



Transfer of spatio-temporal multifractal properties of rainfall to simulated surface runoff

Auguste Gires (1), Agathe Giangola-Murzyn (1), Julien Richard (1), Jean-Baptiste Abbes (1), Ioulia Tchiguirinskaia (1), Daniel Schertzer (1), Bernard Willinger (2), Hervé Cardinal (3), and Thomas Thouvenot (4)
(1) Univ. Paris Est, LEESU, Ecole des Ponts ParisTech, LEESU, Marne-la-Vallée Cedex 2, France (auguste.gires@leesu.enpc.fr), (2) Véolia Eau, (3) Syndicat Intercommunal pour l'Assainissement de la Vallée de la Bièvre, (4) Veolia Environnement Research & Innovation

In this paper we suggest to use scaling laws and more specifically Universal Multifractals (UM) to analyse in a spatio-temporal framework both the radar rainfall and the simulated surface runoff. Such tools have been extensively used to analyse and simulate geophysical fields extremely variable over wide range of spatio-temporal scales such as rainfall, but have not often if ever been applied to surface runoff. Such novel combined analysis helps to improve the understanding of the rainfall-runoff relationship.

Two catchments of the chair "Hydrology for resilient cities" sponsored by Véolia, and of the European Interreg IV RainGain project are used. They are both located in the Paris area: a 144 ha flat urban area in the Seine-Saint-Denis County, and a 250 ha urban area with a significant portion of forest located on a steep hillside of the Bièvre River. A fully distributed urban hydrological model currently under development called Multi-Hydro is implemented to represent the catchments response. It consists in an interacting core between open source software packages, each of them representing a portion of the water cycle in urban environment. The fully distributed model is tested with pixels of size 5, 10 and 20 m.

In a first step the model is validated for three rainfall events that occurred in 2010 and 2011, for which the Météo-France radar mosaic with a resolution of 1 km in space and 5 min in time is available. These events generated significant surface runoff and some local flooding. The sensitivity of the model to the rainfall resolution is briefly checked by stochastically generating an ensemble of realistic downscaled rainfall fields (obtained by continuing the underlying cascade process which is observed on the available range of scales) and inputting them into the model. The impact is significant on both the simulated sewer flow and surface runoff. Then rainfall fields are generated with the help of discrete multifractal cascades and inputted in the numerical hydrological model. It appears that the outputs (maps of water depth and velocity) of the hydrological model exhibit a scaling behaviour both in space and time. Various sets of UM parameters are tested. The three UM parameters of the various processes at stake are then compared which enables to analyse how the extremes are either dampened or enhanced. This hints at innovative techniques to quantify the extremes at very high resolution (typically 1 m) without having to run the model at these resolutions which would require too much time especially for real time applications.