# AN INTEGRATED STUDY OF THE EARLY-SPRING CARBON FLUX IN THE WESTERN MEDITERRANEAN SEA. RESULTS OF THE SESAME-IT4 CRUISE.

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## Abstract

The SESAME-IT4 cruise covered a large area of the Western Mediterranean Sea characterized by strong gradients. On the basis of satellite images and physico-chemical properties different regions were individuated. These regions showed also different biological populations. These data underline that DOC plays an important role in carbon fluxes in the Mediterranean Sea.

*Keywords: Carbon, Organic Matter, Western Mediterranean, Surface Waters, Nutrients*

The Western Mediterranean Sea is an area characterized by the strongest gradient observed in the whole basin. The analysis of the ten years climatological map of chlorophyll *a* shows that SESAME-IT4 survey covered regions characterized by very low Chl a concentrations exhibiting a sub-tropical regime (no bloom), as well as areas with maximum Chl-a concentrations (the Gulf of Lions), where intense blooms are observed [1]. The cruise was carried out in March-April 2008, which is the period characterized by the maximum biomass accumulation. Main goal of the survey was to get information on the functioning of different trophic systems in terms of biomass, nutrients, carbon accumulation and/or carbon export. Satellite images confirmed what we expected from the literature (high gradients and strong biomass accumulation). In particular the occurrence of strong variability and intense mesoscale activity was observed as well as an extended bloom in the northern part (> 40°N) of the study area. Another feature that emerged from satellite images is the occurrence of an anticyclonic eddy in the central part of the study area (S-IT4-008). In situ data evidenced that in the northern stations (>40 °N) water column was well mixed and the chimney of winter convection was still visible; in contrast in the southern stations, stratification was more pronounced. The evaluation of the residual nutrients confirmed that the bloom in the Gulf of Lions was still in progress.

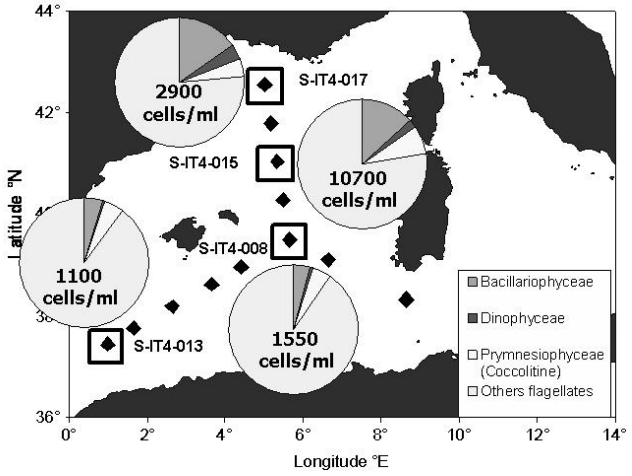


Fig. 1. Phytoplankton abundance and composition at the surface (5 m), superimposed to the map of sampling stations. The black diamonds indicate all the sampling stations (CTD, DOC, $O_2$, Nutrients), the black squares indicate the stations where biological parameters (phytoplankton, mesozooplankton, bacterial, abundance and composition) were also measured.

Phytoplankton abundance and composition showed that small flagellates dominated everywhere and that the composition was different between the northern and the southern stations with a higher percentage of diatoms (small non-colonial species) in S-IT4-0015 and S-IT4-017 (Fig. 1). In the microplankton fraction (cells> 20 µm) collected by net samples, Silicoflagellates dominated at S-IT4-017 and S-IT04-015, where the highest abundance of nanoplankton was also observed (Fig. 1). Mesozooplankton communities were numerically dominated by copepods in the whole area, but at S-IT4-015 salps also occurred with high abundance. These pelagic tunicates play an important role in C export, due to their high reproduction rates, efficient feeding on particles in a wide size-range, and production of large and fast sinking fecal pellets. The northern stations were also characterized by the highest bacterial abundance (14.1x $10^5$ cells $mL^{-1}$) about twice that found below 41 °N.

Tab. 1. Integrated average in the layer 0-100 m for $PO_4$, $NO_3$+$NO_2$, POC and DOC. The ratio C.N and C:P were calculated by using the integrated average.

| Station | $PO_4$ | $NO_3$+$NO_2$ | POC | POM | POM | DOC | DOM | DOM |
|---|---|---|---|---|---|---|---|---|
| | µM | µM | µM | C:N | C:P | µM | C:N | C:P |
| S-IT4-008 | 0.01 | 0.17 | 3.804 | 7 | 182 | 72 | 13 | 529 |
| S-IT4-013 | 0.15 | 3.61 | 2.971 | 8 | 209 | 54 | - | - |
| S-IT4-015 | 0.10 | 3.61 | 5.430 | 7 | 142 | 53 | 12 | 296 |
| S-IT4-017 | 0.10 | 3.70 | 4.634 | 6 | 106 | 55 | - | 306 |

Despite the marked difference in biomass, POC fluxes were 70 mg C $m^{-2}$ $d^{-1}$ in S-IT4-017 and 38 mg C $m^{-2}$ $d^{-1}$ in S-IT4-008. A large gradient was observed in DOC, with a minimum (49 mM) in areas with a well mixed water column, a maximum (72 µM) at S-IT4-008 and values of 53-55 µM at the other stations (Tab. 1). As it is very probable that DOC production was very high in the northern stations, the low values observed there can be explained to some extent by the mixing and by very fast consumption due to the production of labile material and/or to a high efficiency of microbial loop. One interesting feature is that the C:P ratio in both POM and DOM was clearly affected by the trophic regime: low C:P ratios were found where $PO_4$ was available, suggesting the occurrence of POM and DOM rich in P and hence a less extent of P recycle; in contrast, in conditions of P limitation (S-IT08), most of the P available in the POM and DOM was efficiently used, resulting in higher C:P ratio (Tab. 1). The S-IT4-08, shows a peculiar behavior: here the nutricline was located at 150 m and the highest DOC concentrations were found (72 µM). TS properties evidence the presence of a different water mass, likely isolated by surrounding waters by the anticyclonic circulation. The low nutrients concentrations, the low biomass, the high C:P ratios in both POM and DOM and the high DOC concentration, all indicate an advanced stage of seasonal cycle. The accumulated DOC plays an important role in carbon fluxes because it can be transported below the mixed layer when the thermocline breaks. A rough estimate of the relevance of such transfer suggests that, in the Mediterranean Sea, the role of DOC in C export is comparable to that of POC .

## References

1 - D'Ortenzio F. and Ribera d'Alcalà M., 2009. On the trophic regimes of the Mediterranean Sea: a satellite analysis. *Biogeosciences*. 6: 139-148.