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Resolving Lake Erie's Evaporation Estimates Using Stable Isotope Geochemistry

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Evaporation fluxes are a significant component of Lake Erie's water balance. Monthly evaporation calculations are critical for predicting short and long-term fluctuations in Lake Erie's water levels. However, constraining the evaporative fluxes from Lake Erie is challenging; the current statistical estimates from the National Oceanic and Atmospheric Association Great Lakes Environmental Research Laboratory (NOAA-GLERL) rely on 70 years of sparse hydro-meteorological records that have large uncertainties. Stable isotopes are sensitive to evaporation and can provide additional constraints on these fluxes. Previous work has shown promise for using distributions of oxygen and hydrogen stable isotopes to quantify yearly evaporation off Lake Erie. These estimates can be a valuable addition to constraining the evaporation fluxes off the Lake, but previous work has not considered seasonal shifts in evaporation, which can be important for forecasting short-term changes in Lake Erie's water balance. To explore the value of increasing the resolution of this approach, here, we present new monthly water isotopic data ($\delta^{18}O$, $\delta^{2}H$) from Lake Erie, which we then use to calculate monthly evaporation estimates using an isotope mass balance model adapted from Jasechko et al. (2014). Isotopic evaporation estimates overlap with statistical estimates from NOAA-GLERL for spring and early summer (April to June 2023), but the estimates diverge for periods of higher evaporation (August 2023). These discrepancies may be due to uncertainty around downwind lake effects with humidity and the fraction of moisture recycled into the atmosphere, the analytical standard deviations of the isotopic measurements, residence time, and molecular diffusion into the free atmosphere. Going forward, this project will continue to evaluate the utility of the isotope evaporation model by determining whether $\delta^{17}O$ can provide an additional constraint for evaporation, incorporating weekly isotopic measurements from the Detroit River, and implementing a Bayesian approach. Regardless of the added utility for constraining evaporation fluxes today, this work will be critical for advancing the use of isotopic data to constrain water fluxes from Lake Erie's past.