An Evaluation of POP/QPF Forecasts for the Winter of 2007-2008 across Central and Northern Nevada

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1. Introduction

The winter of 2007-2008 was quite variable across the Great Basin. The period had two major wet periods in January, resulting in the 5th snowiest January on record in Elko, NV. This paper is an examination of the Quantitative Precipitation Forecast (QPF) and Probability of Precipitation (PoP) across WFO Elko's (LKN) forecast area. Examined first are the QPF forecasts, both spatially and temporally, followed by a more detailed examination of the PoP forecasts. The forecasts are compared to the Quantitative Precipitation Estimate (QPE) data as provided by the River Forecast Centers (RFC) in BOIVerify. The period examined is December 20th through February 20th.

2. QPF Forecasts

The QPF forecasts exhibited a slight wet bias for the 12-hour forecast (verified in a 12-hour block), on the order of 0.02 to 0.05" (Fig. 1). Figure 1 represents the bias from the 00Z forecasts only, although the 12Z forecasts exhibit similar characteristics. This bias

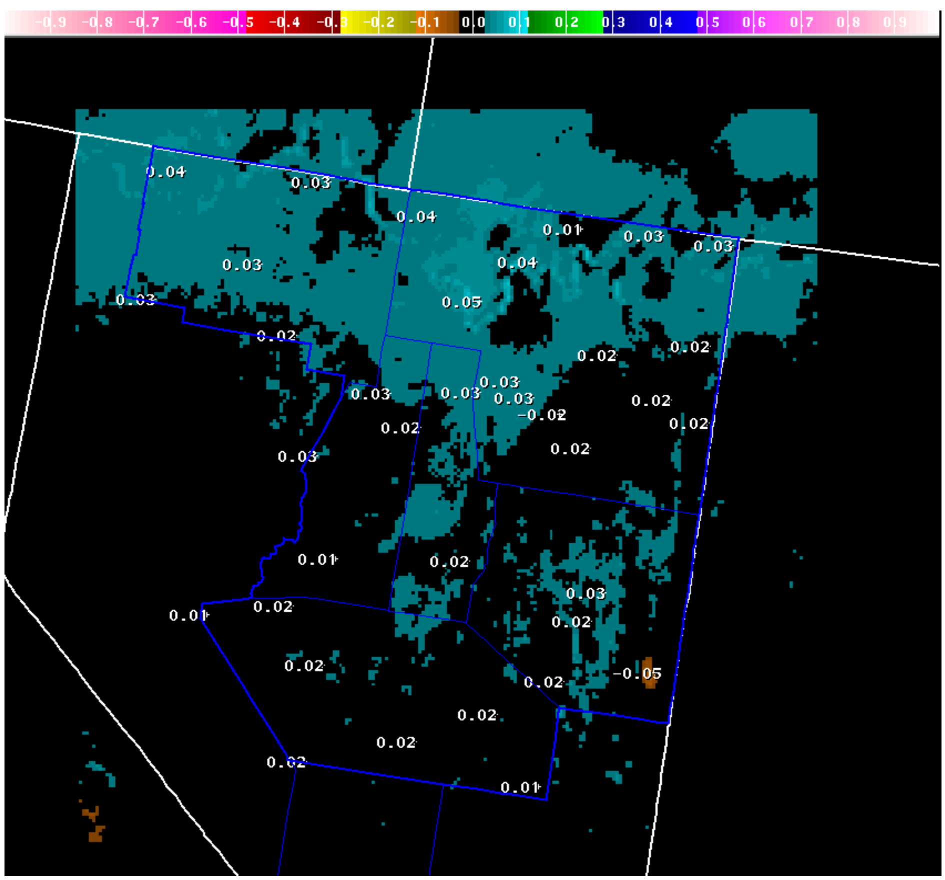

Figure 1: QPF bias for Official forecasts across central and northern Nevada.

is likely due in part to a local policy to have at least 0.01" of QPF for PoPs greater than 14%. In figure 2 it is evident that the bias holds throughout the short-term forecast period (0-72 hours). Beyond 72 hours, the forecasts are not Official, so there are differences in the way the grids are populated. Those grids get less attention since they are not viewed by the public.

The conclusion of the QPF verification is that during this period the forecasts exhibited a slight wet bias and that is likely due to local policy.

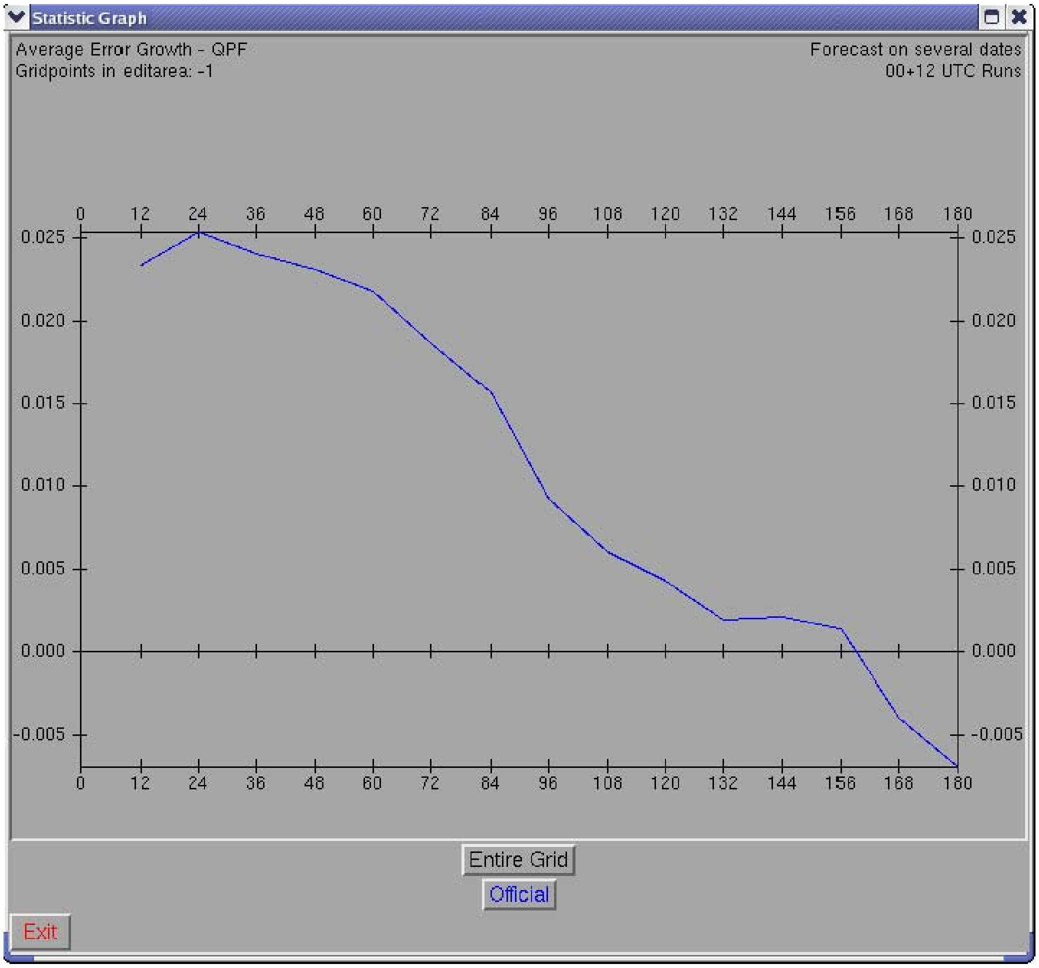

Figure 2: QPF bias chart. The x-axis is forecast hours and the y-axis is bias in hundredths of an inch.

3. PoP Forecasts

The PoP forecasts during this period (calculated in a 12-hour block) across central and northern Nevada were rather reliable at 12 hours out (Figs. 3 and 4); although a slight dry bias shows up in the chance category. The forecasts then trended toward a slightly stronger dry bias by 48 hours (Figs. 5 and 6) and an even stronger dry bias by 120 hours (Figs. 7 and 8). This was expected and is likely due to the fact that model uncertainty increases as forecast time increases. Thus, forecasters are more conservative with PoP forecasts for forecasts that are further out in time.

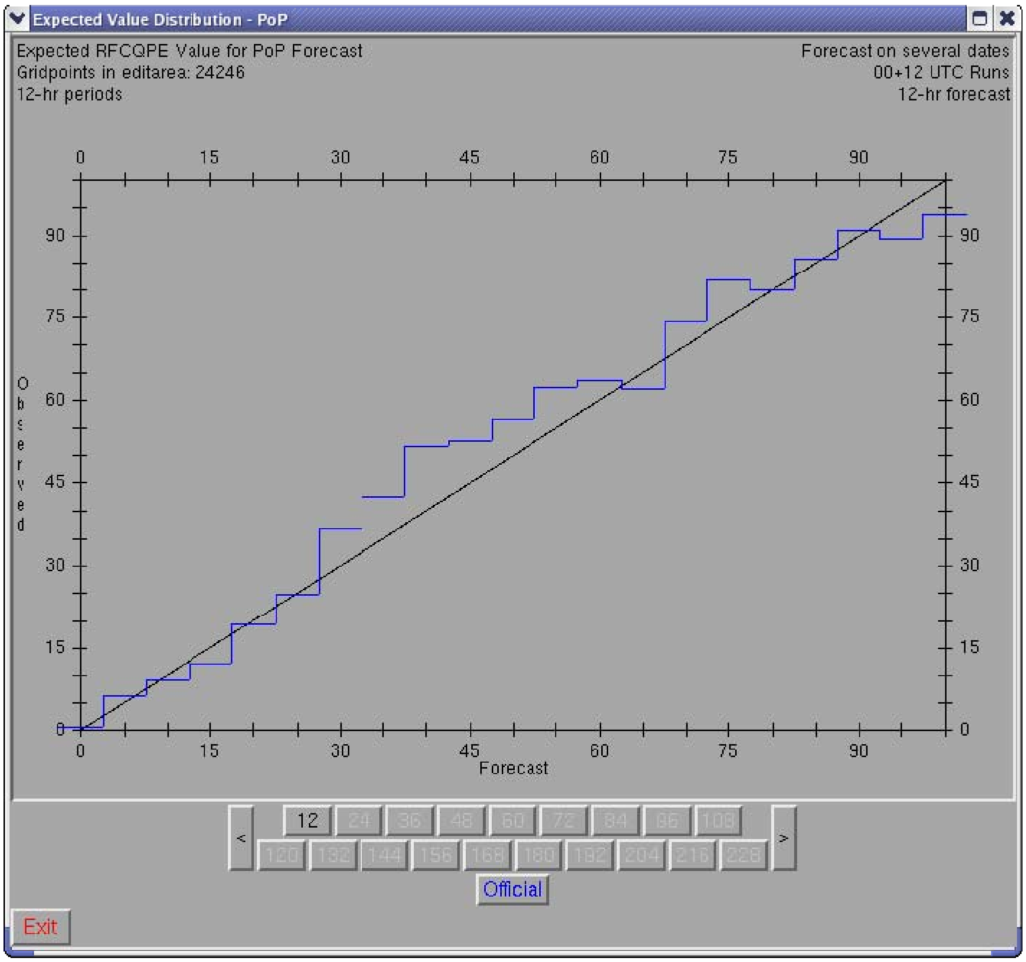

Figure 3: PoP reliability chart for 12-hour forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

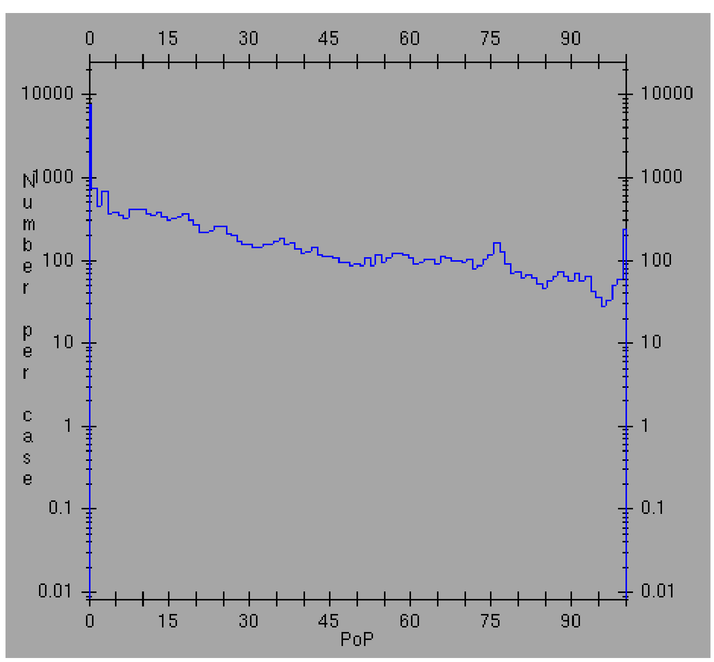

Figure 4: PoP versus number per cases for 12-hour forecasts.

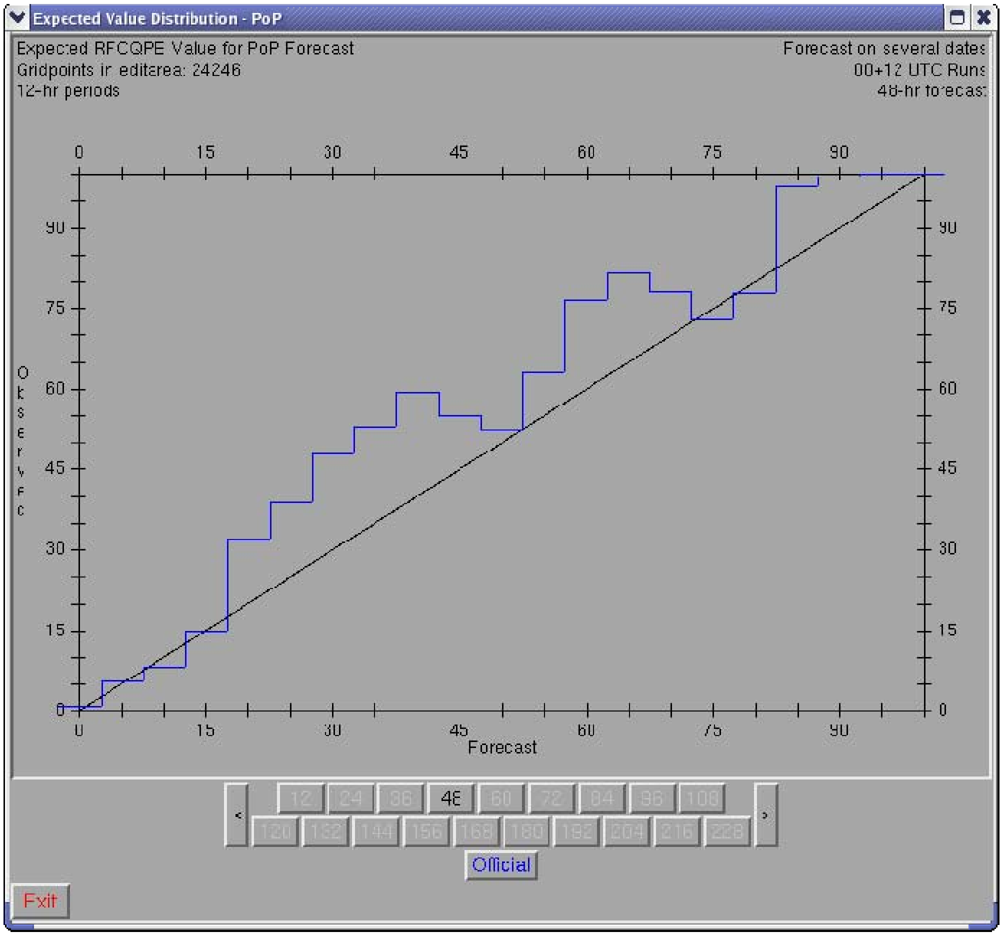

Figure 5: PoP reliability chart for 48-hour forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

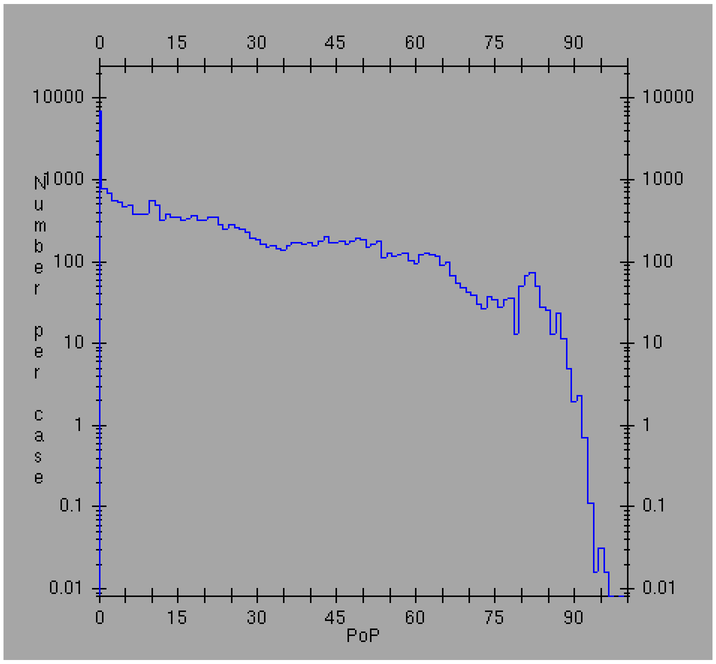

Figure 6: PoP versus number per cases for 48-hour forecasts.

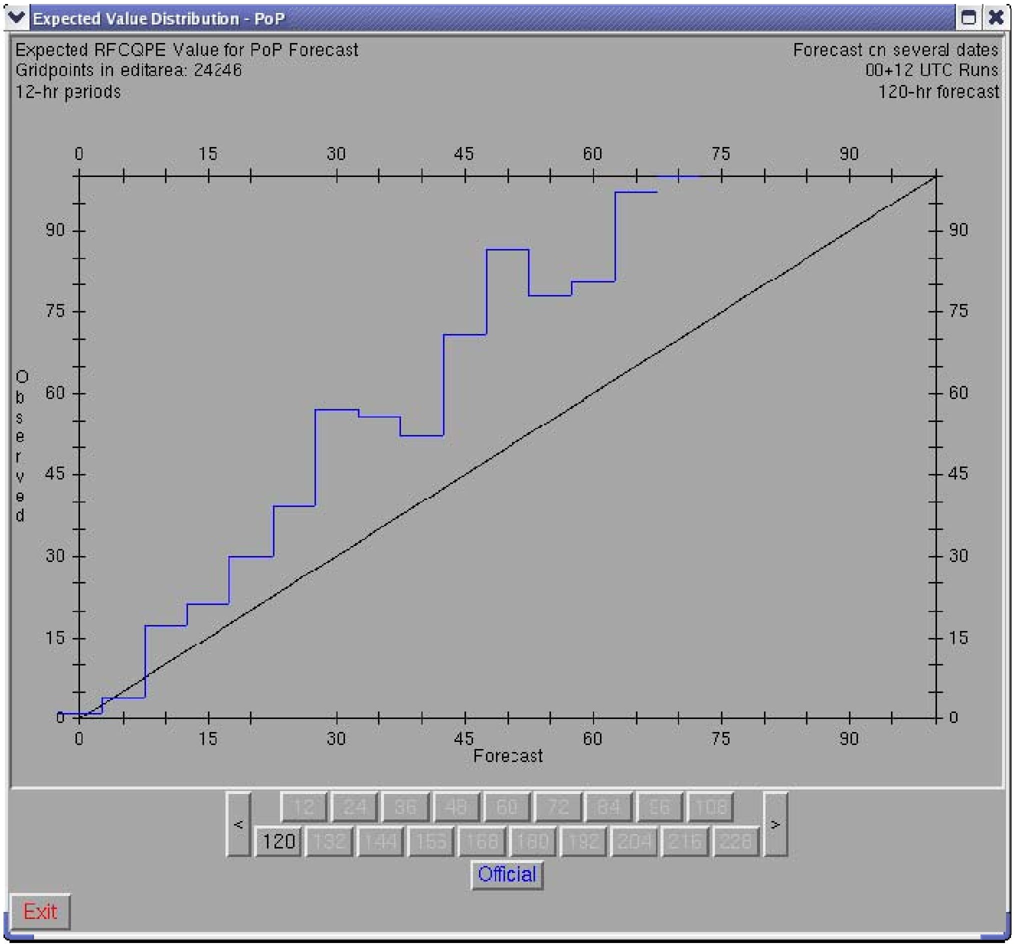

Figure 7: PoP reliability chart for 120-hour forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

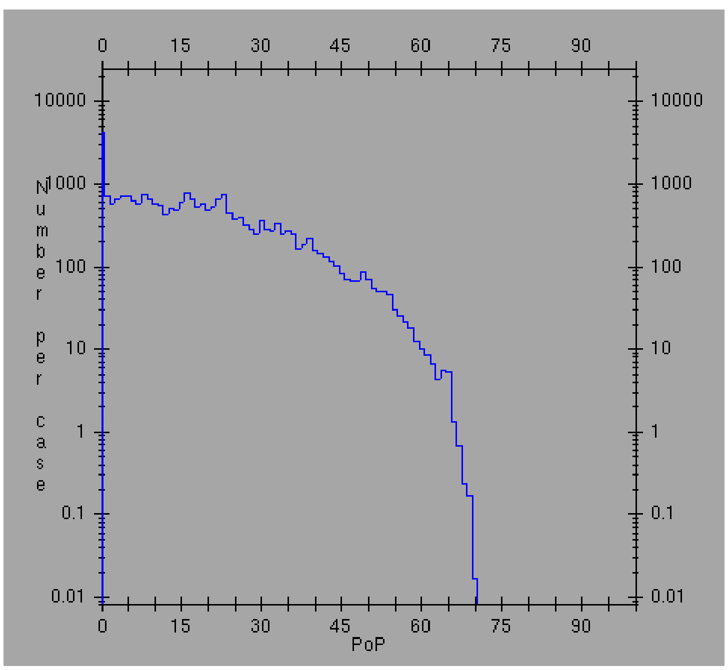

Figure 8: PoP versus number per cases for 48-hour forecasts.

4. PoP Forecasts – Valleys versus Mountains

The PoP forecasts for the valleys and mountains are examined separately in this section to see if there is a difference in how forecasters forecast for those areas. The edit area used for the mountain calculations can be found in Figure 9. The inverse edit area (within the CWA boundary) was used for the valley calculations. The PoP forecasts for the valleys exhibit excellent reliability for the 12-hour forecasts (Figs. 10 and 11). However the forecasts for the mountains show a slight dry bias, mainly in the chance category (Figs. 12 and 13). The 48 hour forecasts for the valleys have a slight dry bias (Figs. 14 and 15), while the forecasts for the mountains show an even more pronounced dry bias (Figs. 16 and 17). The dry bias in the valleys is likely the natural dry bias that forecasters tend to have as forecast time increases. The more pronounced dry bias in the mountains may be alleviated if a tool like ClimoPoP is used more frequently. This tool uses climatological data to help forecast PoP grids that are spatially realistic based on climatology.

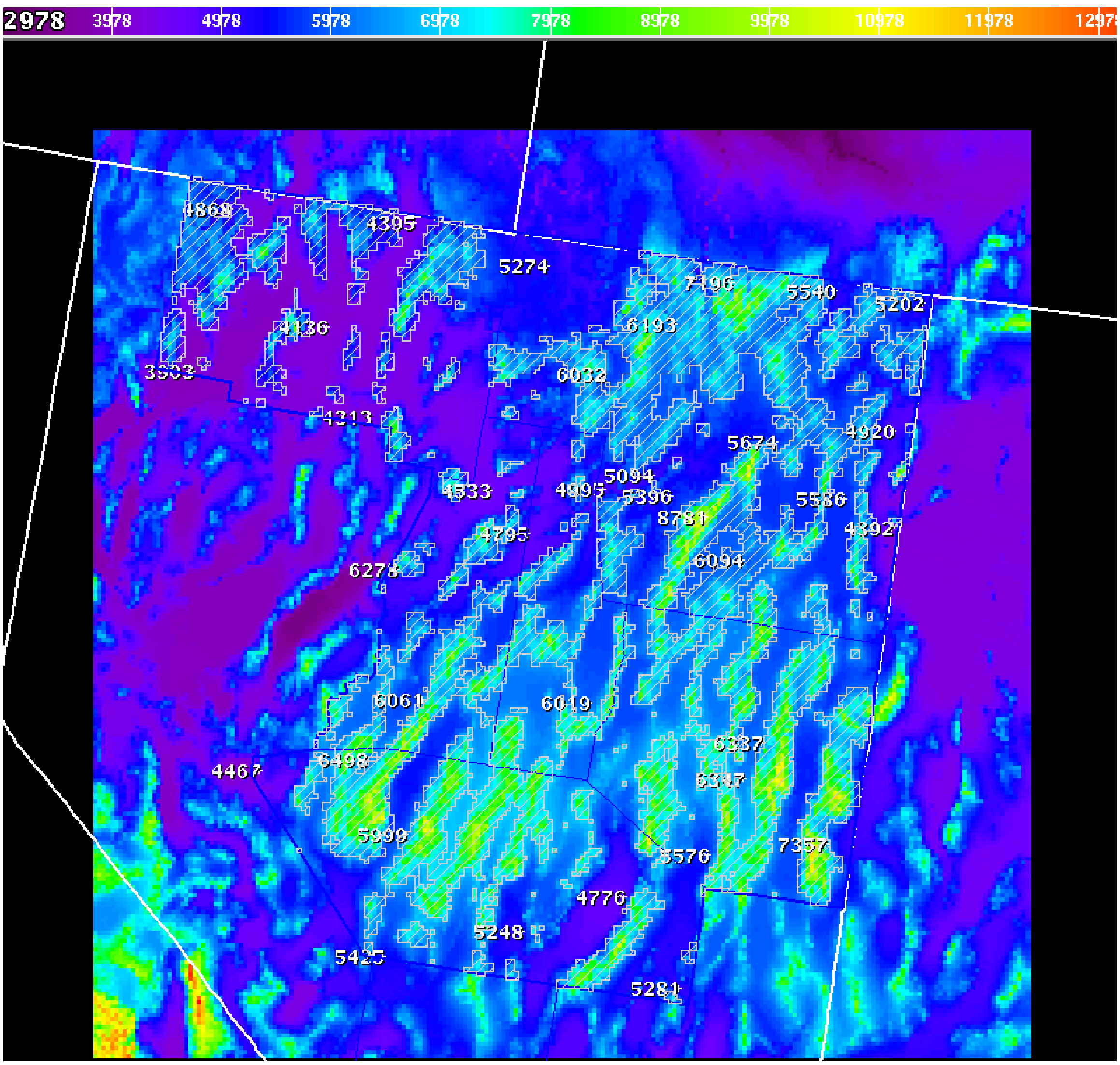

Figure 9: Edit area used for the "mountain" calculations.

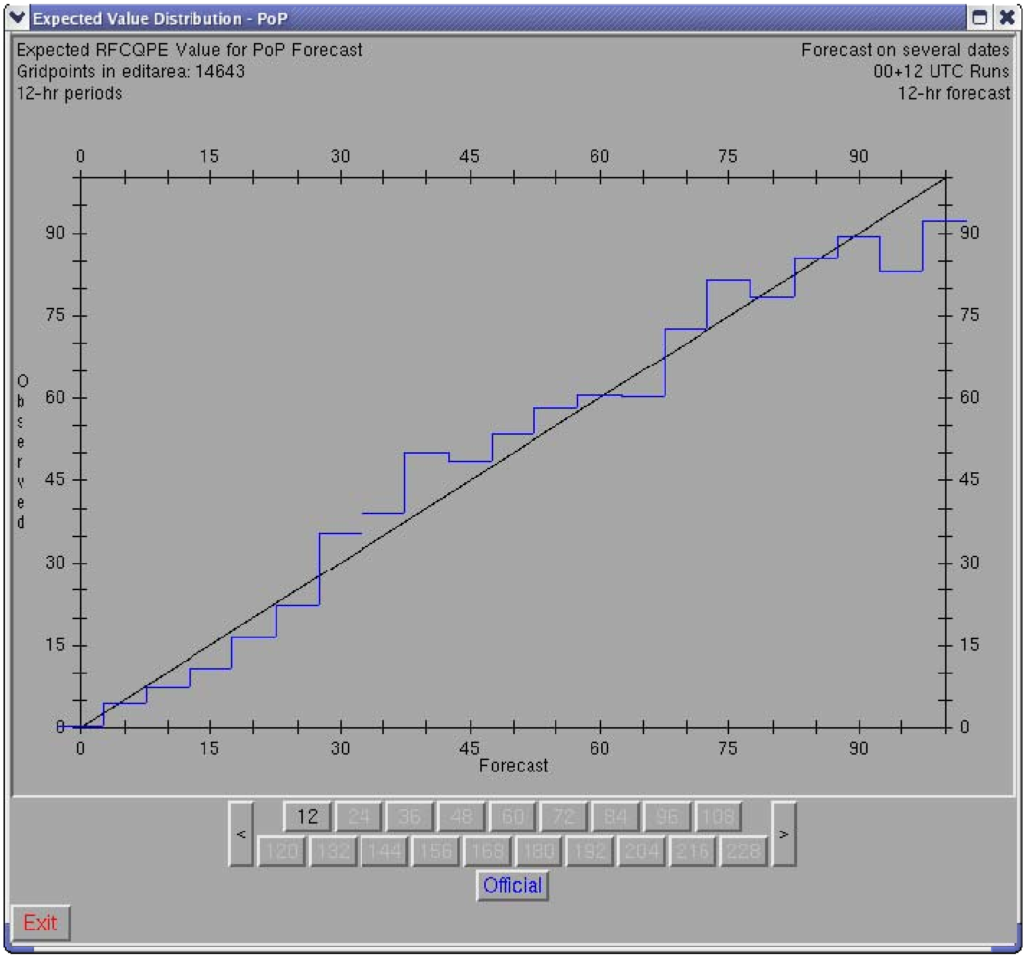

Figure 10: PoP reliability chart for 12-hour Official forecasts and valley locations with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

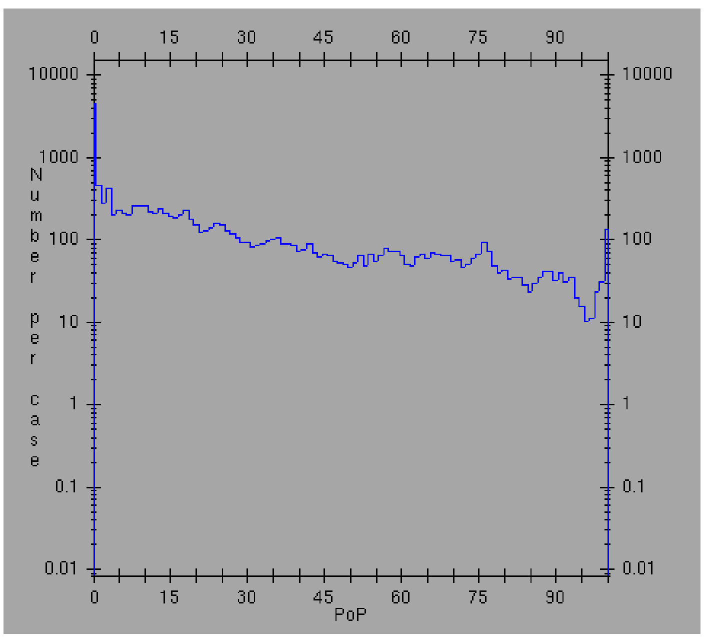

Figure 11: PoP versus number per cases for 12-hour Official forecasts and valley locations.

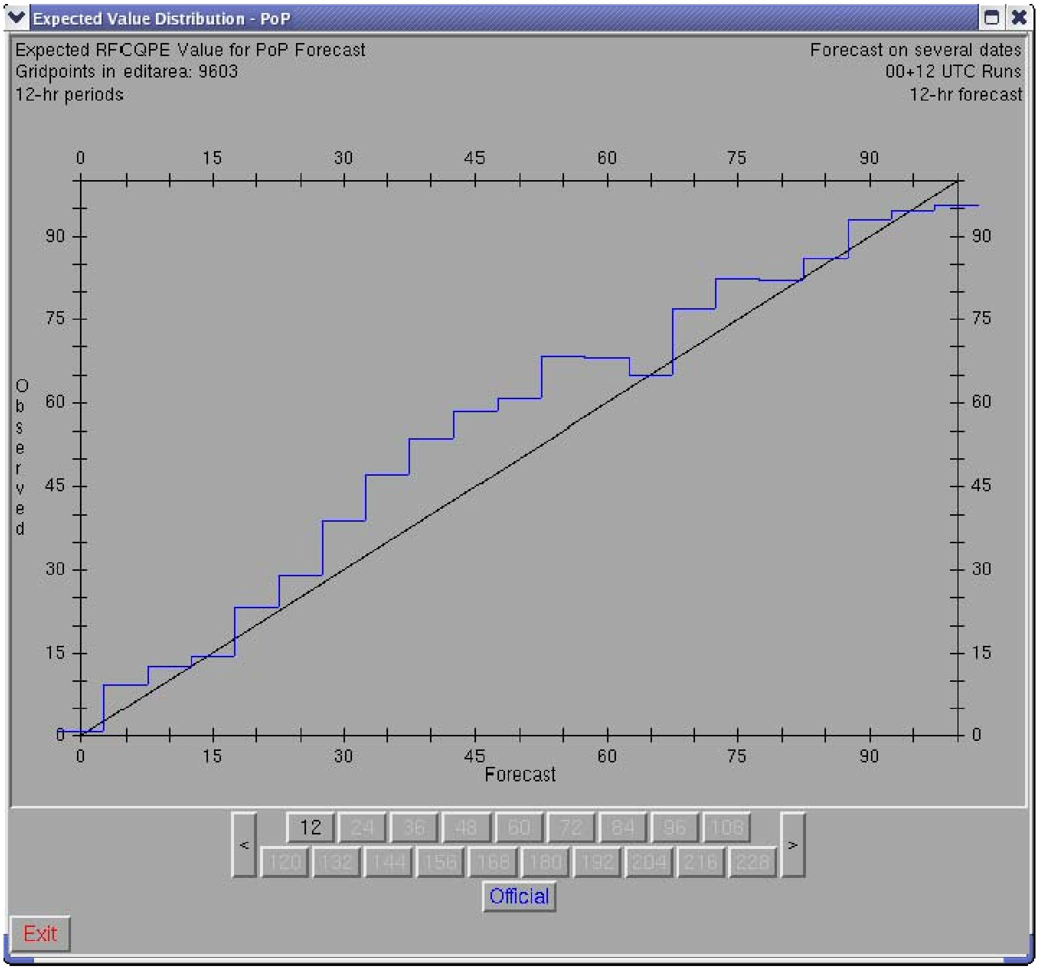

Figure 12: PoP reliability chart for 12-hour Official forecasts and mountain locations with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

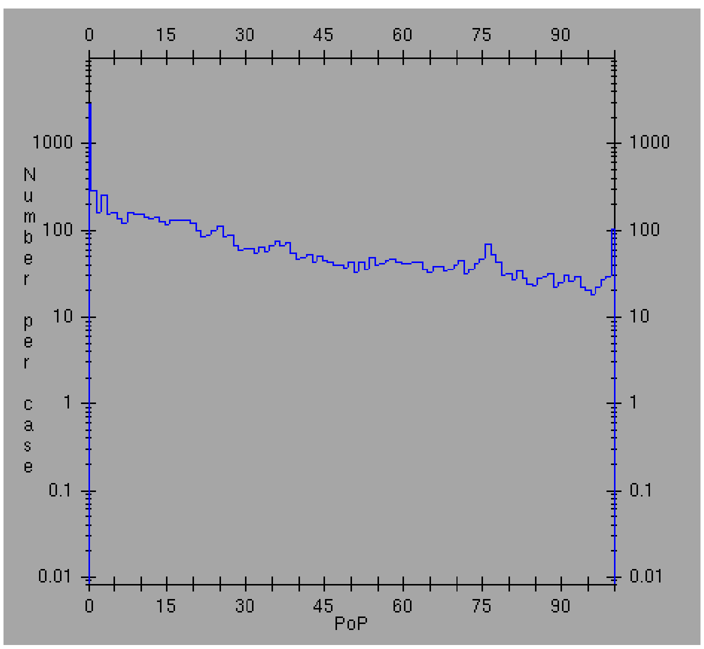

Figure 13: PoP versus number per cases for 12-hour Official forecasts and mountain locations.

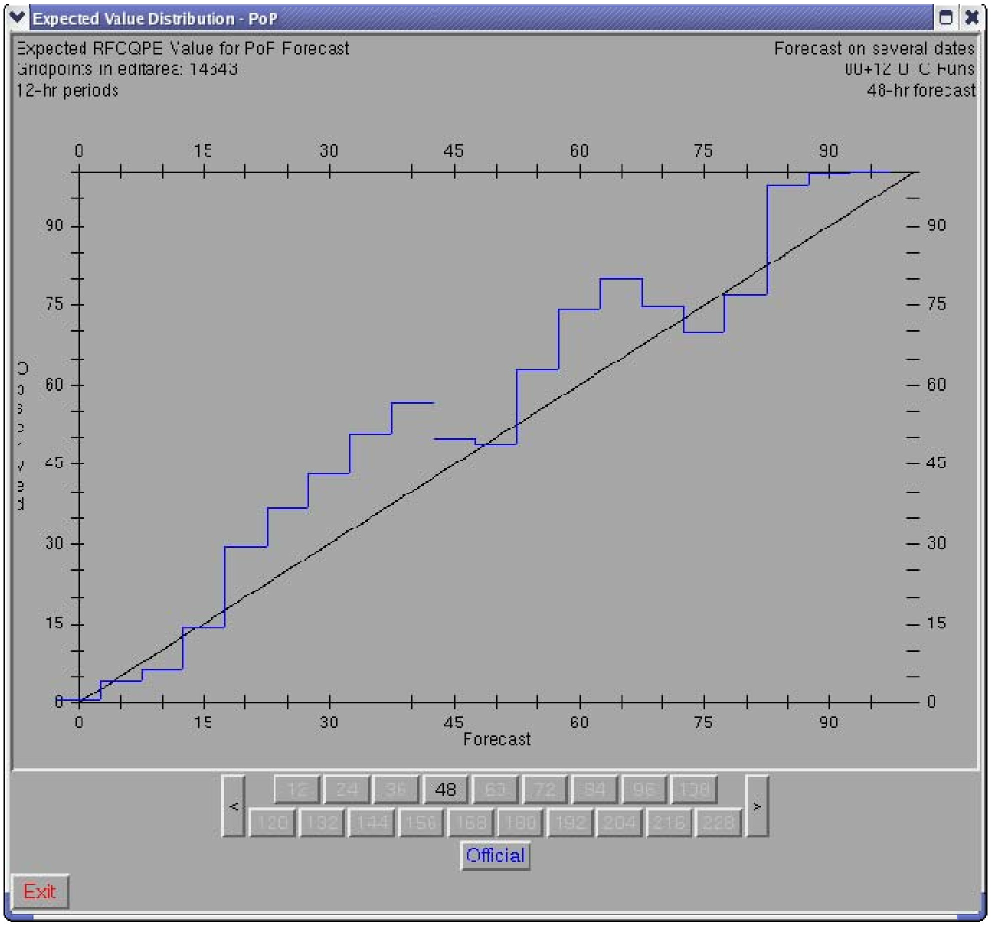

Figure 14: PoP reliability chart for 48-hour Official forecasts and valley locations with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

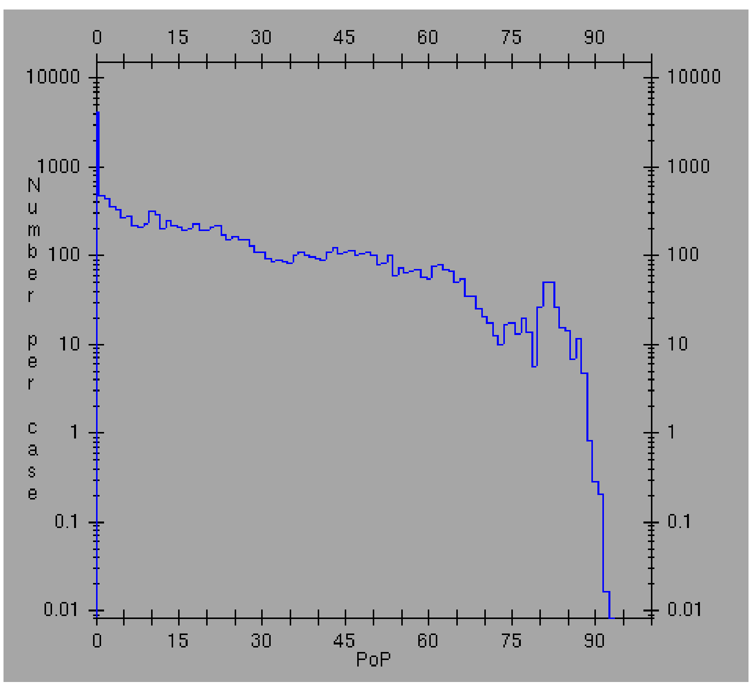

Figure 15: PoP versus number per cases for 48-hour Official forecasts and valley locations.

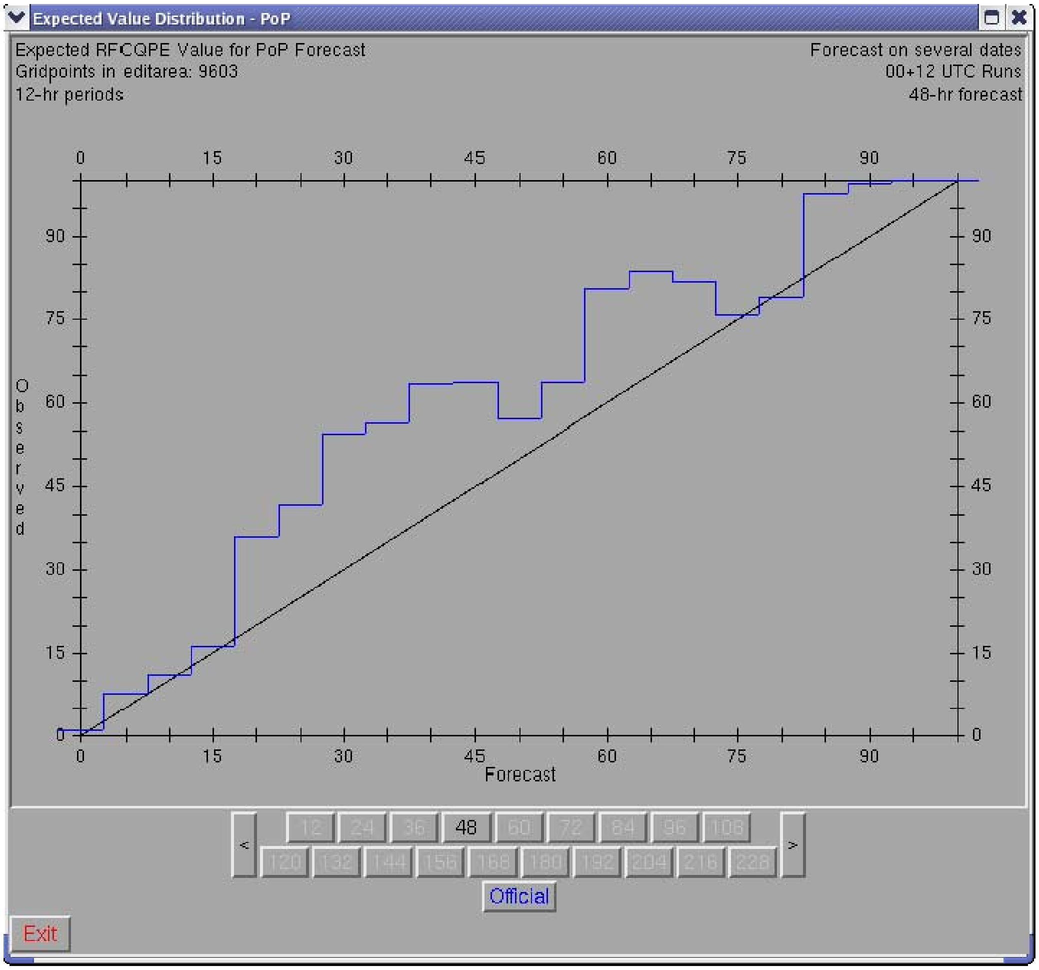

Figure 16: PoP reliability chart for 48-hour Official forecasts and mountain locations with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

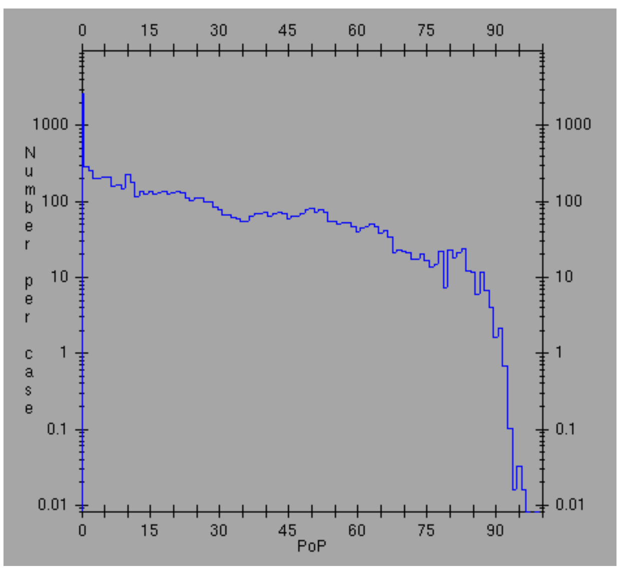

Figure 17: PoP versus number per cases for 48-hour Official forecasts and mountain locations.

5. PoP Forecasts - January 2008
The year started off with a wet month as January 2008 was the fifth snowiest January on record for Elko (28”). Looking at the verification statistics for the 12-hour Official forecasts, it is evident that there was a significant wet bias during this period (Figs. 18 and 19). The 60-hour forecasts still showed signs of a wet bias (Figs. 20 and 21). The standard dry bias started to reveal itself in the high chance category for the 120-hour forecasts (Figs. 22 and 23).

An examination of the verification statistics for some of the model data reveals that the models’ PoP forecasts were not very helpful. The 12-hour forecasts from the GFS (40-km) had a strong wet bias for nearly all PoPs (Figs. 24 and 25). The wet bias was slightly stronger for the 60-hour forecasts (Figs. 26 and 27) and even stronger for the 120-hour forecasts (not shown). The SREF mean had similar problems, but on a new level. The wet bias for the SREF model at 21 hours out was so extreme that a PoP of 60 verified with at least 0.01” of precipitation 15% of the time (Figs. 28 and 29). The extreme wet bias was evident for all forecast periods. The 12-hour NAM (12-km) forecasts had a dry bias above 30% and a slight wet bias below 30% for January (Figs. 30 and 31). Forecasts above 50% were rather limited in number however. The bias was similar for longer lead time forecasts. The ADJMEX model had very different forecasts, however. (The ADJMEX is created by starting with the GFS40 forecast and objectively adjusting it towards the MEX MOS guidance.) The reliability chart for the 12-hour forecasts indicates that the ADJMEX had excellent reliability for PoPs with a good sample size (Figs. 32 and 33). However, forecasts with longer lead time (beyond 48 hours) had a slight wet bias.

6. Summary
After examining the Official QPF forecasts, it is evident that the forecasts exhibited a slight wet bias, which is likely due to local policy. Local policy states that the QPF must have values of least 0.01” for PoPs greater than 14%. It is designed to give the customer an idea of how much precipitation they might expect, if precipitation does reach the ground. One reason the policy is in place is to have a consistent methodology for generating QPF. There are pros and cons to this policy and it is beyond the scope of this paper to examine this policy.

The examination of the PoP forecasts revealed that the Official forecasts have good reliability in the first period, with only a slight dry bias showing up in the chance category. Longer lead time forecasts (i.e. 48 and 120-hour forecasts) show an increasing dry bias as lead time increases. This is likely due to the fact that model uncertainty increases as lead time increases. As a result, forecasters tend to be more conservative with their PoP forecasts as lead time increases. However in cases of model certainty with several runs in a row showing storminess, forecasters may try to be bolder in the future.

The PoP forecasts for the valleys had excellent reliability for the first period. A slight dry bias then was revealed as forecast time increased. The PoP forecasts for the mountains had a slight dry bias, which increased as lead time increased. This dry bias may be reduced by using a tool such as ClimoPoP more often.

When examining the Official forecasts for the month of January, which was a rather wet month, the reliability chart reveals that a wet bias existed. The wet bias decreased to a slight dry bias as the forecast lead-time increased. The model forecasts for the month of January were very different. The GFS had a wet bias, the SREF had an extreme wet bias, the NAM had a dry bias, and the ADJMEX had excellent reliability that trended to a slight wet bias with increasing lead time.

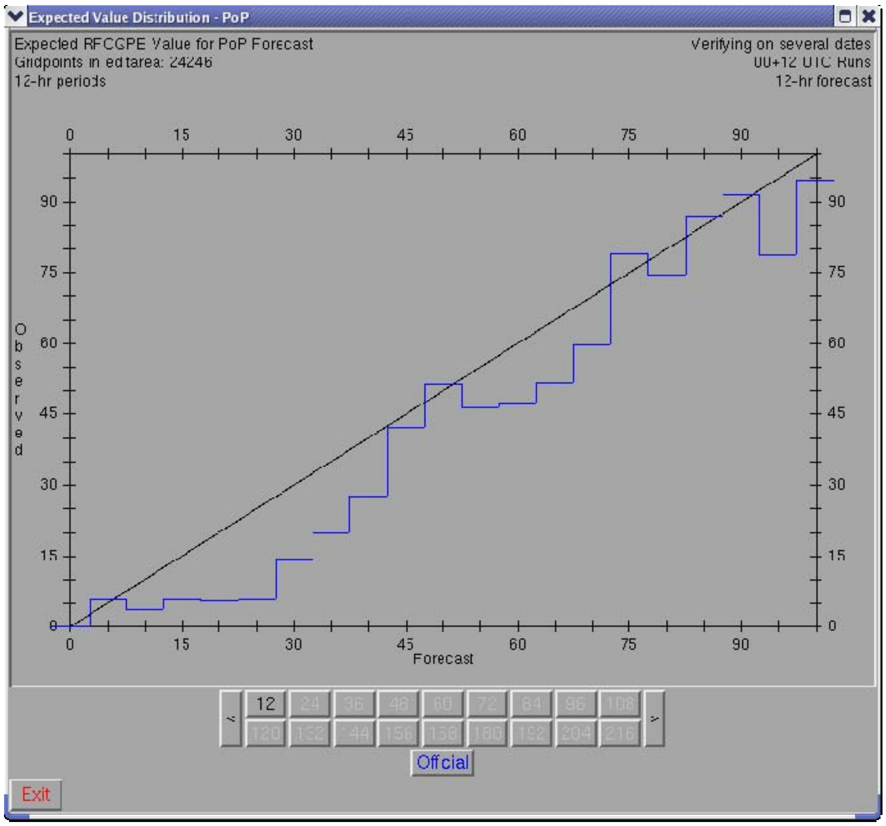

Figure 18: January PoP reliability chart for 12-hour Official forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

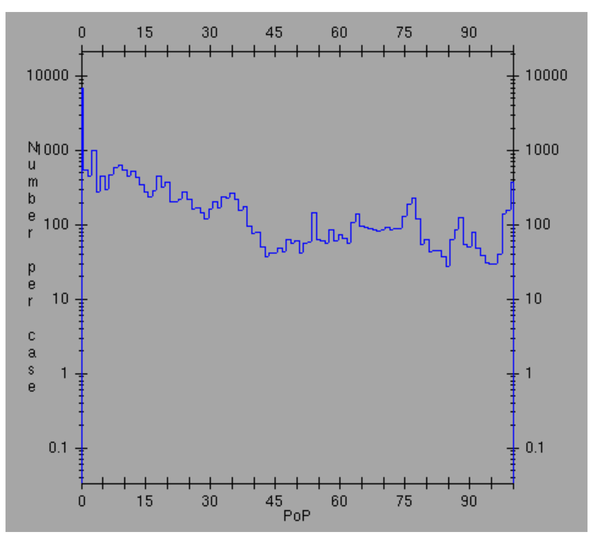

Figure 19: PoP versus number per cases for 12-hour Official forecasts in January.

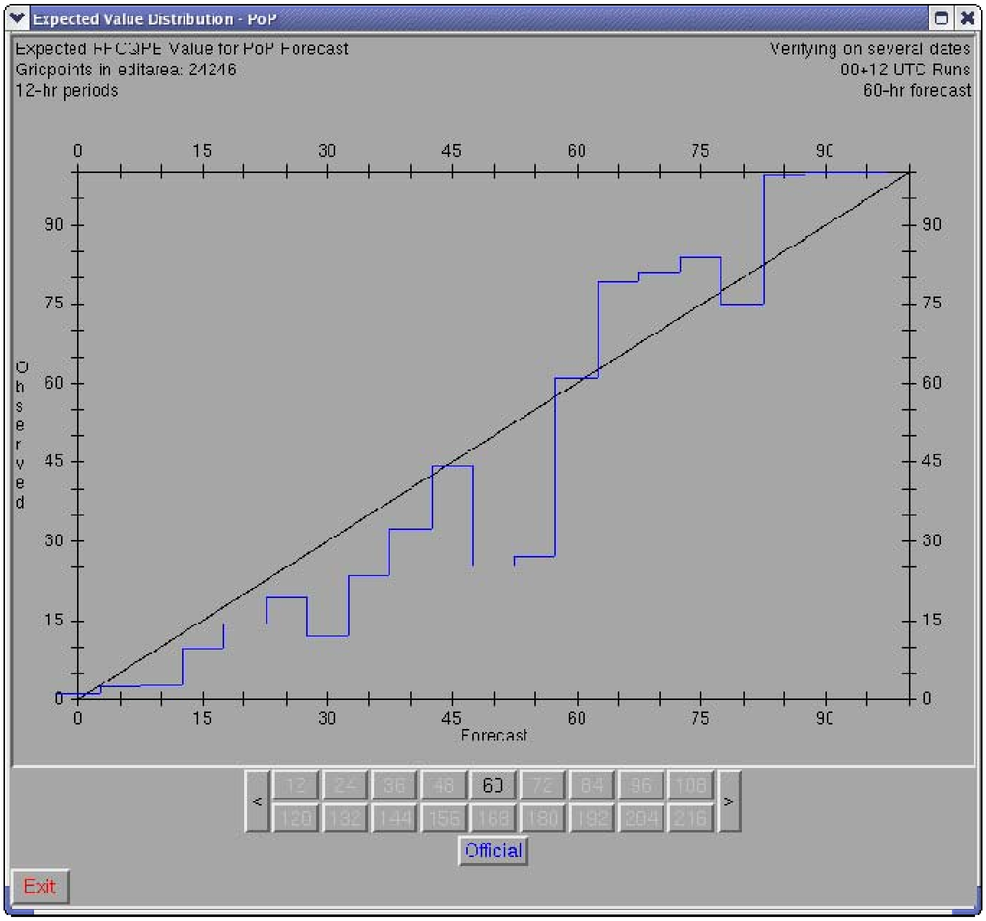

Figure 20: January PoP reliability chart for 60-hour Official forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

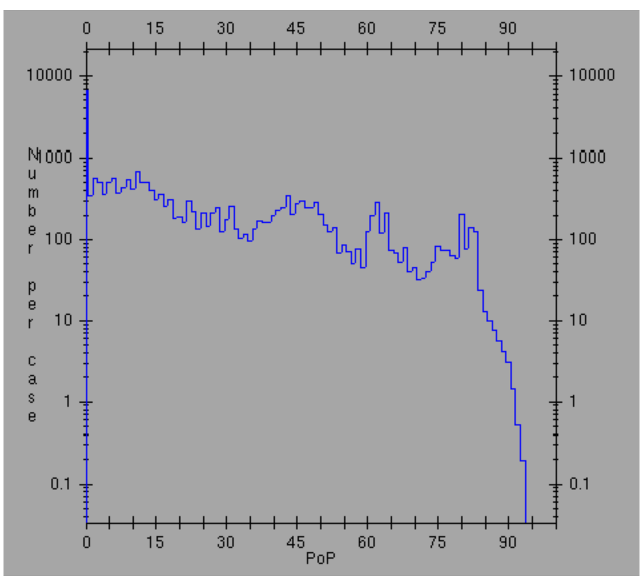

Figure 21: PoP versus number per cases for 60-hour Official forecasts in January.

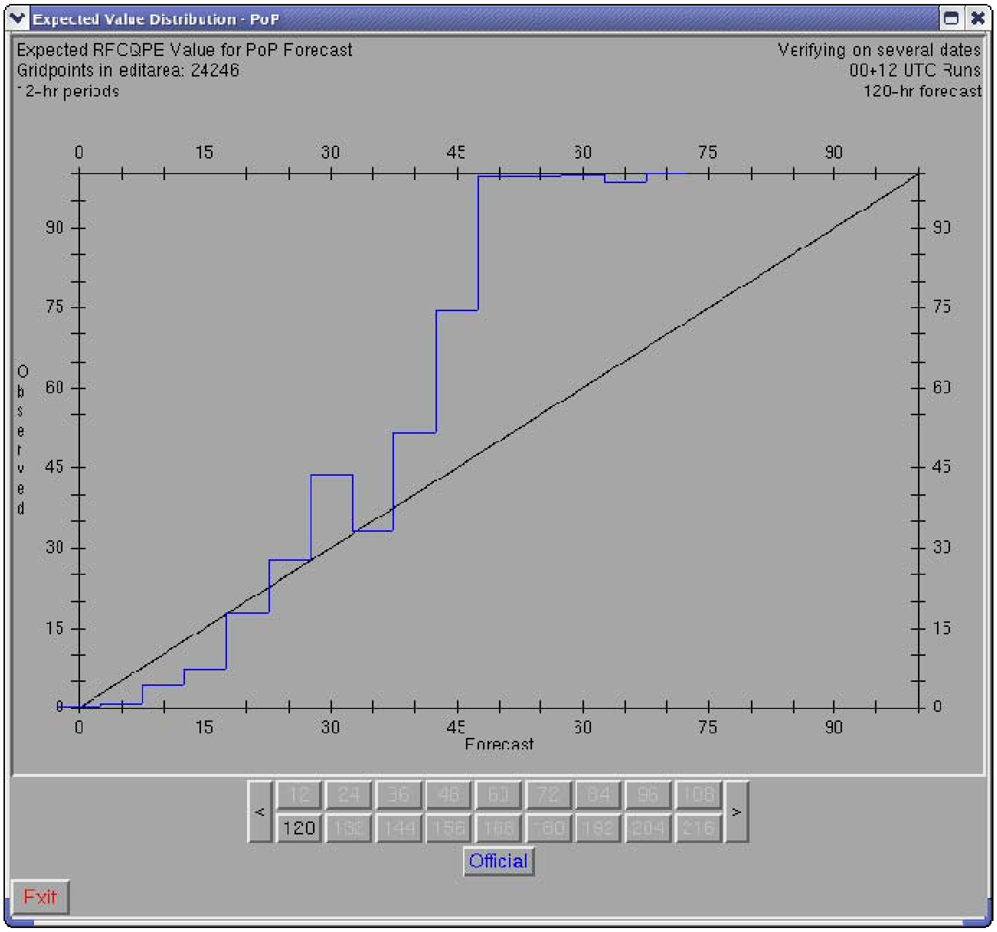

Figure 22: January PoP reliability chart for 120-hour Official forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

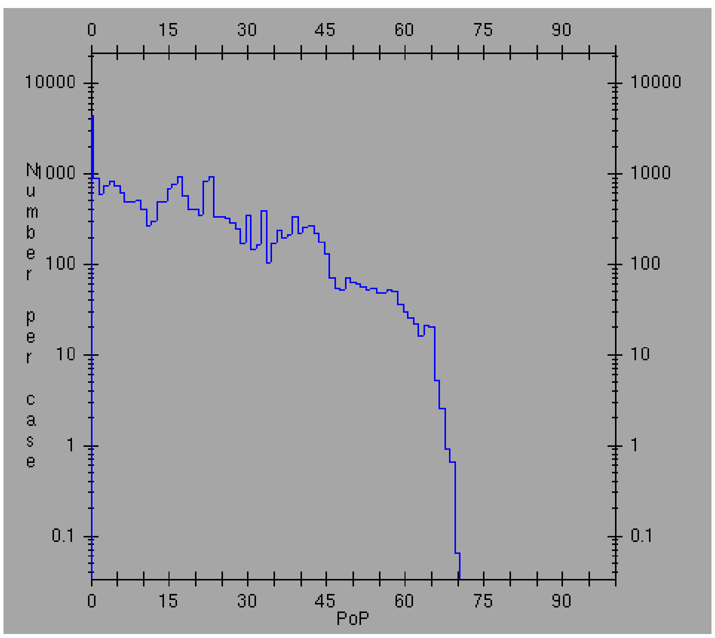

Figure 23: PoP versus number per cases for 120-hour Official forecasts in January.

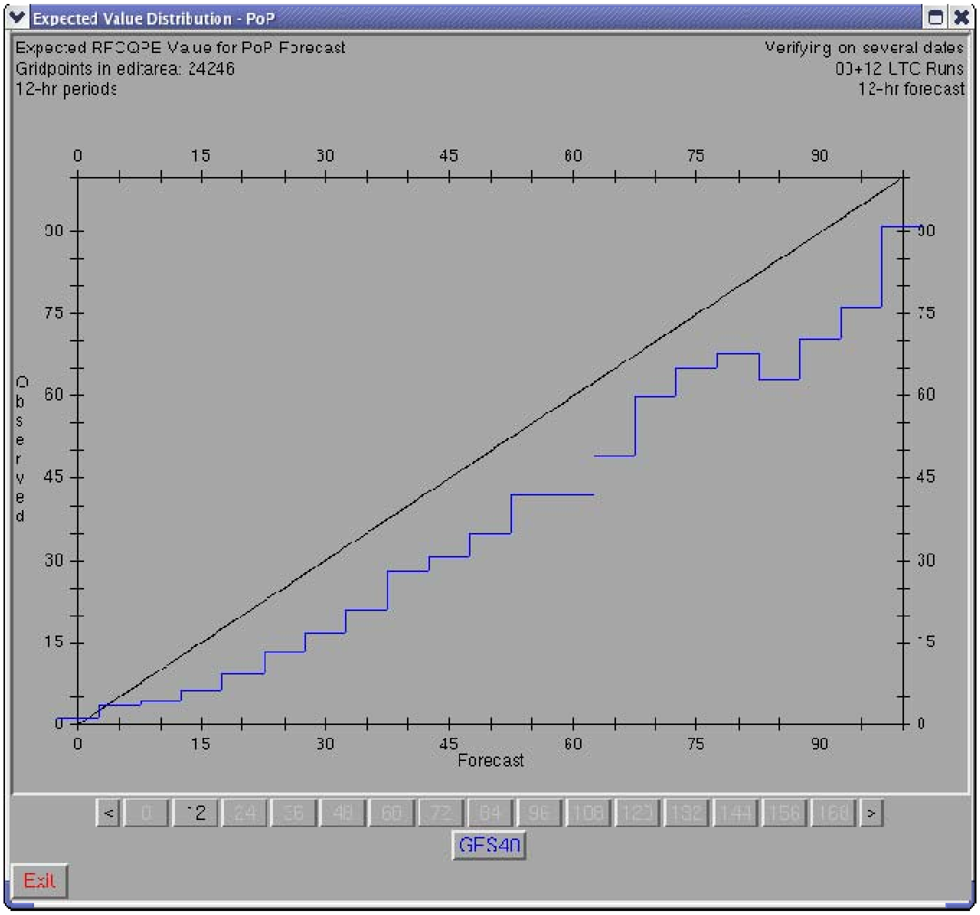

Figure 24: January PoP reliability chart for 12-hour GFS forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

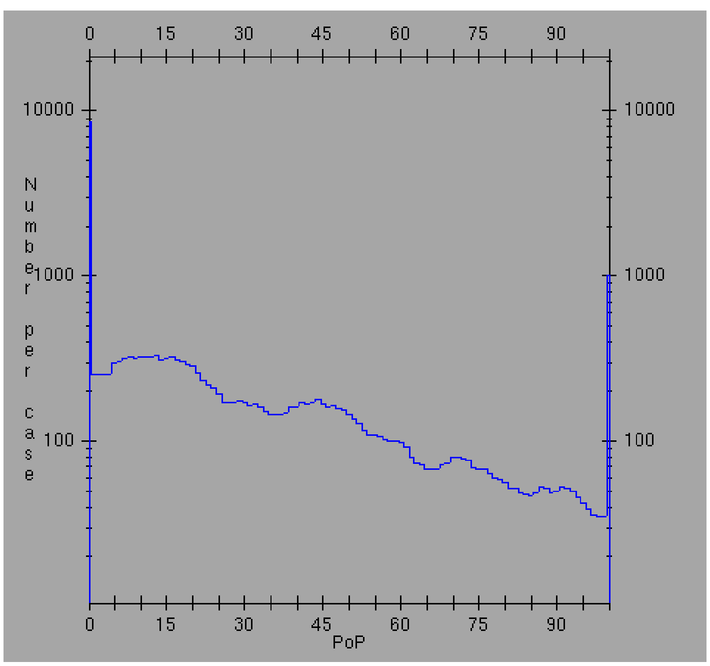

Figure 25: PoP versus number per cases for 12-hour GFS forecasts in January.

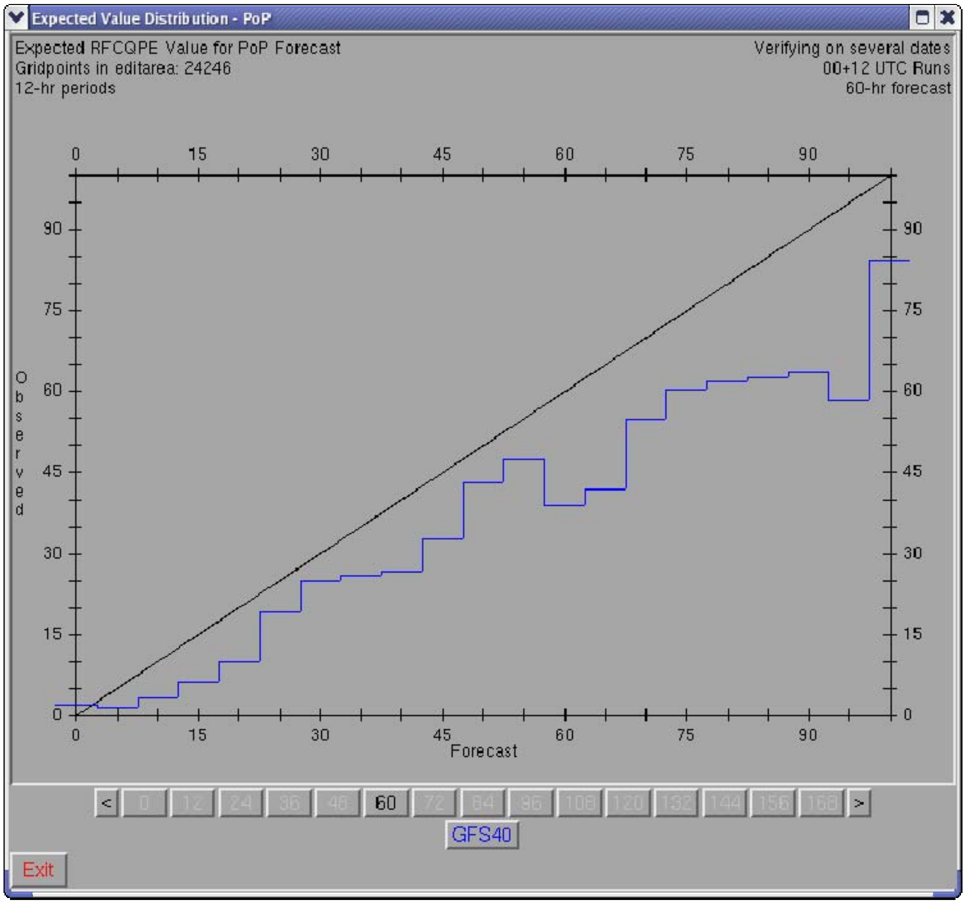

Figure 26: January PoP reliability chart for 60-hour GFS forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

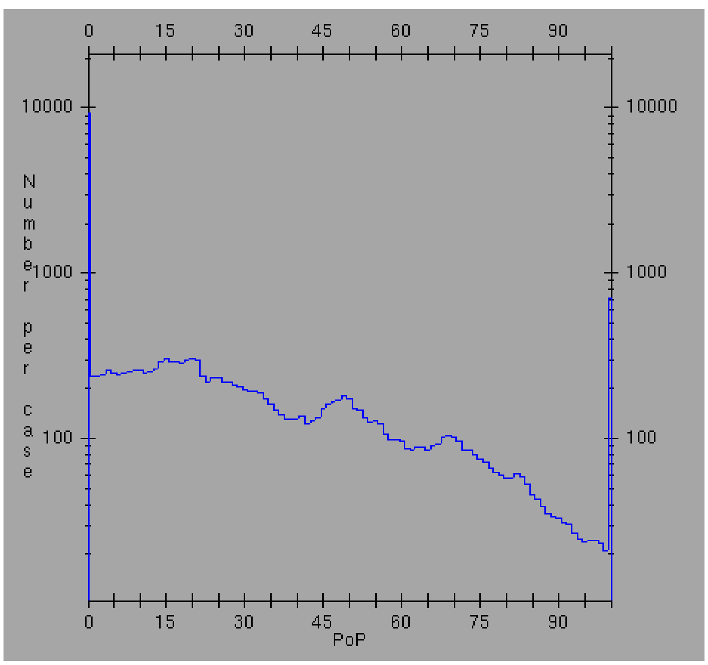

Figure 27: PoP versus number per cases for 60-hour GFS forecasts in January.

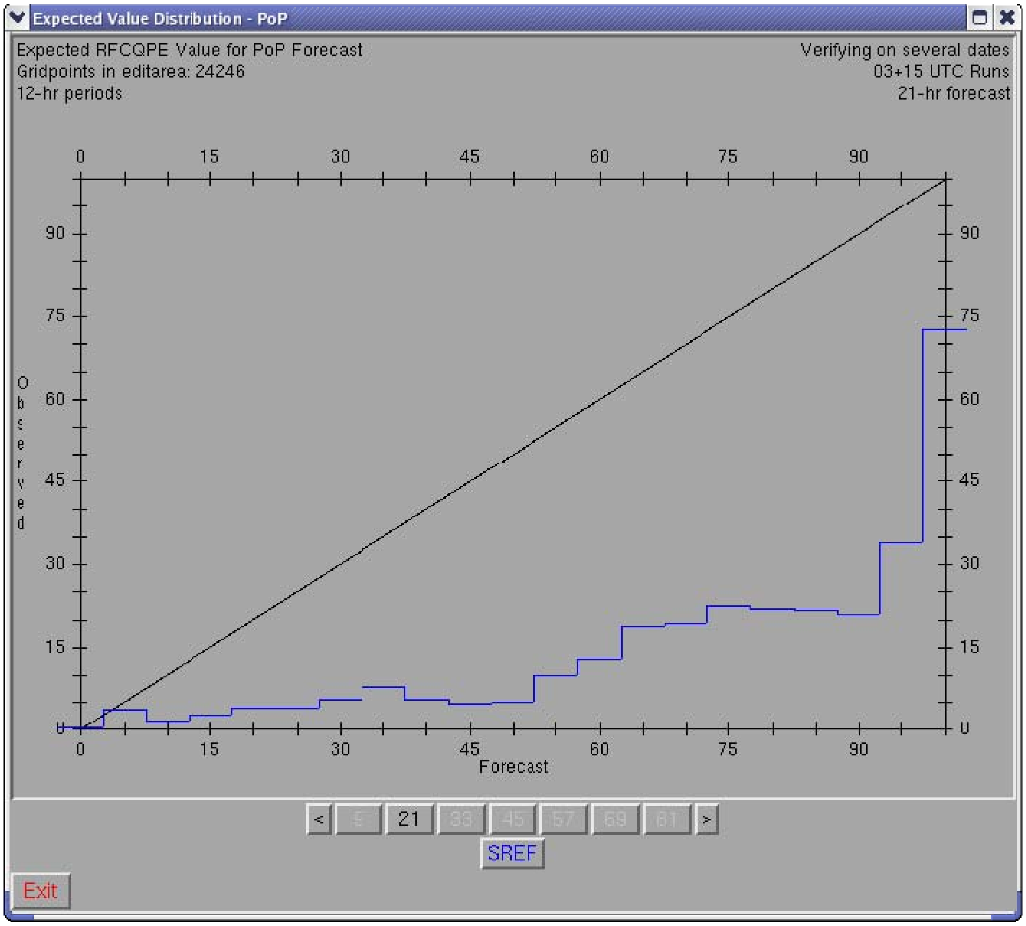

Figure 28: January PoP reliability chart for 21-hour SREF forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

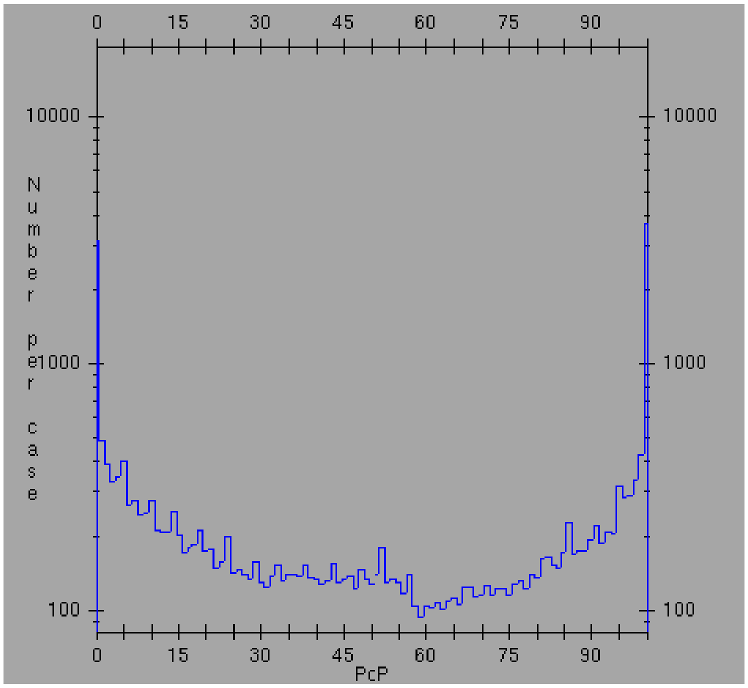

Figure 29: PoP versus number per cases for 21-hour SREF forecasts in January.

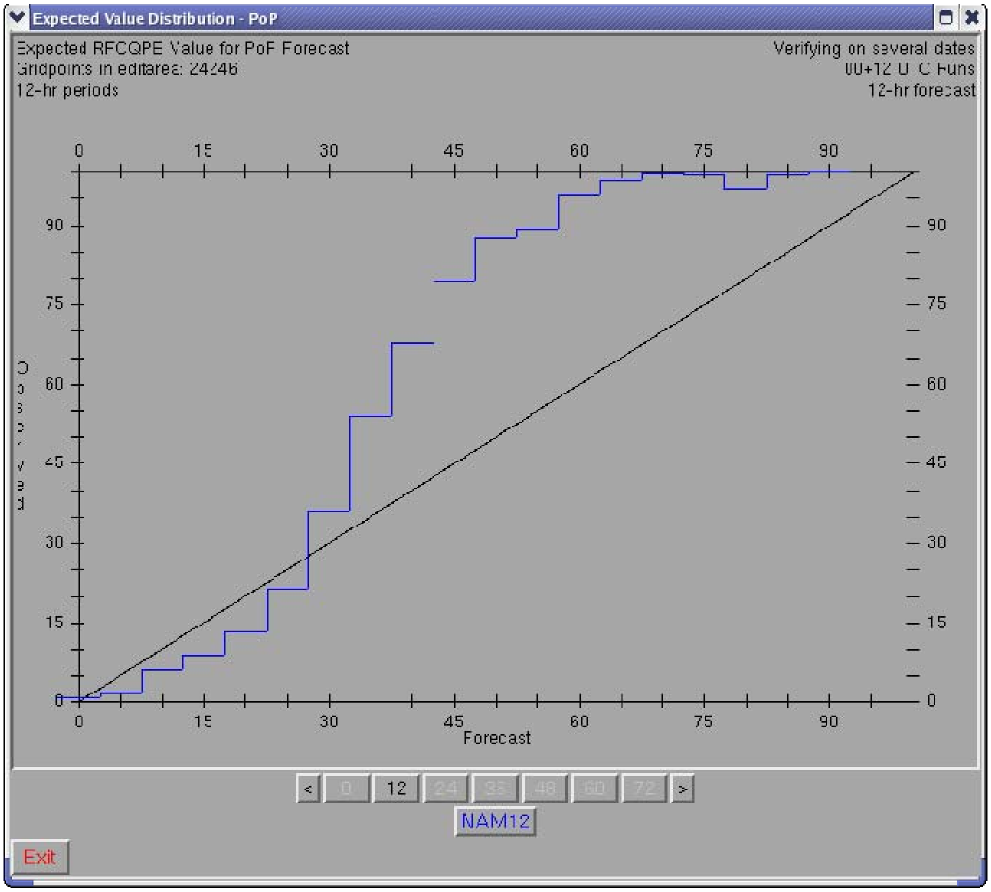

Figure 30: January PoP reliability chart for 12-hour NAM forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

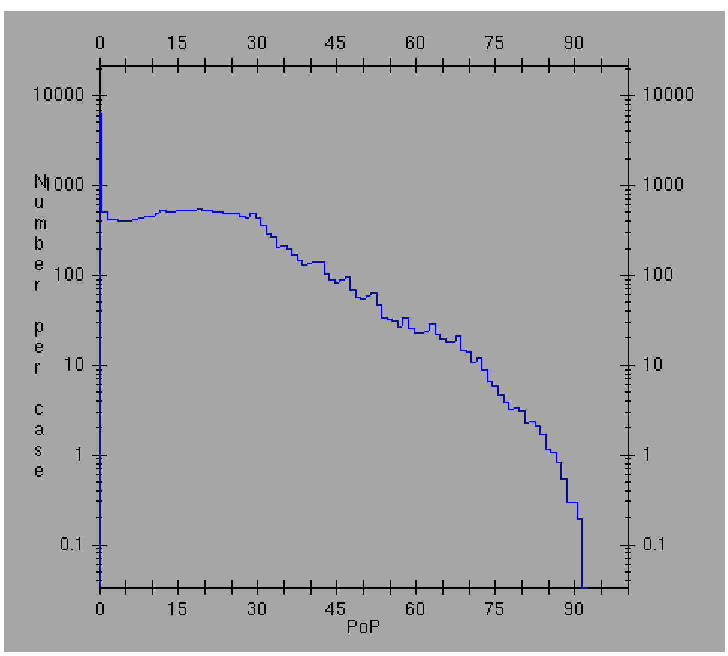

Figure 31: PoP versus number per cases for 12-hour NAM forecasts in January.

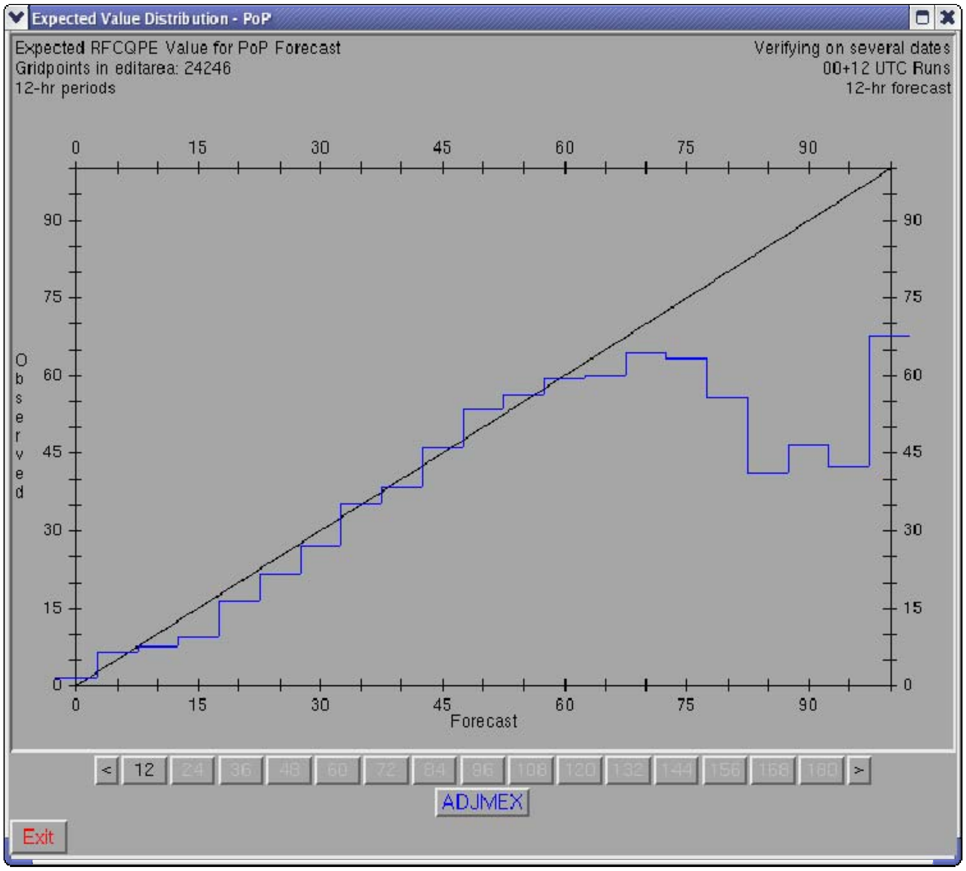

Figure 32: January PoP reliability chart for 12-hour ADJMEX forecasts with forecast PoP on the x-axis and observed frequency of precipitation on the y-axis.

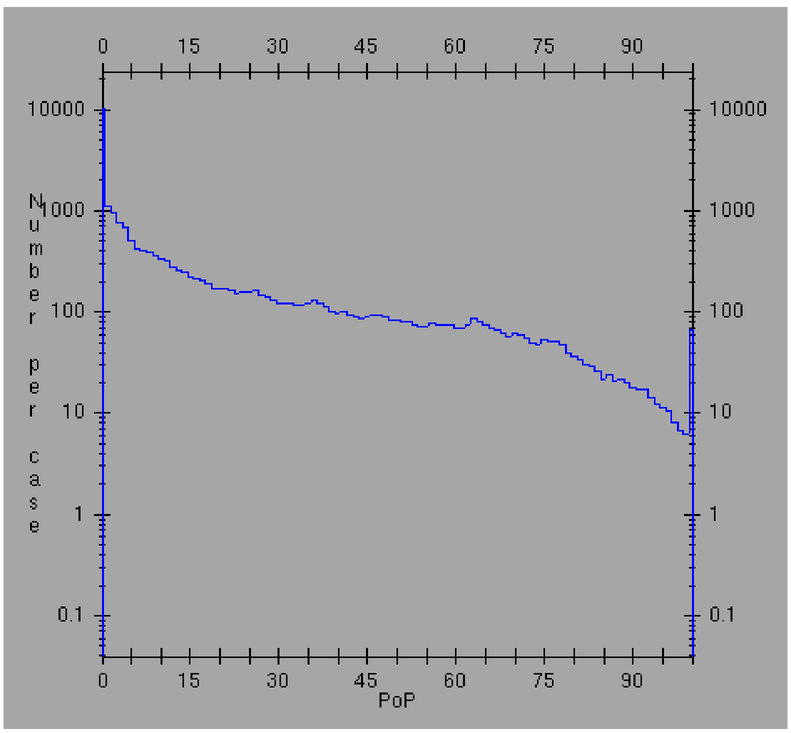

Figure 33: PoP versus number per cases for 12-hour ADJMEX forecasts in January.