TRACKING THE MEDITERRANEAN ABYSS

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Abstract
The abyssal velocity of the Northern Current, in the north-western Mediterranean has been estimated using for the first time MERMAID instruments, i.e. submarine drifting instruments that record seismic waves. In this study the Northern Current shows an intense activity even in deep layers of the water column. Through pseudo-eulerian statistics different components of the observed variability are described.

Keywords: Abyssal, Mediterranean Sea, Gulf of Lyon, Ibiza Channel, Circulation

The Mediterranean Sea is well known to be a miniature ocean with small enough time-scales to allow the observation of main oceanographic events, e.g. deep water formation and overturning circulation, in a human life time. Therefore the Mediterranean can be considered as a key oceanographic observatory site. The deep sea is challenging to monitor. This work is focused on the north-western Mediterranean basin (figure 1), where deep water formation events often occur in the Gulf of Lion (GoL) [1].

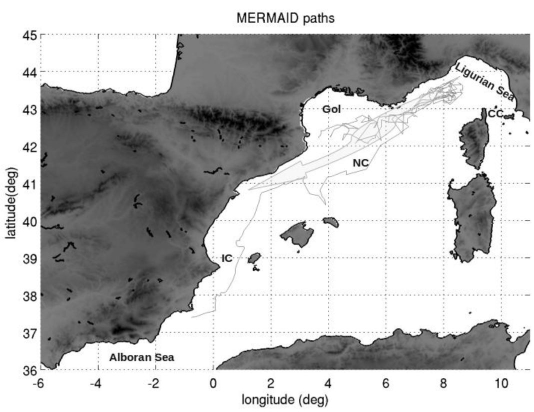

Fig. 1. Paths of the seven MERMAIDs deployed in the Ligurian Sea, some of which followed the deep Northern Current (NC) until the Ibiza Channel (IC).

The north-western Mediterranean circulation is characterised by a marked frontal structure [2] that flows cyclonically along the coast from the Corsica Channel (CC) to the Alboran Sea. This flow constitutes the Northern Current (NC). MERMAIDs are submarine robots designed to observe underwater seismic waves in order to improve ocean tomography, i.e. the imaging by sections through the use of a penetrating wave. The functioning of MERMAID profiling process is illustrated in figure 2. After the deployment the instrument communicates its surface position via GPS and Iridium satellite. When the Iridium transmission stops an internal bladder starts to be filled with oil, the floater begins its descent. At 50 m depth the bladder is full and the profiler sinks until it reaches its park depth where the acquisition starts. The park depth is provided by the instrument measurements and it ranges from 555 m to 2332 m depth. At the end of the acquisition the ascent phase begins until 50 m depth is reached again, the bladder is emptied and the float can reach the surface. The 50 m positions and times, both during the descent and the ascent phase, are known with an uncertainty of 5 minutes. The position at 50 m depth is calculated assuming a linear drift evinced by two consequential GPS communications before the float starts its descent. The time at sea of the profilers goes from 3 to 19 months. Seven MERMAIDS were deployed in the Ligurian Sea, one of them particularly followed the Northern Current until the Ibiza Channel (IC), figure 1, allowing us to estimate the north-western Mediterranean abyssal circulation. We extract MERMAIDs deep velocities, correcting them with geostrophic velocities estimated values, extracted from an historical database of hydrographic stations. The geostrophic velocities are applied to correct the drift that the instruments undergo from 50 m depth, last known position, to their park depth, at which they float following the deep current and from park depth to 50 m during the up-cast. Furthermore pseudo-eulerian calculations, following the methods suggested by [3], have been also applied and interpreted. Eddy Kinetic Energy (EKE) and Mean Kinetic Energy (MKE) values show particularly high values in the GoL and in the IC, meaning that both the kinetic energy given to the mean flow and the kinetic energy ascribable to the flow fluctuations, occur close to the main site of deep water formation, the GoL, and in a choke point like the IC. The importance of the IC is due to its high variability, mostly dictated by the intermittent presence of a cyclonic eddy that prevents the Atlantic Water recently entered in the Mediterranean from crossing the IC [4]. An intense activity in the abyss of the north-western Mediterranean has been depicted, allowing the estimate of deep circulation of the NC and highlighting abyssal velocities that can reach 1 m/s. The NC appears to involve the whole water column and not only the superficial and intermediate layers as it was suggested in the past [5].

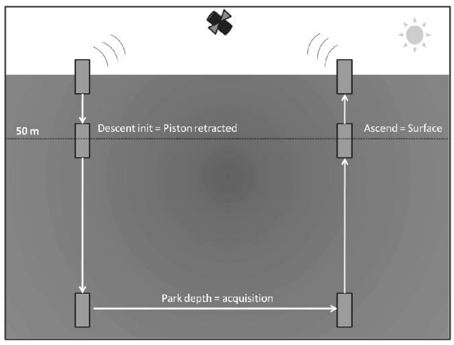

Fig. 2. MERMAID profiling process.

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