

UNPRECEDENTED HEAVY RAIN IN PARTS OF ANDHRA AND MAHARASHTRA DURING 23 TO 25 JULY 1989—SYNOPTIC STUDY

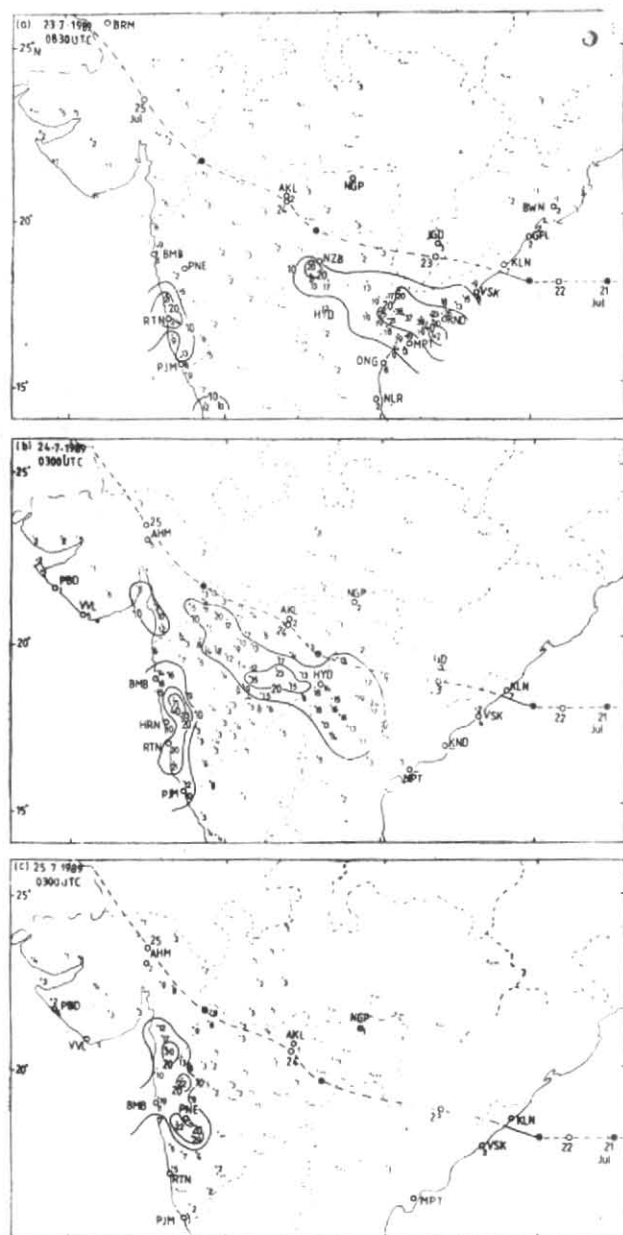
Monsoon depressions generally form over the eastern end of the monsoon trough over north Bay of Bengal and move along the axis of the monsoon trough. Due to the formation of monsoon depression the monsoon trough becomes more active. Monsoon trough is a most important synoptic manifestation which forms in the monsoon season. The intensity, position and tilt of the monsoon trough with height causes and controls the entire monsoon rainfall distribution over India. When a monsoon depression is embedded over the axis of the monsoon trough there is further enhancement of rainfall activity, particularly over the southwest sector of the monsoon depression. In addition heavy rainfall is generally confined to the area between the axis of the monsoon trough on the sea level and at 700 hPa level (Desai 1987). Strong low level shear

to the south of the axis of the monsoon trough in association with moisture convergence enhances the associated rainfall distribution.

The cyclonic storm between 23 and 25 July had many interesting characteristic features which gave heavy rainfall causing floods, over parts of Maharashtra and Andhra Pradesh. A detailed synoptic study of the system is presented here.

2. *Data used*—Daily weather charts of Weather Central, Pune and *Weekly Weather Reports* and *Indian Daily Weather Reports* published by India Met. Dept. have been consulted for this study.

3. *Rainfall*—Intensity and spatial distribution of rainfall over Andhra Pradesh and Maharashtra during 23 to 25 July 1989 in association with the cyclonic storm is discussed here. Figs. 1 (a-c) show the rainfall (cm) in 24-hr ending at 0830 IST of 23, 24 and 25 July 1989. The track of the cyclonic storm and the isohyetal analysis of rainfall are also shown in these figures. Heavy rainfall of the order of 10 cm or more occurred south of

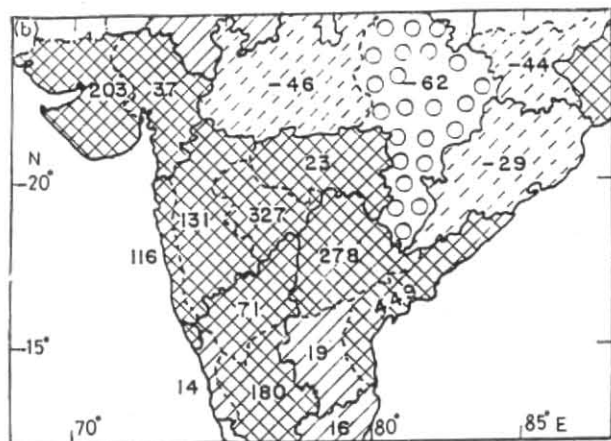
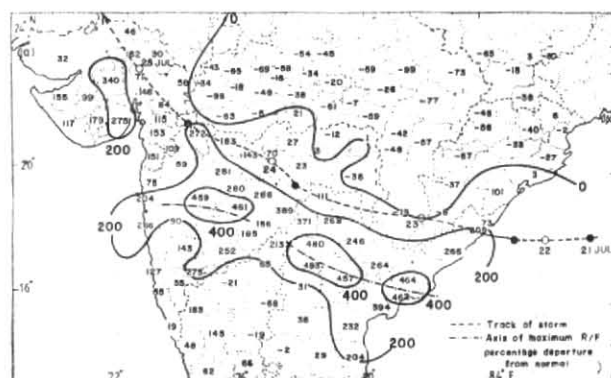


Figs. 1 (a-c). Rainfall recorded at 03 UTC on : (a) 23rd, (b) 24th, and (c) 25th July 1989

the track and a belt of heaviest rainfall moved west-northwestwards from the central parts of coastal Andhra Pradesh to Telangana and Marathwada from 23rd to 24th. Further, the heavy rainfall belt over south Konkan moved northwards and was over north Konkan, Madhya Maharashtra and adjoining Gujarat region. On 25th, heavy rainfall belt was only over Madhya Maharashtra, north Konkan and adjoining Gujarat region.

The significant amounts of rainfall (more than 20 cm) are :

Koderu 42, Nidadavole 39, Tiruvur 38, Chintalapudi 37, Kakinada 30, Peddapuram 26, Rajahmundry 23 (all in coastal Andhra Pradesh), Khammam 25, Parkal 24, Banswada, Koida & Kothagudam 20 each (all in Telangana), Ratnagiri and Dhule 24 each, Harnai 21 (all in Maharashtra) on 23rd, Bhira 71, Beed 35, Parbhani 23, Dhule, Billoli and Ratnagiri 20 on 24th, Chikali 42, Igatpuri and Bhira 22 on 25th.



Figs. 2 (a & b). Districtwise rainfall (percentage departure from normal) for the week 20-26 July 1989

Fig. 2(a) shows percentage departure of rainfall from normal (districtwise) for the week 20 to 26 July 1989. More than 200% rainfall departures from normal are observed to the south of the track over Andhra Pradesh and parts of Maharashtra State. The axis of the maximum percentage departures roughly runs from south coastal Andhra Pradesh, south Telangana to Marathwada.

Fig. 2(b) shows the rainfall percentage departure from normal for the week 20 to 26 July 1989, meteorological sub-divisionwise. It is seen that coastal Andhra Pradesh, Telangana and Marathwada had the positive percentage departure from normal as 449, 278 and 377 respectively. Further, Andhra Pradesh, Karnataka, Maharashtra and Gujarat received excess rainfall, which are in the southern parts of the track of the system. Orissa and Madhya Pradesh which are on the northern parts of the track received scanty or deficient rainfall.

4. *Synoptic features of the system* — The system appeared initially as a low level circulation and subsequently descended down and concentrated into a depression in the evening of 21 July over west central and adjoining northwest Bay of Bengal. Moving initially in a westerly direction, it intensified into a cyclonic storm on 22nd evening. It crossed Andhra—south Orissa coast near Kalingapatnam on 22nd night. Moving in a westnorth-westerly direction it weakened into a deep depression and was centred on 28th morning near Jagdalpur (19.1°N, 82.0°E). Further moving in a westnorth-westerly direction, across south Madhya Pradesh, Vidarbha and Gujarat, it dissipated over south Pakistan by the evening of 25th. The track of the system is shown in Figs. 1 (a-c). Following are the characteristic features of the system :

4.1. *Pressure change and departure fields* — Maximum pressure change was about 10 hPa on 23 July and maximum departure was 12 to 14 hPa on 23 and 24th. The horizontal extension of the system was about 12 to 15 degree latitude which covered entire Peninsular India particularly on 23rd.

4.2. *Wind field* — The system extended up to 300 hPa level and had little tilt up to 500 hPa with height. Low level winds (both easterlies and westerlies) up to 3.1 km were very strong and of the order of 45 to 50 kt. Maximum moisture convergence was in association with strong low level westerlies to the south of the centre of the system. Figs. 3(a&b) show the wind field at 0.9, 1.5 and 200 hPa level for 22 and 23 July.

Tibetan anticyclone in the mid and upper troposphere was very strong and south of the normal position. Because of the position and intensity of Tibetan anticyclone the system moved in a more westerly direction and retained its intensity as a deep depression even over land area for more than 60 hours.

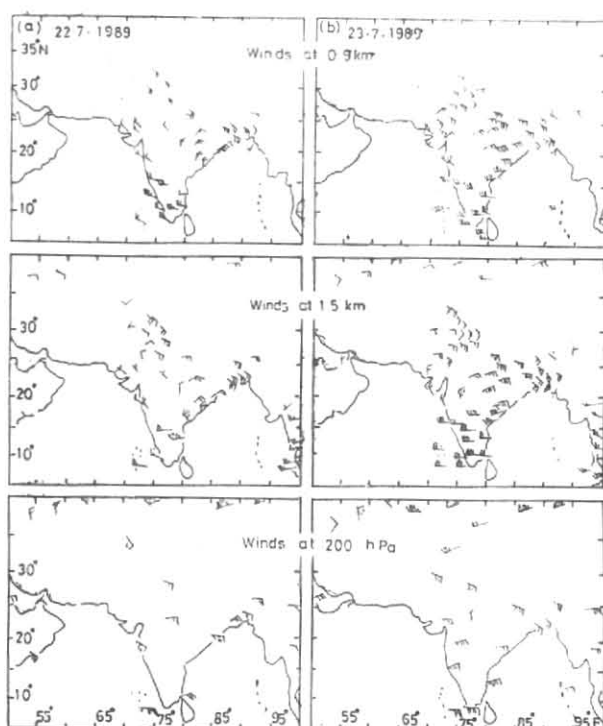
4.3. *Track of the system* — The system moved along a more southerly track [Figs. 1 (a-c)] and was much south of the normal track.

This is a southernmost track traversed by any monsoon depression so far on record.

Movement of the system was rather slow overland particularly after landfall over central parts of Peninsular India. During 15-hour period from the evening of 23rd to the morning of 24th, the deep depression moved just 150 km with the speed of 10 kmph.

5. *Conclusions* — The unprecedented heavy rainfall over Andhra Pradesh and Maharashtra State in association with the cyclonic storm from 22 to 26 July 1989 is due to :

(i) Formation of the cyclonic storm in a southerly latitude and its movement in a westerly direction very much south of the normal track across Peninsular India.



Figs. 3 (a & b). Winds at 0.9 km, 1.5 km & 200 hPa at 00 UTC on : (a) 22, and (b) 23 July 1989

(ii) Because of intense Tibetan anticyclone and its south of the normal position the system remained deep depression even overland for a long period. The system also moved along the southern periphery of the Tibetan anticyclone in a more westerly direction.

(iii) Movement of the system particularly from 23rd evening to 24th morning was rather slow.

(iv) As the system did not have any tilt up to 600 hPa in the vertical, westerly winds in the lower levels were strong to the south of the system contributing strong incursion of moisture from the Arabian Sea into the Peninsular India.

References

- Desai, D.S., 1987, "Field of vorticity, divergence and vertical velocity associated with break and strong monsoon 1987", *Mausam*, 38, 4, pp. 419-424.
- Rao, Y.P., "Southwest Monsoon", India Meteorological Department, Met. Monogr. Synoptic Met. No. 1/1976.

N. B. THADE
V. R. MISHRA
D. S. DESAI

Meteorological Office, Pune
26 March 1991