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ORIGINAL ARTICLE

Characterization and climate response patterns of a high-elevation, multi-species tree-ring network in the European Alps

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Abstract

We combine 53 ring width and 31 maximum latewood density data sets from a network of high-elevation tree sites distributed across the European Alps (43–48°N and 6–14°E). This network is analyzed to understand the climate, and in particular, the temperature signal, in terms of geography, species and measured parameter. These analyses will be useful for any subsequent climatic reconstruction. The first Principal Component (PC) of the ring width chronologies explains 20% of the network's variance and correlates significantly with the June–August summer season temperatures, while that of the density chronologies explains 69% of the variance and correlates with the wider April–September season. Of the four species considered, ring width records from *Picea abies*, *Larix decidua*, and *Pinus cembra* tend to show most similar responses to climate, with the *Abies alba* having a more unique response. The climatic signal of the density chronologies is rather independent of species and site ecology. It is quite strong across the network, although possibly weighted towards the higher-frequency domains. In comparison, the ring width chronologies display much greater site- and species-specific components in their climate response, with only elevation found to serve as an indicator for the level of seasonal temperature response. Climatic gradients across the network are shown to exist through spatial correlation and rotated Principal Component Analysis (PCA). These gradients are rather small, but show similar patterns to those observed in PCA of instrumental data. High correlations between temperature and *Latix decidua* are found despite concern over the presence of effects from the larch budmoth on the climatic signal. Similarly, the ring width parameter of *Pinus cembra* showed strong ability to serve as a proxy, notable in the context of this species to have poorer responses to temperature when considering maximum latewood density. The potential for a regional climatic reconstruction, using the networks PCs as predictors exists, as demonstrated by the high and consistent loadings across the network on the first PCs for both the ring width and density chronologies.

Keywords: Dendroclimatology; Temperature; Ring width; Maximum latewood density; Network; Alps

Introduction

Tree-ring data currently play a prominent role in the characterization and assessment of climate variations prior to the instrumental period. The spatial scale of tree-ring reconstructions ranges from local (e.g., Pederson et al., 2001; Schweingruber et al., 1988), to regional (e.g., Cook et al., 2003; Wilson and Luckman, 2003) to hemispheric (e.g., Briffa, 2000; Esper et al., 2002a; Jacoby and D'Arrigo, 1989). In detail, the potential for trees to serve as a proxy can depend on a variety of factors including species, altitude, site ecology, tree age, measured parameter, and

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