Geophysical Research Abstracts
Vol. 19, EGU2017-14565, 2017
EGU General Assembly 2017

Dynamic Hyporheic Zones: Exploring the Role of Transient Flood Pulses on Bedform-induced Exchange under Gaining and Losing Conditions

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Understanding transient hyporheic processes requires systematic investigation on the interplay of time-varying hydraulic forces, streambed morphology and ambient groundwater conditions. In this study, we explore the impacts of time-varying flood events on hyporheic zone (HZ) with groundwater upwelling/downwelling. A wide range of flood events with various flood intensities and skewness, stream morphology with different slopes and aspect ratios, and groundwater upwelling/downwelling conditions were generated. To evaluate the impacts of transient forcing while modulated by groundwater fluxes, we chose the following metrics: hyporheic exchange fluxes, HZ extent and depth, and the spatial patterns of residence time and oxic/anoxic zones. Our study suggested that flood pulses have the potential to alter flow directions from a gaining to a losing stream, indicating interesting impacts on geochemical transformation potentials. Strong upwelling or downwelling flow compresses the HZs, which counteracts the effects caused by flood pulses. Streambed slop modifies ambient groundwater conditions; steeper slope generates larger relative change of hyporheic exchange flux during flood. Flood pulses have long-lasting effects in HZ, which are influenced by streambed morphology, sediment properties, flood types and groundwater conditions.