EGU24-6784, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-6784
EGU General Assembly 2024


# Shifting potential for high-resolution climate reconstructions under global warming

**Jernej Jevšenak**[1,2], Allan Buras[1], and Flurin Babst[3,4]
[1]Technical University of Munich, TUM School of Life Sciences, Freising, Germany (jernej.jevsenak@gozdis.si)
[2]Slovenian Forestry Institute, Department of Forest and Landscape Planning and Monitoring, Ljubljana, Slovenia
[3]University of Arizona, School of Natural Resources and the Environment, Tucson, USA
[4]University of Arizona, Laboratory of Tree-Ring Research, Tucson, USA

Tree-ring based reconstructions of climate in pre-instrumental times render a cornerstone of earth-system science and critically rely on statistical relationships between meteorological observations and natural proxy archives. Recent studies have frequently reported that these relationships are not stable in time (non-stationarity), possibly caused by global change (climate, atmospheric $CO_2$), data resolution and quality, and statistical methods applied. Here, we assess the elusive impacts of these factors on the palaeoclimatological potential across the Northern Hemisphere. Scrutinizing spatiotemporal patterns in widely applied validation metrics derived from 3,781 tree-ring chronologies and 517 published dendroclimatic studies, we show that temperature and precipitation sensitivity have increased in the late 20$^{th}$ century. This increase was consistent with trends derived from our meta-analysis. Projecting our results into climate scenarios for the 2021-2040 period indicated further expansion of areas with strong water limitation (+5±2%), whereas the areas with strong temperature limitation were projected to shrink by 8±3% (tree-ring width proxy) and 3±2% (maximum latewood density proxy). Moreover, under increased atmospheric $CO_2$ concentrations and consequently water-use efficiency, water limitation on tree growth may weaken and so the sensitivity to precipitation with consequences for corresponding reconstructions. These spatiotemporal shifts in the climate response of tree growth indicate that continued climate change over the next decades will substantially alter our capacity to establish a robust historical baseline for climate change research. However, our assessment of 517 published climate reconstructions revealed that scientists have, so far, successfully conserved climate signals in trees through refined statistical approaches. But we deem it unlikely that methodological advances will continue to compensate for projected weakening temperature correlations, which will pose a daunting challenge for future temperature reconstructions based on TRW records. Encouragingly, despite minor decreases in projected climate sensitivity, MXD is expected to remain a strong temperature proxy. High-resolution paleoclimatology will thus need new innovations to ensure its continued support of earth system science. Lastly, a better understanding of tree growth response to environmental changes is crucial for accurately addressing non-stationarity in climate reconstructions.

Jevšenak, J., Buras, A., Babst, F., 2024. Shifting potential for high-resolution climate reconstructions

under global warming. Quaternary Science Reviews 325, 108486.