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Application of 3D CFD to quantify bedform dynamics in a sandy braided river

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Sand-bed rivers are characterised by multiple scales of topography (e.g., channels, bars, dunes and ripples) that influence morphodynamics and channel evolution. Recently there has been a significant advance in monitoring and modelling of these processes down to the scale of individual bedforms. However, relatively less progress has been made in parameterising the role of bedforms in controlling channel-scale morphodynamics, or in explicitly modelling the interactions between bedform-scale and bar-scale processes in a single simulation. Consequently, we do not yet understand the influence of dune scale roughness on the spatial distribution of flow and bed shear stress, sediment transport or bar evolution in sandy braided rivers.

Results are presented from a combined numerical modelling and field monitoring project of the sandy braided South Saskatchewan River, near Outlook (SK Province, Canada). A high-resolution (c. 6 cm) Digital Elevation Model of a 350 m section of channel that contained submerged alternate bars was derived from aerial imagery using a combination of Structure from Motion photogrammetry and a statistical model between flow depth and image brightness. Spatially-distributed velocity data required to define model boundary conditions and for model validation were obtained using acoustic Doppler current profiler surveys. Numerical simulations of the three-dimensional flow structure within the channel were carried out using the OpenFOAM CFD package. Simulations were undertaken using DEMs with varying representation of bedform topography. Results from two simulations are presented, one representing both dune and bar scale topography, and a second in which dune scale topography superimposed on bars has been removed by filtering. Comparison of the results from these simulations yields insights into the role of bedform scale topography as a control on flow steering and the spatial distribution of bed shear stress.