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Spectra of heat and momentum fluxes over the east coast of India during MONEX-1979

U. S. SINGH and R. S. SINGH

Department of Geophysics, Banaras Hindu University, Varanasi

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सार — मई से अगस्त तक मानसून प्रयोग (मौनेक्स-79) के लिए भारतीय प्रायद्वीप के पूर्वी तट पर ऊष्मा और संवेग अभिवाह (मूमेन्टम फ्लक्स) की गणना की गई है। इन अभिवाहों का वर्णक्रम विश्लेषण किया गया है। संवेग अभिवाहों में लघु एवं मध्यम परास आवर्तिता पाई गई हैं। माध्य आवर्त संवेदी ऊष्मा और माध्य आवर्त गुप्त ऊष्मा अभिवाह अक्षांश के साथ-साथ आवर्तिता में विपरीत परिवर्तन दर्शाते हैं।

ABSTRACT. The heat and momentum fluxes at the eastern coast of Indian Peninsula have been computed for the MONEX-79, May through August. The spectral analyses of these fluxes were performed. Oscillations of short and medium range periodicity in momentum fluxes were observed. The mean eddy sensible heat and mean eddy latent heat flux show opposite variations in periodicity with latitude.

1. Introduction

The necessity of the study of heat and momentum fluxes have its importance in better understanding of excess and deficit in the budget analysis. The spectral analysis has been widely used to understand the dominant periodicities in the meteorological parameters with a view to understand the cause of the oscillations. Several investigators in the past including Sankar Rao (1962), Sankar Rao and Ramanadham (1963), Pisharoty (1965), Sikka and Mathur (1965), Saha (1970), Saha and Bavadekar (1973, 1977), Ghosh *et al.* (1978), Bavadekar and Mooley (1978), Rao and Ramanamurty (1977), Rao (1981) have attempted to study the transport of fluxes over the Indian region.

The present study is motivated to throw some light on the significant periodicities is sensible heat fluxes, latent heat fluxes and momentum fluxes and its variation with latitude over the eastern coast of India during the MONEX-79 summer monsoon months, May through August.

2. Data and method of analysis

The daily aerological data obtained from the MONEX-1979 set of data at Agartala, Calcutta, Bhubaneswar, Visakhapatnam, Madras and Port Blair have been used for the computations of sensible heat flux, latent heat flux and momentum flux. These vertically integrated fluxes were subjected to spectral analysis in time domain following Blackman and Tukey (1958).

The heat and momentum fluxes at any station may be expressed as :

$$Q = \frac{c_p}{g}\int_0^p \bar{V}\,\bar{T}\,dp + \frac{L}{g}\int_0^{p_0} \bar{V}\,\bar{X}dp +$$

$$+ \frac{c_p}{g}\int_0^{p_0} \overline{V'\,T'}\,dp + \frac{L}{g}\int_0^{p_0} \overline{V'\,X'}\,dp$$

$$M = \frac{1}{g}\int_0^{p_0} \bar{U}\,\bar{V}\,dp + \frac{1}{g}\int_0^{p_0} \overline{U'\,V'}\,dp$$

where, Q is the time averaged northward flux of sensible and latent heat, and M the momentum flux per unit time respectively. X is the humidity mixing ratio.

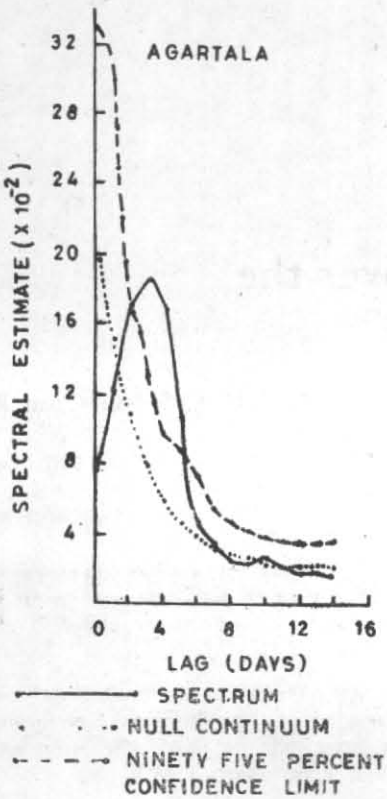

Fig. 1. Power spectrum of vertical mean eddy sensible heat flux

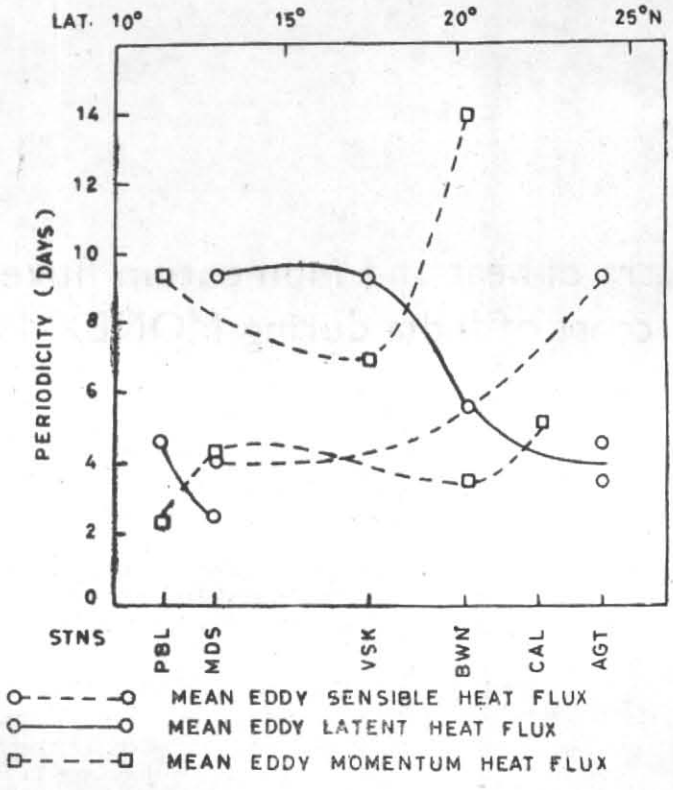

Fig. 2. Periodicity in different fluxes at various stations

The other parameters have their usual meaning. (−) denotes the time average and (′) the deviation from the time average.

3. Discussion of the results

Out of several charts of the power spectra it has been considered adequate to present the chart for the mean eddy sensible heat flux at a single station, Agartala only, in Fig. 1 for the purpose of an illustration.

Table 1 shows the existing periodicities along eastern coast of India for mean eddy sensible heat flux, mean eddy latent heat flux and mean eddy momentum flux at Agartala, Calcutta, Bhubaneswar, Visakhapatnam, Madras and Port Blair.

The remarkable periodicity of 9.3, 5.6 and 4.0 days has been observed over Agartala, Bhubaneswar and Madras respectively. Elsewhere over the east coast of Indian region there is no any remarkable periodicity. Thus, the peak of mean eddy sensible heat flux have medium range (5 to 10 days) periodicity over the extreme northeastern coast and as we move towards southeastern coast, it is reduced to short range (less than 5 days) periodicity as in Fig. 2.

We notice a short range periodicity in mean eddy latent heat flux varying from 3.5 to 4.5 days over Agartala which gradually increases from short range periodicity at Calcutta and Bhubaneswar into medium range periodicity at Visakhapatnam and Madras. Besides that over Madras and Port Blair a short range periodicity is also present.

Thus, the short range periodicity over northeastern part of east coast changes to medium range periodicity over the lower latitude of eastern coast of Indian subcontinent (Fig. 2). In general, the variations of periodicity with respect to latitude are in phase with the latitude for mean eddy sensible heat flux and opposite for mean eddy latent heat flux over the eastern coast of Indian subcontinent.

However, in the mean eddy momentum flux, besides the short range periodicity from Port Blair through Calcutta

TABLE 1

Periodicities in different fluxes (days)

Parameters	Periodicities (days)					
	Long	Medium	Short	Long	Medium	Short
		Agartala			**Calcutta**	
Mean eddy sensible heat flux	x	9.3	x	x	x	x
Mean eddy latent heat flux	x	x	4.5–3.5	x	x	4.3
Mean eddy momentum flux	x	x	x	x	5.2	x
		Bhubaneswar			**Visakhapatnam**	
Mean eddy sensible heat flux	x	5.6	x	x	x	x
Mean eddy latent heat flux	x	5.6	x	x	9.3	x
Mean eddy momentum flux	14.0	x	3.5	x	7.0	
		Madras			**Port Blair**	
Mean eddy sensible heat flux	x	x	4.0	x	x	x
Mean eddy latent heat flux	x	9.3	2.5	x	x	4.6
Mean eddy momentum flux	x	x	4.3	x	9.3	3.3

along eastern coast, there are medium range periodicity present from Port Blair through Bhubaneswar along the eastern coast with maximum 14.0 days periodicity at Bhubaneswar. Thus, large momentum fluxes across the eastern coast seem to be due to short range weather disturbances varying from 3 to 5 days associated with depressions over Head Bay of Bengal and medium range periodicity 5 to 10 days may be due to movement of cyclone waves over the region.

4. Conclusions

(*i*) The mean eddy sensible heat flux and mean eddy latent heat flux show opposite variations from short range periodicity at lower latitude to medium range periodicity at higher latitude in mean eddy sensible heat flux whereas besides short range periodicity in mean eddy latent heat flux, the variation is from medium range periodicity at lower latitude to short range periodicity at higher latitude.

(*ii*) The mean eddy momentum flux shows the presence of medium range periodicity from Port Blair (9.3 days) through Bhubaneswar (14 days) besides the short range periodicity throughout the east coast of India.

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