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Reconstructing Holocene sea-level change from coastal freshwater peat: A combined empirical and model-based approach

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Freshwater environments have long been considered to be unsuitable for the reconstruction of Holocene sea-level changes as they provide limiting, rather than precise, sea-level index points. We recorded the stratigraphy of a small beach and backbarrier coastal Phragmites marsh at Hallsands, south Devon, southwest England, using hand-drilled cores and ground penetrating radar, and collected five new sea-level index points from the base of a Holocene peat sequence to refine the regional Holocene relative sea-level curve. We demonstrate that the samples, despite their freshwater origin, represent accurate sea-level index points due to the quantifiable relationship between tide levels and groundwater. By means of water-table monitoring and groundwater modelling we show that the primary controls on the water table in the marsh are: (1) stratigraphy; (2) peat permeability; and (3) recharge rates in the backbarrier marsh. The five index points document relative sea-level positions between 7200 and 2400 cal yr BP. Three points are in good agreement with previously collected regional data from intertidal deposits and two points usefully fill gaps in the existing reconstruction. We present an amended Holocene relative sea-level curve for south Devon, based on 30 data points. We conclude that the base of Holocene freshwater peat sequences in small backbarrier systems provide reliable index points for the reconstruction of relative Holocene sea-level changes provided that: (1) the backbarrier stratigraphy show uninterrupted peat sequences demonstrating that the barrier has remain closed; (2) the water table in the backbarrier marsh is controlled by the tidally-oscillating sea level; (3) values of recharge and peat permeability are such that ponding and drying of the backbarrier marsh is limited; and (4) the beach is relatively thin and its permeability is not the primary control of water-table elevations in the backbarrier marsh. The combined approach of data collection and modelling used in this method can be applied to similar coastal settings around the world and will allow the collection of sea-level index points from locations not previously thought possible.