Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

A Correlation Matrix Approach to Esimtating Velocity Fields Using Sensor Measurements DIETMAR REMPFER, PARITOSH MOKHASI, IIT, Chicago — A new approach to estimating velocity fields from sensor measurements is proposed based on approximating the correlation of the unknown velocity fields with a sample ensemble of snapshots. Proper orthogonal decomposition (POD) is performed on the ensemble to extract the spatial eigenfunctions. If the POD coefficients are known at a certain instance in time, then the velocity field at that time can be estimated. The POD coefficients can be computed if the correlations between the ensemble and the velocity field are known. However, since the velocity field is not known, an extension of POD called "episodic-POD" is used to produce models that enable one to approximate the correlation between the unknown velocity fields at the ensemble based on sensor measurements taken from the domain. The episodic-POD analysis on the correlation matrix reveals that the underlying structure of the velocity correlation is low-dimensional even if the original flow is high-dimensional. Furthermore, the structures are seen to be similar for different problems indicating some form of universality. It is shown that the method is robust in the presence of noisy measurements and sparse temporal data. It is also proposed that this new approach suggests that solving a high-dimensional system could be replaced with solving a single low-dimensional system with multiple initial conditions.

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Date submitted: 06 Aug 2009 Electronic form version 1.4