Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Role of large-scale advection and small-scale turbulence on the vertical migration of gyrotactic swimmers CRISTIAN MARCHIOLI, University of Udine, GAETANO SARDINA, Chalmers University of Technology, LUCA BRANDT, Linn FLOW Centre and SeRC, KTH Mechanics, ALFREDO SOLDATI, TU Wien — We use DNS-based Eulerian-Lagrangian simulations to investigate the dynamics of small gyrotactic swimmers in free-surface turbulence. Swimmers are characterized by different vertical stability: some realign with a characteristic time smaller than the Kolmogorov time scale, τ_K, while others possess a re-orientation time longer than τ_K. We cover one order of magnitude in the flow Reynolds number, and two orders of magnitude in the stability number, which measures bottom heaviness. We observe that large-scale advection dominates vertical motion when the stability number, scaled on the local Kolmogorov time scale, is above unity: This leads to enhanced migration towards the surface, particularly at low Reynolds number, when swimmers can rise through surface renewal motions that originate from the bottom-boundary turbulent bursts. Small-scale effects become important when the Kolmogorov-based stability number is below unity: Migration towards the surface is hindered, particularly at high Reynolds, when bottom-boundary bursts are less effective in bringing bulk fluid to the surface. We demonstrate that a Kolmogorov-based stability number around unity represents a threshold beyond which swimmer capability to reach the surface and form clusters saturates.

Cristian Marchioli
University of Udine

Date submitted: 30 Jul 2019 Electronic form version 1.4