Understanding Future Regional Sea Level Change Using Observation-Driven Extrapolations

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Introduction

1. Sea level change is driven by changes in ocean mass and changes in ocean density
2. The mass-driven component or sea level "fingerprint" is associated with melting ice complexes on land and has only recently emerged in observational data sets (Adhikari et al., 2019; Coulson et al., 2023)
3. Therefore, observation-based extrapolations may significantly underestimate the contribution to sea level change and regional variations associated with melting ice

- **Mass loss at ice sheets and glaciers are projected forward in time and the associated sea level fingerprints are computed using a semi-analytic model (A et al., 2013)**
- **The sea level fingerprint is removed from the altimeter data record to isolate the density-driven component of sea level change**
- **The independent projections of ocean mass and density change are combined to produce a new observation-driven extrapolation of sea level with regional variations**

Surface Loading History

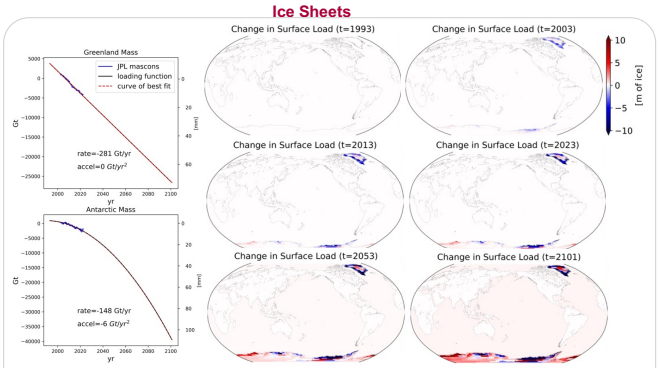

Figure 1. Mass loss at the Greenland and Antarctic ice sheets based on GRACE mascons, projected to 2100.

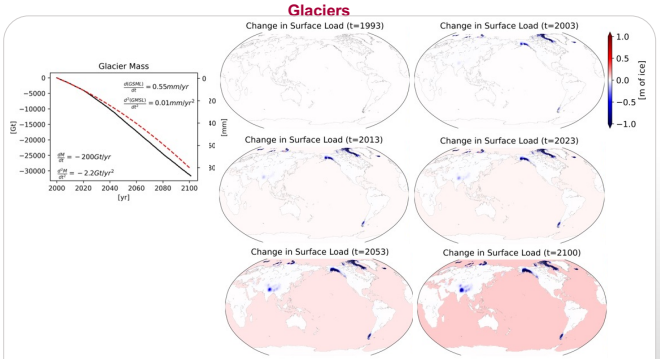

Figure 2. Mass loss at all glaciers outside of Greenland and Antarctica based on dynamic glacier modeling (RCP 2.6 from Rounce et al., 2023).

Sea Level Fingerprints

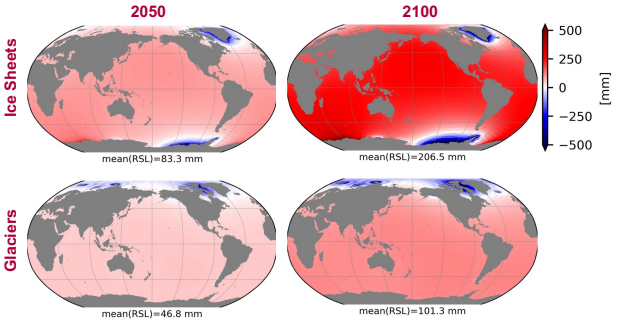

Figure 3. The relative sea level fingerprint as cumulative total change relative to 1993 for ice sheets and glaciers. Sea level fingerprints are the gravitational, rotational, and deformational response of the Earth to surface mass redistribution. Relative sea level falls around melting ice complexes because the geoid falls and the crust rebounds.

Steric Sea Level

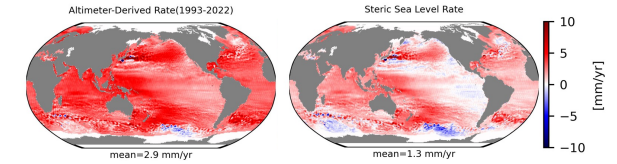

Figure 4. Altimeters measure the total change in sea surface position relative to the geocenter (a). Removing the sea level fingerprint (i.e., mass-driven change) isolates the density-driven change (b).

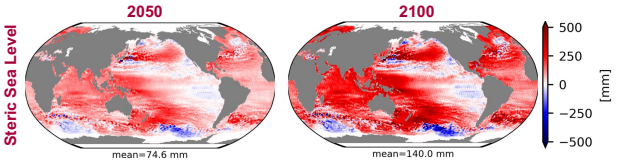

Figure 5. Linear projection of the steric sea level rate, which is derived from the altimeter data record minus the predicted sea level fingerprints shown above.

Total Relative Sea Level Projection

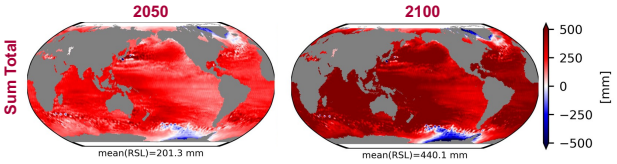

Figure 6. The sum of independently extrapolated components of sea level change.

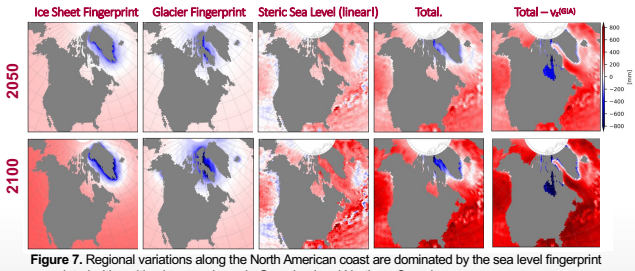

Figure 7. Regional variations along the North American coast are dominated by the sea level fingerprint associated with melting ice complexes in Greenland and Northern Canada.

Key Takeaways

- **Relative sea level change is significantly reduced in the vicinity of melting ice complexes**
- **This result is in contrast with other sea level projections (e.g., AR6)**
- **Independent projection of sea level fingerprints from ice mass loss on land can resolve regional variations in sea level change**

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