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Potential and limitation of combining terrestrial and marine growth records from Iceland

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ABSTRACT

Seasonally formed, perennial growth increments of various organisms may possibly contain information about past environmental changes, well before instrumental measurements occurred. Such annually resolved proxy records have been mainly obtained from terrestrial archives, with a paucity of similar data originating from marine habitats. Iceland represents ideal conditions to develop both, tree ring (dendro) and bivalve shell (sclero) chronologies from adjacent sites. Here we introduce the first network of Icelandic birch (*Betula pubescens* Ehrh.) and rowan (*Sorbus aucuparia*) dendrochronologies, as well as ocean quahog (*Arctica islandica* L.) sclerochronologies. In order to identify the dominant external drivers of tree and shell growth, we assess the common growth trends and growth extremes within and between the terrestrial and marine records, as well as relationships of both archives with instrumental-based meteorological indices. Capturing a strong signal of June–August mean air temperature, the dendrochronologies are significantly positively correlated to each other. The sclerochronologies, however, reveal much lower growth coherency, which likely results from different sampling strategies and growth habitats. Disagreement between the dendro- and sclerochronologies possibly originates from unequal sample size, offset in the seasonal timing and rate of the growth, as well as varying sensitivities to different environmental factors. Our results emphasize the importance of considering a wide range of species and taxa to reconstruct a more complete picture of terrestrial and marine ecosystem functioning and productivity across various spatiotemporal scales.

1. Introduction

Chronologies of annual growth increments extracted from a range of organisms can be used to reconstruct past environmental and climatic conditions (Jones et al., 2009). Tree rings constitute the backbone of high-resolution, terrestrial paleoclimatology (IPCC, 2013). Marine conditions at annual or even higher temporal resolutions (Thompson et al., 1980) have been reconstructed from tropical, shallow-water corals (e.g., Gagan et al., 2000; Tierney et al., 2015), coralline red algae (e.g., Halfar et al., 2000), and shells of bivalves (e.g., Wanamaker et al., 2008a; Schöne, 2013; Mette et al., 2016; Reynolds et al., 2016), for instance. Sclerochronology is frequently applied to the study of accretionary hard tissues in some animal and algae species (Buddemeier et al., 1974; Hudson et al., 1976; Witbaard, 1996; Oschmann, 2009; Helmle and Dodge, 2011; Butler and Schöne, 2017). Among sclerochronological archives, bivalves hold a special position for their informative power; some species, such as *Arctica islandica*, can reach ages of > 500 years (Schöne et al., 2005a; Butler et al., 2013; Wanamaker et al., 2008b). This results in continuous and distinct temporal growth patterns at different resolutions, such as daily, tidal, fortnightly, monthly and annual. Environmental changes affect shell growth rates, as well as their geochemical and microstructural properties (e.g.,

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