Local Sea Level Rise Projections

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Methods

Local sea level (LSL) projections require the aggregation of the individual components of sea level change including changes in the mass distribution and density of the ocean, glacier mass balance, ice sheet mass balance, land water storage, and vertical land motion. LSL change differs from global sea level (GSL) change because of: (1) non-uniform changes in ocean properties and dynamics; (2) changes in the Earth's gravitational field, rotation and lithospheric flexure associated with the redistribution of mass between the cryosphere and the ocean; and (3) vertical land motion due to glacial isostatic adjustment, tectonics, local groundwater withdrawal, and natural sediment compaction and transport. The design sites considered in this report have experienced long-term rates of LSL rise ranging from 2.5 to 4.3 mm/yr (approximately 50-150% higher than GSL rise) (Figure 1).

SCR utilizes projections developed in Kopp et al. (2014), based on climate changes forced by a Representative Concentration Pathway (RCP 8.5) (Meinshausen et al 2013). The probability distributions for future LSL change due to each component are informed by climate models, expert assessment, and tide gauge observations, and are combined using a Monte Carlo technique (Figure 2).

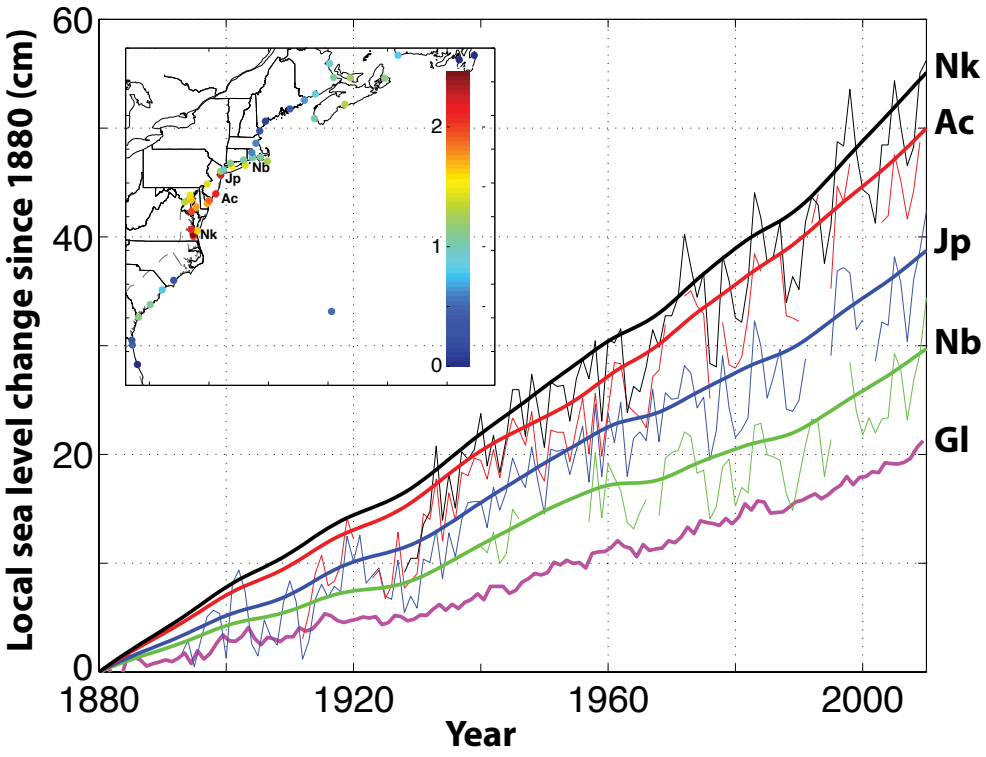

Figure 1: The historical local sea level record (thin lines) and long-term trends (thick lines, from Kopp 2013) at the closest tide gauges to the four design sites: Norfolk (**Nk**, black); Atlantic City (**Ac**, red); Jamaica Bay (**Jp**, blue); Narragansett Bay (**Nb**, green). Sea level at each location is shown relative to the value of the smoothed trend in 1880. The global mean trend (from Church and White 2011) is shown in purple. The inset shows long-term linear trends in relative sea level (colors, in mm/yr), for the Eastern United States and Canada. Data and inset map courtesy of Bob Kopp and modified from Kopp (2013)

Results

21st century projections of GSL and LSL rise are shown at four tide gauge locations in Figure 3. The magnitude of sea level change at all locations is expected to be far larger over the second half of the century than the first half. Uncertainty also grows over time.

US east coast sea level rise is almost certain to be higher than the global mean over the 21st century, due to ongoing land subsidence and projections of enhanced dynamic sea-level rise in the mid-Atlantic. At the four tide gauges considered here, the median LSL rise ranges from 90-110 cm, substantially higher than the global mean value of 78 cm. High-end (95th percentile) LSL projections (145-165 cm) exhibit a larger divergence from GSL (120 cm) because these low-likelihood outcomes are driven by Antarctic ice loss which has a large "fingerprint" on the east coast. Low-end (5th percentile) projections of LSL range from 40-65 cm, reflecting: (1) very high confidence in at least a continuation of current trends and (2) disparities resulting from spatial variation in subsidence rates.

For design efforts that seek to be robust to lower-probability outcomes, these results suggest that regional differences in LSL rise over the study region may not be as important as the uncertainty in GSL sources that are largely common among the sites. However, the findings shown in this section apply only to the mean rate of sea level rise and may not indicate trends in flood risk, which require the combination of these projections of mean sea level with those for storm surge.

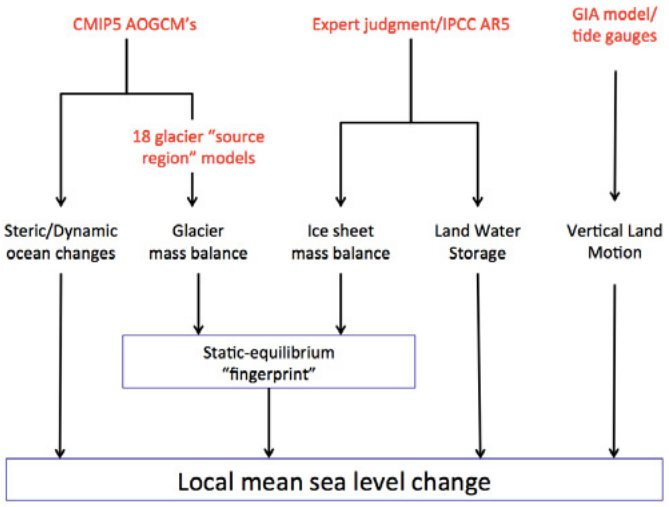

Figure 2: Schematic illustration of the sources of information (red) and physical processes (black) included in the mean sea level projections

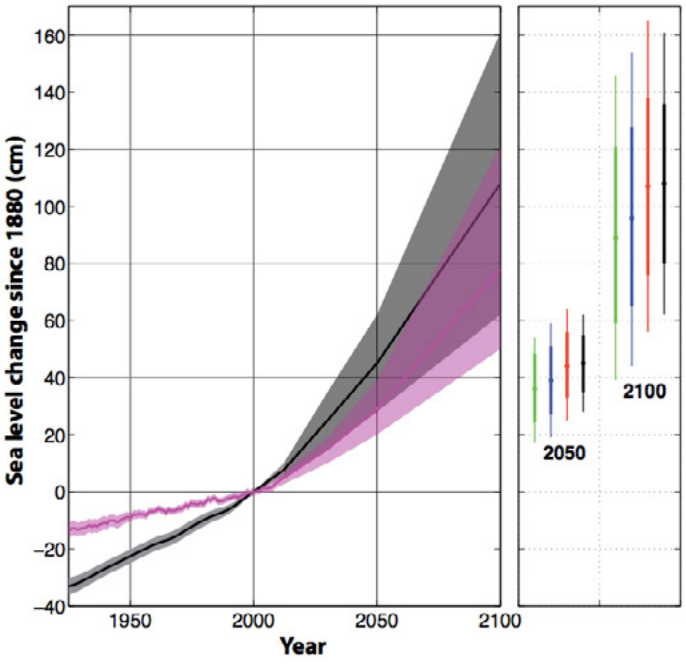

Figure 3: Observations (to 2011) and preliminary projections (to 2100) of sea level (relative to 2000) for RCP 8.5. Solid lines in the left panel show the historical trend and median projection of local sea level for Norfolk (Sewell's Point, in black) and the global mean (purple). Shading encompasses 2-sigma uncertainty ranges for observations and 5-95th percentile ranges of relative sea level. The right panel shows median (circles), 17-83rd percentile (thick bars), and 5-95th percentile (thin bars) ranges of local sea level change in 2050 and 2100 for all four sites (colors correspond to those in Figure 3.1)

References

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Kopp, R. E. (2013), Does the Mid-Atlantic United States sea level acceleration hot spot reflect ocean dynamic variability?, Geophysical Research Letters, 40, 3981–3985, doi: 10.1002/grl.50781.

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