Boulder Fluid Dynamics Seminar Series

Tuesday, April 14, 2015
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

A nonlinear dynamical systems based modeling approach for understanding predictability and stochastic simulation of stream flow

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A nonlinear dynamical systems based time series approach to recover the underlying dynamics and understand the predictability of streamflow variability. Further, this information is used to produce skillful projections. The signal component of the time series is isolated using wavelet spectral analysis. This signal is embedded in a *D*-dimensional space with an appropriate lag tau to reconstruct the phase space (or 'attractor') in which the dynamics unfolds. The parameters D and tau are obtained using False Nearest Neighbor and Mutual Information, respectively. Then, time varying predictability is assessed by quantifying the divergence of trajectories in the phase space with time, as local Lyapunov exponents. Ensembles of projections from a current time are generated by block resampling trajectories of desired projection length, from the K-nearest neighbors of the current vector in the phase space. This modeling approach was applied to paleo reconstructed streamflow at Lees Ferry gauge on the Colorado River which offered three interesting insights: (i) The flows exhibited significant epochal variations in predictability – with recent decades indicating low predictability. (ii) The temporal variability of, predictability and the *signal* variance of the flow and large scale climate, are strongly related – indicating high predictability during periods of low variability in flow and large scale *signal* and vice-versa. (iii) Blind projections of flows during high predictable epochs showed good skill in capturing the distributional, drought and surplus statistics and poor performance during low predictability epochs. These results provoke an adaptive and flexible water management approach.

Multiscale analysis of the equatorial dynamics of protoplanetary disks

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Protoplanetary Disks (PPD) are sheet-like, large scale astrophysical vortices that rotate around central massive object such as young stars. These disks are mainly composed of cold gas with a small portion of dust. Though PPD are believed to be the birthplace of planets, no mechanism has been identified so far to explain the aggregation of dust into planets on timescales shorter than the lifespan of the disks themselves, of order of magnitude one million years. The generation of local, small scale vortices in the flow could promote aggregation of a planetesimal by confining dust. In this talk, we consider the potentiality of vortex generation in a PPD: we investigate the stability of a quasi-Keplerian, non magnetic flow in the vicinity of its equatorial plane by means of a multiscale analysis which yields a family of reduced systems of equations for the dynamics of perturbations. We will focus on one of these models that features potentiality for instability: we will discuss analytical results about linear stability, along with direct numerical simulations of the fully non linear viscous equations.