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Reaction of monsoonal temperate valley glaciers in southeast Tibet to climate change inferred from tree-ring proxies

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South- and Southeast Asia is home to more than one third of the world's population, with the monsoon system as the main provider of precipitation. While the glaciers act as a reservoir, the system is characterized by a high year-to-year variability. Presuming a changing climate, this combination means great vulnerability of the whole region. The reconstruction of patterns regarding onset, intensity and duration of the different monsoonal branches poses therefore an important and challenging task since high-quality instrumental climate data is sparse in High Asia.

Our paleoclimatic study is based on two approaches: a) the analysis of different dendrochronological parameters to disentangle and to reconstruct monsoonal activities in southeast Tibet, and b) the dating and analysis of recently developed glacial landforms due to climate warming.

Our analyses include dating of glacial moraine stands, as well as an inter-site comparison with regards to date and speed of glacial shrinkage since the Little Ice Age (LIA). Subject to our studies were four glaciers of different size and altitude of the accumulation and ablation area. While the resulting landforms and processes are divers, all studied glaciers react very similar in terms of beginning and speed of their retreat. Also, two major phases of retreat and advance at around 1670 AD and 1745 AD can be deduced from tree-ring data in case of all studied glaciers. The findings are confirmed by side-to-side geochemical analyses of glacial and glacio-fluvial sediments.

While the tree stands on the lateral LIA moraines remain nearly undisturbed since around 1750, the terminal moraines offer only much younger material (maximum 80 years). This points towards an active moraine deposition until the beginning of the 20^{th} century. These findings indicate a pronounced thickness reduction since the LIA, while length reduction of the tongue and development of dead ice bodies occurred only very recently.

Regarding the tree-ring parameters, each is known to react specifically to a set of climatic and environmental variables. Within this multi-proxy approach are time series of tree-ring width (TRW), maximum latewood density (MXD) and stable oxygen isotopes (δ^{18}O). First results show a high synchronicity between ring width and MXD in cases of extreme events, whereas the oxygen isotope variations display a long-term variability of summer monsoon precipitation. While TRW seems mostly dependent on local to regional climate, MXD shows higher synchronicities on a regional level. δ^{18}O values are in good accordance with other regional δ^{18}Ochronologies. Regarding this, the effects of recent climate warming scenarios can be depicted: While changes on the global to regional level occur subtle and slowly, local effects can be triggered fast and thus sometimes contradict the general trend. The resulting patterns provide a complex picture, which requires further statistical analysis.