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Water mass formation processes in the Mediterranean Sea over the past 30 years

Simona Simoncelli (1), Claudia Fratianni (1), Emanuela Clementi (1), Stefano Salon (2), Cosimo Solidoro (2), and Gianpiero Cossarini (2)

(1) INGV, Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy (simona.simoncelli@ingv.it), (2) OGS, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy

The formation of intermediate and deep water masses is one of the most important processes occurring in the Mediterranean Sea, being a component of its general overturning circulation, and it has crucial implications on the ecosystem.

The objective of the proposed work is to revise the main water mass formation events occurred during the latest 30 years (1987-2016) in the Mediterranean Sea and analyse their impact on biogeochemical properties considering the CMEMS Med-MFC physical and biogeochemical reanalysis data sets (https://doi.org/10.25423/medsea_reanalysis_phys_006_004 and https://doi.org/10.25423/MEDSEA_REANALYSIS_BIO_006_008 respectively).
The analysis takes into consideration the four regions where events of intermediate and deep water formation are known to occur: 1) the Gulf of Lions for the Western Mediterranean Deep Waters; 2) the Southern Adriatic Pit for the Eastern Mediterranean Deep Waters; 3) the Cretan Sea for Cretan Intermediate Waters and Cretan Deep Waters; 4) the Rhodes Gyre, the area of formation of the so- called Levantine Intermediate Waters and Levantine Deep Waters.

Annual water mass formation rates have been computed using daily mixed layer depth estimates considering the annual maximum volume of water above mixed layer depth with potential density within or higher than specific thresholds, and then divided by seconds per year. The use of different density thresholds reported in literature to identify water masses allows to detect variations of their characteristics over time, as observed from observations. The adopted methodology might underestimate the actual water mass formation rate but, thanks to the assimilation of in situ temperature and salinity profiles and the interactive heat flux correction based on observed satellite sea surface temperature, it permits an accurate estimation of the mixed layer depth and to detect the main open ocean convection events from the selected reanalysis data set.

The analysis of chlorophyll and nutrient dynamics during the most significant episodes of water mass formation in North West Mediterranean and South Adriatic Sea highlights that these intense physical processes have an impact on the biogeochemical properties. We verified that dense water formation changes the structure of nutrients fields and might cause precondition for chlorophyll blooms, highlighting a strong link between vertical transport mechanisms and primary productivity.

The CMEMS Mediterranean Sea physical reanalysis is able to reproduce both Eastern Mediterranean Transient and Western Mediterranean Transition phenomena and catches the principal water mass formation events reported in literature. This result is promising because it allows a constant monitoring of the open ocean deep convection process in the Mediterranean Sea, a better understanding of the multiple drivers of the general overturning circulation at interannual and multidecadal time scales and the possible effects on the Mediterranean ecosystems.