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Foraminifera nitrogen isotopes and body size reveal an oxygen rise in the tropical upper ocean during the Paleocene-Eocene Thermal Maximum (PETM)

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Ocean's oxygen (O_2) is essential to most marine life forms and represent a fundamental component of the biogeochemical cycling of nitrogen and carbon. Its inventory is declining in response to global warming. Contrasting predictions about the future of the tropical oxygen deficient zones (ODZs) in numerical simulations and palaeoceanographic evidence for contracted ODZs during Cenozoic's warmest periods, make long-term predictions about the future of ocean O_2 challenging. We present new evidence for tropical ocean oxygenation during the Paleocene-Eocene Thermal Maximum (PETM), a rapid warming event that serves as a geologic analogue to ongoing warming. Foraminifera-bound nitrogen isotopes indicate that the tropical North Pacific ODZ contracted during the PETM, implying higher O_2. Metabolic modelling of aquatic ectotherms shows that a concomitant increase in planktic foraminifera size implies that seawater oxygen partial pressure (pO_2) rose in the shallow subsurface throughout the tropical North Pacific, beyond the spatial extent of the ODZs. These findings call for an oceanographic mechanism capable of both enhancing subsurface oxygenation and operating beyond the regional scale of the North Pacific ODZs, on millennial timescales. These divergent changes are consistent with Ocean General Circulation Models under SSP5-8.5 scenario for 2300, in which a decline in biological productivity allows tropical subsurface oxygen to rise even as global ocean oxygen declines. The tropical upper ocean oxygen increase may have relieved physiological stress, helping to avoid a mass extinction

in planktic organisms during the PETM, in spite of the largest benthic extinction of the Cenozoic.