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Introduction

Pollen transfer functions are currently one of the most reliable methods for paleoclimate modelling of continental Mean Annual Air Temperature (MAAT) and Mean Annual Precipitation (MAP). Over the last few decades, molecular biomarkers have emerged as a powerful alternative to pollen transfer functions in continental settings. The fractional abundances of branched glycerol dialkyl glycerol tetraethers (brGDGTs) are a promising tool known to be related to climate parameters via the soil/lacustrine bacterial communities.

In extremely arid environments such as the mountainous areas ranging from Arid Central Asia (ACA) to Sibero-Mongolian Khangai, a coupled pollen-brGDGT climate approach has been tested to provide robust estimates of Holocene climate and environment changes. The two proxies were calibrated for both global (Naafs et al., 2017a, b) and local (NMSDB, Dugerdil et al., in press) modern datasets. The multiproxy approach was then applied to a sediment core from Lake Ayrag, Arkhangai, covering the Late Holocene.

Results

The 4,000 year cal BP sequence from Lake Ayrag documents the Late Holocene climate and human impact variations. While the globally calibrated records (both for pollen and brGDGTs, Figure 1) display a slight millennial-scale cooling, the local calibration highlights centennial-scale climate oscillations such as the Little Ice Age (LIA), Warm Medieval Period (WMP), Dark Ages Cold Period (DACP), Roman Warm Period (RWP), and the 3.8 kyr and 4.2 kyr events. Climate oscillations are discussed in regards to the main Mongolian human historical occupation events also documented by pastoralism proxies (anthropogenic pollen indicator and dung fungal spores bumps).

Both pollen and biomarkers show an anti-correlated trend between MAAT and MAP: over the last 4,000 ky cal BP, the warm periods (WMP, RWP) were dry and the cold periods (LIA, DACP) were wetter. Thus, the East Asian Summer Monsoon (EASM, i.e., warm and wet conditions during the summer season) seems not to influence central Mongolian climate during the Late Holocene, which stayed dominated by the Westerlies / Siberian Highs circulation conflict.

Conclusions

The EASM front oscillated since the Holocene Optimum, and its consequences for the dry ACA areas are determinant to improve our understanding of climate changes' impacts on human societies. In this context, the central mountainous part of Mongolia (Khangai range) has been set apart. At a larger scale, a climate synthesis following the same approach (brGDGT vs. pollen-inferred climate) for all of the ACA records available for the Holocene should help us to better delineate the climate systems paced by centennial to millennial oscillations and their consequences for human societies.
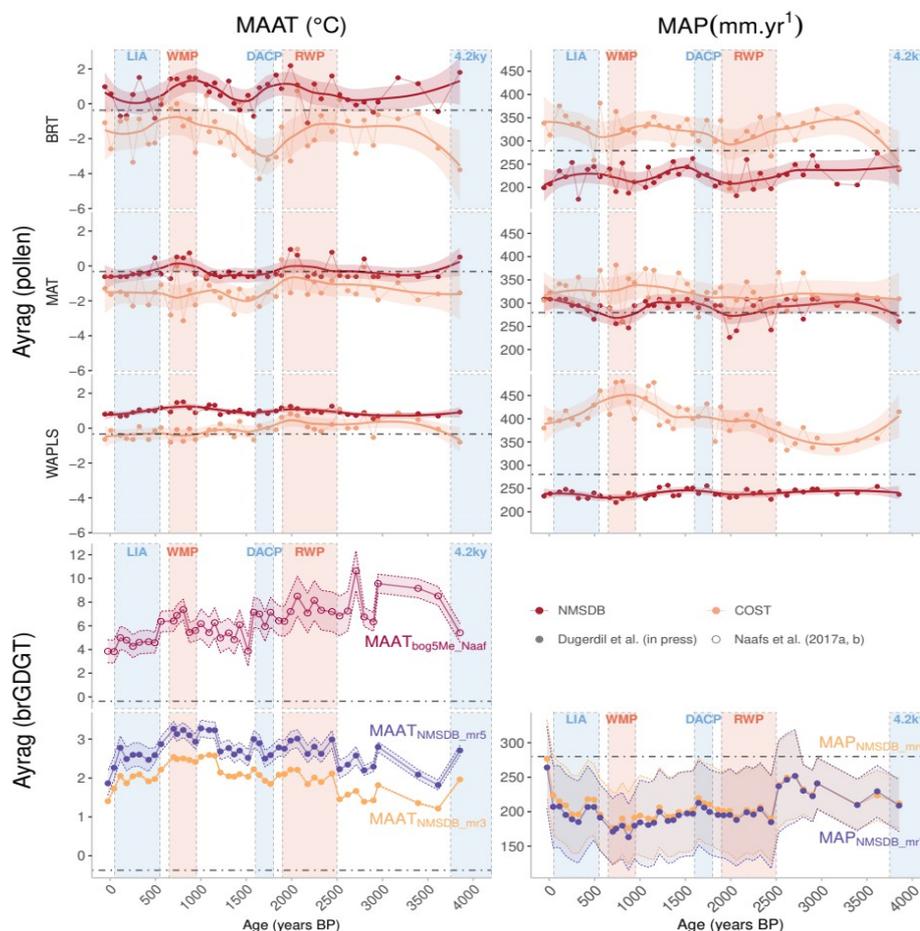
Figure 1 *Comparison of MAAT (left part) and MAP inferred from pollen data with a multi-method approach, including Boosted Regression Trees (BRT), Modern Analogue Technique (MAT) and Weighted Averaging Partial Least Squares regression (WAPLS), and brGDGT from local (Dugerdil et al., 2020) to global calibrations (Naafs et al., 2017a, b).*

References

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