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Multi-platform observation of submesoscale vortices formed by deep vertical mixing: characterization and role for the general circulation of the Mediterranean Sea

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Since 2010, an intense effort in the collection of in-situ observations has been carried out in the Northwestern Mediterranean Sea thanks to gliders, regular cruises and a highly instrumented mooring line. This integrated observing system enabled a year-to-year monitoring of the deep water formation that occurred in the Gulf of Lions area during the 4 consecutive winters of the study period (2010-2013).

Vortical structures remnant of wintertime deep vertical mixing events were regularly sampled by different platforms. They are isolated Submesoscale Coherent Vortices (SCVs) characterized by a small radius ($\sim$5km), strong depth-intensified azimutal velocities ($\sim$10-15cm/s) with a weaker surface signature, high Rossby ($\sim$0.5) and Burger ($\sim$1) numbers.

Anticyclones are found to transport mode and newly formed deep waters resulting from vertical mixing characterized by intermediate ($\sim$300-500m) to deep ($\sim$2000m) mixing. Cyclones are characterized by a weakly stratified core of newly formed Western Mediterranean Deep Waters (or Dense Shelf Waters that cascaded from the shelf of the Gulf of Lions in 2012) extending from $\sim$500-1000m depth to the bottom ($\sim$2300m). The formation of the cyclones might be favoured by bottom-reaching convection or cascading events reaching the abyssal plain.

This study confirms the prominent role anticyclonic SCVs and shed light into the role of cyclonic SCVs in the spreading of newly formed deep waters out of an open-ocean deep convection area. They could also potentially impact vertical mixing during the the following winter through a local preconditioning effect.