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EXTENDED ABSTRACT ONLY

A wavelet-based method to analyse sustained hydrological anomalies under climate change

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Abstract: Industries and sectors affected by changes in water availability include agriculture, natural ecosystems, mining and domestic water supplies. Understanding the vulnerability of these systems to climate variability has traditionally been achieved by assuming that past hydrological extremes will occur in the future, an assumption that is no longer tenable due to anthropogenic climate change. Future sustained hydrological anomalies (e.g., sustained droughts) assessments have generally been based on General Circulation Model (GCM) simulations of precipitation, temperature, soil moisture, and so forth. However, firstly it is known that climate models with biases at a range of time scales have varying ability to represent sustained climate anomalies. Secondly, sustained droughts, for example, are natural hazards associated with a range of climatic factors such as sustained low precipitation, high temperature, strong winds, low relative humidity, and low frequency climate fluctuations (e.g., El Niño Southern Oscillation). It is a natural system consisting of the interaction among a large number of variables. Therefore, regardless of considerable uncertainty and bias in climate models, how to better model such a complex natural system is key to address all these climatic extreme events. In this study, we propose a wavelet-based downscaling framework to assess the sustained hydrological anomalies under climate change.

In the framework, given a set of observations (predictors) from a system, the goal is to first identify best possible drivers (inputs) from large numbers of climatic variables, form a predictive model based on the identified drivers, estimate the model parameters that best fit to the data, and finally predict the system response for new inputs. This approach is often limited by the internal variability and weak relationship between the response and predictors in climate system. To address these issues, we present a wavelet-based predictor selection and prediction method, which is based on two assumptions: 1) If the spectral variance structure of the predictor is similar to that of the response, the predictive model using that predictor will exhibit better accuracy (as measured by root mean square error, RMSE); 2) If the variance structure of the residual information contained within the predictor and response variable conditioned to the pre-existing predictor(s) is similar, the predictive model using the that predictor will exhibit better accuracy than otherwise. This method essentially reconstructs a new set of predictors by redistributing the variance in the spectrum of predictors. We assess the utility of the wavelet-based framework using synthetically generated data sets from known linear and nonlinear systems with parametric and nonparametric predictive models. A real application of predicting sustained drought anomalies over Sydney region confirms its utility in an applied setting. The results show clear improvements in predictability of the response compared to the use of unfiltered predictors.

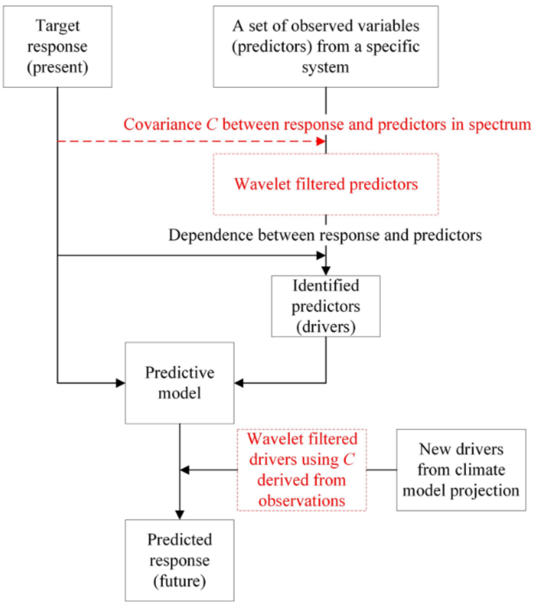

Figure 1. The proposed wavelet-based system modelling and response prediction framework

Keywords: *Wavelet transform, system modelling, prediction*