The Emerging Role of Geology in Future Sea Level Projections

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The instrumental record of past sea-level change (based on globally distributed tide gauges and more recently satellite altimetry) is very short relative to the response time of the relevant processes that cause sea level rise. This is especially true for the great polar ice sheets covering Greenland and Antarctica. Semi-empirical methods have been used to extrapolate relationships between changes in sea level and global mean temperature into the future, but these 'models' are largely calibrated over the 20th century, when ocean thermal expansion was the primary driver of sea-level rise. The loss of land ice now dominates the sea-level signal, so the physical processes are changing, limiting the utility of the recent past to inform future projections. This will become increasingly true as the polar ice sheets on Greenland and Antarctica begin to play an increasing important role in sea level rise.

Past climates warmer than today, including the 'super interglacials' of the late Pleistocene, and the Pliocene hold important clues regarding the long-term sensitivity of the polar ice sheets to a warming atmosphere and ocean. However, ample uncertainty in ancient sea level reconstructions remains. This is particularly true in the more geologically distant Pliocene. Nonetheless, the critical need to validate numerical models (particularly ice sheet models) used in deterministic sea level projections is driving new methods of integrating numerical models with geological information. In some cases, information from the geological record has sparked innovative model development, with potentially profound consequences for understanding what future sea level might look like. Here, we will explore some of the emerging science regarding our understanding of the sensitivity of the cryosphere to a warming world, and the potential for geology to inform projections of Greenland and Antarctica's future.