STATISTICS OF MEDITERRANEAN COHERENT VORTICES: ANALYSIS OF THE SEA SURFACE HEIGHT

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Abstract

Basic statistics of coherent vortices in the Mediterranean sea are investigated from the analysis of Sea Level Anomalies. The study includes the analysis of their energy, amplitude size and spatial distribution. Their effect on velocity Probability Densitiy Function (PDF) is also analyzed.

Keywords: Mesoscale eddies, velocity PDF, altimetry

Mesoscale variability is characterized by the presence of coherent vortices. This makes mesoscale observations of ocean resemble two-dimensional turbulence. This similarity suggests that vortex identification techniques common in turbulence studies can be used for ocean studies [1]. The Okubo-Weiss parameter (W) is defined as the squared strain minus squared vorticity [2,3]. A coherent vortex is defined as the simply connected region with values of the Okubo-Weiss parameter $W<-0.2\sigma$ where σ is the spatial standard deviation of W. When vortices areidentified their properties can be estimated. In this study, this definition is applied to altimetric Sea Level Anomaly (SLA) maps between October 1992 and October 1999 constructed by CLS [4] combining TOPEX/Poseidon and ERS-1/2 data onto a regular grid [5].

Results show that the Mediterranean sea is characterized by an approximately homogeneous distribution of vortices. However, some of their properties such energy or amplitude are irregularly distributed showing higher values in regions where the presence of mesoscale eddies is well known. This suggests that a classification based on the amplitude could allow to separate these eddies from other structures. The analysis of the dependence of the mean size of vortices with amplitude shows an asymptotic behavior that tends to radius of the order of 40 km. These results suggest the heuristic classification of coherent structures into intense vortices (characterized by values of the amplitude smaller than -2σ) that have the size of mesoscale vortices, and weak vortices (characterized by amplitudes greater or equal than -2σ) that correspond to noisy structures and low energy stages of mesoscale vortices. This separation of structures allows to easily track vortices from map to map and for the first time construct a complete picture of the preferential paths followed by them.

Furthermore, the Probability Density Functions (PDF) of the velocity field derived from SLA maps have also been analyzed. The Mediterranean sea has been divided into 7 regions depending on the geometry and the distribution of intense vortices. For each region PDF of the geostrophic velocities have been calculated. Observed shapes of velocity PDF are characterized by a Gaussian core with exponential tails as observed in the Atlantic and numerical simulations of 2D turbulence [6,7]. However, the size of the core and the tails change from one region to the other depending on the distribution of intense vortices. A decomposition of the velocity field into: a background induced field, a weak vortices-induced field and a intense-vortices field shows that the first two are characterized by distributions close to a Gaussian, while the third one has a distribution close to an exponential distribution.

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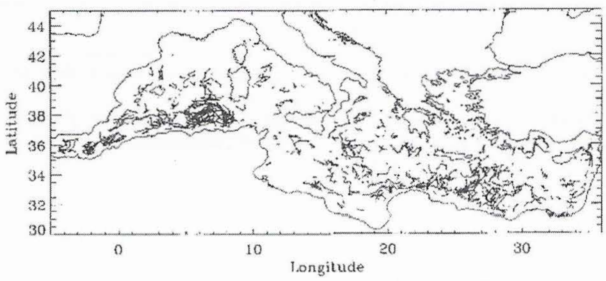

Fig. 1. Observed trajectories of anticyclonic intense eddies.

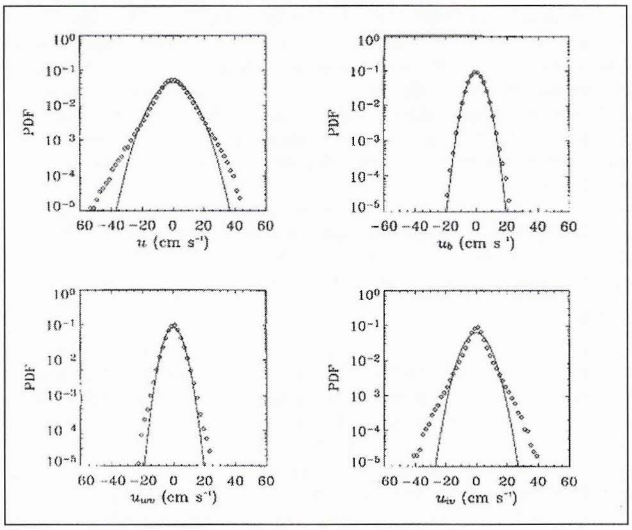

Fig. 2. Example of the velocity PDF of the decomposition of the velocity field (U) into a background-induced field (Ub), a weak eddy-induced field (Uwv) and an intense eddy induced field (Uiv) for the Algerian basin.

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