WORKSHOP
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# Statistical Data Assimilation in Oceanography and Meteorology

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**Abstract**

The problem of combining dynamical models with measurements in oceanography and the atmospheric sciences is known as data assimilation. It is the foundation for numerical weather prediction, as well as emerging ocean prediction systems. With improvements in both models and measurements, these ideas are also increasingly being applied to the prediction of ocean biology and chemistry.

The last decade has witnessed a revolution in ocean observations. In addition to traditional point observations and time series, many new and complex data types are now available. These include: satellite imagery; acoustic, optical and electromagnetic remote sensing; and measurements from autonomous robotic platforms. Interpretation of these complex space-time data requires dynamical models.

The dynamical models used are time/space dependent (stochastic) differential equations. They are characterized by high dimensionality and/or complex nonlinear dynamical behaviour, and generally solved using numerical integration methods. The goals of data assimilation include nowcasting, hindcasting and forecasting of the ocean state, and the estimation of key parameters.

My presentation will overview the data assimilation problem within the broader context of time dependent state and parameter estimation for nonlinear dynamic systems. Methodologies fall broadly under two categories: (i) those for deterministic dynamics, and (ii) those for stochastic dynamics. The former utilizes variational methods to estimate parameters, initial and boundary conditions (and so may be viewed as constrained optimization relying on adjoint equations). The

latter stochastic dynamic case can be treated from the perspective of the nonlinear and nonGaussian state space model.

I will discuss the various solution methodologies under current use for deterministic dynamics, as well as more recent approaches under development for state and parameter estimation based on stochastic nonlinear dynamics (in particular, the ensemble methods which rely on Monte Carlo integration and Bayes theorem). Oceanographic and atmospheric examples will be used throughout for illustration. Challenges in the application of statistical methodologies to the data assimilation problem and future research directions will also be emphasized.