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Coherent-Structure Resolving Simulations of Turbulence in Natural Streams with the Curvilinear Immersed-Boundary Method[1]

SEOKKOO KANG, IMAN BORAZJANI, FOTIS SOTIROPOULOS, University of Minnesota — Critical prerequisite for developing a science-based approach to restoring natural streams is being able to model turbulence in real-life aquatic environments. We develop a powerful computational model for carrying out coherent structure resolving simulations of turbulent flows in natural streams at field scale conditions. The model employs the curvilinear immersed boundary method (CURVIB) of Ge and Sotiropoulos (J. Comp. Phys., 2007) to handle the arbitrarily complex channel geometries. To enable efficient simulations in the large-aspect ratio domains and highly stretched grids, arising due to the very small depth-to-length ratio of natural streams, we employ a fully implicit matrix-free GMRES method for the momentum equations coupled with a parallel algebraic multigrid method for the pressure Poisson equation. The capabilities of the method are demonstrated by carrying out high resolution LES as well as coarser resolution RANS simulations for the field scale meandering stream flow in the St. Anthony Falls Laboratory Outdoor StreamLab.

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