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USE OF MODEL OUTPUT STATISTICS IN
AUTOMATED PREDICTION OF SURFACE WINDS

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INTRODUCTION

National Weather Service forecasters serving aviation, fire weather, agriculture, air pollution, and public weather are involved in the prediction of surface winds. However, numerical guidance for this element has, in the past, been available for only 79 stations in the Eastern United States (1).

The Techniques Development Laboratory has now developed a method for producing objective forecasts of surface wind for the conterminous United States for projections of 12 to 48 hours in advance. Wind estimate equations have been derived for 233 stations by use of Model Output Statistics (2), a technique which consists of determining a statistical relationship between a predictand and variables forecast by a numerical model.

PROCEDURE

Observed surface winds during the warm seasons of 1970-72 were statistically related to variables, primarily from NMC's primitive equation model, by use of the screening regression technique. As shown in Table 1, potential predictors include forecast values of U and V wind components, wind speed, geostrophic winds, constant pressure heights, relative vorticity, vertical velocity, mean relative humidity, temperature, potential temperature, and stability at various projection times, smoothings, and levels throughout the atmosphere. The sine and cosine of the day of the year were also included. In addition, U and V wind components, wind speed, and cloud cover from surface synoptic reports available six hours after PE model input time were screened for the initial projection.

One group of equations was derived for the 0000 GMT run and another group for the 1200 GMT run of the PE model. Each group included wind estimate equations for seven projections (i.e., 12,18,24,30,36,42, and 48 hours). Furthermore, back-up equations free of observed predictors were derived for the initial projection in order to handle those situations where surface observations are missing or garbled.

Some constraints were imposed on the selection of predictors. For any given station and projection, the three equations for the U and V wind components and the wind speed all contain the same 10 predictors, but have different regression coefficients and regression constants, as illustrated in Table 2. Further, the first three predictors were forced to be the boundary layer U and V wind components and the wind speed forecast by the PE model for the valid time of the wind predictand. The remaining seven predictors were selected by using the meteorological variable for which the variance of any one of the three predictands was reduced by the largest amount.

RESULTS

In order to evaluate this system, wind estimate equations were derived for the 20 widely distributed stations which are depicted in Figure 1. The dependent data sample consisted of 303 days from the warm seasons (April-September) of 1970-71.

For these 20 stations, the various wind components were found to be of major importance as illustrated by Table 3 for the 18 hour forecast from 0000 GMT. The frequency of selections of relative vorticity and mean relative humidity indicate that they were also of significance.

VERIFICATION

The equations were evaluated for each day in April and May of 1972 for which data were available. The wind forecasts for the same 20 stations in the NWS official terminal (FT) forecasts were used for comparison purposes. It was assumed that the NWS forecasters had 0900 GMT surface observations available for input. As noted before, the MOS equations had 0600 GMT surface observations available for the initial projection forecast.

Since the FTs do not mention wind if the speed is expected to be less than 10 knots, the comparison was made in two ways. For all those cases where the FTs included wind and for which objective forecasts were available, the mean absolute error (MAE) of direction (computed from the U and V equations) and speed (direct from the speed equation) and the bias (mean forecast minus observed) of speed were computed. Also for all cases when the FTs and objective forecasts were available, contingency tables for speed were prepared by considering the FT forecast of wind to be under 10 knots when wind was not mentioned. From these contingency tables, which had categories of less than 10, 10-12, 13-17, 18-22, and greater than 22 knots, skill scores and percent correct were computed. These scores are presented in Table 4.

As indicated by the MAE computations in Table 4, the objective forecasts were superior to the FT's for both direction and speed at 1800 and 2400 GMT. The FT forecasts of direction were better than the MOS estimates at 1200 GMT; however, MOS forecasts were better than the FT's for speed.

CONCLUSION

Verification of wind forecasts from warm season equations on independent data for a sample of 20 stations indicates that the MOS technique is as accurate as FT wind forecasts. Based on these results, equations for 233 stations were derived from the entire warm season data sample (approximately 480 days from 1970-1972). These equations were implemented on an operational basis on May 22, 1973. Automated forecasts for 233 stations are available on teletypewriter on a request/reply basis through the Kansas City Switch. The forecasts are updated twice daily at approximately 0700 and 1900 GMT.

Similar forecasting equations are being derived and tested from cool season data (i.e., October-March of 1969-1973). Additional information pertaining to surface wind forecasting equations based on MOS is contained in NWS Technical Procedures Bulletins No. 86 (3) and No. 93 (4).

REFERENCES

1. Technical Procedures Bulletin No. 50, "Operational Forecasts with the Subsynoptic Advection Model (SAM)--No. 8," June 12, 1970.

2. Glahn, H. R., and D. A. Lowry, 1972: "The Use of Model Output Statistics (MOS) in Objective Weather Forecasting," J. Appl. Meteor., 11, 1203-1211.

3. Technical Procedures Bulletin No. 86, "Surface Wind Forecasts Based on Model Output Statistics (MOS)--No. 1," April 6, 1973.

4. Technical Procedures Bulletin No. 93, "Surface Wind Forecasts Based on Model Output Statistics (MOS)--No. 2," June 21, 1973.