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The thermal response of lake surface water temperature to atmospheric heatwave

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The sensitivity of lake surface water temperature (LSWT) to atmospheric warming has been well-established due to rapid sensible heat exchange. However, the specific impact of discrete heatwave events on LSWT dynamics, including their magnitude and persistence, remains poorly understood. To address this gap, we comprehensively analyze changes in LSWT during atmospheric heatwave events across a global network of 16,609 lakes. LSWT data are derived from Landsat 5, 7, 8, and 9 satellite imagery spanning 1985 to 2021, while heatwave intensity is quantified using hourly air temperature data from the ERA5-Land reanalysis. Our analysis identifies and characterizes heatwave events and their associated LSWT changes for each lake during the study period. Key findings reveal: (1) A widespread increase in both heatwave intensity and LSWT change across the majority of lakes, highlighting a concerning intensification of coupled air-water warming trends. (2) Significant spatial heterogeneity in LSWT sensitivity to heatwaves is observed. Notably, a pronounced memory effect is detected in LSWT response to heatwaves, suggesting a lingering influence of atmospheric heat events on lake energy balance, with implications for ecosystem stability and resilience.