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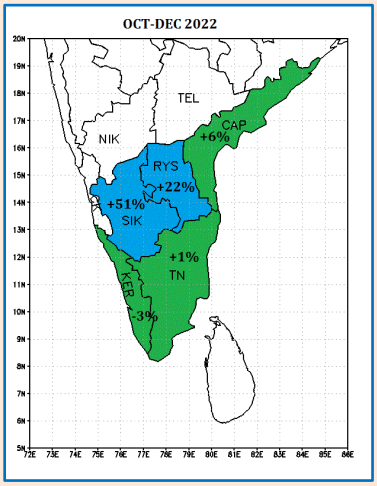
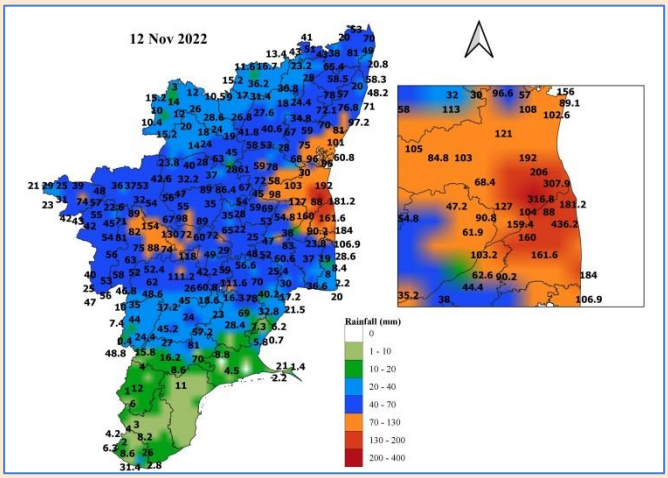
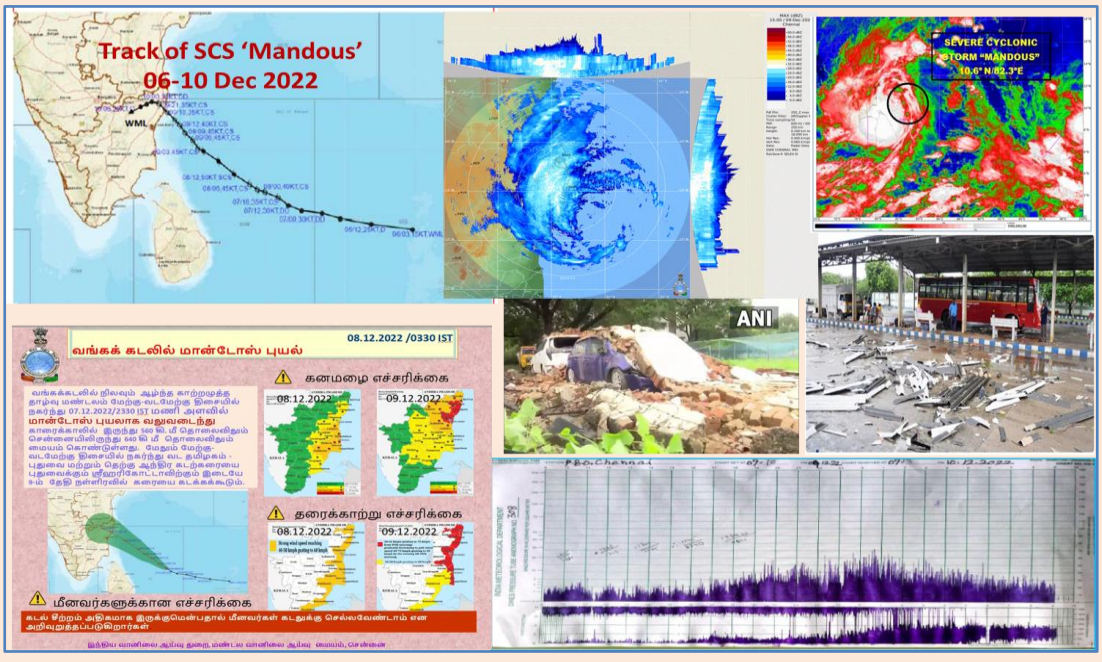
REPORT ON NORTHEAST MONSOON – 2022







Regional Meteorological Centre, Chennai

March 2023

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Executive Summary

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Abstract

During the year 2022, the southwest monsoon withdrew from the Indian region on 23rd October and the Northeast monsoon (NEM) of 2022 commenced over the southeastern parts of peninsular India on 29th October against the normal date of 20th October. All the five meteorological sub divisions benefitted by the NEM [Tamil Nadu (including Puducherry & Karaikal), Coastal Andhra Pradesh (CAP), Rayalaseema (RYS), Kerala (KER), and South Interior Karnataka (SIK)] received **normal to excess** rainfall during the NEM season (October-December).There were 18 days of *active* to *vigorous* monsoon conditions over TN, SIK & KER during the season. There were **51** days of *isolated heavy* rainfall activity with 20 days of *isolated very heavy* rain including 04 days of *isolated extremely heavy rainfall* activity over TN. **Two cyclones, two depressions & one well marked low** were the major synoptic systems that formed over the Bay of Bengal during the season. The **Cyclonic storm (CS)** '***Sitrang***' over the Bay of Bengal during 22nd-25th October moved northwards and crossed Bangladesh coast and delayed the commencement of the NEM. The **Severe Cyclonic Storm (SCS)** '***Mandous***' over the Bay of Bengal during 06th-10th December crossed coast close the **Mamallapuram** (north Tamilnadu) around the midnight of 09th December as a cyclonic storm with maximum sustained surface wind speed of **65-75 kmph gusting to 85 kmph**. Associated with the passage of this system, *very heavy to extremely heavy* rainfall occurred over the extreme north Tamilnadu and adjoining Rayalaseema with Vembakkam (Thiruvannamalai district, TN), Srikalahasti (Chittoor district, RYS) & Thottambedu (Chittoor district, RYS) reporting **25 cm, 23 cm & 22 cm** respectively during the 24-hour ending 0830 IST of 10th December. Two **Depressions** that formed over the Bay of Bengal – one in November (20th-22nd) and another in December (22nd-25th) did not contribute significantly to NEM rainfall over the peninsular India. Whereas the 20th-22nd November Depression weakened off North Tamilnadu coast, the Depression during 22nd-25th December crossed Sri Lanka coast, and weakened gradually. However, associated with the passage of a **Well marked Low pressure area (WML)** during 09th-13th November, isolated *heavy to very heavy/ extremely heavy* rainfall occurred during 12th-16th November with **Sirkazhi** (Mayiladuthurai district) reporting **44 cm of rain** followed by Kollidam (Mayiladuthurai district): **32 cm**, Chidambaram (Cuddalore district): **31 cm**, Annamalai nagar (Cuddalore district): **28 cm** & Bhuvanagiri (Cuddalore district): **21 cm** during the 24-hr ending 0830 IST of 12th November. Under the influence of this event, the seasonal rainfall of TN which was 'minus 4%' on 10th November rose to 'plus 15%' on 17th November. After the Depression during last week of December, with the gradual decrease in rainfall activity, the cessation of NEM 2022 rainfall over peninsular India was declared on **12.01.2023**.

1. Background

The Indian southwest monsoon (SWM) season of June to September is the chief rainy season for India and about 75% of the country's annual rainfall is realised during this season. Subsequent to the withdrawal of SWM, the northeast monsoon (NEM), a small scale monsoon confined to parts of southern peninsular India comprising of the meteorological sub-divisions of Tamil Nadu, Puducherry & Karaikal (TN), Kerala & Mahe (KER), Coastal Andhra Pradesh & Yanam (CAP), Rayalaseema (RYS) and South Interior Karnataka (SIK) occurs. For the subdivision of TN, the normal SWM seasonal rainfall realised is only about 36% (336.1 mm) of its annual rainfall (939.3 mm) as this subdivision comes under the rain-shadow region during the SWM. The northeast monsoon (NEM) season of October to December (OND) is the chief rainy season for this subdivision with 48% (443.3 mm) of its annual rainfall realised during this season and hence its performance is a key factor for this regional agricultural activity.

Further, the NEM season is also the primary cyclone season for the North Indian Ocean (NIO) basin comprising of the Bay of Bengal (BOB) and the Arabian Sea (AS) and cyclonic disturbances (CDs; low pressure systems (LPS) with maximum sustained surface wind speed (MSW) of 17 knots or more) forming over BOB and moving west/northwest-wards affect the coastal areas of southeastern peninsular India and also contribute significantly to NEM rainfall. As such, the NEM season assumes importance from the agricultural as well as cyclone disaster management perspectives.

Prior to the commencement of NEM rains, after the withdrawal of SWM upto 15°N, reversal of low level winds from southwesterly to northeasterly occurs. The normal date of setting in of easterlies over the southeastern peninsular India is 14th October. The normal date of onset of NEM over Coastal TN (CTN) and south CAP is 20th October. The normal rainfall received over the five NEM sub-divisions during OND is TN-443.3 mm, KER-492.0 mm, CAP-322.9 mm, RYS-236.4 mm and SIK-199.0 mm. However, the NEM seasonal rainfall shows a high degree of variability with 27% co-efficient of variation.

The NEM rainfall is influenced by global climate parameters such as ENSO (El Nino/La Nina & Southern Oscillation Index), Indian Ocean Dipole (IOD) and Madden-Julian Oscillation (MJO). El Nino, positive IOD and MJO in phase 2-4 with amplitude greater than one are generally associated with good NEM rainfall.

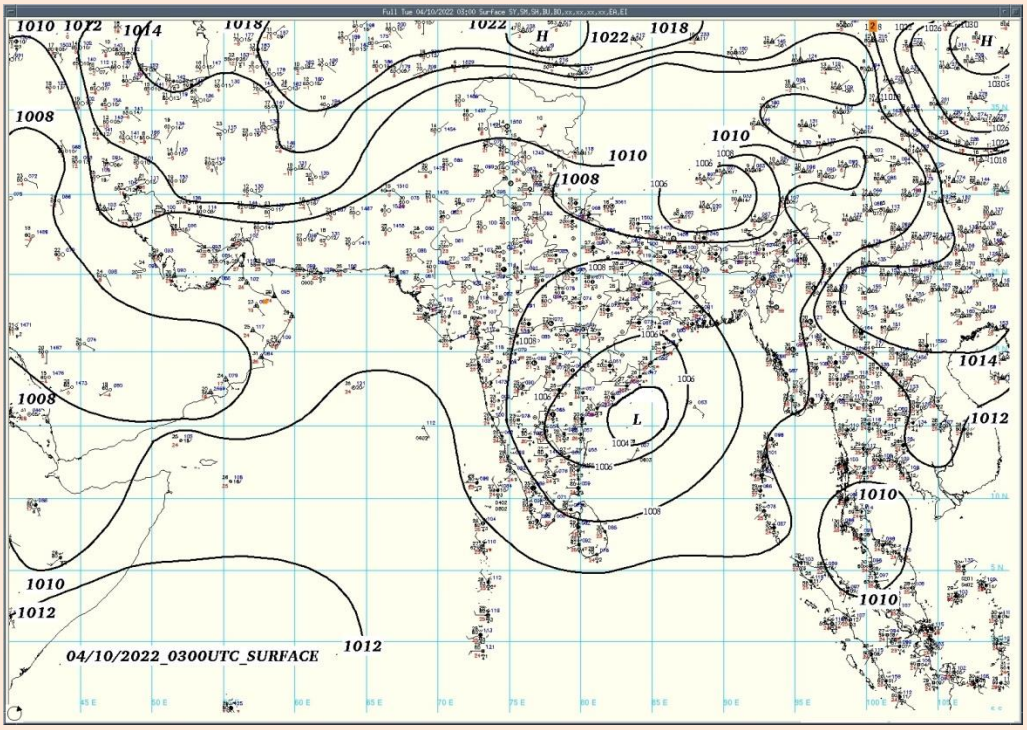
2. Onset phase

During October 2022, La Nina conditions prevailed over the equatorial Pacific Ocean and IOD was negative during the start season (October). MJO was insignificant during the first half of the month and was in phase-6-7 the later half of the month. As such, large scale setting was not favourable for NEM activity and commencement of NEM over the southern peninsular India was delayed.

(i) Pre-onset phase (Extended southwest monsoon): Under La Nina conditions, and favourable synoptic situations such as (i) formation of a low pressure area (LOPAR) over the westcentral Bay of Bengal off Andhra Pradesh coast during 03rd-04th October (ii) formation of Cyclonic Storm (CS) '*Sitrang*' over the Bay of Bengal and its northward movement towards Bangladesh coast during 22nd-24th October, (iii) formation of upper air cyclonic circulations over the Bay of Bengal and their westward movement across peninsular India & (iv) east-west shear zone across peninsular India in the lower tropospheric levels - extended the southwest monsoon over the Indian region upto 23rd October 2022.

Associated with the LOPAR over Bay of Bengal during 03rd-04th October and its subsequent movement inland, widespread rainfall occurred over CAP, RYS & Telangana (TEL)during the 24-hr ending 0830 IST of 06th & 07th October with *isolated heavy to very heavy rain* over CAP on 05th & 06th & over RYS on 07th October. Isolated heavy rain occurred over TEL on 06th & 07th; over RYS on 06th & over CAP on 07th October. *Active to Vigorous* monsoon conditions prevailed over CAP, RYS & TEL on 06th & 07th October. Surface isobaric analysis and upper air streamline analysis based on 0830 IST & 0530 IST respectively in respect of 04th & 05th October depicting the LOPAR over Bay of Bengal and its movement inland are presented in Fig.1a(i). INSAT-3D satellite imagery as on 05th/2000 IST & 06th /1500 IST depicting the cloudiness associated with the system are shown in Fig.1a(ii) and gauge observed 24-hour accumulated rainfall over CAP, RYS & TEL as on 0830 IST of 06th & 07th October 2022 are presented in Fig.1a(iii).

Associated with (i) an upper air cyclonic circulation over southwest Bay of Bengal off Sri Lanka coast on 09th October that moved across TN, KER & Comorin area during 10th-13th October (ii) an upper air cyclonic circulation over westcentral Bay of Bengal off south Andhra Pradesh & north Tamilnadu coasts & another cylonic circulation over southeast Arabian sea off Karnataka-Kerala coast during 13th-15th October [Fig.1b(i)]and (iii) east-west shear zone in the lower levels across TN-KER during 16th-23rd October rainfall activity continued over the southern peninsula during 09th-22nd October. *Fairly widespread* to *Widespread* rainfall occurred on many days over interior Karnataka & Tamilnadu during 09th-22nd and over Kerala & Coastal Karnataka during 14th-22nd October 2022. Fig.1b(ii) presents the satellite imageries as on 09 /0530 IST, 10/0530 IST, 13/2100 IST & 16/2100 IST depicting the cloudiness associated with the extended southwest monsoon, 2022 over the southern peninsula. Fig.1b(iii) presents the past 24-hour rainfall distribution and intensity as on 0830 IST of 10th, 11th & 15th October 2022 depicting the extended southwest monsoon activity over the southern peninsula.



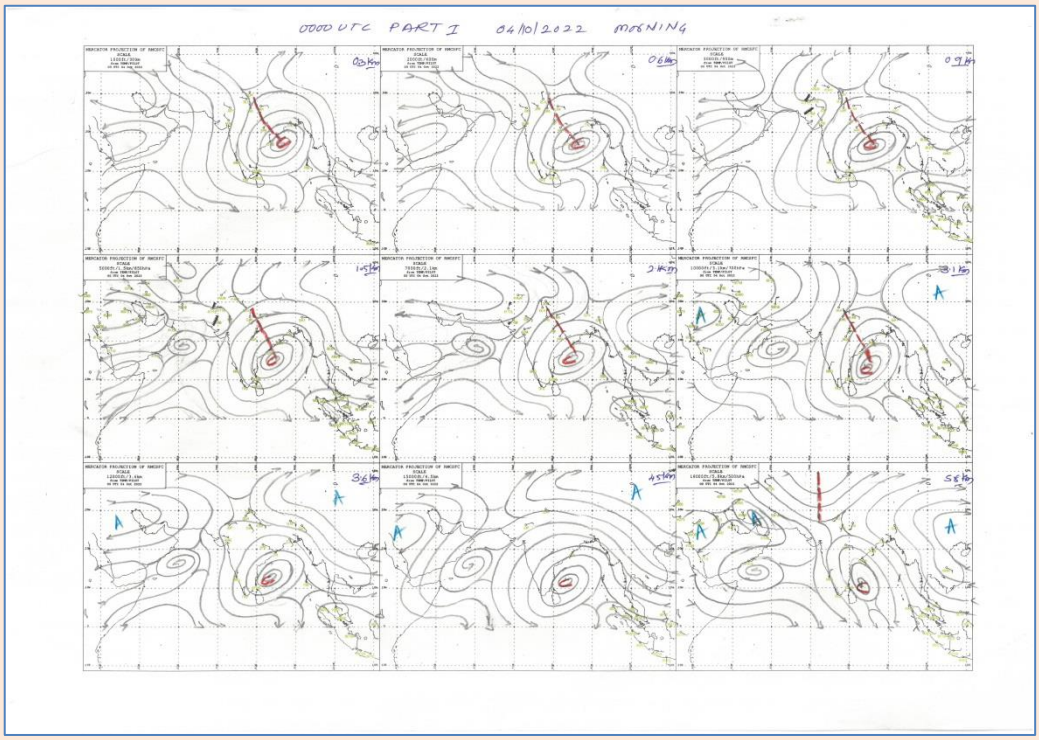
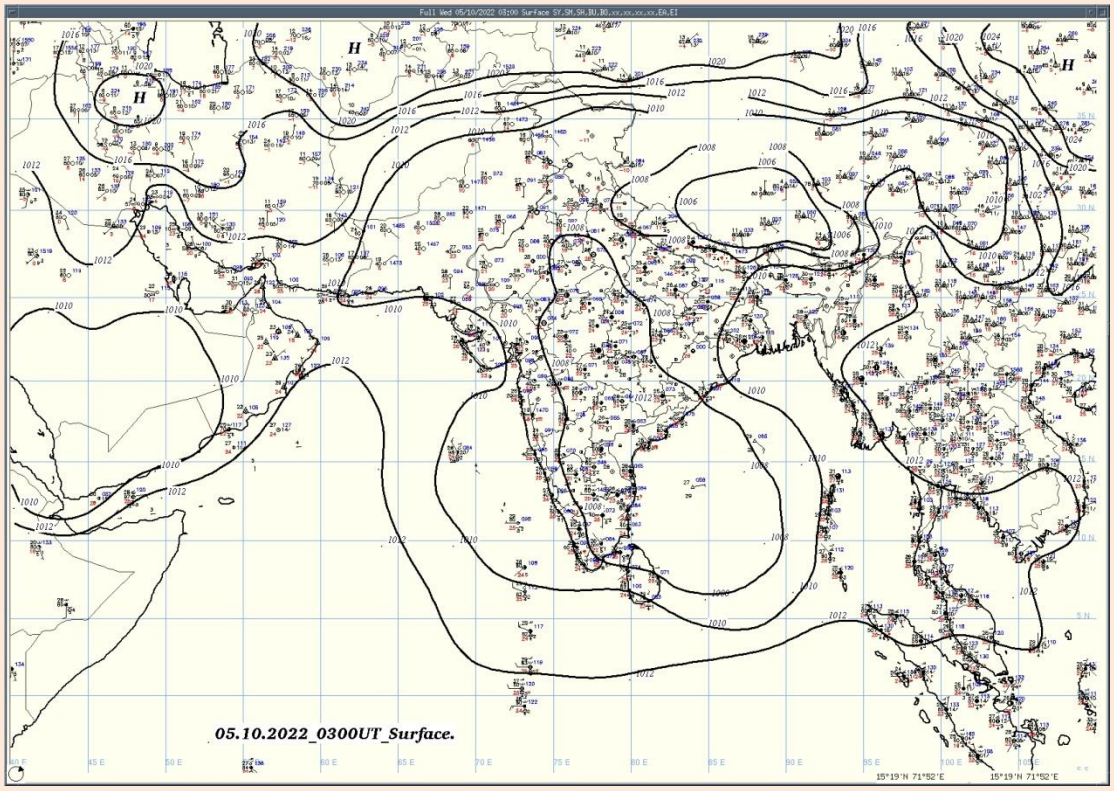


Fig.1a(i): Surface isobaric analysis based on 0830 IST and upper air (lower-mid levels) streamline analysis based on 0530 IST observations of 04th & 05th October 2022



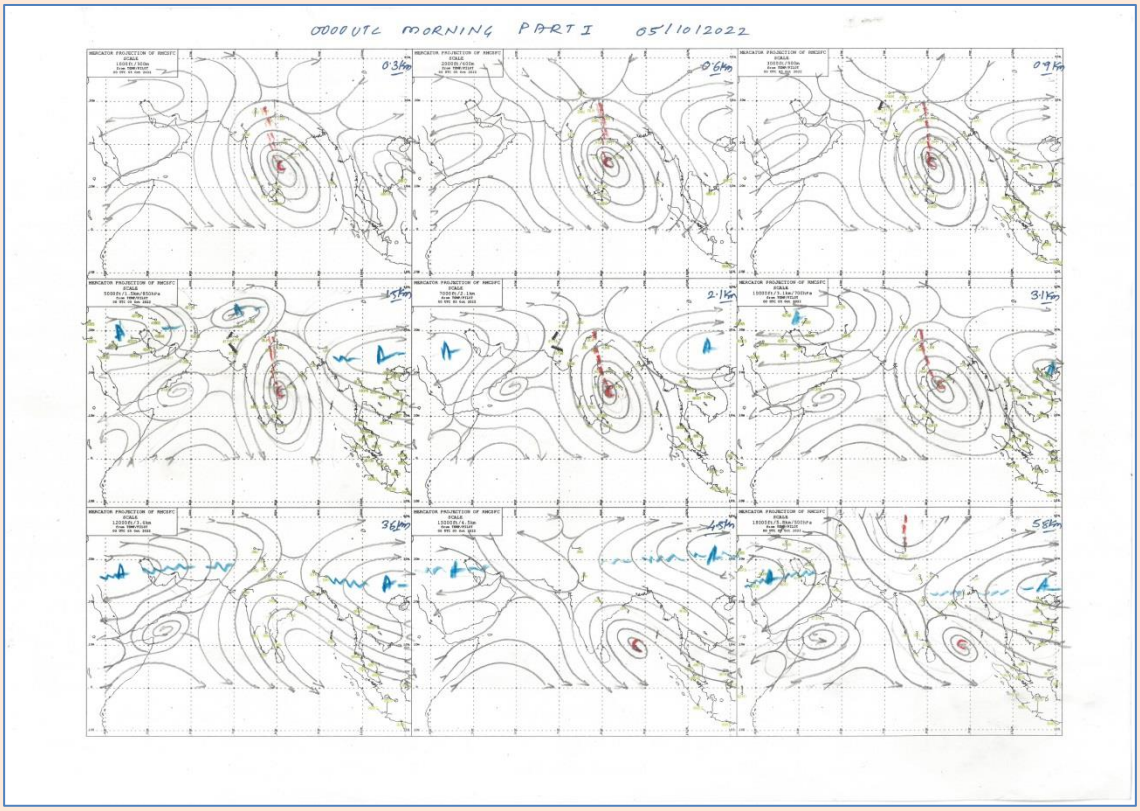


Fig.1a(i) contd.

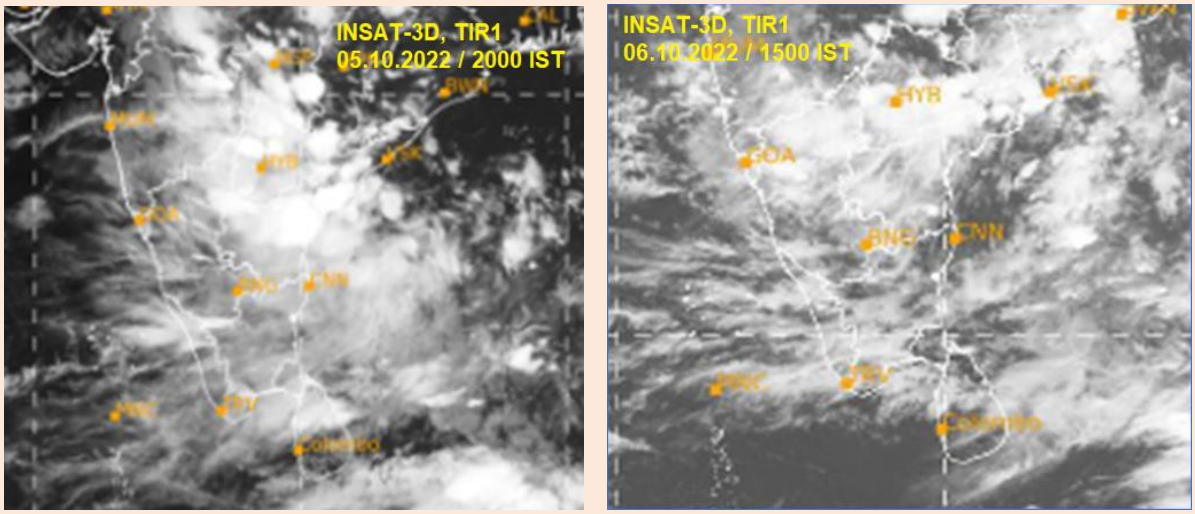


Fig.1a(ii): INSAT-3D infra-red imagery as on 05.10.2022/2000 IST & 06.10.2022/1500 IST

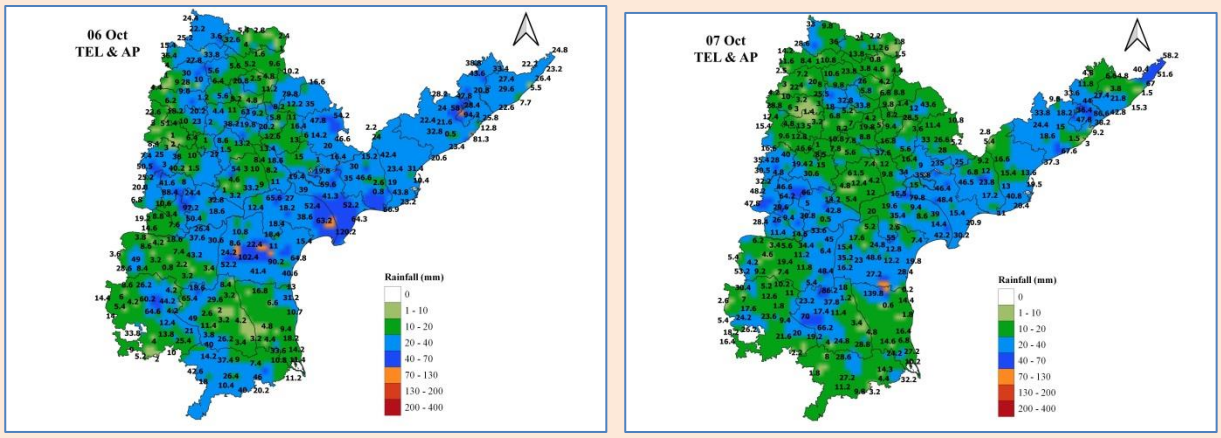
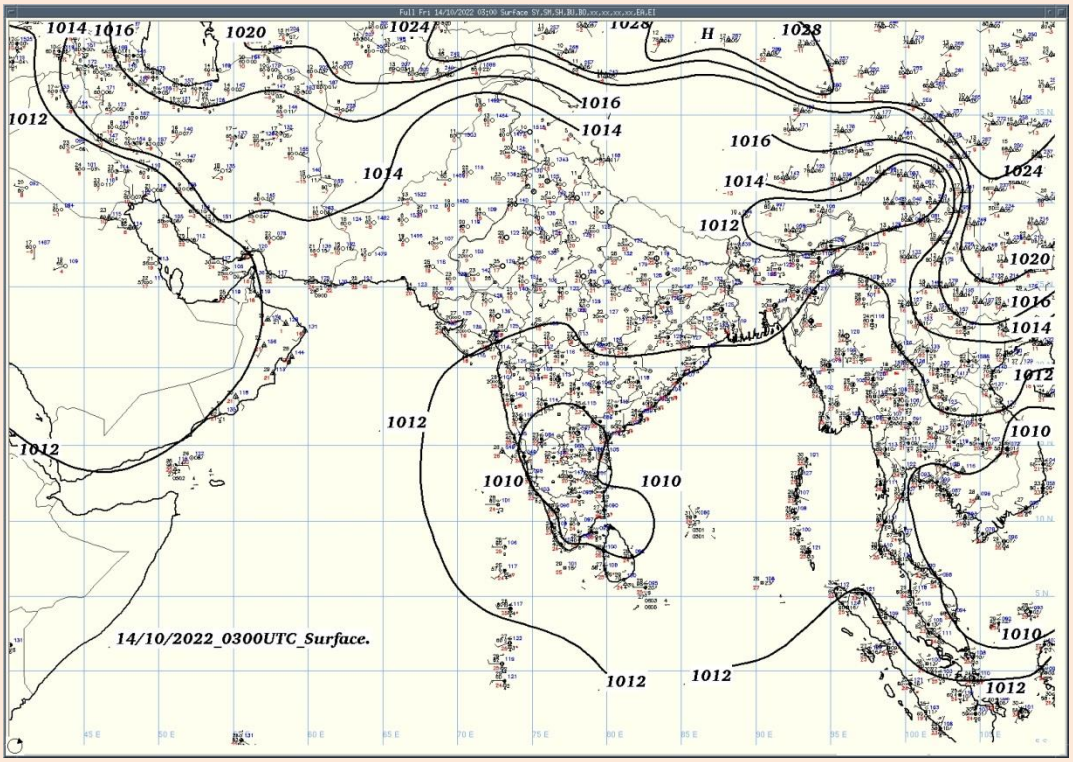


Fig.1a(iii): Accumulated rainfall (based on gauge observed data) over CAP, RYS & TEL during the 24-hr ending 0830 IST of 06th & 07th October.



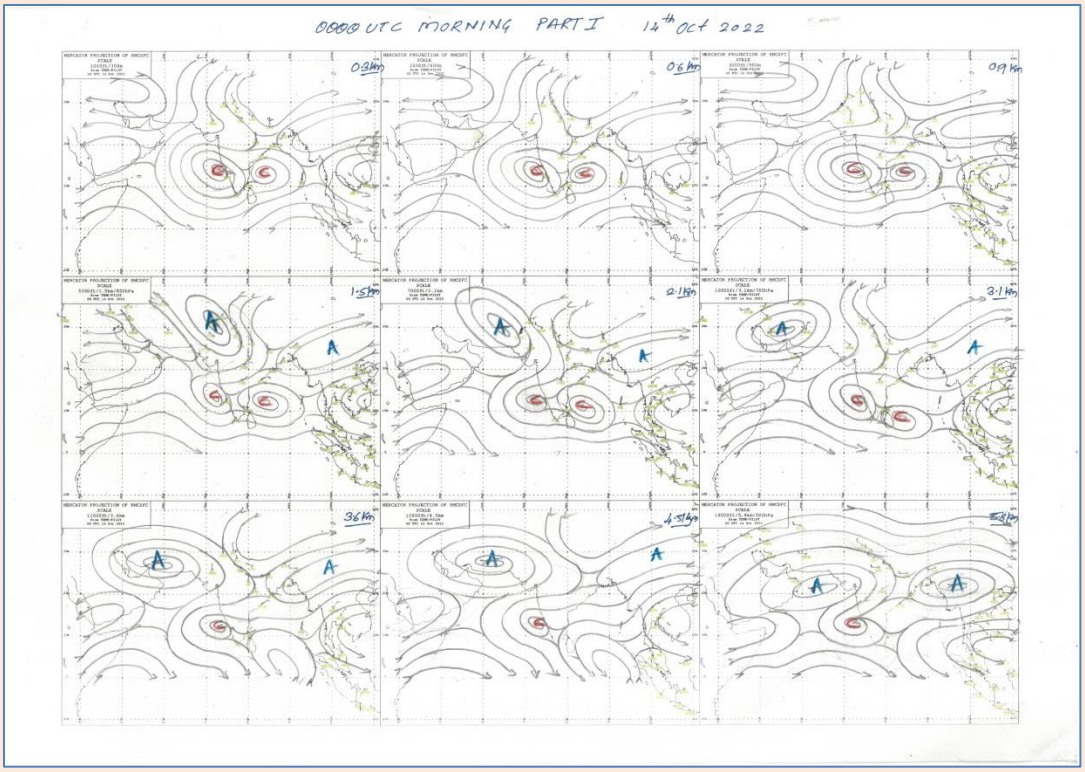


Fig.1b(i): Surface isobaric analysis based on 0830 IST and upper air (lower-mid levels) streamline analysis based on 0530 IST observations of 14th October 2022

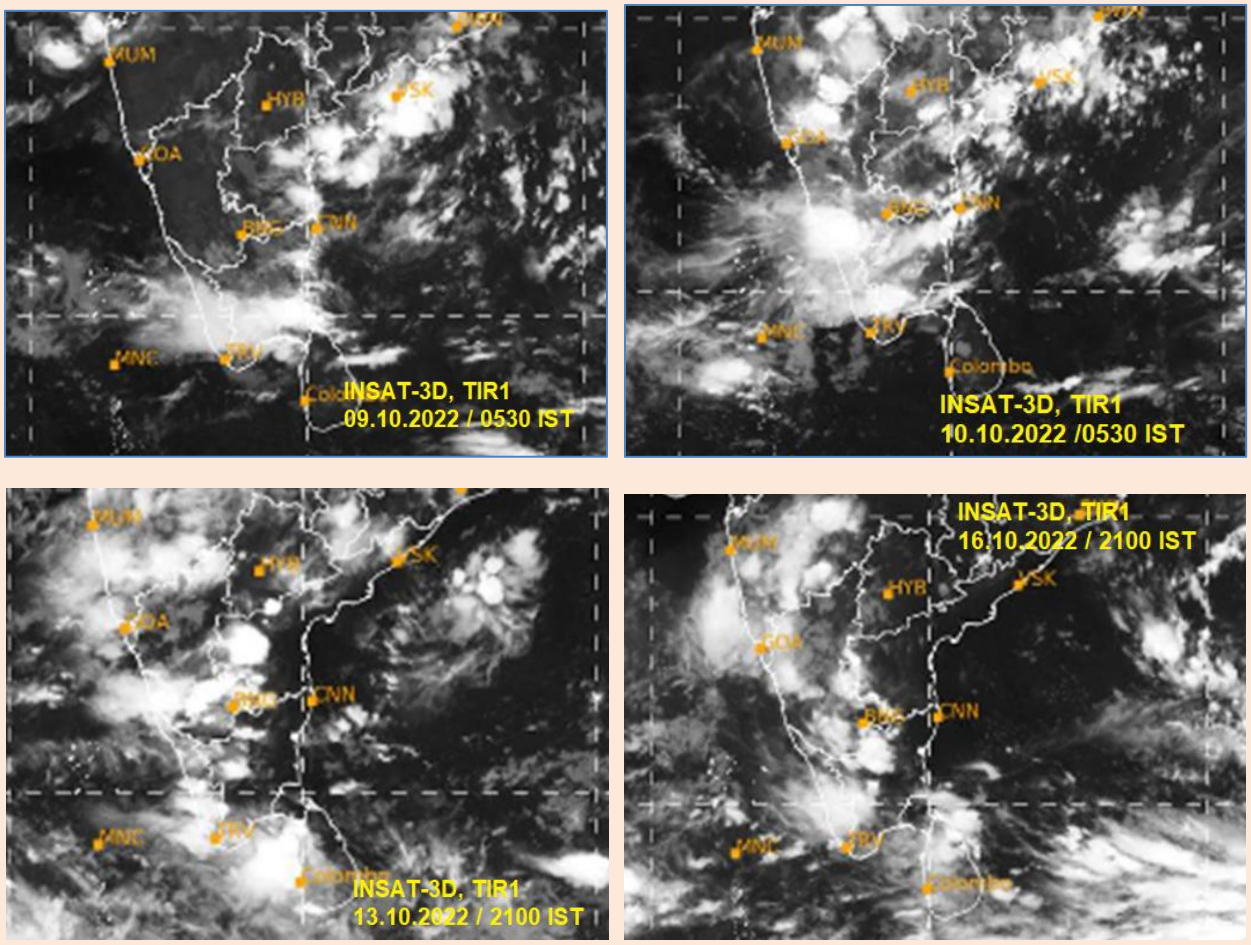


Fig.1b(ii): Satellite infra-red imageries as on 09 /0530 IST, 10/0530 IST, 13/2100 IST & 16/2100 IST depicting the cloudiness over the southern peninsula during the extended southwest monsoon, 2022.

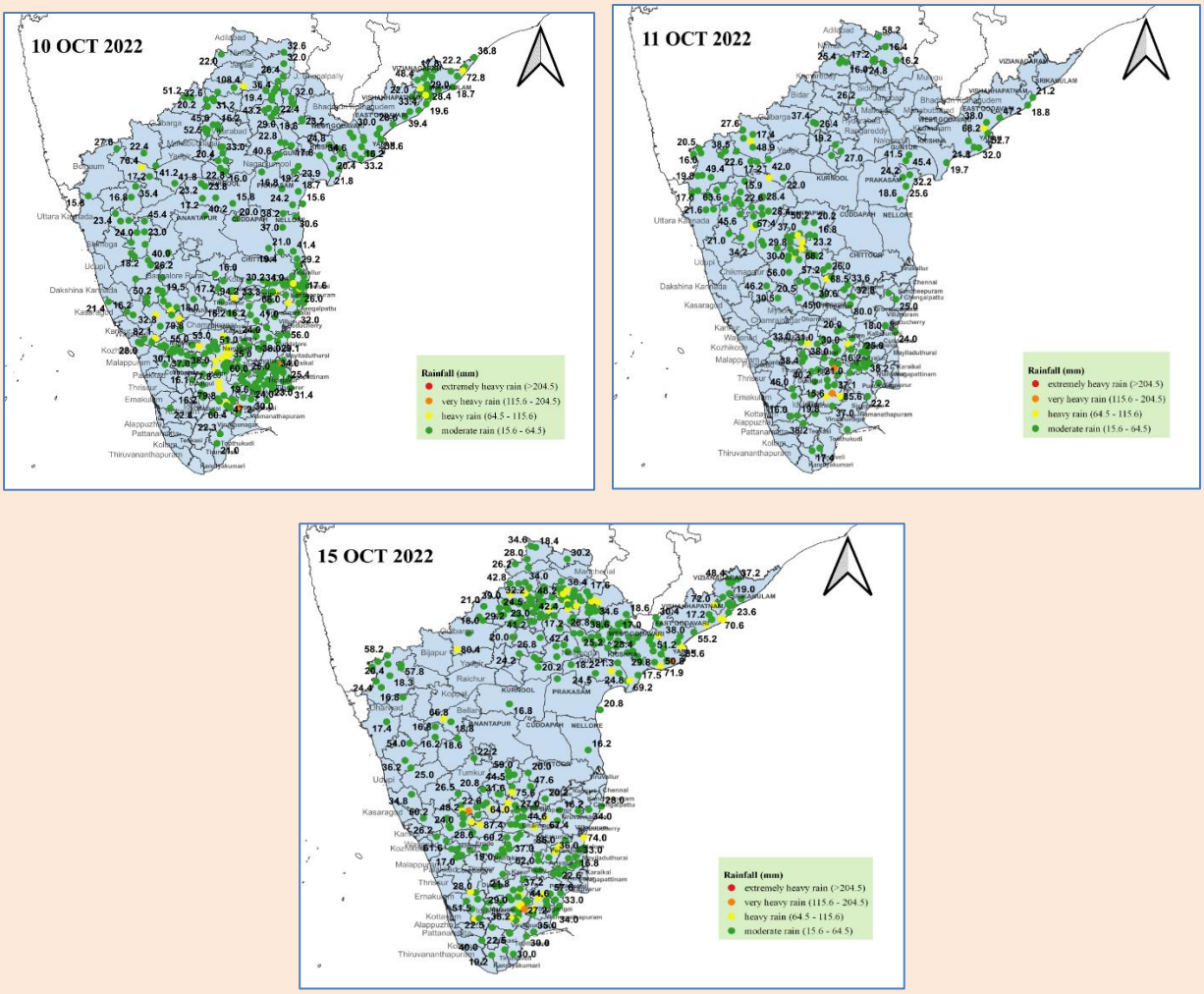


Fig.1b(iii) Rainfall distribution over southern peninsular India during the 24-hr ending 0830 IST of 10th, 11th & 15th October 2022

Subsequently with the formation of CS '*SITRANG'* on 22nd October and its northward movement towards Bangaladesh coast, rainfall activity decreased drastically over the Indian region and the southwest monsoon withdrew from the Indian region on 23rd October and gradually, the flow pattern reversed to easterlies in the lower levels around 28th October leading to commencement of northeast monsoon rains over coastal Tamilnadu and adjoining south coastal Andhra Pradesh on 29th October 2022. Pentad mean wind flow pattern depicting the reversal of wind from westerlies to easterlies during the end of October 2022 are presented in Fig.1c.

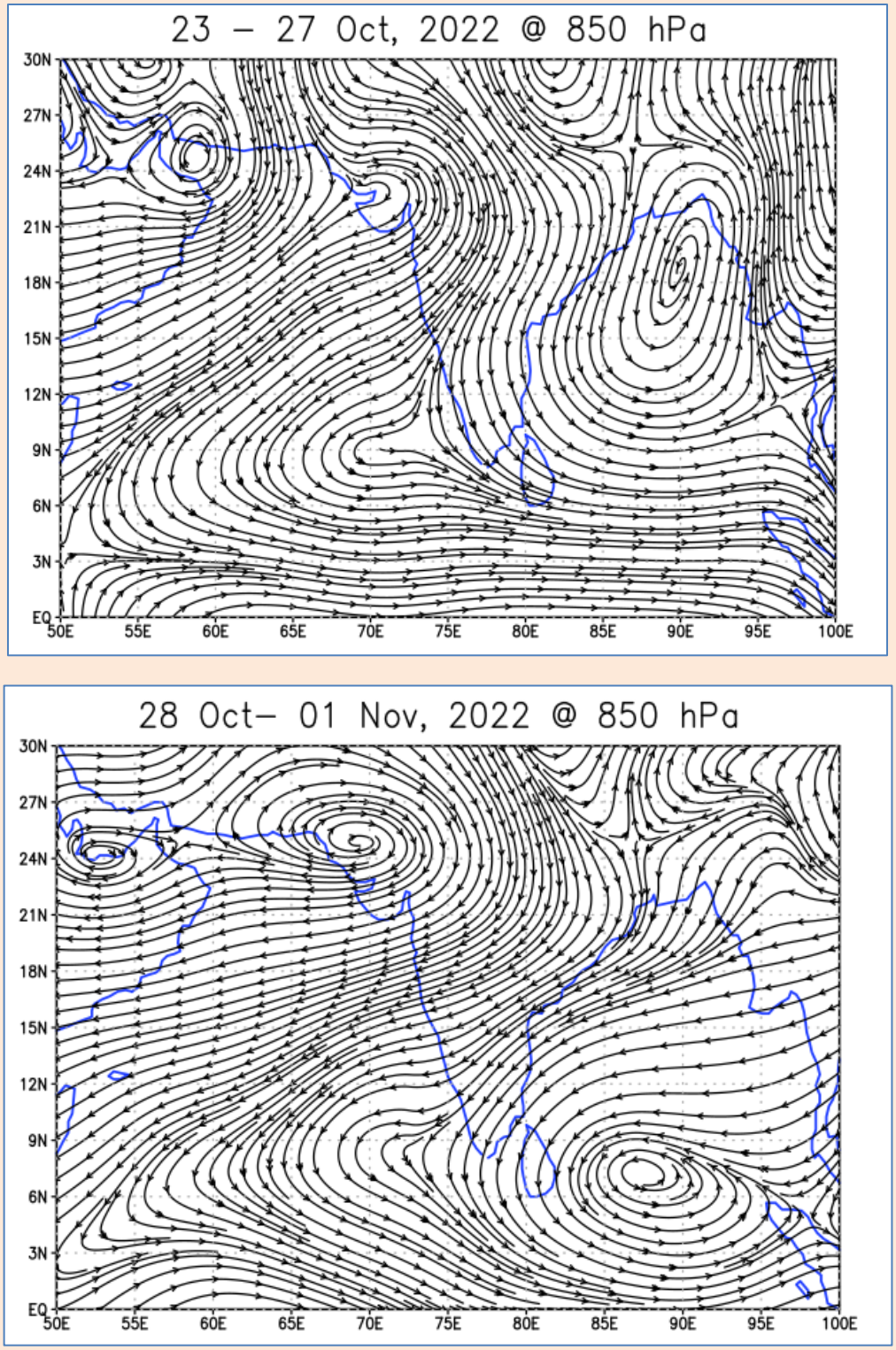


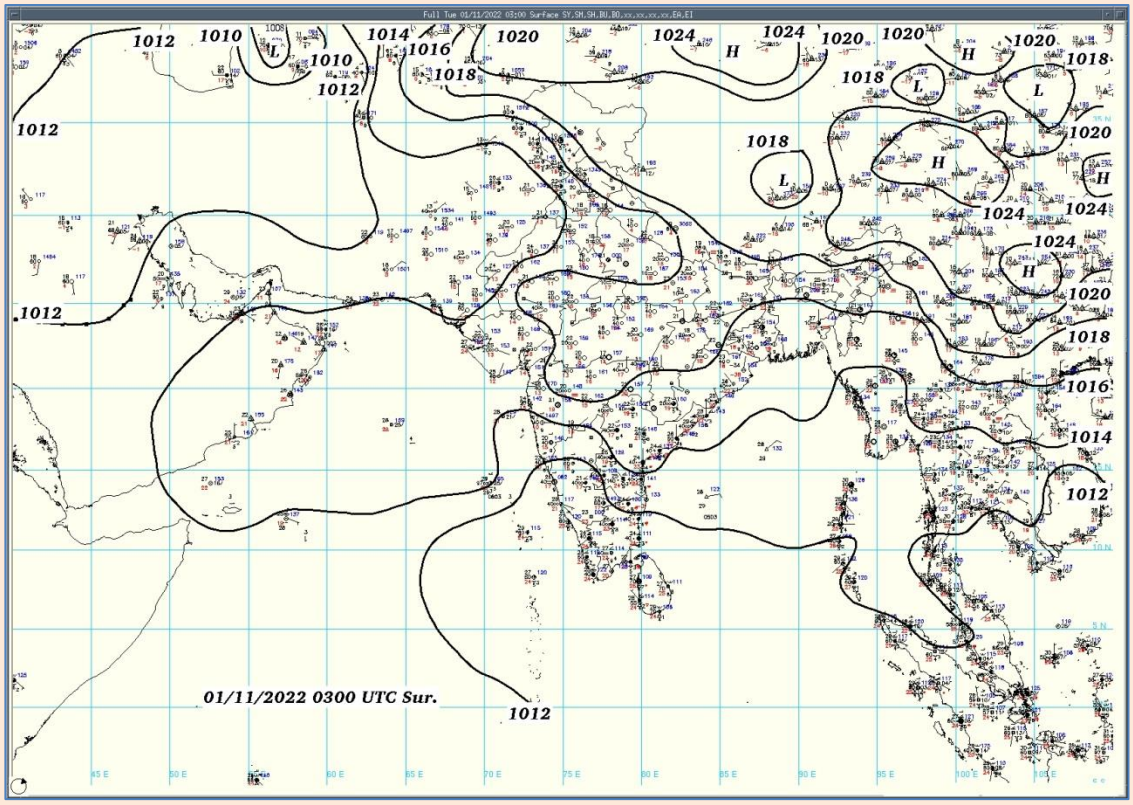
Fig.1c: NCEP reanalysis 850 hPa streamline pattern indicating reversal wind from westerly to easterly over peninsular India during the pentad 28th Oct -01st Nov 2022.

(ii) Commencement of NEM rains: With the setting in of northeasterly winds and under the influence of a cyclonic circulation over southwest Bay of Bengal and adjoining Sri Lanka in the lower tropospheric levels, NEM rains commenced over the coastal Tamilnadu, Puducherry & Karaikal and adjoining south Andhra Pradesh on 29th October 2022. With a cyclonic circulation in the lower tropospheric levels laying over the southwest Bay of Bengal and adjoining Kerala during 30th & 31st October and its gradual movement of the across TN & KER during 01st-05th November, rainfall activity over the NEM subdivisions increased. *Fairly widespread / widespread* rainfall occurred over TN on many days during 30th October to 05th November and over Kerala during 01st-07th November. In TN, *isolated heavy to very heavy* rain occurred on 01st, 02nd & 04th and *isolated heavy to very heavy* rainfall with *extremely heavy* rain at one or two places occurred on 03rd November. *Isolated heavy to very heavy* rain occurred over KER on 04th & 05th November. *Isolated heavy* rain also occurred over KER & CAP on 01st; over CAP, RYS & SIK on 02nd; over KER on 03rd; over TN on 05th & 06th; and over KER on 07th November. ***Active*** monsoon conditions prevailed over TN & RYS on 02nd and over TN & KER on 03rd November 2022.

In TN, **Sirkali** in **Mayiladuthurai** district recorded ***extremely heavy*** **rainfall of 22 cm** during the 24-hr ending 0830 IST of **03rd November**; ***very heavy*** rainfall was recorded in **Tiruvallur** (Red Hills: 13 cm) & **Chennai** (Perambur: 12 cm) districts on **01st**; **Tiruvallur** (Avadi: 17 cm; Ponneri: 16 cm; Red Hills & Gummidipoondi : 14 cm each; Ambathur & Villivakkam : 13 cm each), **Chennai** (Perambur & Collectorate office: 17 cm each; Sholinganallur, MGR Nagar, Nungambakkam & Ayanavaram : 13 cm each; Anna University: 12 cm), **Kancheepuram** (Kattukuppam Arg: 16 cm) and **Chengalpattu** (Cheyyur : 13 cm) districts on **02nd**; **Thanjavur** (Thanjavur: 18 cm, Thanjavur PTO : 12 cm), **Mayiladuthurai** (Kollidam: 16 cm) and **Cuddalore** (Chidambaram : 15 cm, Sethiathope & Chidambaram Aws : 13 cm each, Annamalai Nagar & Parangipettai 12 cm each) districts on **03rd**; **Chennai** (Tondaiyarpet: 14 cm, DGP office: 12 cm) & **Coimbatore** (Mettupalayam: 12 cm) districts on 04th November 2022.

In KER, ***very heavy*** rainfall of 13 cm was recorded in **Idukki** (Peermade AWS) district on **04th** and at **Kottayam** on **05th**.

Surface isobaric analysis and upper air streamline analysis (lower-mid levels) as on 0830 IST & 0530 IST respectively in respect of 01st & 02nd November depicting the cyclonic circulation over southwest Bay of Bengal moving inland are presented in Fig.2a(i); satellite infra-red imageries as on 30 Oct /1530 IST, 01 Nov /0500 IST & 03 Nov /0530 IST depicting the cloudiness associated with intense rainfall activity over TN-KER & Doppler Weather Radar (X-Band) product showing the maximum reflectivity (as on 1130 IST of 01 Nov 2022) associated with very heavy rainfall event over Chennai and neighbourhood during the 24-hr ending 0830 IST of 02nd November 2022 are presented in Fig.2a(ii) and 24-hr accumulated rainfall (based on gauge observed point rainfall data) as on 0830 IST of 02nd & 03rd November 2022 are shown in Fig.2a(iii).



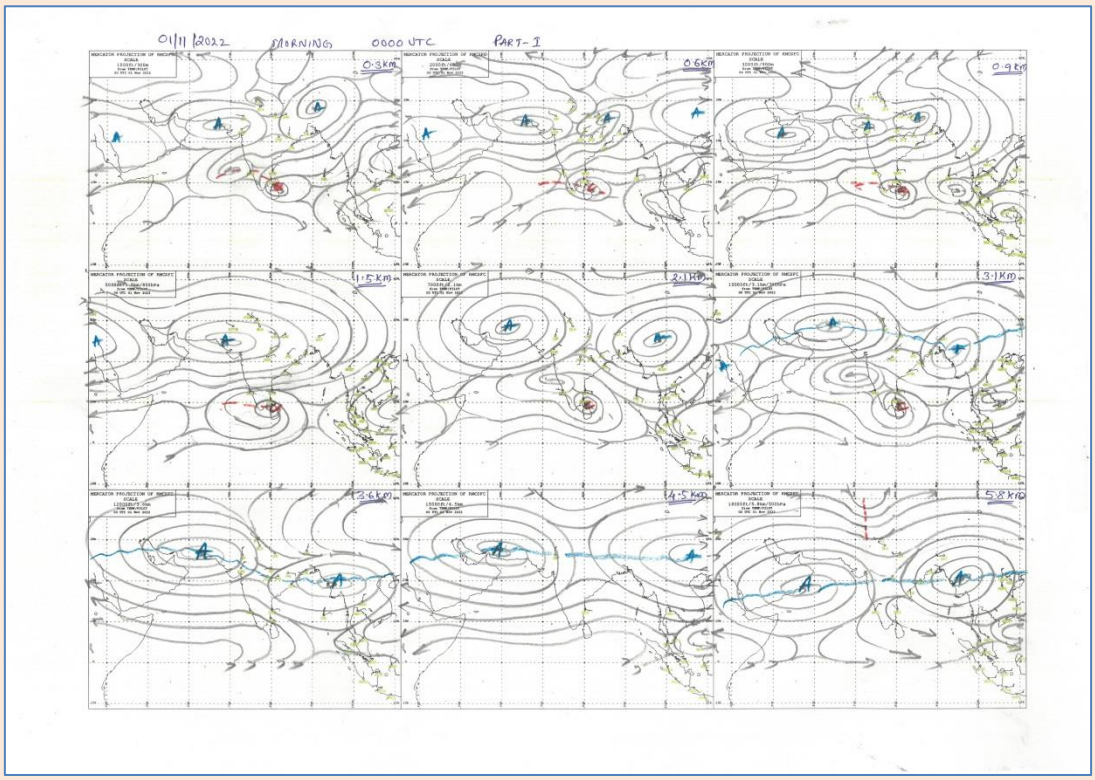
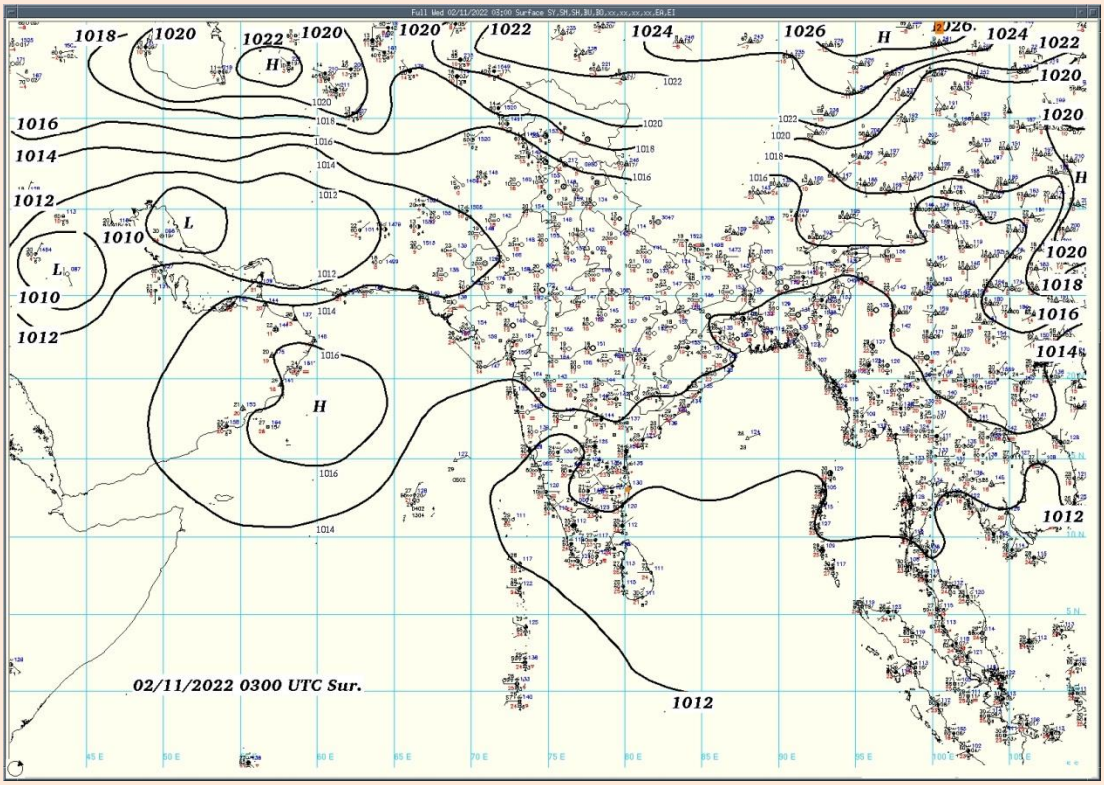
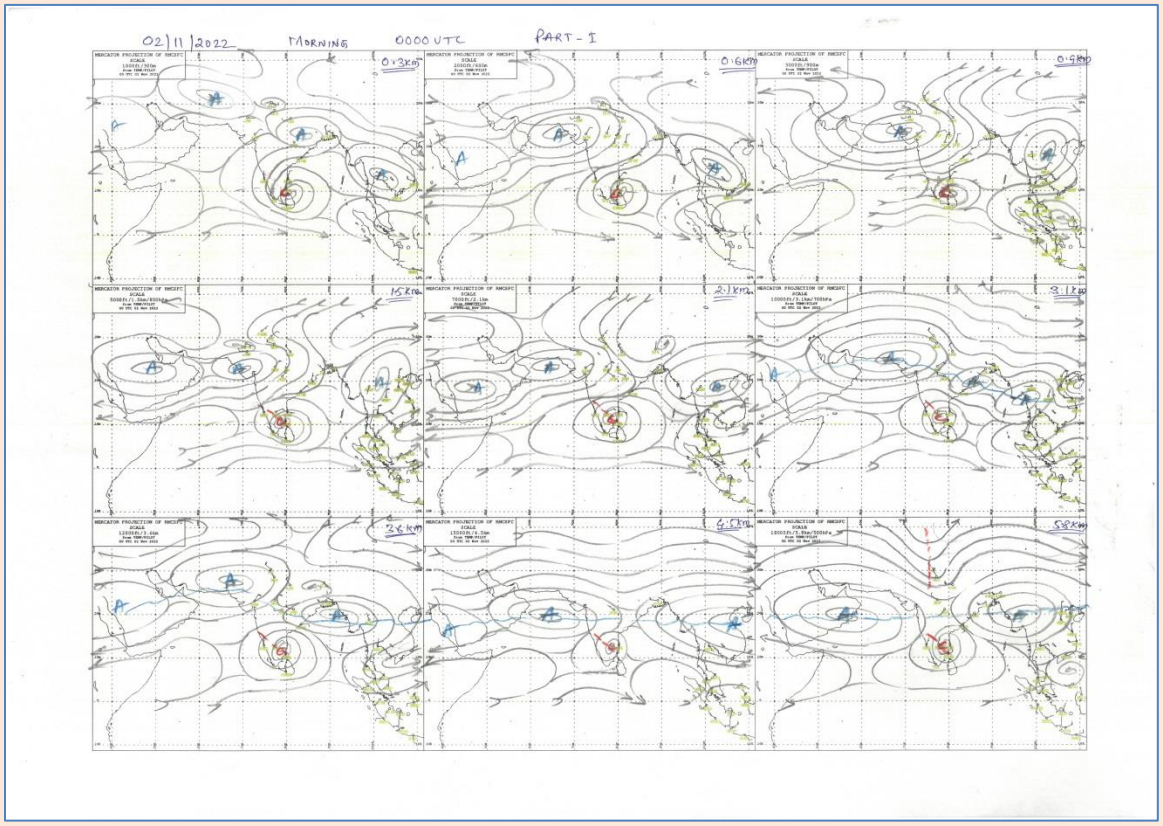


Fig.2a(i): Surface isobaric analysis based on 0830 IST and upper air (lower-mid levels) streamline analysis based on 0530 IST observations of 01st & 02nd November 2022





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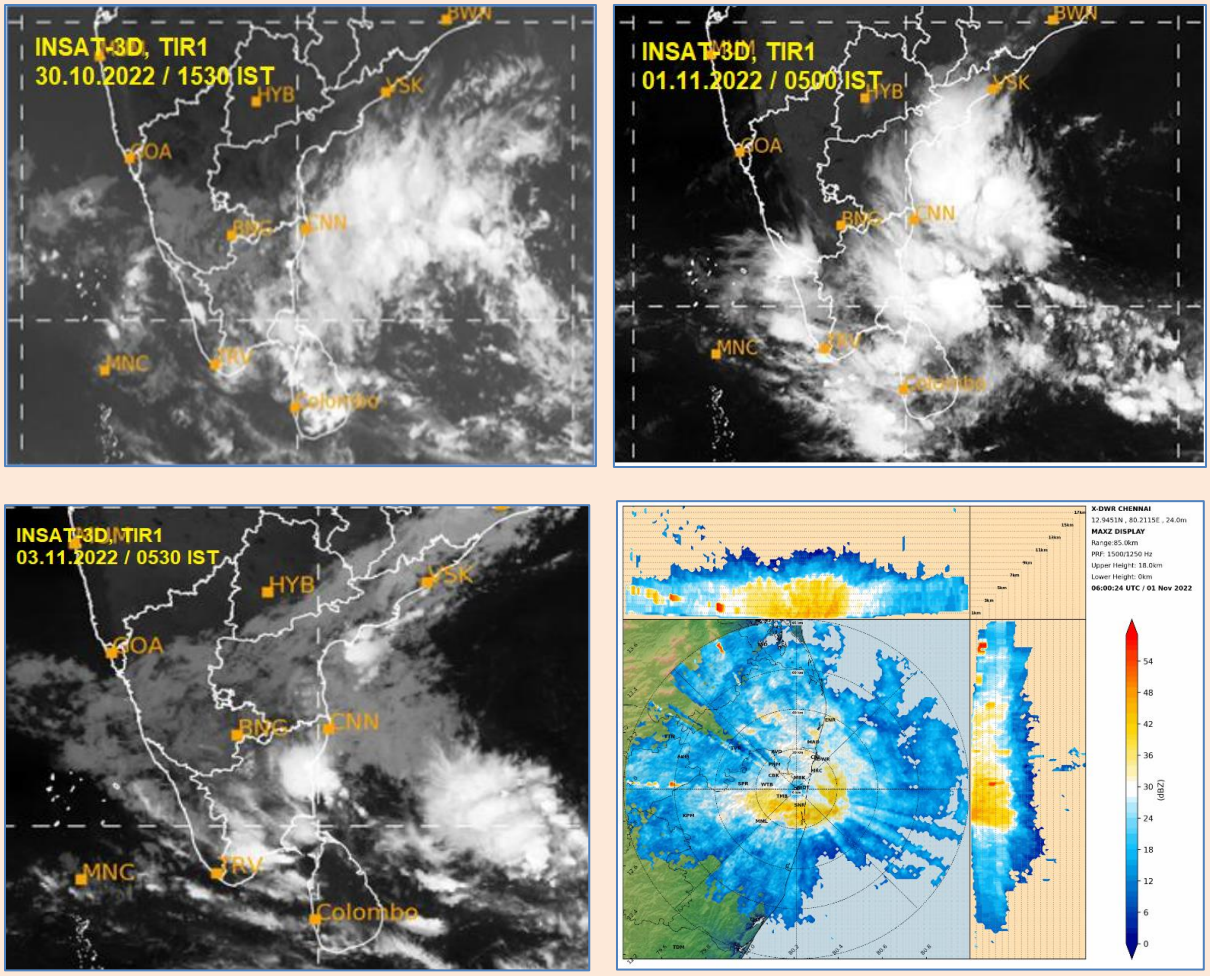
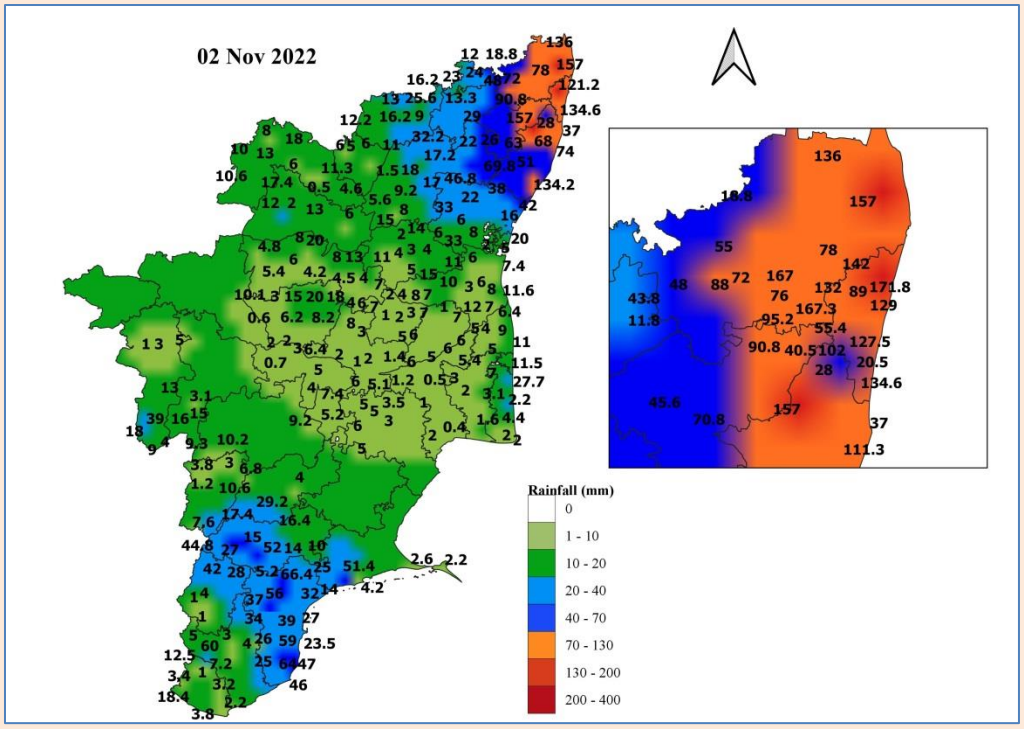


Fig.2a(ii): INSAT-3D infra-red imageries as on 30 Oct /1530 IST, 01 Nov /0500 IST & 03 Nov /05300 IST & Doppler Weather Radar (X-Band) maximum reflectivity product as on 1130 IST of 01 Nov 2022.



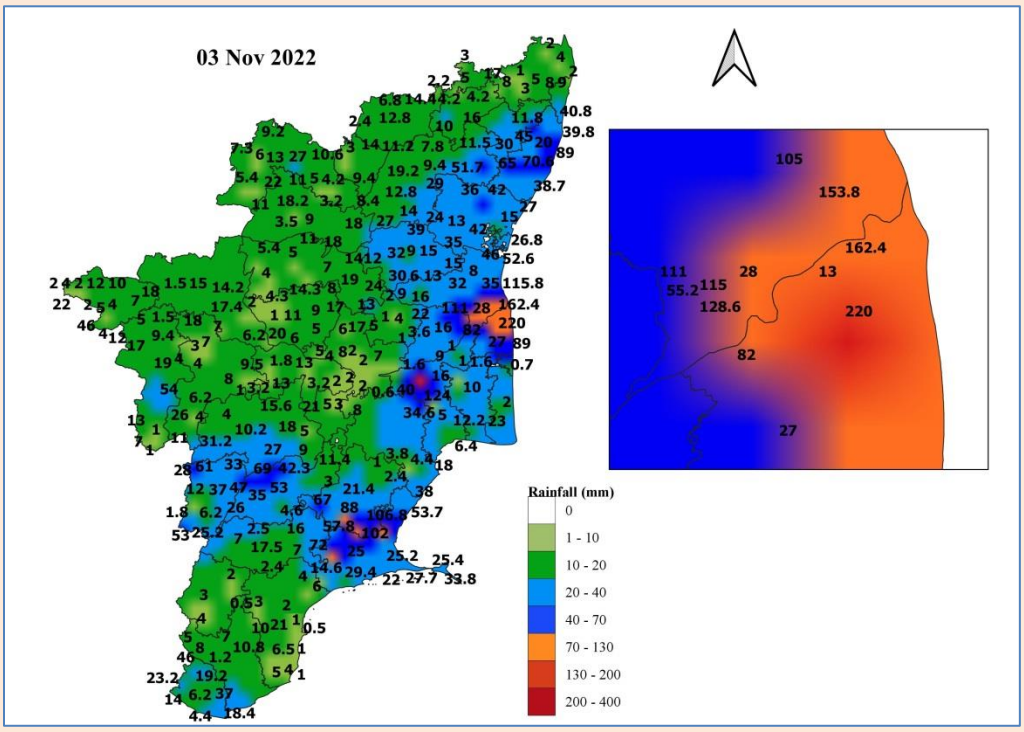


Fig.2a(iii): 24-hr accumulated rainfall (based on gauge observed point rainfall data) as on 0830 IST of 02nd & 03rd November 2022

3. Major synoptic scale systems during the NEM 2022 season

(a) Cyclonic Storm 'SITRANG' over Bay of Bengal during 22nd-25th October 2022

Under the influence of a cyclonic circulation over North Andaman sea and neighbourhood in the lower tropospheric levels on 18th & 19th October 2022, a **Low Pressure Area** (**LOPAR**) formed over North Andaman Sea and adjoining areas of south Andaman Sea & Southeast Bay of Bengal in the early morning (0530 hrs IST) of 20th October. It lay as a well marked LOPAR (**WML**) over north Andaman Sea and adjoining southeast BOB in the evening (1730 hours IST) of 21st October. Under favourable environmental conditions, it concentrated into a **Depression** over southeast and adjoining eastcentral BOB close to Andaman Islands in the forenoon (0830 hrs IST) of 22nd. Moving northwestwards it intensified into a **Deep Depression** (**DD**) over westcentral BOB in the early morning (0530 hrs IST) of 23rd October. Thereafter, it moved nearly northwards and intensified into the **Cyclonic Storm (CS)** "**SITRANG**" in the evening (1730 hrs IST) of 23rd and then gradually recurved north-northeastwards and **crossed Bangladesh coast** between Tinkona and Sandwip close to Barisal (near 22.15°N/90.35°E) in the night of 24th October during 2130 to 2330 hours IST **as a Cyclonic Storm with maximum sustained wind speed of 80-90 kmph gusting to 100 kmph**. Continuing to move north-northeastwards, it weakened into a **DD** over northeast Bangladesh in the early hours (0230 hours IST of 25th) and further into a **Depression** over interior Bangladesh in the early morning (0530 hours IST) of 25th October It then lay as a **WML** over northeast Bangladesh & adjoining Meghalaya in the forenoon (0830 hours IST) of 25th October, 2022.

Under the influence of this cyclone, due to sweeping away of moisture from the Indian region, rainfall activity over the central and peninsular India decreased drastically leading to withdrawal of southwest monsoon from the Indian region on 23rd October 2022.

Track of the system is presented in Fig.3a(i) and INSAT-3D infra-red imagery depicting the cloudiness associated with the system as on 23rd October / 1900 IST is shown in Fig.3a(ii).

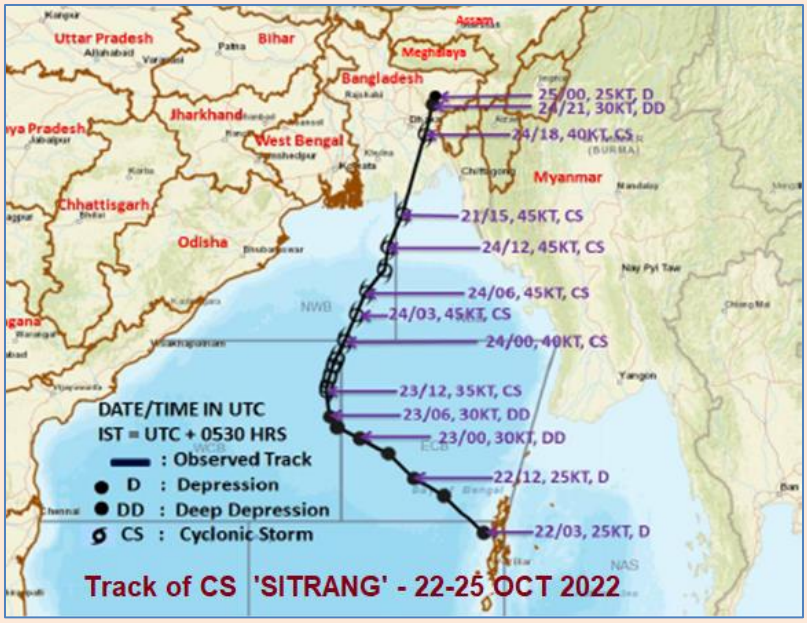


Fig.3a(i) : Track of Cyclonic Storm 'SITRANG' over Bay of Bengal during 22-25 Oct 2022

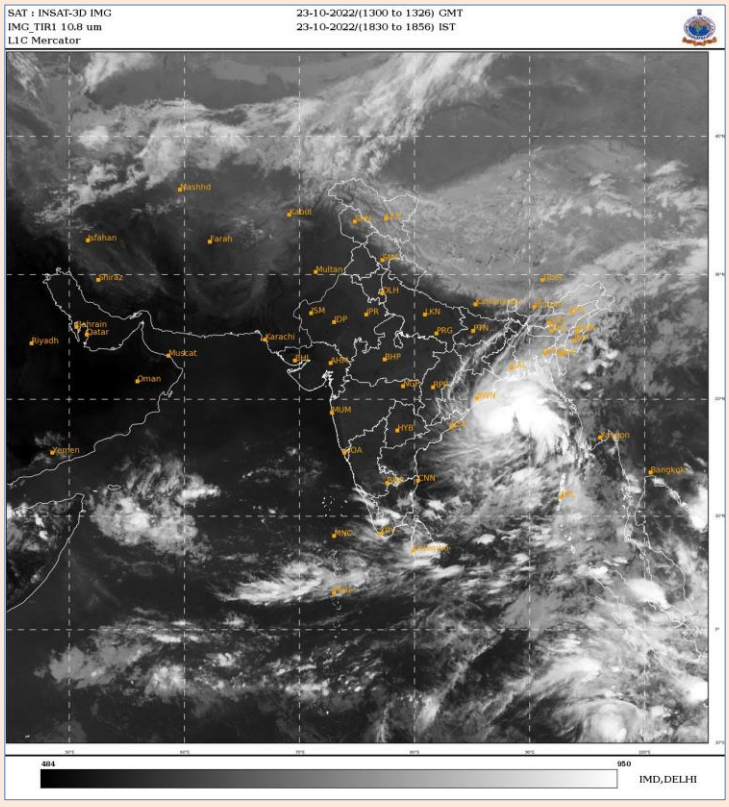


Fig.3a(ii): INSAT-3D, infra red imagery as on 1900 IST of 23 October 2022

(b) Well marked Low Pressure Area over Bay of Bengal during 09th-13th November 2022

Under the influence of a cyclonic circulation over southwest Bay of Bengal and adjoining equatorial Indian ocean extending up to mid tropospheric levels on 08th November 2022, a **Low Pressure Area** formed over the southwest Bay of Bengal and neighbourhood with associated upper air cyclonic circulation extending upto upper tropospheric levels as on 0830 IST of 9th November, 2022. It lay over southwest BOB off Sri Lanka coast on 10th and became **well marked LOPAR (WML)** and lay over southwest BOB and adjoining north Sri Lanka at 0830 IST of 11th November. It moved across north coastal TN and KER during 12th & 13th as a **LOPAR** and weakened over southeast Arabian Sea on 14th November 2022. Fig.3b(i) presents Surface isobaric analysis as on 11th/0830 IST and upper air streamline analysis (lower-mid levels) as on 11th/0530 IST of November 2022 depicting the WML and the associated cyclonic circulation extending upto the mid tropospheric levels.

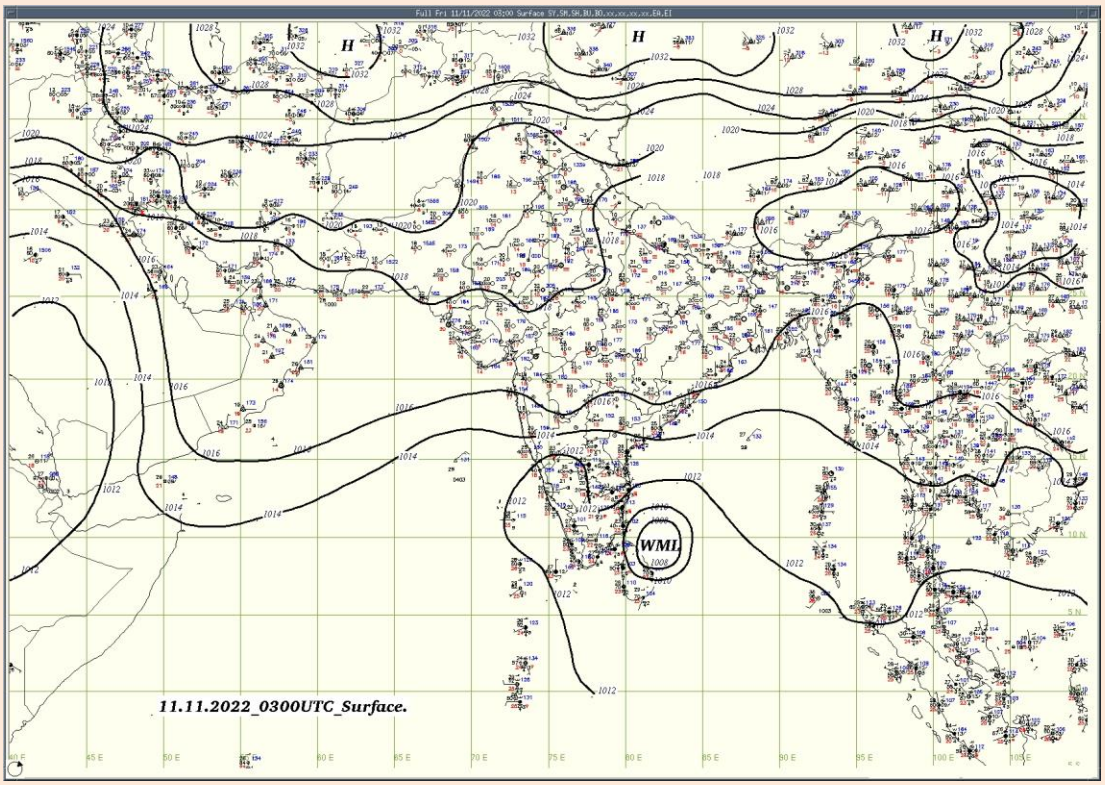
Associated with the formation and movement of the system, *fairly widespread* to *widespread* rainfall occurred over the TN subdivision during 11th-15th & over KER during 12th-15th November.

Heavy* to *very heavy rainfall at isolated places with ***extremely heavy*** falls (≥ 21 cm/day) at one or two places occurred over TN subdivision in **Mayiladuthurai** (**Sirkazhi – 44 cm, Kollidam: 32 cm) and Cuddalore (Chidambaram: 31 cm, Annamalai nagar : 28 cm & Bhuvanagiri : 21 cm**) districts on 12th November. ***Heavy to very heavy* rain** also occurred over TN at *isolated* places over Tiruppur, Pudukkottai & Karur districts on 12th, over Kancheepuram, Tiruvallur and Erode districts on 13th, over Tirunelveli district on 15th and over Virudhunagar district on 16th & over Nellore district in CAP on 13th & 14th November 2022. ***Isolated heavy*** rain also occurred in a few other districts in TN during 11th-16th, over KER on 12th, 14th & 15th and over RYS on 13th November 2022.

Active to Vigorous monsoon conditions prevailed over TN during 11th-13th and ***active*** monsoon conditions prevailed over KER on 12th & 13th November 2022.

. INSAT-3D infrared imagery as on 11th/0500 IST and brightness temperature product as on 11th/2000 IST depicting the intense cloudiness associated with the system and Doppler Weather Radars - Karaikal & Chennai (X-band) – maximum reflectivity product as on 11th/ 2030 IST & 12th / 0430 IST depicting the rainfall associated the system are presented in Fig.3b(ii). 24-hr accumulated rainfall ending 0830 IST of 12th November 2022 (based on gauge observed point rainfall data) depicting the intense rainfall activity over the delta and adjoining districts on 12th is shown in Fig.3b(iii).

Associated with intense rainfall activity, inland flooding occurred in several areas of Mayiladuthurai, Cuddalore, Thiruvallur & adjoining districts of north coastal Tamilnadu during 12th-14th November 2022. Fig.3b(iv) presents some sample media reports on inland flooding associated with the intense rainfall activity during 12th-14th November 2022.



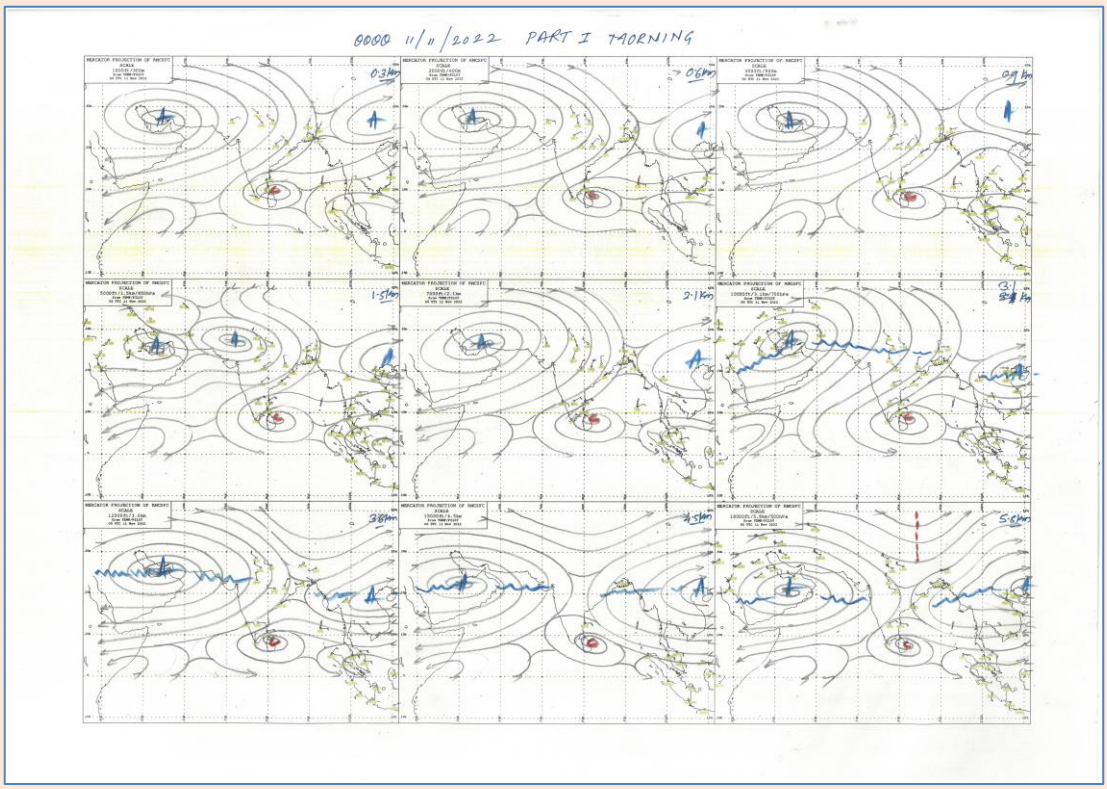


Fig.3b(i): Surface isobaric analysis based on 0830 IST and upper air (lower-mid levels) streamline analysis based on 0530 IST observations of 11th November 2022

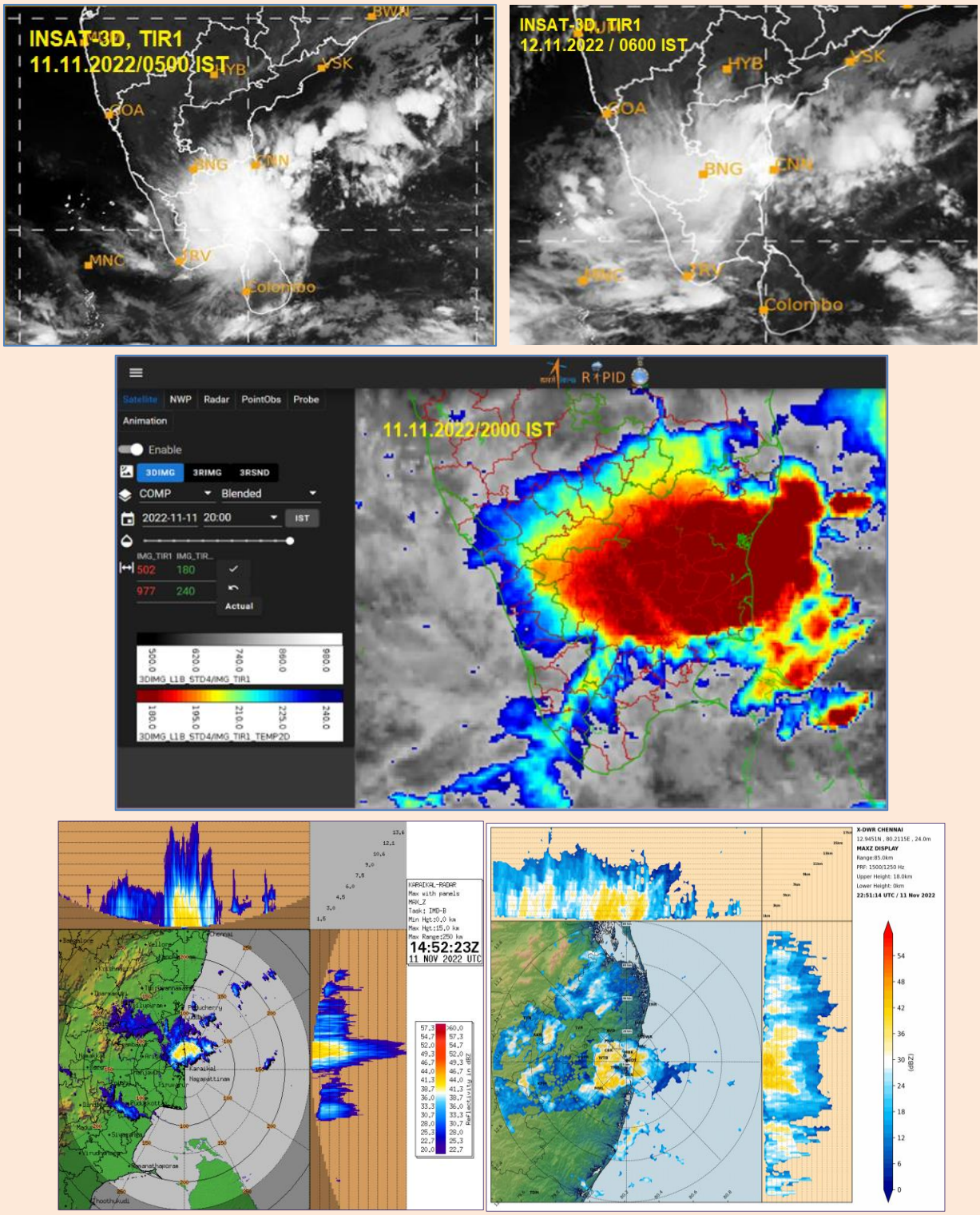
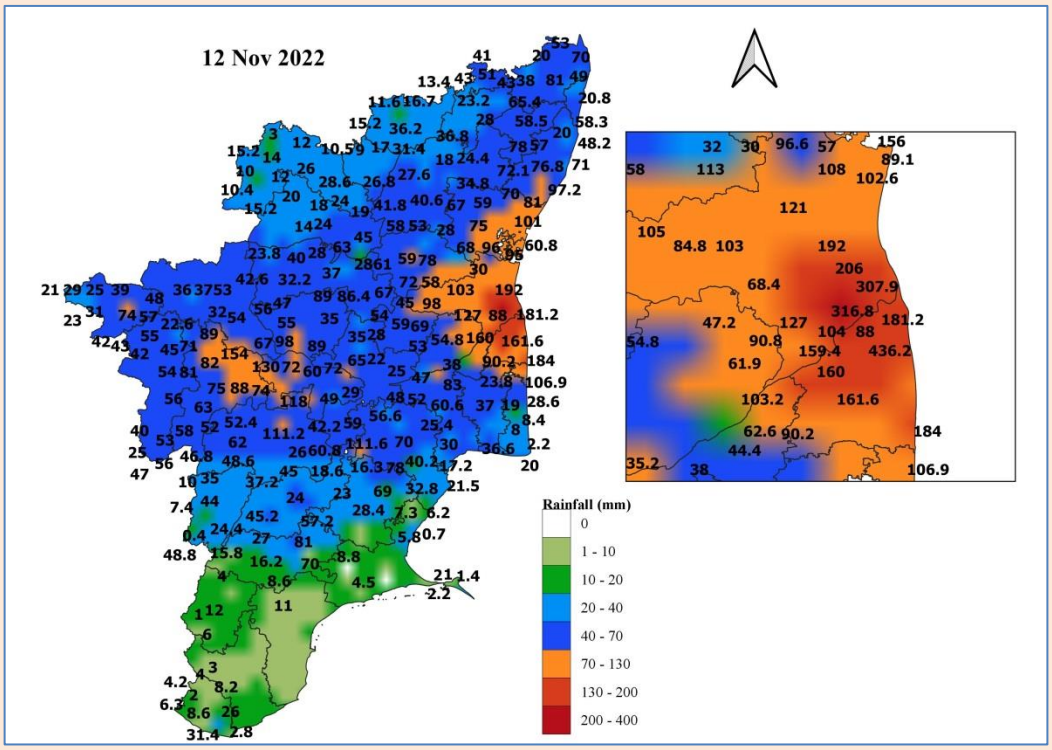


Fig.3b(ii): INSAT-3D infrared imageries as on 11th/0500 IST & 12th/0600 IST and IR brightness temperature product as on 11th/2000 IST, Doppler Weather Radars Karaikal & Chennai (X-band) as on 11th/ 2030 IST & 12th / 0430 IST respectively of November 2022



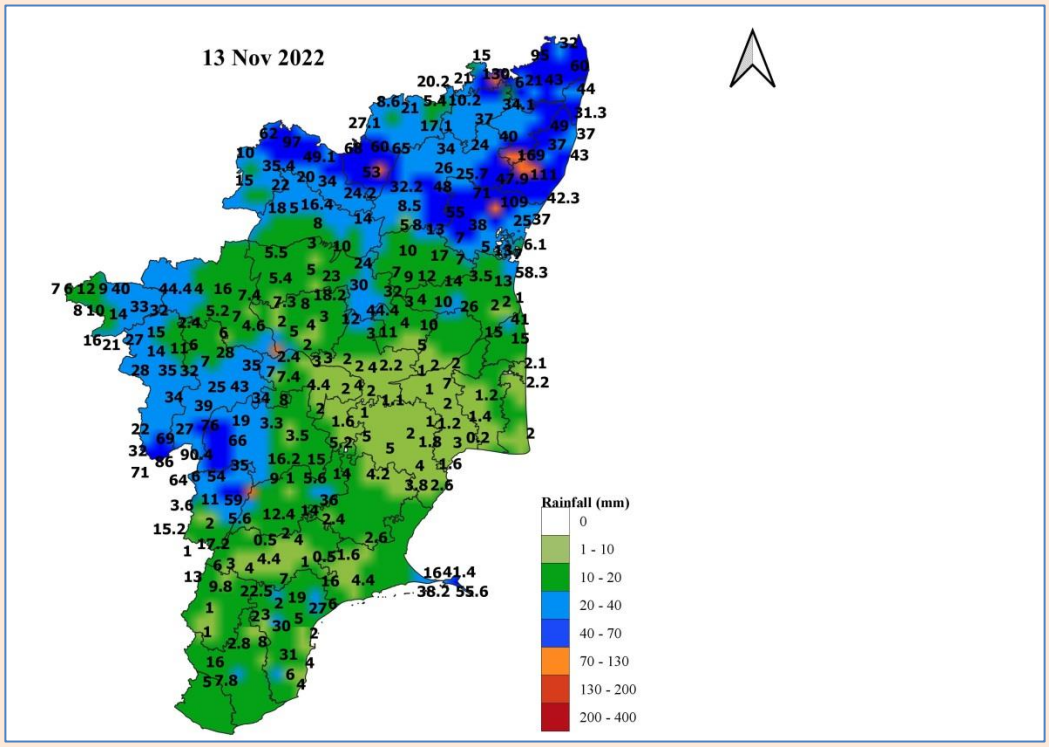


Fig.3b(iii): 24-hr accumulated rainfall (based on gauge observed point rainfall data) ending 0830 IST of 12th & 13th November 2022

Fig.3b(iv): Sample media reports depicting the inland flooding over Mayiladuthurai and Thrivallur districts during 12th-14th November 2022

(c) Depression over Bay of Bengal during 20th-22nd November 2022

Under the influence of an upper air cyclonic circulation over South Andaman Sea & neighbourhood extending up to middle tropospheric levels from the morning (0530 hours IST) of 15th November, a **Low Pressure Area** formed over Southeast Bay of Bengal & adjoining Andaman Sea in the morning (0530 hours IST) of 17th. It moved west-northwestwards and

became a well-marked LOPAR (**WML**) over central parts of south BOB in the morning (0530 hours IST) of 19th. Moving in the same direction, under favourable environmental conditions, it concentrated into a **Depression** over southwest and adjoining Southeast BOB in the morning (0530 hours IST) of the 20th. Moving further west-northwestwards it weakened into a **WML** over Westcentral and adjoining Southwest Bay of Bengal off North Tamil Nadu – South Andhra Pradesh coasts in the morning (0830 hours IST) of the 22nd. The remnant of the system continued to move west-northwestwards and gradually weakened further into a **LOPAR** on in the evening (1730 hours IST) of 22nd November 2022. The observed track of the system is presented in Fig.3c(i).

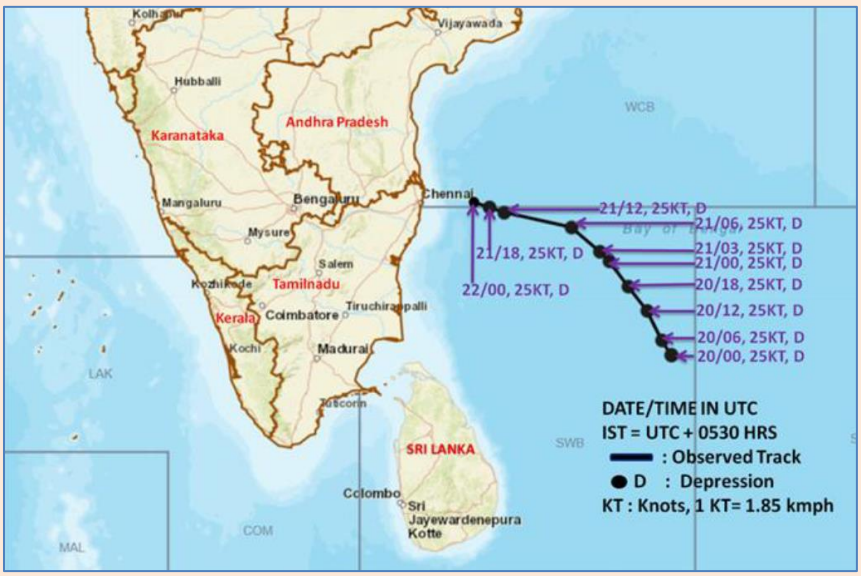


Fig.3c(i): Observed track of the Depression over Bay of Bengal during 20th-22nd Nov 2022

Associated with the passage of the remnant of the system, *scattered* rainfall occurred over CAP during 21st-25th November; *scattered* to *fairly widespread* rainfall over RYS and *fairly widespread* to *widespread* rainfall over SIK during 23rd-25th; only *isolated* rainfall activity was reported over the TN subdivision during the period.

Isolated heavy rain occurred during the 24-hr ending 0830 IST of 23rd over CAP (Tada & Sulurpeta in SPSR Nellore district: 9 cm) and RYS (Satyavedu in Chittoor district: 9 cm); & on 24th over TN (Thamaraipakkam & Tiruttani in Thiruvallur district: 10 cm & Kanchipuram: 7 cm).

Active monsoon conditions prevailed over RYS on 23rd & 24th November 2022.

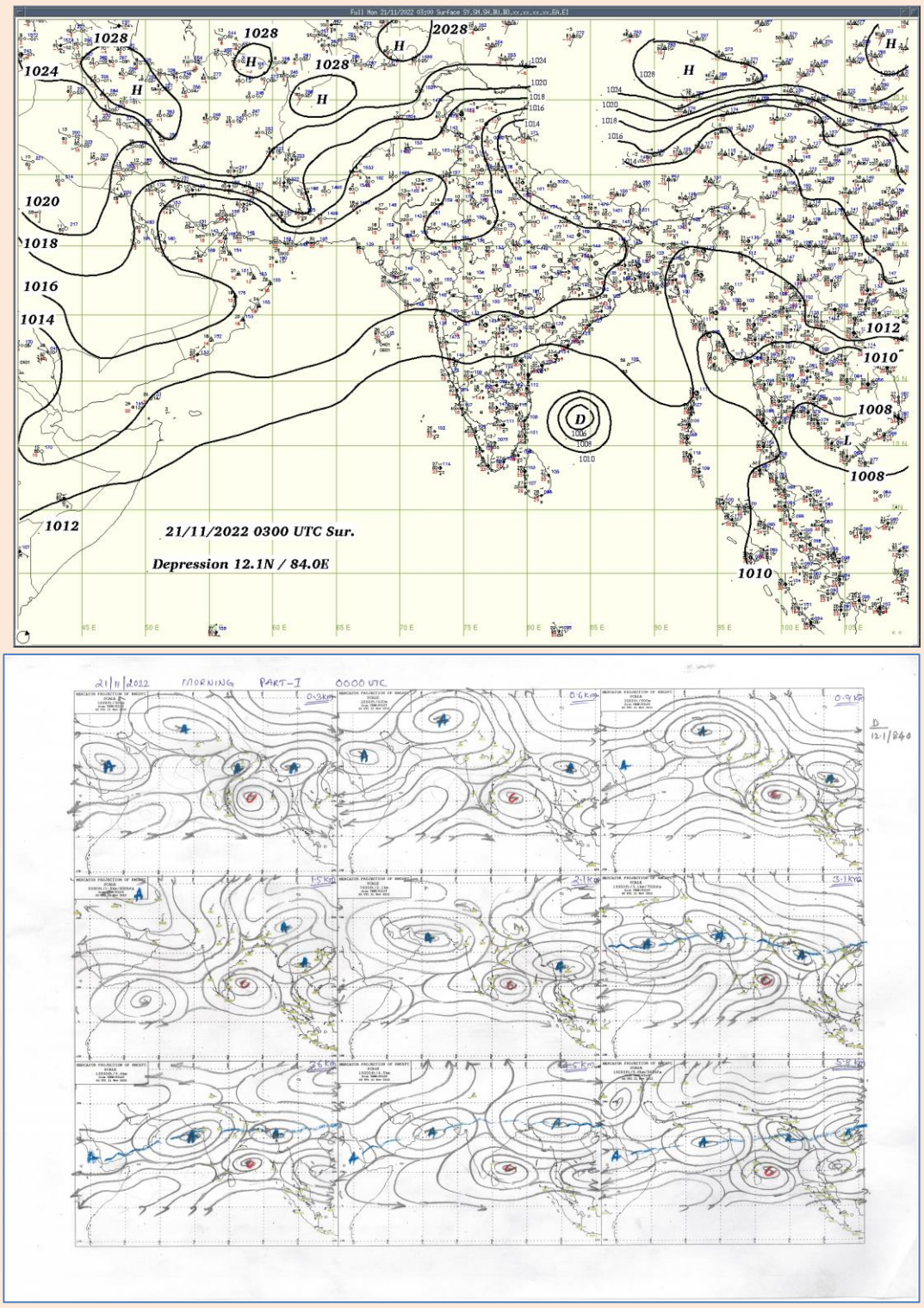


Fig.3c(ii): Surface isobaric analysis based on 0830 IST and upper air (lower-mid levels) streamline analysis based on 0530 IST observations of 21st November 2022

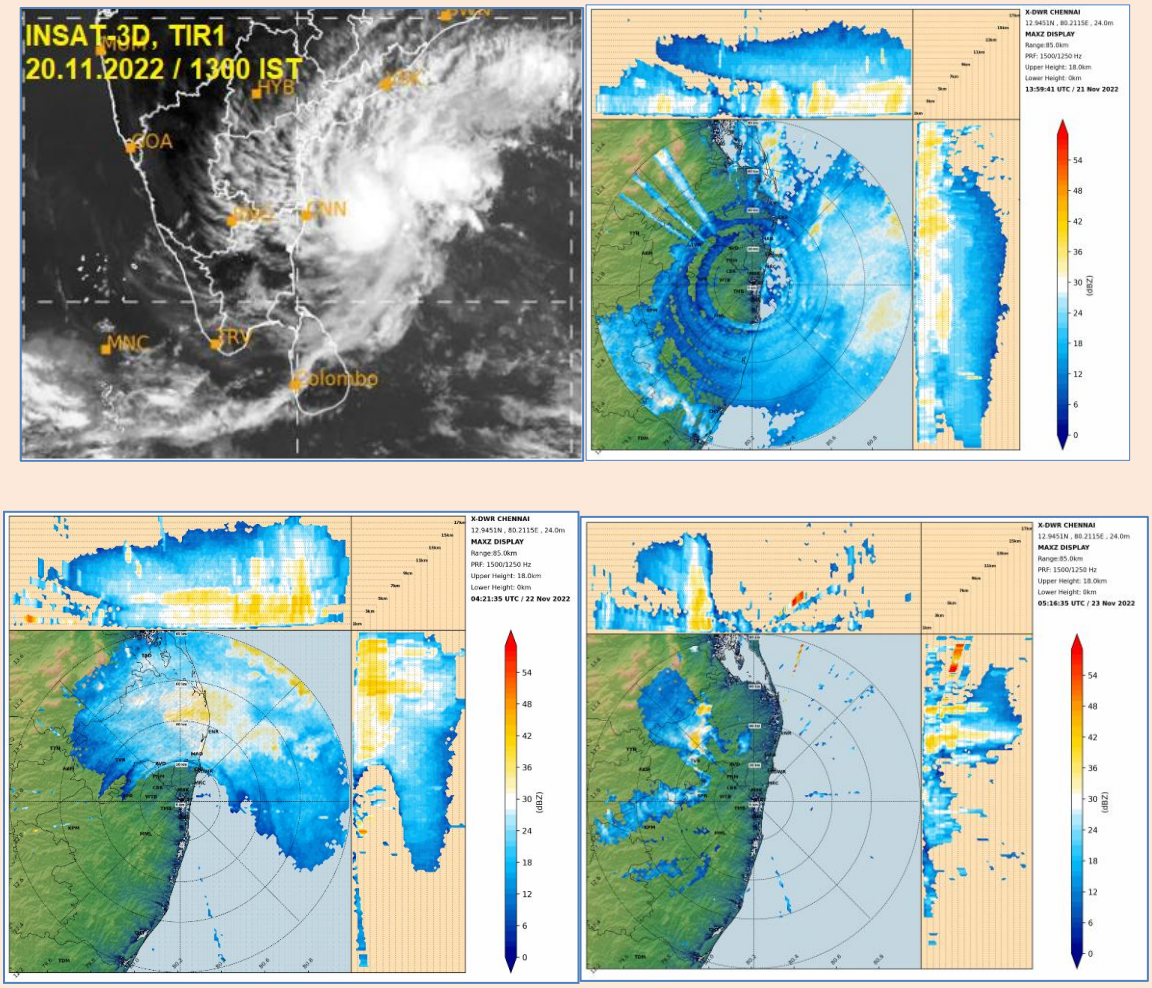


Fig.3c(iii): INSAT-3D infra-red imagery as on 20th/1300 IST & Doppler Weather Radar, Chennai (X-band) maximum reflectivity product as on as on 21st/1930 IST, 22nd/1000 IST & 23rd 1045 IST of November 2022

(d) Severe Cyclonic Storm 'MANDOUS' over Bay of Bengal during 06-10 December 2022

Under the influence of an upper air cyclonic circulation from south China Sea observed over south Andaman Sea and adjoining equatorial Indian Ocean and strait of Malacca in the morning (0530 hours IST) of 4th December, a **Low Pressure Area** formed over South Andaman Sea & neighbourhood in the morning (0530 hours IST) of 5th. It became a well marked LOPAR (WML) over Southeast BOB in the morning (0530 hours IST) of 06th. Under favourable environmental conditions, it concentrated into a **Depression** over Southeast BOB in the evening (1730 hours IST) of 6th. It moved west-northwestwards and intensified further into a **Deep Depression** (DD) over southeast & adjoining southwest BOB n the morning (0530 hours IST) of 7th. Continuing to move west-northwestwards, it intensified into the **Cyclonic Storm (CS) "MANDOUS" pronounced as "Man-Dous"** over southwest BOB around midnight (2330 hours IST) of 7th and further into a Severe Cyclonic Storm (SCS) in the evening (1730 hours IST) of

8th. It maintained the intensity of SCS till early hours of 9th. The peak intensity of the storm was **85-95 kmph gusting to 95 kmph** during this period.

Thereafter, continuing to move west-northwestwards, it entered unfavourable environment (moderate to high wind shear, interaction with land surface, relatively colder sea and lower Ocean heat content) and weakened into a CS over southwest BOB off north Tamilnadu and Puducherry coasts in the morning (0530 hours IST) of 9th. It then moved nearly northwestwards and **crossed north Tamilnadu, Puducherry and adjoining south Andhra Pradesh coasts between Puducherry and Sriharikota, near latitude 12.60°N and longitude 80.15°E, close to Mamallapuram (Mahabalipuram) during midnight (2330 hours IST) of 9th** and early hours (0230 hours IST) of 10th December as a CS with the maximum sustained wind speed (MSW) of **65-75 kmph gusting to 85 kmph**.

During landfall, Radar, High Wind Speed Recorder (HWSR) and hourly special coastal observations indicate that, gale winds speed reaching 65-75 kmph gusting to 85 kmph prevailed around the landfall area. Chennai (MBK) reported surface wind speed of 25-30 knots (45-55 kmph) during 09th/2330 IST to 10th/0130 IST and 24-hr pressure change of **-10.4 hPa** on 09th/2330 IST and -9.1 hPa on 10th/0230 IST. Chennai (MBK) anemograph recorded **70 kmph** during 0030-0045 IST of 10th December. Chennai (NBK) HWSR recorded **85 kmph** in gust (45-48 knots; about 83-88 kmph) during the period 09th/2330 IST to 10th/0035 IST (1800-1935 UTC).

After the landfall, it moved west-northwestwards and weakened into a DD over North Tamilnadu in the early morning (0530 hours IST) of 10th and then moved west-southwestwards and weakened into a **Depression** over North Tamilnadu around noon (1130 hours IST), into a **WML** over north interior Tamilnadu in the evening (1730 hours IST) of 10th and into a **LOPAR** over north interior Tamilnadu and adjoining South Interior Karnataka & north Kerala in the morning (0530 hours IST) of 11th December 2022.

The observed track of the system is presented in Fig. 3d(i). Surface isobaric analysis as on 0830 IST and upper air streamline analysis as on 0530 IST of 09th December depicting the CS off north Tamilnadu-Puducherry coasts and the associated upper air cyclonic circulation extending upto upper tropospheric levels are presented in Fig.3d(ii). Satellite & Radar imageries, plot of hourly coastal observations, Chennai (MBK) anemograph of 09th-10th December, plot of Chennai (NBK) HWSR data depicting the synoptic features during the landfall of the system are presented in Fig.3d(iii).

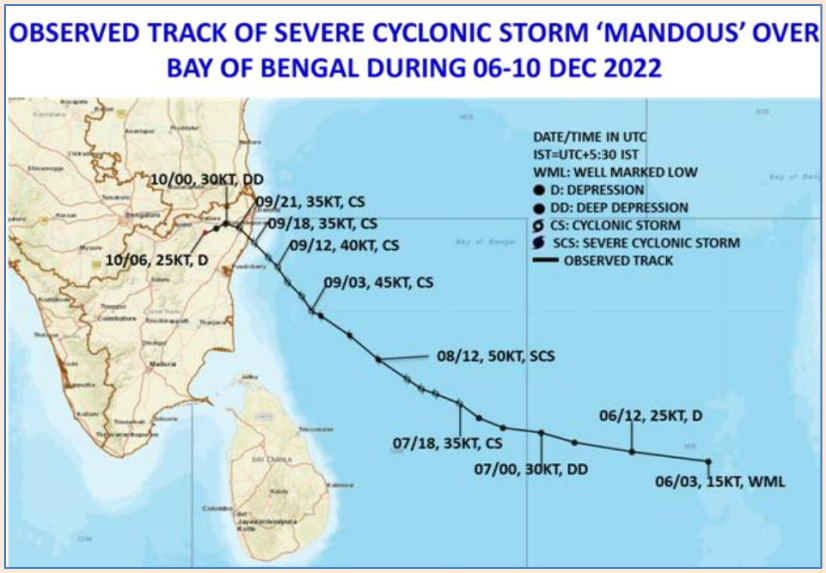


Fig.3d(i): Observed track of Severe Cyclonic Storm 'MANDOUS' over the Bay of Bengal during 06th-10th December 2022

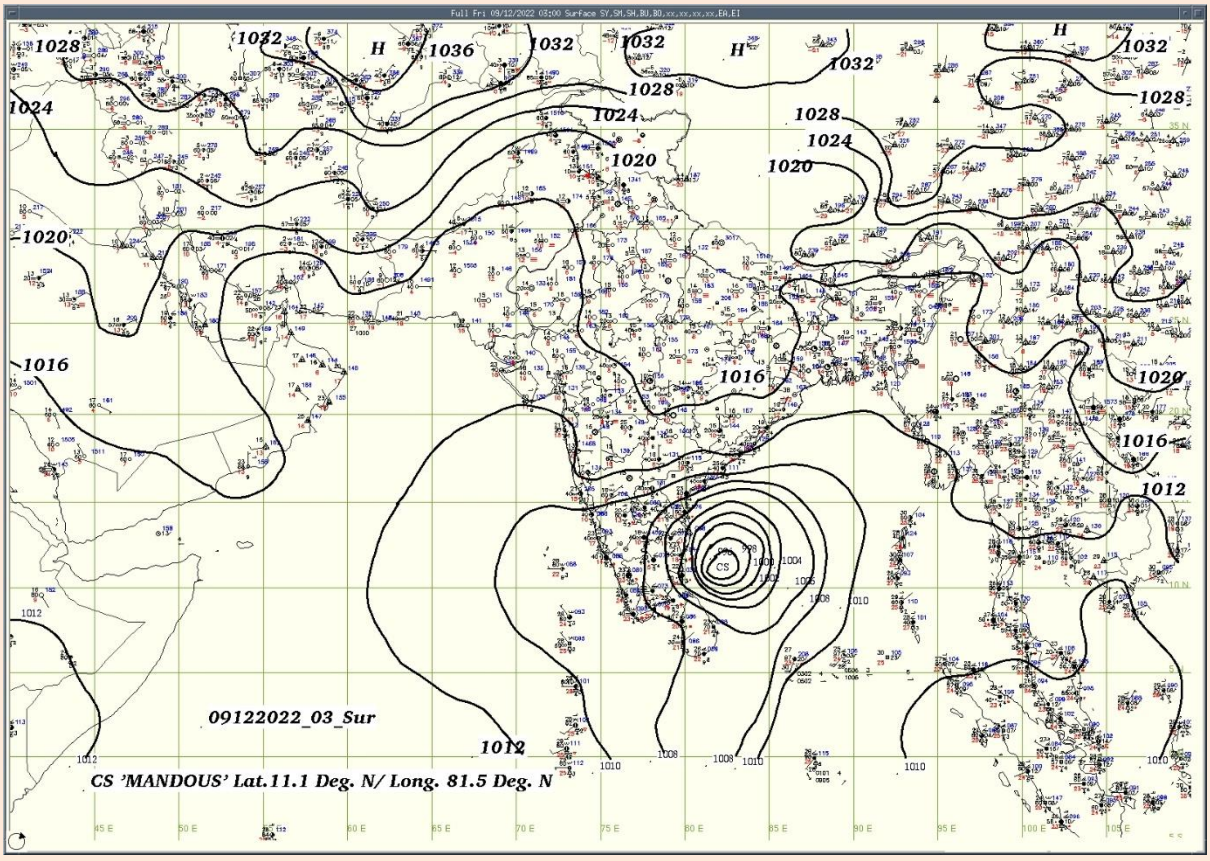
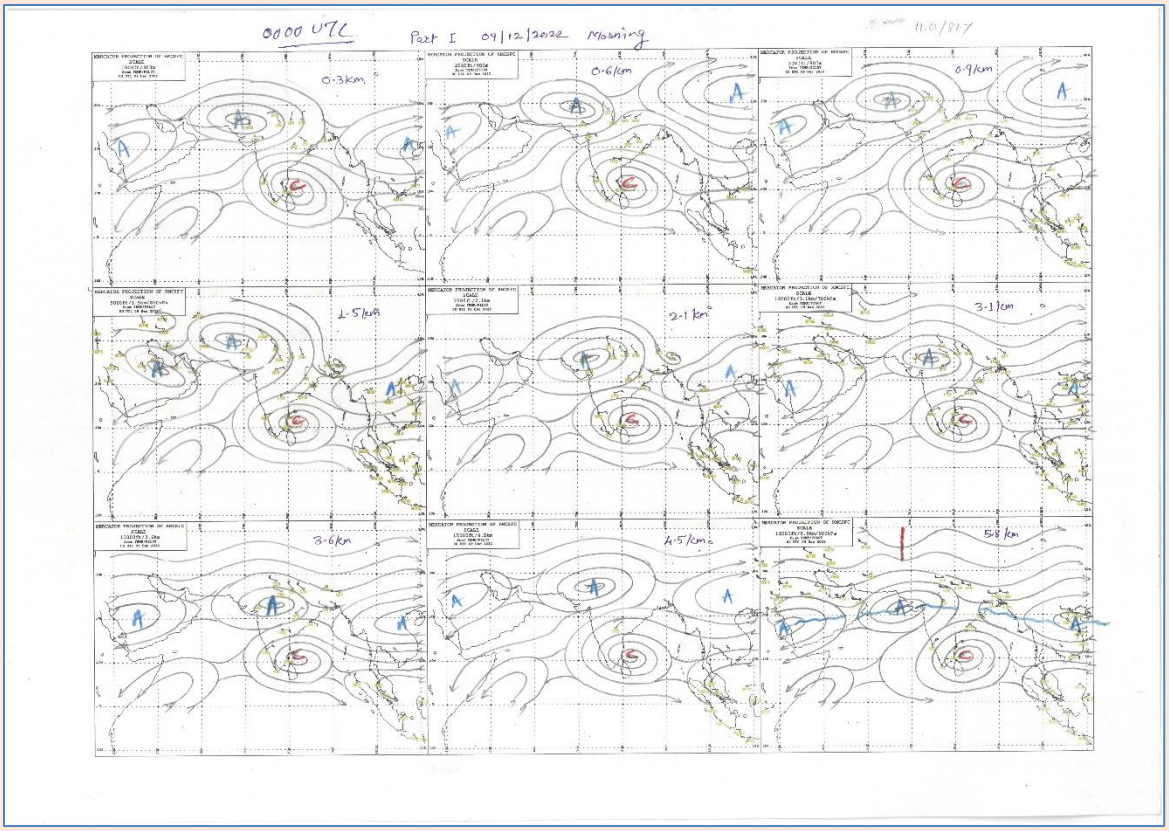


Fig.3d(ii): Surface isobaric analysis based on 0830 IST and upper air streamline analysis based on 0530 IST observations of 09th December 2022



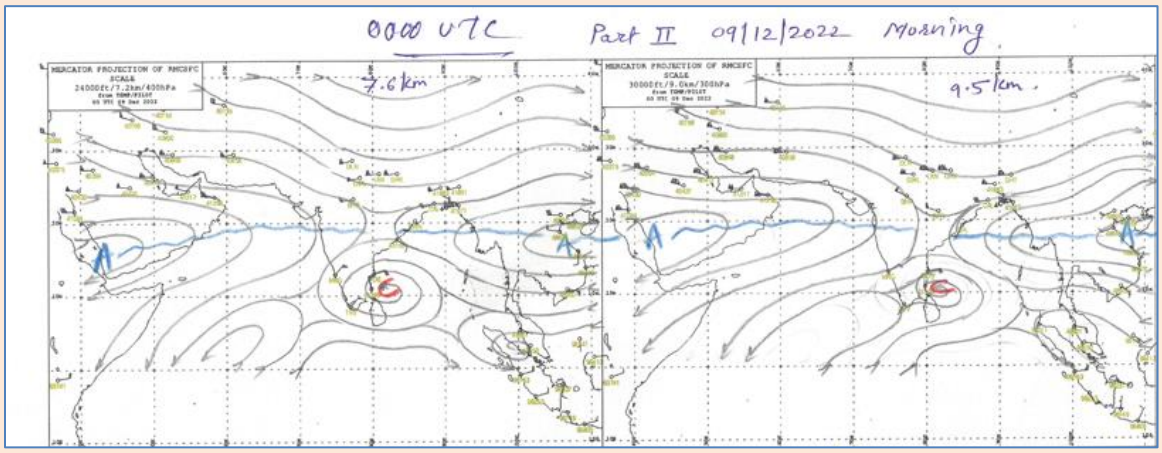


Fig.3d(ii) contd.

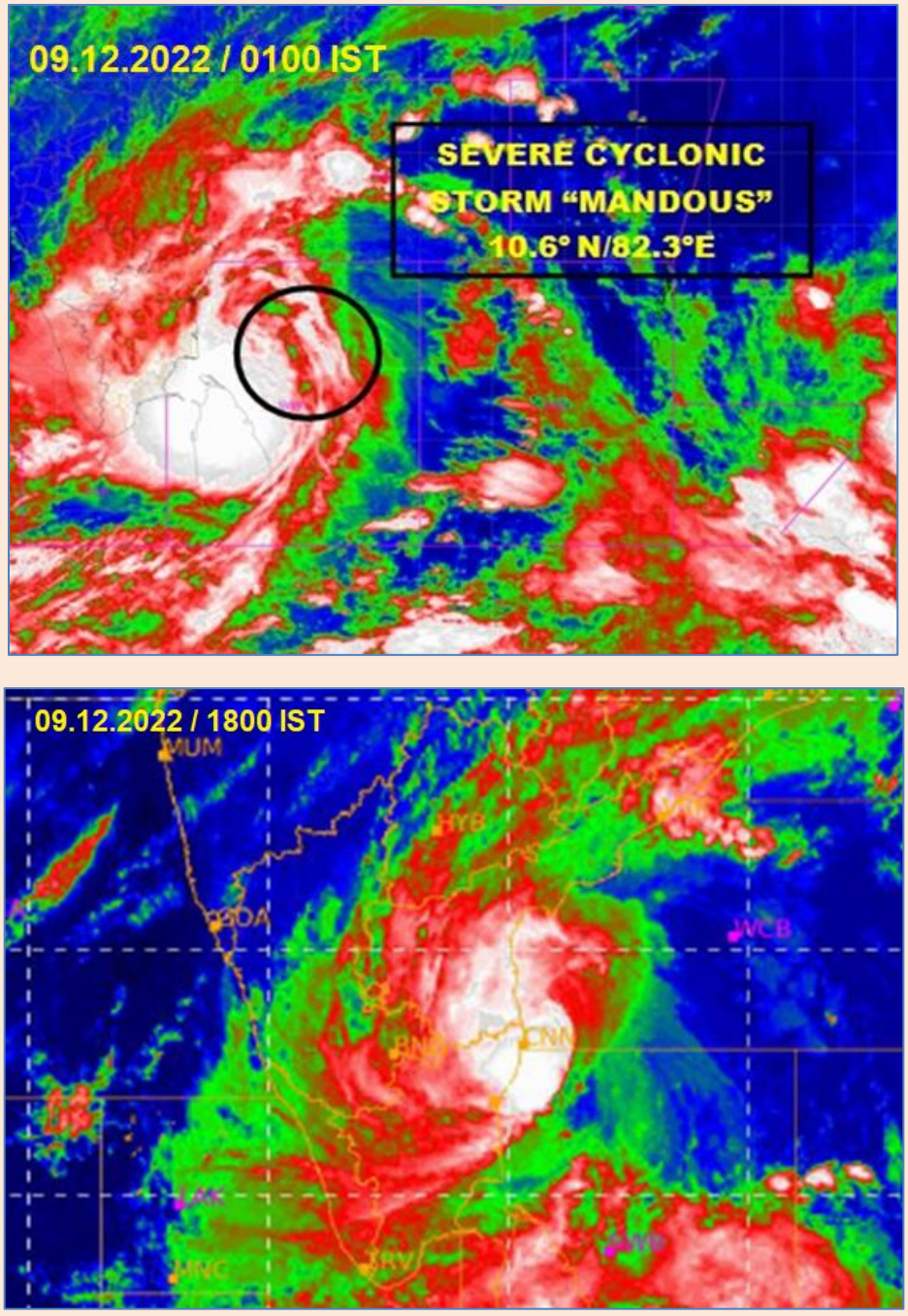


Fig.3d(iii) : INSAT-3D - enhanced product as on 09/0100 IST & 09/1800 IST and Doppler Weather Radar Chennai - maximum reflectivity product ason 09/2030 IST

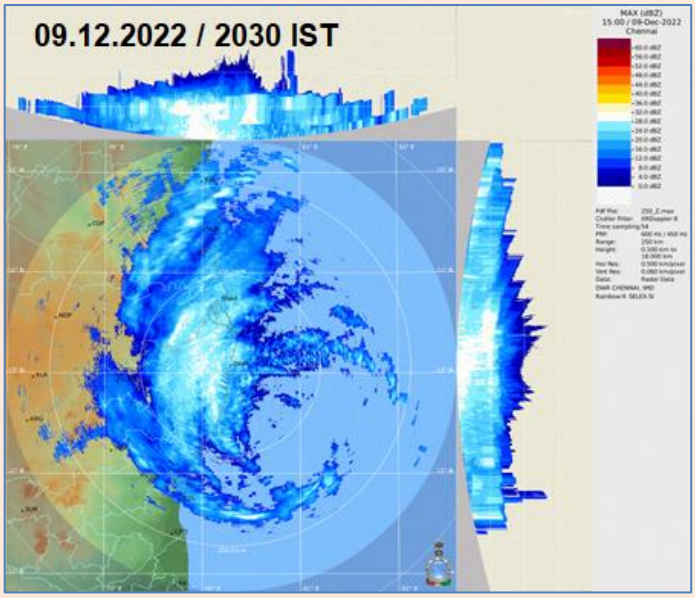


Fig.3d(iii) contd.

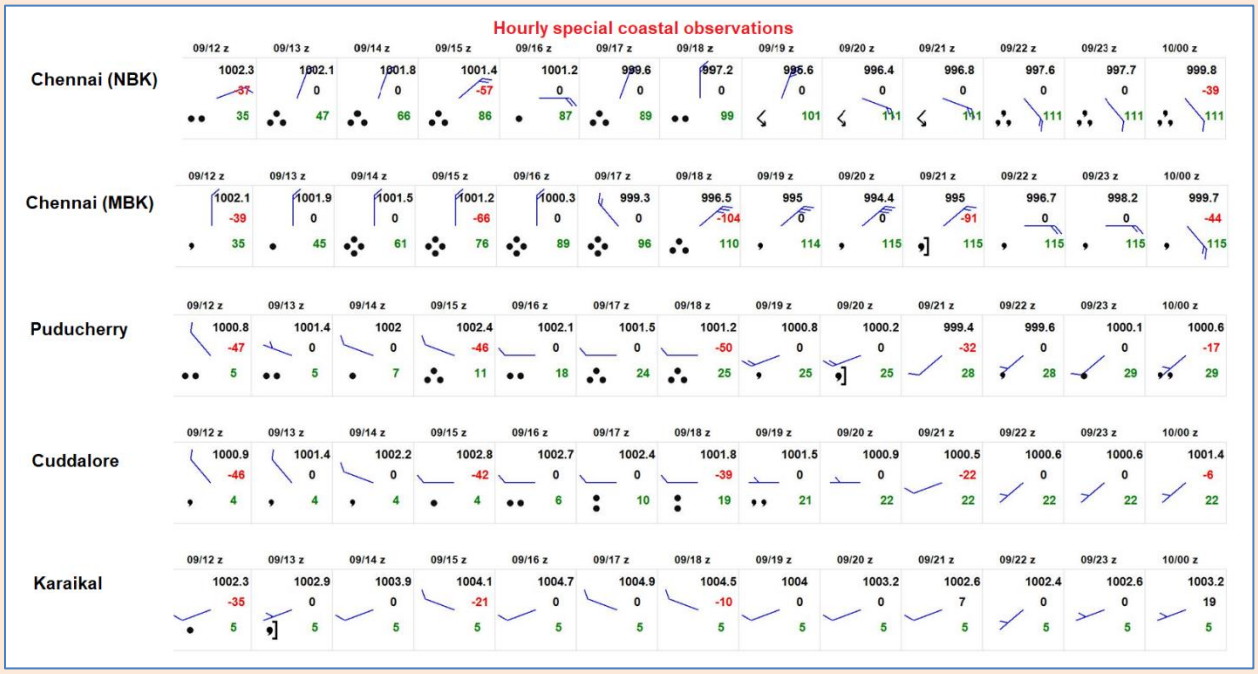
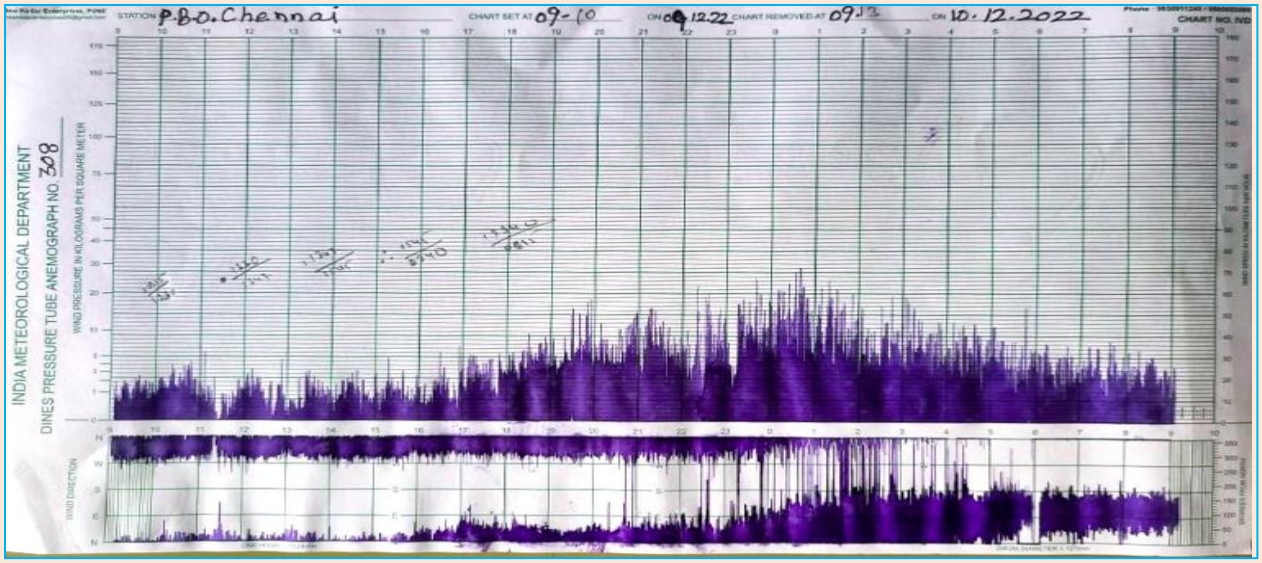


Fig.3d(iv) Plot of hourly special coastal observations during 09th/1730 IST to 10th/0530 IST



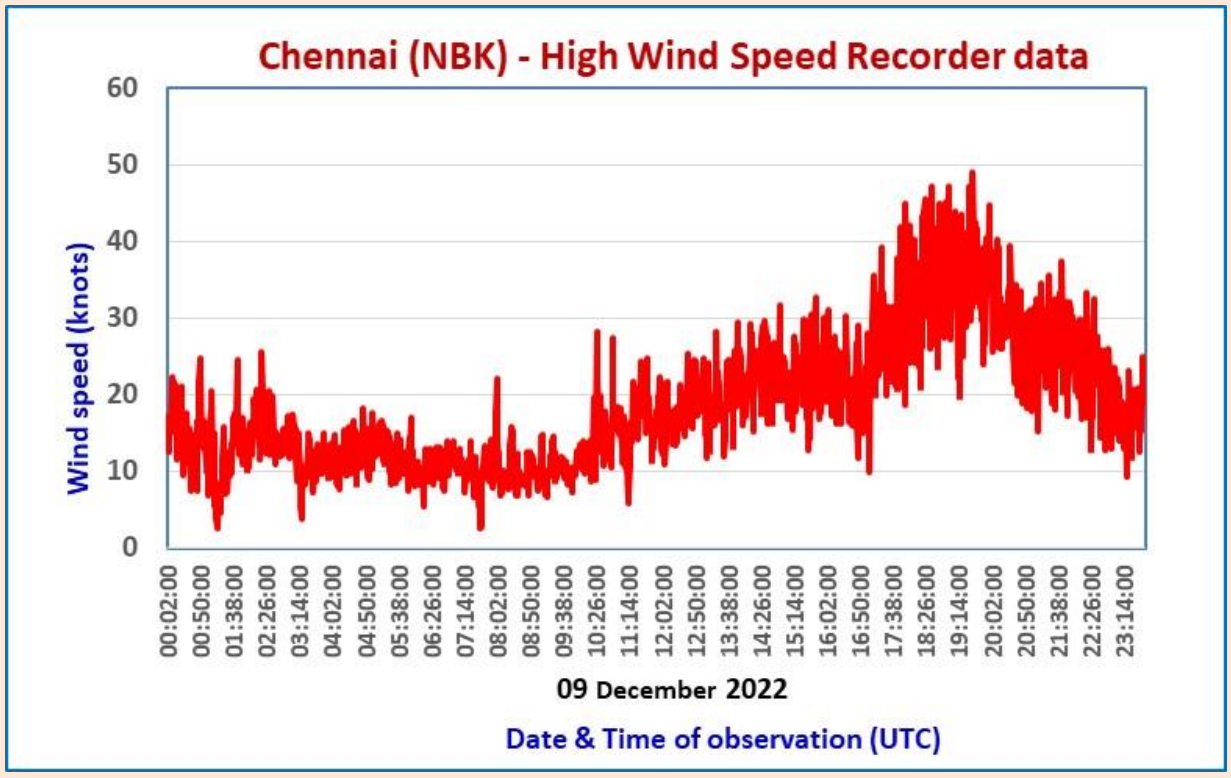


Fig.3d(v): Chennai (MBK) Anemograph of 09/0900-10/0900 IST, Chennai (NBK) HWSR observations of wind speed (knots) during 09th/0530 IST to 10th/0445 IST of December 2022

Associated with the passage of the system, *fairly widespread* rainfall occurred over TN on most of the days during the 24-hr ending 0830 IST of 09th-14th; *fairly widespread to widespread* rainfall occurred over CAP & RYS during the 24-hr ending 0830 IST of 10th-12th &

10^{th}-13^{th} respectively and over SIK & KER during the 24-hr ending 0830 IST of 11^{th}-14^{th} & 11^{th}-15^{th} respectively.

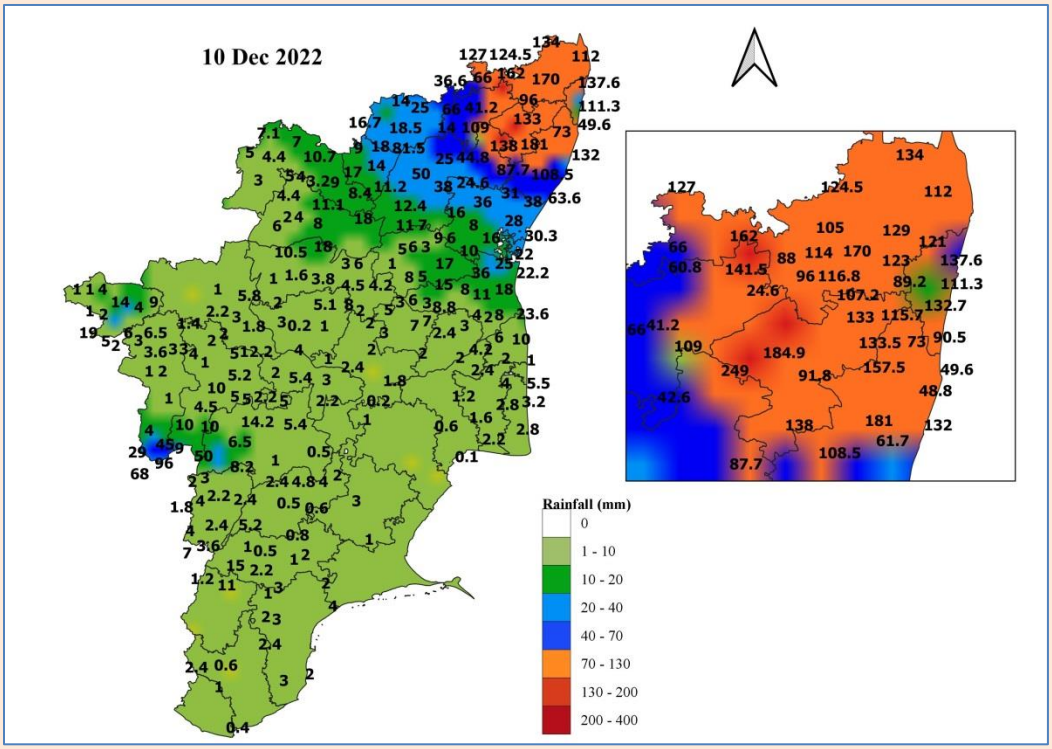
Isolated heavy rain occurred over TN on all days during the 24-hr ending 0830 IST of 09^{th}-14^{th}, over RYS during 10^{th}-13^{th}, over CAP during 10^{th}-12^{th}, over KER on 11^{th},12^{th} & 15^{th} and over SIK on 11^{th} & 14^{th} December. ***Isolated heavy to very heavy*** rain with ***extremely heavy*** falls at one or two places was reported over TN during the 24-hr ending 0830 IST of 10^{th} & 14^{th} & over RYS on 10^{th}. ***Isolated heavy to very heavy*** rain also occurred over CAP on 10^{th} & 11^{th} and over KER on 12^{th}.

Extremely heavy rain of **25 cm** occurred at **Vembakkam in Thiruvannamalai** district, TN; **23 cm & 22 cm at Srikalahasti & Thottambedu** respectively in **Chittoor** district, RYS during the 24-hr ending 0830 IST of **10^{th} December**; and **30 cm** of rain occurred at **Coonoor in Nilgiris** district, TN on **14^{th} December** 2022.

Vigorous monsoon conditions prevailed over TN during the 24-hr ending 0830 IST of 10^{th}, over RYS & CAP during 10^{th}-13^{th} & 10^{th}-12^{th} respectively, over KER during 11^{th}-13^{th} & on 15^{th} and over SIK on 14^{th} December; and ***active*** monsoon conditions prevailed over TN during 12^{th}-14^{th} and over SIK on 13^{th} December 2022. Fig.3d(vi) presents the rainfall distribution over TN, CAP & RYS based on gauge observed point rainfall observation as on 24-hr ending 0830 IST of 10^{th} December 2023.

Early warnings for *very heavy to extremely heavy* rainfall and gale force winds during the landfall with frequent updates were issued to the state administrative & disaster management authorities, agriculture and fisheries departments of Tamilnadu, Puducherry & Andhra Pradesh and to the port authorities along Tamilnadu, Puducherry & Andhra Pradesh coasts. Warnings and frequent updates were also disseminated to the Press and media (in English & Regional language) and to the general public through social media and website updates. Sample warning poster, in Tamil, posted in the social media and website is shown in Fig.3d(vii).

Damages due to gale winds and intense rainfall activity around the landfall area, were reported by the media. Sample media reports are presented in Fig.3d(viii). 4 persons & 98 cattle lost life, about 180 houses / huts were damaged in TN; about 400 trees were uprooted in Chennai (*The Hindu* dated 10.12.2022 & *Times of India* dated 11.12.2022). Parts of beach resorts have been washed away due to high tides near Mahabalipuram (*The New Indian Express* dated 11.12.2022). Damages to crops and roads in Andhra Pradesh were also reported (*Mint* dated 11.12.2022).



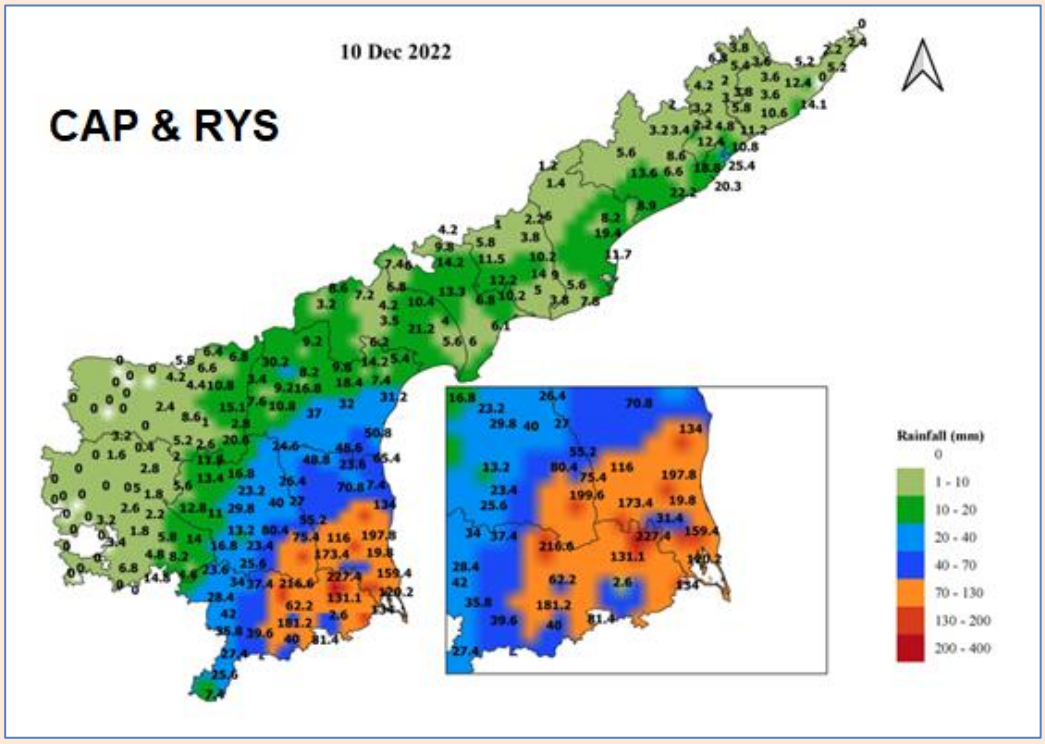


Fig.3d(vi) 24-hr accumulated rainfall during the 24-hr ending 0830 IST of 10th December 2022 over TN; CAP&RYS (AP); and TN & AP combined

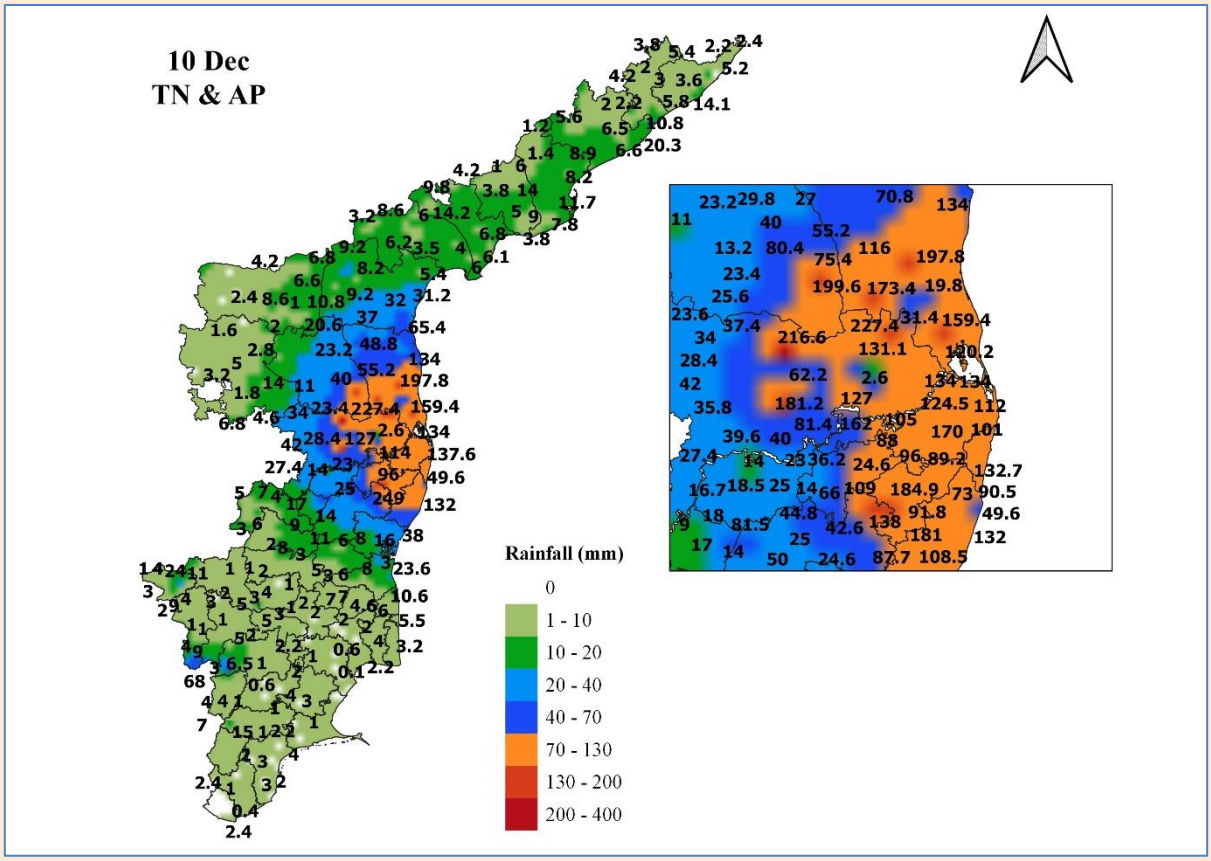


Fig.3d(vi) contd.

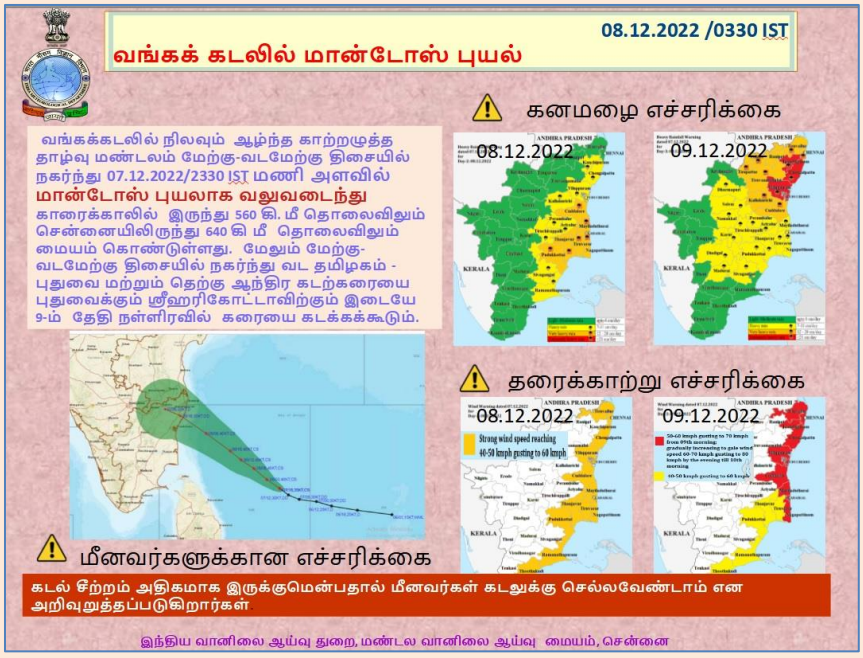


Fig.3d(vii): Sample warning poster in Tamil posted in website and social media in the early morning of 08th December 2022

Fig.3d(viii): Damage reports from the media

Fig.3d(viii) contd.

(e) Deep Depression over Arabian Sea during 14th-17th December 2022

The remnant of the cyclone ***MANDOUS*** entered Eastcentral Arabian Sea as an upper air cyclonic circulation. Under its influence, a **Low Pressure Area** (LPA) formed over Eastcentral and adjoining Southeast Arabian Sea off north Kerala-Karnataka coasts during early morning of 13th December 2022 and became **Well Marked Low Pressure Area** (WML) over the same region around 1730 IST of the same day. It moved further northwestwards and lay as a well marked low pressure area over Eastcentral and Southeast Arabian Sea at 0830 IST of 14th and concentrated into a **Depression** over the same region. It then moved west-northwestwards and intensified into **Deep Depression** and lay centered at 0530 hours IST of 15th over eastcentral and adjoining Southeast Arabian Sea near latitude 13.9°N and longitude 68.2°E. It then moved westwards. It then moved initially westward and then west-northwestwards and weakened into **Depression** and lay centered at 1730 IST of 16th December 2022, over Westcentral & adjoining Eastcentral Arabian Sea near latitude 14.0°N and longitude 63.8°E. Thereafter, it moved westwards over Westcentral Arabian Sea and weakened into a WML over westcentral Arabian Sea in the evening of 17th December 2022. It then moved west- southwestwards and weakened further over the same region. The track of the system is shown in Fig.3e(i). Under the influence of this system, light to moderate rain was reported at most places over KER with ***isolated heavy*** rain over Kottayam district in KER (Kozhikode & Kanjirappally :**7 cm**) on 15th December 2022. Light to moderate rain also occurred at *a few* places over south TN on the same day.

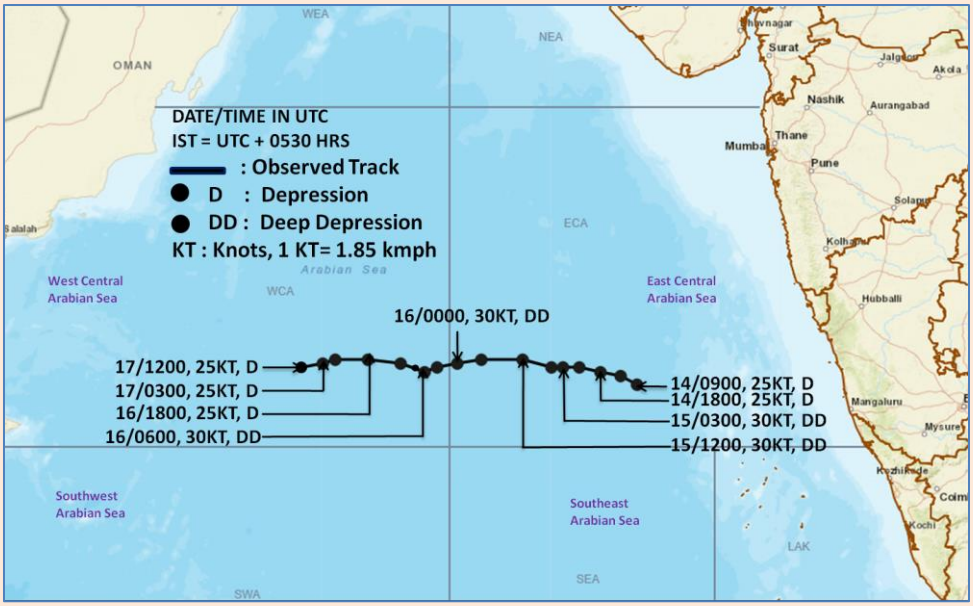


Fig.3e(i): Observed track of Deep Depression over the Arabian Sea during 14-17 Dec 2022

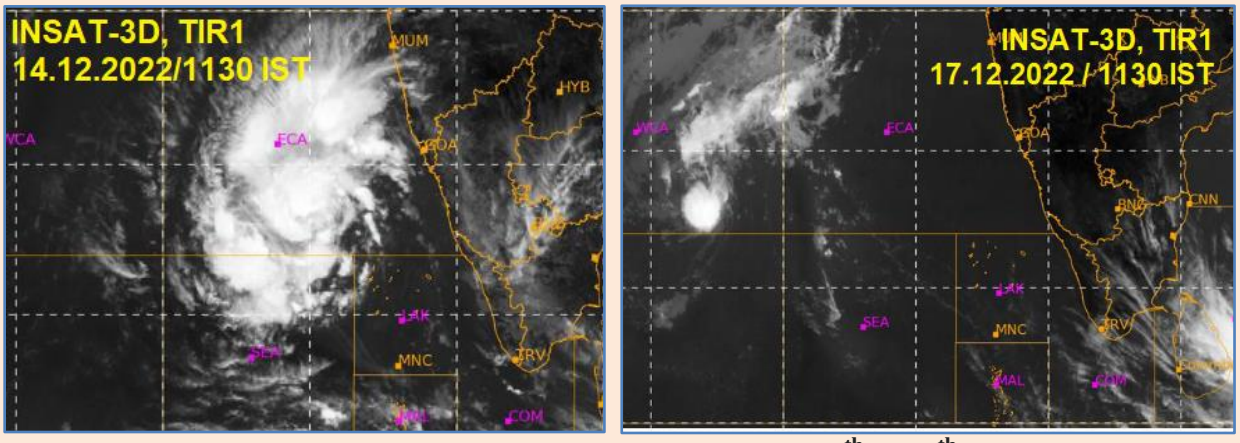


Fig.3e(ii): INSAT-3D infra red imageries as on 1130 IST of 14th & 17th December 2022

(f) Depression over Bay of Bengal during 22nd-25th December 2022

A **Low Pressure Area** formed over southeast Bay of Bengal and adjoining equatorial India Ocean on 14th afternoon and persisted over the same region during 15th to 17th December 2022. It then moved slowly westwards and lay over central parts of South Bay of Bengal & adjoining East Equatorial Indian Ocean during 18th to 20th and became a Well Marked Low Pressure Area over Southwest Bay of Bengal & adjoining East Equatorial Indian Ocean on 21st early morning.

It concentrated into a **Depression** at 0830 hours IST of 22nd December over southwest and adjoining southeast Bay of Bengal near latitude 9.0°N and longitude 85.0°E. Moving initially north-northwestwards and then northwestwards, it lay over southwest Bay of Bengal near latitude 10.1°N and longitude 84.2°E at 2330 hours IST of 22nd. Thereafter, it moved slowly

and recurved east-northeastwards, made a clockwise loop and then moved west-northwestwards. At 0530 hours IST of 24th, it reached Southwest Bay of Bengal and started to recurve slowly west-southwestwards towards Sri Lanka coast. It lay over Southwest Bay of Bengal and adjoining Sri Lanka coast at 0830 hours IST of 25th. It then continued to move west-southwestwards, **crossed Sri Lanka coast, south of Trincomalee**, near latitude 8.35°N and longitude 81.4°E **as a Depression with maximum sustained wind speed of 45-55 kmph gusting to 65 kmph during 1230 to 1330 hours IST of 25th December 2022**.

Thereafter, the system continued to move west-southwestwards and weakened into a WML over Sri Lanka at 1430 hrs IST of today, the 25th December 2022. It emerged into Comorin area in the early morning of 26th and became a low pressure area over the same region in the forenoon of the same day. Continuing to move in the same direction, it became less marked over the Maldives and adjoining Lakshadweep area. The observed track of the system is presented in Fig.3f(i).

Satellite imagery of the system as on Surface isobaric analysis as on 0830 IST of 25th December 2022 depicting the Depression over Southwest Bay of Bengal is shown in Fig.3f(ii). Surface isobaric analysis as on 0830 IST & upper air streamline analysis as on 0530 IST of 25th December are presented in Fig.3f(iii).

Associated with the passage of the remnant of the system over Sri Lanka & Comorin area during 25th- 26th December, *fairly widespread / widespread* rainfall occurred over TN during the 24-hr ending 0830 IST of 26th & 27th & *fairly widespread* rainfall over KER during the 24-hr ending 0830 IST of 26th December 2022. ***Isolated heavy*** rain occurred over Tirunelveli district of TN (25th: Naalumukku: 9 cm, Oothu: 8 cm; 26th: Oothu: 9 cm, Manjolai: 7 cm) during the same period. Isolated very heavy rain was also reported from Tirunelveli district of TN (Papanasam : 12 cm) on 28th December. ***Vigorous*** monsoon conditions prevailed over TN during the 24-hr ending 0830 IST of 26th & 27th December 2022. Plots of 24-hr accumulated rainfall over TN 7 KER as on 0830 IST of 26th & 27th December 2022 are presented in Fig.3f(iv).

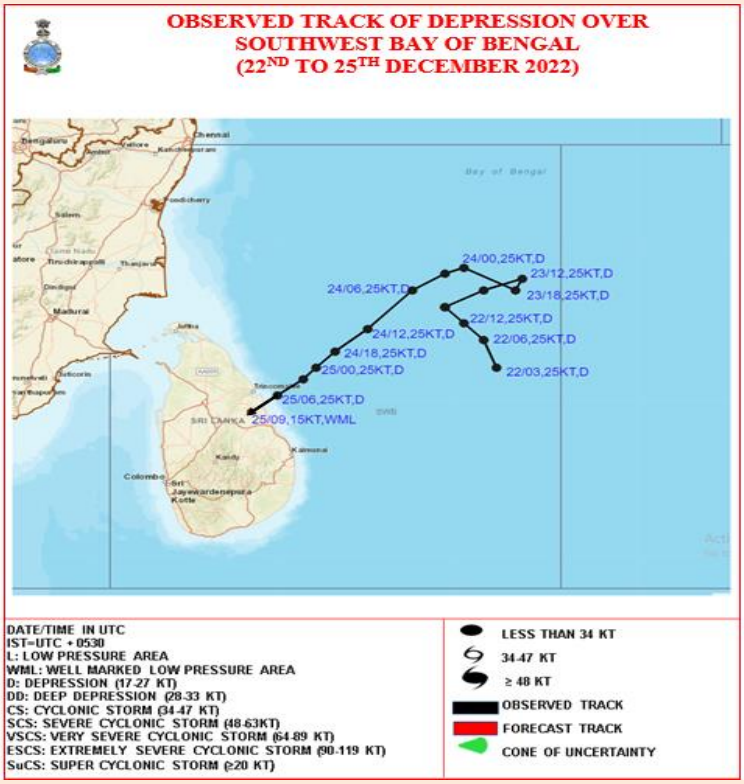


Fig.3f(i) Observed track of the Depression over Bay of Bengal during 22-25 December 2022

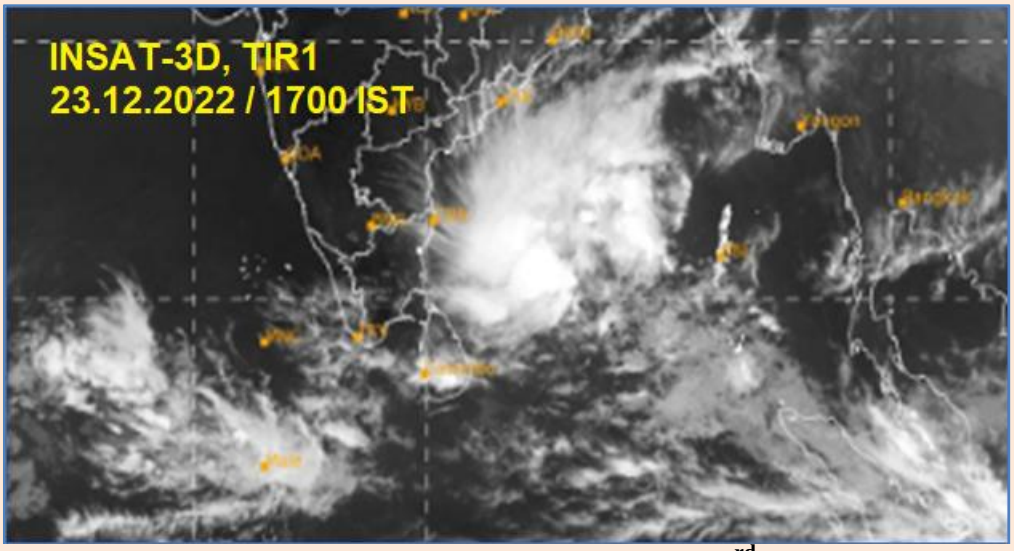
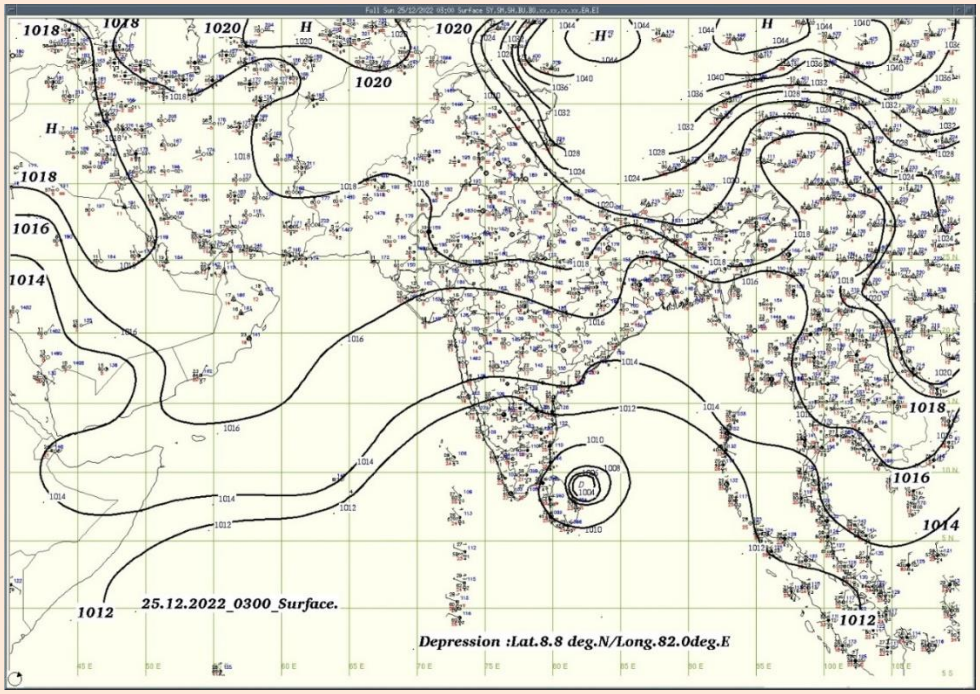


Fig.3f(ii): INSAT-3D, infra-red imagery as on 1700 IST of 23rd December 2022



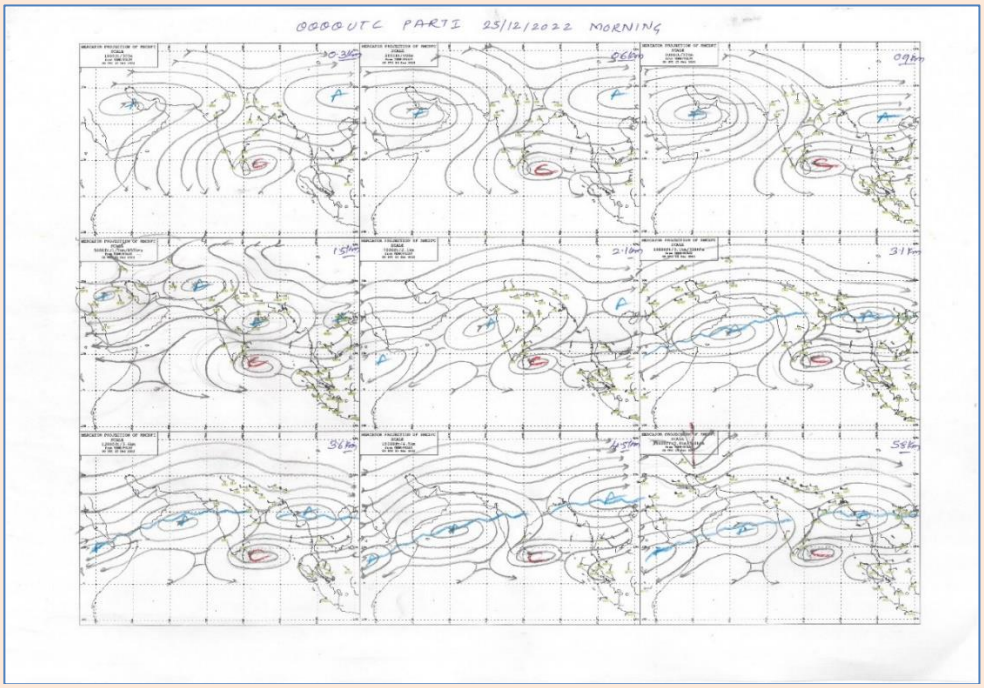


Fig.3f(iii): Surface isobaric analysis as on 0830 IST upper air streamline analysis as on 0530 IST of 25th December 2022

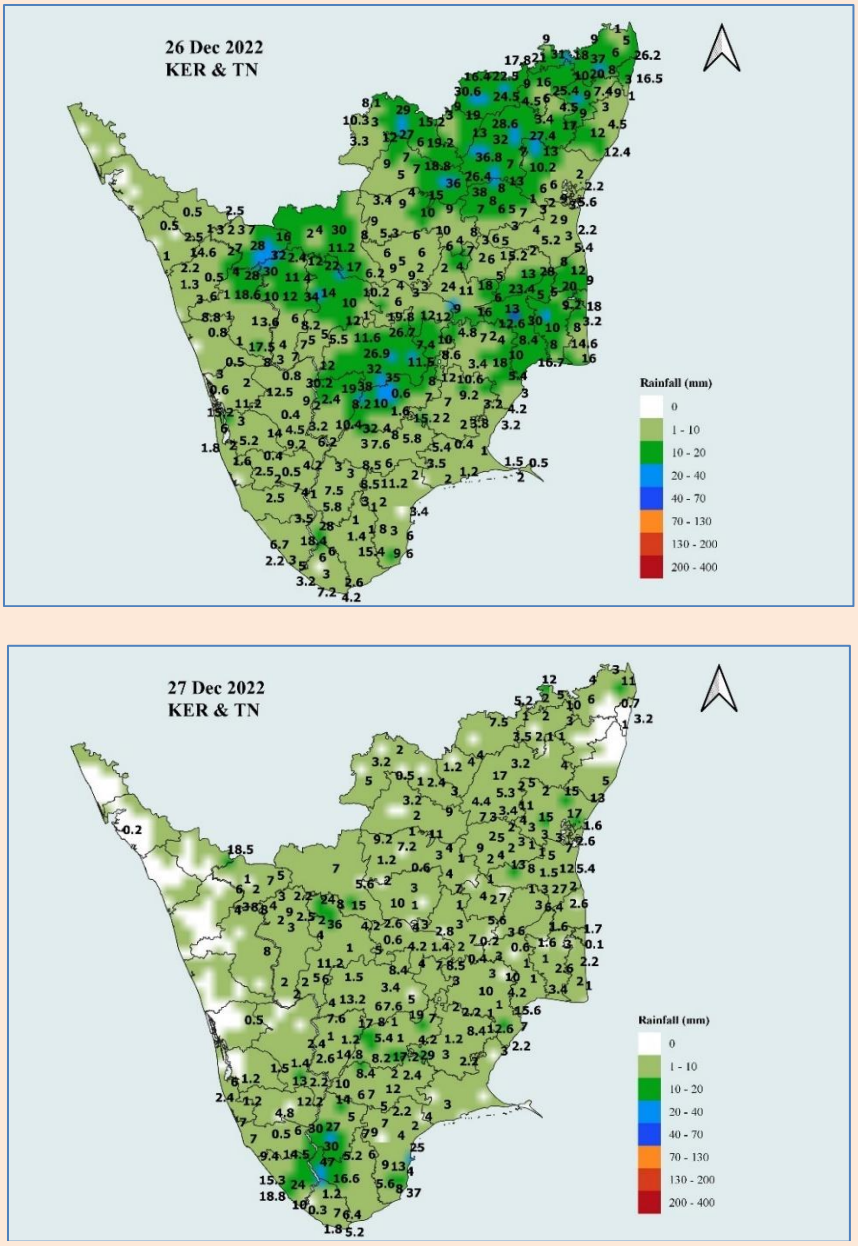


Fig.3f(iv): 24-hr accumulated rainfall as on 0830 IST of 26th & 27th December 2022 over TN & KER

4. Sub divisional rainfall performance during NEM 2022

4.1 Seasonal rainfall

During October-December 2022, the northeast monsoon seasonal rainfall was *normal* (-19% to +19%) to *excess* (+20% to +59%)vover the 5 meteorological subdivisions benefitted by the NEM (TN, KER, CAP, RYS and SIK). It was *excess* over SIK (+51%) & RYS (+22%) and

normal over TN (+1%), CAP (+6%) & KER (-3%). Fig.4a and Table-1 present the season ending (01st Oct-31st December 2022) rainfall figures over these subdivisions.

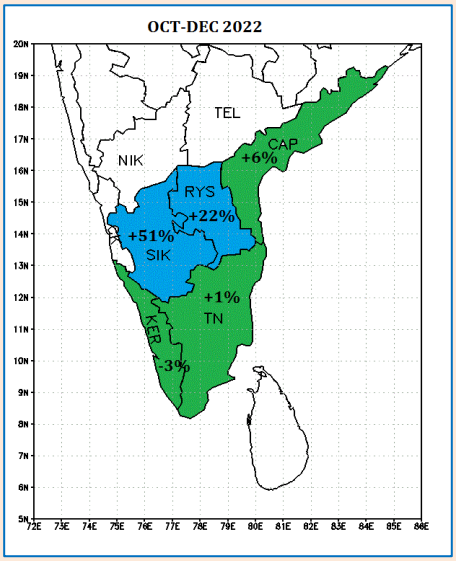


Fig.4a: Seasonal rainfall performance of NEM 2022 over the five meteorological subdivisions benefitted by the NEM

Table-1: Sub-divisional seasonal rainfall during October-December 2022

Subdivision	01st October – 31st December 2022		
	Actual (mm)	Normal (mm)	PDN (%)
Tamilnadu, Puducherry & Karaikal (TN)	445.6	443.3	**1**
Coastal Andhra Pradesh & Yanam (CAP)	341.7	322.9	**6**
Rayalaseema (RYS)	288.1	236.4	**22**
South Interior Karnataka (SIK)	300.1	199.0	**51**
Kerala & Mahe (KER)	476.2	492.0	**-3**

PDN: Percentage Departure from Normal

Legend:

Largely Deficient	*Deficient*	*Normal*	*Excess*	*Large Excess*
≤ -60%	**-20% to -59%**	**-19% to +19%**	**+20% to +59%**	**≥+60%**

4.2 Monthly, Weekly & Daily rainfall scenario

The intra-seasonal rainfall distribution over various sub-divisions during Oct-Dec 2022 is presented in monthly and daily scales. Month-wise rainfall statistics are presented in Table-2 and Fig.4b. Tables-3a&b present the weekly rainfall over the various subdivisions and Tables-4a&b present the daily rainfall scenario in terms of spatial rainfall distribution (*Widespread*: WS, *Fairly widespread*: FWS, *Scattered*: SCT, *Isolated*: ISOL and DRY).

Table-2: Sub-divisional monthly rainfall during NEM 2022

2022	OCT			NOV			DEC		
SUB-DIVISION	Actual rainfall (mm)	Normal rainfall (mm)	PDN (%)	Actual rainfall (mm)	Normal rainfall (mm)	PDN (%)	Actual rainfall (mm)	Normal rainfall (mm)	PDN (%)
TN	165.9	172.0	-4	178.5	181.9	-2	101.1	89.4	13
CAP	200.7	182.2	10	63.0	113.1	-44	78.0	27.6	183
RYS	141.2	132.1	7	59.4	78.4	-24	87.5	25.9	238
SIK	226.2	137.2	65	30.9	51.2	-40	43.0	10.6	306
KER	214.1	306.5	-30	172.5	153.1	13	89.6	32.4	177

Largely Deficient	*Deficient*	*Normal*	*Excess*	*Large Excess*
≤ -60%	-20% to -59%	-19% to +19%	+20% to +59%	≥+60%

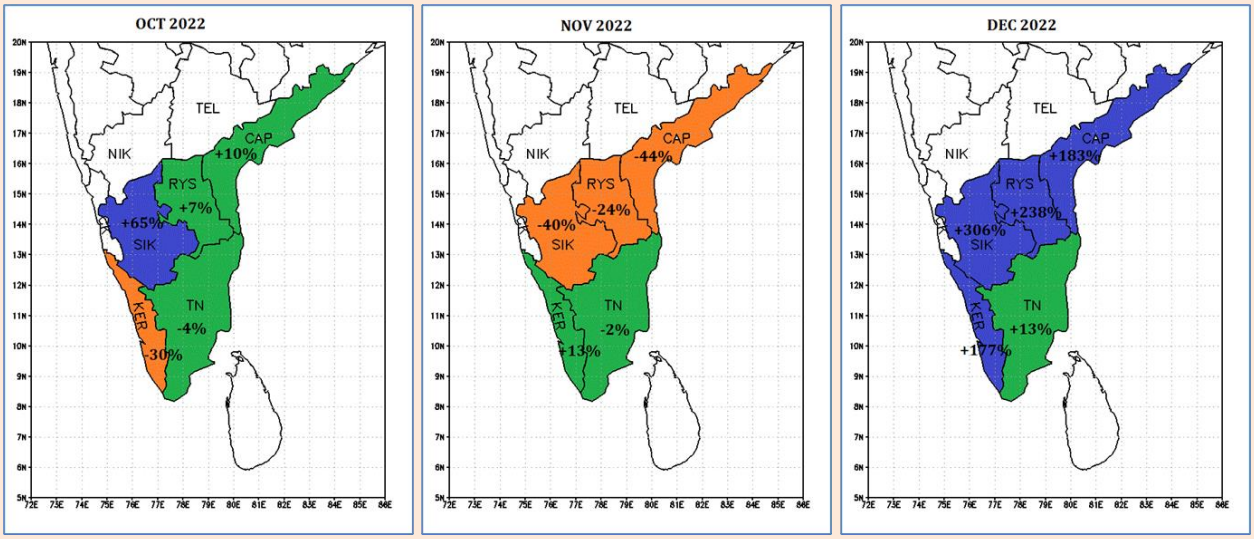


Fig.4b: Subdivisional monthly rainfall performance during October-December 2022

During October, excepting KER that became *deficient*, all the other four subdivisions received *normal* to *large excess* rainfall. In November, with the absence of any major transient low pressure system excepting the well marked low pressure area that moved across TN & KER, whereas TN & KER received *normal* rainfall, CAP, RYS & SIK became *deficient*. In December, under the influence of the cyclone *MANDOUS* and its remnant and the remnant of the Depression that crossed Sri Lanka coast, CAP, RYS, SIK & KER received *large excess* rainfall and TN came under *normal* category.

Table 3a: Weekly rainfall performance over various subdivisions during Oct-Dec 2022

SUB-DIVISION	WEEK-BY-WEEK: PDN (%)												
	05-10-22	12/10/22	19/10/22	26/10/22	02/11/22	09/11/22	16/11/22	23/11/22	30/11/22	07-12-22	14/12/22	21/12/22	28/12/22
CAP	7	148	35	-87	-61	-77	-9	-63	-46	-89	543	-98	73
RYS	47	75	129	-72	-53	-57	14	-47	-44	-97	1167	-88	111
TN	-70	66	80	-28	-46	-4	124	-91	-60	-26	145	-90	54
SIK	6	167	244	-85	-46	-92	-30	22	-47	-91	1222	-100	-8
KER	-37	-67	29	-22	-46	14	9	-70	153	53	495	63	53

Table 3b: Cumulative week ending scenario during Oct-Dec 2022

SUB-DIVISION	CUMULATIVE WEEK ENDING : PDN (%)												
	05-10-22	12/10/22	19/10/22	26/10/22	02/11/22	09/11/22	16/11/22	23/11/22	30/11/22	07-12-22	14/12/22	21/12/22	28/12/22
CAP	6	83	67	31	9	-4	-4	-9	-11	-13	8	6	6
RYS	19	27	56	25	9	0	1	-2	-5	-10	23	23	22
TN	-75	9	38	14	-2	-2	15	4	-3	-5	4	0	1
SIK	6	77	119	75	57	43	38	38	36	34	52	52	51
KER	-37	-55	-23	-23	-27	-21	-19	-22	-16	-14	-4	-3	-3

In the weekly scale (tables 3a&b), the major rainfall weeks were the first three weeks of the season duing the extended southwest monsoon. Exceping KER that came under *deficient* category, all the other subdivisions received *normal* to *large excess* rainfall during this period. Subsequently, during the weeks ending 26th October & 02nd November, under the influence of the cyclone ***SITRANG*** that swept away moisture towards Bangladesh region and during the period of transition from southwest to northeast monsoon regime, all the subdivisions received *deficient* to *scanty* rainfall only. With the formation and movement of ***well marked low pressure area*** across TN & KER, rainfall activity increased during the week ending 16th November with TN recording 124% *excess* during the week. Thereafter, for the subsequent three weeks excepting KER & SIK that received *excess / large excess* rainfall during one or two weeks, all the other subdivisions received *deficient* to *scanty* rainfall only. Under the influence of the passage of cyclone ***MANDOUS*** and its remnant across the southern peninsula and the remnant of the ***Depression*** that crossed Sri Lanka coast in December, *large excess* rainfall was realized over all the five subdivisions during the week ending 14th December and *normal* to *large excess* rainfall was received over all the subdivisions during the week ending 28.12.2022. Excepting KER that remained mostly deficient during October & November, all the subdivisions in the region came under normal to excess cumulative seasonal rainfall throughout.

Table-4a: Spatial rainfall distribution during 01st October -31st December 2022

Date as on 24-hr ending 08:30 IST	TN	CAP	RYS	SIK	KER
01-10-2022	ISOL	FWS	WS	WS	WS
02-10-2022	ISOL	FWS	FWS	SCT	SCT
03-10-2022	ISOL	SCT	ISOL	SCT	WS
04-10-2022	ISOL	SCT	ISOL	SCT	SCT
05-10-2022	ISOL	SCT	ISOL	ISOL	ISOL
06-10-2022	SCT	WS	WS	SCT	FWS
07-10-2022	ISOL	WS	WS	SCT	SCT
08-10-2022	ISOL	FWS	ISOL	ISOL	ISOL
09-10-2022	FWS	WS	ISOL	ISOL	ISOL
10-10-2022	WS	WS	FWS	WS	SCT
11-10-2022	FWS	FWS	SCT	WS	SCT
12-10-2022	SCT	SCT	SCT	WS	SCT
13-10-2022	SCT	SCT	WS	WS	SCT
14-10-2022	SCT	SCT	FWS	WS	WS
15-10-2022	FWS	WS	ISOL	WS	FWS
16-10-2022	FWS	WS	SCT	FWS	WS
17-10-2022	FWS	FWS	SCT	WS	FWS
18-10-2022	SCT	ISOL	ISOL	SCT	WS
19-10-2022	SCT	SCT	ISOL	FWS	FWS
20-10-2022	FWS	SCT	SCT	WS	WS
21-10-2022	WS	ISOL	ISOL	FWS	WS
22-10-2022	ISOL	SCT	ISOL	FWS	WS
23-10-2022	ISOL	SCT	ISOL	SCT	WS
24-10-2022	ISOL	DRY	DRY	DRY	WS
25-10-2022	ISOL	ISOL	DRY	DRY	SCT
26-10-2022	ISOL	DRY	DRY	DRY	ISOL
27-10-2022	ISOL	DRY	DRY	DRY	ISOL
28-10-2022	ISOL	ISOL	ISOL	DRY	ISOL
29-10-2022	ISOL	ISOL	ISOL	ISOL	SCT
30-10-2022	FWS	ISOL	ISOL	SCT	SCT
31-10-2022	ISOL	ISOL	ISOL	ISOL	SCT
01-11-2022	SCT	SCT	ISOL	DRY	FWS
02-11-2022	FWS	SCT	FWS	SCT	SCT
03-11-2022	FWS	ISOL	FWS	WS	WS
04-11-2022	FWS	ISOL	FWS	SCT	SCT
05-11-2022	FWS	SCT	ISOL	ISOL	FWS
06-11-2022	SCT	ISOL	ISOL	ISOL	FWS
07-11-2022	FWS	DRY	ISOL	ISOL	WS
08-11-2022	SCT	DRY	DRY	DRY	SCT
09-11-2022	SCT	DRY	DRY	DRY	SCT
10-11-2022	ISOL	ISOL	ISOL	DRY	ISOL
11-11-2022	FWS	ISOL	ISOL	ISOL	ISOL
12-11-2022	WS	ISOL	SCT	SCT	WS
13-11-2022	WS	ISOL	SCT	SCT	FWS
14-11-2022	FWS	ISOL	SCT	ISOL	WS
15-11-2022	FWS	ISOL	SCT	ISOL	FWS

Table-3a (contd.)

Date as on 24-hr ending 08:30 IST	TN	CAP	RYS	SIK	KER
16-11-2022	ISOL	DRY	DRY	ISOL	SCT
17-11-2022	ISOL	DRY	DRY	DRY	ISOL
18-11-2022	ISOL	DRY	DRY	DRY	SCT
19-11-2022	ISOL	ISOL	DRY	DRY	ISOL
20-11-2022	ISOL	DRY	DRY	DRY	ISOL
21-11-2022	ISOL	SCT	ISOL	DRY	ISOL
22-11-2022	ISOL	SCT	ISOL	ISOL	ISOL
23-11-2022	ISOL	SCT	FWS	FWS	ISOL
24-11-2022	ISOL	SCT	FWS	WS	ISOL
25-11-2022	ISOL	SCT	SCT	FWS	ISOL
26-11-2022	ISOL	ISOL	ISOL	ISOL	ISOL
27-11-2022	ISOL	ISOL	DRY	ISOL	ISOL
28-11-2022	ISOL	DRY	ISOL	ISOL	FWS
29-11-2022	SCT	DRY	DRY	ISOL	FWS
30-11-2022	ISOL	DRY	DRY	ISOL	SCT
01-12-2022	ISOL	ISOL	ISOL	DRY	ISOL
02-12-2022	ISOL	ISOL	ISOL	ISOL	ISOL
03-12-2022	ISOL	ISOL	ISOL	ISOL	SCT
04-12-2022	SCT	ISOL	ISOL	ISOL	SCT
05-12-2022	FWS	ISOL	DRY	ISOL	WS
06-12-2022	ISOL	DRY	DRY	DRY	ISOL
07-12-2022	ISOL	DRY	DRY	DRY	DRY
08-12-2022	ISOL	DRY	DRY	DRY	ISOL
09-12-2022	FWS	ISOL	ISOL	ISOL	ISOL
10-12-2022	FWS	WS	FWS	SCT	SCT
11-12-2022	SCT	WS	WS	WS	WS
12-12-2022	FWS	FWS	FWS	WS	WS
13-12-2022	FWS	SCT	WS	WS	FWS
14-12-2022	FWS	ISOL	SCT	FWS	SCT
15-12-2022	ISOL	ISOL	ISOL	ISOL	WS
16-12-2022	ISOL	ISOL	DRY	DRY	ISOL
17-12-2022	ISOL	ISOL	DRY	DRY	DRY
18-12-2022	ISOL	ISOL	ISOL	DRY	DRY
19-12-2022	ISOL	ISOL	DRY	DRY	DRY
20-12-2022	ISOL	ISOL	DRY	DRY	DRY
21-12-2022	ISOL	DRY	DRY	DRY	DRY
22-12-2022	ISOL	ISOL	DRY	DRY	DRY
23-12-2022	ISOL	DRY	DRY	DRY	DRY
24-12-2022	ISOL	DRY	DRY	DRY	DRY
25-12-2022	ISOL	ISOL	ISOL	DRY	DRY
26-12-2022	WS	ISOL	SCT	ISOL	FWS
27-12-2022	FWS	ISOL	ISOL	ISOL	ISOL
28-12-2022	SCT	ISOL	ISOL	ISOL	ISOL
29-12-2022	ISOL	ISOL	DRY	DRY	ISOL
30-12-2022	ISOL	ISOL	DRY	DRY	DRY
31-12-2022	ISOL	DRY	DRY	DRY	DRY

Table-4b: Percentage frequency of various categories of daily spatial rainfall distribution

Category	OCT - DEC 2022				
	TN	CAP	RYS	SIK	KER
WS	5	9	7	15	20
FWS	24	7	11	8	14
SCT	15	21	13	14	24
ISOL	55	42	38	29	29
DRY	0	22	32	34	13

WD: ***Widespread*** (76-100% of stations reporting rainfall)

FWD : Fairly widespread (51-75% of stations reporting rainfall)

SCT: Scattered (26-50% of stations reporting rainfall)

ISOL: Isolated (≤25% of stations reporting rainfall)

DRY: No rain

In the daily scale, ***fairly widespread*** to ***widespread*** rainfall occurred over KER on 34% of the days during the season; over TN on 29% of the days and over CAP, RYS & SIK – on about 7 to15% of the days. On about 70% of the days during the season, TN recorded ***isolated*** *to* ***scattered*** rainfall activity. On about 20-35% of the days during the season, CAP, RYS & SIK remained ***dry***.

4.3 Monsoon activity & heavy rainfall events

Table-5a&b present the frequency of active and vigorous monsoon days and frequency of heavy rainfall days (***Heavy*** rainfall ≥ 7cm/day***;*** ***Very Heavy*** rainfall ≥ 12cm/day; ***Extremely Heavy*** rainfall ≥ 21 cm/day) during the season.

Table-5a: Frequencies of active and vigorous monsoon days and heavy rainfall days

Subdivision	No. of days of active and vigorous monsoon conditions							
	OCT		NOV		DEC		OCT-DEC 2022	
	ACT	VIG	ACT	VIG	ACT	VIG	ACT	VIG
TN	5	1	4	1	5	2	14	4
CAP	7	1	0	0	3	0	10	1
RYS	6	1	2	0	4	0	12	1
SIK	11	2	1	0	2	2	14	4
KER	4	0	6	2	1	5	11	7

Active: Fairly widespread to widespread sub-divisional rainfall with rainfall more than 1½ to 4 times the normal with at least two stations reporting more than or equal to 3 cm in coastal Tamil Nadu, south coastal Andhra Pradesh and 2 cm elsewhere in the NEM region.

Vigorous: Fairly widespread to widespread sub-divisional rainfall with rainfall more than 4 times the normal with at least two stations reporting more than or equal to 5 cm in coastal Tamil Nadu, south coastal Andhra Pradesh and 3 cm elsewhere in the NEM region.

Active to vigorous monsoon conditions prevailed over TN, SIK & KER on about 20% of the days during the season; and over CAP & RYS, on about 12-15% of the days. In October, there were 13 days of ***active to vigorous*** monsoon conditions over SIK; 6-8 days over TN, CAP & RYS and 4 days over KER. In November, 8 & 5 days of ***active to vigorous*** monsoon conditions prevailed over KER & TN respectively; and 1 & 2 days of ***active*** monsoon over SIK & RYS respectively. In December, 6 & 7 days of ***active to vigorous*** monsoon activity occurred over KER & TN respectively; and 3-4 days over CAP, RYS & SIK.

Table-5b: Frequency of heavy rainfall days

No. of days of heavy / very heavy / extremely heavy rainfall occurrences												
Sub Division	OCT			NOV			DEC			OCT-DEC 2022		
	>=7 cm	>=12 cm	>=21 cm	>=7 cm	>=12 cm	>=21 cm	>=7 cm	>=12 cm	>=21 cm	>=7 cm	>=12 cm	>=21 cm
TN	20	7	0	18	10	2	13	3	2	51	20	4
CAP	13	3	0	4	1	0	3	2	0	20	6	0
RYS	7	2	0	3	0	0	4	1	1	14	3	1
SIK	12	2	0	1	0	0	2	0	0	15	2	0
KER	16	2	0	12	3	0	5	1	0	33	6	0

Heavy: rainfall ≥ 7cm/day***;*** ***Very Heavy:*** rainfall ≥ 12cm/day; ***Extremely Heavy:*** rainfall ≥21 cm/day

Regarding *heavy* rainfall occurrences (≥ 7 cm/day), TN experienced 51 days of *isolated heavy* rainfall events during the season including 20 days of *isolated very heavy* rain with *isolated extremely heavy* falls on 4 days. Over Kerala, *isolated heavy* rain occurred on 33 days including 6 days of *isolated very heavy* rain. Over CAP, *isolated heavy* rain occurred on 20 days including 6 days of *isolated very heavy* rainfall. SIK experienced 15 days of *isolated heavy* rain including 2 days of *isolated very heavy* rain. There were 14 of *isolated heavy* rainfall activity over RYS including 3 days of *isolated very heavy* rain with *isolated extremely heavy* falls on 1 day. District-wise list of very heavy to extremely heavy rainfall events over various subdivisions is presented in Table-5c.

4.4 District rainfall scenario

Fig.4c presents the district wise seasonal rainfall during October to December 2022. As seen, in SIK & RYS all the districts received *normal to large excess / excess* rainfall during the season; in CAP excepting the extreme northern district of Srikakulam, all the districts received *normal to excess* rainfall; in TN, excepting a few south coastal and delta & adjoining districts and Puducherry, all other districts received *normal to excess* rainfall; and in KER, most of the northern & adjoining districts became *deficient* while the extreme southern districts received *normal to excess* rainfall during the season.

Table-5c: List of very heavy to extremely heavy rainfall events during Oct-Dec 2022

DISTRICT	**Date, Station and 24-hr accumulated rainfall (in cm) (ending 0830 IST of the specified date)**
TN	
Cuddalore	**Oct: 10th:** Lakkur-14; **17th:** Kudithangi-13 **Nov: 03rd:** Chidambaram-15, Sethiathope-13, Chidambaram Aws-13, Annamalai Nagar-12, Parangipettai-12; **12th:** Chidambaram-31, Annamalai Nagar-28, Chidambaram Aws-27, Bhuvanagiri-21, Kothavacherry-19, K.m.koil-19, Parangipettai-18, Sethiathope-16, Kurinjipadi-16, Lalpet-13, Vadakuthu-12
Thanjavur	**Oct: 10th:** Manjalaru-12 **Nov: 03rd:** Thanjavur-18, Thanjavur PTO-12 **Dec: 05th:** Thanjavur-16, Lower Anaicut-12
Sivaganga	**Oct: 10th:** Sivaganga-12; **15th:** Tirupuvanam-12
Madurai	**Oct: 11th:** Mettupatti-17
Karur	**Oct: 11th:** Panchapatti-12 **Nov: 12th:** Mylampatti-12, Aravakurichi-12;
Dindigul	**Oct: 12th:** Kodaikanal Boat Club-13
Kanyakumari	**Oct: 16th:** Lower Kothaiyar ARG-14 **Nov: 29th:** Kannimar-12
Coimbatore	**Oct: 17th:** Valparai PAP-13; **18th:** Cincona-12, Valparai PAP-12 **Nov: 04th:** Mettupalayam-12
Theni	**Oct: 18th:** Aranmanaipudur-13, Periyakulam PTO-13
Chennai	**Nov: 01st:** Perambur-12; **02nd:** Perambur-17, Chennai Collectorate-17, Sholinganallur-13, MGR Nagar-13, Chennai Nungambakkam-13, Ayanavaram-13, Anna University-12; **04th:** Tondaiyarpet-14, DGP Office-12 **Dec: 10th:** Ayanavaram Taluk Office-15, Perambur-14, Mgr Nagar-13, Alandur-13, Chennai Ap-12
Tiruvallur	**Nov: 01st:** Red Hills-13; **02nd:** Avadi-17, Ponneri-16, Red Hills-14, Gummidipoondi-14, Ambathur-13, Villivakkam-13; **13th:** Tiruttani-13 **Dec: 10th:** Avadi-17, Tiruttani-16, Gummidipoondi-13, Cholavaram-13, Pallipattu-13, Uthukottai-13, Ambathur-12, Red Hills-12, Koratur-12
Chengalpattu	**Nov: 02nd:** Cheyyur-13 **Dec: 10th:** Tambaram-13, Mahabalipuram-13, Chengalpattu-12
Kancheepuram	**Nov: 02nd:** Kattukuppam Arg-16; **13th:** Uthiramerur-17 **Dec: 10th:** Kancheepuram-19, KVK Kattukuppam Agro-16, Kundrathur-15, Uthiramerur-14, Sriperumbudur-13
Mayiladuthurai	**Nov: 03rd:** Sirkali-22, Kollidam-16; **12th:** Sirkali-44, Kollidam-32, Tarangambadi-18, Mayiladuthurai-16, Manalmedu-16
Pudukkottai	**Nov: 12th:** Ponnamaravathi-13
Tiruppur	**Nov: 12th:** Kangeyam-15, Vellakoil-13
Erode	**Nov: 13th:** Kodumudi-12; **16th:** Kodivery-12

Tirunelveli	**Nov: 15th:** Nalumukku-12 **Dec: 05th:** Nalumukku-16, Oothu-16, Kakkachi-15, Manjolai-13; **28th:** Papanasam-12
Virudhunagar	**Nov: 16th:** Rajapalayam-12
Tiruvarur	**Dec: 05th:** Needamangalam-14; **14th:**Needamangalam-16
Ranipet	**Dec: 10th:** Minnal-20, Arakonam-14
Tiruvannamalai	**Dec: 10th:** Vembakkam-25, Cheyyar-18
Nilgiris	**Dec: 14th:** Coonoor-30, Coonoor PTO-14
Ariyalur	**Dec: 14th:** Thirumanur-15
CAP	
Prakasam	**Oct: 01st:** Addanki-18
Srikakulam	**Oct: 05th:** Palasa-13
Guntur	**Oct: 06th:**Repalle-12
East Godavari	**Oct: 15th:** Amalapuram-15
Nellore	**Nov: 13th:** Kavali-12; **13th:** Kavali-12; **Dec: 10th:** Gudur-20, Venkatagiri-17, Sullurpeta-16, Nellore-13, Tada-12, Rapur-12; **11th:** Atmakur-13
RYS	
Ysr District	**Oct: 07th:** Duvvur-14; **13th:** Jammalamadugu-12 **Dec: 10th:** Kodur-20
Anantapuramu	**Oct: 13th:** Rayadurg-14
Kurnool	**Oct: 13th:** Devanakonda-16
Chittoor	**Dec: 10th:** Srikalahasti-23, Thottambedu-22, Nagari-18, Satyavedu-13, Tirupati Aero-13
SIK	
Chamarajanagara	**Oct: 14th:** Hardanhally_KVK-13
Mandya	**Oct: 15th:** Mandya-17, Mandya_KVK-15
KER	
Kottayam	**Oct: 18th:** Poonjar AWS-14 **Nov: 05th:** Kottayam-13
Idukki	**Oct: 18th:** Peerumedu-12 **Nov: 04th:** Peermade-13
Alappuzha	**Oct: 24th:** Kayamkulam_agri-14
Pathanamthitta	**Nov: 28th:** Kurudamannil-15
Ernakulam	**Dec: 10th:** Aluva-12

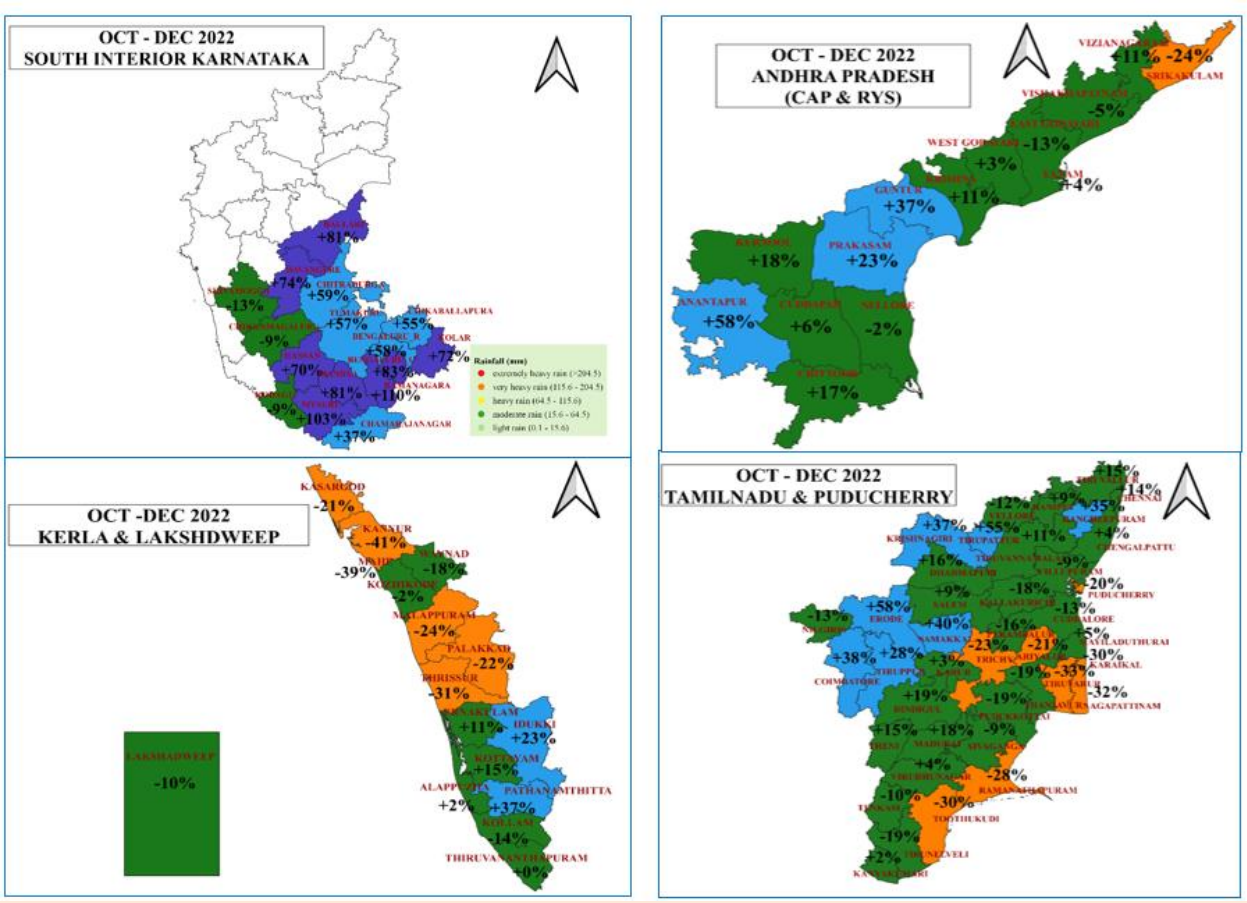


Fig.4c: District-wise rainfall performance in various subdivisions during Oct-Dec 2022

5. Rainfall distribution over Tamil Nadu and Puducherry

Spatial and temporal distribution of rainfall over the TN subdivision during Oct-Dec 2022 are depicted by the district-wise rainfall distribution and area averaged daily rainfall distribution over TN. Fig.5a presents the daily rainfall distribution over the TN subdivision (including Puducherry and Karaikal) during Oct-Dec 2022. During the period from 30th October to 01st December (33 days) the subdivisional rainfall was above normal on 30 out of 33 days.

State / UT & District-wise rainfall realized are presented in Tables-6a&b and Fig.5b. As seen, rainfall over TN subdivision was below normal on all days during the periods from 16th November to 04th December and from 15th December to 25th December (Fig.5a). Erode, Coimbatore, Tiruppur, Namakkal, Krishnagiri & Tirupattur districts received *excess* rainfall; Ariyalur, Thiruchirapalli, Tiruvarur, Nagapattinam, Ramanathapuram, Thootukudi districts of Tamilnadu, Puducherry & Karaikal received *deficient* rainfall. Rest of the 26 districts in TN received *normal* rainfall during the period.

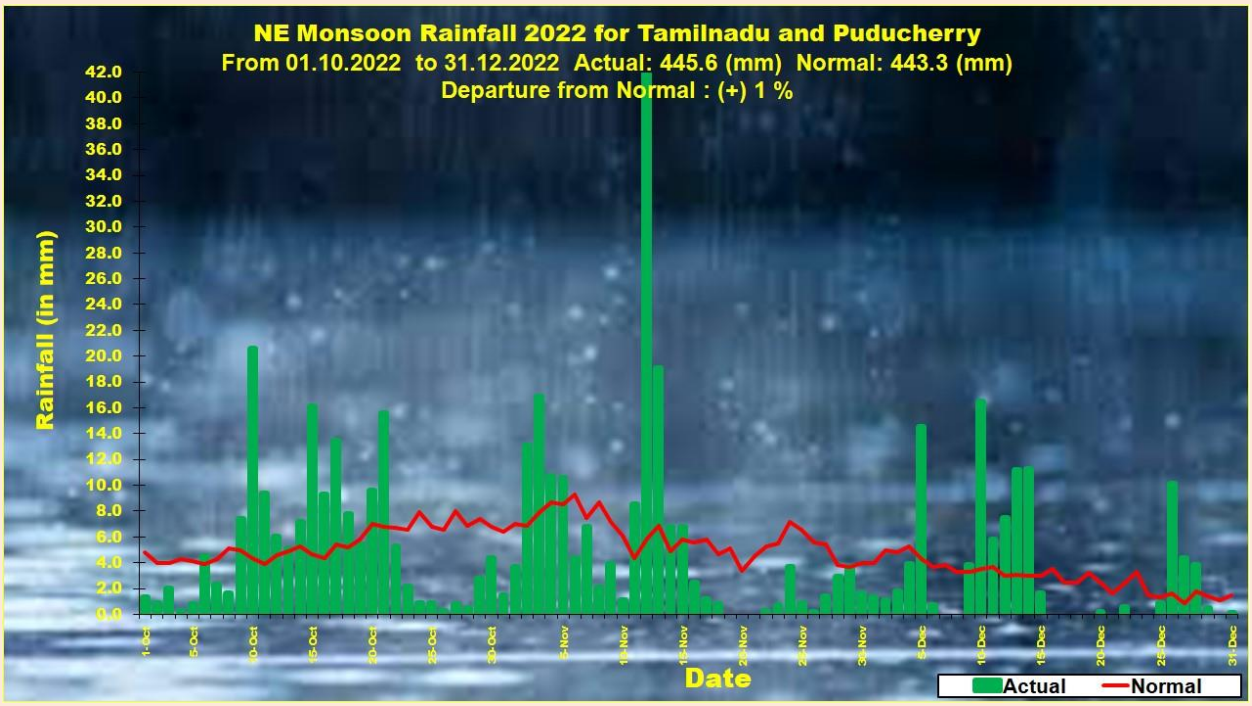


Fig.5a: Area averaged daily rainfall over TN subdivision during Oct-Dec 2022

Table-6a: State /UT wise rainfall figures of Tamil Nadu, Puducherry& Karaikal during Oct-Dec 2022

Subdivision / State / UT	Actual rainfall (mm)	Normal rainfall (mm)	Percentage departure from normal (%)
TN subdivision	445.6	443.3	1
Puducherry& Karaikal (UT)	682.5	860.3	-21
Tamil Nadu State	444.8	441.7	1

Table-6b: District-wise rainfall figures of Tamil Nadu, Puducherry& Karaikal during Oct-Dec 2022

District	Actual rainfall (mm)	Normal rainfall (mm)	Percentage departure from normal (%)
ARIYALUR	398.7	501.9	-21
CHENGALPATTU	738.1	707.7	4
CHENNAI	924.6	809.6	14
COIMBATORE	466.9	337.6	38
CUDDALORE	612.1	701.5	-13
DHARMAPURI	363.9	314.2	16
DINDIGUL	545.3	460.0	19
ERODE	485.3	307.1	58
KALLAKURICHI	372.2	455.5	-18
KANCHEEPURAM	800.5	591.7	35
KANYAKUMARI	540.6	532.6	2
KARAIKAL	709.9	1014.2	-30
KARUR	324.1	313.2	3
KRISHNAGIRI	381.2	278.7	37
MADURAI	438.4	370.0	18
MAYILADUTHURAI	929.8	888.1	5
NAGAPATTINAM	639.2	935.3	-32
NAMAKKAL	378.9	270.4	40
NILGIRIS	434.2	501.3	-13
PERAMBALUR	364.1	432.0	-16
PUDUCHERRY	667.6	831.6	-20
PUDUKKOTTAI	311.3	385.6	-19
RAMANATHAPURAM	383.5	531.4	-28
RANIPET	441.7	406.0	9
SALEM	361.1	331.7	9
SIVAGANGA	385.1	422.7	-9
TENKASI	420.4	465.7	-10
THANJAVUR	466.6	579.4	-19
THENI	417.4	364.3	15
TIRUNELVELI	417.8	514.9	-19
TIRUPATTUR	412	266.3	55
TIRUPPUR	391.4	305.7	28
TIRUVALLUR	716.3	623.9	15
TIRUVANNAMALAI	499.6	450.4	11
TIRUVARUR	487.5	725.4	-33
TOOTHUKUDI	308.9	441.9	-30
TRICHY	290.7	379.4	-23
VELLORE	332.4	375.8	-12
VILLUPURAM	484.6	531.3	-9
VIRUDHUNAGAR	414.9	398.5	4

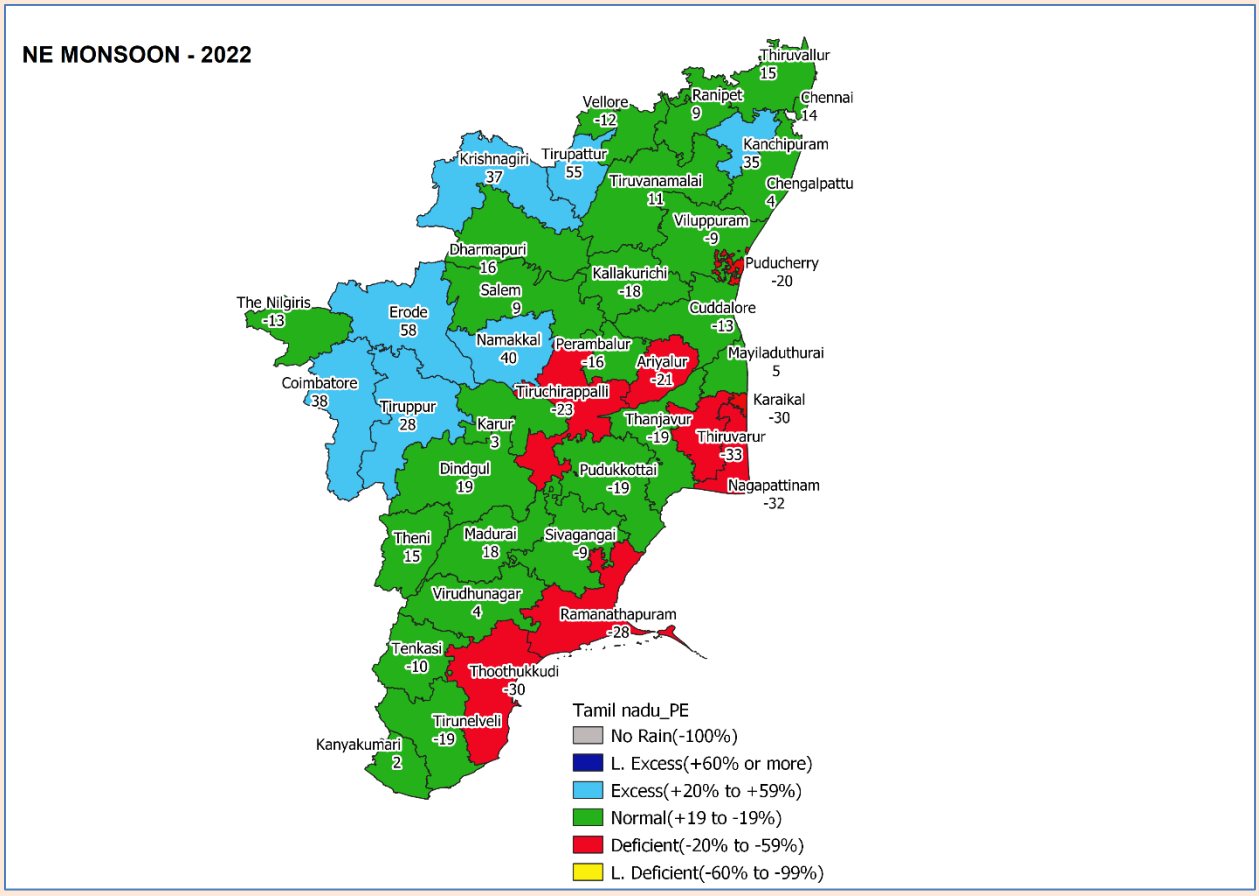


Fig.5b: District-wise rainfall distribution over the TN subdivision during Oct-Dec 2022

6. Standardised Precipitation Index

The Standardized Precipitation Index (SPI) is an index used for monitoring drought and is based on precipitation. This index is negative for dry and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. For October to December 2022, SPI indicated *Mildly Wet* / *Mildly Dry* conditions over many districts in the NEM region (Fig.6). Whereas Mysuru & Ramanagara districts in SIK came under *Severely Wet* category, Nagapattinam, Mayiladuthurai districts & Karaikal in TN came under Moderately Dry category. All other districts in TN, CAP, RYS, SIK & KER ended up as either Mildly Dry or *Mildly / Moderately* Wet. Whereas Vellore, Ranipet, Cuddalore, Villupuram, Kallakurichi, Perambalur, Ariyalur, Thiruchirapalli, Thanjavur, Tiruvarur, Pudukkottai, Sivagangai, Ramanathapuram, Thootukudi, Tirunelveli, Thenkasi districts in TN, Kasargod, Kannur, Kozhikode, Wayanad, Maplappuram, Thrissur, Palakkad, Kollam in Kerala, East Godavari, Srikakulam districts in CAP & Chikkamagaluru, Shivamogga districts in SIK came under *Mildly Dry* category rest of the districts came under *Mildly / Moderately Wet* category.

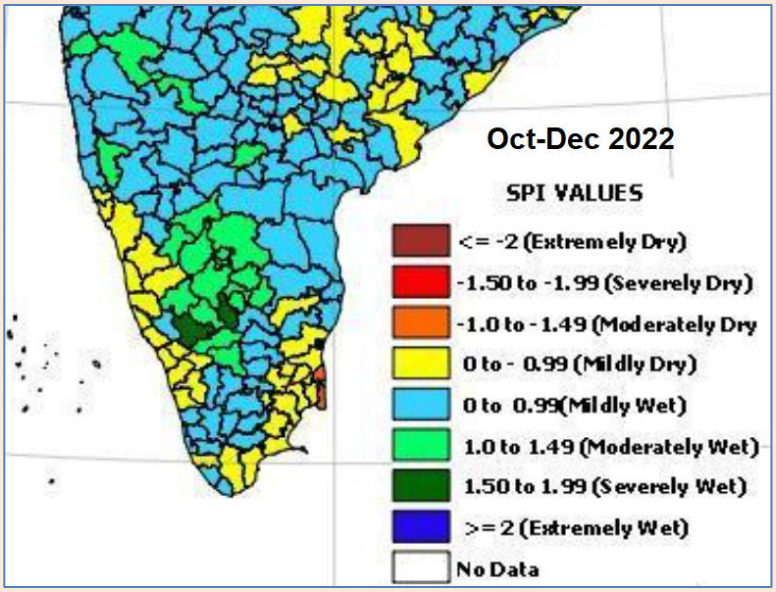


Fig.6: Standardised Precipitation Index for October-December 2022 over the southern peninsular India.

7. Large & Regional scale circulation features

(a) ***Flow pattern:*** The mean and anomalous wind pattern over the Indian region at 850 hPa, 500 hPa and 250 hPa levels during October –December 2022 are presented in Fig.7a(i)-(iii).

In October 2022, anomalous westerlies were observed over the southern parts of Arabian Sea in the lower tropospheric levels (850 hPa level) and anomalous cyclonic circulations over the southern parts of Bay of Bengal in the lower-mis tropospheric levels (850 hPa & 500 hPa); in the upper troposphere (250 hPa level), anomalous anticyclonic circulations were noted over the western and the eastern parts of north India.

In November, anomalous westerlies were observed over the southern parts of Bay of Bengal and off Sri Lanka coast in the lower tropospheric levels (850 hPa); anomalous cyclonic circulation over the Bay of Bengal and easterlies over the central India were observed in the mid levels; and anomalous anticyclonic circulations were observed over the western and eastern parts of north India in the upper tropospheric levels (250 hPa).

In December, anomalous westerlies were observed over the Comorin area and Equatorial Indian Ocean in the lower tropospheric levels; anomalous easterlies over the peninsular and central India in the mid levels and anomalous anticyclone over the central and eastern parts of North India in the upper tropospheric levels.

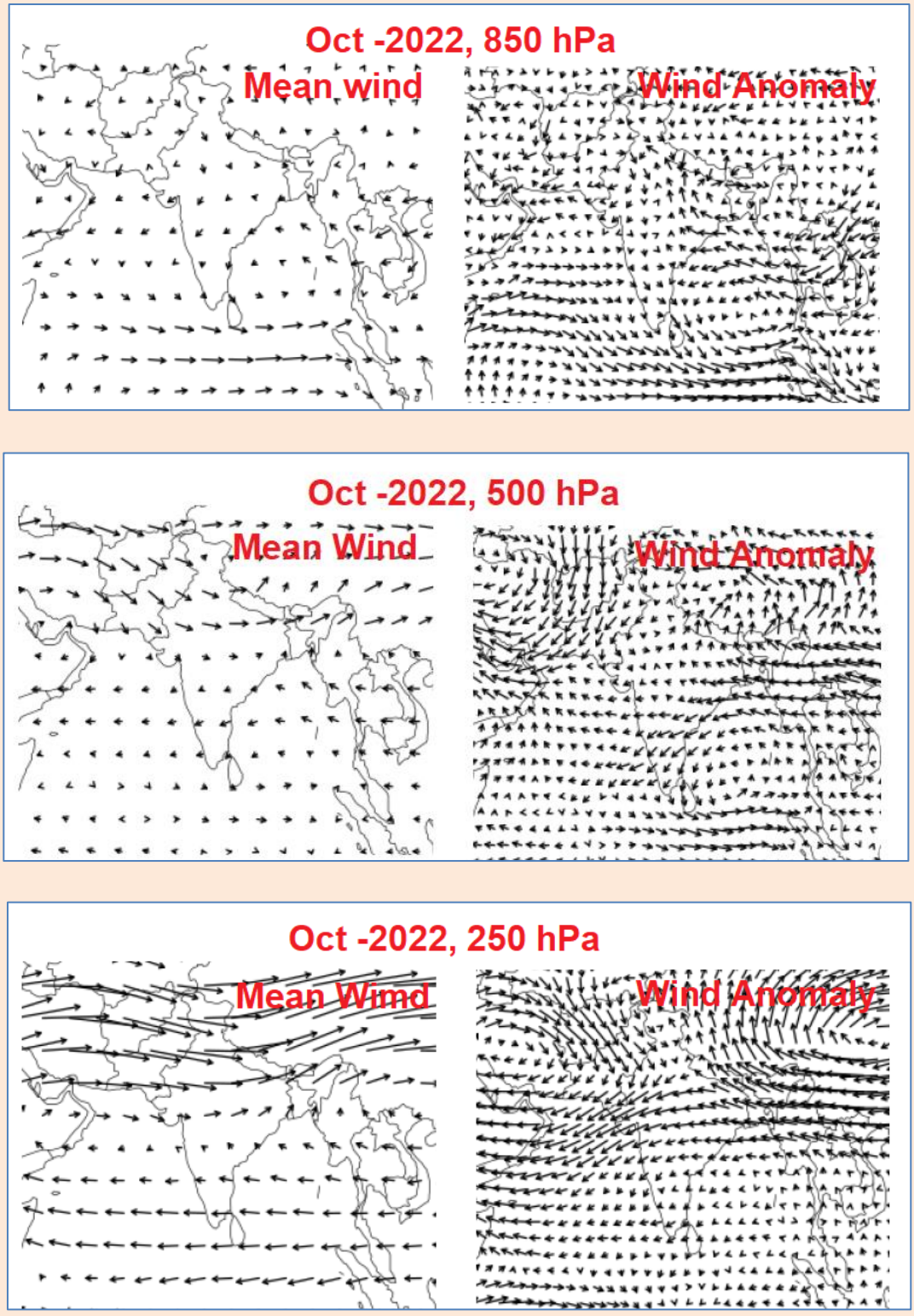


Fig.7a(i): Mean and anomalous wind pattern over the Indian region at 850 hPa, 500 hPa and 250 hPa levels during October 2022 (Source: Climate Diagnostic Bulletin of India, IMD Pune)

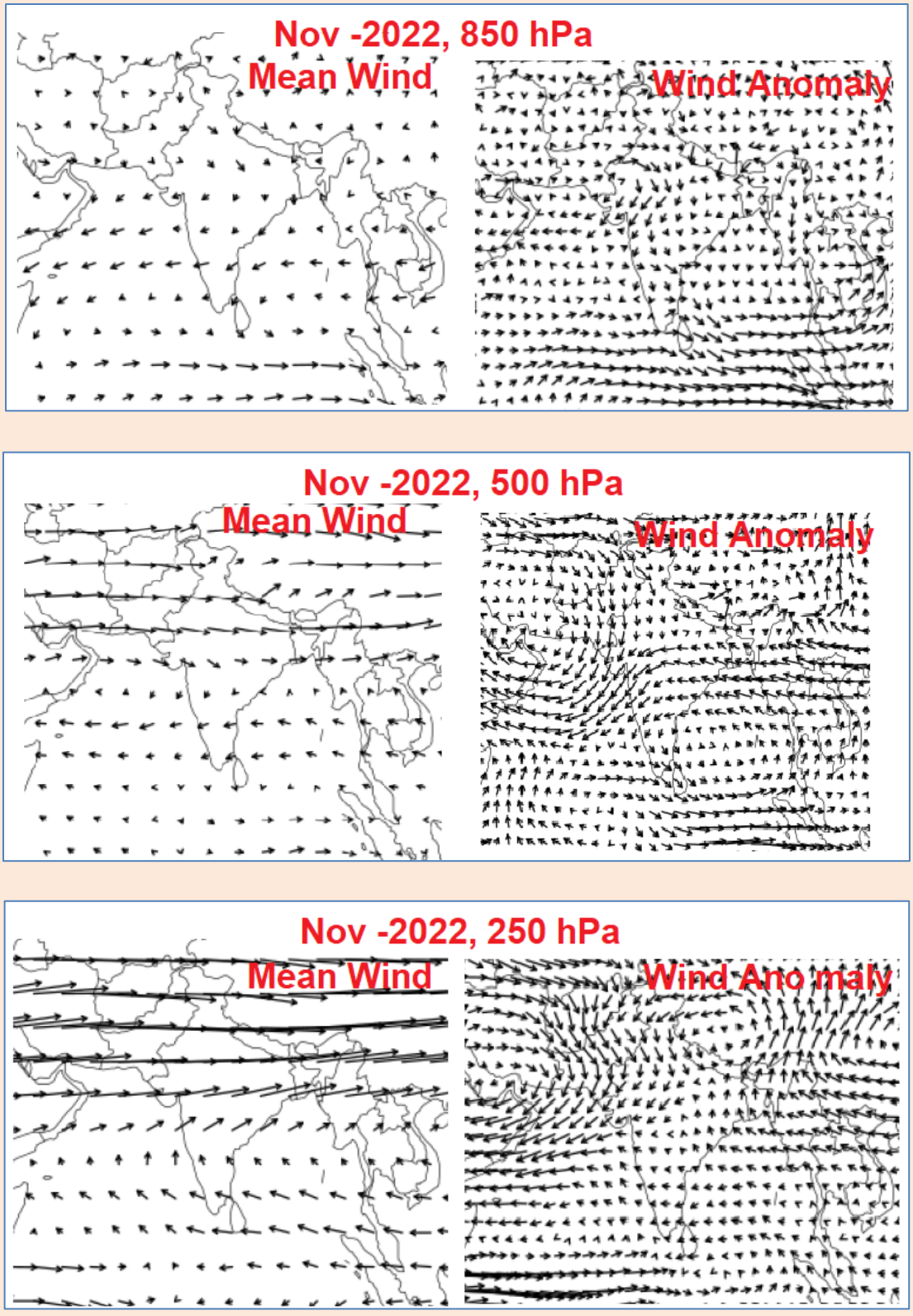


Fig.7a(ii): Mean and anomalous wind pattern over the Indian region at 850 hPa, 500 hPa and 250 hPa levels during Nov 2022 (Source: Climate Diagnostic Bulletin of India, IMD Pune)

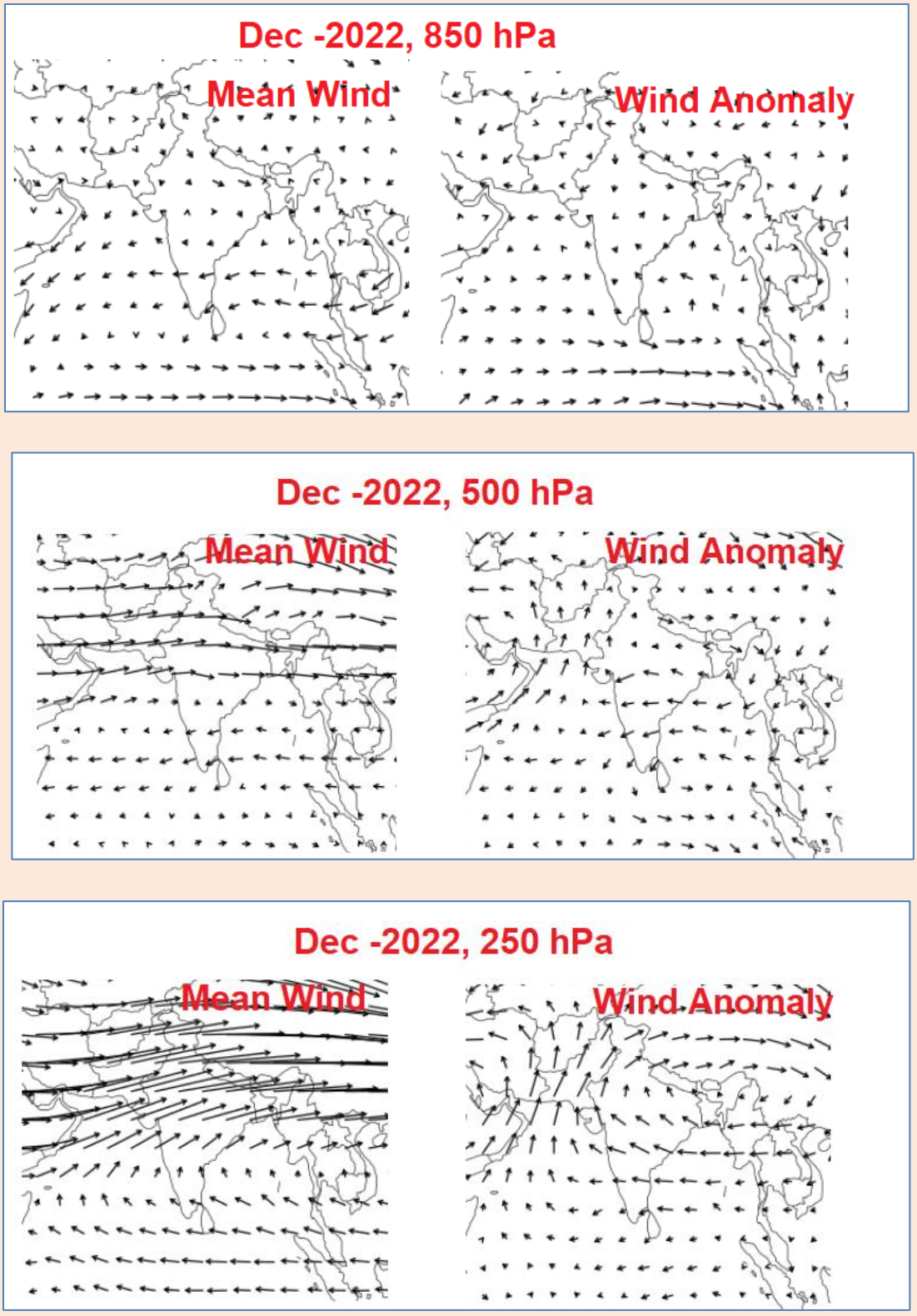


Fig.7a(iii): Mean and anomalous wind pattern over the Indian region at 850 hPa, 500 hPa and 250 hPa levels during December 2022 (Source: Climate Diagnostic Bulletin of India, IMD Pune)

(b) Monthly OLR patterns: In October 2022, negative OLR anomalies associated with extended SWM were observed over the southern and the central & eastern parts of the north Indian region. In November, near normal OLR were seen over the NEM region and in December, negative OLR anomalies upto about -20 W/m^2 were observed along and off Tamilnadu coast & Comorin area.

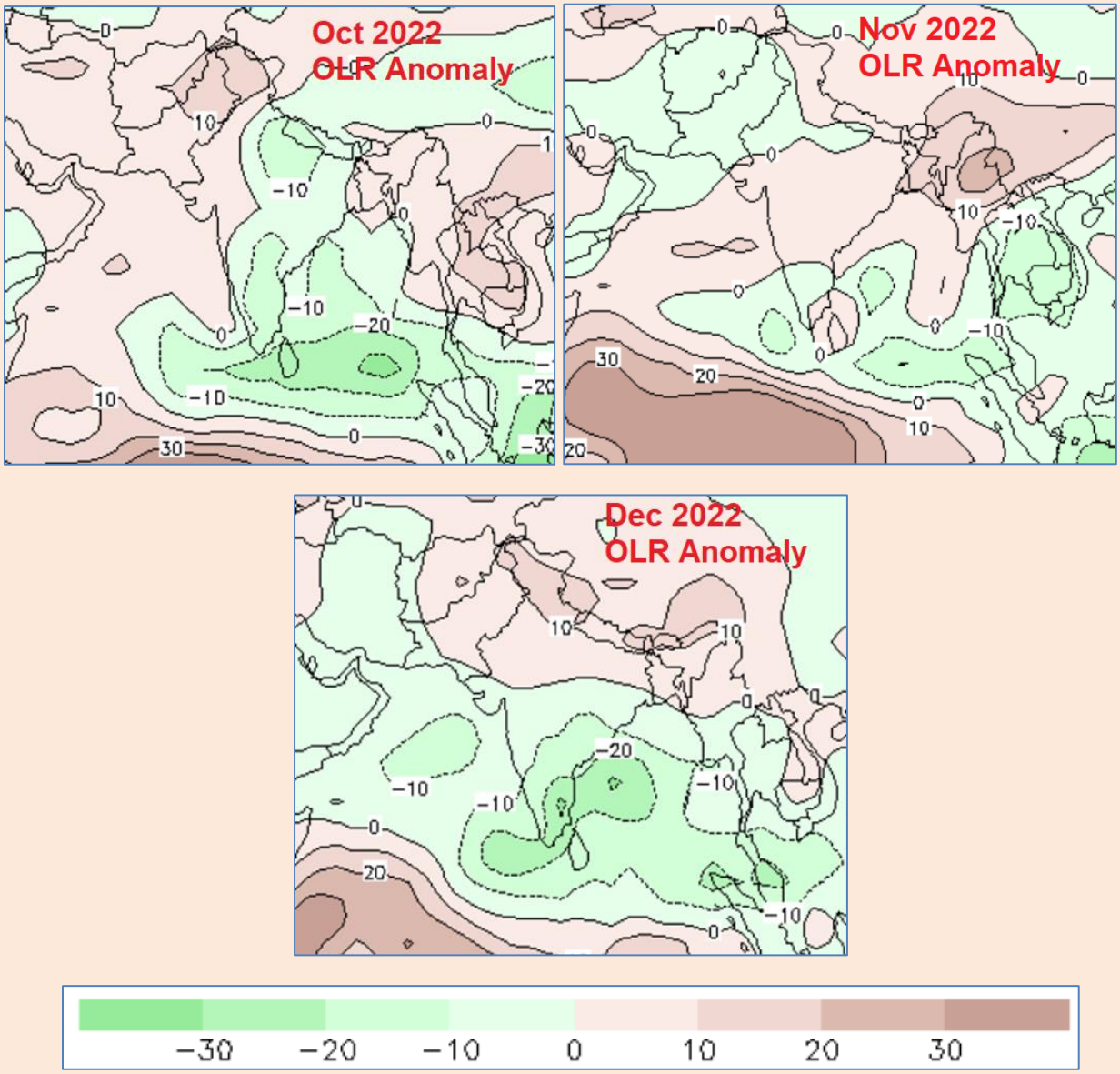


Fig.7b: OLR anomalies over the Indian region during Oct, Nov & Dec 2022 (Source: Climate Diagnostic Bulletin of India, IMD Pune)

(c) ***Large scale features****:* Based on MoES- MMCFS (Ministry of Earth Sciences- Monsoon mission: Climate Forecasting System) analysis and reports of various global climate monitoring

centres, it was noted that during October-December 2022, La Nina conditions (negative sea surface temperature anomalies) prevailed over the equatorial Pacific region. Indian Ocean Dipole was negative during the start of the season and became neutral during the later half of the season. Both these major climate indices were not favourable for good NEM activity especially during the first half of the season. MJO was in the western hemisphere or significant during most of the days during the season excepting a few days in the first & fourth weeks of December 2022 when it was in phase 3-4 (Fig.7c(i)-(iii).

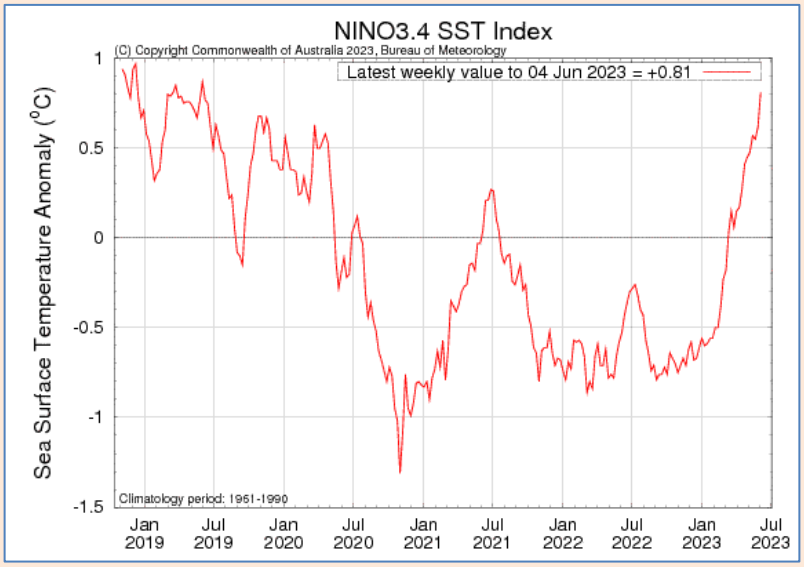


Fig.7c(i): Sea surface temperature over the equatorial Pacific Ocean (Source: Bureau of Meteorology, Australia)

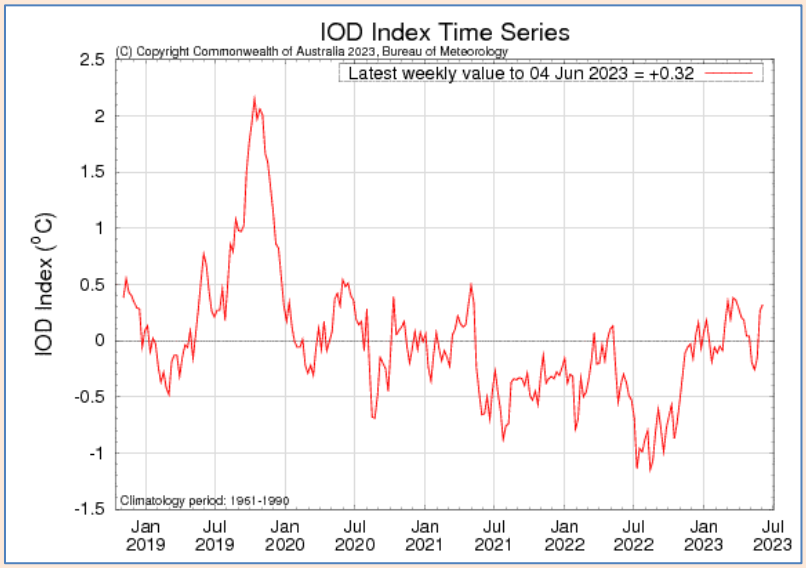


Fig.7c(ii): Indian Ocean Dipole mode index(Source: Bureau of Meteorology, Australia)

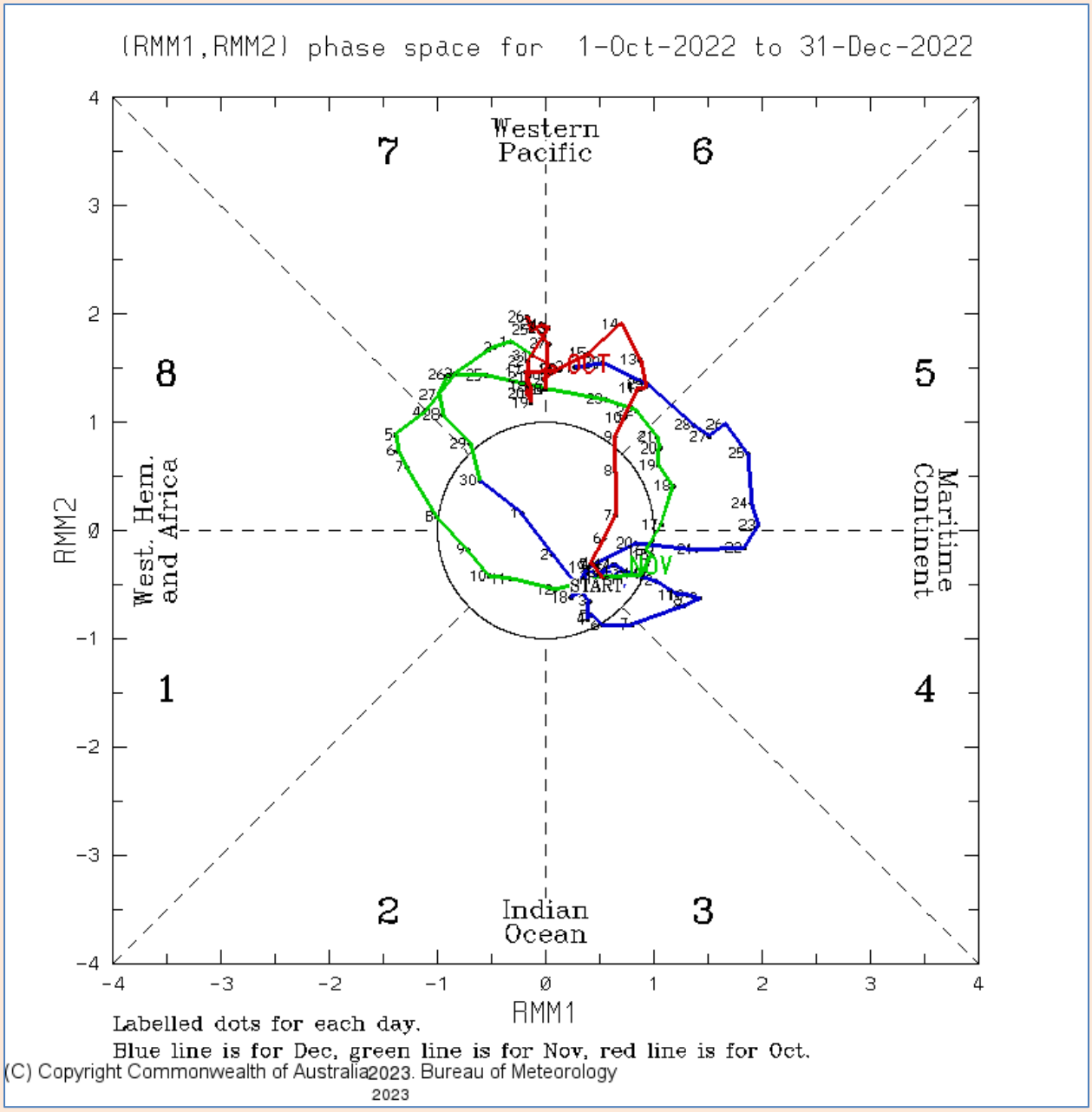


Fig.7c(iii): MJO during Oct-Dec 2022 (Source: Bureau of Meteorology, Australia)

8. Cessation of NEM rains over peninsular India

Subsequent to the Depression over the Bay of Bengal during 22nd-25th December, with the gradual decrease in rainfall activity, cessation of NEM rains over southern peninsular India was declared on 12th January 2023.

9. Summary

During the year 2022, the southwest monsoon withdrew from the Indian region on 23rd October and the Northeast monsoon of 2022 commenced over the southeastern parts of peninsular India on 29th October against the normal date of 20th October. All the five subdivisions benefitted by the NEM (TN, CAP, RYS, SIK & KER) received normal to excess rainfall during the season (October to December). There were two cyclones – (i) **CS *SITRANG*** over the Bay of Bengal during 22nd-25th October which crossed Bangaladesh coast and (ii) **SCS *MANDOUS*** over the Bay of Bengal during 06th-10th December that crossed north Tamilnadu, Puducherry and adjoining south Andhra Pradesh coasts near Mahabalipuram as a Cyclonic Storm with maximum sustained wind speed of 65-75 kmph gusting to 85 kmph during the midnight of 09th-10th December; a Deep Depression over Arabian Sea during 14th-17th December which formed from the remnant of the cyclone MANDOUS and weakened over the sea; and two Depressions over the Bay of Bengal (i) during 20th -22nd December that weakened off south Andhra Pradesh coast and (ii) during 22nd-25th December that crossed Sri Lanka coast. There were 18 days of *active* to *vigorous* monsoon conditions over TN, KER & SIK during the season. There were 51 days of *isolated heavy* rainfall activity with 20 days of *isolated very heavy* rain including 04 days of *isolated extremely heavy rainfall* activity over TN. *Extremely heavy* rain also occurred over RYS on one day. Associated with the passage of a Well Marked Low Pressure Area (WML) over Bay of Bengal during 09th-13th November across TN, extremely heavy rainfall were reported from Mayiladuthurai district (Sirkazhi: **44cm**, Kollidam: **32cm**) & Cuddalore district (Chidambaram: **31cm**, Annamalai Nagar :**28 cm**, Bhuvanagiri : **21 cm)** on 12th November and associated with the passage of the cyclone ***MANDOUS*** isolated *extremely heavy* rainfall were reported from Thiruvannamalai district in TN (Vembakkam: **25 cm**) and Chittoor district in RYS (Srilakahasti: **23 cm** & Thottambedu: **22 cm**) on 10th December. After the Depression over the Bay of Bengal during 22nd-25 December, with the gradual decrease in rainfall activity, cessation of NEM 2022 rainfall over peninsular India was declared on 12th January 2023.

Acknowledgements

This report is a compilation of real-time observational data and analytical products generated by various IMD offices including IMD New Delhi, Pune, Thirvananthapuram, Hyderabad, Bangalore & Amaravati as well as raingauge networks of state government departments. Contribution from all officials involved in generation of data and analytical products used for preparation of this report is duly acknowledged. Use of US-NCEP reanalysis data, analytical product of Bureau of Meteorology, Australia and local media reports are also duly acknowledged.

APPENDIX-(i): Terminologies for Spatial rainfall distribution

WS - Widespread (Most places): 75 % or more number of stations of a region (sub-division) reporting at least 2.5 mm rainfall.

FWS- Fairly widespread (Many places): 51% to 74 % number of stations of a region (sub-division) reporting at least 2.5 mm rainfall.

SCT- Scattered (at a few places): 26 % to 50% number of stations of a region (sub-division) reporting at least 2.5 mm rainfall.

ISOL- Isolated (At isolated places): 25% or less number of stations of a region (sub-division) reporting at least 2.5 mm rainfall.

DRY: No station of a region reported rainfall

APPENDIX-(ii): Terminologies for description of intensity of rainfall

S No.	Terminology	Rainfall range In mm	Rainfall range In cm	Percentile
1	Very light rainfall	Trace -2.4		
2	Light rainfall	2.5-15.5	Upto 1	Upto 65
3	Moderate rainfall	15.6-64.4	02-06	65-95
4	Heavy Rainfall	64.5- 115.5	07-11	95-99
5	Very Heavy Rainfall	115.6-204.4	12-20	99.0-99.9
6	Extremely heavy rainfall	Greater or equal to 204.5 mm	21 cm or more	>99.9
7	Exceptionally Heavy Rainfall	When the amount is a value near about the highest recorded rainfall at or near the station for the month or season. However, this term will be used only when the actual rainfall amount exceeds 12 cm.		

APPENDIX-(iii): Description of NEM rainfall activity

Active: Fairly widespread to widespread sub-divisional rainfall with rainfall more than 1½ to 4 times the normal with at least two stations reporting more than or equal to 3 cm in coastal Tamil Nadu, south coastal Andhra Pradesh and 2 cm elsewhere in the NEM region.

Vigorous: Fairly widespread to widespread sub-divisional rainfall with rainfall more than 4 times the normal with at least two stations reporting more than or equal to 5 cm in coastal Tamil Nadu, south coastal Andhra Pradesh and 3 cm elsewhere in the NEM region.