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# Contrasting records of sea-level change in the eastern and western North Atlantic during the last 300 years

A.J. Long [a,*], N.L.M. Barlow [a], W.R. Gehrels [b], M.H. Saher [b], P.L. Woodworth [c], R.G. Scaife [d], M.J. Brain [a], N. Cahill [e]

[a] Department of Geography, Durham University, South Road, Durham, DH1 3LE, United Kingdom
[b] Environment Department, University of York, Heslington, York, YO10 5DD, United Kingdom
[c] National Oceanography Centre, Joseph Proudman Building, 6 Brownlow Street, Liverpool L3 5DA, United Kingdom
[d] Department of Geography and Environment, University of Southampton, University Road, Southampton, SO17 1BJ, United Kingdom
[e] School of Mathematical Sciences (Statistics), University College Dublin, Belfield, Dublin 4, Ireland

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ABSTRACT

We present a new 300-year sea-level reconstruction from a salt marsh on the Isle of Wight (central English Channel, UK) that we compare to other salt-marsh and long tide-gauge records to examine spatial and temporal variability in sea-level change in the North Atlantic. Our new reconstruction identifies an overall rise in relative sea level (RSL) of c. 0.30 m since the start of the eighteenth century at a rate of $0.9 \pm 0.3$ mm yr$^{-1}$. Error-in-variables changepoint analysis indicates that there is no statistically significant deviation from a constant rate within the dataset. The reconstruction is broadly comparable to other tide-gauge and salt-marsh records from the European Atlantic, demonstrating coherence in sea level in this region over the last 150–300 years. In contrast, we identify significant differences in the rate and timing of RSL with records from the east coast of North America. The absence of a strong late 19th/early 20th century RSL acceleration contrasts with that recorded in salt marsh sediments along the eastern USA coastline, in particular in a well-dated and precise sea-level reconstruction from North Carolina. This suggests that this part of the North Carolina sea level record represents a regionally specific sea level acceleration. This is significant because the North Carolina record has been used as if it were globally representative within semi-empirical parameterisations of past and future sea-level change. We conclude that regional-scale differences of sea-level change highlight the value of using several, regionally representative RSL records when calibrating and testing semi-empirical models of sea level against palaeo-records. This is because by using records that potentially over-estimate sea-level rise in the past such models risk over-estimating sea-level rise in the future.



## 1. Introduction

Salt-marsh sea-level reconstructions can extend tide-gauge measurements back in time to create multi-century or millennia time series that may be compared with various forcing mechanisms, such as climate, ocean dynamics and ice sheet history. A key way to assess the reliability of these long-term records is to compare periods of overlapping salt-marsh data with tide-gauge measurements. Often the data agree (e.g. Gehrels et al., 2005) but in some instances they do not; for example, a study of 20th century sea-level rise using salt-marsh foraminifera from New Zealand's North Island reconstructed rates of sea-level rise that are about double that recorded at the nearby Auckland tide gauge (Grenfell et al., 2012).

On the east coast of the USA, where several late Holocene salt-marsh records exist (e.g. Donnelly et al., 2004; Gehrels et al., 2005; Kemp et al., 2009b; van de Plassche, 2000), comparisons with tide-gauge data are typically restricted to less than 100 years, with the longest tide-gauge record, that from New York, starting in AD 1856. Some of these salt-marsh records suggest a sea-level acceleration dated to the late 19th/early 20th century, several decades before the start of reliable tide-gauge data from the region. In the best dated and most precise reconstruction, from North Carolina, this acceleration is dated from a salt-marsh study as having taken place in the period AD 1865–1892 when the detrended (i.e. corrected for background glacio-isostatic adjustment (GIA)) rate of sea level increased by 2.2 mm yr$^{-1}$, from $-0.1$ mm yr$^{-1}$ to $+2.1$ mm yr$^{-1}$ (Kemp et al., 2011).

The five longest tide-gauge records in the world exist in north-west Europe (Liverpool, Brest, Amsterdam, Stockholm and Swinoujscie) with record lengths of between 200 and 300 years (Figs. 1

* Corresponding author. Tel.: +44 191 334 1913.
*E-mail address:* a.j.long@durham.ac.uk (A.J. Long).

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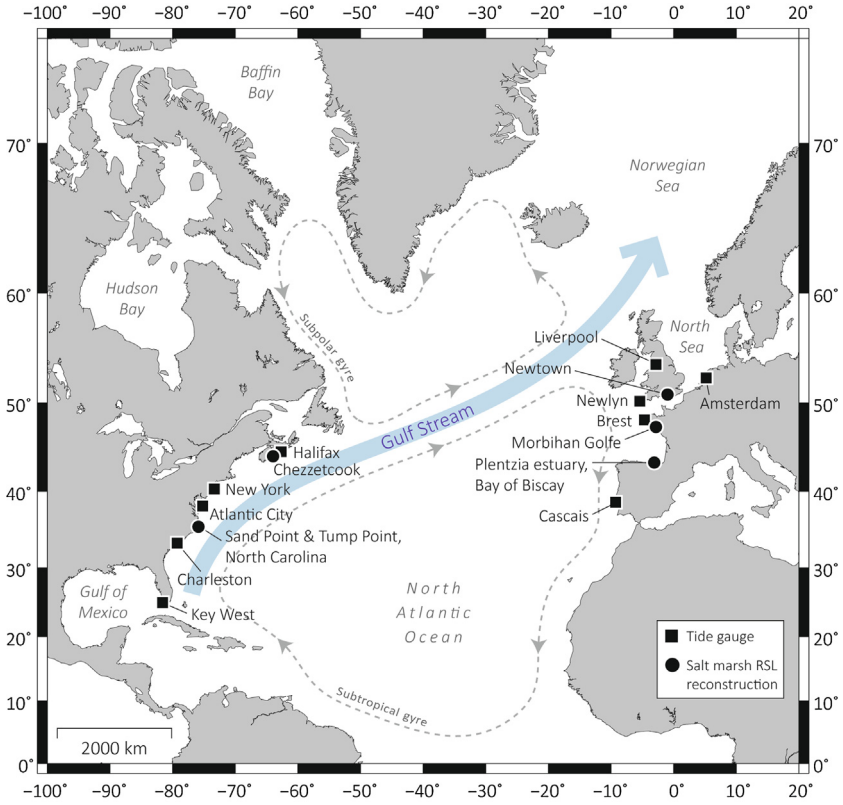


**Fig. 1.** Location map showing key tide-gauge and salt-marsh study sites mentioned in the text. The approximate configuration of the Gulf Stream and direction of the ocean gyres is shown for illustrative purposes.

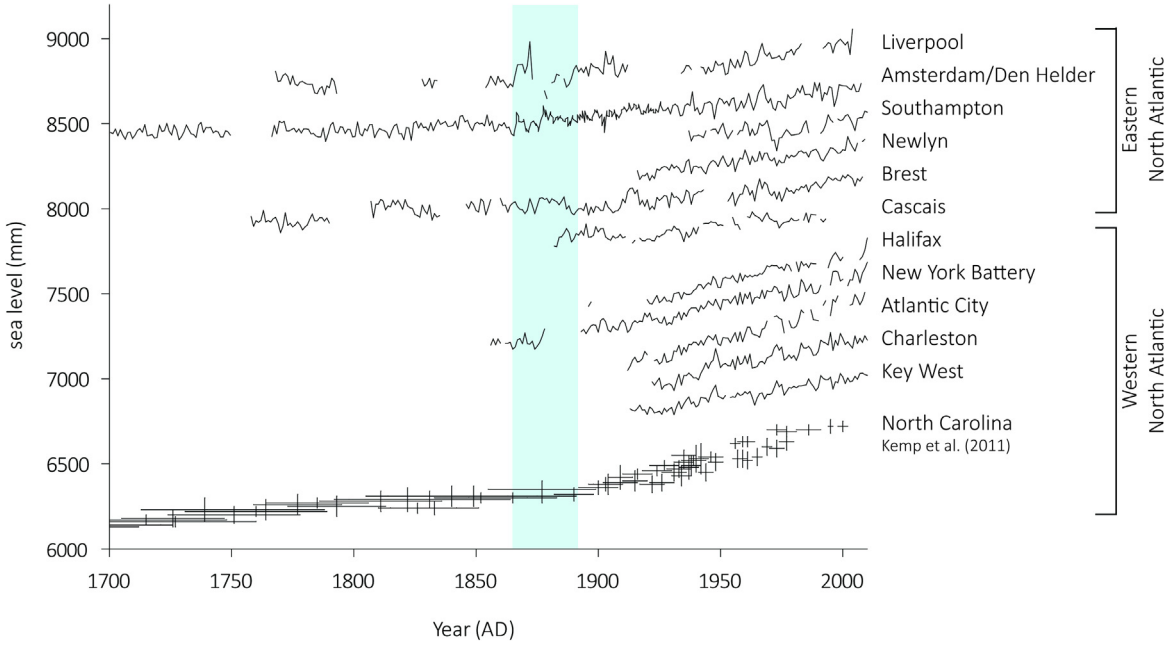


**Fig. 2.** Selected tide-gauge records from the North Atlantic. Data are sourced from the Permanent Service for Mean Sea-level (http://www.psmsl.org/), with the Southampton record by Haigh et al. (2009). The salt-marsh RSL reconstruction of Kemp et al. (2011) from North Carolina is also shown. None of the records are corrected for vertical land motions (GIA). The vertical shaded bar denotes the period of sea-level acceleration identified in North Carolina salt-marsh sediments by Kemp et al. (2011).

and 2). Compared with the American salt-marsh records referred to above, these European tide-gauges record a more gradual long-term acceleration in sea-level of about 0.01 mm $yr^{-2}$ (Gehrels and Woodworth, 2013; Woodworth et al., 2011a, 2009, 2011b). Two European salt-marsh studies reconstruct RSL trends over the last 150 years and provide evidence for this acceleration (Leorri et al., 2008; Rossi et al., 2011), but well-dated records over the last 300 years are lacking.

Gehrels and Woodworth (2013) re-analysed the salt-marsh RSL records referred to above, focusing on when sea level first deviated from a background linear trend. Using only directly dated sea-level index points, they argued that the onset of modern RSL