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Introducing PETRARCH: Pinpointing Earth-System Thresholds for Anoxia with new Reconstructions of the Cretaceous Hothouse

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Oxygen levels in Earth's oceans are dropping fast due to anthropogenic nutrient input and CO_2 release, and the consequences of this for marine ecosystems are difficult to predict. The Cretaceous Period (66- 145 million years ago) witnessed numerous extreme ocean anoxic events (OAEs) – some regional, some global in scale – that are thought to have been caused by pulses of volcanism and CO_2 release. If we knew the exact mechanisms by which volcanism triggered these Cretaceous OAEs, and the role of feedbacks and boundary conditions, they could provide vital information as to where potential future tipping points in the Earth system lie. Presently, however, our estimates of climate, atmospheric CO_2 and carbon cycling in the Cretaceous are qualitative at best, preventing OAEs from being useful analogues. In this poster, I will introduce the planned PETRARCH project, funded through UKRI matching of an ERC Consolidator Grant, that will aim to fill that gap. PETRARCH will combine new and proven geochemical proxy archives with cutting-edge Earth system modelling to look at how marine life and changes in marine pelagic ecosystems may have interacted with environmental changes to drive pervasive global anoxia. To do this, we will calibrate boron isotopes in the silica shells of radiolarians as a new proxy archive for ocean pH and atmospheric CO_2, combine this new radiolarian data with new measurements of carbonate microfossils to reconstruct Cretaceous marine carbon cycling, and use Earth System modelling, tuned to these data, to test what exact biogeochemical feedbacks and climate forcings tipped the Cretaceous Earth into profound, and sometimes global, ocean anoxia.