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Analysis of the lower tropospheric disturbances in the Bay of Bengal in October-November

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सार — अक्टूबर-नवम्बर में निम्न क्षोभमण्डलीय पूर्वी पवनों में तरंगों को बंगाल की बगाल की खाड़ी के द्वीपों के पार पश्चिम की ओर तथा प्रायद्वीप के दक्षिण छोर की ओर बढ़ते हुए देखा जाता है। यह प्रेक्षित किया गया है कि छः दिनों से अधिक की समयावधियों की आवृतियां अपेक्षाकृत अधिक वास्तविक हैं। उत्तरी घटक के क्षेत्र के दक्षिणी घटक की ओर परिवर्तित होने की समयावधि के दौरान जल वाष्प की मात्रा तीव्रता से बढ़ती है, वर्षा होती है और तापमान बढ़ता है। पश्चिमी पवन का घटक दक्षिणी घटक से मिलकर, पूर्वी घटक के दक्षिणी घटक के साथ मिलकर लाई जाने वाली वर्षा की तुलना में, अधिक भारी वर्षा लाता है।

ABSTRACT. Waves in the lower tropospheric easterlies are seen moving westwards across Bay islands and extreme southern Peninsula in October-November. It is observed that periodicities exceeding six days are more frequently real. In the regime of northerly component changing over to southerly component, moisture level rises sharply, rainfall occurs and the temperature rises. The westerly wind component associated with southerly component brings heavier precipitation than easterly component associated with southerly component.

1. Introduction

The lower tropospheric wave disturbances in the tropics have been extensively studied by using a variety of analysis methods. The wave disturbances in the trade wind easterlies on a (Riehl 1945, 1954; Palmer 1952) synoptic scale are known as easterly waves. Riehl observed in the Caribbean Sea that the wave disturbances propagate westwards with a period of 3-4 days and wavelength of about 2000 km. In the Atlantic Ocean, off west African coast (Burpee 1972) easterly waves were observed to be of period 3-5 days and wavelength of 4000 km, originating between 35° E and 15° E. Spectral analysis (Murakami 1976) of the wave disturbances over India during the summer monsoon showed that there exist westward moving disturbances with a period of 4-5 days and a wavelength of 3000 km from the northern Bay of Bengal through the monsoon trough region in north India. Power spectral analysis studies in the NE monsoon season (Pant and Bedi 1977) over Indian region indicate the existence of dominant periodicity of a week to about ten days.

2. Objective

It is known that extensive investigations have been carried out in respect of waves in the easterlies over tropical central and western Pacific Ocean, Atlantic Ocean and Caribbean Sea. A limited number of such studies have been carried out in respect of the Indian seas, particularly the Bay of Bengal. All observational results indicate that the lower tropospheric disturbances in the different tropical regions have similar periods and wavelengths, but appear to have regional differences in vertical structure such as vertical inclination of the trough axis and distribution of weather which is related to vertical motion.

The purpose of this study is to find out whether there are any wave like disturbances in the trades which are set up at the time of withdrawal of SW monsoon and onset of NE monsoon (Oct-Nov) over Bay of Bengal and study their structure.

3. Data

Data in the Indian seas, particularly in the Bay of Bengal, is scanty. For the purpose of the present study, radiosonde and rawin data of 0000 GMT and 1200 GMT for the years 1982 and 1984 in respect of Port Blair and Madras were used. The data for 1983 was inadequate and hence it was not used. The data for Port Blair for the first thirteen days in 1982 was also not available.

The wind field was split into u and v components. The air temperature and dew point temperature were used to calculate absolute moisture, relative humidity and potential temperature. The height field was used for D-value analysis.

4. Methodology

Meridional components of wind for standard levels of 850 mb, 700 mb, 500 mb, 400 mb, 300 mb, 200 mb for Port Blair and Madras (for October and November months of 1982 and 1984) along with rainfall data were plotted on a time-section chart. Harmonic analysis of

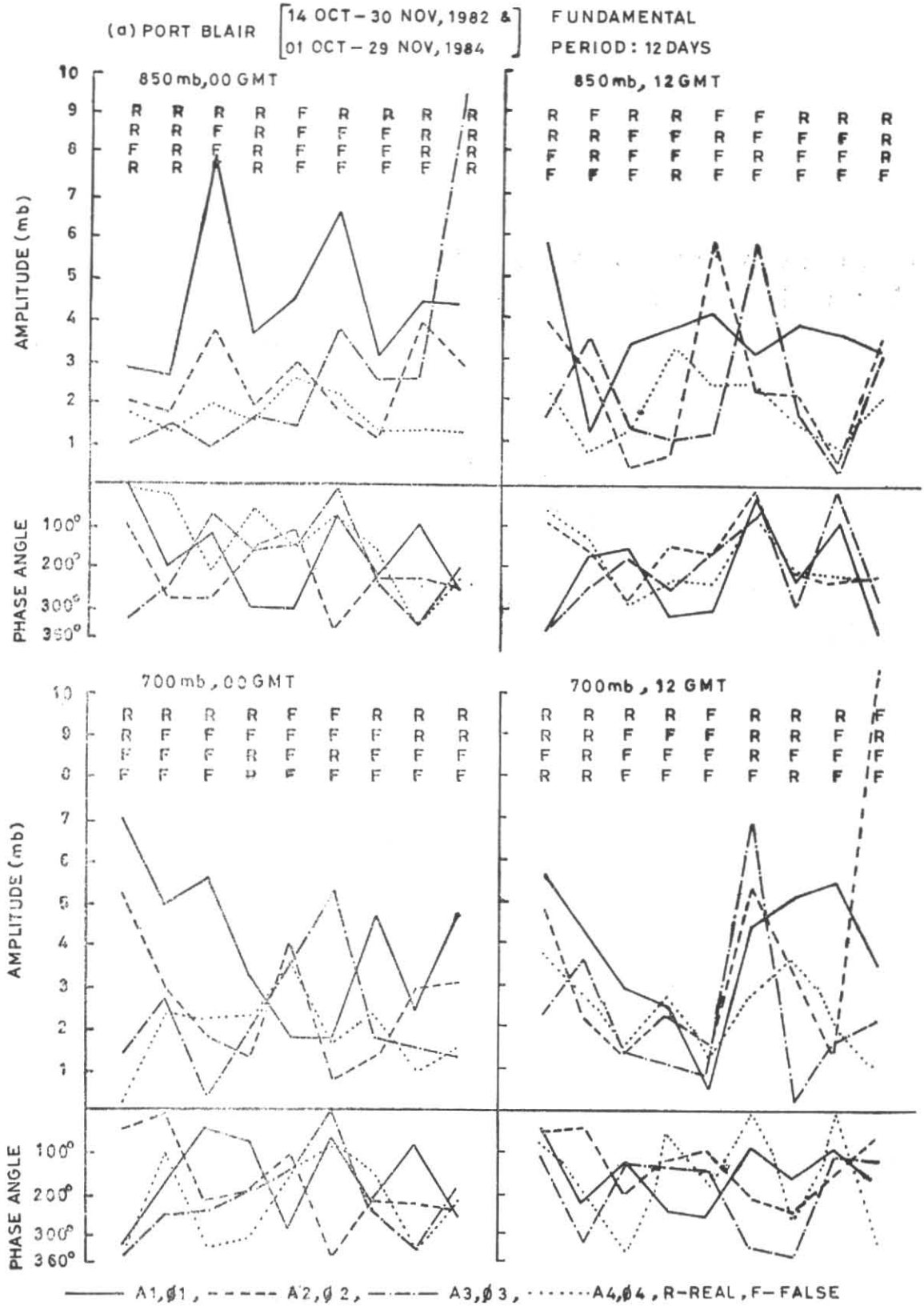

Fig. 1(a). Amplitude of first four harmonics and their phase angles

the meridional component of the wind at 850 mb and 700 mb for Port Blair and Madras was carried out (Carruthers and Brooks 1953) using 12 days as fundamental period. Only first four harmonics were evaluated and a test of significance for these periodicities conducted. *u* component of the wind field was also plotted on a time-section and lines separating easterlies from westerlies drawn. Relative humidity values upto 500 mb or above,

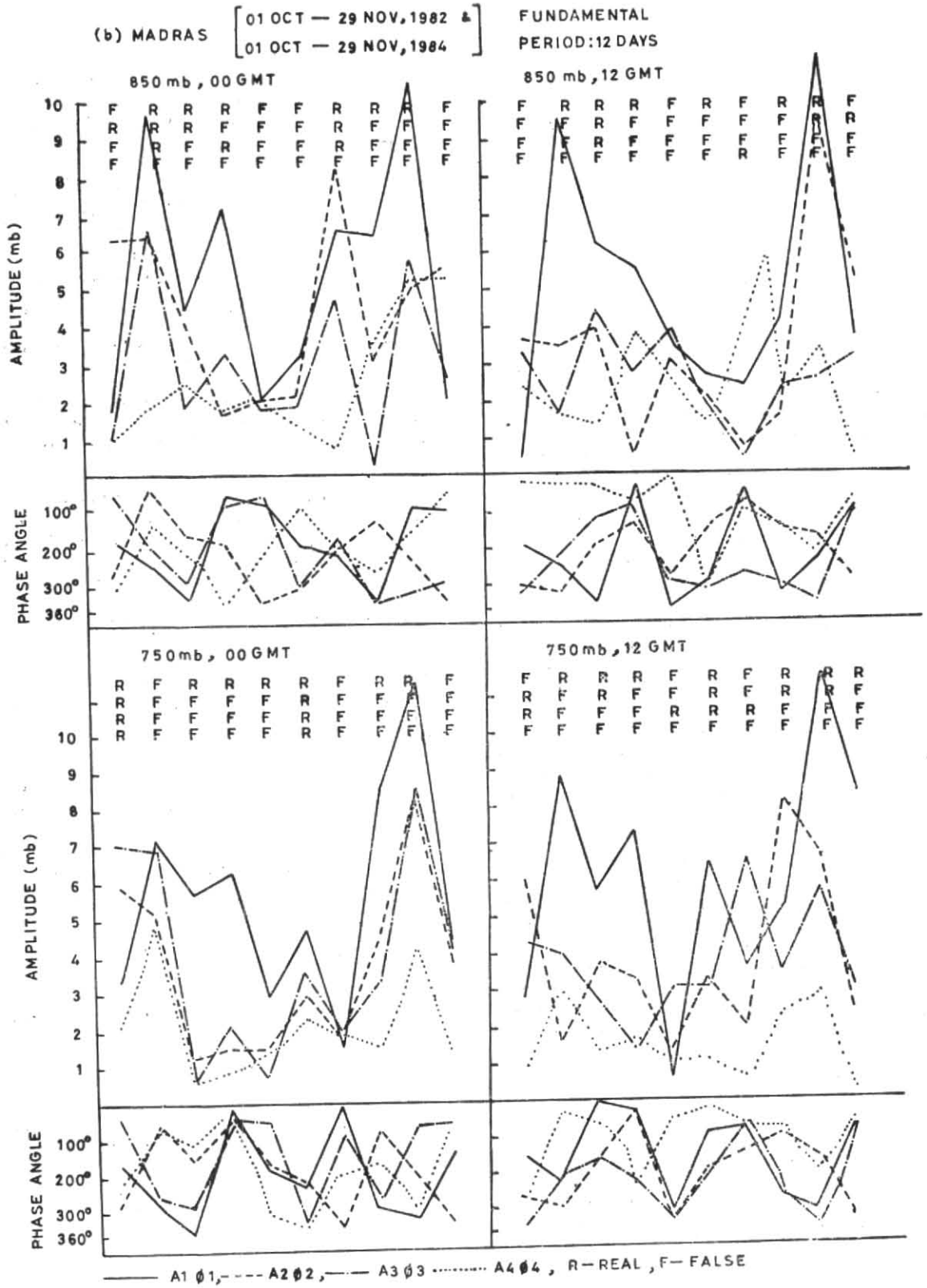

Fig. 1(b). Amplitude of first four harmonics and their phase angles

the heights of 3 gm and 5 gm isohygrics, *D*-values, potential temperature and actual temperature TT, zonal and meridional wind shears for the layers 700-850 mb and 500-850 mb were also plotted on a time section,

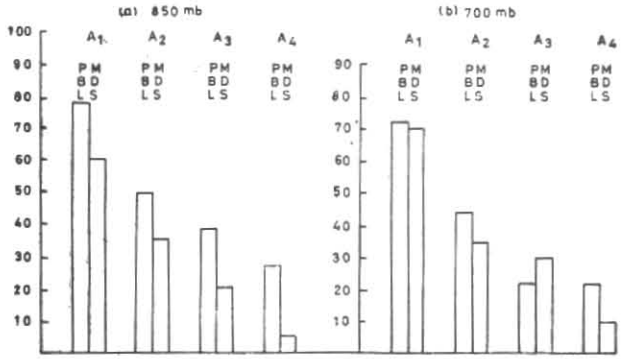

Fig. 2. Percentage of significant amplitudes, first four harmonics

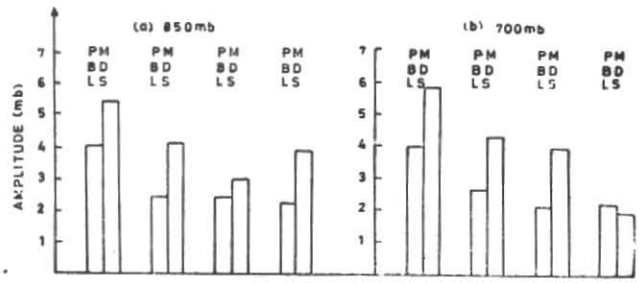

Fig. 3. Mean amplitudes of first four harmonics

5. Presentation and discussion of the results

The amplitudes A_1, A_2, A_3 and A_4 of the first four harmonics and their phase angles, for the levels 850 mb and 700 mb for Port Blair and Madras at 0000 GMT and 12 GMT are given in Figs. 1(a) and 1(b) respectively. These amplitudes are subjected to test of reality and the same is reflected by writing *R* for significant or real amplitude and *F* for non-significant amplitude. Percentage of real or significant amplitude for 850 and 700 mb for Port Blair and Madras are given in Fig. 2. Arithmetic mean of the amplitudes for 850 mb and 700 mb for Port Blair and Madras are given in Fig. 3. It is observed from Figs. 1 and 2 that the frequency of amplitudes in respect of the first harmonic is nearly 70 per cent while for the second harmonic it is less than 50 per cent. Percentage of real amplitudes in respect of 3rd and 4th harmonic is less than 30 per cent. This brings out that a periodicity of exceeding 6 days has higher percentage of reality both at 850 and 700 mb. Fig. 3 indicates that the mean amplitude at Madras is higher than at Port Blair both for 850 and 700 mb. This is due to the fact that some of the periodicities or waves deepen into well marked low pressure areas/depressions/cyclonic storms between Port Blair and Madras. In order to study the structure of these waves, time-section charts were studied for the entire period. From the analysis of the various cases, it is observed that northerly component and southerly component exist in the component wind field. In well marked cases a definite regime of northerly component ahead of the trough and southerly component to the rear of the trough extend through a deep layer, sometimes upto 200 mb. In feeble and ill-defined systems such a clear cut pattern is not seen. Rainfall generally takes place close to the time of crossing the wave and to the rear. Further, high amount of rainfall takes place when westerly component up to 700 mb is associated with southerly component. The moisture content rises to the rear of the trough. The temperatures at 850 mb are warmer by 1°-2°C in the southerly wind field. At higher levels, however, no significant differences are noted. The zonal or meridional wind shear bear no relationship to the change in the wind field regime from northerly to southerly or *vice versa*.

6. Conclusion

(*a*) The frequency of periodicity exceeding six days is large and observed to be significant.

(*b*) The frequency percentage of real periodicities at Port Blair both at 850 and 700 mb is higher than that at Madras. It is possible that some of the periodicities get damped out while moving westwards.

(*c*) At Port Blair the percentage of real frequencies is higher at 850 mb than at 700 mb, while at Madras the percentage of real frequencies is slightly more at 700 mb as compared to 850 mb.

(*d*) The mean amplitude of periodicities at Madras is higher than at Port Blair. This is due to the fact that some of the waves deepen as they travel westwards towards Madras.

(*e*) The moisture field rises sharply to the rear of the trough axis in the regime of southerly winds.

(*f*) At Port Blair the precipitation occurs to the rear of the trough, but at Madras the precipitation is noticed both in the domain of northerly as well as southerly components. This probably could be due to land effect.

(*g*) Temperatures appear to be slightly warmer by 1°-2°C to the rear of the trough in the lower levels up to 850 mb.

(*h*) At Port Blair westerly wind component associated with the southerly components gives heavier precipitation.

(*i*) *D*-values, zonal shear, meridional shear bear no relationship to the occurrence of rainfall.

(*j*) The axis of the trough appears to be nearly vertical till 700 mb and aloft it is seen to be tilting both eastwards and westwards.

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