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VERIFICATION OF OCEAN WAVE FORECASTS BY THE SINGULAR AND SPECTRAL METHODS

N. Arthur Pore

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1. INTRODUCTION

The NOAA/Navy Cooperative Study Group Subcommittee on Marine Prediction has been considering issues such as meteorological and oceanographic data exchange between the Fleet Numerical Oceanography Center (FNOC) and the National Meteorological Center (NMC) and atmospheric and oceanographic modeling. This includes the exchange of numerical products between NMC and FNOC.

On the division of responsibilities, the Subcommittee has recommended that FNOC be responsible for the oceanographic modeling in the World Ocean and that NMC be responsible for both atmospheric and oceanographic modeling over North America and in coastal and offshore areas of North America.

The agreement for FNOC to provide World Ocean products has led to the decision that the ocean wave forecasts of FNOC will replace similar NMC products developed by the Techniques Development Laboratory (TDL) of the National Weather Service (NWS). The FNOC wave model is a directional wave spectral model, whereas the TDL model is a simpler singular wave model. The singular wave model produces forecasts, for each grid point, of a wind-wave component and a swell component. The forecasts include height, period, and direction of travel of the significant waves. The spectral wave model produces, for each grid point, forecasts of the wave energy spectrum. Wave energy is computed for 15 wave frequency bands and for 12 directional arcs of 30 degrees. From the wave energy spectra, such properties as significant wave height can be computed.

At an NWS meeting in October 1979, TDL agreed to look into a comparison of the wave forecasts by the two models. The purpose was not to determine which model is better, as it is well known that the spectral model considers the physics of wave generation and propagation more precisely than the singular wave model. The purpose is simply to document a comparison before the singular wave forecasts are discontinued. Subjective comparison of forecast charts of significant wave height has shown both methods to forecast wave centers of about the same magnitude in the same areas. Of course, the forecasts of both models depend very heavily upon the wind input to the models. Therefore any comparison of wave forecasts is not just a comparison of wave models but also of the wind forecasts used by the models. The comparison of wave forecasts described in this note is not necessary to decide which type of forecasts to use in the NWS; that decision has already been made.

2. THE DATA AND THE METHOD

The period of wave forecast verification started about the time of the NWS meeting last October. It was decided to verify 24- and 48-h forecasts of significant wave height against wave observations of the NOAA data buoys.

Listings of the observations from the data buoys were obtained. For those buoys with a wave observation an effort was made to obtain the NWS singular wave forecast and the FNOC spectral wave forecast. The locations of the buoys which were considered are shown in Fig. 1. Note that most of the Atlantic buoys did not have wave observations during this period. The NWS wave forecasts for the North Atlantic and North Pacific were obtained from listings of wind-wave and swell forecasts for the nearest grid point to the buoy locations. Values of combined wave forecasts were computed to compare to the buoy observations. For the Gulf of Mexico, forecasts of wind-wave height at the buoy location were obtained directly from the contoured wave forecast charts as transmitted on the DIFAX Faxsimile System. Wave forecasts of the FNOC spectral forecast model were obtained from contoured wave forecasts charts of significant wave height.

The values of both the NWS and the FNOC wave forecasts were tabulated to the nearest foot. The significant wave heights of the buoy observations are expressed to the nearest half meter. It is felt that this difference in observation and forecast units does not invalidate the comparison.

Because of the limited resources devoted to this task, the verification of wave forecasts could not continue for a very long period. The period of verification was October 14 through November 15, 1979. For a case to be considered, we had to have three values available--the wave observation from the buoy, the NWS significant wave height forecast, and the FNOC significant wave height forecast. For the period of verification, the number of cases used was 101 for the 24-h forecasts and 107 for the 48-h forecasts.

3. RESULTS

For the period of October 14 through November 15, forecasts of significant wave height by FNOC and NWS wave programs were verified with data buoy wave observations. Values of mean algebraic error, mean absolute error, and root-mean-square-error were determined. These verification statistics are shown in Table 1.

The observations ranged from 1 to 11 half-meters (1.6 to 18.0 feet). The values of mean algebraic error show the NWS forecasts to be too low and the FNOC forecasts to be too high. Perhaps the best forecasts would have been the means of the two. The mean absolute errors and the root-mean-square-errors of the NWS forecasts are slightly lower than those of the FNOC forecasts. This verification study was made on a limited data sample and the statistics should be viewed cautiously.

4. SUMMARY

The Techniques Development Laboratory has done a limited verification study of the NWS singular wave forecasts and the FNOC spectral wave forecasts. Values of 24- and 48-h forecasts of significant wave height were compared to NOAA data buoy wave observations. The purpose of the verification was to make some comparison of the two types of forecasts before the NWS wave forecast program is discontinued. This will occur when the NWS adapts the FNOC wave forecasts for its high seas forecast responsibilities. The verification statistics show the NWS forecasts to be slightly low and the FNOC forecasts to be slightly high. The values of mean absolute error and root-mean-square-error show the two forecast types to have about the same accuracy with slightly larger errors in the FNOC forecasts.

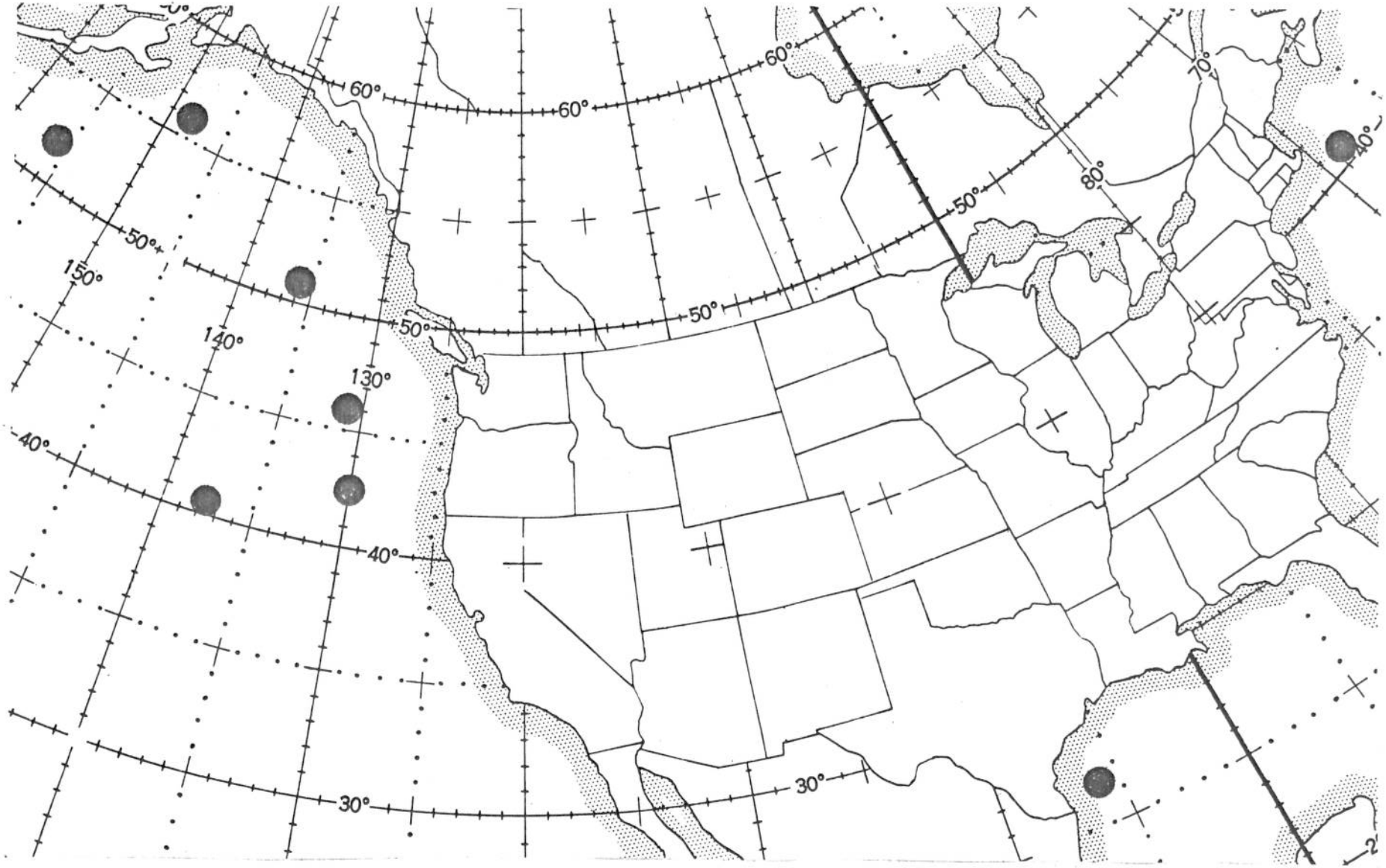

Figure 1. The locations of the buoys with wave observations which were used for the verification of wave forecasts.

Table 1. Verification statistics of Fleet Numerical Oceanography Center and National Weather Service 24- and 48-h forecasts of significant wave height for the period of October 14 - November 15, 1979. All errors are in feet.

Forecast Type	Observed Mean	Mean Algebraic Error	Mean Absolute Error	Root-Mean-Square-Error	Number of Cases
FNOC 24-h	7.49	+1.76	3.33	4.03	101
NWS 24-h	7.49	-2.90	3.27	3.91	101
FNOC 48-h	7.85	+2.49	4.48	6.07	107
NWS 48-h	7.85	-3.16	3.65	4.51	107