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Growth divergence: a challenging opportunity for dendrochronology

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Dendrochronology is an essential cornerstone of paleoclimatology and the evaluation of climate change impacts on forest ecosystems. However, a growing body of literature indicates that the standard dendrochronological approach may too rigorously neglect individualistic tree-growth (e.g. Wilmking et al., 2004, Buras et al., 2016). Amongst others, these studies showed convincing evidence that individual trees of the same species sampled at one site expressed different long-term growth patterns and therefore differing climate-growth relationships. This phenomenon is commonly termed growth divergence (GD) and possibly weakens our ability to correctly estimate past climate variability as discussed in the context of the so-called divergence phenomenon (D'Arrigo et al., 2008). In this context, climate change may naturally select for trees on the stand-level which are better adapted to future conditions. Although GD has been reported for several sites, the standard dendrochronological approach yet does not consider the existence of GD. A possible reason for this methodological persistence is the lack of detailed information on the frequency, magnitude, and impact of GD occurrence.
To assess GD occurrence and related tree-individual variations in climate-growth response we conducted a global GD study by using 134 ring-width data representing 52 tree species and 16 genera distributed over 115 sites across 22 countries. Our analyses clearly reveal GD to be a common phenomenon as occurring in 85 % of all sites. GD was clearly related to the degree of tree-individual differences in climate-growth response. Respective transfer functions which appropriately accounted for GD by selection of tree-cohorts with a high share of long-term variance on average increased the precision and stability of tree-ring based climate reconstructions. Concluding, incorporation of GD assessments into the dendrochronological approach has a strong potential to improve the precision of our predictions of past climates as well as the response of forest ecosystems to climate change.

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