Seasonal variability of branched glycerol dialkyl glycerol tetraethers in a temperate lake system

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Despite the potential for branched glycerol dialkyl glycerol tetraethers (brGDGTs) to reconstruct temperature from lake sediments, we have a poor understanding of 1) autochthonous vs. allochthonous sources of brGDGTs in lakes and 2) the seasonality of and environmental controls on brGDGT production within lakes. To investigate the sources, seasonality, and controls on brGDGT production and distribution within lakes, we examined water column suspended particulate matter (SPM) and settling particles from a sediment trap collected on a biweekly to monthly basis over a period of three years at a small kettle lake in Vermont and compared these brGDGT data with those of catchment soils, river sediments, and lake surface sediments to constrain the relative importance of brGDGTs washed in from the landscape versus brGDGTs produced in situ. We find significant differences in concentrations and fractional abundances of brGDGTs between catchment samples and lake sediments, indicating a mostly autochthonous source for lacustrine brGDGTs. BrGDGT concentrations, fluxes, and fractional abundances in SPM vary over the course of the year, indicating that brGDGTs are produced throughout the entire year and respond to the physical and chemical properties of the water column. The total annual flux of brGDGTs settling through the water column is comparable to the brGDGT accumulation rates in surface sediments, indicating that brGDGTs are mostly produced within the water column, not in the sediment itself. While brGDGTs are produced in all seasons within the water column, the flux to the sediments is highest during periods of spring and fall isothermal mixing, potentially biasing paleotemperature reconstructions towards mixing season temperature. Because the seasonal timing and frequency of lake mixing varies as a function of regional climate, lacustrine brGDGT calibrations should be regional in nature and comprise lakes with similar mixing regimes.