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Estimating Eulerian spectra from pairs of drifters

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GPS-tracked surface drifters offer the possibility of sampling energetic variations at the ocean surface on scales of only 10s of meters, much less than that resolved by satellite. Here we investigate whether velocity differences between pairs of drifters can be used to estimate kinetic energy spectra. Theoretical relations between the spectrum and the second-order longitudinal structure function for 2D non-divergent flow are derived. The structure function is a natural statistic for particle pairs and is easily calculated. However it integrates contributions across wavenumber, and this tends to obscure the spectral dependencies when turbulent inertial ranges are of finite extent. Nevertheless, the transform from spectrum to structure function is robust, as illustrated with Eulerian data collected from aircraft. The inverse transform, from structure function to spectrum, is much less robust, yielding poor results in particular at large wavenumbers. This occurs because the transform involves a filter function which magnifies contributions from large pair separations, which tend to be noisy. Fitting the structure function to a polynomial improves the spectral estimate, but not sufficiently to distinguish correct inertial range dependencies. Thus with Lagrangian data, it is appears preferable to focus on structure functions, despite their shortcomings.