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Enhancing Quantitative Precipitation Estimation in Urban Areas Using IoT Sensors and Radar Data

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In the city of Lübeck, 50 optical sensors from NIVUS were installed as part of the mFund project heavyRAIN. These measurements, combined with radar-derived precipitation data, aim to improve quantitative precipitation estimation (QPE) through additional information from many measurement points (Einfalt et al., 2024). A key aspect of the study was the careful selection of sensor locations to optimize data quality in the challenging urban environment. To achieve this, a set of quality criteria was defined to guide the placement of the sensors (Jahnke-Bornemann & Einfalt, 2023). Together with the radar measurements, these measurements serve to better understand the spatial and temporal relationships between radar and ground measurements during heavy rainfall events. This leads to an improvement of the adjustment by estimating the adjustment error in space and time.

Heavy rainfall events often exhibit high spatial gradients in radar measurements due to small-scale precipitation cells. Since radar measures precipitation at altitudes ranging from several hundred meters to a few kilometres, two critical questions arise:

- When does the precipitation measured at higher altitudes reach the ground? Depending on the altitude and droplet size, which determines the fall velocity, raindrops can take up to 10 minutes to reach the surface (WMO, 2024).
- Where does the precipitation reach the ground? Wind conditions between the radar measurement height and the surface can cause precipitation to drift horizontally, sometimes over distances equivalent to the measurement altitude (Lack & Fox, 2007).
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A comparison with a ground-based measurement network, such as the IoT sensor system, can help address these questions. The study involved a comprehensive quality assessment by classifying IoT sensor precipitation data into seven categories and comparing them with radar pixels at the corresponding locations. Initial efforts focused on handling data gaps and erroneous values in the IoT measurements. Subsequently, an extensive spatiotemporal analysis was conducted using a data cube approach to improve the correlation between radar and sensor data. The data can be shifted spatially and temporally in the data cube.

The findings demonstrate that integrating IoT sensors with radar data enhances the knowledge on small-scale rainfall patterns. The improved correlation between ground and radar measurements and supports the development of more accurate adjustment techniques. These results contribute to the advancement of high-resolution precipitation monitoring and, as a consequence, forecasting in complex urban environments.

Literature

Einfalt, T., Jahnke-Bornemann, A., Jasper-Tönnies, A., Kupzig, J., Neumann, J., Oppel, H. (2024) Weather radar and IoT sensor networks: which information from which source? Book of Abstracts, International Conference on Urban Drainage ICUD 2024, Delft. https://www.hydrometeo.de/wp-content/uploads/202406_ICUD_IoT_sensors_Poster.pdf (besucht am 26.02.2025)

Jahnke-Bornemann, A. and Einfalt, T. (2023) heavyRain - Use of IoT rain sensors to improve heavy rain forecasts in Lübeck. UrbanRain23 Book of Abstracts, P. Molnar, Switzerland, https://ethz.ch/content/dam/ethz/special-interest/conference-websites-dam/urbanrain-dam/documents/UrbanRain23_BOOK-OF-ABSTRACTS.pdf (besucht am 26.02.2025)

WMO (2024): WMO Guide to Operational Weather Radar Best Practices, WMO-No. 1257. https://community.wmo.int/en/activity-areas/weather-radar-observations/best-practices-guidance (besucht am 28.11.2024)

Lack, S. A., & Fox, N. I. (2007). An examination of the effect of wind-drift on radar-derived surface rainfall estimations. Atmospheric Research, 85(2), 217–229.

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