DOM STOICHIOMETRY IN THE MARMARA SEA DURING SEPTEMBER 2008

C. Zeri [1]*, S. Besiktepe [2], A. Pavlidou [1], A. Giannakourou [1] and E. Krasakopoulou [1]
[1] Institute of Oceanograqphy, Hellenic Centre for Marine Research - chris@ath.hcmr.gr
[2] NATO Undersea Research Centre, La Spezia, Italy

Abstract

Dissolved organic carbon, nitrogen and phosphorus (DOC, DON, DOP) were measured in the Marmara Sea, the Dardanelles Straits and the adjacent North Aegean Sea, during September 2008. Additionally, surface waters at selected stations of the Marmara Sea were sampled for bacterial production (BP) and bacterial respiration (BR). The analysis and coupling of chemical and biological data showed that at least during September 2008 newly produced surface dissolved organic matter (DOM) was consumed in the Marmara Sea in times scales shorter than the surface water residence time and that the outflowing waters from the Dardanelles carry DOM of more refractory nature.

Keywords: Aegean Sea, Marmara Sea, Nutrients, Organic Matter

Introduction

The purpose of our study is to present new data on DOC, DON, DOP for the study system and investigate the processes which control their distribution. Also, we focus on the impact of the Dardanelles outflow on the North Aegean trophic status.

Results - Discussion

The Marmara Sea is a two layer counterflow system extensively studied in terms of its hydrography ([1] and references therein) but to a lesser extent in terms of its chemistry [2], [3].Taking into consideration this specific flow regime we present our results in Table I.

Tab. 1. DOC, DON, DOP concentrations (μmol L^{-1}) and ratios in the studied area.

	North Aegean	Dardanelles Straits	Marmara Sea
overflow	σ_θ<28.8	σ_θ<22.4	σ_θ<22.4
DOC	80 ± 15	165 ± 31	172 ± 37
DON	3.97 ± 0.97	6.54 ± 2.55	8.22 ± 0.85
DOP	0.11 ± 0.01	0.19 ± 0.06	0.14 ± 0.07
DOC:DON:DOP	*704:35:1*	*719:33:1*	*1618:73:1*
	n=12	*n=3*	*n=14*
underflow	σ_θ>28.9	σ_θ>28.3	σ_θ>28.3
DOC	63 ± 6	65 ± 2	62 ± 8
DON	3.18 ± 0.34	3.86 ± 0.520	3.60 ± 1.17
DOP	0.11 ± 0.02	0.15 ± 0.04	0.19 ± 0.09
DOC:DON:DOP	*517:29:1*	*440:26:1*	*426:23:1*
	n=12	*n=5*	*n=42*

DOM in the overflow shows a 2-fold decrease in its DOC and DON content while DOP remains constant. DOM in the underflow shows stable DOC, DON, DOP concentrations. DOM stoichiometric ratios shown in Table I are indicative of the presence of considerable amounts of refractory material. The refractory character is more pronounced in the surface low salinity waters. In order to clarify to what extent the concentrations observed in the Marmara Sea reflect merely the mixing of rich in DOM low salinity Black Sea waters with poor in DOM high salinity N. Aegean waters, we plotted our DOC results along the mixing line of the two end members (Figure 1).

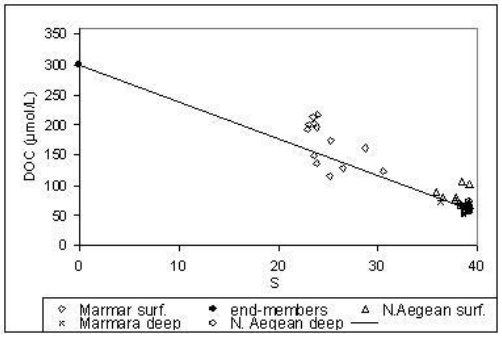

Fig. 1. Figure 1. Mixing line of low salinity high DOC BS waters with high salinity low DOC Aegean waters.

It was shown that in situ DOC production is also taking place in surface waters of the Marmara Sea. Deep waters of the Marmara and the N. Aegean Seas lie very close to the Aegean end member with a very good fit. Surface Aegean waters also show a good fit to the mixing line with the exception of 2 points indicative of an extra DOC source. In systems such as the Marmara Sea with strong influence of terrestrial inputs and freshly produced organic material, it is very difficult to distinguish between refractory and labile forms of DOM. The two layer counter flow and the limited vertical mixing in the Marmara Sea does not allow us to consider bottom water DOC concentration as the refractory one, as it has been proposed for the open ocean. Therefore, in an attempt to get an estimate of DOM lability in the overflowing waters we considered that DOM found there is similar in nature as in surface waters of the Black Sea. In fact the similar nature of POM between the Black and Marmara seas has been reported [4]. The labile+semilabile component in surface waters of the Black Sea has been estimated to be 41% of bulk DOC and 50% of bulk DON [5]. Based on these percentages we calculated the amount of excess DOC and DON in the upper layer of the Marmara Sea and found 71 μmol/L for DOC and 4.1 μmol/L. DOC:DON ratio in this labile+semilabile material is 17.2, a value indicative of relatively fresher material compared to the DOC:DON ratio of the remaining refractory DOM (24.9). Mean depth integrated BP measured in Marmara surface waters was 1.25 μmolC/m^3/h, and BR 0.7 μmol O_2/L/h. Based on these data we calculated the bacterial carbon demand (BCD) and found that 15 μmol C/m^3/h are consumed by the bacterial community. Since the source of this carbon is the labile+semilabile component of DOM, then the time needed for the bacterial community to consume this DOM was found to be ~30 days. This time is less than the mean residence time of surface waters (~ 4 months) in the Marmara Sea before they reach the N. Aegean [1], and implies that at least during September 2008 outflowing waters from the Dardanelles Straits carry DOM of more refractory nature. This is in accordance with the generally low BP values observed in the southern exit of the Dardanelles (0.25 μmolC/m^3/h, present study) and in the N.Aegean (0.21-0.41 μmolC/m^3/h) during the same period (Giannakourou unpublished data).

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