Towards a peat-specific temperature proxy based on brGDGTs

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The majority of our knowledge of past climate comes from marine sediment records. While being a crucial component of the global climate system, our understanding of continental climate in the geological past remains limited. Potentially powerful continental climatic insights could come from the distributions of branched glycerol dialklyl glycerol tetraethers (brGDGTs). They can be used to generate high resolution continental temperature records but their application in peat – and by extension lignite (fossilized peat) – is poorly constrained and considered problematic. Thus, these archives have not been exploited, despite the fact that they contain abundant brGDGTs, are widespread, and span the last ~ 140 million years.

We explored the controlling mechanisms of the brGDGT distribution in peats using a newly generated global peat database (spanning a mean annual temperature range from 1 to 26 °C). Similar to what has been previously observed in soils and lakes, temperature appears to exert a dominant control on the degree of methylation of brGDGTs in peats. However, downcore peat records can show abrupt and significant changes in brGDGT distribution (e.g. across acrotelm/catotelm boundary), arguing for caution. These changes in brGDGT distributions likely reflect changes in microbial communities with depth. However, changes in peat vegetation or water table depth do not appear to significantly influence the brGDGT distributions. Guided by these results we tentively generate a novel global peat-specific temperature proxy ($MAAT_{peat}$) based on the degree of brGDGT methylation. Importantly, this proxy (and calibration) are significantly different to the available brGDGT lake and soil-calibrations. The development of a peat-specific temperature proxy opens up a completely novel set of palaeo-archives: peats and lignites, and will aid in our understanding of continental climate in the geological past, especially during greenhouse episodes such as the Paleogene, from which many lignites are preserved.