

Large-scale Processes

Water mass transformations in the Mediterranean outflow water

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Abstract

The start of the Atlantic Meridional Overturning Circulation takes place at high latitudes in the North Atlantic Ocean, through the deep convection of surface waters. For these surface waters to reach the deep ocean it is necessary that the upper and intermediate waters be sufficiently salty, i.e. preconditioned towards instability. One potential mechanism for the salinization of the upper North Atlantic Ocean, particularly at high latitudes, is through salt release from Mediterranean outflow waters (MOW). The amount and level where salt is released is determined by its initial salinity and temperature values ($S=38.4$, $T=13^{\circ}\text{C}$) and by the degree of turbulent mixing with the overlaying North Atlantic Central Water (NACW).

This study describes the transformation of the MOW in the northeastern Gulf of Cadiz using a combination of data from the MEDOUT-2009 (Gasser et al., 2011; Nash et al., 2012) and MEDOUT- 2011 oceanographic cruises with historical data from Price et al. (1993). A detailed description of the region, as obtained using multibeam bathymetry during the 2011 cruise, helps to appreciate the key role played by the bottom topography on the turbulent mixing of the MOW with the surrounding NACW.

As the MOW exits the Strait of Gibraltar it experiences three distinct dynamic regions in a distance of about 50 km. Between Spartel Sill (360 m) and Western Spartel Sill (420 m, located at $6^{\circ}20'\text{W}$, $35^{\circ}47'\text{N}$), the MOW flows west along a narrow (5 km wide) and gently sloping channel, the water depth changing from 360 to 420 m in some 20 km. The MOW continues west along a channel of variable amplitude (5 to 10 km) and experiences at least three topography-driven rapid accelerations (the bottom depth changes from 420 to 700 m over a distance of 20 km) where the core velocities exceed 1 m s^{-1} ; these accelerations result in substantial vertical mixing and the separation of the MOW into two well defined cores (the upper one at 800-1000 m and the lower one at 1000-1200 m). During these two stages the MOW approximately occupies the bottom third of the water column. In the third and final phase the MOW follows northwest, its diluted core moving much slower, along the Iberian continental slope (Price et al., 1993).

References

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