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HOW TO USE MOS GUIDANCE EFFECTIVELY
PART II

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Introduction

In this, the second in a series of Technical Attachments on how to use Model Output Statistics (MOS) effectively, I will discuss the MOS probability of snow amount (PoSA) guidance. Probability forecasts are provided for three snow amount categories which are then converted to one of four possible categorical forecasts: less than 2, 2 or 3, 4 or 5, and greater than 6 inches of snow. As in Part I, this discussion will generally address problems that arise with MOS forecasts even when the LFM is performing reasonably well because these problems are difficult to diagnose.

Background and Definitions

A. MOS PoSA guidance is a regionalized system - this means the same equation produces the probability forecast for a particular category and projection for a group of stations, only the LFM model data varies from station to station.

B. Probability forecasts are provided for the categories of ≥ 2, ≥ 4, ≥ 6 inches of snow for the first (12-24 hr) period only.

C. For each of the snow amount categories listed in B, two probability forecasts are provided, conditional and unconditional:

1. Conditional PoSA's are the probability of a particular snow amount occurring if precipitation in the form of snow actually occurs. The conditional PoSA is made under the assumption that snow will occur. This was accomplished by including only snow precipitation events in the sample used to develop the equations. As a result, conditional PoSA's are, simply, probability forecasts of how much snow will fall if snow occurs, but the likelihood of frozen precipitation is not considered.

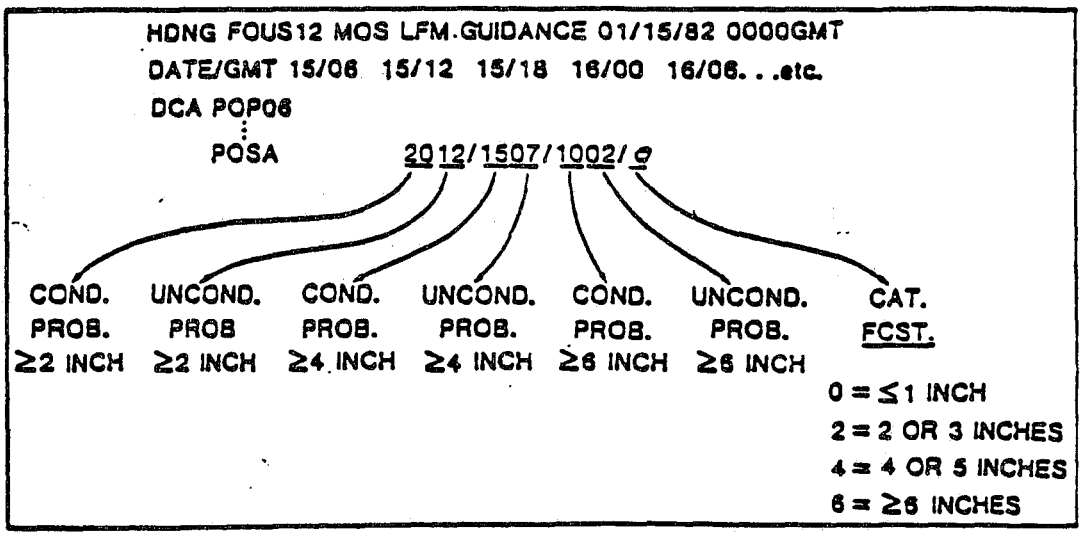
2. Unconditional PoSA's are the absolute probability of a particular snow amount occurring. These probability forecasts take into account how likely precipitation is and whether or not it will be snow, as well as how much will fall.

D. The average MOS probability of frozen precipitation (AVGPoF) forecast for the 12-24 hr period plays an important role in the PoSA system and is calculated in the following manner using the following MOS probability of frozen (PoF) forecasts:

$$\text{AVGPoF} = \frac{(\text{12-hr PoF}) + (2)\ (\text{18-hr PoF}) + (\text{24-hr PoF})}{4}$$

In this way the MOS PoF forecast in the middle of the 12-24 hr period is given more weight. (Use of the AVGPoF forecast will be discussed in E.)

E. The procedure to determine the final categorical snow amount forecast is done in three main steps which will be discussed following the example PoSA forecasts shown below:



STEP 1 The first step is to determine the probability of occurrence of each specific snow amount category, if snow actually occurs. This is the conditional PoSA. Even though the equations which produce these forecasts were derived with only snow precipitation events in the sample, in day to day operations they provide probability forecasts for all events, so these probabilities can be high for rain events for July. Thus, at this point, the probability of how much snow will fall, if snow falls, has been determined but how likely the precipitation is and whether or not it will be frozen has not been taken into account yet.

STEP 2 In order to adjust the conditional PoSA forecasts to take into account the likelihood of precipitation and whether or not it will be frozen, the conditional PoSA's are multiplied by the MOS 12-24 hr probability of precipitation (PoP) forecast and the MOS AVGPoF forecast for the 12-24 hr period. These are the MOS version of how likely precipitation is and whether or not it will be frozen, respectively. By performing this operation the conditional PoSA's have been converted to the unconditional, or absolute, PoSA's for that particular 12-24 hr period.

STEP 3 To make a final categorical forecast of snow amount, the unconditional PoSA's are compared to statistically derived threshold values for each category. If the probability exceeds the threshold, then that category is forecast. The procedure is as follows:

If the ≥2 inch probability forecast is less than the ≥2 inch threshold value (≥2 inch threshold values average around 26% for the Eastern Region); then forecast <2 inch (CAT FCST = 0). If greater than; continue.

If the ≥4 inch probability forecast is less than the ≥4 inch threshold value (≥4 inch threshold values average around 22% for the Eastern Region); then forecast 2 or 3 inches (CAT FCST = 2). If greater than; continue.

If the ≥6 inch probability forecast is less than the ≥6 inch threshold value (≥6 inch threshold values average around 22% for the Eastern Region); then forecast 4 or 5 inches (CAT FCST = 4). If greater than; forecast 6 or more inches (CAT FCST = 6).

F. MOS PoSA equations are valid from approximately September-May.

Tips and Guidelines

The conditional PoSA's will be high for any heavy precipitation event forecast by the LFM, no matter what the temperature may be: A quick look at the equations that produce these forecasts reveals that they only contain variables useful for the forecasting of precipitation amount and do not include any terms useful for precipitation type forecasting.

A heavy precipitation event forecast by the LFM also implies the MOS PoP will be high, so the MOS AVGPoF forecast will determine whether heavy snow is forecast or not: For example, if a high conditional PoSA is multiplied by a MOS PoP forecast of 100%, the result is the same as the original conditional PoSA, so only the AVGPoF will determine heavy snow versus heavy rain.

It is possible to get a categorical forecast of as much as ≥6 inches of snow for a heavy precipitation event even when the AVGPoF forecast is less

than 50%: Since the likelihood of snow is in question, the PoSA guidance should be used with caution in such cases. Such forecasts arise with heavy precipitation events because the conditional PoSA's are very high, the 12-24 hr PoP's are near 100%, and the AVGPoF is just high enough to produce an unconditional PoSA that will exceed the threshold value for the ≥6 inch category.

Due to the great importance of the MOS AVGPoF forecast on the PoSA guidance for all events, and especially for the heavier precipitation events, it is a good idea to carefully consider the accuracy of the MOS AVGPoF forecast and how it will affect the PoSA guidance: A AVGPoF forecast that is too low may mean not enough snow is forecast, too high may mean too much is forecast. An in-depth discussion on how to interpret MOS PoF forecasts in general is provided in Central Region Technical Attachment No. 87-22[1] entitled "How to Use MOS Guidance Effectively - Part I." Two of the most important tips and guidelines for diagnosing erroneous PoF forecasts were:

1. Perform a consistency check with the MOS 3-hourly temperature guidance to insure the PoF forecasts are reasonable (see Central Region Technical Attachment No. 87-22 for more details)[1].

2. Day to day monitoring of MOS PoF forecasts indicate there is a tendency to overforecast the PoF during the fall and spring which also results in a tendency to overforecast snow amount. The MOS temperature consistency check is very useful for diagnosing this problem.

The procedure followed by the PoSA system can sometimes produce a misleading forecast: In some cases a precipitation event is confined to the beginning or end of the 12-24 hr period. This can present a problem for the AVGPoF forecast because it is the average of the PoF forecasts for the 12-24 hr period and it may not be representative of the MOS PoF when precipitation is actually expected to occur. Thus, for example, if precipitation is forecast to end early in the period but the MOS PoF forecasts are rising rapidly during the period, the result may be a AVGPoF high enough to result in an erroneously high snow amount forecast. The problem is illustrated by the hypothetical MOS forecasts shown below:

PROJECTION	12-h	18-h	24-h
6 HR POP	90	90	20
12 HR POP			100
PoPT	0000/3	0040/3	0080/2
PoSA		8032/6024/3012/4	

AVGPoF = 40%

By following the PoSA procedure discussed earlier, a forecast of 4 or 5 inches of snow was made even though it would appear from the 6-12 hr and the

[1] Originally issued as Eastern Region Technical Attachment No. 86-19(B).

12-18 hr PoP's that most of the precipitation would fall as rain if all of the forecasts shown above were accurate. If 20%, which represents the average of the MOS 12-hr and 18-hr PoPT, was used as the AVGPoP forecast, the snow amount forecast would have been <2 inches of snow.

A consistency check with the MOS 12-24 hr quantitative precipitation forecast (QPF) is useful to determine the degree of confidence to place in the conditional PoSA's. In a snow situation the QPF equations would be attempting to forecast the water equivalent of the snow, so the QPF and conditional PoSA forecasts should be in reasonable agreement. If they are not, it is up to the forecaster to resolve the inconsistency through the use of recent observations and radar data.

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