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Long-term organic carbon sequestration in tidal marsh sediments is dominated by old-aged allochthonous inputs in a macro-tidal estuary

Marijn Van de Broek (1), Caroline Vandendriessche (1), Dries Poppelmonde (1), Merckx Roel (1), Stijn Temmerman (2), and Gerard Govers (1)

(1) KU Leuven, Earth and Environmental Sciences, Heverlee, Belgium, (2) Department of Biology, Ecosystem Management Research Group, University of Antwerp, 2610 Wilrijk, Belgium

Tidal marshes are vegetated coastal ecosystems that are often considered as hotspots of atmospheric CO_2 sequestration. Although large amounts of organic carbon (OC) are indeed being deposited on tidal marshes, there is no direct link between high OC deposition rates and high OC sequestration rates as (i) the deposited OC may become rapidly decomposed once it is buried and (ii) a significant part preserved OC may be allochthonous OC that has been sequestered elsewhere. In this study, we aimed to identify the mechanisms controlling long-term OC sequestration in sediments of 10 tidal marshes along an estuarine salinity gradient (Scheldt estuary, Belgium and The Netherlands). Analyses of deposited sediments, collected using sediment traps during tidal inundation in summer and winter, have shown that OC deposited during tidal inundations is up to millennia old. This allochthonous OC is the main component of OC that is effectively preserved in these sediments, as indicated by the low radiocarbon content of buried OC. Furthermore, OC fractionation of buried OC showed that autochthonous OC is decomposed on a decadal timescale in saltmarsh sediments, while in freshwater marsh sediments locally-produced biomass is more efficiently preserved after burial. Our results show that long-term OC sequestration is decoupled from local biomass production in the studied tidal marsh sediments. This implies that OC sequestration rates are greatly overestimated when they are calculated based on short-term OC deposition rates, which are controlled by labile autochthonous OC inputs. Moreover, as allochthonous OC has not been sequestered in-situ, it does not contribute to active atmospheric CO_2 sequestration in these ecosystems. A correct assessment of the contribution of allochthonous OC to the total sedimentary OC stock in tidal marsh sediments as well as a correct understanding of the long-term fate of locally-produced OC are both necessary to avoid overestimations of the rate of in-situ atmospheric CO_2 sequestration in tidal marsh sediments.