RealPEP

RealPEP P1- radar-based QPE

Status on the most recent QPE-products and snow analyses provided for RealPEP and Outlook

Ju-Yu Chen
Silke Trömel, Clemens Simmer, Alexander Ryzhkov

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Institute for Geosciences, Department of Meteorology, Uni Bonn

institut für geowissenschaften GEOPHYSIK

UNIVERSITÄT BONN

Outline

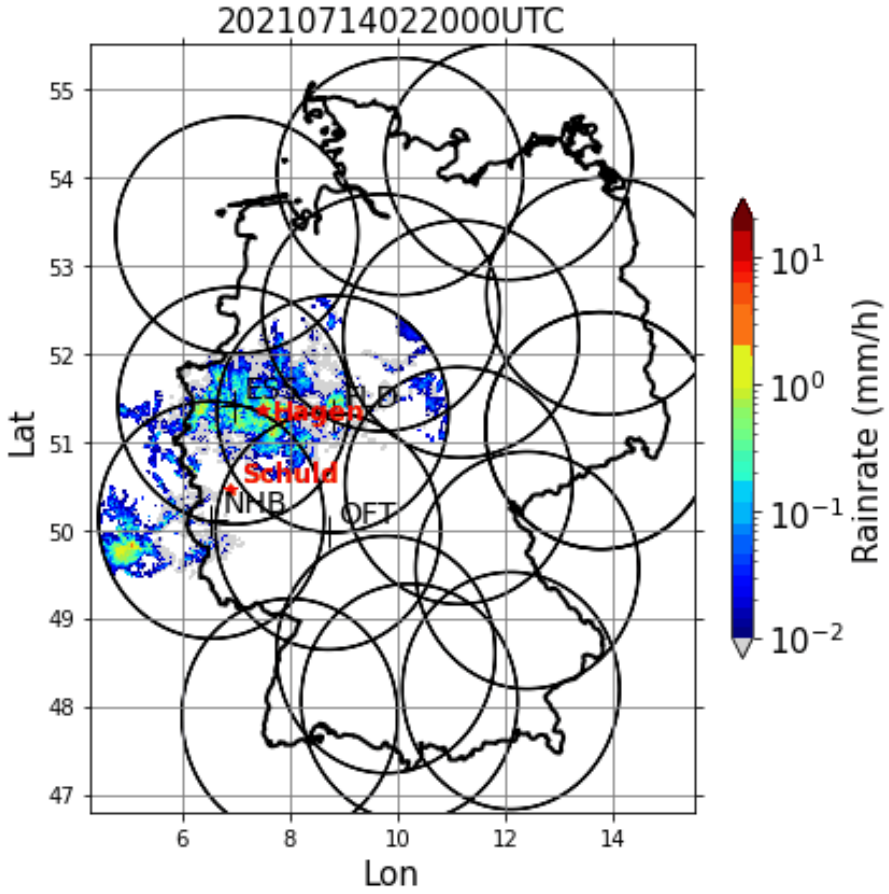
- QPE of the flooding event in western Germany on 14/07/2021
  - ✓Rainfall algorithms based on the method of the 1st work package (Chen et al. 2021)
  - ✓Juxpol radar used as gap fillers
  - ✓RD-QVPs of radar variables
- Snow retrievals based on polarimetric variables

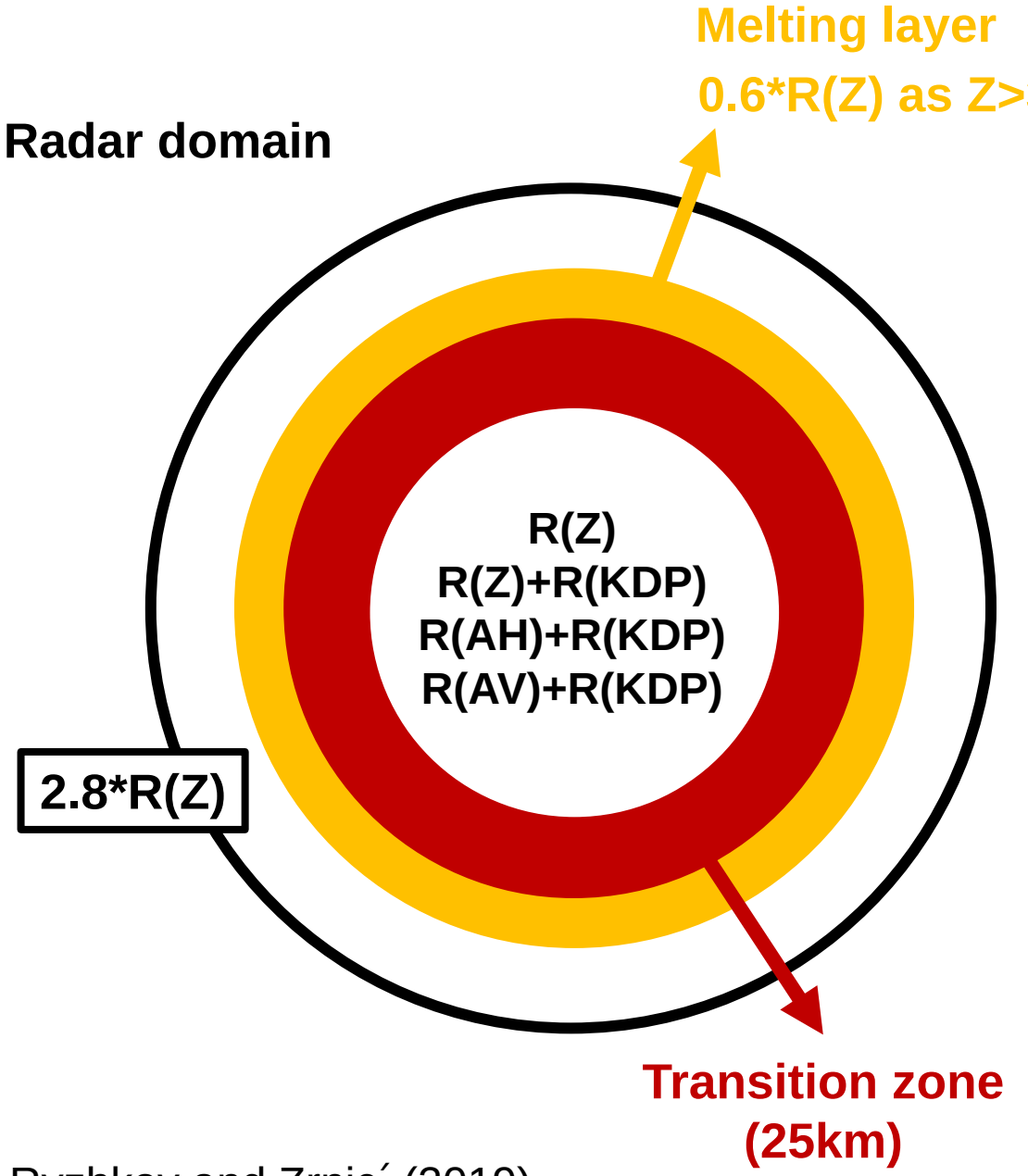
QPE of the flooding event on 14/07/2021

Before and after images from the Ahr and Eifel regions

https://www.dw.com/en/flooding-in-germany-before-and-after-images-from-the-ahr-and-eifel-regions/a-58299008

Rain map composite





QPE product list

- R(Z)
- R(Z)+R(KDP) as Z>40dBZ
- R(AH)+R(KDP) as Z>40dBZ
- R(AV)+R(KDP) as Z>40dBZ
  with alpha adjustment and KDP substitute
- RY: DWD operational R(Z) QPE product
- RW: DWD operational R(Z) QPE with gauge adjustment

R(Z)+R(KDP)
R(AH)+R(KDP)
R(AV)+R(KDP)

IDW from inner circle →
← IDW from outer circle

R(Z)

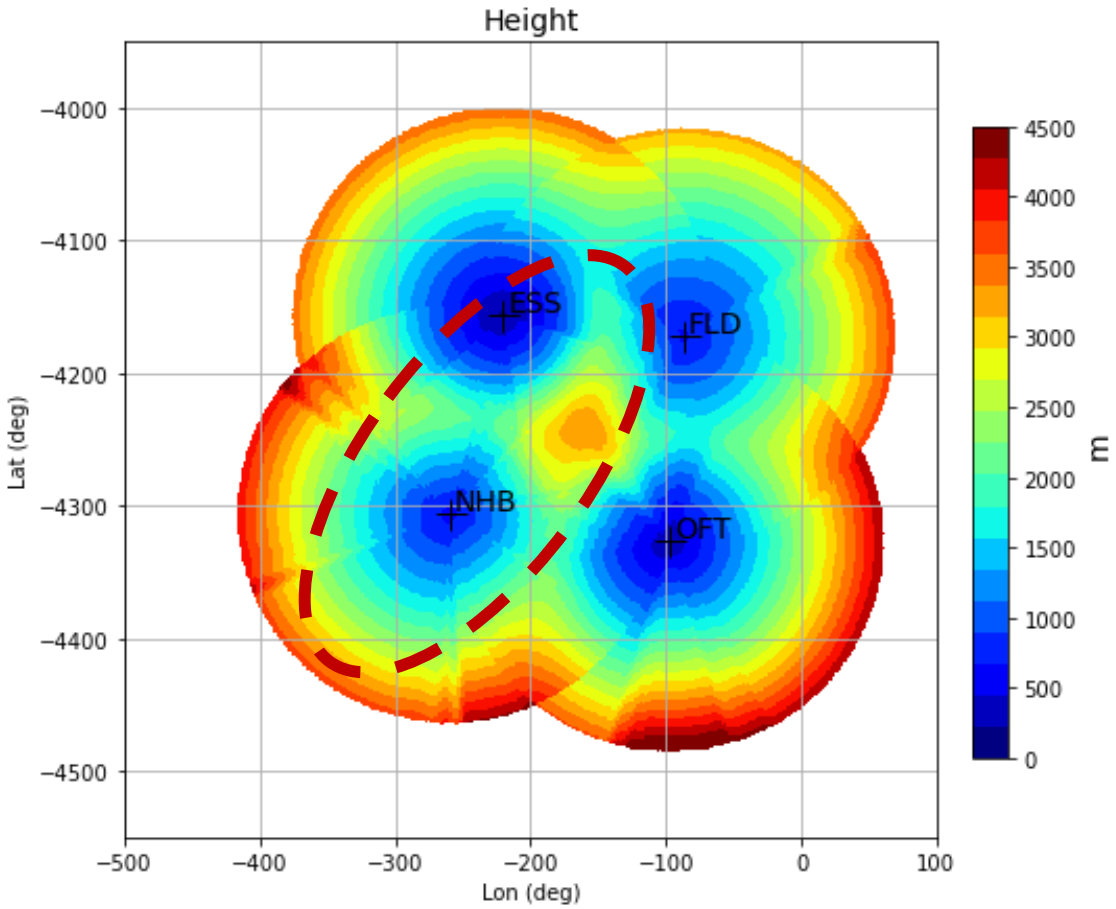
Ryzhkov and Zrnic´ (2019)

QPE Composite

The value of the composed grid is the weighted average of data from all available heights, with the quality values as the weights.

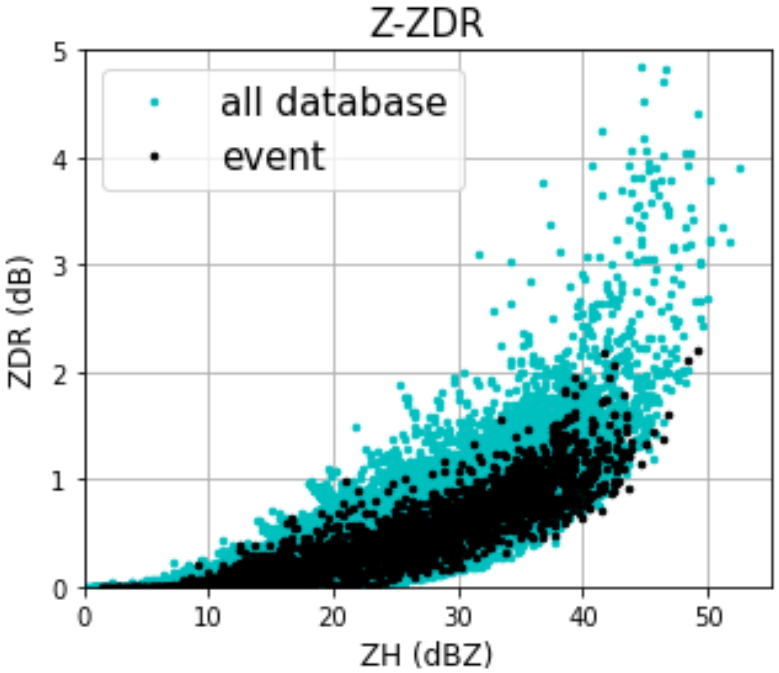
Quality index :
the sampling volume of the radar beam per gate depending on range and aperture.

4 DWD C-band radars (ESS/NHB/FLD/OFT)

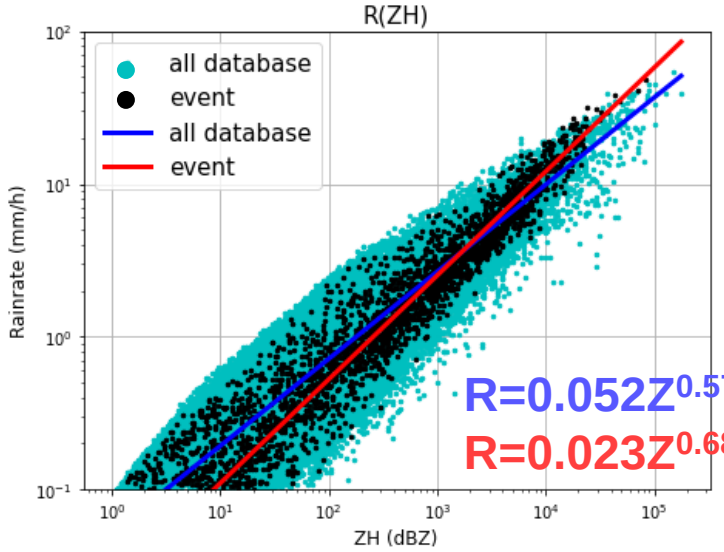


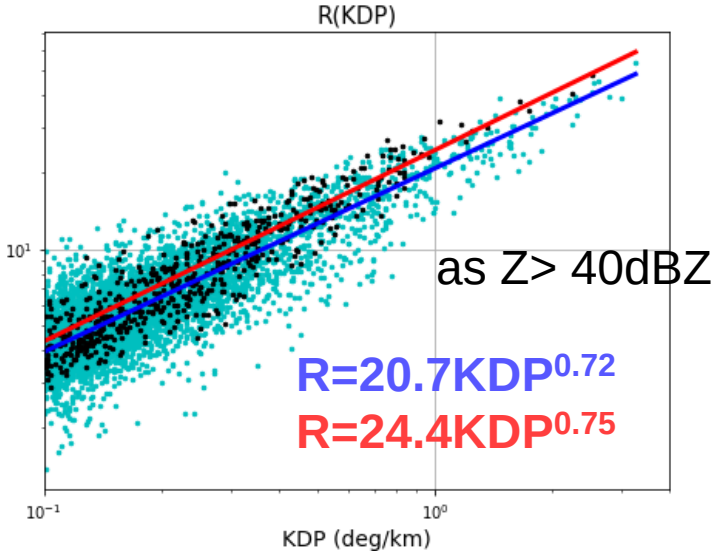
- ✓ 1 Parsivel from JOYCE
- ✓ 1 Thies from Bonn
- ✓ 29 Thies from DWD (within 4 radars' coverage)

→ Resulting in 2588 1min DSDs

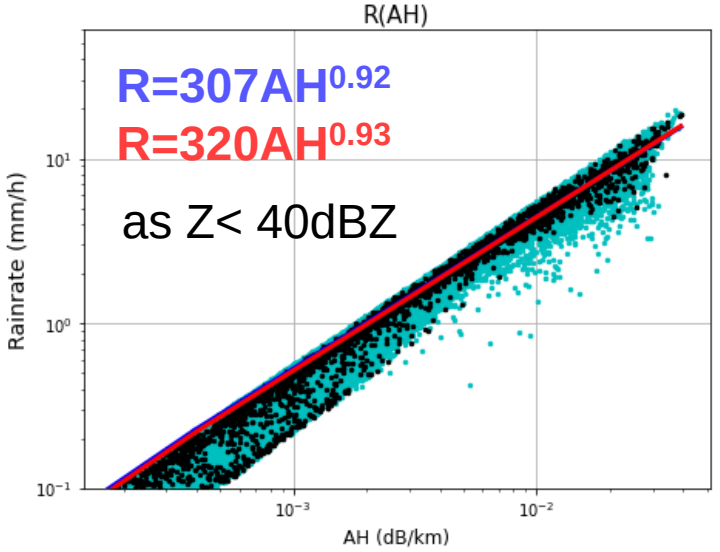


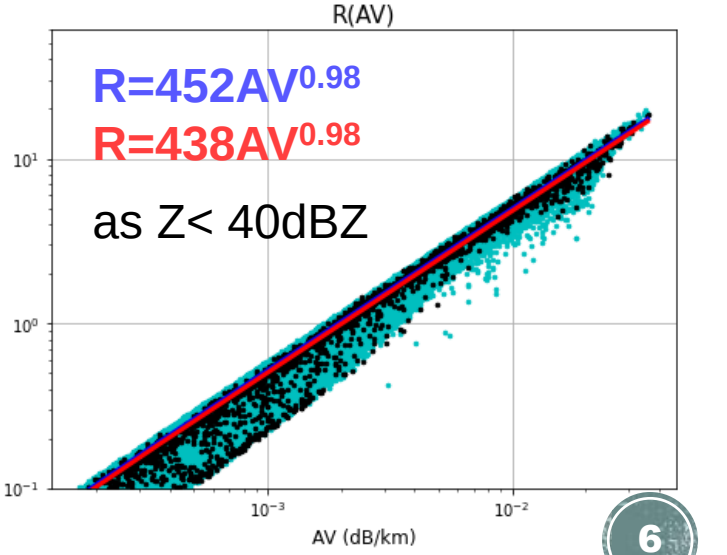
More like tropical rain type



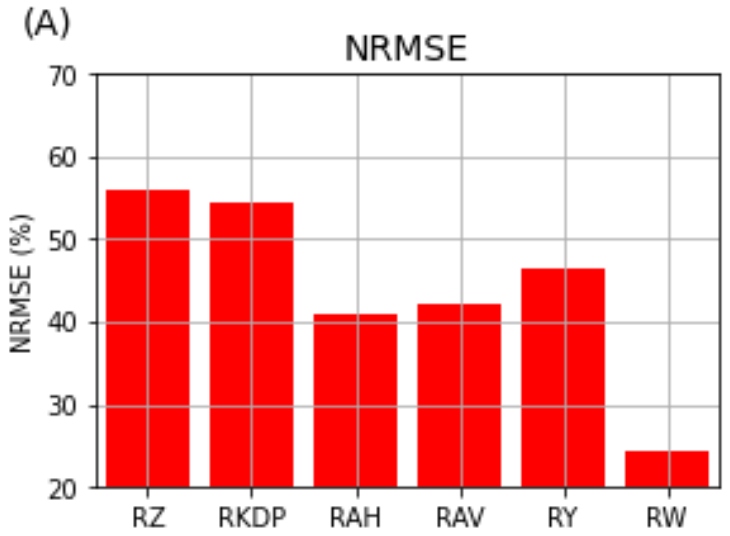


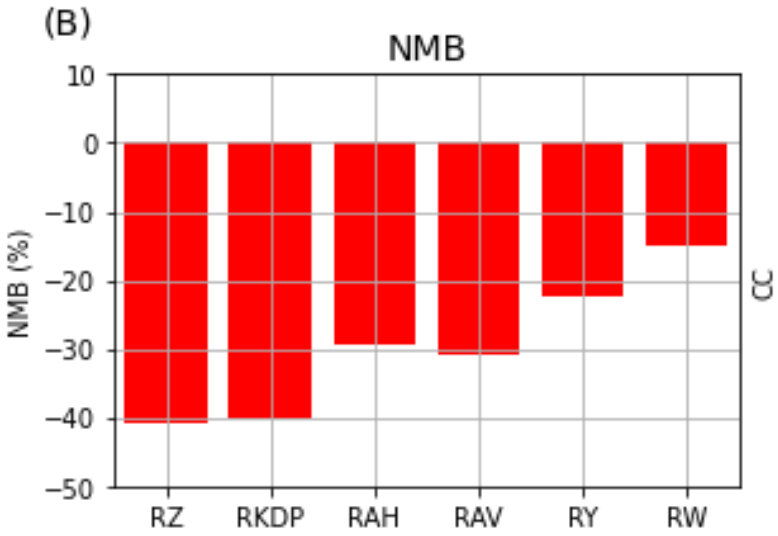
Reduce 5% NMB and 8% NRMSE

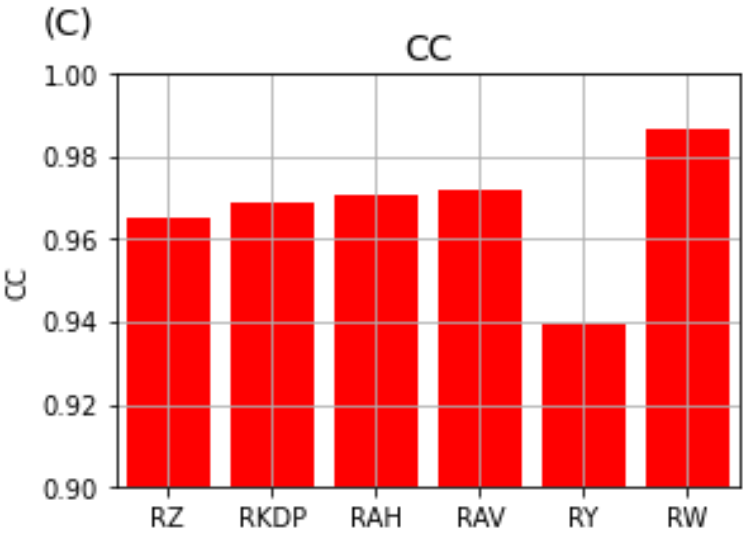


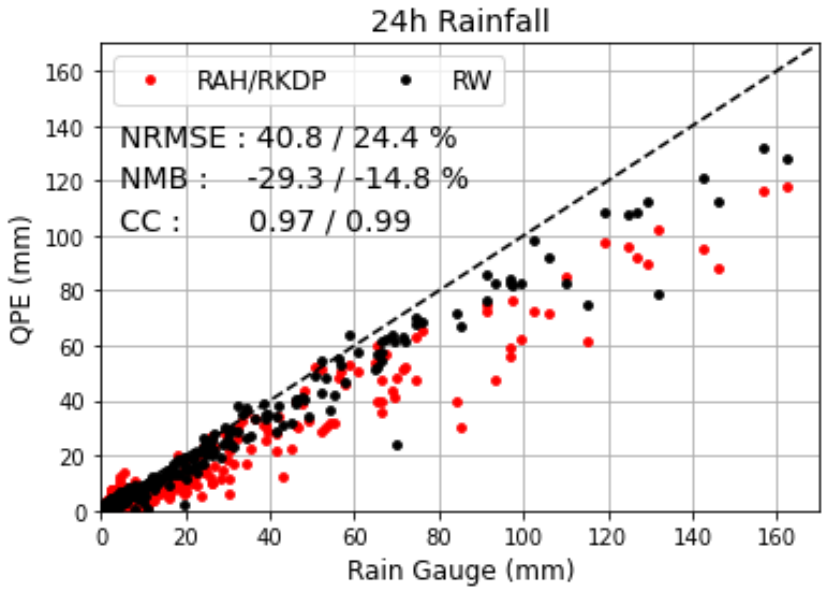


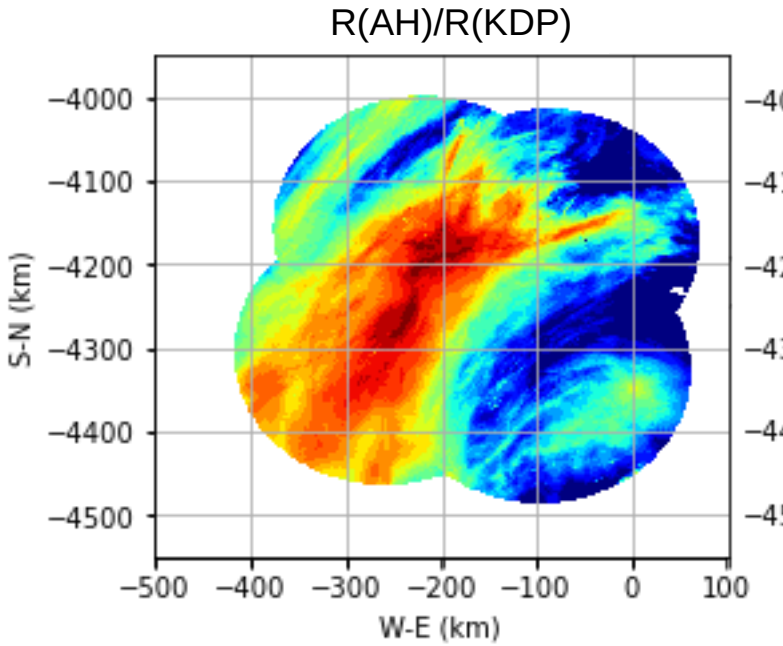
Evaluated with DWD rain gauge measurements

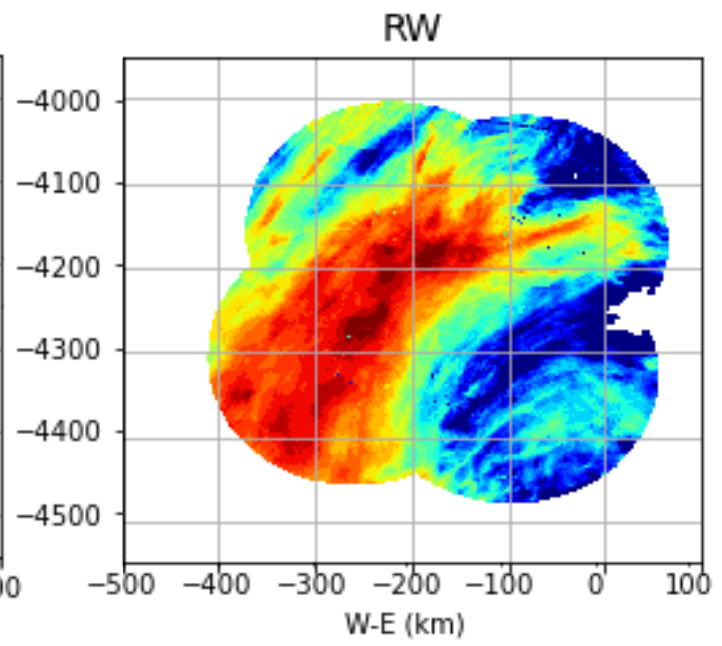


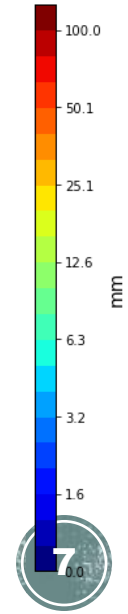




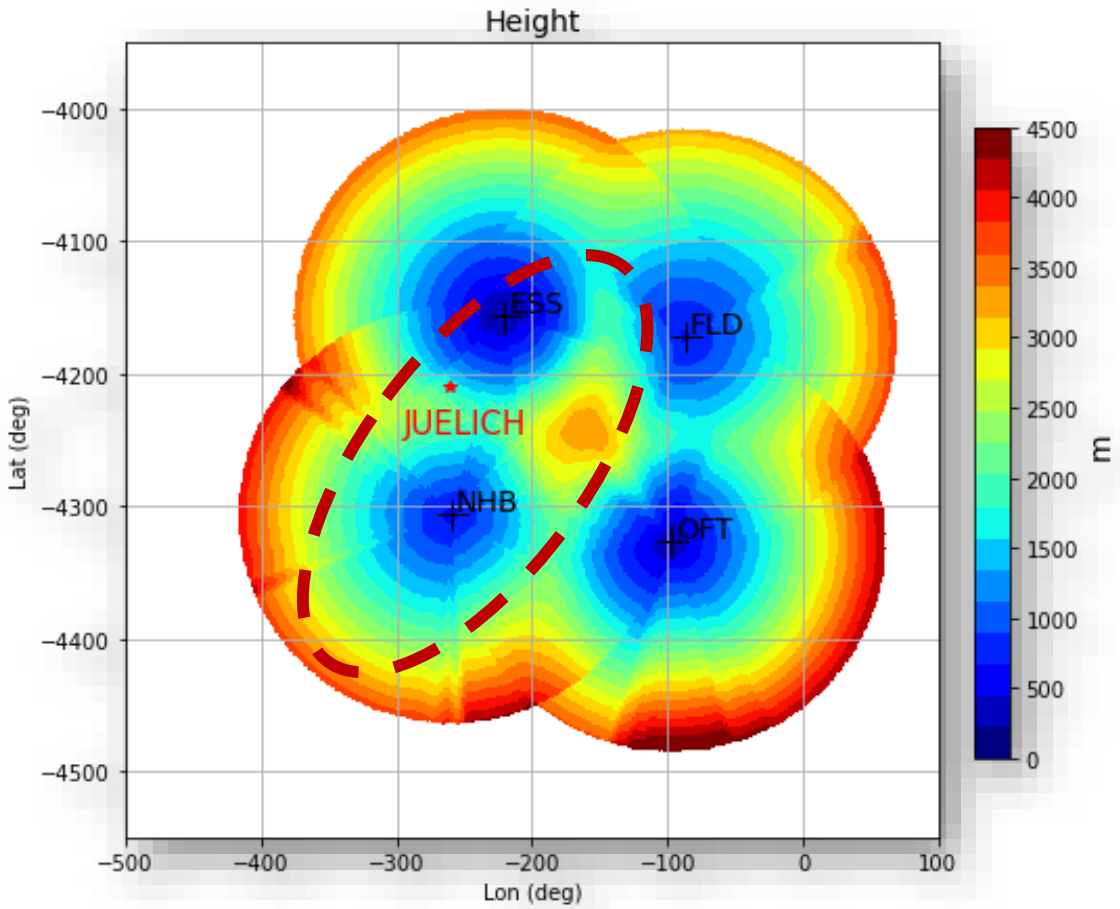




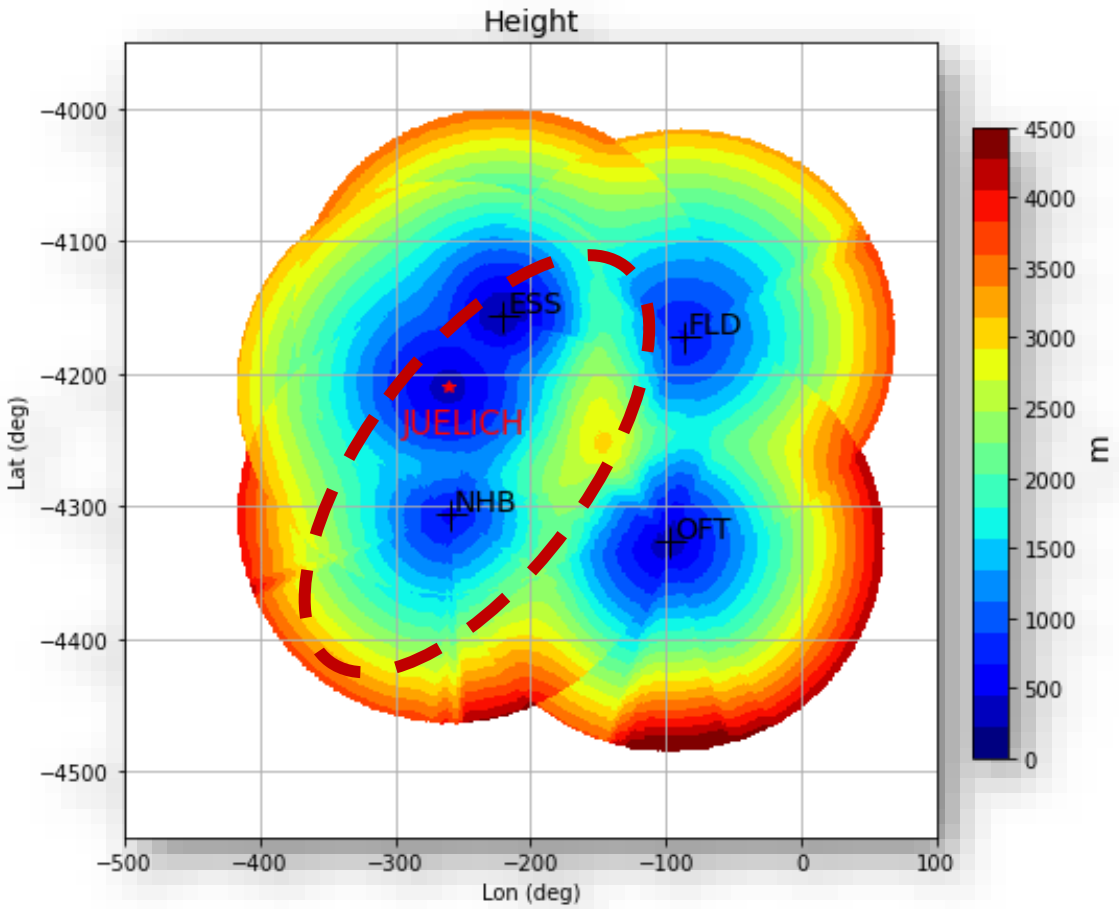




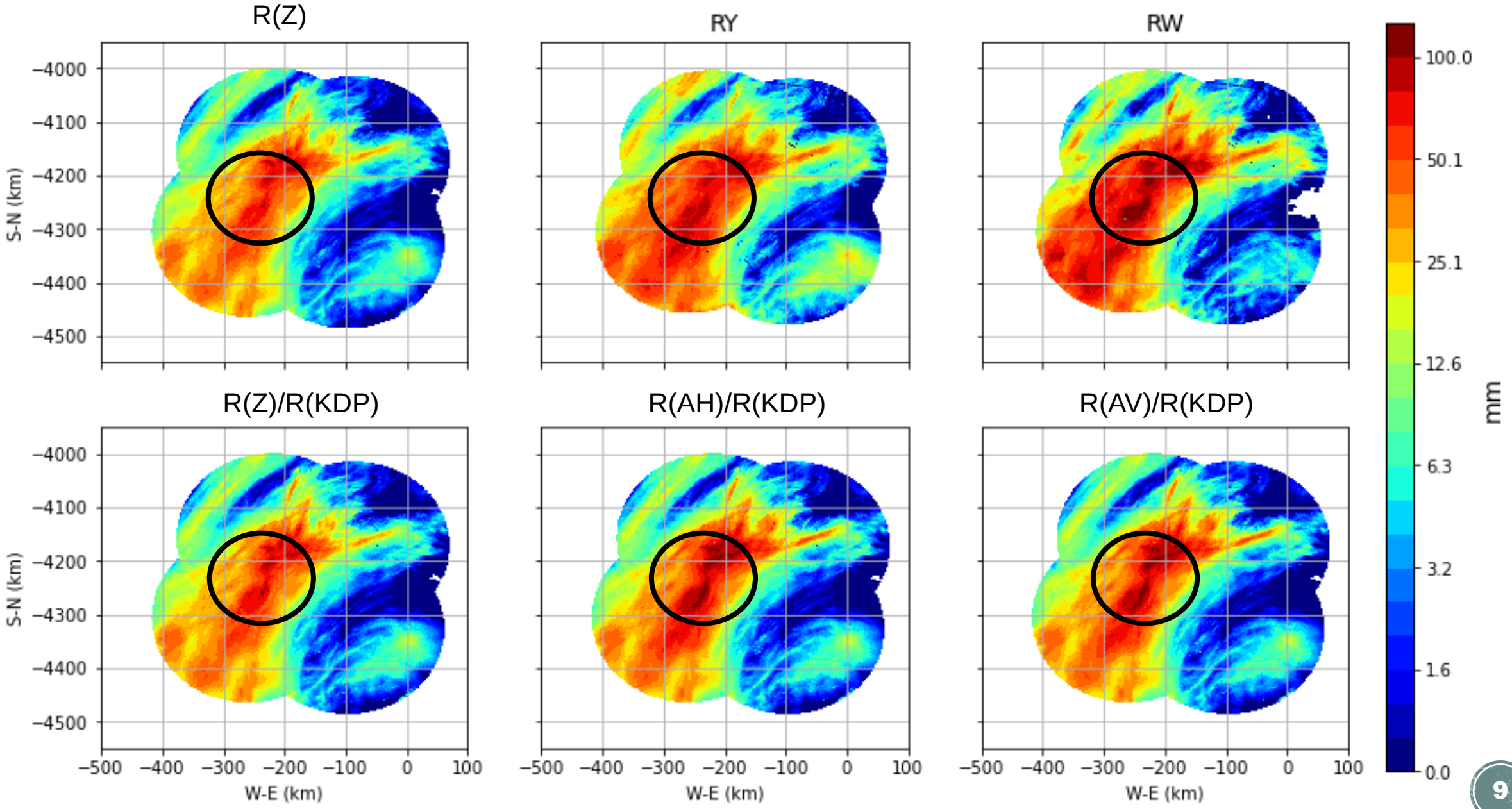
4 DWD C-band radars



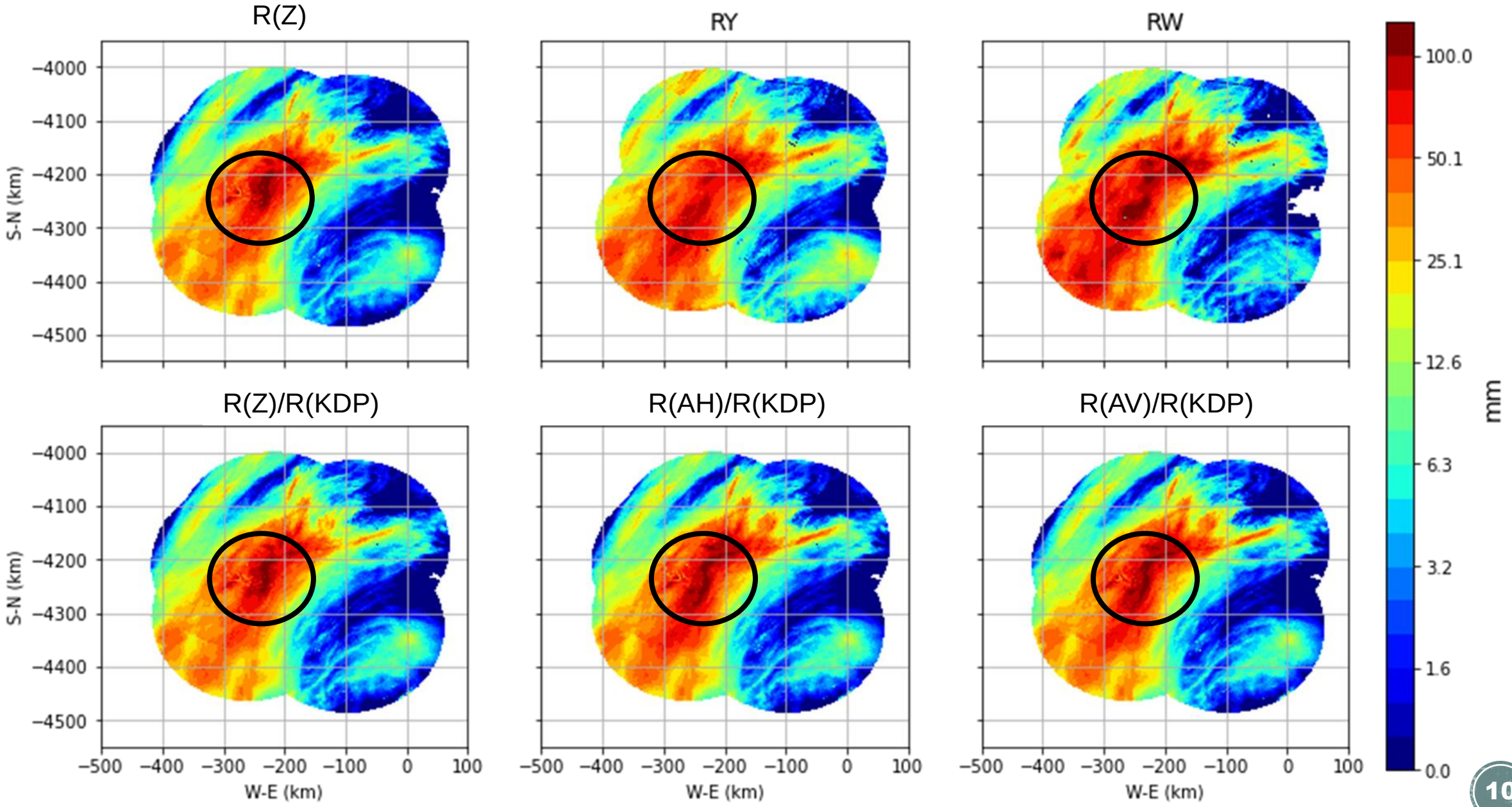
4 DWD C-band radars + X-band JUXPOL



4 DWD C-band radars

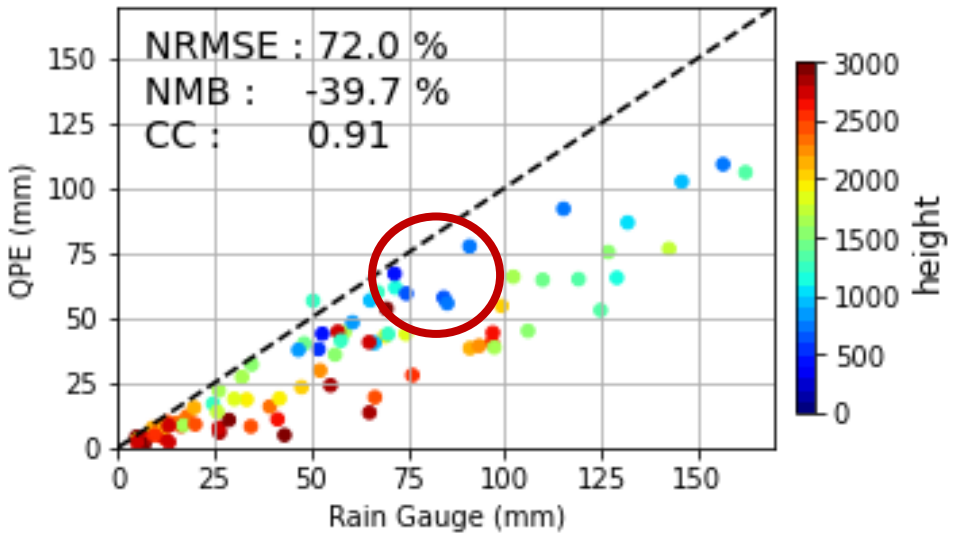


4 DWD C-band radars + X-band JUXPOL

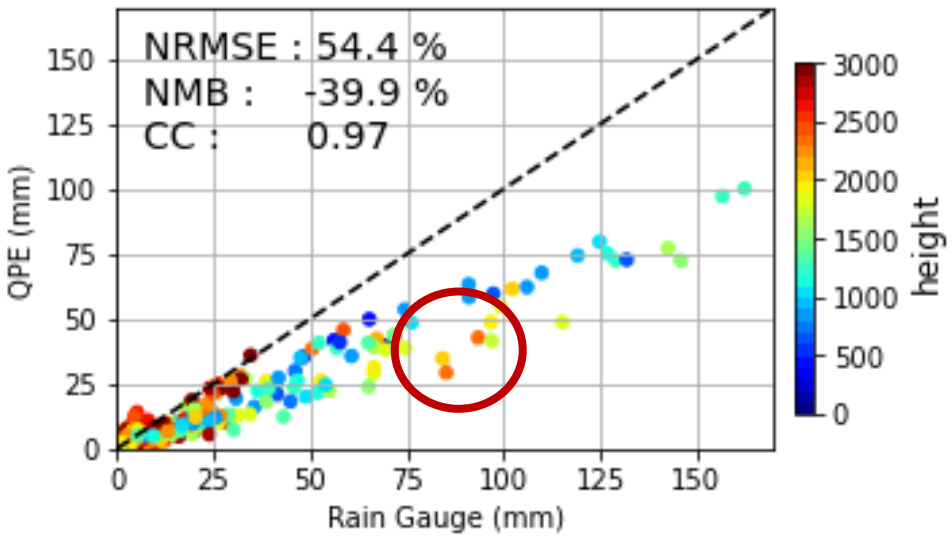


Evaluated with DWD rain gauge measurements – R(Z)+R(KDP)

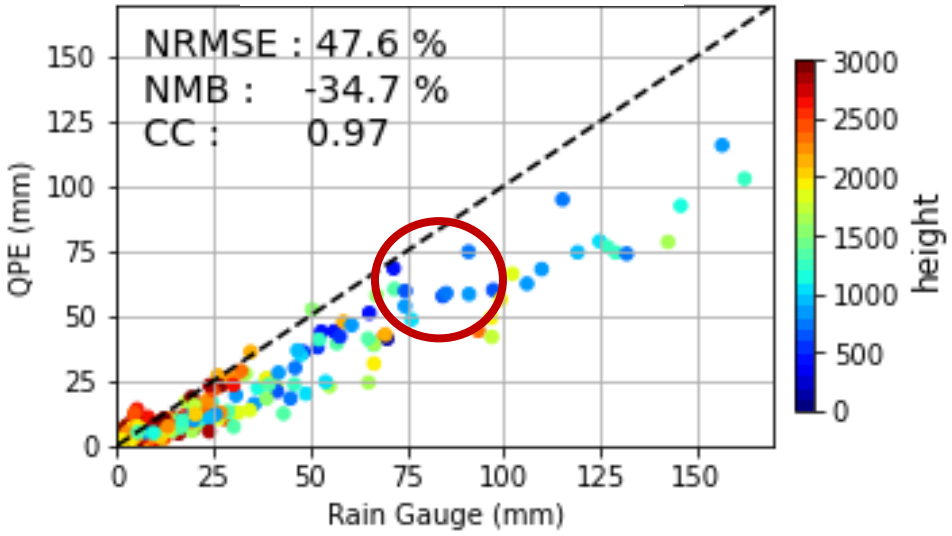
JUXPOL



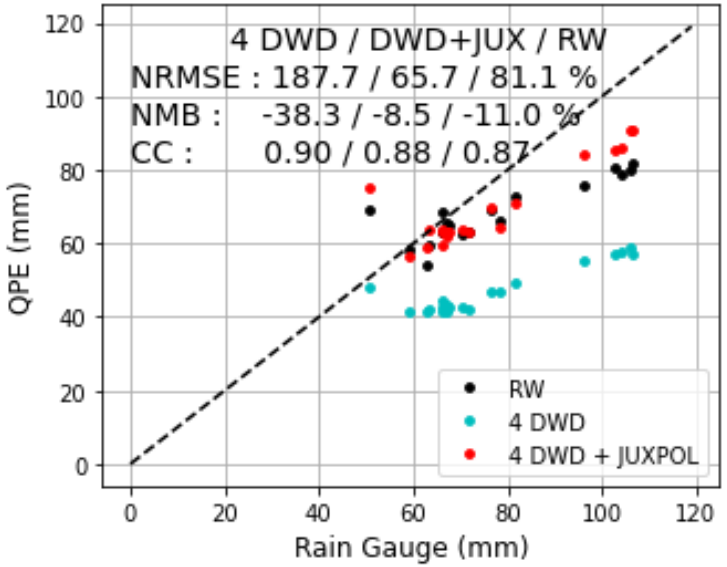
4 DWD



4 DWD + JUXPOL

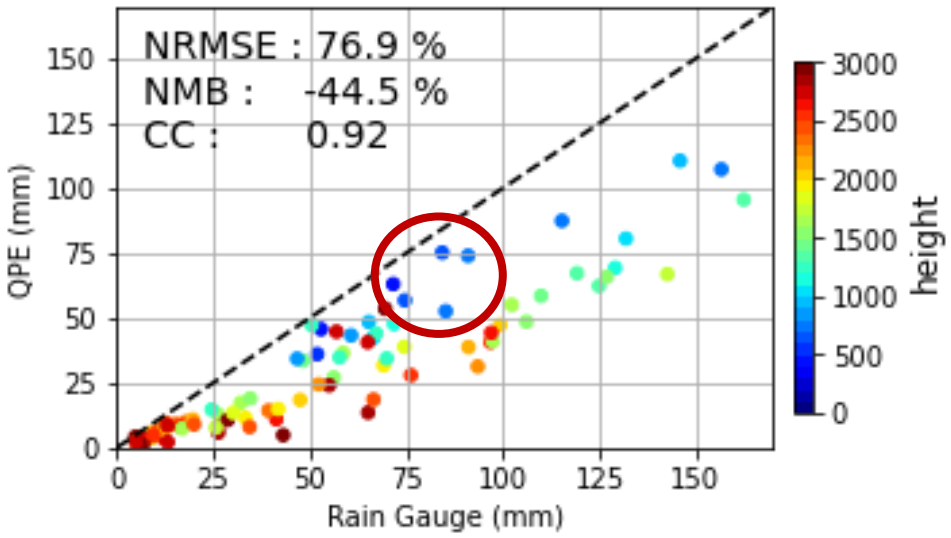


City of Bonn rain gauge measurements

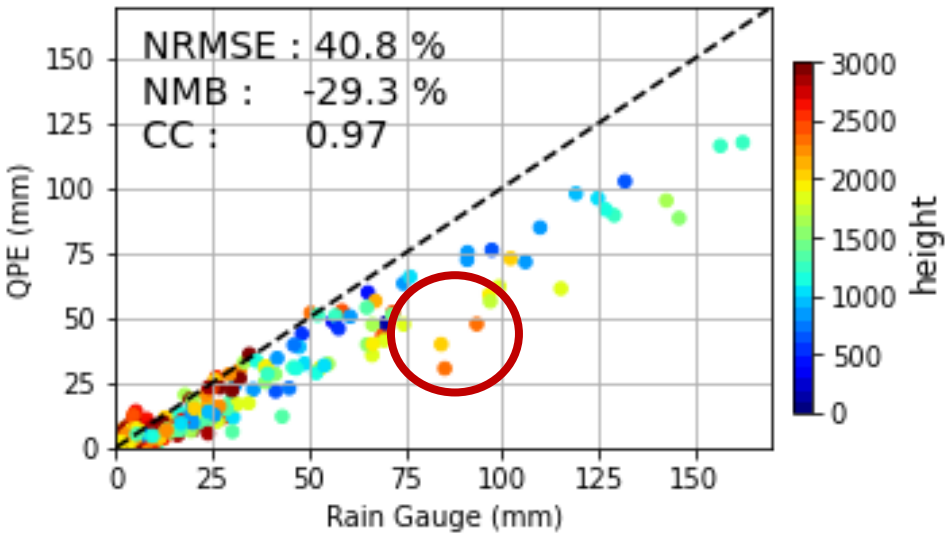


Evaluated with DWD rain gauge measurements – R(AH)+R(KDP)

JUXPOL



4 DWD



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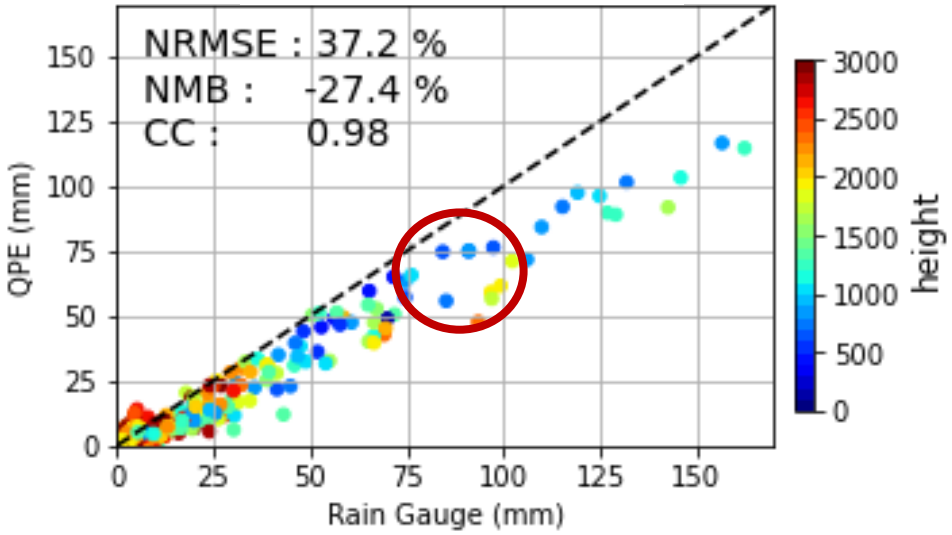

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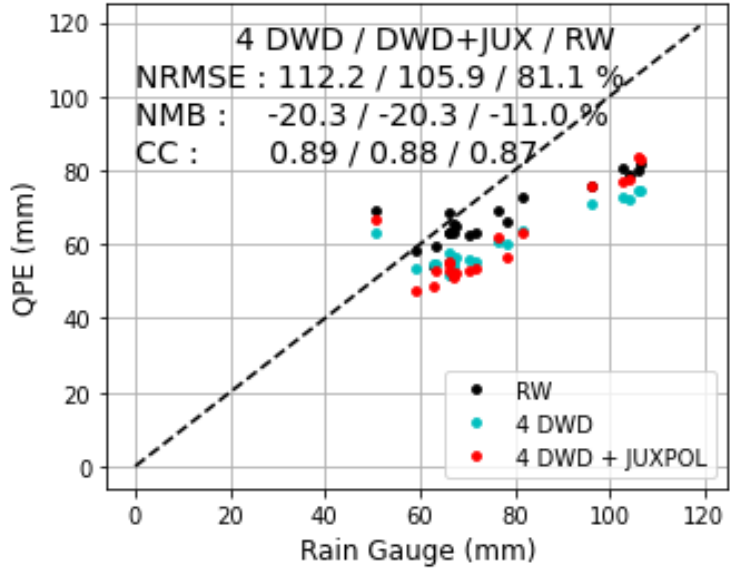
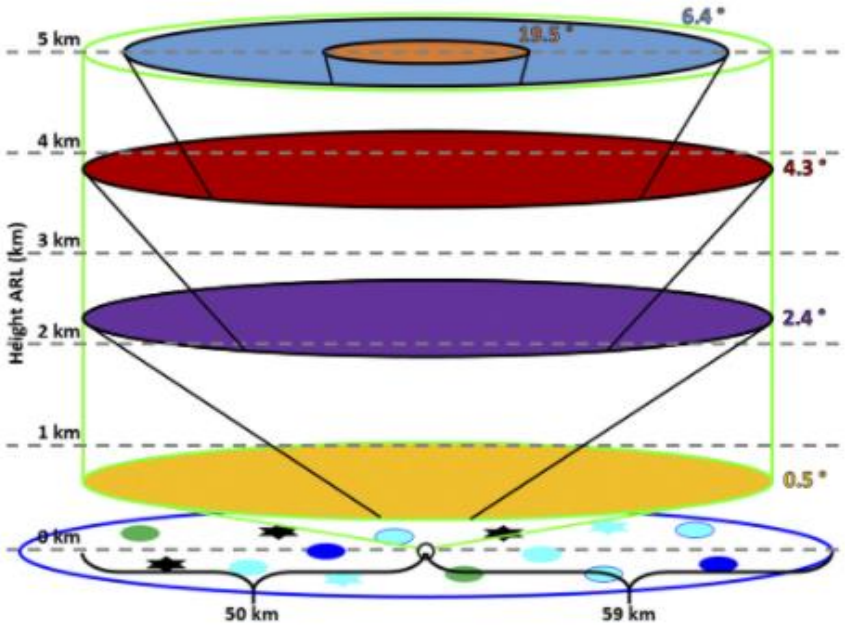


RD-QVP (Range-defined QVP)

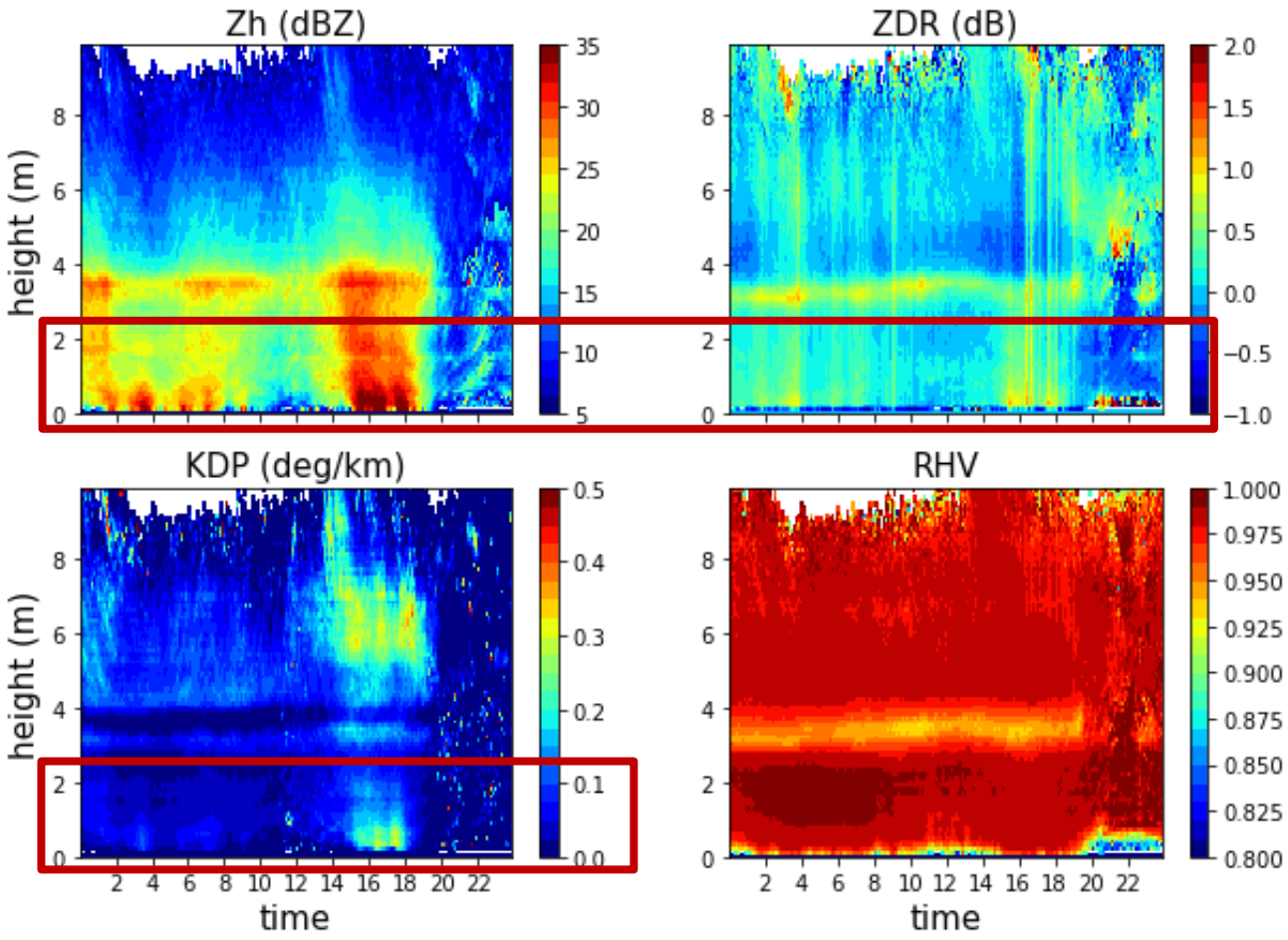


Tobin et al. (2017)

Data from all elevation angles are averaged according to the specified range using an inverse distance weighting:

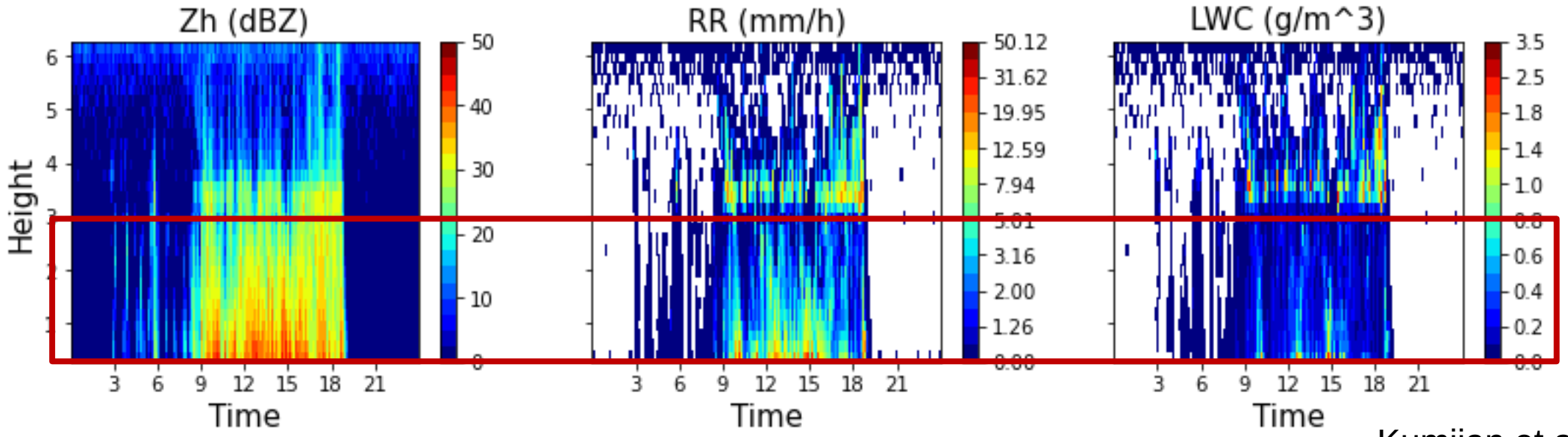
- ✓ R < 100 km w = 1
- ✓ R > 100 km w = IDW

ESS radar



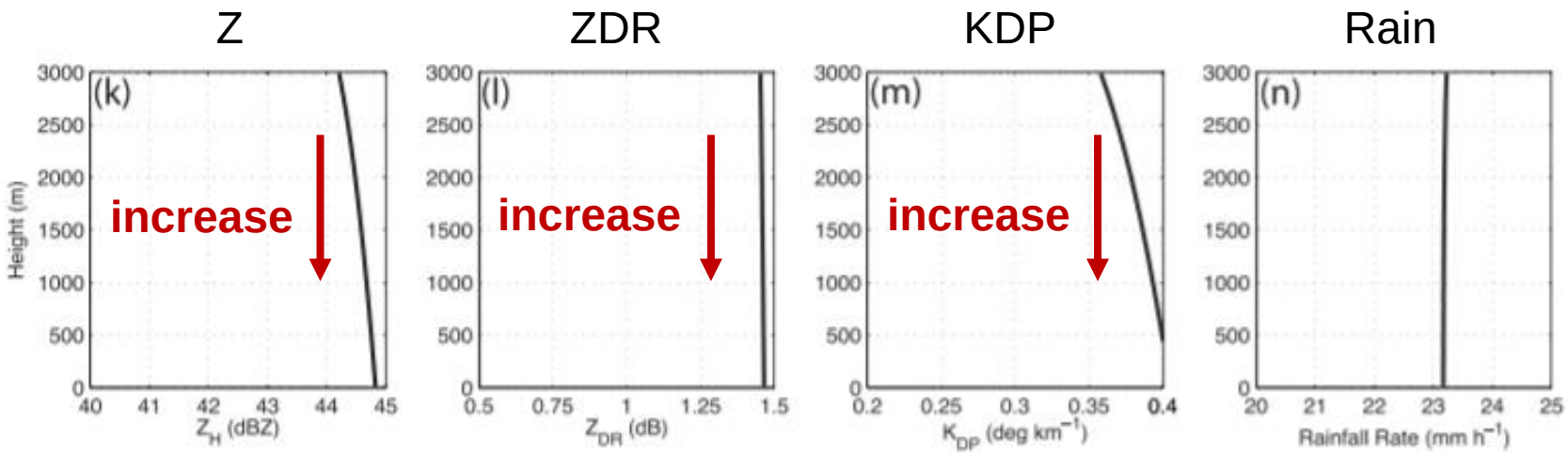
pronounced vertical gradients in the lowest 3 km near the surface

UNI BONN MRR



Kumjian et al. (2014)

Warm rain processes (collision-coalescence) play the dominant role and lead to an underestimation of radar-based QPE.



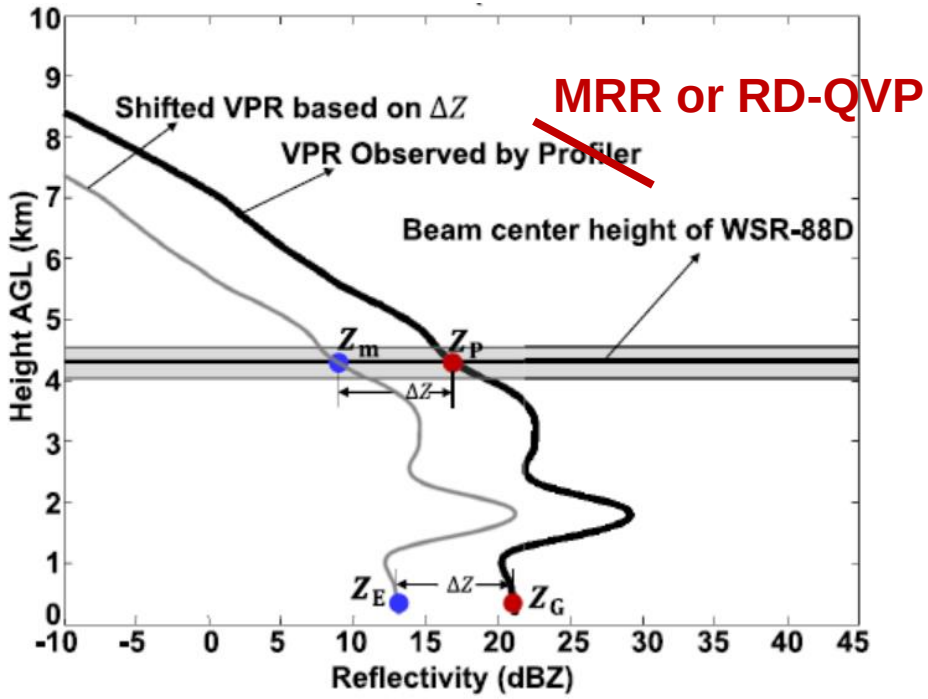
Vertical profiles of the polarimetric radar variables after 60 min of simulation

Conclusions

- Juelich X-band radar provides data from lower altitudes and improves QPE performances especially for R(Z)-based products.
- Polarimetric variable-based QPEs still show large underestimation due to the pronounced vertical gradient of Z and KDP below the ML.
- A correction/consideration of the vertical profile of Z (VPR) or KDP is needed for more accurate QPE products.

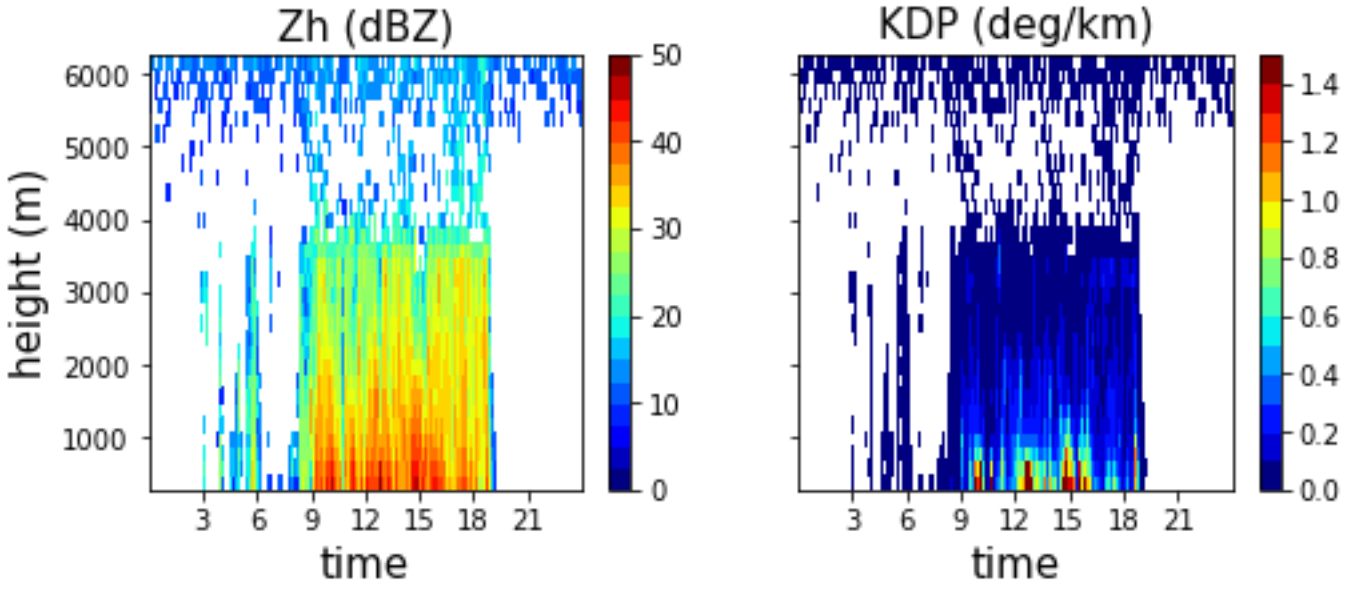
Near future work

(1) VPR correction based on MRR or RD-QVP



Chen et al. (2020)

(2) Derived rainrate relationships based on DSDs measured by MRR at different height levels



Snow retrievals based on polarimetric variables – S(Z,KDP)

- ✓ $S(Z)=0.115Z^{0.5}$ by Vasiloff (1997)
- ✓ S(Z,KDP) by Petar Bukovčić et al. (2020)

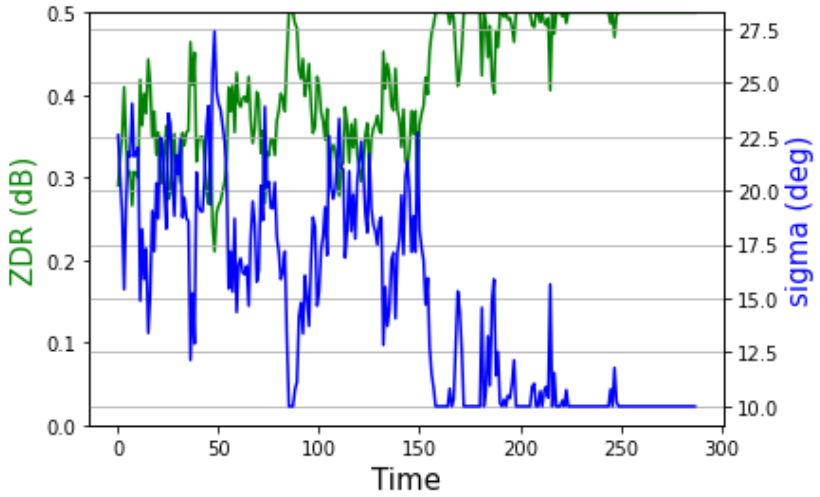
$$S(K_{DP},Z)=\frac{27.9\times10^{-3}}{(F_oF_s)^{0.615}}\left(\frac{p_0}{p}\right)^{0.5}(K_{DP}\lambda)^{0.615}Z^{0.33}$$

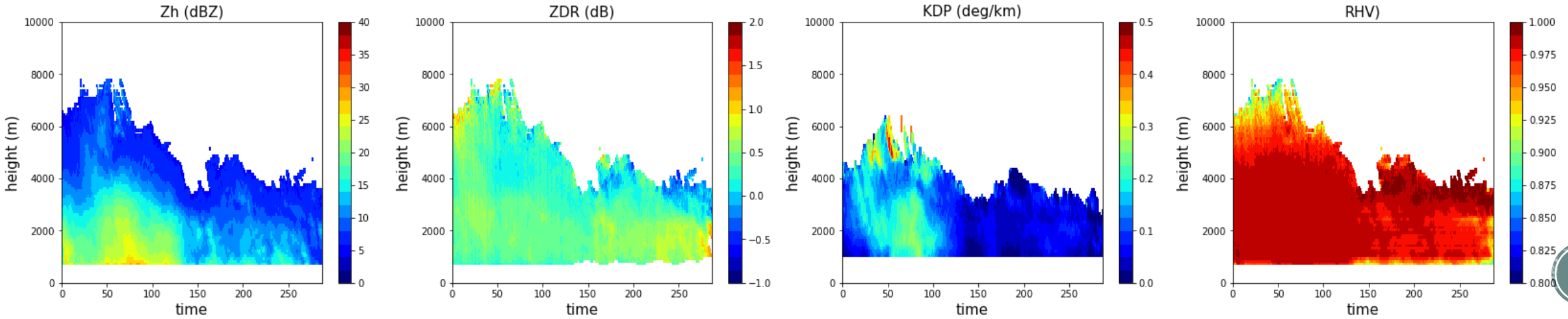
σ (canting angle distribution) linearly increases from the DGL towards the ground

→ 10° within the DGL (T=-10 deg)

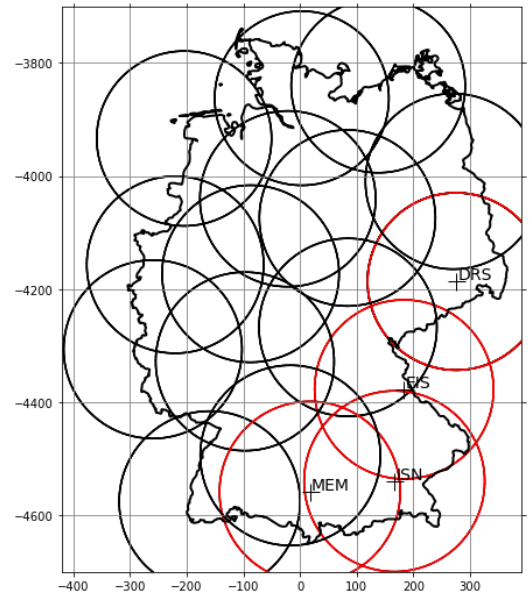
→ up to 40° right above the top of the ML/ground

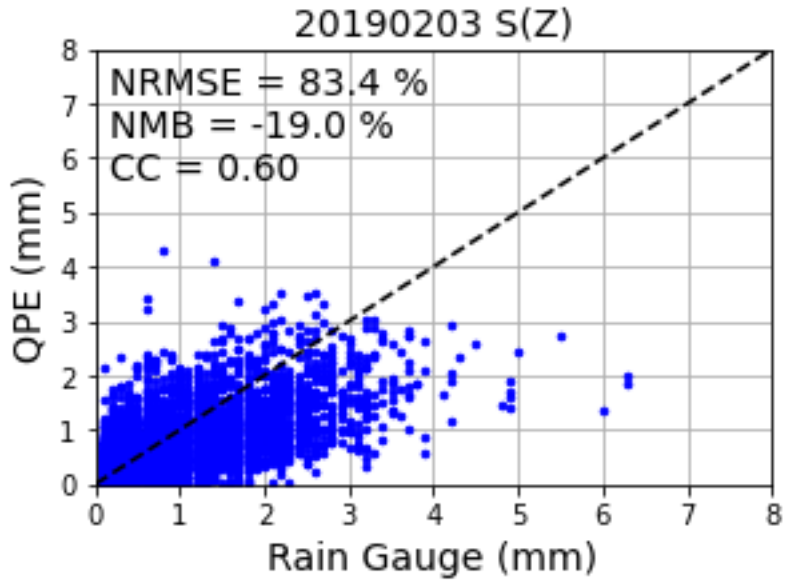
ZDR and σ timeseries

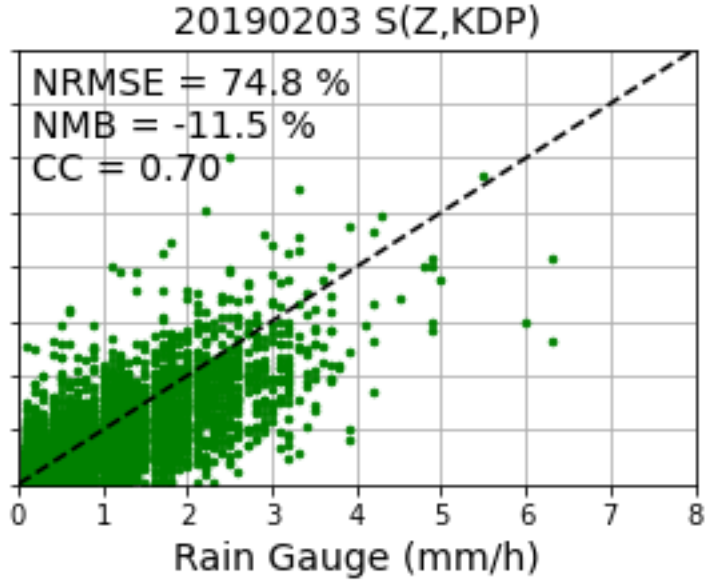




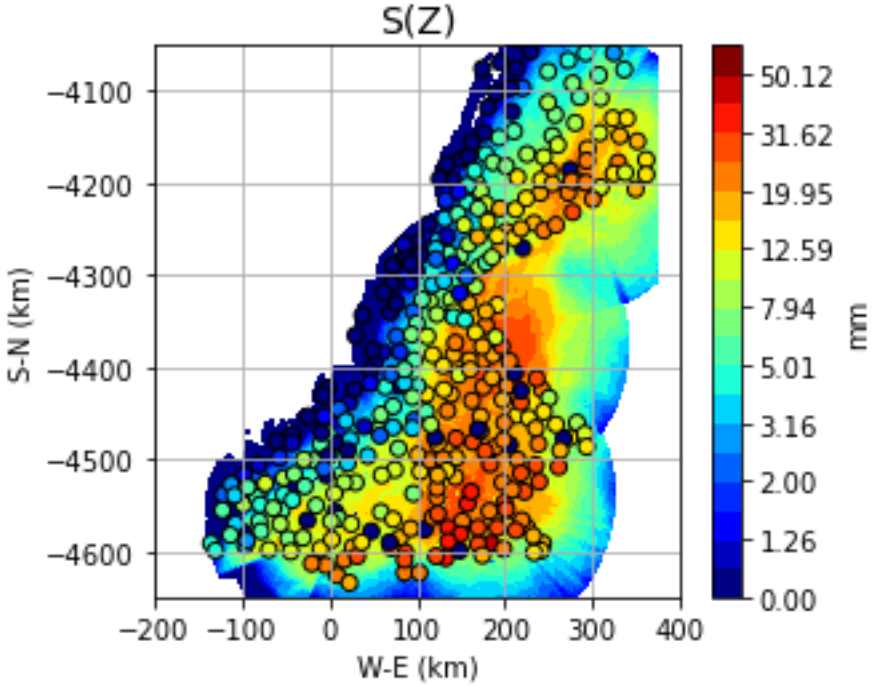
Hourly rainfall

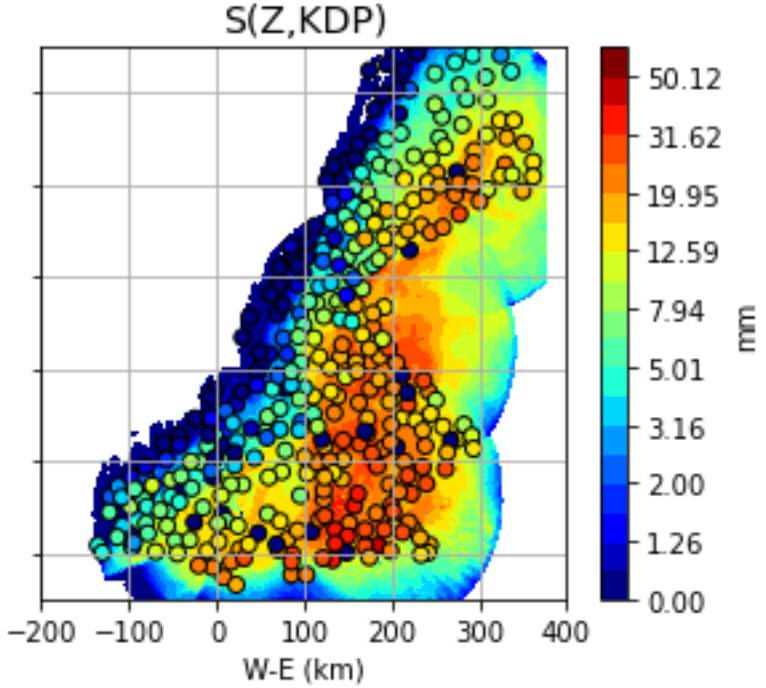




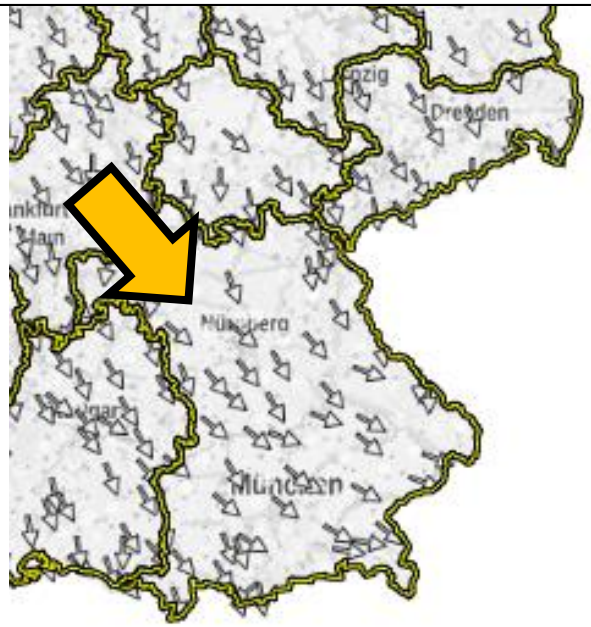


Daily accum. rainfall maps

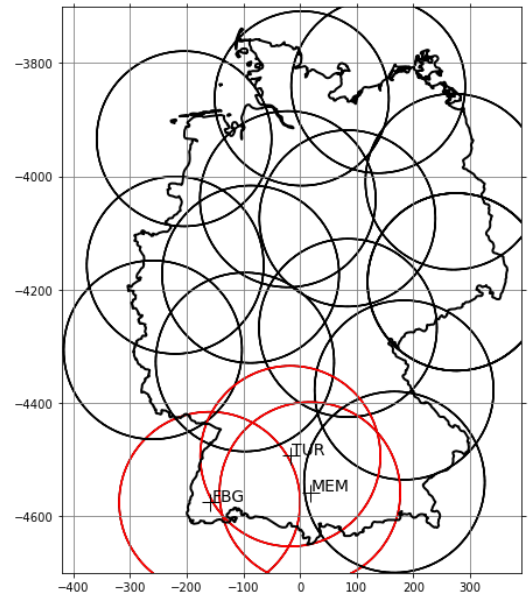


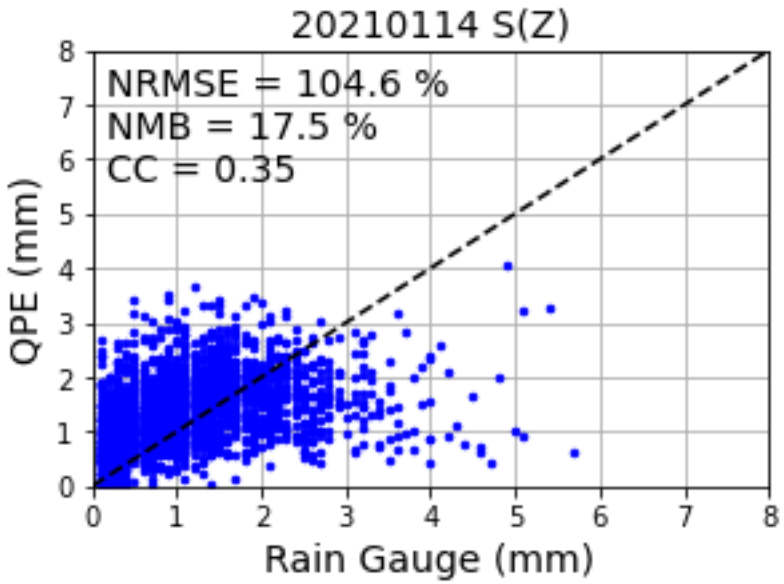


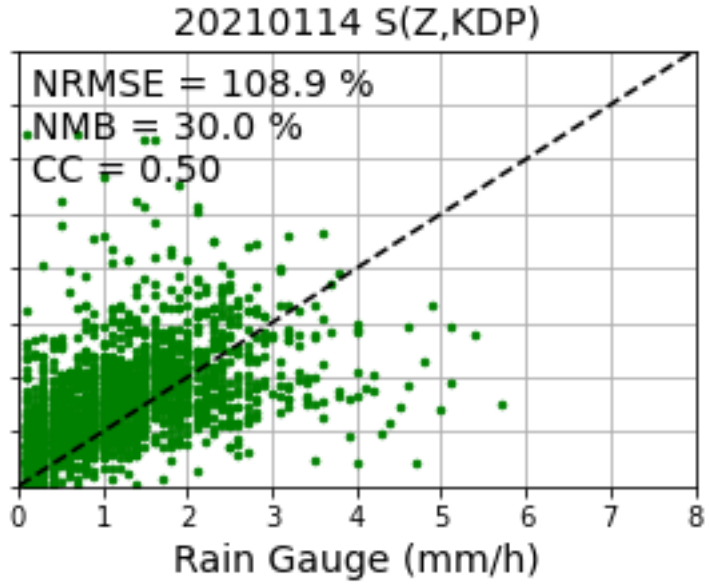
Hourly station observations of wind direction ca. 10 m above the ground



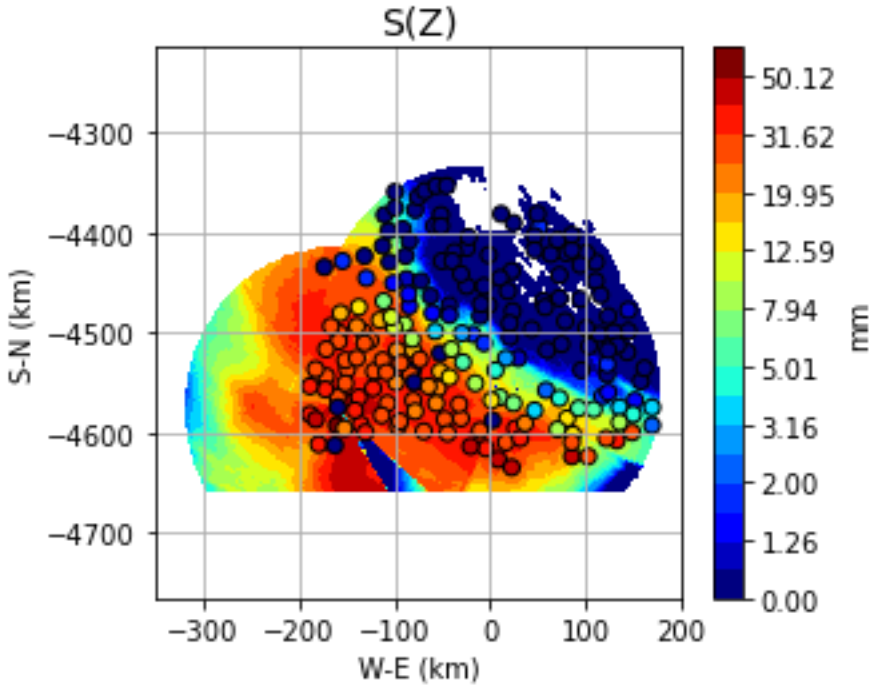
Hourly rainfall

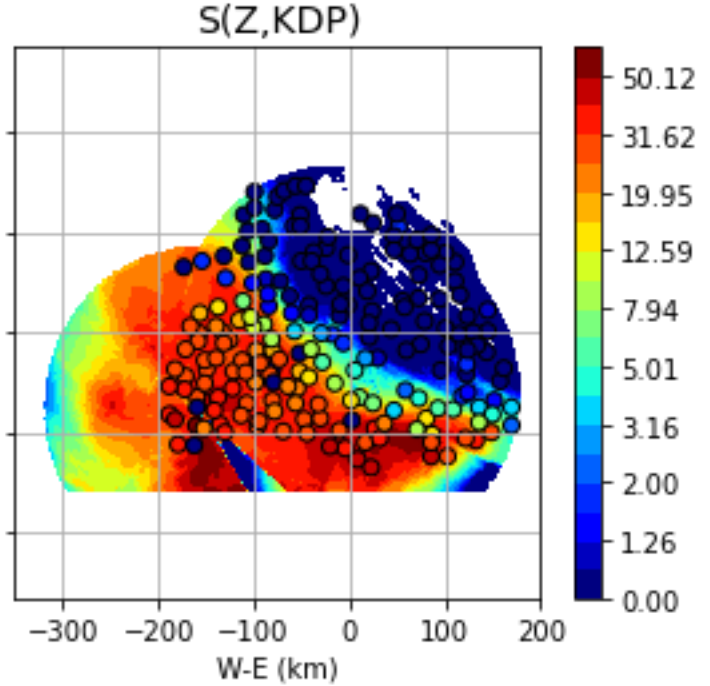




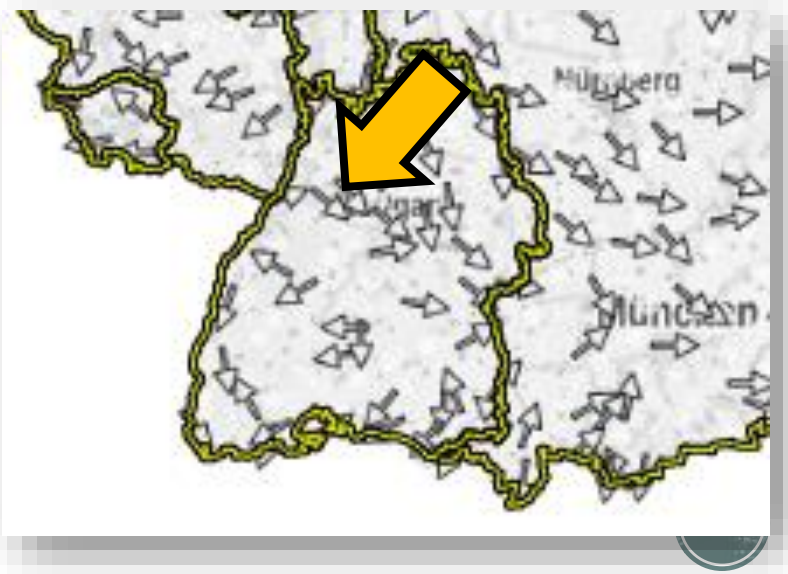


Daily accum. rainfall maps

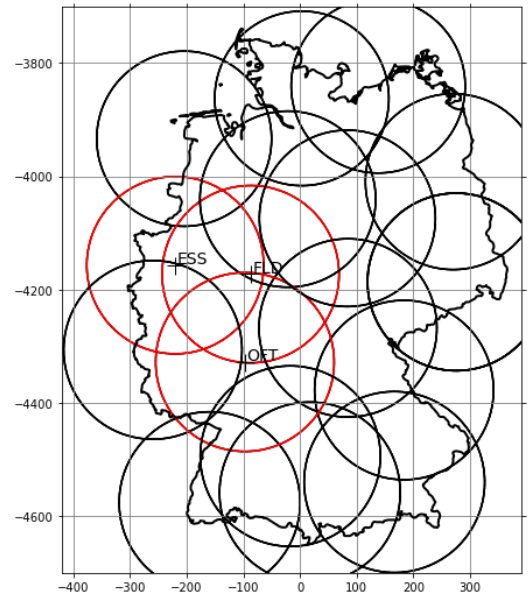


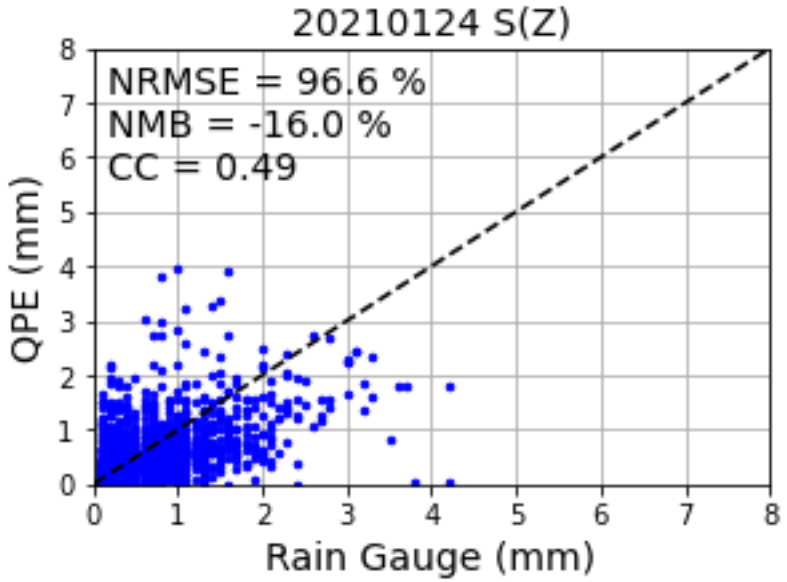


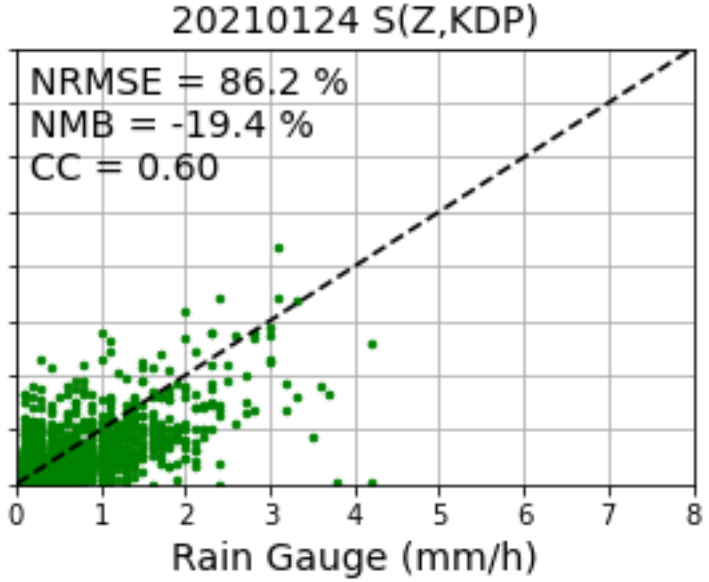
Hourly station observations of wind direction ca. 10 m above the ground



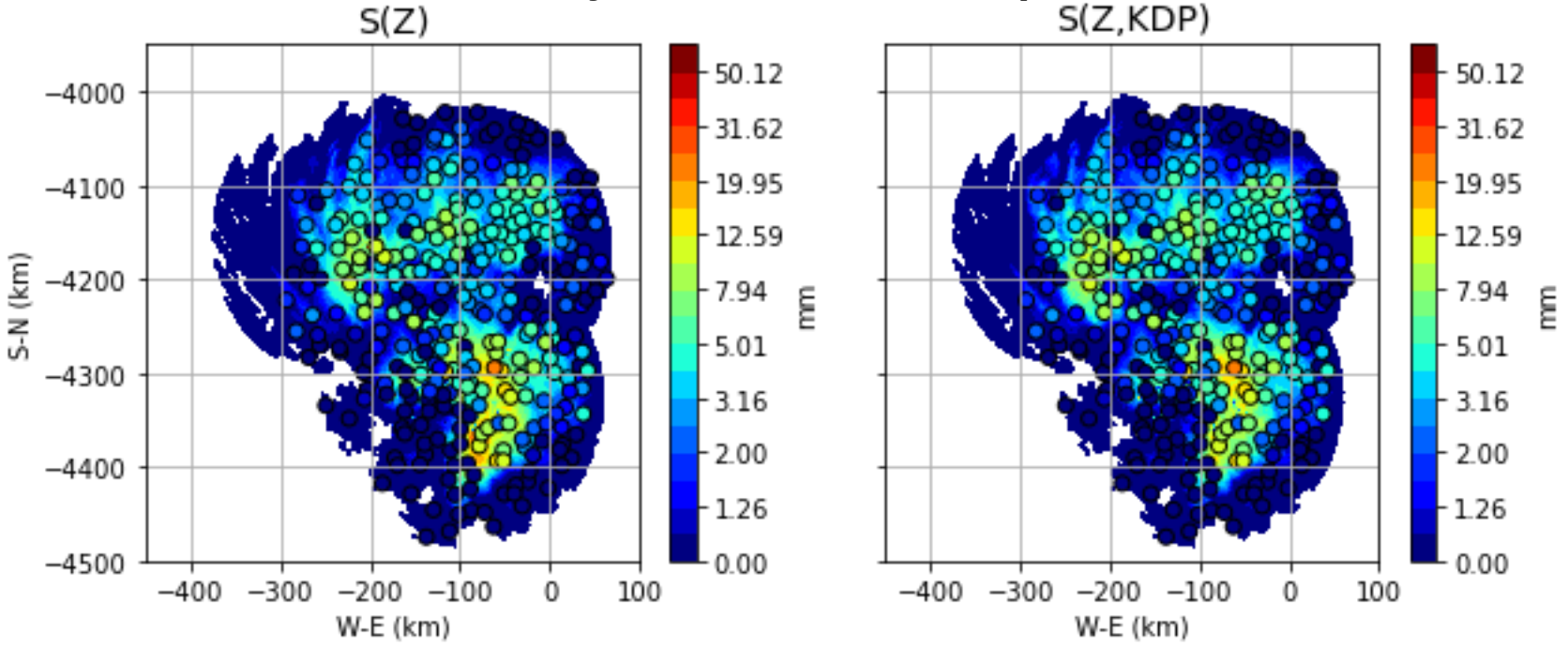
Hourly rainfall



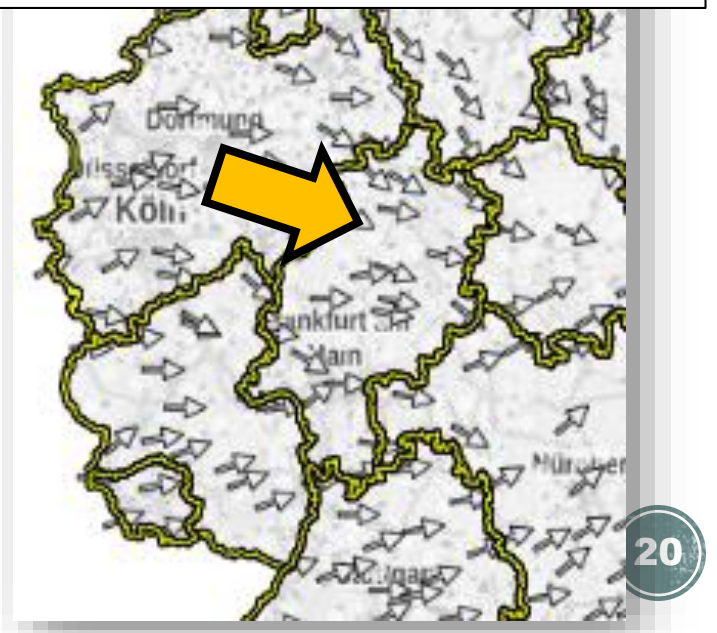




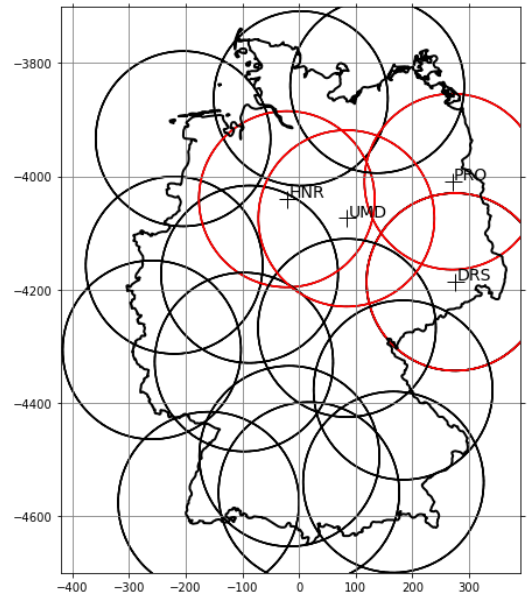
8-hourly accum. rainfall maps

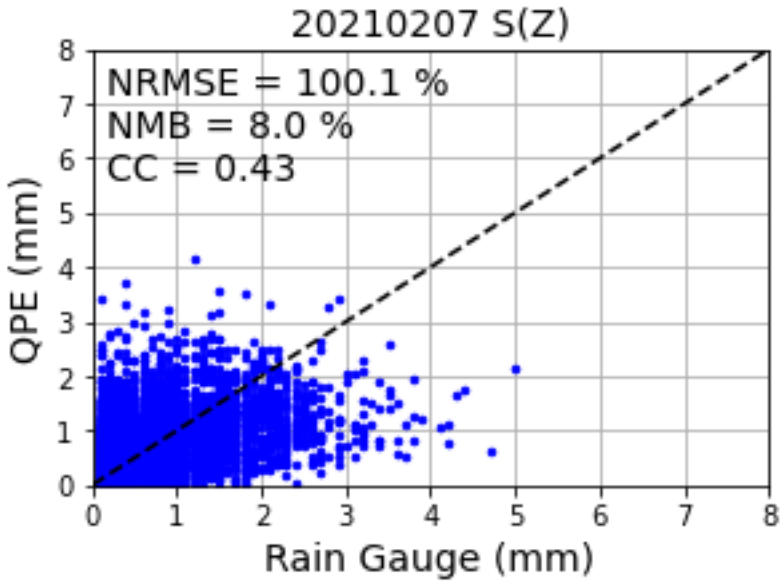


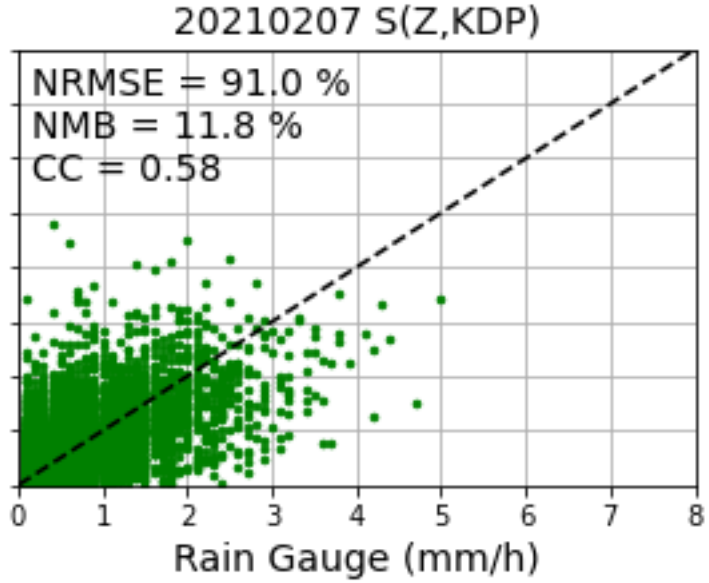
Hourly station observations of wind direction ca. 10 m above the ground



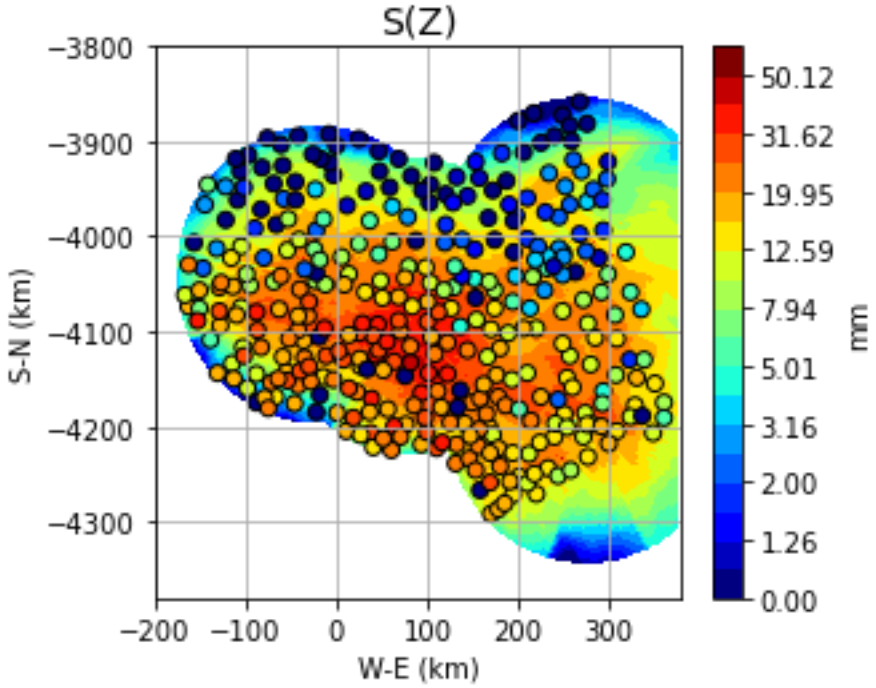
Hourly rainfall

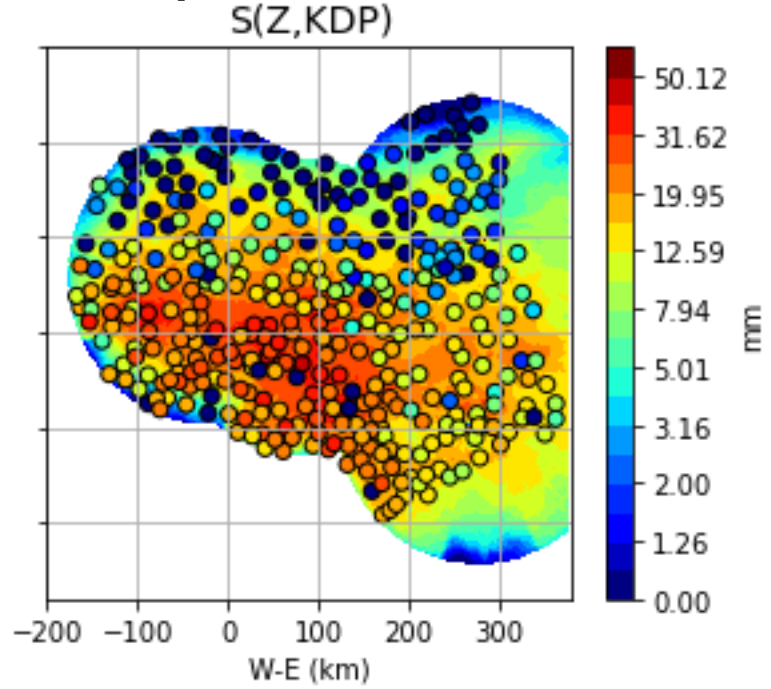




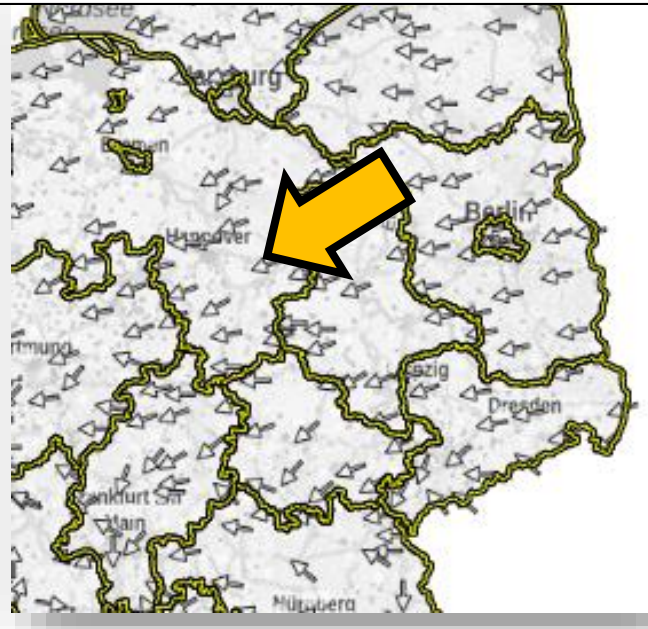


2-day accum. rainfall maps





Hourly station observations of wind direction ca. 10 m above the ground



Conclusions and Near future work

- S(Z,KDP) has lower errors and much higher CC values than S(Z).
- Wind advection plays an important role in snowfall estimation and needs to be considered.

-- Thanks for your listening --