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A combination of flow velocity measurements to estimate flow discharge time series in a rough stream of a headwater catchment

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This work contributed to the study of the hydrological processes that cause flash floods in the Mediterranean region. This study focuses on the estimation of flow discharge time series taking into account various measurements of water velocity. The case of the Claduègne hydrometric station, defining a catchment of 43 km^2 and located on a stream of medium mountain region in Ardèche, France, is selected as it is densely equipped and it is representative of many other sites of headwater catchments with potentially very short response times and difficulty to estimate flood discharges. Many on-alert campaigns were carried out at this site during the period 2012-2015 (HyMeX and Flashflood projects) which resulted in flow gauging measurements, in particular during floods using a portable Surface Velocity Radar (SVR). Water level and surface flow velocity are measured continuously using fixed radars. Flow velocity was also measured continuously using a V-ADCP during a cumulative period of 7 months. In this study we take advantage of all the data measured on this velocimetric station to (i) evaluate the index velocity method compared to the conventional stage-discharge rating curve for a 5 years period (2012-2016) including a 10 years return period flood which produced a significant shift in the rating curve due to the change of morphology of the cross-section. (ii) Decompose the "index velocity rating" into two sub-relations: a relation between the "depth averaged velocity" and the "surface velocity" and a relation between the "depth averaged velocity" and the "mean channel velocity". The analysis of these two sub-relations allows us to better understand the physics of the index velocity rating. It enables to assess whether there exists a form of genericity in one of these sub-relations in order to facilitate its application in other environments. (iii) Propose a new method of calculating flow discharge that makes limited use of gaugings using continuous water level and velocity measurements, a stage-area rating and a parabolic model for the lateral distribution of velocity.