Geophysical Research Abstracts
Vol. 18, EGU2016-3192-1, 2016
EGU General Assembly 2016

Towards reliable seasonal ensemble streamflow forecasts for ephemeral rivers

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Despite their inherently variable nature, ephemeral rivers are an important water resource in many dry regions. Water managers are likely benefit considerably from even mildly skilful ensemble forecasts of streamflow in ephemeral rivers. As with any ensemble forecast, forecast uncertainty – i.e. the spread of the ensemble – must be reliably quantified to allow users of the forecasts to make well-founded decisions. Correctly quantifying uncertainty in ephemeral rivers is particularly challenging because of the high incidence of zero flows, which are difficult to handle with conventional statistical techniques.

Here we apply a seasonal streamflow forecasting system, the model for generating Forecast Guided Stochastic Scenarios (FoGSS), to 26 Australian ephemeral rivers. FoGSS uses post-processed ensemble rainfall forecasts from a coupled ocean-atmosphere prediction system to force an initialised monthly rainfall runoff model, and then applies a staged hydrological error model to describe and propagate hydrological uncertainty in the forecast. FoGSS produces 12-month streamflow forecasts; as forecast skill declines with lead time, the forecasts are designed to transit seamlessly to stochastic scenarios. The ensemble rainfall forecasts used in FoGSS are known to be unbiased and reliable, and we concentrate here on the hydrological error model.

The FoGSS error model has several features that make it well suited to forecasting ephemeral rivers. First, FoGSS models the error after data is transformed with a log-sinh transformation. The log-sinh transformation is able to normalise even highly skewed data and homogenise its variance, allowing us to assume that errors are Gaussian. Second, FoGSS handles zero values using data censoring. Data censoring allows streamflow in ephemeral rivers to be treated as a continuous variable, rather than having to model the occurrence of non-zero values and the distribution of non-zero values separately. This greatly simplifies parameter inference. Third, FoGSS applies a linear bias-correction to transformed data, which is able to handle strongly non-linear and conditional biases that are sometimes present in forecasts of ephemeral rivers.

In this presentation we focus on recent developments of FoGGS that have been necessary to ensure that forecasts for ephemeral rivers are reliable. We show that if more than half of observations are zero, it is necessary to treat both observations and simulations as censored data. This requires a more complex procedure to infer parameters, but is able to produce reliable forecasts in even the driest catchments. However, the new inference procedure did not resolve all instances of negative forecast skill. We discuss prospects for eliminating negative forecast skill in ephemeral rivers.