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Study of fine-scale dynamics and their coupling with biogeochemistry - FUMSECK cruise

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FUMSECK (Facilities for Updating the Mediterranean Submesoscale - Ecosystem Coupling Knowledge) is a one-week cruise, which took place in spring 2019, in the gulf of Genoa (NW Mediterranean Sea), onboard the R/V *Téthys II*. It was conducted in preparation of the BioSWOT-Med cruise in the SW Mediterranean Sea in 2022, planned as part of the "Adopt a Cross Over" initiative organising simultaneous oceanographic cruises around the world during the SWOT fast sampling phase. During FUMSECK we tested various technological innovations for the study of fine-scale dynamics and their coupling with biogeochemistry.

By their interactions, the fine scales could induce some ageostrophic and tridimensional dynamics, which are a critical point for the understanding of the vertical exchanges and their effect on biogeochemistry. Therefore, the fine scales play a key role in the oceans global balance and, despite their low intensity, clearly impact processes such as nutrient vertical transfer and carbon export. However, their ephemeral nature complicates their in situ measurements, which are nevertheless essential for their understanding and for the confirmation of the models' prediction and the satellite observations. Furthermore, measuring vertical velocities in situ represents a real challenge since they are several orders of magnitude below the horizontal ones.

The FUMSECK cruise benefited from the automatic Lagrangian SPASSO treatment of the satellite data with an onshore team providing a daily bulletin of analysis and guidance on the fine-scale structures in the studied area. The distribution of phytoplankton functional groups at a small spatio-temporal scale was measured by automated flow cytometry with imaging. This technology allows to address the distribution of phytoplankton at fine scales within its hydrodynamic context. Several methods of measuring vertical velocities have been deployed, using different ADCP at fixed depth and in profile, FF-ADCP (Free Fall ADCP), the VVP (Vertical Velocities Profiler) prototype developed at MIO, and a SeaExplorer glider. These methods have shown promising results for in situ measurement of vertical velocities. Overall results show an abrupt change of population associated with a fine-scale structure appearance in relation with a storm event.

In addition, in order to study the physical part of the biological carbon pump, we experienced the release, following, pumping and detection by cytometry of a sample of biodegradable micro-particles that mimic the phytoplankton, and established a proof-of-concept for this method. Finally, we studied the MVP (Moving Vessel Profiler) instruments behaviour and reduced significantly a rotative effect.

We will describe the instrumental and analysis methodology deployed during FUMSECK in the study area of the Ligurian Sea, including the Northern Current, and present the results on the fine-scale dynamics and their impact on biology.