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The Dynamics of sediment oxygenation in Spartina anglica Rhizospheres – a Planar Optode Study

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The salt marsh grass Spartina anglica have well-developed aerenthyma tissue facilitating a rapid transport of oxygen from the atmosphere to belowground roots and rhizomes, where oxygen can leak out of the root system and oxygenate the surrounding sediment. In this way, oxic microzones are distributed vertically in marsh sediments promoting aerobic microbial activity at depth.
In this study, the dynamics of sediment oxygenation in Spartina anglica rhizospheres was investigated, visualizing the belowground oxygen content using planar optode technology. Oxic microzones around roots and rhizomes were monitored in the laboratory under different light conditions and during tidal inundations of the aboveground biomass. Oxic microzones were restricted to the root tips extending up to16mm along the root and 1.5mm into the anoxic bulk sediment from the root surface. The oxygen concentration was highest at the root-surface ranging from 58-85μM.
The volume of the oxic microzones did not change significantly with decreasing light availability of the aboveground biomass showing that the atmosphere is the primary source for oxygen transported below ground. Consequently, tidal inundations cutting off the access to atmospheric oxygen resulted in a complete collapse of the oxic microzones after 3 hours of inundation in the light as well as in the dark. However, monitoring oxic microzones during a 24h tidal cycle with diurnal tidal inundations lasting 90min showed a 36% reduction of the oxic microzones in the light in contrast to a complete collapse of the oxic microzones in the dark. Hence, light availability and photosynthetic oxygen production of the aboveground biomass does influence the kinetics of oxic microzone develupment.
Belowground sediment oxygenation is of significant importance for the biogeochemical cycles in salt marsh sediment, in particular coupled nitrification-denitrification occurring at depth associated with oxic microzones can account for a significant proportion of the gaseous export of nitrogen from Spartina spp.-dominated marshes. This study shows that tidal inundations have significant impact on belowground biogeochemical conditions and must be taken into account when monitoring tidal marsh processes on a daily basis.