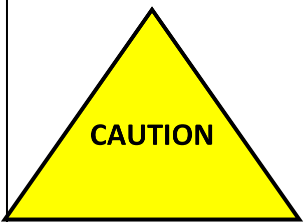
About Ensemble QPF Hydrographs



Disclaimer: These ensembles are based on hydrologic model simulations that have not been reviewed by hydrologists, who add value and produce official river forecasts by adjusting hydrologic model output to account for model limitations. **These ensembles DO NOT represent official river forecasts.** It is imperative for decision makers to contact their local NWS Weather Forecast Office before taking action based upon an Ensemble QPF Hydrograph.

Please read on to learn more about Ensemble QPF Hydrographs.

Background

A hydrograph shows how the river level changes over time at a specific location. The National Weather Service (NWS) River Forecast Centers (RFCs) have traditionally produced "deterministic" river forecast hydrographs based on current conditions and a forecast amount of precipitation (Quantified Precipitation Forecast, or "QPF") over a period ranging from zero to 24 hours. Deterministic implies a level of certainty and is usually expressed as one value (e.g., a river forecast at St. Louis might be expressed as "20 ft by day X." For the purposes of this document, we will refer to the one value of QPF used in a river forecast as the "deterministic QPF." One may view graphics of deterministic river forecasts at http://www.weather.gov/ahps/. Additional information about QPF can be found at http://www.hpc.ncep.noaa.gov/html/fam2.shtml#qpf.

A number of NWS customers have expressed the need to vary the aspects of future precipitation used in the production of river forecast hydrographs to produce "What if?" scenarios. These variations take on two forms. First, customers would like to vary the duration of the deterministic QPF used. In other words, instead of using only the next 24 hours of deterministic QPF to generate the river forecast hydrograph, users would like to know the impact of using the next 48-hours of QPF. The second type of variation is with regard to the amount of future precipitation considered for any given duration. That is, instead of using the deterministic QPF amount for the next 24 hours (say one inch), customers would like to know the impact of using two inches over the same 24-hour future period.

This new product, Ensemble QPF Hydrographs (EQHs), attempts to address this need to vary the QPF used in the production of river forecast hydrographs to show multiple river level scenarios.

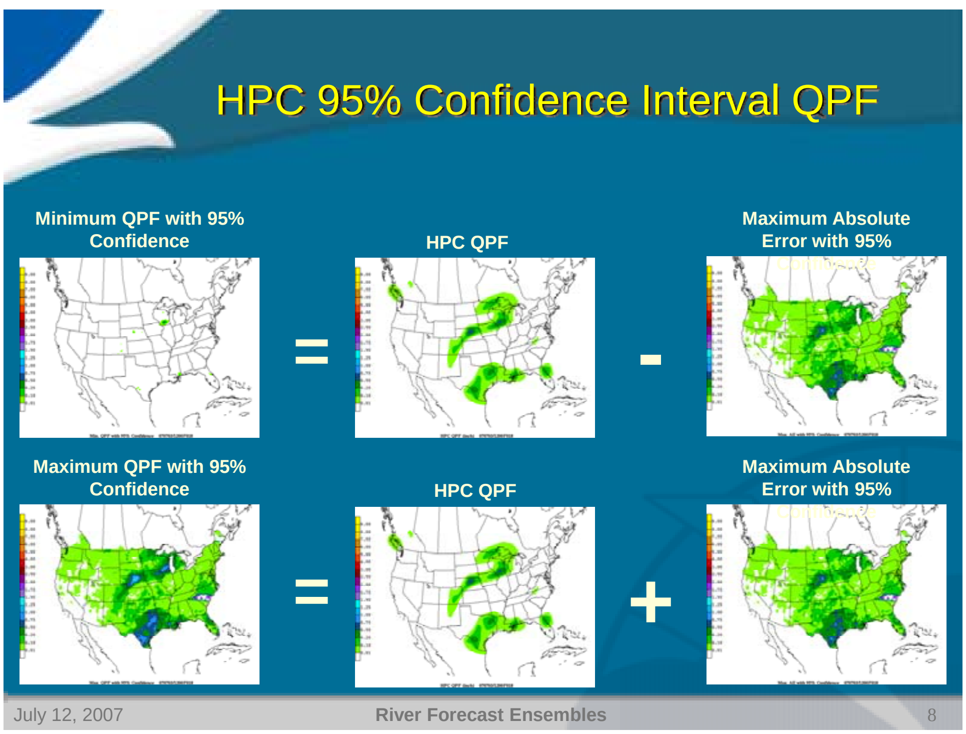
Ensemble QPF Hydrographs

Ensemble QPF Hydrographs (EQHs) use 0, 24, 48 and/or 60 hours of QPF. While varying the duration of deterministic QPF is a straightforward concept, varying the amount (for any given duration) is not so clear-cut. Different customers may desire to see the impact of differing amounts of future precipitation (i.e., one customer may want to use less future precipitation than contained in the deterministic QPF, while another may desire more). The use of Confidence Interval (CI) QPF addresses this need to vary the amount of QPF in a way which accounts for meteorological guidance and statistical analysis.

NWS Hydrometeorological Prediction Center (HPC) Confidence Interval (CI) QPF

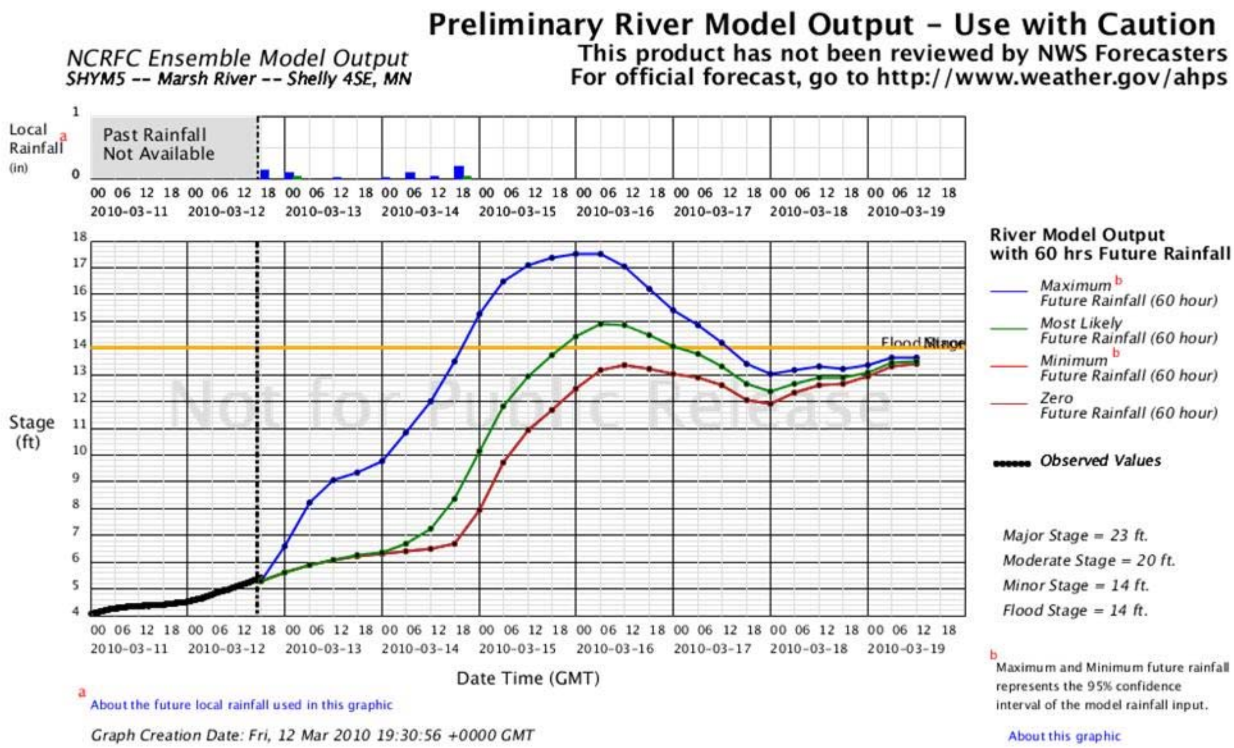
HPC began producing CI QPF in 2004. CI QPF attempts to quantify the uncertainty in the deterministic QPF. The following is a brief description of CI QPF; additional information can be found at http://www.hpc.ncep.noaa.gov/qpfci/qpfci.shtml.

Through statistical analysis of past performance, deterministic QPF absolute errors (AE) and Short Range Ensemble Forecast (SREF) model maximum/minimum QPFs (SREF QPF spread) were found to be highly correlated. Regression model equations were then developed to predict the 95% confidence interval (CI) of AE using the SREF spread. As shown in the figure below, the predicted maximum AE CI was then added to/subtracted from the deterministic QPF to create a max/min range of CI QPF. The CI QPF is conditional, that is, given that the precipitation occurs, there is 95% confidence that the amount will be within the range of max/min CI QPF values.



CI QPF is used to input a range of possible future precipitation values into the river model resulting in a range of river responses, the EQH. It should be noted here that these hydrographs assume liquid precipitation. While snowfall and snowmelt are taken into account in official forecasts, they are not used in the EQHs. EQHs are produced considering the following durations of CI QPF: 0, 24, 48 and/or 60 hours. The NWS North Central River Forecast Center (NCRFC) pioneered the use of CI QPF in generating river forecast hydrographs.

An annotated example of an EQH graphic is shown below. The amount of QPF used to develop each EQH hydrograph is depicted in the *Local Rainfall* section of the graphic, and the local rainfall is color coded to correspond with the appropriate EQH hydrograph. The *Maximum Future Rainfall* hydrograph represents the ensemble-based hydrologic response to the 95% Maximum CI QPF. The *Most Likely Future Rainfall* hydrograph represents the ensemble-based hydrologic response to the standard HPC QPF. The *Minimum Future Rainfall* hydrograph represents the ensemble-based hydrologic response to the 95% Minimum CI QPF. The *Zero Future Rainfall* hydrograph represents the hydrologic response to the zero QPF.



Three graphics are produced for each NWS river forecast point: 24, 48 and 60-hours Future Rainfall. The following table tabulates the various QFP inputs utilized in each EQH graphic type.

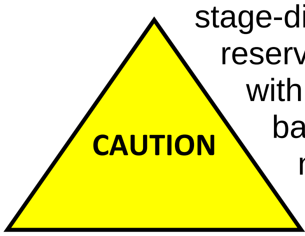
	QPF Duration (hours)[a]			
Graphic Type	**0**	**24**	**48**	**60**
24-hours Future Rainfall	X	X		
48-hours Future Rainfall	X		X	
60-hours Future Rainfall	X			X

[a] includes HPC 95% CI QPF MIN, HPC QPF and HPC 95% CI MAX time series.

Ensemble QPF Hydrographs: Challenges

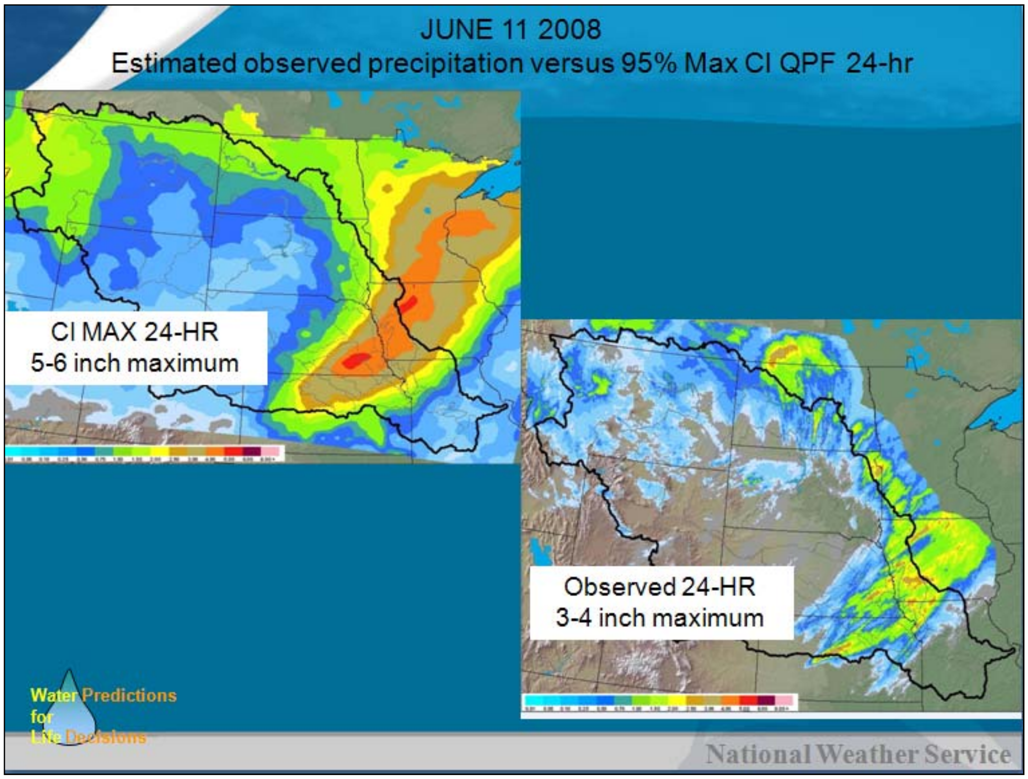
The EQH product has many advantages. For example, while the NWS is working toward providing short-term (<14 days) probabilistic river forecasts (analogous to the current production of long-term probabilistic river forecasts such as 30-day, 90-day, etc.), the EQH provides the customer with a “spread” of hydrologic solutions, not yet available. The zero-QPF scenario can show the relative impact future precipitation has upon the forecast river hydrograph. Automatic production of EQHs enables the generation of multiple solutions with little resource allocation.

Nevertheless, while the EQH has advantages, it also is not without its interpretive challenges. Difficulties in using EQH for decision making fall into two main categories: river forecast model limitations, and QPF uncertainties. Both categories are to some degree the result of the automatic production approach.



Model limitations. The hydrologic model used to produce river forecasts is a tool, not an infallible guide. Hydrologic model inaccuracies can stem from many sources, including hydraulic phenomena (backwater effects, routing assumptions, changing stage-discharge relationships), and regulation activities (unscheduled reservoir releases, diversion operations). As the river forecaster works with the model to produce a forecast, he or she must make modifications based on scientific reasoning and expertise. These forecaster modifications may frequently produce an official NWS deterministic forecast that does not agree with the EQH graphic. Situations may arise where the official NWS forecast may be below the EQH zero QFP forecast. In addition, the general shape or hydrologic response of the EQH hydrograph may not agree with the shape or hydrologic response of the official NWS forecast hydrograph.

QPF uncertainties. The QPF, whether deterministic or the CI, can vary from what actually occurs in three ways: timing, location, and amount. The CI has a further interpretive challenge in the actual probability of occurrence. That is, given that the precipitation at any one location may have only a 5% chance of exceeding the 95% maximum, what is the resultant probability of all the grids in a given watershed experiencing the 95% maximum at the same time? Also, it is unclear as to the resultant probability of a given watershed experiencing 95% maximum precipitation in back-to-back six-hour periods. The following is an example of the variance between the 95% maximum CI QPF solution versus what actually occurred. The graphic compares the CI QPF forecast on the morning of June 11, 2008, with the multisensor precipitation estimate of what actually fell.



Therefore, it is imperative for decision makers to contact their local NWS Weather Forecast Office before taking action based upon an EQH.