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Observational evidence of mesoscale variability of the Northern Current (North-Western Mediterranean Sea): a combined study via gliders, HF RADAR, surface drifters, and vessel data

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Results from a combined observational effort put forth in December 2011 are here presented. The focus is on the mesoscale variability of the Northern Current (NC), the branch of the general North-Western Mediterranean cyclonic circulation extending from the Ligurian to the Catalan Sea (Albérola et al., Oceanologica Acta, vol. 18, n. 2, 1995). The study area, located between the Ligurian Sea and the Gulf of Lions, includes the part of French coast between Nice and Toulon, where only a few hydrographic data have been collected in the past. Dynamic instabilities of the NC, observed and reported in literature (Picco et al., Ocean Science, vol. 6, 2010), make this region particularly important, with consequences in the recirculation of the Ligurian Gyre and in the NC intrusions in the Gulf of Lions (Millot and Wald, Oceanologica Acta, vol. 3, n. 4, 1980).

This works aims at providing experimental evidence of the effects that mesoscale exerts on the NC dynamics via an innovative and complementary data set. Two Slocum Gliders (a Shallow and a Deep one), both equipped with CTD and dissolved oxygen sensors, sampled the area within 70 km from the coast for about 20 days. The shallow one (200 m) realized six transects describing a "W"-shaped pattern from Nice to Toulon, whereas the deep one (1000 m) performed repeated cross-current sections off Toulon. Concurrent observations were obtained via: a) CTD and both Lowered and Vessel-Mounted ADCP transects obtained during a 5-day oceanographic cruise on board of the Research Vessel Urania; b) repeated deployments of surface drifters; c) a continuously-recording High Frequency (HF) RADAR which measures surface currents off Toulon in a 40×25 km^2 region with high resolution both in space (2 km) and in time (1 hour).

The combined use of data from the shallow glider and the ship-based ADCP measurements reveals the presence of an instability of the offshore front of the NC. Its location is confirmed by high-resolution satellite images in the same period and by the trajectories of the drifters. The instability is thought to evolve in a filament which detaches from the main branch and moves eastward, participating to the recirculation of the Ligurian Gyre.

Data from the deep glider and the HF RADAR are used to assess the temporal evolution of the NC front in the region off Toulon. The analysis shows that the surface front is here eroded during the observational period. Possible reasons include a) the blowing of Mistral and/or Tramontane, which are the strongest and most persistent winds of the region, with associated offshore Ekman transport and mixing; b) buoyancy loss which induce convective cells at the surface; c) simply lateral advection as the HF RADAR synoptic view reveals that the front is often interrupted or modified because of instabilities.