GEFÖRDERT VOM

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Deutscher Wetterdienst
Wetter und Klima aus einer Hand

pyRADMAN: A flexible Python Framework for radar adjustment using CML and rain gauge data

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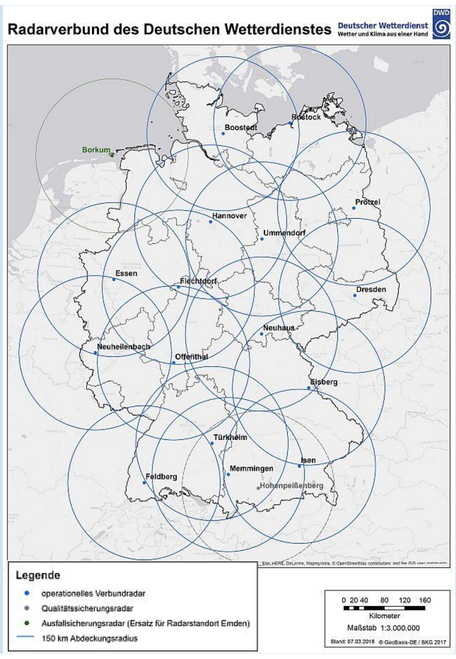
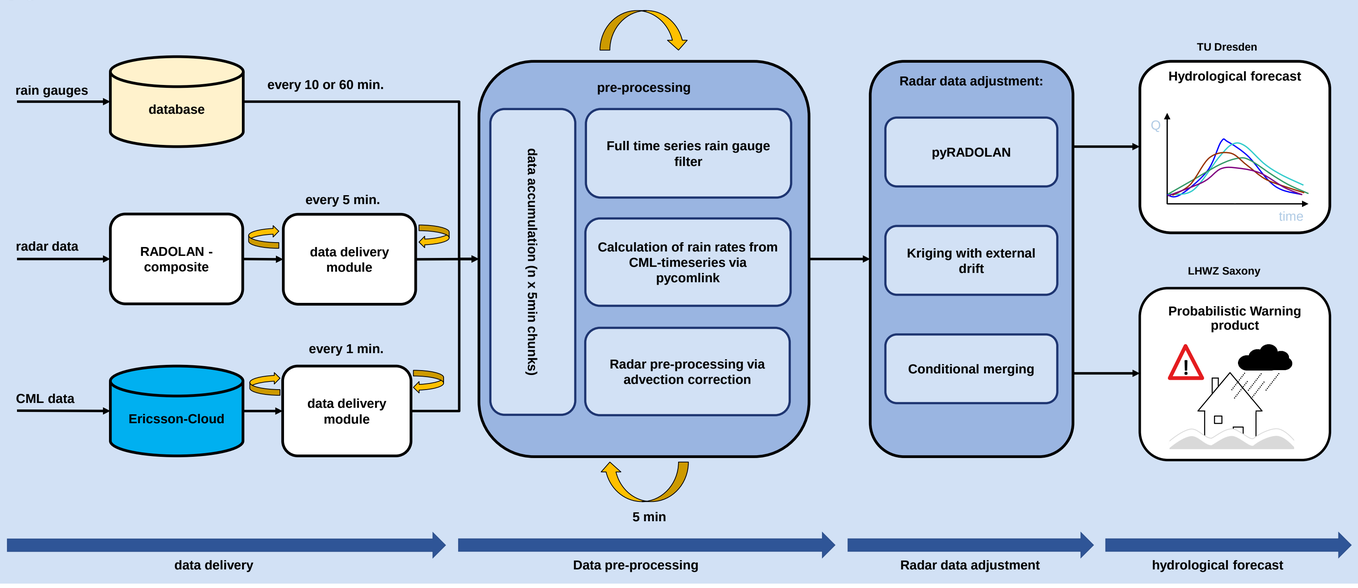
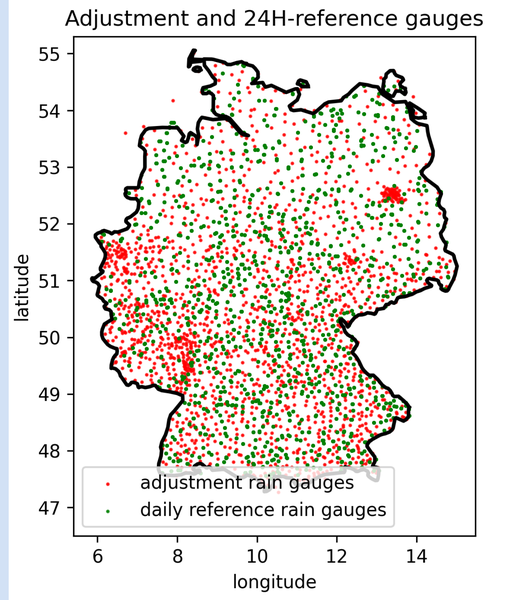


pyRADMAN's process chain:





Adjusting weather radar data with rain gauges is an established way to overcome radar-specific uncertainties. In addition to rain gauge data we added CML (commercial micro wave link) data of Germany's telecommunication network to increase the number of precipitation sensors at ground-level. The radar data adjustment using rain gauge and CML data is performed by pyRADMAN – a new software running at DWD.

CML rainfall estimation:

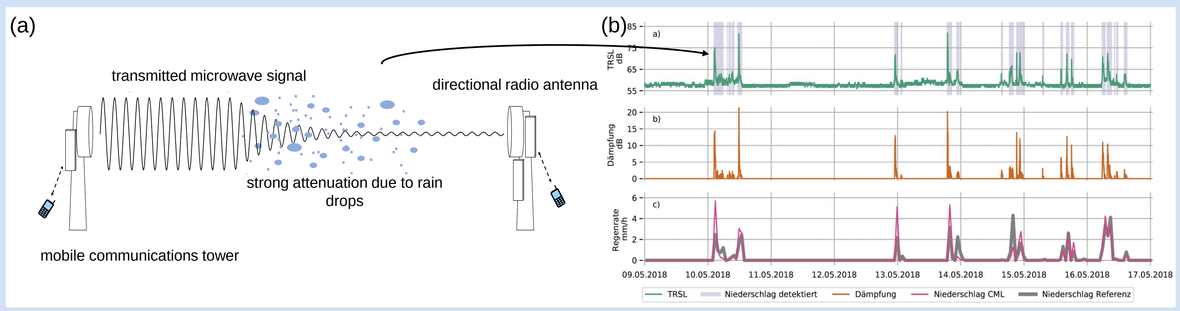


Fig. 1 (a): Schematic of measuring rainfall using CML antennas. (b): Example timeseries of CML's damping level with and without rain phases.

Rainfall leads to attenuation of the signal level between CML's. Fig. 1(b) shows, that additional ground-level precipitation information can be derived from the attenuation of CML's during rainfall. For CML data processing a python package called pycomlink was developed at Karlsruher Institute of Technologies and University of Augsburg. At DWD we implemented pycomlink into pyRADMAN to perform radar data adjustment using CML data. pyRADMAN controls all input and output data, while keeping the sensor combinations, accumulation times and adjustment methods flexible. We use the well known RADOLAN adjustment principal and conditional merging, which are compared in Fig. 2(b)-(d) and Fig. 2(e)-(h). The adjustment principals are briefly summarized.

Adjustment method comparison

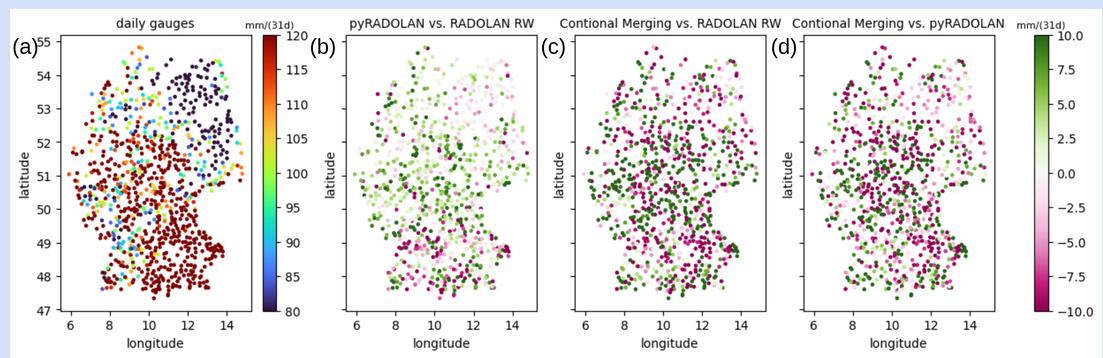


Fig. 2(a): Monthly sum of all 24H-reference gauges for August 2023. Fig. 2(b)-(d): Comparison of adjustment methods. Green indicates: First adjustment method in the plot title is closer to the reference gauges. Fig. 2(e)-(h): Hexbin-plots of aggregated product data of August 2023 using different adjustment methods.

RADOLAN**:** The ratios and differences of the radar precipitation estimates and rain gauges are calculated. The best matching ratio or difference at each radar pixel is used to adjust the radar data in a certain radius.
pyRADOLAN**:** The RADOLAN adjustment principal was translated into python in the previous project: "HoWa-Innovativ". pyRADOLAN has been enhanced to use CML's rain rates and gauge rain rates as input data for adjustment.
Conditional Merging: The rain gauge values and radar precipitation values are interpolated using ordinary kriging. The radar field minus the kriged radar field is added to the kriged rain gauge field.

Daily validation of pyRADMAN products

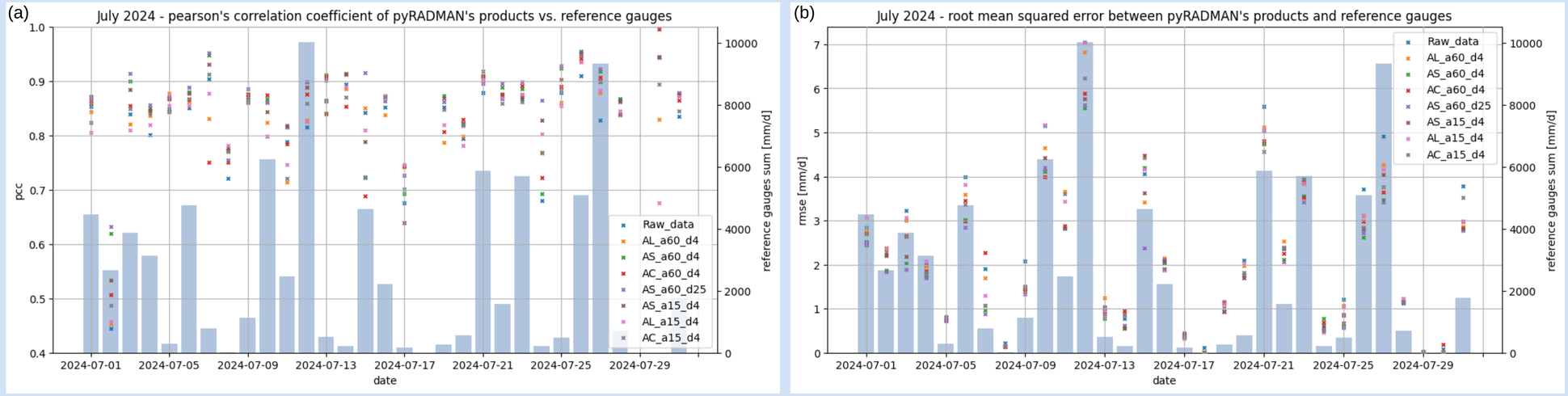


*Fig. 3(a): Evaluation of pearson's correlation coefficient of pyRADMAN's products and reference gauges. (b): Root mean squared error of pyRADMAN's products and reference gauges. In (a) and (b) the daily rainfall sums of all reference gauges are drawn with blue bars. The sensor combinations are defined as **AS**: radar + rain gauges, **AL**: radar + CML's and **AC**: radar + rain gauges + CML's, where the subsequent number of **a** and **d** describes the accumulation time and processing delay of the product type.*

Adjustment data sources

- CML data of ~10,000 sender-receiver pairs with a time resolution of 10 sec are available every minute
- Radar data from 17 locations in Germany are delivered every 5 min
- 1,400 rain gauges with a time resolution down to 1 min are accessible every 10 min for DWD in total
- ~900 24H-reference gauges operated by DWD employees

Conclusion:

pyRADMAN were developed to perform radar data adjustment at DWD. It is capable to combine different sensor data individually, while keeping the accumulation time flexible. The quality of pyRADMAN's rain gauge adjusted products is comparable to RADOLAN's RW. As shown in Fig. 3(b) fast available CML adjusted products show improved quality compared to raw data in most cases. We expect, that the quality of CML adjusted products can be further improved by more strict filtering and other adjustment principals.

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