UNIVERSITÄT BONN

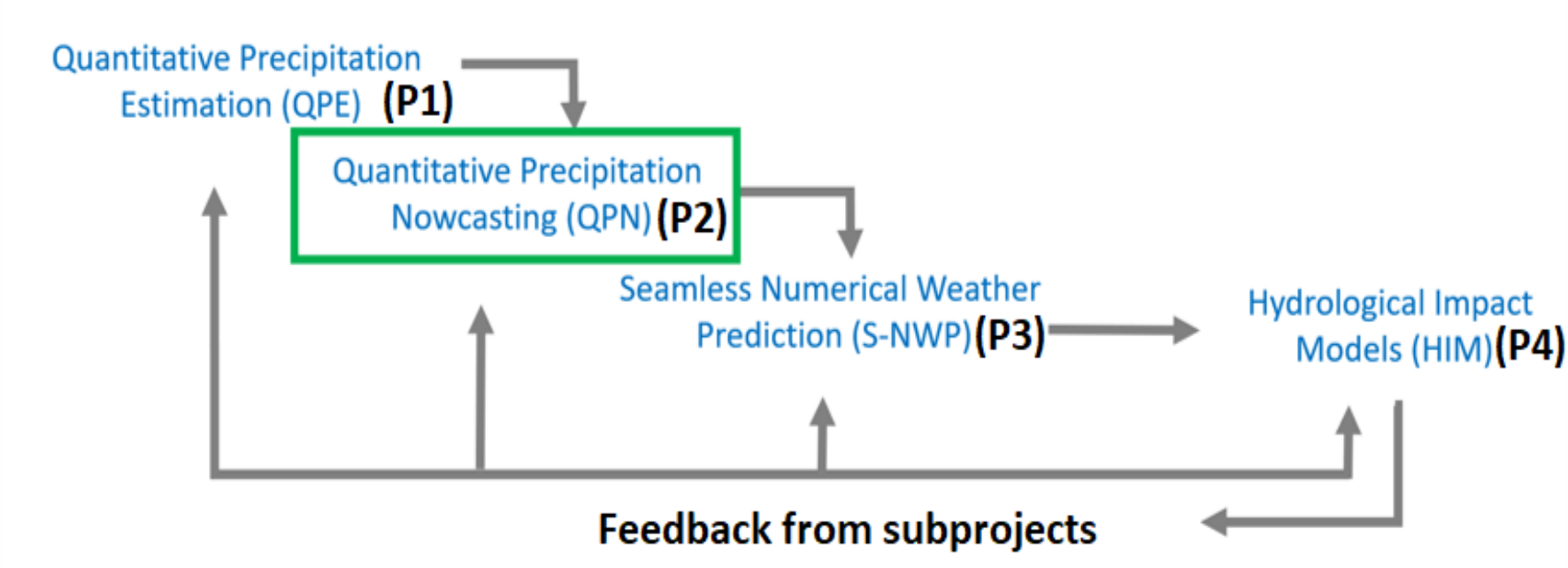
RealPEP

RealPEP-P2 : Observation-based Weather Analysis and Nowcasting (QPN)

Presented by Mathias Emond and Silke Troemel

On the 19 th of September 2023

The subproject P2 among RealPEP



Cooperation between P2 and P4:

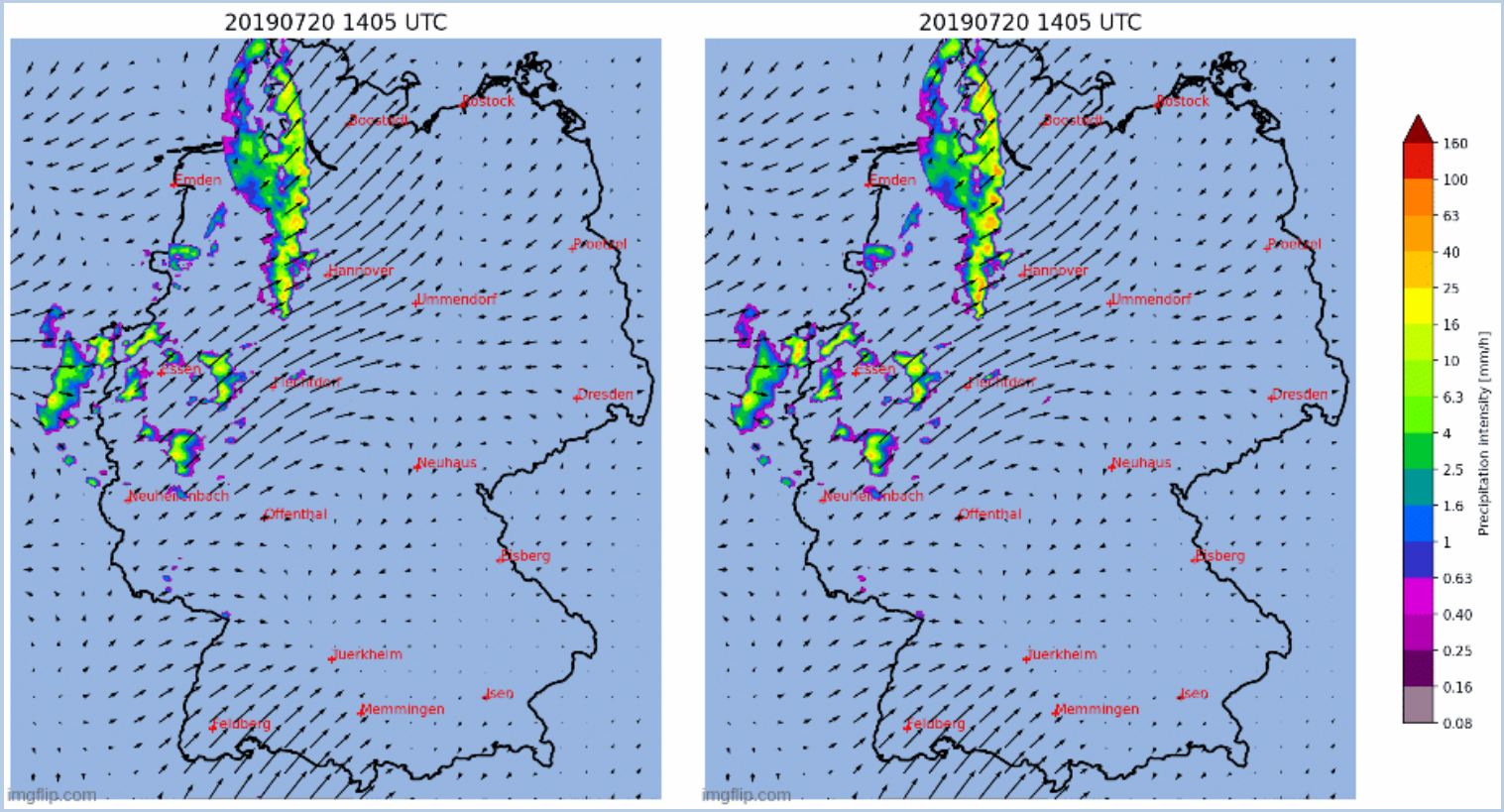
Poméon T et al, 2020 « *Performance of a PDE-Based hydrologic Model in a Flash Flood Modeling Framework in Sparsely-Gauged Catchments* »

Saadi, M et al, 2022 « *Comparison of three radar-based precipitation nowcasts for the extreme July 2021 flooding event in Germany* » (under review)

P2-Phase I

P2-Phase I: SPROG vs SPROG-LOC

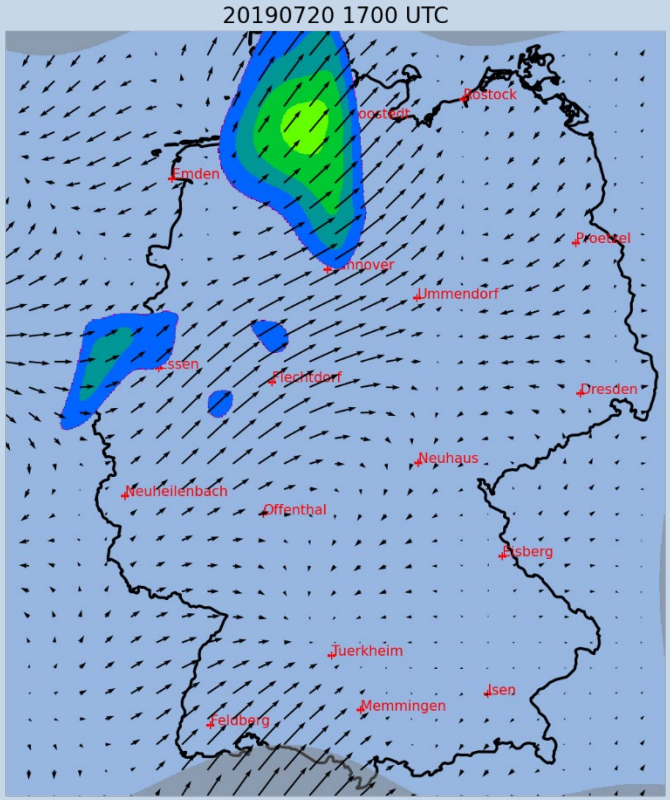
SPROG **SPROG-LOC**



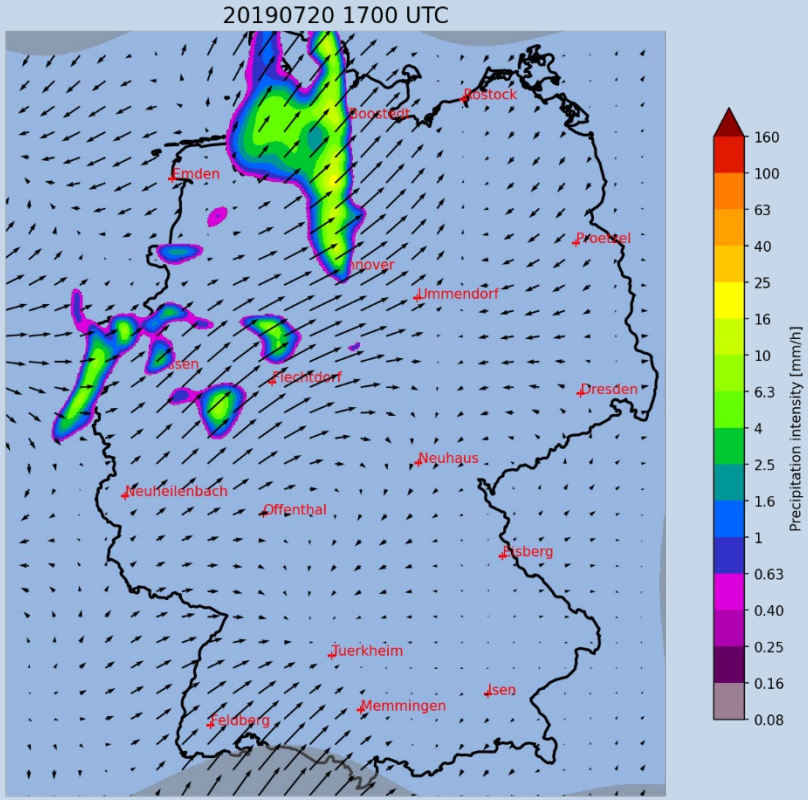
P2-Phase I

P2-Phase I: SPROG vs SPROG-LOC

SPROG



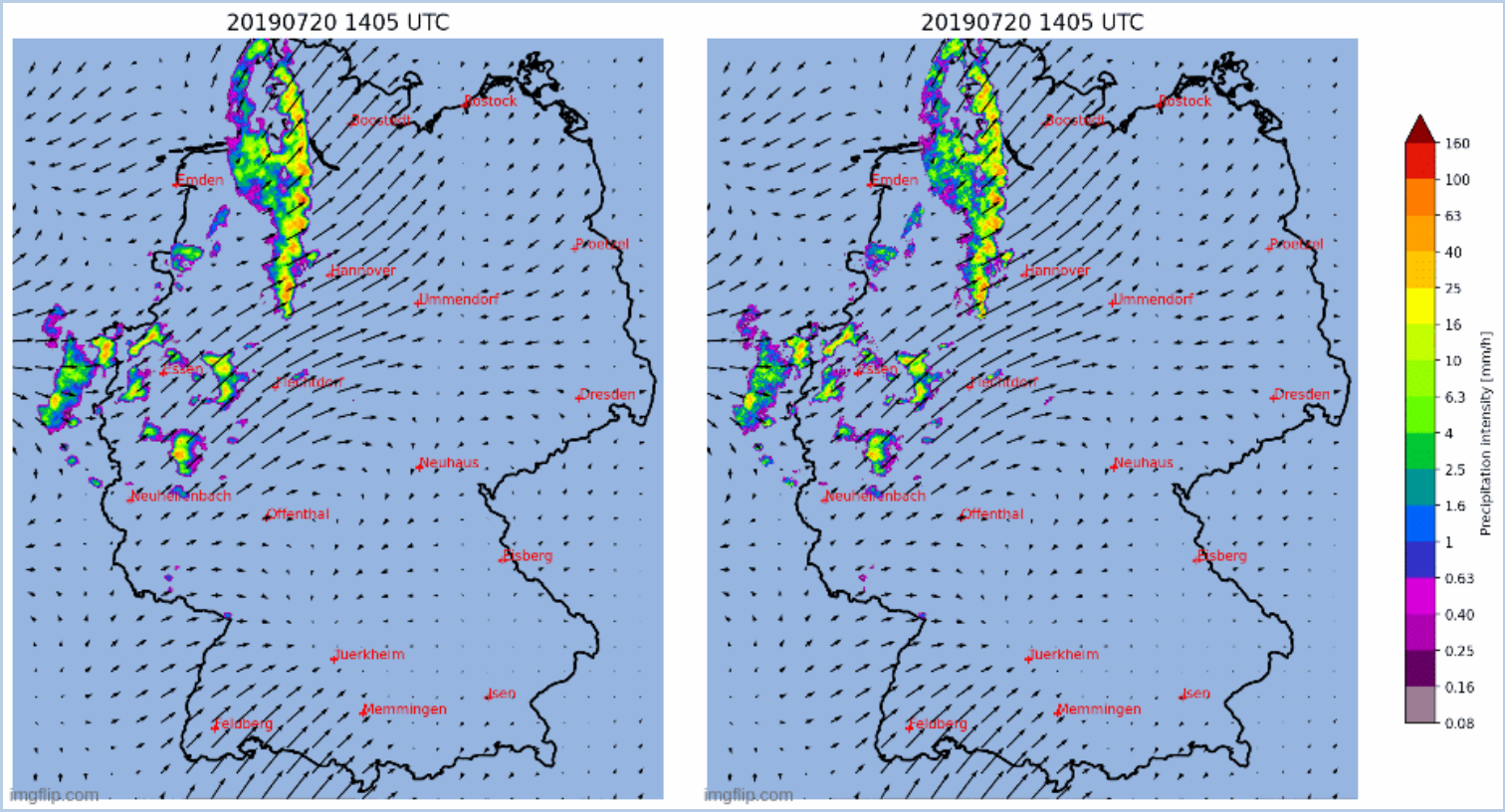
SPROG-LOC



P2-Phase II

P2-Phase II: STEPS vs STEPS-LOC

STEPS **STEPS-LOC**



P2-Phase II

Tasks for P2-Phase II:

- Benchmark over SPROG-LOC and STEPS-LOC over 120 days of C-band Radar data
- Evaluation of the new QPE's products uncertainties
- Detection and quantification of updrafts using Z-DR Columns and Size Sorting effect
- Feeding of a machine learning neural network by satellite observations to include Convection Initiation
- Detection of stratiform rain enhancement throught the study of K_{DP} between -10°C and -15°C

P2-Phase II

Tasks for P2-Phase II:

- Benchmark over SPROG-LOC and STEPS-LOC over 120 days of C-band Radar data
- Evaluation of the new QPE's products uncertainties
- Detection and quantification of updrafts using Z-DR Columns and Size Sorting effect
- Feeding of a machine learning neural network by satellite observations to include Convection Initiation
- Detection of stratiform rain enhancement throught the study of K_{DP} between -10°C and -15°C

P2-Phase II

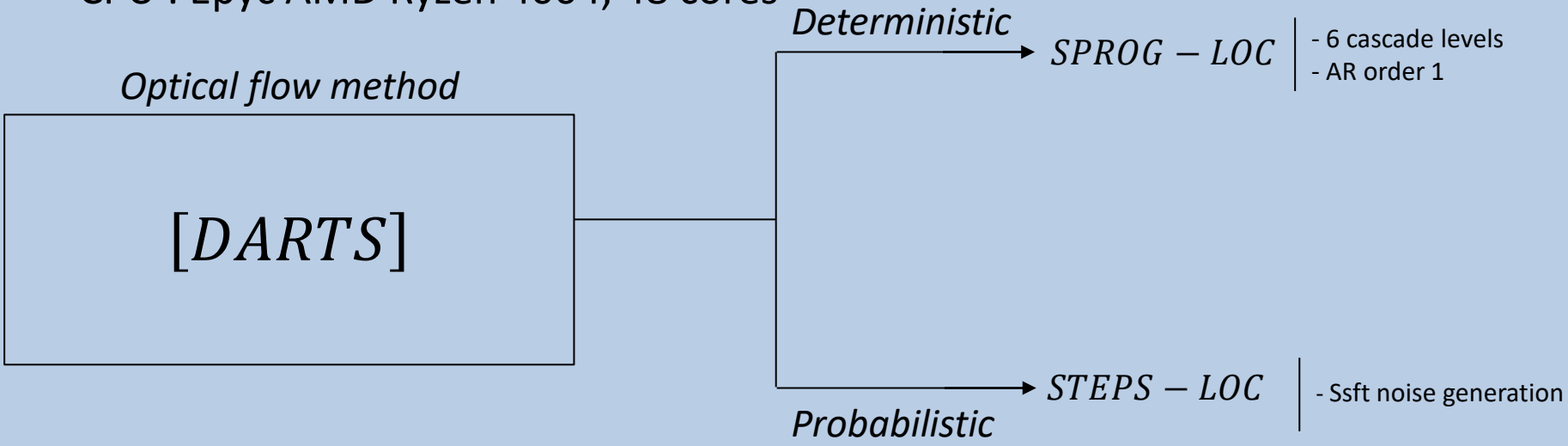
Tasks for P2-Phase II:

- Benchmark over SPROG-LOC and STEPS-LOC over 120 days of C-band Radar data
- Evaluation of the new QPE's products uncertainties
- Detection and quantification of updrafts using Z-DR Columns and Size Sorting effect
- Feeding of a machine learning neural network by satellite observations to include Convection Initiation
- Detection of stratiform rain enhancement throught the study of K_{DP} between -10°C and -15°C

Benchmark

Method for the benchmark:

- Nowcasting duration : 3 hours
- Amount of data : 120 days
- Frequency of Nowcasts : every 30 min
- CPU : Epyc AMD Ryzen 4004, 48 cores



P2-Phase II

Tasks for P2-Phase II:

- Benchmark over SPROG-LOC and STEPS-LOC over 120 days of C-band Radar data
- Evaluation of the new QPE's products uncertainties
- Detection and quantification of updrafts using Z-DR Columns and Size Sorting effect
- Feeding of a machine learning neural network by satellite observations to include Convection Initiation
- Detection of stratiform rain enhancement throught the study of K_{DP} between -10°C and -15°C

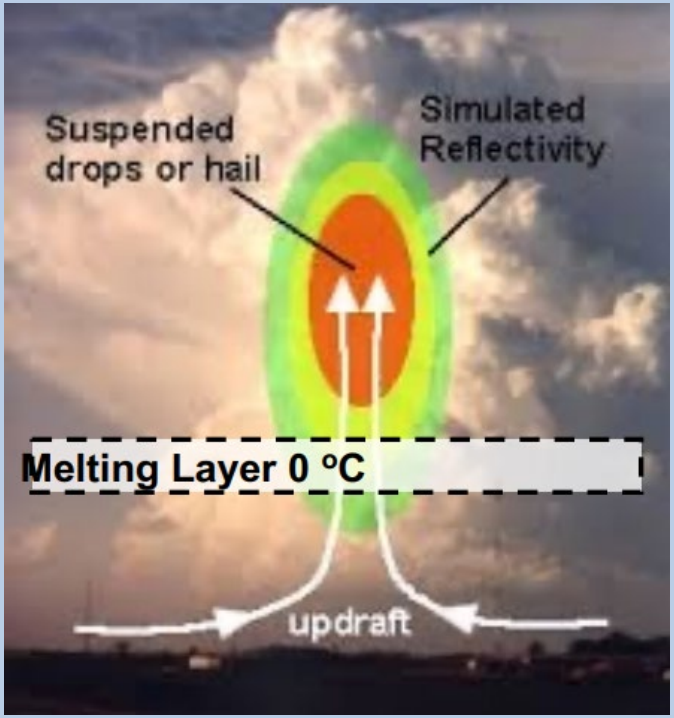
P2-Phase II

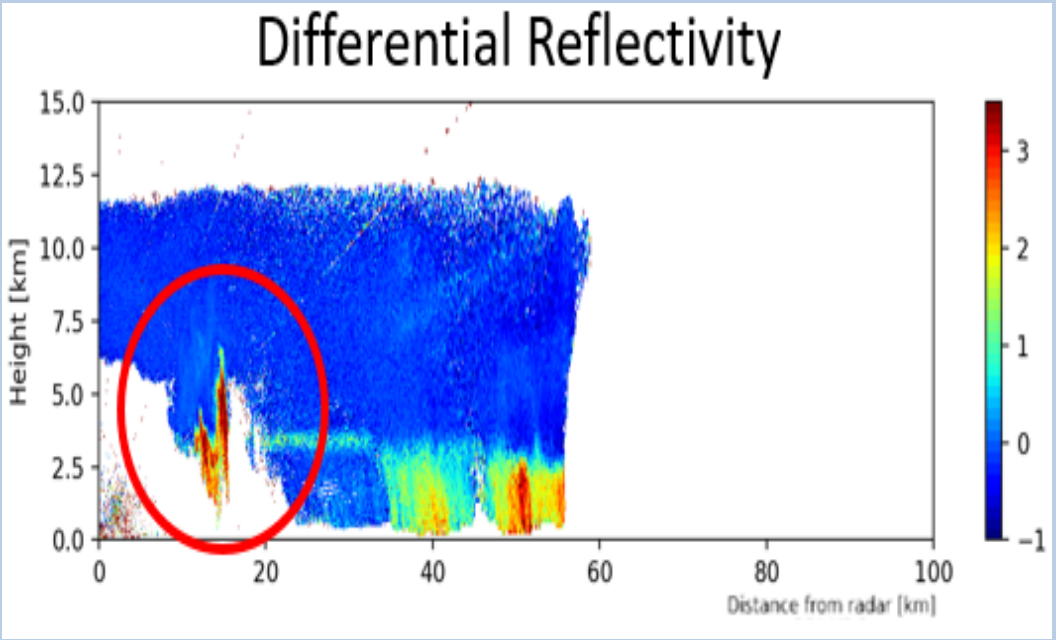
Tasks for P2-Phase II:

- Benchmark over SPROG-LOC and STEPS-LOC over 120 days of C-band Radar data
- Evaluation of the new QPE's products uncertainties
- Detection and quantification of updrafts using Z-DR Columns and Size Sorting effect
- Feeding of a machine learning neural network by satellite observations to include Convection Initiation
- Detection of stratiform rain enhancement throught the study of K_{DP} between -10°C and -15°C

P2-Phase I

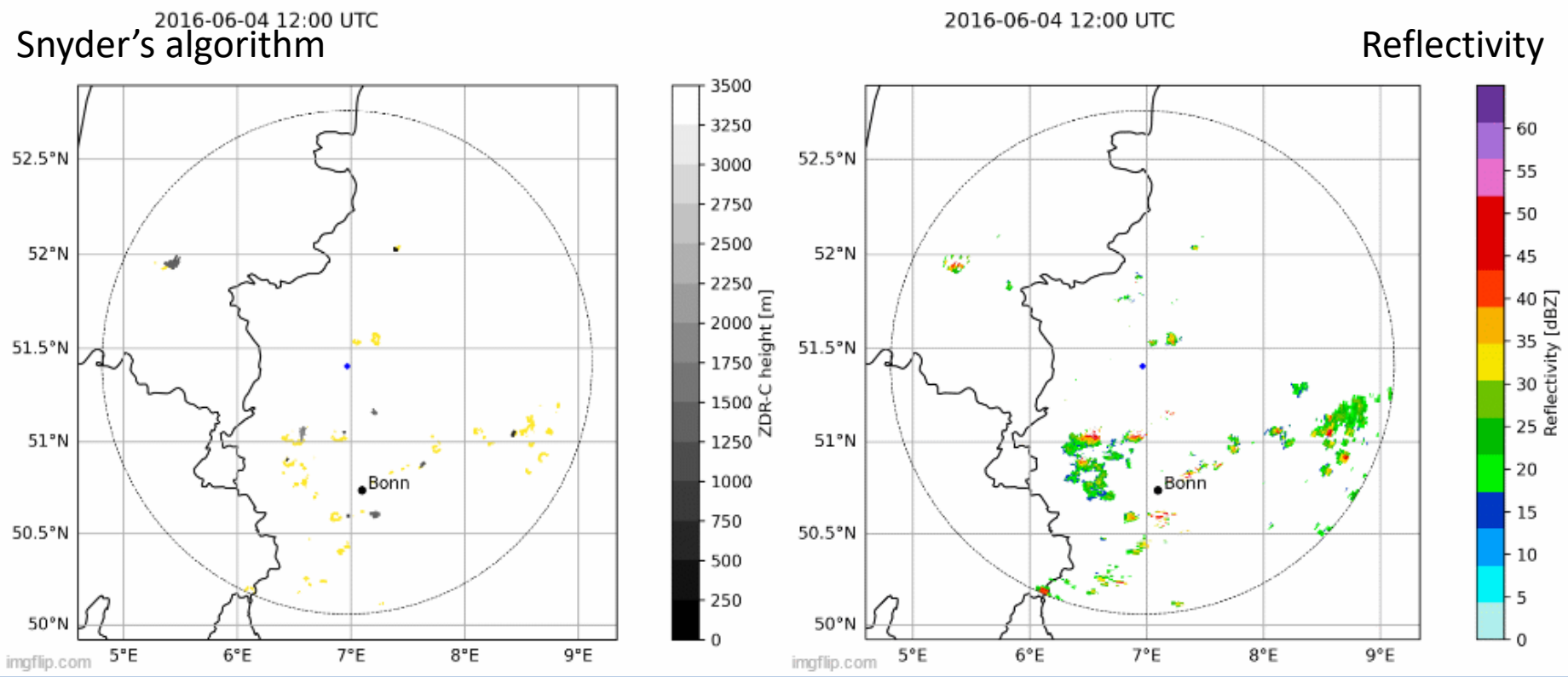
Detection of updrafts: Z-DR columns





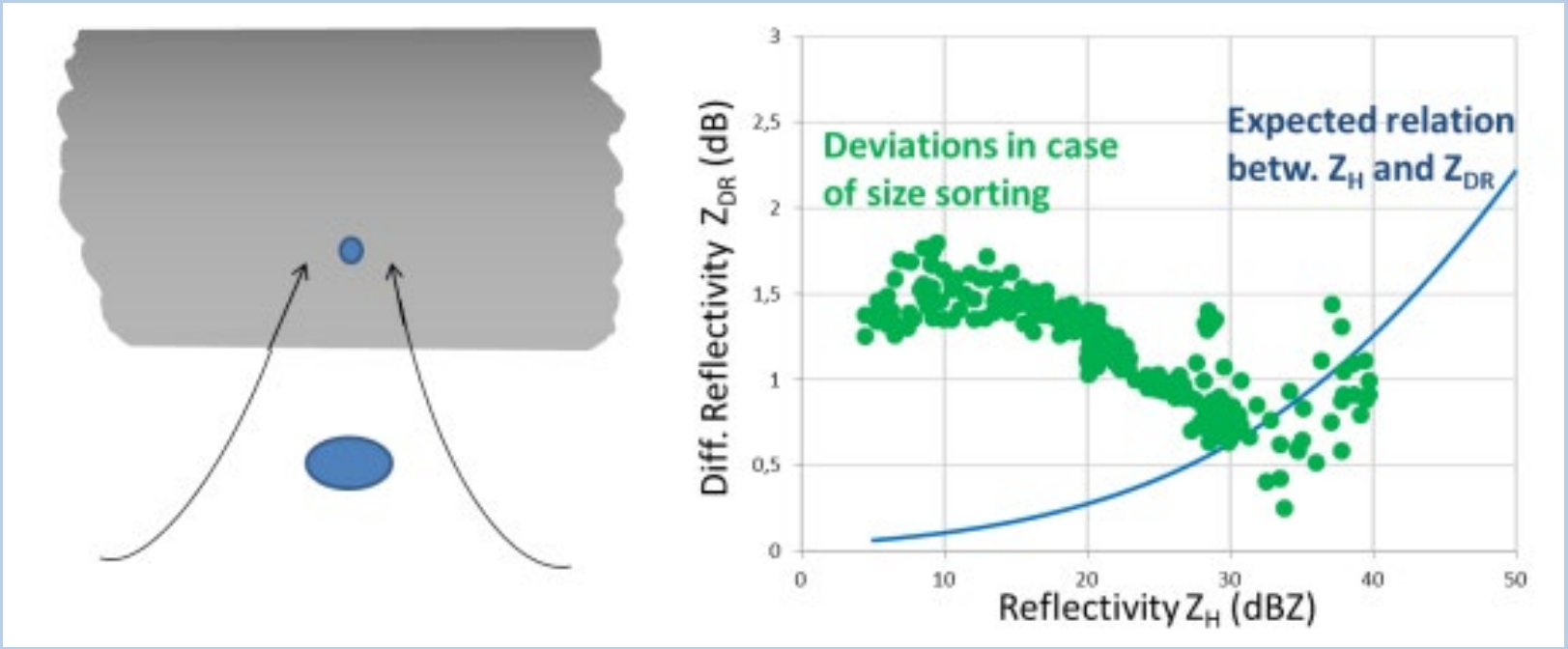
P2-Phase I

Detection of updrafts: Snyder's algorithm (2015)



P2-Phase II

Size Sorting detection:



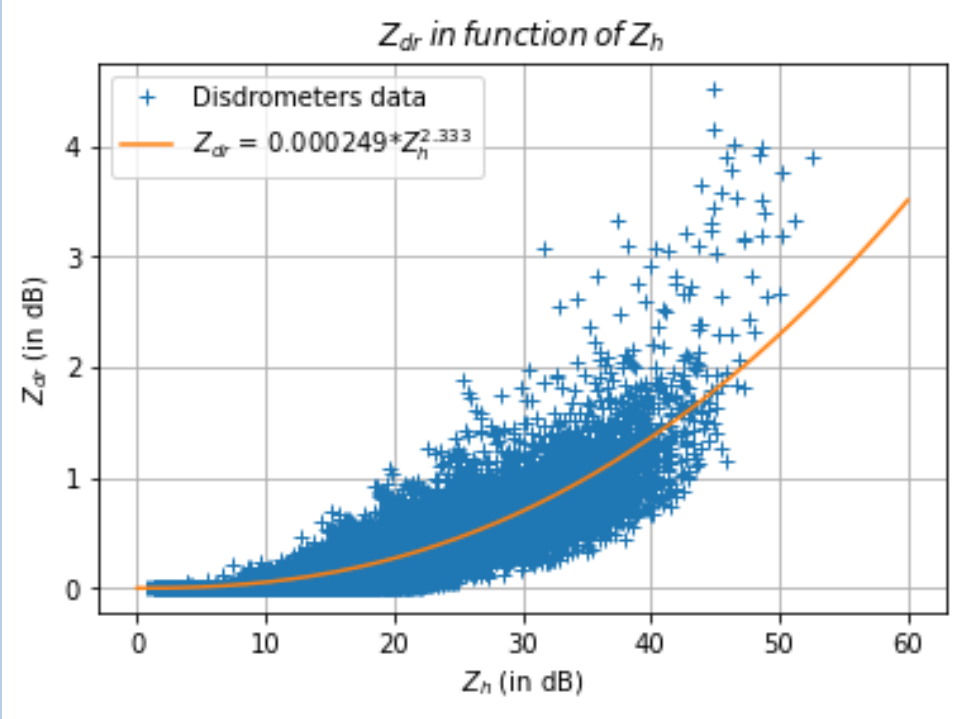
P2-Phase II

Algorithm for Size Sorting detection:

High values of Z_{dr} for relatively low values of Z_h.

Relation $Z_{dr} - Z_h$ (P1):

$$Z_{dr} = 2{,}49 * 10^{-4} * Z_h^{2{,}33}$$

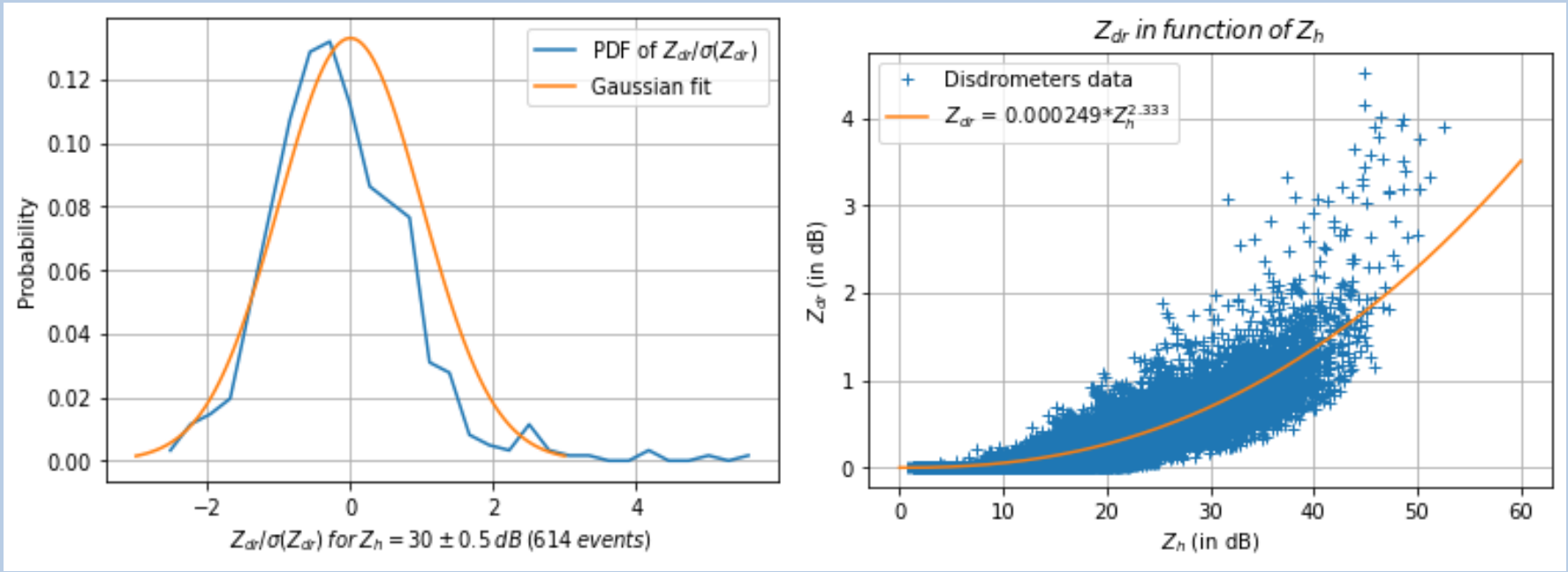


Juyu Chen et al, 2021 « *Assessing the Benefits of Specific Attenuation for Quantitative precipitation Estimation with a C-band Radar Network* »

P2-Phase II

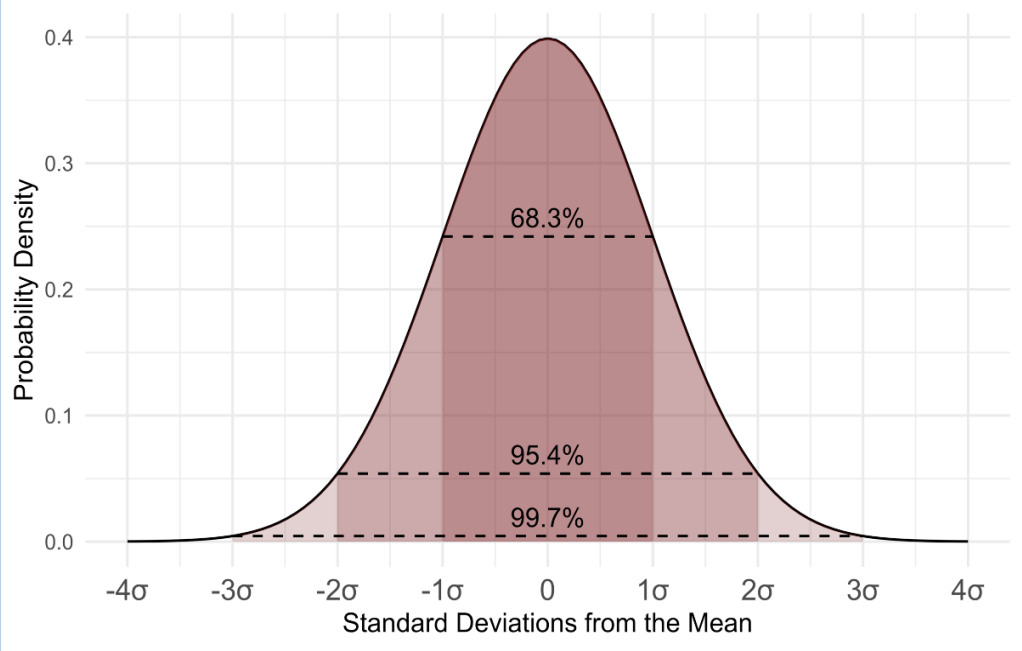
Z_{dr} statistical distribution:

PDF on $Z_h = 30\ dB$



P2-Phase II

Statistics and criterion for Size Sorting detection:



Gaussian distribution

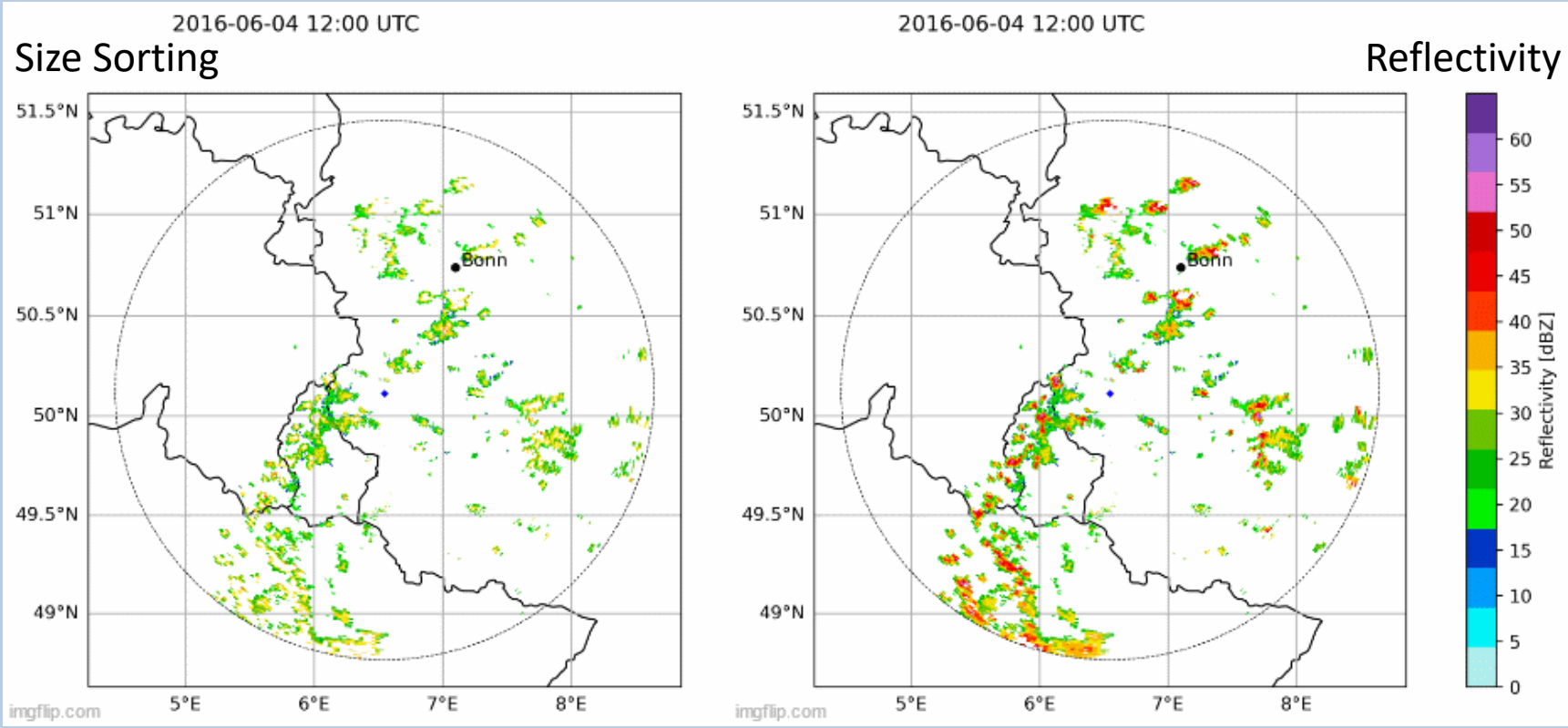
« Events in the area $\pm 3\sigma$ represent 99,7 % of the events »

Criterion of discrimination :

$$\boldsymbol{Z_{dr} \geq mean(Z_{dr}) + 3\sigma}$$

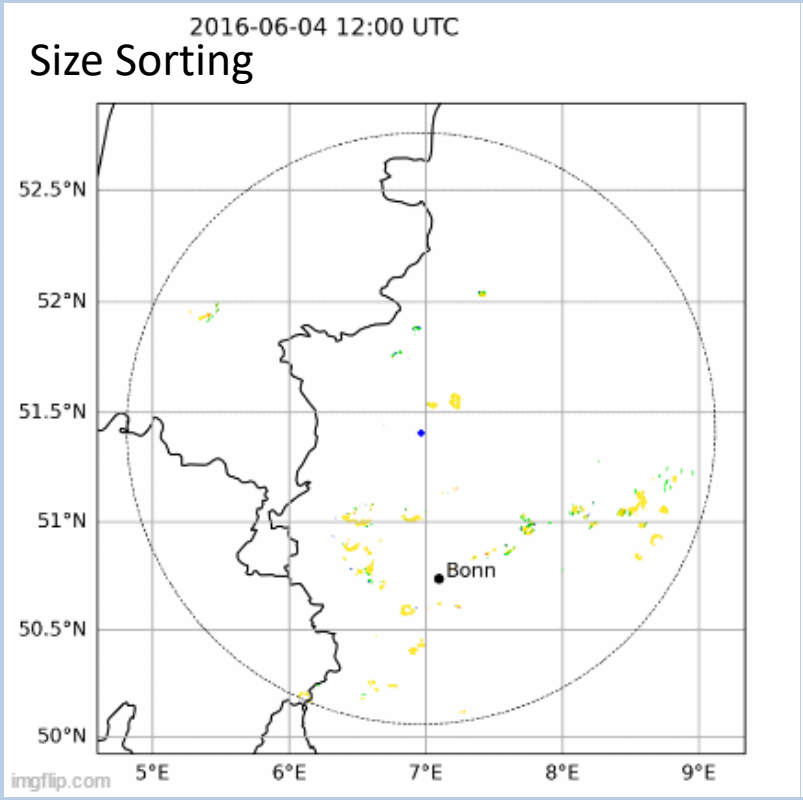
P2-Phase II

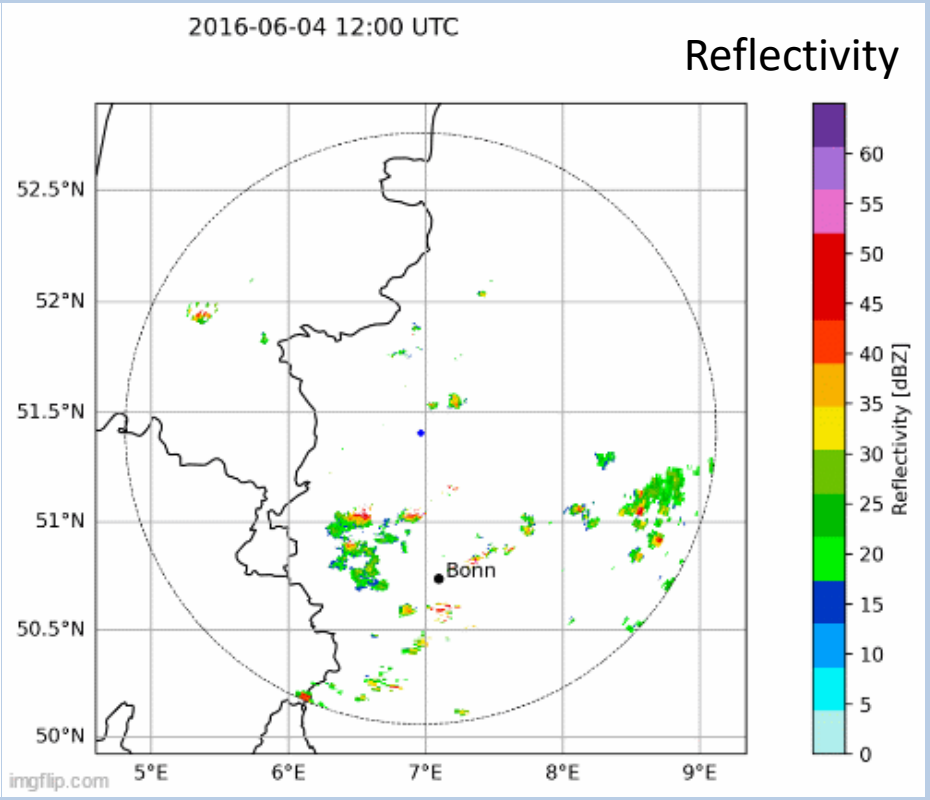
Size Sorting detection: Neuheilenbach Radar



P2-Phase II

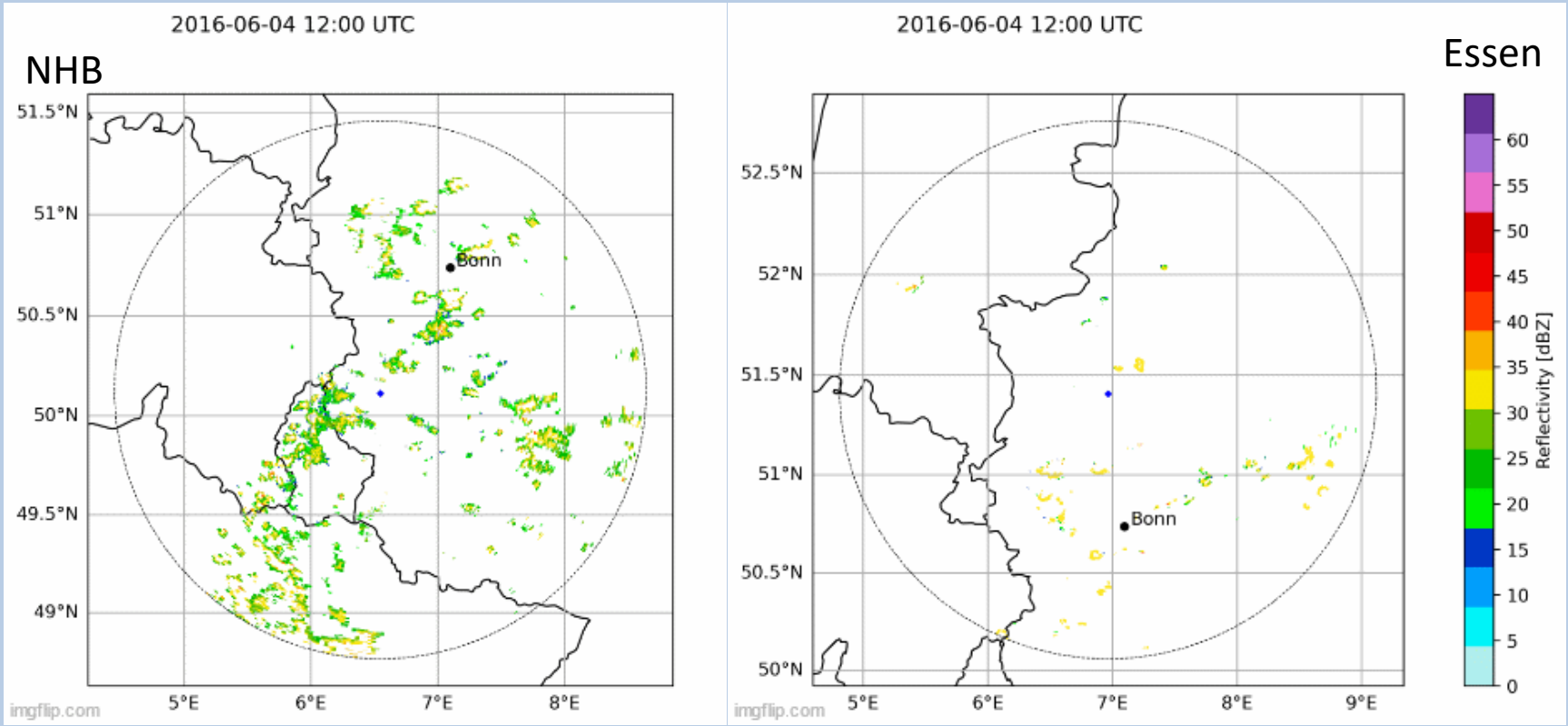
Size Sorting detection: Essen Radar





P2-Phase II

Neuheilenbach Radar vs Essen Radar



P2-Phase II

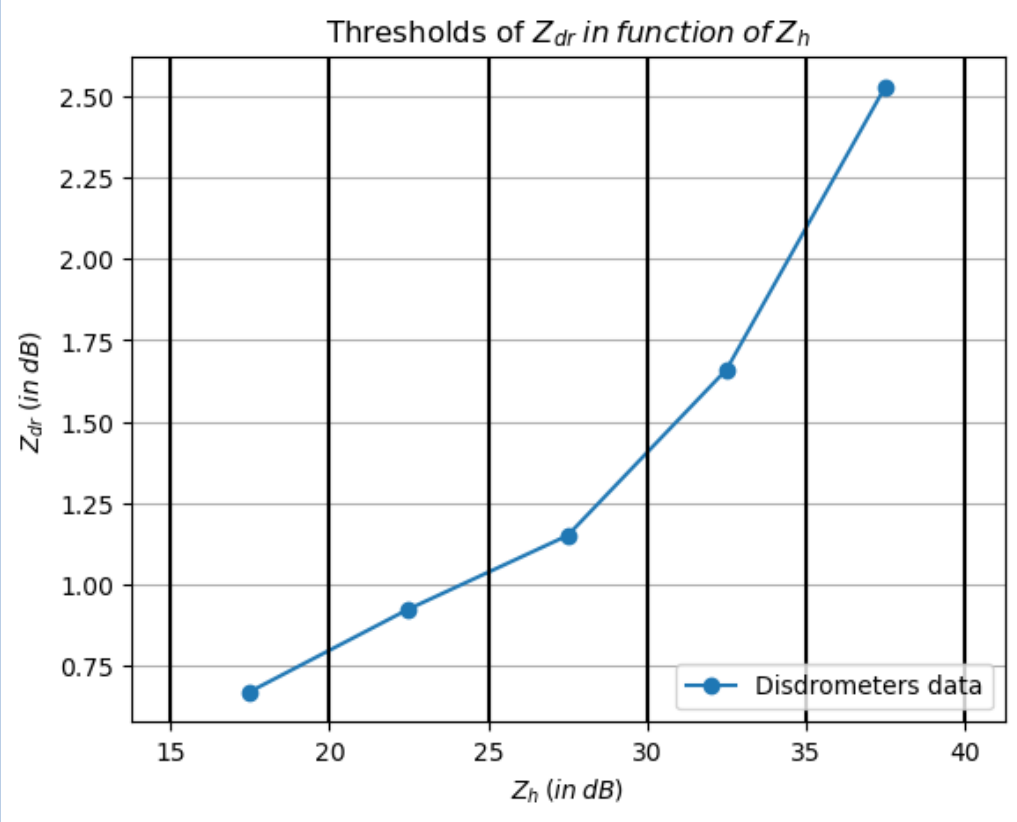
Thresholds and miscalibration issue:

Thresholds values used:

$$\boldsymbol{Z_{dr}} \geq mean(\boldsymbol{Z_{dr}}) + \boldsymbol{3}\sigma$$

$$\boldsymbol{Z_{dr}} = [0{,}67,\ 0{,}92,\ 1{,}15,\ 1{,}66,\ \ 2{,}53]$$

Uncertainty on $\boldsymbol{Z_{dr}}$: $\pm 0{,}2\ dB$

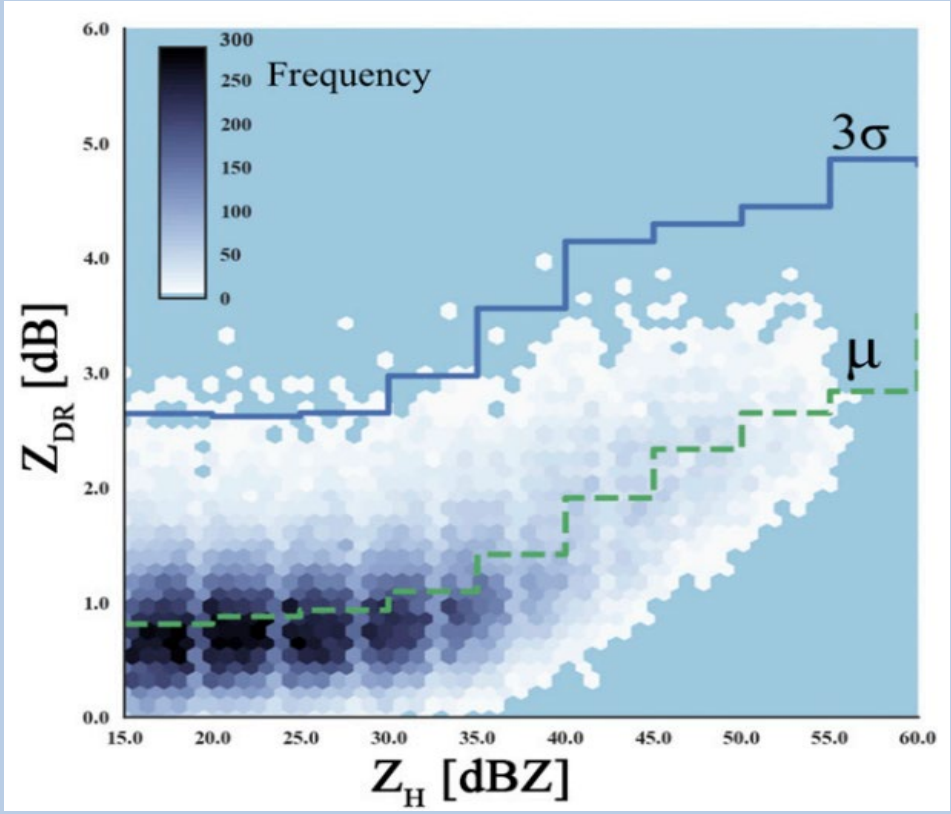


P2-Phase II

Thresholds and miscalibration issue:

An immune to miscalibration algorithm from:

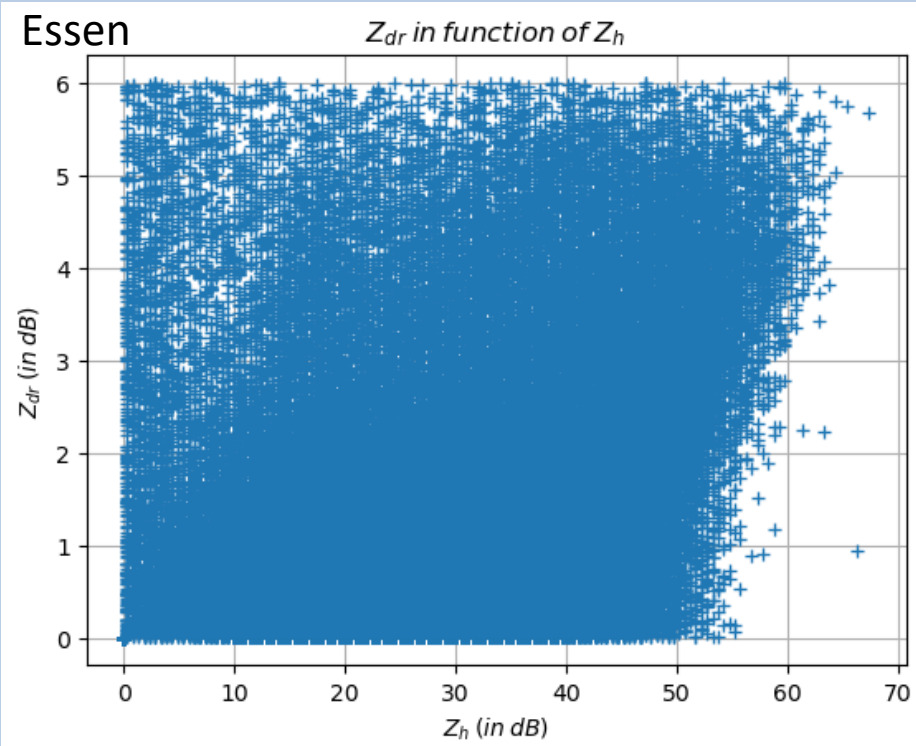
Darrel Kingfield et al, 2018

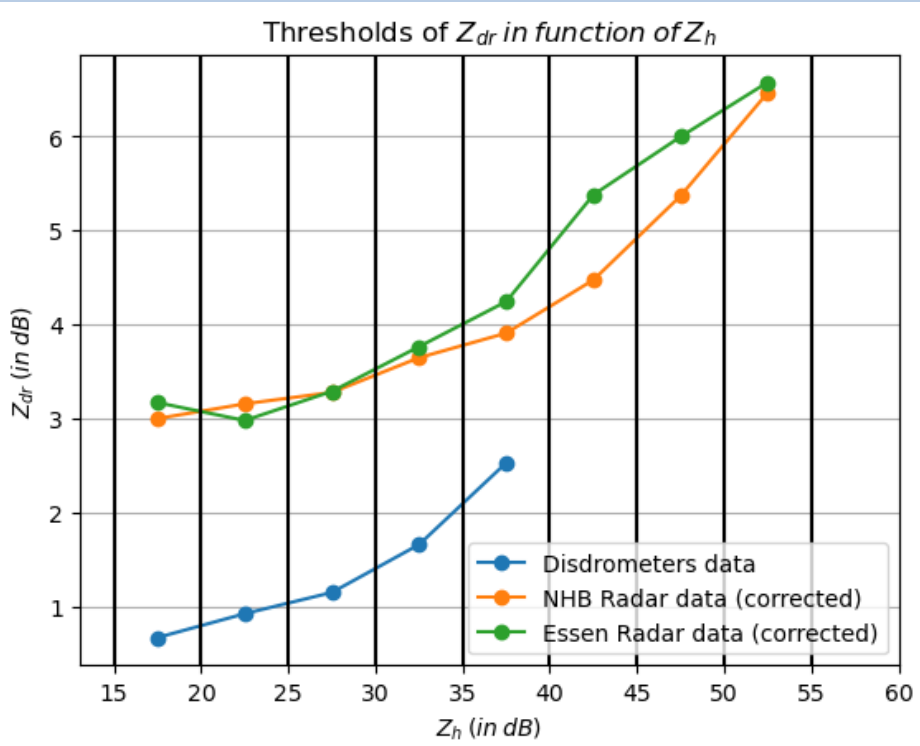


P2-Phase II

Immune to miscalibration algorithm:

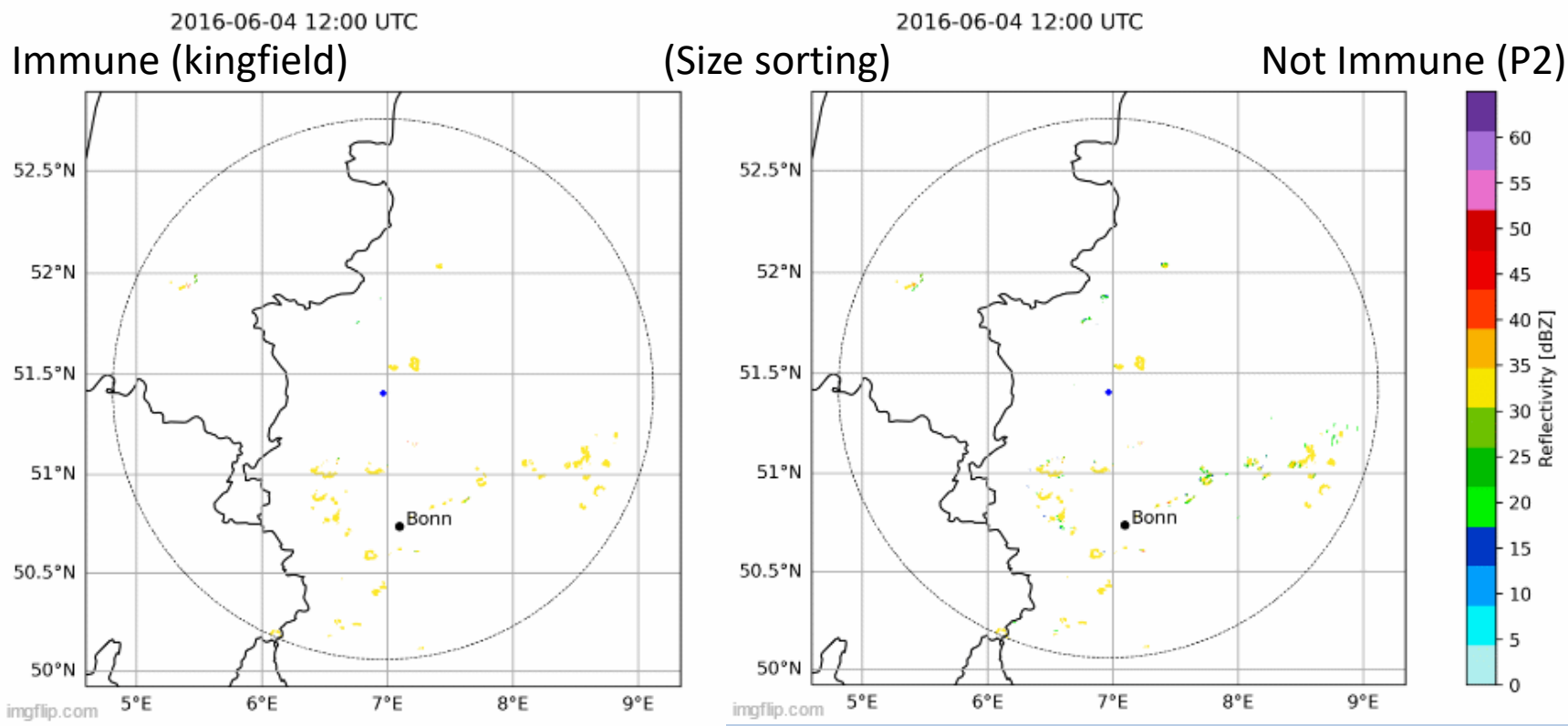
Essen





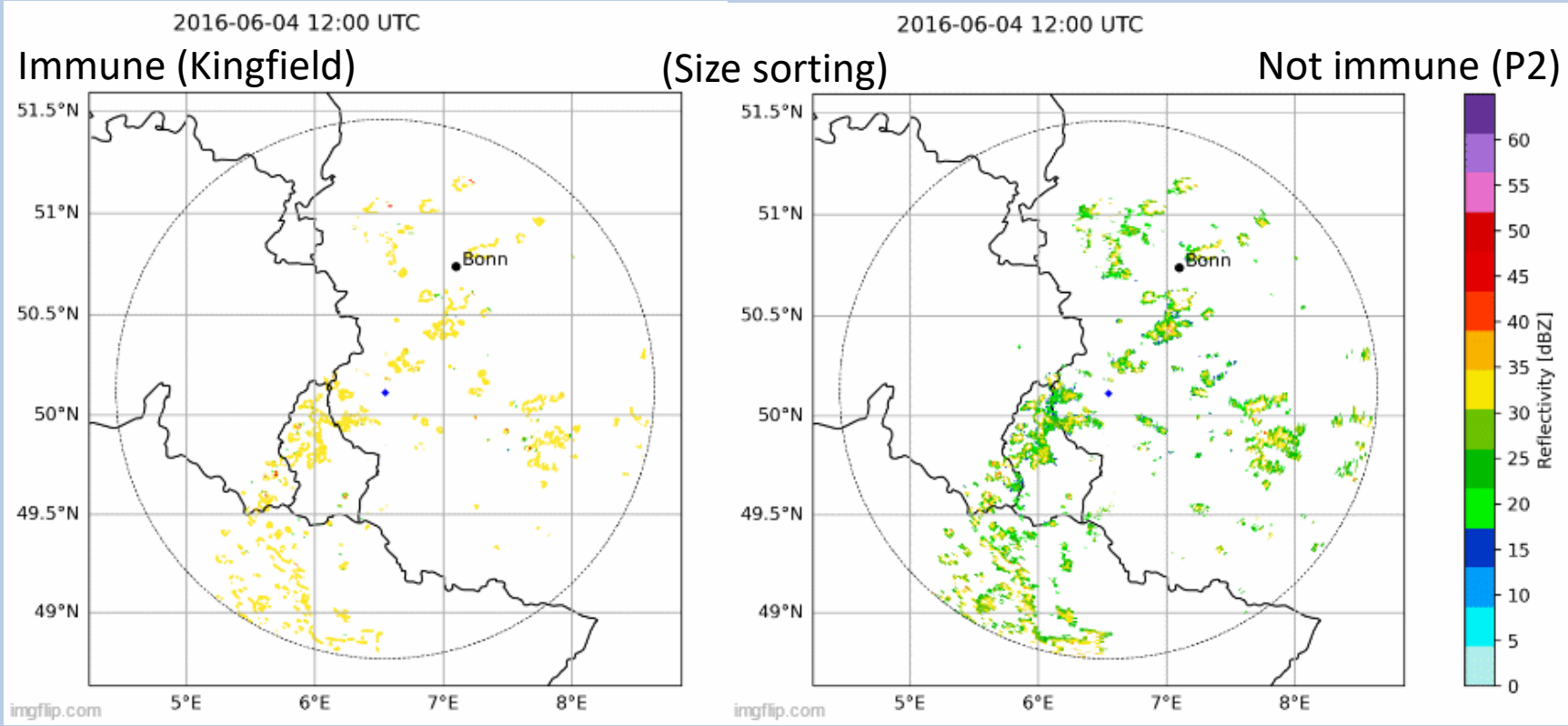
P2-Phase II

Kingfield's algorithm vs P2's algorithm (Essen):



P2-Phase II

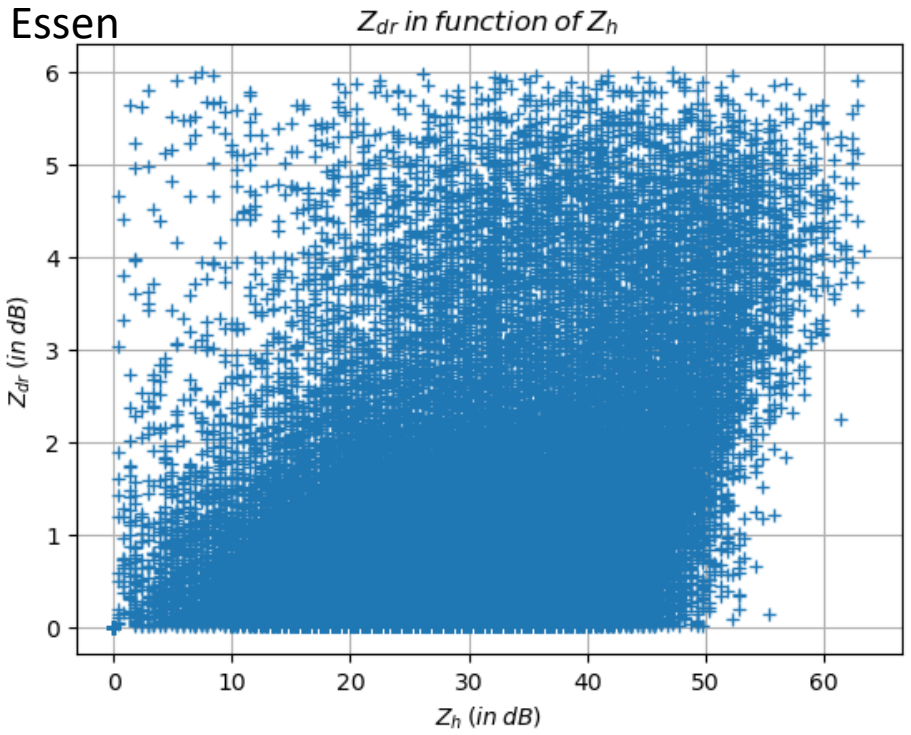
Kingfield's algorithm vs P2's algorithm (NHB):

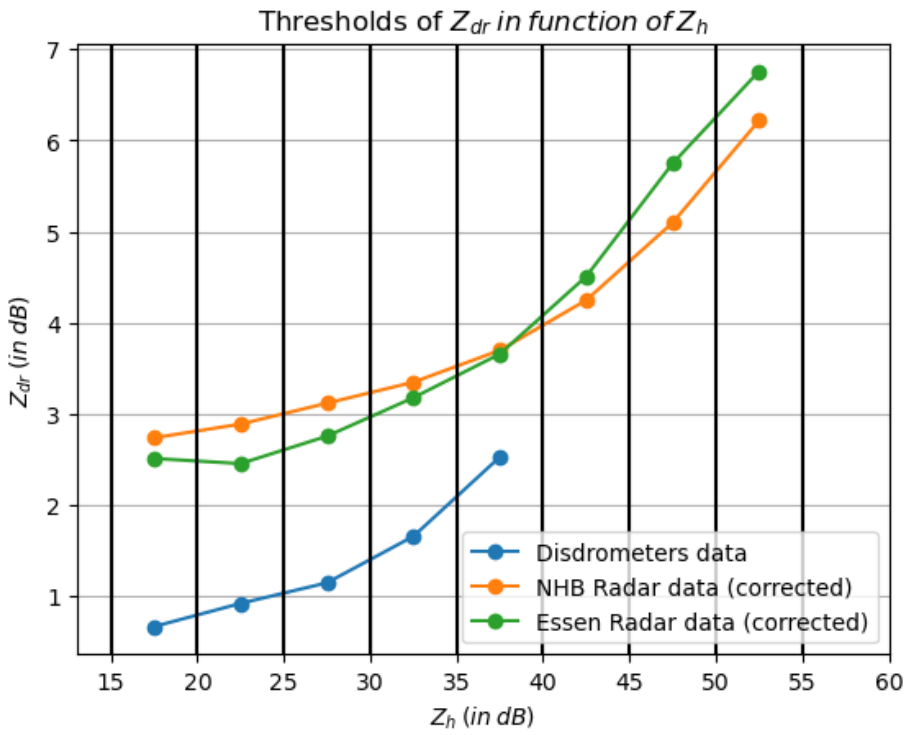


P2-Phase II

Kingfield's algorithm (cleaner):

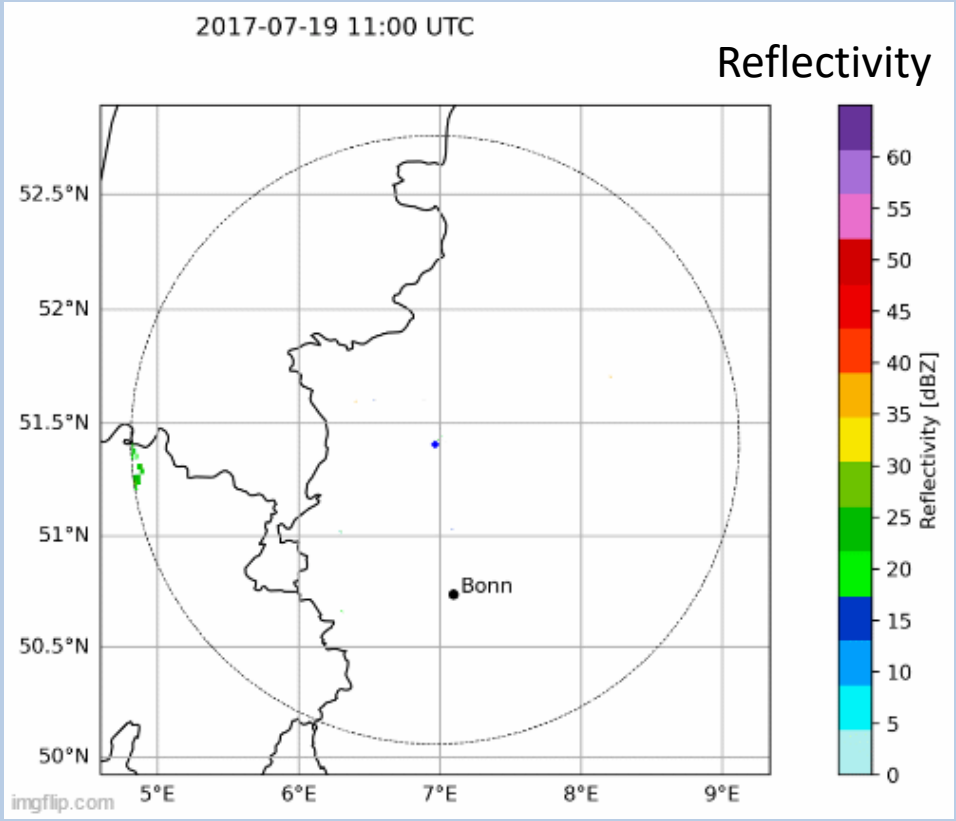
Essen





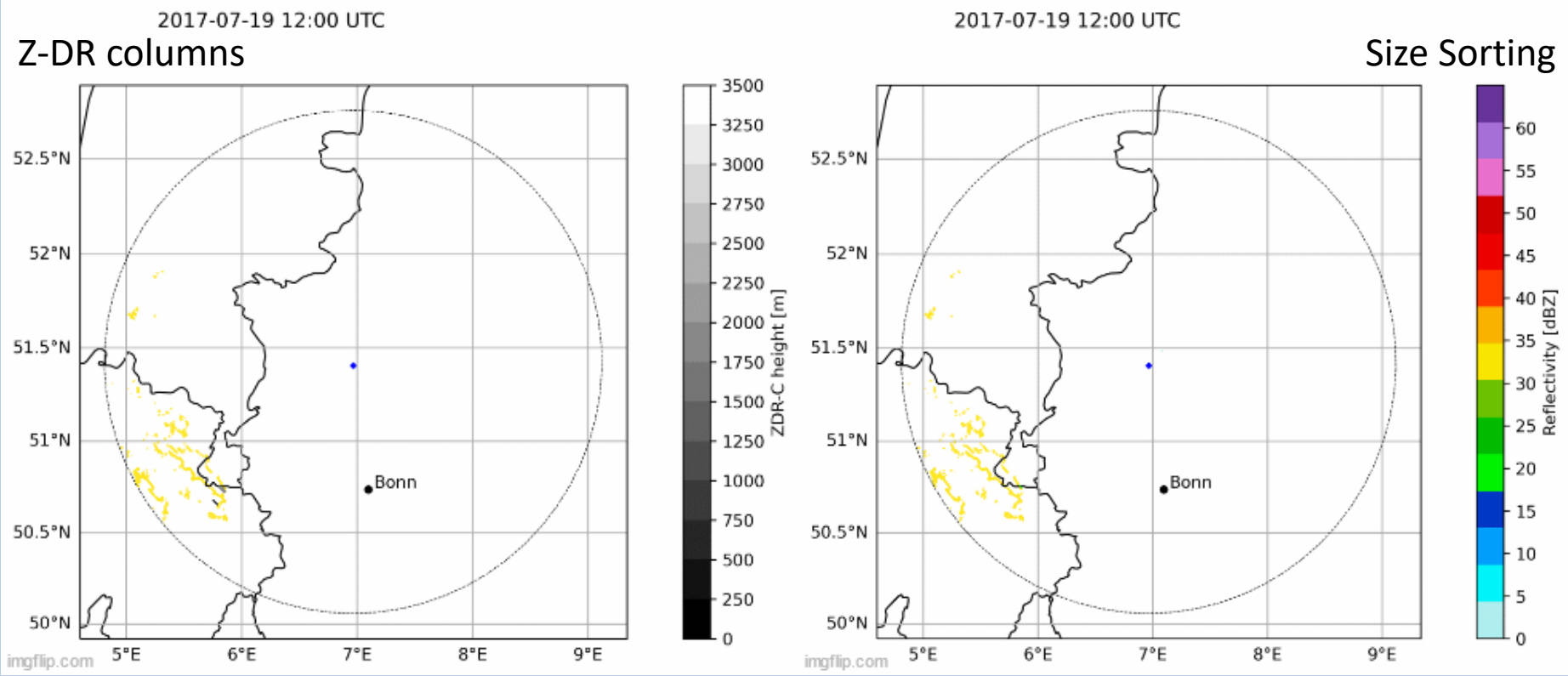
P2-Phase II

Kingfield's algorithm (cleaner):



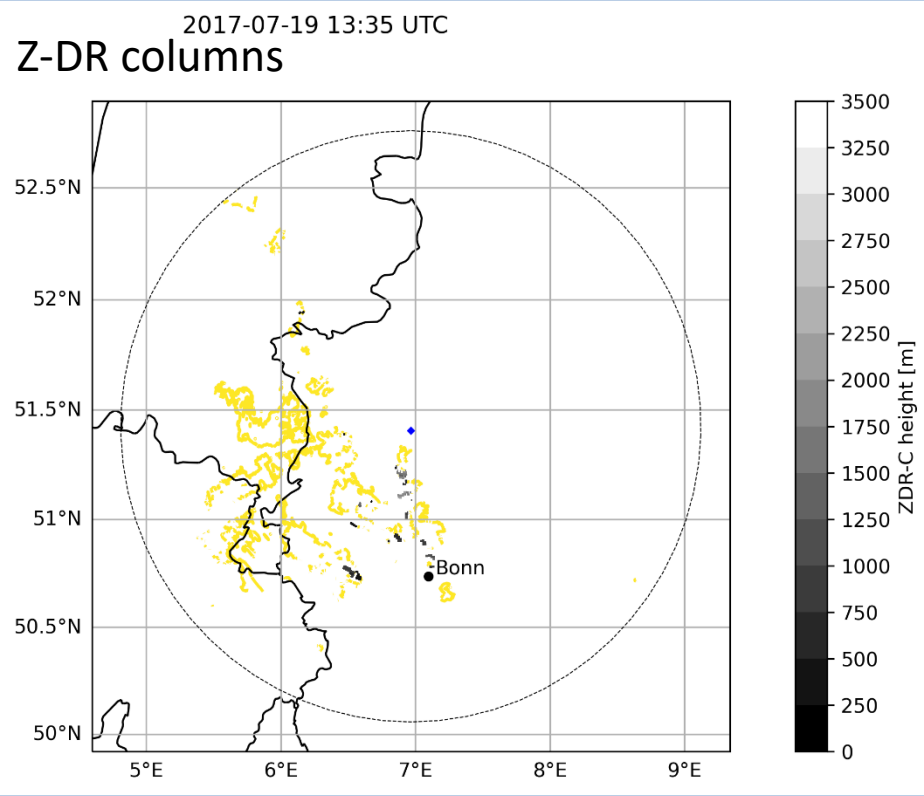
P2-Phase II

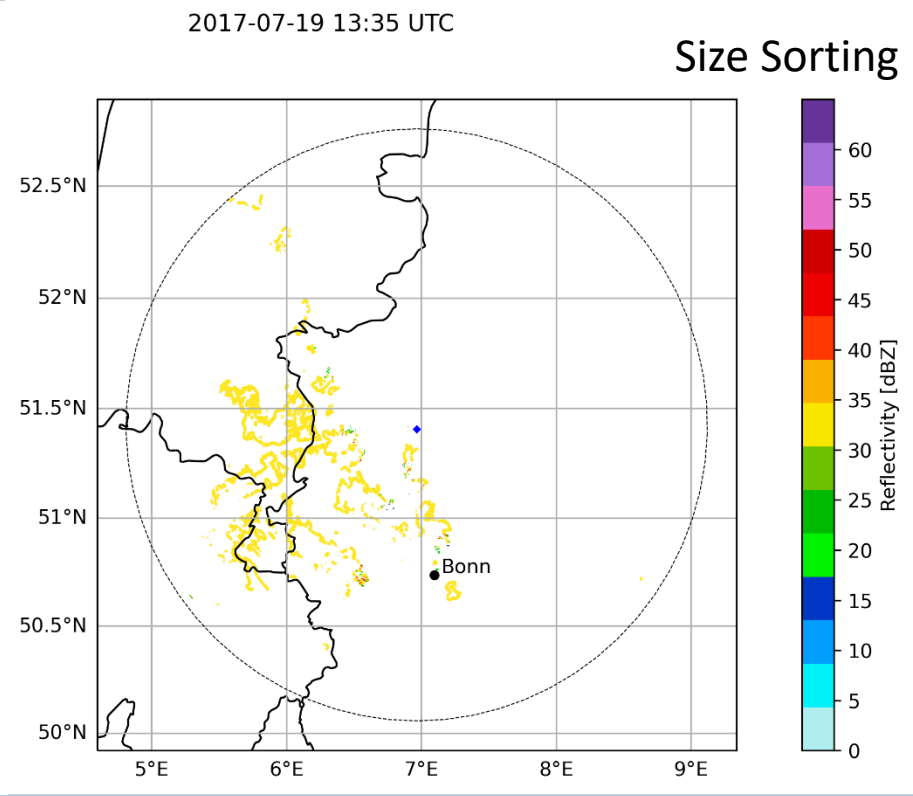
Kingfield's algorithm (cleaner):



P2-Phase II

Kingfield's algorithm (cleaner):





P2-Phase II

Tasks for P2-Phase II:

- Benchmark over SPROG-LOC and STEPS-LOC over 120 days of C-band Radar data
- Evaluation of the new QPE's products uncertainties
- Detection and quantification of updrafts using Z-DR Columns and Size Sorting effect
- Feeding of a machine learning neural network by satellite observations to include Convection Initiation
- Detection of stratiform rain enhancement throught the study of K_{DP} between -10°C and -15°C

Thank you for your attention

Questions

References

- *Darrel Kingfield et al , 2018. « Development of an Operational Convective Nowcasting Algorithm Using Raindrop Size Sorting Information from Polarimetric Radar Data »*

- *French et al, 2021. « Tornado Formation and Intensity Prediction Using Polametric Radar Estimates of Updraft area »*