Wavelet-based Time Series Bootstrap Model for Multi-decadal Streamflow Simulation Using Climate Indicators

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Abstract. It is increasingly evident that large scale climate forcings such as El Nino Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO) and Atlantic Multi-decadal Oscillation (AMO) are known to modulate the hydro climatology of Western United States at multi-decadal time scales. We developed a wavelet-based time series bootstrap simulation model to generate streamflow projections conditioned on climate indices of the aforementioned large scale climate forcings. These indices are based on sea surface temperature (SST) anomalies. The wavelet analysis is performed on each climate index and significant periodicities (components) are identified that pass the 95% significance test. Then a K-nearest neighbor (K-NN) *Block bootstrap* method is employed to generate ensembles of the identified significant components. The components being orthogonal by construction are summed to obtain sequences of the 'climate signal'. This is performed on each climate index separately, thus obtaining a climate signal vector,Y_t, at each time step, t. Conditioned on Y_t, a K-NN bootstrap is applied to simulate streamflow ensembles. We demonstrated this method by applying it for simulation of streamflow at Lees Ferry gauge on the Colorado River using two large scale climate forcings Pacific Decadal Oscillation (PDO) and Atlantic Multi-decadal Oscillation (AMO) which have been known to modulate the upper Colorado River Basin hydrology at multi-decadal time scales. The simulations reproduce skillfully all the distribution and nonstationary spectral properties in addition the method also provides good projections of decadal mean flow. All of these are crucial for water resources management.