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Imaging pH and oxygen at the soil-root interface by planar optodes: a challenging technology to study dynamic rhizosphere processes.

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Roots do not only take up water and nutrients from surrounding soil but they also release a wide range of exudates, such as low molecular weight organic compounds, CO_2 or protons. Root-soil interactions trigger heterogeneous rhizosphere processes based on differences in root activity along the root axis and with distance from the root surface. Elucidating their temporal and spatial dynamics is of crucial importance for a better understanding of these interrelated biogeochemical processes in the rhizosphere. Therefore, monitoring key parameters at a fine scale and in a non-invasive way at the root-soil interface is essential. Planar optodes are an emerging technology that allows in situ and non-destructive imaging of mainly pH, CO_2 and O_2. Originated in limnology, planar optodes have recently been applied to soil-root systems in laboratory conditions. This presentation will highlight advantages and challenges of using planar optodes to image pH and O_2 dynamics in the rhizosphere, focusing on two RGB (red-green-blue) approaches: a commercially available system (PreSens) and a custom-made one. Important insights into robustness, accuracy, potentials and limitations of the two systems applied to different laboratory/greenhouse-based experimental conditions (flooded and aerobic rhizobox systems, plant species) will be addressed. Furthermore, challenges of optode measurements in the field, including a first case study with Eucalyptus grandis in Brazil, will be discussed.