The unknown third - exploring the climatic and non-climatic signals of hydrogen isotopes in tree-ring cellulose across Europe

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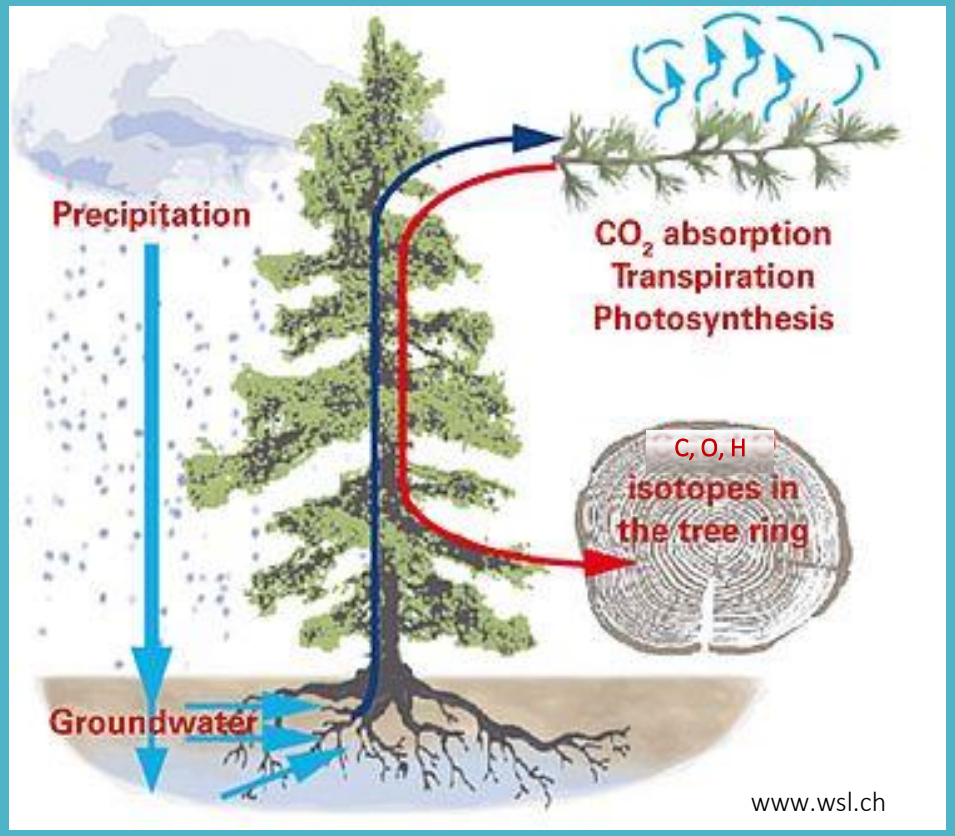
Using tree-ring isotopes in tree rings



Tracing the **"natural" variability** of stable isotopes in tree rings, we can provide annually resolved information on

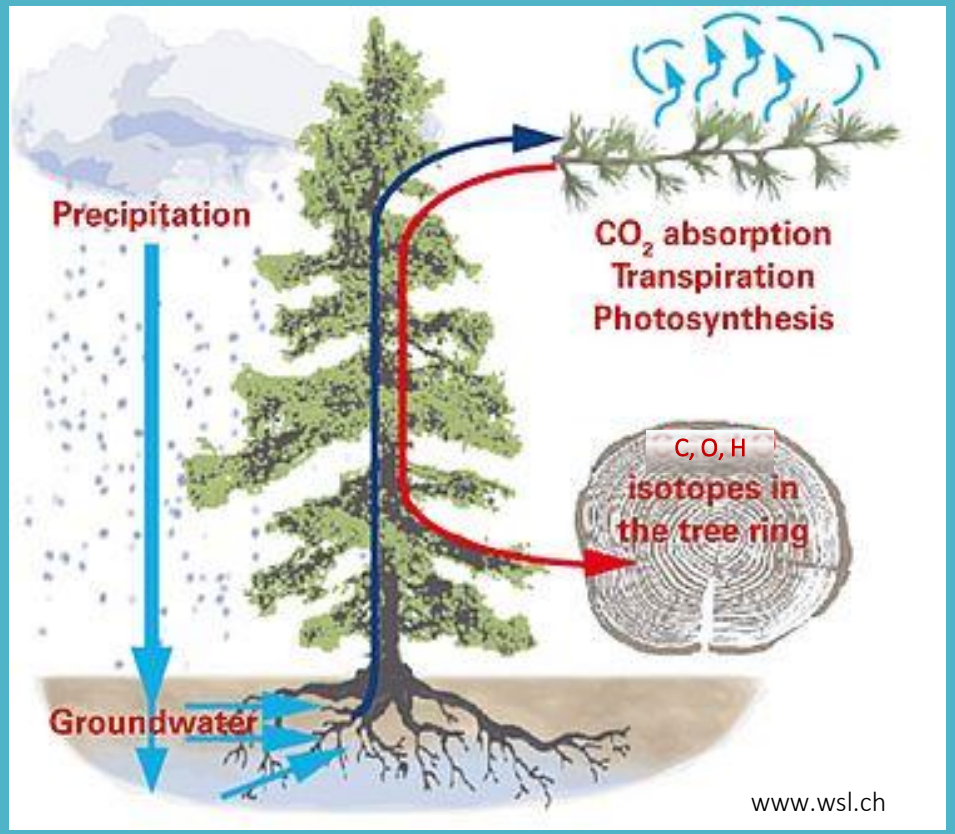
- trees **physiological responses to climate**,
- **tree water use efficiency, and carbon allocation,**

at the net of all variables' interactions and fractionation processes.

$\delta^{13}C$ and $\delta^{18}O$ have been successfully used as indicators of photosynthetic CO_2 absorption, and stomata transpiration.

But much is still unknown about the signal stored in **$\delta^{2}H$**.

What about δ^2H?



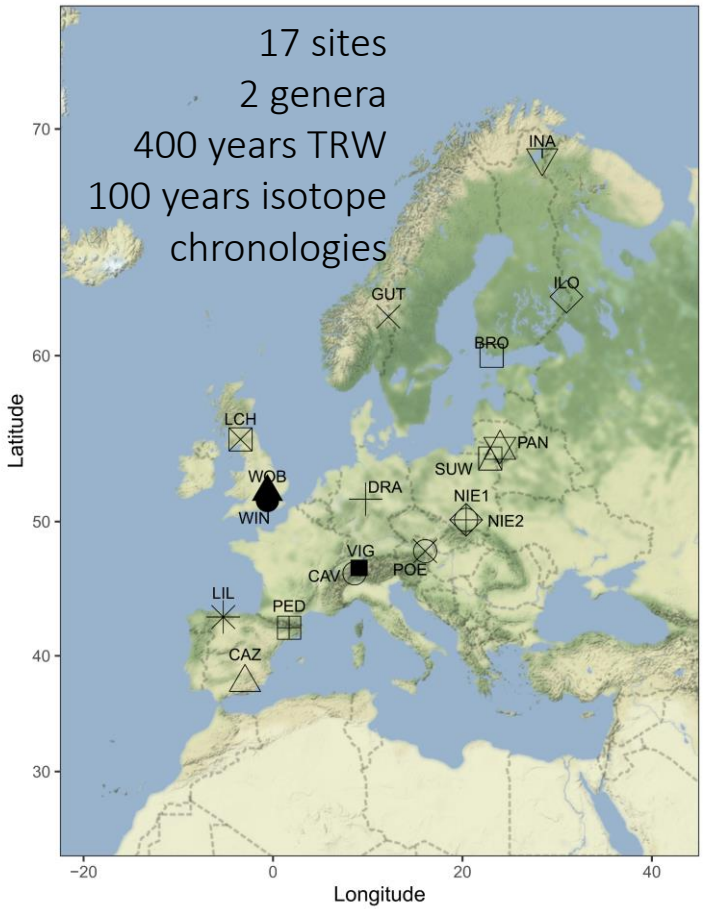
Can we extract a **climatic signal** from δ^2H?

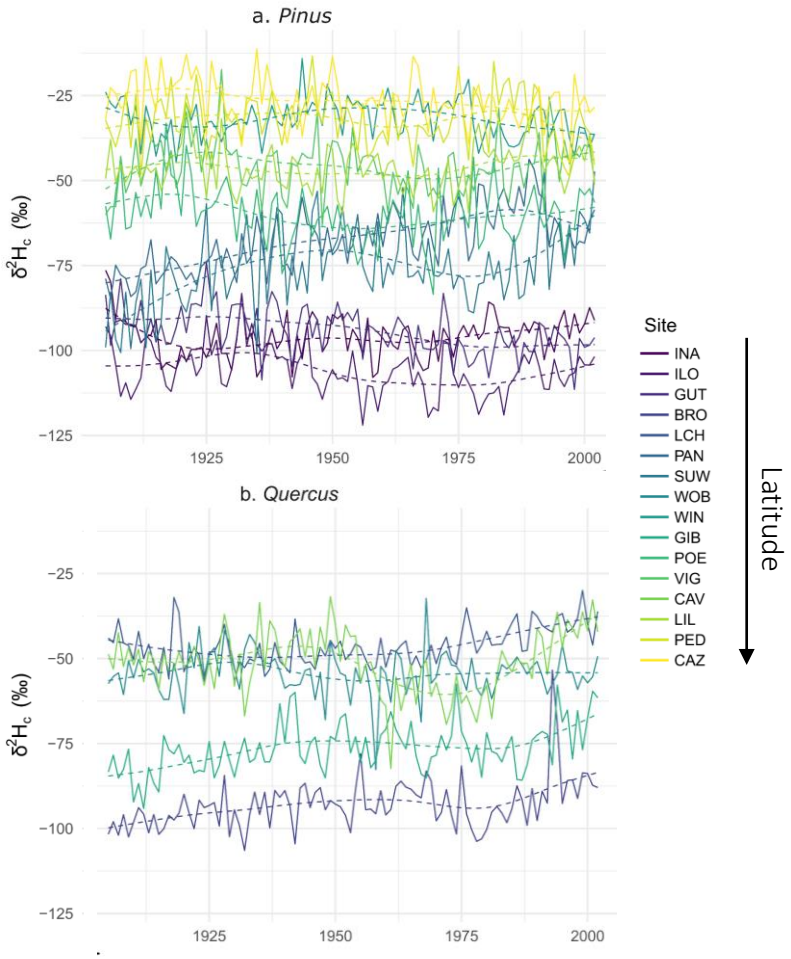
How does it perform in comparison to **$\delta^{13}C$ and $\delta^{18}O$**?

Can we highlight **genera-specific** physiological mechanisms?

How well does the relationship between the water-isotopes hold?

ISONET: European Isotope Network



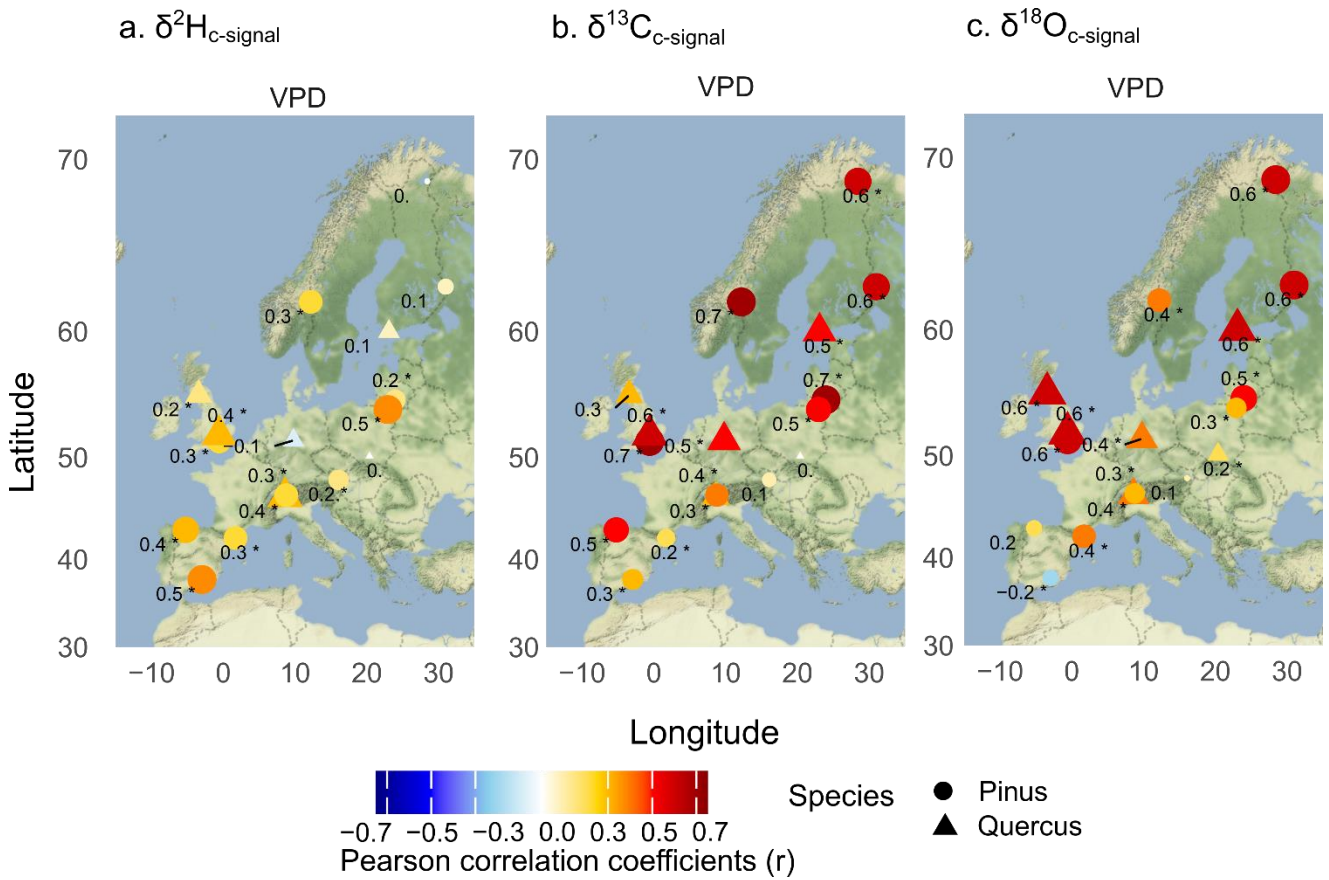


20 studies investigated the ISONET sites **$\delta^{13}C$ and $\delta^{18}O$** chronologies, both at site and EU-level.

But **$\delta^{2}H$** was only investigated in 5 site's studies.

This is the first European-scale study exploring 100-year tree-ring chronologies in both low- and high-frequency domains, to create a baseline for future research on $\delta^{2}H$.

δ^2H, $\delta^{13}C$, $\delta^{18}O$, European-wide century-long climate signals.



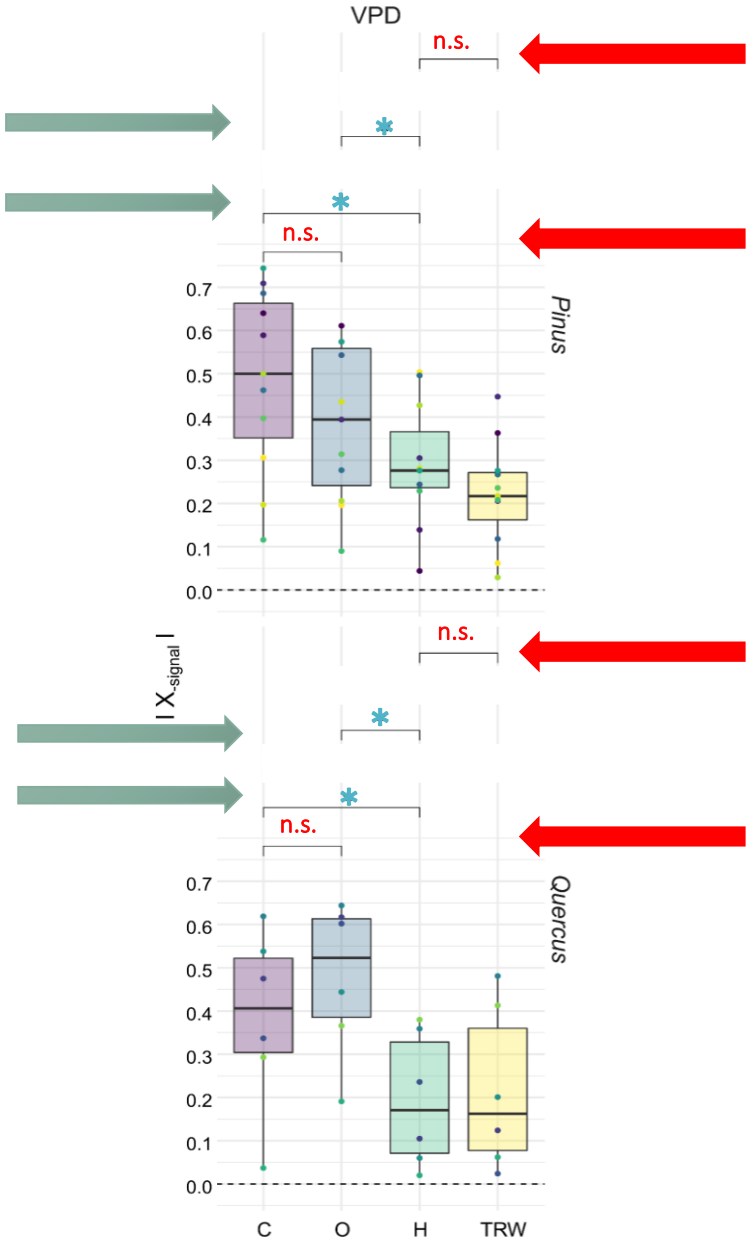
Correlations of tree-ring width and all tree-ring isotopes with summer (June-July-August) VPD, for the 1905-2002 period.

Vitali V., et al. 2021.

$\delta^{13}C$ and $\delta^{18}O$ isotope ratios show **a strong (er)** relation with **summer climate** variables and in particular Summer vapour pressure deficit (VPD), **across Europe**.

The **δ^2H** and tree-ring width climate signals were significantly weaker. and shows **site- and species-specific responses.**

Genera-specific δ^2H climate signal



Correlations of tree-ring width and tree-ring isotopes with summer climate, for the 1905-2002 period, show:

1. A stronger climate signal of Pinus compared to Quercus sp.
2. Significant differences of the climate signal between

$\delta^{13}C$ and $\delta^{18}O$ vs. δ^2H

3. No differences between

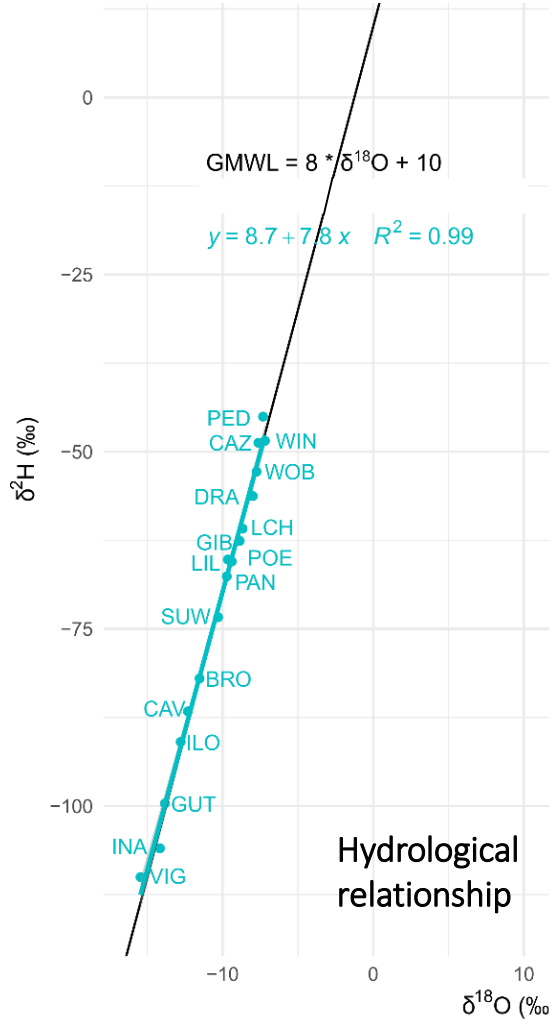
TRW vs. δ^2H

$\delta^{13}C$ vs. $\delta^{18}O$

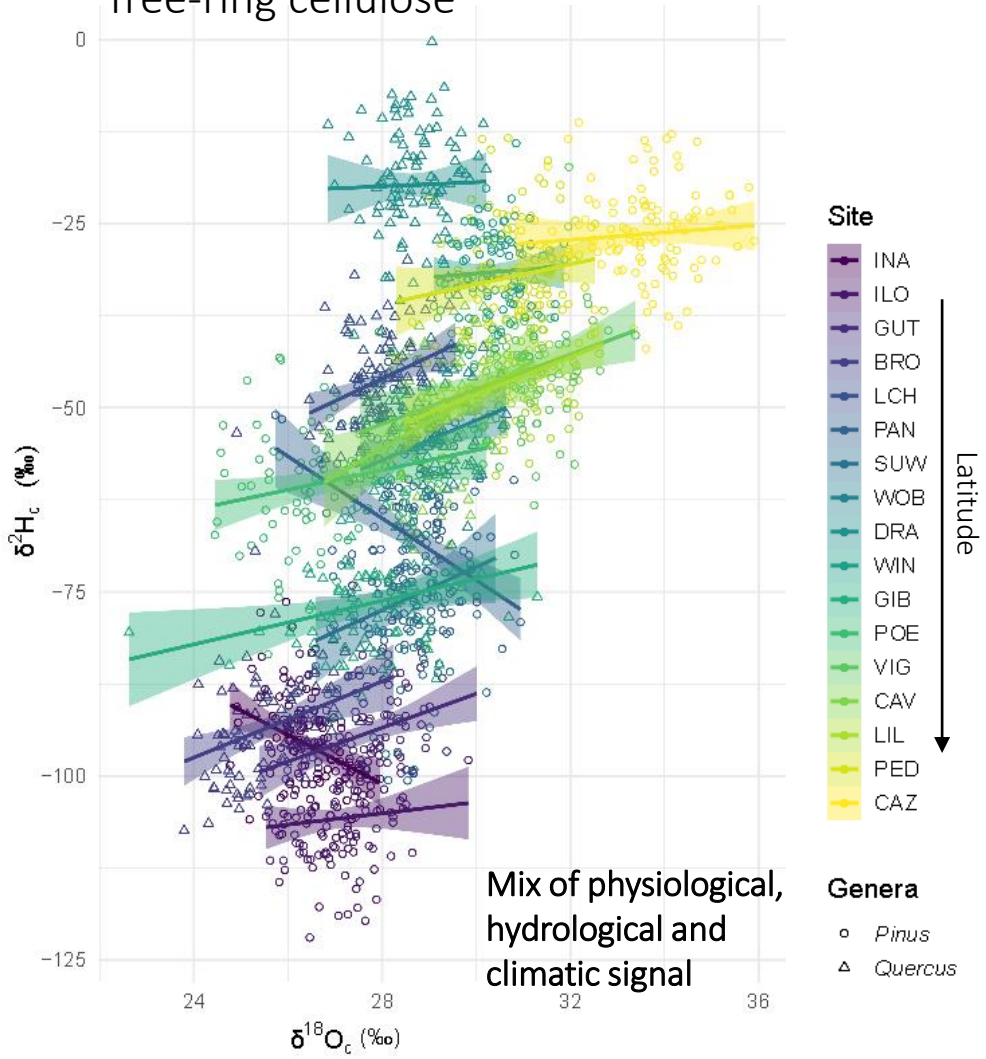
Vitali V., et al. 2021.

The $\delta^{18}O$ - $\delta^{2}H$ relationship: from precipitation to tree-rings

Site-level precipitation



Tree-ring cellulose



The relationship between $\delta^{18}O$ and $\delta^{2}H$ in precipitation is strong and follows the Global Meteoric Water Line.

BUT the $\delta^{2}H$ relationships with $\delta^{18}O$, becomes less strong and **site-specific**, once the isotopes are stored in the tree-rings cellulose.

Therefore the investigation of the **OH-relationship** can be used as an indicator of how tree physiology modifies the hydrological signal given by the source water.

Vitali V., et al. 2021.

The signal stored in $\delta^{2}H$ is significantly different from the one stored in $\delta^{13}C$ and $\delta^{18}O$.

$\delta^{2}H$ shows a lower climate signal compared to $\delta^{13}C$ and $\delta^{18}O$.

The $\delta^{2}H$ climate signal is genera – specific, and likely linked to tree-physiological mechanisms.

$\delta^{2}H$ records a mix of hydrological, climatic, and physiological signals.

! Chances for NEW information from tree-rings isotopes beyond the climatic signal !

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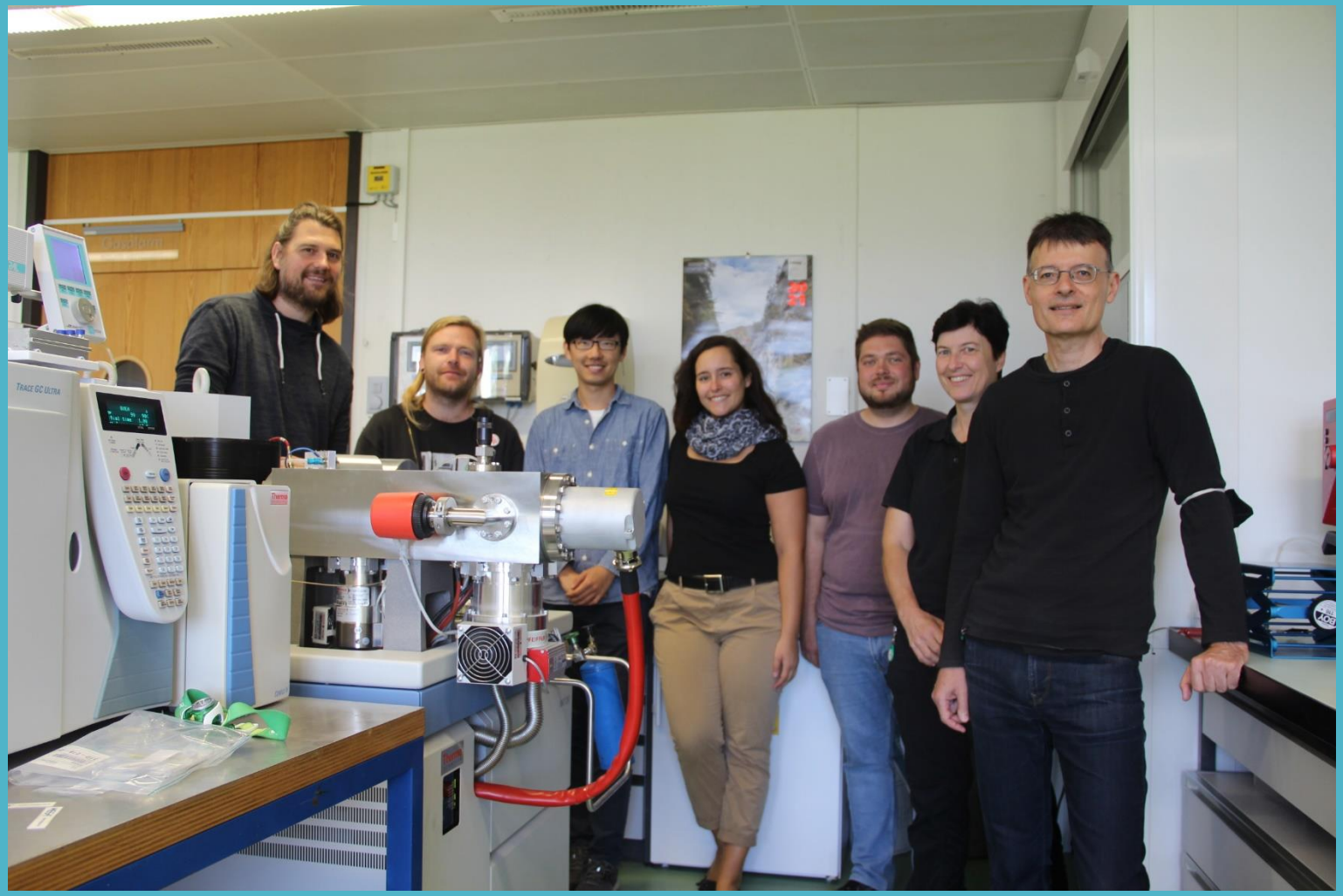

Thank you

Questions @ valentina.vitali@wsl.ch

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