Combining C-band and X-band weather radars for accurate precipitation measurements over urban areas

Preliminary comparison of weather radar based precipitation measurements from C-band and X-band weather radars

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Over approximately the last decade, there has been a growing interest of and research in weather radars and the applications of radar based rainfall measurements in the field of urban drainage. This activity, development and research has led to, that the weather radar today is considered as an important supplement to the traditional tipping bucked rain gauges in the field of urban drainage. The weather radar is today seen as a valuable tool to enlightening the dynamic effect in the drainage system coursed by the time and spacial distributed developments in the rainfall event. In the same way, the weather radar is considered as an indispensable tool for accurate short-time precipitation forecast, that in the near future facilitates intelligent and active drainage systems, with the potential of a more efficient wastewater transport and treatment as the consequence.

Different types of weather radars ranging from massive long-range S- and C-band radars to small cost-efficient X-band radars are in operation to day and in Denmark it is quite common with dual coverage from both C- and X-band radars. The radars are operating with different configuration regarding: antenna design, wavelength, scanning strategy etc, which results in different properties for the measurement. Shorter wavelength results in a higher resolution and thereby a more detailed description of the precipitation and its propagation, while longer wavelengths are less sensitive to the atmospheric attenuation. Depending on antenna design and the scanning strategy, the volumetric integration of the atmosphere is different regarding e.g. the vertical opening angle of the antenna, which means that some radar types scans the hole cloud formation, while others scans a slice of it.

An important prerequisite for a wide application of weather radar precipitation data in the field of urban drainage is however, that the volume integration performed by the radar of the droplets in the atmosphere is representative for the actual water volume hitting the ground surface and affecting the urban drainage system. If this transformation are incorrect or insufficient described it may course significant errors in the radar based rainfall measurements, reducing the overall data quality and its applicability for e.g. urban drainage modeling of precipitation forecasts. In the past this relationship between radar measurement and precipitation are described and established in different scientific contexts since the 1940s. Nevertheless there are still today so many problems and pitfalls associated with the use of weather radar measurements in urban hydrology, that the actual practical application are still relatively small and reserved for research and scientific purposes.

The basic concept behind the PhD project is that it is possible to reduce the weaknesses and inaccuracies of one radar types by utilising the strength from another and vice versa. The overall aim for the PhD project is to investigate, how this combination is possible and to develop the necessary intercalibration and data assimilation tools to produce a merged measurement. As an outcome of this it is expected that the project will facilitate methods for data fusion of different types of weather radar data in radar networks that produces a single combined precipitation image, which outperforms the individual radars. This will increase the overall quality, value and the future applicability of weather radar based precipitation measurements in the field of urban drainage.

The presentation contains preliminary results based on a case study from a dual coverage area in the northern part of Jutland. The radars which are investigated are a C-band weather radar and a X-band LAWR (Local Area Weather Radar). By mapping of differences and similarities the results illuminates both the challenges and potentials in the data integration. In this context the differences is just as important as the similarities, because it is in the differences the possible improvements is hidden, while it is in the similarities that makes the future integration possible.