Precipitation Events: Probability of Precipitation Bias Statistics

Dean Hazen
National Weather Service
Pocatello, Idaho

Introduction

Bias statistics were generated for four "big" precipitation events which occurred between January 1 and February 10, 2008. Big events were defined to be periods when the National Precipitation Verification Unit (NPVU) precipitation analysis indicated that precipitation amounts well above the climatological norm occurred over a significant portion of the Pocatello forecast area. These events were identified using a WR/SSD developed web page available on the WR AWIPS network. The BOIVerify2.0 application was used to generate bias statistics for the Probability of Precipitation (PoP) forecasts issued by the Pocatello office and for available model guidance through a forecast lead-time of 72 hours. In addition to generating forecast statistics for the entire forecast area, bias statistics were generated for four distinct sub-regions: the Snake River Plain, the Central Mountains, the Eastern Highlands, and the Southern Highlands. Finally, statistics were generated for the full range of PoP values at 24 and 72 hour forecast lead-times for the 40 day period ending on February 10, 2008. This period included dry (Verified PoP $\leq$ 40%) periods, wet (Verified PoP $\geq$ 50%) periods and the four "big" precipitation events, so a full range of expected or verified PoP (VPoP) values could be evaluated.

Discussion

Southeast Idaho

Bias statistics for the forecast area served by Pocatello (Figure 1) indicate an overall dry bias of approximately 30 to 35 percent at 72 hours forecast lead-time which decreases to around 15 percent at 12 hours for "big" events. The PoP distribution at 72 hours lead-time for the 40 day period (Figure 2) shows a dry bias of around 10-15% at a VPoP of 30% which increases to around 25% at 40% and remains at that level up to a VPoP of 75% or better. At VPoP values below 30% the bias is negligible. The PoP distribution at 24 hours lead-time for the 40 day period (Figure 3) shows a dry bias of around 10% at 50% VPoP which gradually increases to around 15% at 60% and remains at that level up to a VPoP of 75% or better.

These graphs indicate that forecasters at Pocatello do a good job of identifying "dry" events or alternatively, identifying events which produce little or no measurable precipitation regardless of forecast lead-time. Inversely, these graphs indicate a substantial dry PoP bias at 72 hours lead-time with forecast values approximately 25% below VPoPs for events producing measurable precipitation. For example, a PoP forecast of 60% (Low Range Likely) corresponded with a VPoP of 85-90% (Mid-Range Categorical). Similarly, a PoP forecast of 50% (Mid-Range Chance), correlated with a VPoP of 70-75% (High Range Likely category). On a positive note, this dry bias is reduced by about half at the 24 hour forecast lead-time which indicates that as a "wet" event approaches the forecast trends in the correct direction.

Statistics were also generated for similar climate/weather sub-regions to determine if significant differences in skill were noted. The following sections will focus on statistical differences noted for each sub-region relative to the entire Southeast Idaho area for the four "big" events and the 40 day period presented above.

Snake River Plain (SRP)

Bias statistics for the SRP (Figure 4) indicate an overall dry bias of approximately 35 to 40 percent at 72 hours lead-time which decreases to around 25 percent at 12 hours for "big" events. The PoP distributions for 24 and 72 hour lead-times for the 40 day period (not shown) are consistent with Figures 2 and 3 above. A comparison of Figures 1 and 4 would seem to indicate that forecasters are less likely to forecast a "big" (well above climatological) event for the SRP relative to the entire forecast area. One possible reason is increased forecast uncertainty due to the variety of precipitation patterns generated by local orographic effects which are dependant on flow regime and strength. For example, westerly or northwesterly flow can suppress precipitation amounts in the western portion of the SRP along the Central Mountains, and can enhance precipitation along I-15 corridor and foothills on the eastern and southern edge of the SRP. A strong southerly flow produces even more dramatic shadowing effects in the southern SRP and precipitation enhancement along the SRP boundaries with the Central Mountains and Upper Snake Highlands. In many cases, the suppression of precipitation is strong enough to overcome moderate synoptic forcing in the mid and upper levels.

Central Mountains

Bias statistics for the Central Mountains (Figure 5) indicate an overall dry bias of approximately 35 to 40 percent at 72 hours forecast lead-time which decreases to around 15 percent at 12 hours for "big" events. The PoP distributions at 24 and 72 hours lead-time for the 40 day period (not shown) are consistent with Figures 2 and 3 above. In summary, the forecast PoP trends and biases are similar to those for all of Southeast Idaho.

Eastern Highlands

Bias statistics for the Eastern Highlands (Figure 6) indicate an overall dry bias of approximately 20 to 25 percent at 72 hours forecast lead-time which decreases to around 0 percent at 12 hours for "big" events. The PoP distribution at 72 hours lead-time for the 40 day period (Figure 7) shows a dry bias of around 10-15% at 30% VPoP which increases to around 20-25% at 40% and remains at that level up to a VPoP of 75% or better. At VPoP values below 30% the bias is negligible. The PoP distribution at 24 hours lead-time for the 40 day period (Figure 8) shows no significant bias (< 10%) regardless of VPoP. This would indicate forecasters are somewhat more inclined to forecast "wet" at 72 hours and do an outstanding job of distinguishing dry vs. wet events at 24 hours lead-time. One possible reason is that orographic effects associated with the Eastern Highlands are much more consistently tied to precipitation production for a variety of synoptic flow regimes. Moist regimes affecting the Eastern Highlands tend to have a westerly component with southwest flow in the early stage and then transition to a westerly and then northwesterly direction in later stages. Thus the favorable time period for precipitation production is extended through the entire event.

Southern Highlands

Bias statistics for the Southern Highlands (Figure 9) indicate an overall dry bias of approximately 20 to 25 percent at 72 hours forecast lead-time which decreases to 10 to 15 percent at 12 hours for "big" events. The PoP distribution at 72 hours lead-time for the 40 day period (Figure 10) shows a larger dry bias of around 30% for VPoP values of 40% and greater, which is the highest dry bias of all regions examined. The PoP distribution at 24 hours lead-time for the 40 day period (not shown) indicates a substantial adjustment to forecast PoP with dry bias returning to levels consistent with the entire Southeast Idaho forecast area.

Conclusions

PoP forecasts during the period examined indicate that forecasters do a good job of identifying dry events (VPoP < 40%); however, a substantial dry bias exists when forecasting wet events (VPoP $\geq$ 50%) and particularly "big" events producing precipitation amounts which are magnitudes of order greater than climatology.

An evaluation of forecast sub-regions indicates that forecast skill does vary from region to region with the best forecast performance in the Eastern Highlands and the worst performance in the Snake River Plain for "big" events. Evaluation of 72 hour forecasts for wet events indicates a substantial and consistent dry bias of 20-30% for all sub-regions with little difference in performance from sub-region to sub-region. At 24 hours lead-time, PoP forecasts show improvement for wet events with a consistent dry bias of 10-15% for sub-regions with the exception of the Eastern Highlands which shows no significant bias.

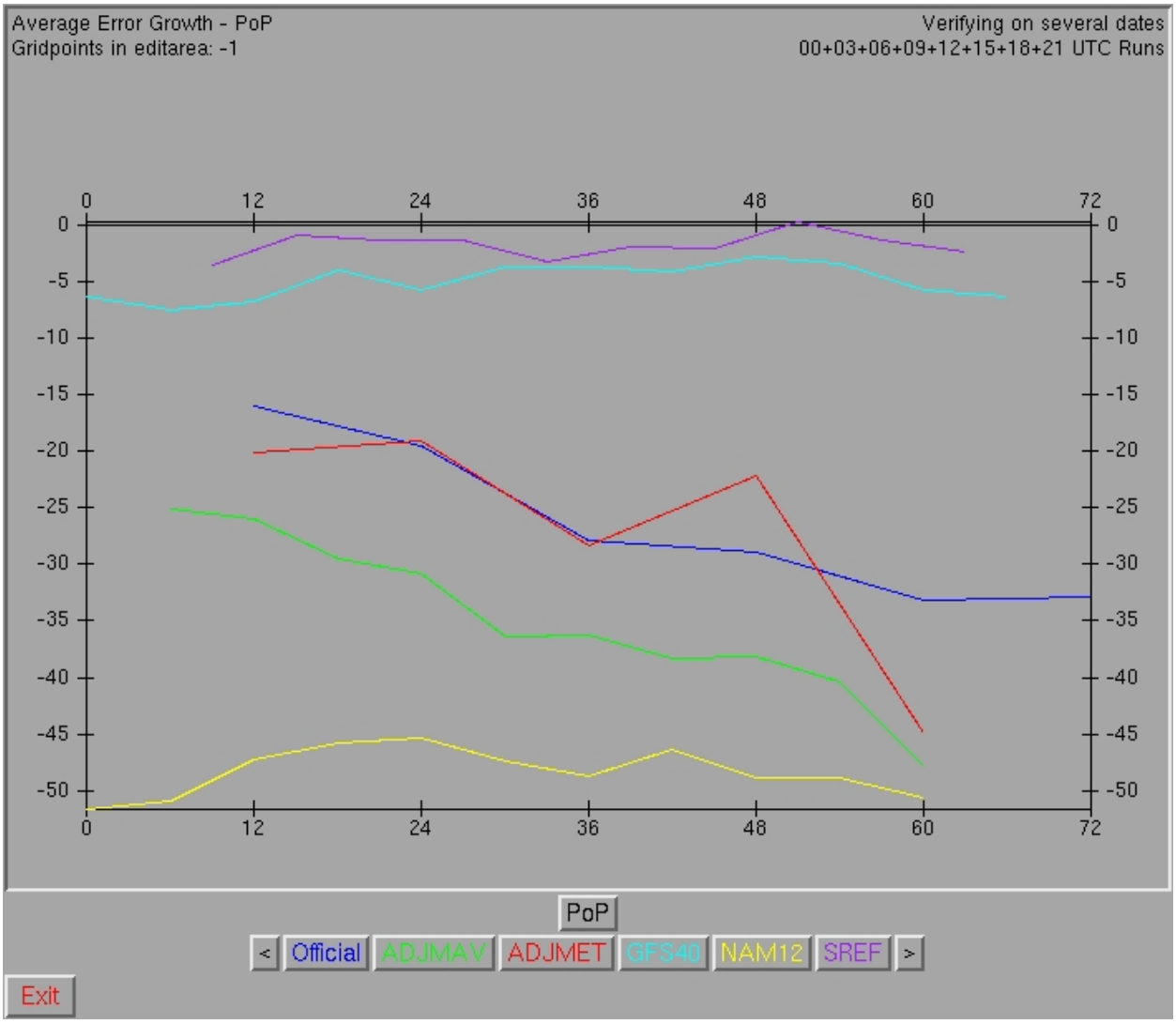

Figure 1 – PoP Bias (y-axis) for Southeast Idaho “big” events for forecast lead-time of 12 to 72 hours.

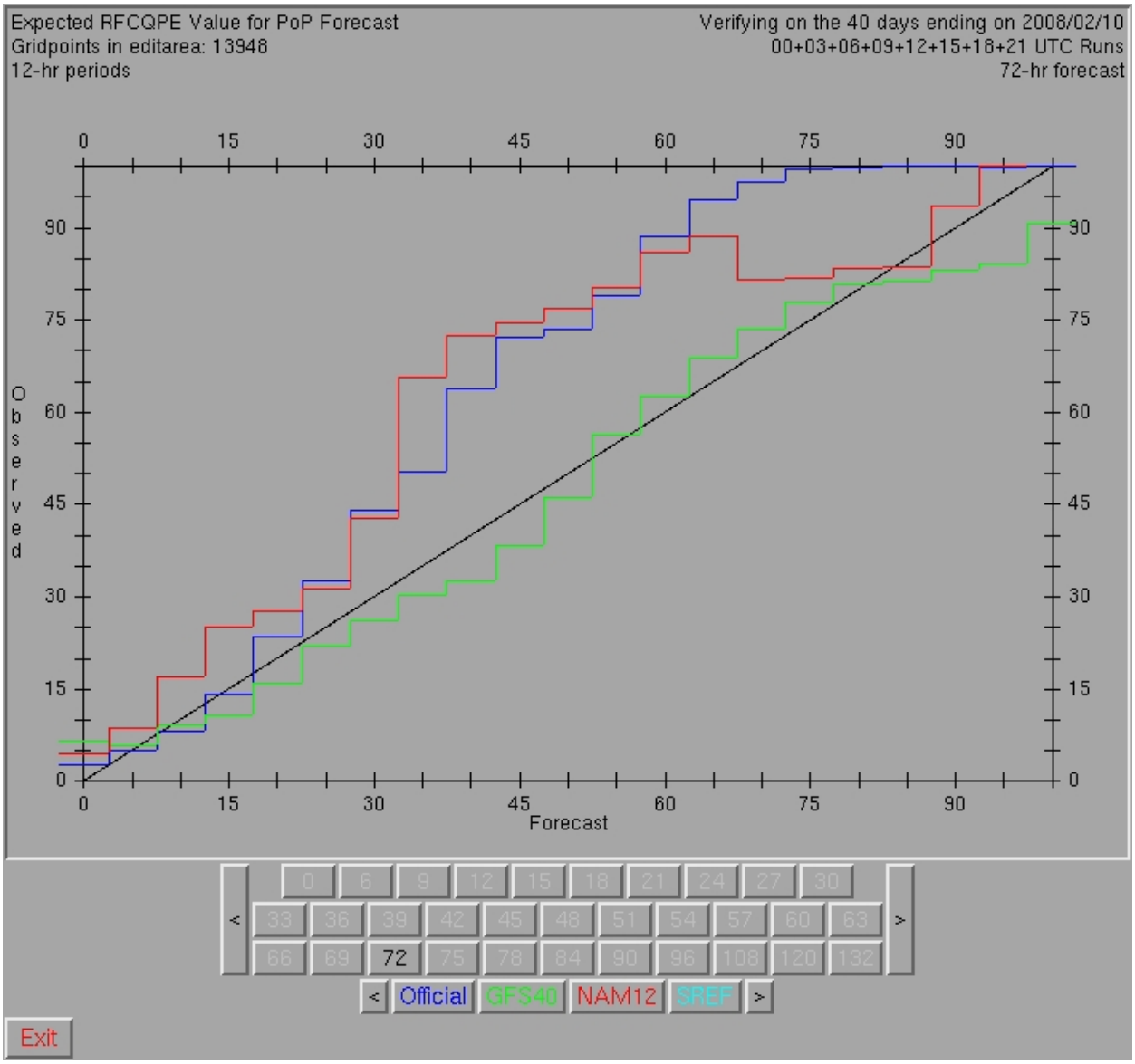

Figure 2 – Southeast Idaho forecast PoP versus verified PoP for 72 hour forecast lead-time for the 40 day period.

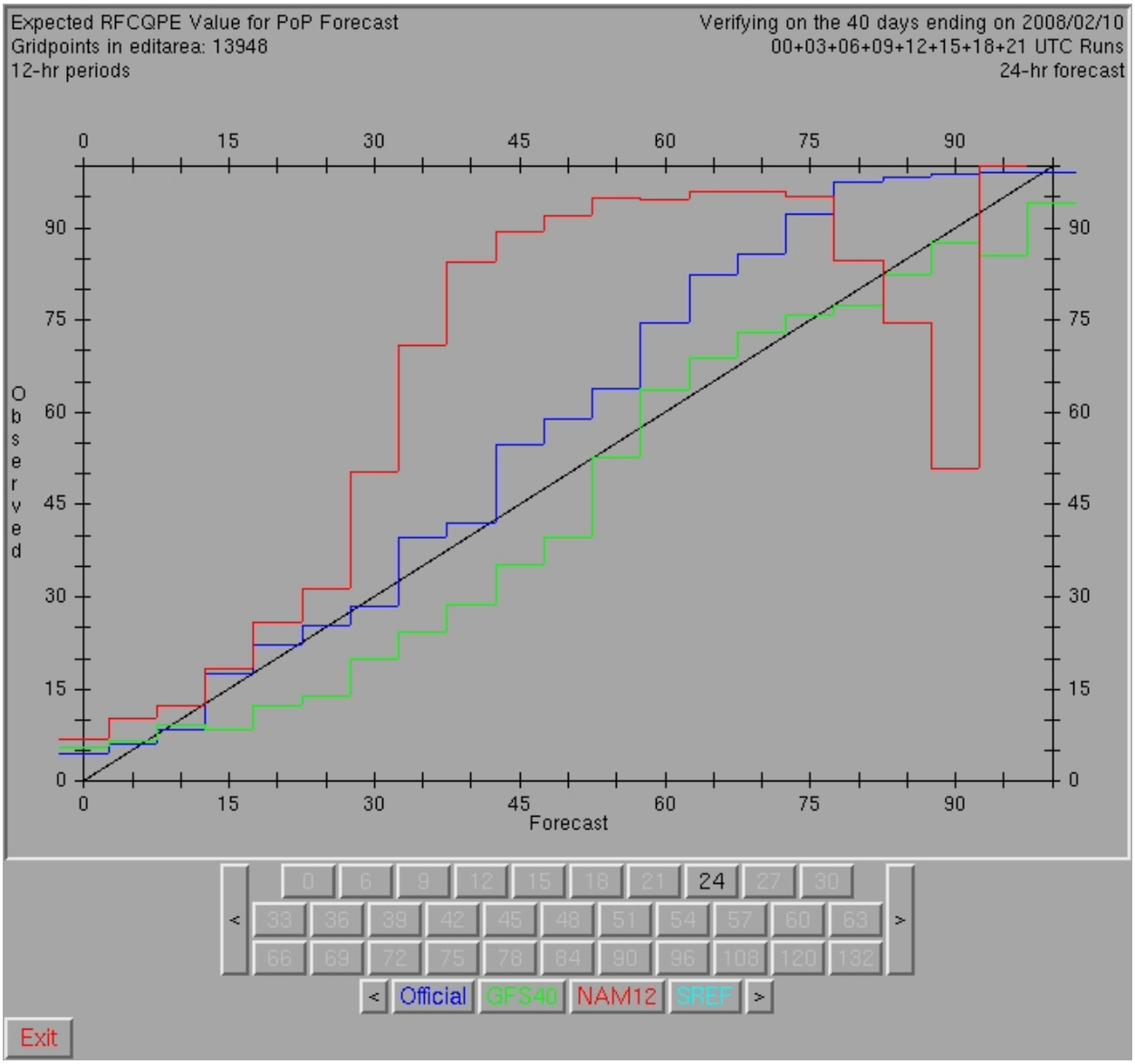

Figure 3 – Southeast Idaho forecast PoP versus verified PoP for 24 hour forecast lead-time for the 40 day period.

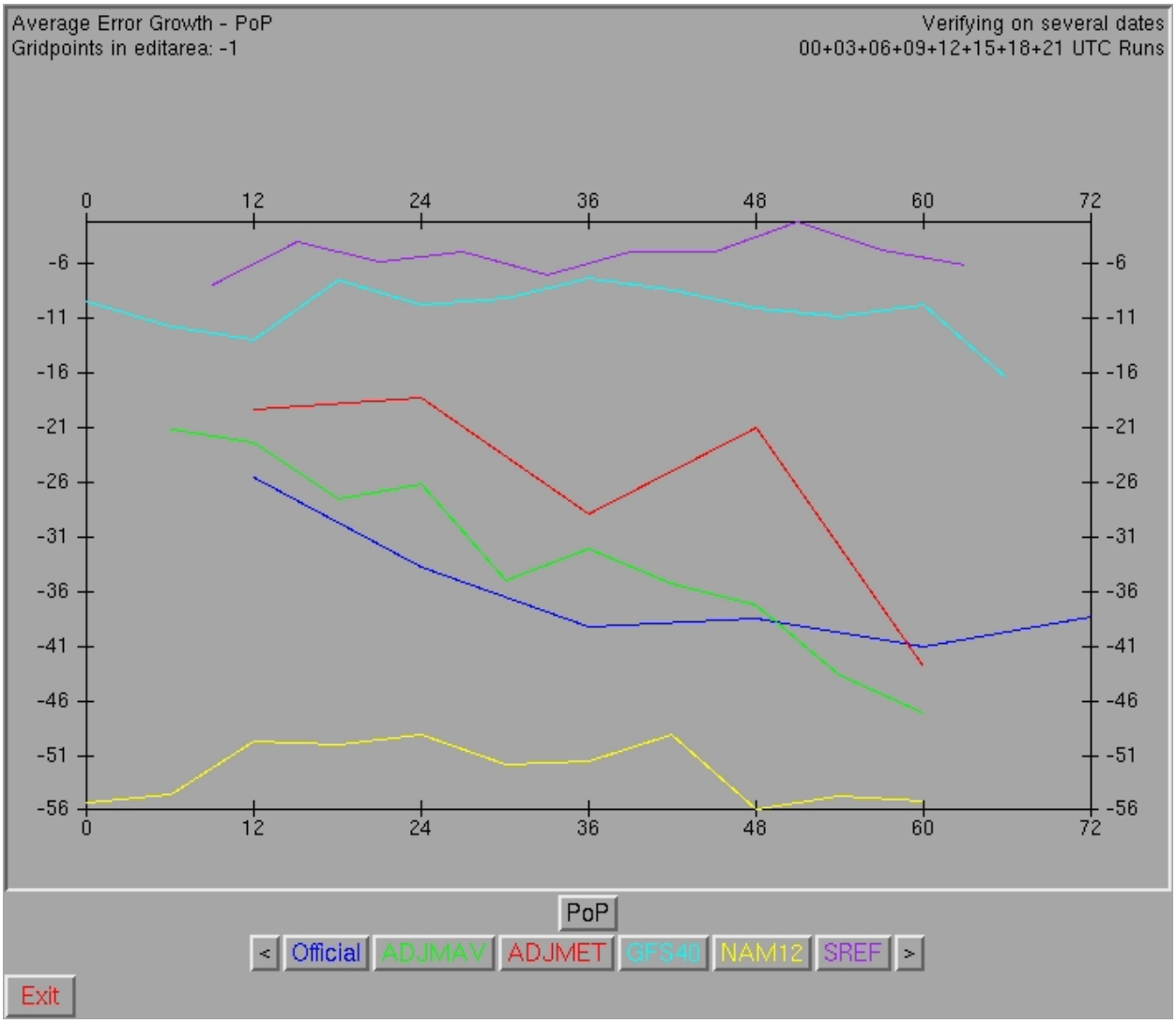

Figure 4 – PoP Bias (y-axis) for the Snake River Plain for “big” events for forecast lead-time of 12 to 72 hours.

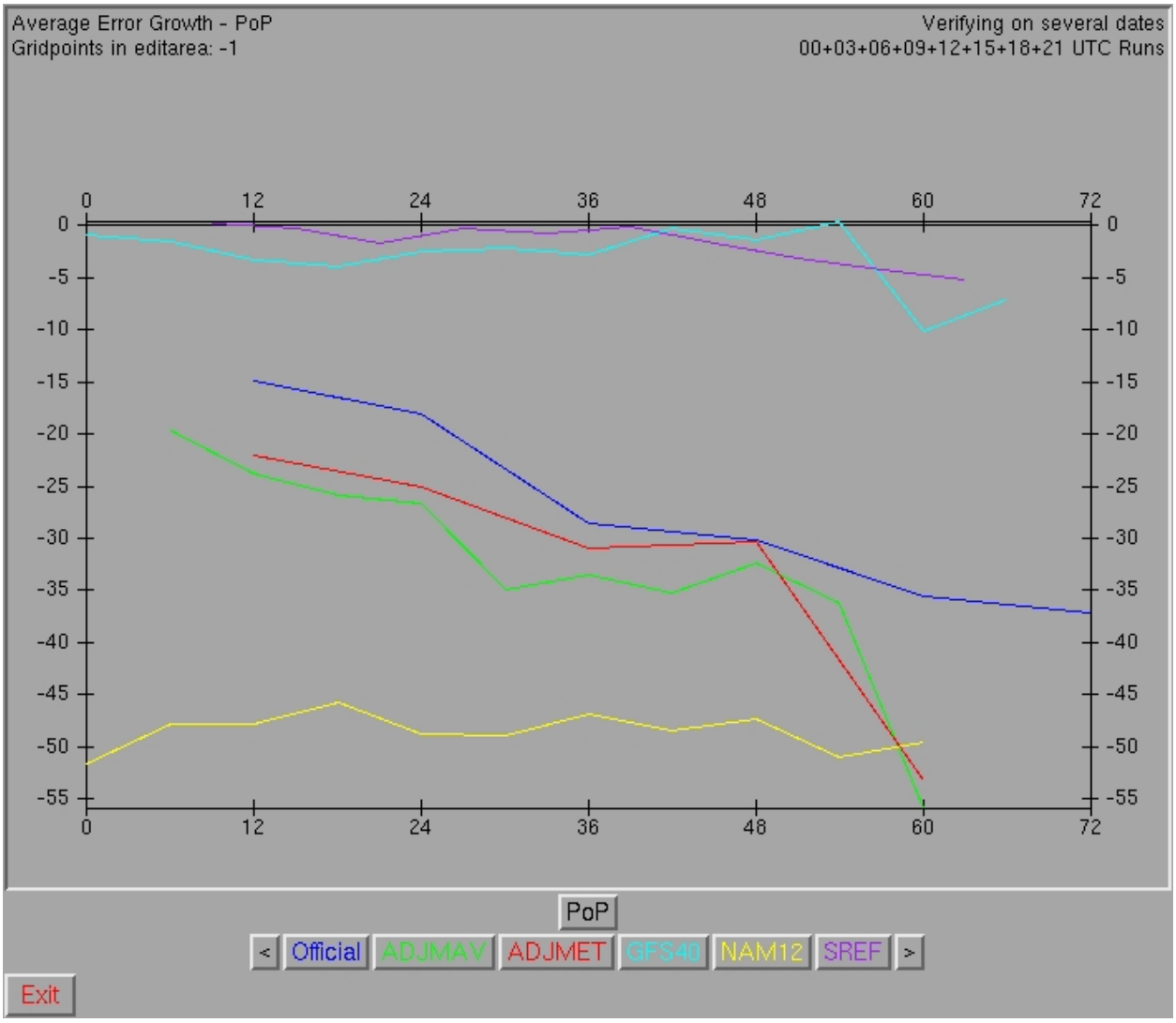

Figure 5 – PoP Bias (y-axis) for the Central Mountains for “big” events for forecast lead-time of 12 to 72 hours.

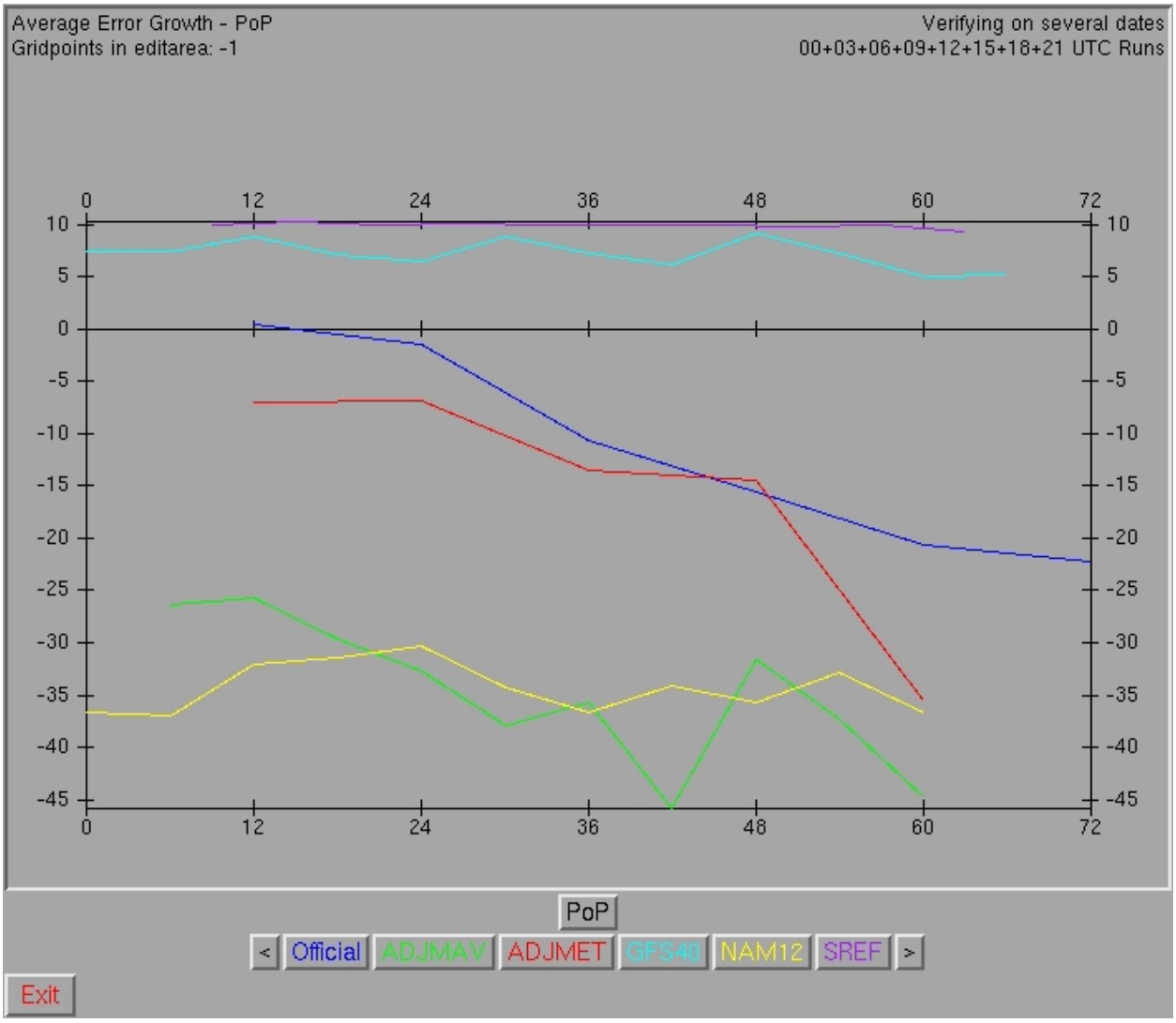

Figure 6 – PoP Bias (y-axis) for the Eastern Highlands for “big” events for forecast lead-time of 12 to 72 hours.

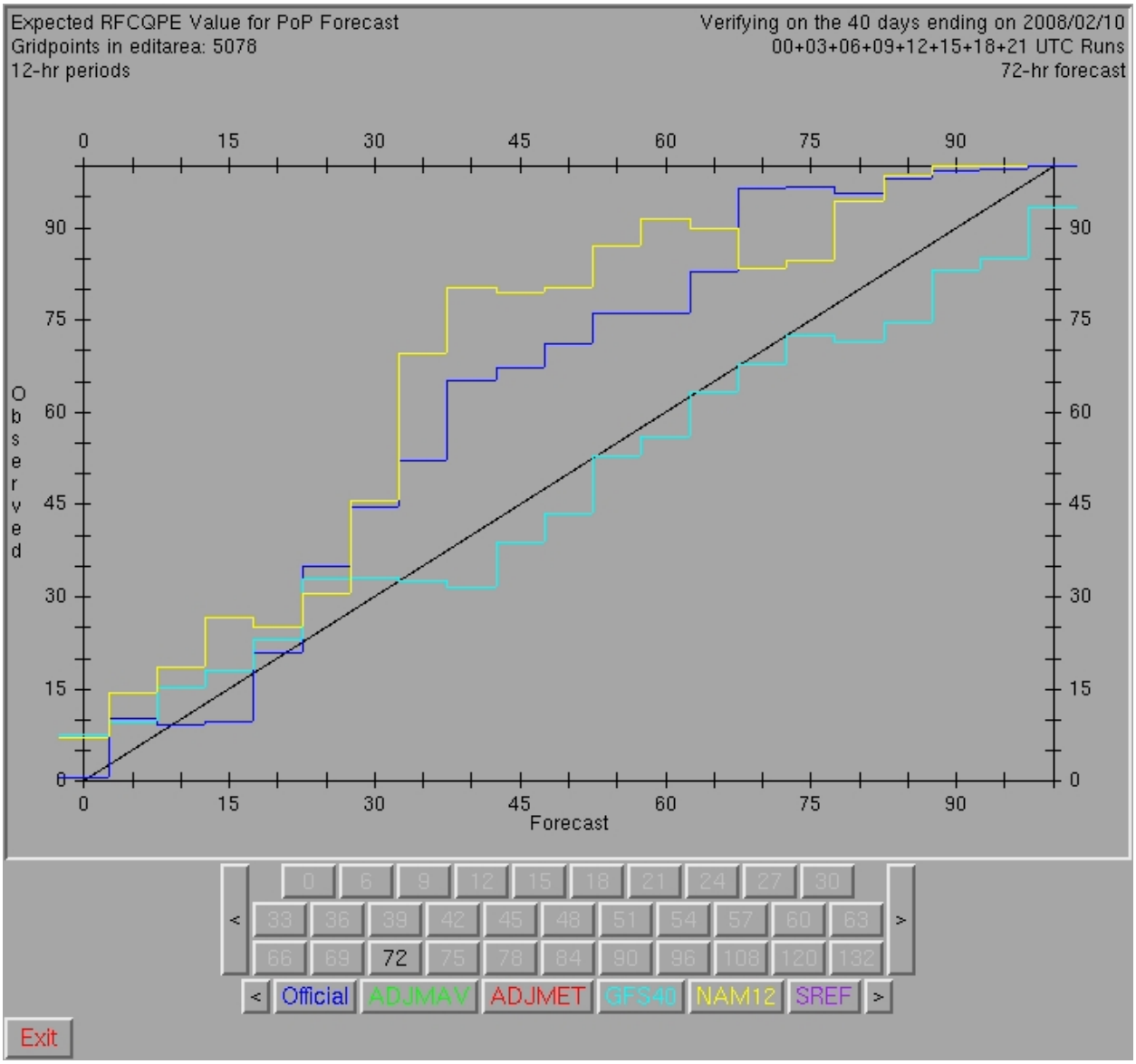

Figure 7 – Eastern Highlands forecast PoP versus verified PoP for 72 hour forecast lead-time for the 40 day period.

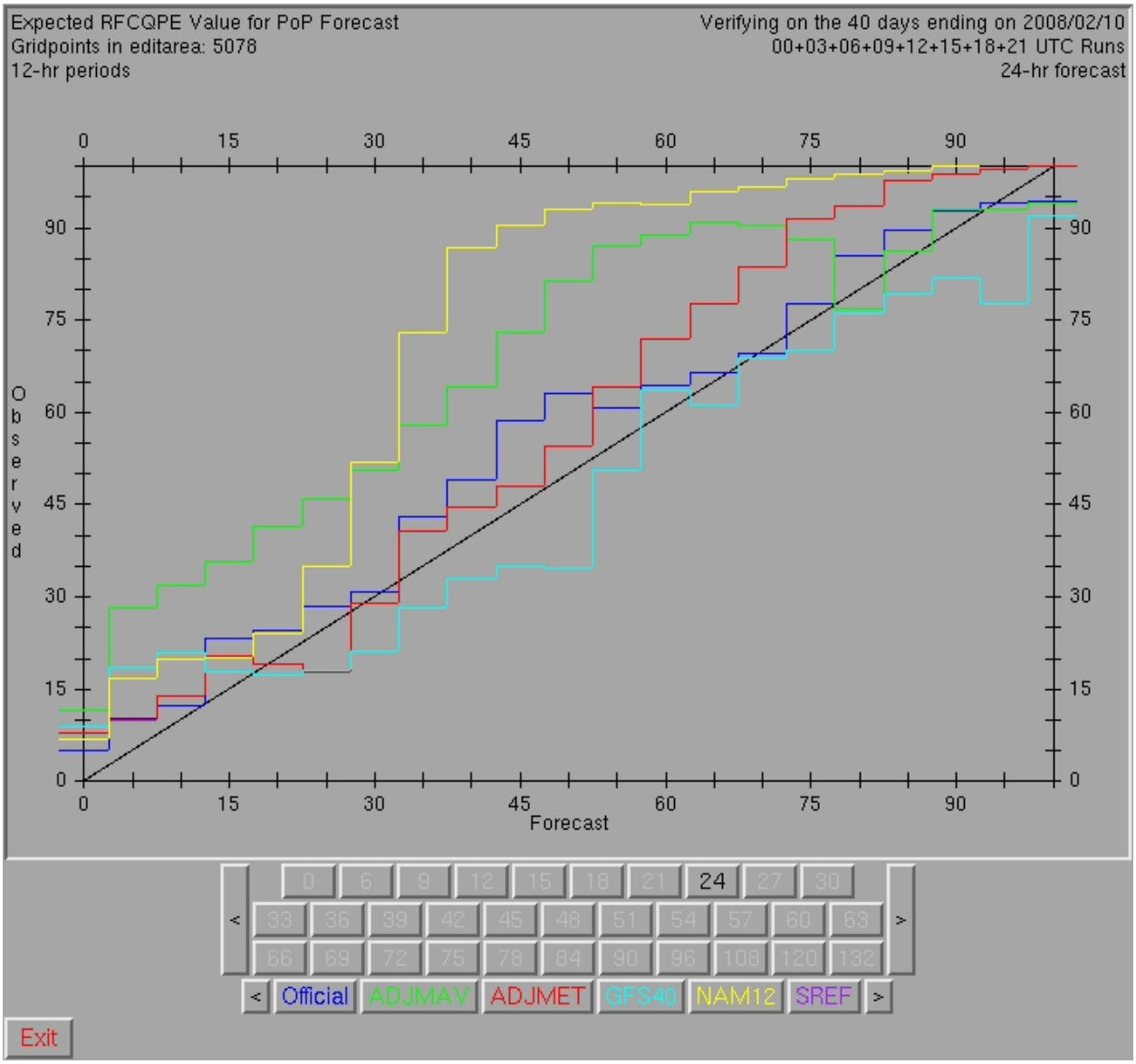

Figure 8 – Eastern Highlands forecast PoP versus verified PoP for 24 hour forecast lead-time for the 40 day period.

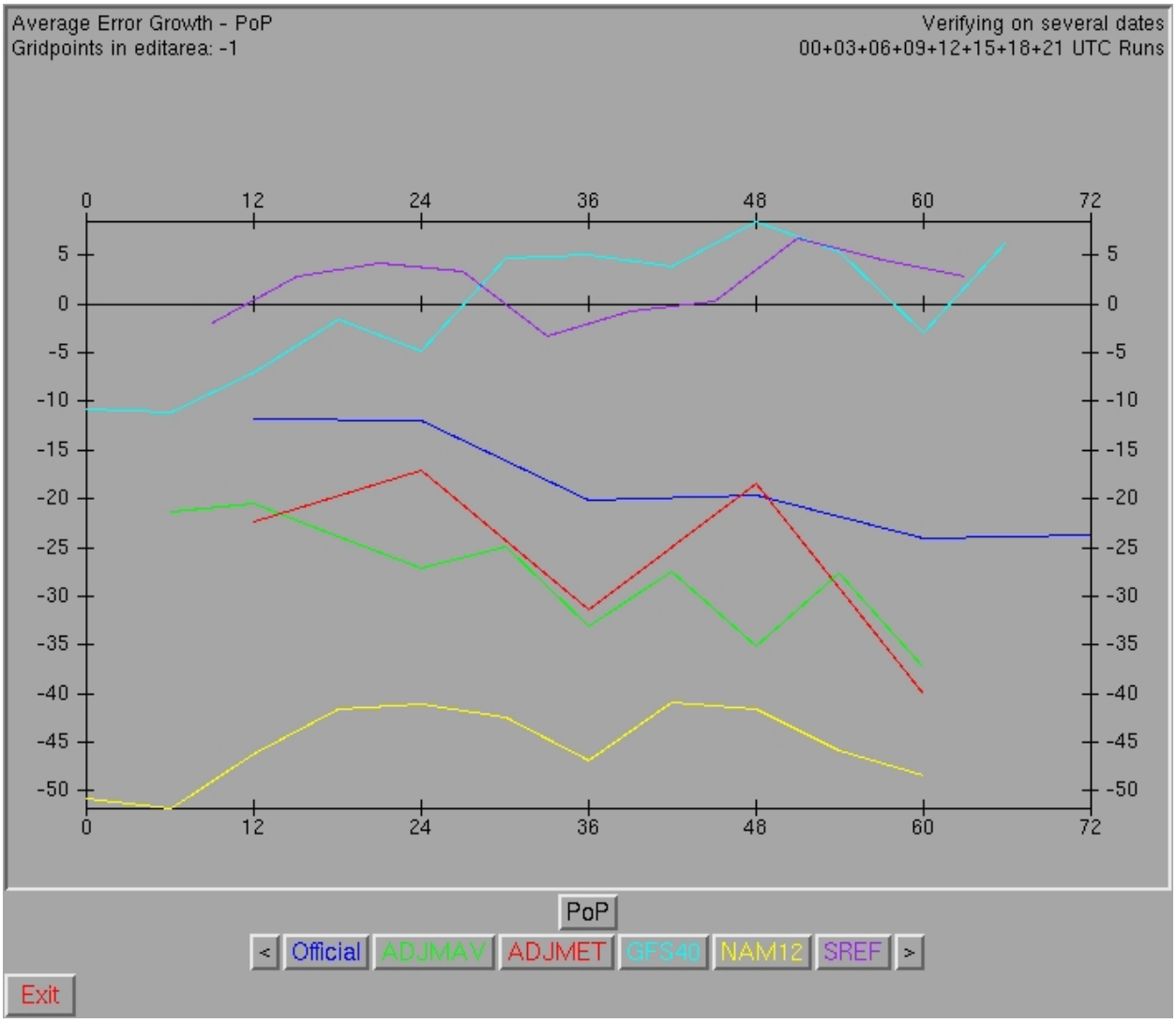

Figure 9 – PoP Bias for the Southern Highlands for “big” events for forecast lead-time of 12 to 72 hours.

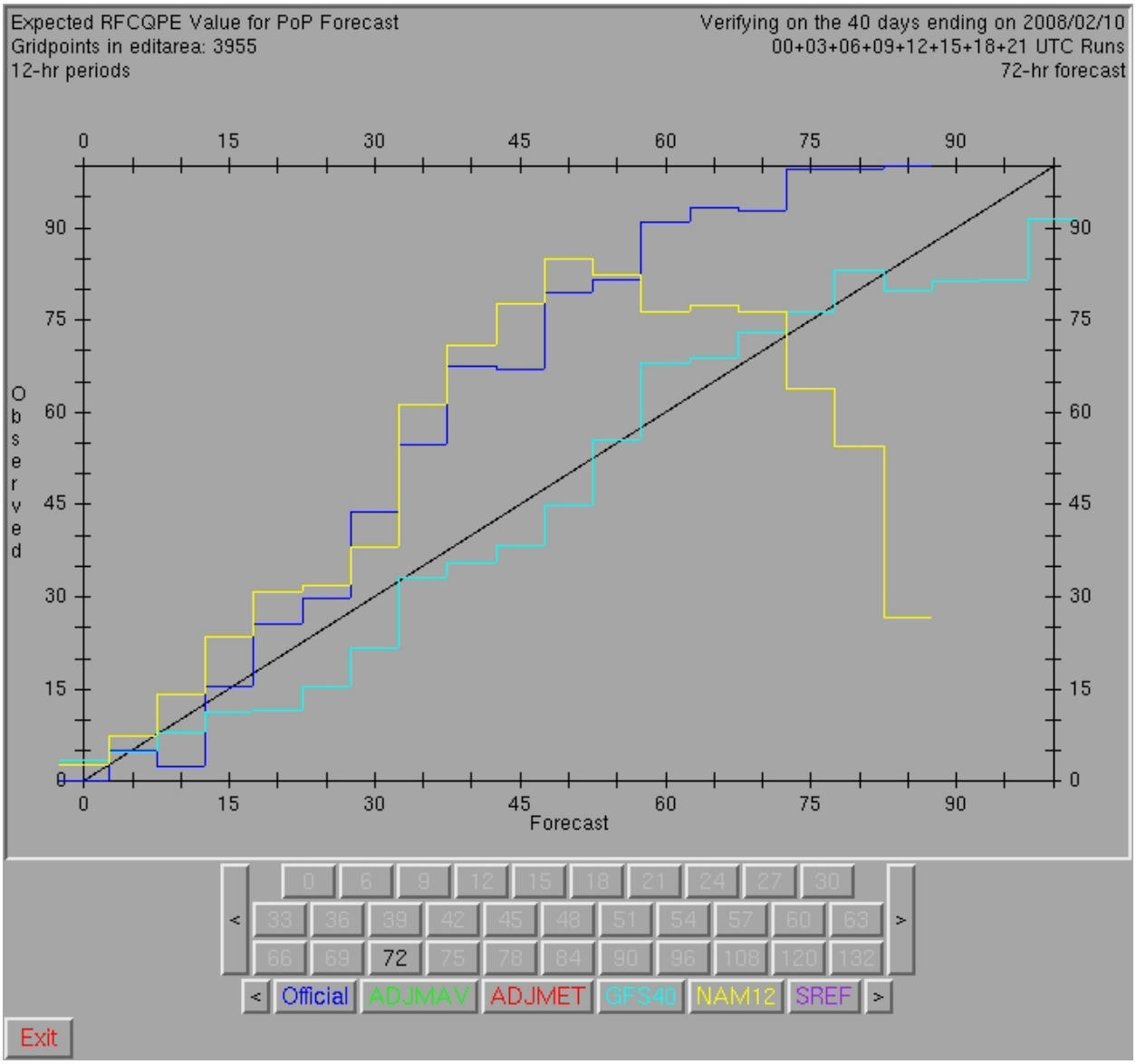

Figure 10 – Southern Highlands forecast PoP versus verified PoP for 72 hour forecast lead-time for the 40 day period.