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Extreme temperature events in millennial length tree-ring chronologies from the Alps

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Extreme events are an important focus of climate research mainly because they are one of the main channels through which the climate and socio-economic systems interact. However, the link between such extreme events, climate variability, and climate change is poorly understood.
While instrumental data have been used to quantify changes in extremes during recent times and model projections may suggest likelihoods for potential future changes, natural 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.
We analyzed three different summer temperature sensitive tree-ring chronologies across the European Alpine region: Tyrol (Austria), Lauenen, and Lötschental (both Switzerland). To specifically preserve climate variations and the frequency and magnitude of annual extremes, both tree ring detrending and variance stabilization methods are applied. We focus on the maximum latewood density measurements (MXD), as our results suggest MXD data are more reliable recorders of extreme events in comparison to tree-ring width. The combination of the three millennial length tree-ring chronologies allows robust detection of extreme warm and cold summers. Although, the chronology quality decreases back in time, this compilation, along with documentary evidence, provides increased understanding of climatic extremes and variation of the alpine region for the past 1000 years. In addition to providing a catalogue of extreme summers, we discuss the occurrence of climatic extremes in the context of multi-centennial climate variability and relate this discussion to the characteristics of proxy archives and (natural and anthropogenically forced) climate variability.