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Challenges in Establishing Multi-Millennial Tree Ring Records for the Holocene

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Recent finds of wood remains from glacier forefields and peat bogs along a SW-NE transect in the Alps represent a unique high-frequency archive which allows the reconstruction of climate variability over the entire Holocene. We use a multi-proxy approach that combines both tree ring width and multiple stable isotope chronologies by establishing highly resolved tree ring and stable isotope records from calendar-dated wood covering the past 9000 years.

Therefore, tree ring width and stable isotope series are generated by a standardized procedure, where first the tree ring widths are measured and samples are calendrically dated by means of tree ring analysis. Afterwards, samples are cut into 5-year tree ring blocks, cellulose is extracted and crushed by ultrasonic homogenization, and subsequently, the stable isotopes of carbon, oxygen and hydrogen are simultaneously measured.

Although the sample preparation follows a standardized procedure, the establishment of the multi-millennial tree ring and isotope chronologies is not straightforward. By investigating the individual measurement series from the Early and Mid-Holocene as well as recent samples from living trees from key sites – which will provide the connection of the Holocene tree ring series to the present – the individual measurement series reveal effects due to different sampling sites, tree species, growth trend, potential degree of decay and cellulose content. These specific effects influence both the tree ring width, and to a higher degree the stable isotope series. For instance, the measured deuterium records reveal a species-specific isotope signature for the investigated species Larix decidua and Pinus cembra, which is not resembled in the oxygen and carbon records. In order to establish stable isotope chronologies which span the time period from 9000 years b2k to the present, such tree specific features need to be corrected from the individual time series.

In this study, we try to overcome these various effects and their resulting offsets by measures of standardization and we try to establish environmental records for which the low frequency signal is kept as much as possible. Such records from high-frequency archives which reveal low frequency signals are rare.