# Rhizosphere reactive transport and transformation induced by diel root processes

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A single plant, *Avena sativa* (common oat), grown in a rhizobox under controlled conditions, was studied to better understand the impact of dynamic root processes on rhizosphere (hydro)biogeochemistry. In the rhizobox, the soil around individual roots was continuously monitored for changes in the concentration of reactive species. Diel plant biophysical processes led to peak rates of root water uptake and exudation during the daytime. Dissolved organic carbon near the root tip was observed to peak at mid-day. This was accompanied by a significant decrease in dissolved oxygen and an increase in pH and Fe(II). Modeling was used as a testbed to address uncertainty in the mechanisms controlling the observed behaviors. Over diel time scales, modeling provided for the systematic integration of root system architecture, transpiration-driven root xylem flow, exudation of organic carbon, variably saturated flow in silty loam soil, and multicomponent biogeochemical reactive transport. Microbially-mediated consumption of organic carbon promoted aerobic respiration and Fe(III) reduction. Redox cycling led to the reductive dissolution and precipitation of Fe(III) minerals, which are effective sorbents for organic compounds and plant-relevant nutrients. This systematic interplay between roots, microbes, and minerals, and its sensitivity to shifts in climate and vegetation is fundamental to the prediction of larger scale fluxes of water, carbon, and nutrients.