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Nonlinear climate forcing of deep-circulation off northern Chile (25ºS) during the last 1 Myr: evidence from stable carbon and oxygen isotopes of planktic and benthic foraminifers

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We use stable carbon isotope records measured on planktic and benthic foraminifers and their difference (13Cp, 13Cb, Δ13Cp-b) and stable oxygen isotopes of benthic foraminifers (18O), to identify and describe the temporal changes of nutrient content, circulation and ice volume off northern Chile at $\sim$25ºS during the last 1 Myr, thus providing a quantitative estimate of Milankovitch-scale variability in the properties of surface and deep-water masses of the Humboldt Current System (HCS). The time-series methods applied (Wavelet, Fourier and Maximum Entropy Method) on both 13C and 18O records allow us to show multiple peaks (80-120, 30-60 and 15-30 kyrs) related to the Non-linear effects on the Milankovitch orbital cycles of eccentricity (E), obliquity (T) and precession (P), respectively. Among the main Non-linear mechanisms invoked AABW production off New Zealand and latitudinal shifts of the ACC/PCC and the westerlies are the main driving-mechanism of deep (PDW) and surface waters changes off Chile during glacial/interglacial periods and long-term variability along the Pleistocene. The Δ13Cp-b suggest decreasing deep Pacific Ocean inflow from MIS 22 to MIS 11 (with highest values between MIS 13 and 11), and increasing ventilation (AABW formation) from 600 kyr up to the present. AABW production rate might be linked to the magnitude of the Ekman transport driven by winds at the latitude of Drake Passage. As the position of this coupled system (ACC/PCC) is controlled by the location of both the sub-polar low-pressure belt around Antarctica and the southeast Pacific high-pressure system in the tropics, climate changes are under the influence of forcing mechanisms originating in both the high- and low-latitudes.