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Data-adaptive harmonic analysis and stochastic modeling of sea level altimetry

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This study aims to characterize North Atlantic sea level variability across the temporal and spatial scales. We apply recently developed data-adaptive Harmonic Decomposition (DAH) and Multilayer Stuart-Landau Models (MSLM) stochastic modeling techniques [Chekroun and Kondrashov, 2017] to monthly 1993–2017 dataset of Combined TOPEX/Poseidon, Jason-1 and Jason-2/OSTM altimetry fields over North Atlantic region. The key numerical feature of the DAH relies on the eigendecomposition of a matrix constructed from time-lagged spatial cross-correlations. The eigenmodes form an orthogonal set of oscillating data-adaptive harmonic modes (DAHMs) that come in pairs and in exact phase quadrature for a given temporal frequency. Furthermore, the pairs of data-adaptive harmonic coefficients (DAHCs), obtained by projecting the altimetry dataset onto associated DAHMs, can be very efficiently modeled by a universal parametric family of simple nonlinear stochastic models - coupled Stuart-Landau oscillators stacked per frequency, and synchronized across different frequencies by the stochastic forcing. Despite the short record of altimetry dataset, DAH-MSLM model provides skillful prediction of key dynamical and statistical features of sea level variability.

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