BIOPHYSICAL DYNAMICS IN A SUBMESOSCALE EDDY BY THE SYNERGY BETWEEN SATELLITE SWOT ALTIMETRY AND AUTONOMOUS PLATFORMS

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Abstract
The BioSWOT-Med cruise (https://doi.org/10.17600/18002392) was carried out in the northwestern Mediterranean Sea during the fast-sampling phase of the satellite SWOT mission (i.e., fixed tracks were revisited every 24h), between April and May 2023, contributing to the international efforts of studying the oceanic submesoscale to mesoscale (1 to 100 km) dynamics. The SWOT satellite captured a (sub)mesoscale anticyclone not recognized with conventional (i.e., pre-SWOT) altimetry. In this work, we present the preliminary outcomes derived by autonomous platforms (BGC-Argo floats, gliders, and surface drifters) with high-frequency sampling, in defining the sub mesoscale anticyclonic characteristics.

Keywords: Mesoscale phenomena, Circulation, Remote sensing, Western Mediterranean

Introduction
The ocean's fine scales, which spans around 1-100 km with a short lifetime of days to weeks, play a crucial role in ocean physics and ecology, influencing climate due to their energetic dynamics creating strong gradients. These gradients facilitate vertical exchanges between ocean's surface and its interior, impacting biogeochemical cycles, biodiversity, fish distribution, and mega-fauna foraging strategies. Numerical studies and field campaigns have enhanced our understanding of these processes, but empirical evidence remains limited [1; 2]. Efforts have focused on novel platforms like satellite missions, offering extensive coverage and high spatial-temporal resolution of the ocean surface. While remote sensing doesn't capture fine-scale processes, it provides valuable context, aiding in distinguishing spatial from temporal variability, guiding in-situ sampling strategies, and validating field data representativeness. The deployment strategy achieved high spatial-temporal resolution multidisciplinary measurements within SWOT swaths to resolve biological and physical interactions at fine scales.

Material and methods
The BioSWOT-Med cruise used an adaptive and Lagrangian sampling strategy, determined from near-real time satellite observations analysis, combining in-situ shipborne measurements with drifters, gliders and Biogeochemical (BGC)-Argo floats, to achieve high spatial and temporal resolution measurements within the SWOT passages. Drifters combined with SWOT observations have been able to observe distinct features such as frontal zones, cyclones, anticyclones, and filaments. BGC-Argo floats collected measurements within an anticyclonic eddy and along a meander of the North Balearic front visible in SWOT images. Lastly, glider and Zooglider collected information at the edge and in the center of the anticyclonic eddy, with high resolution sampling.

Results and discussion
The combination of SWOT-HR maps and in-situ observations from autonomous platforms allowed us to explore the three-dimensional structure of the anticyclonic eddy including its temporal evolution and giving new insight about the physical and biogeochemical properties both at the edge and the center of the eddy. As revealed by gliders measurements, the anticyclonic eddy, located south of the front, was characterised by fresher, warmer, and less productive Atlantic Water, and exhibited a distinct horizontal gradient compared with waters north of the front. The BGC-Argo floats captured the changes of the phytoplankton biomass along the water column and its temporal evolution. In addition, such robotic platforms enable to characterize the 4D changes of particulate organic carbon at the boarder of the gyres. This study demonstrates the importance of performing a synergic approach combining unprecedented high resolution satellite observations from SWOT and autonomous platforms (BGC-Argo floats, gliders, and drifters) to unveil the bio-physical dynamics at fine scales both in space and time which are at the base of ocean ecosystem functioning.

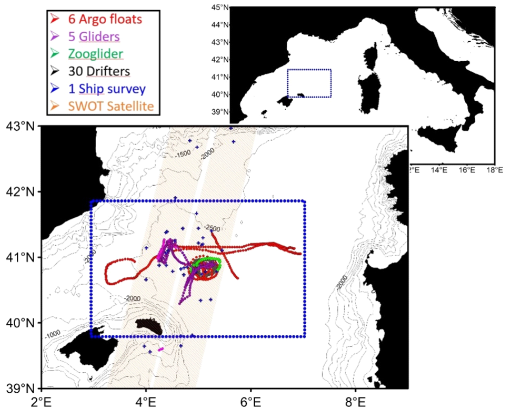

Fig. 1. Study area during the BIOSWAT-MED experiment, alongside with fixed ship survey (blue cross), glider (purple circle), BGC-Argo Float (red circle), drifter (black circle), zoo-glider (green circle) and SWOT swaths (orange area) in the Wester Mediterranean Sea.

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