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Holocene sea level, a semi-empirical contemplation

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Holocene eustatic sea level from approximately -10,000–1800 CE was characterized by an increase of about 60 m, with the rate progressively slowing down until sea level almost stabilizes between 500–1800 CE. Global and northern-hemisphere temperatures rose from the last glacial termination until the 'Holocene Optimum'. From there, up to the start of the recent anthropogenic rise, they almost steadily decline.

How are the sea-level and temperature evolutions linked? We investigate this with a semi-empirical sea-level model.

We found that, due to the nature of Milankovitch forcing, northern-hemisphere temperature (we used the Greenland temperature by Vinther et al., 2009) is a better model driver than global mean temperature because the evolving mass of northern-hemisphere land ice was the dominant cause of Holocene global sea-level trends. The adjustment timescale for this contribution is $\sim$1200 years (900–1500 years; 90% confidence interval).

To fit the observed sea-level history, the model requires a small additional constant rate (Bittermann 2016). This rate turns out to be of the same order of magnitude as reconstructions of Antarctic sea-level contributions (Briggs et al. 2014, Golledge et al. 2014). In reality this contribution is unlikely to be constant but rather has a dominant timescale that is large compared to the time considered.

We thus propose that Holocene sea level can be described by a linear combination of a temperature driven rate, which becomes negative in the late Holocene (as Northern Hemisphere ice masses are diminished), and a positive, approximately constant term (possibly from Antarctica), which starts to dominate from the middle of the Holocene until the start of industrialization.

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