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Carbon stable isotope (δ13C) and elemental (TOC, TN, C/N) geochemistry in salt marsh surface sediments (Western Brittany, France): Adequate proxies for relative sea-level reconstruction?

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Reconstructing a dense network of precise and reliable records of Holocene relative sea-level (RSL) changes is still a major challenge for the paleo climate scientific community. In some regions, the use of traditional foraminifera-based transfer function is prevented by micro-fauna scarcity (e.g. Stéphan et al., 2014, Goslin et al., 2015), thus fostering the need for alternative proxies to be developed and used. Rather recently, isotopic and elemental geochemistry tools have been shown to form promising alternative proxies for RSL reconstruction (e.g. Wilson et al., 2005, Engelhart et al., 2013, Khan et al., 2015). Questions remain nonetheless open regarding the possibility for such markers to allow (i) distinguishing between freshwater and brackish to marine domains (this condition being needed if RSL index-points are to be derived from sedimentary markers) and (ii) to adequately identify the source of the organic matter preserved in the sediment. Concerns about the preservation of carbon and nitrogen compounds during diagenesis have also arose questioning the reliability of such markers for paleo-environmental reconstruction purposes (Wilson et al., 2005; Lamb et al., 2006).

We analyzed stable carbon isotope ratios (δ13C), Total Organic Carbon (TOC), and Total Nitrogen (TN) values within 94 surface sediments sampled across two C-3 plants dominated saltmarshes (Brittany, France). The distributions of δ13C, TOC, TN and C/N values is observed to follow clear and strong elevation-dependent trends. Some slight local variability appears between the studied sites that can be easily explained by the different morphological configuration and functioning of these latter. An indicator is found that allows sediments from below and above the high-tide level to be discriminated. This finding forms an interesting advance in the field as it permits to ensure that samples formed under saline conditions and thus suggests that these can be used as stand-alone proxies for RSL reconstruction.

This dataset is then used as a modern referential for Holocene RSL reconstruction. Statistical clustering analyses, conducted on the combined regional dataset allow for the identification of several intertidal elevation-dependent groups, characterized by specific values of δ13C, TOC, and TN. Our study thus confirm that δ13C, TOC, TN can act as direct RSL indicators in the context of C-3 plants dominated salt-marshes. Nonetheless, potential preservation issues are observed for the nitrogen compounds within the ancient sediments that deposited in the upper-tidal domain. This eventually challenges the reliable positioning of these latter on the former tidal frame, and thus introduces some uncertainty in the RSL positions that can be derived from them.