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Observed and modeled global-ocean turbulence regimes as deduced from surface trajectory data

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This study aims to follow up and remember the work on Lagrangian diffusion undertaken by Volfango Rupolo, who died prematurely nearly three years ago. It was within this field that he achieved the highest of creativity, and his rather recent 2007 work Rupolo (2007) is undoubtedly the fullest and most important example. In that paper, he identified the utility of the relationship between the acceleration and velocity time scales of Lagrangian trajectories, and he separated these trajectories into four homogenous classes according to their correlation and dispersal properties. This classification is better known as 'trajectories taxonomy' and can be used to characterize and separate different turbulence regimes in the global ocean (Rupolo, 2007). He showed that the Lagrangian time scales could be obtained from the inverse use of Lagrangian Stochastic Models, and proposed a screening method for rationalizing the data analysis using the time scale relationships, and successfully applied it to both drifter and Argo-float observations.

In the present study, his data analysis methods have been extended to study and evaluate trajectories from both surface drifters and an ocean general circulation model (OGCM) with different grid resolutions. The drifter data can most accurately be described as quasi-Lagrangian trajectories due to the fact that although the buoy is freely drifting in the horizontal plane, it is anchored at 15 m depth by its drogue, and thus the observed trajectories represent a two-dimensional (2D) approximation of the surrounding flow field. The model trajectories were obtained by analytical computations of the particle advection equation, using the Lagrangian open-source software package TRACMASS, in the near-surface velocity fields from three different configurations of the global NEMO Ocean/Sea-Ice general circulation model.

In global-scale ocean modeling, compromises are frequently made in terms of grid resolution and time-averaging of the output fields since high-resolution data require considerable amounts of storage space. Here, the implications of such approximations on the modeled velocity fields and, consequently, on the particle dispersion, have been assessed through the validation against observed drifter tracks. This study aims, moreover, to shed some light on the relatively unknown turbulent properties of the near-surface ocean dynamics and its representation in numerical models globally and in a number of key regions. These results could be of interest for other studies within the field of turbulent eddy-diffusion parameterization in ocean models, or ocean circulation studies involving long-term coarse-grid model experiments.