Geophysical Research Abstracts
Vol. 21, EGU2019-18394-3, 2019
EGU General Assembly 2019

Mixing efficiency in decaying stratified turbulence

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In 1850, the historical experiment of Joule on the "mechanical equivalent of heat" quantified the turbulent transfer of turbulent kinetic energy into heat in a closed water tank. So far, the stratified version of this experiment still challenges the scientific community. In a homogeneous fluid, viscous dissipation converts 100% of the mechanical energy into heat; in a stratified fluid however, part of the energy is converted into an irreversible increase of the background potential energy. This ratio is directly related to the so-called mixing efficiency, which is of particular importance in the oceanic context, since small-scale diapycnal mixing participates to the circulation of the abyssal ocean by means of irreversible density fluxes. We have realized a set of Direct Numerical Simulations in a closed domain, linearly stratified, where turbulent kinetic energy is initially injected in the system and decays. A closed energy budget is realized, for which all transfer terms are resolved in time and space and integrated in time. This approach fundamentally differs from forced (stationary) numerical simulations, often used as a reference in the literature; as oceanic turbulence is known to be unstationary and intermittent, the distinction between instantaneous and cumulative mixing efficiency in stratified turbulence is addressed here.