Karlsruhe Institute of Technology

RealPEP

KIT-Campus Alpin

IMK-IFU: Atmosphärische Umweltforschung

RealPEP P1

Merging Radar and CML QPE

Julius Polz, Maximilian Graf, **Christian Chwala**

HoWa PRO

RealPEP project meeting, 16.05.23, online

P1 KIT overview

Roadmap by Julius

Roadmap

5 minute

1 minute

Optical flow estimation to compute intermediate timesteps

Intercomparison

Roadmap

5 minute

Optical flow estimation to compute intermediate timesteps

1 minute

Intercomparison

Random error

Systematic bias

Ensemble QPE

Probabilistic QPE

Bayesian inference approach

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Correction

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Neural network approach to gauge adjusted radar super-resolution

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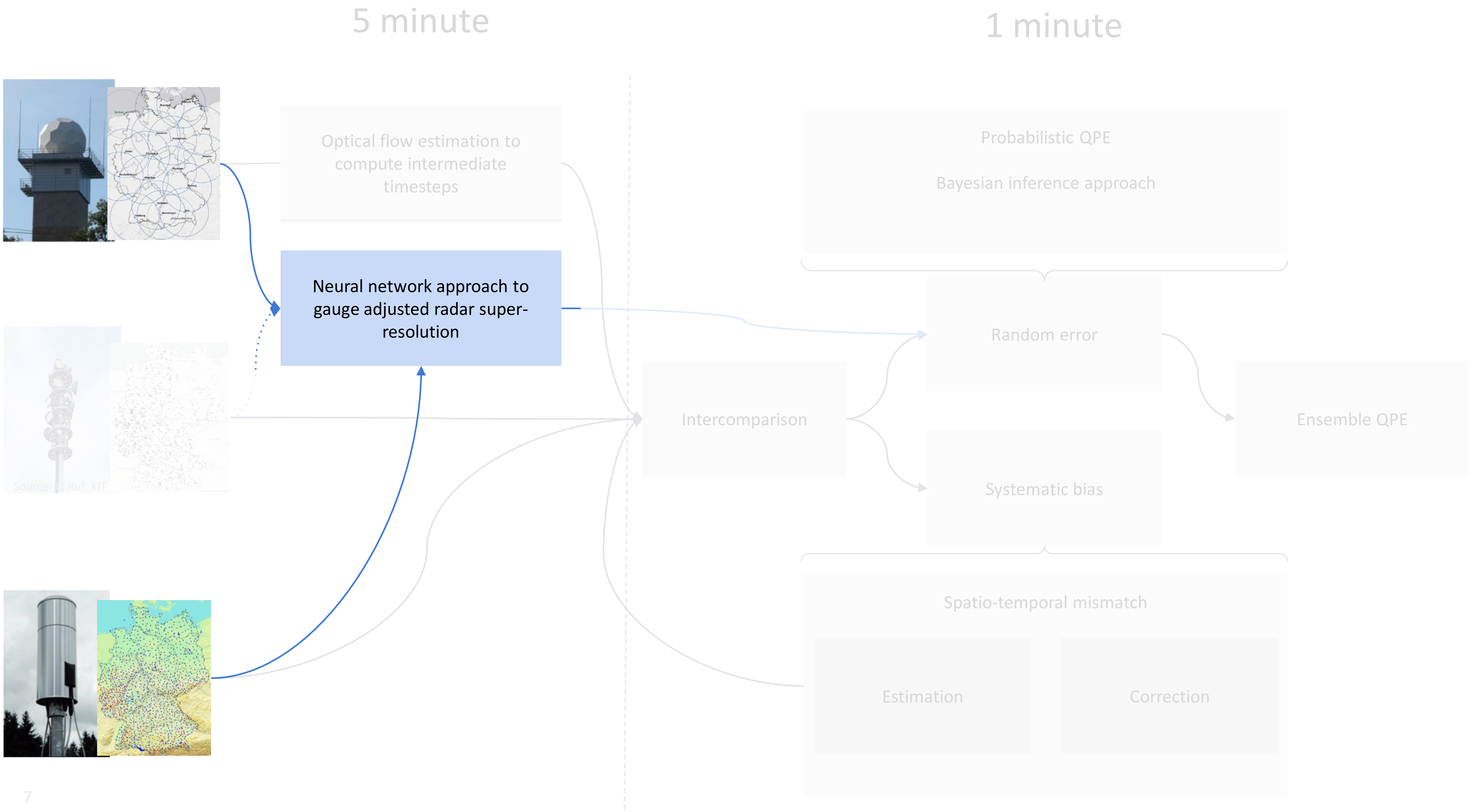
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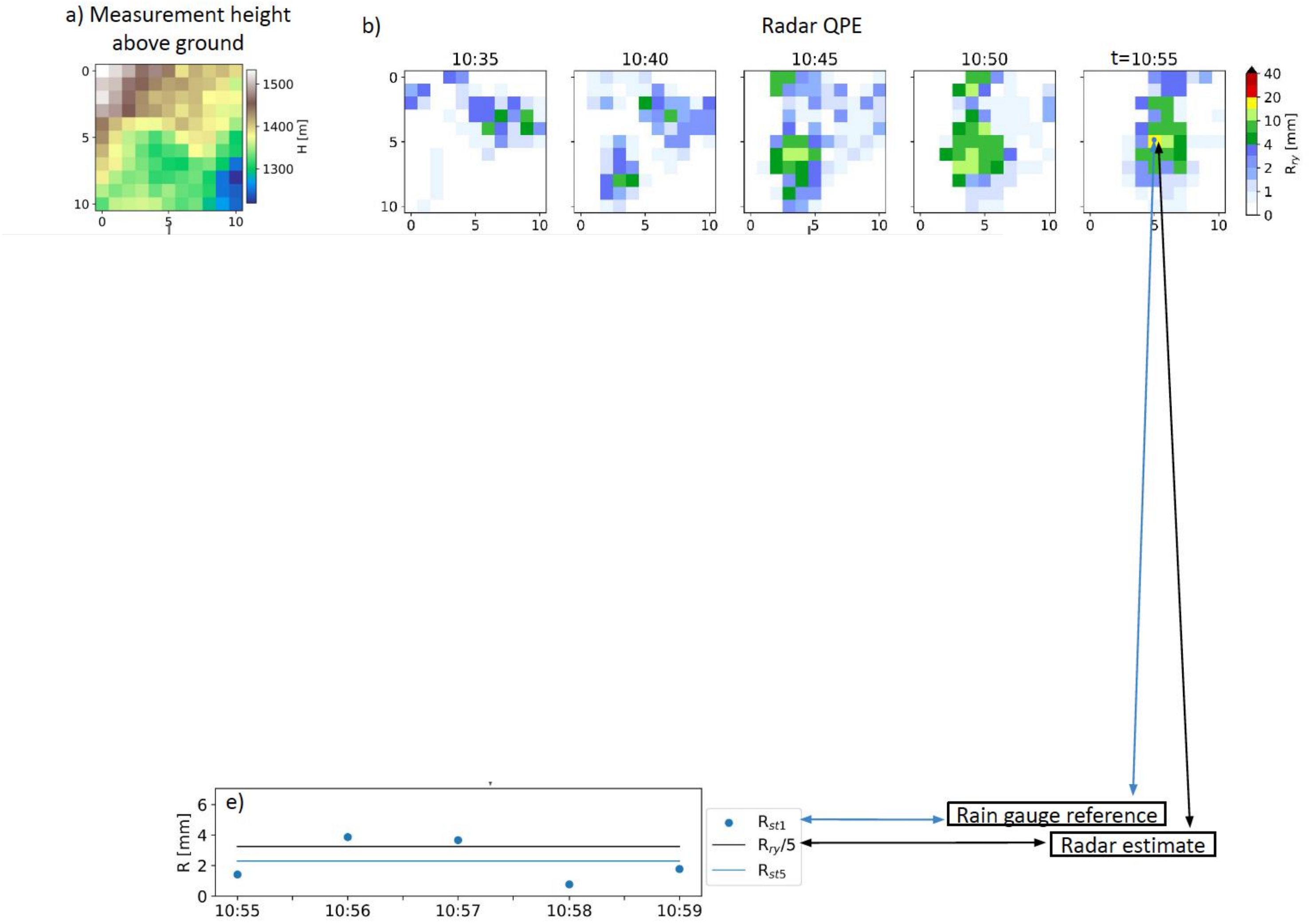
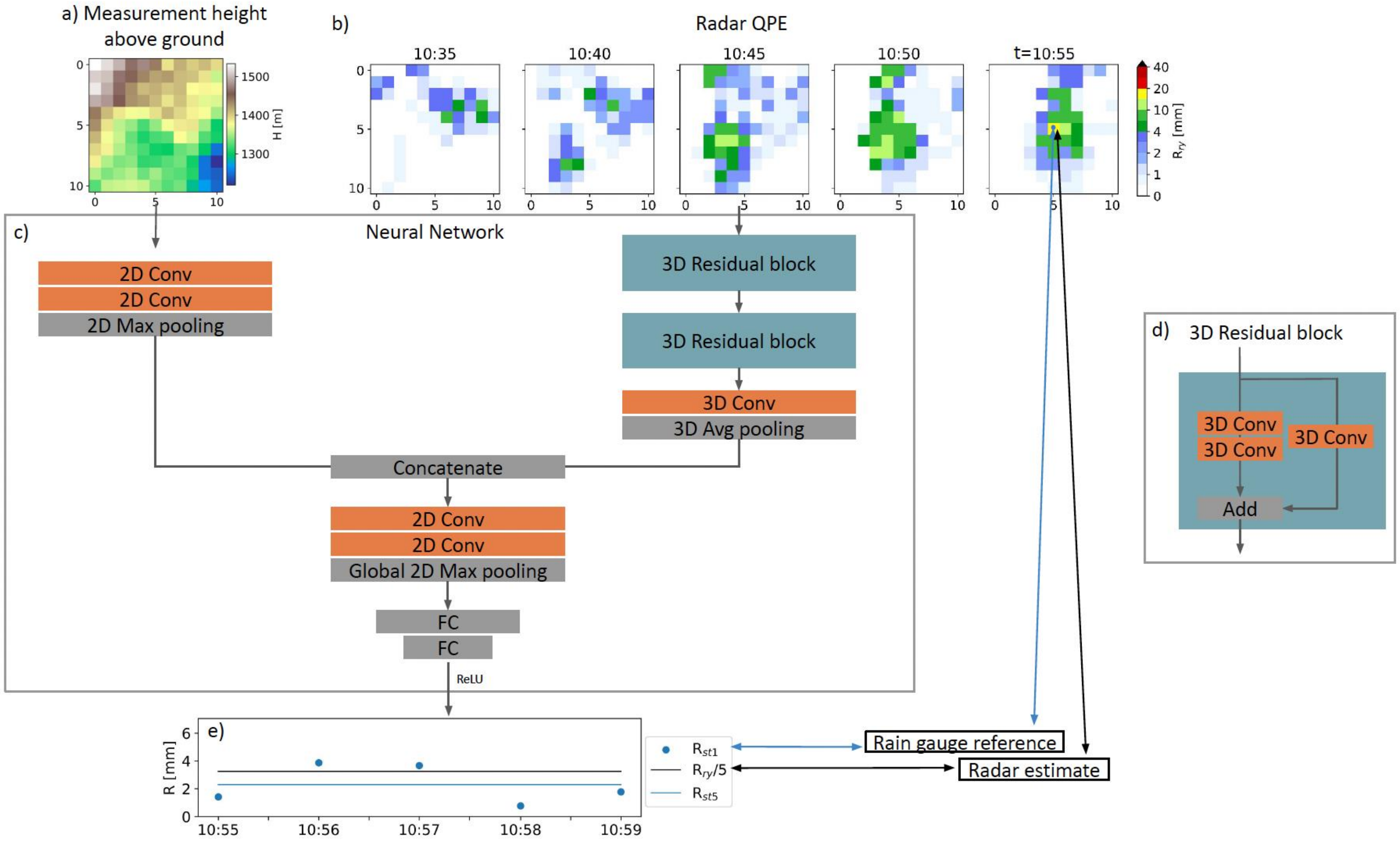
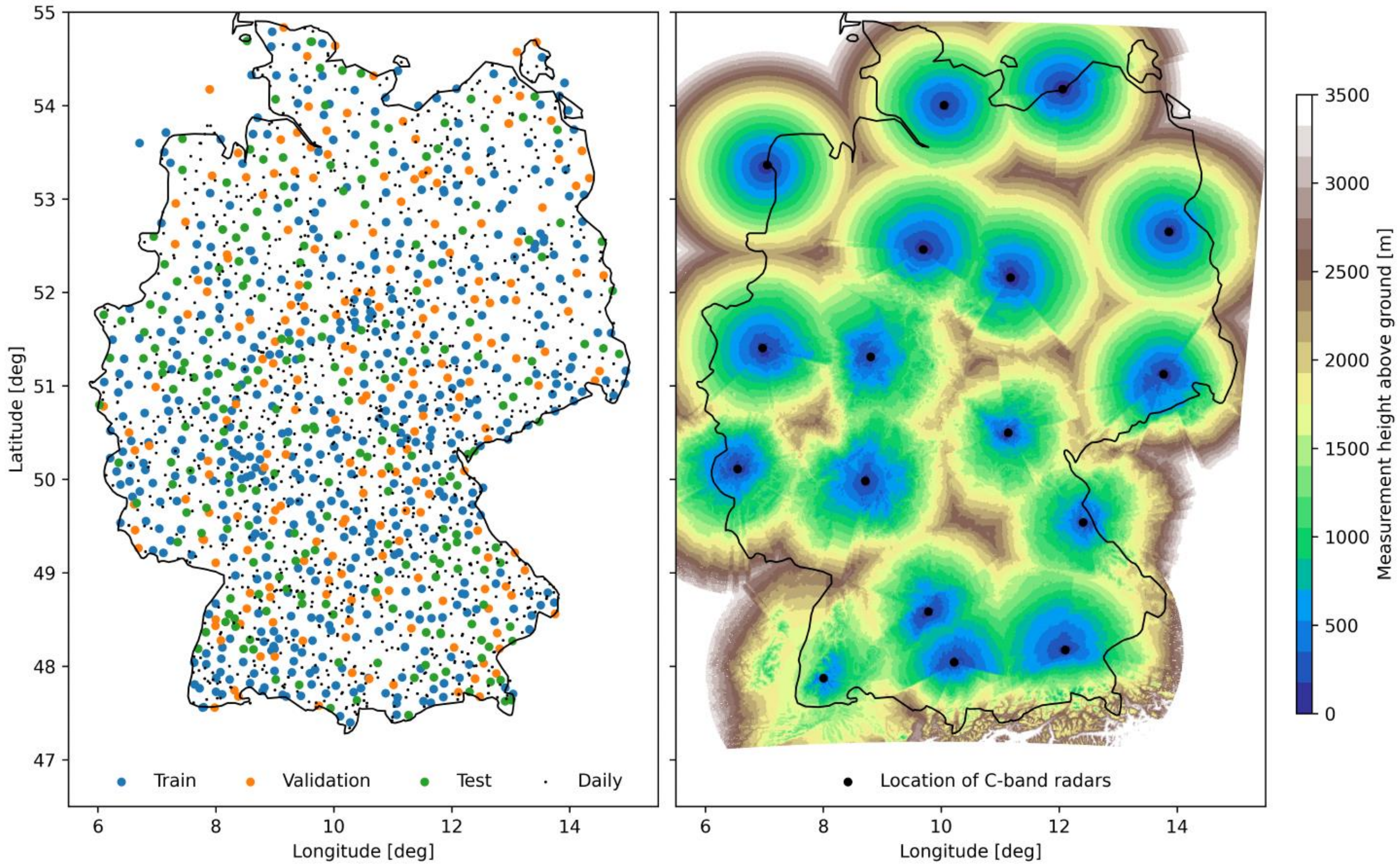
A deep convolutional neural network with residual blocks is trained to fit radar patches to gauge data



A deep convolutional neural network with residual blocks is trained to fit radar patches to gauge data



We use a large database of RADOLAN-RY and 1-minute gauge data

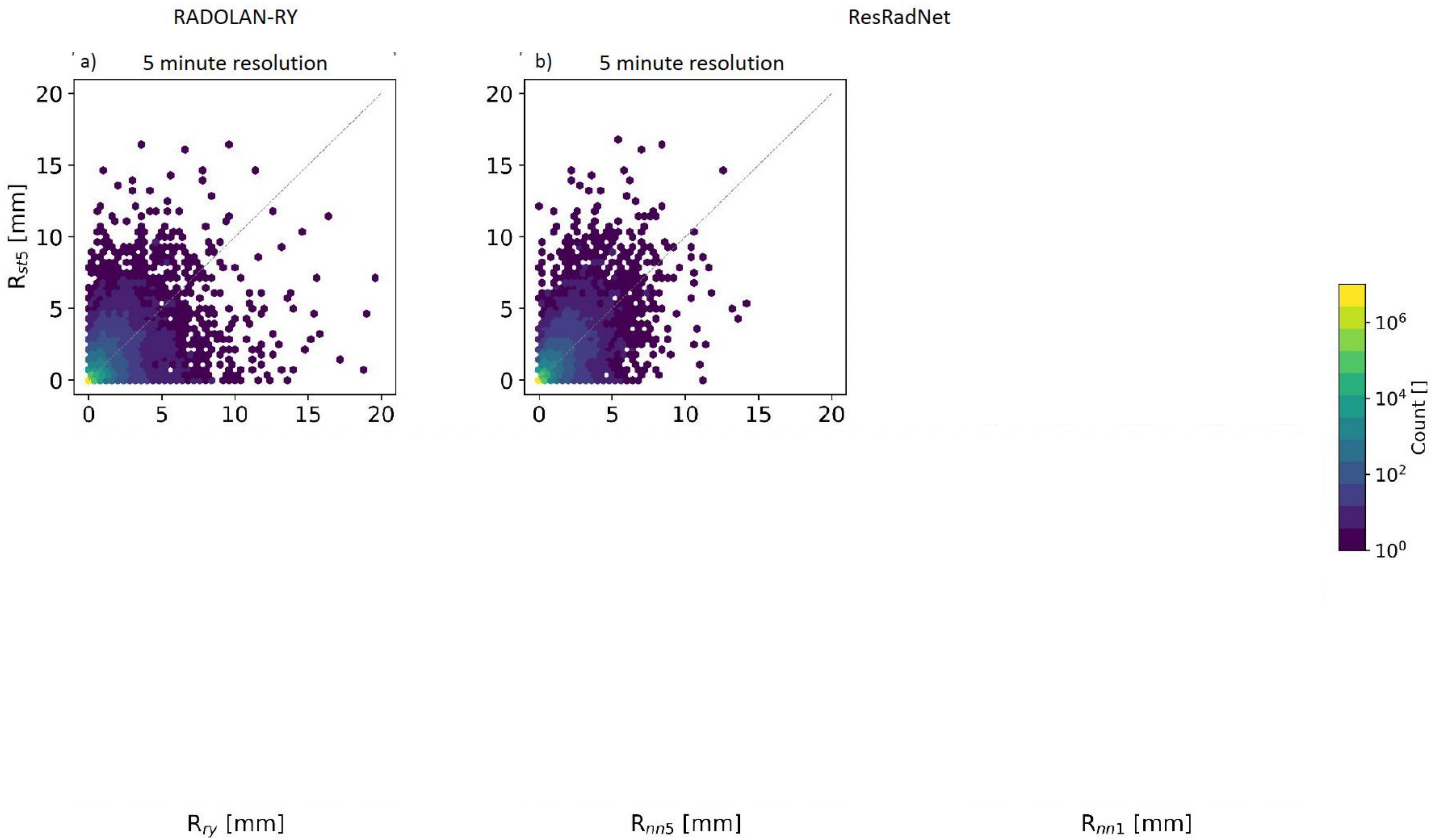


Training data: 2020

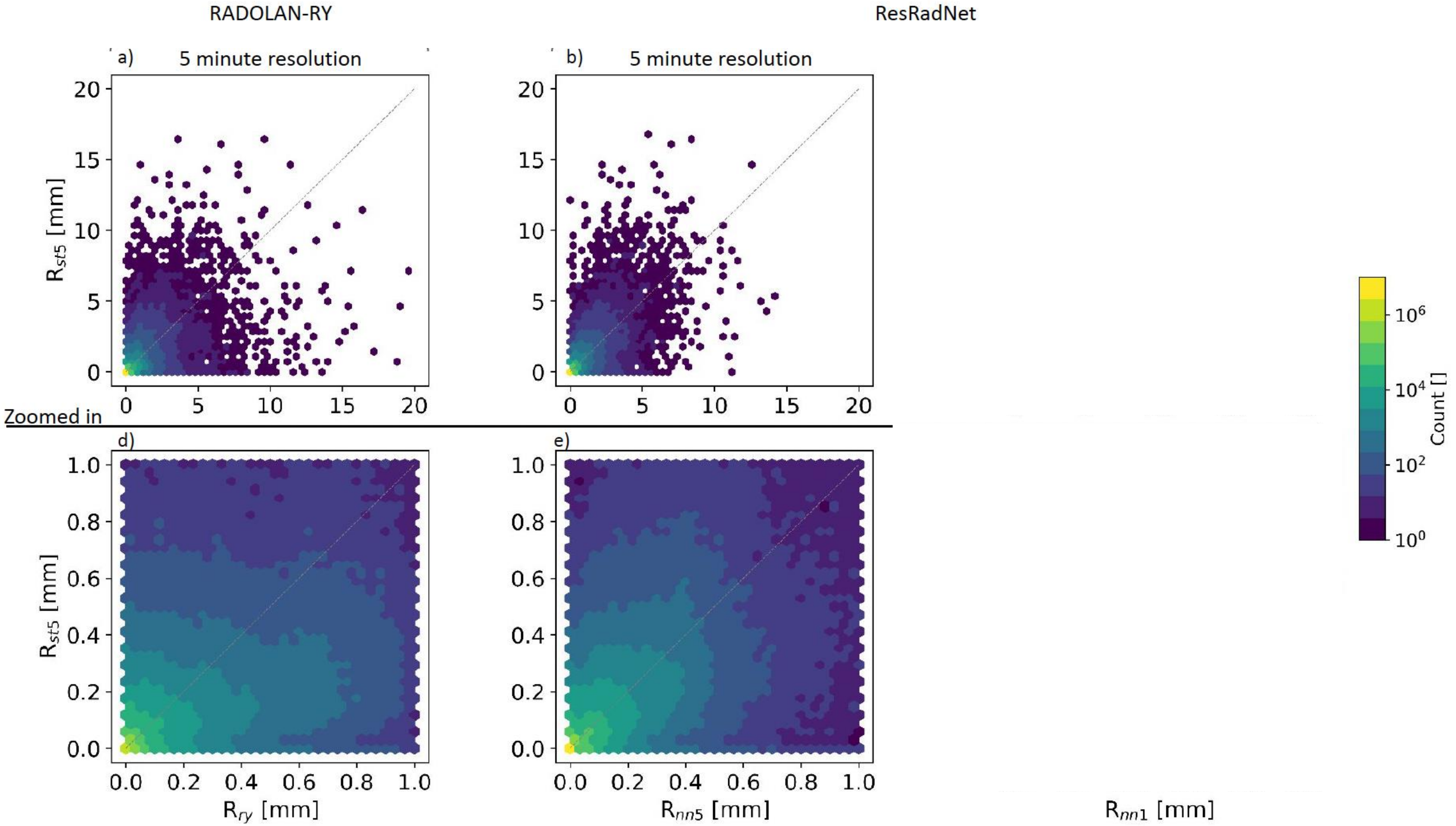
Validation data: 2021

Test data: 2013 to 2021

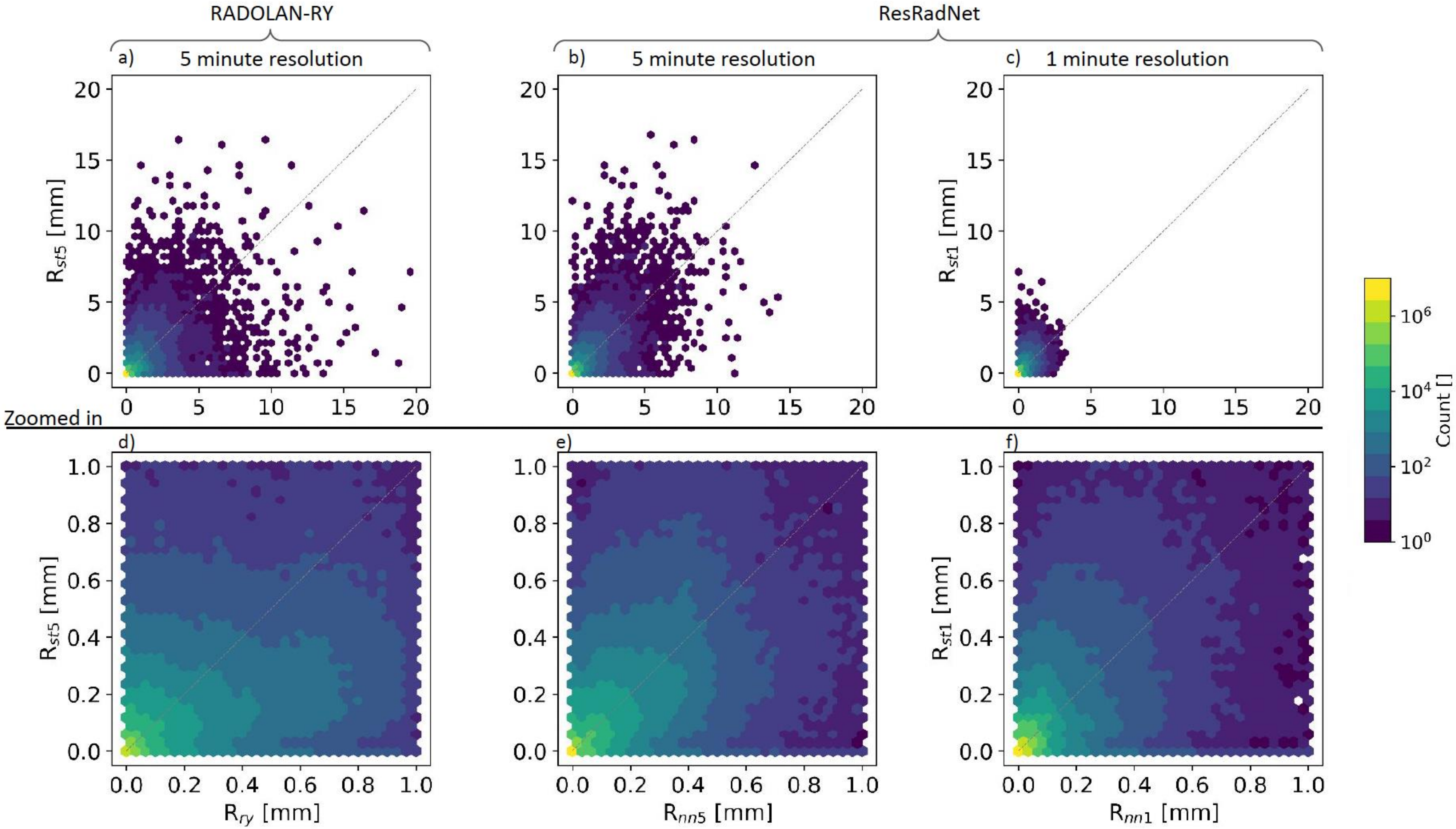
ResRadNet shows clear improvement of RADOLAN-RY



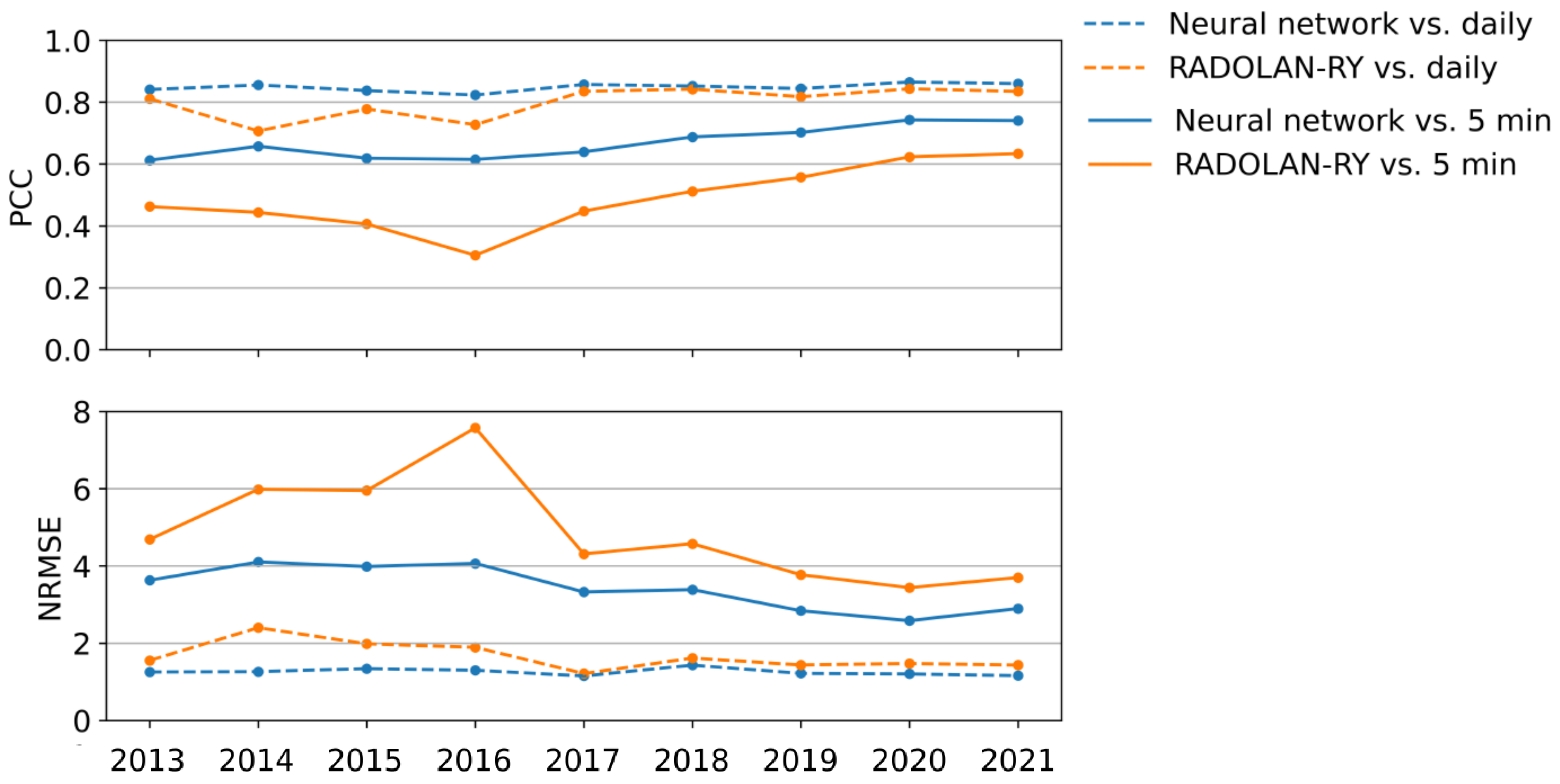
ResResNet shows clear improvement of RADOLAN-RY

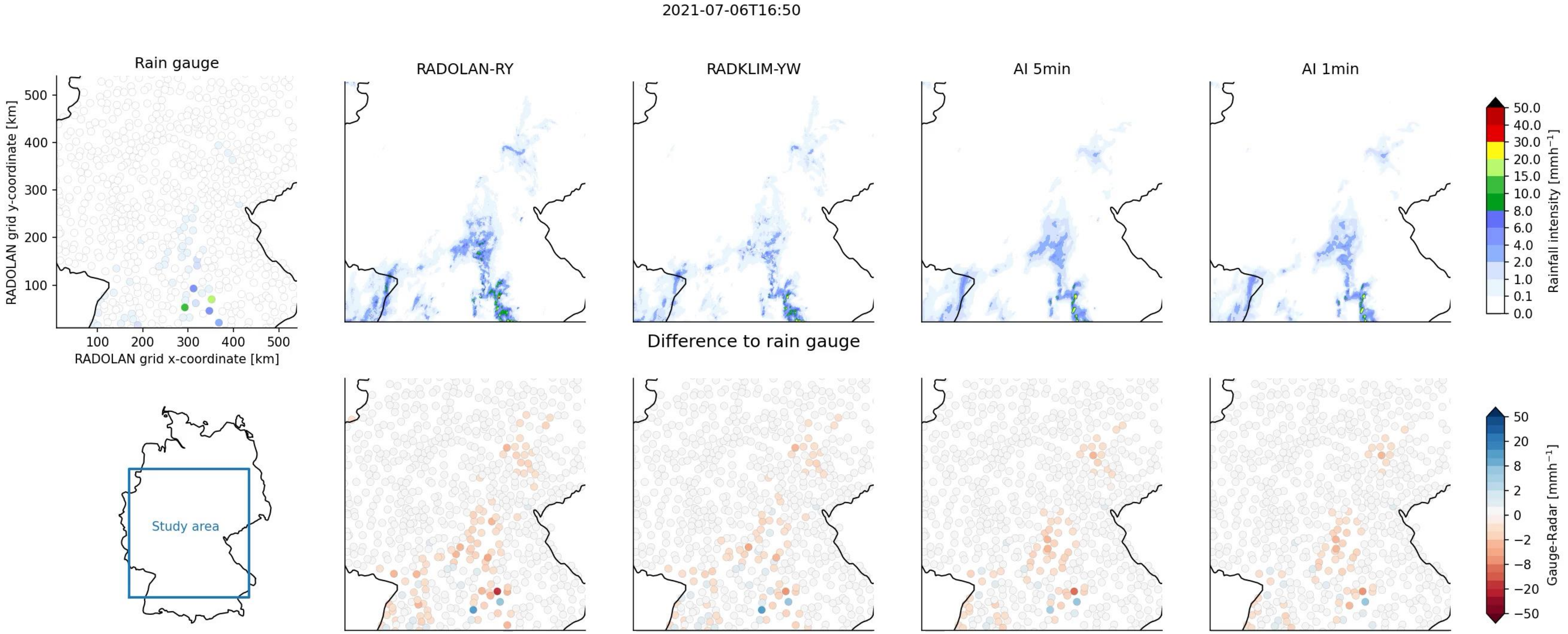


ResRadNet shows clear improvement of RADOLAN-RY



Improvement is also consistent over time




2021-07-06T16:50
Rain gauge
RADOLAN-RY
RADKLIM-YW
AI 5min
AI 1min
RADOLAN grid y-coordinate [km]
RADOLAN grid x-coordinate [km]
Rainfall intensity [mmh⁻¹]
Difference to rain gauge
Study area
Gauge-Radar [mmh⁻¹]

Conclusion for Radar-DeepLearning-adjustment

- Neural network approach improves common metrics significantly (PCC, NRMSE etc.)
- Result not satisfying for extreme values

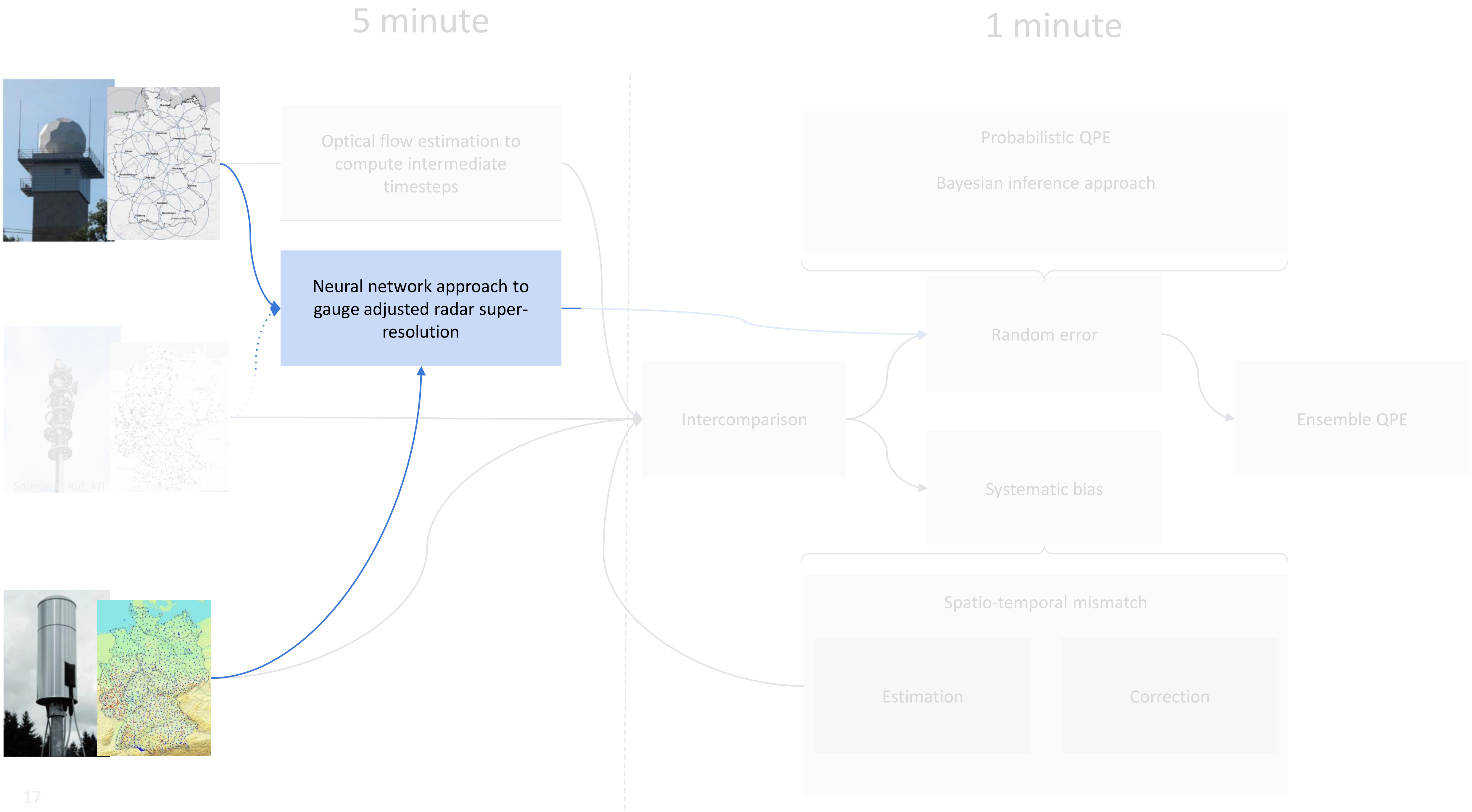
Julius‘ intepretation:

- Probabilistic approach necessary to predict range of possible values.
- Neural network likely to learn the mean (maximum likelihood).
- Bias stemming from large amount of small rain rate values during training

Also try in the future:

- ~~Predict the five 1-minute values of the station → similar to advection correction~~ (done)
- Add CML information as additional input

Paper under review (Polz et al., 2023, TGRS)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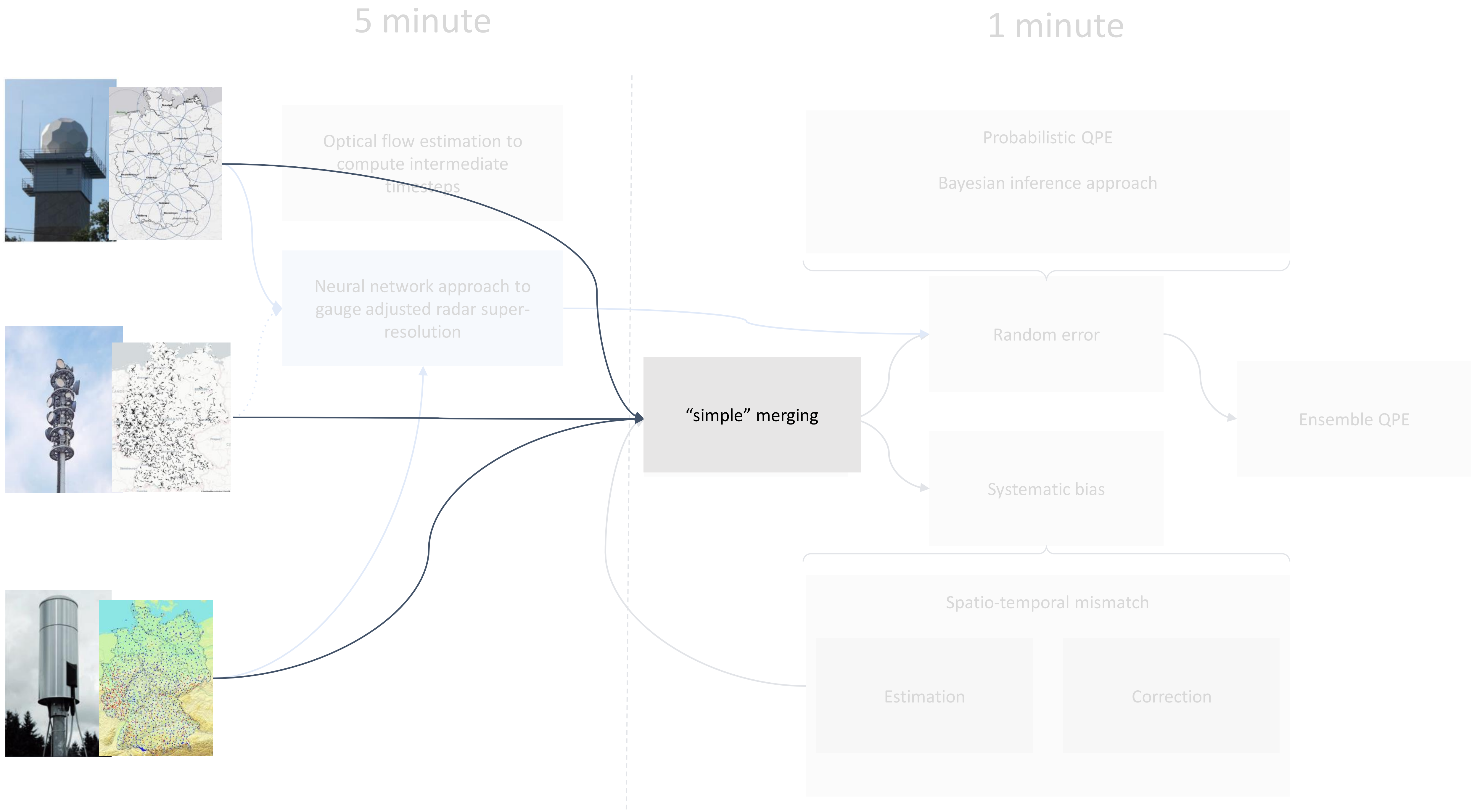
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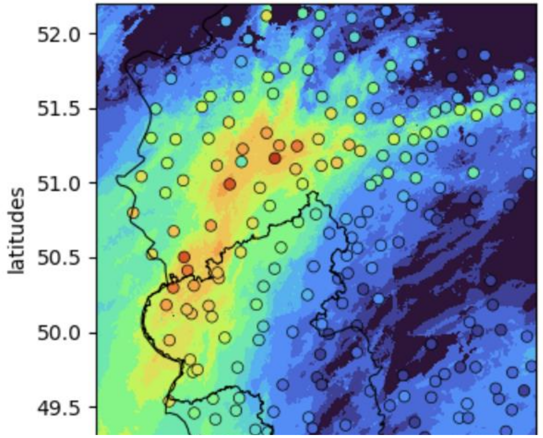
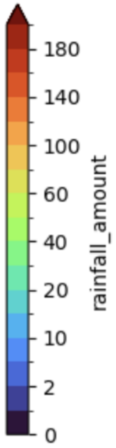
Preliminary results for Dual-Pol QPE CML adjustment

$R(Z_{lin}, K_{DP})$



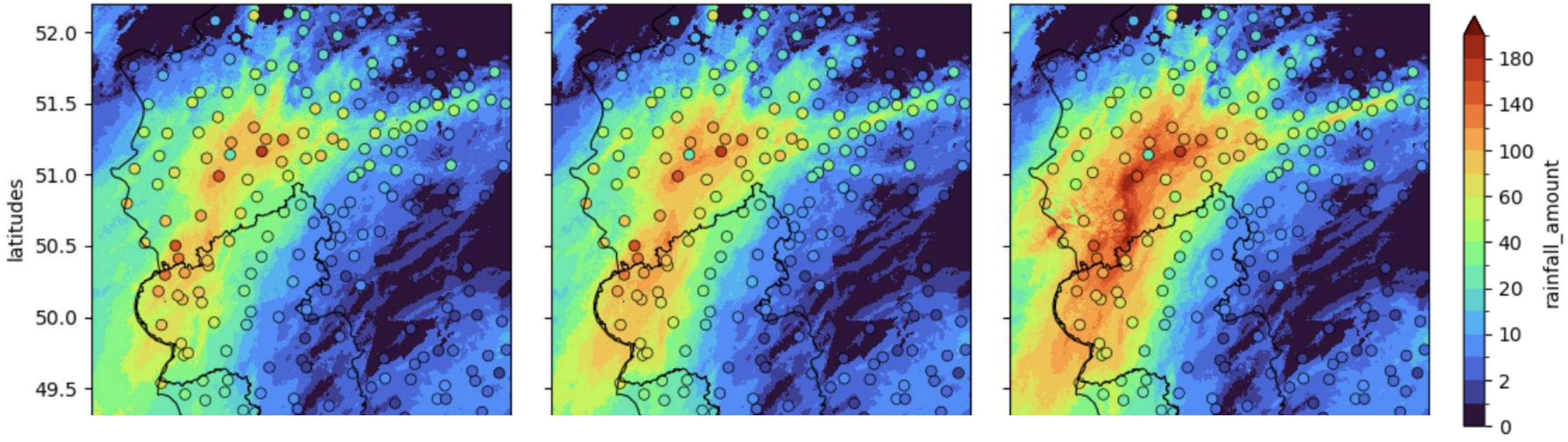


$R(Z_{lin}, K_{DP}) = R(Z_{lin})$ combined with $R(K_{DP})$ for $Z > 40$ dBZ

Chen et al. (2023), JHM

Preliminary results for Dual-Pol QPE CML adjustment

$R(Z_{lin}, K_{DP})$ | $R(A, K_{DP})$ | $R(A, K_{DP})$ with MRR and X-band



$R(Z_{lin}, K_{DP}) = R(Z_{lin})$ combined with $R(K_{DP})$ for Z > 40 dBZ

$R(A, K_{DP}) = R(A)$ combined with $R(K_{DP})$ for Z > 40 dBZ

$R(A, K_{DP})$ with
- MRR (vertical profile correction of Z and K_{DP})
- gap filling with X-band radar observations

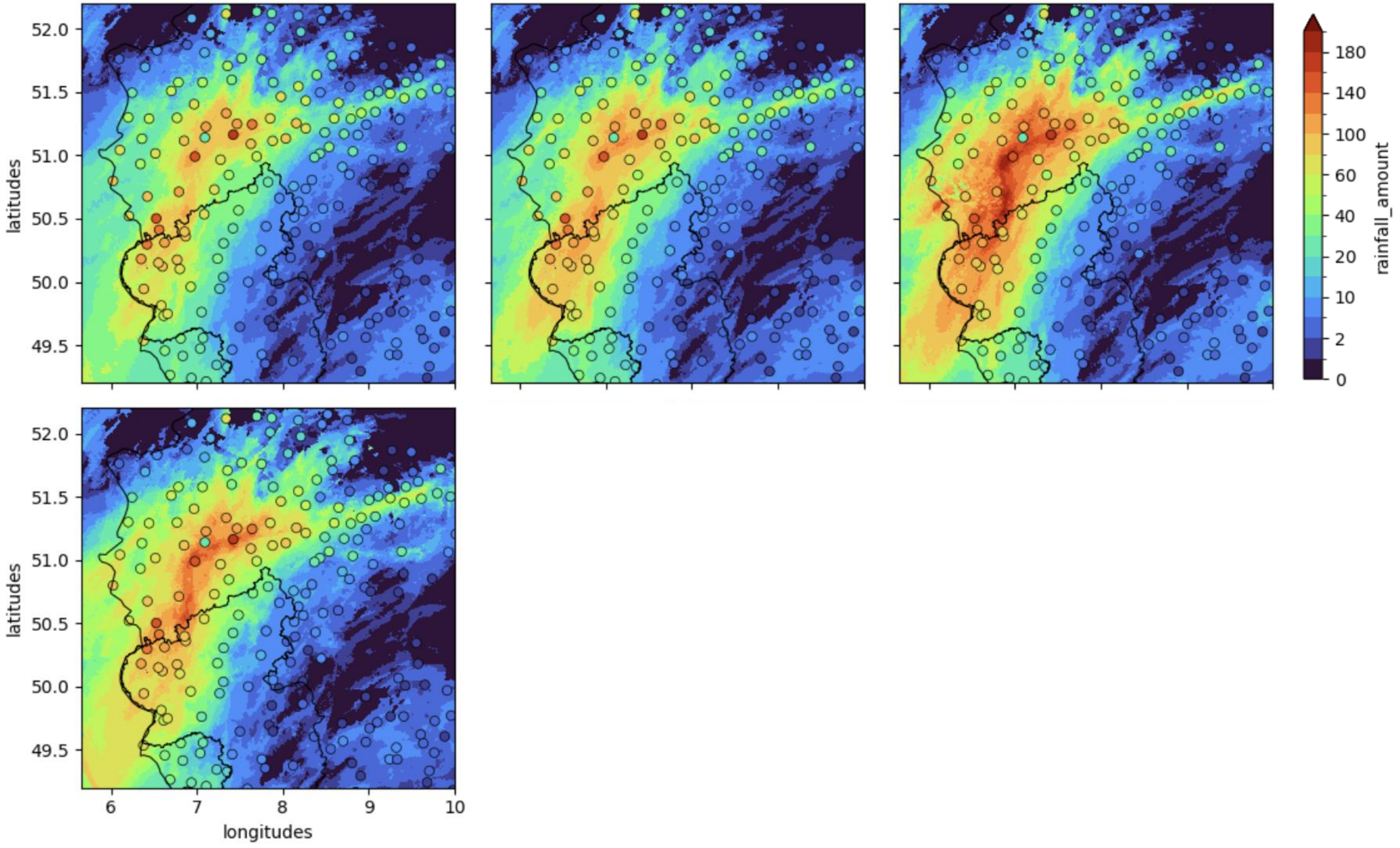
Chen et al. (2023), JHM

Preliminary results for Dual-Pol QPE CML adjustment

$R(Z_{lin}, K_{DP})$ | $R(A, K_{DP})$ | $R(A, K_{DP})$ with MRR and X-band

not adjusted

CML adjusted



Preliminary results for Dual-Pol QPE CML adjustment

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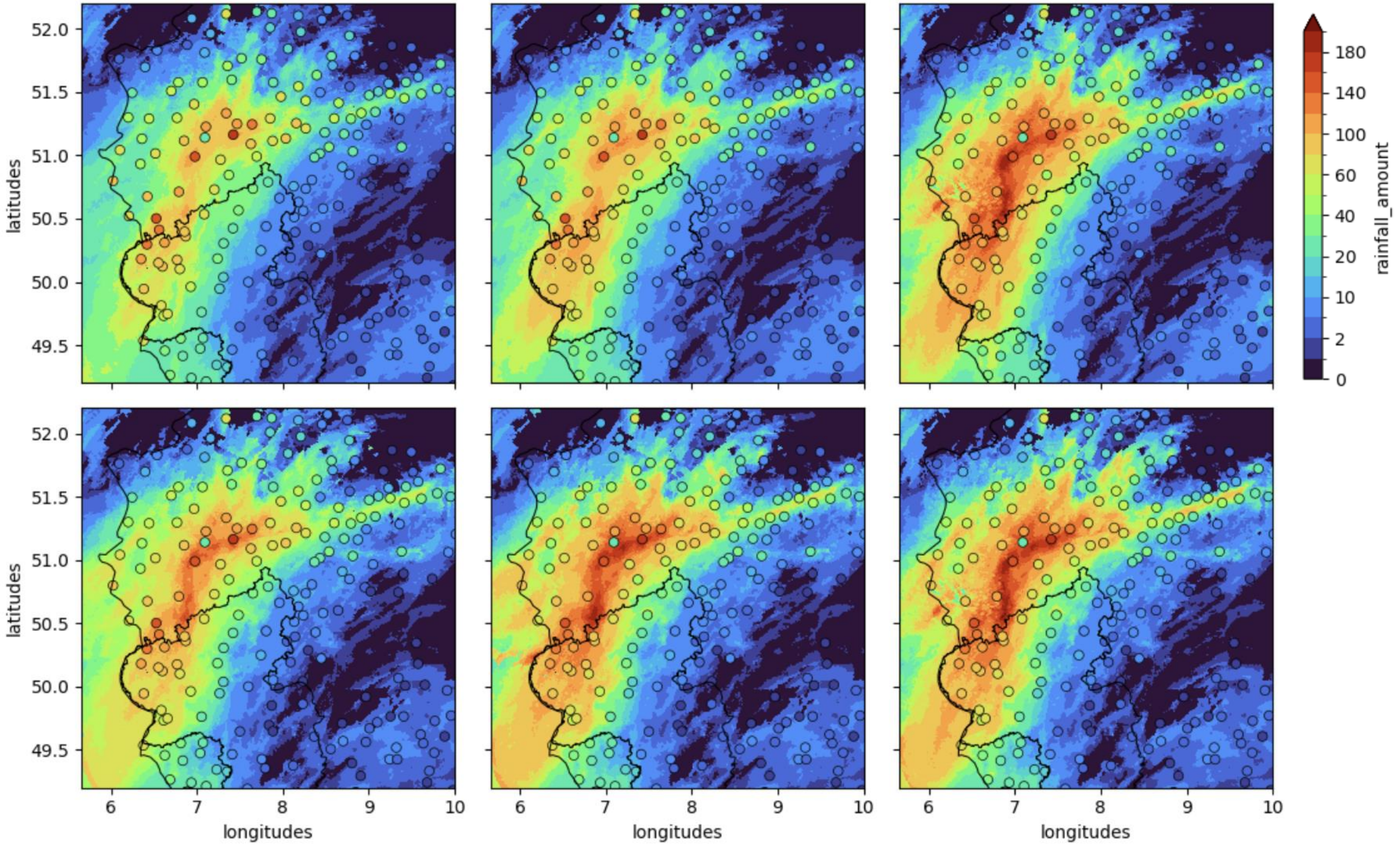
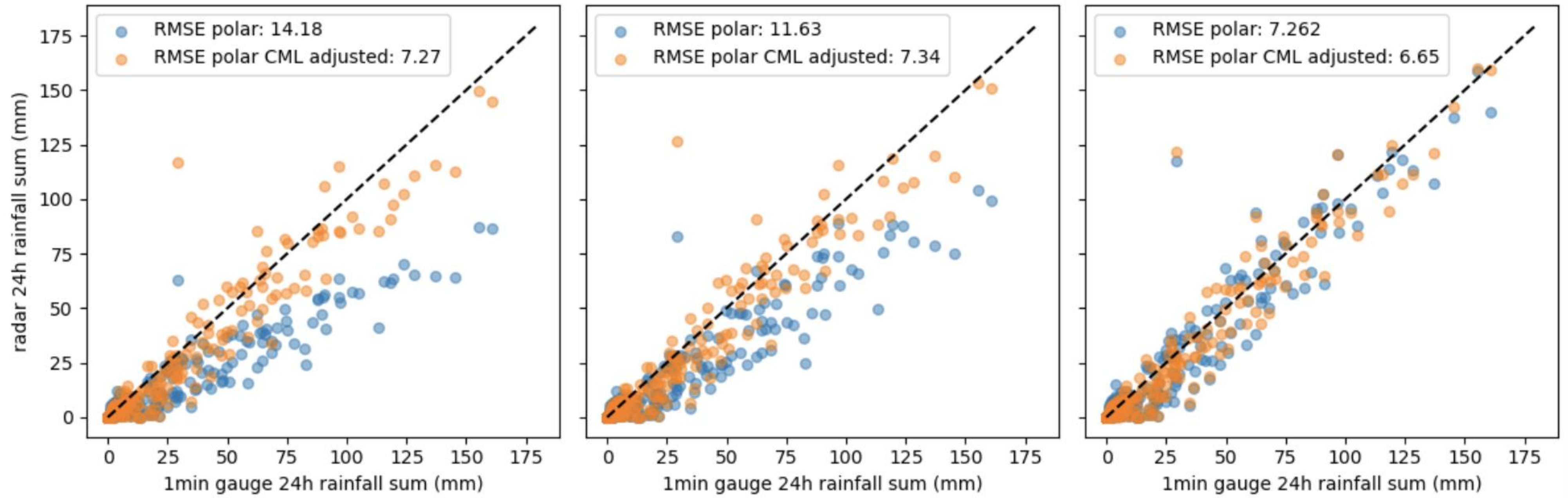


CML adjustment shows clear improvement, except for the case of Radar QPE with X-Band and MRR data

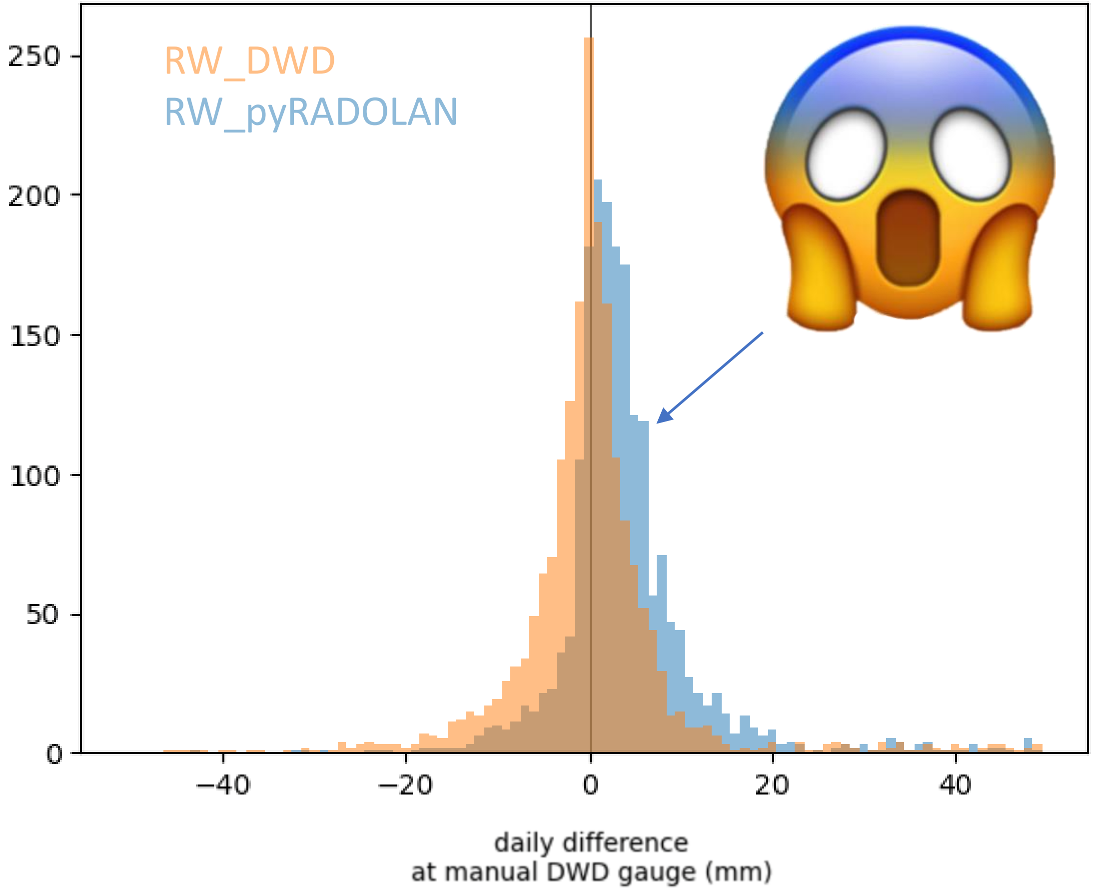
R(Z_{lin}, K_{DP})

R(A, K_{DP})

R(A, K_{DP}) with MRR and X-band

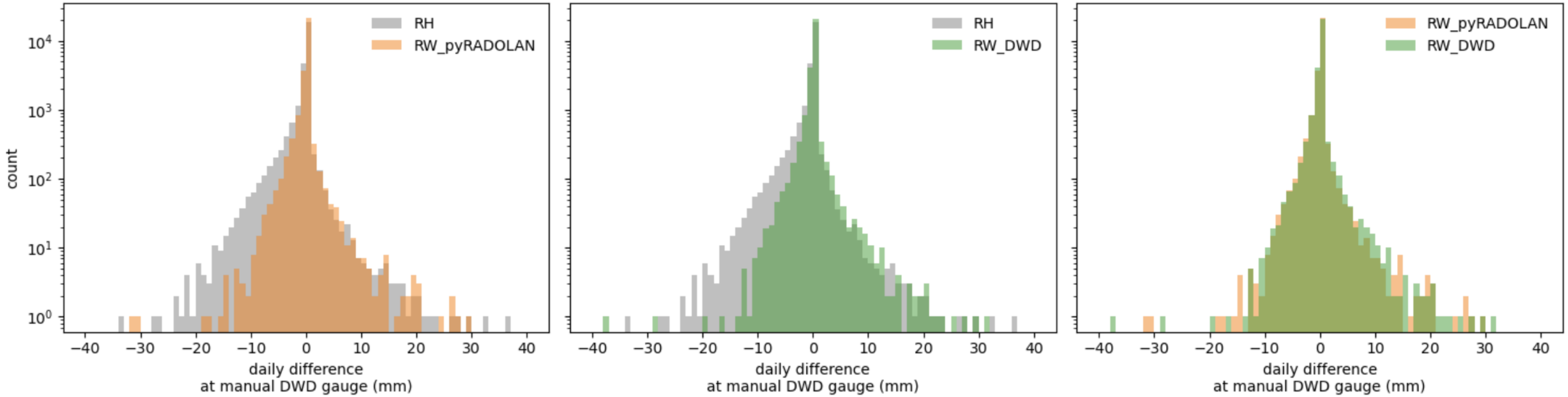


Had to fix bug in pyRADOLAN adjustment code...

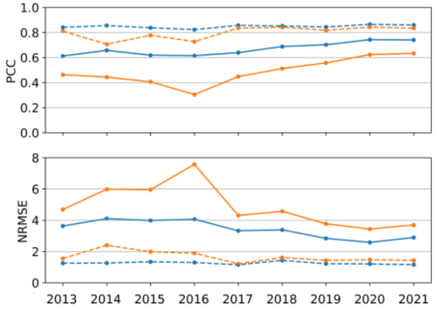


Had to fix bug in pyRADOLAN adjustment code...

New long-term comparison of own RW (produced with *pyRADOLAN)* and DWD's RADOLAN-RW shows good agreement



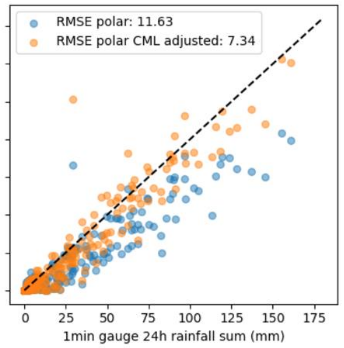
Summary



Neural network approach to gauge adjusted radar super-resolution

"simple" merging

$R(A, K_{DP})$



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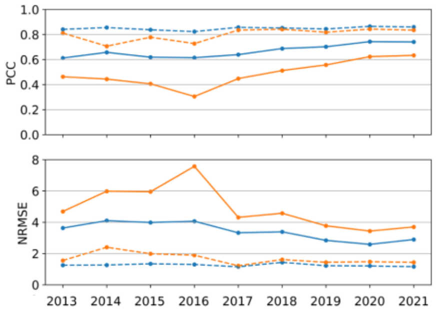

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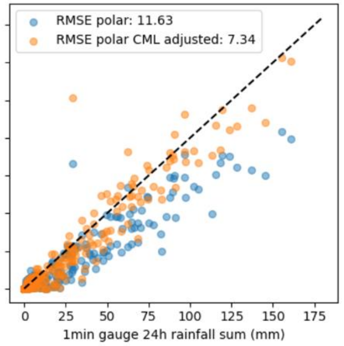

Still a lot to do here…

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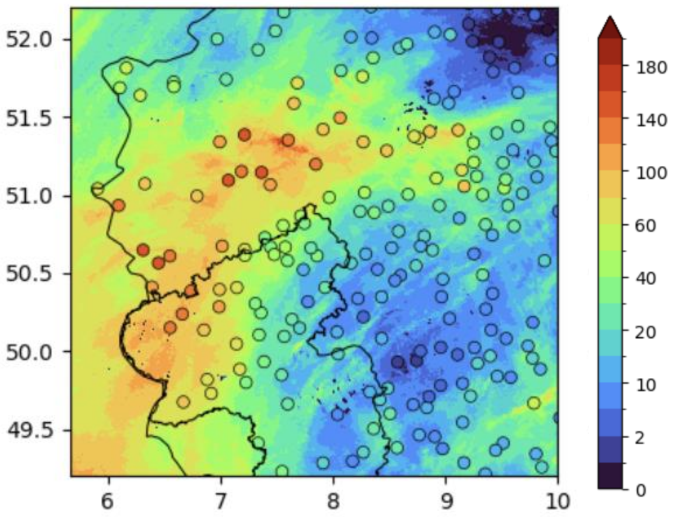
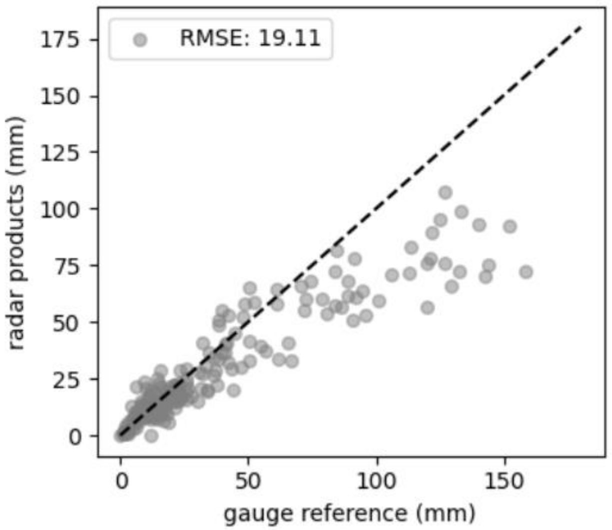
Backup slides

Ahr-Hochwasser: Unangeeichtes Radar unterschätzt stark

Radar unangeeicht





Niederschlagssumme
13.-15. Juli 2021

Aktuelle Ergebnisse
aus dem Projekt HoWa-PRO

HoWa PRO

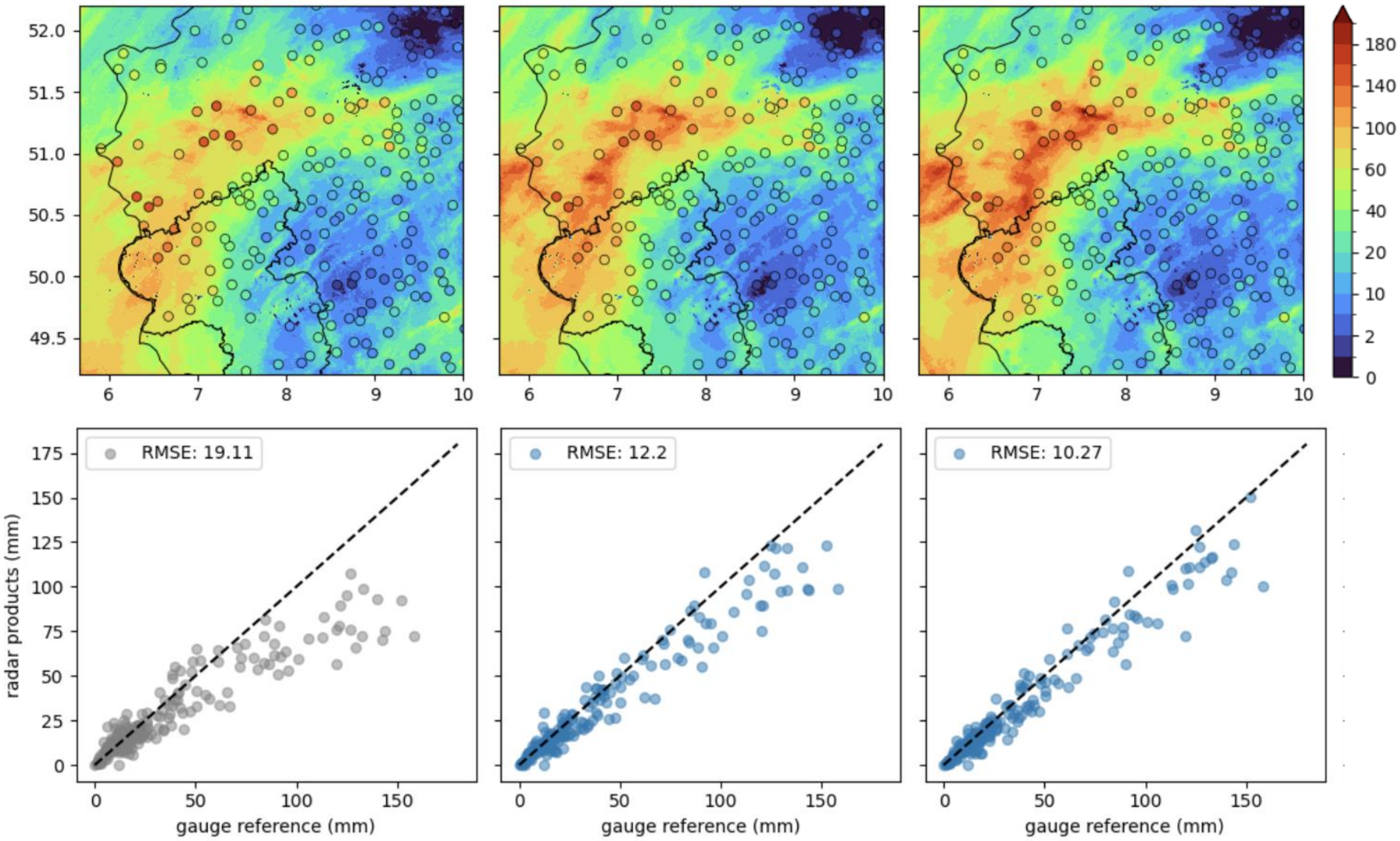
GEFÖRDERT VOM
Bundesministerium
für Bildung
und Forschung

Universität
Augsburg
University

DWD

Korrektur durch CML-Aneichung ist ähnlich zu Stationsaneichung

Radar unangeeicht | Radar + Gauge | Radar + CML



Bester RMSE für Aneichung mit CML + Stationen