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Fluctuating lake levels in humid climates: a suitable proxy of past precipitation?

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Precipitation is a fundamental climate parameter essentially in arid and semi-arid climates, but changes in precipitation may have influenced Holocene vegetation development and human occupation in humid climates as well. However, past precipitation is notoriously difficult to reconstruct because the proxies available are widely imprecise. For example, peatland proxies such as testate amoebae are suited to reconstruct wet and dry periods of the local environment but they are poorly suited to quantify precipitation. In contrast, lake levels potentially provide a closer link to the past precipitation. In our case study, isolated lakes in the Schorfheide area (NE-Germany), fed by groundwater and rain, show at present prominent water level fluctuations that are closely correlated to annual to decadal changes in precipitation. But are these lakes indeed suitable archives to reconstruct past precipitation?

To answer this question we have cored two small lakes in that area (Warnitzsee, Briesensee) with water level fluctuations well above 3 m over the past 40 years. We took seven cores along two transects from the lake shore towards the centre in Lake Warnitzsee and one core near the shore in Lake Briesensee. Core lengths range from 2.5 m to 10 m. Analysis of the cores includes geochemical parameters and pollen analysis. Two cores were dated by radiocarbon ages.

All cores show recurrent marked shifts in sediment composition with up to seven peat-gyttia alternations. These sediment shifts indicate that both lakes have strongly fluctuated over the Holocene, partly with a larger magnitude than today. However, whereas the modern fluctuation periods (low and high stands) occurred over years to a few decades, we so far could only detect past fluctuation periods that lasted centuries to millennia. Furthermore, the water level in Lake Warnitzsee possibly followed a long-term trend of high water levels in the early Holocene (10.500-9000 cal. BP), low water levels between 8000 and 6000 cal. BP and again high water levels after 5000 cal. BP. By comparing the modern and past pattern of lake level fluctuations we discuss, whether the water level fluctuations observed indeed represent past changes in precipitation or, alternatively, changes in groundwater discharge and evapotranspiration induced by land cover (vegetation) dynamics.

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