Southern Africa is a semi-arid region with few terrestrial climate archives spanning the Last Glacial Maximum. Therefore, there is much uncertainty around how the region responded to global climate shifts since the Late Pleistocene. Moreover, due to quantitative temperature proxies being particularly challenging, they have not been commonly employed in producing high resolution temperature reconstructions for the Southern African region. We applied the branched glycerol dialkyl glycerol tetraethers (brGDGTs) proxy to reconstruct mean annual air temperature (MAAT) from the Mfabeni peatland basin. This peat deposit is a continuous sedimentary record which recorded palaeoenvironmental conditions since c. 47 cal kyr BP. We then compared the MAAT with previously published bulk geochemical (Baker et al., 2014) and other biomarker (Baker et al., 2016; 2018) data to delineate the relationships between temperature and different paleoenvironmental parameters (Figure 1). The reconstructed MAAT for the upper interval (-16 cal yr BP; 23.4°C) is comparable with contemporary MAAT, underpinning the application of brGDGT proxy in this setting (Naafs et al., 2017). We found that the MAAT varied throughout the accumulation history of the peatland, with the maximum temperature recorded at c. 29.7 cal kyr BP (27.5 °C) and minimum at c. 14.8 cal kyr BP (12.5 °C). When comparing the MAAT data with the relative temperature saturated/unsaturated n-alkanoic acid (sat/unsat_FA) proxy, we found they correlate significantly during the Late Pleistocene. However, this relationship breaks down during the Holocene, and the %TOC showed a weak correlation with the MAAT data during the Holocene. The n-alkane aquatic plant proxy (P_{aq}), which has been used to reconstruct basin water levels, exhibited minimal correlation with MAAT, more so in the Holocene than Late Pleistocene. These data infer that the region experienced relatively elevated, albeit fluctuating MAAT during the Late Pleistocene and lead up to the Last Glacial Maximum (c. 24 to c. 19 cal kyr BP) with temperatures only increasing after the mid deglaciation (c. 15 cal kyr BP). This is supported by the relative sat/unsat_FA temperature proxy (Baker et al., 2016). The Holocene exhibited persistent elevated MAAT and displayed a muted correlation with %TOC, a physical parameter for peat accumulation. The lack of significant correlation between MAAT and P_{aq}, suggests there is no direct link between regional temperatures and precipitation. The breakdown in the co-variant relationship between the two temperature proxies (MAAT and sat/unsat_FA) infers that the peat accumulation regime in the late Pleistocene was largely controlled by microbial activity, while during the Holocene, due to persistent elevated temperatures that are conducive for the proliferation of higher plants, high sedimentation rates dictated peat formation.
Figure 1: Bulk geochemical and biomarker proxies of the Mfabeni peatland, Isimangoliso Westland park, KwaZulu Natal, South Africa. Percentage total organic carbon (%TOC); mean annual air temperature (MAAT) as calculated from distribution of brGDGTs; saturated / unsaturated n-alkanoic acids (sat/unsatFA); n-alkane aquatic plant proxy (P_{aq}).

References:

Baker et al., 2018. n-Alkan-2-one biomarkers as a proxy for palaeoclimate reconstruction in the Mfabeni fen, South Africa. Organic Geochemistry. 120, 75–85.

