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Impact of Bed Form Celerity on Oxygen Dynamics in the Hyporheic Zone

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Abstract:
Oxygen distribution and uptake in the hyporheic zone regulate various redox-sensitive reactions and influence habitat conditions. Despite the fact that fine-grain sediments in streams and rivers are commonly in motion, most studies on biogeochemistry have focused on stagnant sediments. In order to evaluate the effect of bed form celerity on oxygen dynamics and uptake in sandy beds, we conducted experiments in a recirculating indoor flume. Oxygen distribution in the bed was measured under various celerities using 2D planar optodes. Bed morphodynamic were measured by a surface elevation sensor and time-lapsed photography. Oxygenated zones in stationary beds had a conchoidal shape due to influx through the stoss side of the bed form, and upwelling anoxic water at the lee side. Increasing bed celerity resulted in the gradual disappearance of the upwelling anoxic zone and flattening of the interface between the oxic (moving fraction of the bed) and the anoxic zone (stationary fraction of the bed), as well as in a reduction of the volumetric oxygen uptake rates due to shortened residence times in the hyporheic zone. These results suggest that including processes related to bed form migration are important for understanding the biogeochemistry of hyporheic zones.

Keywords: hyporheic exchange, bed form migration, moving streambed, ripples, planar optodes