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Two centuries of southwest Iceland annually-resolved marine temperature reconstructed from *Arctica islandica* shells

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ABSTRACT

Iceland's exposure to major ocean current pathways of the central North Atlantic makes it a useful location for developing long-term proxy records of past marine climate. Such records provide more detailed understanding of the full range of past variability which is necessary to improve predictions of future changes. We constructed a 225-year (1791–2015 CE) master shell growth chronology from 29 shells of *Arctica islandica* collected at 100 m water depth in southwest Iceland (Faxaflói). The growth chronology provides a robust age model for shell oxygen isotope ($\delta^{18}O_{shell}$) data produced at annual resolution for 251 years (1765–2015 CE). The temperature reconstruction derived from $\delta^{18}O_{shell}$ shows coherence with May–October local surface temperature records and sea surface temperatures in the North Atlantic region, suggesting it is a useful proxy indicator of water temperature variability at 100 m depth within Faxaflói. Field correlations between the shell-based records and gridded sea surface temperature data reveal strong positive correlations between the 1-year lagged shell growth and temperatures within the subpolar gyre post-1972, suggesting a delayed influence of subpolar gyre dynamics on ecological indicators in southwest Iceland in recent decades. However, the shell growth chronology and $\delta^{18}O_{shell}$ record generally show relatively weak and insignificant correlations with larger region climate indices including the Atlantic Multidecadal Variability, North Atlantic Oscillation, and East Atlantic pattern. Therefore the interannual variations in the newly produced shell-based records appear to reflect more local to regional dynamics around southwest Iceland than large-scale modes of climate variability.

1. Introduction

North Atlantic Ocean dynamics are important drivers of global climate, yet the complexities among major current systems, large-scale teleconnections, and ocean-atmosphere exchanges pose significant challenges for understanding and modeling past and future change. Uncertainty and debate exist about, for example, the past and predicted behavior of the Atlantic Meridional Overturning Circulation (AMOC; Caesar et al., 2021), the role of surface ocean circulation dynamics in past local to regional climate events (Lund et al., 2006), and the nature and impacts of large-scale low-frequency modes such as Atlantic Multidecadal Variability (AMV; Zhang et al., 2019). Long-term records of hydrographic variability are important for reaching a more comprehensive understanding of marine climate of the North Atlantic Ocean. Due to limited length of instrumental records, development of geographically diverse, multicentury proxy reconstructions of hydrographic variability is necessary. Its exposure to major ocean current pathways of the central North Atlantic (Fig. 1) makes Iceland a key locality for developing long-term proxy records of marine climate to understand the full range of past variability and provide context for present and future changes.

Shells from the marine bivalve *Arctica islandica* have increasingly been applied as environmental proxy archives across the northern North Atlantic over the past few decades (Schöne, 2013). Records from shells of *A. islandica* are used in paleoclimate research as the marine equivalent to terrestrial records from trees (Fig. 2). Annual banding within the shell, synchronous growth rates within populations, and the long lifespan of individuals (maximum >500 years; Butler et al., 2013) enable

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