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Differential Heat Propagation in Ripples, Dunes and Riffle-Pool Bedforms and its Impact on Hyporheic Exchange Flows

Tanu Singh (1), Liwen Wu (2), Jesus D. Gomez-Velez (3), David Hannah (1), and Stefan Krause (1)

(1) University of Birmingham, United Kingdom (t.singh.2@bham.ac.uk), (2) Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, (3) New Mexico Institute of Mining and Technology, Earth & Environmental Science, Socorro, NM, United States

The physical, chemical and biological processes occurring in the hyporheic zones are often temperature-dependent. Thermal shifts have a direct impact on bacterial activity which primarily controls the degradation of organic matter, attenuation of contaminants, and nitrogen cycling. Heat propagation and distribution within streambed is dependent on the induced pressure gradients along the sediment-water interface, which in turn are caused by interactions between channel flow and bed topography. Hitherto, little attention has been paid to the interplay between different bedform geometries (such as ripples, dunes and alternating bars) and their impact on heat propagation and hyporheic zone behaviors. To understand these interactions, we constructed a numerical model that coupled Darcy flow with heat transport equations. Diurnal temperature fluctuations in the water column were imposed at the sediment-water interface. Our results show the diurnal oscillations in surface water temperature propagate differently for different bedforms. Variations in dynamic viscosity generate significant changes in hyporheic flux, residence time distributions and solute transportation in the streambed. Understanding thermal patterns within the streambed with geomorphological controls facilitates deeper understanding of water chemistry and quality.