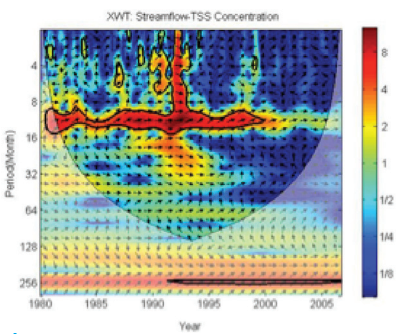
Multiscale characterisation of hydro-climatic time series for improved prediction of hydrological variables

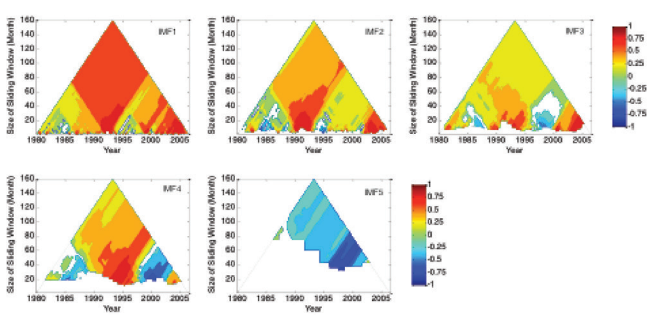
Most of the hydro-climatic time series possess nonlinear and non-stationary properties, and understanding the changing behavior and its modeling is challenging and it has a high practical significance in the simulation and forecasting of hydrological variables. As compared to the conventional spectral analysis techniques (such as Fourier analysis, whose use is constrained by the requirements of linearity and stationarity of the time series), the latest statistical methods such as Wavelet transforms / Hilbert-Huang transforms are found to be well suited for processing nonstationary signals in multiple time scales, and offer better understanding of the spectral properties of the time series in the time-frequency domain.

Our research group works on developing and employing the computational tools to understand the associations of hydro-climatic series, and engaging predictive models to forecast the hydrological variables. For instance, understanding the multiscale associations between streamflow and sediment concentrations in a river basin can help in modeling the sedimentation processes and an improved estimation of the sediments in river-reservoir systems. Also the prediction of hydrological variables could be improved by finding the possible association of hydrological variables with climate oscillations at different time scales or specific periodicity through engaging efficient multi-scale decomposition process such as multivariate empirical mode decomposition (MEMD) and time dependent intrinsic correlation (TDIC) analysis.

Our group investigates the hydro-climatic teleconnections [say, Indian monsoon season rainfall / hydrological series with large scale climatic oscillations / indicators such as ElNiño Southern Oscillation (ENSO), Quasi Bienniel Oscillation (QBO), Sunspot Number (SN), Atlantic Multi Decadal Oscillation (AMO), Equatorial Indian Ocean Oscillation (EQUINOO), etc.] and develops prediction models by using advanced statistical techniques such as Genetic Programming, Model Trees, Support Vector Machines, etc. We also develop models and techniques for attribution analysis to identify the nature of changes and its causative factors, vis., changes in streamflows from watershed attributed due to climate change and/or anthropogenic activities, etc.



Cross wavelet spectrum between streamflow and sediments



TDIC plots between different modes of streamflow and sediments

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