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Mapping sea-level change in time, space and probability

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As recorded instrumentally and reconstructed from geological proxies, sea levels have risen and fallen throughout Earth history, on timescales ranging from minutes to millions of years. The vast majority of instrumental records contain < 60 years of 20th and 21st century data. The shortness of this record exacerbates uncertainty in projections of future sea-level rise. Sea-level projections depend upon establishing a robust relationship between sea level and climate forcing, yet the brief instrumental period captures only a single climate mode of rising temperatures and sea level within a baseline state that is mild by geological standards. In contrast, geological proxies provides valuable archives of the sea level response to past climate variability, including periods of more extreme global mean temperature. Ultimately, the information contained in the geological record can help assess the relationship between sea level and climate change, and provide a firmer basis for projecting the future. But current ties between past changes and future projections are often vague and heuristic. If both reconstructions and projections are made cognizant of uncertainty and spatial variability, there are a range of specific connections between reconstructing past changes and improving future projections. Greater interconnections between the two sub-disciplines may be key to major progress. Here, we focus on data sources and methodologies for piecing together lines of evidence related to past and future sea-level change in order to map changes in space, time and probability. We provide two case study regions – Singapore and New Jersey – to illustrate the way in which proxy and instrumental data can improve future projections, and future projections can guide the development of sea-level research questions from both the instrumental and geological time periods.