Eight million years of polar ice sheet variations from cosmogenic nuclides in marine sediments

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Ice-sheet melt will dominate sea-level rise over the coming centuries, but projections are hindered by uncertainty in how they responded to past warm periods, for example during the Pliocene (5.3-2.6 Myr ago) when atmospheric CO_2 concentrations were last ≥ 400 ppm. This uncertainty stems from difficulty in extracting the sea-level signal from the marine $\delta^{18}O$ record and paleo-shorelines, and the patchy terrestrial record of glaciation on land. In contrast, material shed continuously from continents is preserved as marine sediment that can be analysed to infer the time-varying state of major ice sheets. We have measured several multi-million year-long records of glaciation from cores offshore Greenland and Antarctica based on the ^{10}Be and ^{26}Al concentrations in quartz sands sourced from the adjacent continent. These nuclides monitor ice sheet history and process because they are produced in land surfaces when exposed to cosmic radiation, but are removed by decay and erosion when ice covered. The results suggest that the Greenland Ice Sheet was persistent but dynamic over the past several million years, while terrestrial ice in East Antarctica was stable and experienced minimal retreat onto land. Our results point toward Pliocene sea levels in the range ~10 to 30 m above present.