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Changes in sulfur cycling in a large lake during the Paleocene-Eocene Thermal Maximum and implications for lake deoxygenation

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Understanding the biogeochemical effects of global warming on large lakes is central to managing aquatic resources. The Paleocene-Eocene Thermal Maximum (PETM) presents an excellent paleo-analog for potential impacts arising from current global warming. Here, we reconstructed dynamic redox changes in a large lake located in modern Central China during the PETM, using carbonate-associated sulfate sulfur and oxygen isotopes. Three major anoxic episodes (AE) associated with intensive microbial sulfate reduction (MSR) were identified, as indicated by higher sulfur and oxygen isotope compositions, and/or decreased sulfate contents. Thermal strat[1]ification in the lake was the likely main cause of the anoxia and associated changes in sulfur geochemical cycles. The first two AEs occurred during the initial stage of PETM. They are characterized by low sulfate and total organic carbon-minus-black carbon (TOC-BC) contents, suggestive of low biological productivity related to limited nutrient cycling in a stratified and anoxic water mass. The third AE occurred during the peak of the PETM. It was characterized by extremely low sulfate and high TOC-BC contents, possibly the product of increased near-surface productivity coupled with anoxia in the lower water column. An intensified hydrological cycle triggered by severe warming may have enhanced terrestrial nutrient fluxes to the lake, leading to increased surficial lake productivity. Upward expansion of the anoxic/sulfidic zone, however, may have suppressed the lake ecosystem by contracting its livable space. Our results suggest that current global warming could trigger similar ecological stress in large lakes.