Bacterial GDGTs in Holocene sediments and catchment soils of a high Alpine lake: application of the MBT/CBT-paleothermometer

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A novel proxy for continental mean annual air temperature (MAAT) and soil pH, the MBT/CBT-paleothermometer, is based on the temperature (T) and pH-dependent distribution of specific bacterial membrane lipids (branched glycerol dialkyl glycerol tetraethers – GDGTs) in soil organic matter. Here, we tested the applicability of the MBT/CBT-paleothermometer to sediments from Lake Cadagno, a high Alpine lake in southern Switzerland with a small catchment of 2.4 km2. We analysed the distribution of bacterial GDGTs in catchment soils and in a radiocarbon-dated sediment core from the centre of the lake, covering the past 11 000 yr. The distribution of bacterial GDGTs in the catchment soils is very similar to that in the lake's surface sediments, indicating a common origin of the lipids. Consequently, their transfer from the soils into the sediment record seems undisturbed, probably without any significant alteration of their distribution through in situ production in the lake itself or early diagenesis of branched GDGTs. The MBT/CBT-inferred MAAT estimates from soils and surface sediments are in good agreement with instrumental values for the Lake Cadagno region (0.5 řC). Moreover, downcore MBT/CBT-derived MAAT estimates match in timing and magnitude other proxy-based T reconstructions from nearby locations for the last two millennia. Major climate anomalies recorded by the MBT/CBT-paleothermometer are, for instance, the Little Ice Age (14th to 19th century) and the Medieval Warm Period (MWP, 9th to 14th century). Together, our observations indicate the quantitative applicability of the MBT/CBT-paleothermometer to Lake Cadagno sediments. In addition to the MWP, our lacustrine paleo T record indicates Holocene warm phases at about 3, 5, 7 and 11 kyr before present, which agrees in timing with other records from both the Alps and the sub-polar North-East Atlantic Ocean. The good temporal match of the warm periods determined for the central Alpine region with north-west European winter precipitation strength implies a strong and far-reaching influence of the North Atlantic Oscillation on continental European T variations during the Holocene.
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