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► To cite this version:

Charlie Hureau, Valérie Daux, Sébastien Guillet, François Blondel, Monique Pierre, et al.. Contribution of oak tree-ring width and stable isotopes to reconstruct hydroclimate variability in central France over the last millennium. 13èmes Journées Scientifiques du GDR 3544 Sciences du Bois, Nov 2024, Nantes, France. hal-04858502

HAL Id: hal-04858502

<https://hal.science/hal-04858502v1>

Submitted on 29 Dec 2024

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Contribution of oak tree-ring width and stable isotopes to reconstruct hydroclimate variability in central France over the last millennium

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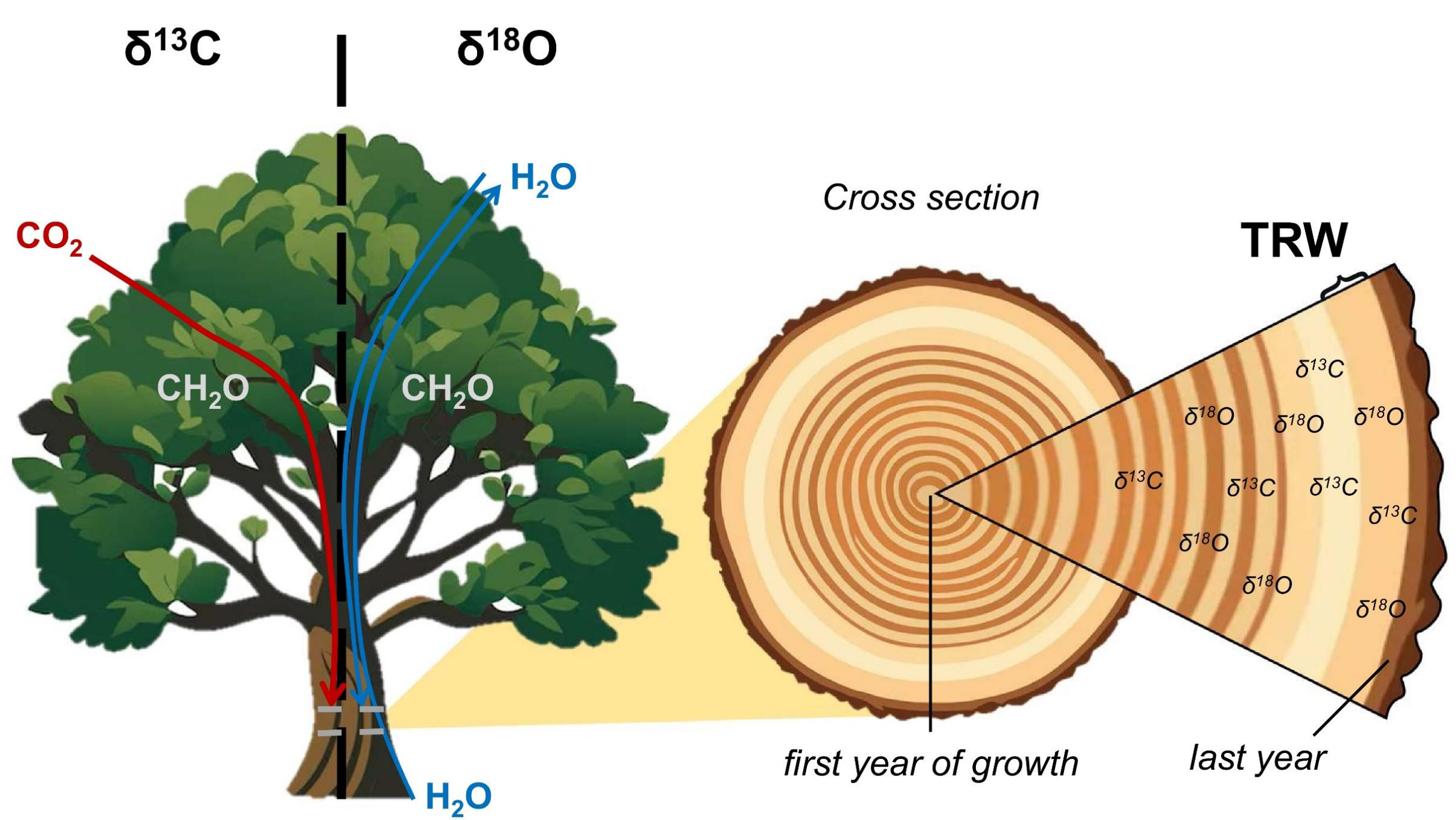
Context

Aim: characterize natural climate variability on a regional scale

Context: no high-resolution millennial climate reconstructions in central and northern France

Tool: tree-ring parameters (width, isotopic composition of oxygen and carbon)

- response of the tree to environmental conditions
- excellent indicators of past temperature, precipitation and drought



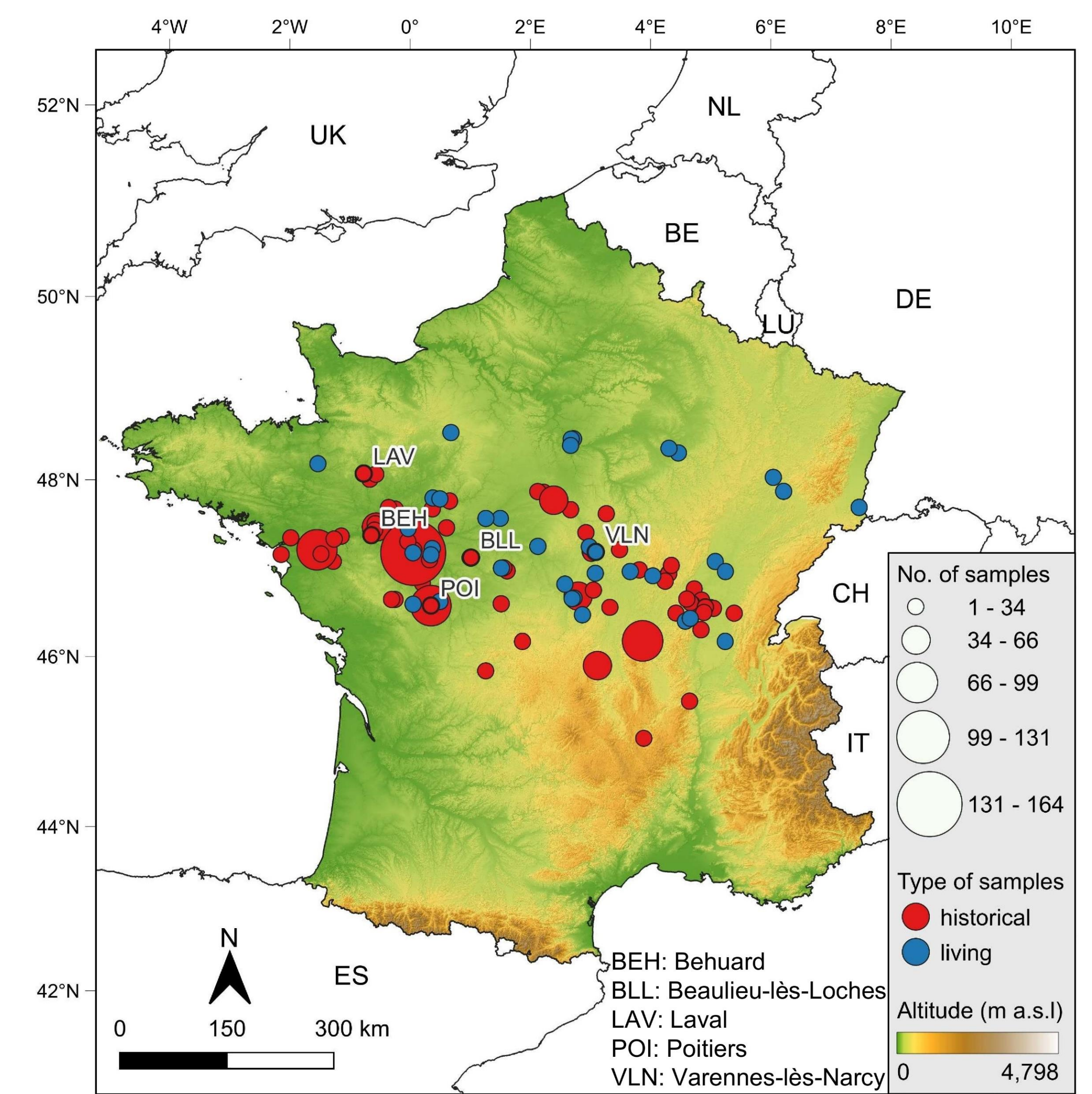
Material and methods

Tree-ring width (TRW) data

- **Material:** living and historical samples (> 3,000 TRW series)
- **Time span:** last millennium
- **Aim:** reconstruct multi-centennial hydroclimatic variability

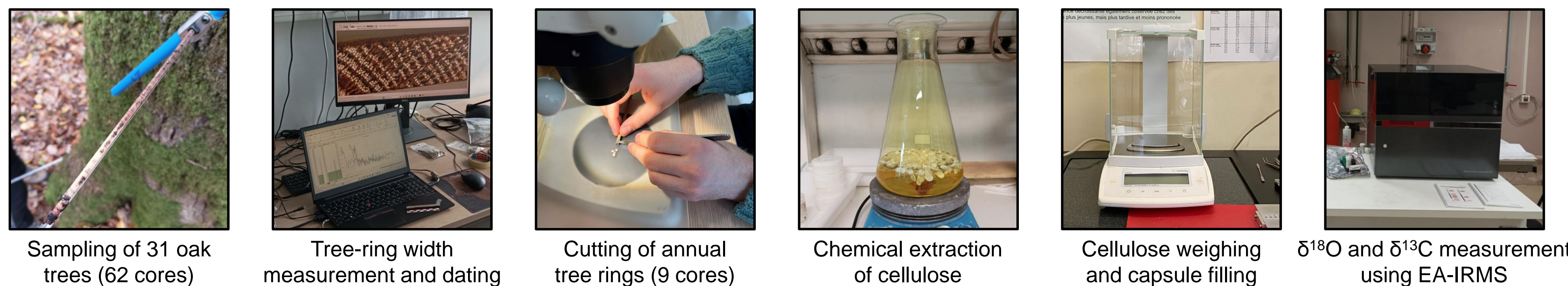
Tree-ring stable isotopes (TRSI) data

- **Material:** living and historical samples (418 samples)
- **Time span:** 1199–1402 CE and 1910–2023 CE
- **Aim:** characterize the 1200–1400 CE climatic transition period and complete the 900-year tree-ring $\delta^{18}\text{O}$ chronology from Fontainebleau



Tree-ring width (TRW) and stable isotopes (TRSI) series studied. TRSI series sites are indicated by labels.

The dendrochronological and dendroisotopic analysis protocol



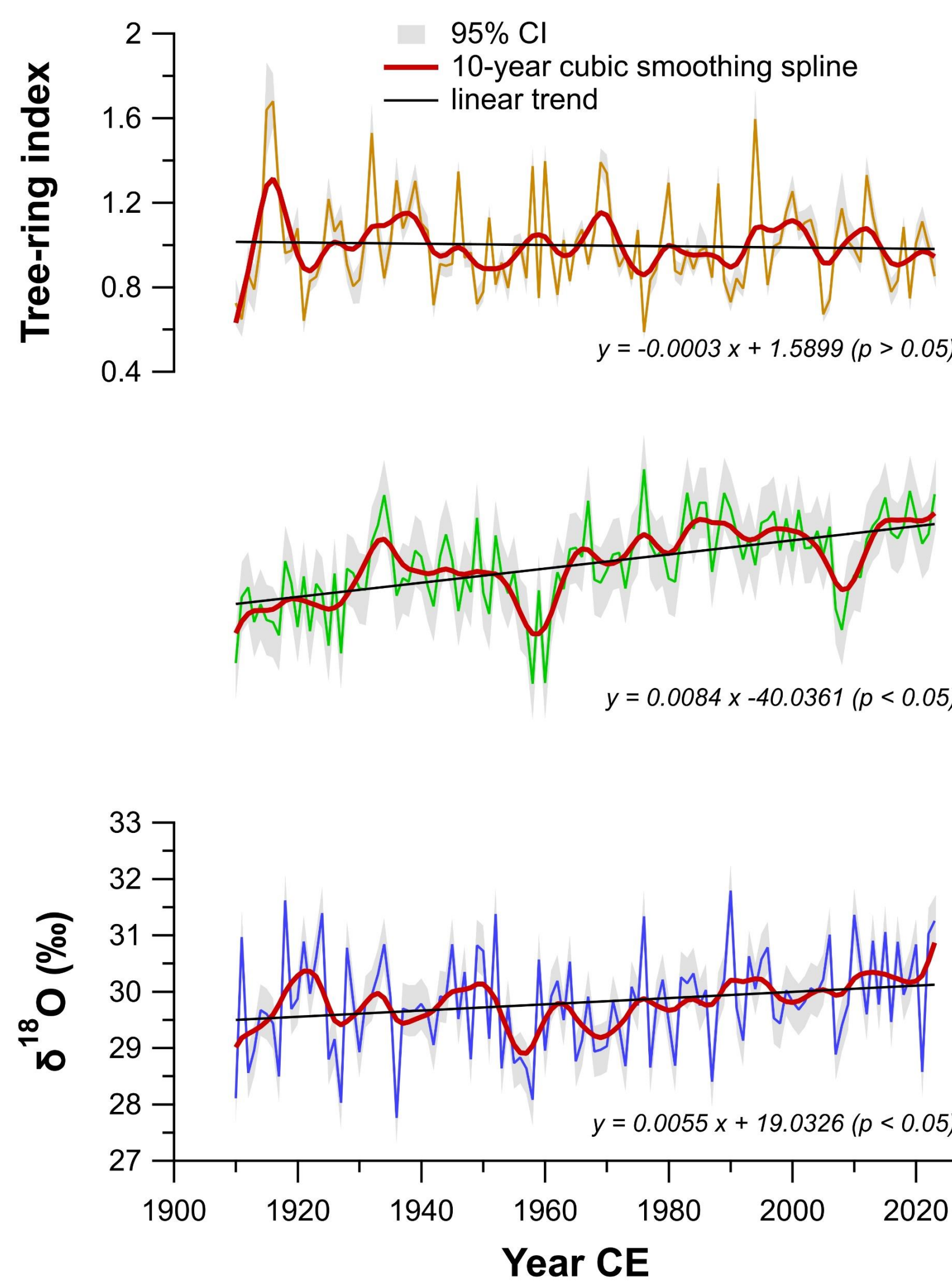
Here we present new data from the VLN site (1910–2023 CE) and test its robustness as a calibration point.

Calibration of tree-ring parameters-climate relationships

Transformation of proxy data to climatic parameters → calibration with meteorological data

- **Method:** linear and spatial Pearson correlation
- **Number of climatic parameter tested:** 8
- **Period of test:** 1910–2023 CE
- **Temporal scale:** monthly and seasonal (39 variables)

Main results



Standardized TRW, $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ chronologies for the VLN site.

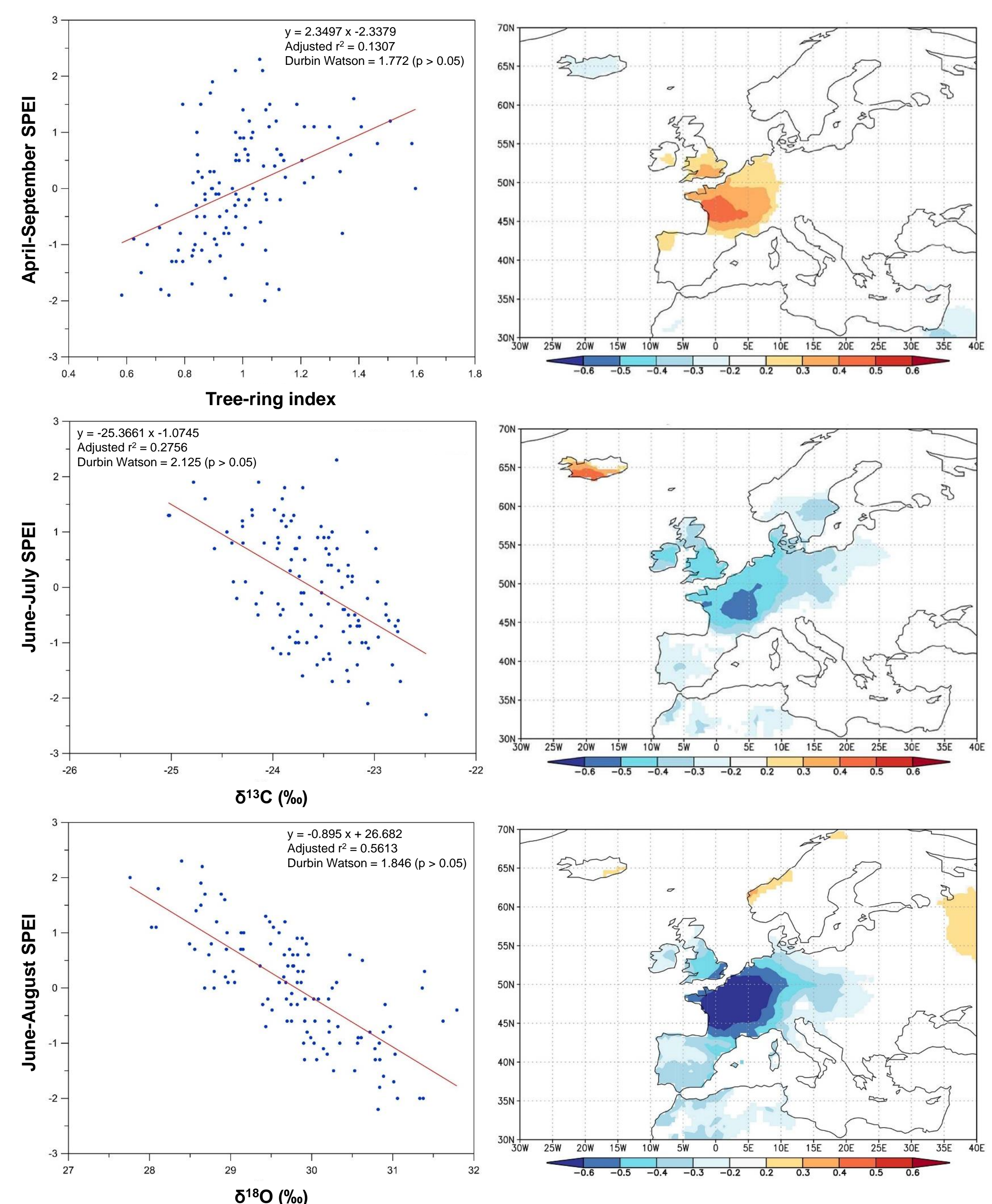
3 new chronologies in central France over the period 1910–2023 CE

- Non-significant decreasing trend in the TRW chronology
- Significant increasing trends linked to current climate change in the $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ chronologies

Assessing the strength of the climate signal in chronologies

- Key climate control parameters:
- **TRW:** April-September SPEI ($r = 0.45$)
 - **$\delta^{13}\text{C}$:** June-August SPEI ($r = -0.53$)
 - **$\delta^{18}\text{O}$:** June-July SPEI ($r = -0.75$).

- Tree-ring oxygen isotope:
- best models summer SPEI variability ($r^2 = 0.56$)
 - stronger and more extensive climate signal



Linear regression and spatial correlation between tree-ring chronologies and Standardized Precipitation-Evapotranspiration Index (SPEI).

Conclusions

- TRW, $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ → mainly controlled by summer hydroclimatic variability (SPEI and precipitation). $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ → strongly correlated with summer temperature
- Weak TRW climate signal but better sensitivities at other sites in the region → possibility of reconstructing droughts in the region from this proxy
- $\delta^{18}\text{O}$ → best skills (lowest uncertainties) for reconstructing hydroclimatic variability