IMPROVEMENT IN THE NATIONAL WEATHER SERVICE'S NORTH ATLANTIC WAVE FORECASTS

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1. INTRODUCTION

The Weather Service Forecast Office (WSFO), Washington, DC, makes weather forecasts for the North Atlantic Ocean. The area of responsibility for high seas forecasting is north of 32 degrees N and west of 35 degrees W. Expected conditions of waves are included in the marine forecasts. Forecast guidance material available to the marine forecasters includes the automated wave forecasts of the Techniques Development Laboratory (TDL).

A special forecast and verification program was established at the WSFO in September 1973 to evaluate the automated wave forecasts and the manually produced wave forecasts of the WSFO. Summaries of the forecasts for waves are prepared each month. The verification for January 1978 showed the smallest mean absolute error for 36-h wave forecasts of the TDL for any January since the verification program was started in 1973. The error of 2.4 feet was considerably lower than the previous January low of 3.40 feet, which was set in 1976.

These automated 36-h wave forecasts (2) are based on 1000-mb wind forecasts (adjusted for atmospheric stability as a function of wind direction) of the National Meteorological Center's (NMC's) Primitive Equation (PE) model. The finer scale seven-layer Primitive Equation (7LPE) model (3) replaced the previous six-layer Primitive Equation (6LPE) model (4) on January 19, 1978. Speculation was aroused that perhaps the low mean absolute error of the wave forecasts was the result of improved wind forecasts of the new 7LPE model, even though the model was used for only about a third of January 1978. It was decided to carefully follow the wave forecast verification for the other 11 months of 1978.

The results of the verification of the 1978 wave forecasts compared to earlier forecasts were presented at the recent Second Conference on Coastal Meteorology of the American Meteorological Society by Pore and Brown (5). The comparison showed the 1978 wave forecasts to be better than those during the 1973-1977 period and it was suggested that the improved wave forecasts resulted from improved performance of the new 7LPE model over that of the previous model. We now have an additional year (1979) of forecasts to add to the verification statistics. This paper is therefore an updated report on the wave forecast verification results.

2. THE FORECAST AND VERIFICATION SYSTEMS

The forecast areas for this program are 10 circular areas in the North Atlantic north of 32 degrees N and west of 35 degrees W. These circular area have radii of 2-1/2 degrees and are shown in Figure 1. For the verification times of 0000GMT and 1200GMT, forecasts of significant wave height are made. The two types of forecasts discussed will be referred to as:

36-h TDL wave: Automated wave forecasts based on PE model winds, and

24-h WSFO wave: Marine Forecaster, WSFO Washington, wave forecasts.

The 36-h TDL wave forecast is defined as the average significant wave height forecast for the circular area and is taken from the TDL wind-wave charts. The WSFO forecasts are essentially 24-h forecasts.

Verification of the forecasts is made by comparing forecasts to averages of ship observations of waves in the circular areas. Verification is done only for those circular areas in which there are two or more ship reports. The number of forecasts that have been verified has varied considerably from year to year; the average is about 1500 per year.

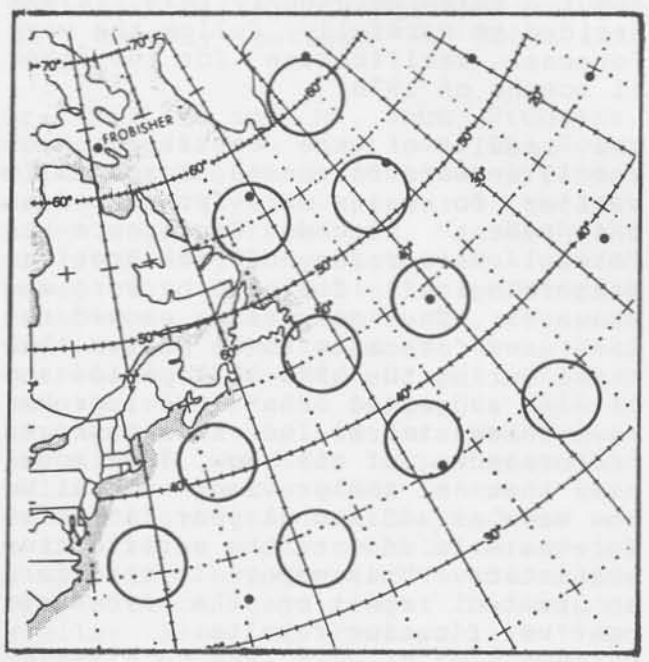

Figure 1. The 10 circular areas in the North Atlantic Ocean for which special wave forecasts are verified.

3. VERIFICATION SCORES OF 1978-1979 FORECASTS COMPARED TO SCORES OF 1973-1977

The mean absolute errors for each of the two types of forecasts were compared for each month since the beginning of the forecast verification program in September 1973. The years in which record monthly low values of mean absolute error in the wave forecasts were recorded are shown in Table 1 for both the 36-h TDL wave forecasts and the 24-h WSFO wave forecasts. The years of 1978 and 1979 had record low mean absolute errors for 10 months of the year for the 36-h TDL wave forecasts and for 8 months for the 24-h WSFO wave forecasts. This shows new low forecast errors for most months since the implementation of NMC's 7LPE model.

Table 1. Years from 1973 through 1979 which had the lowest monthly mean absolute errors of 36-h TDL wave forecasts and 24-h WSFO wave forecasts.

Month	36-h TDL Wave	24-h WSFO Wave
Jan	1978	1978
Feb	1976	1976
Mar	1979	1979
Apr	1979	1976
May	1977	1977
Jun	1979	1977
Jul	1978	1978-79
Aug	1978	1979
Sep	1979	1979
Oct	1979	1979
Nov	1978	1978
Dec	1979	1979

Another measure of improved forecasts during 1978 and 1979 is the percentage of forecasts with zero error. To be considered perfect, the wave forecasts, which are made to the nearest foot, must agree with the average of the wave observations in the circular forecast area. Table 2 shows the percent correct for the two types of wave forecasts. Both types of forecasts, the 36-h TDL wave and the 24-h WSFO wave, were made correctly a significantly larger percentage of the time in 1978 and 1979 than they were during the years of 1974 through 1977.

The mean absolute errors for the years 1974 through 1979 for both the 36-h TDL wave forecasts and the 24-h WSFO wave forecasts are shown in Figure 2. Here it is evident that both types of forecasts were better during 1978 and 1979 than they were during the previous 4 years.

Table 2. Percentage of correct forecasts for the 36-h TDL wave forecasts and the 24-h WSFO wave forecasts.

Year	36-h TDL Wave	24-h WSFO Wave
1974	18	23
1975	21	22
1976	17	22
1977	18	22
1978	23	27
1979	23	28

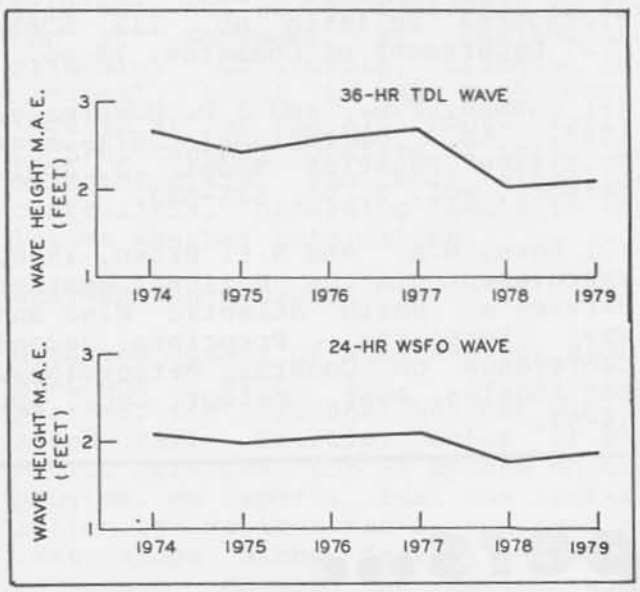

Figure 2. Annual values of mean absolute error of 36-h TDL wave forecasts and 24-h WSFO wave forecasts for the years 1974 through 1979.

Average monthly values of mean absolute error were determined for the period of September 1973 through 1977 for both types of forecasts. These were then compared to the average monthly values of mean absolute error for 1978 and 1979. Graphs of these comparisons are shown in Figures 3 and 4. Highlights of these curves are:

the mean absolute errors of the 36-h TDL wave forecasts were lower for every month of the period 1978-79 than for the period September 1973 through 1977; and,

the mean absolute errors of the 24-h WSFO wave forecasts were lower for eleven months of the year of the time 1978-79 than for September 1973 through 1977.

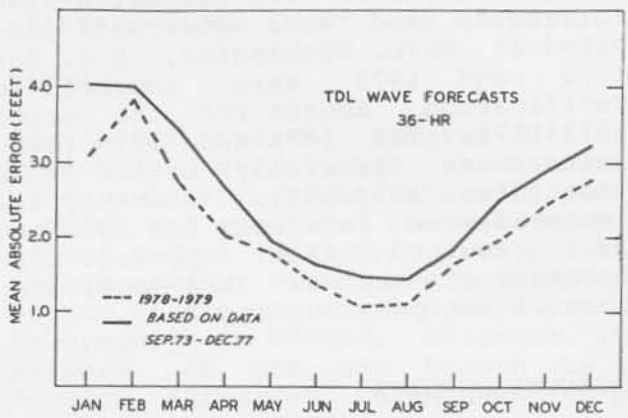

Figure 3. Average monthly values of mean absolute error of 36-h TDL wave forecasts for the periods of September 1973 through 1977 and January 1978 through 1979.

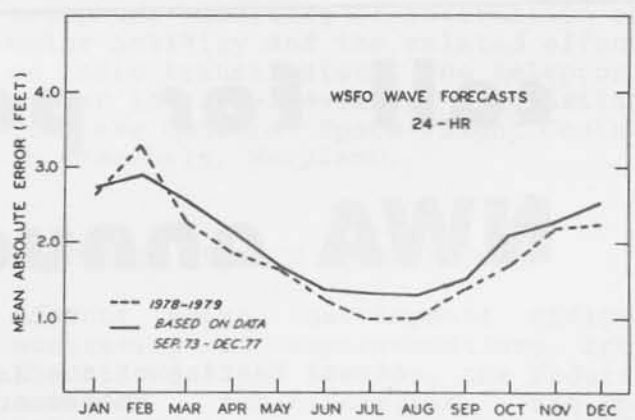

Figure 4. As in Figure 3 except for 24-h WSFO forecasts.

Comparison of Figure 3 to Figure 4 indicates a rather high correlation between the mean absolute errors of the 36-h TDL wave forecasts and the 24-h WSFO wave forecasts. This brings up the subject of how much the 36-h TDL wave forecasts are used as guidance by the WSFO marine forecasters in preparing the 24-h WSFO wave forecasts. Although the TDL wave forecasts are used as guidance, the extent of application depends on experience of the forecasters and knowledge of bias of the PE model. In

any case, the curves of Figure 4 show consistent improvement of the 24-h WSFO forecasts over the automated 36-h wave forecasts.

4. SUMMARY

Yearly and monthly values of mean absolute error of TDL automated wave forecasts, and wave forecasts prepared at WSFO, Washington, D.C. for 1978 and 1979 were compared to verification scores for the period 1973-1977. The 1978 and 1979 forecasts were generally better than those for 1973-1977. Probably the improved wave forecasts for 1978 and 1979 resulted from improved performance of the new 7LPE model over that of the previous model.

ACKNOWLEDGMENTS

The authors acknowledge the marine forecasters of the National Weather Service Forecast Office, Washington, D.C., for their participation in the North Atlantic wind and wave forecast verification program.

REFERENCES AND FOOTNOTES

(1) Former affiliation: National Weather Service Forecast Office, Washington, D.C.

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