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Horizontal and vertical variability of d13C in a single Larix decidua from a high altitude site near Simplon, Switzerland

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Only very few studies exist dealing with the reproducibility of stable isotope data from tree rings. In this study, we show that within-tree variability of d13C is significant and has to be considered for the design of sampling strategies and interpretation of results. We analyzed tree rings from European larch (Larix decidua) growing at 1,700 m above sea level in the Simplon area, Switzerland. Samples were taken at seven height levels between 1m and 13m above ground, from a single tree. At each height, we analyzed tree rings representing the 1991-2010 AD period, along six radii every 60 degrees around the stem.

Results show that the circumferential d13C variability, i.e. the difference between maximum and minimum isotope values within a tree ring, is in the order of 0.5 to 2.8 per mil. A comparison of isotope data between different height levels revealed a rather consistent gradient of $\sim$0.1 per mil d13C per meter, with increasing values with stem height.

A comparison of tree-ring d13C with climate data from nearby weather stations revealed that summer temperature explains most of the d13C variability, but also summer (JJA) precipitation from the previous year shows some correlation.

We conclude that it is important to be aware of the vertical isotope gradient, especially when studying subfossil material with unknown and differing height levels. The large circumferential variability we found for Larix decidua at our sampling site suggests that more than only two cores should be analyzed in order to get a reliable isotope signal from each tree. Our results also highlight the need for a better understanding of intra-plant processes which lead to isotope fractionation.