

P6.3 QPFHELPER: APPLICATION OF THE MOUNTAIN MAPPER FORECAST TECHNIQUE WITHIN THE GRAPHICAL FORECAST EDITOR

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1. INTRODUCTION

The National Oceanic and Atmospheric Administration's National Weather Service (NWS) provides regular quantitative precipitation forecasts (QPF). At NWS Weather Forecast Offices (WFO's), QPF is derived within the Interactive Forecast Preparation System (IFPS). QPF from the local forecast database is collected nationally and used to populate the National Digital Forecast Database (NDFD).

At the WFO, the QPF grids are developed on the Graphical Forecast Editor (GFE). These grids are shared through the GFE intersite coordination process with surrounding WFO's and NWS River Forecast Centers (RFC's). In addition, the RFC precipitation forecasts, developed by meteorologists and hydrologists at the RFC's, are collected at the WFO's. Figure 1 provides an image of the Graphical Forecast Editor portion of IFPS.

Sections 2 and 3 provide background and motivation for development of the QPFHelper tool for use at WFO's and RFC's. Section 4 details how the forecasters run the tool and section 5 explains the inner workings of the tool.

2. BACKGROUND

At the RFC's, QPF is used as input to a river modeling system which simulates the flow of water throughout the rivers within the RFC area of responsibility. Since the early 1990's, RFC's have used the Mountain Mapper (Schaake et al. 2004) technique for developing QPF grids. The Mountain

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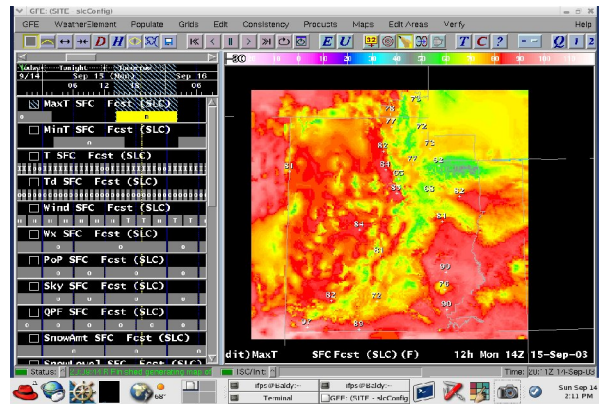


Figure 1 Graphical Forecast Editor

Mapper approach relies on PRISM (Daly et al. 1991) climatology to populate a grid of forecast or observed precipitation based the data at selected points. PRISM climatology was developed by the Oregon State University – Spatial Climate Analysis Service, where point measurements of climate data were combined with a digital elevation model through a statistical approach to create a high resolution climatology grid. The PRISM approach provides a quality estimation of normal precipitation at unaged locations even within complex terrain. Monthly PRISM climatology grids are contained within the GFE for precipitation, as well as maximum and minimum temperatures.

3. QPF AT THE WFO's

Forecasters at WFO's have been creating QPF grids since GFE became operational in 2002. QPF is now an official element on the National Digital Forecast Database (NDFD) (Glahn and Ruth 2003). The grids are typically created for 3 or 6 hour forecast periods with lead time of 72 hours from each forecast issuance. Recently, the authors developed a GFE tool to utilize the Mountain Mapper approach and the PRISM climatological data available within GFE in the development of WFO

QPF grids.

4. RUNNING THE QPFHELPER TOOL

4.1 Step One – Initial Settings

To summarize how QPFHelper works, forecasters first develop their QPF for “control points”. The relatively few point forecasts are then used to influence the many other grid points across the entire grid using the PRISM climatology. Figure 2 shows the initial interface used to run the QPFHelper tool, where the meteorologist selects the type of data used to initialize the control points. For example, the forecaster may want to start with the latest numerical model output, the previously developed gridded QPF, national NWS or RFC guidance, climatology, etc.

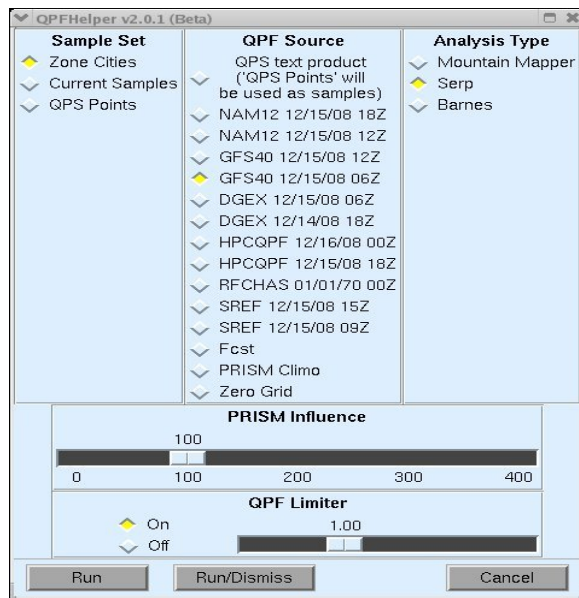


Figure 2. Initial interface of the QPFHelper GFE tool.

At this stage, the forecaster can also control other aspects of the QPFHelper tool. In the left hand column, a control point set can be selected. For example, RFC forecast points (labeled “QPS Points” in this example) or public forecast “Zone Cities” may be selected.

Creating useful sample sets (which become QPF “control points”) is an important part of the tool configuration. Normally, control points are placed where forecasters have familiarity, quality observations and skill. In addition, control points should be placed at various elevations for best

results. The control point set should be dense enough to control the forecast while influencing the forecast with climatology. The forecaster may also select “Current Samples” for control points. This is useful for working on a detailed smaller portion of an overall grid. Forecasters can place samples on a GFE grid and use those as control points for QPF.

In the right hand column of the initial settings (Fig. 2), the forecaster can change the analysis type. Three type of analyses are available: Mountain Mapper, Serpentine Curve and Barnes Analysis. Qualitatively, all three analysis types yield similar results.

The Mountain Mapper analysis is the traditional technique applied at RFC’s. This uses a “distance squared” technique where a control points’ influence decreases with distance. Equation 1 describes this relationship where d represents the distance from the control point.

$$\text{Influence} = 1/d^2$$

Equation 1.

A serpentine curve analysis is also available. The serpentine curve will create an analysis of a scalar quantity on a grid accurately and quickly (Weissten, for example). Finally, a Barnes analysis is available (Barnes 1964). Unlike the other analyses, the final grid created with the Barnes technique does not necessarily match the values at control points input by the forecaster.

Other settings for the forecaster to consider are the “PRISM Influence” and “QPF Limiter”. The “PRISM Influence” setting allows the forecaster to choose the amount of influence that the PRISM grid has on the forecast. This is useful for non-climatological weather regimes. For example, a warm front with stratiform precipitation may produce a homogenous distribution of precipitation, even in an area of complex terrain, where climatology may vary significantly over a short distance. In this case, a forecaster would want to reduce the influence of the terrain signal inherent in the climatology. Lastly, a “QPF Limiter” is available, which simply restricts QPF to remain below the setting chosen.

Typically, the main selections changed at this point by a forecaster are the QPF Source and perhaps the PRISM Influence. Most of the selections can be left at default values.

4.2 Control Point Adjustments

Once the forecaster has selected the “Run” or “Run/Dismiss” option, a new interface is presented which shows the QPF values sampled from the chosen guidance type at the chosen points (Figure 3). At this point the meteorologist can make adjustments. Often this is based on knowledge of certain model biases in different weather patterns. At each control point, the value sampled from the chosen guidance is indicated by the slider bar. In addition, the percentage of monthly normal for the QPF value forecasted is indicated in parentheses.

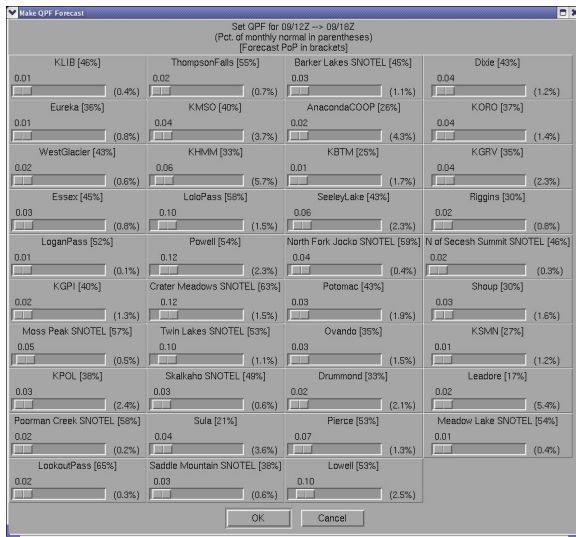


Figure 3. Control point adjustment step within the QPFHelper tool

4.3 Final Forecast Grid

Once the forecaster selects the “Ok” option, the tool runs and creates a QPF grid. An example is provided in Figure 4. This example is centered on Missoula, Montana.

5. HOW THE QPFHELPER TOOL WORKS

This section details some of the inner workings of the QPFHelper tool that a forecaster would not normally see while utilizing the tool. The result will be a 6 hour long QPF grid based on model guidance and climatology.

5.1 Guidance

In this example the forecaster starts with QPF from the latest National Centers for Environmental Prediction - Global Forecast System (GFS) run (Kalney et al. 1990, for example).

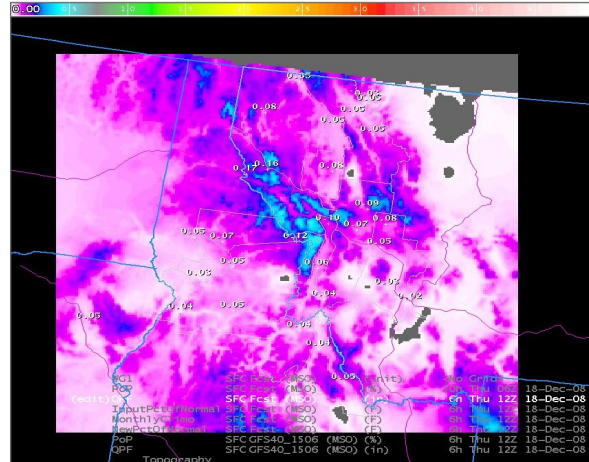


Figure 4. Example QPF grid (in.) created with the QPFHelper tool

Figure 5 presents the GFS QPF for the chosen period over the forecast domain. The forecaster runs the QPFHelper tool and selects the 06Z run of the GFS from December 15th as the input guidance as shown in figure 2.

5.2 Control Points

In the next step, the control points are sampled from the GFS forecast and the percentage of climatology for this forecast period at each point has been calculated (see figure 3). In this example, the control points are not adjusted by the forecaster. As a result, the exact values at each point in Figure 5 are maintained in the final forecast grid.

5.3 PRISM Precipitation in GFE

Figure 6 provides an example of PRISM precipitation climatological data available within GFE.

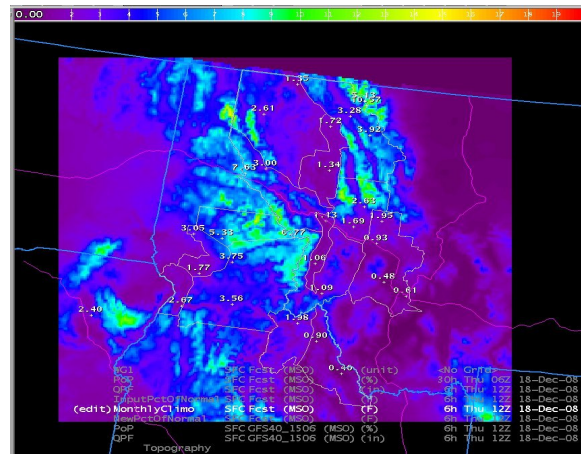


Figure 6. Monthly Average PRISM Precipitation for December (mm)

When QPFHelper runs, it calculates a climatology for the exact forecast grid period, which typically is 3 to 6 hours in duration. In the GFE database, PRISM precipitation data is available monthly.

5.4 Percentage of Normal Grid

As an intermediate step, the QPFHelper tool calculates a grid containing the percentage of PRISM normal for the period in question. This grid is not normally seen by the forecaster but is presented here for background.

Figure 7 presents a "percentage of normal" grid created by comparing the forecast precipitation at each control point with the PRISM climatological normal for the period.

This example is based on the serpentine curve analysis technique. With this technique, there is no radius of influence setting. The radius of influence of any one control point is determined by the proximity of other control points. That can be seen in the pattern illustrated in Figure 7. With a "distance squared" approach (Equation 1), the radius of influence decreases more rapidly with distance from a control point.

5.5 QPF Result

In the final step, the QPFHelper tool simply multiplies the "percentage of normal" grid with the PRISM normal precipitation grid for the forecast period to create the final QPF grid. Figure 8 represents the QPF grid created from the GFS QPF input shown in figure 5.

The result is a QPF grid which contains detail provided by climatological influence. In practice, forecasters provide expertise based on their experience and meteorological understanding which provides additional detail, and hopefully accuracy.

The large scale GFS model data provides deterministic timing, intensity and location information about a forecast precipitation event and the forecaster provides local expertise. Finally, the tool utilizes climatological information to populate grid points away from the control points.

6. CONCLUSIONS

The QPFHelper GFE tool developed by the authors is widely used within the NWS Western Region, which includes some of the most complex terrain in the conterminous United States. The tool allows forecasters to rapidly apply accepted techniques of combining deterministic model guidance and local forecast knowledge to create a complex gridded QPF.

This tool is considered an improvement over the RFC Mountain Mapper approach for at least five reasons. First, QPFHelper allows many more first guess guidance selections, including numerical weather prediction models run locally at the WFO, a climatology grid and the full suite of nationally supported numerical models available at the WFO. Second, QPFHelper allows flexible use of the climatological influence for meteorological scenarios involving atypical precipitation distribution. Third, the tool provides multiple analysis techniques. Fourth, the grids calculated by the QPFHelper tool can be further edited with any GFE grid editing techniques normally used on scalar grids at WFO's. Finally, mesoscale detail can be added to the QPF grids by rapidly changing control points and using small scale editing areas, while applying the climatological influence of the Mountain Mapper approach.

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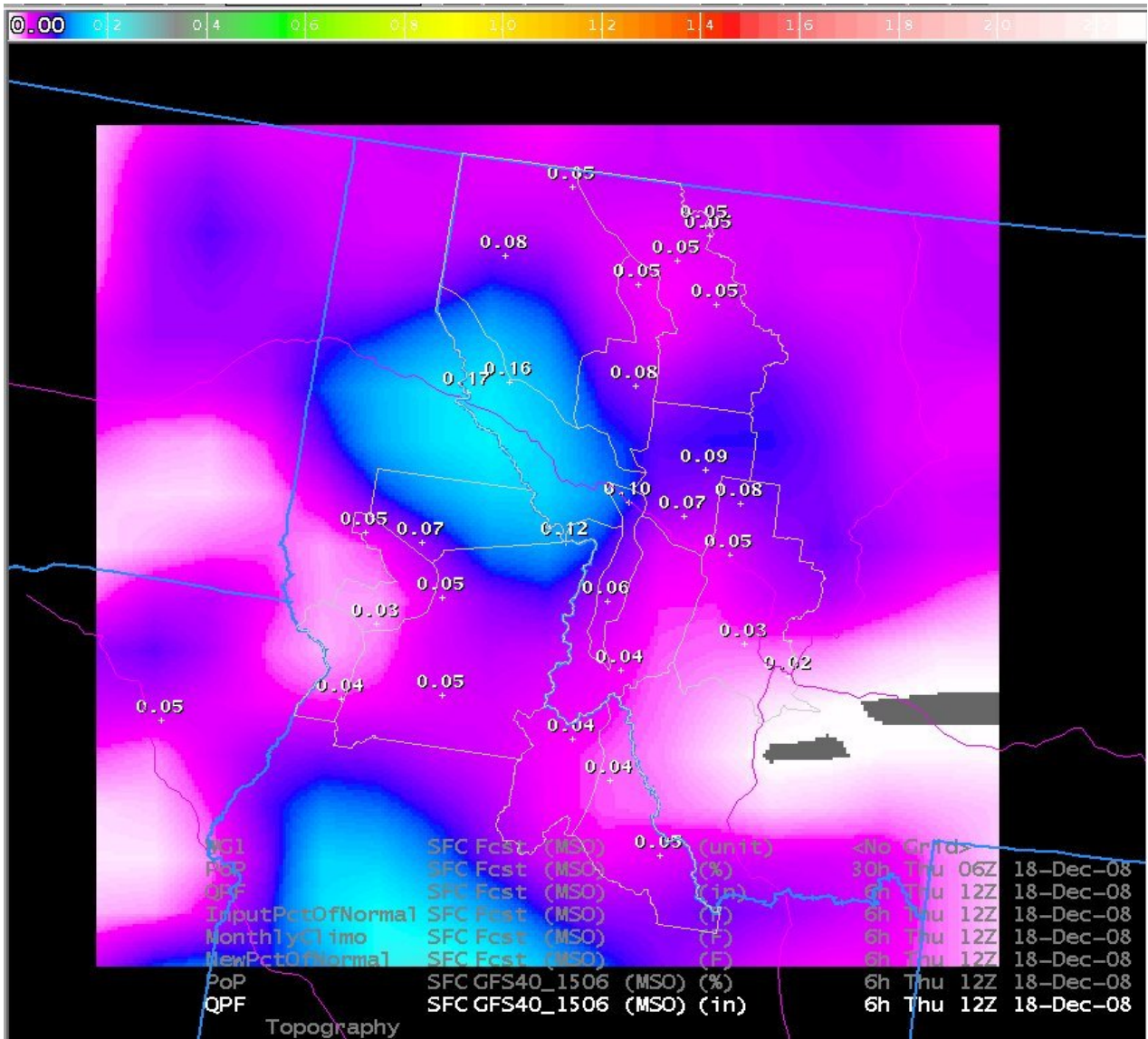


Figure 5. GFS QPF (in.) for 12Z to 18Z December 6, 2008 for an area centered on Missoula, Montana

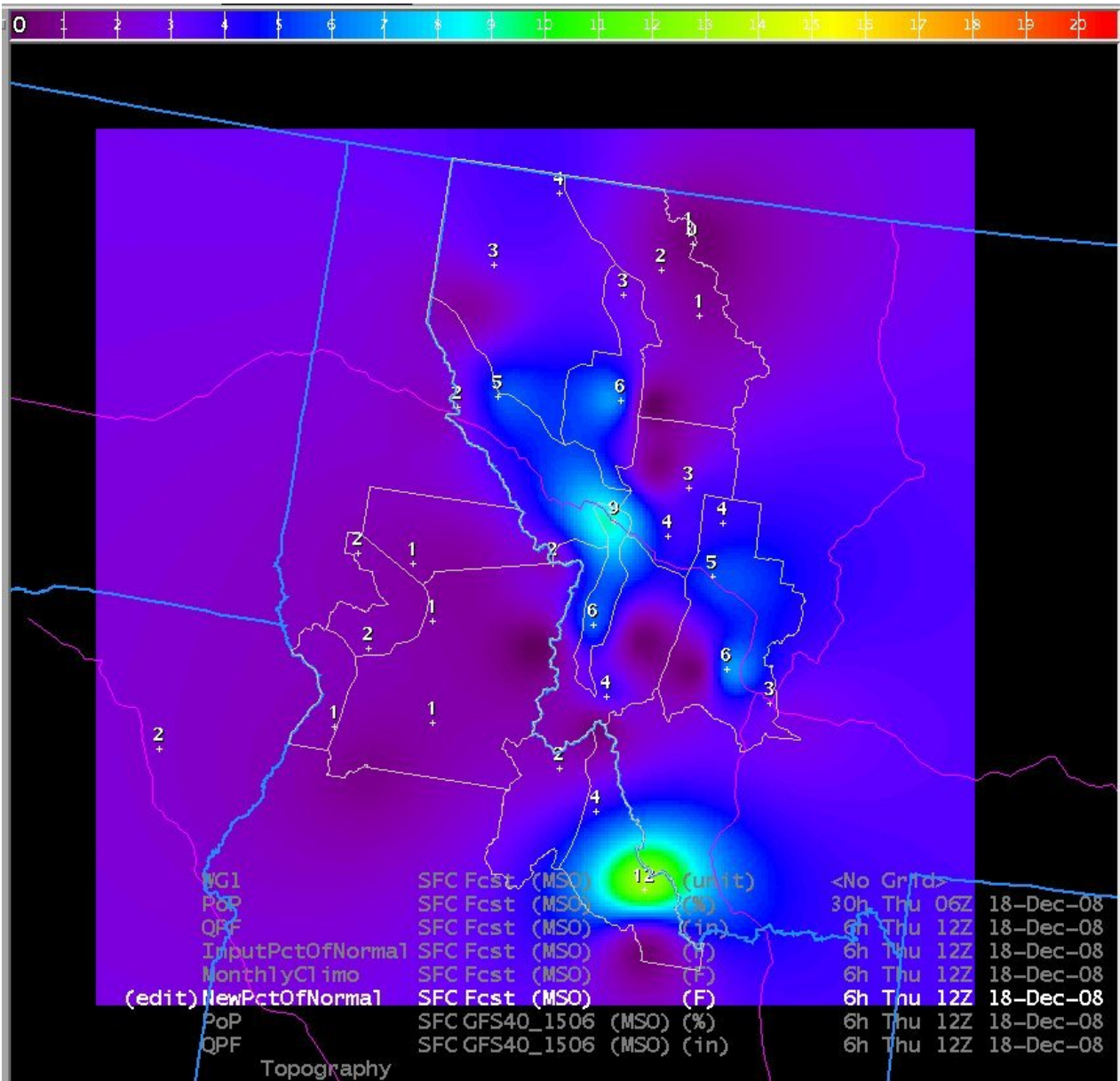


Figure 7. Percent of Normal Grid Calculated by the QPFHelper Tool

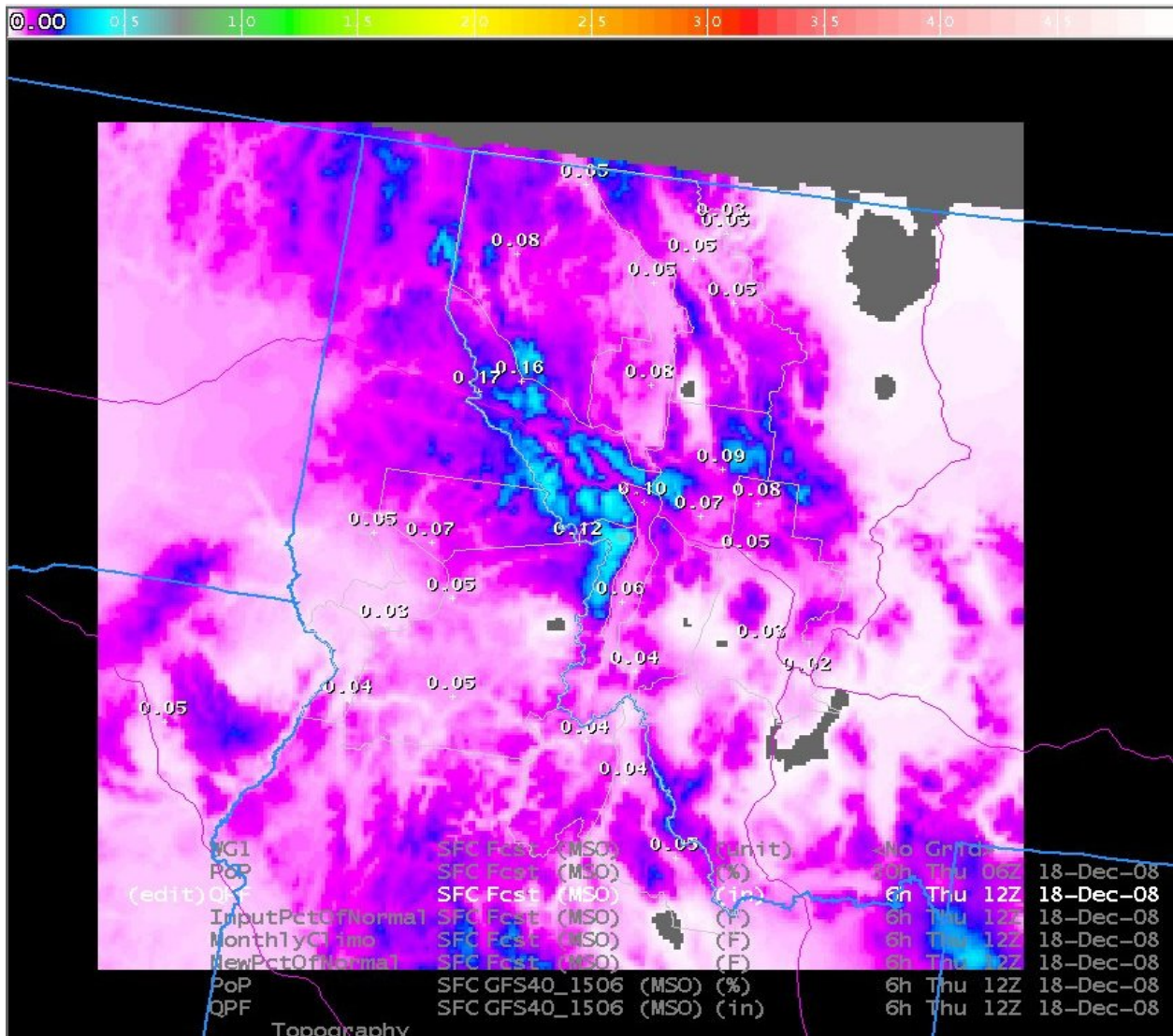


Figure 8. Final QPF Forecast Grid Based on GFS QPF (in.)