Lagrangian Skeleton on the Gulf of Mexico Oil Spill

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Abstract

The understanding of the circulation of ocean currents, the exchange of CO_2 between atmosphere and oceans, and the influence of the oceans on the distribution of heat on a global scale is key to our ability to predict and assess the future evolution of climate [1, 2]. Global climate change is affecting sea breathing through mechanisms not yet understood [3]. The ocean is important in the regulation of heat and moisture fluxes, and oceanic physical and bio-geochemical processes are major regulators of natural greenhouse gases. Understanding how oceans mix their waters is key to provide sound forecasts on the climate [1]. Global change also affects marine biodiversity and threatens the survival of ecosystems and exploitable resources. To predict not only the effects of global change on the oceans, but also the response time of climate feedback requires to improve detection systems and to open new lines of research.

We use a novel Lagrangian descriptor (function M, introduced in [4, 5]). It is based on the measure of the arclength of particle trajectories on the ocean surface at a given time. In [6, 7, 8] this technique has been proven to be successful for characterizing the Kuroshio current.

We employ this tool on velocity data sets on the Gulf of Mexico obtained from HYCOM project. The tool identifies the underlying Lagrangian structures in the oceanic currents. In particular invariant manifolds, hyperbolic and non-hyperbolic flow regions are detected. We study the influence of these structures on particle motions on the oil spill.

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