

WAVE PERSISTENCE IN CENTRAL BAY OF BENGAL DURING THE SOUTHWEST MONSOON

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ABSTRACT

Wave data collected on board RV *Gaveshani* in central Bay of Bengal during Monex-79 are analysed for significant wave height (H_s), average period (T_c), zero-crossing period (T_z) and spectral width parameter (E). A modified method to compute wave persistence is suggested and persistence diagrams for different wave height levels are presented for both rough and calm conditions and their implications discussed. Except in one case, values of H_s exceeded 1 m, and over 60% of values are between 1 and 2 m. 75% values of T_z are between 7.5 and 9.5 sec and values of E are concentrated between 0.7 and 0.9.

Key words: Wave persistence, monsoon, Bay of Bengal.

INTRODUCTION

The data available so far on wave measurements in Indian Ocean are mainly restricted to a few coastal areas (Dattatri, 1973; N.I.O. Report, 1977; Gopinathan, Sathe and Ramaraju, 1979). There is a general lack of continuous wave data in the open ocean. During the south-west monsoon of 1979, RV *Gaveshani* occupied two stationary positions in central Bay of Bengal under the Monex-79 programme. This opportunity was used to collect continuous wave data in the Central Bay of Bengal. The data was used to compute common wave characteristics representing typical monsoonal conditions in the open ocean. A modified method to calculate wave persistence has also been suggested. A study of persistence of different wave heights in a given region becomes useful in such cases. Persistence of a wave condition has two aspects. One is how long will it take for a relatively severe wave condition to calm down and the other is how long will a relatively calm condition remain. The former aspect is studied as persistence of waves (also known as persistence of storm), while the latter is studied as persistence of calm.

MATERIAL AND METHODS

During 58th cruise of RV *Gaveshani* in connection with Monex-79, wave data were collected at two stationary locations in central Bay of Bengal (Fig. 1) using a shipborne wave recorder. The wave recorder, designed and developed by Institute of Oceanographic Sciences, UK, is a modified version of an earlier one developed by Tucker (1956). The records were taken every three hours, each with a length of 15 min. Position I (13°N and 85°E) was occupied by RV *Gaveshani* from July 19 to 23 and Position II (16°N and 87°E) from July 24 to 31. In all, 96 wave records were collected for this study. The wave data from both the locations were combined to give a representative wave condition in central Bay of Bengal. Wave

records were analysed in accordance with the method suggested by Draper (1966). Wave heights were corrected for depth attenuation effect. Significant wave heights (H_s) obtained from all records are represented in Fig. 2 in the form of a percentage exceedance curve.

Wave persistence was obtained by counting the number of occasions for which a given wave height persisted for at least a given length of time. Fig. 3 (persistence of waves) is drawn by plotting the number of occasions for which the conditions at or above a given height level persisted for a certain duration or more. While Fig. 4 (persistence of calm) is drawn by plotting number of occasions for which the conditions at or below a certain height level persisted. In both the cases, it is the number of occurrence for each height level which is plotted against the duration of their persistence. Draper (1966) suggested a method for calculating wave persistence where in the number of occurrences when conditions persist at or above (or below in the case of persistence of calm, Draper, 1976), a certain height level is to be plotted against the length of time for which they persist. However, in our persistence diagrams, we have plotted the number of occurrences when conditions at or above (or at or below in case of calm) a certain height level persist for at least a given length of time, e.g. while counting a certain height level say for 6 hours, occurrences persisting for 9, 12 hours etc. are also included in the count. This is obvious because if a condition persists for 9 hours, it has to have *de facto* persisted for 6 hours as well. In the earlier method counts of lower duration do not include spells exceeding that duration. Persistence curves are usually drawn for a season or a year. In the present paper, we have developed a new method of computing persistence with a new definition. At present, we have applied this method to only 12 days of wave observation during a typical monsoonal condition. This method has certain advantages over the traditional Draper's method as discussed in results. It is expected that if the method is found satisfactory, it may be applied to longer spells like a season or a year.

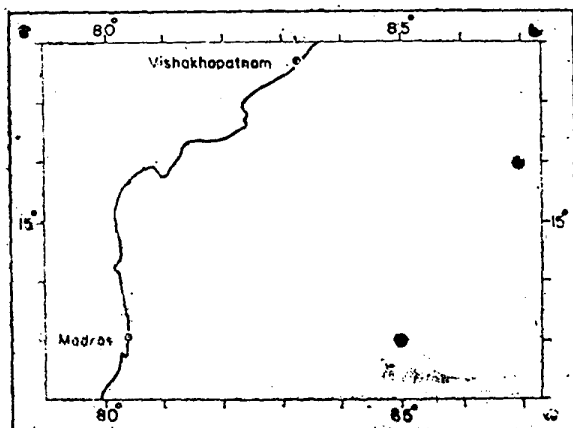


Fig. 1. Station locations.

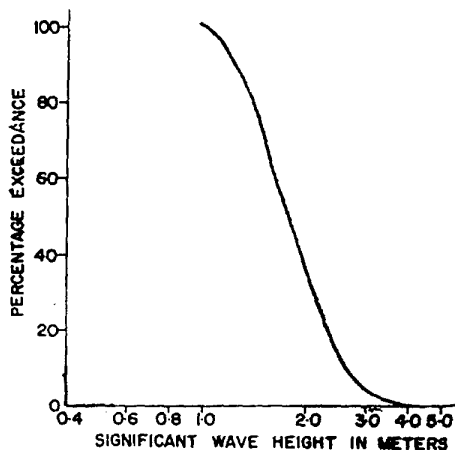


Fig. 2. Distribution of significant wave height.

A spectral width parameter (E) was calculated for the wave records using the relation,

$$E^2 = 1 - (T_c/T_z)^2$$

where T_c is the average period and T_z is the zero-crossing period. Fig. 5 represents the spectral width parameter in the form of a percentage occurrence. A scatter diagram relating significant wave height (H_s) to zero-crossing period (T_z) is presented in Fig. 6.

RESULTS AND DISCUSSION

Significant wave heights are represented in Fig. 2 in the form of an exceedance curve. It is seen from this figure that though height varied from 0.97 to 4 m, more than 60% of wave heights are between 1 and 2 m. Fig. 3 and 4 represent persistence of waves and persistence of calm respectively. From these figures it may be inferred how often and how long a given wave condition is likely to persist, e.g. it is seen from Fig. 3 that there were 51 occasions out of 96 when wave heights of 1.5 m and above persisted for at least 15 hours. Similarly it can be seen from Fig. 4 that there were only 18 occasions when wave heights of 1.5 m and below persisted for at least 15 hours. The former case being persistence of waves (storms), implies that after 15 hours the wave heights are likely to subside while in the latter case, it implies that after 15 hours the wave heights are likely to exceed 1.5 m. For planning programmes of vessels which have operational limitations in certain wave climates, studies of persistence of wave become very useful. These studies will show the likelihood of each wave condition occurring, persisting, subsiding or worsening in a given season and region. The diagrams of persistence of calm can be used in planning operations like drilling, pipe-laying, surveying etc. which require prolonged calm condition. It is not possible to derive persistence of calm from persistence of waves and vice versa. In cases of persistence for 3 hours duration also, the number of occurrences of calm cannot be obtained from those of rough. This is for the reason

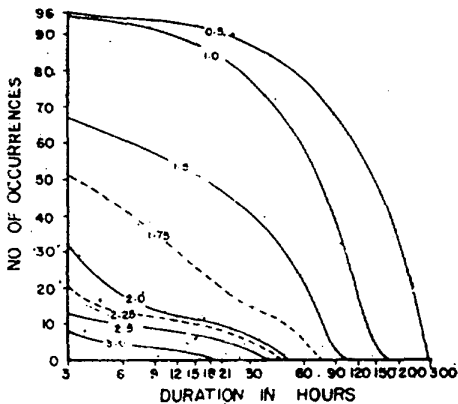


Fig. 3. Persistence of waves.

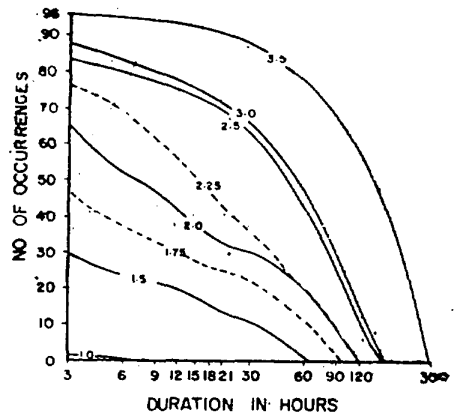


Fig. 4. Persistence of calm.

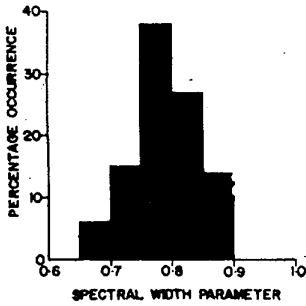


Fig. 5. Distribution of spectral width parameter.

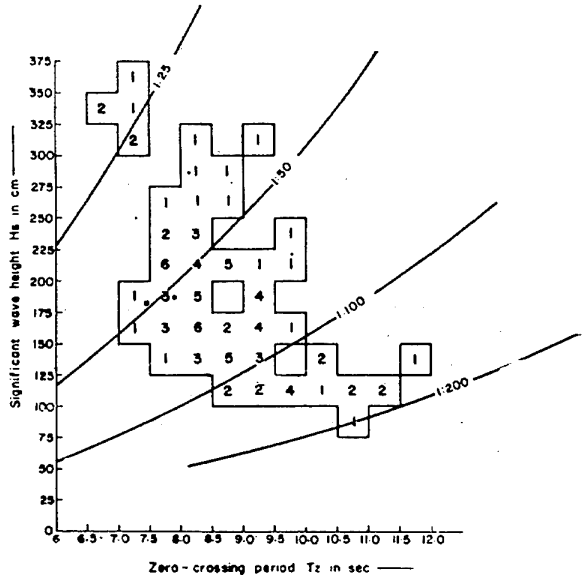


Fig. 6. A scatter diagram relating significant wave height to zero-crossing period.

that cases of wave heights being exactly equal to say 1.5 m will be considered for both calm and rough conditions and hence the total number of combined cases is likely to exceed the total number of observations.

This way of representation is more useful than earlier method (Draper, 1976), e.g., if a sailor is interested in knowing whether a given wave climate will last for say 6 hours, he is certainly not interested in exactly '6 hours' persistence as is brought out in earlier representations. He is, in fact, interested in whether the climate will at least last for 6 hours. So cases of 9, 12 hours etc. also become meaningful for him, since they include his 6 hours case. In such cases, cumulative persistence diagrams as depicted in the present paper, becomes more useful as they do not underestimate his safety margin.

Fig. 5 shows distribution of spectral width parameter as percentage occurrence. The values are concentrated mainly between 0.7 and 0.9. The shift of spectral width parameter towards 1 is an indication suggesting that waves encountered are mostly locally generated (Draper, 1966). Scatter diagram in Fig. 6 relating significant wave height to zero-crossing period shows that although wave period ranges from 6.5 to 12 sec, 75% of wave periods are confined to 7.5 and 9.5 sec. Majority of these waves having the above periods have heights within 1.25 and 2.25 m. Although spectral width parameter indicates locally generated waves the position of some of the data on the scatter diagram of quite low steepness suggests that there is a substantial swell component as well.

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