The Remote Monitoring of Flow Rate Based on the Surface Velocity Field and Bathymetry Inferred from Surface Turbulence Metrics

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Abstract. Traditional methods of measuring river flow rates are relatively expensive and often require field technicians to work in hazardous conditions. Under high flow conditions, during which the bathymetry changes widely, the use of extrapolated rating curves can result in errors of up to 70%. In an effort to develop a reliable, continuous and efficient method of remotely monitoring volumetric flow rate, a surface particle image velocimetry (SPIV) experiment is conducted in a wide open channel flow facility to measure the surface velocity field and study the physics connecting the surface turbulence metrics to bathymetry. The experiment is carried out in fully developed flows at a range of non-dimensional flow depths \(B/H = 8 – 20\), where \(B\) is the channel width and \(H\) is the flow depth, Reynolds numbers \(\text{Re}H = 8,000 – 59,000\), based on the mean velocity and flow depth) and Froude numbers \(\text{Fr} = 0.1 – 0.5\). Both mean and turbulent velocities and integral length scales are calculated from the surface PIV data. It is found that the mean surface velocity is related to the depth-averaged velocity and the integral length scale varies predictably with the flow depth, thus calculation of the flow rate is enabled. The primary objective is to develop a non-contact discharge monitoring approach that will reduce streamgaging costs at the same, or potentially better accuracy relative to current methods, while reducing hazards associated with traditional methods.