Lagrangian tracer transport in surface ocean turbulence with ageostrophic dynamics

M. Maalouly[1], G. Mompean[1], S. Berti[1]

Univ. Lille, ULR 7512, Unité de Mécanique de Lille Joseph Boussinesq (UML), F-59000 Lille, France
michael.maalouly@univ-lille.fr

Ocean submesoscales, which have length scales of $\mathcal{O}(1-10)$ km, are notoriously difficult to measure due to their small size and rapid temporal evolution. However, recent studies have shown that these small scales can have a relevant impact on the advection of Lagrangian tracer particles, as well as on phenomena such as aquatic life migration, and pollutant dispersion and accumulation. Despite their importance, the present understanding of submesoscale ocean dynamics remains limited, with a key open question concerning the role of the non-geostrophic components of the surface velocity field. To address this question, we conducted numerical simulations using a model that includes non-geostrophic motions related to fronts, and that is derived as a small, but finite, Rossby number approximation of the fundamental equations of motion. In the limit of vanishing Rossby number, this model describes surface quasi-geostrophic (SQG) dynamics, and is known as SQG^{+1} [1].

Our study focuses on the effect of the ageostrophic flow component on Lagrangian transport properties, specifically particle clustering. We used different statistical indicators to examine the characteristics of the turbulent flow, and to assess the impact of the latter onthe spatial distribution of particles. Our results show that the ageostrophic flow components are responsible for the (temporary) formation of particle clusters, and that the intensity of this phenomenon increases with the Rossby number. Moreover, we provide evidence that Lagrangian tracers preferentially accumulate in frontal regions characterized by intense strain and positive (i.e. cyclonic) vorticity, as suggested by previous observations and modeling studies [2].

This study demonstrates that the relatively simple model we adopted captures some of the main features characterizing ocean turbulence at submesoscales,and can help shedding light on the mechanisms underlying particle clustering in this range of scales.

Références

1. G. Hakim, C. Snyder, D. Muraki, *Journal of the Atmospheric Sciences*, **59**, 2405-2420, (2002).
2. Vic, C., Hascoët, S., Gula, J., Huck, T., Maes, C., *Geophysical Research Letters*, **49**, (2022).