

Seasonal precipitation forecasts over the Missouri River Basin

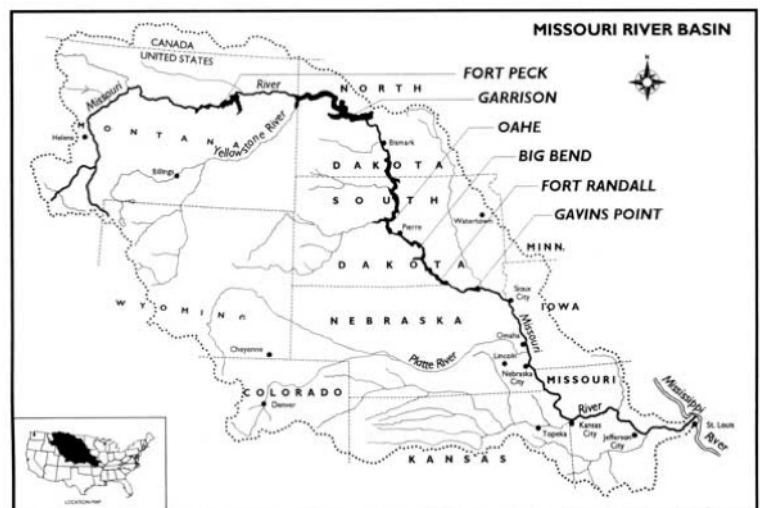
An assessment of operational and experimental forecast system skill and reliability

In 2011, the Missouri River Basin experienced devastating flooding, which caused significant property loss and disrupted thousands of lives. In 2012, the basin experienced extreme drought that impacted water supplies and downstream navigation. Historically, the climate of this region shows a general tendency for both very wet and very dry months in a given year. The ability to accurately predict seasonal flood and drought conditions between one and six months in advance was recognized to be extremely beneficial to water managers, emergency personnel, as well as the general public for planning purposes.

At the request of the Missouri River Basin Water Management office and the U.S. Army Corps of Engineers, NOAA's Earth System Research Laboratory and the University of Colorado's Cooperative Institute for Research in Environmental Sciences (CIRES) performed an assessment study to determine the skill and reliability of current state-of-the-art operational and experimental seasonal forecast systems in predicting the atmospheric conditions that led to the 2011 flood or the 2012 drought.

For the study, NOAA operational and experimental modeling systems were analyzed for December 2010 precipitation forecasts for the winter (January-February-March) and spring (April-May-June) of 2011. Likewise, December 2011 precipitation forecasts for 2012 winter and spring were analyzed. These 'retrospective' forecasts were compared to actual observations for just the Upper Missouri River Basin, for just the Lower Missouri River Basin, and for the entire Missouri River Basin.

The effects of El Niño and La Niña (together known as ENSO) on seasonal temperature and precipitation are well-known in many part of



The Missouri River Basin, the Missouri River, and the main U.S. Army Corps of Engineers reservoirs (Image courtesy Missouri Department of Natural Resources).

the U.S. Previous analyses have found increased forecast skill for the winter and early spring in some regions on the U.S. during El Niño and La Niña events. Thus, as an additional component of the study, data exclusively for neutral, El Niño and La Niña years were analyzed to assess if the forecast skill improved under these conditions.

Major Findings

Monthly and seasonal precipitation in the Upper Basin, in the Lower Basin, and entire Missouri River Basin is highly variable with standard deviations averaging close to 30 percent of the long term average.

The upper Missouri River Basin received approximately 70% more precipitation in May 2011 than would be considered normal based on the monthly climatology. In contrast, during September 2012, rainfall in the upper Missouri River Basin was more than 80% below normal for the month, as part of a prolonged dry period lasting from June-September 2012.

The lower Missouri River Basin experienced similar wet (2011) and dry (2012) periods to those observed for the Upper Basin, but the precipitation values were not as extreme relative to the monthly long term averages.

Comparisons of model versus observed precipitation showed similar patterns of wet and dry conditions. However, the forecasts did not provide consistently skillful and reliable predictions of the amplitude and duration of conditions leading to the 2011 flooding and 2012 drought.

The only potentially useful forecast skill was for short lead predictions in the Lower Basin during El Niño events.

Conclusions

The meteorological factors leading to the 2011 flood or the 2012 drought are not accurately predicted at seasonal lead times by current state-of-the-art, operational and experimental forecast systems.

For the lead times and for the times of year of interest, in separate analyses made using all years, only ENSO neutral years, or only La Niña years, the three metrics used to quantify forecast skill in the Missouri River Basin indicate no useful skill in precipitation forecasts for the Upper Basin, for the Lower Basin, or for the entire Missouri River Basin.

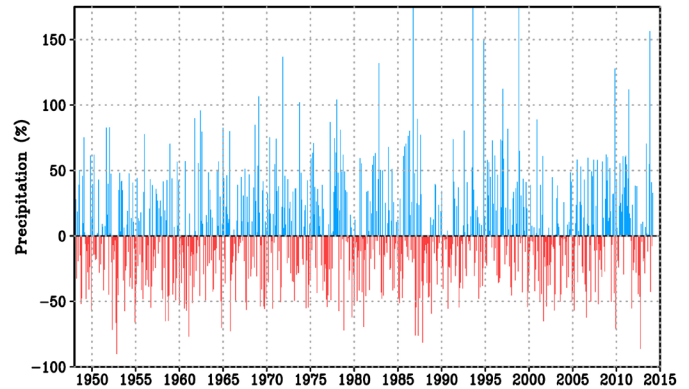
While perhaps not useful to manage basin-wide flood and water supply risks, there is potential skill for predictions of precipitation at short lead times during El Niño events in the unregulated lower part of the basin below the mainstem dams.

The link between El Niño and precipitation in the Lower Basin may potentially be of value in the Lower Basin to inform a broad range of regional to local regulatory and management practices.

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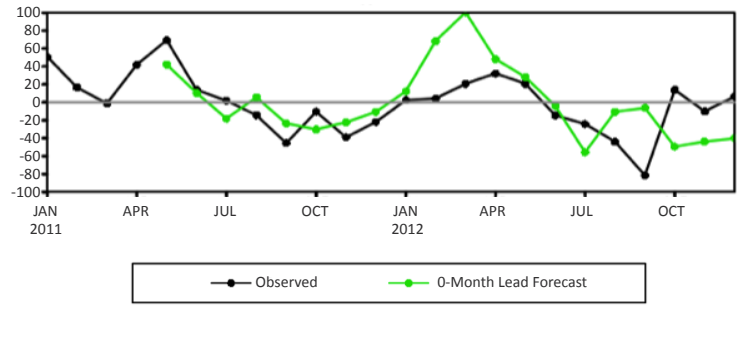
Cover photo: Missouri River, by Aimee Castenell

Upper Missouri River Basin Monthly Precipitation Departures



Monthly precipitation departures from the long term monthly averages for 1948 to present illustrating high month-to-month variability within the Upper Basin.

Upper Missouri River Basin 2011–2012 Precipitation



Comparison of precipitation observations (black), and 0-month lead time precipitation forecast (green). Units are percentage of above or below observed monthly climatology from 1982 - 2009.

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