

## Jet streams at 150 mb during a large scale drought in Indian summer monsoon

ABDULKARIM AHMED SAEED\*

Meteorological Department

Directorate of Civil Aviation, Aden International Airport

(Received 24 March 1982)

संक्षेप- 1972, भारतीय ग्रीष्म कालीन मानसून वर्षा का बहुत परिमाण में अभाव का वर्ष रहा। इस अवधि का  $u$ - क्षेत्र माध्य यह दर्शाता है कि 150 मि० बार पर जेट धाराएं दक्षिण एशिया पर की उप-उष्णकटिबंधीय पूर्वी-सामान्य जेट धाराओं की तुलना में दुर्बल रही तथा आस्ट्रेलिया पर की उप-उष्णकटिबंधीय पश्चिमी जेट धाराओं की तुलना में प्रबल रही। माध्य  $v$  क्षेत्र यह दर्शाता है कि भूमध्य रेखा के उस पार उत्तरी जेट धाराएं दुर्बल रही और लगभग  $20^\circ$  देशान्तर की ओर विस्थापित हो गईं।

1970-1979 तक के दशक के भारत की उच्चतम मानसून वर्षा के दो वर्ष 1970 एवं 1975 की जेट धाराओं की आस्ट्रेलिया पर की 1972 एवं 1979 की दो वर्षों की निम्नतम मानसून वर्षा में उप-उष्णकटिबंधीय जेट धाराओं की सामर्थ्य की तुलना की गई है। जैसा कि जुलाई और अगस्त के  $u$ - क्षेत्रों के मासिक माध्यों के विश्लेषण से देखा जा सकता है। यह देखा गया है कि कम वर्षा वाले वर्षों में उप-उष्णकटिबंधीय जेट अक्षे मानसून वर्षा की तुलना में 20 प्रतिशत प्रबल रहती है।

**ABSTRACT.** During 1972 a year of large scale drought in the Indian summer monsoon rainfall, the mean  $u$ -field at 150 mb shows a weaker than normal tropical easterly jet stream over south Asia and a stronger than normal sub-tropical westerly jet stream over Australia; the mean  $v$ -field shows that the cross equatorial northerlies are weaker and displaced eastwards by about  $20^\circ$  longitude.

The two years 1970 and 1975 of highest monsoon rainfall for India of the decade 1970-1979 were compared with the two years of lowest monsoon rainfall 1972 and 1979, in the strength of the sub-tropical jet stream (STJ) over Australia as seen from an analysis of monthly mean  $u$ -fields of July and August. It is seen that during the poor rainfall years, the STJ is about 20% stronger than in the good monsoon years.

### 1. Introduction

1.1. During 1972, the summer monsoon gave considerably below normal rainfall over India. The area weighted rainfall of India during the period 1 June to 30 September was 66 cm compared to the long period normal of 89 cm (Parthasarathy and Mooley 1978). In 1972, drought also affected a number of other countries in the tropical belt. In this paper the 150 mb wind field of the eastern hemisphere during June,

July and August 1972 has been studied, particularly the easterly jet-stream occurring over Asia and Africa and the sub-tropical jet-stream occurring over Australia.

1.2. Koteswaram (1958) examining the general circulation over the entire tropics during the summer of 1955 found that an easterly jet-stream exists from the east coast of China to the west coast of Africa. This jet-stream has its core passing through the southern portion of peninsular

\*Present affiliation : Training Div., Met. Office, Pune (India).

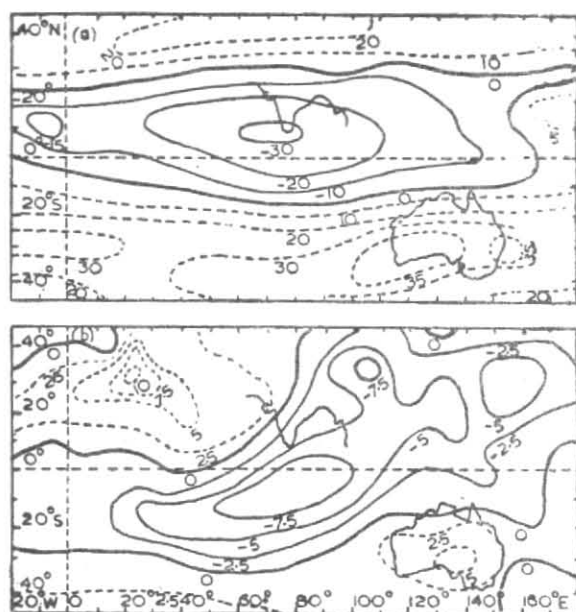


Fig. 1. Mean  $u$  and  $v$  in metres per second of June to August using data of 1957-1964 taken from Newell *et al* (1972):

- (a) gives the  $u$ -field, easterlies by continuous lines and westerlies by dashed lines  
 (b) gives the  $v$ -field, northerlies by continuous lines and southerlies by dashed lines

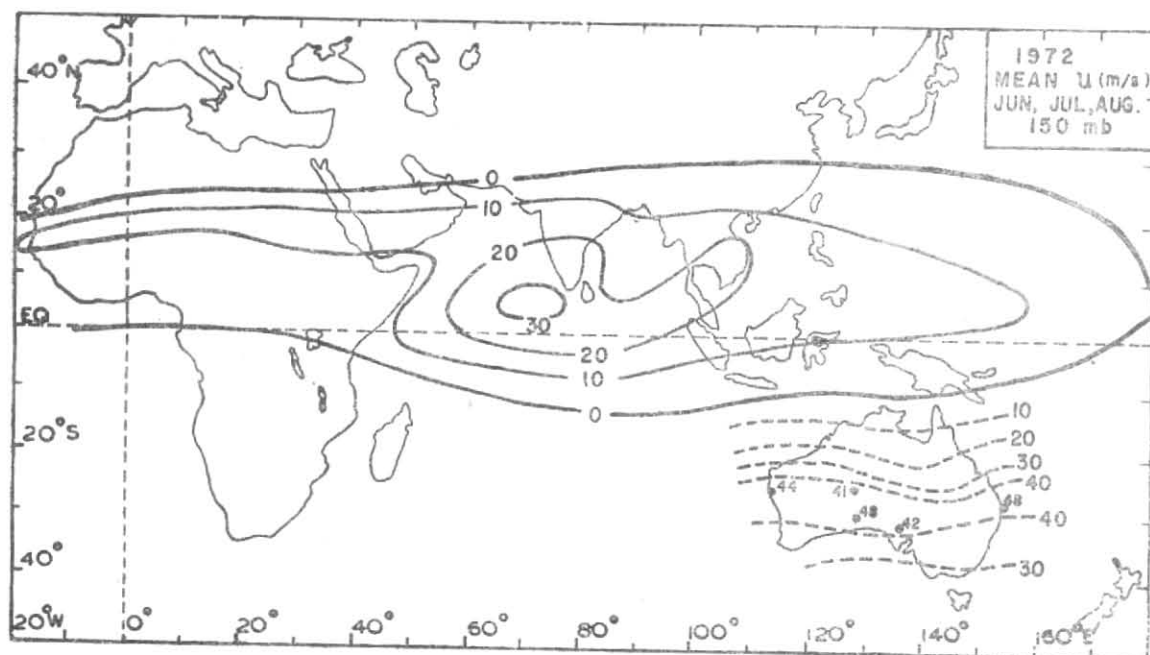


Fig. 2 (a). Mean  $u$  and  $v$  metres per second of June to August 1972. It gives easterly  $u$ -field only except for Australia where westerly  $u$ -field is marked by dashed lines

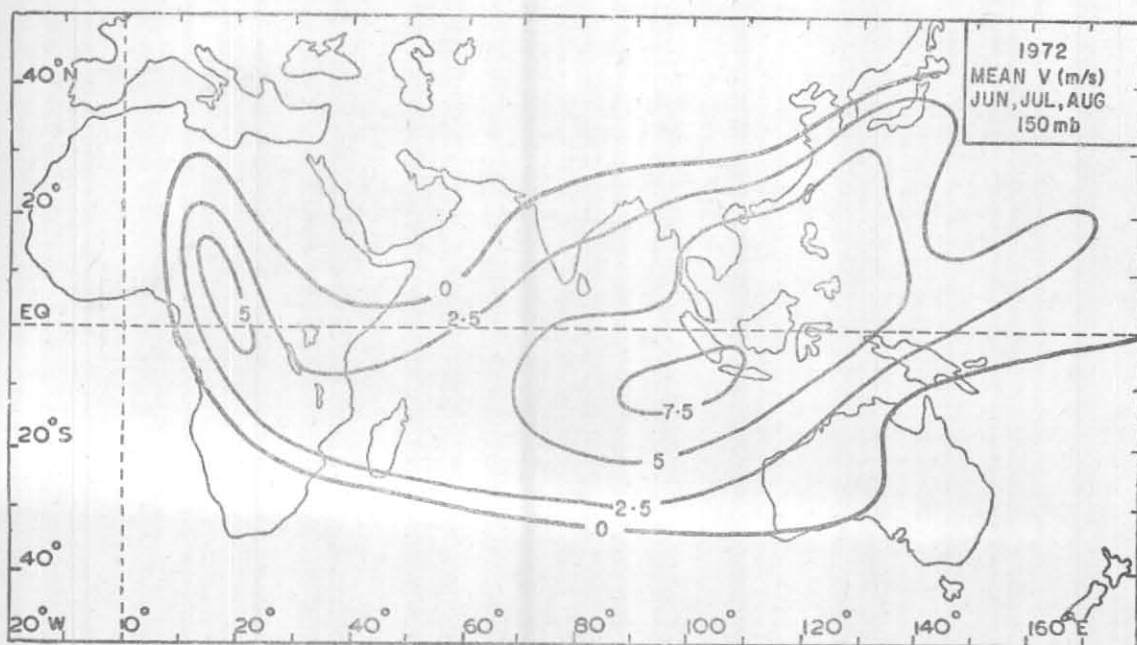


Fig. 2 (b). Mean  $u$  and  $v$  in metres per second of June to August 1972. It gives northerly  $v$ -field only

India at an altitude of about 150-100 mb. The jet core is found to have a wind maximum in the south Arabian Sea. It is interesting to study the tropical easterly jet-stream in a year when the monsoon rainfall of India is considerably below normal as in 1972.

1.3. Newell *et al.* (1972) have given monthly mean parameters of the tropical atmosphere using the data of 1957 to 1964. These were taken as normal values and the 150 mb wind field of 1972 was compared with this normal. Newell *et al.* have given charts for mean  $u$  and mean  $v$  for the summer season June to August. For the eastern hemisphere tropics and 150 mb level, these are given in Fig. 1. During these 8 years (1957-1964) India had near or above normal rainfall and the average monsoon rainfall during the period is 93 cm.

## 2. $u$ and $v$ fields at 150 mb for June to August 1972

2.1. Using all the monthly mean wind data for 150 mb given in 'Monthly Climatic data of the World' mean  $u$  and mean  $v$  charts for the period June to August 1972 were made. These are given in Fig. 2.

2.2. In Fig. 2(a) the isotachs of easterly  $u$ -component have been drawn at 10 m/s intervals by continuous lines. Isotachs of westerly  $u$ -component represented by the dashed lines have been marked over Australia only, as over this area there is a good net-work of upper air stations in the southern hemisphere. Comparing  $u$ -field of 1972 with the normal  $u$ -field of Newell *et al.* (1972) the following inferences are made :

- (a) Over south Asia, although the maximum  $u$  isotach is 30 metre per second in both the cases,  $u$ -field is considerably weaker in 1972. This is shown by the 20 metre per second isotach which is contracted both longitudinally and latitudinally in 1972.
- (b) The easterly  $u$ -field is considerably weaker over tropical Africa in 1972.
- (c) In the mean picture the zero  $u$ -isotach is around 160°E whereas in 1972 the zero isotach extends eastwards upto 180°E.

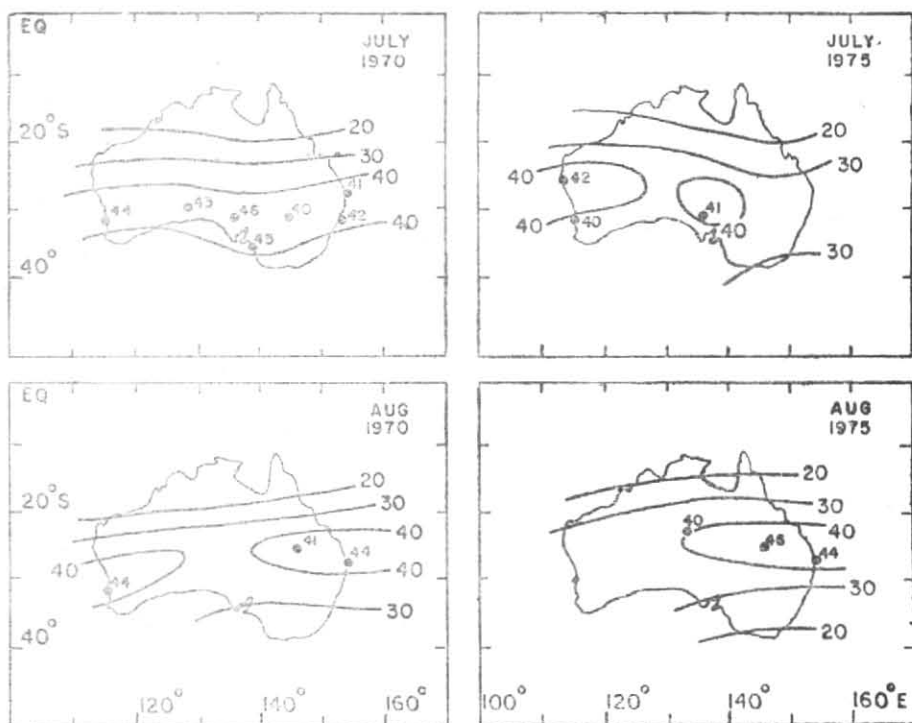


Fig. 3(a). Westerly  $u$ -field at 150 mb of July and August of years 1970 and 1975 when India had good summer monsoon rainfall

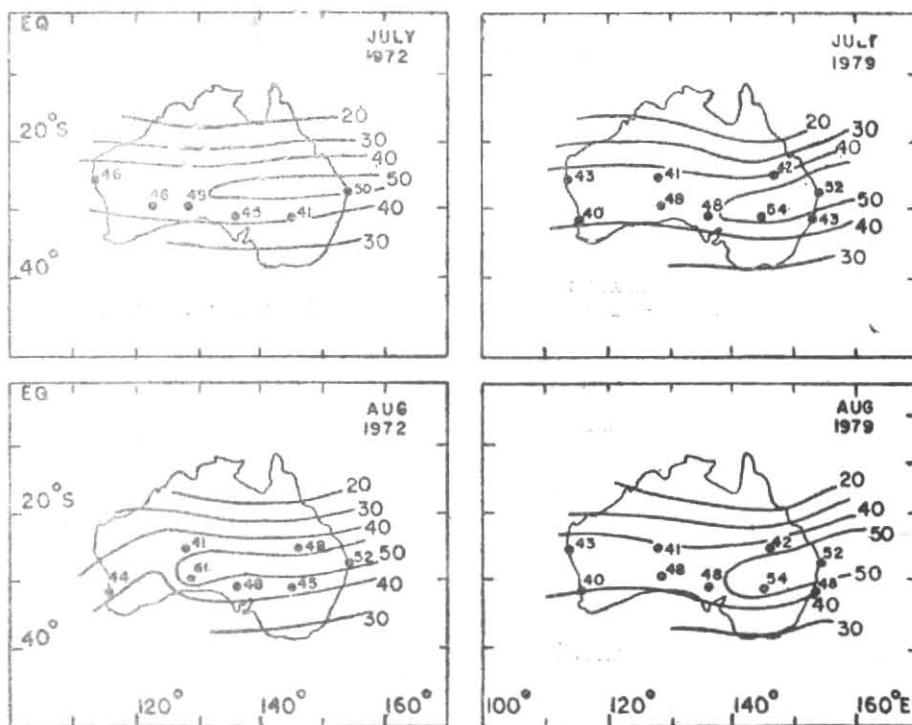


Fig. 3 (b). Westerly  $u$ -field at 150 mb of July and August of years 1972 and 1979 when India had poor summer monsoon rainfall

(d) The westerly  $u$ -field over Australia is considerably stronger in 1972 compared to the normal. There is a broad band of 40 metre per second across Australia in 1972 with two stations reporting 48 metre per second. The mean  $u$  for June to September 1972 of stations showing 40 metre per second or more are marked in Fig. 2(a).

2.3. The results given in 2.2 generally agree with the analysis by Kanamitsu and Krishnamurthy (1978) who compared the 200 mb  $u$ -field of the drought year 1972 with that of the good monsoon year for India of 1967. They found in particular that in the drought year of 1972, the June to August zonal easterly winds in the near equatorial tropical belt (global) were weaker and the westerlies in the middle latitudes of northern and southern hemispheres were stronger.

2.4. Fig. 2(b) gives the mean  $v$ -field for the period June to August 1972. This may be compared with the normal  $v$ -field of the same season as derived by Newell *et al.* (1972) and given in Fig. 1(b). In the mean picture the 5 metre per second northerly  $v$ -component isotach extends from south China to tropical south Africa across the regions south of India. The maximum northerlies represented by the 7.5 metre per second isotach is in the southern hemisphere due south of peninsular India. In 1972 the entire northerly  $v$ -field area appears to have shifted by about 20° eastwards and the extent of the 5 metre per second isotach contracted. The maximum northerlies represented by the 7.5 metre per second isotach of 1972 lies in the southern hemisphere due south of Singapore.

2.5. During large scale drought in summer monsoon over India, it has been found that there is a shift eastwards of upper tropospheric circulation features particularly of the Tibetan anticyclone as documented by Kanamitsu and Krishnamurthy (1978), Murakami (1978) etc, Joseph *et al.* (1981) finds southerly meridional wind anomalies in the upper troposphere over India during a year of large scale drought which shows the effect of intrusion of northern hemisphere sub-tropical westerlies equatorwards, and the conse-

quent shift eastwards of upper tropospheric circulation features.

### 3. Sub-tropical westerly jet stream over Australia

3.1. The study of 150 mb wind field during June to August 1972 has shown that the sub-tropical jet-stream over Australia is stronger than normal. It is interesting to examine whether the strength of the sub-tropical jet-stream over Australia and the intensity of the monsoon rains over India are related. This was done in a limited way by examining the  $u$ -field of July and August over Australia at 150 mb level for two monsoons of the decade 1970-1979 which gave the highest rainfall for India and two monsoons of the same decade which gave the lowest rainfall. Using the area weighted rainfall figures for India as derived by Parathasarathy and Mooley, 1970 and 1975 were the best years when the area weighted average rainfall (1 June to 30 September) of India was 96 cm and 102 cm respectively; the worst years were 1972 and 1979 with rainfall figures 66 cm and 69 cm respectively (The rainfall figures were taken from Joseph *et al.* 1981). Fig. 3 gives the monthly mean  $u$ -field of the good and poor rainfall years. Isotachs have been drawn at 10 metre per second intervals from the 20 metre per second isotach. Stations giving monthly mean  $u$  of 40 metre per second and more are marked in the figure. It is seen that during July and August of 1970 and 1975 the highest  $u$ -value has been 46 metre per second. The 40 metre per second isotach is found not as a continuous band, but as small closed isotachs. During the bad monsoon years 1972 and 1979 maximum  $u$ -field is considerably higher, of the order 52 to 54 metre per second with an isolated 61 metre per second in August 1972. 50 metre per second isotach could be drawn during all the four months.

3.2. Thus between the extreme good monsoon years and extreme bad monsoon years there is a difference of more than 20 per cent in the strength of the monthly mean sub-tropical jet-stream over Australia at 150 mb level. The sub-tropical jet-stream is stronger at 200 mb than at 150 mb and this contrast, therefore, is expected to be even stronger at 200 mb.

*Acknowledgement*

This research work was undertaken by the author as 'Project Work' which is a part of the Advanced Course of Training in Meteorology which he took at the India Meteorological Department's Training School at Pune during 1981-1982. The work was done under the guidance of Mr. P. V. Joseph, Director of the Training School. The author thanks Dr. A. K. Mukherjee, Deputy Director General of Meteorology (Weather Forecasting), Pune for his keen interest in the work. Thanks are also due to Mr. S. A. Shaikh for typing the manuscript and Mr. A. R. Murudkar for drawing the diagrams.

*References*

- Joseph, P. V., Mukhopadhyaya, R. K., Dixit, W. V. and Vaidya, D. V., 1981, 'Meridional wind index for long range forecasting of Indian summer monsoon rainfall', *Mausam*, **32**, 1, pp. 31-34.
- Kanamitsu, M. and Krishnamurthy, T. N., 1978, 'Northern summer tropical circulations during drought and normal rainfall months', *Mon. Weath. Rev.*, **106**, pp. 331-347.
- Koteswaram, P., 1958, 'The easterly jet stream over the tropics', *Tellus*, **10**, pp. 101-108.
- Murakami, T., 1978, 'Regional energetics of the 200 mb summer circulations', *Mon. Weath. Rev.*, **106**, pp. 614-628.
- Newell, R. E., Kidson, J. W., Vincent, D. G. and Boer, G. J., 1972, 'The general circulation of the tropical atmosphere and interactions with extra-tropical latitudes', **I**, MIT Press, Cambridge, England.
- Parthasarathy, B. and Mooley, D. A., 1978, 'Some features of a long homogeneous series of Indian summer monsoon rainfall', *Mon. Weath. Rev.*, **106**, pp. 771-781.