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Data-driven multiscale stochastic emulators: application to the oceanic gyres

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The multiscale variability of the ocean circulation due to its nonlinear dynamics remains a big challenge for theoretical understanding and practical ocean modeling. This paper demonstrates how recently developed data-adaptive harmonic (DAH) decomposition and inverse stochastic modeling techniques [Chekroun and Kondrashov, 2017] allow to reproduce with high fidelity the main statistical properties of multiscale variability in the coarse-grained eddy-resolving ocean flow. This fully data-driven approach relies on extraction of frequency-based time-dependent coefficients describing evolution of the spatio-temporal DAH modes in the oceanic flow data. In turn, the time series of these coefficients are efficiently modeled by a universal family of low-order and frequency-based stochastic differential equations (SDEs), involving a fixed set of predictor functions and small number of model coefficients.

Chekroun, M. D., and D. Kondrashov, 2017: Data-adaptive harmonic spectra and multilayer Stuart-Landau models, Chaos, 27, 093110: doi:10.1063/1.4989400