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A SEASONALLY RESOLVED BOTTOM-WATER TEMPERATURE RECORD FOR THE PERIOD AD 1866–2002 BASED ON SHELLS OF *ARCTICA ISLANDICA* (MOLLUSCA, NORTH SEA)

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ABSTRACT

Existing studies on recent global warming are almost exclusively based on environmental data from the Earth's surface. Seasonal information on the effects of climate change on subsurface settings of mid to high latitudes is extremely scarce. Here, we present the first temperature proxy record from bottom (c. 50 m) water settings of the North Sea employing the oxygen isotope composition of ocean quahog shells. Results indicate that $\delta^{18}O_{aragonite}$ measured across shells of *Arctica islandica* can provide reliable estimates (± 0.25 to $\pm 0.4\,^{\circ}C$) of the ambient bottom water temperatures. Over the period AD 1880–2001, warming trends in bottom waters are of the order of 0.042 to 0.138 °C/decade. Apparently, the annual maximum-temperature trend shows a twofold increase over the past four decades (0.236 °C/decade) while the minimum-temperature trend has remained relatively stable (0.042 °C/decade). During the same time interval, however, annual maximum temperatures at the sea surface quadrupled. Shell oxygen-isotope-derived winter temperatures also provide a proxy for the winter North Atlantic oscillation index (WNAO). Some 28 to 50% of the variability in minimum temperatures below the thermocline can be explained by changes of the WNAO. Our new tool enables testing and verification of climate models prior to the 20th century greenhouse forcing. Copyright © 2005 Royal Meteorological Society.

KEY WORDS: ocean quahog; thermocline; temperature; oxygen isotope; sclerochronology; model

1. INTRODUCTION

Marine archives of seasonal environmental variability in mid to high latitudes are extremely scarce. Meteorological records, such as the extended reconstructed sea-surface temperature (ERSST) data set (National Oceanic and Atmospheric Administration; www.cdc.noaa.gov) cover surface conditions during the past 100 to 150 years. Much less is known about conditions in the bottom water, where measurements were only taken occasionally (e.g. Levitus *et al*., 2000). High-resolution, decadal to centennial reconstructions of such settings require extensive modelling. For example, the Hamburg Shelf Ocean Model (HAMSOM; Pohlmann, 1996 a–c) provides monthly reconstructed bottom-water temperatures (BWTs) for the period 1969–82 (note: all years are AD). Such models are based upon atmospheric heat flux and wind stress data and cannot easily be extended beyond times of instrumental measurements.

For times and places without direct measurements, climate system modellers rely on proxy records. High-resolution environmental reconstructions in mid to high latitudes have predominantly been derived from trees.

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