Geophysical Research Abstracts
Vol. 18, EGU2016-15166-2, 2016
EGU General Assembly 2016

Small-scale Rainfall Challenges Tested with Semi-distributed and Distributed Hydrological Models

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Nowadays, there is a growing interest on small-scale rainfall information, provided by weather radars, to be used in urban water management and decision-making. Indeed, it helps to better understand the essential interactions between natural and man-made urban environments, both being complex systems. However the integration of this information in hydrological models remains a big challenge. In fact, urban water managers often rely on lumped or semi-distributed models with much coarser data resolution.

The scope of this work is to investigate the sensitivity of two hydrological models to small-scale rainfall, and their potential improvements to integrate wholly the small-scale information. The case study selected to perform this study is a small urban catchment (245 ha), located at Val-de-Marne county (southeast of Paris, France). Investigations were conducted using either CANOE model, a semi-distributed conceptual model that is widely used in France for urban modeling, or a fully distributed and physically based model, Multi-Hydro, developed at Ecole des Ponts ParisTech (www hmco-dev.enpc.fr/Tools-Training/Tools/Multi-Hydro.php).

Initially, in CANOE model the catchment was divided into 9 sub-catchments with size ranging from 1ha to 76ha. A refinement process was conduced in the framework of this investigation in order to improve the model resolution by considering higher number of smaller sub-catchments. The new configuration consists of 44 sub-catchments with size ranging from 1ha-14ha. The Multi-Hydro modeling approach consists on rasterizing the catchment information to a regular spatial grid of a resolution chosen by the user. Each pixel is then affected by specific information, e.g., a unique land type per pixel, for which hydrological and physical properties are set. First of all, both models were validated with respect to real flow measurements using three types of rainfall data: (1) point measurement data coming form the Sucy-en-Brie rain gauge; (2) Meteo-France C-band radar data at 1km pixel scale and (3) ENPC X-band dual polarization radar data at 250m pixel scale.

Results show that considering bigger number of smaller sub-catchments improve the response of CANOE model to small-scale rainfall. However, the fully distributed approach demonstrates much higher sensitivity than the semi-distributed one, suggesting that this approach is more appropriate to integrate the rainfall structures measured at small scales. Finally, we compare these results with those obtained earlier in the framework of the RainGain project (www.raingain.eu), which helps to re-interpret some of our former conclusions.