Scientific Paper:

Front. Plant Sci. (2018) Volume 9, Article 541

Plant-Sediment Interactions in Salt Marshes – An Optode Imaging Study of O_2, pH and CO_2 Gradients in the Rhizosphere

Ketil Koop-Jakobsen[1], Peter Mueller[2], Robert J. Meier[3], Gregor Liebsch[3] and Kai Jensen[2]
[1]MARUM – Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany
[2]Applied Plant Ecology, Biocenter Klein Flottbek, University of Hamburg, Germany
[3]PreSens Precision Sensing GmbH, Regensburg, Germany

Abstract:

In many wetland plants, belowground transport of O_2 via aerenchyma tissue and subsequent O_2 loss across root surfaces generates small oxic root zones at depth in the rhizosphere with important consequences for carbon and nutrient cycling. This study demonstrates how roots of the intertidal salt-marsh plant *Spartina anglica* affect not only O_2, but also pH and CO_2 dynamics, resulting in distinct gradients of O_2, pH and CO_2 in the rhizosphere. A novel planar optode System (VisiSens TD, PreSens GmbH) was used for taking high-resolution 2D-images of the O_2, pH and CO_2 distribution around roots during alternating light-dark cycles. Belowground sediment oxygenation was detected in the immediate vicinity of the roots, resulting in oxic root zones with a 1.7 mm radius from the root surface. CO_2 accumulated around the roots, reaching a concentration up to threefold higher than the background concentration, and generally affected a larger area within a radius for 12.6 mm from the root surface. This contributed to a lowering of pH by 0.6 units around the roots. The O_2, pH and CO_2 distribution was recorded on the same individual roots over diurnal light cycles in order to investigate the interlinkage between sediment oxygenation and CO_2 and pH patterns. In the rhizosphere, oxic root zones showed higher oxygen concentrations during illumination of the aboveground biomass. In darkness, intraspecific differences were observed, where some plants maintained oxic root zones in darkness, while others did not. However, the temporal variation in sediment oxygenation was not reflected in the temporal variations of pH and CO_2 around the roots, which were unaffected by changing light conditions at all times. This demonstrates that plant-mediated sediment oxygenation fueling microbial decomposition and chemical oxidation has limited impact on the dynamics of pH and CO_2 in *S. anglica* rhizospheres, which may in turn be controlled by other processes such as root respiration and root exudation.

Keywords: salt marsh, planar optode, sediment oxygenation, plant-soil interactions, soil chemistry, roots, Spartina, imaging methods