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A Middle Pleistocene Northeast Atlantic coccolithophore record: Paleoclimatology and paleoproductivity aspects

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ABSTRACT

Changes in paleoclimate and paleoproductivity patterns have been identified by analysing, in conjunction with other available proxy data, the coccolithophore assemblages from core MD03-2699, located in the Portuguese margin in the time interval from the Marine Isotope Stage (MIS) 13/14 boundary to MIS 9 (535 to 300 ka). During the Mid-Brunhes event, the assemblages associated with the eccentricity minima are characterised by higher nannoplankton accumulation rate (NAR) values and by the blooming of the opportunistic genus *Gephyrocapsa.* Changes in coccolithophore abundance are also related to glacial–interglacial cycles. Higher NAR and numbers of coccoliths/g mainly occurred during the interglacial periods, while these values decreased during the glacial periods. Superimposed on the glacial/interglacial cycles, climatic and paleoceanographic variability has been observed on precessional timescales. The structure of the assemblages highlights the prevailing long-term influence of the Portugal (PC) and Iberian Poleward (IPC) Currents, following half and full precession harmonics, related to the migration of the Azores High (AH) Pressure System. Small *Gephyrocapsa* and *Coccolithus pelagicus braarudii* are regarded as good indicators for periods of prevailing PC influence. *Gephyrocapsa caribbeanica, Syracosphaera* spp., *Rhabdosphaera* spp. and *Umbilicosphaera sibogae* denote periods of IPC influence. Our data also highlights the increased percentages of *Coccolithus pelagicus pelagicus* during the occurrence of episodes of very cold and low salinity surface water, probably related to abrupt climatic events and millennial-scale oscillations of the AH/Icelandic Low (IL) System.

1. Introduction

The ecological factors that mainly act on the distribution and structure of coccolithophore assemblages are light, the salinity and temperature of water masses, nutrient availability, terrigenous inputs, and water turbidity (McIntyre and Bé, 1967; Samtleben and Schröder, 1992; Giraudeau et al., 1993; Winter and Siesser, 1994; Samtleben et al., 1995; Takahashi and Okada, 2000; Andruleit et al., 2003, 2005; Hagino et al., 2005; Andruleit, 2007). These factors are connected to changes in paleoceanographic and paleoclimatic conditions. Thus the variations in the structure of calcareous nannoplankton assemblages are tools used to investigate paleoceanographic and paleoclimatic changes (e.g., Flores et al., 2003; Baumann and Freitag, 2004; Giraudeau et al., 2004; Baumann et al., 2005; Rogalla and Andruleit, 2005) and the development of the Earth's climate system. Coccolithophores also release CO_2 during the intracellular calcification process and use light energy to convert CO_2 into organic molecules. Through these processes, known as the 'biological carbon pumps' (Rost and Riebesell, 2004), coccolithophores contribute to the CO_2 exchanges between seawater and the atmosphere. Therefore, similar to the foraminiferal fragmentation index (Le and Shackleton, 1992; Becquey and Gersonde, 2002), the reconstruction of coccolith preservation and coccolithophore productivity can be used to evaluate changes in biogenic carbonate preservation and the relationship to variations in carbonate export, biogenic productivity, ocean circulation, and biogeochemistry.

In this study we use coccolithophore assemblages to reconstruct the climate signal and productivity patterns during the mid-Brunhes. Our study area is the Iberian margin, an area known for its good preservation of the record of millennial-scale climate variability for the last several climatic cycles (e.g., de Abreu et al., 2003; Martrat et al., 2007; Voelker et al., 2010). Significant paleoclimatic changes and sea surface temperature (SST) variations occurred during the last 0.6 Ma (McManus et al., 1999; Martrat et al., 2007; Voelker et al., 2010; Rodrigues et al., 2011) influencing North Atlantic Deep

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