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Spatial patterns of climate extreme anomalies in the French Alps between 1500 to 2000 revealed from a dense tree ring chronology network

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While instrumental data have been used to quantify changes in extremes during recent times and model projections may suggest likelihoods for potential future changes, the link between extreme weather events, climate variability, and climate change is poorly understood over pre-instrumental time. Proxy data, and tree rings in particular, may be useful to assess variations over many centuries and to understand climatic extremes and their temporal distribution with respect to long-term climate evolution. In this study, we first examine extreme pointer years of tree ring series, showing annual growth reactions due to abrupt changes in environmental conditions especially due to climatic variations. An annually resolved calendar of extreme pointer years covering the past 500 years is inferred from 81 larch and Swiss stone pine tree ring unpublished chronologies (1050 series), covering the French Alps (6-7.5°E, 44-46° N). The spatial patterns of annual growth anomalies are compared to the updated HISTALP high spatial resolution meteorological dataset (Böhm et al. 2009, monthly temperature anomalies: 1*1° lat/long, monthly precipitation sums: 0.1*0.1° lat/long) for the period 1760-2000 in order to assess the relation between climate and tree-ring extremes. For the pre-instrumental period, 1500-1760, the spatial patterns of pointer years are compared to lower spatial resolution historical dataset from Pichard (1999) for the southern part of the French Alps and from Chuine et al. (2004), Pfister (1981) and Leroy Ladurie (1967, 2007) for the northern part. In the second part of the study, the list of the cold and warm springs and/or summers, as extracted from HISTALP dataset (1760-2000) and cited as extremes in the literature (1500-1760) are compared to the spatial patterns of growth variations. Our results suggest that a dense network of tree ring chronologies is very useful in the detection of extreme years at a local scale. Although, the number of chronologies decreases back in time, this dataset, along with documentary evidences, provides increased understanding of climatic extremes and variation of the French alpine region for the past 500 years. However, in French Alps submitted to Oceanic and Mediterranean influences, high frequency changes in radial growth patterns, appear complex and might be caused by various external climatological forcing agents, such as variations in spring, summer or autumn temperature, and precipitation.