New perspectives on "old" data: What the earth's past tells us about future sea-level rise

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Over the last century, sea-level rise has been dominated by thermal expansion and glacier loss, but mass loss from the Greenland and Antarctic ice sheets is expected to exceed other contributions to future sea-level rise under sustained warming. One of the challenges entailed in projecting the magnitude and timing of future sea-level rise is that humans have not previously witnessed, much less documented, major retreat of the polar ice sheets in Greenland and Antarctica in response to polar temperatures warmer than today. This presents a conceptual hurdle for ice sheet modelers, who strive to make projections of ice sheet behavior but lack comprehensive observational data of all of the physics involved. A complementary approach to projecting how polar ice-sheet retreat will unfold is to integrate observations of sea-level change during past warm periods with models of sea level, ice sheets, and climate to determine the expected response of sea level in the future.

A previous analysis evaluated the evidence of polar ice sheet mass loss during several warm periods, including interglacials during the mid-Pliocene warm period, Marine Isotope Stages (MIS) 11, 5e (Last Interglacial), and 1 (Holocene). Sea-level benchmarks of ice-sheet retreat during the first of these three periods, when global mean climate was ~1 to 3 °C warmer than preindustrial, are useful for understanding the long-term potential for future sea-level rise. Despite existing uncertainties in these reconstructions, it is clear from this analysis that our present climate is warming to a level associated with significant polar ice-sheet loss in the past, resulting in a conservative estimate for a global mean sea-level rise at least 6 meters above present that involve contributions from Antarctica.

This presentation will focus on revisiting the evidence for an Antarctic contribution to higher sea levels during the Last Interglacial period (~125,000 years ago) in the context of emerging data and modeling. A key component that has led to advances in sea-level reconstructions from this time period is the ability to recognize and quantify the imprint of geophysical processes, such as glacial isostatic adjustment (GIA) and dynamic topography, which lead to significant spatial variability in sea level reconstructions. Identifying specific ice-sheet sources that contributed to higher sea levels is a challenge that is currently hindered, in part, by limited field evidence at high latitudes.

Even with improved interpretations of past magnitudes of sea-level rise, there remain several challenges, including relating sea level response to concomitant ambient climate conditions, and elucidating past rates of sea-level change. Nonetheless, the paleo record of sea-level rise during past warm periods is able to inform us that our future can be expected to involve global mean sea-level rise that will continue for several millennia, as the polar ice sheets respond to our changing climate.

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