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Oceanography Seminar

SPEAKER
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AFFILIATION:
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TITLE:
Spectral Representation in Oceanography: Observation and Modeling
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ABSTRACT:
Great advantages of spectral representation in ocean observation and modeling are demonstrated in this paper. For observation, two-scalar (toroidal and poloidal) spectral representation is used to reconstruct three-dimensional ocean flow from noisy data in an open domain. This approach includes: (a) a boundary extension method to determine normal and tangential velocities at an open boundary, (b) establishment of homogeneous open boundary conditions for the two potentials with a spatially varying coefficient $\varkappa$, (c) spectral expansion of $\varkappa$, (d) calculation of basis functions for each of the scalar potentials , and (e) determination of coefficients in the spectral decomposition of both velocity and $\varkappa$ using linear or nonlinear regressions. The basis functions are the eigenfunctions of the Laplacian operator with homogeneous mixed boundary conditions and depend upon the spatially varying parameter $\varkappa$ at the open boundary. A cost function used for poor data statistics is introduced to determine the optimal number of basis functions. An optimization scheme with iteration and regularization is proposed to obtain unique and stable solutions. The capability of the method is demonstrated through analyzing various sparse and noisy ocean data from ARGO floats, surface drifters, and CODAR ocean sensors.

Using the spectral representation, the observational and modeled data are tracks in phase space. In the phase space, the first passage time (FPT) is defined as the time period when the prediction error first exceeds a pre-determined criterion (i.e., the tolerance level) is introduced to estimate the model predictability for linear and nonlinear stages in the prediction error evolution. The probability density function (PDF) of FPT satisfies the backward Fokker-Planck equation. The advantages of using FPT for ocean predictability are also presented.