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The relationship between needle sugar δ13C and tree rings of larch in Siberia

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Significant gaps still exist in our knowledge about post-photosynthetic leaf level and downstream metabolic processes and isotopic fractionations. This includes their impact on the isotopic climate signal stored in the carbon isotope composition (δ13C) of leaf assimilates and tree rings. For the first time, we compared the seasonal δ13C variability of leaf sucrose with intra-annual, high-resolution δ13C signature of tree rings from larch. The trees were growing in the continuous permafrost zone of Siberia. Our results indicate very similar low-frequency intra-seasonal trends of the sucrose and tree ring δ13C records with little or no indication for the use of 'old' photosynthates formed during the previous year(s). The comparison of leaf sucrose δ13C values with that in other leaf sugars and in tree rings elucidates the cause for the reported 13C-enrichment of sink organs compared with leaves. We observed that while the average δ13C of all needle sugars was 1.2‰ more negative than δ13C value of wood, the δ13C value of the transport sugar sucrose was on an average 1.0‰ more positive than that of wood. Our study shows a high potential of the combined use of compound-specific isotope analysis of sugars (leaf and phloem) with intra-annual tree ring δ13C measurements for deepening our understanding about the mechanisms controlling the isotope variability in tree rings under different environmental conditions.