



Young trees climate sensitivity above the forestline: the case study of *Pinus nigra* upward shift in Central Apennines (Italy)

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In the context of ecological research, tree-ring analysis often deals with short time series (< 30 years). Their crossdating and averaging can be difficult but crucial to use such data for ecological modelling, multivariate statistics, and climate-growth analysis. Several studies were conducted in the Central Apennines (Italy) on recent encroachment of European black pine (*Pinus nigra* J.F. Arnold) on treeless areas above the current forestline. Growth of young trees is mainly controlled by endogenous or microclimatic factors making usual dendrochronology methods less applicable and crossdating very difficult or even impossible. The potential ecological information deriving from tree-ring growth in short series is therefore limited by this methodological bias. The aim of this study is to test suitable methods for optimizing the use of short ring series for further analytical use. A dataset of 734 tree-ring series of young European black pines (mean cambial age 15 years) growing at high altitude in 8 sites was used in this analysis. At each site tree-ring series were divided in two groups based on inter-series correlation: the crossdated or selected series (SEL), and non-crossdated or rejected ones (REJ). The following dendrochronological parameters were calculated for SEL and REJ series: mean tree-ring width, mean sensitivity, Gini coefficient, first order autocorrelation, inter-series correlation, and *Gleichläufigkeit* (GLK). Two methods of pointer years analysis were tested in order to detect years with synchronous growth: i) Normalization in a moving Window (NW) and ii) the RELative growth change method (RE). The two methods were applied to the raw series varying the standard thresholds, in order to detect synchronous growth-years in SEL and REJ group. A sensitivity analysis was included to assess how the threshold choice in the analysis could affect the results obtained. The term “common” was used to indicate years with similar tree growth response. Differences in the detected number of common years within SEL and REJ were obtained using different time windows with the RE and NW methods. The 47 % of all series were classified as SEL, showing more common years than the REJ series. However, a similar result occurred considering all the series together without SEL/REJ discrimination. In general, a significant occurrence of common years could be a tool to select series to be averaged for a site mean chronology. These are preliminary but encouraging results contributing to a more efficient use of the ecological information provided by short time series from young trees.