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INDIAN DROUGHTS-QUASI BIENNIAL OSCILLATIONS OF STRATOSPHERIC WINDS

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ABSTRACT

In his earlier paper (Ranjit Singh, 1986), the author has shown that between 1964 and 1975, there had been five occurrences of drought in India. They have coincided on four occasions with the easterly phase of the quasi biennial oscillation (QBO) of the lower stratospheric winds over Gan Island (0°41'S, 73°09'E), an equatorial station in the Indian longitudes. It was also shown, that, the westerly and easterly phases of the stratospheric winds modify the tropospheric circulation features, and therefore, form the best parameter for forecasting as well as monitoring the performance of the SW monsoon rainfall over India.

The Gan I station has stopped taking upper air observations from 1975. Time sections of Singapore and Nairobi were prepared for winds at 50 hPa and 30 hPa for the years 1975 to March 1987. It was seen that the longitudinal differences in phase of the equatorial circulation are small enough and we may use the stratospheric wind data of Singapore (1°22'N, 103°55'E) to forecast and monitor the behaviour of SW monsoon over India. It was found that droughts occurred in 1979, 1982, 1985, 1986 and 1987 and on four occasions they coincided with the easterly phase of the stratospheric winds over Singapore.

1. Introduction

The author has shown earlier that the setting in and/or strengthening of the westerly phase of quasi-biennial oscillation of the stratospheric winds over Gan I (00°41'S, 73°09'E) an equatorial station in Indian longitudes can be used for forecasting a good monsoon rainfall over India. Below normal rainfall or droughts occur in India mainly with the setting in and/or strengthening of the easterly phase of this QBO. It was further shown, that the westerly phase of the lower stratospheric winds over Gan I strengthen the Tropical Easterly Jet (TEJ) and monsoon westerlies and the reverse process takes place during the easterly phase. The phases of stratospheric winds therefore, have a linkage with the tropospheric circulation features and they can be used for forecasting as well as monitoring the performance of monsoon. The Gan I station has however, stopped taking upper air observations from 1975. Since QBO is a climatological scale feature of the equatorial circulation,

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SINGAPORE

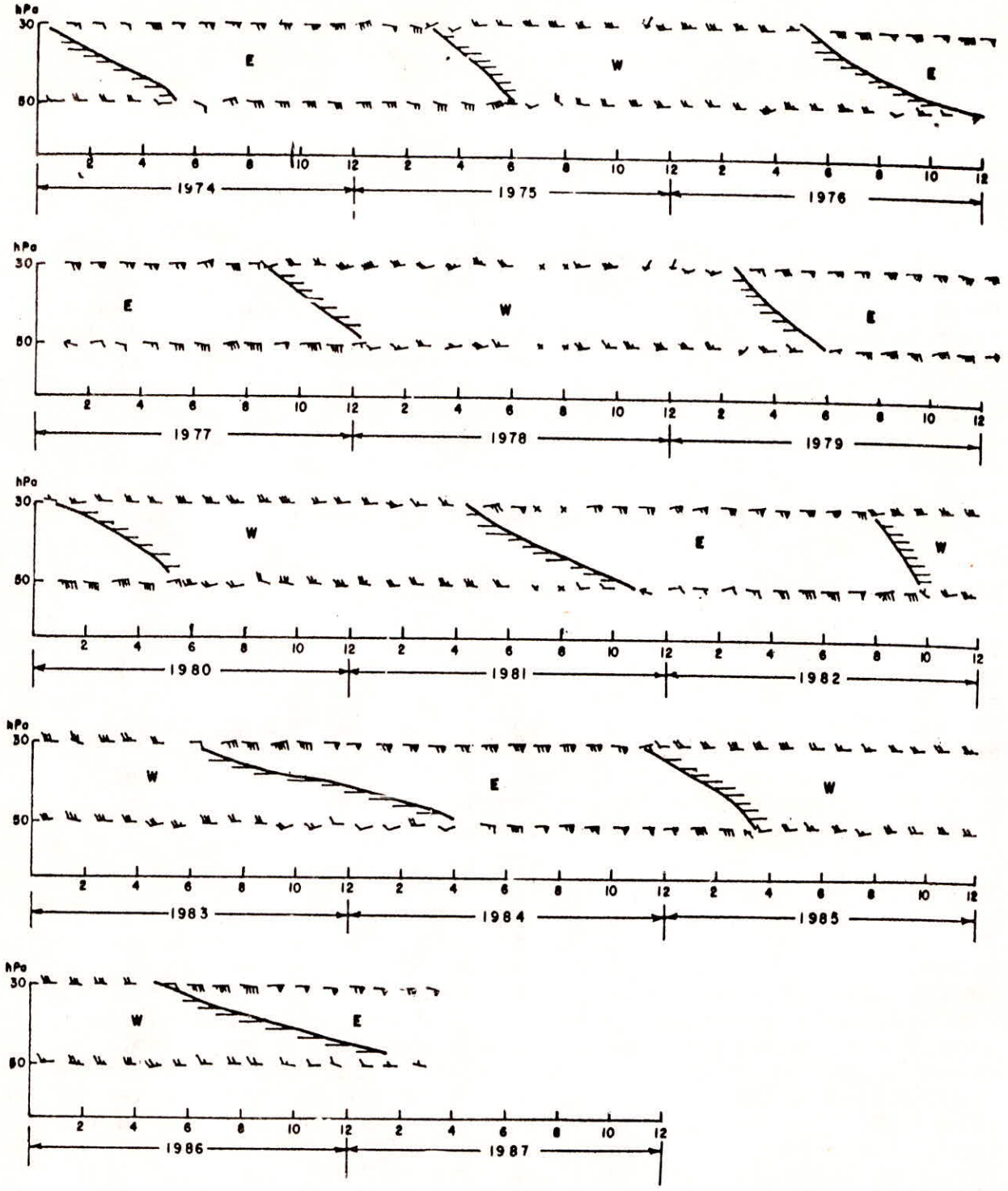

FIG.— 1. MONTHLY MEAN WINDS (ms^{-1})

TABLE - 1

Performance of the SW monsoon and Stratospheric winds over Singapore

	1976	77	78	79	80	81	82	83	84	85	86	87
i) Divisions with deficit rainfall	0	2	1	14	2	7	11	3	7	13	14	22
ii) Divisions with surplus rainfall	6	6	11	2	4	5	0	12	4	1	0	2
iii) Area weighted rainfall for the whole country (cm)	85.5	88.1	90.8	74.6	88.1	84.5	73.7	96.4	83.5	77.9	74.0	69.2
iv) Rainfall Characteristic	N	N	N	BN	N	N	BN	AN	N	BN	BN	BN
QBO of Stratospheric wind over Singapore												
	SP	WP	SP	WP	SP	WP	SP	WP	SP	WP	SP	WP
30 hPa	Apr 75	May 76	Sep 77	Mar 79	Jan 80	Apr 81	Aug 82	Jun 83	Nov 84	May 86		
50 hPa	Jul 75	Dec 76	Jan 78	Jun 79	Jun 80	Nov 81	Oct 82	Apr 84	Apr 85	Mar 87		
Phase during Jun - Sep	W_{50}	E	W	E	W	W_{50}	E	W_{50}	E	W	W_{50}	E

The Area weighted values of rainfall have been extracted from Mooley and Parthasarathy 1984 and updated.

N - Normal = 85.31 $\pm$ 8.29 AN - Above Normal $>$ 93.60 cm BN - Below Normal $<$ 77.03 cm

SP - Setting Phase of W WP - Withdrawing Phase of W W - Westerly Phase

E - Easterly Phase W_{50} - Westerly phase at 50 hPa alone.

stratospheric data of some neighbouring stations along the equator is likely to be as good as that of Gan I to forecast and monitor the SW monsoon rainfall over India. An attempt in this direction is made with the Singapore (1°22'N, 103°55'E) and Nairobi (1°18'S, 36°45'E) stratospheric wind observations, both located near the equator in the SW monsoon regime.

2. Data used

Time sections of Singapore (1974-1987) and Nairobi (1975-1987) have been prepared with wind data at 50 hPa and 30 hPa taken from the monthly Climat Data Publications for the years 1974 to 1987 (Fig.1 gives the time section of Singapore).

3. Quasi-biennial oscillation of lower equatorial stratosphere and the SW monsoon rainfall over India

Comparing the wind field over Gan I (Fig.2 of Ranjit Singh 1986), Singapore and Nairobi, it is seen that the longitudinal differences in the phase of the equatorial circulation are small enough (Naujokat 1986), to use Singapore or Nairobi data in place of Gan I to forecast and monitor the behaviour of SW monsoon over India. The performance of SW monsoon over India between 1976 and 1987, for 12 years, has been summarised and correlated with the phases of stratospheric winds in TABLE 1. It is seen that out of the 5 occurrences of below normal rainfall or droughts, four have been with the onset and strengthening of the easterly phase (or during the easterly phase) of stratospheric winds. Of the one case of above normal and another 6 cases of normal rainfall, five have been with the onset and strengthening or during the westerly phase at 30 and/or 50 hPa levels. Following this technique the success of forecasting of good and below normal rainfall over the country has been 75 per cent. Success of forecasting droughts alone has been 80 per cent.

4. Discussion

In this paper we have related the performance of SW monsoon rainfall over India with the stratospheric winds over Singapore. The earlier study Ranjit Singh, 1986, for the period 1964-1975 has thus been extended to 1987. Out of these 24 years, there have been 10 occurrences of drought in India. Out of these 8 have taken place during the easterly phase of the stratospheric winds at 50 and 30 hPa. These occurrences could be forecast 3 to 6 months in advance by following the change over, of the phase from westerly to easterly. This has given a simple and readily available climatological parameter within the region. In another paper (Ranjit Singh 1987), the author has again shown that

the monsoon circulation over India is basically the northward extension of equatorial circulation during summer. The use of an equatorial parameter for the long-range forecasting is therefore justified. This parameter is present throughout the monsoon period and hence has an added advantage over the other parameters such as, the April 500 hPa ridge along 75°E (Banerjee, et.al.,1978, Thapliyal, 1982 and Mooley, et.al., 1986) and 150 hPa westerlies (Joseph, 1976 & 1978) etc. in monitoring the performance of the monsoon.

In 1985, a drought occurred contrary to the prediction given by the westerly phase of the stratospheric winds; this could be explained as due to the absence of cross-equatorial flow from southern hemisphere (SH) into the Arabian sea (Ranjit Singh and Rao 1986). This is possible, if, (1) the SH trade winds are weak and the SH equatorial trough (SHET) is less active. (2) The extratropical westerlies in SH have not advanced sufficiently northward and are more zonal. This suggests that apart from the northern hemispheric or the equatorial parameters, we have to develop some SH parameters as well, to account for the circulation features in SH and the combined use may help in perfecting the long-range forecasting techniques for the SW monsoon rainfall over India.

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