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HOW TO USE MOS GUIDANCE EFFECTIVELY
PART I

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Introduction

Model Output Statistics (MOS) guidance plays an important role in day to day forecasts. The use of MOS guidance varies from forecaster to forecaster, but all of us use it to some degree. As a result, I would like to begin a series of Technical Attachments with some tips and guidelines on how to use MOS guidance effectively. These tips and guidelines are based on more than five years of personal experience working at the Techniques Development Laboratory (TDL) and the experience of others at TDL. This personal experience has been enhanced by working at WSFO/WBC during the past eight months and using the MOS products operationally.

In the technical attachments that will follow, I will discuss several of the weather elements for which MOS forecasts are provided and also give some useful general information on each. Much of this material stems from several MOS user workshops held at various WSFO's and the Technical Discussion Forums about MOS held at WSFO/WBC. Since winter is almost here, I will begin this series with the MOS probability of precipitation type forecasts (PoPT).

When the LFM is too wet or dry, too fast or slow, etc., forecasters generally have a good idea how this will affect the MOS guidance. Thus, in the discussion that follows, the tips and guidelines given will be given under the assumption that the LFM model is performing well and any problems with the MOS PoPT guidance are not the result of LFM errors. Even when the LFM is performing reasonably well, there are many times when the MOS guidance is inconsistent or is in error. These situations are usually difficult to diagnose so this and the Technical Attachments that will follow will seek to help forecasters spot and correctly interpret these situations.

As a side note, with the LFM and NGM running concurrently at this time, it is important to mention here that the NGM output is not used in any way to

adjust the current MOS package. When statistical guidance becomes available from NGM output it will be a completely separate package.

Background and Definitions

A. MOS PoPT is a regionalized system - this means that the same equation produces the probability valid at a particular projection for a group of stations, only the LFM model data varies from station to station.

B. The MOS PoPT system provides probability and categorical forecasts of frozen (SNOW), freezing (ZR), and liquid (RAIN) precipitation:

SNOW - any combination of snow and or sleet.

ZR - freezing rain or freezing rain mixed with anything else.

RAIN - rain or rain mixed with anything else.

C. MOS PoPT equations are valid from approximately September-May.

D. Categorical forecasts are determined by comparing probability forecasts to statistically derived threshold values for each category. If the probability exceeds the threshold, then that category is forecast.

E. MOS PoPT categorical forecast selection procedure:

1. Compare ZR probability forecast to ZR threshold (ZR threshold values for the Eastern Region are generally between 15-35%). If the probability exceeds the threshold -> forecast ZR. If not, go on the SNOW category.

2. Compare SNOW probability forecast to SNOW threshold (SNOW threshold values for the Eastern Region are generally between 35-55%). If probability exceeds the threshold -> forecast SNOW. Otherwise, automatically forecast RAIN.

Tips and Guidelines

Forecasters should be aware of the fact that the equations are valid for the entire period from September-May. This can lead to overforecasting of the probability of SNOW and also can result in erroneous categorical forecasts of SNOW. The reason for this is that the equations are biased towards winter time situations when the upper level to surface thermal relationships are different than during the fall or spring. For example, given the same 1000-500 mb thickness and cloud cover on January 1 and April 1, the surface temperatures on April 1 will be warmer due to the higher sun elevation, longer day, warmer ground, etc., if there is no convection present. The bias towards forecasting winter like situations at any time of the year arises because most of the cases used to develop the equations were winter time cases. (Please

note that the general terms fall, winter, spring are used here because their time periods vary from station to station. Longer winters north, shorter winters south.)

One method for determining if the SNOW probabilities are being overforecast in the spring and fall is to perform a consistency check with the MOS 3-hourly temperature (TEMP) forecasts valid for the same projection. The MOS TEMP guidance is based on the three month seasons of September-November, December-February, March-May, June-August, and is thus better able to account for the varying upper level to surface thermal relationships during the course of the year. So if the SNOW probability forecasts in the springtime are high, but the TEMP forecasts are well above freezing, it is best to put more weight on the TEMP forecasts since they are better seasonally adjusted.

It is a good idea to perform a consistency check with MOS TEMP forecasts at any time of the year and for ZR forecasts as well because inconsistent forecasts, such as the springtime example given above, are a good indication that a problem exists with the MOS guidance. In trying to resolve these inconsistencies, much more weight should be given to the TEMP forecasts in the fall and spring, or any time of the year when ZR forecasts are involved. Although TEMP forecasts are considered more reliable on average, during the winter the PoPT system should be performing at its best so inconsistent forecasts should not automatically be decided in favor of the TEMP guidance. Some guidelines to use when performing these consistency checks, as well as other guidelines are discussed below.

When ZR is Forecast Categorically

1. Check the SNOW probability. The MOS PoPT categorical selection procedure assigns great importance to the ZR probability forecast because it compares the ZR probability to the ZR threshold first. If the threshold is exceeded it then proceeds to forecast ZR without considering the possibility of SNOW or RAIN. Very often the SNOW probability will also be high enough to have resulted in a categorical forecast of SNOW if SNOW had been checked first. Although RAIN probabilities are not given, a low SNOW probability sometimes implies a high RAIN probability. Thus, many situations arise where ZR and either RAIN or SNOW could have been forecast categorically by the PoPT system at the same time. Since ZR forecasts are much less accurate than SNOW or RAIN forecasts, SNOW or RAIN would usually be a better forecast in these situations.

2. Consider the possibility of mixed precipitation. Freezing rain mixed with anything else was included in the sample used to develop the equations as ZR by the MOS PoPT system, so the possibility of freezing rain mixed with sleet and or snow must be considered. A look at the SNOW probability is again useful. The higher the probability, the more likely freezing rain may be mixed with sleet and or snow.

3. If MOS 3-hourly TEMP forecast valid at the same projection is ≥34°F, do not forecast ZR. As already discussed, MOS TEMP forecasts are usually more accurate than PoPT forecasts, especially ZR forecasts, so it is best to use the TEMP guidance when inconsistencies occur. (This cutoff, and those that follow below, represent values at which the PoPT guidance should automatically be disregarded in favor of the TEMP guidance if the TEMP guidance is considered reasonable. These cutoffs may vary in mountain regions or due to local effects but are otherwise representative of most stations.)

When SNOW is Forecast Categorically

1. Consider the possibility of sleet or mixed snow and sleet. Sleet or snow and sleet mixed were included in the sample as SNOW but sleet is generally more similar to freezing rain by nature (warm layer aloft and cold at surface), so it is useful to also look at the ZR probability. If the ZR probability is significant (around 15% or higher), but was not high enough to produce a categorical forecast of ZR, it is likely indicating the presence of a warm layer aloft which would make sleet a possibility.

2. If MOS 3-hourly TEMP forecast valid at the same projection is ≥44°F, do not forecast SNOW. The reason is similar to that given for the ZR temperature cutoff. The SNOW cutoff is quite high in order to take into account possible evaporative cooling effects or convective overturning as might occur in the spring.

When RAIN is Forecast Categorically

1. Consider the possibility of mixed precipitation. Rain mixed with snow and or sleet was included in the sample as RAIN. To determine situations where mixed precipitation is possible, it is once again useful to look at the SNOW probability. A probability greater than 30% is generally a good indication the atmosphere is cold enough to make mixed precipitation possible. This determination can be important since the general public, especially in warm locations, perceives rain mixed with snow as snow.

2. If MOS 3-hourly TEMP forecast valid at the same projection is ≤30°F, do not forecast RAIN. The reason is the same as that given for the ZR and SNOW temperature cutoff. In order to forecast RAIN categorically, neither the ZR or SNOW probabilities were high enough to have produced a categorical forecast. Since ZR forecasts are much less accurate than SNOW forecasts, the ZR probability was likely the forecast in error, and it is best to consider a ZR forecast at this point.

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