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A combined heat and water budget approach to quantify the groundwater inflow to a meromictic lake

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Groundwater exchange may have an important role in the mixing dynamics of certain lakes, in addition to the recognized effect of seasonally varying surface heat fluxes. However, the heat and mass fluxes associated with groundwater input to a lake are often difficult to measure and are poorly constrained. Permanent bottom anoxia in meromictic lakes is sometimes associated with significant inputs of surface water, which create a permanent upwelling system for phytoplankton blooms. In this contribution, we report the results of a 17 month experimental investigation of the heat and water budget of a meromictic lake in upstate New York. Fayetteville Green Lake is a good model system to conduct a combined heat and water budget analysis, with one outflow stream and a single inflow stream. The lake is contained in a relatively deep ($\sim$50m) flat-bottomed basin with a groundwater injection depth at $\sim$20m at the base of the mixolimnion. The heat budget was formulated from data from regional meteorological stations and a vertical array of temperature sensors on a subsurface mooring. The mass budget was created from continuous measurements of lake stage and precipitation data. The results highlight that groundwater input has an important effect on the overall heat budget of the lake, with a critical role on the timing of the overturning of the mixolimnion in the spring and late autumn. Although lake heat budget studies have formerly been conducted to constrain the poorly-constrained evaporative term (latent heat) in the heat budget, our results suggest that groundwater exchange may dominate the surface latent heat flux of certain lakes.