

Some aspects of changes in microseism recorded at Madras during the period of two cyclones in November 1977

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सारांश — नवम्बर 1977 में बंगाल की खाड़ी में दो प्रमुख चक्रवात आए। पहला चक्रवात नागापट्टिनम के निकट तट को पार करके प्रायद्वीप के चंडू ओर भ्रमण करते हुए भीषण चक्रवात के रूप में पुनः तीव्र हो गया। खाड़ी का चक्रवात इस देश के भीषण चक्रवातों में से एक था। ये दोनों तूफान 16 और 20 तारीख को साथ-साथ विद्यमान रहे। यह लेख दोनों तूफानों की एक साथ उपस्थिति की अवधि में मद्रास में अंकित किए सूक्ष्म भूकम्पन अध्ययन से संबंधित है। परिणामों से पता चला है कि सूक्ष्म भूकम्पन के आयाम में वृद्धि केवल तूफान के भीषण हो जाने से ही नहीं होती, बल्कि यह कई अन्य कारकों पर भी निर्भर करती है।

ABSTRACT. Two major cyclones developed in November 1977 in the Bay of Bengal. The first storm that crossed coast near Nagapattinam moved across the Peninsula and reintensified into a severe storm. The Bay cyclone was one of the severest storms of this century. These two storms coexisted between 16th and 20th. This work pertains to a study of the microseism recorded at Madras during this period when the two storms coexisted. The results indicate that the increase in amplitude of the microseism not only depends on the severity of the storm but also on several other factors.

1. Introduction

Microseism with amplitudes larger than normal and periods of the order of 6 to 12 seconds recorded during disturbed conditions have been identified with cyclonic storms of various intensities when they are out at sea.

Banerji (1930) showed that microseisms were recorded at Colaba (Bombay) whenever disturbed weather existed over the Arabian Sea or Bay of Bengal. Tandon (1957, 1961) observed that microseism were recorded at all inland stations of India when a cyclonic storm of sufficient intensity existed in the Bay of Bengal or Arabian Sea and if the storm centre was within 0-200 metre depth contour from the coast. He also observed that at the time of crossing the coast, the amplitude was maximum.

Anjaneyulu (1961) had shown that there are some regions in the Bay of Bengal which are more favourable for transmission of microseisms. Such favourable regions have been called by him as 'High Index' regions. According to him High Index region lies (1) off north Coromondal coast and south Circars coast, (2) in northeast Bay and (3) over central parts of Bay. He also identified two regions of 'Low Index' in the Bay of Bengal — one from Andaman Sea to Sunderban coast and another off east coast of Srilanka.

The availability of satellite data during recent years has enabled estimation of the maximum winds associated with cyclonic storms with greater confidence and at more frequent intervals. Thus a comparative study of the changes in the intensity of storms and the changes in the microseisms is now possible. The results pertaining to the two storms which occurred simultaneously in November 1977 are presented in this paper based on the data of the microseismograph at Madras during the storm days.

2. Data studied

In the present study, the microseisms recorded at Madras by the Sprengnether microseismograph during the period 9 to 24 November 1977 has been made use of. The free periods of seismometer and the galvanometer were 7.30 sec, and maximum magnification was 5000 for this seismograph. The data regarding the maximum sustained wind, location of the storms etc were obtained from *Indian Daily Weather Reports* and other published records.

3. Synoptic situation

On 10 November a cyclonic storm formed at a distance of about 650 km southeast of Madras. Moving in a westerly direction, it crossed coast near Nagapattinam on 12th morning as a severe cyclonic storm. It weakened and after moving across the Peninsula emerged into the Arabian Sea. It reintensified and

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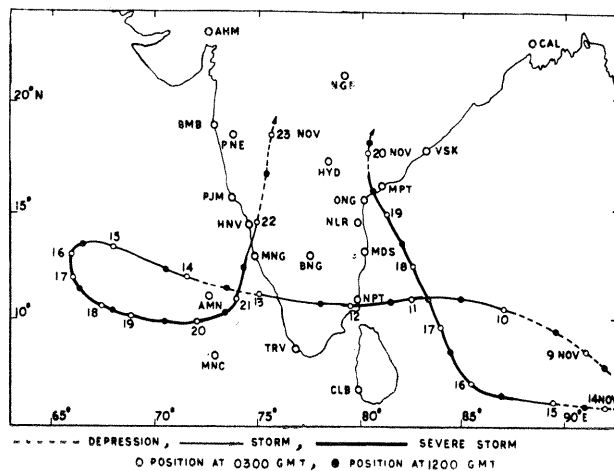


Fig. 1. Tracks of two cyclonic storms during November 1977

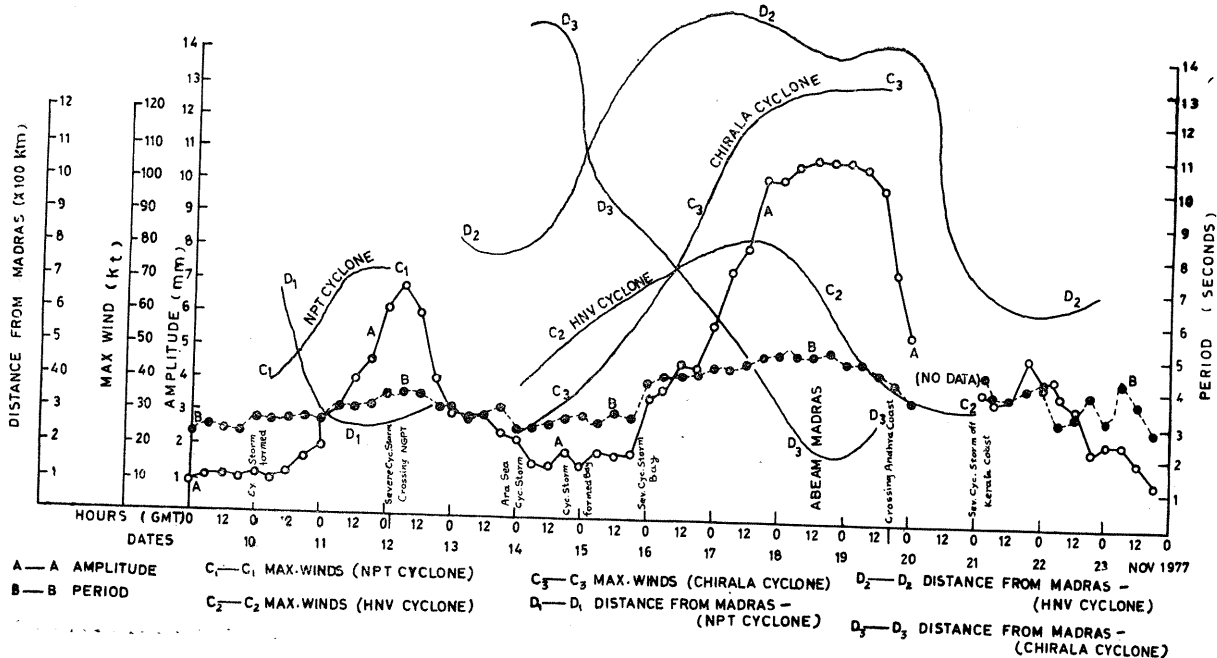


Fig. 2. Microseisms recorded at Madras

developed into a cyclonic storm in southeast Arabian Sea on 15th morning. During the subsequent days it made a loop and crossed the Karnataka coast near Honavar on 22nd morning.

During this period another cyclonic storm developed on the 15th morning in the Bay of Bengal at a distance of about 1000 km southeast of Madras and moved in a westerly direction. On 16th it abruptly changed course and moved in a northwesterly direction and crossed the south Andhra coast on 19th evening near Chirala. The tracks of the two systems are shown in Fig. 1. It can be seen that from 14th to 19th the two systems coexisted.

4. Results and discussion

Fig. 2 represents microseism recording for the period 9 to 23 November 1977. Curves A and B represent microseism period and amplitude respectively. The data were picked up for every six hours for preparing these curves. Curves C₁ and C₂ refer to the maximum sustained wind speed associated with the first system when it was in the Bay of Bengal and in the Arabian Sea respectively. Curve C₃ shows maximum sustained wind speed associated with the second storm. Curves D₁ and D₂ refer to the distance of the first system from Madras while it was in the Bay of Bengal and Arabian Sea respectively and curve D₃ that of the second system in the Bay. It can be seen

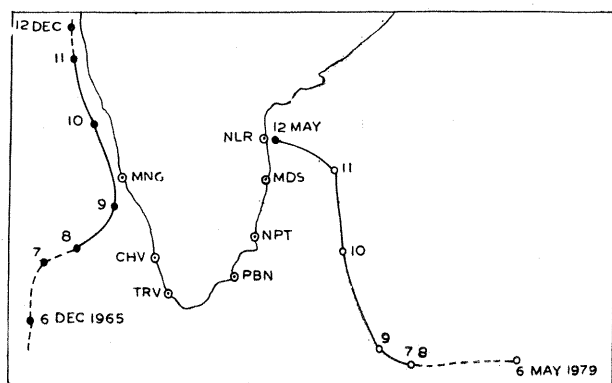


Fig. 3. Tracks of Nellore cyclone and an Arabian Sea cyclone

from the curves that the variation in amplitudes is much larger than the increase in period of microseism. The period increased by only about a second in association with the approach and crossing coast of the first system and by about 2 seconds in the case of the second system, whereas the amplitude increased by 2 to 7 mm in the first case and 2 to 11 mm in the second case. The much lesser variation of period of microseism may be due to the fact that the maximum magnification of Sprengnether microseismograph is for ground vibration which is half the seismometer/galvanometer period.

Critical examination of the curves for Nagapattinam cyclone between 10th and 13th brings out the some noteworthy results. The storm attained its maximum intensity around 0300 GMT of 11th and it was also practically as much near to Madras as when it was crossing the coast. However, the amplitude of the microseism reached their maximum only by 0000 GMT of 12th when the storm was crossing coast. This is in agreement with the result of Tandon (1961). The steady increase in amplitude of microseism from 1200 GMT of 10th to 0000 GMT of 12th is due to the increase in intensity of the storm. It can also be seen from the curve that the system did not cause any significant change in amplitude on period as long as it remained a depression from 1200 GMT of 8th to 0000 GMT of 10th.

A study of the curves D_3 , C_3 and A from 1200 GMT of 14th to 1200 GMT of 17th show that the increase in the amplitude of microseism in the case of the second storm are also on the same lines as the first storm, *i.e.*, the amplitude increasing steadily and rapidly as the storm intensified and approached coast. The amplitude of microseism is of course much greater than in the earlier case as the second storm was much more severe than the earlier one. From 1200 GMT of 17th onwards the intensity of the storm did not increase significantly and the amplitude did not show noteworthy increase, even though the distance of the storm to the coast decreased till 1200 GMT of 18th. It is also to be noted that there is no increase in amplitude as the storm was crossing coast. This may perhaps be due to the following facts :

- (1) The storm was moving in northnorthwesterly direction and so its track was having a larger component parallel to the coast. Its distance from coast decreases slowly while its distance from the seismograph remained practically stationary.
- (2) During the period 1800 GMT of 18th till the time of crossing it was moving from a high index zone into a relatively low index zone near the coast (Anjaneyulu 1961).
- (3) The effect of the other storm in the Arabian Sea might have contributed to the increase in the microseism when the latter intensified till 1200 GMT of 17th. Its contribution might have decreased as it weakened rapidly thereafter.

It may be mentioned that persistence of such high amplitude microseisms for a period of over 36 hours between 1200 GMT of 17th and 0000 GMT of 19th is rather unusual.

In absolute value the maximum amplitudes attained in association with the storm were 7 mm and 11 mm for the two cases reported. In the cases studied earlier (Anjaneyulu 1961) much higher amplitude values were reported (15 mm for Madras cyclone of 1958 and 13.5 mm in the case of Ongole cyclone of 1956). Compared to the above, the maximum amplitude recorded with the Chirala cyclone was much lower even though this storm was much more severe than those studied by Anjaneyulu (1961) and probably one of the severest storm of this century.

In order to seek an explanation for this anomaly, two cases of cyclones — one in the Bay of Bengal (Nellore cyclone) having track quite similar to Chirala cyclone and another in the Arabian Sea having track similar to that of the Honavar cyclone were studied. The tracks are given in Fig. 3. The microseism records corresponding to the periods of the two cyclone *vis-a-vis* their distance from Madras and maximum velocity are given in Fig. 4.

From Fig. 4 it can be seen that the relationship between maximum wind and amplitude of microseism holds in the case of these two cyclones also. That is intensification of the system is accompanied by corresponding increase in the amplitude of microseism.

The maximum amplitude of microseisms caused by the Nellore cyclone was 19.5 whereas the maximum amplitude caused by the Chirala cyclone was only 11. The effect of the Arabian Sea cyclone on microseisms at Madras is minimal as can be seen from Fig. 4 (maximum amplitude is about 3).

These observations bring about the high variability possible in the amplitude of microseisms. It clearly indicates that the maximum amplitude of microseism caused by a cyclone not only depends upon the severity (intensity) of the storm but also on other factors.

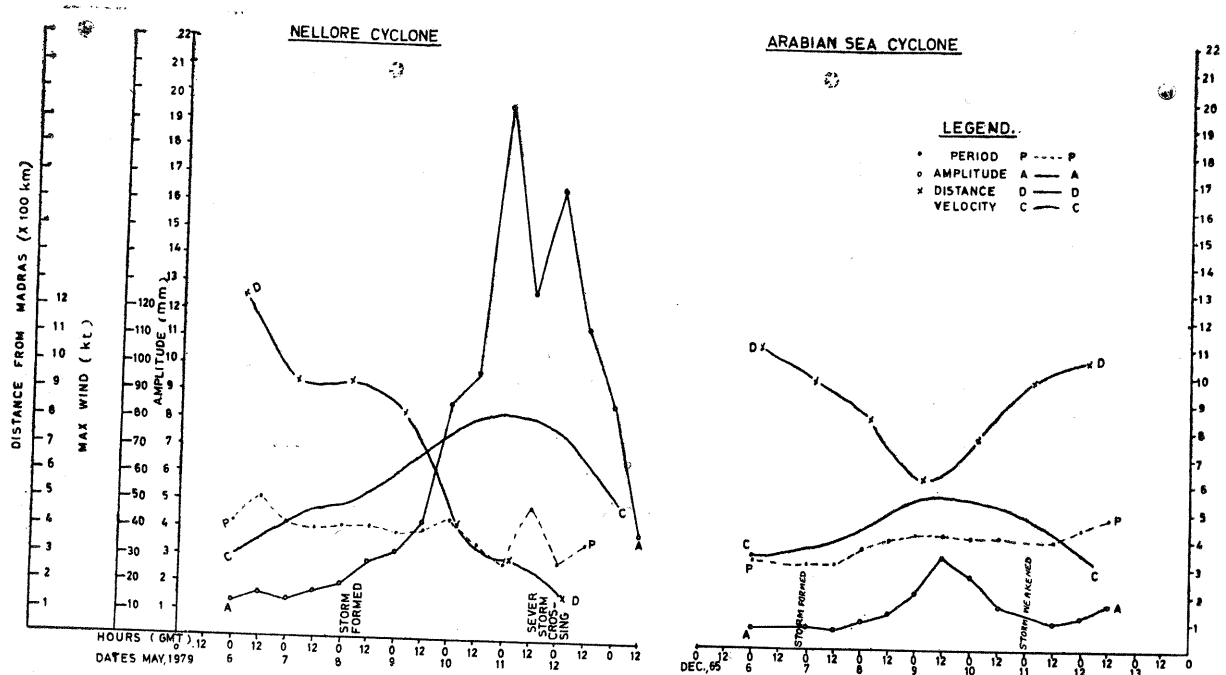


Fig. 4. Microseisms recorded at Madras

Of the two types of microseisms likely (primary one of 12-14 sec and secondary one of 5-7 sec) the Sprengnether recorder is capable of the recording only the secondary one. According to Longuet-Higgins (1950) standing waves are formed by sea waves travelling in opposite directions. The formation of standing waves are affected by many factors and thereby affecting the microseismic amplitude of waves being recorded at the station. The effect of movement of the system on microseism recorded has been studied by Bhattacharya (1967). The direction of approach of the system to the coast also affects the microseism. The bathymetry of the ocean basin near the coast also affects the amplitude of the microseisms reaching the shore (Tandon 1961).

Considering these factors we may conclude that the following could have caused a lower amplitude of microseism in the case of Chirala (1977) cyclone :

(1) The direction of approach of the Chirala cyclone was more northerly than the Nellore cyclone (1979).

(2) The maximum microseism was recorded in the case of Chirala cyclone during 17 November, 1200 GMT to 19 November, 0000 GMT when the system

was moving to the coast steadily, but at some distance from the recording station. In the case of Nellore cyclone the maximum had two peaks between 10 May, 1200 GMT and 12 May, 0000 GMT and it can be noticed that during this period the cyclone changed its course (recurved) from northerly direction to almost westerly direction obviously slowing down in the process.

Thus it is surmised that the microseisms produced at the coast by a system out at the sea depend on a number of factors.

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