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Fast solver of the shallow water equations with application to estimation of the riverine surface flow velocity[1] MOJTABA FORGHANI, YIZHOU QIAN, PETER KITANIDIS, Stanford Univ, MATTHEW FARTHING, TYLER HESSER, US Army Eng Res and Dev Ctr, JONGHYUN LEE, University of Hawaii, ERIC DARVE, Stanford Univ — Estimation of the riverine flow velocity is important in applications such as the safe and efficient maritime transportation, prediction of beach erosion, and flood risk management. By assuming small vertical length scale compared to the horizontal length scale, the shallow water equations (SWE) are derived from the Navier-Stokes equations to predict flow velocity, given the riverbed profile (bathymetry) and the boundary conditions (BCs), e.g., the discharge and the free surface elevation. Here, we propose a fast solver using machine learning for the SWE that can be used for the online prediction of riverine flow velocities. Our approach consists of first, estimating the probability density function of the bathymetry from the flow velocity measurements, and then using deep learning to obtain a fast solver of the SWE, given the distribution of the bathymetry and known BCs. Our method can incorporate bathymetry information into the flow velocity prediction for improved accuracy at no additional cost; for example, in cases where the bathymetry is available for a limited number of cross-sections. Our results, validated on Savannah river, GA, show reasonable accuracy of prediction at a very low computational cost.

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