Master 2

INTERNSHIP PROPOSAL

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Thesis possibility after internship: YES

Lagrangian transport in realistic simulations of ocean submesoscale turbulence

Ocean flows at scales larger than few tens of km are quasi-horizontal due to the pronounced stratification of seawater and Earth's rotation and are characterized by quasi-2D turbulence. Mesoscale (O(100) km) vortices contain most of the kinetic energy and are key for ocean dynamics at climatic scales. Submesoscale flows (scales below O(10) km), instead, display smaller and faster eddies, and filaments associated with strong gradients (e.g. of temperature) and intense vertical transport, which play an important role in both physical and biogeochemical budgets. Mesoscale and submesoscale flows also shape the physical and chemical environment of marine life. Direct observation of submesoscale surface velocity fields at global scale is still not possible but it should be achieved in the near future by the satellite SWOT (NASA-CNES, launch in late 2022).

To compute large-scale horizontal transport, surface energy exchanges or global estimates of other quantities, it is crucial to assess how well the horizontal velocities provided by the satellite compare to actual surface currents and down to what length scale. For this purpose, Lagrangian approaches provide an ideal framework, as, differently from standard Eulerian ones, they integrate in time the signal. Thanks to this property, they may allow a clear separation between fast (ageostrophic) processes, that could contaminate the satellite-derived velocity, and slower (geostrophic) ones.

In this internship, funded by CNES, we will explore Lagrangian transport in surface ocean turbulence by means of state-of-the-art realistic numerical simulations. The analysis will rely on the comparison of different statistical indicators of Lagrangian dispersion in the full flow and its geostrophic component, which should be measured by the satellite. The aim is to determine the effect of high-frequency, ageostrophic motions on dispersion features. In particular, this study should allow the identification of a threshold length scale above which the approximate velocity field is accurate enough, at least in a statistical sense, as well as an estimate of the kinetic energy of the missing small scales.

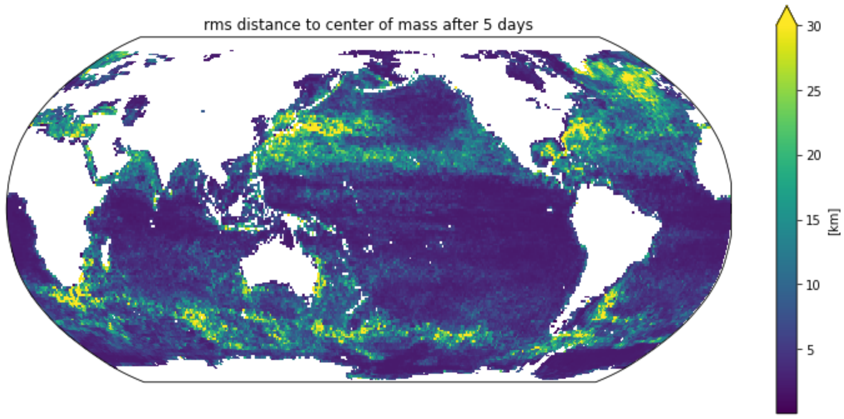

Figure 1: Typical size of clusters of synthetic surface drifters that were initially very close to each other, after 5 days of advection [preliminary results by A. Ponte].

Keywords: turbulence, oceanography, numerical modeling