# Long Term Verification Statistics for the Missouri River Based on 12 Daily Forecast Locations for the Period 1983-2013

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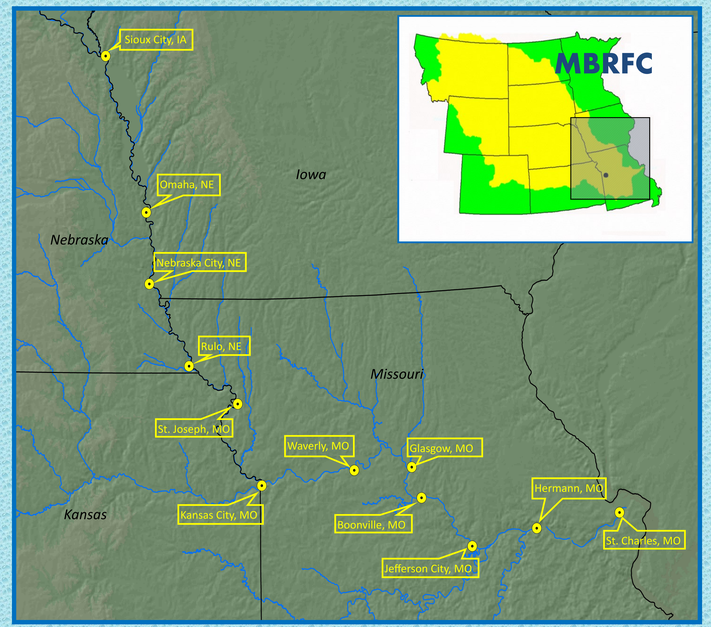
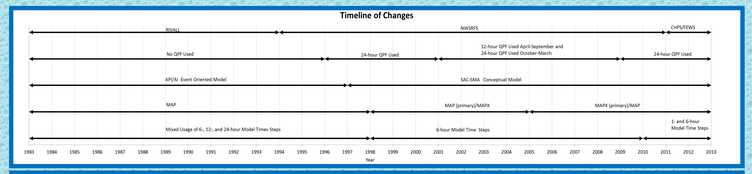
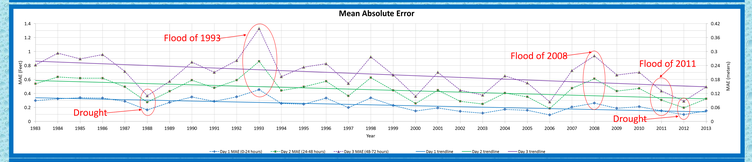
The Missouri Basin River Forecast Center (MBRFC) issues daily forecasts on the mainstem Missouri River for navigation and water supply year-round and issues flood forecasts as needed . Verification statistics for 12 points on the mainstem Missouri River were produced using standard statistical measures to examine forecast accuracy. Included here are the annual Mean Absolute Error and Mean Error values for the period 1983 through 2013, which show an improving trend in the under-forecasting bias over the period, concurrent with modeling and computing advances and improvements in coordination and information sharing between stakeholders. Improved forecasts facilitate better decision support services and translate to cost savings for interests along the Missouri River and downstream on the Mississippi.

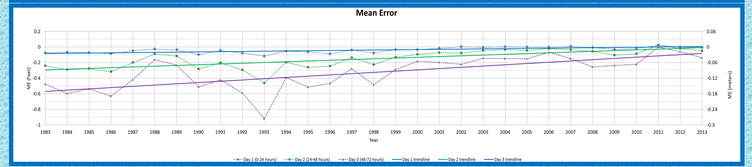
This study examines collectively the long-term river forecast verification statistics for twelve daily forecast locations on the Missouri River from Sioux City, Iowa downstream to Saint Charles, Missouri. This study covers the time period from Jan 1, 1983 through Dec 31, 2013 and focuses on forecast lead times of 24, 48, and 72 hours. The metrics used for this statistical analysis are correlation (scatter plots), distribution properties (standard deviation), and accuracy "error statistics" (mean absolute error and mean error). The paper also includes the topics of long term flows in the Missouri basin with regard to forecasting errors and the many changes in hydrologic modeling and forecasting that have taken place the past three decades.




The Missouri Basin River Forecast Center (MBRFC) in Pleasant Hill, Missouri is responsible for providing river forecast services for the entire Missouri River basin and St. Mary River basin in Montana. The Missouri River has a length of about 2341 miles ( 3767 km) and is the longest river in the United States. The headwaters begin along the Rocky Mountains in Montana and the river flows east and south to its confluence with the Mississippi River near St. Louis. The Missouri River spans all or part of ten states in America and part of Canada and drains about 530,000 square miles (1,372,694 km$^2$) in the heartland of America.

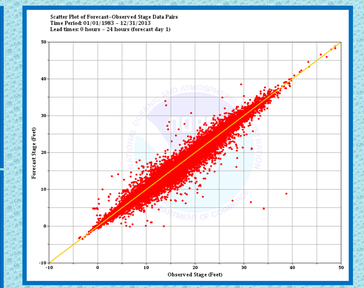


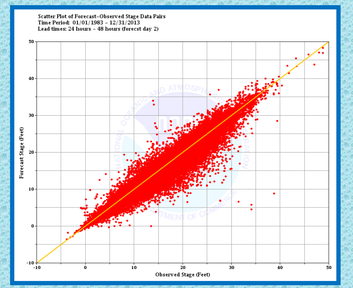



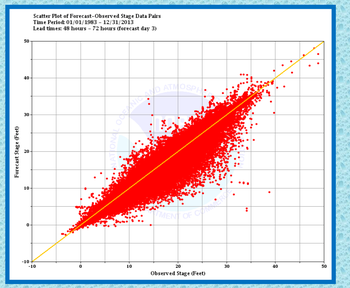




Trend lines for all three forecast days indicate that annual forecast error (MAE) and bias (ME) have decreased over the past 30 years. This decrease is likely due to more data, improved modeling and the inclusion of some quantitative precipitation forecasts (QPF) in the river forecasts. While the RFC still has a slight under-forecasting bias, the forecast day 3 bias has decreased by about 86% and the forecast day 3 error has decreased by about 57%.

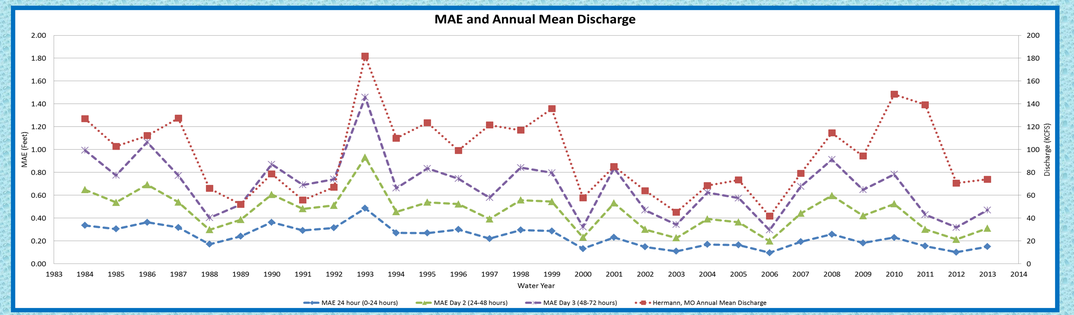

From 1983 through 2000 only the routine morning forecasts and the 24-hour time step values were archived. Starting in 2001 the River Forecast Center (RFC) began archiving all forecasts that were issued throughout a given day and all time steps of the forecasts were saved; the RFC went from a 24-hour to a 6-hour time step.




The scatter plots for these twelve locations indicate a definite under-forecasting bias over the past 30 years and the bias increases with lead time.




This plot shows the 24, 48 and 72- hour annual MAEs against the U.S. Geological Survey's (USGS) annual mean discharge (KCFS) for the Missouri River at Hermann, Missouri. This location was chosen because the Missouri River flow at Hermann, Missouri integrates all flows in the basin since it is the furthest downstream forecast point and near the mouth of the river. It is also far enough upstream from the mouth that it is not significantly impacted by backwater from the Mississippi River. For this plot the MAE values were recomputed by water year as the annual mean discharge values provided by the USGS are computed by water year. The plot shows a clear relationship between the magnitude of the flow and the magnitude of the MAE for most years.

References: Larson L. W. and Schwein, N. O, Temperature, Precipitation and Streamflow Trends in the Missouri Basin, 1895 to 2001, 84th Annual AMS Meeting, Seattle, Jan. 2004;
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USGS, Surface Water Statistics, http://waterdata.usgs.gov/,2013;
Welles, E., Sorooshian, S., Carter, G., and Olsen, B., Hydrologic Verification: A Call for Action and Collaboration, BAMS, April. 2007.

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