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Rapid Antarctic ice sheet retreat under low atmospheric CO2

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Over the last 5 Million years, outstanding warm interglacial periods (i.e. 'super-interglacials') occurred under low atmospheric CO_2 levels that may feature extensive Antarctica ice sheet collapse. Here, we focus on the extreme super-interglacial known as Marine Isotope Stage 31 (MIS31) that took place 1.072 million years ago and is the subject of intense debate.

Our Southern Ocean organic biomarker based paleotemperature reconstructions show that the surface ocean was warmer by ~5 °C than today between 50 °S and the Antarctic ice margin. We used these ocean temperature records to constrain the climate and ice sheet simulations to explore the impact of ocean warming on the Antarctic ice sheets. Our results show that low amplitude short term oceanic modifications drove the collapse of the West Antarctic Ice Sheet (WAIS) and deflation of sectors of the East Antarctic Ice Sheet (EAIS) resulting in sustained sea-level rise of centimeters to decimeters per decade.

We suggest the WAIS retreated because of anomalously high Southern Hemisphere insolation combined with the intrusion of Circumpolar Deep Water onto the continental shelf under poleward-intensified winds leading to a shorter sea ice season and ocean warming at the continental margin. Under this scenario, the extreme warming we observe likely reflects the extensively modified oceanic and hydrological circulation patterns following ice sheet collapse. Our work highlights the sensitivity of the Antarctic ice sheets to relatively minor oceanic and/or atmospheric perturbations that could be at play in the near future.