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On the characterisation of open-flow seeding conditions for image-velocimetry techniques using UASs

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In the last years, new technologies have been developed to monitor rivers in a real-time framework opening new opportunities and challenges for the research community and practitioners. Acquiring data in open flow conditions can be performed through the use of Unmanned Aerial System (UAS) to derive surface velocity fields and in consequence, river discharge. Significant work has been done to investigate the reliability of image-velocimetry techniques using numerical simulations and laboratory flume experiments, but, to date, the effects of environmental factors on velocity estimates are not addressed adequately. In this context, a critical variable is represented by the number of particles transiting on the water surface (defined as seeding density) during field surveys and their challenging dynamics along the cross-section, on both time and space. Seeding density has a significant effect on surface velocity estimation and river discharge accuracy. The goal of this study was, therefore, to evaluate the accuracy and feasibility of LSPIV and PTV techniques under different seeding and flow conditions using several footages acquired employing UASs. To this purpose, the seeding behaviour during the whole acquisition time was examined for each case study focusing on the quantification of essential variables such as seeding density, average tracers' dimension, coefficient of variation of tracers' area, and spatial dispersion of them in the field of view. For each case study, both image-velocimetry techniques have been applied considering several different sets of images to locally measure the accuracy of velocity estimations in challenging seeding conditions. Results show that the local seeding density, tracers' dimension and their spatial distribution can strongly influence the reconstruction of velocity fields in natural stream reaches. Therefore, prior knowledge of seeding characteristics in the field can deal with the choice of the optimal image-velocimetry technique to use and the related setting parameters.