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Multi-storm, multi-catchment investigation of rainfall spatial resolution requirements for urban hydrological applications

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Rainfall estimates of the highest possible resolution are required for urban hydrological applications, given the small size and fast response which characterise urban catchments. While significant progress has been made over the last few decades in high resolution measurement of rainfall at urban scales and in the modelling of urban runoff processes, a number of questions as to the actual resolution requirements for input data and models remain to be answered. With the aim of answering some of these questions, this work investigates the impact of rainfall estimates of different spatial resolutions and structures on the hydraulic outputs of models of several urban catchments with different characteristics. For this purpose multiple storm events, including convective and stratiform ones, measured by a polarimetric X-band radar located in Cabauw (NL) were selected for analysis. The original radar estimates, at 100 m and 1 min resolutions, were aggregated to coarser spatial resolutions of up to 1000 m. These estimates were then applied to the high-resolution semi distributed hydraulic models of four urban catchments of similar size (approx. 7 km2), but different morphological and land use characteristics; these are: the Herent catchment (Belgium), the Cranbrook catchment (UK), the Morée Sausset catchment (France) and the Kralingen District of Rotterdam (The Netherlands). When doing so, methodologies for standardising rainfall inputs and making results comparable were implemented. Moreover, the results were analysed considering different points at each catchment, while also taking into account the particular storm and catchment characteristics.
The results obtained for the storms used in this study show that flat and less compact catchments (e.g. polder areas) may be more sensitive to the spatial resolution of rainfall estimates, as compared to catchments with higher slopes and compactness, which in general show little sensitivity to changes in spatial resolution. While this study provides interesting insights, further investigation is still required in order to obtain a more complete answer regarding rainfall resolution requirements for urban hydrological applications. Future work should include testing on higher resolution fully distributed hydro models, as well as the analysis of many more storm events.