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Combined Water and Heat Budget to Constrain the Vertical Flow in a Meromictic Lake

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Fayetteville Green Lake in upstate New York is a deep (∼50 m) meromictic lake with an oxygenated mixolimnion ∼18 m depth overlying an anoxic monomolimnion in the lowermost ∼35 m. The bottom sediments underlying the anoxic monomolimnion are mostly undisturbed varves composed mostly of calcite that have been biologically precipitated near the lake surface by the dominant cyanobacterial population. Previous studies have demonstrated the sediments of this lake are important to characterize the regional climate fluctuations extending back to the last glaciation. However, it is difficult to interpret the climate proxies that are derived from the bottom layers because of the potential impact from a several biological and physical factors. The reasons for the year to year variability of varve thickness over the past century are unclear, but it is related to meteorological forcing, groundwater input, and biological productivity. The key to understanding the most important biological and the biogeochemical features of this lake system may be to characterize the upwelling flow field. Here, we present the results of an ongoing study in its first year to document the seasonal variation of the water and heat budget of the lake. We make explicit calculations of the surface and stream fluxes, and compare this with energy storage calculated from a time series of temperature measurements. In addition to the water and energy flows associated with streams, evaporation, and precipitation, there is a significant groundwater source so that upper lake represents a constantly upwelling system with important biological and dynamical implications. Although 'normal' lakes – responding only to surface meteorological fluxes – typically exhibit one (monomictic) or two (dimictic) overturning events per year, groundwater inflow has the potential to change the overturning dynamics of the lakes with important consequences for biogeochemistry.