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Effects of intense physical and biological forcing factors on CNP pools in coastal waters (Gulf of Trieste, Northern Adriatic Sea)

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ABSTRACT

To obtain more insight into the effects of severe forcing factors on a shallow coastal system, the elemental stoichiometry and the availability and partition of nitrogen, phosphorus and carbon in dissolved and particulate pools were assessed during events of particularly strong inputs of freshwater, high salinity anomalies, wind storms, algal blooms and elevated heterotrophic respiration processes. The research is based on data collected in the Long Term Ecological Research station of the Northern Adriatic Sea (Gulf of Trieste), from January 1999 to December 2010. During all considered events, stoichiometric ratios were higher than Redfield, due to an excess of carbon and nitrogen in relation to phosphorus. The particularly intense meteorological and biological events considered in this study altered the abundance, the relative availabilities of C, N and P and the stoichiometric ratios in different directions. Freshwater inputs and phytoplankton blooms caused a rise in the ratio between dissolved organic carbon and phosphorus, in N:P and C:P in the particulate compartment and, in the case of high freshwater only, in dissolved inorganic N:P, while the opposite was observed during events dominated by ingression of south-eastern waters and heterotrophic processes, when stoichiometric ratios decreased. Strong wind events, which are mainly due to north-easterly winds, did not seem to significantly modify the biogeochemical properties in the bottom layer.

1. Introduction

In shallow coastal areas, biogeochemical nutrient cycles result from the concurrence of different forcing factors such as the general circulation, alternation between summer stratification and winter mixing, weather conditions, river discharge, diffuse and point-source continental inputs, sediment–water interactions and several biological processes.

In recent years, several articles have described the overall dynamics of nutrients and dissolved and particulate matter in the northernmost part of the Adriatic, the Gulf of Trieste (Solidoro et al., 2007; De Vittor et al., 2008; Lipizer et al., 2011). The findings of these papers show that this gulf is strongly influenced by river inputs, by ingression of the oligotrophic Eastern Adriatic Current (EAC) and by biological processes, which all influence the partitioning of dissolved and particulate matter and are responsible for large inter-annual and short-term variability.

In temperate coastal zones, episodic meteorological forcing such as heavy rainfalls and wind storms may cause abrupt disturbances, which can be similar to or larger than seasonal variability (e.g. Duarte et al., 1999; Nogueira et al., 2000; Ulses et al., 2008) and which have a strong impact on biogeochemical properties and planktonic ecosystem dynamics (e.g. Malej et al., 1997; Boldrin et al., 2009; Guadayol et al., 2009). Strong episodic rainfall events may also have severe consequences on the continental runoff and on river discharge patterns, abruptly altering terrestrial nutrient and particulate loads, water column turbidity, light penetration and particle sedimentation, which can deeply modify the biogeochemistry and the planktonic production of shallow coastal areas. In addition, large and abrupt discharges of freshwater modify surface circulation and can determine conditions of strong vertical haline stratification, which limits oxygenation of the deeper layer. In contrast, wind storms enhance vertical mixing, promoting oxygenation of the deeper layer. Together with the intensification of bottom currents and wave-driven sediment resuspension, wind storms may determine the release of dissolved matter stored in the benthic compartment, nutrient and particulate matter enrichment

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