551.509.33(545.8)

HEAVY RAINFALL FORECAST OVER LUCKNOW IN SOUTHWEST MONSOON

1. The precipitable water content over India (up to 200 hPa) based on the radiosonde data of 12 stations for the period 1956 to 1964 show considerable seasonal and spatial variation in the atmosphere over India (Ananthakrishnan *et al.* 1965). The maximum value of about 7 gm cm^{-2} occurs over northeast India in the peak summer monsoon months of July and August. The lower rainfall area of northwest India also have high values of 5 to 6 gm cm^{-2}. Thus, the precipitable water content alone is not an index of rainfall activity. Synoptic and meso-scale disturbances leading to low level convergence and vertical motion in humid air are required for precipitation to occur.

Rao and Sharma (1950) have studied the utility of precipitation index (PI) for local weather forecasting. This index was used to forecast rainy day at Madras was calculated using 14 UTC radiosonde ascents.

Schell (1946) defined PI ($=\Sigma W/L$) taking into account the amount of vapour and the ascent required to saturate the air. Here W is the mixing ratio for standard level and L is the pressure fall in centibars during ascent from standard level to the saturation level. Layers up to 600 hPa are taken for the computation of PI utilizing the data of morning and evening radiosonde ascents for southwest monsoon season.

2. In this study 0000 and 1200 UTC radiosonde ascent of Lucknow during the southwest monsoon (1985 to 1988) have been utilized and PI values for morning and evening radiosonde ascents are calculated. Also rainfall dates for the period are collected.

From the computed PI values based on 1200 UTC, it was found that there were 8 values of the order of 6 to 10 during monsoon season (1985-1988). In most of the heavy rainfall cases, the PI value was higher than 4.

The curve showing rainfall *versus* PI for 1985 indicates that when PI value is less than 4, heavy rainfall does not occur (Fig. 1). If the PI value exceeds the limit 4, the chances of heavy rainfall occurrence become more. The curves for the years 1986, 1987 and 1988 also show the same tendency of heavy rainfall. When the PI value is between 0 & 1, the number of occasions of no rain is 70.4% (Table 1). As the PI increases, the percentage occasions of no rain decreases.

TABLE 1

Precipitation index for southwest monsoon season (1985-88) at 1200 UTC

Precipitation Index	Total No. of occasions	No rain	Trace (<2.4 mm)	Light rain (2.5-20.0 mm)	Moderate rain (20.1-34.9 mm)	Heavy rain (35.0-64.9 mm)	Heavy to very heavy rain (65.0 and above)	Rainfall occasions (%)
0.0-1.0	115	81 (70.4%)	26 (22.6%)	8 (7.0%)	—	—	—	29.6
1.1-2.0	61	32 (52.4%)	16 (26.2%)	12 (19.6%)	1 (1.8%)	—	—	47.6
2.1-3.0	84	17 (20.2%)	22 (26.2%)	35 (41.7%)	8 (9.5%)	2 (2.4%)	—	79.8
3.1-4.0	30	4 (13.3%)	8 (26.8%)	6 (20.9%)	7 (23.3%)	4 (13.3%)	1 (3.3%)	86.6
4.1-5.0	5	—	—	—	—	2 (40.0%)	3 (60.0%)	100
5.1-6.0	1	—	—	—	—	—	1 (100%)	100
6.1-7.0	1	—	—	—	—	—	1 (100%)	100
7.1 & above	9	—	—	—	1 (11.0%)	1 (11.0%)	7 (78.0%)	100

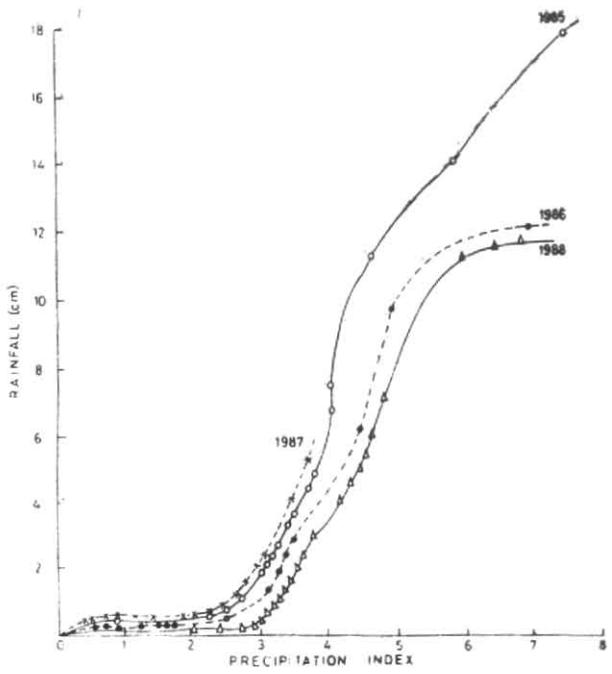

Fig. 1. Profile of rainfall activity in southwest monsoon (1985-1988) for Lucknow at 12 UTC

TABLE 2

Precipitation index for exceptional heavy rainfall in SW monsoon season (1985-1988) for Lucknow

Date	R/F (mm)	PI (0000 UTC)	PI (1200 UTC)
13 Sep 1985	177.1	3.5	7.6
14 Sep 1985	113.8	2.8	44.6
23 Sep 1985	139.2	2.9	5.9
9 Jul 1986	1121.3	3.3	7.0
14 Jul 1988	115.2	3.1	7.0
10 Aug 1988	1116.8	3.1	66.9
13 Aug 1988	112.8	3.0	5.7

TABLE 3

Date	Synoptic situation	PI (1200 UTC)	R/F (mm)
13 Sep '85	Well marked low pressure area lay over south Orissa & adjoining southeast M.P. on 12th	7.6	177.1
14 Sep '85	A low pressure area lay over north M.P. & U.P. with cyclonic circulation upto mid-tropospheric levels on 13th & over central U.P. on 14th	4.6	113.8
23 Sep '85	A well marked low pressure area lay over west M.P. & U.P. on 22nd and concentrated into a depression on 23rd	5.9	139.2
9 Jul '86	A low pressure area lay over east U.P. & northeast M.P. with cyclonic circulation upto 7.6 km a.s.l. on 8th. Another cyclonic circulation over north Pakistan and Punjab up to 1.5 km a.s.l.	7.0	121.3
14 Jul '88	A cyclonic circulation in the lower tropospheric levels lay over Bihar & adjoining U.P. on 13th. Another cyclonic circulation lay over northwest M.P. and neighbourhood on 13th & persisted on 14th	7.0	115.2
10 Aug '88	A cyclonic circulation extending upto mid-tropospheric levels lay over north M.P. & plains of U.P. on 9th and become unimportant 10th	6.9	116.8
13 Aug '88	A low pressure area lay over north Orissa and Bihar plateau on 12th & moved further across north M.P. & south U.P. on 13th	5.7	112.8

For PI between 3.1&4.0, the percentage occasions of no rain is only 13.3% and for higher PI values it is 00. When the PI$\geq$4.1 the chances of rain was 100%. On 40% occasions rather heavy rainfall occurred when PI range was 4.1 to 5.0 and on 78% occasions heavy to very rainfall occurred with PI value above 7.

From Tables 2 & 3 it is seen that there are 7 occasions of exceptional heavy rainfall and on each occasions the synoptic situation is favourable and 1200 UTC PI has increased to nearly double its value at 0000 UTC. For heavy rain to occur next day PI should show high values at 0000 UTC and should continue to show (even) higher value at 1200 UTC, *i.e.*, the value of PI should be sustained. On certain days it showed a higher value 4 or more in the morning but decreased in the evening. On such occasions heavy rainfall generally did not occur next day.

3. Heavy rain can be forecast when the precipitation index is 4 or more in the evening ascent. However, would be advantageous to use this index in conjuction with the synoptic situation. If the synoptic situation is clearly defined, then on the basis of PI value of 4 and above, heavy rainfall could be forecasted.

References

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