

{rokbox title=|Schematic representations of biophysical turbulence in contrasting levels of stratification :: Image: Authors| thumb=|images/stories/ieo/imagenespublicaciones/centro-oceanografico-baleares-ieo-csic-intense-upper-ocean-mixing-due-to-large-aggregations-spawning-fish-fernandez-et-al-2022-thumb.jpg|images/stories/ieo/imagenespublicaciones/centro-oceanografico-baleares-ieo-csic-intense-upper-ocean-mixing-due-to-large-aggregations-spawning-fish-fernandez-et-al-2022.jpg|/rokbox}

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[Intense upper ocean](#)

[mixing due to large aggregations of spawning fish.](#)

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**Abstract:** Small-scale turbulent mixing plays a pivotal role in shaping ocean circulation and a broad range of physical and biogeochemical processes. Despite advances in our understanding of the geophysical processes responsible for this mixing, the nature and importance of biomixing—turbulent mixing caused by marine biota—are still debated. A major source of uncertainty pertains to the efficiency of biomixing (the fraction of the turbulent energy produced through swimming that is spent in mixing the ocean vertically), which the few in situ observations available suggest to be much lower than that of geophysical turbulence. Here we shed light on this problem by analysing 14 days of continuous measurements of centimetre-scale turbulence in an area of coastal upwelling. We show that turbulent dissipation is elevated 10- to 100-fold (reaching  $10\text{--}6\text{--}10\text{--}5\text{ W kg}^{-1}$ ) every night of the survey due to the swimming activity of large aggregations of anchovies that gather regularly over the spawning season. Turbulent mixing is invigorated concurrently with dissipation, and occurs with an efficiency comparable to that of geophysical turbulence. Our results demonstrate that biologically driven turbulence can be a highly effective mixing agent, and call for a re-examination of its impacts on productive upper ocean regions.

**Keywords:**