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Avaliação de ciclos biogeoquímicos (C, Si, N e P) e fluxos de partículas em uma estação fixa no sistema estuarino de Cananéia-Iguape (São Paulo, Brasil)

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Resumo

Este trabalho teve como objetivo avaliar os ciclos biogeoquímicos (C, Si, N e P) em uma estação fixa no sistema estuarino de Cananéia-Iguape, verificando interações entre processos físicos e biogeoquímicos e fluxos de partículas, que foram quantificados através de um cilíndrico *Sediment Trap*. Os resultados levantaram relações entre fluxos de partículas e flutuações de nutrientes, revelando-se uma metodologia importante para verificar os nutrientes limitantes e os fluxos de carbono em coluna de água de estuários.
Palavras-Chave: Ciclos Biogeoquímicos; Nutrientes; Sediment Trap; Estuário

Biogeochemical cycles (C, Si, N, and P) and particle fluxes assessment in a fixed station in the Cananéia-Iguape estuarine system (São Paulo, Brazil)

Abstract

This study aimed to evaluate biogeochemical cycles (C, Si, N, and P) in a fixed station in the Cananéia-Iguape estuarine system, verifying interactions among physical and biogeochemical processes, and particle fluxes, which was measured by a cylindrical sediment trap. The result interpretation raised relationships between particle fluxes and nutrient fluctuation, what can be an important data both to reveal the limiting nutrient and the carbon fluxes at estuary water column.
Key-words: Biogeochemical Cycles; Nutrients; Sediment trap; Estuary

Introduction

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The magnitude variability of particle fluxes has been evaluated in different estuaries all over the world through the use of sediment traps. [6]. The southern region of the Cananéia-Iguape estuarine system is not impacted by any significant human activity, where the low nutrient level is a suitable reference to evaluate the eutrophication processes in Brazilian subtropical estuaries [1]. Under this context, the present study aimed to evaluate "natural" biogeochemical cycles (C, Si, N, and P) in a fixed station in the Cananéia sea (Fig. 1) with focus on the estuarine ecology at the water column, observing interactions among physical and biogeochemical processes, and particle fluxes.

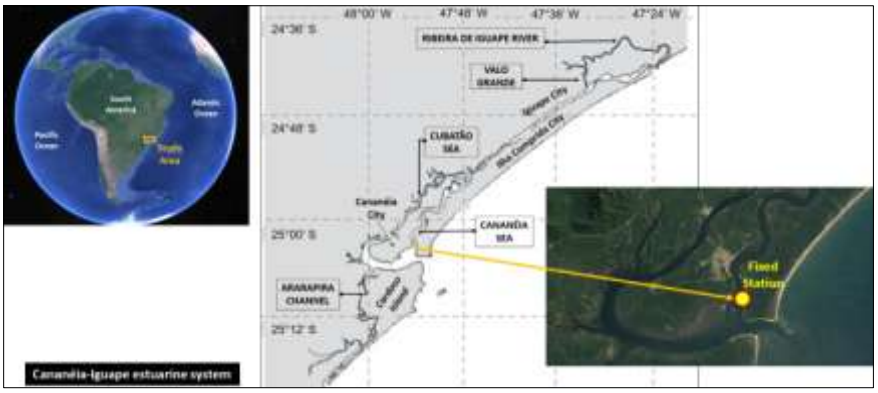


Figure 1. Sampling fixed station at the Cananeia sea (southern of the Cananéia-Iguape estuarine system).

Materials and Methods

The water samples were taken in two depths (0 and 5 m) at 9 sampling moments of a spring tide cycle, covering the flood tide at 5 sampling moments (08:30 - 09:22 - 10:15 - 11:23 - 12:10) and the ebb tide at 4 moments (12:43 - 14:39 - 15:33 - 16:34). Meanwhile, the sediment trap was established in operation from 10:00 to 14:00, covering a low hydrodynamic period within the tide transition (flood → ebb) (Fig. 2). Secchi Disc was used initially to position the sediment trap at the limit between photic and dark zone. Volumes obtained from water samples were used to determine the fowling parameters: temperature, salinity, pH, dissolved oxygen (DO) [3], dissolved inorganic nutrients [3], urea, phaeopigments (Phaeo) and chlorophyll-a (Chl-a) [7], and suspend particulate material (SPM) [7]. Under this gravimetric method, it also was obtained the particulate organic matter (POM) values after burning in a muffle furnace.

The sediment trap presents four cylindrical bottles (Fig. 2), of which two were used for photosynthetic pigments analysis and the others two for the suspend material determination (Fig. 2). Thus, the total mass (SPM_{Flux}, POM_{Flux}, $Chl\text{-}a_{Flux}$, and $Phaeo_{Flux}$) fluxes were calculated as follows: $Flux = \alpha / (A*\gamma)$. The α represents the total masses obtained through the filtered volume at each cylinder; A is the area of the cylinder ($0.60*0.006 = 0.28\ m^2$); and γ represents the exposure time (2 hours) at the water column.

Results and Discussion

Overall, the sampling day presented weak surface winds, and the water temperature reached values pertinent to the autumn seasons in Brazilian subtropical coast [1]. In spite of the low range, the surface water (0 m) temperature answered to the insolation increase during the sampling day, with the highest values coinciding with the highest air temperature values (Fig.2). It is important to note that the majority of the sampling moments presented dissolved oxygen (DO) and chlorophyll-a values higher at 0

m than at 5 m, evidencing the photosynthetic activity as influential for the high % DO saturation levels.

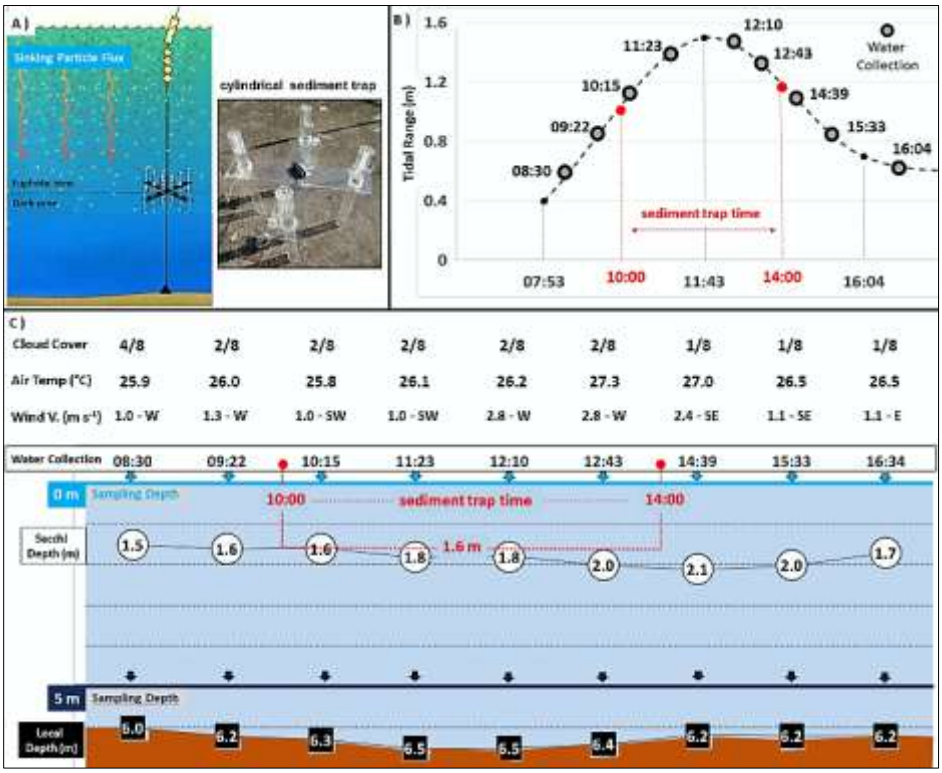


Figure 2. A) The operating mode layout of the cylindrical sediment trap adopted for this study. B) Water collection moments and sediment trap time within a spring tidal range. C) Parameters measured on board at each water collection moment.

The salinity line graphic showed a relative freshwater influence on the studied estuarine zone at 8:30, and posteriorly it was possible to note a weak haline stratification presence in function of the low salinity difference between the evaluated layers (0 and 5m) (Fig. 3). This aspect may have contributed to the SPM values higher at the deep water (5 m) than surface water (0 m), possibly due to the sediment resuspension by the deep flood tide current (saline intrusion). However, based on the sediment trap data (high particle sinking rate and high phytoplankton biomass) and on the low hydrodynamic over its operation time, it is possible to presume that a high biological activity initiated the particle sinking into the euphotic zone (between 0 and 1.6 m), thereby contributing considerably to the higher SPM values found at 5 m. Due to its significant presence into the terrestrial crust (aluminum-silicate), the silicate is normally the macronutrient most abundant in coastal waters, presenting a conservative behavior and thus suffering dilution by saline water toward the adjacent sea. This theory explains the highest silicate concentration in surface water at the same time in that was observed the lowest salinity value (Fig. 3).

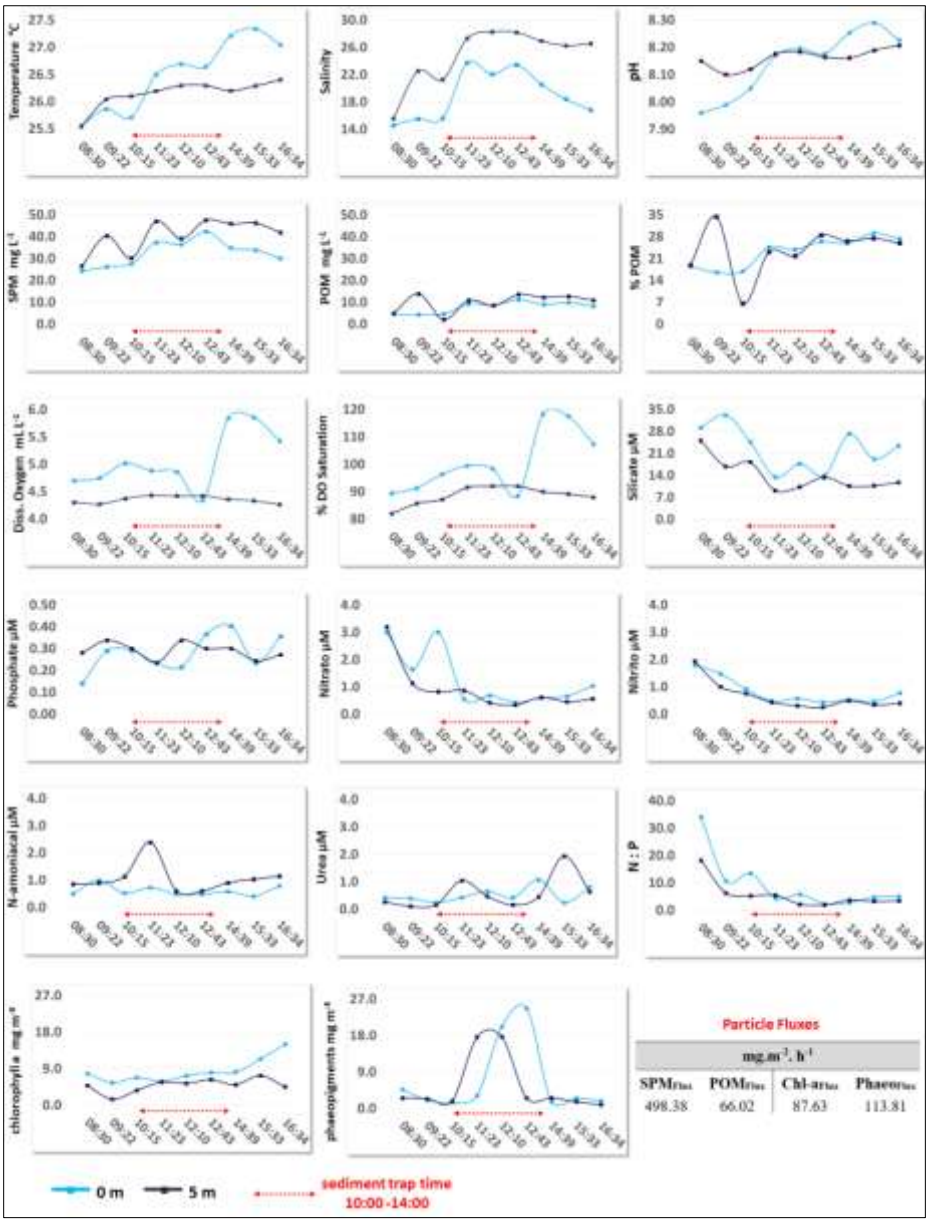


Figure 3. Parameters taken from the water samples and particle fluxes calculated by sediment trap data.

On the other hand, both N and P can act as limiting agents for the primary producers in estuarine systems [4]. Regarding the high N:P ratios (Fig. 3), it is possible to note that the phosphate was closer to act as the limiting nutrient than the nitrogenous forms, possibly due to the high presence of SPM. In Pearl River Estuary (Chinese subtropical coast), the river discharge input established the water column stratification, favoring the settlement of SPM and enhancing light levels and, consequently, promoting the phytoplankton growth, which was responsible for a phosphate drawdown of 0.56 ± 0.42 µM at surface water [3]. In turn, the urea concentration peak at 15:33 at 5 m probably indicated the plankton excretion (from both the zoo and phyto), thereby

suggesting that these microorganisms contributed for the POM_{flux} hours ago. The high %POM peak at 9:22 on the bottom supports this hypothesis. Within the sediment trap operation time, the high Phaeo:Chl-a ratio found both in the water samples and in the sediment trap indicated that mangrove structures in decomposition also contributed for the POM_{flux} value. In this case, must be assumed that a part of vegetable cells (Chl-a) captured by sediment trap lost their photosynthetic activity during the exposure time, thereby contributing to the phaeopigments values.

Conclusion

Overall, the interpretation of the combined results between the parameters obtained from water samples and sediment trap revealed to be an important methodology for studies that relate ecological aspects with the physical and biogeochemical processes in estuarine systems. This study raised relationships between particle fluxes and nutrient fluctuation, what can be an important data both to reveal the limiting nutrient and the vertical carbon fluxes in estuaries.

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