

Supplementary material

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Multi-proxy tree-ring analysis to improve the dating
around the Older Dryas

Multi-proxy tree-ring analysis to improve the dating around the Older Dryas

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To the abstract

Introduction

Swiss Late Glacial tree-ring chronologies cover the period around the Older Dryas (~14,000 cal BP) and are linked to the longest absolutely dated chronology from Germany with an uncertainty of only ± 8 years. The Swiss chronologies are extended by recently published chronologies from southern France. However, both the Swiss and the French chronologies still contain dating uncertainties and could not be cross-dated with each other. This study aims to improve the dating of the Swiss chronologies and to establish a link between the French and Swiss chronologies using a multi-proxy tree-ring approach.

Material & Methods

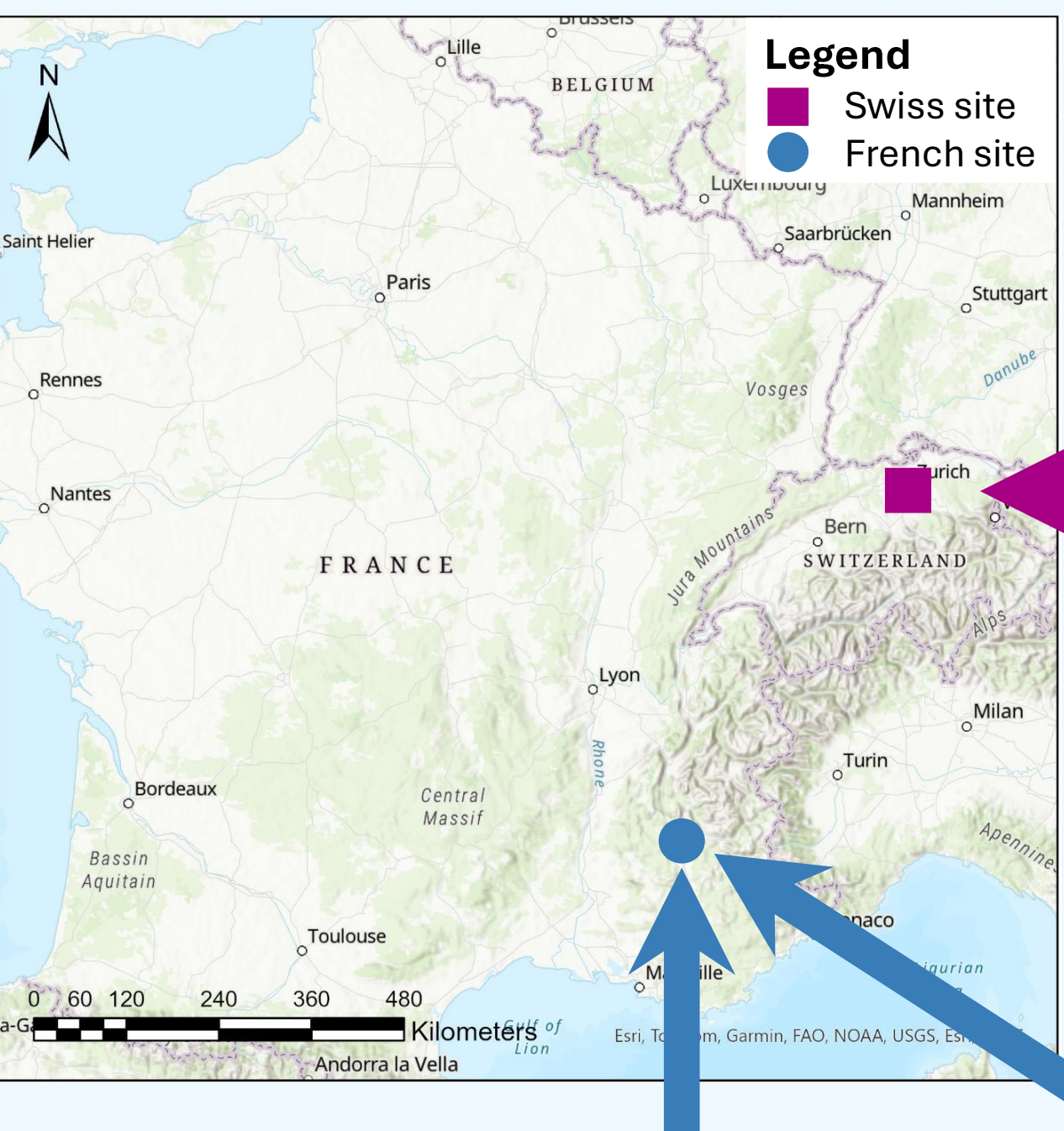


Figure 1: Map from ArcGIS Pro [1], subfossil tree buried in clay from Binz (picture from Reinig [2]), subfossil trees from Drouzet France in loam (picture from Bard [3]), subfossil wood (picture taken by Cécile Miramont, 2024)

- Review of existing data to identify dating uncertainties
- Visual alignment of the previously available radiocarbon data for an improved sample selection
- Radiocarbon Bayesian wiggle matching with 160 new samples
- Stable isotope analysis of 430 new samples
- Multi-proxy tree-ring comparison

Results & Discussion

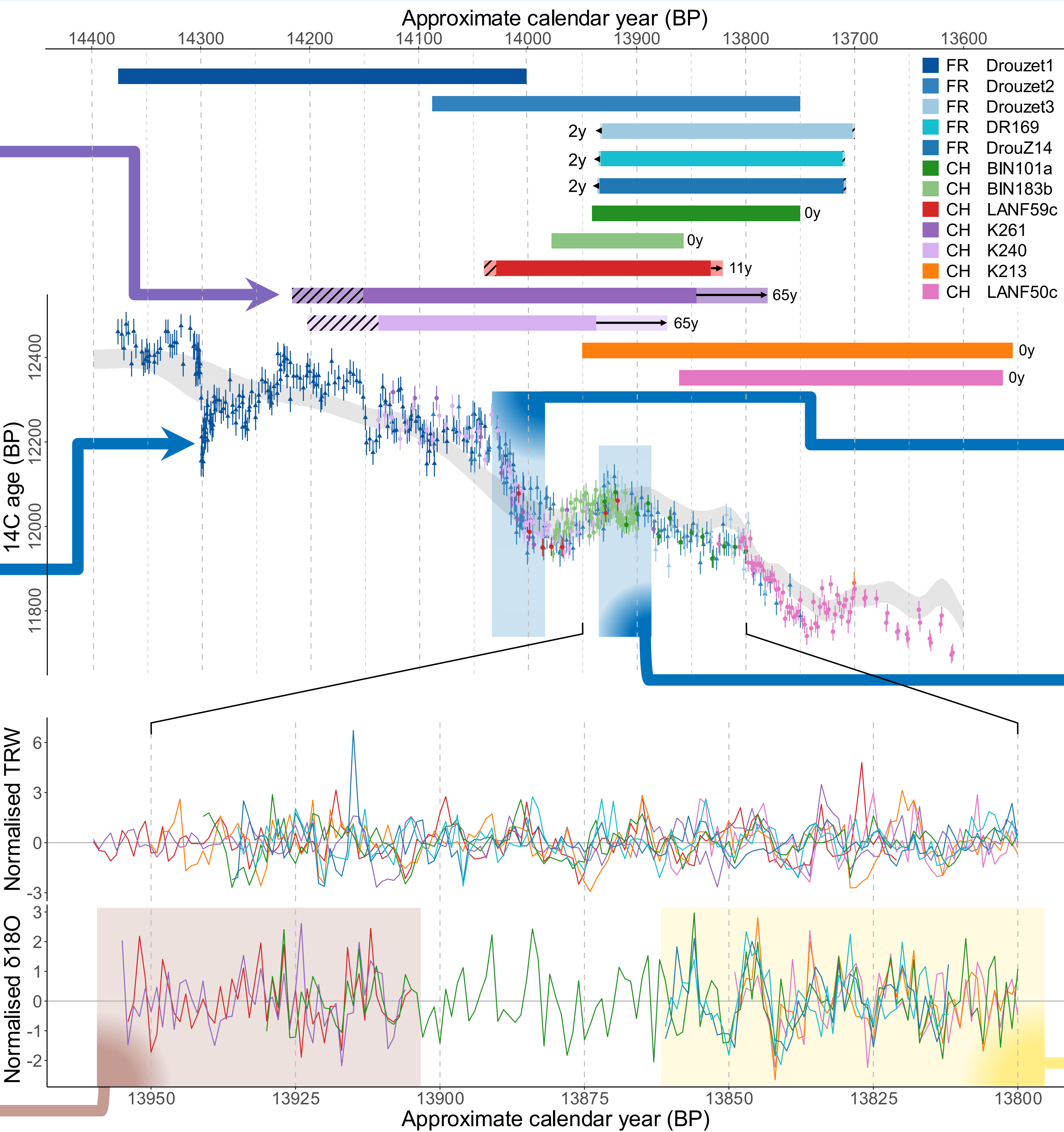
Two trees, K261 and K240, from a Swiss chronology were shifted 65 years younger

Radiocarbon data
(previous [3,4] and new) at the new most likely positions

Solar energetic particle event
~14,300 cal BP [3]

Tree-ring width data
for all trees with oxygen isotope data [2,3], which generally show lower correlations

Significant ($p < 0.05$) Pearson correlation coefficients (r) and Gleichläufigkeit (GLK), but low t -values (0.1-3.8)



Time period
around the Older Dryas ~
14,300 to 13,600 before 1950
(BP)

Dating
of the trees and chronologies
and the shifts to reach the new
most likely positions (no shift
indicated for uncertain cases)

Solar minimum during the
Older Dryas [3]

New potential radiocarbon
feature possibly due to a small
solar energetic particle event

Oxygen isotope data
shows promising and generally
higher correlations

Mostly significant r -values
($p < 0.05$), significant GLK within
the Swiss data, non-significant
GLK within French and between
French and Swiss data, varying
 t -values between (0.1-14)

Conclusion

- Improved dating of the Swiss chronologies around the Older Dryas
- Tentative link established between the Swiss chronologies and the French Drouzet 3 chronology
- The multi-proxy tree-ring approach was essential to identify new links and positions
- Longer overlap periods and more trees should be analysed to further improve the statistical significance
- In the future, precisely dated tree-ring chronologies can enhance synchronisation across proxy archives, and enable climate or solar reconstructions

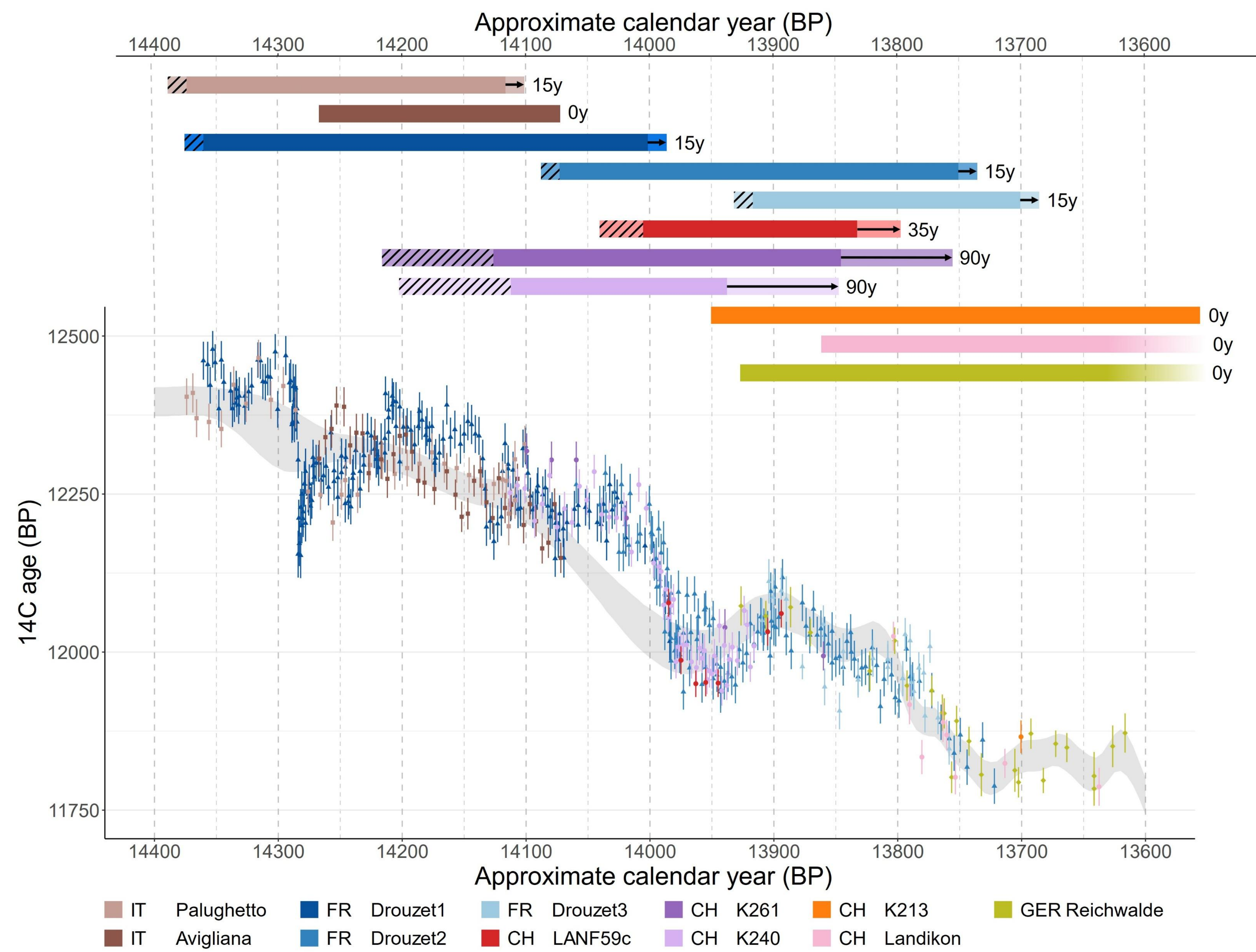


Figure 3: Visual alignment of the previously available and the new radiocarbon data from LANF59c to the German, Reichwalde and the Swiss Landikon data

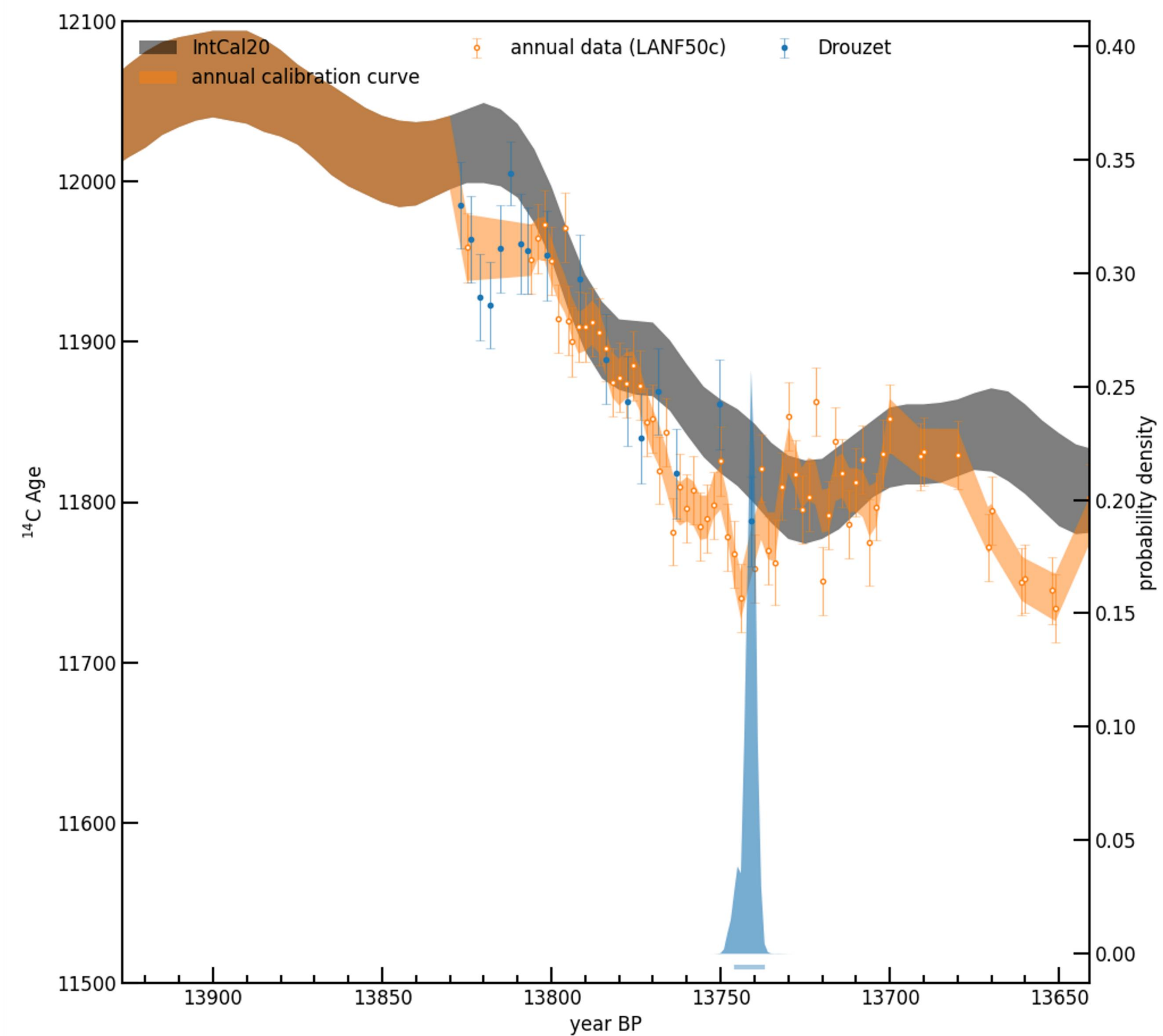


Figure done by Nicolas Brehm

Figure 4: First radiocarbon wiggle match with the new radiocarbon data of the LANF50c tree from the most securely placed Swiss Landikon chronology that was used as reference data and the overlapping data of the French Drouzet 1 and 2 chronologies

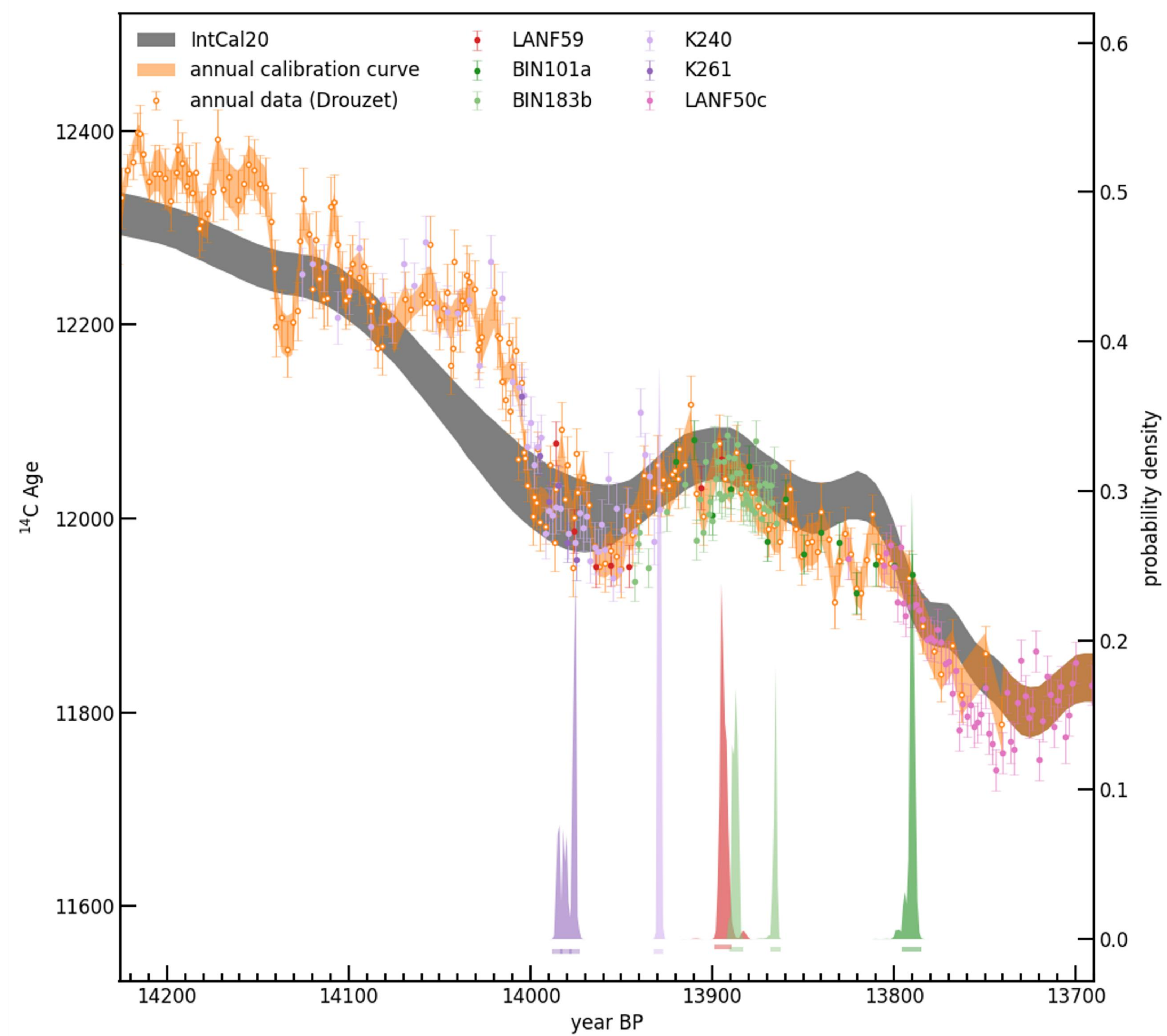


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Figure 5: Second radiocarbon wiggle match with the newly placed radiocarbon data of the French Drouzet 1 and 2 chronologies that was used as reference data and the data of five Swiss trees

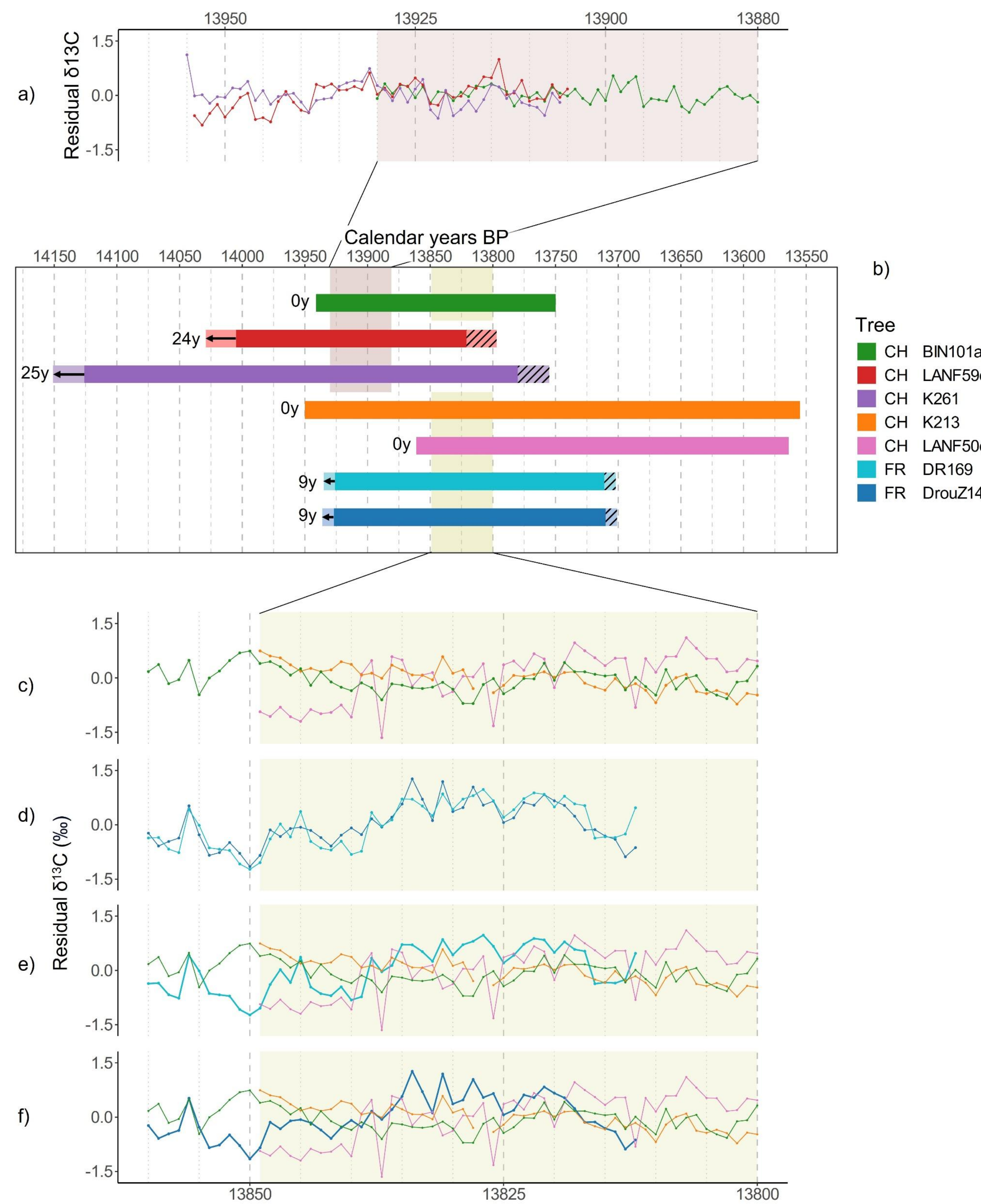


Figure 6: The $\delta^{13}\text{C}$ data which is placed according to the $\delta^{18}\text{O}$ dating. The segments in the middle indicate the dating of the individual trees according to the visual alignment of the radiocarbon data and the shifts suggested by the $\delta^{18}\text{O}$ dating.

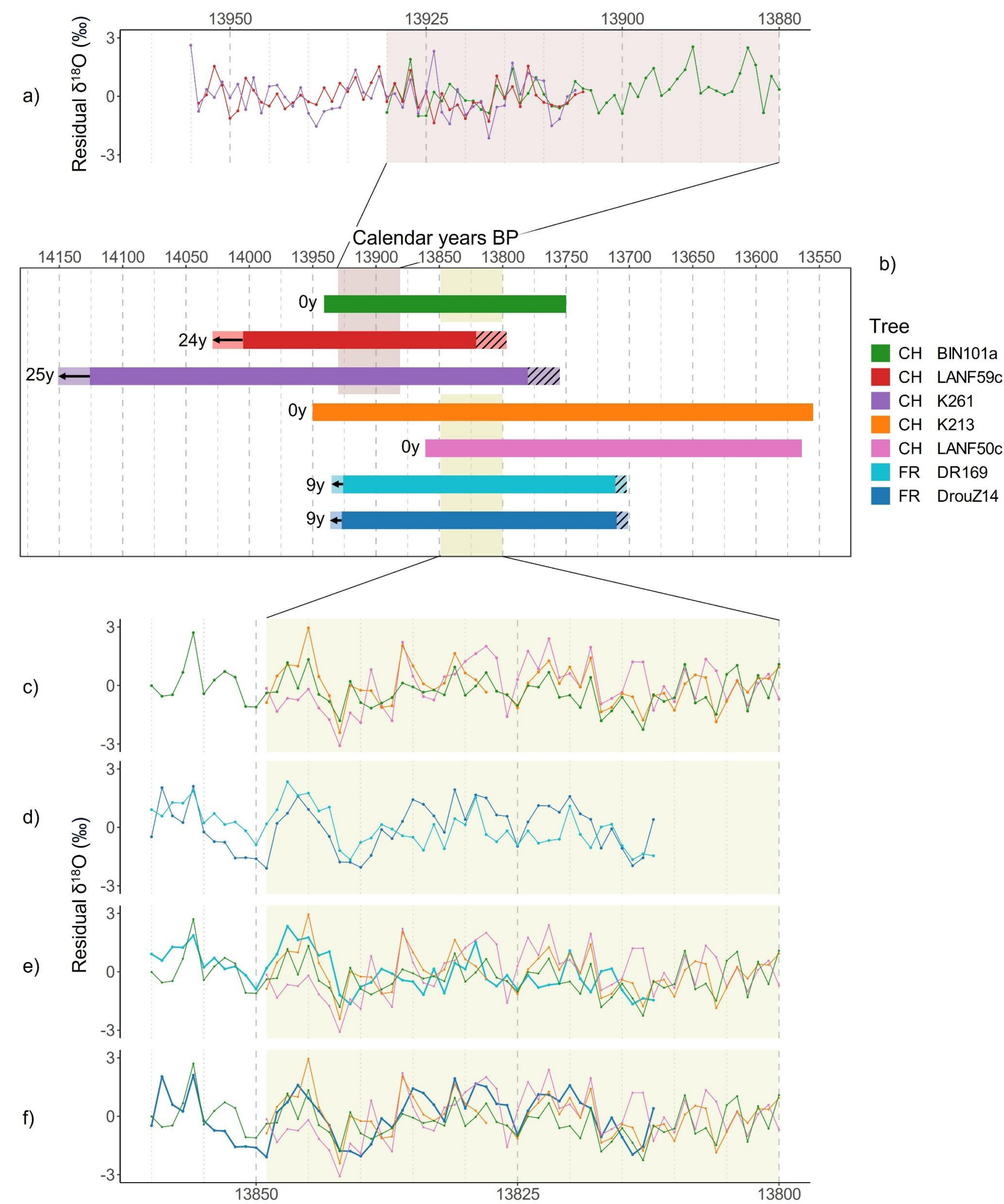


Figure 7: The $\delta^{18}\text{O}$ data which is placed according to the $\delta^{18}\text{O}$ dating. The segments in the middle indicate the dating of the individual trees according to the visual alignment of the radiocarbon data and the shifts suggested by the $\delta^{18}\text{O}$ dating.

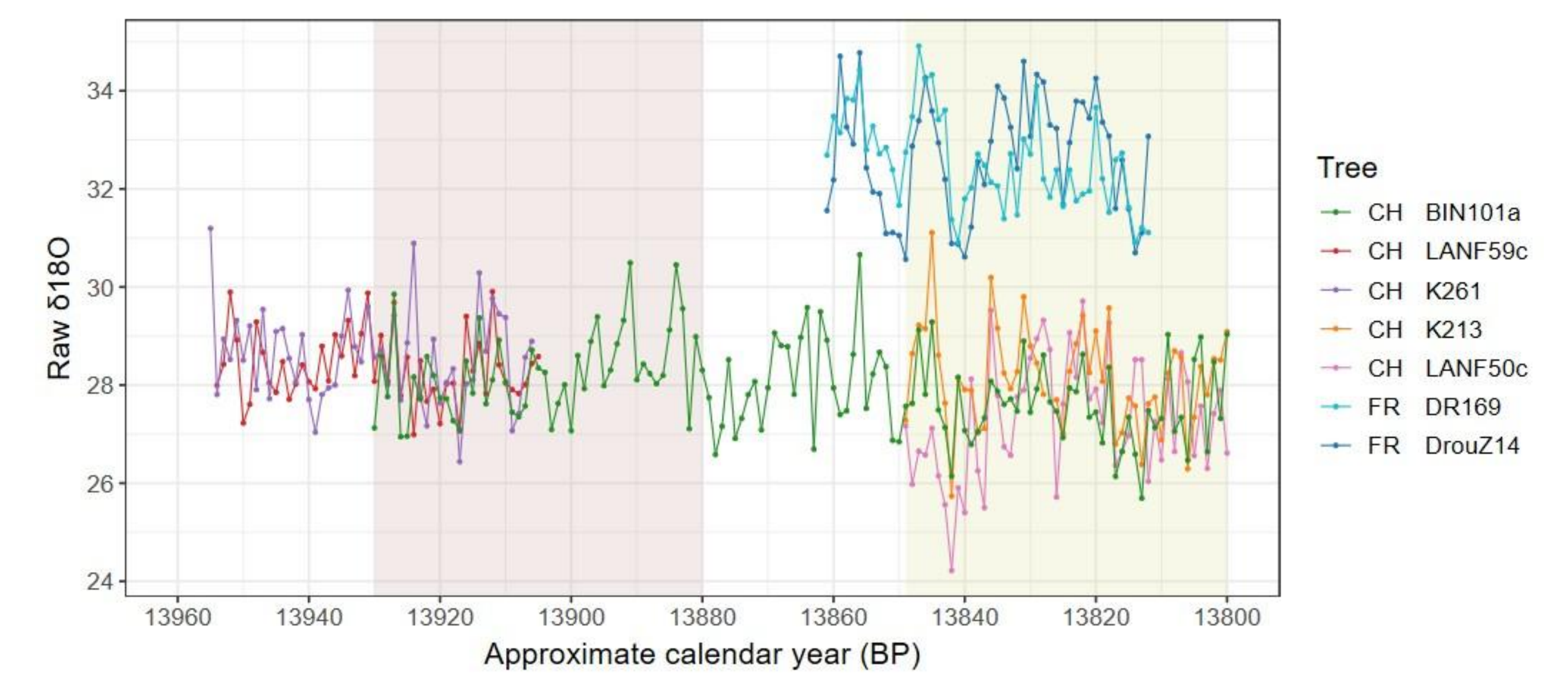


Figure 8: Offset between the raw $\delta^{18}\text{O}$ data of the Swiss and the French trees of approximately 5‰

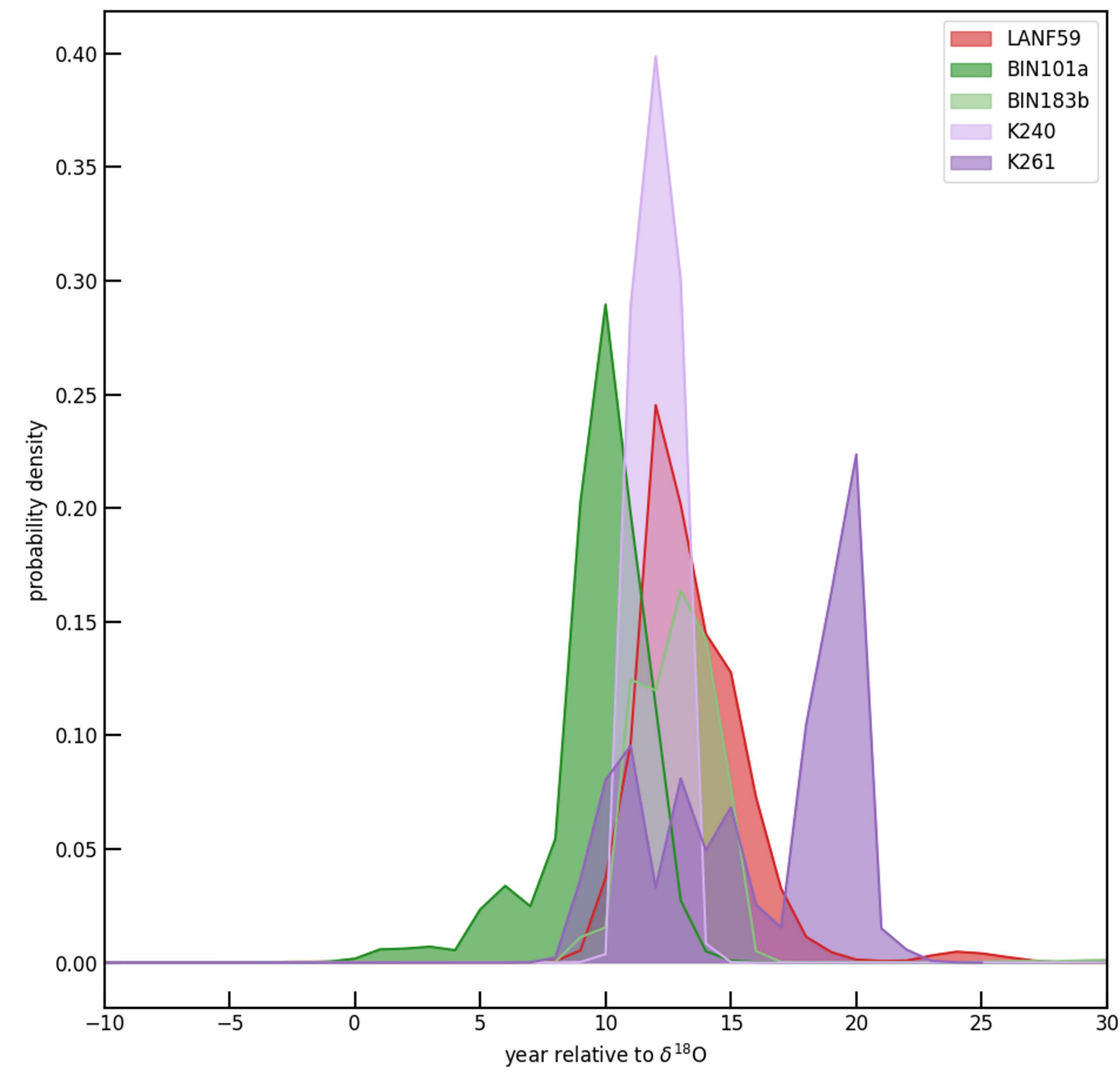


Figure done by Nicolas Brehm

Figure 9: Comparison between the dating according to the radiocarbon wiggle matching and the $\delta^{18}\text{O}$ data

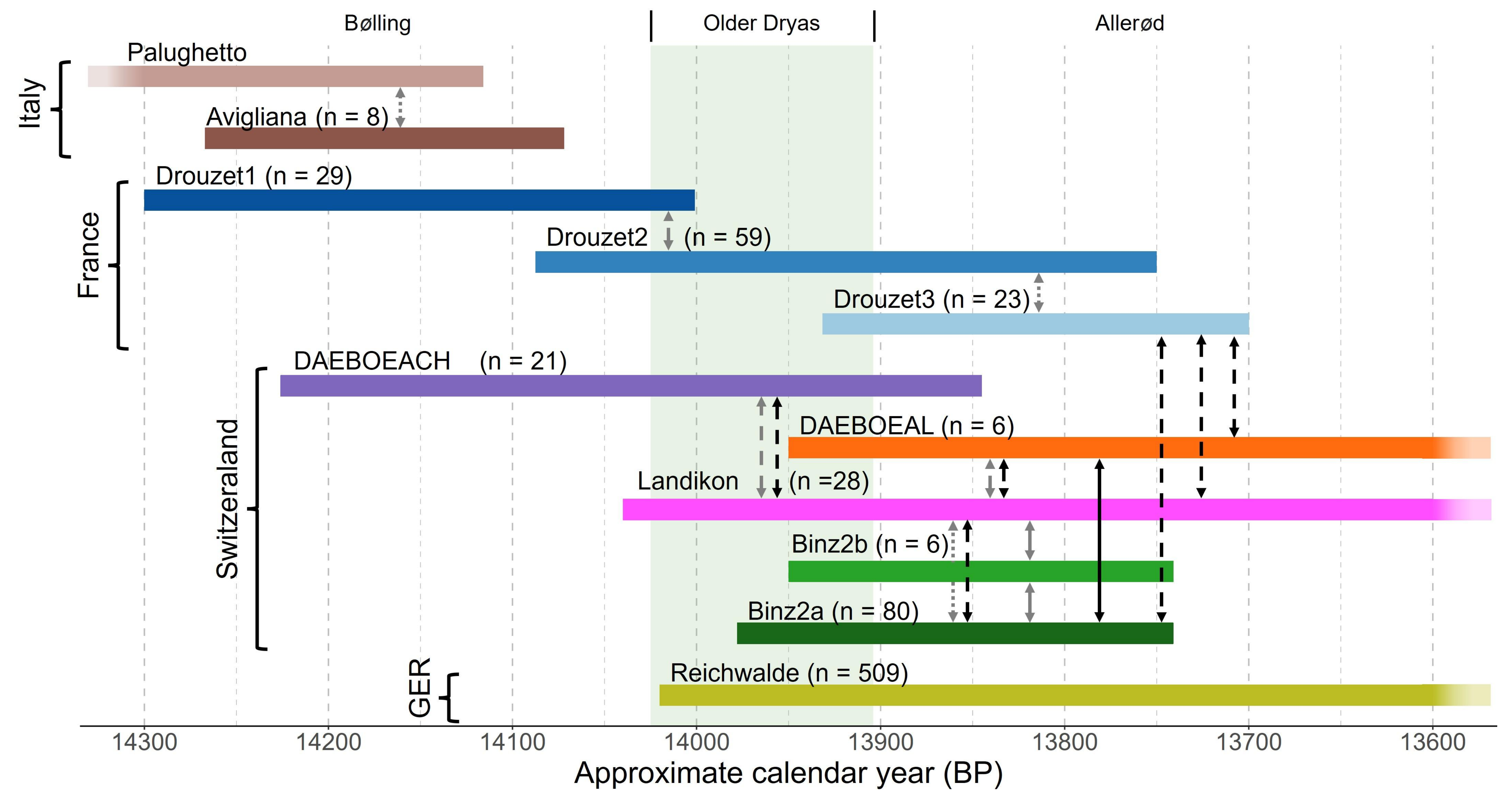


Figure 10: European chronologies around the Older Dryas considered within this work, where black arrows indicate new and grey arrows old links and arrows with solid lines indicate a confident link, dashed arrows a tentative one, and dotted arrows a very tentative one