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Coastal salt-marsh sediments of the southeastern North Sea region document North Atlantic climate variability

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Salt marshes are of substantial importance for the adaptation of coastal regions to present-day and predicted future climate changes, and accompanied sea-level fluctuations. This gives the motivation to investigate salt-marsh archives from the southern North Sea region, which provide an exceptional archive to understand the response of coastal systems to climate variability of the recent past. For this study, well-stratified sediment sequences from two different salt-marsh systems were analysed by scanning XRF spectroscopy. The study sites are affected by both natural processes and anthropogenic interventions on different time scales. To address the complex interplay between storm surges, human-induced coastal management, and coupled internally forced atmosphere-ocean mechanisms during the last century, this study focuses on the $\ln(\text{Zr}/\text{Rb})$ ratio as proxy for the relative particle-size distribution, and the $\text{Br}/\text{C}_{\text{org}}$ ratio as an indicator for the marine versus terrestrial organic matter input to the sediment. Additional information about local changes in the sedimentary organic matter quality is provided by the alteration of $\ln(\text{Br}/\text{Cl})$ ratios. The $\ln(\text{Zr}/\text{Rb})$ records reveal periodic fluctuations at inter-annual, inter-decadal to multi-decadal time scales, suggesting a close link of sediment accretion to the atmospheric-ocean climate oscillation over the North Atlantic and Europe, which is accompanied by variations in the wind field, precipitation and river runoff. By contrast, the $\text{Br}/\text{C}_{\text{org}}$ ratios exhibit a long-term increase starting from the mid-twentieth century towards recent times, resembling the observed increasing trend in North Sea storminess. Abrupt drops in the $\ln(\text{Br}/\text{Cl})$ records coincide with relatively coarser sand layers, indicating impacts by regional storm surges during winter, while intervals of comparable higher $\ln(\text{Br}/\text{Cl})$ values represent times of generally calm weather conditions of periods with less frequent storm surges. Our results imply that past regional to super-regional climate changes have been transferred into the sedimentary salt-marsh archives of the southern North Sea region.