Mean Sea Level and Tidal Change in Ireland since 1842: A case study of Cork

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Mean sea levels are changing worldwide, and local tidal changes have been widely reported. Knowledge of regional changes in mean sea level, and local changes in tides are crucial to inform effective climate adaptation. An essential element of this is the availability of accurate observations of sea level. Sea level data in the Republic of Ireland, prior to the establishment of the National Tide Gauge Network in the mid-2000s, is very limited but belies a wealth of historical data available in archival form. In this study, we digitize records located in Cork Harbour, Ireland from 1842 and show how short duration (6 weeks), high quality data, with a large interval (177 years) to the present, can accurately inform tidal and mean sea level changes. We consider error sources in detail and estimate that for M2 the accuracy of these historical measurements is 1% and 2 minutes for amplitude and timing respectively; and our mean sea level estimates are accurate to the centimetre level. Our results show remarkable tidal stability with a 2% change in the amplitude of the M2 component and 4 minute change in the phase over a period of 177 years; and a mean sea level rise of 41 cm in the Cork Harbour area since 1842, approximately in line with global mean sea level trends plus local glacial isostatic adjustment. More broadly, we show that with careful seasonal, nodal, and atmospheric corrections, together with good knowledge of benchmark provenance, these historic, survey-oriented data can accurately inform of sea level changes.