EGU21-9676
https://doi.org/10.5194/egusphere-egu21-9676
EGU General Assembly 2021

Study of turbulent mixing processes at a mesoscale confluence through aerial drone imagery and eddy-resolved modelling

Jason Duguay, Pascale Biron, and Thomas Buffin-Bélanger
Concordia, Geography, Planning and Environment, Canada (duguay.jason@gmail.com)

The large-scale turbulent structures that develop at confluences fall into three main categories: vertically orientated (Kelvin-Helmholtz) vortices, large-scale secondary flow helical cells and smaller strongly coherent streamwise orientated vortices. The causal mechanisms of each class, how they interact with one another and their respective contributions to mixing is still unclear. Our investigation emphasises the role played by the instantaneous flow field in mixing at a mesoscale confluence (Mitis-Neigette, Quebec, Canada) by complementing aerial drone observations of turbulent suspended sediment mixing processes with results from a high-resolution eddy-resolved numerical simulation. The high velocity near-surface flow of the main channel (Mitis) separates at the crest of the scour hole before downwelling upon collision with the slower tributary (Neigette). Fed by incursions of lateral momentum of the Mitis, shear generated Kelvin-Helmholtz instabilities expand as they advect along the mixing-interface. As the instabilities shed, water from the deeper Neigette passes underneath the fast, over-topping Mitis, causing a large portion of the Neigette's discharge to cross under the mixing-interface in a short distance. The remaining flow of the tributary crosses over inside large-scale lateral incursions farther downstream. The downwelling Mitis, upwelling Neigette and recirculatory cell interact to generate coherent streamwise vortical structures which assist in rapidly mixing the waters of the two rivers in the vicinity of the mixing-interface. Evidence of large-scale helical cells were not observed in the flow field. Results suggest that flow interaction with bathymetry, and both vertical and streamwise orientated coherent turbulent structures play important roles in mixing at confluences. Our findings strongly suggest that investigating mixing at confluences cannot be based solely on mean flow field variables as this approach can be misleading. Visualization of a confluence's mixing processes as revealed by suspended sediment gradients captured in aerial drone imagery complemented with eddy-resolved numerical modelling of the underlying flow is a promising means to gain insights on the role of large-scale turbulent structures on mixing at confluences.