CRH SSD
OCTOBER 1987

CENTRAL REGION TECHNICAL ATTACHMENT 87-25

HOW TO USE MOS GUIDANCE EFFECTIVELY PART III

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Introduction

In this, the third in a series of Technical Attachments on how to use Model Output Statistics (MOS) effectively, I will discuss the MOS probability of precipitation (PoP) guidance. Probability forecasts are provided for the 12-hour periods of 12-24, 24-36, 36-48, and 48-60 hours after 0000Z or 1200Z. Also, within each 12-hour period, two corresponding 6-hour probability forecasts are provided. As mentioned in Parts I and II, significant MOS errors can occur even when the LFM is performing well. In my discussion I will focus on these types of errors because they can be difficult to diagnose.

Background and Definitions

A. Equations used to produce PoP forecasts are stratified into two seasons, warm and cool, valid April-September and October-March, respectively - this means that different sets of equations are used for each of the seasons. Seasonal stratification is done in order to try to take into account seasonal variations in weather patterns.

B. MOS PoP guidance is a regionalized system - this means the same equation produces the probability forecasts for a particular projection for a group of stations. Only the values of the predictors from the LFM model and the observed predictors vary from station to station. The regions used operationally for the warm (cool) season are shown in Fig. 1 (Fig. 2).

C. Corresponding 6-hour PoP equations are derived simultaneously with the appropriate 12-hour PoP equation. As a result, the three equations for each 12-hour period contain the same predictors, but the coefficients for each predictor are different. Simultaneous derivation is done in order to avoid inconsistent forecasts such as a 6-hour PoP being higher than the corresponding 12-hour PoP. Despite simultaneous derivation, inconsistencies still occur occasionally.

D. Although all MOS equations use predictors in continuous form, MOS PoP equations, in particular, use predictors in continuous and binary form. Continuous predictors are LFM or observed variables whose values are used directly by the equations. As a result, the MOS forecast changes linearly as the value of the predictor increases or decreases. Since some of the weather elements MOS forecasts, such as PoP, are not always linearly related with the LFM predictors used, we also use these predictors in binary form. Binary predictors are given a value of one if the original value of the predictor is less than or equal to a given binary limit, and zero otherwise. As a result, there could be a large change in the PoP if the forecast for a binary predictor was slightly different. For example, if the coefficient of a binary predictor in a given PoP equation has a value of -16%, then 16% will be subtracted from the PoP forecast when it is turned "ON" (has a value of one), and 0% will be contributed when it is turned "OFF" (has a value of zero).

E. The LFM mean relative humidity (MEAN RH) and precipitation amount (P AMT) forecasts are by far the most important predictors used by the MOS equations to forecast PoP. In the Eastern U.S., the MEAN RH is the more important of these two.

Tips and Guidelines

Because they are regionalized, MOS PoP equations, on the average, will tend to underforecast (overforecast) the PoP at stations that have a higher (lower) frequency of precipitation than the mean value for the region. Also, these equations generally do not take into account local effects such as precipitation caused by upslope flow, lake effect, etc., unless these influences are the same throughout the entire region. This occurs because equations developed for a group of stations reflect the mean of the stations within the region. What forecasters should do is examine the regions used by the MOS PoP forecast system and note any stations within a region that have a frequency of precipitation that is significantly different than the average for the region, or are effected by local factors not common to the remainder of the region. For these stations, the forecaster should then adjust the MOS PoP forecasts accordingly.

When a tight gradient in PoP forecasts exists between two nearby stations, examine the synoptic situation closely. The tight gradient may simply be the result of the binary predictor being turned "ON" at one station and "OFF" at another due to only a very small difference in the value of the predictor from one station to the other.

As already discussed, simultaneous equation development greatly reduces the number of inconsistent 6- and 12-hour PoP forecasts, but does not eliminate them entirely. When inconsistencies do occur, they are usually the result of unusual weather patterns. Over the years, I have noticed that the biggest cause of inconsistent PoP forecasts is a very rapid change in the LFM MEAN RH either very early or late in a 12-hour period. In this case (and in general when the 6-hour PoP is greater than the corresponding 12-hour PoP), the 6-hour PoP is usually the better forecast.

The LFM MEAN RH and P AMT forecasts are by far the most important predictors in the PoP equations for the Eastern Region. In most cases, the LFM MEAN RH dominates the equations to such a degree that it is very difficult to get a PoP above 30% unless the MEAN RH forecast is above 70%. As a result, many convective situations are underforecast because the LFM MEAN RH forecast is not above 70%, even if the MEAN RH forecast is accurate.

Equally as important as the predictors included in the equations are the predictors not included. This can reveal what type of event will not be forecast well due to the lack of certain predictors. Not included in MOS PoP equations are LFM sigma layer humidity forecasts and forecasts of any type of variable below the 850 mb level. This leads to the underforecasting of precipitation events where the moisture is generally confined to a particular level of the atmosphere (especially low level) or where the forcing mechanisms initiating the precipitation are below 850 mb. The underforecasting occurs most often during the warm season months because precipitation events are frequently caused by a low level moisture source and/or low level forcing mechanisms.

When all (or almost all) precipitation on a given day is expected to occur as a result of thunderstorms, the MOS 12-hour thunderstorm (TSTM) probability considered as a PoP forecast is usually better than the actual MOS PoP forecast, if the MOS PoP is lower (and it usually is lower under these conditions). The reason for this is that the TSTM equations use variables for predictors that are conducive to forecasting convection, whereas the PoP equations are predictors best suited to forecasting synoptic scale overrunning precipitation.

The most likely time for warm season precipitation in the Eastern Region is during the late afternoon and evening. Forecasters should keep in mind that the MOS 12-hour PoP forecasts are valid from 0000Z-1200Z and 1200Z-0000Z. Thus, the most likely period of precipitation is divided across two 12-hour PoP forecasts, rather than confined to one. As a result, these two 12-hour PoP forecasts may often be lower than a single 12-hour PoP forecast would have been if it was valid from 1800Z-0600Z.

Acknowledgements

I would like to thank the staff of the NWS Techniques Development Laboratory for its input and advice and for reviewing the manuscript.

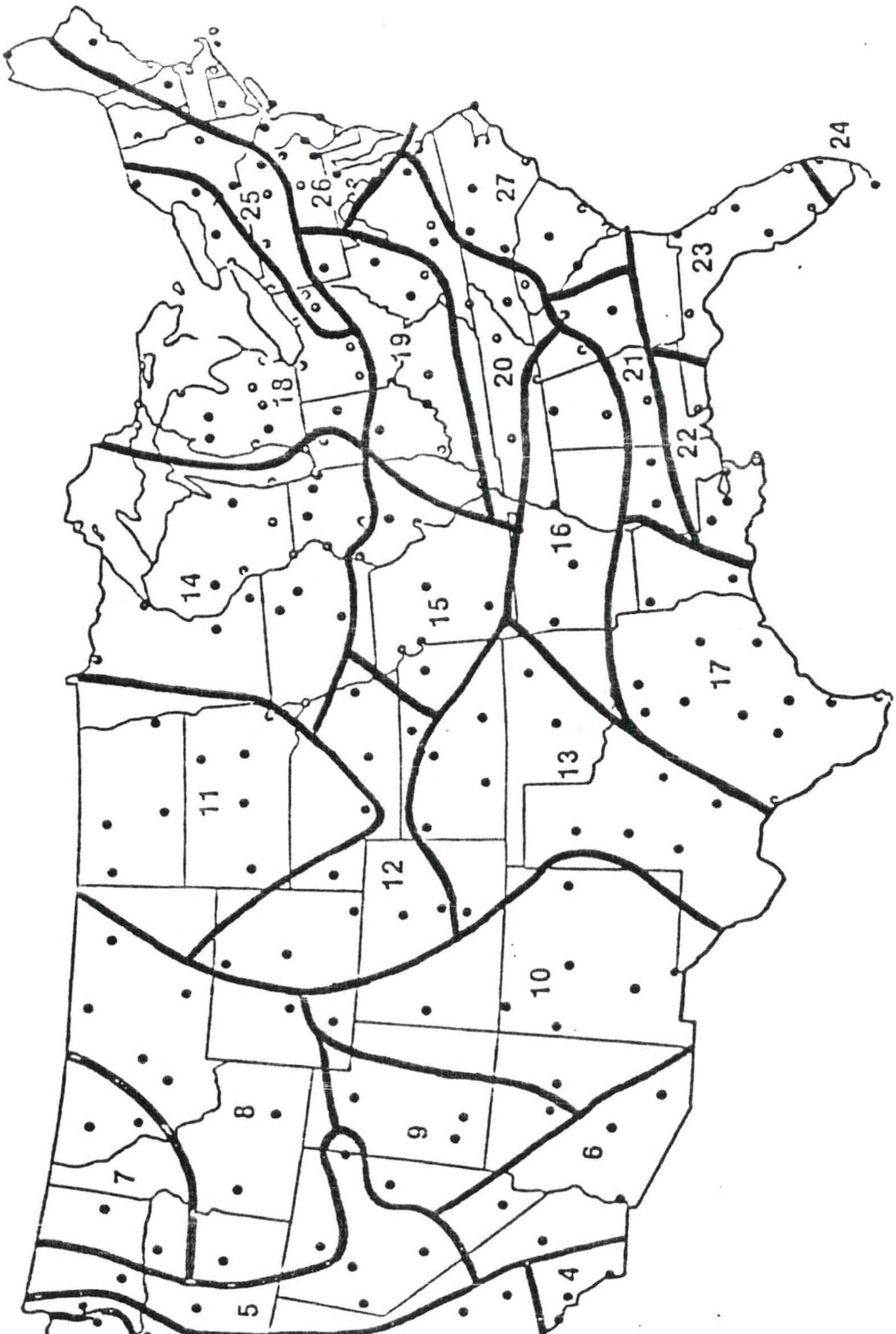

Figure 1. The 27 regions used to derive PoP equations for the warm season.

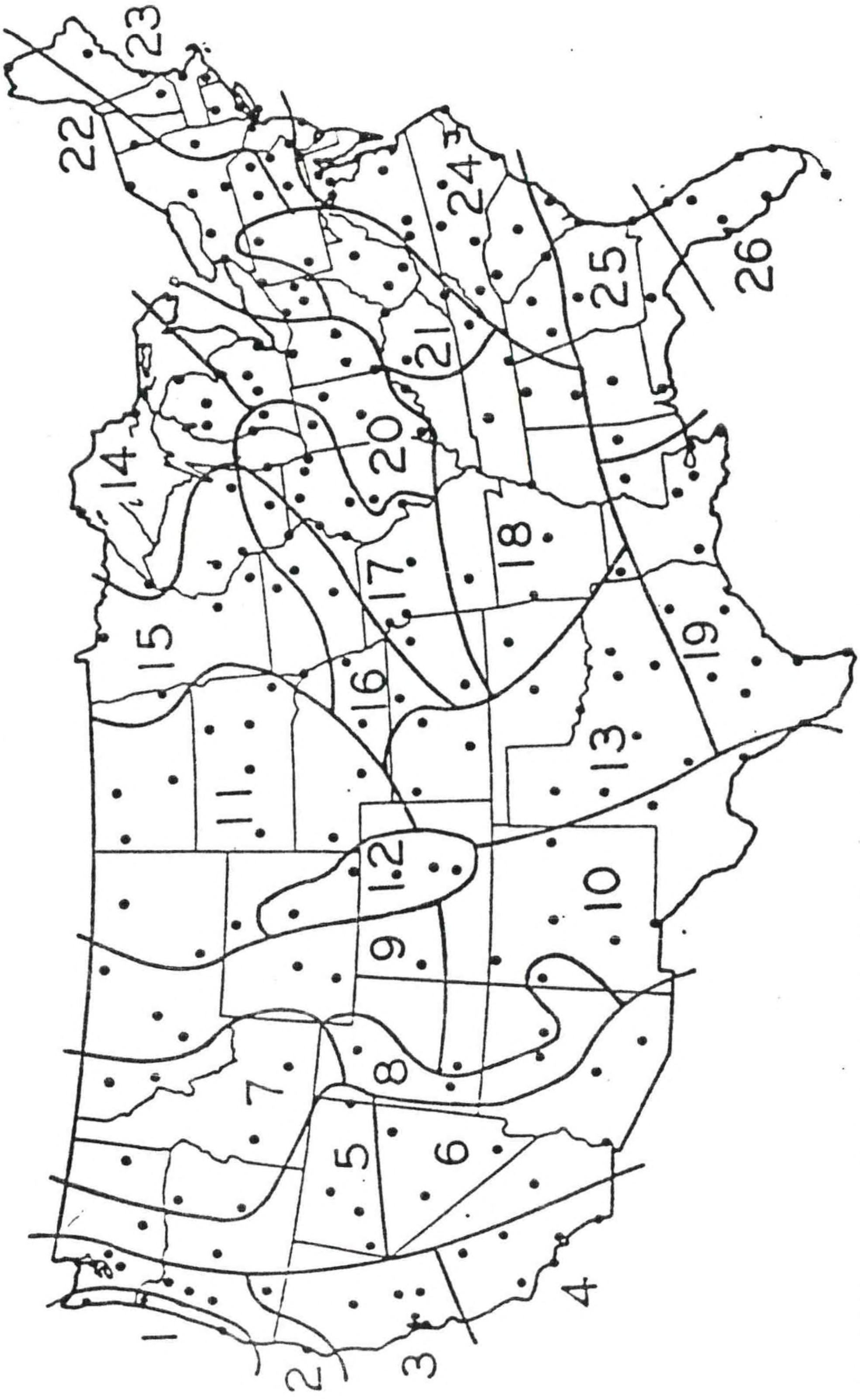

Figure 2. The 26 regions used to derive PoP equations for the cool season.