How to evaluate rainfall estimation performance?

A discussion of thresholds, spatial and temporal aggregations for one year of country-wide CML rainfall estimation

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performance evaluation

thresholds (I)

thresholds (II)

link or map based comparison

temporal aggregation

CML rainfall map

CML processing

radar reference

CML and radar data

underlined text is linked
CML data set

- Number of links: ~4000
- Temporal resolution: 1 min
- Variables: TX, RX
- Power resolution: 0.3 or 1.0 dB
- Length: 0.3 – 35 km (Ø 7 km)
- Frequency range: 10 – 40 GHz
- Analyzed period: Sept. 2017 – Aug. 2018

Radar: RADOLAN-RW

- Data from: 17 weather radars, ~1000 automatic rain gauges
- Temporal resolution: 1 hour
- Spatial resolution: 1 x 1 km
- Gauge adjustment: Mixed additive and multiplicative
- Available at: German Weather Service

More info on the data sets and processing is available in Graf et al. 2019
The impact of the threshold on false positive and false negative rates and the resulting misclassified rain rates

a) hourly, link-based comparison

- scatter plot and measure seem look quiet good, but…
  - the amount of misclassification in b) looks severe
  - while the resulting rain rates in c) are small

b) hourly count of false and true classifications for certain rain rates

- see Polz et al. 2019 for an data-driven processing approach to reduce the amount of misclassification

c) the resulting rain rates

- the choice of an adequate threshold (here they grey area in b) and c) -> 0.1 mm/h) is important and misclassification and the resulting rain rate have to be considered
The variance of correlation with different thresholds

Higher threshold results in a decrease of correlation

Correlation is higher when only for the reference a threshold is considered because all falsely classified CML rain events (false positives) are omitted

The choice of a threshold and to which part of the data it is applied has a considerable influence on the comparison between CML and reference rainfall data
The difference between a link and map-based evaluation

RADOLAN-RW  CML  map based comparison  CML based comparison

May

June

- CMLs underestimate maxima found in RADOLAN in the map based comparison because:
  - CMLs give a path averaged rain rate mostly over 3 -15 km
  - rainfall maxima in the CML maps can only occur at the synthetic observation points at the center of each CML
  - Rainfall events might not intersect with a CML, especially during small convective summer events

- Nevertheless, spatial patterns and rainfall depth are considerably good
The effect of temporal aggregation on performance measures

- With increasing aggregation the visual agreement rises, while correlation decreases especially for seasonal sums

- The CV decreases while RMSE and MAE rise due to higher values

- The bias remains the same

- Individual CMLs with great differences to the reference become visible in a seasonal (or monthly) aggregation
A CML rainfall map example

Rainfall maps from CML and RADOLAN-RW data from 12. – 14. May 2018 (30 km coverage around CMLs)

Download animated rainfall map from zenodo (1.1 MB)