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Challenges with space-time rainfall in urban hydrology highlighted with a semi-distributed model using C-band and X-band radar data

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Climate change and global warming are expected to make precipitation events more frequent, more severe and more local. This may have serious consequences for human health, the environment, cultural heritage, economic activities, utilities and public service providers. Then precipitation risk and water management is a key challenge for densely populated urban areas. Applications derived from high (time and space) resolution observation of precipitations are to make our cities more weather-ready. Finer resolution data available from X-band dual radar measurements enhance engineering tools as used for urban planning policies as well as protection (mitigation/adaptation) strategies to tackle climate-change related weather events.

For decades engineering tools have been developed to work conveniently either with very local rain gauge networks, or with mainly C-band weather radars that have gradually been set up for space-time remote sensing of precipitation. Most of the time, the C-band weather radars continue to be calibrated by the existing rain gauge networks. Inhomogeneous distributions of rain gauging networks lead to only a partial information on the rainfall fields. In fact, the statistics of measured rainfall is strongly biased by the fractality of the measuring networks. This fractality needs to be properly taken in to account to retrieve the original properties of the rainfall fields, in spite of the radar data calibration.

In this presentation, with the help of multifractal analysis, we first demonstrate that the semi-distributed hydrological models statistically reduce the rainfall fields into rainfall measured by a much scarcer network of virtual rain gauges. For this purpose, we use C-band and X-band radar data. The first has a resolution of 1 km in space and 5 min in time and is in fact a product provided by RHEA SAS after treating the Météo-France C-band radar data. The latter is measured by the radar operated at Ecole des Ponts and has a resolution of 250 m in space and 3.4 min in time. The obtained results suggest that a proper rainfall data re-normalisation is needed either when comparing gauged rainfall with the radar data, or when quantifying the impacts of space-time variability within hydrological modelling.

Then, we used the semi-distributed hydrological model InfoWorks CS operated by Veolia over the Bièvre catchment (Paris region) with the same two types of rainfall data as inputs. We simulated six events and analysed the hydrographs resulted from simulations with both data types to show the impacts of initially different resolutions of rainfall fields over the same catchment, especially in respect to the small-scale variability not measured by the C-band radar data.

These results encourage us not only to argue the use of higher resolution rainfall data, compare to that has been so claimed in the literature, but also to emphasise the important role of nonlinear geophysics' methods in taking reliable decisions.