Benthic metabolism and sulfur cycling along an inundation gradient in a tidal Spartina anglica salt marsh

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ABSTRACT: Central aspects of carbon and sulfur biogeochemistry were studied along a transect extending from an unvegetated mudflat into a *Spartina anglica* salt marsh. Conditions along the transect differed with respect to tidal elevation, sediment characteristics, vegetation coverage, and benthic macrofauna abundance. Dark sediment O_2 uptake and CO_2 emission at the highly bioturbated mudflat were low and relatively unaffected by tidal coverage. Sulfate reduction accounted for 30-60% of the daily CO_2 emission from the open mudflat sediment. Sediment O_2 uptake within the nonbioturbated and vegetated marsh was up to seven times higher during air exposure than during inundation, whereas the difference in CO_2 emissions always was less than a factor of 2. The contribution of sulfate reduction to CO_2 production was low (<21%) and decreased progressively with tidal elevation as a result of the oxidizing capacity of *S. anglica* roots in the vegetated marsh. The boundary between the mudflat and the retreating marsh is a unique environment. High near-surface pore-water concentrations of dissolved organic carbon (DOC) above the marsh cliff and highly elevated total carbon dioxide (TCO_2) pore-water concentrations at both sides of the cliff during air exposure coincided with extremely high TCO_2 emissions and apparent respiratory quotients (up to 14) only below the marsh cliff during inundation. We propose that substantial seepage of DOC-poor and HCO_3^--rich pore water may have occurred from the elevated marsh to the unvegetated sediment below during low tide followed by massive release of HCO_3^- during high tide. Accordingly, sulfate reduction accounted for more than the TCO_2 release above the marsh cliff, but only for about 40% below the cliff. Mineralization rates and pathways in salt-marsh sediments vary considerably on small spatial and temporal scales and are dependent on inundation frequency as well as the composition and distribution of flora and fauna.