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Local expression of centennial large scale climatic trends and excursions in the Central Himalayas inferred from tree ring isotopes

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The Himalayas have a large impact on the surrounding lowlands and provide vital services including drinking water, hydropower generation and agricultural sustainability. Climate change is currently affecting the provision of these services, with substantial economic and social consequences. To date, very little is known about the sensitivity of the largest mountain range on Earth to global climate change and oscillations. Particularly over the last century, the planet has experienced unprecedented climatic trends and fluctuations with an unclear impact on the meteorology of the sensitive Himalayan latitudinal transect.
Due to the roughness of the terrain and the remoteness of the trans-Himalayas, instrumental data as well as remote sensed data cover only a limited period, are sparsely distributed and often poorly calibrated. Thus, hydroclimatic proxies, such as oxygen stable isotope ratios in cellulose of tree-rings, are amongst few archives the only source of data to unlock yearly resolved information over the past centuries.
We reconstruct the hydro-climatic variability of the trans-Himalayan region, testing whether an impact of large-scale climate variability is detectable and probing the reaction of meteorology to global drivers. The study spans from trend analysis and breakpoints identification to characterization of extreme years and their spatial propagation.
Here, we present three centennial records of monsoon dynamics, along a latitudinal transect, spanning a pronounced precipitation gradient across the Himalayan orogeny. Three sites were selected along the Kali Gandaki valley in the central Himalayas (Nepal). This valley connects the wet, monsoon dominated Gangetic plain with the arid Tibetan Plateau cutting across and beyond the High Himalayan orographic barrier. The transect covers the sensitive northern end of the precipitation gradient, located in the upper part of the catchment.
The isotope chronologies of these sites span a period of 80-120 years and show a contribution of different water sources. Although the Indian summer monsoon provides the first order water supply in Central Nepal, its contribution is significantly complemented by relatively enriched recycled continental circulation characterizing pre-monsoon rainfall. Moving further north into the Tibetan plateau, the contribution of precipitation to the tree isotopic records is modulated by a progressive increase of temperature and transpiration. Inflexion points in the reconstructed precipitation records match the timing of the main breaks in the global temperature record, reflecting a local expression of a global process. Additional support for a large scale atmospheric circulation imprinting local precipitation dynamics was found in the correlation between isotope anomalies and ENSO events. We link the latitudinal propagation of these extreme events across the orogeny with patterns of intensity and location of sea surface temperature (SST) anomalies.
In doing this, we conclude that significant connection exists between the rapidly changing global climate and the regional Himalayan meteorology.