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Experimental and numerical characterization of sea-state and coastal currents close to the Giglio island.

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The study of sub-mesoscale circulation phenomena in coastal areas is complicated by the high resolution requested for both the observation and the simulation of such currents, and by the difficulty of appropriately validating the remote sensing and the numerical data.
In this work we present the results of a long period of waves and coastal currents observations, produced by the X-band radar that was implemented in 2012 at the Giglio Island, after the accident of the Costa Concordia ship.
The radar installation has allowed to verify the structure of particular sea states and hydrodynamic phenomena that can be reproduced also by means of some numerical models implemented in the area: in particular, SWAN for waves prediction, and ROMS for coastal circulation . The models were configured through multiple nesting in order to reach resolutions comparable to coastal radar observations. The measurements have been validated independently through the use of drifters in experimental campaigns around the island.
The complete view of the 2D spectrum, as recorded by the radar, allowed to fully characterize sea states with crossed-seas and also coastal refraction phenomena (due to the southwest sea that turns all around the island), diffracted and even reflected wave patterns (Ludeno et al., 2014).
The circulation phenomena are even more complex, as they are produced by a combination of local forcing conditions and tides, and by the interaction of the large-scale circulation with the local conformation of the bathymetry and the coastline. Circulation cells have been often observed, even in the form of a double-gyre configuration, also due to the non-stationarity of the atmospheric forcing and to multiple interaction effects. In our work we attempt to reproduce some of these phenomena, which are difficult to model also for their inherent non-linearity. We have considered the use of the native ROMS algorithm for multiple nested domains, by implementing it up to 50 m resolution. The results help to give a reliable interpretation of these phenomena, although the discussion about the predictability of highly nonlinear currents at coastal/littoral scales and sub-mesoscale, with their effective spatial and temporal phases, is still an open question.