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

The Potential for Integration

Nielsen, Jesper Ellerbæk; Larsen, Jakob Badsberg; Thorndahl, Søren Liedtke; Rasmussen, Michael R.

Publication date:
2010

Document Version
Publisher's PDF, also known as Version of record

Link to publication from Aalborg University

Citation for published version (APA):
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 coarser spatial resolution (Einfalt et al., 2004). This is the key trade-off for the consideration of the radars for urban drainage applications. In this case, the disadvantage of low spatial resolution associated with the longer range is a coarser spatial resolution (Einfalt et al., 2004). However, the resolution of the radar data, both the range and resolution are important. The length of the forecast is dependent on the radar range and the spatial resolution is a measure of the independence of the radar results.

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 coarser spatial resolution (Einfalt et al., 2004). This is the key trade-off for the consideration of the radars for urban drainage applications. In this case, the disadvantage of low spatial resolution associated with the longer range is a coarser spatial resolution (Einfalt et al., 2004). However, the resolution of the radar data, both the range and resolution are important. The length of the forecast is dependent on the radar range and the spatial resolution is a measure of the independence of the radar results.

The two radars are working with different temporal and spatial resolution, see figure 2. To be able to quantify the correlation between the two systems, the LAWRA data has been averaged in space to fit the 2 x 2 km 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 20 km square with the LAWRA 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 LAWRA 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 and areas cover the same locations, while for others it differs.

Spatial Correlation

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 LAWRA (see figure 1) and the data shown is the full spatial resolution of both systems. It is evident that the C-band radar detects a much wider spatial extent of the stratiform precipitation than the LAWRA. Due to the large vertical opening angle and the low-laying precipitation, the upper part of the LAWRA beam will break out of the precipitation quite close to the radar. This results in overly filled sampling volumes and thereby poor observations at longer 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 LAWRA. In this case, the disadvantage of low spatial resolution for the C-band radar becomes clear. Even though there is a good visual agreement between the radar images, the result also shows that LAWRA detects the spatial variations within the convective precipitation in more details.

Strength and Weaknesses

For the comparison, an area of the northern part of Denmark is investigated. The area is covered by both a Local Area Weather Radar (LAWRA) and a meteorological C-band radar. The area is instrumented with nine tipping bucket rain gauges. To be able to compare the precipitation measurements from the two radar systems, both radar systems have been calibrated on the basis of the nine rain gauges for the same time period.

Quantitative Precipitation Estimates Measured by C- and X-band Radars — The Potential for Integration and Discussion

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 widespread rain the C-band radar has its strength while the strengths of LAWRA are in relation to the convective precipitation.

For the future integration of the measurements, it will be necessary to consider the meteorological conditions of the precipitation as this affects the performance of the radar systems. The differences in antenna design and target distance mean that width and the elevation of the radar beam will be different. Therefore, the vertical profile of the precipitation will also play an important role for the future combination of the two radar systems. It is important to point out that the differences are just as important as the similarities, because it is within the differences the possible improvements are hidden, while it is the similarities that makes the integration possible.

Acknowledgment

The Authors would like to thank the Danish Meteorological Institute (DMI). The work is part of the Storm and Wastewater Information (SWIN) project partly financed by the Danish Agency for Science, Technology, and Innovation.

References