Global patterns in Lake Ecosystem responses to warming based on the temperature dependence of metabolism. (2016).

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Abstract

Climate warming is expected to have large effects on ecosystems in part due to the temperature dependence of metabolism. The responses of metabolic rates to climate warming may be greatest in the tropics and at low elevations because mean temperatures are warmer there and metabolic rates respond exponentially to temperature (with exponents >1). However, if warming rates are sufficiently fast in higher latitude/elevation lakes, metabolic rate responses to warming may still be greater there even though metabolic rates respond exponentially to temperature. Thus, a wide range of global patterns in the magnitude of metabolic rate responses to warming could emerge depending on global patterns of temperature and warming rates. Here we use the Boltzmann–Arrhenius equation, published estimates of activation energy, and time series of temperature from 271 lakes to estimate long-term (1970–2010) changes in 64 metabolic processes in lakes. The estimated responses of metabolic processes to warming were usually greatest in tropical/low-elevation lakes even though surface temperatures in higher latitude/elevation lakes are warming faster. However, when the thermal sensitivity of a metabolic process is especially weak, higher latitude/elevation lakes had larger responses to warming in parallel with warming rates. Our results show that the sensitivity of a given response to temperature (as described by its activation energy) provides a simple heuristic for predicting whether tropical/low-elevation lakes will have larger or smaller metabolic responses to warming than higher latitude/elevation lakes. Overall, we conclude that the direct metabolic consequences of lake warming are likely to be felt most strongly at low latitudes and low elevations where metabolism-linked ecosystem services may be most affected.

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