Geophysical Research Abstracts
Vol. 20, EGU2018-11037, 2018
EGU General Assembly 2018

Stable carbon isotopes in salt-marsh sediment as proxies for Holocene sea-level change: a comparison of Europe and North America

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Efforts to improve the precision of Holocene relative sea-level reconstructions and/or to provide reconstructions in the absence of microfossils have focused on establishing the origin of coastal sediment by characterizing the carbon that it contains. Specifically, this approach aims to identify the elevation within the intertidal zone at which sediment in the stratigraphic record was originally deposited. The measurements used are typically δ13C, total organic carbon, and C:N. These measurements must have a systematic and quantifiable relationship to tidal elevation to be valid sea-level proxies. We use three, regional-scale datasets to evaluate the utility of these measurements as sea-level proxies in eastern North America, western North America, and northwestern Europe. Each dataset is comprised of paired observations of tidal elevation and surface sediment geochemistry from multiple sites. We use cluster analysis (partitioning around medoids) to objectively identify groups of samples within each dataset and compare the results to cases where combinations of the three variables were replaced with randomly generated data, including a null case where all variables were replaced. In eastern North America, clusters are driven primarily by d13C values that reflect the significant difference between salt-marsh floral zones dominated by C3 and C4 plants. Here d13C are valid sea-level proxies. In northwestern Europe clusters are driven primarily by total organic carbon and carbon characteristics do not meet the criteria of being sea level proxies. Western North America is an intermediate case. Our results indicate that reconstructing RSL using measurements of δ13C, total organic carbon, and C:N is most robust in regions where C3 and C4 plants exist in adjacent and elevation dependent zones. This occurs in eastern North America, but not in western North America or northwestern Europe.