Assessing ocean deoxygenation during the Palaeocene-Eocene Thermal Maximum

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In recent years oxygen minimum zones have been expanding and are projected to continue to grow in size and number due to rising temperatures. Ocean deoxygenation has far-reaching consequences for marine life and therefore it is essential to assess the mechanisms of deoxygenation by evaluating past climate events. We applied an emerging redox proxy, Cr isotopes, and Ce/Ce* anomalies in planktic foraminiferal calcite to assess the variation in redox state during the Palaeocene-Eocene Thermal Maximum (PETM), an episode of dramatic warming 56 million years ago akin to modern anthropogenic climate change. We followed published cleaning (Barker et al., 2003) and analytical (Bonnand et al., 2011) procedures to obtain the foraminiferal Cr and Ce signatures. Both Cr isotopes and Cr concentrations show marked changes over this interval in both shallow and open ocean settings indicating wide-spread reductions in dissolved oxygen concentrations. Open ocean stations (ODP sites 1210 and 1263 in the Pacific and South Atlantic, respectively) point towards deoxygenation caused by rising temperatures and changes in ocean ventilation. Cr data are corroborated by Ce/Ce*. A strong correlation between $\delta^{53}Cr$ and the size of the benthic foraminiferal $\delta^{18}O$ excursion as well as dissolved benthic oxygen level simulations from the climate model cGENIE suggest temperature is the principal driver of open ocean deoxygenation during the PETM.