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Temporal interpolation of radar rainfall fields: meeting the stringent requirements of urban hydrological applications

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Radar rainfall estimates are playing an increasingly important role in urban hydrological applications due to their better description of the spatial and temporal characteristics of rainfall. However, the operational radar rainfall products provided by national weather services (typically at 1 km / 5 min resolution) still fail to meet the stringent resolution requirements of urban hydrological applications. While the spatial and temporal resolution of rainfall inputs are strongly related, recent studies suggest that the latter generally constitutes a more critical factor and that temporal resolutions of $\sim$1-2 min (i.e. below those currently available) are required for urban hydrological applications, while spatial resolutions of $\sim$1 km (i.e. close to those currently available) appear to be sufficient. Traditional strategies for obtaining higher temporal resolution radar rainfall estimates include changes in radar scanning strategies and stochastic downscaling. However, the former is not always possible, due to hardware limitations, and the latter results in large ensembles members which hinder practical use. In this work a temporal interpolation method, based upon the multi-scale variational optical flow technique, is proposed to generate high temporal-resolution (i.e. 1-2 min) radar rainfall estimates. The proposed method has been successfully applied to obtain radar rainfall estimates at 1 and 2 min temporal resolutions from UK Met Office C-band radar products originally at 5 and 10 min temporal resolution and varying spatial resolutions of 1 km, 500 m and 100 m. The performance of the higher temporal-resolution radar rainfall estimates was assessed through comparison against local rain gauge records collected at a pilot urban catchment (size $\sim$ 865 ha) in North-East London. A further evaluation was conducted by applying the different rainfall products as input to the hydraulic model of the pilot catchment and comparing the hydraulic outputs against available flow and depth records. The results show that the temporally-interpolated rainfall estimates can better reproduce the small-scale dynamics of the storm events, leading to better reproduction of urban runoff.