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Sea-level variability over the Common Era

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The Common Era (CE) sea-level response to climate forcing, and its relationship to centennial-timescale climate variability such as the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA), is fragmentary relative to other proxy-derived climate records (e.g. atmospheric surface temperature).

However, the Atlantic coast of North America provides a rich sedimentary record of CE relative sea level with sufficient spatial and temporal resolution to inform mechanisms underlying regional and global sea level variability and their relationship to other climate proxies. This coast has a small tidal range, improving the precision of sea-level reconstructions. Coastal subsidence (from glacial isostatic adjustment, GIA) creates accommodation space that is filled by salt-marsh peat and preserves accurate and precise sea-level indicators and abundant material for radiocarbon dating. In addition to longer term GIA induced land-level change from ongoing collapse of the Laurentide forebulge, these records are ideally situated to capture climate-driven sea level changes. The western North Atlantic Ocean sea level is sensitive to static equilibrium effects from melting of the Greenland Ice Sheet, as well as large-scale changes in ocean circulation and winds.

Our reconstructions reveal two distinct patterns in sea-level during the CE along the United States Atlantic coast: (1) South of Cape Hatteras, North Carolina, to Florida sea-level rise is essentially flat, with the record dominated by long-term geological processes until the onset of historic rates of rise in the late 19th century; (2) North of Cape Hatteras to Connecticut, sea level rise to maximum around 1000CE, a sea-level minimum around 1500 CE, and a long-term sea-level rise through the second half of the second millennium. The northern-intensified sea-level fall beginning $\sim$1000 is coincident with shifts toward persistent positive NAO-like atmospheric states inferred from other proxy records and is consistent with climate model simulations forced with sustained NAO-like heat fluxes. Changes in the wind-driven ocean circulation may also contribute to alongshore sea level variability over the CE.

To reveal global mean sea level variability, we combine the salt-marsh data from North American Atlantic coast with tide-gauge records and other high resolution proxies from the northern and southern hemispheres. All reconstructions are from coasts that are tectonically stable and are based on four types of proxy archives (archaeological indicators, coral microatolls, salt marsh sediments and vermetid [mollusk] bioconstructions) that are best capable of capturing submeter-scale RSL changes. The database consists of reconstructions from Australasia (n = 2), Europe (n=5), Greenland (n = 3), North America (n = 6), the northern Gulf of Mexico (n = 3), the Mediterranean (n = 1), South Africa (n = 2), South America (n =2) and the South Pacific (n =3).

We apply a noisy-input Gaussian process spatio-temporal modeling framework, which identifies a long-term falling global mean sea-level, interrupted in the middle of the 19th century by an acceleration yielding a 20th century rate of rise extremely likely (probability P = 0:95) faster than any previous century in the CE.