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Plankton life and the multiple faces of turbulence

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Microscale turbulence is a ubiquitous feature of aquatic ecosystems, and much has been written about the potential effects of microscale turbulence on plankton biology and ecology. However, some ambiguities remain in the meaning of the word 'turbulence' itself, especially when turbulence is generated in the laboratory. A fully developed turbulent flow is thus characterized by (i) a high Reynolds number, (ii) a -5/3 power law of the Fourier spectrum of velocity fluctuations and (iii) intermittent properties. Here, the stochastic nature of 'turbulent' flows generated at high Reynolds numbers in the laboratory using grid-generated turbulence and a circular flume under steady-state flow conditions is compared to those of flows naturally occurring in the ocean. It is then shown that a 'turbulent' flow generated under laboratory conditions is not necessarily comparable to the real world fully developed turbulence. The consequences of the qualitative differences observed between laboratory-generated turbulence and natural turbulent flows on our understanding of the effects of turbulence on marine life are illustrated on the basis of theoretical arguments, laboratory and field grazing experiments. A special focus is given to properties and the effects of turbulence intermittency.