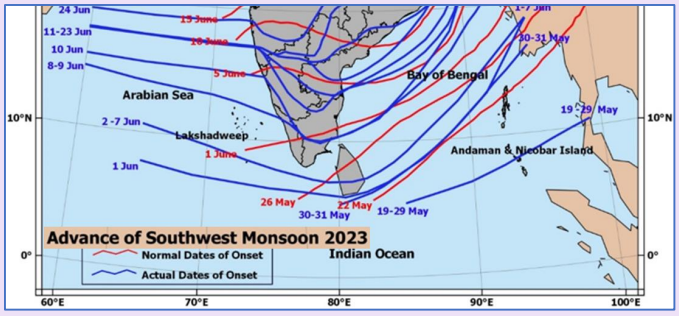
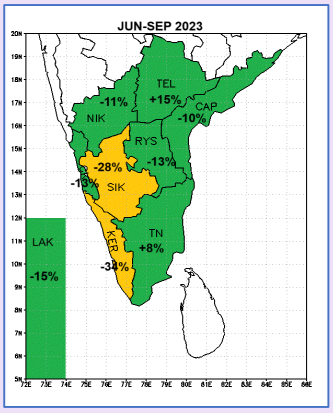
Government of India
Earth System Science Organisation
Ministry of Earth Sciences
India Meteorological Department

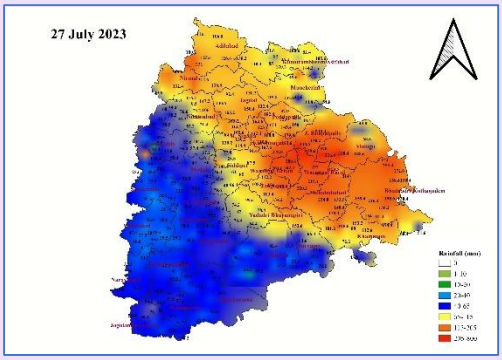
ESSO
Earth System Science Organization
Ministry of Earth Sciences

IMD Chennai Scientific Report No. IMDC-SR/15

SOUTHERN PENINSULAR INDIA:
SOUTHWEST MONSOON, 2023–REPORT







Regional Meteorological Centre, Chennai
December 2023

Table of Contents

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Executive Summary

1	Document title	Southern Peninsular India: Southwest Monsoon, 2023-Report
2	Document type	Scientific Report
3	Issue No.	IMDC-SR/15
4	Issue Date	December 2023
5	Security Classification	Unclassified
6	Control Status	Unclassified
7	No. of pages	67
8	No. of Figures	5
9	No. of Tables	6
10	Appendix	(i)-(iv)
11	No. of references	--
12	Annexure	--
13	Distribution	Unrestricted
14	Language	English
15	Authors	B.Geetha, K.Ramesh, R.V.Deepa, J.Menaka Gandhi, S.Balachandran, P.Senthamarai Kannan, K.Santhosh, S.Stella, Geeta Agnihotri and K.Nagaratna
16	Authors' affiliation	India Meteorological Department
17	Originating group	Research Section, Regional Meteorological Centre, India Meteorological Department, Chennai
18	Reviewing & Approving authority	Head, Regional Meteorological Centre, India Meteorological Department, Chennai
19	End users	State Agriculture departments, State disaster management authorities, Press & media, Researchers and general public
20	Highlights	Given in page 3
21	Keywords	Southwest monsoon, Southern India, Rainfall

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

HIGHLIGHTS

- ✓ During 2023, southwest monsoon (SWM) advanced into Southeast Bay of Bengal, South Andaman Sea and Nicobar Islands on 19th May. It set in over Kerala on 08th June, 7 days after than the normal date of 1st June and covered the entire southern peninsular (SP) India (comprising of the five states of Andhra Pradesh, Telangana, Karnataka, Kerala and Tamil Nadu and two union territories of Puducherry and Lakshadweep) by 24th June, the normal date being during 11th-15th June. It covered the entire country by 02nd July, six days ahead of its normal date of 08th July.

- ✓ All India southwest monsoon (SWM) seasonal rainfall during Jun-Sep, 2023 was *normal*. It was 94% (82 cm) of its Long Period Average (LPA) of 87.0 cm. South Peninsular region recorded 92% (66 cm) of its LPA of 72 cm.

- ✓ Seasonal rainfall over the nine meteorological subdivisions covering the five states and two union territories in the SP region was *normal* in seven subdivisions [Telangana (TEL) Coastal Andhra Pradesh (CAP), Rayalaseema (RYS), Coastal Karnataka (CK), North Interior Karnataka (NIK), Tamil Nadu (TN) & Lakshadweep (LAK)] and *deficient* in the other 2 sub divisions [Kerala (KER) & South Interior Karnataka (SIK)]. The seasonal rainfall figures over the nine subdivisions CAP, RYS, TEL, TN, CK, NIK, SIK, KER, LAK) were -10%, -13%, +15%, +08%, -13%, -11%, -28%, -34%, and -15% respectively.

- ✓ During the season, *Fairly widespread* to *Widespread* rainfall occurred over CK on about 80% of the days, over KER & LAK on 67% of the days and about 35-38% of the days over TEL, SIK & CAP.

- ✓ There were *isolated heavy* rainfall activities on 55 days over TN, 50 days over KER, 46 days over CK & TEL, 40 days over CAP, 26 days over SIK, 24 days over NIK, 21 days over RYS & 3 days over LAK area during the season. Highest 24-hr rainfall recorded during the season in the SP region was over Chityal (J.Bhupalpally district, Telangana)- 62 cm on 27th July.

- ✓ The withdrawal of SWM 2023 from the SP region commenced on 09th October. It withdrew from the entire region & hence the entire country on 16th October 2023.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

1. Onset and Advance

During the year 2023, the Bay of Bengal (BOB) branch of southwest monsoon (SWM) current advanced into the BOB with the characteristic strengthening and deepening of cross equatorial flow and enhanced cloudiness and rainfall over the southeast BOB, Nicobar Islands south Andaman Sea on 19th May, three days ahead of the normal date of 22nd May. It covered many parts of eastcentral BOB, some parts of southwest BOB, Comorin area and southeast Arabian sea by 1st June. Under the influence of formation of Extremely Severe Cyclonic Storm (ESCS) Bi'porjoy' over the southeast Arabian Sea and its northward movement towards Gujarat coast during 06th-16th June, onset of monsoon over Kerala & its further advance into southern peninsular India was delayed. The monsoon advanced into the remaining parts of south AS Lakshadweep area, most parts of Kerala, most parts of south Tamilnadu, Gulf of Mannar and some more parts of southwest BOB & some parts of westcentral & northeast BOB on 08th June. Thus, it set in over Kerala on 08th June 2023, late by about a week from the normal date of onset (i.e.) the 01stJune.

It covered the entire southern peninsular India (SP) comprising of five states (Andhra Pradesh, Telangana, Kerala, Karnataka and Tamil Nadu) and two union territories (Puducherry and Lakshadweep) - divided into nine meteorological subdivisions of Coastal Andhra Pradesh and Yanam (CAP), Telangana (TEL), Rayalaseema (RYS), Tamilnadu, Puducherry and Karaikal (TN), Coastal Karnataka (CK), North Interior Karnataka (NIK), South Interior Karnataka (SIK), Kerala and Mahe (KER) and Lakshadweep (LAK) - by 24th June, delayed by about 10 days (normal: 11th-15th June).

The northern limit of monsoon (NLM) passed over Kannur (KER), Kodaikanal & Adiramapattinam (both TN) on 08th June. It advanced into remaining parts of KER and some parts of KAR on 10th June; some more parts of KAR, most parts of Tamilnadu, Puducherry & Karaikal and some parts of Andhra Pradesh (CAP & RYS) on 11th; some more parts of KAR, remaining parts of TN and some more parts of Andhra Pradesh on 12th; some more parts of KAR & Andhra Pradesh on 19th; some parts of TEL and remaining parts of CAP & RYS on 22nd; some more parts of KAR & TEL on 23rd; remaining parts of KAR & TEL on 24th June 2023. It also gradually covered the entire BOB by 24th June and hence, it covered the entire SP region and the BOB by 24th June. The advance of the monsoon over the SP region, as depicted by the northern limit of the monsoon (NLM) is presented in Fig.1a.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

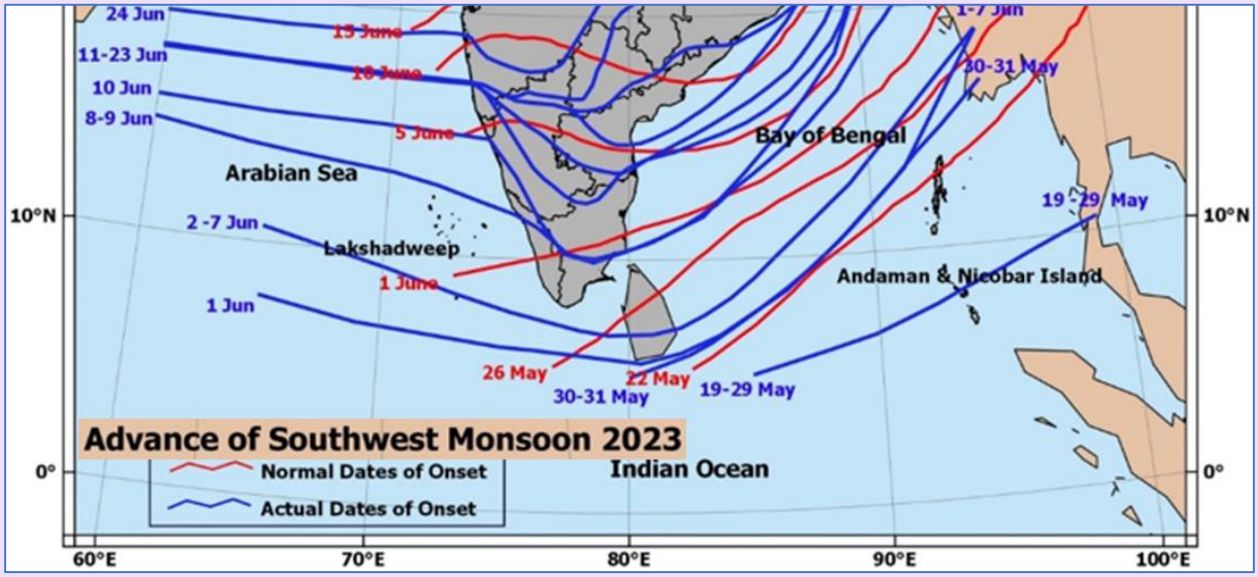


Fig.1a: Advance of southwest monsoon 2023 over southern peninsular India depicted by lines of northern limit of monsoon on various dates

During the onset phase of the monsoon, ***Extremely Severe Cyclonic Storm*** (ESCS) '**Biporjoy**" occurred over the Arabian Sea region during the period 6th-19th June 2023 which affected the onset and advance of the monsoon over the SP region. The onset of monsoon over KER was associated with a cyclonic circulation in the mid tropospheric levels over south TN & neighbourhood on 06th & 07th June. Subsequently, under the influence of east-west shear zone running across peninsular India in the lower-mid tropospheric levels / off shore trough off west coast of India / north-south trough across peninsular India in the lower tropospheric levels / upper air cyclonic circulation over the peninsular India / upper air cyclonic circulation over the BOB, the monsoon gradually advanced into the entire SP region by 24th June. It may be noted that the advance of monsoon over KAR was stalled for about a week during 12th-19th June. Subsequently, with the flow pattern gradually returned to normal with off shore trough forming around 23rd June.

The track of the ESCS 'Biporjoy' is presented in Fig.1b. Surface isobaric analysis as on 0830 IST and 500 hPa streamline analysis as on 0530 IST of 07th June, upper air (lower-mid tropospheric levels) streamline analysis as on 0530 IST of 21st June & Surface isobaric analysis as on 0830 IST of 23rd June depicting these synoptic features associated with the onset of the monsoon over KER and advance of the monsoon over the SP are presented in Fig.1c(i-iv). Satellite imageries depicting the cloudiness associated with the advance of the monsoon over the southern peninsula are presented in Fig.1d.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

During the period of onset and advance of monsoon over the SP region, *fairly widespread* to *widespread* rainfall occurred over KER & CK on *many* days during 08th-24th June; and *scattered* to *widespread* rainfall on *many* days over LAK during the same period; over SIK, CAP, RYS & TN on *many* days during 19th-24th June; over TEL during 21st-24th June & over NIK on 24th June 2023.

During the period 08th-24th June, *isolated heavy* to *very heavy* rain occurred over CK & TN on three days each (CK:18th, 23rd & 24th; TN: 17th, 18th & 24th); over CAP on 11th; and over RYS on 23rd. Also, *isolated heavy* rain occurred over KER on eight days; over TN on 7 days; over CAP on 6 days; over RYS & TEL on 4 days each; over SIK on 3 days and over CK & NIK on one day each during the same period.

Active monsoon conditions prevailed over SIK & RYS on 21st, 22nd & 23rd; over CAP on 22nd, 23rd & 24th; and over CK & TEL on 24th June 2023.

GPM-gauge merged rainfall as on 0830 IST of 08th, 11th, 13th, 19th, 22nd & 24th June over the various sub divisions of the SP region and gauge observed 24-hr accumulated rainfall (as on 0830 IST) over KER on 08th, TN on 13th, Andhra Pradesh (CAP & RYS) on 19th, Karnataka (CK, SIK & NIK) on 24th, & TEL on 24th June 2023 are presented in Fig.1e & Fig.1f.

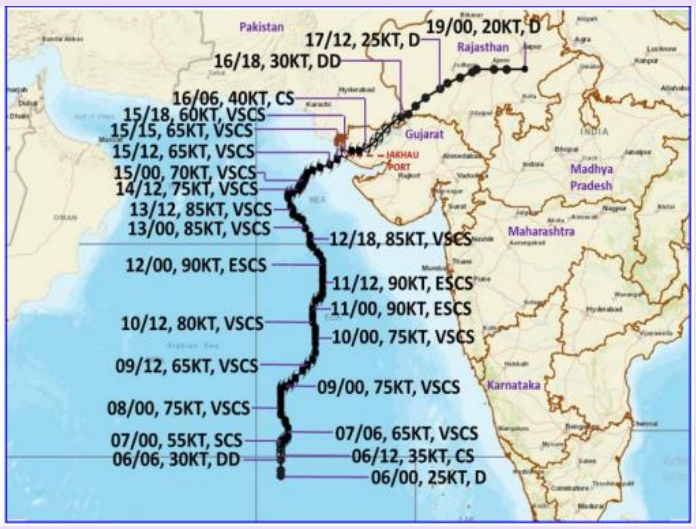
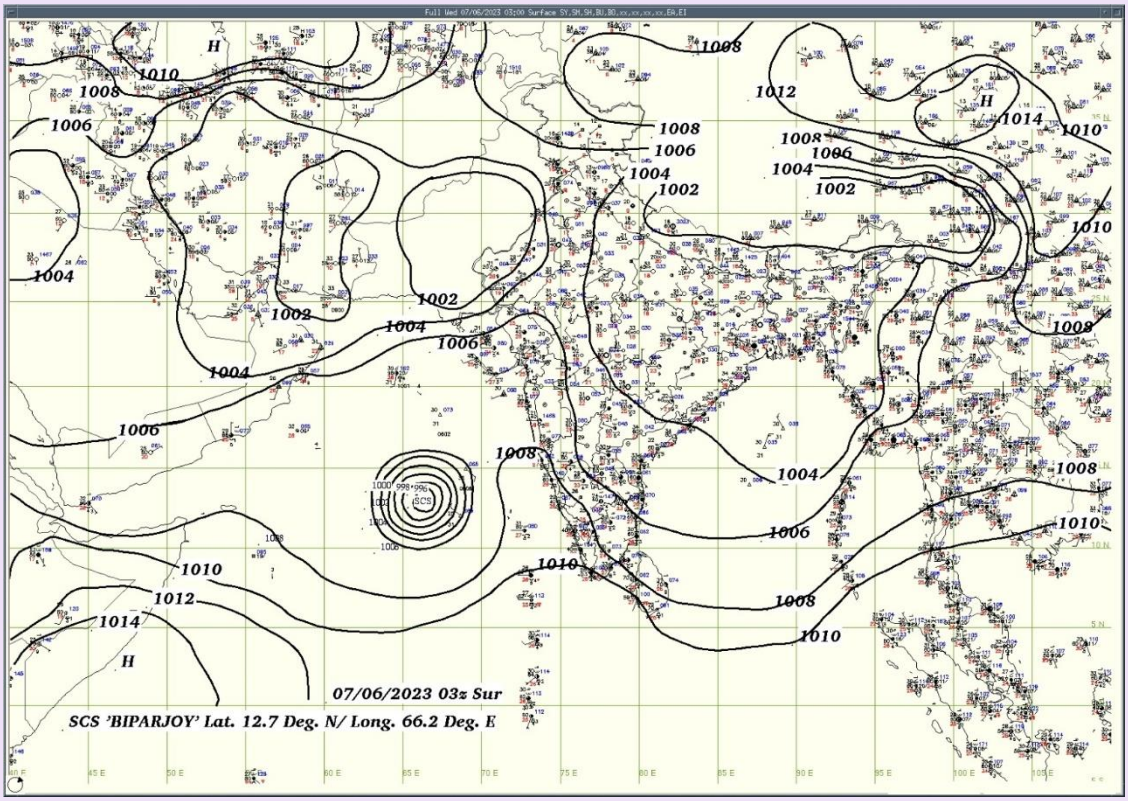
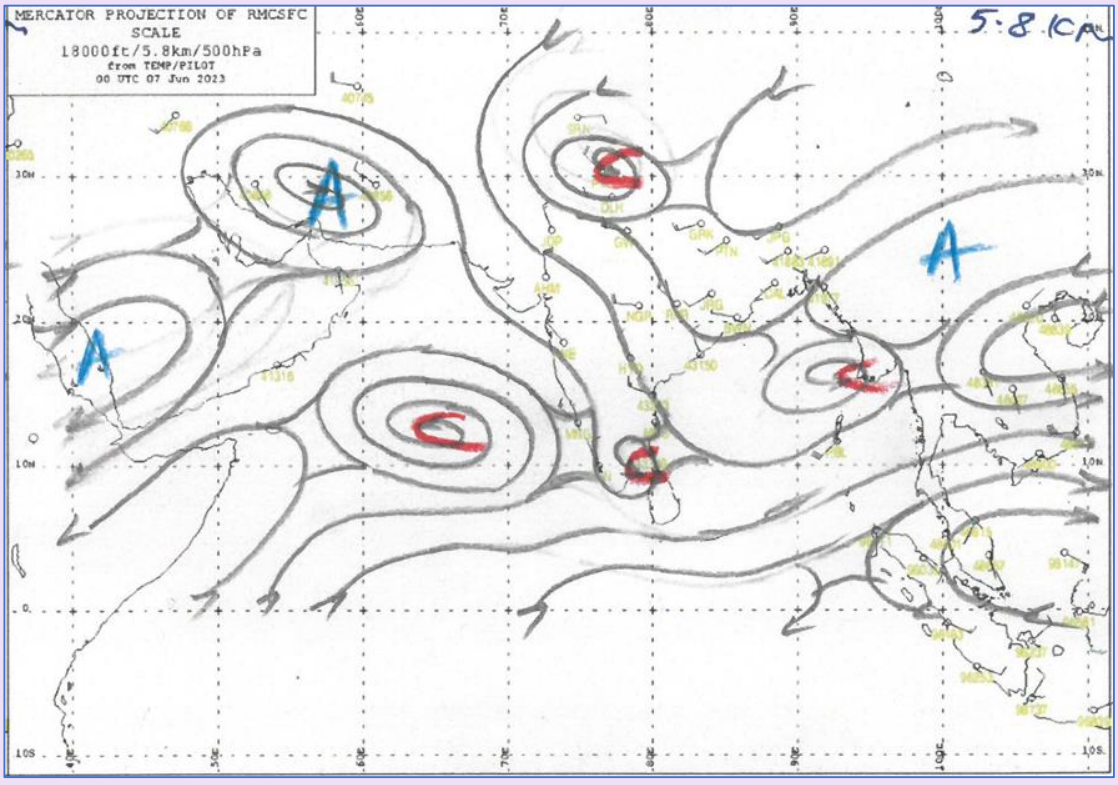


Fig.1b: Track of Extremely Severe Cyclonic Storm Biparjoy during 06th-19th June 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



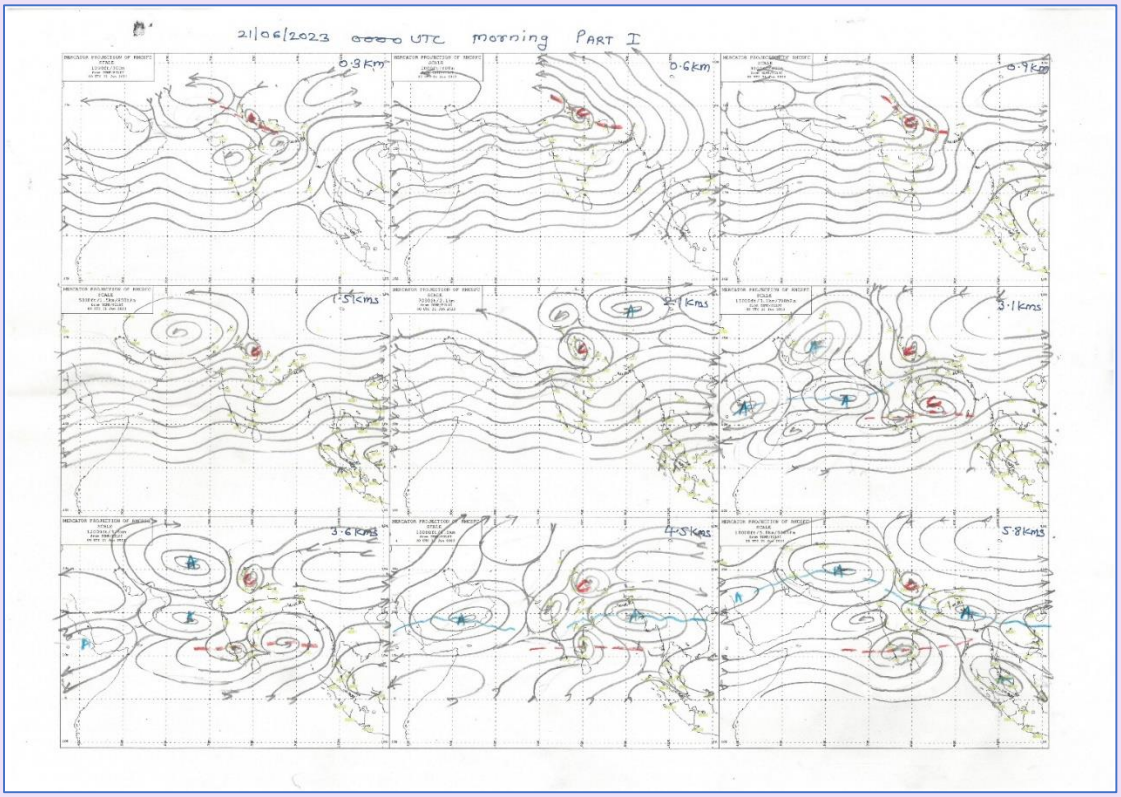
(i)



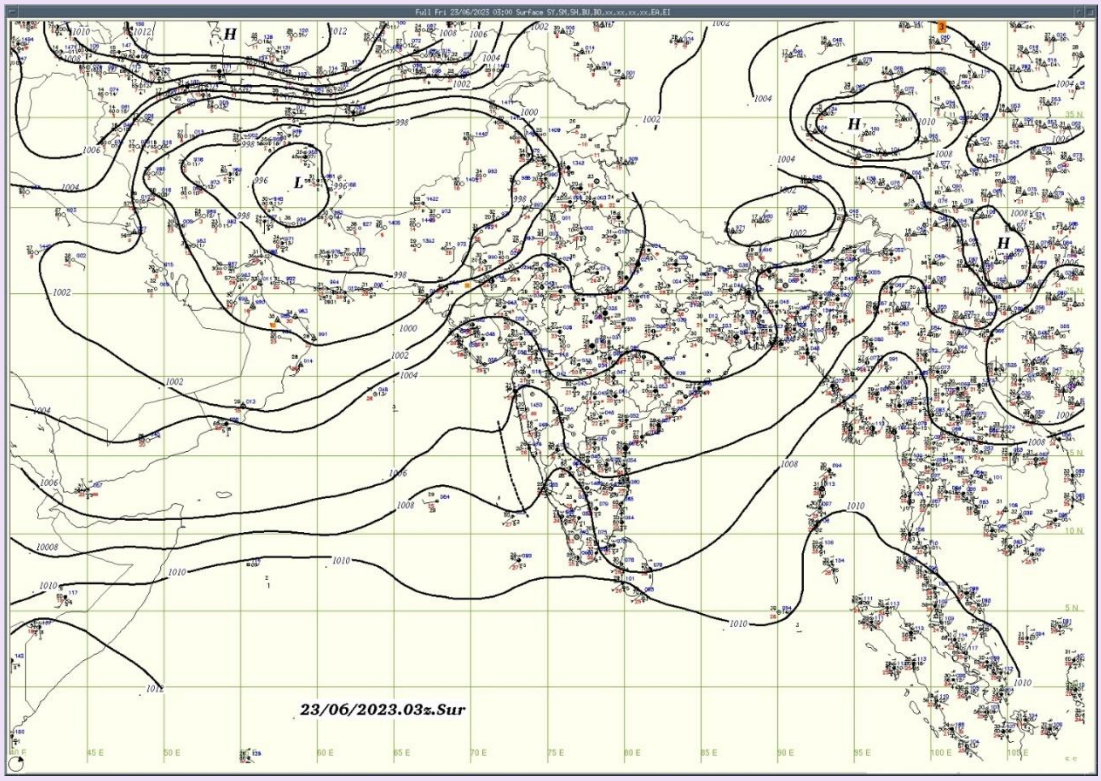
(ii)

Fig.1c: (i) Surface isobaric analysis as on 0830 IST and (ii) 500 hPa streamline analysis as on 0530 IST of 07th June 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



(iii)



(iv)

Fig.1c contd.: (iii) upper air streamline analysis as on 0530 IST of 21st Jun & (iv) Surface isobaric analysis as on 0830 IST of 23rd Jun 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

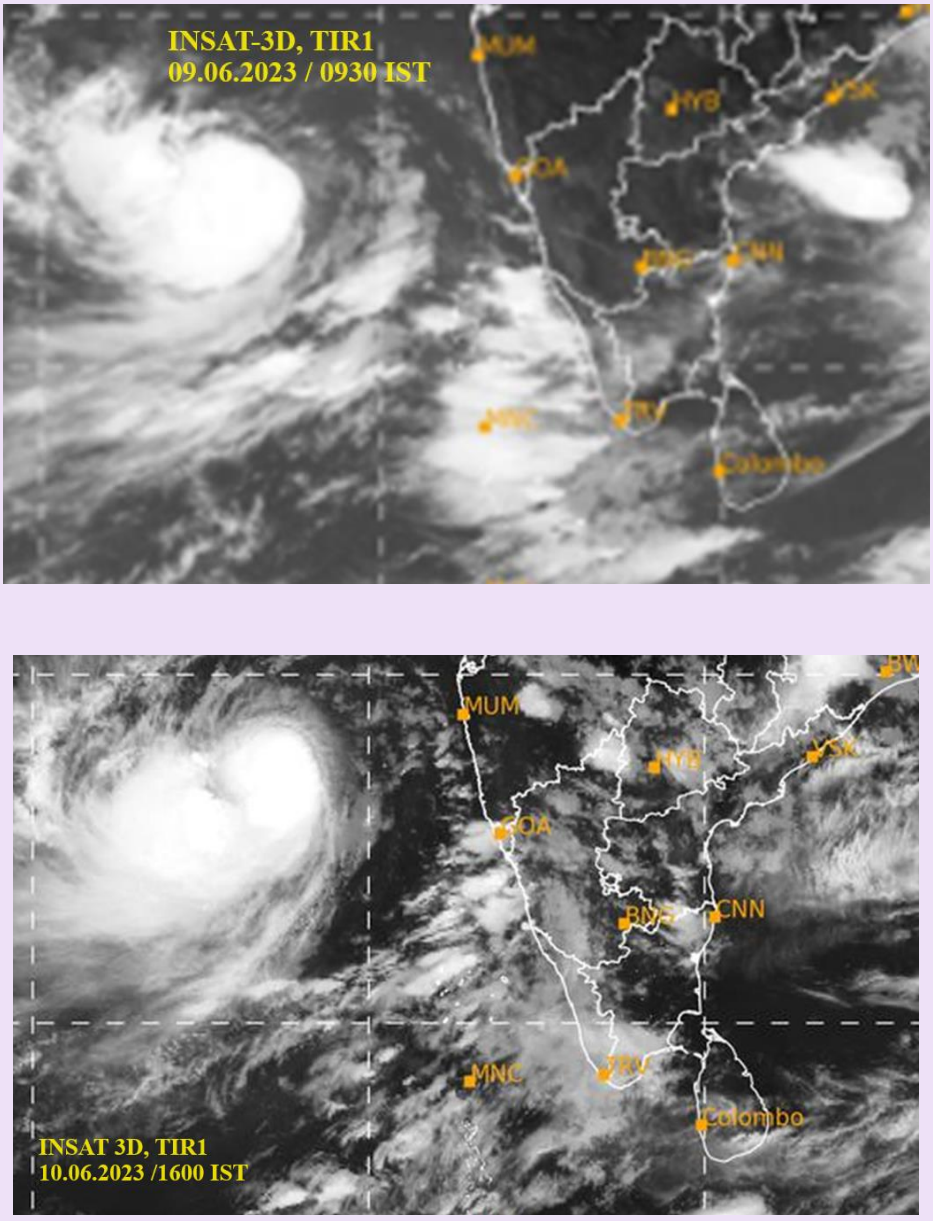
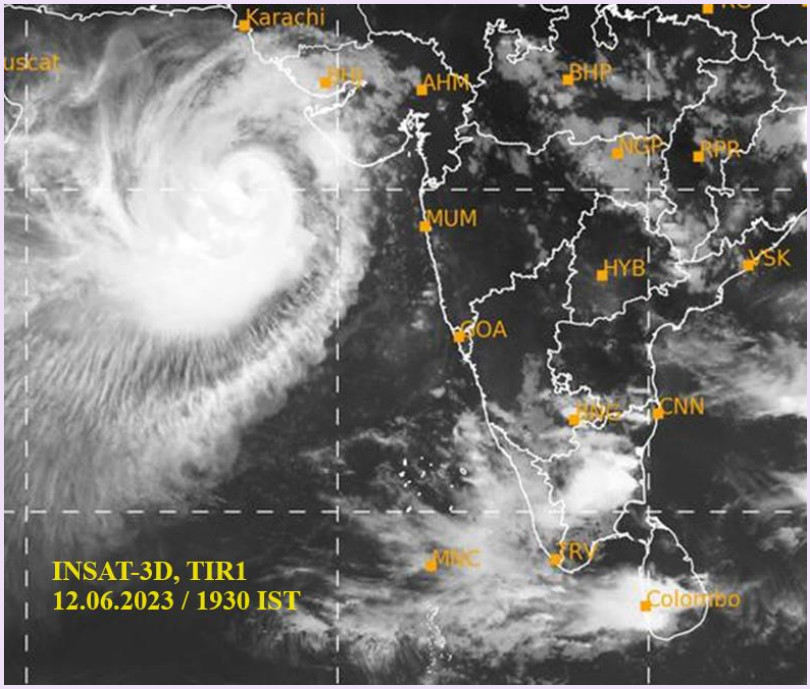


Fig.1d: INSAT-3D, infra-red imageries as on 09/0930 IST, 10/1600 IST, 12/1930 IST, 19/0300 IST & 22/2030 IST of Jun 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



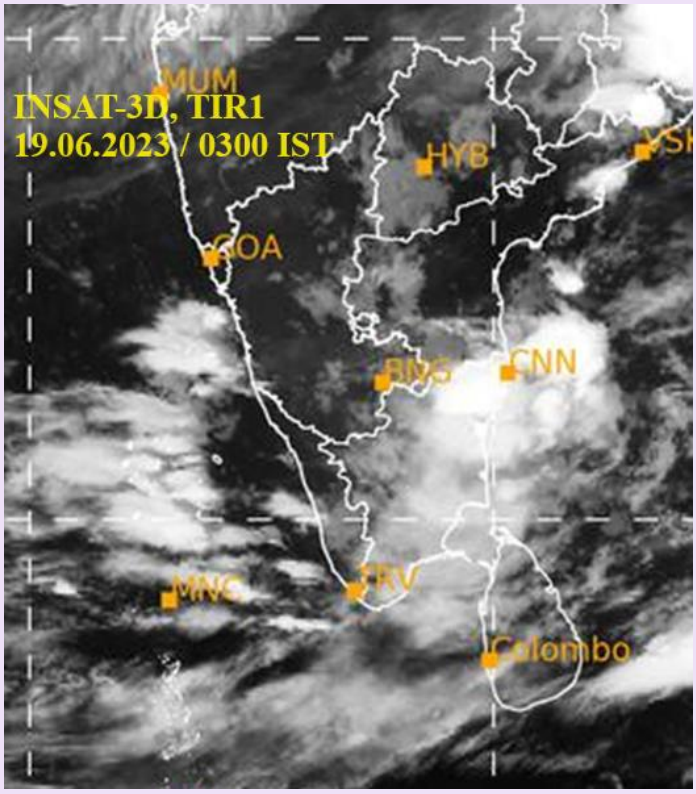


Fig.1d: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

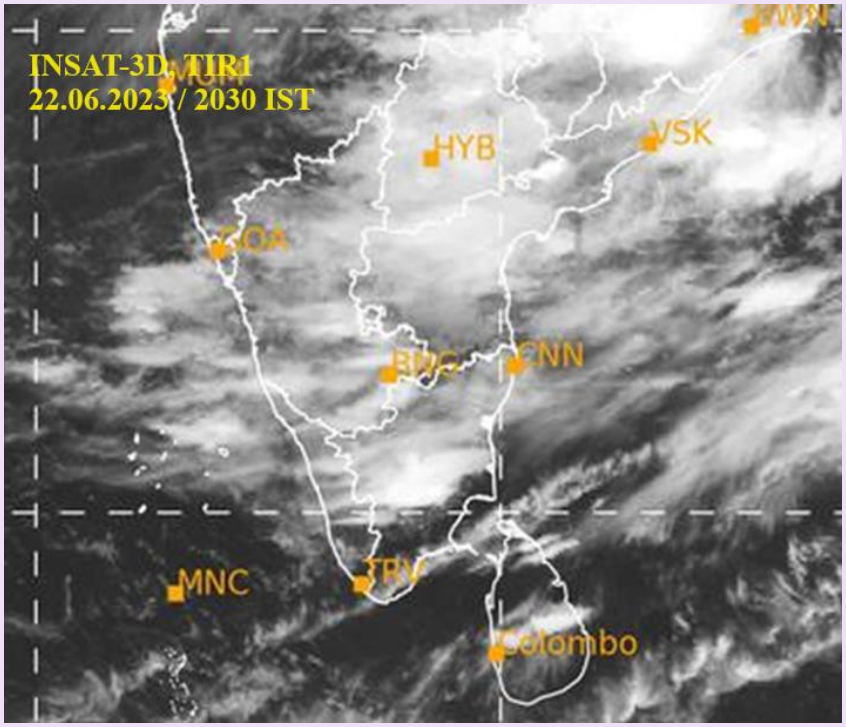


Fig.1d: contd.

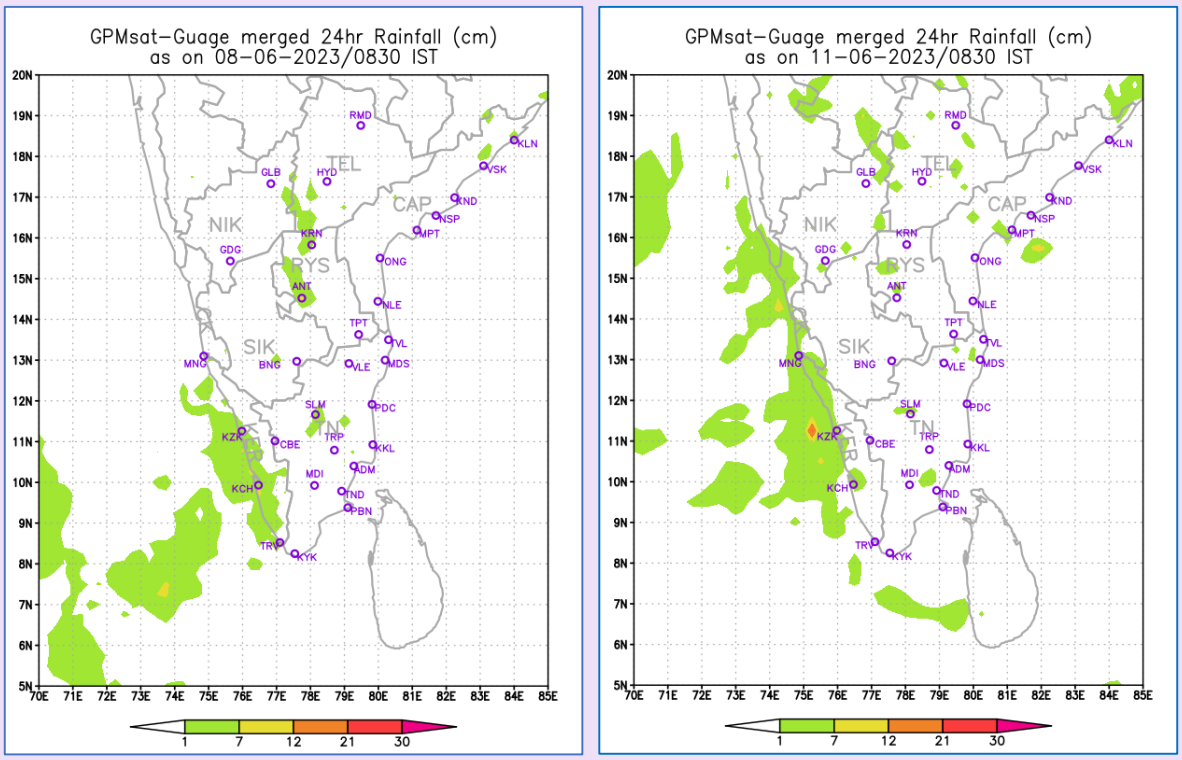


Fig.1e: GPM Sat – Gauge merged rainfall in cm as on 24-hr ending 0830 IST of 08th, 11th, 13th, 19th, 22nd & 24th June 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

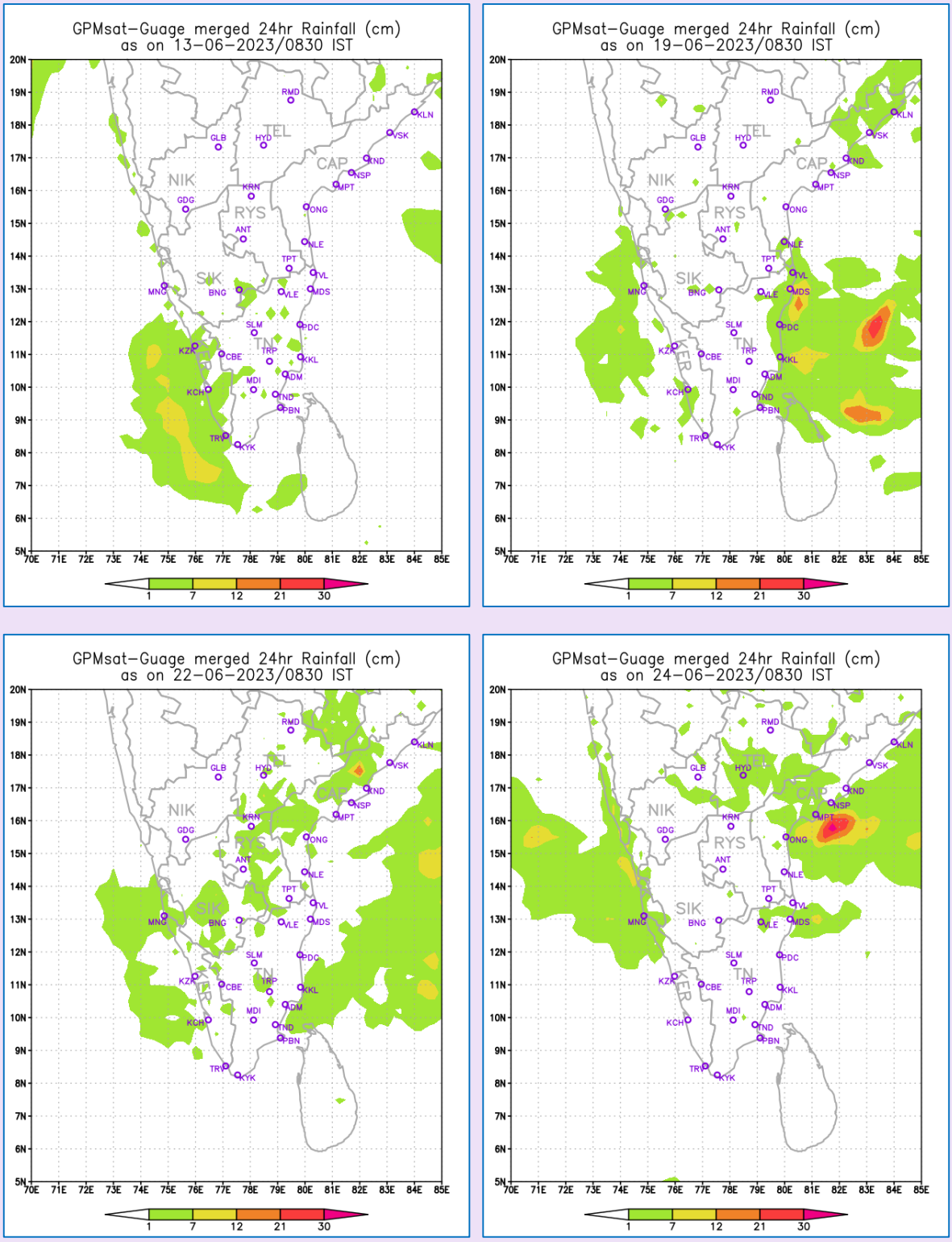


Fig.1e: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

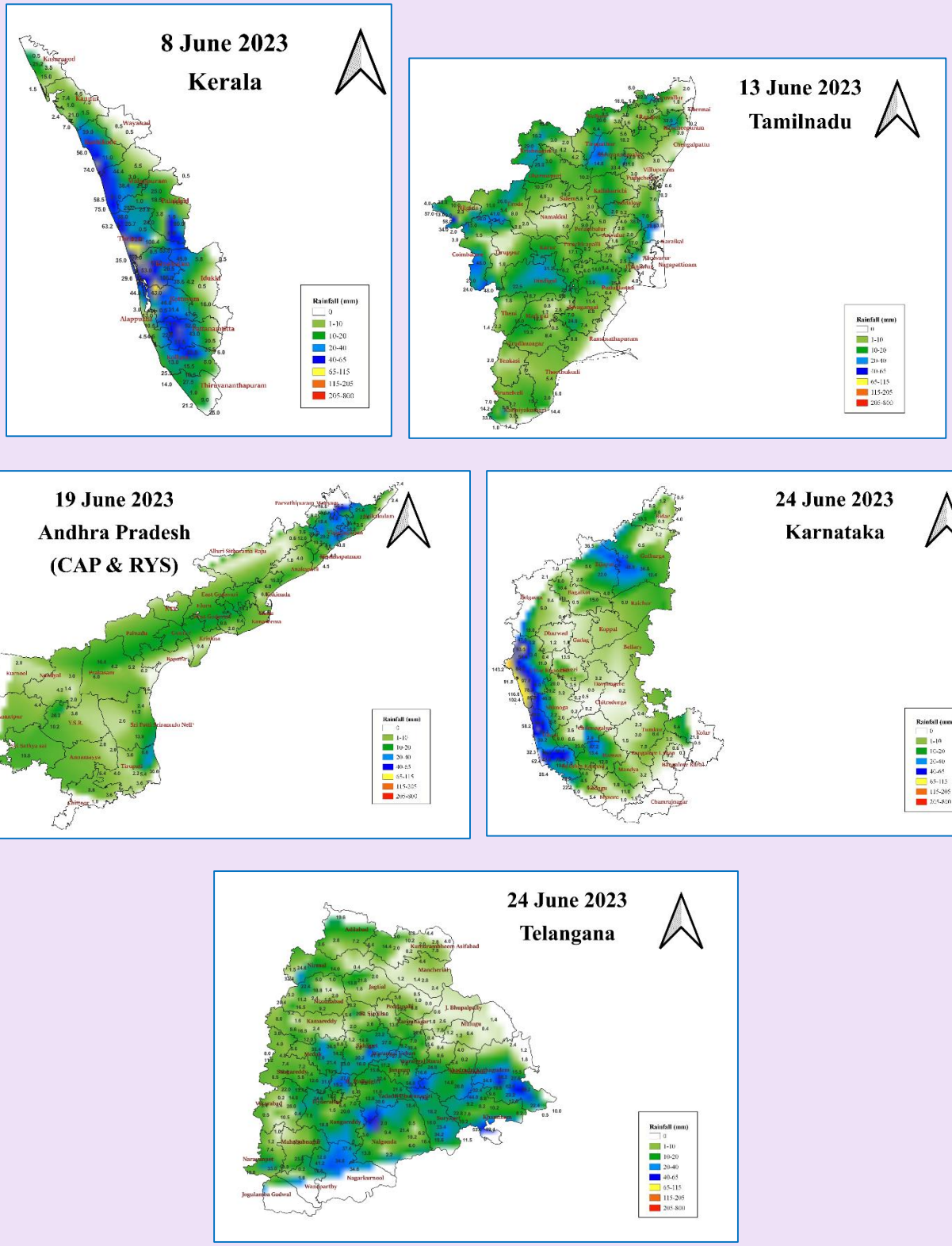


Fig.1f: 24-hr accumulated rainfall (as on 0830 IST) over KER on 08th, TN on 13th, Andhra Pradesh (CAP & RYS) on 19th, Karnataka (CK, SIK & NIK) on 24th, & TEL on 24th June 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

2. Chief synoptic features & associated weather

During June-September 2023, the chief synoptic features that contributed significantly towards rainfall activity over the SP region were the following: (i) Low Pressure Area (LOPAR) over Northwest Bay of Bengal and adjoining Odisha coast with the associated cyclonic circulation extending upto 7.6 km above mean sea level tilting southwards with height with east-west shear zone running roughly along 20° N between 3.1 & 7.6 km above mean sea level tilting southwards during 20th-21st July, (ii) a well-marked LOPAR (WML) that formed and persisted over Westcentral & adjoining Northwest Bay of Bengal off north Andhra Pradesh-south Odisha coasts and neighbourhood during 24th-27th July (iii) LOPAR over Northwest & adjoining Westcentral Bay of Bengal off south Odisha-north Andhra Pradesh coasts with the associated cyclonic circulation extending upto 7.6 km above mean sea level tilting southwestwards with height on 05th September (iv) a WML over Eastcentral Arabian Sea off south Konkan and Goa coasts during 29-30 September (v) presence of off shore trough off the west coast (vi) cyclonic circulations in the lower-mid tropospheric levels over the SP region and neighbourhood (vii) cyclonic circulations in the BOB /AS with a trough extending over the SP region (viii) east-west shear zone across peninsular India in the lower-mid tropospheric levels tilting southwards with height (ix) north-south trough across the southern peninsula.

Whereas the cyclonic circulations over the southeast AS and adjoining areas / off shore trough / east-west shear zone in the lower-mid tropospheric levels across peninsular India were associated with rainfall over CK, KER & LAK, rainfall over SIK, RYS & TN were mainly under the influence of north-south trough across peninsular India / strengthening of westerlies / east-west trough across peninsular India and that over CAP, TEL & NIK were under the influence of the westward moving low pressure systems that formed over the BOB / north-south trough across the southern peninsula / east-west shear zone across the southern peninsula. Significant synoptic situations and associated rainfall features over various parts of the SP region are detailed below:

(i) Under the influence of off shore trough / strengthening of low level westerlies / cyclonic circulations in the lower-mid tropospheric levels / east-west shear zone across peninsular India, *fairly widespread – widespread* rainfall occurred over CK on 97 days out of 122 days (80%), 82 days over KER (68%), 82 days over LAK (67%), 47 days over SIK (37%), 35 days over NIK (28%) during the season. *Active* to *vigorous* monsoon conditions prevailed over CK on 25 days,

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

over NIK – 17 days, over SIK – 18 days and over KER - 22 days. Surface isobaric analysis as on 0830 IST & upper air streamline analysis as on 0530 IST of 05th, 06th & 22nd July depicting the off shore trough off the west coast of peninsular India and east-west shear zone in the lower-mid tropospheric levels over the SP region is presented in Fig. 2(i)a.

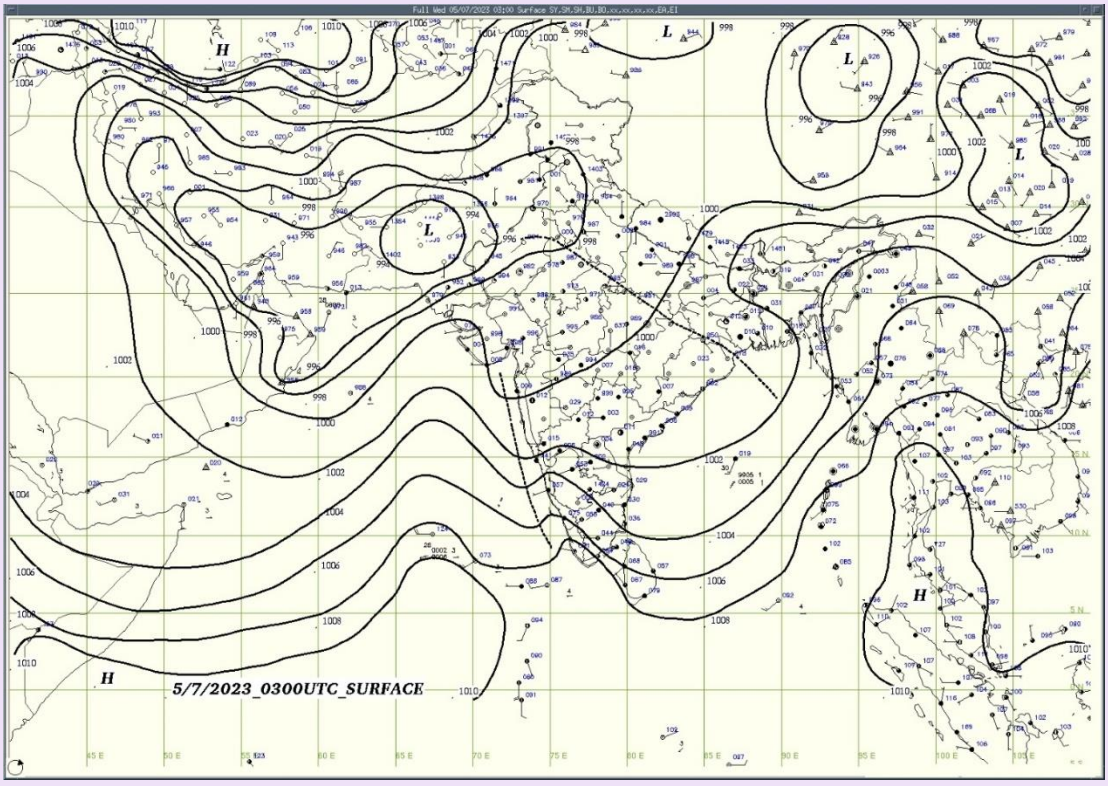
There were 46 days of *heavy rainfall* activity including 26 days of *isolated very heavy rain* with 06 days of *isolated extremely heavy* rain over CK; 50 days of *isolated heavy rainfall* activity including 16 days of *isolated very heavy* rain with 01 day of *isolated extremely heavy* rainfall over KER during the season. SIK reported 26 days of *isolated heavy rainfall* events including 08 days of *isolated very heavy* rain with 02 days of *isolated extremely heavy* rain; and NIK reported *isolated heavy* rainfall events on 24 days including *isolated very heavy* rainfall on 02 days during the season.

Extremely heavy rainfall (≥21 cm/day) occurred in the month of July on **06 days over CK** {**July 06th** [Uttara Kannada (UK) district - Manki: 23 cm & Shirali: 21 cm; Udupi district: Kota: 29 cm, Karkala: 25 cm & Udupi: 23 cm; and Dakshin Kannada (DK) district – Mulki: 33 cm, Panambur: 23, Mangalore: 21]; **19th** [UK district – Castle rock: 24 cm]; **21st** [UK district – Castle rock: 23 cm]; **22nd** [UK district – Castle rock: 28 cm]; **23rd** [UK district – Castle rock: 28 cm; Udupi district – Karkala: 23 cm & Udupi: 22cm; and DK district – Mulki: 22 cm]; and **26th** [UK district – Castle rock: 21 cm]}; on **02 days over SIK** {[**July 07th** [Bhagamandala:23 cm]; and **23rd** [Bhagamandala:24 cm]}; and one day over KER{[**July: 06th**: Kasargod district – Vallarikkundu AWS – 24 cm; Kannur district – Thalassery: 21 cm & Peringome AWS : 21 cm]}.

Fig.2(i)b depicts the cloudiness associated with active off shore trough off Karnataka-Kerala coasts during July 04th-6th & east-west shear zone across southern peninsular India over the lower to mid tropospheric levels on 04th, 05th & 22nd July 2023.

GPM – satellite-gauge merged rainfall and gauge observed rainfall depicting the spatial distribution and intensity as on 24-hr ending 0830 IST of 04th to 06th & 23rd July over the SP region under the influence of off shore trough and east-west shear line across the southern peninsula are presented in Fig.2(i)c.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



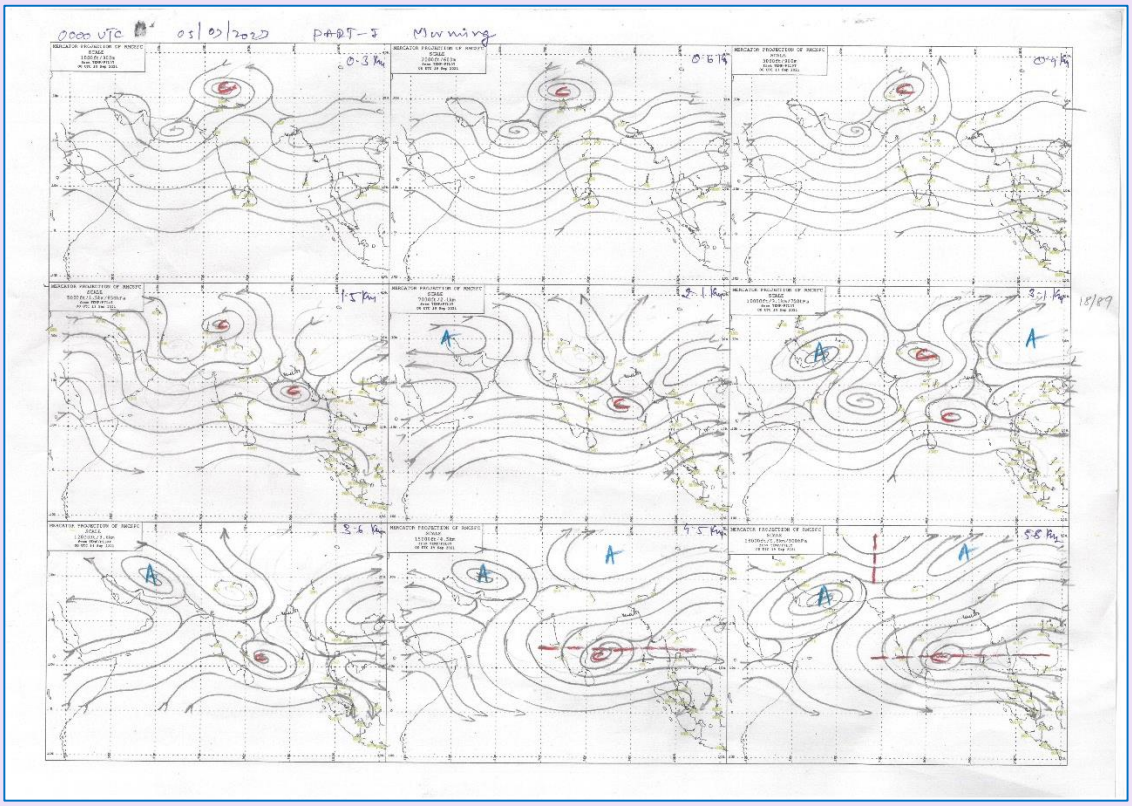
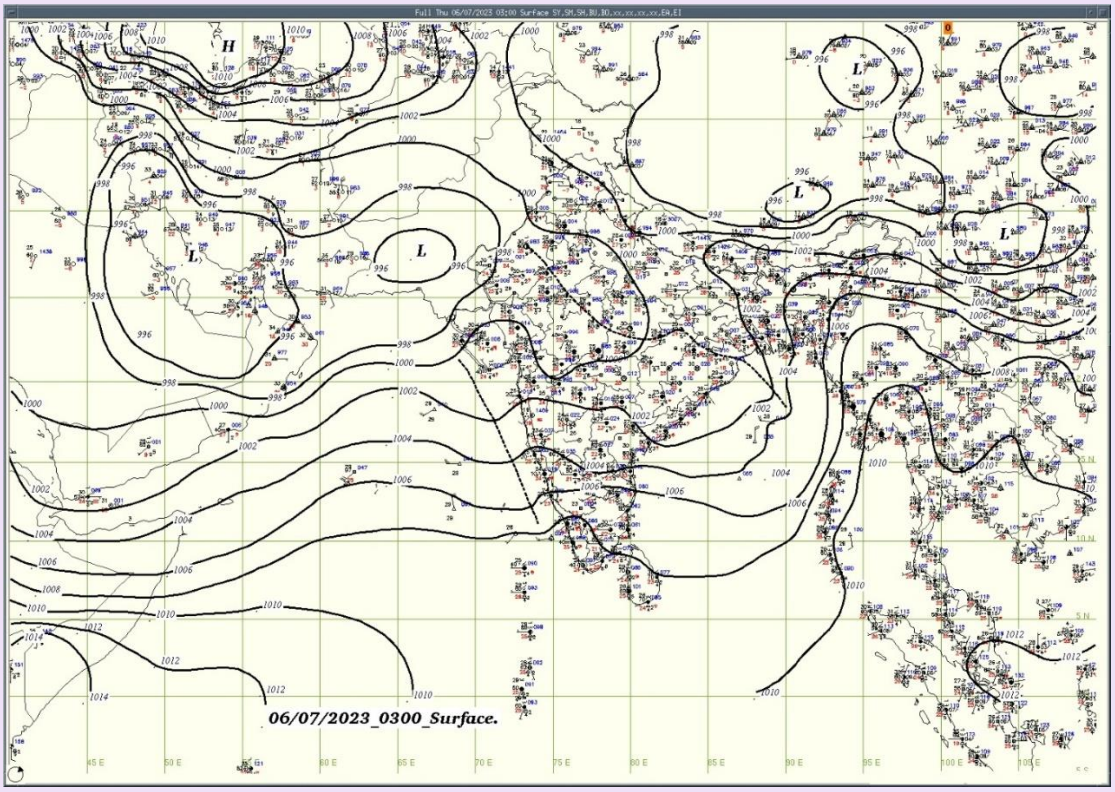


Fig.2(i)a: Surface isobaric analysis as on 0830 IST & upper air streamline analysis as on 0530 IST of 05th, 06th & 22nd July 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



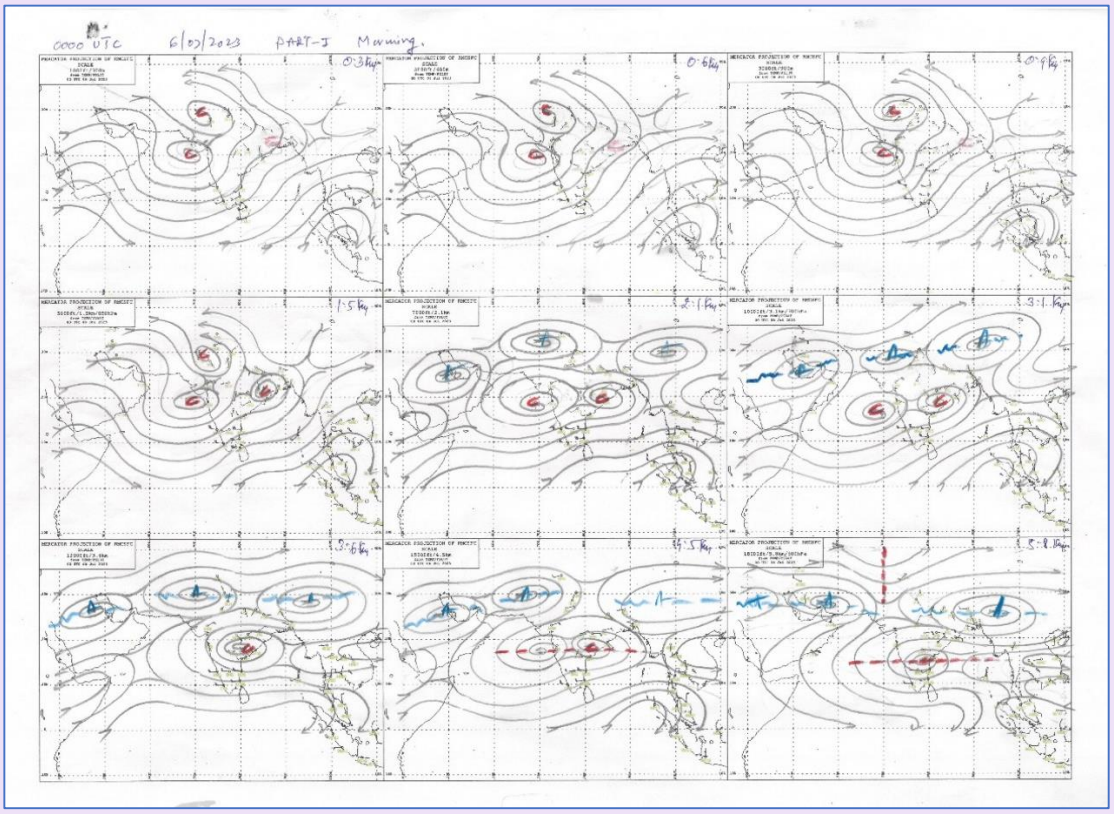
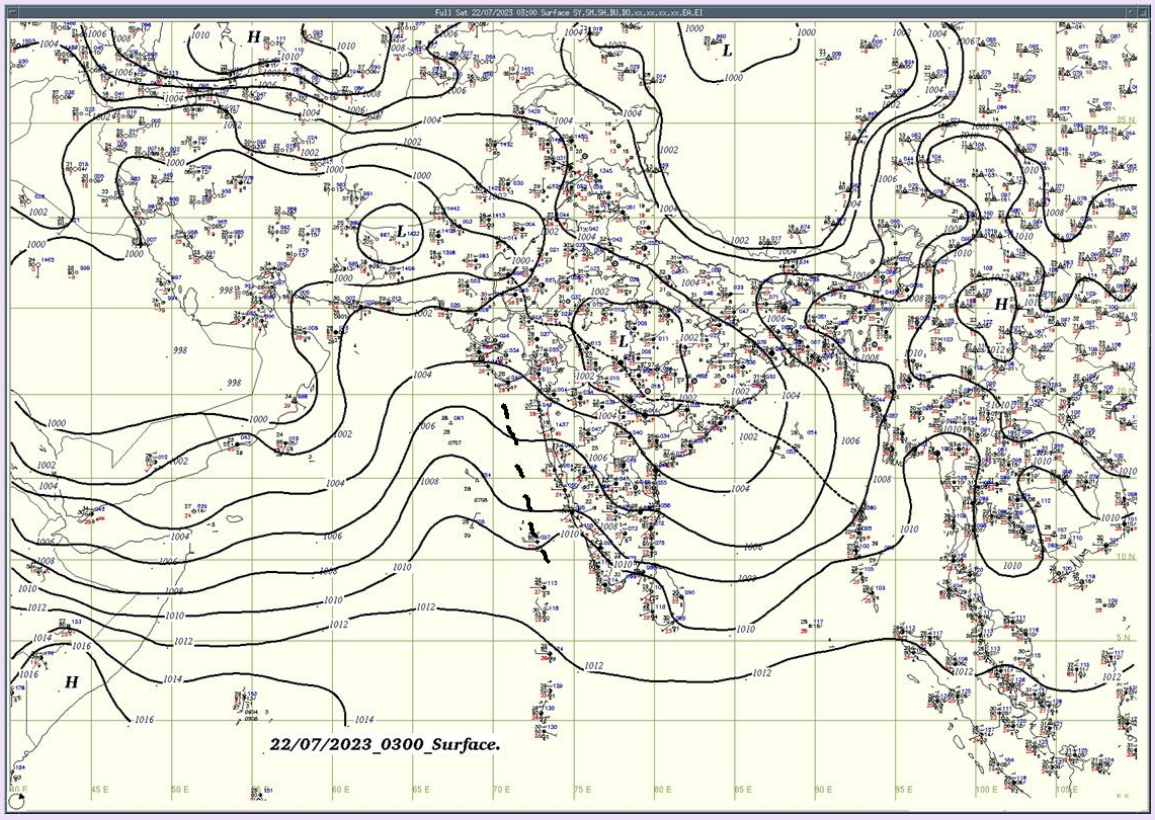


Fig.2(i)a: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



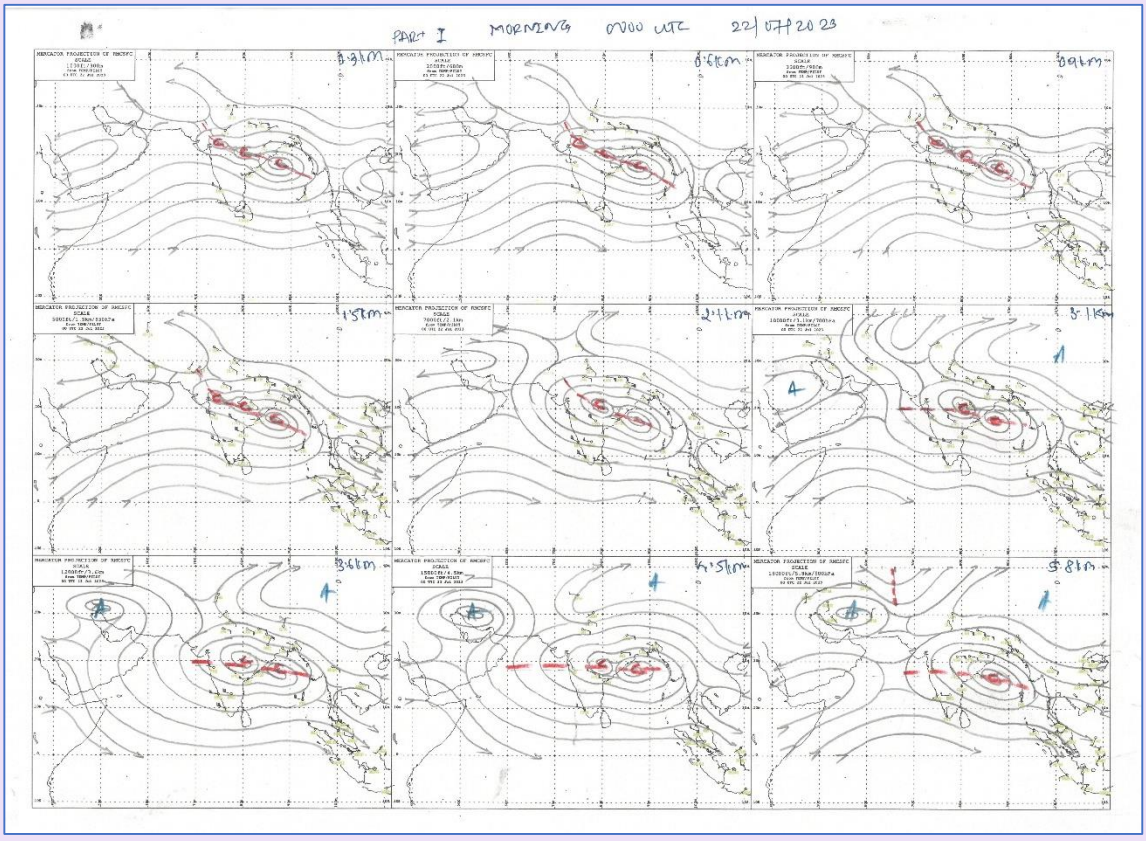


Fig.2(i)a: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

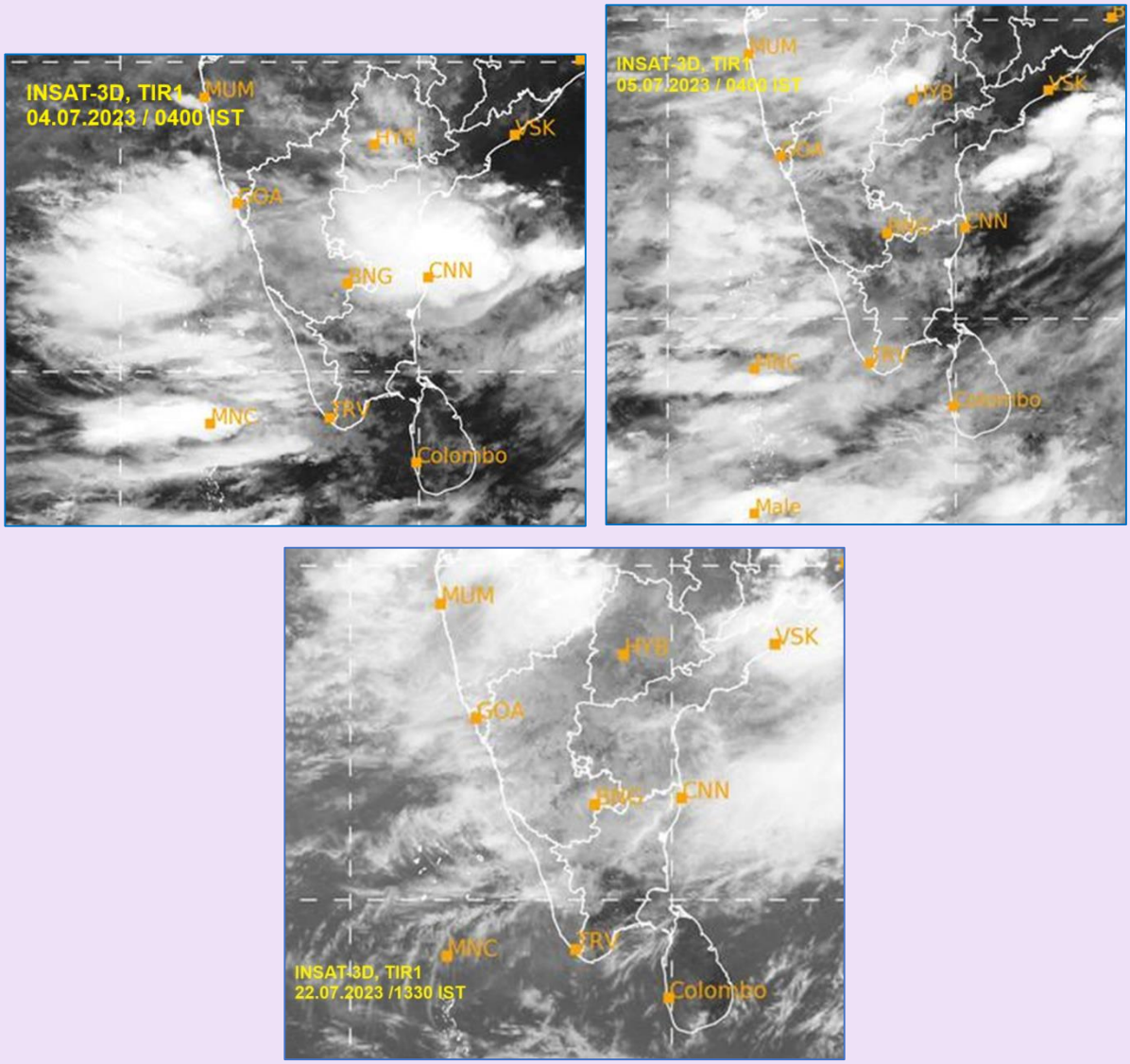
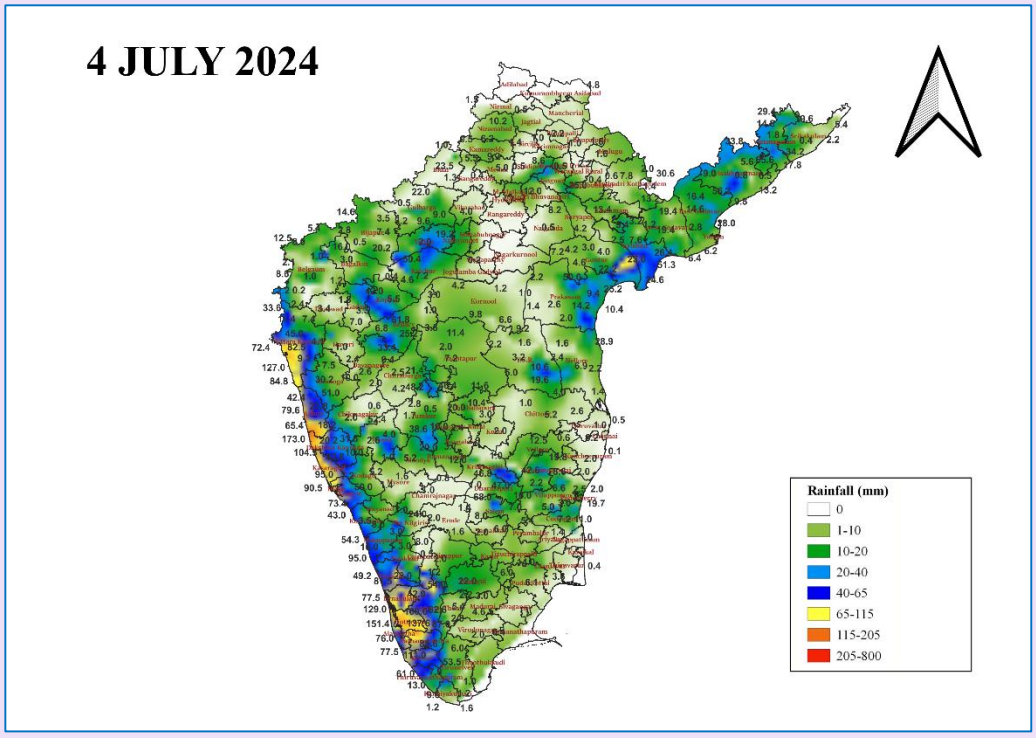
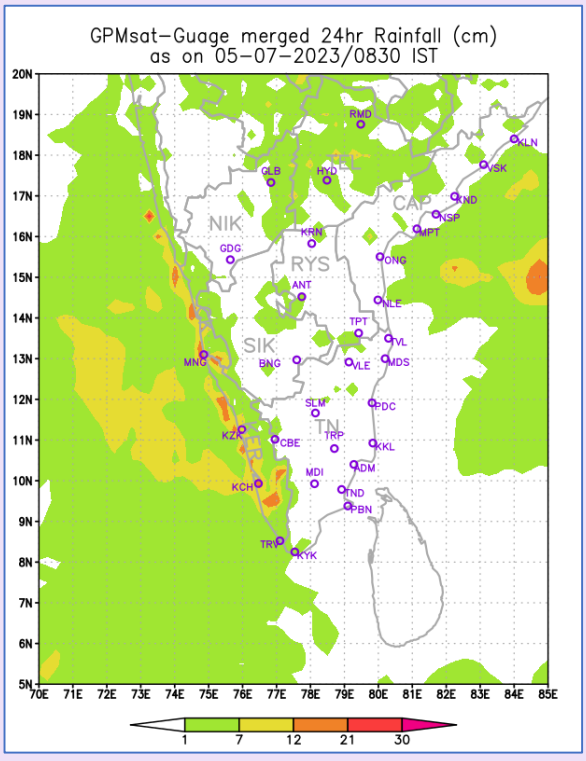


Fig. 2(i)b: INSAT-3D, infra-red imageries as on 04/0400 IST, 05/0400 IST & 22/1330 IST of July 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms





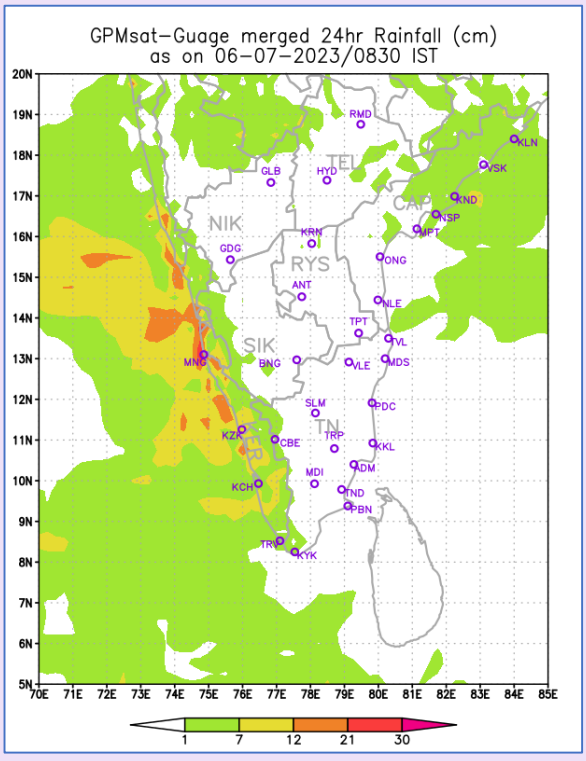
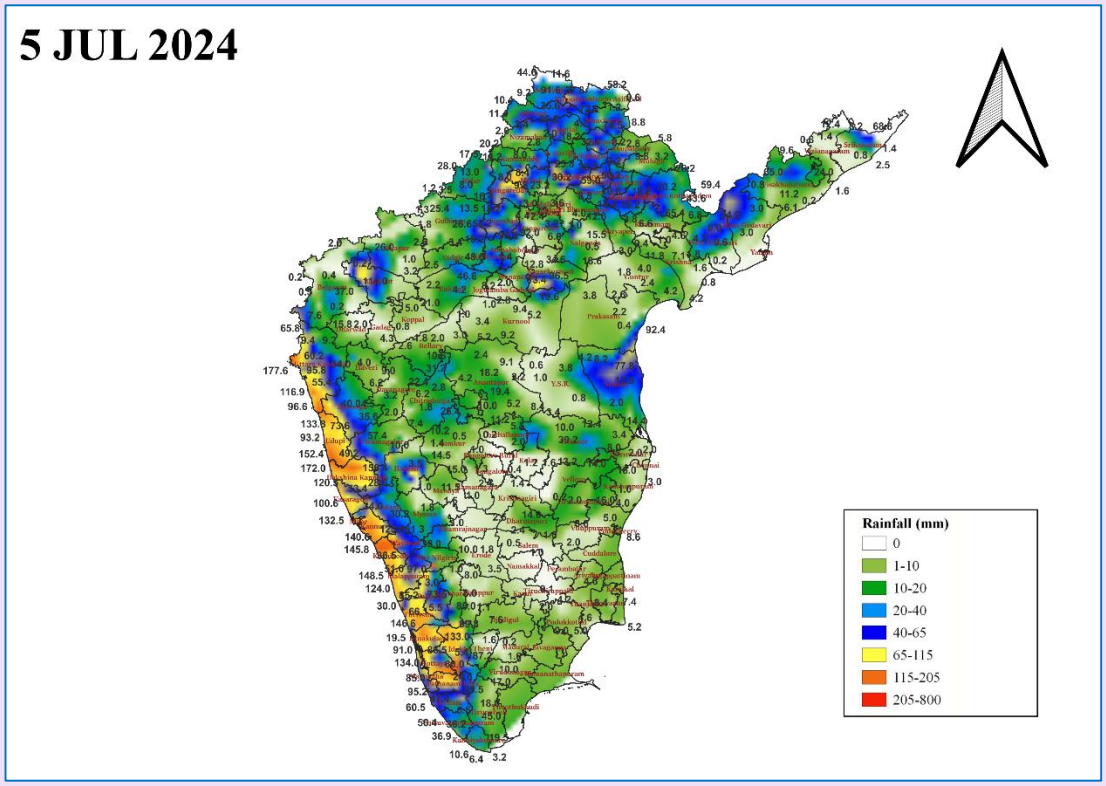


Fig.2(i)c: GPM satellite-gauge merged rainfall and gauge observed 24-hr accumulated rainfall ending 0830 IST of 04th-06th & 23rd July 2023 over the southern peninsular region

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



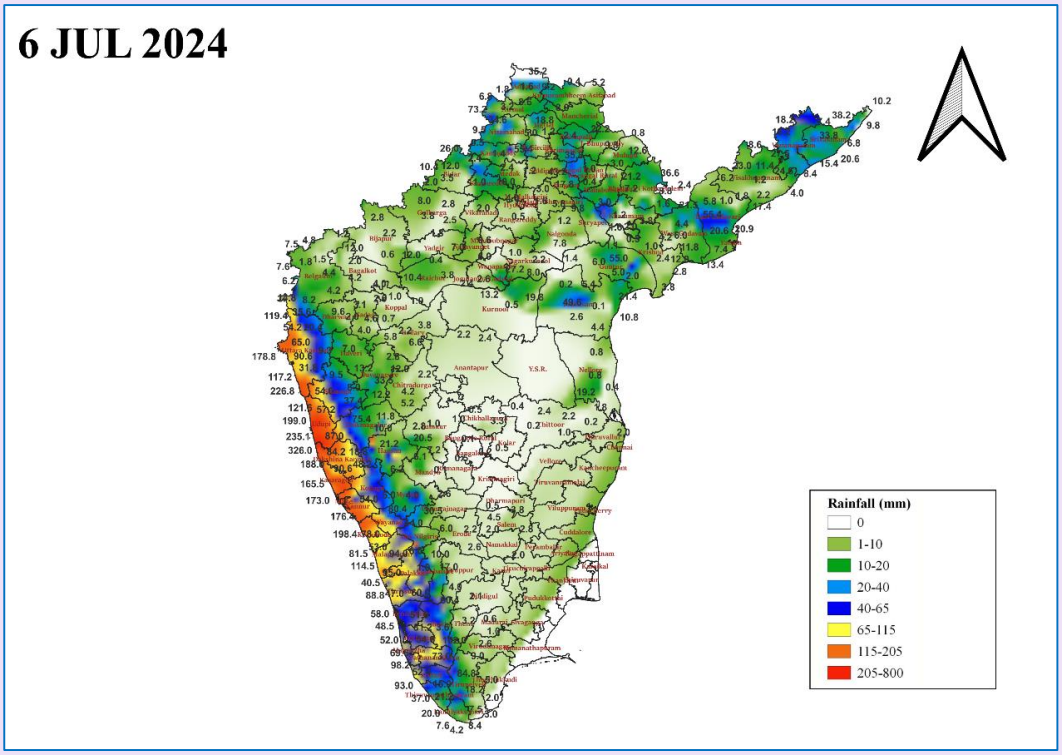
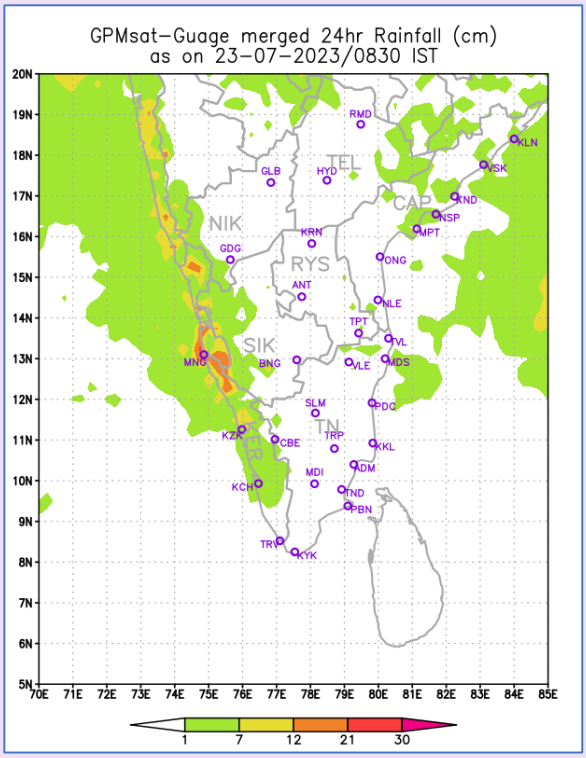


Fig.2(i)c: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



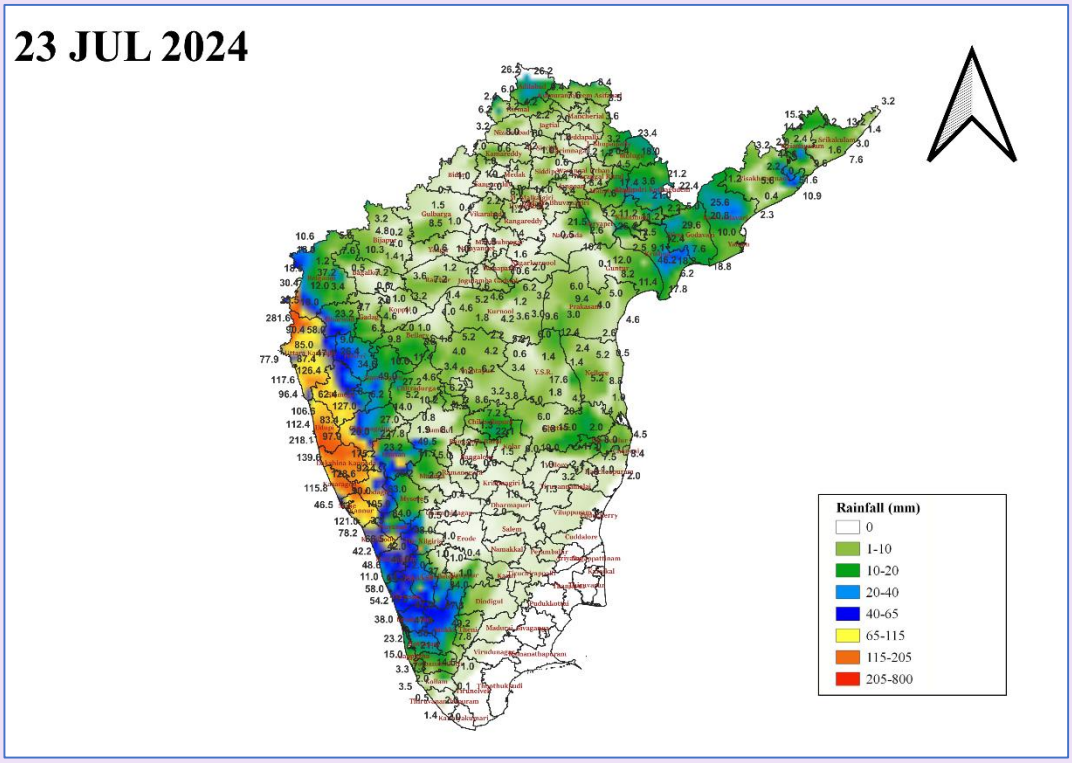


Fig.2(i)c: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

(ii) Under the influence of a **Low Pressure Area** over Northwest Bay of Bengal and adjoining Odisha coast with the associated cyclonic circulation extending upto 7.6 km above mean sea level tilting southwards with height with east-west shear zone running roughly along 20° N between 3.1 & 7.6 km above mean sea level tilting southwards during **20th-21st July 2023**, *widespread* rainfall occurred over TEL, and *fairly widespread to widespread* rainfall occurred over CAP during 18th-22nd July; and *scattered* to fairly *widespread* rainfall occurred over RYS during 18th-21st July. *Isolated heavy* to *very heavy* rain occurred over TEL on all the days during the 24-hr ending 0830 IST of 19th-22nd with *isolated extremely heavy* rain on 20th & 22nd. *Isolated heavy* rain occurred over the CAP on all days during 18th-21st July. Highest rainfall of 26 cm was reported from Bejjur (Kumaram Bheem district) on 20th and 22cm from Sirpuru (Kumaram Bheem district) on 22nd.
In TEL, *active* to *vigorous* monsoon conditions prevailed on all the five days during 18th-22nd: and a*ctive* monsoon conditions prevailed over CAP on 19th July 2023.

Subsequently, under the influence of formation and persistence of a **well-marked LOPAR** over Westcentral & adjoining Northwest Bay of Bengal off north Andhra Pradesh-south Odisha coasts and neighbourhood during **24th-27th July**, there was *widespread* rainfall over TEL during 24th-28th and *fairly widespread to widespread* rainfall over CAP & RYS during 23rd-27th July 2023.
Isolated heavy to very heavy rain occurred over TEL on all the days during 24th-28th July with *extremely heavy* rain on 25th, 27th & 28th July; *isolated heavy / heavy to very heavy* rain occurred over CAP during 24th-27th July & *isolated heavy* rain occurred over RYS on 27th July 2023.

There were four *extremely heavy* rainfall reports on 25th (3 from Nizamabad & 1 from Warangal district) with Velpur (Nizamabad) reporting 40 cm; 28 *extremely heavy* rainfall reports **on 27th** from J.Bhupalpally, Hanumakonda, Mulugu, Karimnagar, Warangal, B.Kothagudem, Jangaon, Adilabad, Mahabubabad & Nirmal districts with **Chityal in J.Bhupalpally district reporting the highest rainfall amount of 62 cm (620.4 mm)**; two extremely heavy rainfall reports on 28th (27 cm from Nirmal & 25 cm from Nizamabad districts). Over CAP, Tamada village in Srikakulam district reported extremely heavy rainfall of 21 cm on 27th July 2023.
Active to *vigorous* monsoon conditions prevailed over TEL on all days during 25th-28th, over CAP during 24th-27th and over RYS during 25th-27th July 2023.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Fig.2(ii)a presents the surface isobaric analysis as on 25th, 26th & 27th /0830 IST and upper air streamline analysis as on 26th & 27th /0530 IST of July 2023. Fig.2(ii)b presents the satellite imageries depicting the cloudiness as on 24/1800 IST, 26/0330 IST & 27/0430 IST of July 2023. Fig.2(ii)c depicts the GPM satellite-gauge merged rainfall and gauge observed 24-hr accumulated rainfall over TEL & CAP as on 0830 IST of 25th / 26th / 27th July 2023.

Associated with recurrent *very heavy to extremely heavy* rainfall activity over TEL, extensive flooding and loss of lives & property were reported by the media [Fig.2(ii)d].

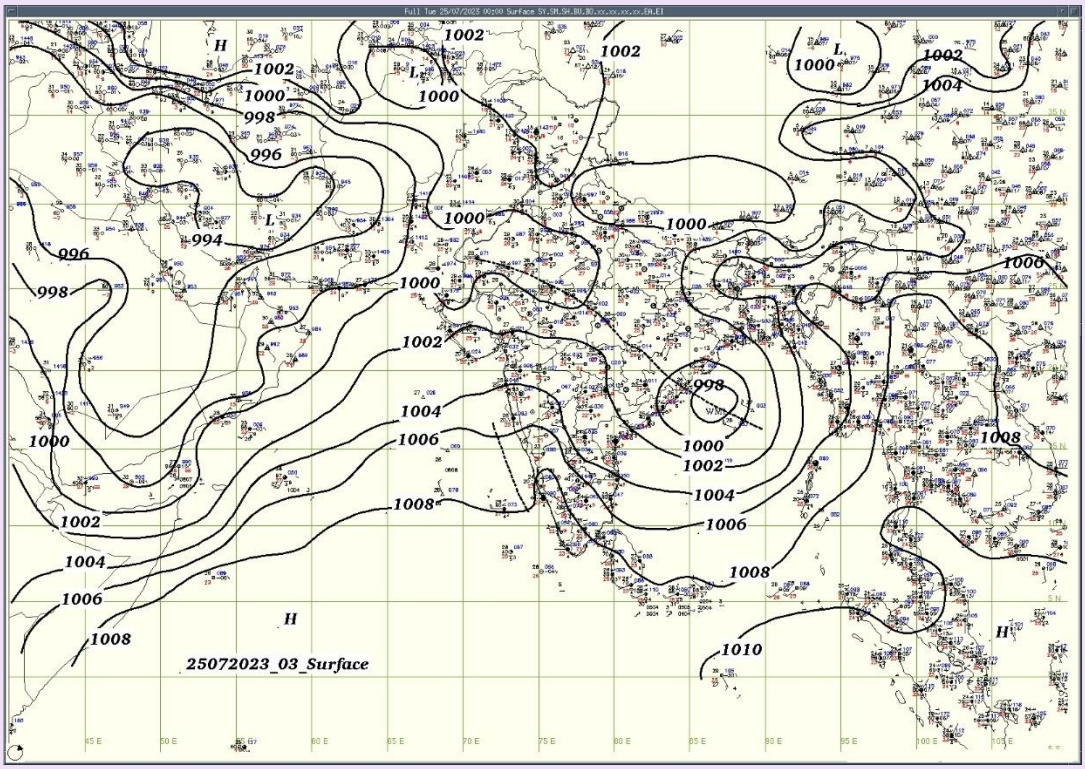
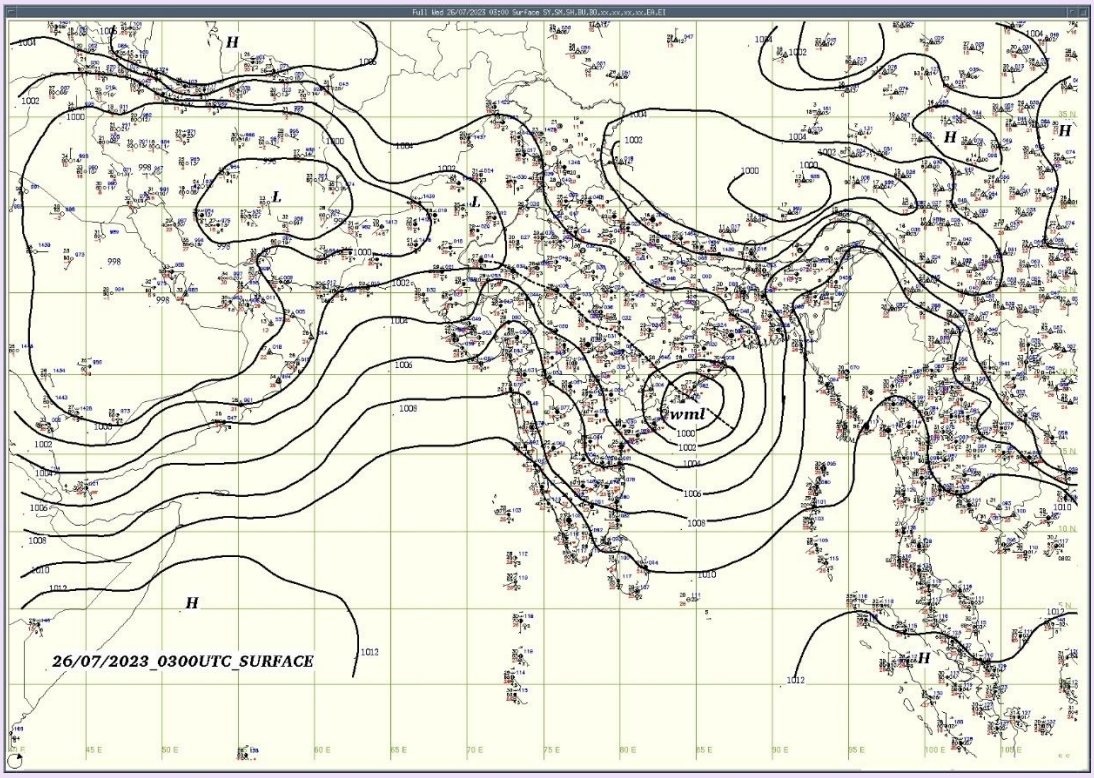


Fig.2(ii)a: Surface isobaric analysis as on 25th, 26th & 27th /0830 IST and upper air streamline analysis as on 26th & 27th /0530 IST of July 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



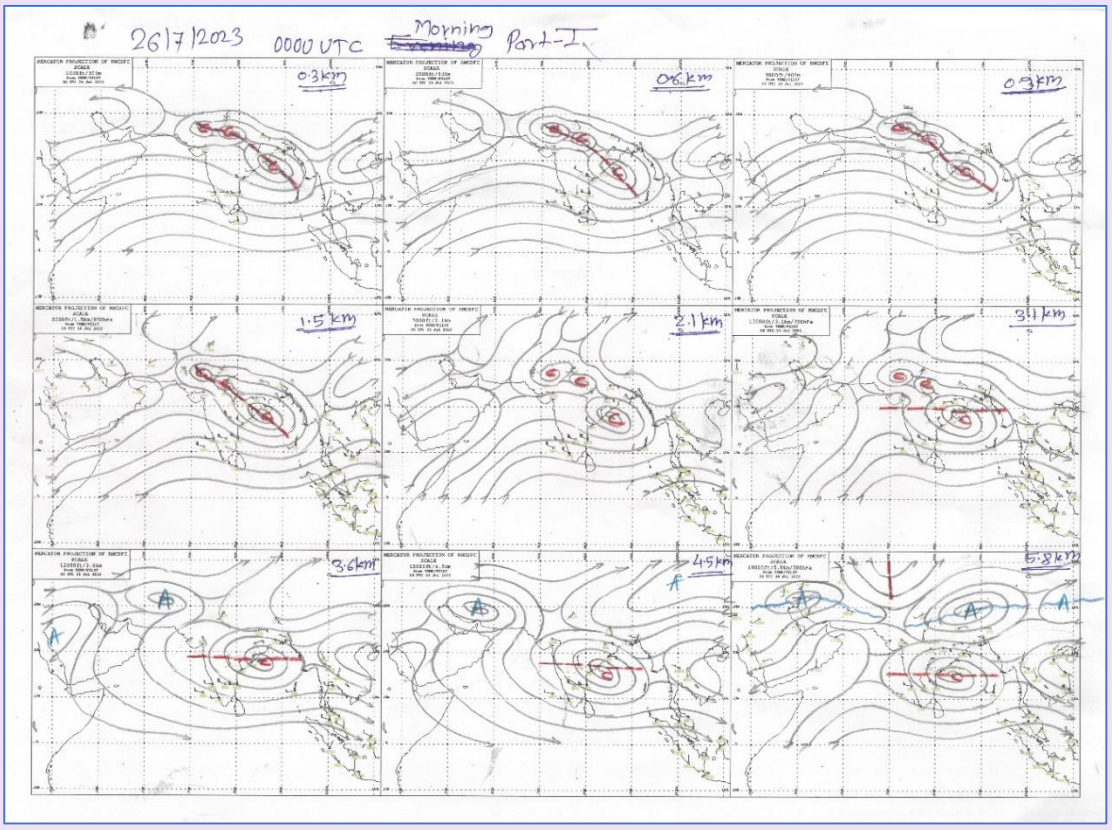
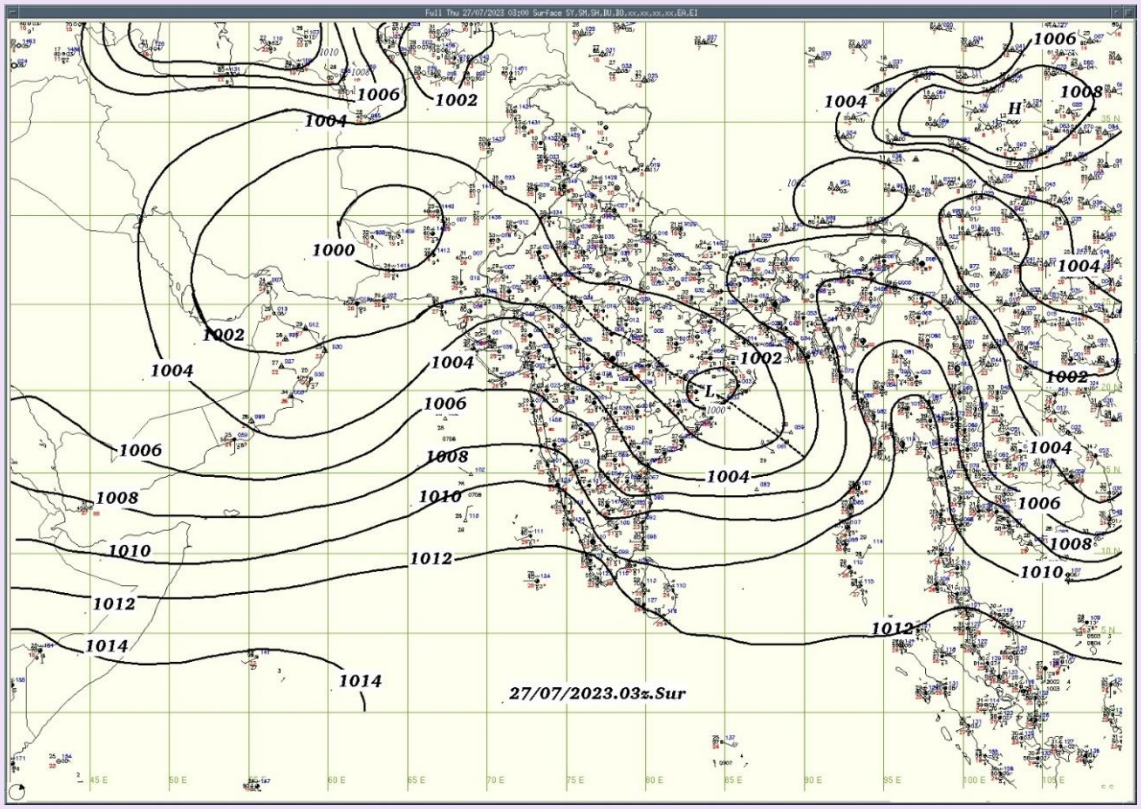


Fig.2(ii)a: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



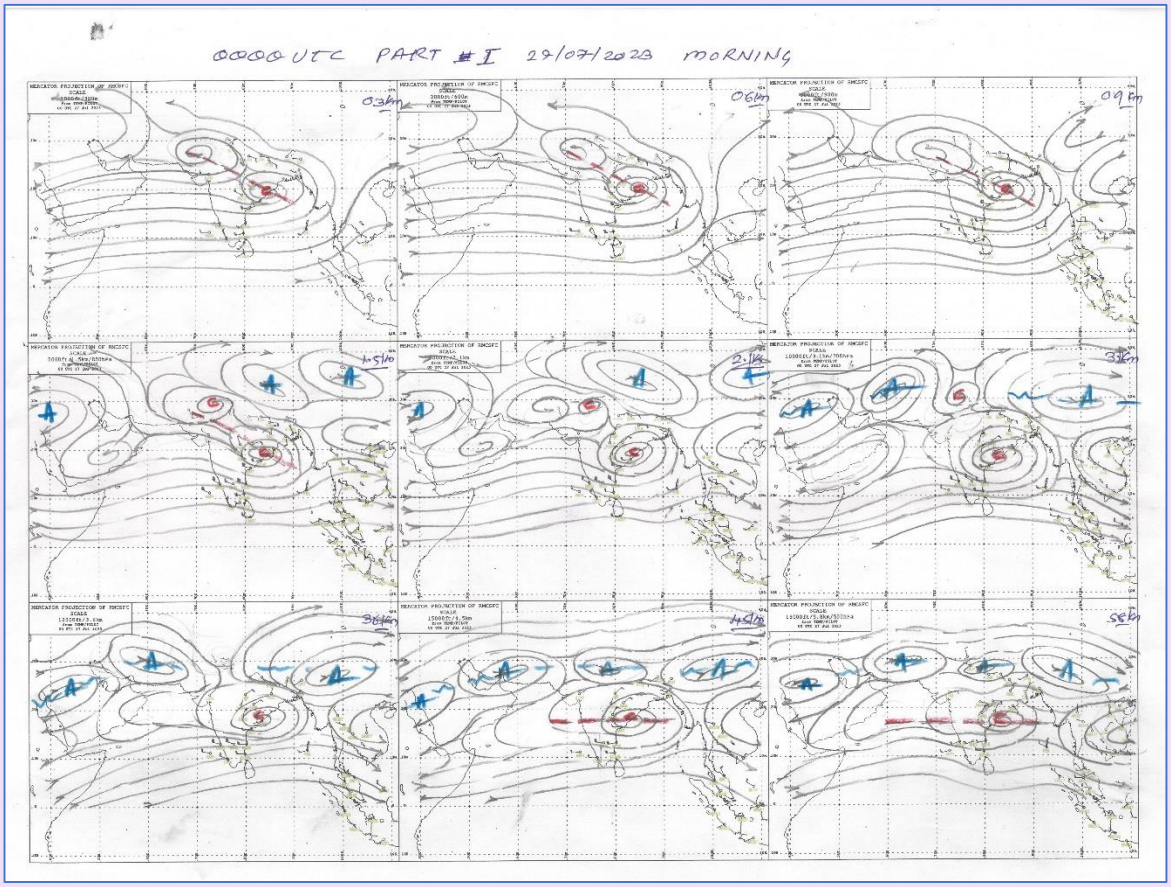


Fig.2(ii)a: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

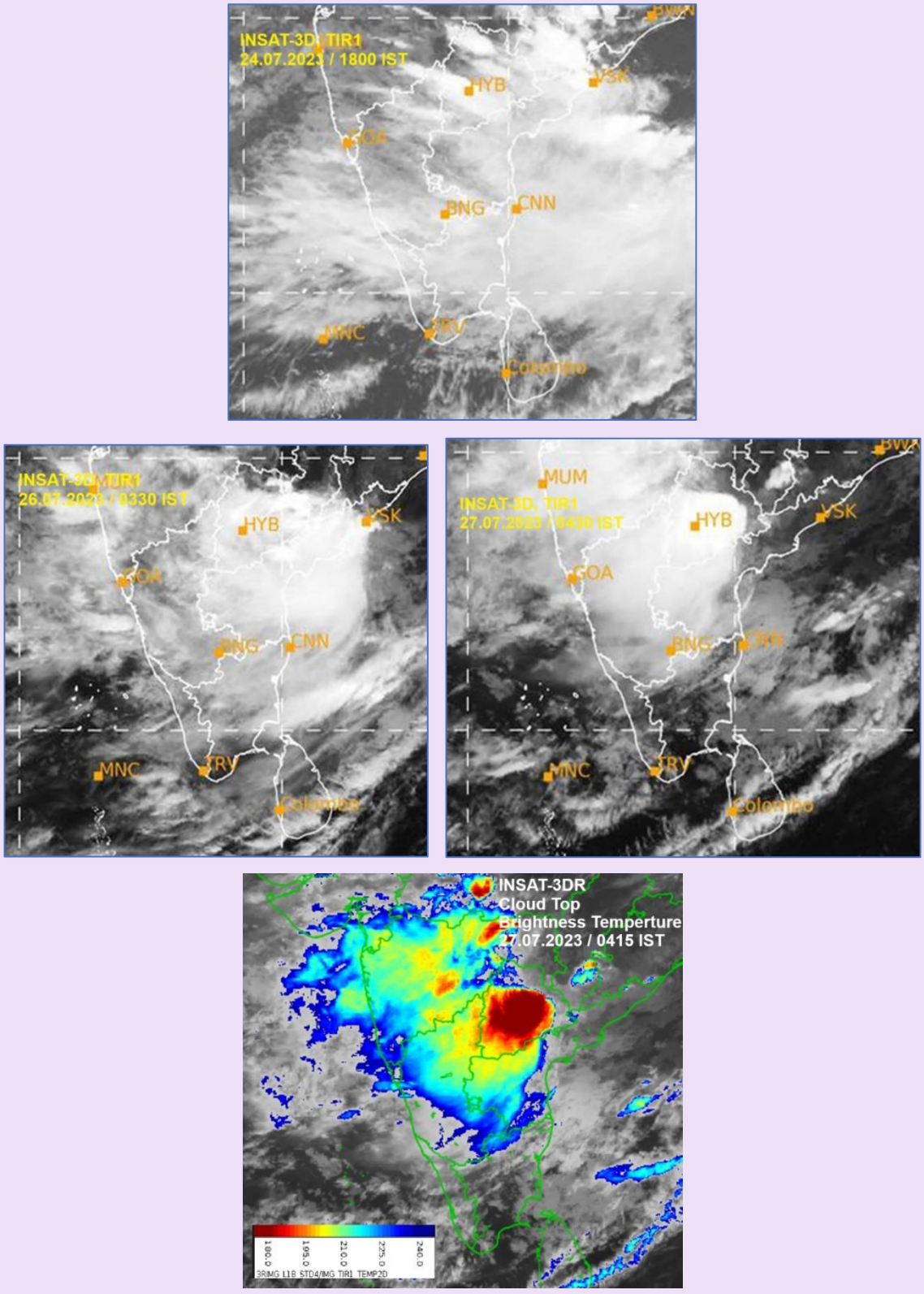


Fig.2(ii)b: INSAT-3D infra-red imageries as on 24/1800 IST, 26/0330 IST & 27/0430 IST & INSAT-3DR, cloud top Brightness Temperature product as on 27 / 0415 IST of July 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

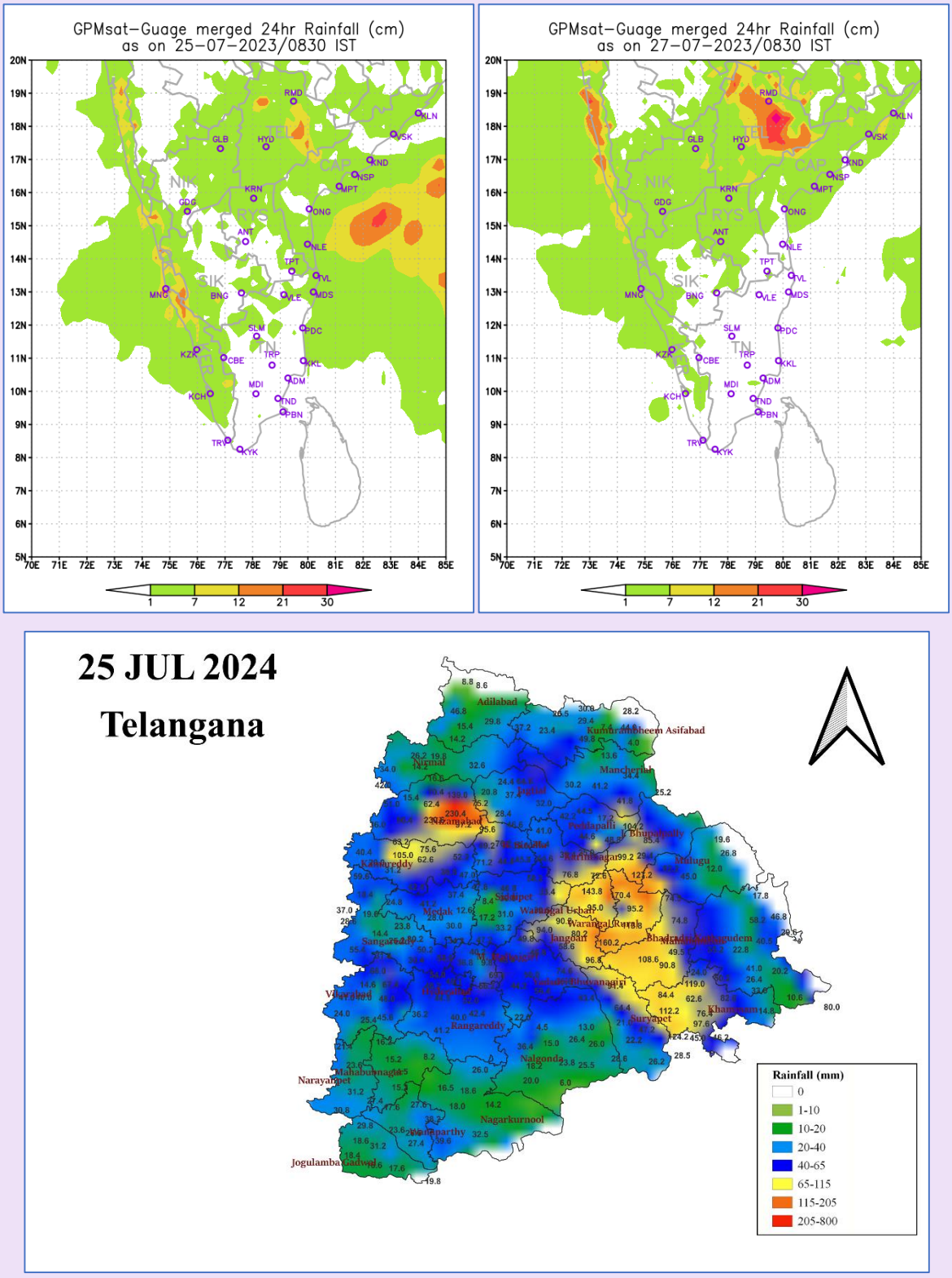
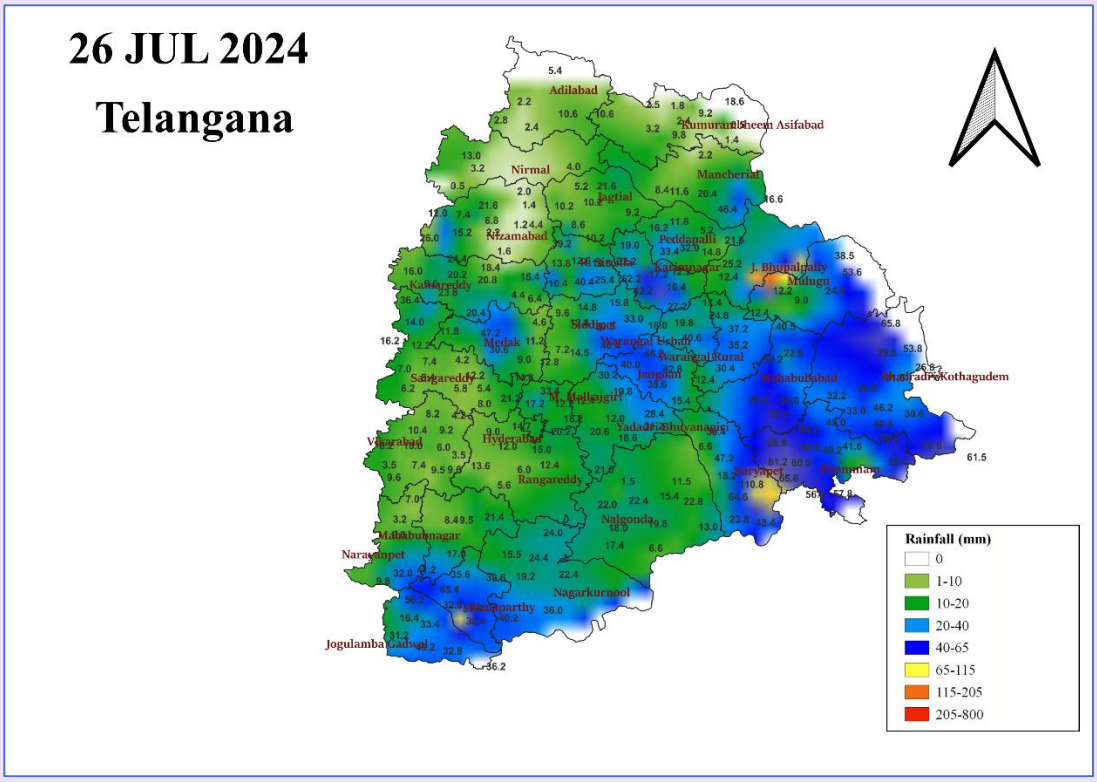


Fig.2(ii)c: GPM satellite-gauge merged rainfall and gauge observed 24-hr accumulated rainfall ending 0830 IST of 25th-27th July 2023 over TEL & CAP

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



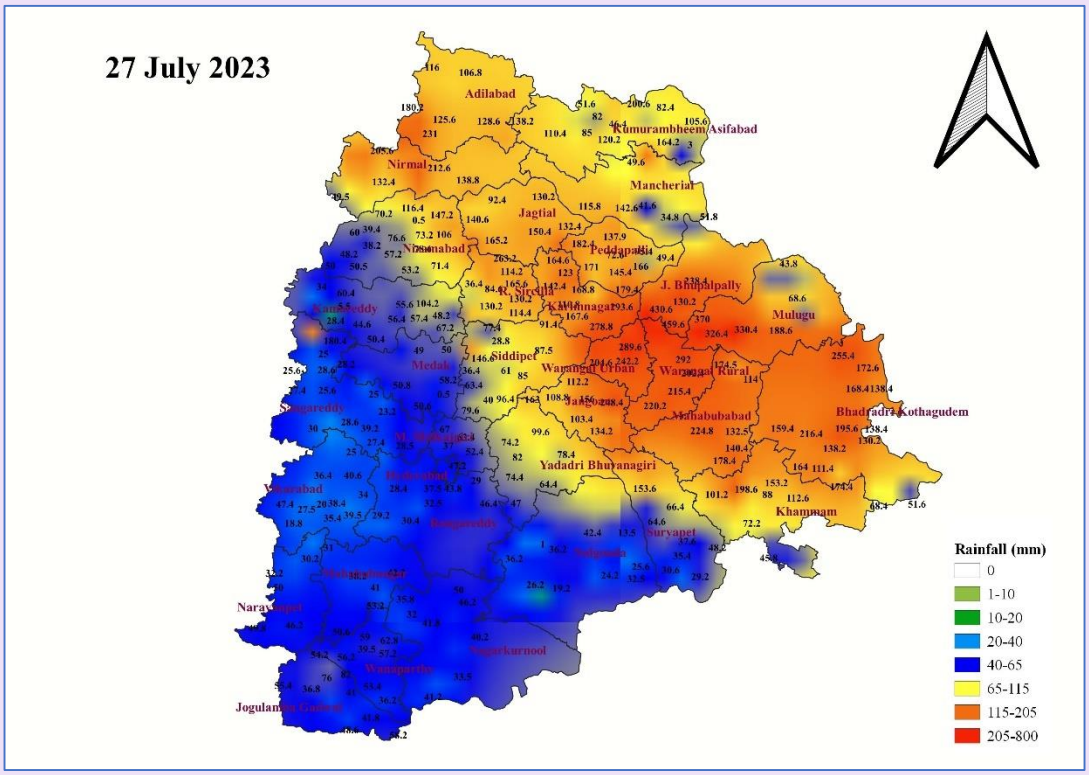
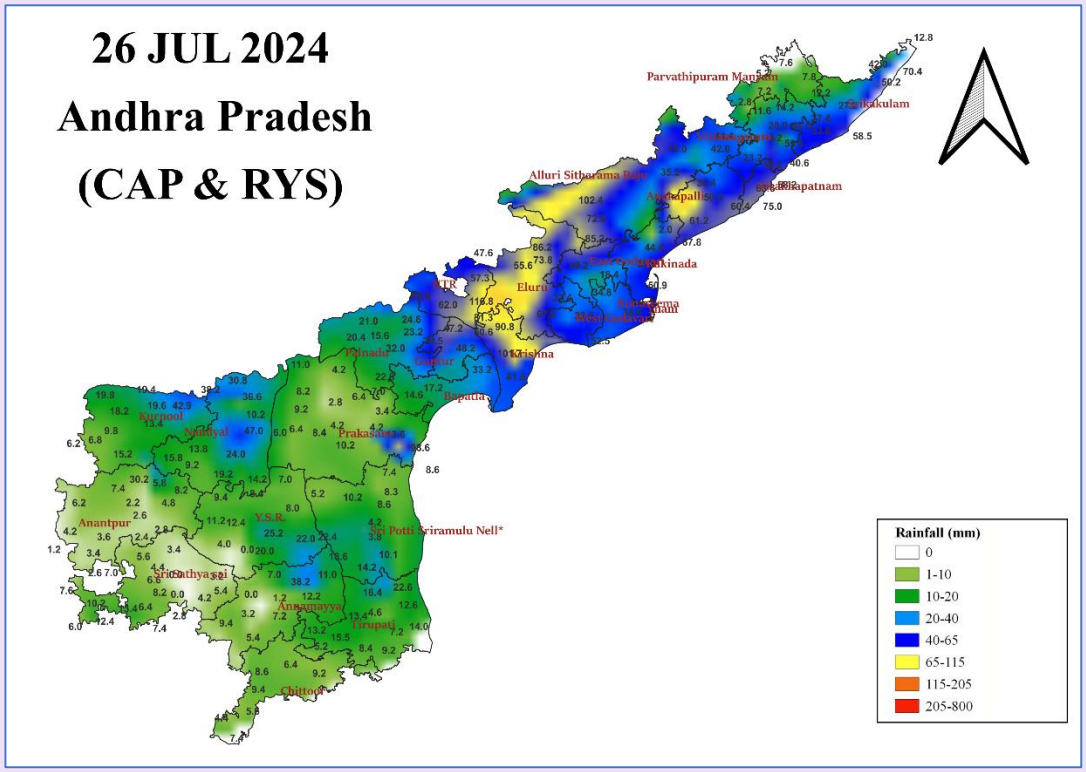


Fig.2(ii)c: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



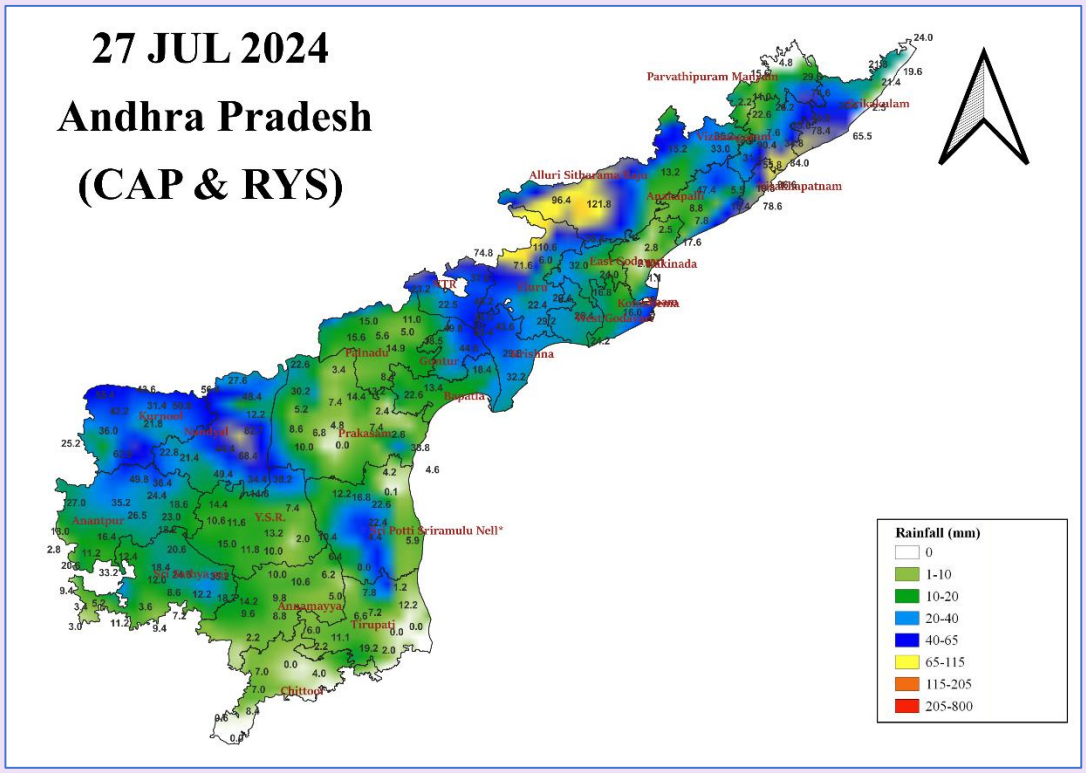


Fig.2(ii)c: contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

The Indian EXPRESS
JOURNALISM OF COURAGE

News / Cities / Hyderabad / 8 feared dead in Telangana floods, over 10k shifted to safe locations; 'orange' alert in 8 districts today

8 feared dead in Telangana floods, over 10k shifted to safe locations; 'orange' alert in 8 districts today

As of July 27, Telangana's cumulative southwest monsoon rainfall figures stand at an excess of 61%, with July alone recording an excess of 129% precipitation.

At least eight people are feared dead across Telangana while more than 10,000 people were rescued from severely affected areas across central and eastern districts and moved to safer locations on Thursday after extremely heavy rain battered these regions. After three days of red alert, the weather department has reduced the warning level to 'orange' alert (heavy to very heavy rain) in several districts.

Over a dozen locations across these districts recorded extremely heavy rainfall of over 23 cm, with Laxmidevipeta (Mulugu district) and Chityal (Jayashankar Bhupalpally) recording exceptionally high rainfall of 64.98 cm and 61.65 cm, respectively in the 24 hours till 8 am on Thursday.

National Disaster Response Force (NDRF), State Disaster Response Force (SDRF), fire personnel and police personnel have been deployed for the rescue operations. Two Indian Air Force (IAF) helicopters joined the operations and retrieved six people stranded on top of an earthmover in the flood-stricken Nainpaka village. The state police rescued and relocated 7,000 people to safer locations, according to DGP Anjani Kumar, who added that national highways and other roads were damaged in 85 locations and efforts are on to repair them.

With rivers and reservoirs swollen, Irrigation Department Special Chief Secretary Rajat Kumar said the flow of floodwater into water projects across Adilabad, Warangal and Khammam districts is increasing and operation teams under chief engineers in 19 territorial areas of the state are reviewing the flood situation. Water inflows into the Kadem project in north Telangana's Nirmal had almost doubled Thursday morning, receiving an inflow of 6.04 lakh cusecs as against its capacity of over 3.5 lakh cusecs. He said people living downstream were shifted to safe places.

At Bhadrachalam, river Godavari breached the second warning level and was flowing at 50.5 feet in the morning and the state government has requested the Andhra Pradesh government to keep all gates of the Polavaram project open to avoid submergence of villages on the Telangana side. From Bhadrachalam, Dummuguda, Cherla and surrounding mandals, a total of 1211 families in 18 villages were relocated.

By: Express News Service
Hyderabad | Updated: July 28, 2023 13:25 IST

NewsGuard

Follow Us

Over a dozen locations across these districts recorded extremely heavy rainfall of over 23 cm. (PTI photo)

An aerial view of a partially damaged road submerged in the floodwaters of the swollen Godavari River, in Bhupalpally district, Thursday, July 29, 2023. (PTI Photo)

Fig.2(ii)d: the Indian Express report dated 28th July 2023

Thereafter, under the influence of formation of LOPAR over Northwest Bay of Bengal & neighbourhood on 17th August /1730 IST with associated upper cyclonic circulation extending upto upper tropospheric levels tilting southwestwards with height and its gradual west-

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

northwestward movement across Odisha & Chhattisgarh during 18th-19th August 2023, *fairly widespread to widespread* rainfall occurred over CAP on 18th & 19th and over TEL on 19th & 20th with *isolated heavy* rain over TEL on 19th August 2023.

Further, under the influence of formation of LOPAR over Northwest & adjoining Westcentral Bay of Bengal off south Odisha-north Andhra Pradesh coasts on 05th September with associated upper cyclonic circulation extending upto upper tropospheric levels tilting southwestwards with height and gradual westward movement during 03th-07th September, *fairly widespread to widespread* rainfall occurred over TEL and *scattered to widespread* rainfall occurred over CAP during 03rd-08th September; and *fairly widespread to widespread* rainfall occurred over RYS during 03rd-06th September 2023. Isolated heavy to very heavy rain occurred over TEL on 04th & 05th and over CAP on 07th; and isolated heavy rain occurred over CAP on 04th & 05th, over RYS on 04th and over TEL on 06th & 07th September 2023.

(vii) Over the TN subdivision, under the influence of strengthening of low level westerlies, *isolated heavy* rainfall occurred in the western ghat areas on some days with ghat areas of Coimbatore and Nilgiris districts reporting *heavy* rain on 15 and 16 days respectively during the season. *Very heavy* rainfall occurred at *isolated* places over Nilgiris / ghat areas of Coimbatore districts during July 04th-07th; 23rd & 25th July and 30th August 2023 with *extremely heavy* rainfall report of **38 cm** (382.0 mm) over **Avalanche** in Nilgiris district on 25th July 2023.

Further, under the influence of north-south trough over the southern peninsula in the lower levels / east-west shear zone across the southern peninsula / upper air cyclonic circulations over the extreme southern peninsula, there were 07 days of fairly *widespread* rainfall and 37 days of *scattered* rainfall activity over the TN subdivision. On the rest of the 78 days during the season, *isolated* rainfall activity prevailed over this sub division.

However, there were 55 days of *isolated heavy* rainfall, with many events occurring due to intense convective activity. It also includes 20 days of *isolated very heavy* rain with 02 days of *isolated extremely heavy* rainfall events.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

3. Rainfall distribution

3.1 Seasonal sub-divisional rainfall

The SWM seasonal rainfall (June-September) during 2023 over the country as a whole was 94% of its long period average (LPA) of 87.0 cm and that over the SP region was 92% of its LPA.

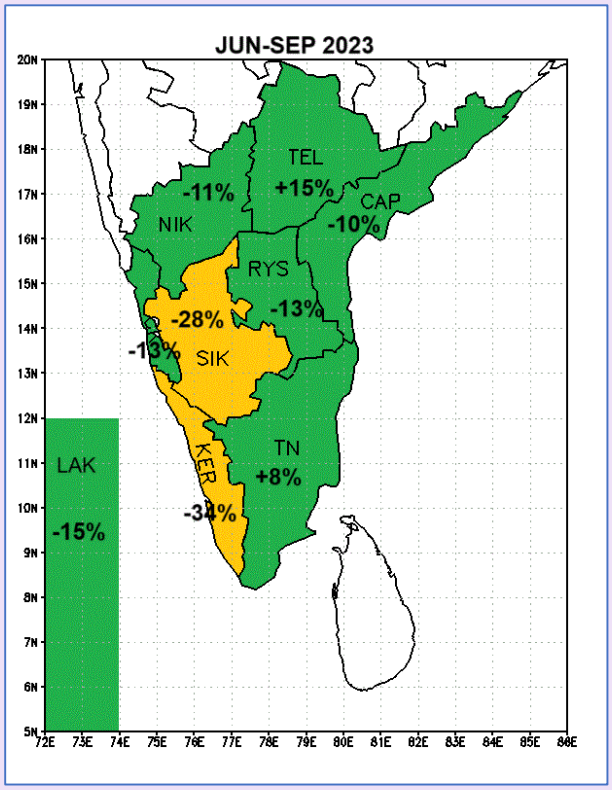
The spatial rainfall distribution is determined in terms of percentage departure from normal (PDN) over 36 meteorological subdivisions in the country. As per IMD's classification of monsoon performance over a meteorological subdivision, if the amount of rainfall received over a region (expressed as PDN) is between -19% and +19%, the monsoon performance is termed as *normal*. If the PDN is between -20% and -59%, the region comes under *deficient* category, if PDN is less than or equal to -60%, the region falls under *scanty* rainfall category, PDN of +20% to +59% indicates *excess* rainfall category and if the PDN is greater than or equal to +60%, it is termed as *large excess*.

During SWM 2023, seven sub divisions in the SP region received *normal* [TEL, CAP, RYS, CK, NIK, TN & LAK] and the other subdivisions [KER & SIK] became *deficient*. The seasonal rainfall figures over the nine subdivisions CAP, RYS, TEL, TN, CK, NIK, SIK, KER, LAK) were -10%, -13%, +15%, +08%, -13%, -11%, -28%, -34%, and -15% respectively. The cumulative seasonal (01st June to 30th Sep 2023) rainfall figures for the nine meteorological subdivisions of the SP region are presented inTable-3.1 and Fig.3(i).

Table-3.1: Seasonal sub-divisional rainfall distribution over the SP region during the SWM season, 2020 (01stJune-30th Sep 2023)

SUB-DIVISION	Actual rainfall (mm)	Normal rainfall (mm)	Percentage departure from normal (%)
COASTAL AP & YANAM (CAP)	538.8	601.4	-10
TELENGANA (TEL)	846.4	734.8	15
RAYALASEEMA (RYS)	357.0	408.6	-13
TAMILNADU, PUDUCHERRY & KARAIKAL (TN)	354.3	328.5	8
COASTAL KARNATAKA (CK)	2699.7	3093.9	-13
NORTH INTERIOR KARNATAKA (NIK)	429.5	480.8	-11
SOUTH INTERIOR KARNATAKA (SIK)	489.8	678.4	-28
KERALA & MAHE (KER)	1326.5	2018.6	-34
LAKSHADWEEP (LAK)	872.7	1026.6	-15

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



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

Fig.3(i): Seasonal Sub-divisional rainfall (in percentage departures from normal) during Jun-Sep 2023 over the SP region

3.2 Monthly sub-divisional rainfall

The monthly sub-divisional rainfall scenario during the SWM 2023 season is presented inTable-3.2 and Fig.3(ii). It is noted that excepting TN that received *normal-excess* rainfall during all the four months of the season, rainfall over the all other eight subdivisions was *normal to excess / large excess* in July and September and *deficient-largely deficient* during June & August 2023. TEL & NIK received *large excess* rainfall of +120% & +89% respectively during July. KER became largely deficient during June and August & Karnataka (CK, NIK & SIK), deficient / largely deficient during both the months with KER recording -60% & -87% respectively and KAR, -50% to -60% during June and -70% to -80% in August 2023.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.2: Monthly sub-divisional rainfall performance during SWM 2023

2023	Jun			Jul			Aug			Sep		
Sub division	Actual rainfall (mm)	Normal rainfall (mm)	PDN (%)	Actual rainfall (mm)	Normal rainfall (mm)	PDN (%)	Actual rainfall (mm)	Normal rainfall (mm)	PDN (%)	Actual rainfall (mm)	Normal rainfall (mm)	PDN (%)
CAP	**64.8**	**109.5**	**-41**	**206.4**	**158.6**	**+30**	**82.9**	**170.3**	**-51**	**184.7**	**163**	**+13**
TEL	**65.2**	**131.4**	**-50**	**481.2**	**218.5**	**+120**	**79.6**	**226.1**	**-65**	**220.3**	**158.8**	**+39**
RYS	**52.8**	**72.3**	**-27**	**87.8**	**92.1**	**-5**	**48.4**	**107.3**	**-55**	**167.9**	**136.9**	**+23**
TN	**53.5**	**50.7**	**+6**	**65.1**	**69.0**	**-6**	**87.5**	**90.1**	**-3**	**148.2**	**118.7**	**+25**
CK	**435.5**	**863.6**	**-50**	**1609.3**	**1088.9**	**+48**	**222.9**	**821.3**	**-73**	**432.1**	**320.1**	**+35**
NIK	**47.6**	**105.3**	**-55**	**219.8**	**116.5**	**+89**	**33.5**	**119.4**	**-72**	**128.6**	**139.6**	**-8**
SIK	**65.6**	**149.7**	**-56**	**258.9**	**200.6**	**+29**	**41.8**	**179.5**	**-77**	**123.6**	**148.6**	**-17**
KER	**259.4**	**648.3**	**-60**	**591.7**	**653.4**	**-9**	**60**	**445.2**	**-87**	**415.4**	**271.7**	**+53**
LAK	**226.9**	**335.6**	**-32**	**291.9**	**289.3**	**+1**	**85.4**	**232**	**-63**	**268.5**	**169.7**	**+58**

PDN: Percentage Departures from Normal

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

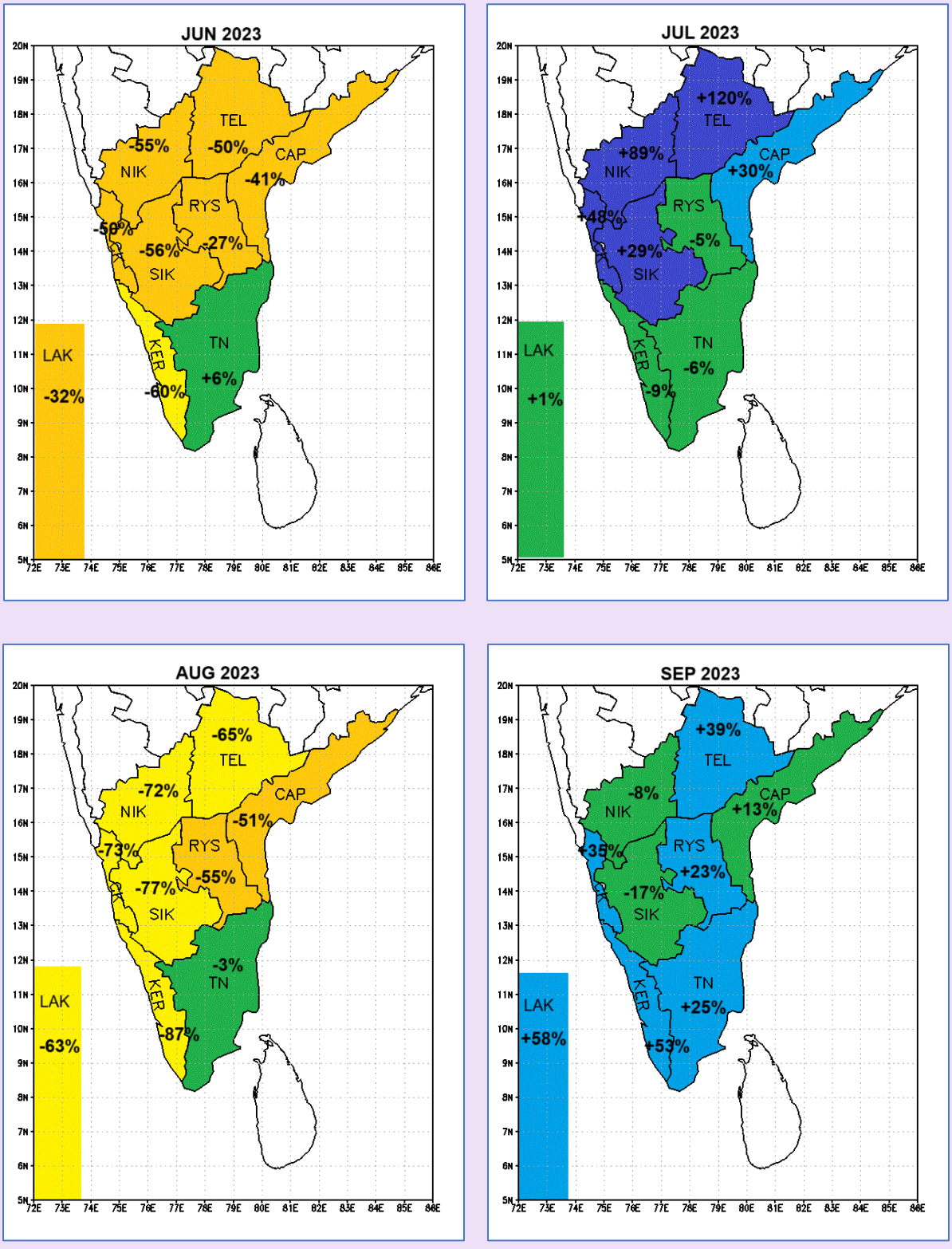
3.3 Weekly sub-divisional rainfall progress

Week by week and cumulative weekly performance of SWM 2023 over the SP region are presented in Table-3.3a and Table-3.3b respectively.

During the SWM season of 2023, during the weeks ending 05th & 26th July 2023, *normal to large excess* rainfall occurred over eight out of nine subdivisions in the region. During the week ending 26th July, five subdivisions (CAP, TEL, CK, NIK & SIK) received *large excess* rainfall by more than 100% to 250%. Also, during the week ending 06th September, four subdivisions (TEL, RYS, TN & NIK) received *large excess* rainfall by more than 100%. During the weeks ending 07th June & 09th August, all the nine subdivisions in the region became *deficient – largely deficient*.

The cumulative week ending rainfall figures were generally *deficient – largely deficient* over all the subdivisions excepting TN (that was mainly under normal category throughout) during the first four weeks. Thereafter, it was *normal-excess* over TEL from the week ending 19th July onwards and generally *normal* over CK, CAP, NIK from the week ending 12th, 26th & 26th July onwards respectively. The cumulative week ending remained *deficient-largely deficient* over KER throughout the season. But for a brief period of 20th July to 09th August, SIK also remained *deficient-largely deficient* throughout the season.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



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

Fig.3(ii): Monthly sub-divisional rainfall distribution during Jun-Sep2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.3a: Week by week sub-divisional rainfall during June-Sep 2023 over the SP region

SUB-DIVISION	2023: WEEK-BY-WEEK: PDN (%)																
	07-Jun	14-Jun	21-Jun	28-Jun	05-Jul	12-Jul	19-Jul	26-Jul	02-Aug	09-Aug	16-Aug	23-Aug	30-Aug	06-Sep	13-Sep	20-Sep	27-Sep
CAP	-68	-86	-54	+43	-22	0	+9	+119	-22	-89	-50	-27	-29	+69	+60	-66	-7
TEL	-74	-75	-91	+24	+1	-5	+88	+212	+171	-94	-81	-16	-61	+161	+2	-65	-33
RYS	-65	-39	+9	+8	+50	-74	-54	+51	+2	-92	-25	-62	-36	+166	-86	-53	+82
TN	-20	+3	+79	-11	+34	+66	-36	-17	-89	-61	+112	-63	+3	+102	-34	+39	+41
CK	-87	-61	-77	+4	+28	+63	-2	+127	-31	-62	-95	-48	-85	-74	+32	+91	+40
NIK	-71	-50	-86	-14	+34	-40	69	+247	+35	-81	-74	-68	-63	+114	-51	-79	+9
SIK	-66	-65	-65	-35	-11	+12	-28	+165	-42	-76	-82	-67	-85	+41	-32	-28	-30
KER	-72	-43	-74	-54	+26	+13	-73	+23	-80	-88	-94	-81	-80	-4	+92	+32	-11
LAK	-44	-16	-87	+10	+76	+72	-21	-80	-87	-84	-92	-96	+37	-22	+141	+29	-19

Table-3.3b: Weekly cumulative sub-divisional rainfall during Jun-Sep 2023

SUB-DIVISION	2023: CUMULATIVE WEEK ENDING : PDN (%)																
	07-Jun	14-Jun	21-Jun	28-Jun	05-Jul	12-Jul	19-Jul	26-Jul	02-Aug	09-Aug	16-Aug	23-Aug	30-Aug	06-Sep	13-Sep	20-Sep	27-Sep
CAP	-68	-79	-70	-38	-34	-27	-20	+3	0	-11	-17	-17	-18	-12	-7	-12	-11
TEL	-74	-75	-82	-51	-39	-31	-9	+33	+52	+33	+19	+16	+10	+20	+19	+14	+20
RYS	-65	-52	-36	-26	-15	-27	-32	-19	-16	-24	-26	-30	-30	-13	-19	-23	-14
TN	-20	-9	+13	+8	+13	+24	+13	+8	-5	-11	+4	-6	-5	+6	+2	+6	+9
CK	-87	-71	-74	-51	-31	-15	-13	+7	+2	-4	-12	-14	-18	-20	-19	-16	-15
NIK	-71	-60	-68	-54	-38	-38	-22	+16	+17	+6	-1	-7	-11	-2	-5	-12	-10
SIK	-66	-65	-65	-57	-46	-35	-34	-5	-10	-18	-24	-27	-31	-27	-27	-27	-27
KER	-72	-55	-62	-60	-42	-32	-38	-31	-36	-40	-44	-46	-48	-46	-41	-39	-38
LAK	-44	-31	-48	-35	-17	-2	-4	-13	-19	-23	-28	-33	-29	-29	-20	-18	-18

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

3.4 Daily sub-divisional rainfall and monsoon activity

Table-3.4a presents daily spatial rainfall distribution over various subdivisions of the SP region during the SWM 2023 and Table-3.4b, the percentage frequency of various categories of spatial rainfall distribution over each subdivision during the season.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.4a: Daily sub-divisional rainfall distribution over the SP region during SWM 2023

Date as on 08:30 IST	CAP	TEL	RYS	TN	CK	NIK	SIK	KER	LAK
01-06-2023	ISOL	ISOL	DRY	ISOL	FWS	SCT	FWS	FWS	SCT
02-06-2023	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	WS
03-06-2023	DRY	ISOL	ISOL	ISOL	DRY	DRY	ISOL	SCT	DRY
04-06-2023	ISOL	ISOL	ISOL	ISOL	DRY	ISOL	ISOL	SCT	SCT
05-06-2023	SCT	SCT	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	SCT
06-06-2023	ISOL	ISOL	ISOL	SCT	ISOL	ISOL	ISOL	FWS	FWS
07-06-2023	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	FWS	WS
08-06-2023	SCT	ISOL	SCT	ISOL	SCT	ISOL	ISOL	WS	SCT
09-06-2023	ISOL	ISOL	ISOL	ISOL	SCT	SCT	ISOL	FWS	WS
10-06-2023	ISOL	ISOL	ISOL	ISOL	WS	ISOL	ISOL	WS	WS
11-06-2023	ISOL	SCT	ISOL	ISOL	WS	SCT	ISOL	WS	FWS
12-06-2023	ISOL	ISOL	ISOL	ISOL	WS	SCT	FWS	WS	WS
13-06-2023	ISOL	ISOL	ISOL	SCT	WS	ISOL	SCT	WS	SCT
14-06-2023	ISOL	ISOL	ISOL	SCT	WS	ISOL	ISOL	WS	FWS
15-06-2023	ISOL	ISOL	DRY	ISOL	WS	ISOL	SCT	FWS	SCT
16-06-2023	DRY	DRY	DRY	ISOL	FWS	ISOL	ISOL	FWS	DRY
17-06-2023	ISOL	ISOL	ISOL	ISOL	FWS	ISOL	ISOL	FWS	DRY
18-06-2023	ISOL	ISOL	ISOL	ISOL	WS	ISOL	ISOL	WS	FWS
19-06-2023	SCT	ISOL	ISOL	SCT	WS	ISOL	SCT	FWS	FWS
20-06-2023	ISOL	ISOL	SCT	SCT	SCT	ISOL	SCT	SCT	DRY
21-06-2023	SCT	SCT	FWS	SCT	SCT	ISOL	FWS	SCT	FWS
22-06-2023	FWS	SCT	FWS	ISOL	FWS	ISOL	WS	FWS	SCT
23-06-2023	FWS	FWS	ISOL	SCT	WS	ISOL	FWS	SCT	WS
24-06-2023	FWS	WS	ISOL	ISOL	WS	SCT	SCT	SCT	DRY
25-06-2023	FWS	FWS	ISOL	ISOL	WS	WS	SCT	FWS	FWS
26-06-2023	FWS	FWS	SCT	ISOL	WS	WS	FWS	WS	WS
27-06-2023	ISOL	FWS	ISOL	ISOL	WS	ISOL	SCT	FWS	WS
28-06-2023	ISOL	FWS	ISOL	ISOL	WS	SCT	FWS	WS	WS
29-06-2023	ISOL	FWS	ISOL	ISOL	WS	ISOL	ISOL	WS	WS
30-06-2023	ISOL	ISOL	ISOL	ISOL	WS	SCT	WS	WS	WS
01-07-2023	ISOL	ISOL	ISOL	ISOL	WS	SCT	SCT	FWS	SCT
02-07-2023	ISOL	SCT	ISOL	ISOL	WS	SCT	SCT	WS	SCT
03-07-2023	FWS	SCT	WS	ISOL	WS	WS	FWS	WS	WS
04-07-2023	WS	ISOL	SCT	SCT	WS	FWS	FWS	WS	WS
05-07-2023	SCT	WS	FWS	SCT	WS	FWS	FWS	WS	WS
06-07-2023	WS	SCT	ISOL	ISOL	WS	FWS	FWS	WS	WS
07-07-2023	FWS	FWS	ISOL	ISOL	WS	SCT	WS	WS	WS
08-07-2023	SCT	FWS	ISOL	ISOL	WS	FWS	FWS	WS	WS
09-07-2023	ISOL	FWS	ISOL	ISOL	WS	FWS	FWS	WS	WS
10-07-2023	SCT	SCT	ISOL	SCT	WS	SCT	FWS	FWS	SCT
11-07-2023	SCT	FWS	ISOL	FWS	WS	ISOL	SCT	FWS	WS
12-07-2023	FWS	WS	ISOL	SCT	WS	ISOL	FWS	FWS	FWS
13-07-2023	FWS	FWS	ISOL	SCT	WS	ISOL	FWS	FWS	WS
14-07-2023	FWS	FWS	ISOL	FWS	WS	FWS	FWS	WS	WS
15-07-2023	SCT	FWS	ISOL	ISOL	WS	SCT	FWS	FWS	WS
16-07-2023	SCT	WS	ISOL	ISOL	WS	FWS	FWS	FWS	FWS
17-07-2023	FWS	FWS	ISOL	ISOL	WS	FWS	SCT	FWS	FWS
18-07-2023	FWS	WS	FWS	ISOL	WS	WS	FWS	WS	FWS
19-07-2023	WS	WS	SCT	ISOL	WS	WS	FWS	WS	WS
20-07-2023	FWS	WS	FWS	ISOL	WS	WS	FWS	WS	WS
21-07-2023	FWS	WS	FWS	ISOL	WS	WS	FWS	FWS	FWS
22-07-2023	FWS	WS	ISOL	ISOL	WS	WS	WS	SCT	DRY
23-07-2023	WS	FWS	FWS	ISOL	WS	FWS	WS	WS	FWS
24-07-2023	FWS	WS	FWS	SCT	WS	WS	WS	WS	SCT
25-07-2023	WS	WS	WS	FWS	WS	WS	WS	WS	WS
26-07-2023	WS	WS	WS	SCT	WS	WS	WS	WS	FWS
27-07-2023	WS	WS	WS	ISOL	WS	WS	WS	WS	WS
28-07-2023	ISOL	WS	ISOL	ISOL	WS	WS	FWS	FWS	FWS
29-07-2023	ISOL	ISOL	ISOL	ISOL	WS	FWS	FWS	SCT	FWS
30-07-2023	ISOL	ISOL	ISOL	ISOL	WS	SCT	FWS	SCT	FWS
31-07-2023	ISOL	SCT	ISOL	ISOL	WS	FWS	SCT	SCT	FWS

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Date as on 08:30 IST	CAP	TEL	RYS	TN	CK	NIK	SIK	KER	LAK
01-08-2023	FWS	FWS	FWS	ISOL	WS	FWS	SCT	FWS	FWS
02-08-2023	SCT	SCT	ISOL	ISOL	WS	SCT	ISOL	ISOL	DRY
03-08-2023	SCT	ISOL	DRY	ISOL	WS	ISOL	ISOL	SCT	DRY
04-08-2023	ISOL	ISOL	DRY	ISOL	WS	SCT	SCT	FWS	WS
05-08-2023	SCT	ISOL	ISOL	ISOL	WS	SCT	SCT	FWS	SCT
06-08-2023	ISOL	ISOL	ISOL	ISOL	WS	SCT	SCT	SCT	DRY
07-08-2023	ISOL	ISOL	ISOL	ISOL	WS	SCT	SCT	SCT	FWS
08-08-2023	ISOL	ISOL	ISOL	ISOL	WS	ISOL	ISOL	SCT	FWS
09-08-2023	ISOL	ISOL	ISOL	ISOL	WS	ISOL	ISOL	SCT	SCT
10-08-2023	ISOL	ISOL	SCT	SCT	FWS	ISOL	ISOL	ISOL	FWS
11-08-2023	FWS	ISOL	FWS	FWS	FWS	ISOL	ISOL	FWS	FWS
12-08-2023	SCT	ISOL	ISOL	FWS	SCT	ISOL	ISOL	SCT	DRY
13-08-2023	ISOL	ISOL	ISOL	SCT	SCT	ISOL	ISOL	SCT	SCT
14-08-2023	SCT	ISOL	ISOL	ISOL	FWS	ISOL	ISOL	ISOL	DRY
15-08-2023	SCT	SCT	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	DRY
16-08-2023	SCT	ISOL	ISOL	ISOL	SCT	ISOL	ISOL	ISOL	SCT
17-08-2023	SCT	ISOL	ISOL	ISOL	FWS	ISOL	ISOL	ISOL	SCT
18-08-2023	WS	SCT	ISOL	ISOL	WS	ISOL	ISOL	ISOL	SCT
19-08-2023	FWS	WS	ISOL	ISOL	WS	SCT	SCT	FWS	SCT
20-08-2023	SCT	FWS	SCT	ISOL	WS	FWS	WS	FWS	SCT
21-08-2023	ISOL	SCT	ISOL	ISOL	WS	ISOL	SCT	SCT	SCT
22-08-2023	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL
23-08-2023	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL
24-08-2023	SCT	ISOL	ISOL	ISOL	SCT	ISOL	ISOL	ISOL	DRY
25-08-2023	FWS	ISOL	DRY	ISOL	FWS	ISOL	ISOL	ISOL	DRY
26-08-2023	FWS	FWS	ISOL	ISOL	FWS	FWS	ISOL	ISOL	SCT
27-08-2023	FWS	SCT	SCT	ISOL	SCT	SCT	SCT	ISOL	FWS
28-08-2023	SCT	SCT	ISOL	ISOL	ISOL	ISOL	ISOL	ISOL	WS
29-08-2023	ISOL	ISOL	SCT	ISOL	SCT	SCT	ISOL	SCT	FWS
30-08-2023	ISOL	ISOL	ISOL	SCT	SCT	SCT	ISOL	FWS	WS
31-08-2023	ISOL	ISOL	ISOL	SCT	ISOL	ISOL	ISOL	ISOL	FWS
01-09-2023	ISOL	ISOL	SCT	SCT	ISOL	SCT	FWS	SCT	FWS
02-09-2023	SCT	ISOL	ISOL	SCT	ISOL	SCT	SCT	FWS	SCT
03-09-2023	WS	WS	WS	SCT	SCT	SCT	SCT	FWS	WS
04-09-2023	SCT	WS	WS	SCT	WS	WS	SCT	WS	WS
05-09-2023	SCT	WS	WS	ISOL	WS	WS	SCT	FWS	WS
06-09-2023	FWS	WS	FWS	ISOL	WS	SCT	WS	WS	WS
07-09-2023	FWS	WS	ISOL	SCT	WS	ISOL	FWS	WS	WS
08-09-2023	FWS	FWS	ISOL	SCT	WS	SCT	FWS	WS	WS
09-09-2023	ISOL	SCT	DRY	ISOL	WS	ISOL	SCT	WS	WS
10-09-2023	FWS	FWS	ISOL	ISOL	WS	FWS	SCT	WS	WS
11-09-2023	FWS	FWS	ISOL	ISOL	WS	ISOL	SCT	WS	WS
12-09-2023	FWS	ISOL	ISOL	ISOL	WS	SCT	SCT	WS	WS
13-09-2023	FWS	ISOL	ISOL	SCT	WS	ISOL	SCT	FWS	WS
14-09-2023	FWS	SCT	ISOL	ISOL	WS	ISOL	SCT	WS	WS
15-09-2023	ISOL	FWS	ISOL	SCT	WS	SCT	SCT	WS	WS
16-09-2023	SCT	SCT	SCT	ISOL	WS	SCT	SCT	WS	WS
17-09-2023	ISOL	ISOL	SCT	SCT	WS	SCT	FWS	WS	WS
18-09-2023	SCT	ISOL	ISOL	FWS	WS	SCT	FWS	WS	FWS
19-09-2023	SCT	ISOL	ISOL	FWS	WS	SCT	FWS	WS	WS
20-09-2023	SCT	ISOL	ISOL	SCT	WS	SCT	SCT	SCT	FWS
21-09-2023	FWS	FWS	ISOL	SCT	WS	SCT	SCT	SCT	WS
22-09-2023	FWS	WS	SCT	SCT	FWS	FWS	ISOL	FWS	WS
23-09-2023	ISOL	SCT	FWS	SCT	FWS	FWS	SCT	WS	WS
24-09-2023	FWS	ISOL	FWS	SCT	WS	ISOL	FWS	WS	SCT
25-09-2023	SCT	FWS	FWS	SCT	WS	FWS	FWS	FWS	FWS
26-09-2023	SCT	ISOL	FWS	SCT	WS	FWS	SCT	SCT	SCT
27-09-2023	SCT	ISOL	SCT	SCT	WS	FWS	SCT	FWS	FWS
28-09-2023	SCT	ISOL	ISOL	SCT	WS	SCT	SCT	WS	WS
29-09-2023	SCT	SCT	FWS	SCT	WS	SCT	FWS	WS	WS
30-09-2023	FWS	FWS	SCT	ISOL	WS	SCT	SCT	WS	WS

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.4b: Percentage frequency of various categories of daily spatial rainfall distribution over the subdivisions of the SP region during SWM season, 2023

Category	Frequency (%)								
	CAP	TEL	RYS	TN	CK	NIK	SIK	KER	LAK
WS	7	17	6	0	70	12	9	39	42
FWS	28	20	13	6	10	16	28	29	25
SCT	27	16	12	30	10	31	32	19	20
ISOL	36	45	63	64	9	39	31	14	2
DRY	2	1	6	0	2	1	0	0	11

***WS**: Widespread; **FWS**: Fairly Widespread; **SCT**: Scattered; **ISOL**: Isolated; **DRY**: No rain*
(Note: Kindly refer Appendix(i) for explanations on categorisation of spatial rainfall distribution)

As seen, *fairly widespread* to w*idespread* rainfall occurred over CK on 80% of the days during the season; over KER & LAK on 67-68% of the days during the season. *Scattered* to *widespread* rainfall occurred over CAP, TEL, NIK & SIK recorded on 50-70% of the days; and over RYS & TN on 30-40% of the days during the season. On 25th July, all the nine Sub-divisions in the region reported *fairly widespread* to *widespread* rainfall.

Table-3.4c presents the monthly and seasonal frequency of *active* and *vigorous* monsoon days over the various subdivisions of the SP region during the SWM season, 2023. *Active to vigorous* monsoon conditions prevailed over CK, KER, TEL & CAP on 20-25 days and over NIK, SIK & RYS on 13-18 days during the season. There were 5 days of *active* to *vigorous* monsoon activity over TN.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.4c: Subdivision-wise frequency of Vigorous and Active monsoon conditions over the SP region during the SWM season, 2023

Subdivision	Jun		Jul		Aug		Sep		Jun-Sep	
	ACT	VIG	ACT	VIG	ACT	VIG	ACT	VIG	ACT	VIG
CAP	3	0	6	2	2	0	6	1	17	3
TEL	2	0	5	7	1	0	3	4	11	11
RYS	3	0	3	1	0	0	5	1	11	2
TN	0	0	1	1	0	1	2	0	3	2
CK	2	0	12	1	1	0	8	1	23	2
NIK	1	0	9	4	0	0	2	1	12	5
SIK	3	0	12	0	1	0	2	0	18	0
KER	1	0	5	2	0	0	12	2	18	4
LAK	0	0	0	0	0	0	0	0	0	0

ACT: Active monsoon conditions (FWS to WS rainfall over the subdivision with rainfall amount 1½ to 4 times the normal and at least 2 stations reporting 5cm or more along the west coast or 3cm or more elsewhere)

VIG: Vigorous monsoon conditions (FWS to WS rainfall over the subdivision with rainfall amount more than 4 times the normal and at least 2 stations reporting 8cm or more along the west coast or 5cm or more elsewhere).

3.5 Heavy rainfall activity

Table-3.5a presents the number of days of *heavy* rainfall occurrences (≥ 7 cm/day) over the various subdivisions of the SP region during SWM 2023 and the month-wise frequencies are presented in Table-3.5b. List of *very heavy* to *extremely heavy* rainfall events is presented in Table-3.5c.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.5a: Subdivision-wise frequency of heavy rainfall days over the SP region during1st June - 30th Sep 2023

Subdivision	No. of days of Heavy rainfall (Rainfall ≥ 7cm/day)		
	Extremely Heavy (≥21 cm/day)	*Very Heavy* (≥12cm/day)	*Heavy* (≥7cm/day)
COASTAL AP and YANAM	0	6	40
TELANGANA	5	18	46
RAYALASEEMA	0	2	21
TAMILNADU, PDC and KKL	2	20	55
COASTAL KARNATAKA	6	26	46
NORTHI NTERIOR KARNATAKA	0	2	24
SOUTH INTERIOR KARNATAKA	2	8	26
KERALA and MAHE	1	16	50
LAKSHADWEEP	0	1	3

Note: Kindly refer Appendix-(ii) for explanations on various terminologies used for description of rainfall intensity.

Table-3.5b: Month-wise frequency of heavy rainfall days during June-Sep 2023

Sub-division	No. of days of Heavy rainfall (Rainfall≥7cm/day)											
	June			July			Aug			Sep		
	ExH	*VH*	*H*	*ExH*	*VH*	*H*	*ExH*	*VH*	*H*	*ExH*	*VH*	*H*
CAP	0	0	6	0	4	14	0	0	5	0	2	15
TEL	0	0	5	5	13	19	0	0	5	0	5	17
RYS	0	0	4	0	0	2	0	0	4	0	2	11
TN	0	1	8	2	7	14	0	6	13	0	6	20
CK	0	5	9	6	19	24	0	1	4	0	1	9
NIK	0	0	2	0	1	11	0	0	0	0	1	11
SIK	0	0	3	2	6	14	0	0	0	0	2	9
KER	0	1	15	1	7	16	0	1	2	0	7	17
LAK	0	0	1	0	1	2	0	0	0	0	0	0

***H*: *Heavy* (≥7cm/day); *VH*: *Very Heavy*(≥12cm/day); *ExH: Extremely Heavy*(≥21cm/day);**

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.5c: List of very to extremely heavy rainfall reports during Jun-Sep 2023

DISTRICT	Date, Station and 24-hr accumulated rainfall (in cm) (ending 0830 IST of the specified date)
COASTAL ANDHRA PRADESH	
ANAKAPALLI	**Jul: 26th:** Narsipatnam-12
ALLURI SITHARAMARAJU	**Jul: 24th:** Chintur-18; **25th**: NarasaraopetaKunavaram-12; **27th**: Kondaigudem-13;
ELURU	**Jul: 26th:** Nuzvid-12
GUNTUR	**Jul: 04th:** Tenali-12 **Sep: 11th:** Amaravati-13
SRIKAKULAM	**Jul: 27th:** TamadaVillage-21, Amadavalasa-13, Burja-13, Viziaramapuram-13, Petcherla-13
PARVATHIPURAM MANYAM	**Sep: 07th:** Balajipeta-13
VIZIANAGARAM	**Jul: 27th:** Govindapuram-14, Appanapanem-14
TELANGANA	
ADILABAD	**Jul: 11th:** Utnur-12: **22nd**: Boath-12, Adilabad-12, Bazarhathnoor-12; **27th**: Boath-23, Bazarhathnoor-18, Utnur-13, Talamadugu-13, Tamsi-12
B. KOTHAGUDEM	**Jul: 19th:** Manuguru-14, Dummugudem-14, Aswapuram-12; **27th**: Pinapaka-25, Kothagudem-22, Palawancha-20, Gundala-17, Manuguru-17, Aswapuram-17, Julurpad-16, Yellandu-16, Tekulapalle-14. Burgampadu-14, Yellandu (arg)-13, Mulakalapalle-13
HANUMAKONDA	**Jul: 25th:** Atmakurwrgl-17, Shayampet-14, Parkal-14; **27th**: Parkal-46, Shayampet-30, Atmakurwrgl-29, Hasanparthy-29, Bheemadevarpalle-26, Dharmasagar-21 **Sep: 22nd:** Parkal-12
J. BHUPALPALLY	**Jul: 25th:** Regonda-14; **27th**: Chityal-62, Regonda-47, Ghanpurjskb-46, Mogullapalle-43, Bhupalpalle-24
JANGAON	**Jul: 20th:** Zaffergadh-17, Raghunathpalle-13, Ghanpur-12; **25th**: Zaffergadh-16, Ghanpur -14, Palakurthi-12; **27th**: Zaffergadh-25, Kodakandla-22, Ghanpur-18, Raghunathpalle-16, Palakurthi-13
JAGTIAL	**Jul: 27th:** Pegadapalle-18, Mallial-17, Kathlapur-17, Jagtial-15, Sarangapur-15, Metpalle-14, Velagatoor-13, Devaruppal-13; **28th**: Kathlapur-18, Metpalle-15, Mallapur-14 **Sep: 04th:** Metpalle-15
KAMAREDDY	**Jul: 05th:** Naga Reddipet-12; **15th**: Banswada-12; **20th**: Gandhari-13; **Sep: 04th:** Gandhari-12; **05th**: Gandhari-14
KARIMNAGAR	**Jul: 21st:** Gangadhara-17; **27th**: Jammikunta-29, Huzurabad-28, Gangadhara-17, Thimmapur-17, Shankarapatnam-17, Choppadandi-17, Chigurumamidy-15, Karimnagar-14, Karimnagar-12

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

KHAMMAM	**Jul: 25th:** Bonakal-12; **27th**: Enkuru-15
KUMARAM BHEEM	**Jul: 11th:** Jainoor-13, Wankdi-12, **20th**: Bejjur-26, Wankdi-12, **22nd**: Sirpuru-22, Jainoor-18; **27th**: Sirpuru-20, Dahegaon-16, Jainoor-14 **Sep: 14th:** Dahegaon-13
MANCHERIAL	**Jul: 24th:** Luxettipet-12; **27th**: Dandepalle-13, Jaipur-12, Luxettipet-12; **Sep: 14th:** Vemanapalle-13
MAHBUBNAGAR	**Jul: 21st:** Gandeed-13
MAHABUBABAD	**Jul: 20th:** Gudurwrg-13; **25th**: Dornakal-12; **27th**: Mahababad-23, Kothaguda-20, Dornakal-20, Garla-18, Malyal-17, Gudurwrgl-16
M. MALKAJGIRI	**Sep: 05th:** Medchal-14, Hakimpet Iaf-12
MEDAK	**Jul: 20th:** Medak-13, Kowdipalle-12, Tekmal-12
MULUGU	**Jul: 25th:** Mulug-13; **26th**: Venkatapuram-19; **27th**: Venkatapur-37, Govindaraopet-33, Mulug-33, Tadwai Mlg-19, Venkatapuram-13
NAGARKURNOOL	**Jul: 05th:** Kollapur-12
NIRMAL	**Jul: 21st:** Sarangapurnrl-12, **27th**: Sarangapurnrl-21, Khanpur-14, Laxmanchanda-13; **28th**: Khanpur-27, Laxmanchanda-17, Mudhole-16, Mudholebasar-15, Dilawarpur-13 **Sep: 04th:** Mudhole-13, Nirmal-12
NIZAMABAD	**Jul: 14th:** Navipet-12, **25th**: Velpur-40, Jakranpalle-23, Bheemgal-23, Mortad-14, Armur-14; **27th**: Kammar Palle-15, Mortad-13, Bheemgal-13, Balkonda-12; **28th**: Navipet-25, Bheemgal-16, Makloor-16, Ranja-14, Mortad-14, Nandipet-13, Jakranpalle-13, Armur-13, Dhar Palle-13, Velpur-12 **Sep**: **04th:** Dich Palle-15, Armur-13, Jakranpalle-12
PEDDAPALLE	**Jul: 27th:** Dharmaram-18, Sultanabad-18, Elagaid-17, Srirampur-16, Julapalle-12
RAJANNA SIRCILLA	**Jul: 27th:** Boinpalle-17, Yellareddypeta-13, Sirsilla-13; **28th**: Chandurthi-13
RANGAREDDY	**Jul: 21st:** Chevella-12
SANGAREDDY	**Sep: 05th:** Kondapur-12
SIDDIPET	**Jul: 05th:** Kondapak-13, Mirdoddi-13; **20th**: Jagadevpur-13, Mirdoddi-12; **27th**: Mirdoddi-15
SURYAPET	**Jul: 27th:** Noothankal-15
WANAPARTHY	**Sep: 03rd:** Khila Ghanpur-13
WARANGAL	**Jul: 20th:** Parvathagiri-12, **25th**: Sangem-22, Nallabelly-17, Parvathagiri-13; **27th**: Nallabelly-29, Parvathagiri-22, Chennaraopet-21, Khanapur-21, Narsampet-20, Sangem-20

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

RAYALASEEMA	
YSR	**Sep: 02nd:** Kondapuram-16
NANDYAL	**Sep: 03rd:** Koilkuntla-15
SRI SATHYASAI	**Sep: 23rd:** Gorantla-15
TAMIL NADU, PUDUCHERRY & KARAIKAL	
CHENNAI	**Jun: 19th:** Chennai Airport-16, Taramani ARG-14, Alandur-14
COIMBATORE	**Jul: 04th:** Chinnakalar-13; **05th**: Chinnakalar-15; **25th**: Chinnakalar-12 **Aug: 30th:** Chinnakalar-15
KALLAKURICHI	**Sep: 18th:** Kallakurichi-12
KANCHEEPURAM	**Sep: 28th:** Kattapakkam KVK ARG-12
KRISHNAGIRI	**Sep: 18th:** Pambar Dam-13, Uthangarai-12
MAYILADUTHURAI	**Aug: 10th:** Kollidam-15
NILGIRIS	**Jul: 05th:** Avalanche-18; **06th**: Avalanche-20; **07th**: Avalanche-14; **23rd**: Avalanche-14; **25th**: Avalanche-38
PUDUKKOTTAI	**Aug: 12th:** Pudukottai -12
SIVAGANGA	**Aug: 30th:** Tirupuvanam -15; **31st**: Tirupuvanam-14
THENI	**Sep: 02nd:** Vaigai Dam-15
TIRUNELVELI	**Sep: 02nd:** Nalumukku-16, Kakkachi-15
TIRUVALLUR	**Jun: 19th:** Chembarambakkam ARG-13 **Aug: 14th:** Jamine Koratur-14, Tirur Kvk AWS-12 **Sep: 17th:** Tiruttani-13; Sep: **24th**: Tiruttani-13
TIRUVANNAMALAI	**Sep: 18th:** Kalasapakkam-13
VELLORE	**Sep: 25th:** Gudiyatham-12
VILLUPURAM	**Jul: 13th:** BASL Manampoondi-27, RSCl-2 Soorapattu-21, BASL Mugaiyur-20, RSCL-2 Kedar -15 **Aug: 10th:** Basl Mugaiyur-12; **31st**: RSCL-2 Koliyanur-12 **Sep: 17th:** Tindivanam-13
VIRUDHUNAGAR	**Aug: 23rd:** Sivakasi-12

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

COASTAL KARNATAKA	
DAKSHINA KANNADA	**Jun:** **18th:** Mangaluru Airport-12; **28th**: Mulki-19, Panambur-15, Mangaluru Airport-14, Mangaluru-13 **Jul:** **04th:** Mulki-17, Panambur-15, Mangaluru-15, Mangaluru Airport-12; **05th**: Mulki-17, Belthangadi-16, Mangaluru-12, Mani-12, Mangaluru Airport-12; **06th**: Mulki -33 , Panambur Obsy-23, Mangaluru-21, Puttur-15, Sulya-13, Belthangady-13; **07th**: Uppinangadi-17, Sulya-14, Puttur Hms-14, Mani-14, Panambur Obsy-13, Mangaluru Ap -13; **08th**: Mulki-15; **23rd**: Mulki-22, Belthangadi-17, Subramanya-16, Uppinangadi-15, Mani-15, Mangaluru Airport-14, Dharmasthala-14, Puttur-14, Panambur-13, Sulya-13; **24th**: Subramanya-17, Mani-16, Uppinangadi-12; **25th**: Mulki-16, Subramanya-16, Sulya-15, Mani-14, Uppinangadi-12, Mangaluru Airport-12, Mangaluru-12, Puttur-12, Panambur-12; **26th**: Subramanya-17 **Aug:** **20th:** Mulki-13 **Sep:** **16th:** Dharmasthala-14
UDUPI	**Jul:** **05th:** Udupi-15, Karkala-15, Kollur-13; **06th**: Kota-29, Karkala-25, Udupi-23, Kundapur-20, Siddapura-15, Kollur-12,; **07th**: Udupi-18; **08th**: Kollur-15; **13th**: Kollur-18, Siddapura-17; **23rd**: Karkala-23, Udupi-22, Kota-15, Siddapura-13; **24th**: Kollur-13; **25th**: Kollur-12; **26th**: Udupi -13
UTTARA KANNADA	**Jun:** **23rd:** Manki -13; **24th:** Karwar -14; Honavar-12; **26th**: Honavar-14, Manki-13; **28th**: Karwar-16, Manki-12, Belikeri-12 **Jul:** **04th:** Kumta-13, Ankola-12; **05th**: Karwar-18, Honavar-18, Shirali Pto-18; **06th**: Manki-23, Shirali-21, Mangaluru AP -19, Kadra-19, Karwar-18, Gersoppa-17, Honavar-13, Ankola-12, Castle Rock-12, Kumta-12; **07th**: Manki-18, Kadra-15; **08th**: Kumta-13, Gersoppa-12, Manki-12; **13th**: Gersoppa-13, Manki-12; **14th**: Manki-15, Ankola-13, Karwar-12; **18th**: Castle Rock-12; **19th**: Castle Rock-24, Yellapur-14, Joida-12; **20th**: Castle Rock-17, Jagalbet-13, Yellapur-12; **21st:** Castle Rock-23; **22nd**: Castle Rock-28, Yellapur-12; **23rd**: Castle Rock-28, Jagalbet-17, Gersoppa-16, Siddapur-13, Kumta-12; **24th**: Siddapur-20, Castle Rock-19, Gersoppa-18, Yellapur-17, Kadra-14, Kumta-14, Manki-14, Shirali Pto-13, Honavar-13; **25th**: Castle Rock-17, Jagalbet-16, Gersoppa-15, Shirali Pto-14; **26th**: Castle Rock-21, Gersoppa-13; **27th**: Castle Rock-17
NORTH INTERIOR KARNATAKA	
BELAGAVI	**Jul:** **19th:** Londa-15
YADGIR	**Sep:** **02nd:** Shahapura-12
SOUTH INTERIOR KARNATAKA	
CHITRADURGA	**Sep:** **01st:** Hiriyur-12
CHIKKAMAGALURU	**Jul:** **23rd:** Kottigehara-17, Jayapura-12, Kalasa-12; **24th**: Kottigehara-16, Kammardi-13, Koppa-13; **25th**: Kottigehara-16, Jayapura-13, Sringeri-12

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

	Sep: **16th**: Kottigehara-13
KODAGU	**Jul:** **06th:** Bhagamandala-12; **07th:** Bhagamandala-23, Virajpet-12; **23rd**: Bhagamandala-24, Napoklu-13; **24th**: Bhagamandala-20, Napoklu-15, Murnadu-14, Somwarpet-13; **25th**: Bhagamandala-19
SHIVAMOGGA	**Jul:** **21st:** Linganamakki-12; **23rd**: Linganamakki Hms-14; **24th**: Hunchadakatte-14, Talaguppa-13, Linganamakki-12; **25th**: Linganamakki-14
KERALA & MAHE	
ALAPPUZHA	**Jul:** **04th:** Cherthala-15 , Cherthala Aws-15; **05th**: Thycauttussery Aws-14 **Aug:** **30th:** Cherthala-13; **Sep:** **04th:** Mancompu-13; **Sep:** **29th:** Cherthala-15, Cherthala-13, Thycauttussery Aws-12
ERNAKULAM	**Jun:** **28th:** North Paravur AWS-16 **Jul:** **04th:** Ernakulam South-13, Kochi I.a.f.-12; Alwaye Pwd-15; **05th**: North Paravur Aws-14; **05th**: Aluva Aws-13, Idamalayar Dam Aws-13, Perumpavur-13, Kochi I.a.f.-12, Kalamassery Aws-12 **Sep:** **30th:** Ernakulam South-13
IDUKKI	**Jul:** **05th:** Peerumedu-19, Munnar Kseb-12
KASARAGOD	**Jun:** **28th:** Bayar AWS-17 **Jul:** **03rd:** Kudulu-12; **04th**: Kudulu-14; **05th**: Padannakkad Aws-13, Bayar Aws-12; **06th**: Vellarikkundu AWS-24, Bayar AWS-19, Padannakkad AWS-17, Muliyar AWS-17, Madikkai AWS-15, Hosdurg-14, Kudulu-13; **23rd**: Vellarikkundu Aws-18, Muliyar Aws-13, Kudulu-12
KANNUR	**Jun:** **28th:** Kannur Airport AWS-15, Mattannur ARG-15, Taliparamba-14 **Jul:** **05th:** Tellichery-15, Taliparamba-14, Irikkur-14, Kannur-14, Ams Kannur-14, Chemberi Aws-14, Mattannur Arg-12; Jul: **06th**: Thalassery-21, Peringome AWS-21, Kannur Airport AWS-19, Ams Kannur-18, Taliparamba-18, Cheruvanchery AWS-18, Irikkur-16, Mattannur ARG-16, Aralam AWS-12; **23rd**: Ams Kannur-13, Aralam Aws-12, Kannur Airport Aws-12; **25th**: Peringome AWS-12
KOTTAYAM	**Jul:** **04th:** Kottayam-14, Kumarakam-13; **05th**: Kanjirappally-16, Vaikom-13
KOZHIKODE	**Jul:** **05th:** Vadakara-19, Kozhikode-15 **Jul:** **06th:** Vadakara-20, Vilangad AWS-18, Quilandi-13 **Sep:** **07th:** Vadakara-17, Urumi AWS-12
MAHE	**Jul:** **05th:** Mahe-15 **Sep:** **07th:** Mahe-16
MALAPPURAM	**Jun:** **28th:** Ponnani-14 **Jul:** **05th:** Ponnani-16, Thennala Aws-12; **06th**: Kannur-19, Ponnani-19
THRISSUR	**Jul:** **05th:** Enamakkal-16, Chalakudi-15, Kunnamkulam-13, Athirappalli Aws-13, Kodungallur-12; **06th**: Irinjalakuda-12 **Sep:** **29th:** Vadakkancherry-12
PALAKKAD	**Jul:** **06th:** Pattambi-14, Thrithala-14 **Sep:** **23rd:** Mannarkkad-18, Mannarkkad AWS-15
PATHANAMTHITTA	**Jul:** **04th:** Ranni Aws-14, Laha Aws-13; **05th**: Kunnathanam Aws-12, Kurudamannil-12

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

	Sep: 02nd: Ranni Aws-13; **04th**: Konni-15, Kunnathanam Aws-13, Kurudamannil-12
WAYANAD	**Jul: 05th:** Padinjarathara Dam Aws-17; **06th**: Padinjarathara Dam AWS-17; **08th**: Padinjarathara Dam AWS-12
LAKSHADWEEP	
LAKSHADWEEP UT	**Jul: 08th:** Amini-15

In the seasonal scale, TN experienced 55 days of *isolated heavy* rainfall activity out of which 20 days were with *isolated very heavy* rainfall events including 02 days of *isolated extremely heavy* rainfall events. Over KER, there were 50 days of *isolated heavy* rainfall activity out of which 16 days of *isolated very heavy* rainfall events including 01 day of *isolated extremely heavy* rainfall event. CK, TEL & CAP experienced 46, 46 & 40 days respectively of *isolated heavy* rainfall activity including 26, 18 & 6 days respectively of *isolated very heavy* rainfall events with 06 & 05 days of *isolated extremely heavy* rainfall over CK & TEL respectively. SIK, NIK & RYS experienced 26, 24 & 21 days respectively of *isolated heavy* rainfall activity including 08, 02 & 02 days respectively of *isolated very heavy* rainfall events with 02 days of *isolated extremely heavy* rainfall over SIK. There were only 3 days of *heavy* rainfall events including 01 day of *very heavy* rainfall over LAK during the season.

In the monthly scale, highest number of *heavy* rainfall days was recorded in July with 24 days of *heavy* rainfall events over CK followed by 20 days of *isolated heavy* rainfall events over TN in September 2023. 10-20 days of isolated heavy rainfall occurred over TEL, KER, CAP, TN, SIK & NIK in July & TEL, KER, CAP, RYS & NIK in September 2023. KER reported *isolated heavy* rain on about 50% of the days during June, July & September 2023.

3.6 District-wise seasonal rainfall distribution

Table -3.6 presents the district rainfall distribution as percentage departures from normal over the nine meteorological subdivisions of the SP region during the period Jun-Sep 2023 and Fig.3(iii), the district-wise seasonal rainfall over the various states and UTs over the SP region.

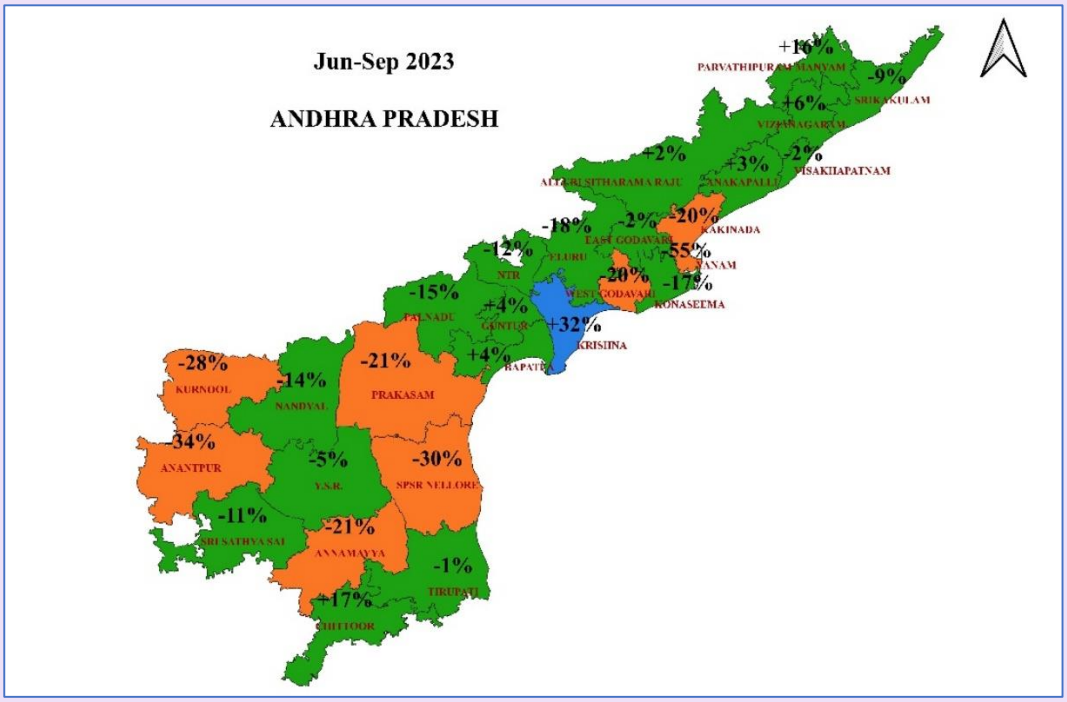
Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Table-3.6: District rainfall performance over various sub-divisions of the SP region during June-September 2023

Sub-division	Total No. of districts	No. of districts under various categories of monsoon performance				
		Large Excess	*Excess*	*Normal*	*Deficient*	*Large Deficient*
COASTAL AP & YANAM	19	0	1	13	5	0
TELANGANA	33	0	15	17	1	0
RAYALASEEMA	8	0	0	5	3	0
TAMILNADU, PDC & KKL	40	3	9	22	6	0
COASTAL KARNATAKA	3	0	0	3	0	0
NORTH INTERIOR KARNATAKA	11	0	0	9	2	0
SOUTH INTERIOR KARNATAKA	17	0	0	6	11	0
KERALA & MAHE	15	0	0	5	10	0
LAKSHADWEEP	1	0	0	1	0	0

Of the 147 districts in the SP region [Andhra Pradesh: 28 (CAP & Yanam -19 & RYS-8), Telangana: 33, Tamilnadu, Puducherry and Karaikal: 40, Karnataka: 31 (CK-3, NIK-11 & SIK-17), Kerala & Mahe:15 and Lakshadweep: 1], 109 districts received *normal to large excess* rainfall and 38 districts came under *deficient* category during the season. *Excess* rainfall was recorded in 15 districts in TEL, 12 districts in TN including 3 districts with *large excess* rainfall & 1 district in CAP during the season. No district in KAR, KER & RYS received *excess* rainfall during the season. 13 out of 19 districts in CAP, 05 out of 08 districts in RYS received *normal* rainfall and the others came under *deficient* category including Yanam. In KAR, all districts in CK and 09 out of 11 districts in NIK received *normal* rainfall; however, in SIK, only 06 out of 17 districts received *normal* rainfall and the other 11 districts came under *deficient* category. In KER, only 5 districts, including Mahe, received *normal* rainfall and the all the other 10 districts became *deficient*. LAK received *normal* rainfall during the season.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



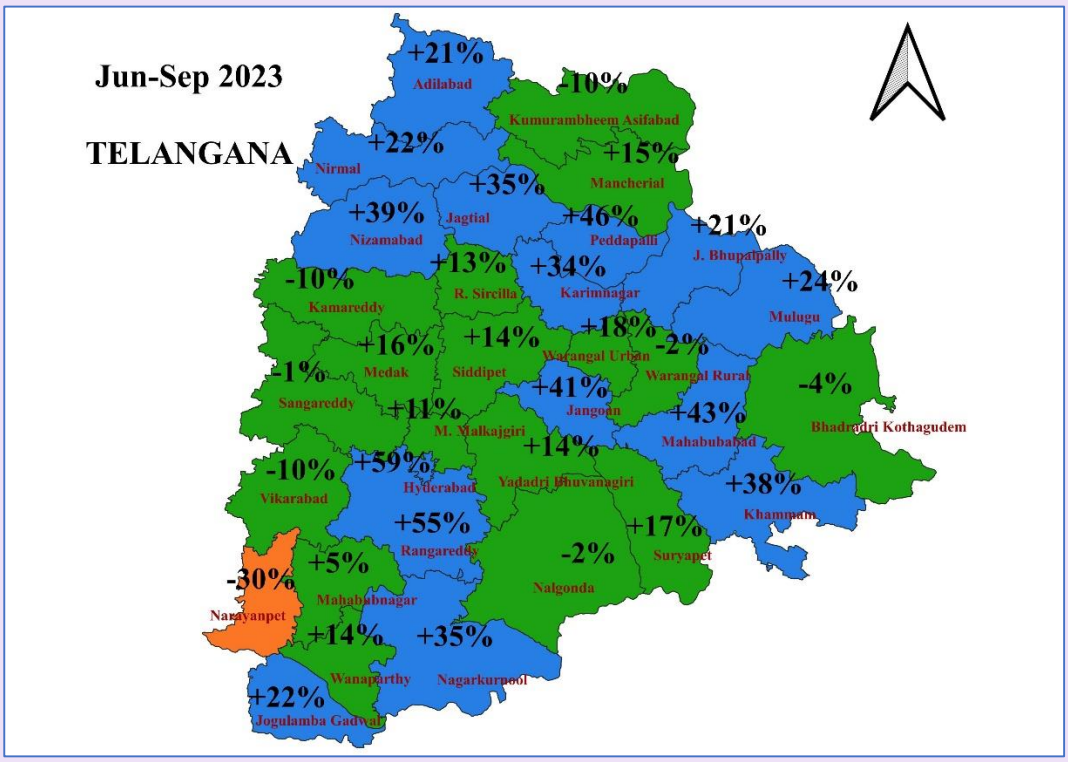
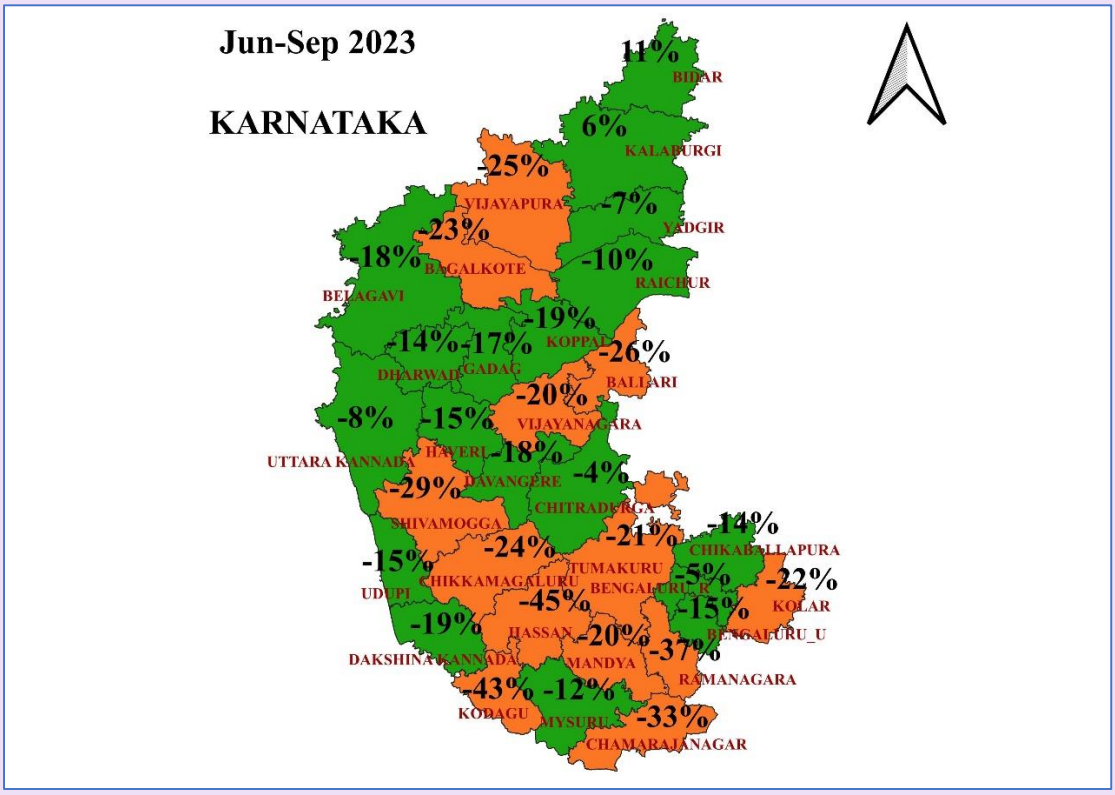


Fig.3(iii): District-wise rainfall (as percentage departure from normal) during Jun-Sep 2023 over various states and UTs in the SP region

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms



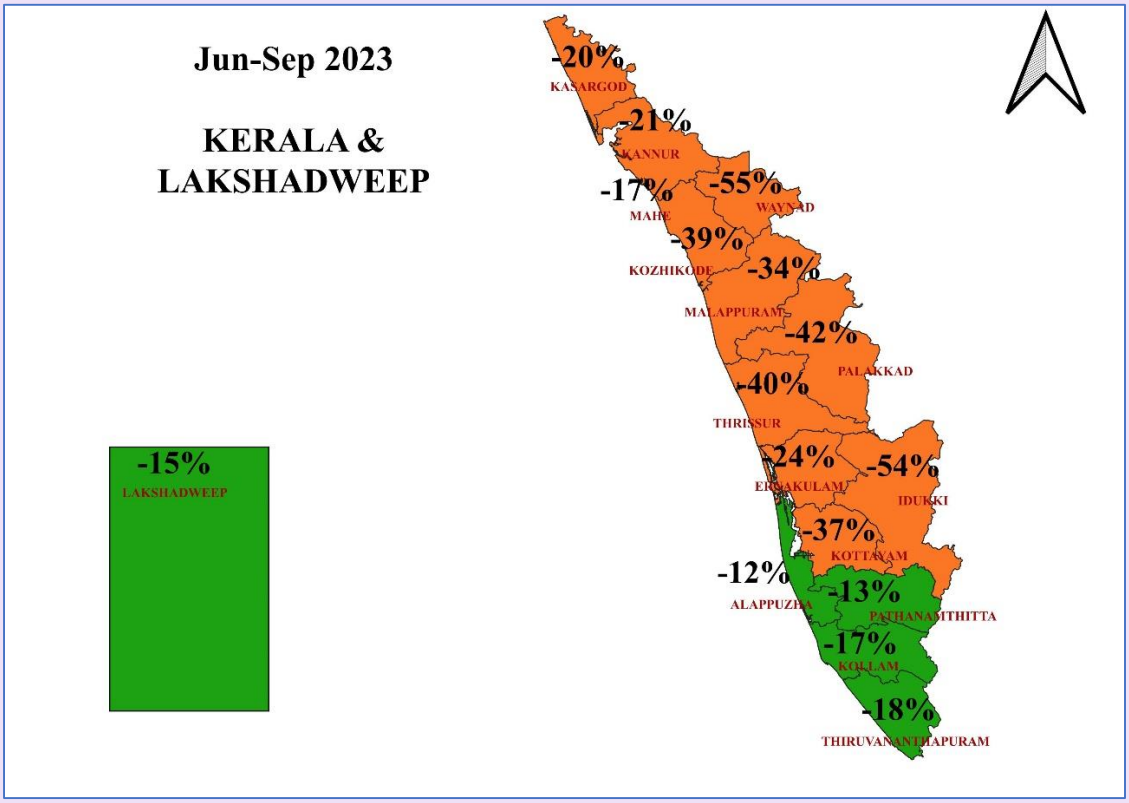


Fig.3(iii): contd.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

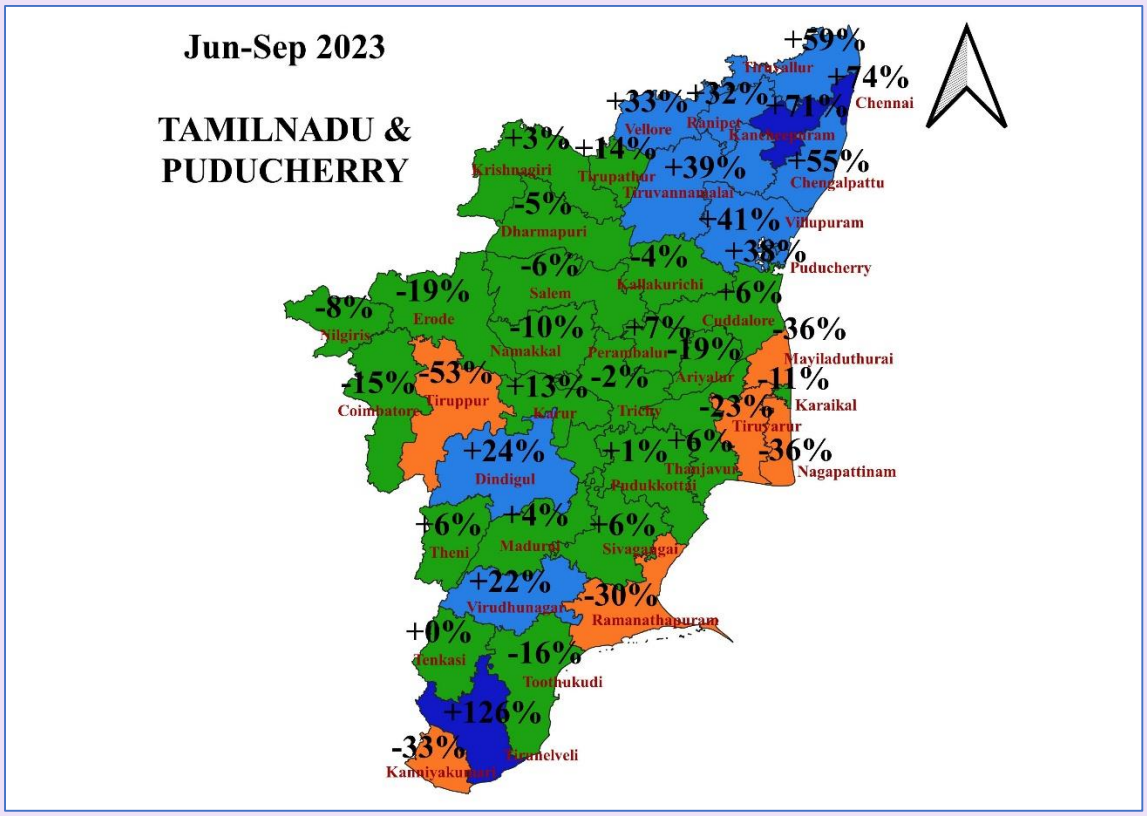


Fig.3(iii): contd.

3.7 Dry and Wet conditions

Based on Standardized Precipitation Index (SPI), a widely accepted index used for drought monitoring world-wide, which is based on rainfall, *mildly/moderately/severely/extremely dry* or *wet* situations over various districts of the region during June-Sep 2023 are depicted in Fig.3(iv). The SPI indicated generally wet conditions (*mildly/moderately/severely/extremely wet* category) over 60 out of 146 districts in the SP region at the end of the season and generally dry (*mildly/moderately/severely/extremely dry* category) conditions prevailed over 86 districts in the region.

In Andhra Pradesh (CAP & RYS), *mild-moderately wet* conditions prevailed over 8 districts and *mild-moderately dry* conditions over the other 19 districts. In TEL, *mild-moderately wet* conditions prevailed over 25 districts and *mildly dry* conditions prevailed over the other 8 districts. In KAR, *extremely dry* conditions prevailed over three districts (Hassan, Kodagu & Shimogga – all three in SIK), *mild-moderately dry* conditions over most other districts (26 districts)

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

and *mild-moderately wet* conditions over just 2 districts (Bidar & Kalburgi in NIK). In TN subdivision, *severely wet* conditions were observed over 5 districts (Chennai, Tiruvallur, Tirunelveli, Tenkasi & Puducherry), *mild-moderately wet* conditions over 20 districts and *mild-moderately dry* conditions over 15 districts. In KER, *severely-extremely dry* conditions prevailed over 7 districts (Thrissur, Idukki, Kottayam, Kozhikode, Malappuram, Palakkad & Wyanad) and *mildly-moderately dry* conditions over the other 8 districts including Mahe.

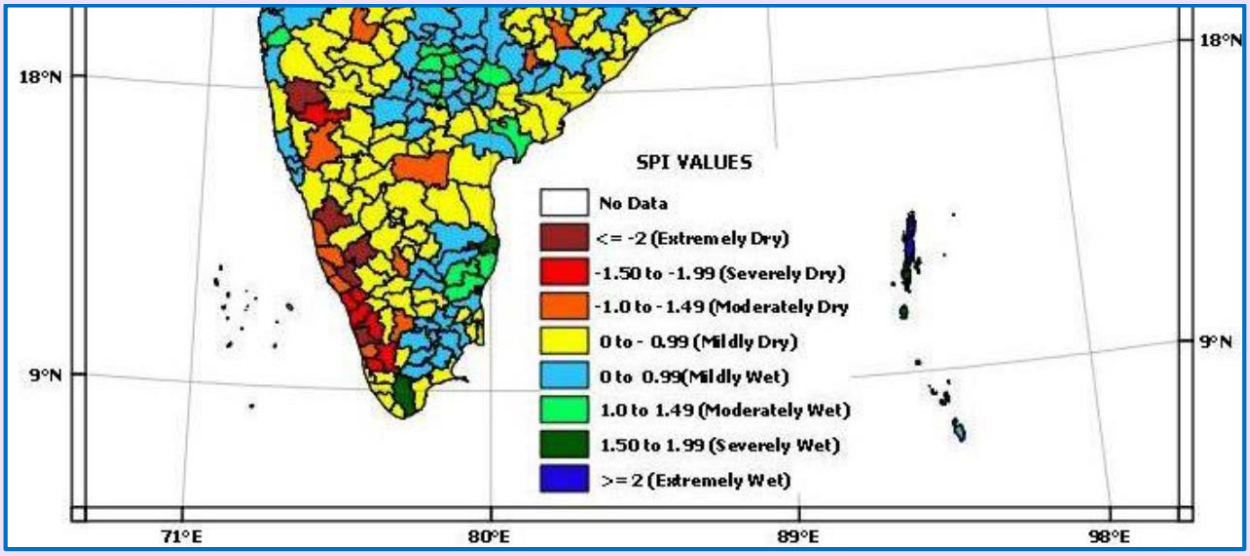


Fig.3(iv): Standardised Precipitation Index (SPI) over the SP region for Jun-Sep 2023
(Source: Climate Diagnostic Bulletin of India, IMD Pune**)**

4. Large and Regional scale circulation features

4.1 Large scale features

Climate drivers such as *ENSO* (that represents *El Nino* / *La Nina* conditions in the equatorial Pacific region), Indian Ocean Dipole (IOD) and Madden-Julian Oscillation (MJO) influence the SWM performance. During the SWM 2023, *neutral ENSO* conditions were observed over the equatorial Pacific Ocean during the month of June, however, *weak El Nino* conditions developed in July which gradually became *moderate El Nino* in August & September 2023. *Indian Ocean Dipole (IOD)* was *neutral* till the third week of August and became *positive* thereafter till the end of the season. *Madden-Julian Oscillation (MJO)* remained locked in Western hemisphere and Africa in June and August and over Indian Ocean and Maritime continent during most of the days of July and September 2023 (Fig.4.1).

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

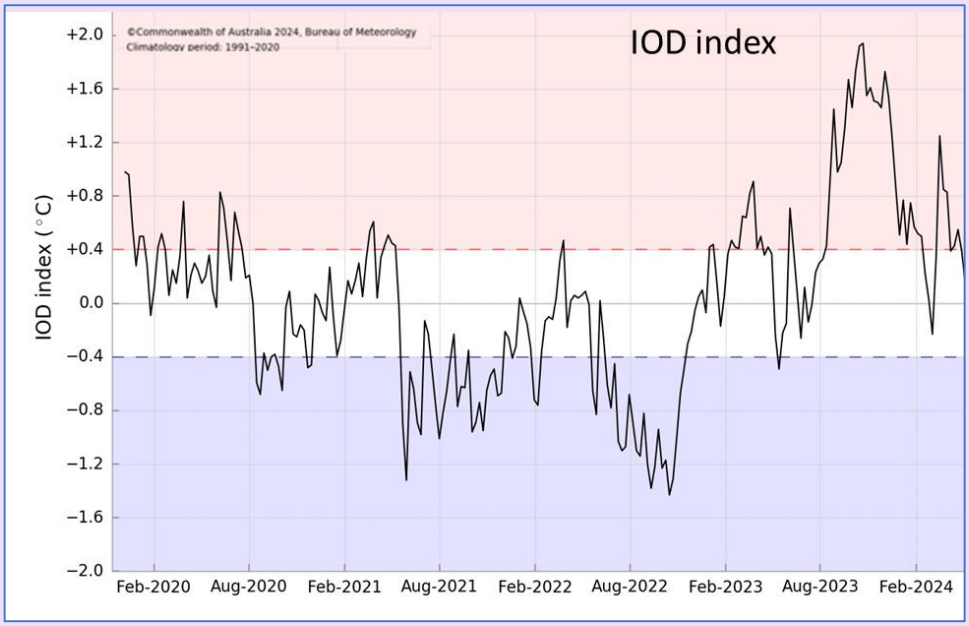


Fig.4.1: Times series of Nino 3.4 SST anomalies, IOD (source: Bureau of Meteorology, Australia**) and MJO during the SWM 2023**

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

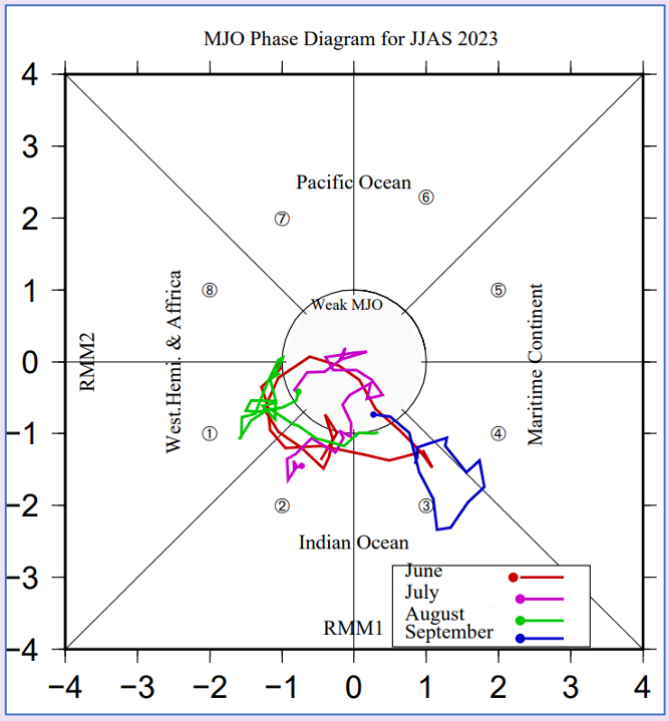


Fig.4.1: contd.

4.2 Regional features

Fig.4.2(a-d) depict the 850, 500 and 250 hPa wind anomaly over the Indian region during the months of June, July, August and September 2023.

It is observed that during June 2023, easterly anomalies were present over the southern peninsula in the lower tropospheric levels (850 hPa), anomalous anti cyclonic circulation over the southern peninsula and adjoining Arabian sea in the mid-levels (500 hPa) and anomalous westerlies over the Arabian sea and the central India in the upper levels (250 hPa).

In July, anomalous easterlies were present over the central Indian region throughout the troposphere.

In August, anomalous anti cyclonic circulation was seen over the Indian region in the lower-mid tropospheric levels and anomalous westerlies / southwesterlies were observed in the upper levels over the low latitude belt.

In September, anomalous cyclonic circulation was observed over the eastern Arabian sea in the lower levels and anomalous easterlies were present over the northern & central Indian region in the mid-levels.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

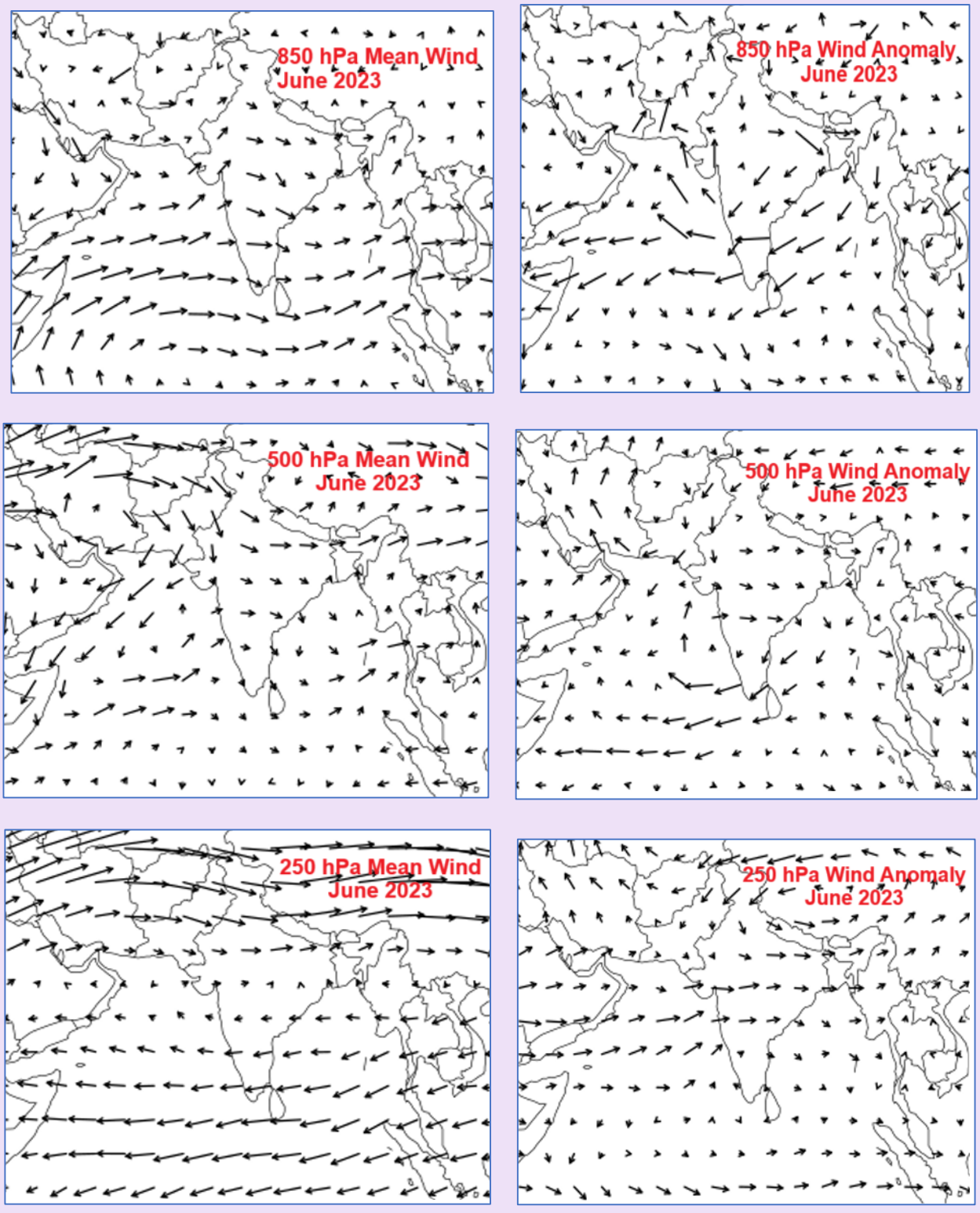


Fig.4.2a: 850hPa, 500hPa & 250hPa wind anomalies over Indian region during June 2023
(Source: Climate Diagnostic Bulletin of India, IMD Pune)

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

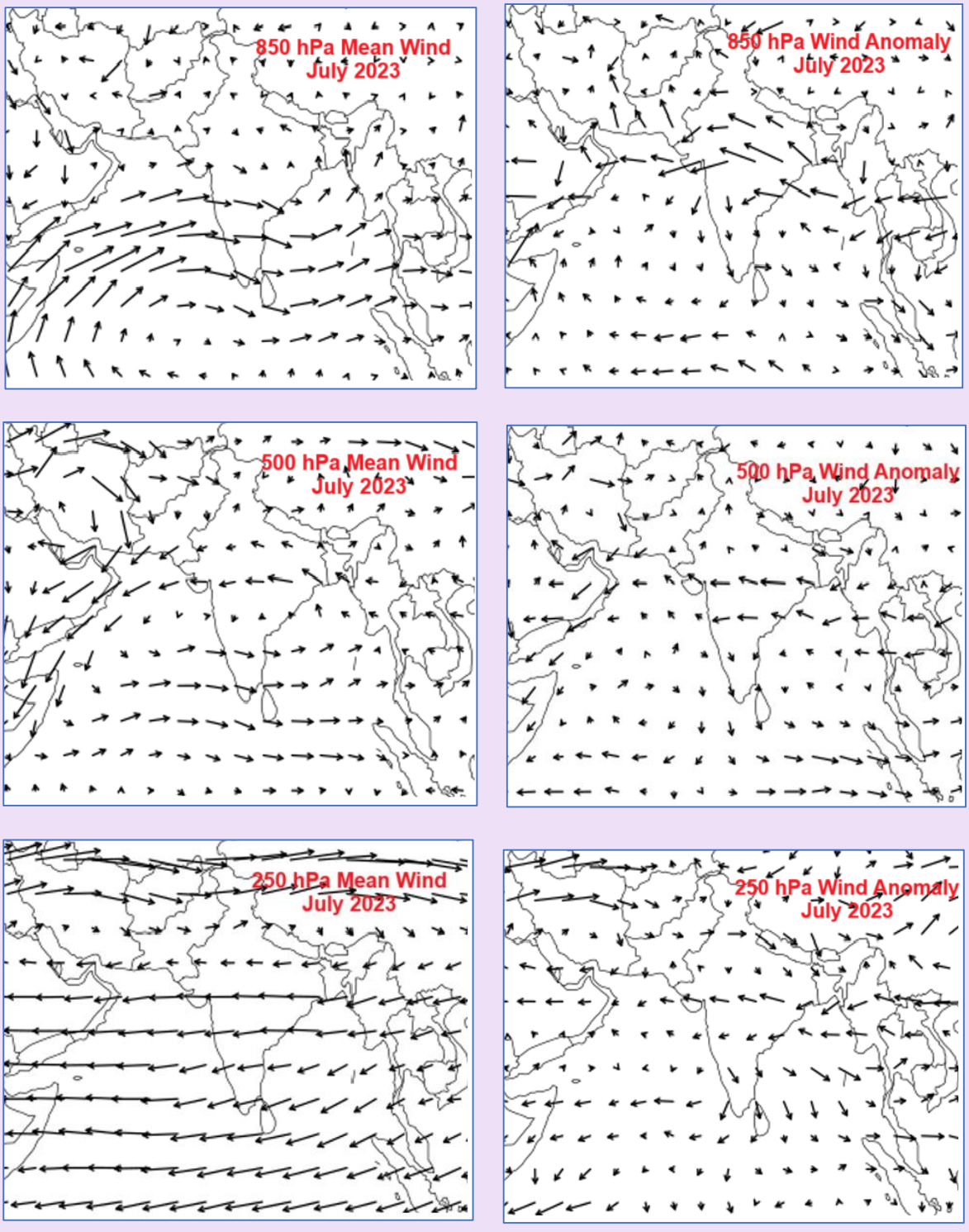


Fig.4.2b: 850hPa, 500hPa & 250hPa wind anomalies over Indian region during July 2023
(Source: Climate Diagnostic Bulletin of India, IMD Pune)

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

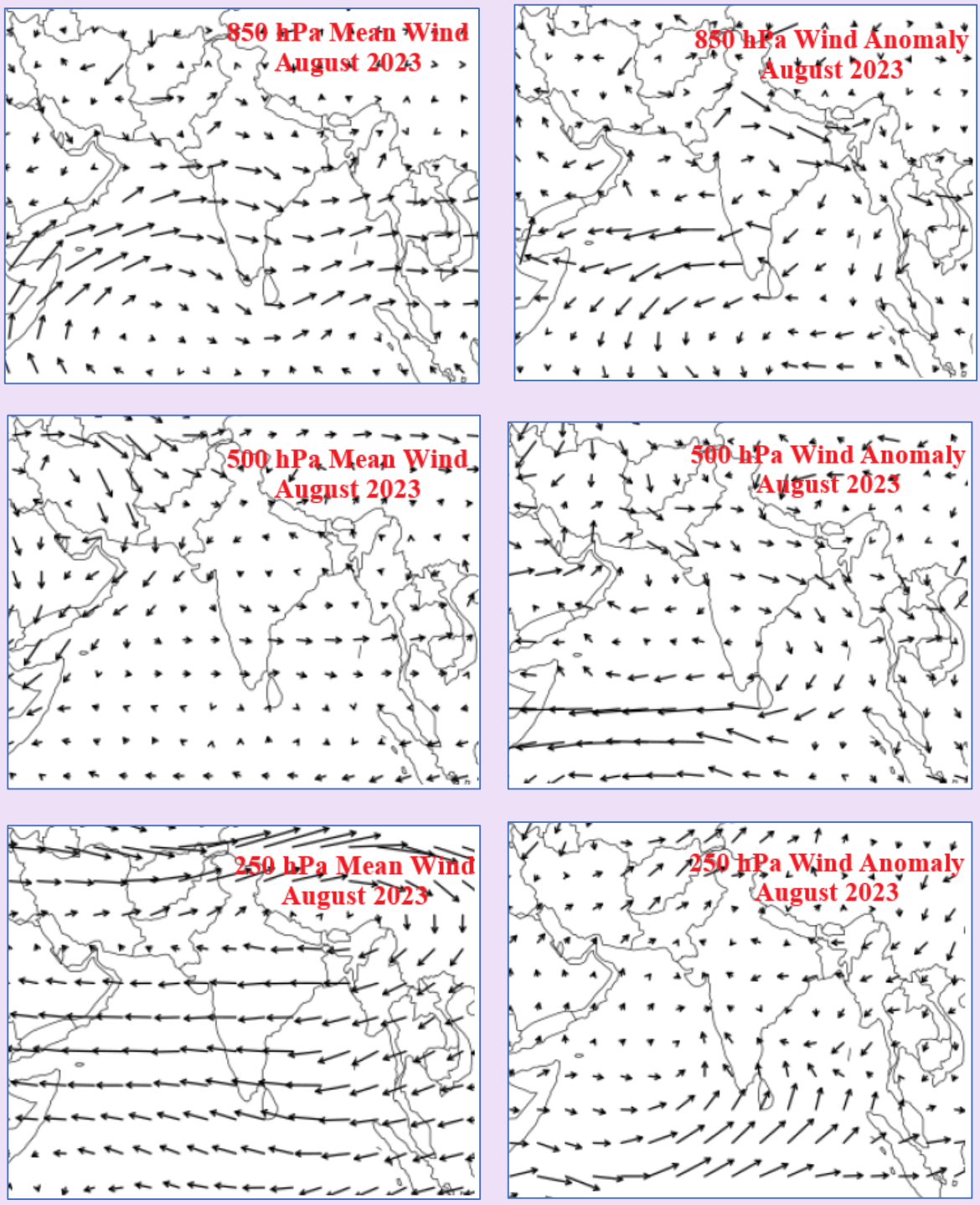


Fig.4.2c: 850hPa, 500hPa & 250hPa wind anomalies over Indian region during Aug 2023
(Source: Climate Diagnostic Bulletin of India, IMD Pune)

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

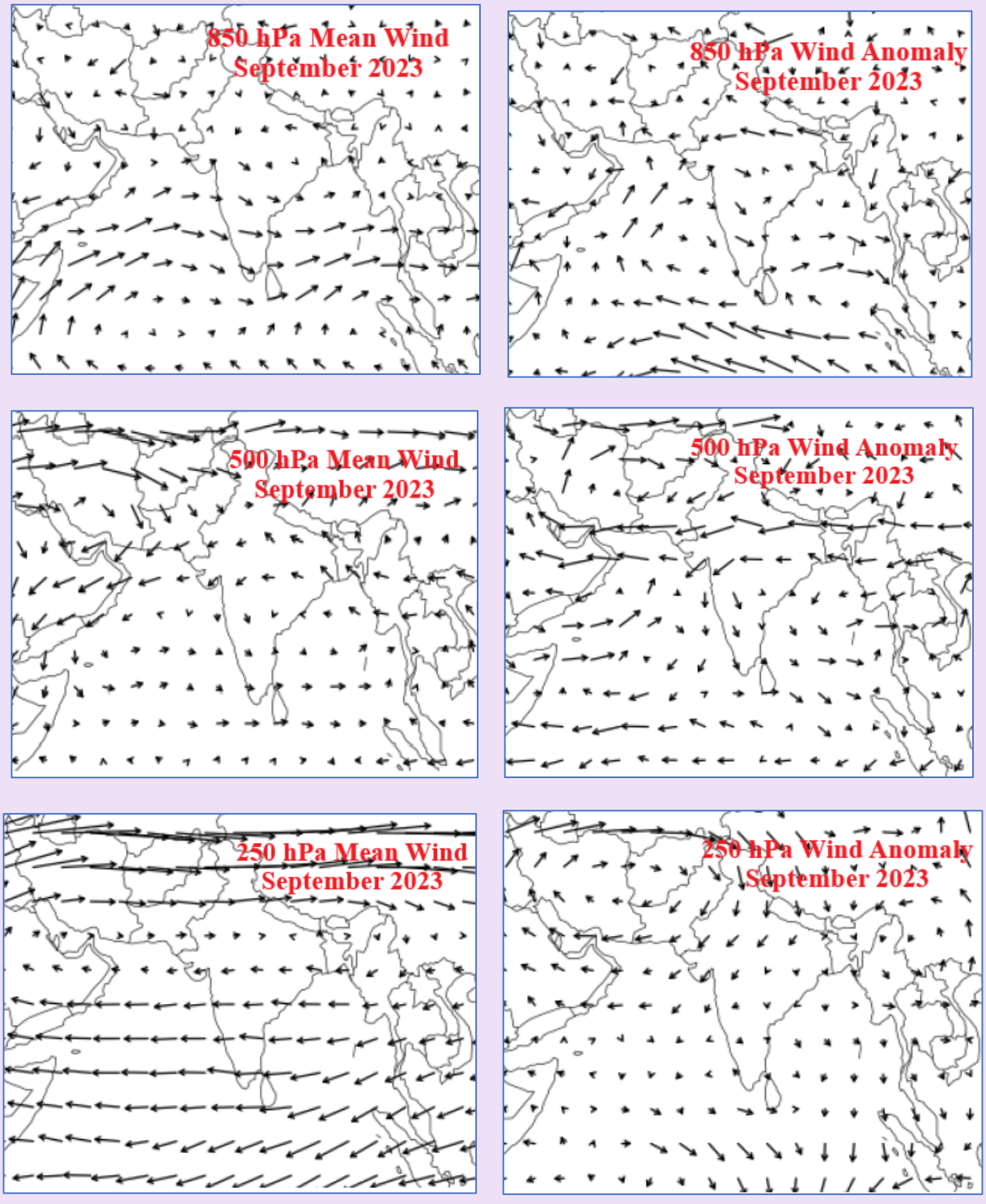


Fig.4.2d: 850hPa, 500hPa & 250hPa wind anomalies over Indian region during Sep 2023
(Source: Climate Diagnostic Bulletin of India, IMD Pune)

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

4.3 Velocity potential and Streamfunction over the Indian region:

Upper tropospheric (250 hPa) velocity potential and lower tropospheric (850 hPa) streamfunction over the Indian region are dipicted in Fig.4.3(a-b). It is seen that upper level divergence over the Indian region was near normal in June, slightly greater than normal during July and September and lesser than normal during August 2023 (Fig.4.3a). Anomalous low level anti cyclonic vorticity was observed over the northern and central Indian region and generally anomalous low level cyclonic vorticity was observed over the Arabian Sea, Bay of Bengal and southern peninsular region in June; generally anomalous cyclonic vorticity was observed over the southern peninsula and the Bay of Bengal and Arabian sea in July and anomalous anti cyclonic vorticity was observed in the lower levels over most parts of the Indian region in August and September 2023 (Fig.4.3b).

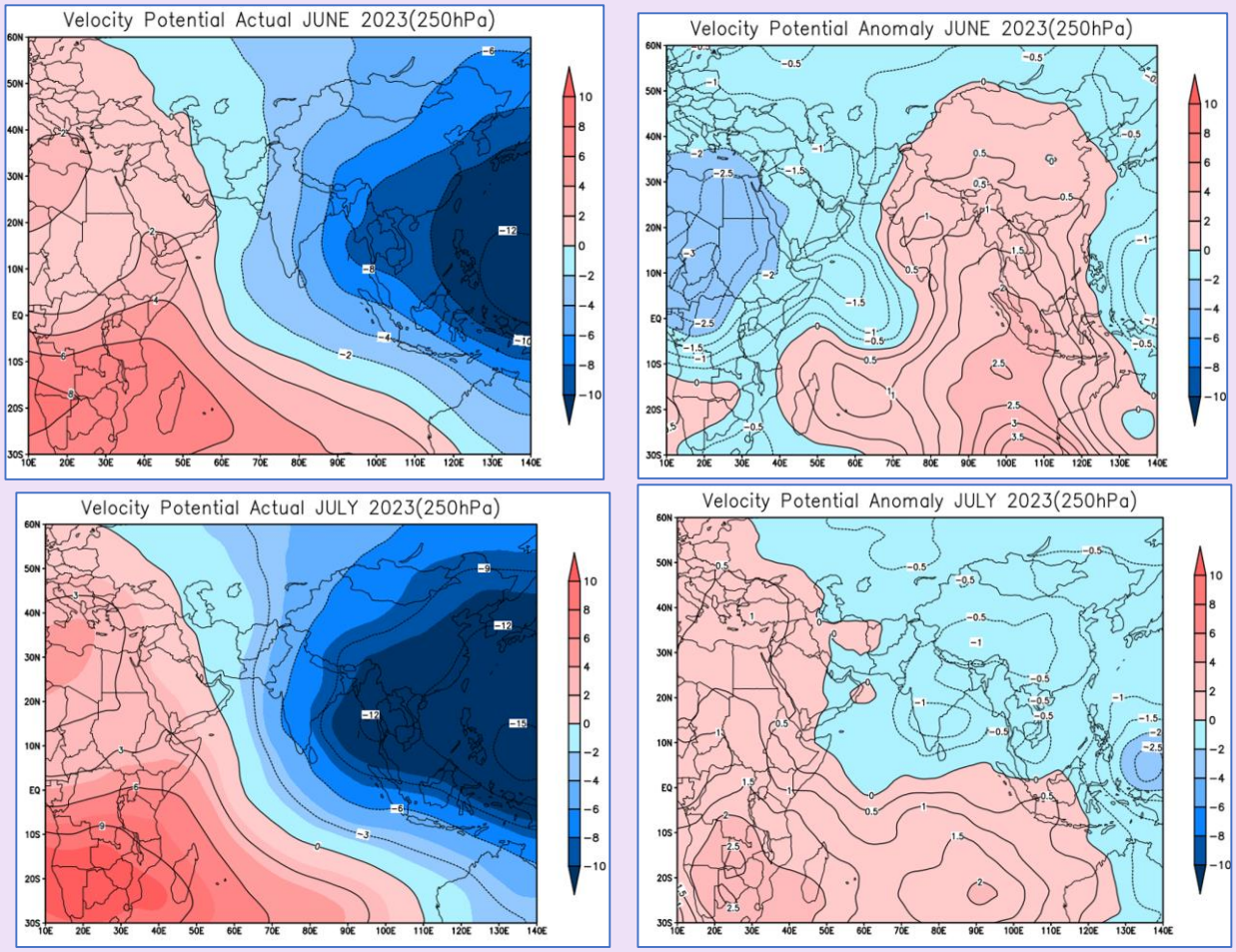
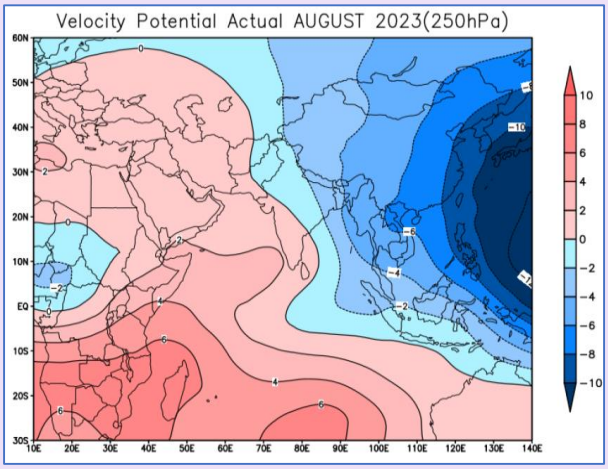
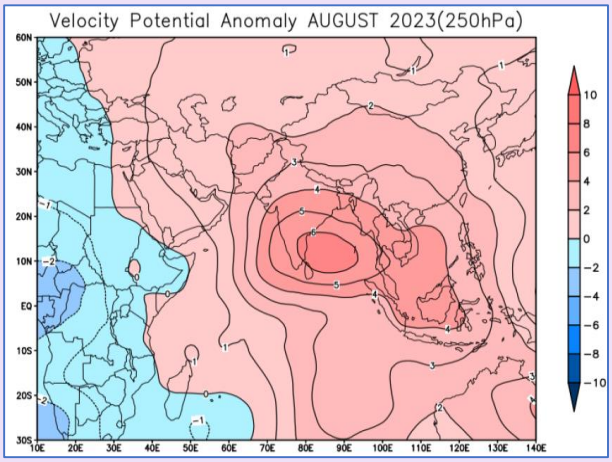
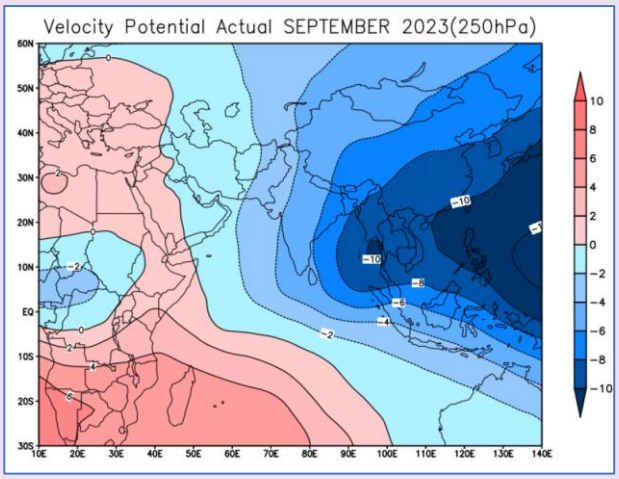


Fig.4.3a: 250 hPa Velocity potential (x 10^6 m^2/s) (actual & anomaly) during Jun, Jul, Aug & Sep 2023
(Source: Climate Diagnostic Bulletin of India, IMD Pune)

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms







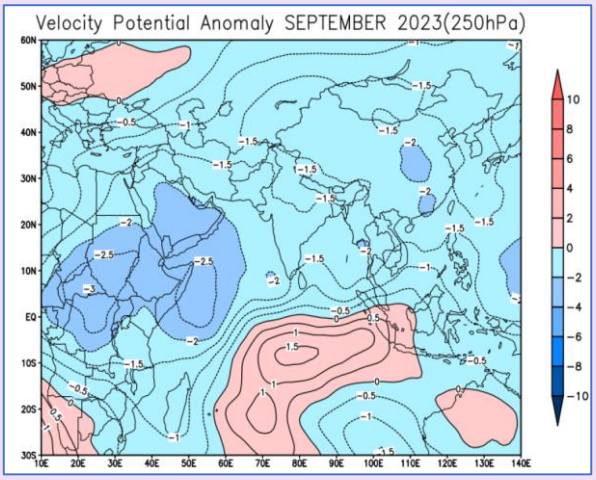
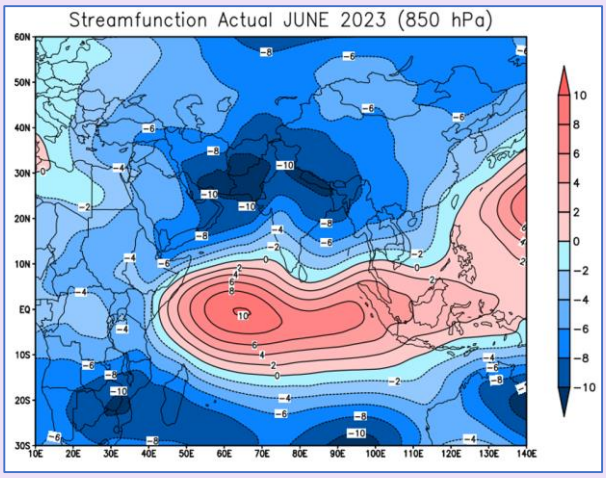


Fig.4.3a: contd.



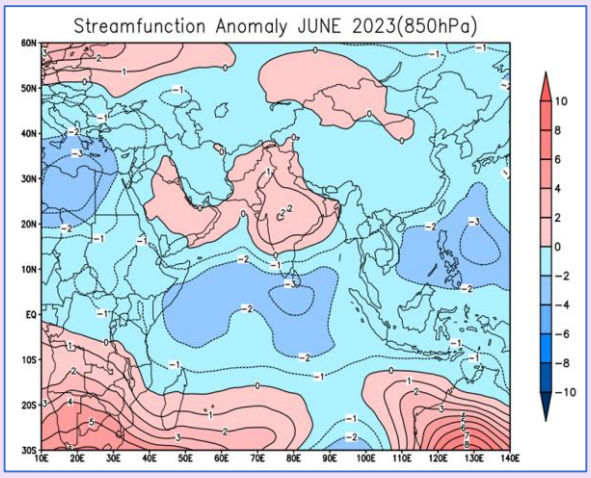


Fig.4.3b: 850 hPa Streamfunction (x 10^6 m^2/s) (actual & anomaly) during Jun, Jul, Aug & Sep 2023
(Source: Climate Diagnostic Bulletin of India, IMD Pune)

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

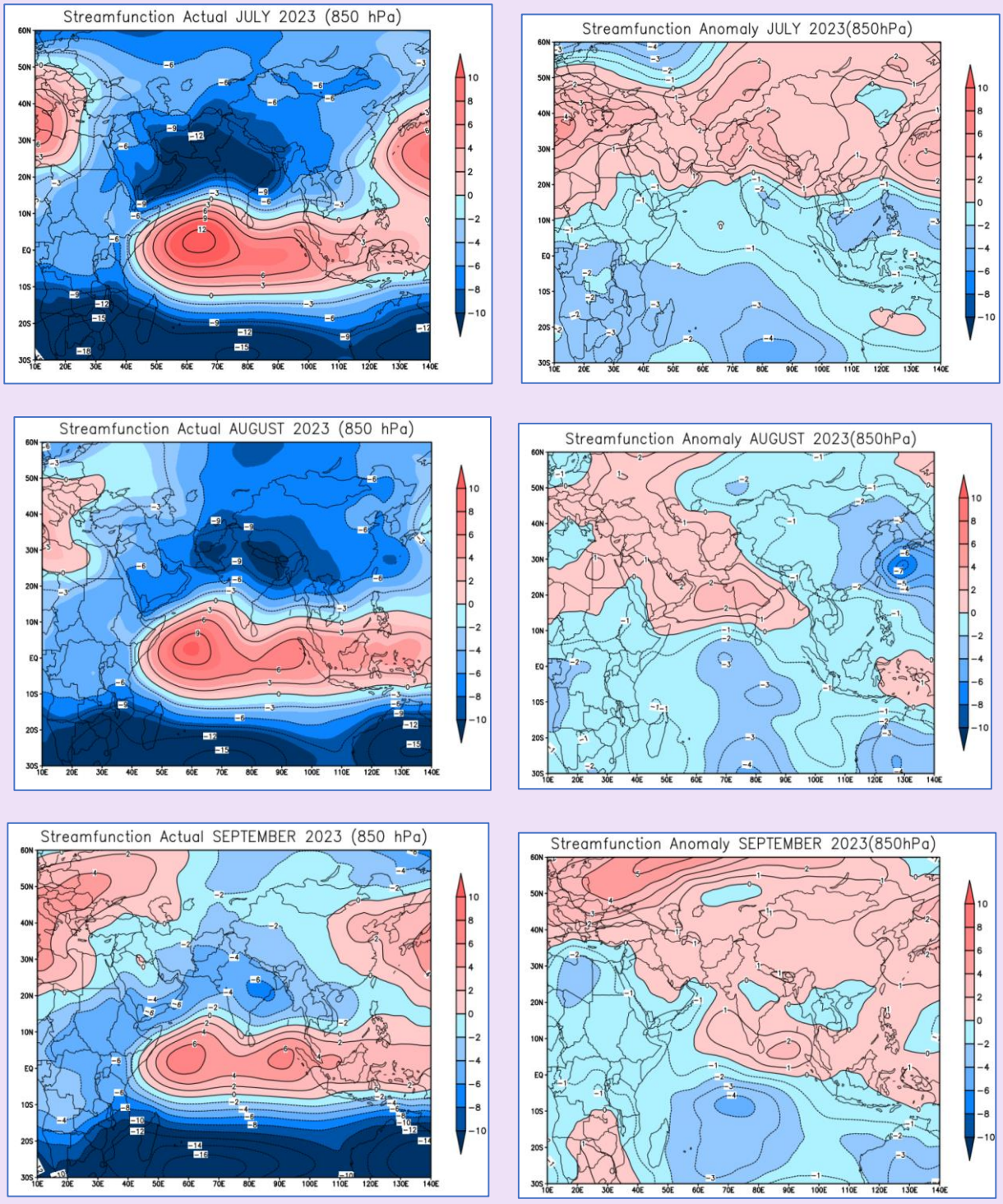


Fig.4.3b: contd

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

4.4 Outgoing Longwave Radiation

The Outgoing Longwave Radiation (OLR) anomalies over the southern peninsular region were generally negative in July and September and positive in June and August 2023 (Fig.4.4).

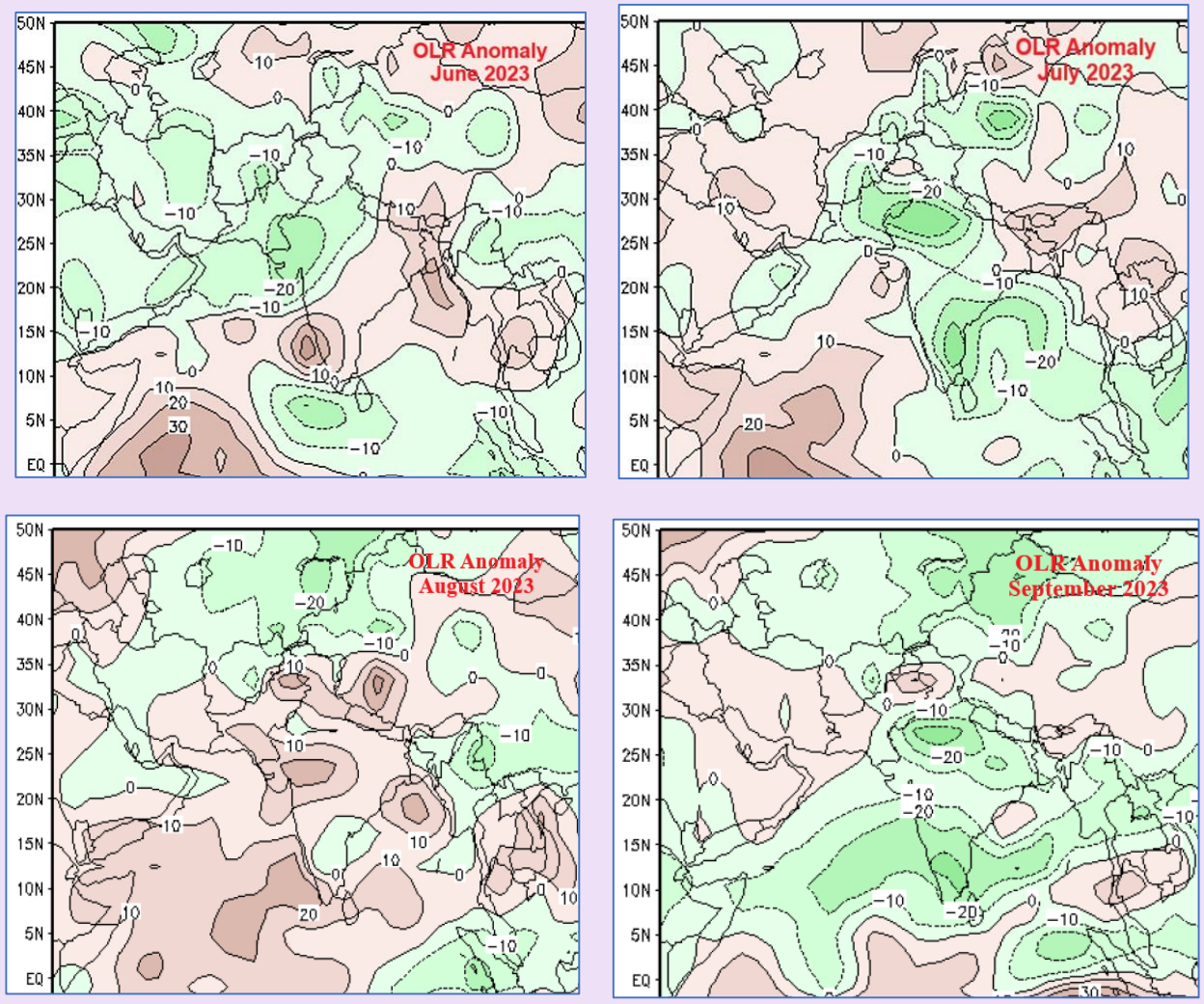


Fig.4.4: OLR anomalies over the Indian region during Jun, Jul, Aug & Sep 2023

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

5. Withdrawal of SWM 2023 from the SP region

The withdrawal of SWM 2023 commenced from the northwest India on 25th September, a delay by about a week (normal date – 17th September). It's withdrawal from the SP region commenced on 09th October. It withdrew from the entire region and hence from the entire country on 16th October 2023. Fig.5 depicts the isolines of dates of withdrawal of SWM 2023 from the SP region.

Fig.5: Isolines of dates of withdrawal of SWM 2023 over the SP region

6. Summary

During 2023, southwest monsoon advanced into Southeast Bay of Bengal, South Andaman Sea and Nicobar Islands on 19th May. It set in over Kerala on 08th June, 7 days after than the normal date of 1st June and covered the entire southern peninsular India (comprising of the five states of Andhra Pradesh, Telangana, Karnataka, Kerala and Tamil Nadu and two union territories of Puducherry and Lakshadweep) by 24th June, the normal date being during 11th-15th June. It covered the entire country by 02nd July, six days ahead of its normal date of 08th July. The All India southwest monsoon seasonal rainfall during Jun-Sep, 2023 was *normal*. It was 94% (82 cm) of its Long Period Average of 87.0 cm. South Peninsular region recorded 92% (66 cm) of its LPA of 72 cm. The seasonal rainfall over the nine meteorological subdivisions covering the five states and two union territories in the SP region was *normal* in seven subdivisions [Telangana (TEL) Coastal

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Andhra Pradesh (CAP), Rayalaseema (RYS), Coastal Karnataka (CK), North Interior Karnataka (NIK), Tamil Nadu (TN) & Lakshadweep (LAK)] and *deficient* in the other 2 sub divisions [Kerala (KER) & South Interior Karnataka (SIK)]. The seasonal rainfall figures over the nine subdivisions CAP, RYS, TEL, TN, CK, NIK, SIK, KER, LAK) were -10%, -13%, +15%, +08%, -13%, -11%, -28%, -34%, and -15% respectively. *Fairly widespread* to *widespread* rainfall occurred over CK on about 80% of the days, over KER & LAK on 67% of the days and about 35-38% of the days over TEL, SIK & CAP. There were *isolated heavy* rainfall activities on 55 days over TN, 50 days over KER, 46 days over CK & TEL, 40 days over CAP, 26 days over SIK, 24 days over NIK, 21 days over RYS & 3 days over LAK area during the season. Highest 24-hr rainfall recorded during the season in the SP region was over Chityal (J.Bhupalpally district, Telangana)- 62 cm on 27th July. The withdrawal of SWM 2023 from the SP region commenced on 09th October. It withdrew from the entire region & hence the entire country on 16th October 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, Hyderabad, Bangalore, Amaravati and Thiruvananthapuram as well as raingauge networks of various state governments. Contribution from all officials involved in generation of data and analytical products used for preparation of this report is duly acknowledged. Use of data and products of national meteorological agencies of the US and Australia are also duly acknowledged.

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

APPENDIX-(i): Terminologies for Spatial rainfall distribution

Terminology	description
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 (a few places)	26% to 50% number of stations of a region (sub-division) reporting at least 2.5 mm rainfall.
ISOL- Isolated (one or two 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

Sl 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	Up to 1	Up to 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 than 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 Monsoon activity

Active (ACT)	Active monsoon conditions (FWS to WS rainfall over the subdivision with rainfall amount 1½ to 4 times the normal and at least 2 stations reporting 5cm or more along the west coast or 3cm or more elsewhere)
Vigorous (VIG)	Vigorous monsoon conditions (FWS to WS rainfall over the subdivision with rainfall amount more than 4 times the normal and at least 2 stations reporting 8cm or more along the west coast or 5cm or more elsewhere).

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms

Appendix-(iv) Monsoon performance

Terminology	Description
Large Excess	Percentage departure from normal: ≥ +60%
Excess	Percentage departure from normal: +20% to +59%
Normal	Percentage departure from normal: -19% to +19%
Deficient	Percentage departure from normal: -20% to -59%
Largely deficient	Percentage departure from normal: ≤ -60%

Kindly refer Appendix-(i)-(iv) in pages 66-67 for description of technical terms