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Lipid-based palaeotemperature reconstruction in lakes: New insights on the applicability of branched GDGTs in lacustrine sedimentary archives

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Branched glycerol dialkyl glycerol tetraethers (brGDGTs) are bacterial membrane lipids that occur ubiquitously in soils worldwide. The relative abundances of nine structurally related brGDGTs (used in the MBT and CBT indices) have been shown to correlate with mean annual air temperature (MAAT) and soil pH, making them potential proxies in sediments that receive soil organic matter from terrestrial environments. The brGDGT distributions in lake deposits, however, mostly follow a different correlation with air temperature and (to a minor extent) lake water pH. This points to a substantial contribution of brGDGTs from in situ production within the lake water column and/or -sediments. It is also quite likely that the fractions of soil- and lake-derived brGDGTs vary considerably between sampling sites and with time, due to spatial and temporal changes in sediment input rates. Paleoclimate reconstructions using lacustrine brGDGT records thus remain challenging, especially because little is known about the environmental variables that control bacterial brGDGT production within aquatic environments. In order to decipher the impact of in situ production, we compared the brGDGT composition of surface sediments and corresponding catchment soils of 35 lakes from the Swiss alpine region, spanning an altitudinal gradient from 200 – 2000 m above mean sea level. We used an improved HPLC method to additionally quantify six recently discovered isomers, which vary in the position of their methyl branches. These 6-methyl compounds previously co-eluted with those brGDGTs used to calculate the MBT and CBT indices, obscuring any paleoenvironmental information they potentially yield. A principal component analysis suggests that the fractional abundances of the 6-methyl brGDGTs are primarily controlled by the surface water pH of the lakes. Notably, and in contrast to soils, the fractional abundance of the 5-methyl pentamethylated brGDGT in lake sediments does not show a correlation with MAAT (derived from the lapse rate model), possibly pointing to different source organisms in soils and lakes. Our results imply that in situ production of brGDGTs plays a mayor role. By further constraining the environmental controls on lake-derived brGDGTs, we aim to improve the future applicability of brGDGT-based proxies in lacustrine climate archives.