FILE: 650.1 MEMO (Improving the Accuracy and Usefulness of Weather Forecasts) WASHINGTON, D.C. 6-10-65

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
WASHINGTON

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IN REPLY, PLEASE ADDRESS
CHIEF, U. S. WEATHER BUREAU
WASHINGTON 25, D. C.
AND REFER TO
MS-6.1

MEMORANDUM

TO : All Regional Directors

FROM : Director, National Meteorological Services

SUBJECT: Improving the Accuracy and Usefulness of Weather Forecasts

The most difficult problem confronting the Weather Bureau in its day to day forecasting operations is that of reducing the errors in weather forecasts to levels which fairly represent the current state of the science of meteorology and, hopefully, to levels which are acceptable to the using public. At the present time no one knows precisely where either of these levels should lie, and concrete measures which will determine acceptable error are not likely to be developed in the near future. In the meantime, we should make every effort to achieve the highest possible level of forecast accuracy and, at the same time, try to improve the usefulness of our forecasts by informing the public of the expected error or the uncertainty that is characteristic of the weather information provided.

Carefully designed programs aimed at improving weather forecasting technology are now underway in both the National Meteorological Center and the Systems Development Office. I am confident that improvements in forecast performance will result from both of these efforts, particularly in the forecasts of basic weather elements.

The problem of deriving and communicating the uncertainty that is bound to be present in all forecasting must also be addressed. There are a variety of ways in which this could be handled. Comprehensive, well-designed verification programs will provide many reliable performance measures; however, these often prove difficult for the average layman to understand or to use. I am inclined to think that the most practical way of communicating uncertainty to the user, therefore, is through the language of probability.

Many recent experiments involving the development and use of probability statements in weather forecasting have concluded that useful probability measures can be derived for weather forecasts, and that these can be communicated effectively to the public. I would like to see the Weather Bureau move into the use of probability concepts wherever appropriate in our weather forecasts, particularly in the wording of forecasts for phenomena that have important effects on public activity.

Prior to the introduction of such a program on a large scale, the public will need to be educated and indoctrinated on the meaning and use of probability statements. Some of our forecasters will also require brief training in methods for developing probability measures. The attached plan for a phased

program involving the widespread use of probability statements in precipitation forecasting is designed to assist Regional Offices in the development of a practical program for their respective regions.

When the probability of precipitation at a point is used, as in the attached proposal, the assignment of areal coverage to a particular precipitation event will be unnecessary in the Zone and Local Forecasts. Unless there are valid objections, we plan to discontinue also the use of areal coverage factors in the State Forecasts.

We anticipate that the Public Information Office at the C. O. will be able to supply appropriate releases to be made to the public prior to the introduction of probability forecasts. This will greatly assist in assuring public acceptance of the forecasts.

Please provide any comments and criticisms of this proposal that you feel are appropriate. Each comment will assist us in drafting the final plan which will be established this summer.

George P. Cressman

George P. Cressman

Attachment

A Plan For The Introduction of Probability Statements In Public Forecasts

1. Introduction -

This plan provides for a phased introduction of probability statements in connection with precipitation occurrence in all public forecasts. This proposed program is based on three assumptions: (1) that the present and foreseeable state-of-the art in precipitation forecasting is such as to permit only the prediction of the probability of the occurrence of a precipitation event (however it is defined); (2) that such predictions can be made with good reliability when the forecaster has accumulated sufficient experience; and (3) that such statements can be understood and used by the public after some brief indoctrination on probability concepts.

2. The Plan -

All stations presently preparing zone and local forecasts will begin on September 1, 1965 to assign routinely (on an experimental basis, not for public release) a probability measure to the event of precipitation, the definition of which is to be based on local criteria, in all forecasts that are prepared. Probability measures will be assigned for all periods up to 36 hours from data time, based on standard guidance materials received.

Probabilities will be assigned as <u>one</u> of the following set of permissible numerical values: 5<, 5, 10, 20, 30, ... 90, 95, >95. The values are to be expressed in percent, stated as "the probability of rain is ninety-five percent", etc. If the probability of precipitation is indicated to be below some threshold value, the value to be established locally depending on the climatology of precipitation and the characteristics of the public activities in the local geographical area, the probability of no rain or fair weather or whatever is appropriate, will be stated. The wording of a forecast in which rain probability is below the assigned threshold might be as follows: "Clear, today, tonight and tomorrow. Probability of fair weather greater than 95 percent." The probability of showers which fulfill the criterion established for a precipitation event will be expressed when it exceeds the threshold probability.

Guidance material for the assignment of precipitation probabilities is being prepared by NMC, on the new FAX Precipitation Charts (Surface Prog Package A and B, Weather Bureau Forecast Center Facsimile Circuit) and will be prepared by the FP Centers.

Probability guidance from the Forecast Centers will be furnished in FP-3. Guidance (when issuance of FP-3 is started later this summer) will be in the form of a numerical message making up the last line of FP-3. Format will be as follows:

$I_iI_iI_i \quad P_1P_1P_2P_2P_3P_3 \quad I_2I_2I_2 \quad P_1P_1P_2P_2P_3P_3 \ldots\ldots\ldots I_6I_6I_6 \ldots\ldots\ldots$

where III is the international index number of a major city in the FP area P_1P_1 is the probability of precipitation in the first twelve-hour period, P_2P_2 is the probability of precipitation in the second twelve-hour period and P_3P_3 is the probability for the third twelve-hour period. Up to six locations will be used to define the distribution of precipitation probabilities for each forecast center area. These may be fixed or varied according to the preference of the FP centers. In all cases, the probability indicated will be for any point in the smallest meteorologically homogeneous area that can be defined. The area is to be centered on the weather station designated by the index number. Likewise, the probability stated in the local or zone forecast will be applicable to any point in the smallest resolvable homogeneous area centered on an identifiable location in the forecast area. If more than one meteorologically homogeneous area can be defined, then probabilities should be assigned to these individually; for example: "in the southern portion rain probability 75 percent dropping to 50 percent in the northern part of the zone." Note that representative points will have to be associated with each of these areas if a meaningful verification and evaluation of the forecasts is to be conducted.

This experiment and test should be conducted for about six months at each station unless sooner terminated by the Regional Director. Termination of the experiment should be based on either of the following conditions:

(1) Evaluation of the results of the experiment by the Regional Director indicates acceptable performance levels have been attained and further trials are unnecessary. In this case, the station should be authorized to issue probability forecasts to the public provided proper acceptance by the public has been assured or

(2) evaluation of the program indicates it is impractical for use at a particular station and no further purpose is served in carrying on the experiment.

Regional Directors should monitor progress of forecast offices through implementation of a practical verification program. Results should be measured and reported in terms of some form of the so-called Brier Score (see forthcoming Note to Forecasters). When the performance revealed by the long period average and trend in the Brier score show that acceptable levels of skill are being attained, the decision can be made by the Regional Director to release to the public the probability forecasts prepared by the office in question.

When the preparation of probability forecasts on a trial basis has been terminated at all forecast offices in the region, this project will be closed and a brief report prepared by the Region on results achieved.