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A Lagrangian model of Copepod dynamics in turbulent flows

Hamidreza Ardeshiri (1,2), Ibtissem Benkeddad (2), Francois G. Schmitt (2), Sami Souissi (2), Federico Toschi (3,4), and Enrico Calzavarini (1)

(1) Univ. Lille, CNRS, FRE 3723, LML, Laboratoire de Mécanique de Lille, F 59000 Lille, France, (2) Univ. Lille, CNRS, Univ. Littoral Cote d'Opale, UMR 8187, LOG, Laboratoire d'Océanologie et de Géoscience, F 62930 Wimereux, France, (3) Department of Applied Physics and Department of Mathematics and Computer Science, Eindhoven University of Technology, 5600 MB, Eindhoven, The Netherlands, (4) Istituto per le Applicazioni del Calcolo CNR, Via dei Taurini 19, 00185 Rome, Italy

Planktonic copepods are small crustaceans that have the ability to swim by quick powerful jumps. Such an aptness is used to escape from high shear regions, which may be caused either by flow perturbations, produced by a large predator such as fish larave, or by the inherent highly turbulent dynamics of the ocean. Through a combined experimental and numerical study, we investigate the impact of jumping behaviour on the small-scale patchiness of copepods in a turbulent environment. Recorded velocity tracks of copepods displaying escape response jumps in still water are used to define and tune a Lagrangian Copepod (LC) model. The model is further employed to simulate the behaviour of thousands of copepods in a fully developed hydrodynamic turbulent flow obtained by direct numerical simulation of the Navier-Stokes equations. First, we show that the LC velocity statistics is in qualitative agreement with available experimental observations of copepods in turbulence. Second, we quantify the clustering of LC, via the fractal dimension D_2. We show that D_2 can be as low as 2.3, corresponding to local sheetlike aggregates, and that it critically depends on the shear-rate sensitivity of the proposed LC model. We further investigate the effect of jump intensity, jump orientation and geometrical aspect ratio of the copepods on the small-scale spatial distribution. Possible ecological implications of the observed clustering on encounter rates and mating success are discussed.