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ON PREDICTING THE DATES OF WITHDRAWAL OF SOUTHWEST MONSOON FROM NORTHWEST INDIA

1. There have been many studies on the onset of the southwest monsoon. The withdrawal aspects have received comparatively little attention. The withdrawal may be considered as a reversal of the onset process (Koteswaram and Bhaskara Rao 1963). During the withdrawal phase, in the Indian region, there is a gradual change-over from the circulation pattern of the southwest monsoon season. The monsoon air is progressively displaced from the Indian region by continental airmass. The mid-latitude westerly jet of the winter regime which was displaced to the north at the onset of the monsoon season commences returning to the Indian region. Anticyclonic circulation develops over the north and central India.

The first major withdrawal from the Indian region begins to take place in the first fortnight of September. If the withdrawal dates from the various sub-divisions in the past 30 years are seen, it will be clear that there are marked variations in the withdrawals over a sub-division or a region from year to year.

2. *Objective criterion for fixing the dates of withdrawal*—The present study is confined to the area to the left of the first major normal withdrawal line, i.e., 15 September, line and the neighbouring areas to the right of the line. The data for the years 1956-1977 were utilised. In order to fix the dates of withdrawal during these past years objectively, time sections of winds from 3 August to the end of September and in some cases to the first fortnight of October (middle dates of five day running averages) have been constructed for each of the years 1956-1977 for 300 mb for Jodhpur and New Delhi. Day-to-day spatial distribution of rainfall for the sub-divisions of west Rajasthan and Haryana were noted above the respective winds for each day. For each week, the ratios of rainfall for the week to the normals for the two sub-divisions and also for east Rajasthan as given in the *Monsoon Rainfall Summaries* were plotted to give an idea of the intensity distribution. Similar time section of winds for Srinagar was also prepared. From these data and also with reference to the daily working charts, a date was selected for each year which could be taken as the date of withdrawal of the monsoon from the area to the left of the 15 September normal withdrawal line. These dates were selected by taking into consideration the cessation of rainfall, general absence of hydrometeors and change in circulation pattern as noticed by the appearance and persistence of moderate westerlies over this area. In many years, there is not

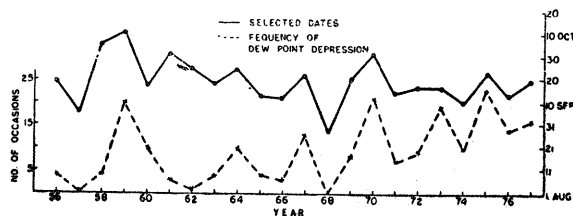


Fig. 1. Jodhpur — 850 mb frequency of dew point depression below 3°C and selected dates of withdrawal

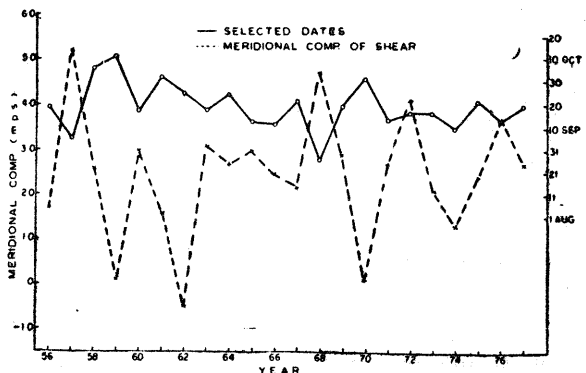


Fig. 2. Jodhpur, 300-700 mb mean August meridional component of wind shear and selected dates of withdrawal

much difference between the selected dates and the official dates (Weather Central, Pune) for west Rajasthan and adjoining areas.

3. *Choice of parameters*—Out of the many parameters tried, only three (their mean values for August) could indicate some predictive trends for forecasting the withdrawal dates. These were: (i) dew point depression at 850 mb over Jodhpur, (ii) wind shear between 300 and 700 mb over Jodhpur, and (iii) wind shear between 300 and 700 mb over New Delhi.

4. *Dew point depression at 850 mb*—The dew point depression at 850 mb over Jodhpur is a measure of the availability of moisture in the lower troposphere over the region to the left of the 15 September normal withdrawal line. Five day running means of dew point depression (dry bulb temperature minus dew point temperature) at 850 mb over Jodhpur for August for each day were calculated for the years 1956-1977. Their frequencies in different ranges such as 0-1, 1-2, 2-3, etc were worked out. Fig. 1 shows a plotting of the frequencies of 3 deg. C or less for each of the year for August with the respective selected days of withdrawal.

5. *Mean monthly shear between 300 & 700 mb*—The circulation pattern changes with the march of the season. With the retreat of the monsoon, the warm ridge is pushed southwards. Some indication of the shift of the ridge can be had from the mean monthly shear between 300

and 700 mb for Jodhpur for August. Fig. 2 shows the mean monthly shear (meridional components) for August for Jodhpur for the years 1956-1977 and the selected days of withdrawal.

6. *Multiple regression equation with two and three parameters* — These selected dates of withdrawal were correlated with (i) frequency of dew point depressions of 3 deg. C or less at 850 mb for August for Jodhpur and (ii) values of meridional components of mean August wind shear for Jodhpur between 300 and 700 mb for the period 1956-1974. Both the correlation coefficients were found to be significant (95 per cent) level. A multiple regression equation giving the best fit was evolved using these two parameters. The multiple correlation coefficient in this case was 0.7. However, it was seen that if the data of two extreme years 1958 and 1974 (wherein there was a large difference between the input and calculated dates) were removed and instead the data for the years 1975 and 1976 were added and a third parameter, the zonal component of mean August wind shear for New Delhi between 300 and 700 mb was introduced, the regression equation could be refined further and the multiple correlation coefficient could also be increased to 0.86.

The following are the two Eqns. (1) & (2) using the above two and three parameters respectively :

$$\bar{Y} = 57.992 + 0.342 X_1 - 4.284 X_2 \quad (1)$$

$$\bar{Y} = 56.184 + 0.419 X_1 - 3.956 X_2 - 1.479 X_3 \quad (2)$$

where, \bar{Y} = Estimated date of withdrawal from the region to the left of the 15 September normal withdrawal line.

X_1 = frequency of dew point depression of 3°C or less at 850 mb for August over Jodhpur.

X_2 = meridional component of mean August wind shear between 300 and 700 mb over Jodhpur.

X_3 = zonal component of mean August wind shear between 300 and 700 mb over New Delhi.

Table 1 gives the calculated and the actual dates (Weather Central, Pune) of withdrawal using the two Eqns. (1) & (2) with two and three parameters respectively.

TABLE 1
Calculated and actual dates of withdrawal (with two and three parameters)

Year	Calculated dates	Actual dates			
		West Rajasthan	East Rajasthan	Punjab	Haryana
With 2-parameters					
75	24.9	23.9	25.9	24.9	25.9
76	16.9	19.9	20.9	19.9	20.9
77	21.9	23.9	25.9	23.9	26.9
78	26.9	11.9	26.9	26.9	26.9
79	20.9	16.9	21.9	21.9	21.9
With 3-parameters					
77	22.9	23.9	25.9	23.9	26.9
78	25.9	11.9	26.9	26.9	26.9
79	20.9	16.9	21.9	21.9	21.9

It may be seen that the predicted dates compare favourably with the actual dates of withdrawal from the area to the left of the normal 15 September withdrawal line in both the cases. This area can be taken as comprising mostly of west Rajasthan, parts of east Rajasthan, Punjab and Haryana.

7. *Withdrawal from northwest India* — It is noticed from the published withdrawal dates for west Rajasthan and the other sub-divisions of northwest India, e.g., Haryana, that the withdrawal at the other sub-divisions occurs simultaneously or within 4 or 5 days from the date of withdrawal from west Rajasthan. Hence, it can be concluded that the withdrawal from the whole of northwest India can be expected to take place either simultaneously or within a week of the predicted dates for 15 September normal withdrawal line.

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Reference

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