Extended Forecasting

SOME NEW PROGRAMS IN OPERATIONAL EXTENDED WEATHER FORECASTING

James F. Andrews (1)
Intercon Weather Consultants, Inc.
4700 Auth Place, Suite 305
Suitland, MD 20746

ABSTRACT

This report examines the accuracy of winter operational forecasts of temperature and wind speed for daily projections of 4 to 9 days, and of 5-day mean temperature for the period 10 to 14 days in advance. The daily forecasts were better than climatology out to about day 9 for temperature and to day 6 for wind. Skill over persistence was shown for the 10 to 14 day mean temperature predictions.

1. INTRODUCTION

Industrial users of weather forecasts have frequently expressed the need for improvement, especially of forecasts in the longer ranges. The gas and electric utility industry is one such user that makes considerable use of climatic and operational weather forecast information. In recent years there has been a steady improvement in the National Meteorological Center's (NMC) 3 to 5 day weather forecasts (2); much of this can be related to implementation of the global spectral model (3). Early awareness of this improvement, particularly in temperature, led to several operational forecast programs conducted primarily for the Washington (D.C.) Gas Light Company (WGL) by Intercon Weather Consultants, Inc. (IWC).

2. NINE-DAY TEMPERATURE AND WIND FORECASTS

The first of these programs, undertaken during the 1980-81 heating season, was for daily projections of 4 to 9 days, where day 1 is the day on which the forecasts are prepared. (The NMC considers day 1 to be the day after forecast preparation.) Weather parameters forecast were daily minimum, maximum and average temperature. Also included were forecasts of average daily wind speed, considered by the gas utility industry to be important with temperature for daily gas sendout. The purpose of this program was to determine the daily limit of skill over climatology and to see whether the extended forecasts had economic value to clients. Forecasts were prepared twice weekly using guidance from NMC's global spectral model run at 0000 GMT. A more detailed description of this program, including procedure, forecast examples and verification, has been described previously (4, 5). The gas control superintendent of WGL found these extended forecasts to be of considerable use in managing the company's gas storage supply, thus leading to an estimated saving of several million dollars to its customers. As a result, this forecast service was continued during the 1981-82 heating season.

Little difference was found in skill of the forecasts between the two winters. Verifications for both heating seasons have been combined and are shown in Figure 1 for temperature and Figure 2 for wind speed. Because of the rather limited data sample, a smoothed version of the skill curve has been added to each graph. It can be seen (Figure 1) that the average daily temperature forecasts had skill to about day 9 when compared with a forecast of climatology.

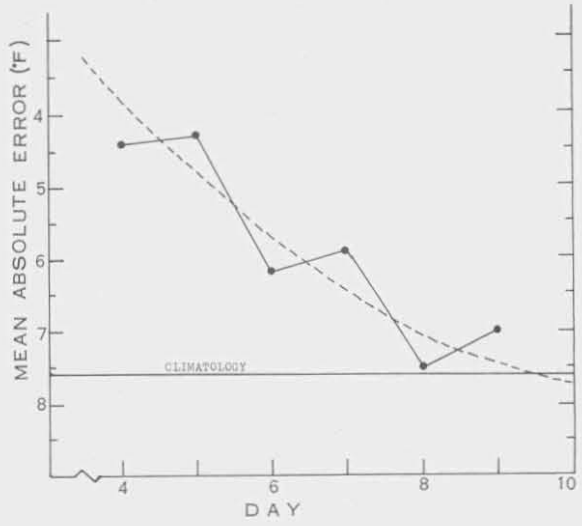

Figure 1. Mean absolute error (°F) for 61 extended temperature forecasts (solid) and smoothed version of skill curve (dashed) for Washington, D.C., December 1980-March 1981 and December 1981-February 1982, for projections of 4 to 9 days. Error produced by a forecast of climatology is shown as a horizontal line.

The average daily wind speed forecasts were verified by placing the forecast speed (mph) into one of three equally likely classes (above, near, or below normal), then computing the percentage of correct forecasts as a function of time (Figure 2). Moderate skill was shown in these forecasts through day 5, but then the skill fell rapidly to near climatology by days 7-8.

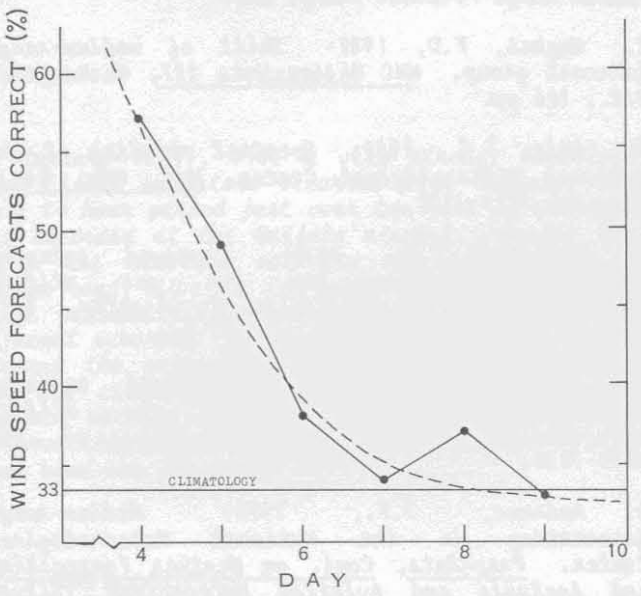

Figure 2. Percentage of 61 extended average daily wind speed forecasts in correct class of 3 (above normal, near normal, below normal) (solid), and smoothed version of skill curve (dashed), for Washington, D.C., for projections of 4 to 9 days. Forecasts were prepared for periods December 1980-March 1981 and December 1981-February 1982. Percent correct based on a forecast of climatology is shown as a horizontal line.

3. MEAN TEMPERATURE OUTLOOK FOR DAYS 10 TO 14

Initial success of the 9-day forecasts led to another operational forecast program during the winter of 1981-82. This program consisted of a mean temperature forecast for the 5-day period ending 14 days in advance. It was undertaken to determine whether there was skill in predicting the trend in temperature after 9 days. For this effort it was necessary to employ a mean map technique since 9 days is assumed to be about the limit of skill for daily temperature forecasts. The 5-day period was chosen because it has been a standard extended forecast period in the National Weather Service since 1940. Furthermore, the statistical tools and necessary techniques had already been developed in NMC's currently operational 6 to 10 forecast program (6, 7).

These forecasts, or outlooks, were part of the 9-day extended forecast package transmitted twice weekly to WGL. The forecasts were expressed in one of three equally likely classes - above normal, near normal or below normal. Five-day mean temperature class limits have been derived for Washington, D.C. such that departures from normal of 3°F or higher are in the above class, and -3°F or lower are in the below class. Guidance used in these forecasts was NMC's global spectral model run to 252 hr (10 days). Two 500mb mean charts for the Northern Hemisphere were available, for days 1-5 and days 6-10. The basic procedure involved identifying and locating the primary 500 mb height anomaly centers over and near North America during the first two pentads (days 1-10), and then extrapolating the movement and changes of those centers to the third pentad (days 10-14). In order to do this considerable use was made of the latest teleconnection charts of mean circulation anomalies (8). These charts indicate the cross-correlations between distant circulation anomalies associated with a given key or primary anomaly center. After the expected general circulation pattern for the 10-14 day period had been estimated, reference was made to another statistical aid. This aid relates the key circulation anomaly centers with conditional probabilities of 5-day temperature classes (unpublished atlases available in NMC). The entire procedure involved considerable subjectivity and was helped by the author's long career in extended forecasting and experience with time-averaged charts.

Table 1 gives the verification of the 10-14 day mean temperature forecasts for Washington, D.C., prepared December 1981-February 1982, in the form of a standard contingency table. Note that there were 14 correct forecasts (along diagonal) out of a possible 26, giving a skill score (S) of 29. This score was computed using the formula:

$$S = \frac{R - E}{T - E} \times 100 \quad (1)$$

		Forecast			
		Below	Normal	Above	Total
Observed	Below	6	1	2	9
	Normal	1	5	4	10
	Above	3	1	3	7
	Total	10	7	9	26
Skill Score = 29					

Table 1. Verification of 10 to 14 day mean temperature forecasts for Washington, D.C. prepared December 1981-February 1982.

where R is the number of correct forecasts, T the total number of forecasts, and E the number of correct forecasts expected by climatology (9). Two persistence controls were utilized for this program. The first, and more standard control, consisted of the mean temperature anomaly class observed during the 5 days prior to forecast day, and assumed to extend unchanged to days 10-14. This persistence-based forecast had a skill score of -9 (only 7 forecasts correct). The second control, and one more difficult to improve, consisted of NMC's mean temperature forecast for days 1-5, and extended to days 10-14. This forecast was not available to IWC until the following day. Five of these forecasts were missing (computer program failure), but 9 were correct out of the available 21, giving E = 7 and S = 14 in Equation (1). Thus, the 10-14 day mean temperature forecasts were better than either a forecast of persistence or climatology. We hasten to add, however, that these results, while very encouraging, may not be representative of future performance because of the small forecast sample.

4. SUMMARY

Implementation of a global spectral model at the NMC has improved extended forecasts during winter to the point where daily temperature forecasts are now better than climatology to about day 9, and average daily wind speed forecasts are better than climatology thru day 6. Mean temperature forecasts for days 10 to 14 have shown skill over a forecast of persistence for one winter season. At least one gas utility found these extended forecasts to be of considerable use, resulting in an estimated annual saving of several million dollars to its rate-payers.

ACKNOWLEDGEMENT

The helpful comments of my colleague Dr. W.H. Klein are most appreciated.

REFERENCES AND FOOTNOTES

1. Mr. Andrews is a consulting meteorologist with Intercon Weather Consultants where he is in charge of forecast operations. He holds the B.S. degree from Rutgers University and the M.S. degree from New York University. His entire career has been in extended forecasting. In 1980 he retired from the National Weather Service after 38 years of service. His last position was that of Chief, Medium Range Forecast Group, NMC.

2. Hughes, F.D, 1982· Skill of medium-range forecast group. NMC Office Note 227, Washington, D.C., 106 pp.

3. Sela, J.G., 1980· Spectral modeling at the National Meteorological Center, Mon. Wea. Rev., 108, pp. 1279-1292.

4. Andrews, J.F., 1981· Improved extended weather forecasts· how one gas utility benefited. Public Utilities Fortnightly, Vol. 108, No. 4, 13 August 1981, pp. 57-64.

5. Andrews, J.F., 1982· Improved extended weather forecasts· how one gas utility benefited. Bull. Amer. Meteoro. Soc., 63, pp. 1035-1039.

6. Andrews, J.F., 1978· Medium-range forecasting in the National Meteorological Center. Preprints, Conf. on Weather Forecasting and Analysis and Aviation Meteorology (Silver Spring), AMS, Boston, pp. 13-19.

7. Ships, J.A., 1979· Use of numerical guidance in medium-range forecasting at the National Meteorological Center. Preprints, Fourth Conf. on Weather Analysis and Forecasting (Silver Spring), AMS, Boston, pp. 98-106.

8. Namias, J., 1981· Teleconnections of 700mb height anomalies for the Northern Hemisphere. California Cooperative Oceanic Fisheries Investigations, Atlas 29, 265 pp.

Our Newsline Editor is interested in obtaining any news items of interest to operations meteorologists. If anyone sees or hears of such news, please consider sending it (with the source identified) to:
Dennis McCarthy
1621 Dawnbreak Court
St. Charles, MO 63301