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Early and Mid-Holocene Climate Variability – A Multi-Proxy Approach from Multi-Millennial Tree Ring Records

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Most reconstructions of Holocene climate variability in the Alps are based on low-frequency archives such as glacier and tree line fluctuations. However; recent finds of wood remains in glacier forefields in the Alps reveal a unique high-frequency archive allowing climate reconstruction over the entire Holocene. The evolution of Holocene climate can be reconstructed by using a multi-proxy approach combining tree ring width and multiple stable isotope chronologies by establishing highly resolved stable isotope records from calendar-dated wood which covers the past 9000 years b2k.
Therefore, we collected samples in the Alps covering a large SW-NE transect, primarily in glacier forefields but also in peat bogs and small lakes. The multiple sample locations allow the analysis of climatic conditions along a climatic gradient characterized by the change from an Atlantic to a more continental climate. Subsequently, tree ring widths are measured and samples are calendrically dated by means of tree ring analysis. Due to the large amount of samples for stable isotope analysis (> 8000 samples to cover the entire Holocene by guaranteeing a sample replication of 4 samples per time unit of 5 years), dated wood samples are separated into 5-year tree ring blocks. These blocks are sliced and the cellulose is extracted after a standardized procedure and crushed by ultrasonic homogenization. In order to establish multi-proxy records, the stable isotopes of carbon, oxygen and hydrogen are simultaneously measured.
Both the 5-year tree ring width and multiple stable isotope series offer new insights into the Early and Mid-Holocene climate and its variability in the Alps. The stable isotope records reveal interesting low-frequency variability. But they also display expected offsets caused by the measurement of individual trees revealing effects of sampling site, tree species and growth trend. These effects offer an additional insight into the tree growth and stand behavior of single trees in the Early and Mid-Holocene. For a robust regional comparison these local and individual tree effects have to be removed. Further, cold events such as the 8.2 ka BP and the 6.3 ka BP event and their representation in the proxy time series as well as the Holocene optimum phase can be investigated in these high-frequency records. Finally, an estimation of the temperature change over the Holocene optimum phase can be proposed.