An Efficient and Statistically Accurate Lagrangian Data Assimilation Algorithm with Applications to Discrete Element Sea Ice Models

报告题目：An Efficient and Statistically Accurate Lagrangian Data Assimilation Algorithm with Applications to Discrete Element Sea Ice Models

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报告摘要：

Lagrangian data assimilation of complex nonlinear turbulent flows is an important but computationally challenging topic. In this talk, I will introduce an efficient data-driven statistically accurate reduced-order modeling algorithm that significantly accelerates the computational efficiency of Lagrangian data assimilation. The algorithm starts with a Fourier transform of the high-dimensional flow field, which is followed by an effective model reduction that retains only a small subset of the Fourier coefficients corresponding to the energetic modes. Then a linear stochastic model is developed to approximate the nonlinear dynamics of each Fourier coefficient. Effective additive and multiplicative noise processes are incorporated to characterize the modes that exhibit Gaussian and non-Gaussian statistics, respectively. All the parameters in the reduced order system, including the multiplicative noise coefficients, are determined systematically via closed analytic formulae. The new Lagrangian data assimilation is then applied to observations of sea ice floe trajectories that are driven by atmospheric winds and turbulent ocean currents. It is shown that observing only about 30 non-interacting floes in a 200km times 200km domain is sufficient to recover the key multi-scale features of the ocean currents. Besides, I will briefly introduce the multiscale model reduction techniques for solving highly heterogeneous PDEs.