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Recent progress in the study of fine-scale physical-biological coupling in the Mediterranean Sea.

Roxane Tzortzis¹, Andrea M. Doglioli¹, Stéphanie Barrillon¹, Anne A. Petrenko¹, Francesco d'Ovidio², Llyod Izard¹, Melilotus Thyssen¹, Nagib Bhairy¹, Ananda Pascual³, Bàrbara Barceló-Llull³, Frédéric Cyr⁴, Marc Tedetti¹, Pierre Garreau⁵, Franck Dumas⁶, Lucie Bordois⁶, Caroline Comby¹, Louise Rousselet⁷, and Gérald Gregori¹

¹Aix Marseille Univ., Université de Toulon, CNRS, IRD, MIO, UM 110, 13288, Marseille, France.

²Sorbonne Université, CNRS, IRD, MNHN, Laboratoire d'Océanographie et du Climat : Expérimentations et Approches Numériques (LOCEAN-IPSL), Paris, France.

³IMEDEA (CSIC-UIB), Instituto Mediterraneo de Estudios Avanzados, Esporles, Spain.

⁴Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada, St. John's, NL, Canada.

⁵UMR 6523 CNRS, IFREMER, IRD, UBO, Laboratoire d'Océanographie Physique et Spatiale, Plouzané 29280, France.

⁶SHOM, Service Hydrographique et Océanographique de la Marine, 13 rue de Chatellier, CS592803, 29228 Brest, CEDEX 2, France.

⁷Scripps Institution of Oceanography, University of California, San Diego, CA, USA.

The fine scales are defined here as oceanic dynamical features (eddies, fronts and filaments) generally induced by mesoscale interactions and frontogenesis, and often associated with intense vertical exchanges. These processes are characterized by horizontal scales of 1–10 km with a relatively short lifetime of days/weeks to months. This temporal scale is similar to that of many biological processes, such as, phytoplankton growth, suggesting a physical and biological coupling. Numerical simulations and satellite observations have allowed the characterization of this regime highlighting the role played by these fine scales on structuring the phytoplankton community. To better understand this coupling mechanism, physical and biological in situ measurements are necessary. However, the observations of fine scales remains challenging due to the difficulties of sampling at high spatio-temporal frequency (~km ~daily).

Over the past few years, the Mediterranean Sea has become a lab for developing fine scale in situ strategies. Indeed, a series of campaigns using a satellite based adaptative and Lagrangian strategy coupled with a high-resolution physical-biological sampling, have been performed in order to follow and describe fine scale structures. Following this strategy, the PROTEVSMED-SWOT 2018 cruise has been led in the South of the Balearic Islands, with a particular attention to correlate the Lagrangian sampling with the temporal phytoplankton growth, in order to reconstruct the phytoplankton diurnal cycle. Multidisciplinary in situ sensors have allowed to identify a frontal area with a dynamic vertical circulation. Furthermore, the presence of two Atlantic waters, at different stages of mixing associated with various abundances of several phytoplankton groups, corroborated that fine scales must be dynamical barriers to transport, as previous modeling studies have proposed. In order to better understand fine scale mechanisms,

the Protevs Gibraltar cruise was performed in the Strait of Gibraltar in October 2020. This region of study is characterized by an important exchange of Mediterranean and Atlantic waters, and also by an intense circulation that generates energetic processes, which make it a favorable place for the formation of fine scale structures.

The new knowledge acquired with these studies paves the way to the future BIOSWOT-Med campaign planned for 2022 in the western Mediterranean Sea under the future SWOT satellite crossover tracks.