Unpiloted aerial vehicles (UAVs) as a remote sensing platform to estimate the velocity of flood water

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Quantifying velocities of flood water on the floodplain is fundamental to the assessments of flood risk, hydrological responses to storm events, geomorphological processes, and physically based inundation models. The study investigates the potential of aerial surface velocity measurements based on the Lagrangian methods of large-scale particle image velocimetry (LSPIV) and Space Time Image velocimetry (STIV), as well as the Eulerian approach of particle tracking velocimetry (PTV) to estimate the velocity of flood water in the floodplain. Six experiments conducted at five sites with three different types of small unpiloted aircraft (SUA) tested the methods and workflow under varied flood and non-flood conditions. The performance was evaluated by comparison of mean velocities against that measured by a conventional Acoustic Doppler Current Profiler (ADCP). The best results were achieved using the STIV method with an off-the-shelf Phantom 3 Pro at the River Severn site, where the ADCP and STIV estimations differed by 0.63%. Very good results were also generated by both other methods, with a 2.56% difference compared to the ADCP at the Sandwell site and a 3.32% difference at the Buckland site. All the methods provided accurate estimation from at least one site, but some methods provided very poor results at others. Sites with visible distinct debris of similar size performed best with the PTV approach. Sites with wave movement or ripples on the surface saw the best result with the LSPIV method, and sites where the debris was significantly darker or lighter than the surrounding water provided the best results with STIV. While the project demonstrates that high-quality GPS aboard the SUA provides better positional accuracy, a workflow is established where similar results are achieved without the need to place ground control points (GCP). Also noted was that while the correction of images based on lens calibration provided better resolution accuracy, these gains did not translate to better velocity estimation, and that images taken without the use of a gimbal could not sufficiently be corrected for movement, and provided sub-optimal results. The study concludes that measuring overland flow velocity in the floodplain from debris generated by the flood or movement in the water, as well as positioning the image without the need to place and survey targets, is a successful low-cost and easy-to-deploy alternative to conventional sensor systems to estimate velocity.