Global patterns in Lake Ecosystem responses to warming based on the temperature
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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.

See more
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