

Capturing temperature extremes in millennial length tree-ring chronologies



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Introduction

Extreme weather events (e.g., hot/dry and cold/wet waves) clearly have a major impact on human activities, food supply and economic well being. Yet, 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, 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.

Objectives

- 1) develop methodologies to preserve and analyze temporal changes in extreme events,
- 2) create a calendar of extreme events over the past millennium, in the Alpine area,
- 3) understand the impact of climatic extremes on tree growth and changes in their characteristics,
- 4) perform analysis of extreme events during the past 500-1000 years using MXD data, and compare findings with documentary evidence back to AD 1500.

Methods

- Maximum Latewood density (MXD), was used because of its climatic signal- strength



- MXD measurement series were detrended using ARSTAN and standardized by various approaches to preserve extremes without variance artefacts
- High-pass components filtering and setting an extreme threshold
- Merging three chronologies to compile one Alpine extreme record
- Comparison between instrumental data and MXD based extreme year record

Study area



Three datasets of living and relict material, high -elevation wood samples, with dominant temperature signal:

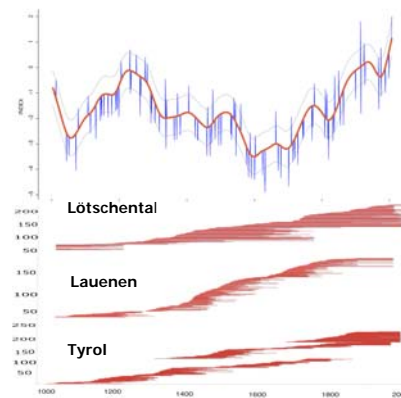
➤ Lötschental: *Larix decidua* Mill. 735-2004 A.D.

➤ Lauenen: *Picea abies* L. 982-1976 A.D.

➤ Tyrol: *Picea abies* L. 1028-2003 A.D.



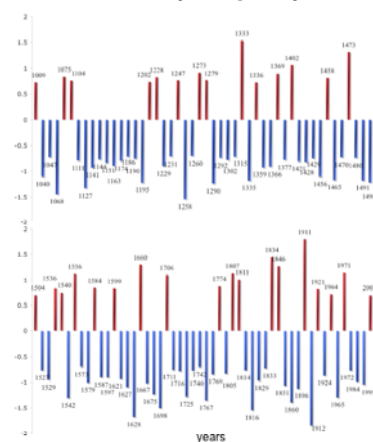
Selected extreme years (>1.5 SD, grey line) including both high and low (red) frequency variations.



Sample replications of the three chronologies

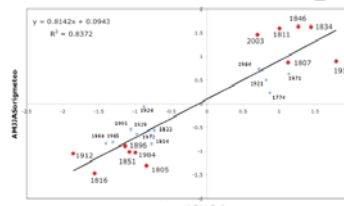
Results

MXD extreme year proxy



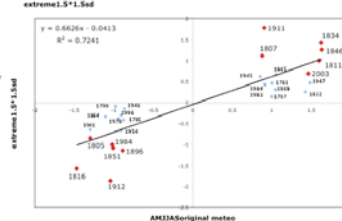
Final mean extreme chronology assessed by averaging the three extreme chronologies. Great emphasis in the cool years.

Instrumental target



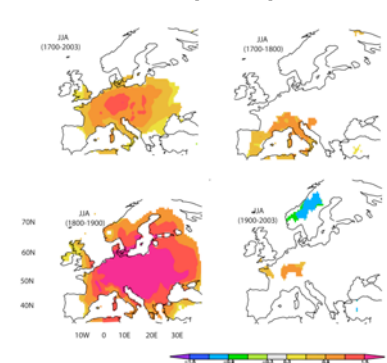
MXD extreme Vs Metro data

Metro extreme Vs MXD data



In red the extreme years with the common signal between tree-ring chronology and AMJJAS meteo data.

Spatial patterns



Correlations between the MXD based extreme year record and the seasonal temperature of June-August (JJA) in different periods. Maps show the positive correlation with the hot extreme years, generated using the KNMI climate explorer (<http://climexp.knmi.nl>)

Acknowledgements

We are grateful to T. Pichler and K. Nicolussi for support in updating the Tyrol tree-ring dataset. This project was supported by the SNF project, NCCR-Climate and EU project MILLENNIUM.

Our results suggest MXD may be exceptionally useful in the detection of extreme years. The combination of the three millennial length tree-ring chronologies allow robust detection of extremes warm and cold summers. Although, the chronology quality decreases back in time, this dataset, along with documentary evidences, provides increased understanding of climatic extremes and variation of the alpine region for the past 1000 years.