BIOTIC VS. ABIOTIC PROCESSES SHAPING ORGANIC MATTER DYNAMICS IN THE NE AEGEAN FRONTAL SYSTEM

C. Zeri [1], A. Gogou [1]*, E. Pitta [1], C. Parinos [1] and A. P. Karageorgis [1]
[1] Hellenic Centre for Marine Research, Institute of Oceanography, Greece - agogou@hcmr.gr

Abstract
In the present study we discuss organic matter (OM) seasonal dynamics in coastal shelf waters of the Dardanelles Straits – North Aegean Sea frontal area. Our main goal was to understand organic matter dynamics taking into account the particle size continuum. We traced the particulate organic matter using inherent optical properties (IOPs), the macromolecular organic carbon fractions by measuring TEPs (Transparent Exopolymer Particles) and the dissolved organic matter using absorbance and fluorescence properties (CDOM). For the latter we used also the indices of absorption spectral slope S275-295 and the fluorescence ratio HIX (i.e. the ratio of the emission spectrum areas between 300-345nm and 435-480nm at 254nm excitation wavelength).

Keywords: Organic matter, Phytoplankton, Sedimentation, Fronts, Aegean Sea

The North Aegean Sea is a highly dynamic coastal area of the eastern Mediterranean Sea, where the low salinity, rich in dissolved organic matter (DOM) Black Sea Waters (BSW) mix with the highly saline and poor in DOM oligotrophic Levantine Waters (LW). In addition, the eutrophic environment of the Marmara Sea, with elevated rates of both primary and bacterial production is known to enrich the incoming BSW with particulate organic matter [1]. At the same time the NE Aegean Sea represents a shelf environment where particle dynamics and in situ processes should be taken into consideration. The study of OM in this environment is of particular importance since it represents the area where highly eutrophic continental waters are transferred to the oligotrophic Mediterranean Sea. Within the framework of the AegeanMarTech project we studied a north south transect from 39.6 oS to 40. 3 oN and from 25.4 oW to 25.7 oE (Figure 1) during October 2013, March 2014 and July 2014. The topography of this region includes the Limnos plateau, a shallow area (<100m) located east of Limnos isl., as well as the Limnos deep basin (~1600m) located between Limnos and Samothraki islands. A strong stratification of the water column (upper 30-40m) throughout the study area, caused by the increased outflow rates of brackish BSW and the higher surface temperatures was evident in October 2013 and July 2014. In addition, during these months, the prevailing strong NE winds (Etesians) spread the surface brackish layer towards the south. In March 2014, BSW waters were confined to the north part of the section and a less pronounced stratification was observed, favored by the lower surface temperatures and the limited Dardanelles outflow during winter. The frontal zone was confined between stations 5 and 6. The northern part of the sampled section is clearly affected by the presence of the Samothraki anticyclone. According to the spatial distribution of the backscattering ratio and the bulk particulate refractive index three water layers could be identified, associated with different particle composition: (a) BSW (~0-30 m) appears to be dominated by material with moderate index of refraction 1.141-1.159; (b) mid-waters (30-65 m) characterized by maximum fluorescence and lower index of refraction (1.120-1.135); and (c) the near-bottom layer which exhibits high n, up to 1.26. During March and July 2014 fluorometric chlorophyll-a concentrations indicate a period of enhanced productivity. TEP concentrations distribution is positively associated to diatoms distribution with high concentrations being recorded into surface waters of Black Sea origin. During March 2014 the elevated TEP concentrations in the top 100 m of the water column in station 2 is probably related to the high levels of extracellular release observed for this station [2]. During stratified conditions (October 2013 and July 2014) TEP distribution patterns in the subsurface layer, display relatively lower values (around 50 m depth), the lowest observed for October 2013. The spatiotemporal variability in the hydrography was depicted in CDOM distribution. Highest CDOM were always associated with low salinity waters. Nevertheless the three campaigns conducted during the present study allowed us to trace several in situ transformations of DOM taking place. A strong conservative character and coupling was established only during March 2014. It becomes clear that all BSW samples fall to the high a300 –low S275-295 terrestrial pool, and all LW samples to the low a300 – high S275-295 marine pool. The inflowing waters are rich in CDOM of high molecular weight and of aromatic character and mix with Levantine waters poor in DOC and CDOM of low molecular weight. During the summer months, the decrease in the CDOM absorption coefficient at 300nm observed for the surface layer during summer and autumn and the parallel increase in the spectral slope S275-295 is indicative of photodegradation processes [3]. Under the strong pycnocline conditions and the limited exchange between the two water layers during summer and autumn, it is expected that the subsurface LW waters (S>38) retain their optical properties i.e. low a300, high S275-295. Instead, our results showed low a300, but also low S275-295values. This could be due to impacts of microbial processes [3], but it could also be due to the influence of particles and sedimentary processes. Under stratified conditions, the Samothraki anticyclone is expected to be attenuated and particle export becomes less intense. We suspect that macromolecular compounds that otherwise will tend to flocculate and adsorb onto particles now remain in solution and may explain the decrease in S275-295 values. This is in accordance with the TEPs distribution discussed previously, and shows that when the vortex effect is attenuated the macromolecular compounds do not coagulate and can be traced in the dissolved rather than the particulate fraction (TEPs are filter retained macromolecules). Another feature, which differentiates bottom waters under stratified conditions, is the existence of different sources of OM at the Limnos plateau, as inferred by the relatively high HIX values, i.e. relatively increased visible fluorescence. Resuspension of sediments has been recorded for the October 2013 and July 2014 samplings at the Limnos plateau exactly at the same sites were HIX was found elevated as traced by the bulk refractive index n. Moreover, the generation and release of visible fluorescent FDOM from sediments has been reported [4] and provides strong evidence that the site specific increases observed in the visible fluorescent CDOM are linked to sedimentary organic material.

References

1 - Polat, S.C., Tugrul, S., 1995. Nutrient and carbon exchanges between the Black and Marmara Seas through the Bosporus Strait. Continental Shelf Research, 15(9), 1115-1132.
2 - Lagaria A., Mandalakis M., Mara P., Frangoulis C., Karatsolis B-Th., Pitta P., Triantaphyllou M., Tsiola A., Psarra S., 2016, Phytoplankton dynamics and community structure in relation to hydrographic features in the NE Aegean frontal area (NE Mediterranean). Submitted to Continental Shelf Research.
3 - Helms, J.R., Stubbins, A., Ritchie, J.D., Minor, E. C., Kieber, D.J., Mopper K., 2008. Absorption spectral slopes and slope ratios as indicators of molecular weight, source and photobleaching of chromophoric dissolved organic matter. Limnology and Oceanography, 53 (3), 955-969.
4 - Skoog, A., Wedborg, M., Fogelqvist, E., 1996. Photobleaching of fluorescence and organic carbon concentration in a coastal environment. Marine Chemistry, 55, 333-345.