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Swell observations on Soviet research ships during Monsoon Experiment (MONEX) 1977—Part I : The equatorial region

A. K. MUKHERJEE, T. R. SIVARAMAKRISHNAN

Regional Meteorological Centre, Bombay

and

P. SATYANARAYANA

Naval Hydrographic Office, Dehra Dun

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ABSTRACT. Observations of swell waves taken on board Soviet Research Ships which worked during Monsoon Experiment of 1977 have been analysed. The first period is the end of May and the beginning of June when the Ships moved in formation along Equator. Swells over equator during the onset of monsoon has been studied from these data. The second period when the ships again went to Equator and remained stationary were towards the end of July. Swells during this period therefore represent those over equator when monsoon is in full swing. It is found that equator is an area of low swells. Heights are less during monsoon than at the onset period.

1. Introduction

Changes of swells and onset of monsoon are connected very intimately. They are generally slight to moderate in the pre-monsoon months, becoming moderate to heavy during the monsoon and again light to moderate after the monsoon withdraws (HMS Alas). Mukherjee and Sivaramakrishnan (1976) have observed a narrow band of high swells developing over Arabian Sea just before the onset of monsoon. During the monsoon experiment 1977 a number of Soviet research vessels have recorded swell observations. In the present study the analysis of these have been reported. The analysis is in three parts (1) Swells over equatorial region (2) Swells over Arabian Sea (3) Swells over the Bay of Bengal during August. For the first and second parts the heights at onset as well as those when the monsoon is well-set have been studied and reported.

2. Data

The Soviet ships started from Singapore in the second half of May and came to equator on 26th. They then moved westwards in a polygon formation as shown in Fig. 1. They used to halt for upper air observations to be taken on board every six hours. Surface meteorological observations were, however, being taken every hour. Only six hourly observations of swells taken visually were analysed as the ships were not moving at those times. While the heights were recorded all the time, the period and direction were not always recorded.

There were three phases of monsoon' 77 experiment. First phase ended when the ships called at Bombay harbour on 21 June 1977. In the second phase the ships again went to the equator and were stationary forming a polygon with four corners at 2° N 78° E, Equator 80° E, 2° S 78° E and Equator 76° E, from 25 July to 31 July 1977. There was a change of ship just before the formation of this polygon. Initially four research ships, Akademic Shirshov, Priliv, Priboy and Okean took part. Just before the formation of polygon at equator in July, the ship Priliv was replaced by the ship Sokalsky. The observations of swells of this formation were extracted and analysed. For the sake of uniformity they have been assumed to be representing the equator region under study.

Here it may be stated that the swell heights as observed by Research Vessel Akademic Shrishov appeared to be generally higher than those by other ships, during the first phase. Later this discrepancy was rectified and observations during the second phase the heights observed by

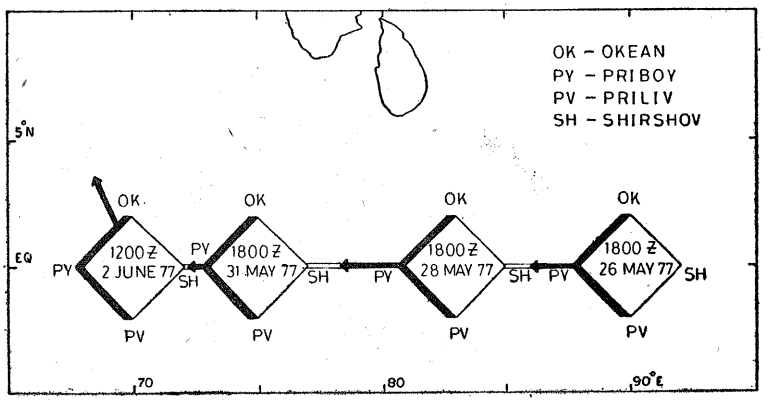

Fig. 1. Movement of Ships

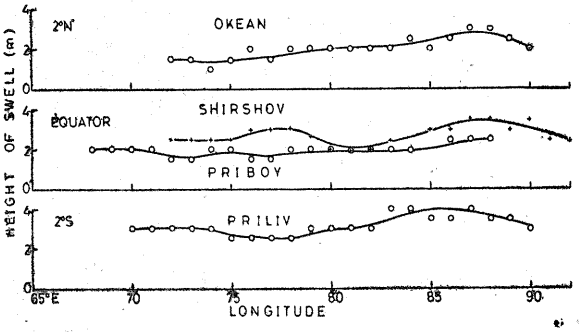

Fig. 2. Variation of heights of swell (May-June) with longitude

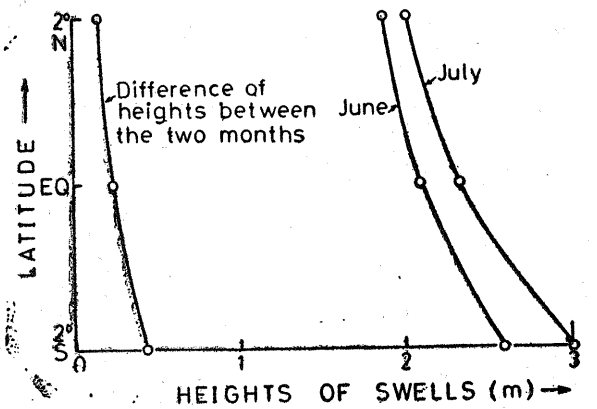

Fig. 3. North-South Variation of swell height

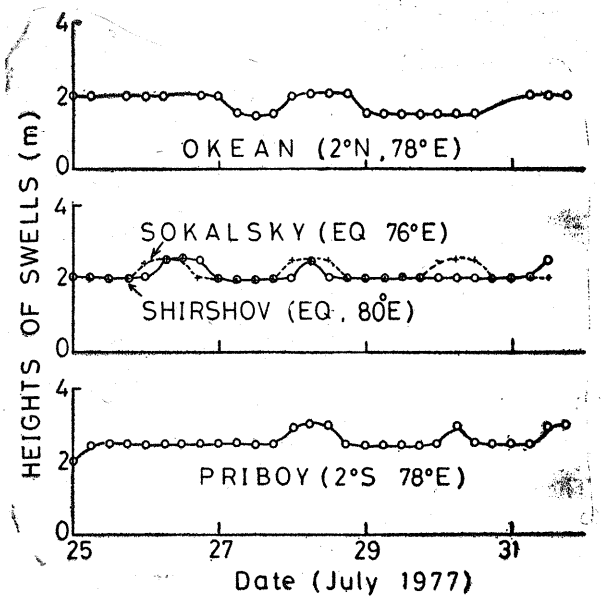

Fig. 4. Variation of heights of swells along different latitudes during 25-31 July 1977

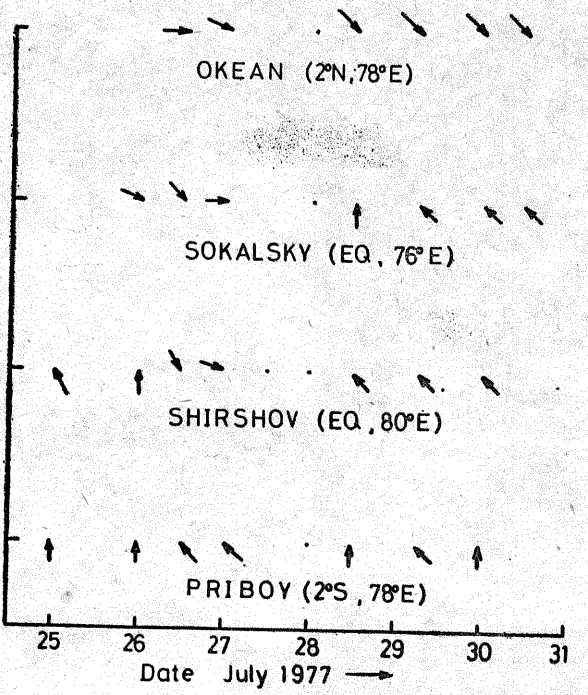

Fig. 5. Swell directions

all the ships were mutually consistent. For our study of swells, however, we have not ignored any observation and have taken all of them.

3. Results and discussions

During the first phase the ships were moving in formation along the equator. We can, therefore, get an idea of variation of swell height along the equator as the ships moved. For the second phase the ships were stationary and hence we can get a time variation of swells for this period. From these two sets of data, change of swell heights for these two periods was estimated.

3.1. *Variation with longitude*

Fig. 2 gives the plot of heights of swells from 68° E to 92° E. It will be seen that there was a small but perceptible decrease of height of swell as the ship moved from east to west. It may have some connection with the fact that the monsoon sets earlier *i.e.* towards end of May in the Andaman and Nicobar Islands as well as in the countries east of Bay of Bengal (Rao 1976). However, with the present set of data the authors are not able to suggest any relationship between these events.

3.2. *North-South Variation*

Since the heights of swells varied within a small range, average values of the heights were determined for each latitude along which the ships moved *i.e.* for 2°S, Equator and 2°N latitudes.

For the second phase, when the stationary polygon was over the equator towards the end of July we got another set of data for the equatorial region. An examination of these showed that there was practically no variation of swell heights (with time) during the period as will be evident from Fig. 4. Average heights were, therefore, worked out for latitudes 2°S, Equator and 2° N separately. The results are shown graphically in Fig. 3. It will be seen that the swell is always higher to the south of equator and gradually decreases upto 2°N.

3.3. *Time variation*

To study the short period time-variation of heights of swells near equator the data of swells as observed by the four ships from 25 July to 31 July 1977 were plotted on a graph. The same is reproduced in Fig. 4. It will be seen that there was little variation with time except for slight increase of height on the 28 July. This appears to be due to a disturbance moving in this area at that time.

The observations of swells for June and July indicate that the swells over equator generally decrease with progress of season. The swell height decreases more to the south of equator than to

the north. The differences of swell heights for these two months at the three latitudes were plotted. This is reproduced in Fig. 3.

3.4. *Period and direction*

As mentioned earlier period and direction of swells were not always recorded. They were available only for some synoptic hours. The period of swells both for the onset of and during the monsoon the period remained between 8 and 9 secs, for all three latitudes.

An analysis of the direction of swells in the first phase over equator showed that it was same at all three latitudes and it varied between S and SE. Thus the swells can be imagined to have originated from south of equator under the influence of southeast trades and then travel northwards and cross the equator and even 2°N latitude from the same direction.

Direction of swells during the last week of July 1977 at the stationary polygon gave a different picture. Available observations are plotted in Fig. 5. It will be seen that swells are southerly in 2° South latitude and generally northerly in the 2°N latitude. The direction of swells at equator itself is confused. It is sometimes southerly and sometimes northerly. Examination of synoptic charts and satellite pictures did not indicate any apparent connection with the disturbances in the equatorial region.

4. Conclusion

There is a small decreasing trend of swell height as we move from east to west between 92° E to 68° E around the time of onset of monsoon. The swell heights are always more to the south of equator than to the north. There is a decreasing trend of height for swells as the monsoon progresses to the north. The period of swells were 8 to 9 secs in general. Direction of swells over equatorial region is S/SE-ly around the time of onset of monsoon. The northern side of equator shows a variability in direction after the monsoon settles.

Acknowledgement

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