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Analysis of the global surface drifter dataset using stochastic processes

Adam Sykulski (1), Jonathan Lilly (2), Sofia Olhede (3), and Jeffrey Early (2)

(1) Lancaster University, United Kingdom, (2) NorthWest Research Associates, USA, (3) University College London, United Kingdom

We present a novel stochastic model that describes the motion of ocean surface drifter trajectories. The model constitutes of four physically-motivated stochastic components: the first is for modelling the turbulent background flow, the second is for inertial oscillations, the third is for the semidiurnal tide, and the fourth is for the diurnal tide. For the turbulent background, we build on existing stochastic models in the literature, by proposing a more generalised stochastic process that allows for a wide range of decay rates of the Lagrangian velocity spectral slope. To model inertial oscillations, we construct a stochastic analogue of the damped-slab model of the surface mixed layer.

We then construct novel and computationally-efficient procedures for fitting the aggregated stochastic model to observed Lagrangian velocity spectra from surface drifters. In total we estimate up to nine free parameters for each analysed trajectory segment, and these parameter estimates then provide useful summaries of structure at the drifter's location. As examples of summaries, spatially-dependent estimates can be made of the rate of horizontal diffusivity, the damping timescale of inertial oscillations, or the rate of decay of the Lagrangian spectral slope.

We present the results of two global analyses. The first uses all observations of the global surface drifter dataset since 1979 at lower temporal resolution to analyse the turbulent background. These findings provide the first global estimates of the Lagrangian spectral slope and how this varies spatially. The second analysis uses higher temporal resolution observations available since 2005 to resolve parameters that describe inertial oscillations. Here the aggregated stochastic model is used to separate the properties of inertial oscillations from the background flow and tidal signals. We present high-resolution global maps of inertial oscillation amplitude and damping timescales.