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Towards the 'hyporheic meter': prediction of hyporheic exchange from bedforms to bars and bends

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The hyporheic zone is now recognized as an integral component of the river-aquifer-floodplain continuum. It hosts myriad ecosystem services and biogeochemical processes. These phenomena are typically mediated by fluid flow processes; by definition, the hyporheic zone is a fluid flow path beginning and ending at the stream-sediment interface. A holistic understanding of the hyporheic zone therefore begins with a solid hydrodynamic basis. This talk presents recent lessons learned about hyporheic zone hydrology primarily from a suite of both standard and state-of-the-art numerical simulations. Coupled simulations of turbulent open channel flow and porewater flow lead to a set of equations useful for predicting hyporheic zone flux, depth, and residence time at the bedform scale under neutral, losing and gaining river conditions. Traditional groundwater flow simulations of hyporheic flow across meander bends and bars lead to a similar set of predictive equations for flux, depth and residence time in rivers of increasing sinuosity and under neutral, gaining and losing conditions. The approach presented here could be used as a template to generate predictive equations for other hyporheic-flow inducing features, such as pool-riffle or step-pool sequences and other in-stream structures. Eventually, this would result in a matrix of predictive equations, and convolution/superposition of the appropriate equations representing a collection of hyporheic forcing mechanisms present in a given river would lead to a robust 'hyporheic meter'.