Letters to the Editor

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PRE-MONSOON JET STREAMS OVER THE INDIAN SUB-CONTINENT AND THE ASSOCIATED VERTICAL MOTIONS

According to Koteswaram (1954), the pre-monsoon jet streams and also the jet streams during the other dry months over the Indian subcontinent are caused by the confluence of two currents, *viz.*, the southwesterlies to westerlies over the Bay of Bengal and the Peninsula and the continental westerlies to northwesterlies from higher latitudes. He has also indicated the existence of an ascending motion to the south of the jet and a descending motion to its north with a southward transport of air below and northward transport above it. Although his conclusions may be justified on the basis of the mean charts prepared by him, it is worthwhile to study how far the same are applicable to day-to-day situations. With this in view a few cases of pre-monsoon jet streams have been examined in this note.

Although the normal position of the pre-monsoon jet streams may be near 29°N as found by Koteswaram, it may sometimes also appear as far south as 23°N. During the period 6 to 11 May 1962, a jet stream passed over the central parts of India, extending from Ahmedabad to Gauhati. This spell has been studied in some detail with reference to Koteswaram's conclusions.

The jet stream was more marked on 9th and 11th when more upper air data were also available. Fig. 1 shows the position of the jet stream on 9th morning drawn on the 300-mb chart. Ahmedabad and Gauhati reported the maximum wind of 118 kt at 10·2 km and 100 kt at 11·1 km respectively. Winds to the north as well as to the south of the jet stream as indicated by the data of Jodhpur, Delhi, Allahabad, Bombay, Nagpur and Calcutta were weaker. At 300-mb level, the temperature decreased northward while at 200-mb level there was a reversal of the gradient; the temperatures at Nagpur and Allahabad were —32° and —37°C respectively at 300 mb and —58° C and —46°C at 200-mb level. Hence, the jet stream was located between these two levels. The wind directions in this layer were 230°—250° at Delhi and Allahabad and 240°—270° at Jodhpur. The winds at stations to the south of the jet stream had also generally southerly components. The data are given in Table 1.

TABLE 1

9 May 1962

Station	300 mb DD/VV (deg./kt)		250 mb DD/VV (deg. /kt)		200 mb DD/VV (deg./kt)	
	00 GMT	12 GMT	00 GMT	12 GMT	00 GMT	12 GMT
Jodhpur	240/32	260/18	..	270/36	..	270/61
New Delhi	x	243/19	x	232/18	x	254/64
Allahabad	251/56	..	244/83	..	..	..
Bombay	260/49	270/34	270/45	280/34	270/42	290/42
Nagpur	250/60	254/75	260/53	249/59	262/39	265/57
Calcutta	245/62	..	259/62	..	240/49	..

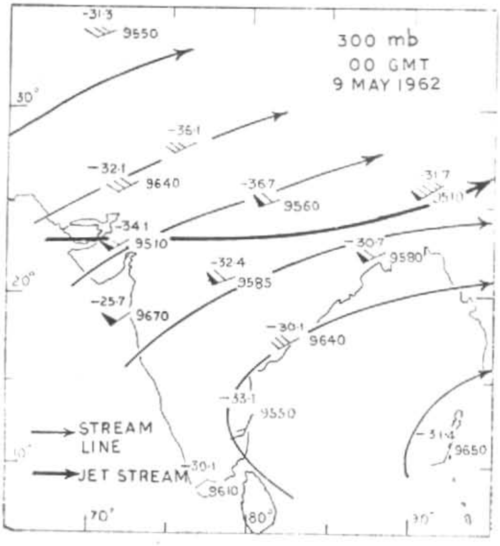

Fig. 1

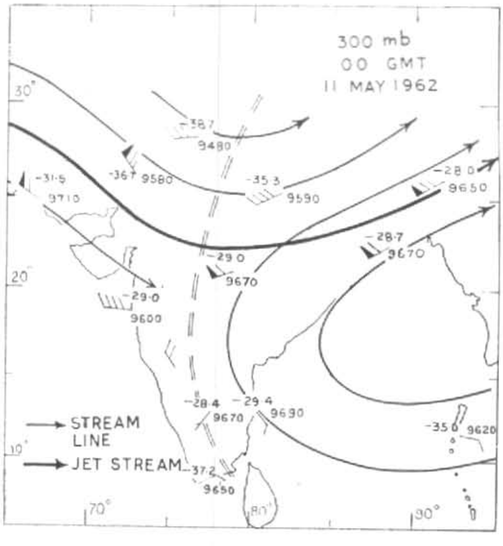

Fig. 2

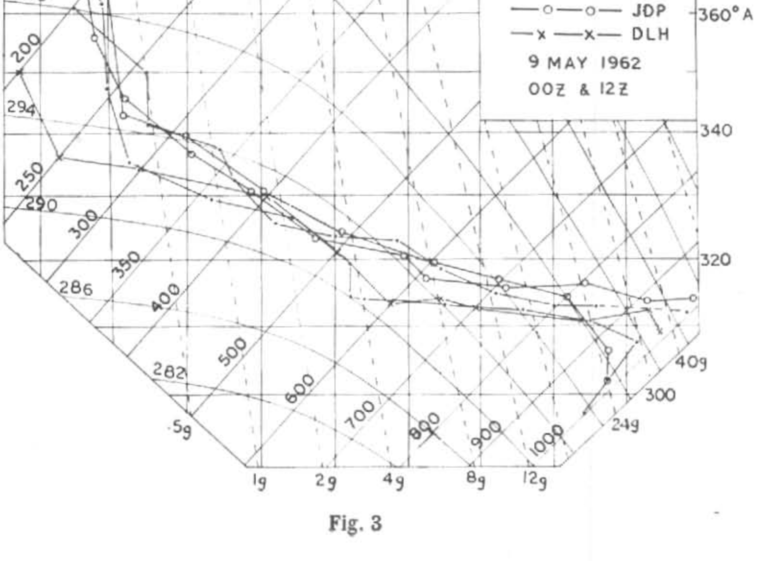

Fig. 3

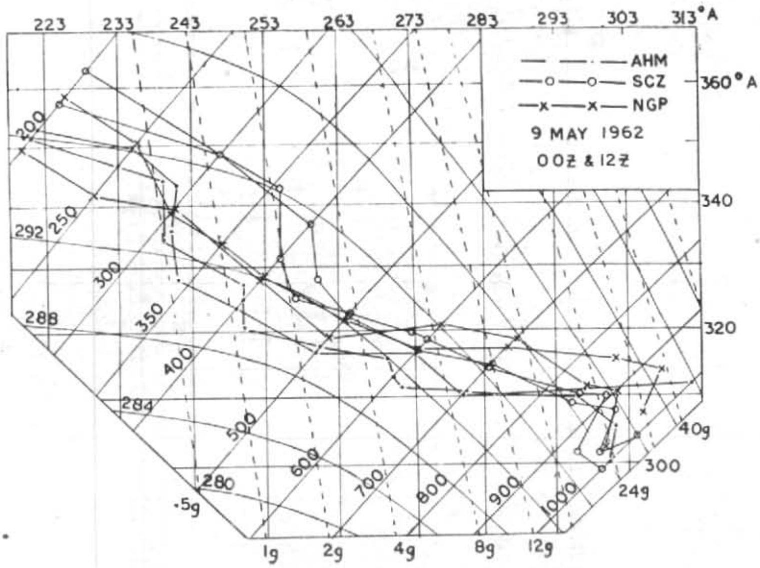

Fig. 4

Thus, in this case there was no evidence of confluence taking place between the northwesterly and southwesterly streams over the area where the jet stream was present.

Fig. 2 represents the 300-mb chart for 11th. The flow pattern at 200-mb level was also similar to that at 300-mb level. It is seen from these charts that the jet stream passed through Dalbandin, Ahmedabad, Jubbalpore and Gauhati. The western part of the jet was embedded in a purely northwesterly stream, while its eastern part lay in a southwesterly stream. Here also, there was no confluence between the southwesterly and northwesterly currents along the axis of the jet stream.

Koteswaram has referred to Panofsky's (1946) well-known formula

$$\frac{\partial T}{\partial t} + \mathbf{V}.\nabla T + w(\gamma_{ad} - \gamma) = 0$$

while putting forward his idea about the vertical motions in the vicinity of a jet stream. As the temperature variation at high level over a station is small and $\mathbf{V}.\nabla T \approx v\ (\partial T/\partial y)$,the above formula may be approximately written as $w = v\beta/(\gamma_{ad} - \gamma)$, where v is the meridional component of the wind (positive when northward) and β is the temperature gradient (positive when temperature decreases northward); $(\gamma_{ad} - \gamma)$ is usually positive. Hence, there should be an upward motion when v and β are of the same sign and a downward motion when they are of the opposite sign. If the confluence theory holds good, Koteswaram's suggestions regarding the circulations round a jet stream appear to be correct. But in the case of the jet stream on 9th, as studied in this note, the winds had generally southerly components both on the southern as well as the northern side. Below the jet stream, the temperature decreased northwards while it decreased southward aloft. These facts would suggest that there was upward motion below and downward motion above the level of the jet stream on both sides of the jet. This conclusion appears to be supported in a general way by the soundings from stations to its north and south (Figs. 3 and 4). As the ascents of Calcutta were short, they have not been included in Fig. 4. It is seen from these diagrams that the lapse rates were generally large in the lower levels on both sides suggesting upward motion. There were small lapse rates or nearly isothermal conditions near the jet level. This warming up might be due to compression of the air caused by the upward motion below and downward motion above the jet stream. Clear air turbulence was likely to be experienced in this transition layer where both upward and downward motions were present. The location of the transition layer at higher altitude to the north of the jet stream was perhaps due to stronger upward motion in the lower levels as suggested by the steeper lapse rate.

The upper wind data in Table 1 show that there was no southward transport of air across the jet stream both below or above it. Thus, circulation round the jet stream as suggested by Koteswaram does not seem to have been present in this case. Instances of similar jet streams are not rare in the month of May.

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REFERENCES

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