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Turbulent unmixing: the sorting of motile phytoplankton by flow
WILLIAM DURHAM, MIT, ERIC CLIMENT, Institut de Mecanique des Fluides de Toulouse, MICHAEL BARRY, ROMAN STOCKER, MIT — Motile phytoplankton in the Ocean are heterogeneously distributed at mm to cm scales, corresponding to the size of the smallest turbulent fluctuations. We demonstrate that this patchiness may originate from a coupling between turbulent shear and gyrotactic motility, a defining feature of many phytoplankton species. By tracking individual cells within a direct numerical simulation (DNS) of turbulence, we observed gyrotactic phytoplankton aggregate in tightly packed clusters. The fate of a species is characterized by two dimensionless parameters, measuring cell stability and swimming speed. We find that turbulent flow separates different species into spatially distinct patches and rationalize these predictions with a simple model of vortical flow. Preliminary experiments support model results. By reducing the mean distance between organisms, this previously unconsidered mechanism can markedly increase encounter rates, which shape all ecological interactions in the Ocean.

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