Geophysical Research Abstracts
Vol. 19, EGU2017-14839, 2017
EGU General Assembly 2017

Unravel the submesoscale dynamics of the phytoplanktonic community in the NW Mediterranean Sea by in situ observations: the 2015 OSCAHR cruise

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Submesoscale phenomena have been recently recognized as a key factor in physical-biological-biogeochemical interactions, even if it remains unclear how these processes affect the global state of the ocean. Significant large-scale impacts of submesoscale structures on primary production and influence on the phytoplankton community structure and diversity have also been reported. In the past decade submesoscale dynamics have been predominately studied through the analysis of numerical simulations. Observing the coupled physical and biogeochemical variability at this scale remains challenging due to the ephemeral nature of submesoscale structures. The in-situ study of such structures necessitates multidisciplinary approaches involving in situ observations, remote sensing and modeling. Last progresses in biogeochemical sensor development and advanced methodology including Lagrangian real-time adaptative strategies represent outstanding opportunities.

The OSCAHR (Observing Submesoscale Coupling At High Resolution) campaign has been conducted thanks to a multidisciplinary approach in order to improve the understanding of submesoscale processes. An ephemeral submesoscale structure was first identified in the Ligurian Sea in fall 2015 using both satellite and numerical modeling data before the campaign. Afterwards, advanced observing systems for the physical, biological and biogeochemical characterization of the sea surface layer at a high spatial and temporal frequency were deployed during a 10-days cruise. A MVP (Moving Vessel Profiler) was used to obtain high resolution CTD profiles associated to a new pumping system with 1-m vertical resolution. Moreover, along the ship track, in addition to the standard measurements of seawater surface samples (Chl-a, nutrients, O_2, SST, SSS . . .), we deployed an automated flow cytometer for near real-time characterization of phytoplankton functional groups (from micro-phytoplankton down to cyanobacteria).

The observed submesoscale feature presented a cyclonic structure with a relatively cold core surrounded by warmer waters. Six phytoplankton groups were identified across the structure with an unprecedented spatial and temporal resolution. According to our observations, we could quantify the influence of the fast established physical structure on the spatial distribution of the phytoplankton functional groups, giving coherence to the observed community structuration. Moreover, the high resolution of our observations allows us to estimate the growth rate of the main phytoplankton groups. Our innovative adaptative strategy with a multidisciplinary and transversal approach provides a deeper understanding of the marine biogeochemical dynamics through the first trophic levels.