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Revisiting global mean sea level changes from tide gauge records corrected for vertical land motion

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Observational evidence of global/regional mean sea level (GMSL/RMSL) over the 20th century is restricted to a spatially and temporally heterogeneously distributed set of tide gauges along the coast, whose measurements are impacted by vertical land motion (VLM) of the Earth's crust. Here we revisit estimates of 20th century RMSL and GMSL using an area weighting virtual station approach applied to a novel set of VLM corrected tide gauges from six coherently varying oceanic regions. We test our approach in a realistic ocean reanalysis, where the "true" modeled GMSL is a priori known. We find that the performance in reconstructing RMSL and GMSL is strongly influenced by the available tide gauges leading to unavoidable biases in the late 19th and early 20th century. While in regions such as the Pacific Ocean spatially coherent large-scale climate signals, as the Pacific Decadal Oscillation, allow for relatively accurate estimates of the low-frequency variability, in regions such as the South Atlantic the poor availability of tide gauge records hampers sophisticated estimates of RMSL. These uncertainties directly transmit into GMSL estimates. A further bias of roughly 0.2 mm/yr is introduced when not accounting for the area weights of regions for which the virtual stations are representative. However, from $\sim$1920 onwards, the available stations allow us to capture the low frequency variability and trends in GMSL.