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Title: Spectral Representation in Oceanography: Observation and Modeling (IWG7)

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. The basis functions are the eigenfunctions of the Laplacian operator with homogeneous mixed boundary conditions and depend upon the spatially varying parameter κ 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 reconstructing a 2D wind-driven circulation in a rotating channel, a baroclinic circulation in the eastern Black Sea, and a large-scale surface circulation in the Southern Ocean. Using the spectral representation, the observational and modeled data are tracks in phase space. In the phase space, a new scalar with the dimension of time, the irreversible-skill time (IT), is defined as the time period when the prediction error first exceeds a pre-determined criterion (i.e., the tolerance level) [originally defined as valid prediction period by Chu et al. (2002a, b, c)], is introduced to estimate the model predictability for linear and nonlinear stages in the prediction error evolution. The probability density function (PDF) of IT satisfies the backward Fokker-Planck equation (or called Pontryagin-Kolmogorov equation in the Russian literature). References Chu, P.C., L.M. Ivanov, C.W. Fan, 2002a: Backward Fokker-Planck equation for determining model valid prediction period. Journal of Geophysical Research, 107, C6, 10.1029/2001JC000879. Chu, P.C., L.M., Ivanov, T.M. Margolina, and O.V. Melnichenko, 2002b: On probabilistic stability of an atmospheric model to various amplitude perturbations. Journal of the Atmospheric Sciences, 59, 2860-2873. Chu, P.C., L.M. Ivanov, T.P. Korzhova, T.M. Margolina, and O.M. Melnichenko, 2003a: Analysis of sparse and noisy ocean current data using flow decomposition. Part 1: Theory. Journal of Atmospheric and Oceanic Technology, 20 (4), 478-491. R78 Chu, P.C., L.M. Ivanov, T.P. Korzhova, T.M. Margolina, and O.M. Melnichenko, 2003b: Analysis of sparse and noisy ocean current data using flow decomposition. Part 2: Application to Eulerian and Lagrangian data. Journal of Atmospheric and Oceanic Technology, 20 (4), 492-512.

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