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Surface circulation patterns and the pathways of sea surface carbon dioxide (CO_2) off northern Chile (~27.5° S) between 30 and 10 kyr BP: global and/or local forcing?

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Abstract

We present a reconstruction of past changes in partial pressure of CO_2 (pCO_2) from northern Chile (~27° S), between 10 and 30 kyr BP, based on carbon isotope composition of $C_{37:2}$-alkenone. The high-pCO_2 during the entire time series indicates that northern Chile upwelling system has been a permanent source of CO_2 to the atmosphere. The multiproxy reconstruction suggests that the CO_2 outgassing and sequestration pathways were modulated by local and global mechanisms. During global glacial conditions, an enhanced coastal upwelling forcing resulted in high-availability of deep water macronutrients and a CO_2-supersaturated water column, which combined with high-inputs of iron from the continent, intensified the carbon sequestration pathway of the biological pump, through diatom biomass export. During the deglacial, a decrease in the upwelling forcing, an increment in water column stability and reduced continental inputs of iron are consistent with a larger role of calcifying organisms in the plankton assemblage in terms of carbon sequestration pathway through the carbonate system.

1 Introduction

Coastal upwelling areas are often described as intense sources of CO_2 and macronutrients (e.g., Borges et al., 2005). The CO_2-supersaturated and high-macronutrient concentration of upwelled waters stimulate intense blooms of phytoplankton that sequester inorganic carbon thus reducing the outgassing of CO_2 (e.g., Simpson and Zirino, 1980).

Large parts of the ocean have been described as High-Nutrient/Low-Chlorophyll (HNLC) areas, where phytoplankton growth is limited by the availability of iron (e.g., Martin, 1990; de Baar and Boyd, 2000; Bruland et al., 2005). Experimental evidence suggests that the availability of dissolved iron permits the rapid interception of upwelled CO_2 by phytoplankton in oceanic (e.g., Bakker et al., 2001) and coastal waters (Torres

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