Drifter experiment in the Tuscan Archipelago

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The experiment, the drifters and the data analysis:

An oceanographic experiment called MILONGA (MIsure Lagrangiane OceaNoGrafiche nell'Arcipelago sud toscano) was carried out in the waters of the Tuscan Archipelago (northern Tyrhennian Sea) in October 2011 as part of the MOMAR (sistema integrato per il MOnitoraggio e il controllo dell'ambiente MARino; www.lamma.rete.toscana.it/progetti/momar) project.

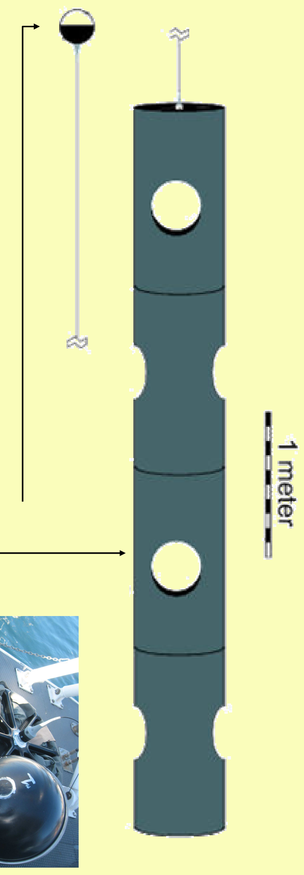
About 20 drifters were operated in this coastal area in order to monitor the surface circulation during a period of about 2 weeks. The drifters used are the CODE design produced by DBI (Florida) and the SVP design manufactured by SIO.

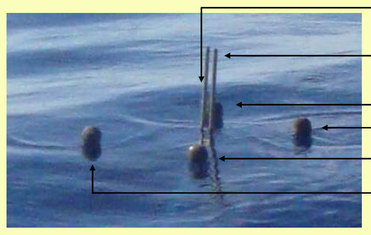
In addition to the standard positioning and data telemetry (SST, battery) provided by the Argos Data Collection and Location System (DCLS), they are equipped with GPS receivers to have a more frequent and a better determination of its position.

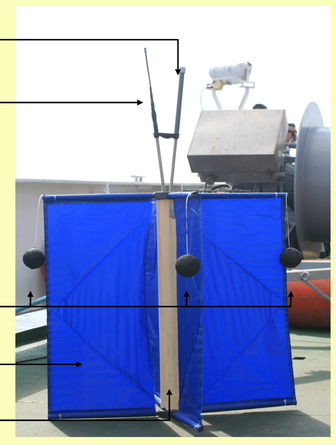
The CODE units consist of a central sealed tube which contains the electronics and power pack. On top of the tube there are the antennas which protrude through the water surface. Four sails made of cloth (area ≈ 1 m^2) hold the drifter almost motionless with respect to the superficial layer and four ball-shaped foam floats provide net positive buoyancy to the unit. The SVP drifters consist of a surface buoy that is tethered to a holey-sock drogue, centered at a nominal depth of 15 m .

Some prototype drifters were also used (two river drifters and a CODE-type drifter). They are all equipped with a Nortek Aquadopp vertical profiling Acoustic Doppler Current Profiler (ADCP). In particular, one river drifter is fitted with a downward-looking 1 MHz ADCP to measure the relative currents below the drifters every meter down to 20 m. The other river drifter is equipped with a upward-looking 2 MHz ADCP to measure the relative currents near the surface and assess the slip of the instrument due to the combined effect of wind and waves. Finally the CODE-type drifter has a Nortec acoustic current current meter on its upper part (about 30 cm below the surface) and a downward-looking 1 MHz ADCP at the bottom of the drifter

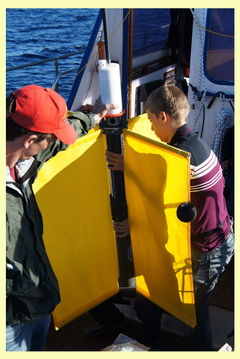
The drifter positions were edited for outliers and spikes using statistical and manual techniques with criteria mainly based on maximum speed and zonal and meridional displacements, as described in Gerin and Bussani (2011) and Gerin et al. (2011). Velocities were estimated by finite differencing the edited drifter positions (central difference with delta-t of 30 minutes for the CODE and 4 hours for the SVP).

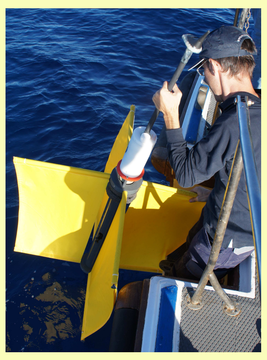


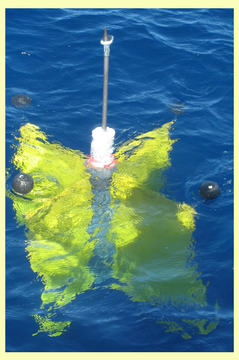


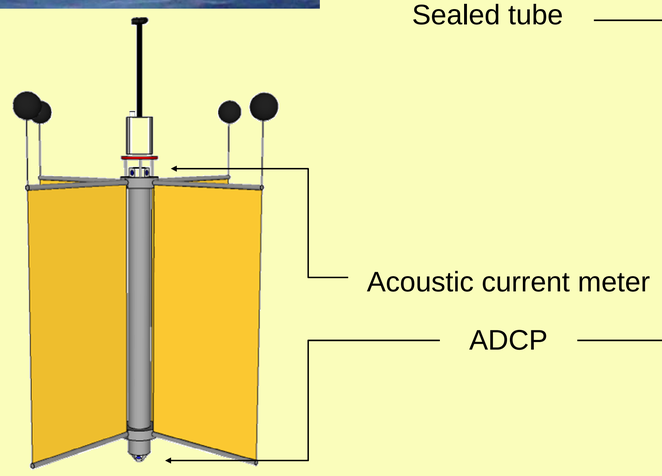


CODE-TYPE PROTOTYPE DRIFTER

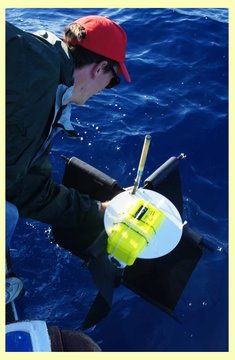


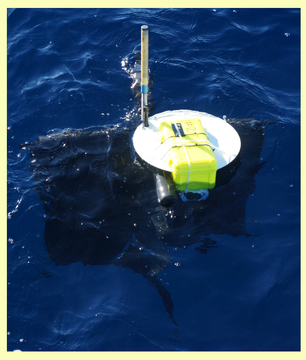






RIVER DRIFTER





Results:

The 15 CODE and 2 SVP drifters were deployed on 11 October 2011 more or less uniformly throughout the study area (uniform grid with typical distance between drifters of 10 km) using two boats, the Poseidon of ARPAT and a rented motor boat. The array of deployment locations is shown in Fig. 1, along with the initial trajectories of the drifters in the Tuscan Archipelago area. Most drifters initially moved to the southwest. In addition to basin-scale and mesoscale motions, many drifters show ubiquitous meandering and looping movements corresponding to sub-mesoscale, inertial or tidal currents. Velocities speeds are color-coded along the drifter tracks in Fig. 2. Most speeds are bounded by 50 cm/s in the Tuscan Archipelago waters.

Pseudo-Eulerian statistics of the surface velocities derived from the drifters were also calculated. The drifter velocities were averaged in bins of 0.1°x 0.1° overlapped by 50%. The definitions of the pseu do-Eulerian statistics can be found in Poulain (2001). The number of drifter observations (every 15 min and 2 hours for the CODE and SVP drifters, respectively) is shown in Fig. 3. The area between Montecristo and Pianosa (eastern Tuscan Archipelago) are the most sampled with about 1000 drifter measurements and 10 drifters providing observations in some bins.

The mean flow and mean kinetic energy (MKE) are illustrated in Fig. 4. Velocity vectors are drawn at the center of mass of the observations in each bin. Southward flow prevails in the eastern sector off the continental Italian coast, and in particular between the Argentario and Giglio. More to the west, prevailing mean currents are directed towards the southwest. Mean currents can reach 20 cm/s and the corresponding mean kinetic energy can reach 400 cm^2/s^2 in the Tuscan Archipelago area.

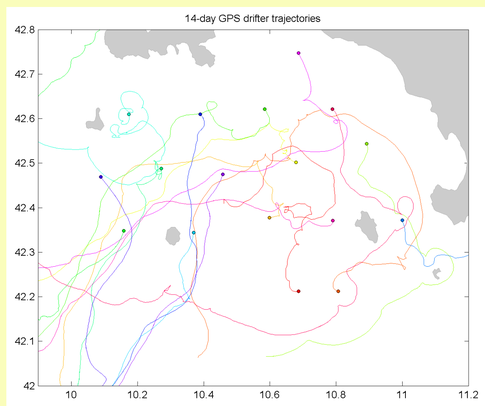


Fig. 1: Deployment locations and trajectories of the drifters in the Tuscan Archipelago.

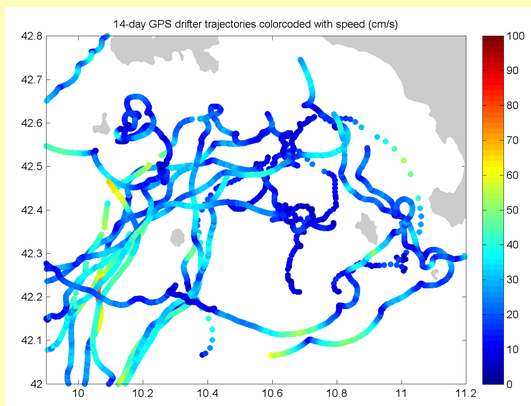


Fig. 2: Drifter trajectories color-coded with speed.

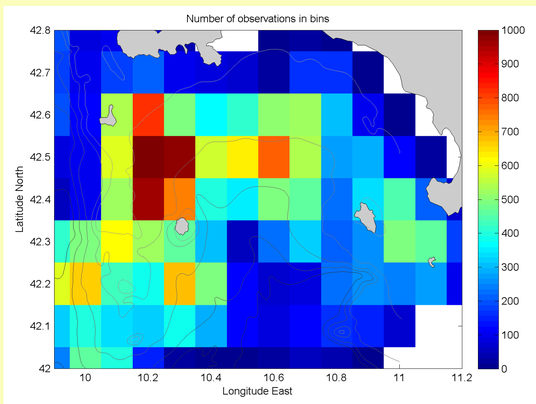


Fig. 3: Number of drifter observations in 0.1°x 0. 1° bins.

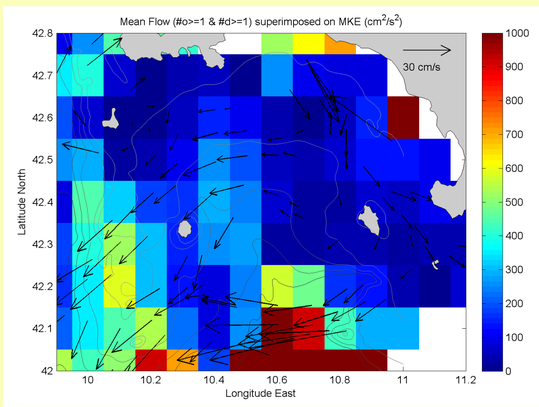


Fig. 4: Mean flow (arrows) and mean kinetic energy (MKE, colors) in 0.1°x 0.1° bins.

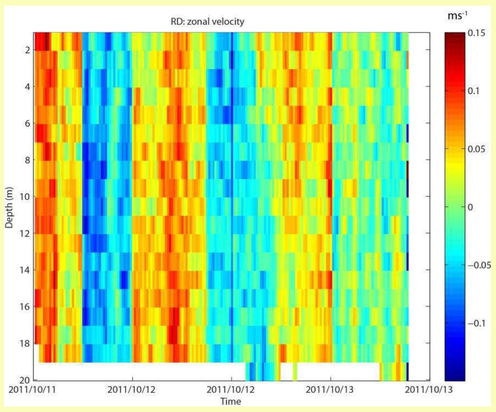


Fig. 5: Zonal velocity versus depth and time as measured with ADCP and corrected for the drifter motion (using the onboard GPS data).

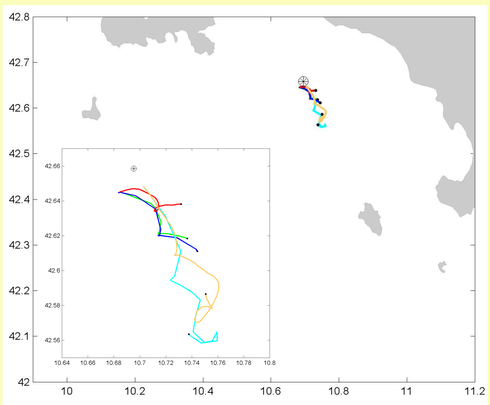


Fig. 6: Trajectories and recovery locations (black dots) of the SIO drifters with downwardlooking ADCP (first deployment in blue and second deployment in cyan) and with upwardlooking ADCP (in green), and of the OGS prototype drifter (first deployment in red and second deployment in orange).

A preliminary analysis of the velocity time series of the ADCP mounted on the prototype drifters suggests a periodicity of about 16.5 hours (Fig. 5). Since the inertial frequency at the experiment location is approximately 17.7 hours, the cycloidal prototype drifter path (Fig. 6) and the periodical measured currents should result from near-inertial currents.

References:

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- Poulain, P.-M. (2001) Adriatic Sea surface circulation as derived from drifter data between 1990 and 1999, J. Marine Sys., 29, 3-32.

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