A Comparative Study of Wave Forecasting Techniques

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1. Introduction

Knowledge of wave forecasting is becoming more and more important due to its numerous applications in naval operations, rescue operations, coastal engineering, and erosion problems. Until now, only a few comparative studies[1,2,3] of the different methods of wave forecasting have been made. Analysis of New Jersey storm data showed that in general the Pierson-Neumann method[4] gives lower values of wave heights than the observed ones. The best approximation to the observed wave heights are those found by the Sverdrup-Munk-Bretschneider (SMB) method.[5] The times of occurrence of maximum wave height in both methods tally fairly well with the observed ones. A discussion of the analysis of Point Arguello storm data appears below.

The general superiority of one method over another has not yet been established. So far as the author knows no comparison of Wilson's[6] graphical method has been made with the other methods of wave forecasting. In this study two (Point Arguello, 26–29 Oct. 1950, and New Jersey, 4–7 May 1948) extratropical cyclones were chosen for the comparative study. Analysis using Wilson's procedure for both of these storms has been done by the author.

2. Discussion of results

a) *Wave hindcasts for Point Arguello, California, for 26–29 October 1950 (Fig. 1).* The peak storm was two hours earlier in the SMB forecast, sixteen hours later in Darbyshire's forecast,[2] six hours later in Pierson-Neumann forecast[3] and nearly six hours later in Wilson's forecast,[7] than the recorded values. The peak height was nearly coincident in the SMB forecast, 2.5 ft less in Darbyshire's forecast, 6.5 ft higher in the Pierson-Neumann forecast and 3 ft higher in Wilson's forecast than the recorded maximum wave height.

The wave height is approximately proportional to the square of the wind velocity.[6] In the case of the SMB, Darbyshire or Pierson-Neumann method the wind velocity is averaged over a large area and then the wave height is determined, while in the case of Wilson's method the actual growth of wave height is followed in different velocity zones. Hence an error in the height determination caused by an error in the wind field will be greater in the case of Wilson's method of forecasting than in other methods. In the present analysis to reduce the geostrophic wind to the surface wind, a procedure[8] was used based on empirical relations, which in the author's opinion are not sufficiently accurate.

The average error in the significant wave period obtained from different methods of wave forecasting is nearly the same in all cases.

b) *Wave hindcasts for Long Branch, New Jersey, for 4–7 May 1948 (Fig. 2).* In the analysis of this storm by the SM method,[9] good height agreement was obtained by a deliberate choice of forecast parameters within the range of their possible values. Every effort was made to get the observed and forecast values to agree.

The time of maximum wave height from Wilson's method coincides fairly well with that of the recorded values.

The wave recording instrument in the above case was a step resistance gage type. It might be mentioned that in such instrument the low period waves are not filtered out and hence the significant wave heights obtained from the record are bound to give a lower value than in the case of pressure type recorder. If a correction for

[1] Kaplan, K., and T. Saville, Jr., 1954: Comparison of hindcasts and observed waves along the northern New Jersey coast for the storm of Nov. 6–7, 1953. Beach Erosion Board, Office, Chief of Engineers, Washington, Bulletin, Vol. 8, No. 3.

[2] Datz, M., 1953: Comparison of deep water wave forecasts by Darbyshire and Bretschneider methods and recorded waves for Point Arguello Calif., 26–29 Oct. 1950. Beach Erosion Board, Office, Chief of Engineers, Washington, Bulletin, Vol. 7, No. 4.

[3] Dearduff, R. F., 1955: A comparison of deep water wave forecasts by the Pierson-Neumann, the Darbyshire, and the Sverdrup-Munk-Bretschneider methods with recorded waves for Point Arguello, California for 26–29 Oct. 1950. Beach Erosion Board, Office, Chief of Engineers, Washington, Bulletin, Vol. 9.

[4] Pierson, W. J., G. S. Neumann and R. W. James, 1953: Practical methods for observing and forecasting ocean waves by means of wave spectra and statistics. Bureau of Aeronautics, Project AROWA Technical Report No. 1, New York University.

[5] Bretschneider, C. L., 1952: Revised wave forecasting relationships. Proceedings, Second Conference on Coastal Engineering, Engineering Foundation, U. S. A.

[6] Wilson, W. B., 1955: Graphical approach to the Forecasting of waves in moving fetches. Beach Erosion Board, Corps of Engineers, Tech. Report No. 95–1.

[7] Srivastava, P. S., 1955: Comparison of wave hindcasts, using Wilson's method, with observations and with other hindcast methods. M. S. Thesis submitted to the Texas A & M College, College Station, Texas.

[8] Arthur, R. S. 1945: Procedure for computing surface wind velocity. Scripps Institution of Oceanography, Wave Report 35, La Jolla, Calif.

[9] Arthur, R. S., 1951: Technique for forecasting wind waves and swell. H. O. Pub. No. 604.

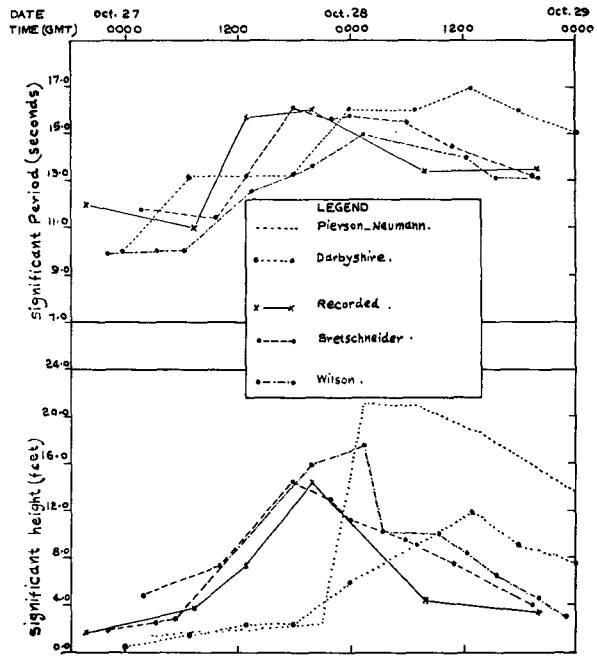

FIG. 1. Comparison of deep water wave forecasts and recorded waves for Point Arguello, Calif., 26–29 October 1950.

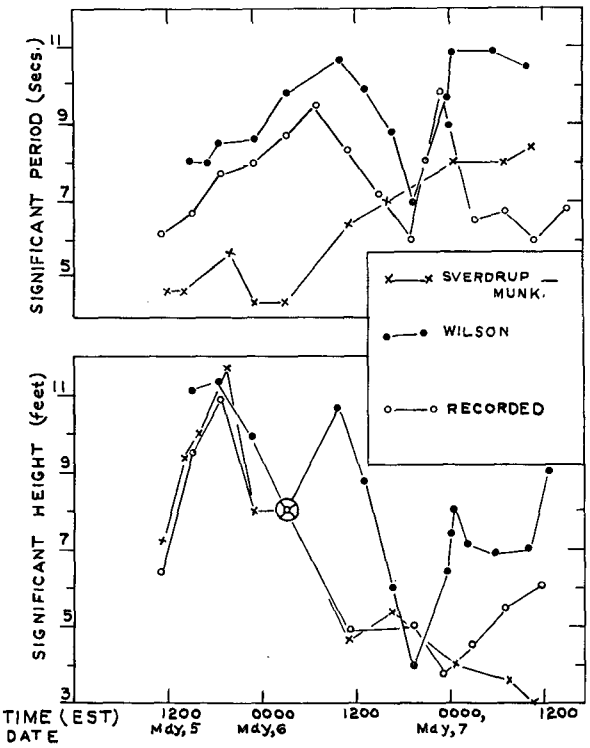

FIG. 2. Calculated period and height of waves at Long Beach, N. J.

this effect was taken into account then some improvement would result between the adjusted observed wave heights and the calculated wave heights after 0300 EST, 6 May, but would give less agreement prior to this time. The wave recorder in the above case was operated for seven minutes every four hours. Nothing can be said with certainty of what was happening in the time intervals between observations. It is not clear whether the secondary high forecast obtained by Wilson's method did occur in nature or was a failure of the forecasting curves. The secondary high can also occur due to error in any portion of the derived wind field.

The periods calculated by Wilson's method are definitely better than those obtained by the SM method.

3. Conclusion

The significant wave heights and periods, calculated by Wilson's method, in general show a tendency towards higher values than those recorded. In the case of cyclonic storms, off the west coast (26–29 October 1950), and the east coast (5–7 May 1948) there is a fairly good agreement in the arrival time of the calculated peak height at the coast with the recorded peak height time. This discrepancy between recorded values and the calculated values might be due to an error in the wind field or the forecasting curves. Further analysis must be made before a definite conclusion can be reached in this regard. The present investigation, although it represents only an indicative sample, has pointed out that further study in connection with existing methods of establishing the wind field must be made.

The results of the present analysis seem to indicate that the simple Sverdrup-Munk-Bretschneider method give a better result than all the other existing methods.

The author also suggests that some method, other than an envelope curve, of taking the weighted mean of the calculated wave heights and periods along different radial lines should be adopted. In his view an envelope curve is bound to give a higher value than the recorded ones, since it results in waves of different heights and periods coming from different directions merging into one.

To get the weighted mean of the wave parameters a greater number of starting points than in the present analysis should be chosen on the field.

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