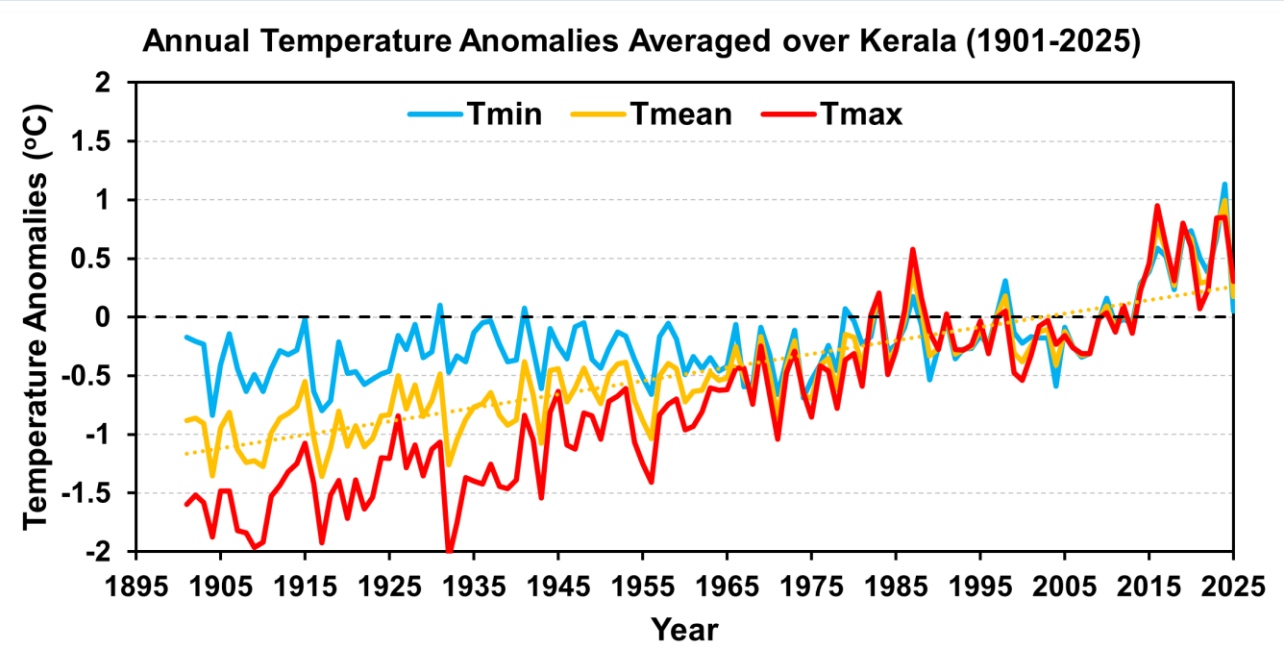


Fig.2: Annual maximum, minimum and mean land surface air temperature anomalies averaged over the State of Kerala for the period 1901-2025.The anomalies were computed with respect to the base period of 1991-2020. The dotted yellow line indicates the linear trend in the annual mean temperature time series.

The trends in the district averaged maximum, minimum and mean temperatures for the period 1901-2025 is shown in the **Figures 3a**, **3b** and **3c** respectively. There are significant increasing trends in the district averaged maximum and mean temperatures for all the 14 districts of the state. However, in the case of minimum temperature, significant increasing trends were observed in 10 out of the 14 districts. Among the remaining four districts, Kannur showed increasing but non-significant trend. Kasaragod, the northern most district, showed significant decreasing trend, and Kollam and Thiruvananthapuram, the two southern most districts showed decreasing but insignificant trends.

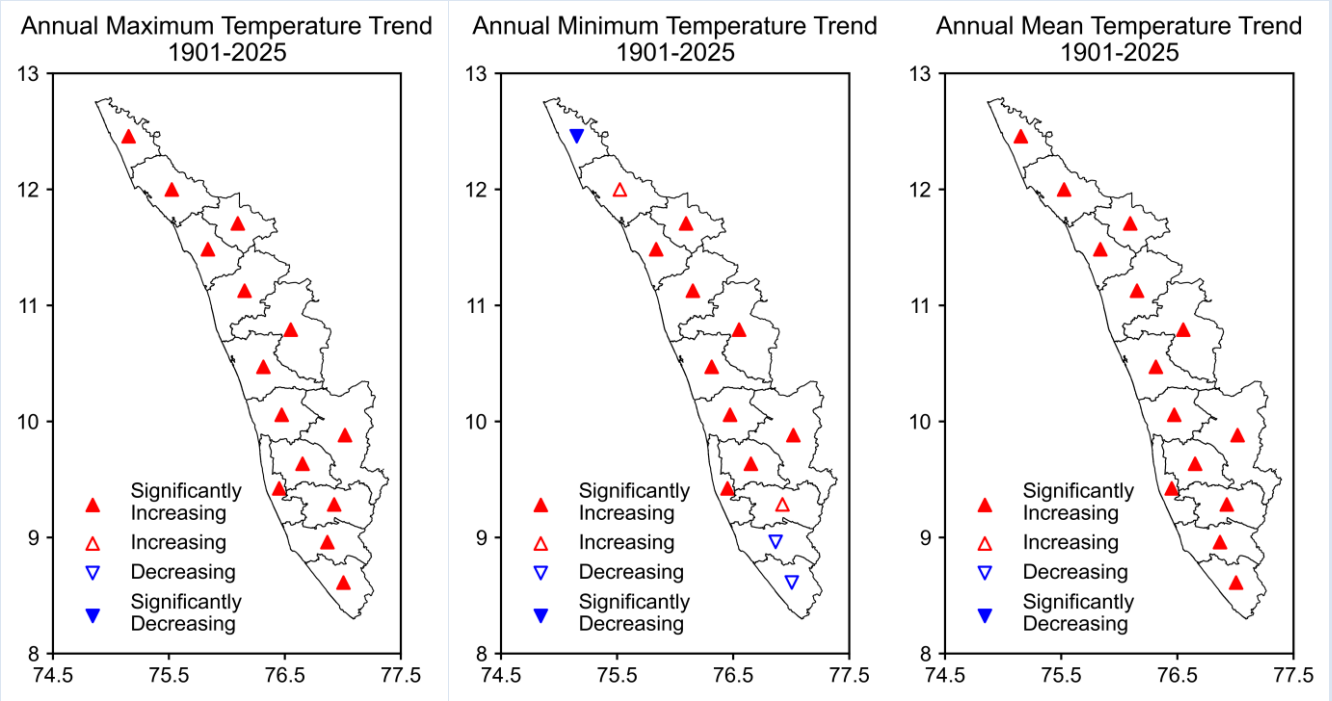


Fig.3: Trends in district averaged **a)** maximum, **b)** minimum, and **c)** mean land surface air temperatures for the period 1901-2025.

Rainfall

The monthly and seasonal rainfall averaged over the state of Kerala and expressed as the percentage of departure from the Long Period Average (LPA) for the period 1971-2020 is given in the **Fig.1** along with temperature anomalies. Kerala receives most of its annual rainfall during the two monsoon seasons; southwest monsoon season (June to September) and northeast monsoon season (October to December). Kerala experienced a rainfall deficit of 13% (21%) below its Long Period Average (LPA, 1971–2020) during the southwest (northeast) monsoon season. However, it recorded 111% above its LPA during the summer season. It is observed that the State averaged seasonal rainfall for the southwest monsoon as well as northeast monsoon seasons during the past 125 years (**Figures 4 & 5**) show decreasing trends.

During the 2025 southwest monsoon season, three out of Kerala's 14 districts experienced deficient rainfall, with actual precipitation falling at least 20% below the LPA. The most affected districts were **Idukki (-35%)**, **Malappuram (-27%)**, and **Wayanad (-36%)**. All other eleven districts received normal rainfall (percentage departure from normal lies between -19% & +19%). On the other hand, the Northeast Monsoon season was largely deficient across the State. **Eight out of 14 districts** recorded deficient rainfall. The most significant deficits were observed in **Kollam (-32%)** and **Malappuram (-33%)**, followed by **Idukki (-26%)**, **Kozhikode (-24%)**, and **Palakkad (-24%)**. Only six districts—Kasaragod (-10%), Ernakulam (-19%), Kottayam (-4%), Alappuzha (-18%), Pathanamthitta (-18%) and Thiruvananthapuram (-3%)—received normal rainfall.

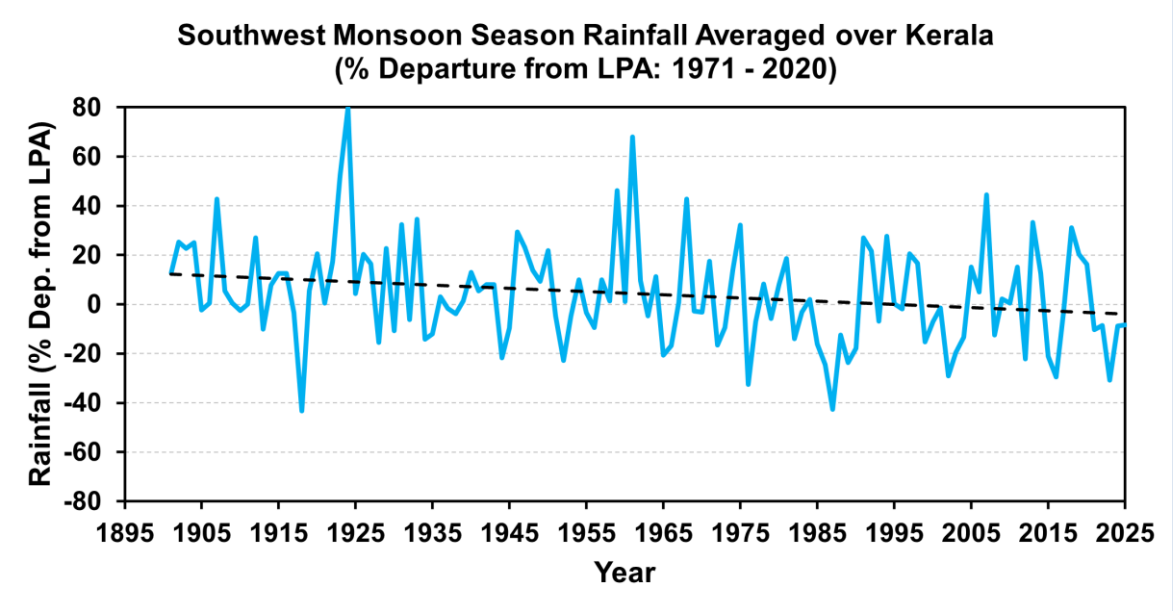


Fig.4: Seasonal departure of southwest monsoon rainfall averaged over Kerala expressed as the percentage from Long Period Average (LPA) computed for the base period of 1971-2020.

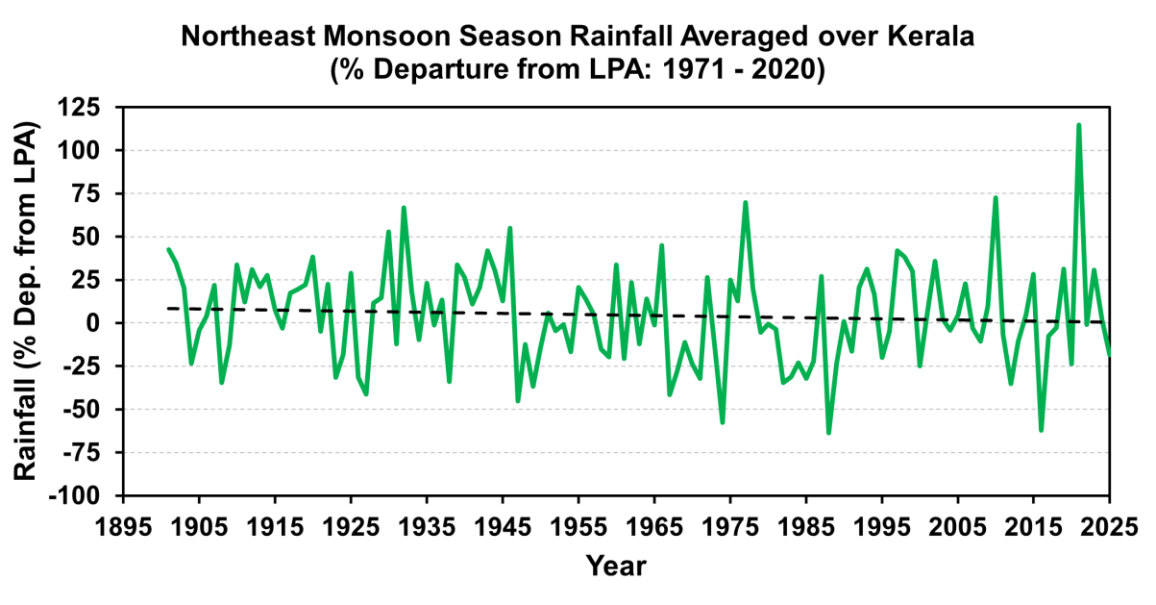


Fig.5: Seasonal departure of northeast monsoon rainfall averaged over Kerala expressed as the percentage from Long Period Average (LPA) computed for the base period of 1971-2020.

The trend map of the district averaged southwest monsoon season rainfall during the period 1901-2025 (**Fig.6a**) shows decreasing trends in all the districts except in Idukki, where insignificant increasing trend is seen. The decreasing trends in the seasonal rainfall over 4 districts in the south (Kottayam, Alappuzha, Kollam and Pathanamthitta) and 5 districts in the north (Kannur, Wayanad, Kozhikode, Malappuram, and Palakkad) are significant. In case of northeast monsoon season (**Fig.6b**), decreasing trends in the seasonal rainfall was seen in all the districts except in Kasaragod, with significant decreasing trends in Wayanad, Palakkad, and Kottayam. Kasaragod showed insignificant increasing but non-significant trend.

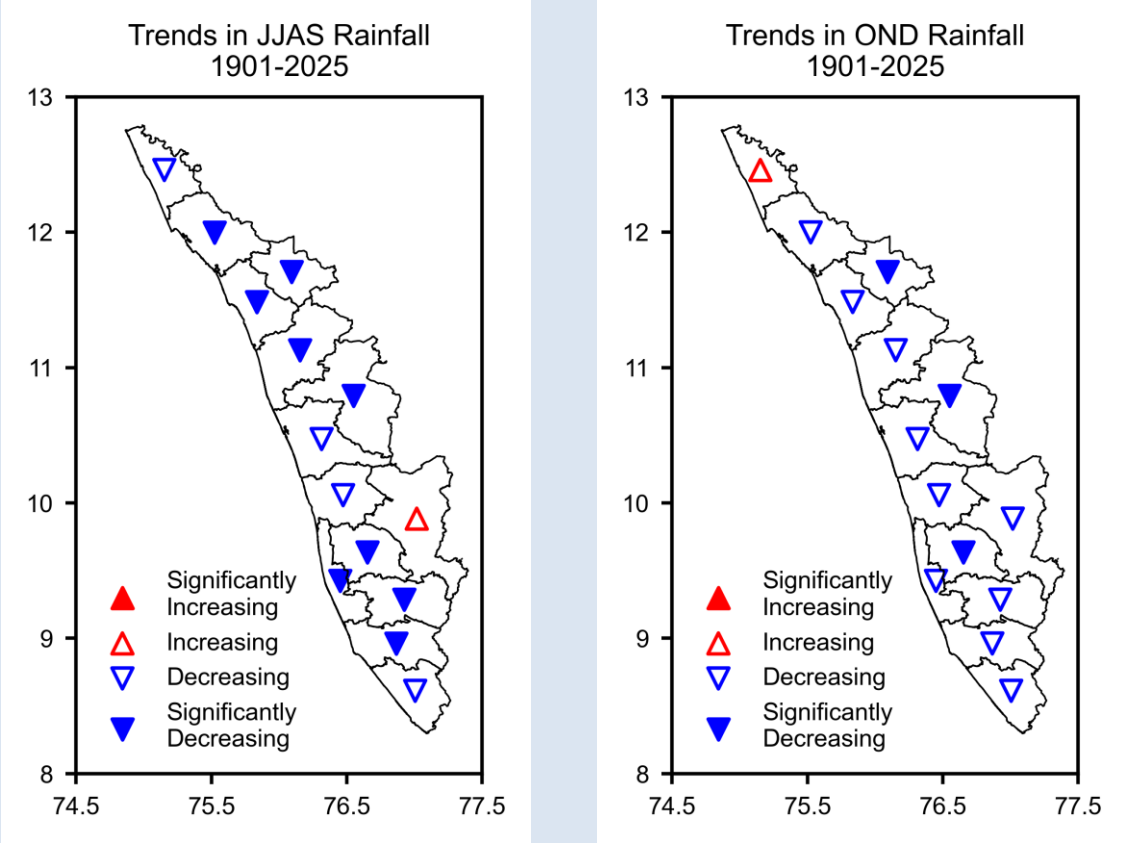


Fig.6: Trends in district averaged **a)** southwest monsoon (JJAS), and **b)** northeast monsoon (OND) season rainfalls for the period 1901-2025.

Extreme Weather Events:

Table 1 shows the highest maximum and minimum temperatures and highest rainfall recorded in the 11 IMD met observatories and one non-departmental observatory across Kerala along with the dates during 2025. It is seen that, among these stations, Kannur Airport reported the highest maximum temperature of 40.4°C (on 25th February) followed by Vellanikara (39.0°C on 5th May) and Kannur (39.0°C on 25th February). The lowest minimum temperature was recorded at Punalur in Kollam district (15.5°C on 21st December) followed by Kannur Airport (17.8°C on 20th December) and Kottayam (17.8°C on 20th December). The highest one-day rainfall was recorded by Kannur Airport (180.4 mm) on 20th May followed by Trivandrum Airport (151.0 mm) on 26th September. Among these observatories, the highest number of daily heavy rainfall events (>64.5mm) were recorded by Vellanikkara and Kannur, and Kannur Airport (18 days).

Table 1: Highest/lowest maximum and minimum temperatures and highest rainfall recorded by the 12 IMD meteorological observatories across Kerala along with the dates during 2025.

IMD Stations	Highest Max. Temperature ^{0}C (Date)	Lowest Max. Temperature ^{0}C (Date)	Highest Min. Temperature ^{0}C (Date)	Lowest Min Temperature ^{0}C (Date)	Highest Rainfall mm (Date)	Frequency of Heavy Rainfall Events (>64.5 mm)
Kannur	39.00 (25-02-2025)	25.20 (31-05-2025)	28.50 (25-04-2025, 26-04-2025)	19.60 (20-12-2025)	144.30 (30-05-2025)	18

Kannur Airport	40.4 (25-02-2025)	24.80 (16-06-2025)	26.60 (26-04-2025)	17.80 (20-12-2025)	180.4 (20-05-2025)	18
Kozhikode city	37.50 (23-04-2025, 05-05-2025)	24.50 (27-07-2025)	29.00 (27-04-2025)	20.30 (20-12-2025)	113.40 (26-05-2025)	12
Karipur A. P.	37.00 (01-03-2025, 12-03-2025)	24.10 (27-07-2025)	28.40 (29-03-2025)	19.70 (20-12-2025)	135.40 (25-05-2025)	13
Palakkad	38.90 (26-03-2025, 28-04-2025)	24.20 (27-07-2025)	28.20 (20-03-2025)	19.70 (21-12-2025)	106.40 (27-05-2025)	7
Vellanikkara	39.00 (05-03-2025)	24.40 (27-07-2025)	27.90 (01-03-2025)	19.20 (26-12-2025)	149.60 (16-08-2025)	18
Kochi (NAS)	34.40 (27-02-2025)	25.00 (27-07-2025)	28.40 (28-05-2025)	20.40 (21-12-2025)	112.6 (30-05-2025)	14
Kochi (CIAL)	37.60 (28-02-2025)	24.50 (27-07-2025)	26.90 (28-05-2025)	18.30 (20-12-2025)	105.90 (15-06-2025)	7
Kottayam	38.60 (28-02-2025)	25.00 (31-05-2025)	26.40 (01-03-2025)	17.80 (20-12-2025)	77.00 (22-03-2025)	3
Punalur	37.80 (06-03-2025)	24.00 (30-11-2025)	26.40 (25-04-2025)	15.50 (21-12-2025)	73.20 (13-10-2025)	5
Trivandrum AP	34.60 (30-03-2025)	26.60 (21-07-2025)	28.10 (11-03-2025)	21.10 (16-12-2025)	151.00 (26-09-2025)	6
Trivandrum city	36.40 (09-02-2025)	26.20 (31-05-2025, 23-11-2025)	27.00 (25-04-2025)	20.60 (21-12-2025)	129.60 (26-09-2025)	6

Sea Surface Temperature

Sea surface temperature (SST) is a key climate variable that strongly influences the air temperature and atmospheric processes over coastal regions. Along the Kerala coast, variability in the Arabian Sea SST plays a critical role in modulating regional weather and climate. Kerala coastal SST anomalies were analyzed for two sectors: North Kerala (10.50°N–12.875°N, 74.125°E–77.375°E) and South Kerala (8.125°N–10.50°N, 74.125°E–77.375°E). The analysis is based on the NOAA 0.25° Daily Optimum Interpolation Sea Surface Temperature (OISST) dataset for the period 1982–2025, which is a long-term Climate Data Record integrating observations from multiple platforms, including satellites, ships, buoys, and Argo floats. The dataset is spatially interpolated to produce a continuous global SST field.

During 2025, SSTs along the Kerala coast remained above the Long Period Average (LPA; 1991–2020) for most of the year. The annual mean SST anomaly was +0.47°C over the North Kerala coast and +0.42°C over the South Kerala coast, indicating persistently warm ocean conditions. However, these values were lower than the record-high anomalies observed in 2024 (+0.96°C in the north and +0.93°C in the south) (**Fig. 7**). All seasons exhibited positive SST anomalies, with the strongest warming during the pre-monsoon (MAM) season (+0.89°C in the north and +0.59°C in the south), followed by the winter (DJF) season (+0.74°C and +0.66°C, respectively). The post-monsoon

(SON) season recorded moderate warming (+0.38°C in the north and +0.43°C in the south), while the southwest monsoon (JJA) season showed comparatively weaker but still positive anomalies (+0.09°C in the north and +0.18°C in the south). Trend analysis for the period 1982–2025 reveals a statistically significant long-term warming of SST along the Kerala coast, with rates of +0.0207°C per year over the North Kerala coast and +0.0198°C per year over the South Kerala coast (**Fig. 7**), indicating sustained ocean warming over the past four decades.

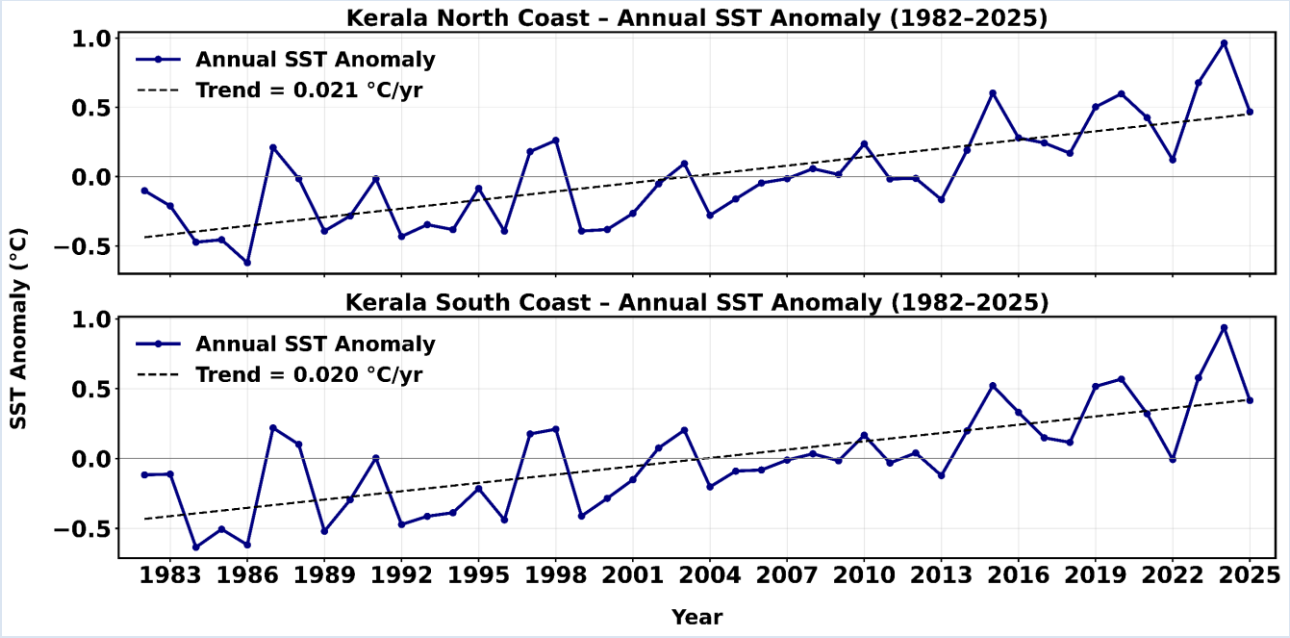


Fig.7: Annual mean SST anomalies averaged over north Kerala [top] and south Kerala [bottom] for the period 1982-2025.The anomalies were computed with respect to the base period of 1991-2020. The dashed black line indicates the linear trend in the annual mean SST time series.

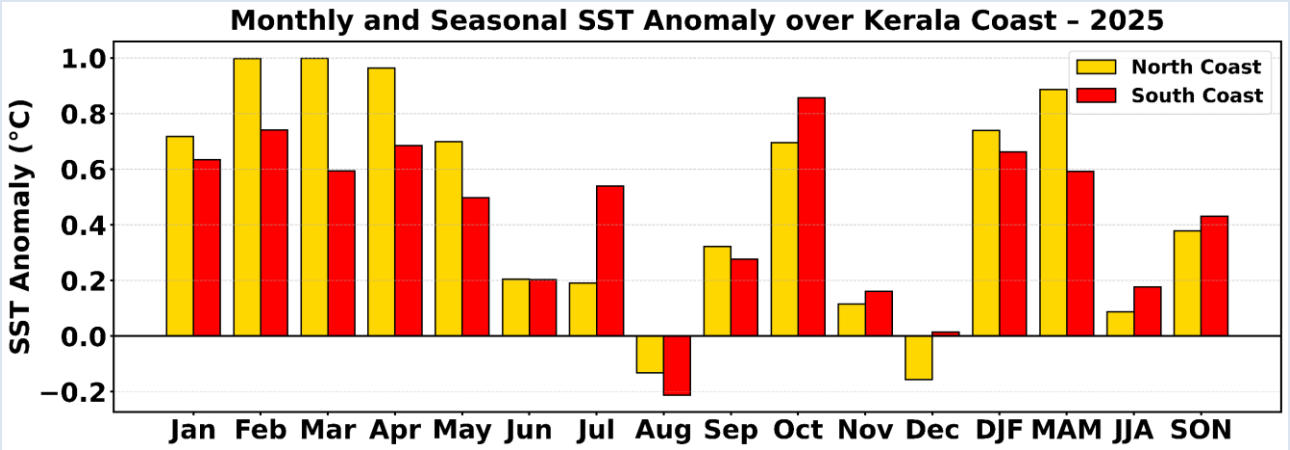


Fig.8: Monthly and Seasonal Mean SST anomalies (°C) averaged over two sectors of Kerala during 2025. The anomalies were computed from Long Period Average (LPA) for the base period of 1991-2020.

At the monthly scale, SST anomalies remained positive throughout the year, except during August and December (**Fig. 8**). Distinct regional differences were evident between the northern and southern sectors. The northern coast exhibited stronger warming from January to May, with anomalies

of +0.72°C, +1.00°C, +1.00°C, +0.96°C, and +0.70°C, respectively, while the southern coast showed relatively lower anomalies during the same period (+0.63°C, +0.74°C, +0.59°C, +0.69°C, and +0.49°C). In contrast, the largest positive anomaly over the southern coast occurred in October (+0.85°C). August recorded negative anomalies in both regions (–0.13°C in the north and –0.21°C in the south).