Quantitative Precipitation Estimates Measured by C- and X-Band Radars

The Potential for Integration

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The perfect weather radar for urban drainage applications is a radar with both long-range and high resolution. Unfortunately, in real life a typical trade-off for better range is a lower resolution. When performing precipitation forecasts on the storm and wastewater system, it is obvious to combine radars with long range and high resolution. This study is based on a single radar, but the results and resolution are important. The length of the forecast is dependent on the radar range and the sampling volume is dependent on the radar resolution.

In this study, a direct comparison of precipitation data from a long range C-band and a high resolution X-band radar is performed. The scope of the study is to investigate the possibilities and potentials for combining the two types of radars.

Introduction

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The purpose of this study was to gain more knowledge about the potential for integration of the two radar systems. As shown, the radars have both strengths and weaknesses associated with their working principle. The radars are supplementing each other quite well and the results demonstrate that a potential for combination of the two radar types is existing. In case of light and wide-spread rain, the C-band radar has its strength while the strengths of LAWR are in relation to the convective rainfall.

The potential for integration of the two radar systems will also play an important role for the future combination of these systems. The differences in antenna design and target distance will also play an important role for the future combination of the radar systems.

The Experimental Setup

The two radars are working with different temporal and spatial resolution, see table 1 and 2. To be able to quantify the correlation between the two systems, the LAWR data has been averaged in space to fit the 2 x 2 grid resolution of the C-band radar. The spatial correlation between the two radar measurements is illustrated in figure 3 for the 6th of July 2009 in the time interval 18:00 to 20:10. The area for comparison is a square with the LAWR located in the center as illustrated in figure 2. Visually, the images show both similarities and dissimilarities, see figure 3. One explanation for the differences could be the different scanning strategies employed by the two different types of radars. The LAWR is conducting the measurement by a time average with a wide vertical antenna opening angle. The C-band radar is creating a ‘snap shot’ conducted from several scans in different elevations every 10 minutes. Despite the differences of the radar systems, the spatial detection of the precipitation by the two systems is relatively similar through the period. At the same time, it is obvious that the images are not identical which is shown by the low correlation coefficients. The similarities of precipitation intensities are somewhat more variable – for some images the highest precipitation intensities are in the same locations, while for others it differs.

Discussion and Conclusion

For the comparison, an area of the northern part of Denmark is investigated. The area is covered by both a Local Area Weather Radar (LAWR) and a meteorological C-band radar. The area is instrumented with nine tipping bucket rain gauges.

Different meteorological conditions are found to yield different results for the two radar systems. As an example of this, a stratiform and a convective precipitation event are displayed in figure 4. The area for comparison is the full range of the LAWR (see figure 1) and the data shown is the full spatial resolution of both systems.

There is a problem that the C-band radar detects a much wider spatial extent of the stratiform precipitation than the LAWR. Due to the large vertical opening angle and the low-laying precipitation, the upper part of the LAWR beam will break out of the precipitation quite close to the radar. This results in partly filled sampling volumes and thereby poor observations at larger distances. In the case of convective precipitation, the vertical extent of the precipitation is much higher and partly filled sampling volumes are no issue for the LAWR radar. In this case, the disadvantage of low spatial resolution for the C-band radar becomes clearer. Even though there is a good visual agreement between the radar images, the result also shows that LAWR detects the spatial variations within the convective precipitation in more details. The authors would like to thank the Danish Meteorological Institute (DMI) for the work part of the Storm and Wastewater Information (SWI) project partly financed by the Danish Agency for Science, Technology, and Innovation.

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