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Research note

Seasonal changes in particulate biogenic and lithogenic silica in the upwelling system off Concepción (~36°S), Chile, and their relationship to fluctuations in marine productivity and continental input

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ABSTRACT

We analyzed the temporal and vertical distribution of biogenic (BSi) and lithogenic (LSi) silica, and diatom abundance in the upwelling center off Concepción, Chile, from April 2004 to May 2005. Measurements were performed at the FONDAP COPAS Time Series Station 18 (36°30.8′S, 73°07.7′W; 88 m water depth), and were combined with primary production estimates and river runoff data to assess the relationships between water column BSi and primary production, and between LSi and river runoff. Throughout the sampling period, water-column-integrated (0–80 m) BSi averaged 252 ± 287 mmol m^{-2}, and was about six times higher than average LSi (44 ± 30 mmol m^{-2}). The highest water column BSi observed during the upwelling season (786 ± 281 mmol m^{-2}) coincided with increments in total diatom abundance, and high integrated chlorophyll *a* concentration and primary production. In contrast, LSi was nearly two times higher in winter (85 ± 43 mmol m^{-2}) than the annual average, in agreement with the period of substantial discharges from the Itata and Bio-Bio rivers. The observed temporal patterns in BSi and LSi are coincident with primary production-related factors and riverine outflow, respectively, suggesting that the BSi and LSi pools are separate. With respect to the vertical distribution in the water column, most of the BSi and diatoms were found in surface waters (0–30 m depth), whereas LSi was most abundant at depth. Our study attempts to make an inventory of both BSi and LSi in the water column off Concepción, and gives the present-day background information necessary to assess potential future changes in the hydrological cycle that, in turn, may induce modifications in the Si path from the watersheds to the ocean.

1. Introduction

It is well known that human activity has resulted in an increase of nitrogen (N) and phosphorus (P) delivery to the coastal ocean. The additional N and P change the Si:N and Si:P ratios, thus modifying the silicon biogeochemical cycle of the receiving water bodies, leading to severe ecosystem changes (e.g. see review in Conley et al., 1993; Humborg et al., 1997; Ittekkot et al., 2006). In order to fully understand these modifications to the Si path from the watersheds to the ocean, an accurate knowledge of biogenic silica (BSi) concentration, production, and dissolution is necessary. However, such assessments can be obscured by the occurrence of significant quantities of silicate minerals in the coastal ocean (Ragueneau and Tréguer, 1994).

Rivers are not only responsible for ~80% of the dissolved silica (DSi) entering the global ocean (Tréguer et al., 1995), but have also been shown (Conley, 1997) to carry particulate Si, both lithogenic (composed of quartz particles, aluminosilicates, and other minerals) and biogenic (freshwater diatoms, phytoliths) that can play a significant role as a source of Si for coastal diatoms (see review in Ragueneau et al., 2006). Conley (1997) estimated that 16% of the gross riverine Si load is delivered to the world ocean as BSi, especially during periods of high discharge.

Suspended particulate BSi in the water column of oceans, rivers, and lakes derives from different biological components (e.g. diatoms, silicoflagellates, radiolarians, chrysophyte cyst phytoliths of higher plants), which take up $Si(OH)_4$ from water to build their skeletons (e.g. Brümmer, 2003) and, as such, has been used to

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