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A new algorithm to identify and correct insect-induced defoliation signals in Alpine tree-ring chronologies

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Larch budmoth (Zeiraphera diniana) induced defoliation events can cause cyclic growth depressions in Alpine ring-width and density chronologies of larch trees (Larix decidua). Although interesting for the study of insect population dynamics, the negative growth and density deviations deteriorate potential climate signals. A common approach to identify and eliminate the effect of these insect outbreaks is based on a multi-step procedure that involves the comparison with a non-host species and the selection of a certain standard deviation as a detection threshold (Büntgen et al., 2009). For a quantitative analysis, however, a one-step technique is preferable because it reduces the propagation of errors and provides a robust error estimation. Here, we present a novel method, adopted from econometric research and designed for detecting pulse-like perturbations in timeseries. The algorithm was previously applied to tree-ring based temperature reconstructions in order to detect volcanic cooling signals (Schneider et al., 2017). The method's potential in identifying and quantifying impacts of insect outbreaks is analyzed here with ring-width and maximum density tree-ring data from high elevation sites (1700-2200m a.s.l) in the Swiss Alps. We investigate the effect of tree-age on the severity of defoliation events and intra-stand dynamics of growth anomalies during known periods of high larch budmoth abundance. The correction of larch chronologies for climatic investigations is approached in two ways: (i) using the refined understanding of the trees' resilience and (ii) employing the break coefficient yielded by the detection algorithm. Results are compared with previously published studies. By applying an econometric method to dendrochronologic data we illustrate the benefit of interdisciplinary approaches, underpin and complement previous results and provide an efficient and easy to use instrument for future studies.

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