

Swells in the Bay of Bengal associated with storms in November

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ABSTRACT. The observations of swell and wind from ships in the Bay of Bengal in and adjacent to a storm field charted on synoptic maps were combined to form a composite chart keeping the position of the various observations relative to the centre and direction of movement of the storm the same. It is observed from these charts drawn for different storms in the month of November that (1) over all regions of the storm, the direction of the wind and the swell are generally inclined in such a way that an observer facing the direction in which the swell moves finds the wind blowing from a direction which is inclined to his right, (2) there is comparatively larger difference in the direction of the swell and that of the wind in the front left sector of the storm field, (3) Eliot's conclusion that the direction from which the swell is experienced outside the storm area nearly coincides with the direction of movement of the storm centre does not hold so well in the right rear quadrant as in the other regions.

1. Whenever two layers of fluid lie in contact with each other and one moves faster than the other, the faster moving layer throws the other into waves. Waves are produced over the surface of the sea when wind blows steadily for some time. The magnitude of these waves depends upon the extent of water area over which the winds blow and their force. Cyclonic storms over the sea are accompanied by strong winds which blow over the water surface and, therefore, generate waves sometimes as high as 30 to 40 feet with a wavelength of nearly 200 to 500 feet. Waves that are produced in this manner are called swells; swells travel steadily on-wards in the same general direction with a speed depending upon their wavelength and are felt at places where there are no actual storm winds. The swell is generally distinguished by its relatively smooth undulating form without the steep and ragged crests, characteristics of waves actually driven by the wind, and its direction of motion does not bear any relation with the direction of wind at the place of observation. The average velocity of the centre of tropical cyclonic storms is of the order of about 12 miles per hour and as the swell advances with velocity considerably exceeding this, the increasing swell is observed at a station much in advance

of the approaching storm. This important subject has been discussed by a number of writers (Reid, Cornish Vaughn and Cline—see references).

Eliot (1890), in his *Handbook of Cyclonic Storms in the Bay of Bengal*, has made the following inferences regarding the swells observed in the Bay of Bengal—

“(1) If a cyclonic storm has formed in the Bay of Bengal, it is a kind of centre from which waves or swell tend to pass out in all directions, and the direction from which the swell is experienced on any part of the coast of the Bay outside the storm area nearly coincides with the direction or bearing of the storm centre.”

“(2) Again, it is evident that the strength of the swell or the distance at which it will be sensibly felt in the open sea, will depend partly upon the strength of the producing winds, and partly upon the distance over which the producing winds act with no considerable change of direction. The former, of course, depends upon the intensity of the winds and hence upon the intensity of the cyclone, and the latter almost entirely upon its extent. Thus, the severe easterly winds of a small but intense cyclone may give rise to a heavy swell at the same distance from

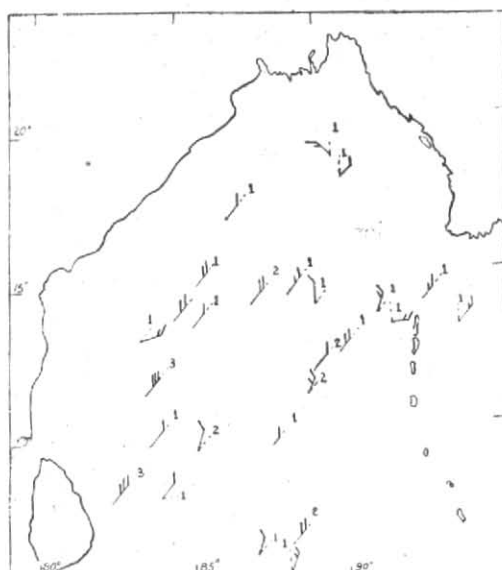


Fig. 1. 17-22 November 1934

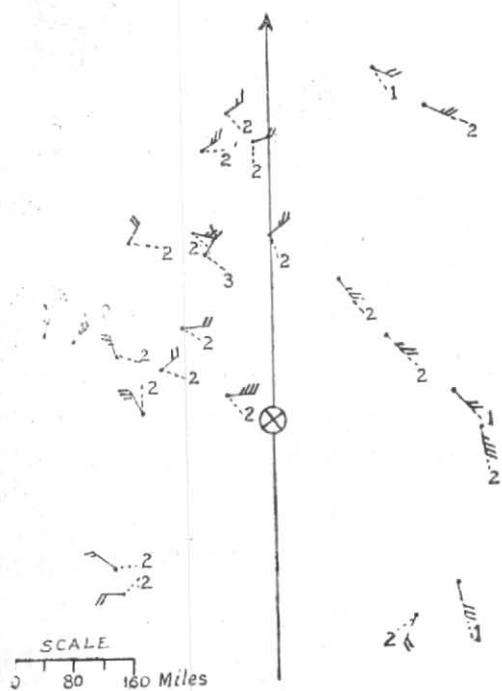


Fig. 2. 14-16 November 1933

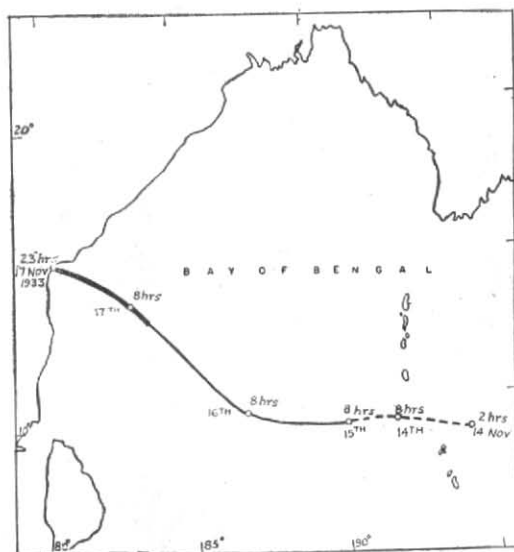


Fig. 2(a). 14-17 November 1933

the centre as the moderate strong easterly winds of a much larger but shallower depression. Hence, with a certain amount of experience, the strength of the swell due to a distant cyclone may not only serve as a rough guide to its bearing, but also to its character (*i.e.*, its size and intensity)".

In confirmation of the conclusions stated above, he has given certain examples from the logs of vessels of the swells experienced by them in cyclonic storms in the Bay together with the data showing their distance from the storm centre and the bearing of the storm centre for comparison with the direction of the swell.

2. The above conclusions and the examples in support of them, are for swells on the coast of the Bay outside the storm area. An attempt was, therefore, made to examine the distribution of both the swell and the wind with reference to the storm centre over all regions including the storm field. Comparatively larger number of storms occur in the Bay of Bengal during the pre-monsoon months of April and May and the post-monsoon months of October and November. Four storms, in the month of November were selected for the examination:

(i) 14 to 17 November 1933, (ii) 5 to 9 November 1934, (iii) 6 to 11 November 1938 and (iv) 21 to 25 November 1938.

A composite chart was prepared for each storm by combining the observations on various days. For this a long arrow to indicate the direction of movement of the cyclone was drawn through a point which represented the storm centre (Fig. 2) and this was oriented on each synoptic map so that the point was on the centre of the storm and the direction of the arrow coincided with the direction of movement of the storm at that moment. In this position, the direction and

state of swell*, and direction and force of wind were plotted. This was similarly transferred from all the synoptic charts for the particular storm and the observations from the various ships in the storm field copied to form the composite chart. These observations were charted only for those days when the storm was sufficiently far out at sea. Figs. 3, 4 and 5 are similar charts for different storms. Figs. 2(a), 3(a), 4(a) and 5(a) are their corresponding tracks in the Bay of Bengal.†

A composite chart for the swell and wind in the Bay of Bengal was also drawn for the month of November for a few days when the weather was not disturbed. This is shown in Fig. 1. In this case, the data from ships for the various days were simply plotted on the same chart.

3. During the period 17 to 22 November 1934, when the weather was not disturbed in the Bay of Bengal, the northeast monsoon was blowing over practically the whole of the Bay of Bengal. It is observed from the chart drawn from this period (Fig. 1) that the direction of the wind and the swell are approximately the same. The reports of the state of the swell appear to indicate, though not conclusively, that in the northern region of the Bay from where the winds blow, the swell is low and that it becomes of moderate height with the increased travel of the wind over the sea.

From Figs. 2 to 5 which show the relation between the wind and swell during a storm, it is seen that over all the regions of the storm, the direction of wind and the direction of motion of swell are generally inclined in such a way that an observer looking in the direction in which the swell moves finds that the wind is blowing from a direction which is inclined towards his right. This is to be expected as the swell originated by the wind

*The state of swell is indicated by 1, 2 or 3 accordingly as it is low, moderate or heavy

†In these figures, broken line indicates that winds of force 8 on B.S. had not been reached in any part of the cyclone, thin line indicates that wind force 8 or 9 on B. S. had been reached and thick line indicates that wind had attained hurricane force.

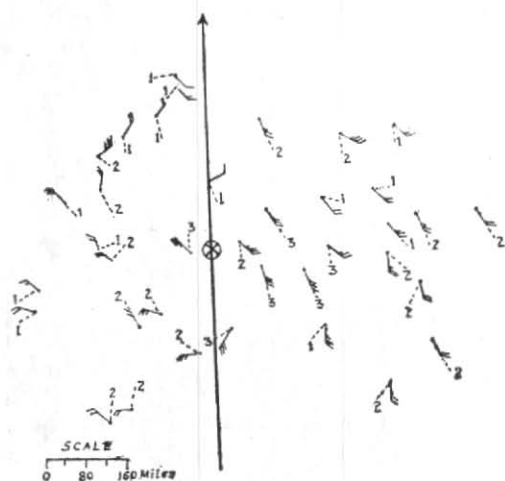


Fig. 3. 5-8 November 1934

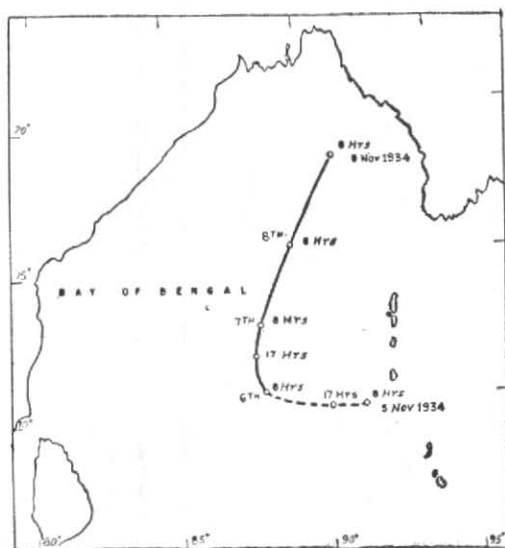


Fig. 3(a). 5-9 November 1934

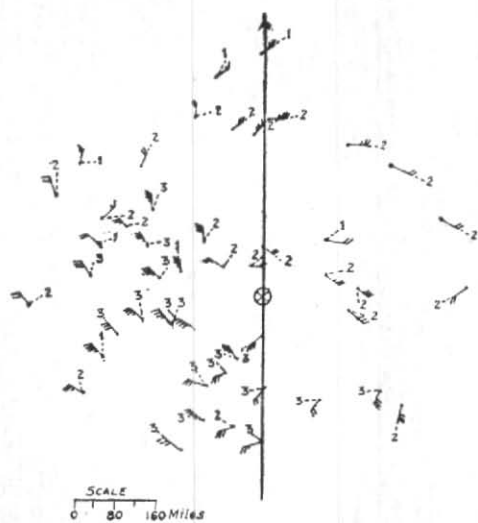


Fig. 4. 6-10 November 1938

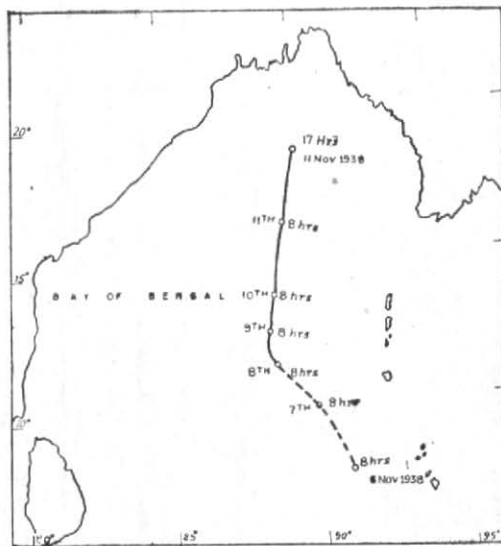


Fig. 4(a). 6-11 November 1938

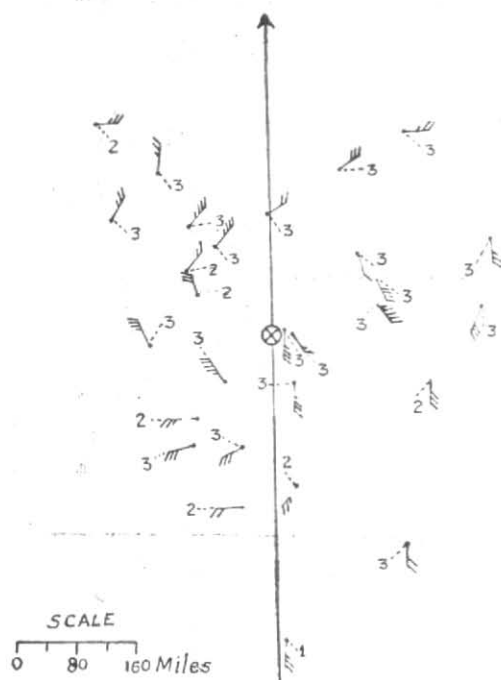


Fig. 5. 21-23 November 1938

moves on, while the wind moves anti-clockwise in the storm. This is also observed from the examples quoted by Eliot in support of his inferences mentioned in previous paragraphs.

Another interesting observation from Figs. 2 to 5 is that the difference between the directions of the swell and wind is not the same in all the quadrants of the storm. It generally appears to be the greatest in the front left sector of the storm field. The in-

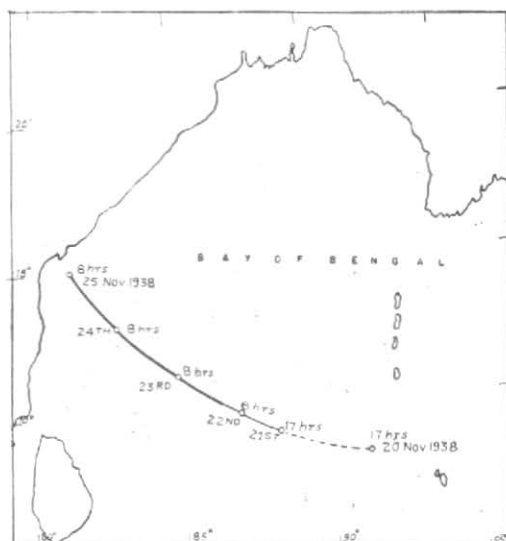


Fig. 5(a). 20-25 November 1938

fluence of the wind in the right hand sector of the storm is greater as the wind is also moving in the direction of the storm and as a result the swell is more in the direction of the wind in this sector than on the left. The reasons for the observed largest difference in the direction of the wind and that of the swell in the front left quadrant are not clear.

Figs. 2 to 5 indicate to what extent Eliot's conclusions, that the direction from which the swell is experienced outside the storm area nearly coincides with the direction of the storm centre, holds in the case of these storms. There seems to be most agreement to the above conclusions only in the front left quadrant, while the right rear quadrant shows the most disagreement to the above conclusions.

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