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Holocene Sea-Levels from Greenland to Antarctica: A Pole-to-Pole Transect of Sea Level History

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The Holocene is the most recent period during which natural temperature variability predominates and, therefore, provides an important paleo perspective for understanding the climate:sea-level relationship prior to anthropogenic modification of the climate system. But our understanding of Holocene sea level is limited by a lack of a standard protocol that incorporates full consideration of vertical and temporal uncertainty for each sea-level index point.

We have compiled a Holocene RSL database of ~3000 validated sea-level index points from Greenland, North American Atlantic coast, Caribbean, South American Atlantic coast and Antarctica. The databases were collated using a formalized and consistent methodology to facilitate the development and comparison of regional RSL records. The database also includes information relevant to sediment compaction, and modelling of both modern-day and paleotidal ranges. We develop a spatio-temporal empirical hierarchical model to compare regional RSL histories and estimate rates of change.

Holocene RSL history from near-field regions (e.g., Antarctica, Greenland and Canada) reveal a complex pattern of RSL fall from a maximum marine limit due to the net effect of eustatic sea-level rise and glacio-isostatic uplift with rates of RSL fall as great as 70 ± 5 m/ka (East Hudson Bay). Intermediate field regions (e.g., North American mid-Atlantic coast) display variable rates of RSL rise from the cumulative effect of eustatic and isostatic factors. Fast rates of RSL rise (up to 10 ± 4m/ka; New Jersey) are found in the early Holocene in regions near the center of forebulge collapse. Far-field RSL records (South American Atlantic coast) exhibit a mid-Holocene highstand, the timing and magnitude of which varies between 8 and 4 ka and <1 and 6 m, respectively.

We compare RSL histories with the predictions from two recent models of the Glacial Isostatic Adjustment (GIA) process, namely the ICE-6G_C (VM5a) model of Peltier et al. (2015) and the ICE-7G_NA (VM7) model of Roy and Peltier (2017 in press). Although the fit of these models to the wide range of inferred RSL histories along the pole-to-pole transect is very high quality, unexplained signals are identified in several restricted regions upon which work is continuing. It is remarkable that a spherically symmetric model of the internal viscoelastic structure is able to reconcile the wide range of RSL signals observed.