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A 9.1 ka long continuous tree-ring width chronology as a base for analyses on the environmental and climatic evolution in the Alps during the Holocene

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An ultra-long tree-ring width chronology (9111 years long, 7109 B.C. to A.D. 2002) has been established based on the analysis and dating of 1432 sub-fossil/dry-dead wood samples and cores from 335 living trees. The material was collected from tree-line or near-tree-line sites (c. 2000 to 2400 m a.s.l.) mainly in the central eastern Alps. This tree-ring chronology is the longest continuous high-mountain chronology in the world. The subfossil/dry-dead samples belong to different conifer species: samples of the species stone pine (Pinus cembra L.) dominate the mixture by more than 80%, larch (Larix decidua Mill.) and spruce (Picea abies L.) samples have only minor fractions (16% and 2%, respectively). Additionally two floating tree-ring chronologies were established for the first section of the Holocene. The dating of these two series each some 600 year long is based on wiggle-matching of radiocarbon dates.

Knowledge of the Holocene environmental and climatic evolution in the Alps has been improved using the absolutely dated Eastern Alpine Conifer Chronology (EACC). It was possible to dendrochronologically date wooden samples found on several Alpine glacier forefields. The samples analysed contain up to some 700 tree rings and usually date back into the early and middle Holocene. These wooden remains generally document multi-centennial to millennial long glacier retreat periods with glaciers extents smaller than at present. Tree remains found at several locations of the central Alps above the present tree line are indicating higher tree-line positions in the past. The sub-fossil stems with life-spans up to 300 years allowed the establishment of a dendrochronological record of the Holocene tree-line variability. Both records (glacier and tree-line) prove a long lasting Holocene climate optimum in the Alps around 7 ka BP. The abundance of sub-fossil samples through time at high elevated sites is influenced by Alpine forest history and is partly climatically controlled, as shown by comparisons of the sample depth record of the EACC with the Holocene glacier record. The similarity of variations over time between the sample depth record and the mid-Holocene GISP2 10Be record suggest a relationship between Holocene forest density at the Alpine tree-line and solar activity. This long tree-ring chronology will be used, along with the lastest dendroclimatological standardisation techniques, to establish estimates of the long-timescale variation of temperature in the high-altitude Alps over the Holocene.