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Impact of climate warming on the coastal upwelling system and primary production off Portugal: lipid biomarkers signatures perspective

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The Iberian Margin is a climate-sensitive area impacted by wind-driven coastal upwelling, and so, part of the productive Eastern Boundary Upwelling Systems (EBUS). EBUS are crucial for climate control, nutrient supply, and the marine food chain. Still, their inherent natural variability and the uncertainties in future ocean dynamics pose significant challenges in projecting EBUS response to climate change and coupled impacts on primary production and marine ecosystem functions and resources [1]. Efforts have been made to understand the climate variability and the response of marine ecosystems to environmental change in the Iberian Margin, in particular, using microfossil assemblages preserved in the sedimentary record [e.g., 2-6], but also through organic biomarkers and SST-derived reconstructions [7]. However, the effects of warming on total primary production are still unclear. Here we present a high-resolution reconstruction of the primary production conditions over the past millennium derived from sediment-preserved lipids commonly applied as proxies for different phytoplankton groups [8, 9] on core PO287-06-2G (off Douro River / NE Portugal). Lipid compounds were determined by GC-MS/FID. Lipids of marine origin (C27, C28, and C30 sterols, short-chain n-alcohols, phytol, and C37 and C38 alkenones) were summed up and normalized to total lipids (sum of all 64 quantified lipids from several sources) to address major marine primary production variation (Fig.1). As proxies for specific phytoplankton groups, we used: 4α-23,24-trimethyl-5α-cholest-22(E)-en-3β-ol (30d22 sterol) for dinoflagellates, 24-methylcholesta-5,24(28)-dien-3β-ol (28d5,28(24) sterol) for diatoms and 8E,15E,22E-heptatriaconta-8,15,22-trien-2-one (C37:3 alkenone) for coccolithophores. Preliminary results reveal an alternation between coccolithophores and dinoflagellates lipid signatures as dominant over time with significant diatoms sterol signature in specific periods (Fig.2). This variability is most likely determined by alterations in hemispheric ocean circulation and coastal upwelling conditions [2].

References: [1] IPCC, 2019 (https://www.ipcc.ch/srocc/); [2] Abrantes et al., 2017 (doi.org/10.5194/cp-13-1901-2017); [3] Abrantes et al., 2011 (doi.org/10.3354/cr01010); [4] Salgueiro et al, 2008 (doi.org/10.1016/j.marmicro.2007.09.003); [5] Ribeiro and Amorim 2008 (doi.org/10.1016/j.marmicro.2008.01.013); [6] Abrantes 2000 (doi.org/10.1016/S0012-821X(99)00312-X); [7] Rodrigues et al., 2009 (doi.org/10.1029/2008GC002367), [8] Sicre, et al., 1993 (doi.org/10.1016/0304-4203(93)90246-K); [9] Volkman et al and others compiled in Volkman 2006 (doi.org/10.1007/698_2_002).

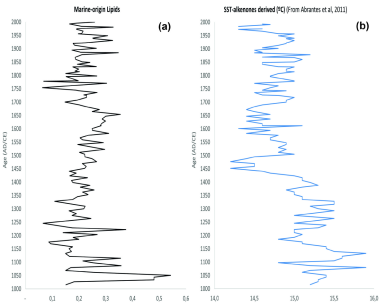

Fig. 1. (a) Primary production reconstruction through the marine-origin lipids normalized to total lipids and (b) the Sea Surface Temperature (SST) derived from alkenones over the last millennia in PO287-06-G core (off Douro River / NE Portugal). SST data from Abrantes et al. (2011) [3].

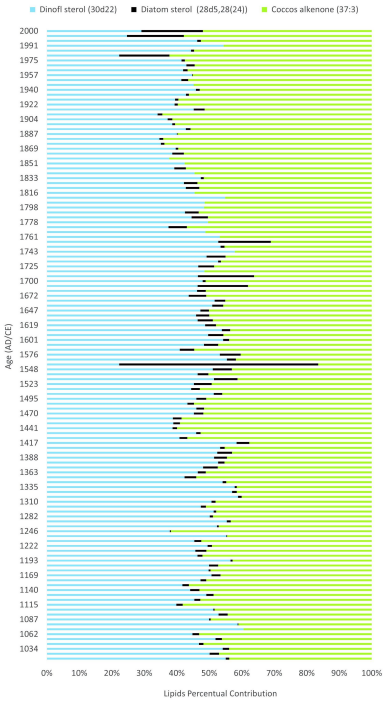

Fig. 2. Dinoflagellates, diatoms and coccolithophores dominant lipid signatures relative contribution over the last millennia in PO287-06-G core (off Douro River / NE Portugal).