Trees (2018) 32:855–869
https://doi.org/10.1007/s00468-018-1678-z

ORIGINAL ARTICLE

Site-specific climatic signals in stable isotope records from Swedish pine forests

Jan Esper[1] · Steffen Holzkämper[2] · Ulf Büntgen[3,4,5] · Bernd Schöne[6] · Frank Keppler[7] · Claudia Hartl[1] · Scott St. George[8] · Dana F. C. Riechelmann[6] · Kerstin Treydte[4]

Received: 2 November 2017 / Accepted: 19 February 2018 / Published online: 23 February 2018

Abstract

Key message ***Pinus sylvestris*** **tree-ring $\delta^{13}C$ and $\delta^{18}O$ records from locally moist sites in central and northern Sweden contain consistently stronger climate signals than their dry site counterparts.**

Abstract We produced twentieth century stable isotope data from *Pinus sylvestris* trees near lakeshores and inland sites in northern Sweden (near Kiruna) and central Sweden (near Stockholm) to evaluate the influence of changing microsite conditions on the climate sensitivity of tree-ring $\delta^{13}C$ and $\delta^{18}O$. The data reveal a latitudinal trend towards lower C and O isotope values near the Arctic tree line (−0.8‰ for $\delta^{13}C$ and −2.4‰ for $\delta^{18}O$ relative to central Sweden) reflecting widely recognized atmospheric changes. At the microsite scale, $\delta^{13}C$ decreases from the dry inland to the moist lakeshore sites (−0.7‰ in Kiruna and −1.2‰ in Stockholm), evidence of the importance of groundwater access to this proxy. While all isotope records from northern and central Sweden correlate significantly against temperature, precipitation, cloud cover and/or drought data, climate signals in the records from moist microsites are consistently stronger, which emphasizes the importance of site selection when producing stable isotope chronologies. Overall strongest correlations are found with summer temperature, except for $\delta^{18}O$ from Stockholm correlating best with instrumental drought indices. These findings are complemented by significant positive correlations with temperature-sensitive ring width data in Kiruna, and inverse (or absent) correlations with precipitation-sensitive ring width data in Stockholm. A conclusive differentiation between leading and co-varying forcings is challenging based on only the calibration against often defective instrumental climate data, and would require an improved understanding of the physiological processes that control isotope fractionation at varying microsites and joined application of forward modelling.

Keywords $\delta^{13}C$ · $\delta^{18}O$ · *Pinus sylvestris* L. · Microsite · Dendrochronology · Sweden

Introduction

Stable carbon and oxygen isotope ratios ($\delta^{13}C$ and $\delta^{18}O$ values) are valuable proxies for reconstructing long-term climatic changes at annual resolution (Leavitt 2010).

Communicated by A. Gessler.

✉ Jan Esper
esper@uni-mainz.de

[1] Department of Geography, Johannes Gutenberg University, Mainz, Germany

[2] Department of Physical Geography, Stockholm University, Stockholm, Sweden

[3] Department of Geography, University of Cambridge, Cambridge, UK

[4] Swiss Federal Research Institute WSL, Birmensdorf, Switzerland

[5] CzechGlobe Research Institute CAS and Masaryk University, Brno, Czech Republic

[6] Institute of Geosciences, Johannes Gutenberg University, Mainz, Germany

[7] Institute of Earth Sciences, Ruprecht-Karls University, Heidelberg, Germany

[8] Department of Geography, Environment and Society, University of Minnesota, Minneapolis, USA