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A probabilistic AI-based merging of Commercial Microwave Link and Radar QPE

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Commercial Microwave Links (CMLs) provide path-integrated attenuation estimates close to the ground which are closely related to the path-averaged rainfall intensity. Therefore, the combination of CMLs with area-wide weather radar observations, each with its strengths and weaknesses, enables us to further improve the accuracy of rainfall maps. Weather radars measure at increasing heights with increasing distance from the radar. Thus, quantitative precipitation estimation (QPE) may show biases due to for example advection, strong up- and downdrafts, size sorting or melting processes. At the same time, CMLs require extensive quality control to deliver robust QPE. QPE from both sources have benefitted from the application of AI based methods in the past.

In this study, we extend ResRadNet [1], a deep learning framework to predict rain gauge estimates on the ground based on radar-derived QPE and the measurement height, by using CML-based QPE as additional model input. Training the model using rain gauges as an accurate point-scale measurement, it is enabled to subsequently provide improved surface estimates without further gauge-adjustments. Additionally, we develop a new Continuous Ranked Probability Score (CRPS) based objective function to enable skillful ensemble predictions and estimate the uncertainty of the ground-adjustment. Using the RADOLAN-RY precipitation product, derived from the C-band radar network of the German Weather Service (DWD), and a large CML network with 3900 link paths, our results demonstrate that the use of CMLs significantly reduces the biases of ResRadNet QPE. We further present the impact of the new objective function on the prediction of extremes and how to calibrate the ensemble variance. Combined rainfall maps are presented and discussed for recent flooding events in Germany.

[1] Polz, J., Glawion, L., Gebisso, H., Altenstrasser, L., Graf, M., Kunstmann, H., Vogl, S., & Chwala, C. (2024). Temporal Super-Resolution, Ground Adjustment, and Advection Correction of Radar Rainfall Using 3-D-Convolutional Neural Networks. IEEE Transactions on Geoscience and Remote Sensing, 62, 1–10. IEEE Transactions on Geoscience and Remote Sensing. https://doi.org/10.1109/TGRS.2024.3371577

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Session

From Classical to Integrated Remote Sensing: New retrieval and estimation techniques (e.g. fusion, Bayesian)

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