Clim. Past, 11, 653–668, 2015
www.clim-past.net/11/653/2015/
doi:10.5194/cp-11-653-2015

Climate of the Past
Open Access

The bivalve *Glycymeris planicostalis* as a high-resolution paleoclimate archive for the Rupelian (Early Oligocene) of central Europe

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Received: 11 September 2014 – Published in Clim. Past Discuss.: 17 October 2014
Revised: 8 January 2015 – Accepted: 17 March 2015 – Published: 10 April 2015

Abstract. Current global warming is likely to result in a unipolar glaciated world with unpredictable repercussions on atmospheric and oceanic circulation patterns. These changes are expected to affect seasonal extremes and the year-to-year variability of seasonality. To better constrain the mode and tempo of the anticipated changes, climatologists require ultra-high-resolution proxy data of time intervals in the past, e.g., the Oligocene, during which boundary conditions were similar to those predicted for the near future. In the present paper, we assess whether such information can be obtained from shells of the long-lived bivalve mollusk *Glycymeris planicostalis* from the late Rupelian of the Mainz Basin, Germany. Our results indicate that the studied shells are pristinely preserved and provide an excellent archive for reconstructing changes of sea surface temperature on seasonal to interannual timescales. Shells of *G. planicostalis* grew uninterruptedly during winter and summer and therefore recorded the full seasonal temperature amplitude that prevailed in the Mainz Basin ~ 30 Ma. Absolute sea surface temperature data were reconstructed from $\delta^{18}O_{shell}$ values assuming a $\delta^{18}O_{water}$ signature that was extrapolated from coeval sirenian tooth enamel. Reconstructed values range between 12.3 and 22.0 °C and agree well with previous estimates based on planktonic foraminifera and shark teeth. However, temperatures during seasonal extremes vary greatly on interannual timescales. Mathematically re-sampled (i.e., corrected for uneven number of samples per annual increment) winter and summer temperatures averaged over 40 annual increments of three specimens equal 13.6 ± 0.8 and 17.3 ± 1.2 °C, respectively. Such high-resolution paleoclimate information can be highly relevant for numerical climate studies aiming to predict possible future climates in a unipolar glaciated or, ultimately, polar-ice-free world.

1 Introduction

Current CO_2-induced global warming is likely to result in a unipolar glaciated world ultimately followed by one without polar ice caps (e.g., Raper and Braithwaite, 2006). In light of these predicted boundary conditions, the climate is expected to change profoundly, particularly at higher latitudes. According to numerical climate models, reduced meridional gradients will lead to substantial changes in atmospheric and oceanic circulation patterns (e.g., Cai and Chu, 1998; Hansen et al., 2004), thereby affecting seasonality as well as the frequency and intensity of decadal climate oscillations (e.g., Marshall et al., 2001; Solomon et al., 2007). In turn, this will alter surface temperature patterns, storm intensities and precipitation rates (Hurrell, 1995; Dai et al., 1997; Barbosa, 2009), all of which present a major challenge to densely populated coastal areas and coastal ecosystems, particularly in Europe (Ottersen et al., 2001; Stenseth et al., 2002).

To date, the mode and tempo of the environmental change anticipated for the near future have remained poorly constrained (e.g., Vellinga and Wood, 2002; Hátún et al., 2005).

Published by Copernicus Publications on behalf of the European Geosciences Union.