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Observations of diapycnal mixing in the western Mediterranean Sea

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The overturning circulation in the Mediterranean Sea is often cited as a small scale laboratory of the Atlantic overturning cell. While diapycnal mixing mostly intensified over rough topography in the Atlantic participates to the overturning cell through the upwelling of bottom and deep water masses, it is not clear how important such a mechanism is for the fate of Mediterranean water masses. Indeed there is less energy inputs through winds and tides in the Mediterranean than there are in some parts of the Atlantic. However, other mechanisms, such as mesoscale flow interactions with topography, flows through narrow passages and sills, double diffusion … , prevail and transfer energy to small scale turbulence and mixing,… Full depth mixing observations is obviously lacking in the Mediterranean basin to quantify the importance of those processes.
In this study, we report on observations of turbulent kinetic energy dissipation rates and vertical diffusivities measured in the western part of the Mediterranean basin. A total of 130 full depth microstructure profiles were gathered during three cruises on board the Urania R/V. The cruises took place in June 2013, October 2013 and March/April, June and November 2014. Excluding the mixed layer, depth averaged dissipation rates $<\varepsilon>$ are usually weak of order 10^{-11} W/kg. Depending on the cruise, slightly enhanced $<\varepsilon>$ (10^{-10} W/kg) are found near the western slope of Sardinia at 40°N, in the Sardinia passage at 38°N, and in a few profiles located in the Algerian basin and around Sicily. Contrastingly, $< \varepsilon >$ is always strong (10^{-9}-10^{-7} W/kg) in the Sicily strait and in the channel of Corsica. Below 1000 m, typical vertical diffusivities are in the range 3×10^{-5} to 3×10^{-4} $m^2\ s^{-1}$ since weak dissipation rates are associated with weak buoyancy frequencies. Below the mixed layer and down to 500 m, vertical diffusivities are usually weaker than 1×10^{-5} $m^2\ s^{-1}$. This contrasts strongly with the high values of order 10^{-3} to 10^{-2} $m^2\ s^{-1}$ reached in the Sicily strait, the Corsica Channel and in the mixed layer. We provide as well first insights on the dynamical processes responsible for enhanced dissipation rates and turbulent mixing, with a focus on the Sicily Strait.

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