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# ESSA Technical Memorandum WBTM TDL 32

U.S. DEPARTMENT OF COMMERCE  
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION  
Weather Bureau

## Computer-Produced Worded Forecasts

HARRY R. GLAHN

Systems  
Development Office

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Harry R. Glahn



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## COMPUTER-PRODUCED WORDED FORECASTS

Harry R. Glahn

## ABSTRACT

Examples of worded weather forecasts prepared entirely by computer are presented. Forecasts of the individual elements are produced objectively with input from the PE and SAM models used operationally at the National Meteorological Center. Possibilities for the use of automated worded forecasts are discussed.

## INTRODUCTION

With the implementation of numerical weather prediction at the Weather Bureau's National Meteorological Center (NMC) in the mid-1950s, the routine forecasting of atmospheric circulation parameters was put on a firmer scientific basis than was possible before the advent of high-speed electronic computers. Since that time, much progress has been made in improving numerical forecasts of atmospheric circulation, and predictions of certain other meteorological variables are now being made by dynamic models (Cressman 1963 and Shuman and Hovermale 1968).

However, dynamic models in operation today do not predict the individual elements necessary for a forecast for most users—for instance, maximum temperature, cloudiness, probability of precipitation, and surface wind. These elements must be inferred from available data and the forecasts made by the dynamic models.

Much progress has also been made in objectively estimating these "weather" elements by statistical methods (Glahn 1965). Automated forecasts of maximum and minimum temperature (Klein, Lewis, and Casely 1967) which are being transmitted to field stations have only one-half to one degree larger mean absolute error than local Weather Bureau Forecasts. Objective forecasts of probability of precipitation have been produced operationally during the last 18 months and have proven slightly more accurate than the official forecasts (Glahn and Lowry 1969). Regression estimates of surface wind have been shown to be more accurate than the wind forecasts in the local Terminal Forecasts (FTs) for 10 stations over a 2-month period (Glahn 1970) and will soon be transmitted to the field as part of the SAM (Glahn, Lowry, and Hollenbaugh 1969) bulletin.

In short, we will soon be able to make objective estimates of all weather elements which are included in routine public weather forecasts with about the same accuracy as those now being made by local forecasters. We already can do this for many stations in the eastern United States for the first (today) forecast period.

With this capability, it is natural to think of packaging these forecasts in a manner acceptable to the final user—the public. This report gives examples of completely automated, worded forecasts and indicates future possibilities.

## WORDED FORECASTS

Regression equations were developed for estimating surface wind, cloudiness, maximum temperature, probability of precipitation, and conditional (on precipitation occurring) probability of frozen precipitation for each of four stations: Atlanta, St. Louis, Washington, and New York. The predictors used were a portion of those variables forecast by the PE (Shuman and Hovermale 1968) and SAM (Glahn, Lowry, and Hollenbaugh 1969) models—namely, relative humidity, saturation deficit, 1000-mb geostrophic wind, sea level pressure, 500-mb wind and height, precipitation amount, and 1000- and 500-mb temperature. These variables were interpolated to the particular stations involved, and in some cases were put into binary form.

A computer program was written which put the forecasts produced by these equations into worded form. Examples are shown in figures 1-3; the corresponding surface synoptic maps for 1200 GMT (the beginning of the forecast period) are in figures 4-6.

The forecasts are introduced in the same manner as are the WE6-1212 telephone forecasts. The element deemed most important is put first; otherwise, the order of the elements depends somewhat on the forecasts themselves and how they best fit together. An "important" or "significant" element is defined to be: wind of 20 mph or greater, probability of precipitation of 35 percent or greater, maximum temperature  $10^{\circ}\text{F}$  above or below yesterday's maximum, or maximum temperature near yesterday's maximum but  $8^{\circ}\text{F}$  or more below the climatological maximum.

A significant difference between the format of the computerized forecasts and forecasts now being prepared operationally is that in the former, the probability of precipitation is put into the main body of the text rather than being tacked onto the end. Also, the probability of rain and probability of snow are both included and can be added to yield a probability of precipitation. This form of presentation would, I believe, be acceptable to the public after a short period of education. However, if necessary, the present operational form could be programmed.

I don't wish to dwell on the details of the computer program which produces the worded forecasts shown in figures 1-3. The important point is that once objective forecasts are available in the necessary quantity and quality, worded forecasts can be composed and produced entirely by computer.



MAR 6, 1970

TDL EXPERIMENTAL FORECASTS

GOOD MORNING. THE SYSTEMS DEVELOPMENT OFFICE BRINGS YOU THE LATEST FORECAST FOR WASHINGTON, D. C. AND VICINITY. STRONG NORTHERLY WINDS THIS MORNING 20 MPH WITH GUSTS TO 30 MPH BECOMING NORTHERLY 5 MPH BY EVENING. COLDER TODAY, MAXIMUM TEMPERATURE 48 DEGREES. MOSTLY CLOUDY THIS MORNING WITH DECREASING CLOUDINESS THIS AFTERNOON. ONLY 2 PERCENT PROBABILITY OF PRECIPITATION TODAY.

GOOD MORNING. THE ESSA WEATHER BUREAU BRINGS YOU THE LATEST FORECAST FOR ATLANTA AND VICINITY. MOSTLY SUNNY THIS MORNING WITH A FEW MORE CLOUDS THIS AFTERNOON. COLDER TODAY, MAXIMUM TEMPERATURE 62 DEGREES. NORTHERLY WINDS 15 MPH THIS MORNING BECOMING NORTHEASTERLY 5 MPH BY LATE AFTERNOON. ONLY 2 PERCENT PROBABILITY OF PRECIPITATION TODAY.

GOOD MORNING. THE TECHNIQUES DEVELOPMENT LABORATORY BRINGS YOU THE LATEST FORECAST FOR ST. LOUIS AND VICINITY. PARTLY CLOUDY WITH LITTLE CHANGE IN TEMPERATURE TODAY, HIGH OF 58 DEGREES. EASTERLY WINDS 5 MPH THIS MORNING BECOMING NORTHEASTERLY 10 MPH BY LATE AFTERNOON. ONLY 2 PERCENT PROBABILITY OF PRECIPITATION TODAY.

GOOD MORNING. THE SYSTEMS DEVELOPMENT OFFICE BRINGS YOU THE LATEST FORECAST FOR NEW YORK JFK AND VICINITY. PARTLY CLOUDY AND COLDER TODAY, MAXIMUM TEMPERATURE 43 DEGREES. NORTHERLY WINDS 15 MPH, WITH ONLY 5 PERCENT PROBABILITY OF RAIN AND 5 PERCENT PROBABILITY OF SNOW.

Figure 1.--Automated forecast for March 6, 1970.

MAR 17, 1970

## TDL EXPERIMENTAL FORECASTS

GOOD MORNING. THE TECHNIQUES DEVELOPMENT LABORATORY BRINGS YOU THE LATEST FORECAST FOR WASHINGTON, D. C. AND VICINITY. MOSTLY SUNNY THIS MORNING WITH A FEW MORE CLOUDS THIS AFTERNOON. SOMEWHAT WARMER TODAY, MAXIMUM TEMPERATURE 47 DEGREES. NORTHWESTERLY WINDS OF 5 MPH THIS MORNING BECOMING LIGHT AND VARIABLE BY AFTERNOON. ONLY 2 PERCENT PROBABILITY OF PRECIPITATION TODAY.

GOOD MORNING. THE TECHNIQUES DEVELOPMENT LABORATORY BRINGS YOU THE LATEST FORECAST FOR ATLANTA AND VICINITY. PARTLY CLOUDY THIS MORNING BECOMING CLOUDY THIS AFTERNOON. LITTLE CHANGE IN TEMPERATURE TODAY, HIGH OF 53 DEGREES. SOUTHEASTERLY WINDS 15 MPH, WITH 15 PERCENT PROBABILITY OF RAIN AND 2 PERCENT PROBABILITY OF SNOW.

GOOD MORNING. THE TECHNIQUES DEVELOPMENT LABORATORY BRINGS YOU THE LATEST FORECAST FOR ST. LOUIS AND VICINITY. 65 PERCENT PROBABILITY OF SNOW AND 20 PERCENT PROBABILITY OF RAIN TODAY. CONTINUED COLD, MAXIMUM TEMPERATURE 39 DEGREES. CLOUDY WITH EASTERLY WINDS 15 MPH THIS MORNING BECOMING NORTHEASTERLY 10 MPH BY LATE AFTERNOON.

GOOD MORNING. THE ESSA WEATHER BUREAU BRINGS YOU THE LATEST FORECAST FOR NEW YORK JFK AND VICINITY. CONTINUED COLD TODAY, MAXIMUM TEMPERATURE 39 DEGREES. MOSTLY SUNNY WITH WESTERLY WINDS 10 MPH. ONLY 10 PERCENT PROBABILITY OF SNOW TODAY.

MAR 21, 1970

## TDL EXPERIMENTAL FORECASTS

GOOD MORNING. THE SYSTEMS DEVELOPMENT OFFICE BRINGS YOU THE LATEST FORECAST FOR WASHINGTON, D. C. AND VICINITY. MUCH WARMER TODAY, MAXIMUM TEMPERATURE 57 DEGREES. PARTLY CLOUDY WITH NORTHWESTERLY WINDS 10 MPH THIS MORNING BECOMING 5 MPH BY LATE AFTERNOON. ONLY 2 PERCENT PROBABILITY OF PRECIPITATION TODAY.

GOOD MORNING. THE TECHNIQUES DEVELOPMENT LABORATORY BRINGS YOU THE LATEST FORECAST FOR ATLANTA AND VICINITY. 60 PERCENT PROBABILITY OF RAIN TODAY. MUCH COLDER, MAXIMUM TEMPERATURE 51 DEGREES. CLOUDY WITH NORTHEASTERLY WINDS 10 MPH.

GOOD MORNING. THE SYSTEMS DEVELOPMENT OFFICE BRINGS YOU THE LATEST FORECAST FOR ST. LOUIS AND VICINITY. 25 PERCENT PROBABILITY OF SNOW AND 20 PERCENT PROBABILITY OF RAIN TODAY. MOSTLY CLOUDY WITH MAXIMUM TEMPERATURE 44 DEGREES. LIGHT AND VARIABLE WINDS TODAY.

GOOD MORNING. THE TECHNIQUES DEVELOPMENT LABORATORY BRINGS YOU THE LATEST FORECAST FOR NEW YORK JFK AND VICINITY. PARTLY CLOUDY AND SOMEWHAT WARMER TODAY, MAXIMUM TEMPERATURE 47 DEGREES. WESTERLY WINDS 10 MPH, WITH ONLY 10 PERCENT PROBABILITY OF RAIN AND 2 PERCENT PROBABILITY OF SNOW.

Figure 3.--Automated forecast for March 21, 1970.

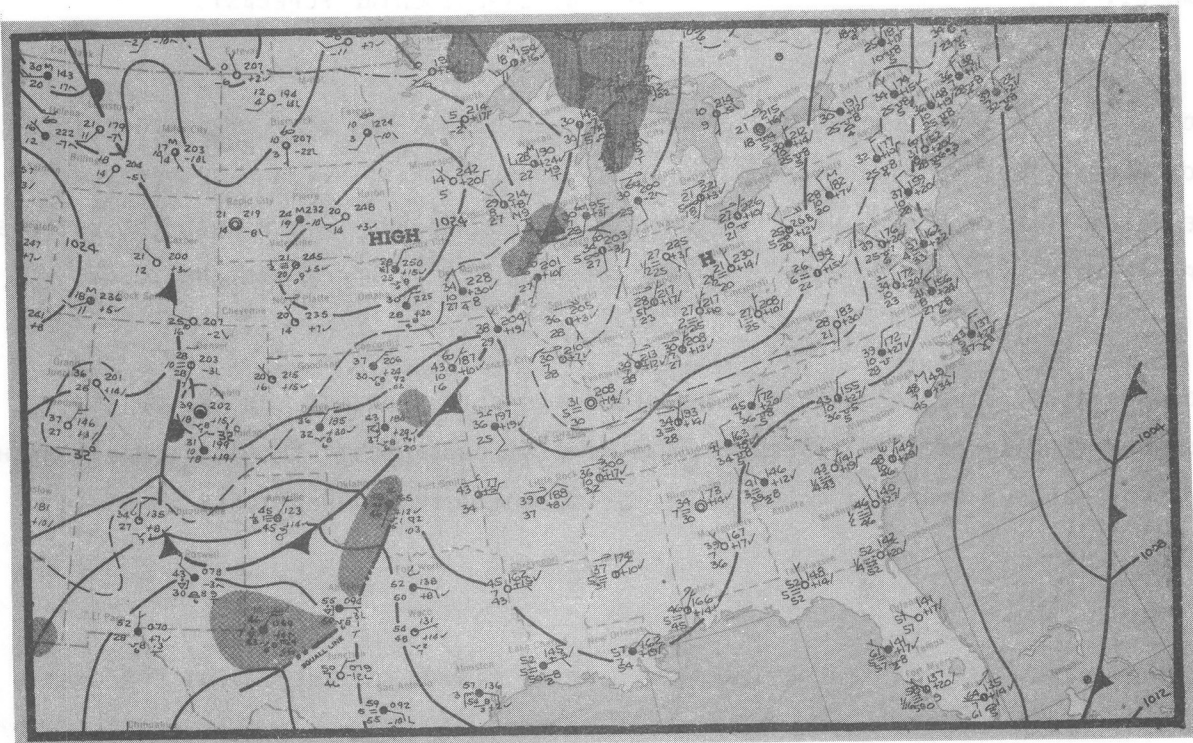


Figure 4.--Surface map for 1200 GMT, March 6, 1970.

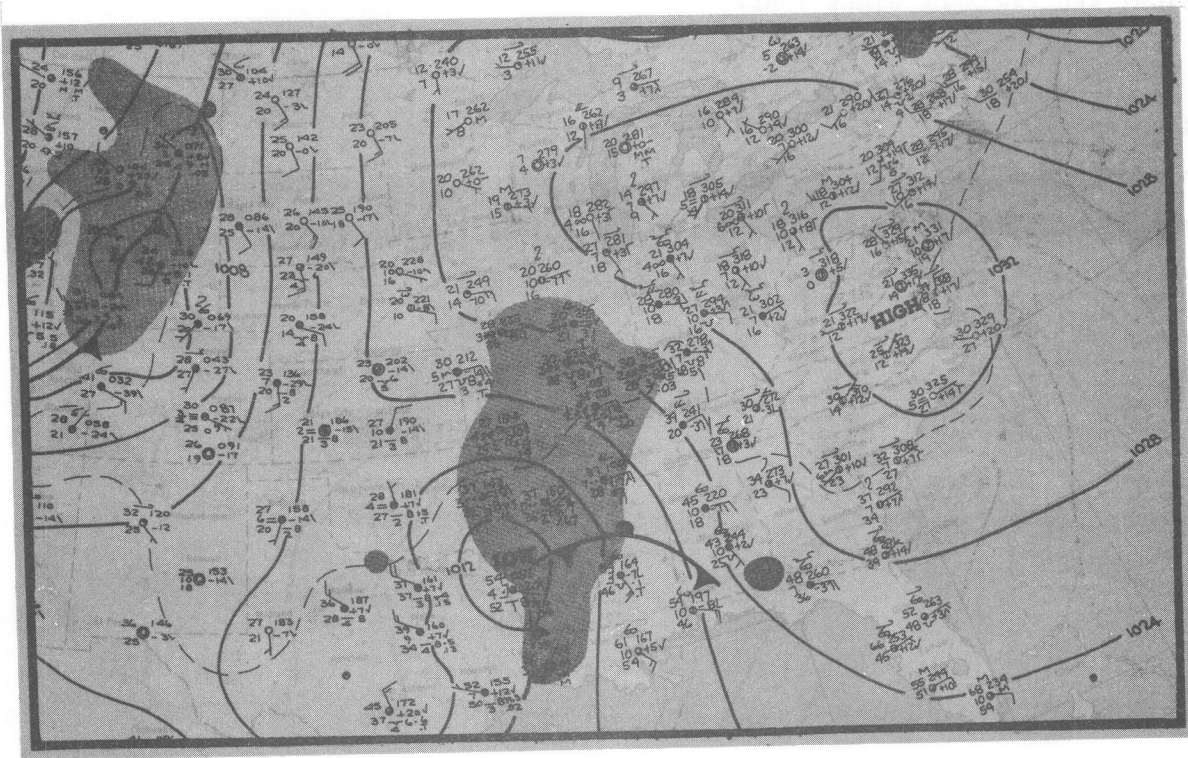


Figure 5.--Surface map for 1200 GMT, March 17, 1970.

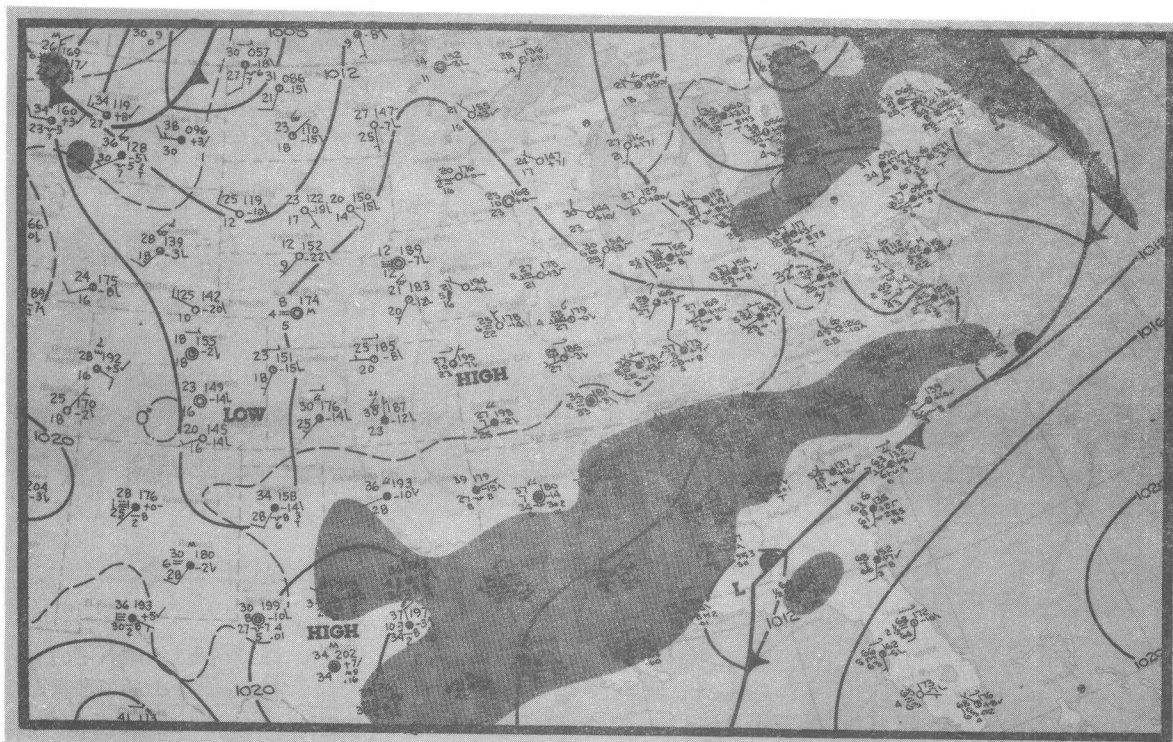


Figure 6.--Surface map for 1200 GMT, March 21, 1970.

#### CONCLUSIONS

Worded forecasts can be composed by computer. It is possible at the present time to produce forecasts for the today period in a form directly usable by the public for many cities in the eastern United States. Within about 3 years, this type of message could be available for cities throughout the United States for all three forecast periods.

Such forecasts could be monitored by local forecasters and modified as deemed desirable. In routine situations, probably little or no modification would be necessary; in unusual and more important synoptic situations, which the forecaster would now have additional time to analyze, more modification could be made.

Other types of forecast messages can also be composed by computer. For instance, the FTs for aviation can be rather easily composed once the objective forecasts of the individual weather elements become available.

Thus, as discussed by Klein (1969), the popular concept of the man-machine mix in weather forecasting can take on new aspects. The more routine duties can be handled by computer, thereby freeing the meteorologist for the more challenging roles of meteorological consultant and specialist on high-impact weather situations.

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The work reported in this paper was supported by many people, particularly those working directly on the SAM Project—Mr. Dale A. Lowry, Mr. George W. Hollenbaugh, Mrs. Evelyn Boston, Mrs. Jackie Hughes, and Ensign John Annett, USESSA. Their help is gratefully acknowledged.

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