Leveraging Climate Prediction in Water Supply Forecasts

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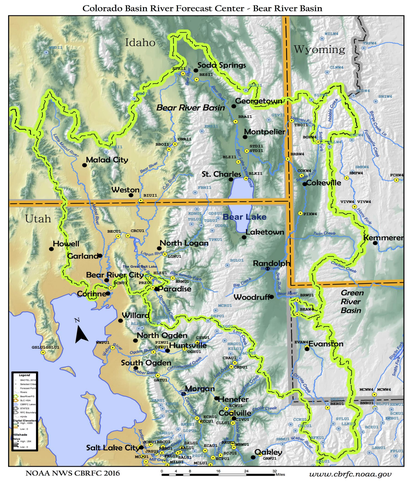
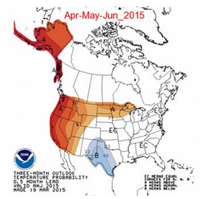
Introduction

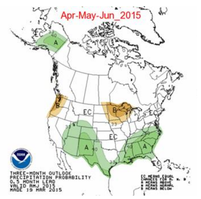
The Colorado Basin River Forecast Center (CBRFC) is one of 13 RFC's throughout the National Oceanic and Atmospheric Administration's NWS that provide advanced hydrologic prediction. The CBRFC's area of responsibility spans the entire Colorado River Basin and the eastern portion of the Great Basin. Forecasts of seasonal (April-July) water supply conditions are a primary focus of the CBRFC. This process uses Ensemble Streamflow Prediction (ESP) to develop a forecast ensemble of 30 traces based on historical temperature and precipitation data over the calibration period (1981-2010). Climate information is not yet considered in these predictions but as the impacts of climate change continue to be realized, there are questions as to whether past historical data still appropriately represent future conditions. In an attempt to incorporate climate forecast information and reduce reliability on historical data, a Stochastic Weather Generator (SWG) developed by the University of Colorado was used. In this project, the Bear River Basin was considered, which is a sub-basin of the Great Basin. The Bear River is the largest tributary to the Great Salt Lake and an important source of irrigation for Utah-based agriculture.

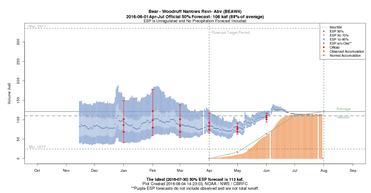


Materials and Procedure

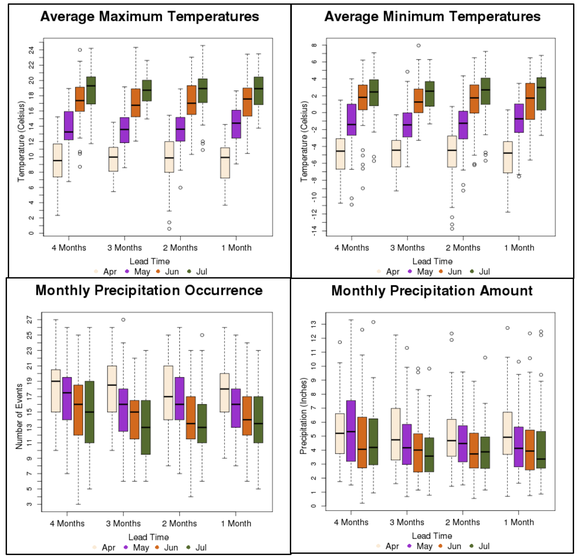
For this project, a SWG developed by the University of Colorado and written in the R programming language was used. The main program ran the SWG simulations. The SWG is able to simulate future weather conditions based on historical data and probabilistic climate outlooks. Research published by the University of Colorado has shown that a SWG weighted by probabilities related El Niño Southern Oscillation (ENSO) may improve forecast skill in the San Juan River Basin, as well as other regions outside of the Colorado River Basin. In this study, probabilistic climate outlooks issued by the Climate Prediction Center (CPC) are used to develop future weather conditions that are independent of historical sequencing. The probabilities refer to how likely an area will undergo warmer, normal, or cooler temperatures and drier, normal, or wetter precipitation conditions. The SWG can be run for two different modes, conditional and unconditional, depending on what output is requested. The conditional simulation takes into account the CPC probabilities. Output data from both the conditional and unconditional runs were analyzed and plotted to best understand the results.



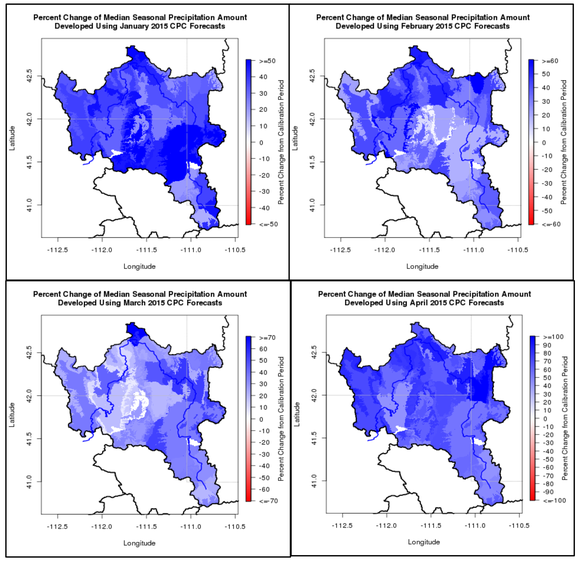




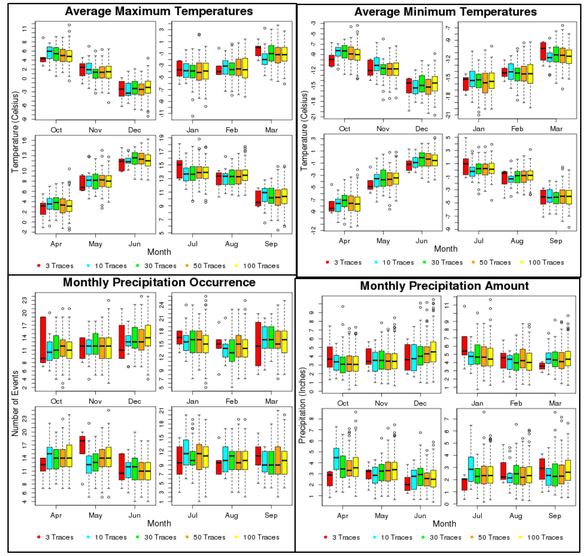
Conditional Results



It can be shown that weighted CPC probabilities run through the SWG can represent a future state and could be implemented into possible future forecast development.



Unconditional Results



Based on simulations at the Bear River Headwater developed by the SWG of unconditional climate projections, it was concluded that using 30 ensembles is sufficient compared to increasing ensemble size to 50 or 100. Currently, the CBRFC uses 30 traces in its ensemble, so this information was directly used by the CBRFC.

Future Work

The next steps would include looking at streamflow forecasts and a verification process to see if the SWG improves forecasts compared to the CBRFC's raw ESP. If positive results are discovered through some of this future work, forecasts might eventually over time start to consider more climatic data in their models. Depending on how climate change progresses, a SWG could aid in future projects as a "climate change tool" that would create weather simulations based on known occurrences of significant changes.

References

Verdin, A., et al. A conditional stochastic weather generator for seasonal to multi-decadal simulations. J. Hydrol. (2015), http://dx.doi.org/10.1016/j.jhydrol.2015.12.036

Verdin, A., Rajagopalan, B., Kleiber, W., Katz, R. W., Springer-Verlag Berlin Heidelberg 2014: Coupled stochastic weather generation using spatial and generalized linear models. Stoch Environ Res Risk Assess
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