ECSS 2023 Conference
Bucharest
08.05. - 12.05.2023

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Using dual-polarimetric radar moments to improve the precipitation estimate over Germany

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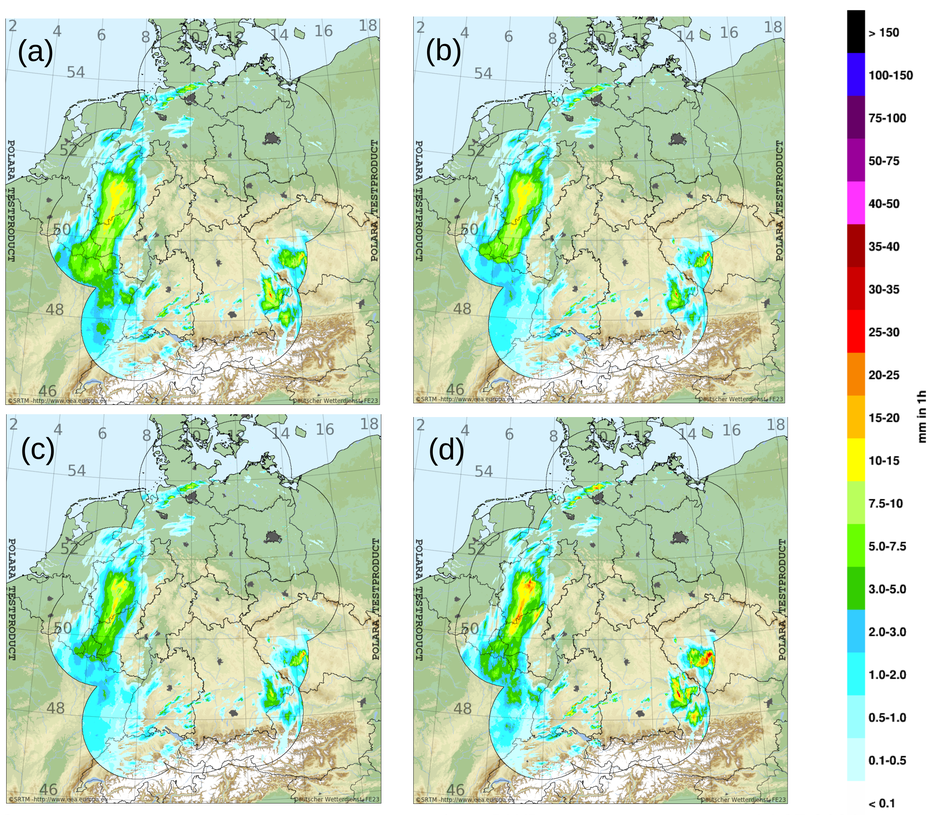
SINFONY (Seamless INtegrated FOrecastiNg sYstem)
- Pilot project at DWD to develop a seamless ensemble prediction system for convective-scale forecasting with forecast range up to 12 hours. Focus on summertime convection.
- Integrates NOWCASTING- and NWP-Ensembles into combined/blended forecast products.

SINFONY **www.dwd.de/sinfony**

QPE relationships

(a) RADOLAN R(Z_H)
Different R(Z_H) relations according to:
- Z_H threshold
- surrounding Z_H gradients
- see Bartels et al. 2004 (DWD report)

(b) R(Z_H, Hymec)
Based on hydrometeor classification Hymec (→ see Poster MIC2.P11):
- Different R(Z_H) relations for solid hydrometeors, see Rasmussen et al. 2003 (DOI: 10.1175/1520-0450(2003)042<0020:SNUART>2.0.CO;2)
- RADOLAN R(Z_H) for liquid hydrometeors



One hour accumulated radar sum composite of the DWD radar network on the 14.07.2021 17 UTC during the 2021 flash flood event

(c) R(Z_H, K_{DP})
- Chen et al. 2021 (DOI: 10.1175/JHM-D-20-0299.1)
  $R = 20.7\ K_{DP}^{0.72}$ (for $Z_H > 40$ dBZ)
  $R = 0.052\ Z_H^{0.57}$ (else)
- For solid hydrometeors same as (b)

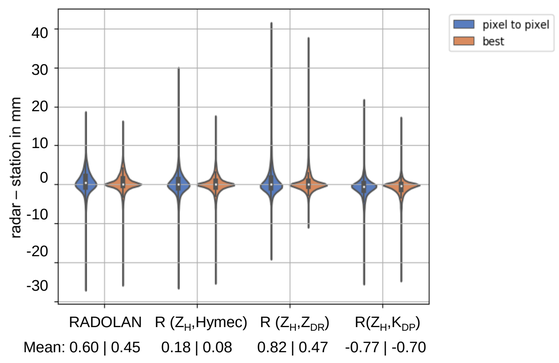
(d) R(Z_H, Z_{DR})
- Gorgucci et al. 1994 (DOI: 10.1175/1520-0426(1994)011<0586:AREORR>2.0.CO;2)

$R = 0.0076\ Z_H^{0.93}\ 10^{-0.281\ ZDR}$ (for $Z_{DR} \geq 0.2$ dB)
$R = 0.0076\ Z_H^{0.93}$ (else)

Goal
- Optimize the current hydrometeor based radar rainfall relationship R(Z_H,Hymec) using dual-polarimetric moments

Radar vs Rain Gauge I (example case: Flash Flood Germany 2021)

- The radar QPE generally over-estimates the precipitation at the ground except for R(Z_H,Z_{DR})
- The R(Z_H,K_{DP}) algorithm shows the strongest positive bias, while R(Z_H,Hymec) shows the best agreement.
- RADOLAN (a), R(Z_H,Hymec) (b) and R (Z_H,K_{DP}) (c) show significant correlation to the rain gauge data on a 1h time scale.

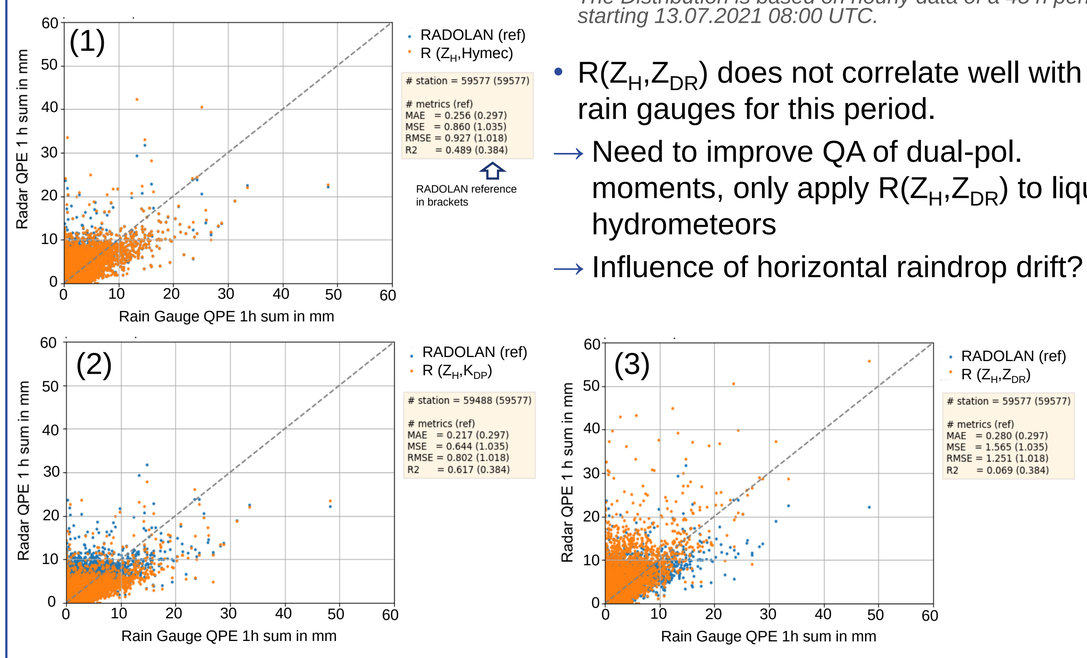


Distribution of a rain gauge to radar comparison for different QPE relationships: blue = nearest pixel to the rain gauge, orange = best fitting pixel of the surrounding 9 pixels to the rain gauge. Only rain gauges with 1 h sums greater 1 mm are used.
The Distribution is based on hourly data of a 48 h period starting 13.07.2021 08:00 UTC.

- R(Z_H,Z_{DR}) does not correlate well with the rain gauges for this period.

→ Need to improve QA of dual-pol. moments, only apply R(Z_H,Z_{DR}) to liquid hydrometeors

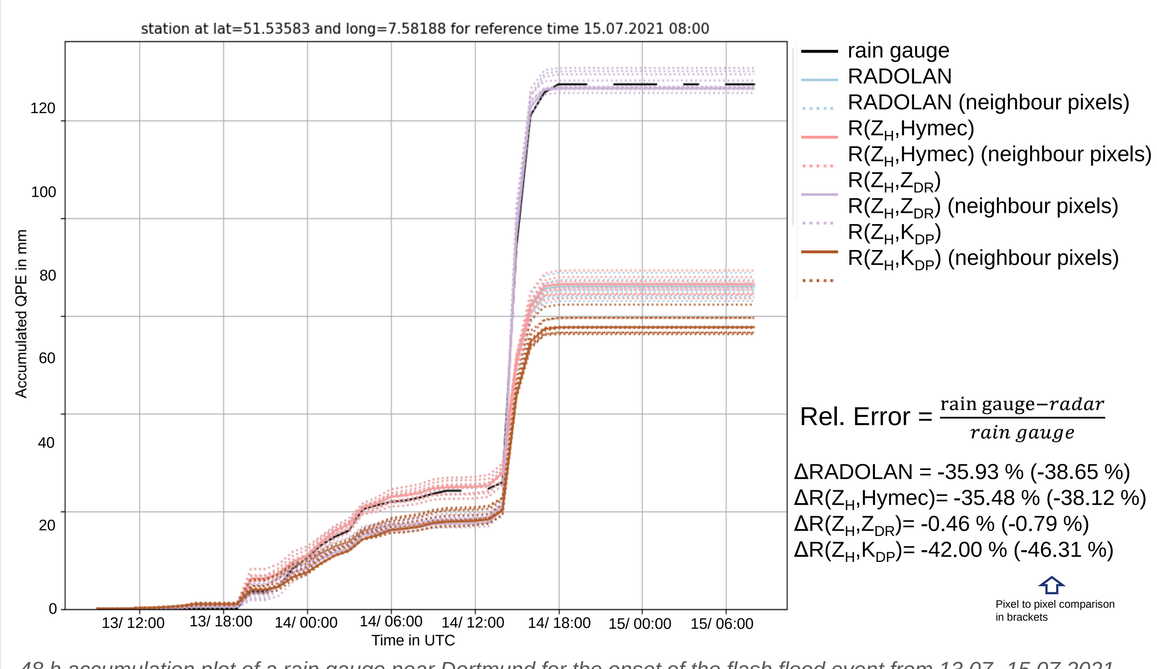
→ Influence of horizontal raindrop drift?



Comparison of the RADOLAN relation to the R(Z_H,Hymec) relation (1), to the R(Z,K_{DP}) relation (2)and to the R(Z_H,Z_{DR}) relation (3) based on hourly data from 13.07.2021 08 UTC to 15.07.2021 08 UTC.

Radar vs Rain Gauge II (example case: Flash Flood Germany 2021)

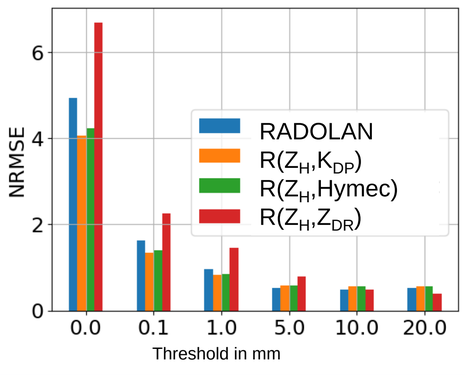
- The performance of the different QPE relations to the measured precipitation at the rain gauges *strongly differs spatially*.
- The onset of the rain event is captured well by the radar, but the estimated rainfall amounts in general show deficits. Some rain gauge measurements are rather well estimated by polarimetric QPE:



48 h accumulation plot of a rain gauge near Dortmund for the onset of the flash flood event from 13.07 -15.07.2021 8UTC. Different radar based QPE relations are accumulated for the nearest radar pixel (solid line) and the surrounding 8 pixels (dashed).

Outlook: QPE relationships, dual-pol. QPE

- Use upcoming improvements in the quality assurance (e.g. K_{DP}) to increase the quality of the dual-pol. QPE
- Use dual-pol. QPE relations within scheme of hydrometeor based QPE R(Z_H,Hymec) → R(Z_H, K_{DP}, $Z_{DR,}$ Hymec)
- Use longer time series and thresholds to exclude case specific effects:



Example 30.06.-17.07.2021:
- Overall performance of R(Z_H,K_{DP}) slightly better
- R(Z_H,Z_{DR}) performs slightly better for higher thresholds

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