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Enhancing radar-based nowcasting of heavy precipitation using IoT Rain Sensors and Machine Learning: A Field Study in Four German Cities

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The “heavyRain” project (duration: 2022 –2025) aims to improve short-term, radar-based forecasting of heavy rainfall events by integrating machine learning (ML) methods with Internet of Things (IoT) sensors. In a field trial conducted in four German cities—Bochum, Hagen, Lübeck, and Lüdenscheid—50 IoT-compatible low-cost rain sensors are deployed in each city. These sensors use an automotive infrared rain sensor, combined with a LoRaWAN transmitter and a photovoltaic element. LoRaWAN (Long Range Wide Area Network), a low-power wireless protocol, is already widely available in these cities. The sensors can distinguish between dry conditions and seven rainfall intensity levels, transmitting minute-averaged data through the municipal LoRaWAN network. This data is automatically collected, validated, and made accessible for further use.
Despite being single-point measurements, the dense network of sensors offers the potential to better capture the spatial structure of rainfall events due to their rapid response, even to low rain intensities. With broad deployment and optimized placement, this network is expected to enhance rainfall pattern detection at scales of 0.5 to 1 km, complementing gauge, radar and satellite data.

The project aims to utilize these sensor data to improve radar-based nowcasting. ML methods will be integrated with a classical, cell-based nowcasting algorithm implemented in the SCOUT software (hydro & meteo), which interpolates motion vectors into a 2D vector field, accounting for cell rotation and divergence, using a semi-Lagrangian method for extrapolation of radar-measured rainfall fields. Nowcast ensembles are generated based on observed uncertainties in cell detection, offering reasonable accuracy in predicting cell direction and path. However, challenges remain in forecasting cell genesis, growth, and decay. This project examines whether ML-generated insights at the cell level can address these gaps. Furthermore, the integration of additional data sources, such as satellite and radar volumetric data, will be assessed for potential improvements to nowcasting accuracy.

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Session

Prediction Scales and Model Development: Modeling elements in nowcasting

Preferred Contribution Type

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