Observing the ocean carbon export with biogeochemical Argo floats

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Description of the new technology and its importance for science and applications and E-AIMS experiment: Recent technological advances in biogeochemical sensors for autonomous platforms provide the opportunity to observe the chemical and biological elements of the marine ecosystem in a new and systematic way. Several low power sensors that can operate for numerous years are now available and already deployed on several Argo floats. Biogeochemical sensors for oxygen, nitrate, fluorescence, irradiance and others are now available and can serve as proxies for several important components of the biological ocean (e.g., chlorophyll, particulate ocean carbon (POC), turbidity, net community production, etc). Within the E-AIMS project, the performance and quality of these low-powered biogeochemical sensors will be studied over several years. Six Argo floats, equipped with additional biogeochemical sensors (oxygen, irradiance, fluorescence, and backscattering) have recently been deployed in three different geographic areas (Black Sea, Atlantic Ocean, and Nordic Seas). From these observations, we will, among other, investigate the dynamics of particles in the mesopelagic zone, phytoplankton blooms, vertical carbon flux, and the seasonal evolution of oxygen in the upper ocean layer.

Results: A biogeochemical Argo float equipped with an optical backscattering sensor measured during two years the seasonal carbon export of small particles in the Norwegian Sea (Fig.1). Both, particle backscattering and the estimated vertically integrated POC were minimal in January-February and began increasing within the upper productive layer at least a month before the shoaling of the mixed layer in spring (Fig. 2). Maximum values were reached during summer. In the mesopelagic layer the particle backscattering increased at deeper depths as the summer advanced. The vertically integrated POC increased as the mixed layer shoaled in the spring. Accumulation of POC then continued throughout the summer until the autumn when the deepening of the mixed layer marked the beginning of a relatively fast removal of POC from the entire water column. The seasonal net POC flux just below the productive layer was estimated to 6-7 $gCm^{-2}yr^{-1}$.

Conclusion: The seasonal carbon flux in the Norwegian Sea can be determined by optical backscattering sensors on Argo floats. During Summer and Autumn, integrated POC stocks of small particles in the mesopelagic layer were comparable to or greater than in the upper productive layer, and the shoaling of the mixed layer in the spring was important for exporting carbon. These findings support the use of autonomous platforms to detect changes in the carbon flux and improve our understanding of the biological carbon pump.

Figures:

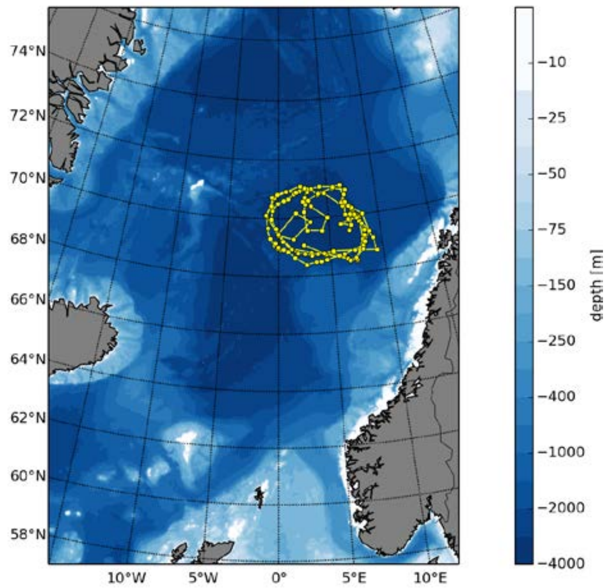

Fig. 1. Locations of the profiles from the Argo float in the Norwegian Sea with bathymetric map of the Nordic Seas.

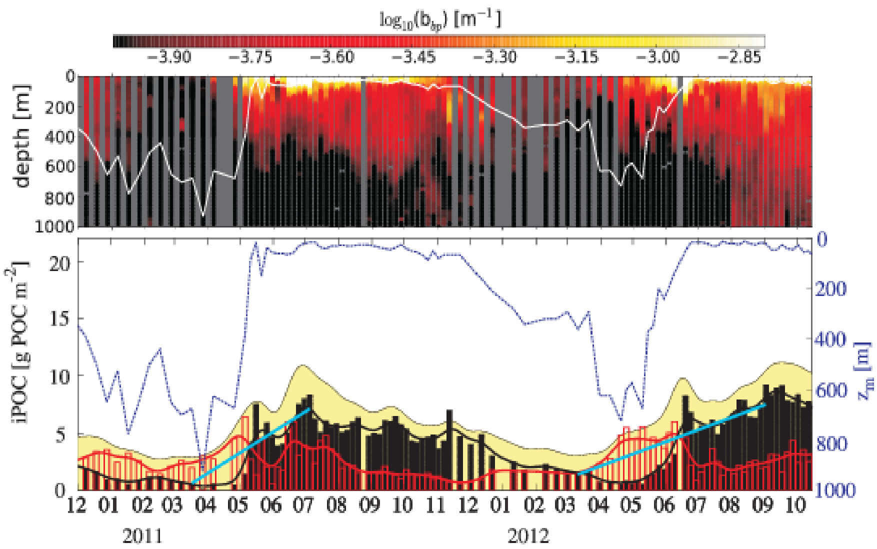

Fig. 2. a) Particulate backscattering (top figure). b) vertically-integrated POC stocks in the upper layer (red), mesopelagic layer (black), and in the upper 1000 m (yellow). Both unsmoothed (bars) and smoothed (lines) data are shown. The white (a) and blue (b) lines are the ML depths. The light blue lines are the seasonal net POC flux just below the productive layer (i.e., export production). From Dall´Olmo and Mork (2014).