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Monitoring of cloud radar stability with disdrometer

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CCRES Workshop, Heraklion, October 26th 2023

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Monitoring of cloud radar stability with disdrometer

Plan

- Methodology
  - Pre-processing and assumptions
  - Workflow
- Monitoring at SIRTA, Lindenberg and Juelich NF sites
  - 3 sites / 4 radars / 5 disdrometers
  - Long-term time series and variabilities
  - Statistical distributions
- Discussions
  - Quality check, filter
  - Outliers
  - Perspectives
- Instrumental setup requirement

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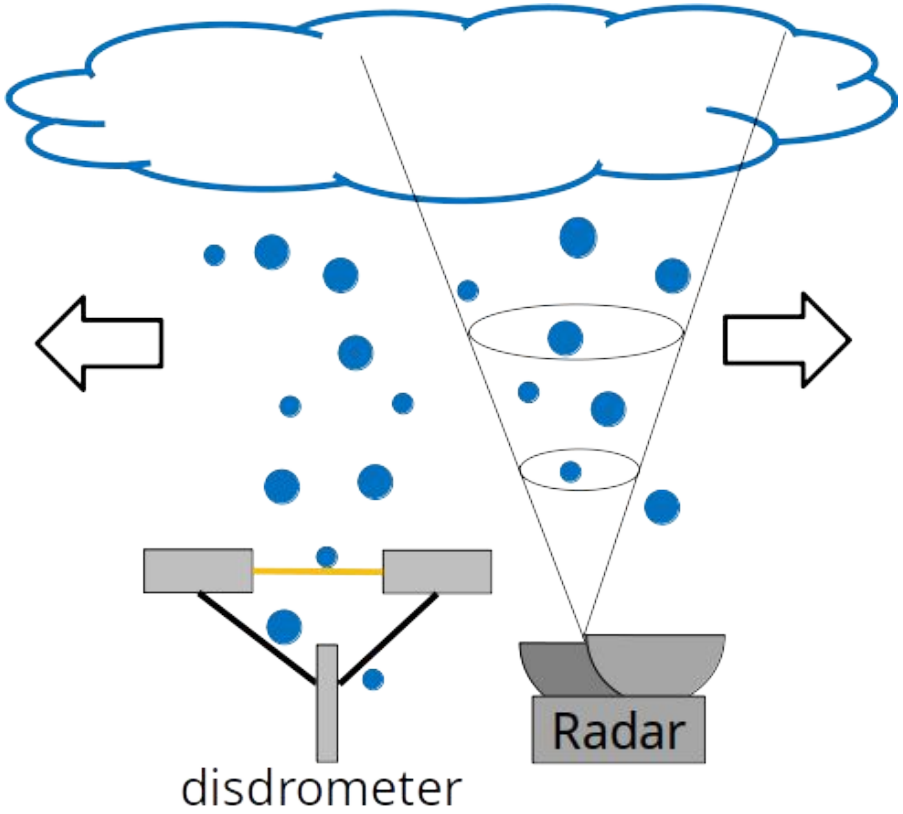
Monitoring of cloud radar stability with disdrometer

Doppler Cloud Radar calibration monitoring based on Disdrometer and radar reflectivity comparison method *

* *Kollias et al., 2019, AMT*
Myagkov et al., 2020, AMT
Chellini, et al., 2022, JGR Atmos

<u>Disdrometer:</u> Optical particle counter, provides N(D) i.e. the droplet size distribution during a rain.

- Forward modeling of **Ze** based on measured **N(D)**
- Compare forward simulated **Z_e(dis)** to **radar Z_e**



*<u>Radar :</u> Measures reflectivity (**Z_e**) of all drops in a volume*
***Z_e ~ N(D) D^6** (6th moment of the droplet size distribution)*

- Correction of **Z_e** for attenuation
- Compare **Z_e** to **Z_e(dis)** got from disdrometer data

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Instruments required for the computation of the calibration monitoring method

Disdrometer

Weather station

Radar

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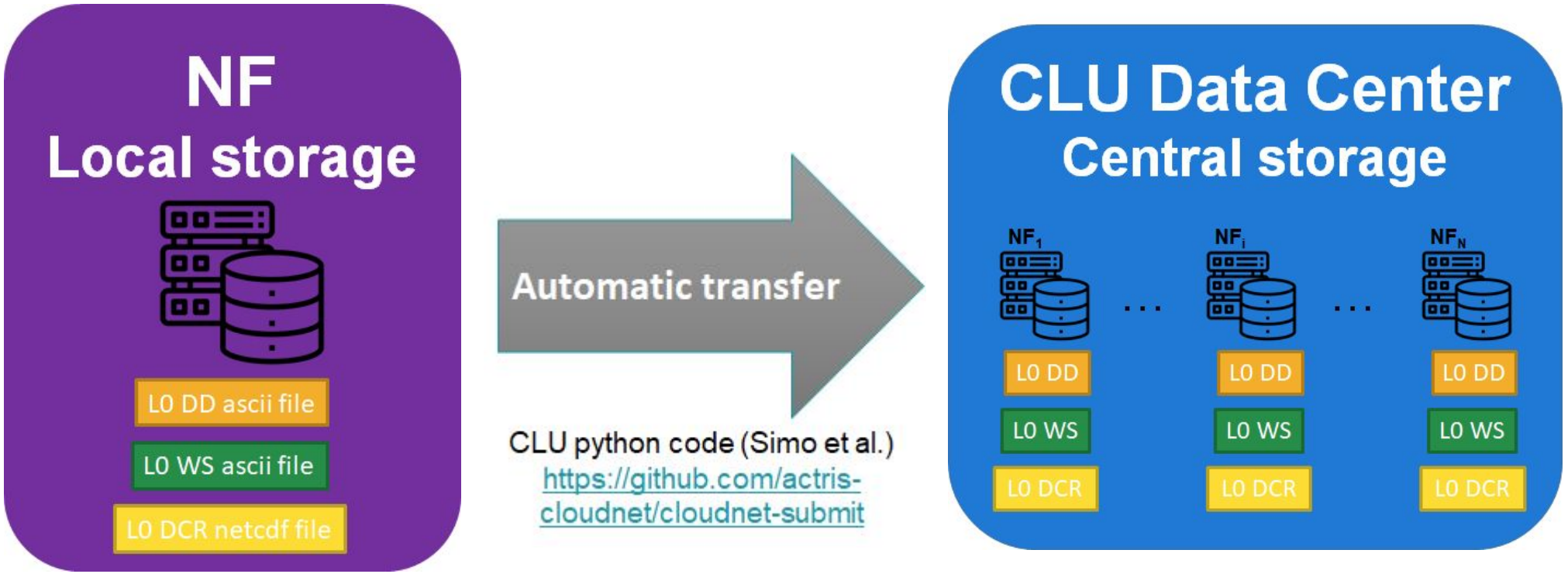
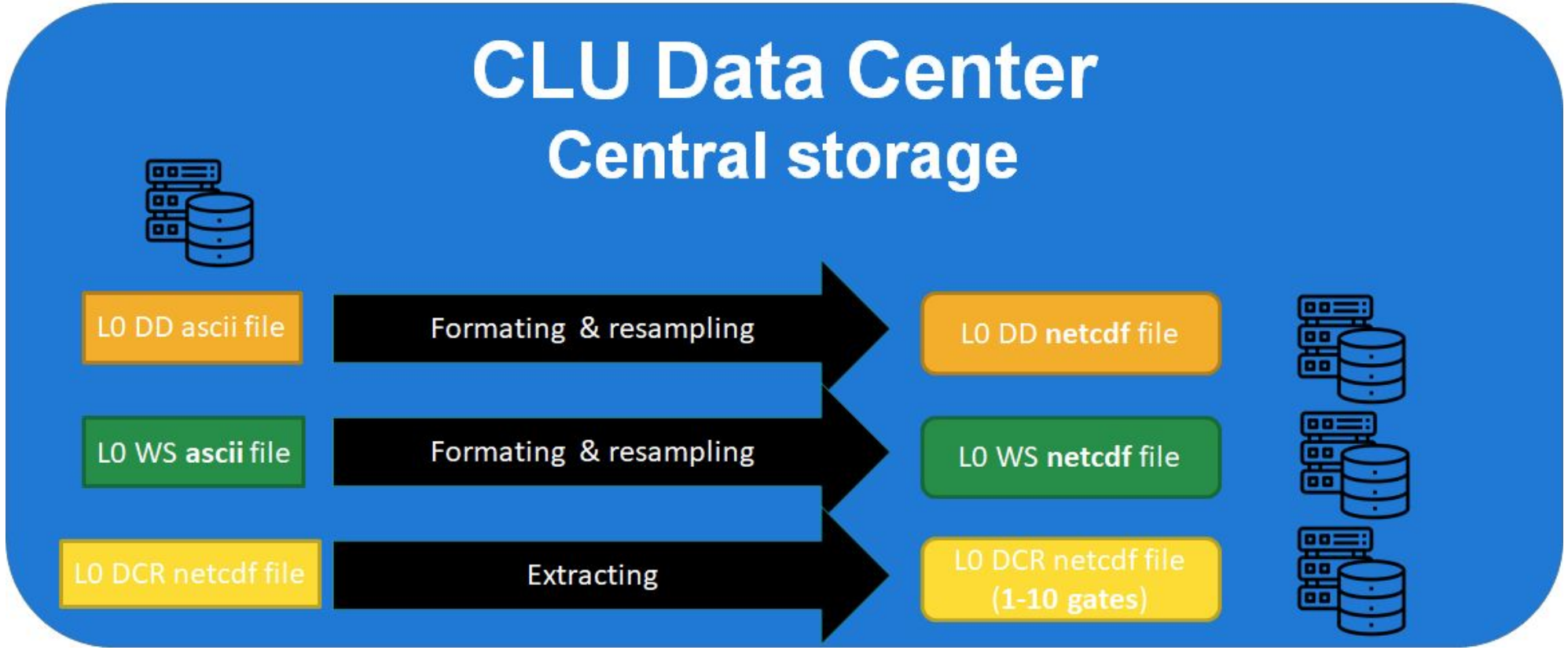
Data NF storage to CLU Data Center storage



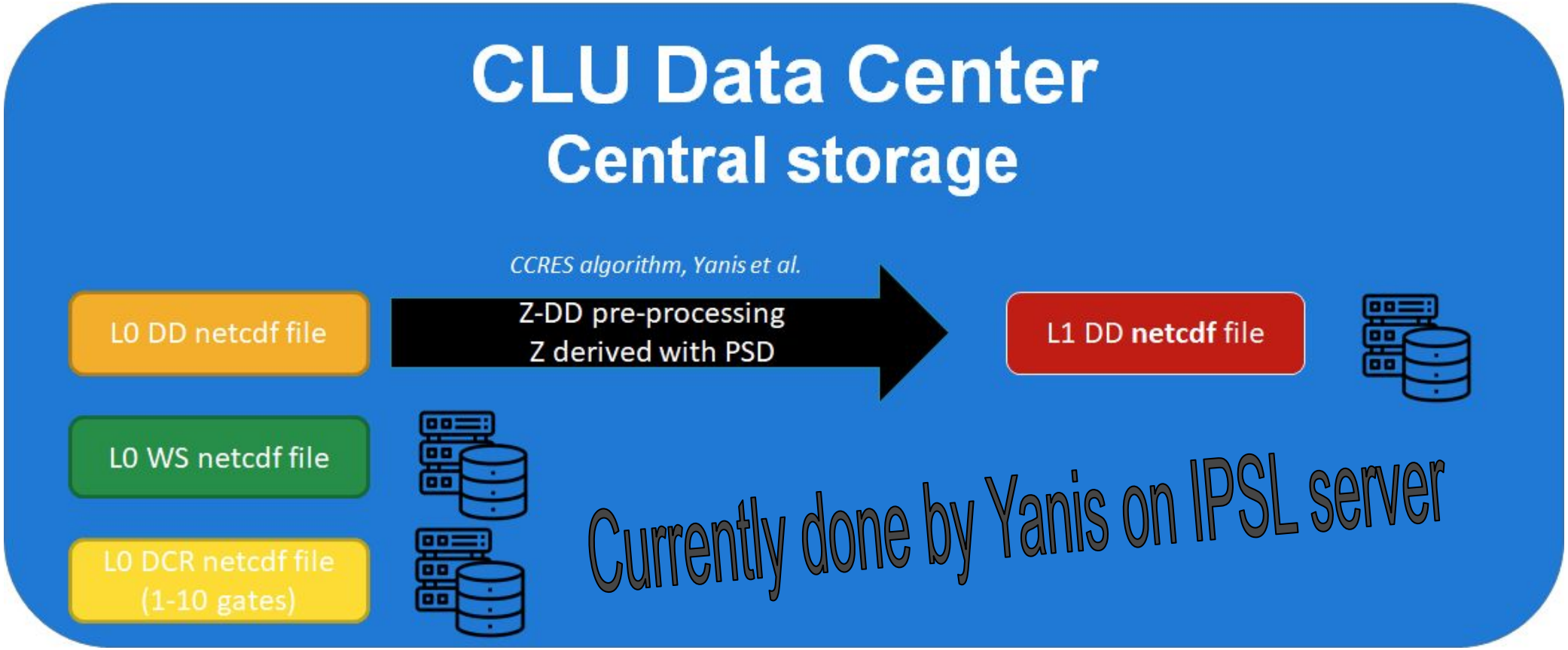
Monitoring of cloud radar stability with disdrometer

Formating & resampling at CLU Data Center



Monitoring of cloud radar stability with disdrometer

Z-DD pre-processing at CLU Data Center



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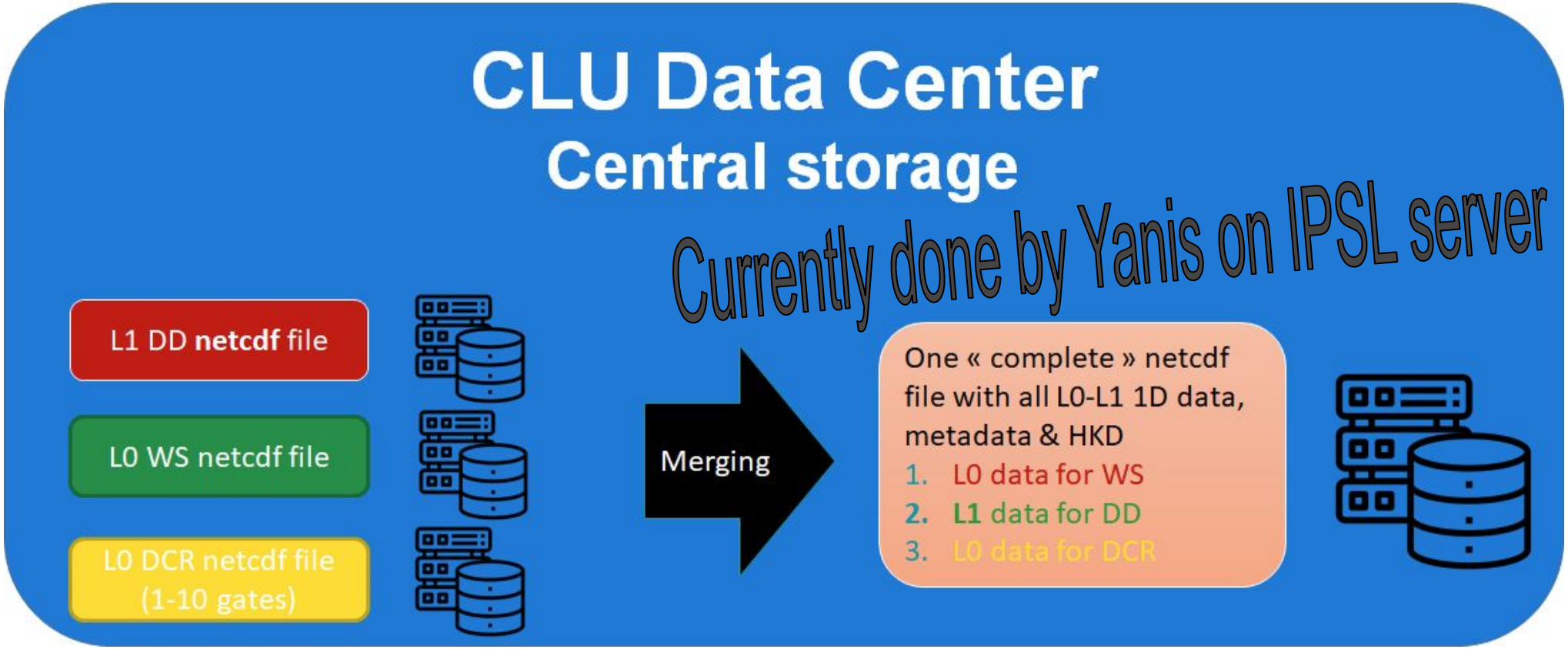
Z-DD processing at CLU Data Center



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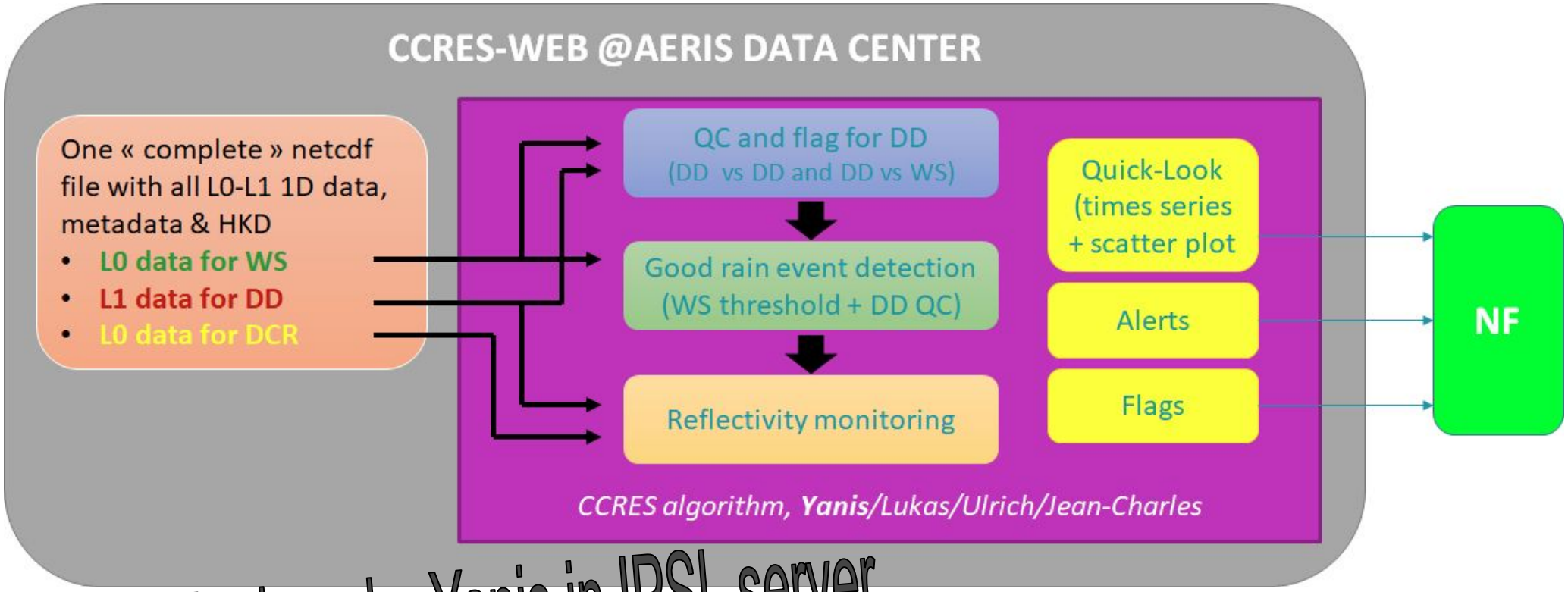
DCR-CC monitoring with CCRES algo @AERIS DC



Currently done by Yanis in IPSL server

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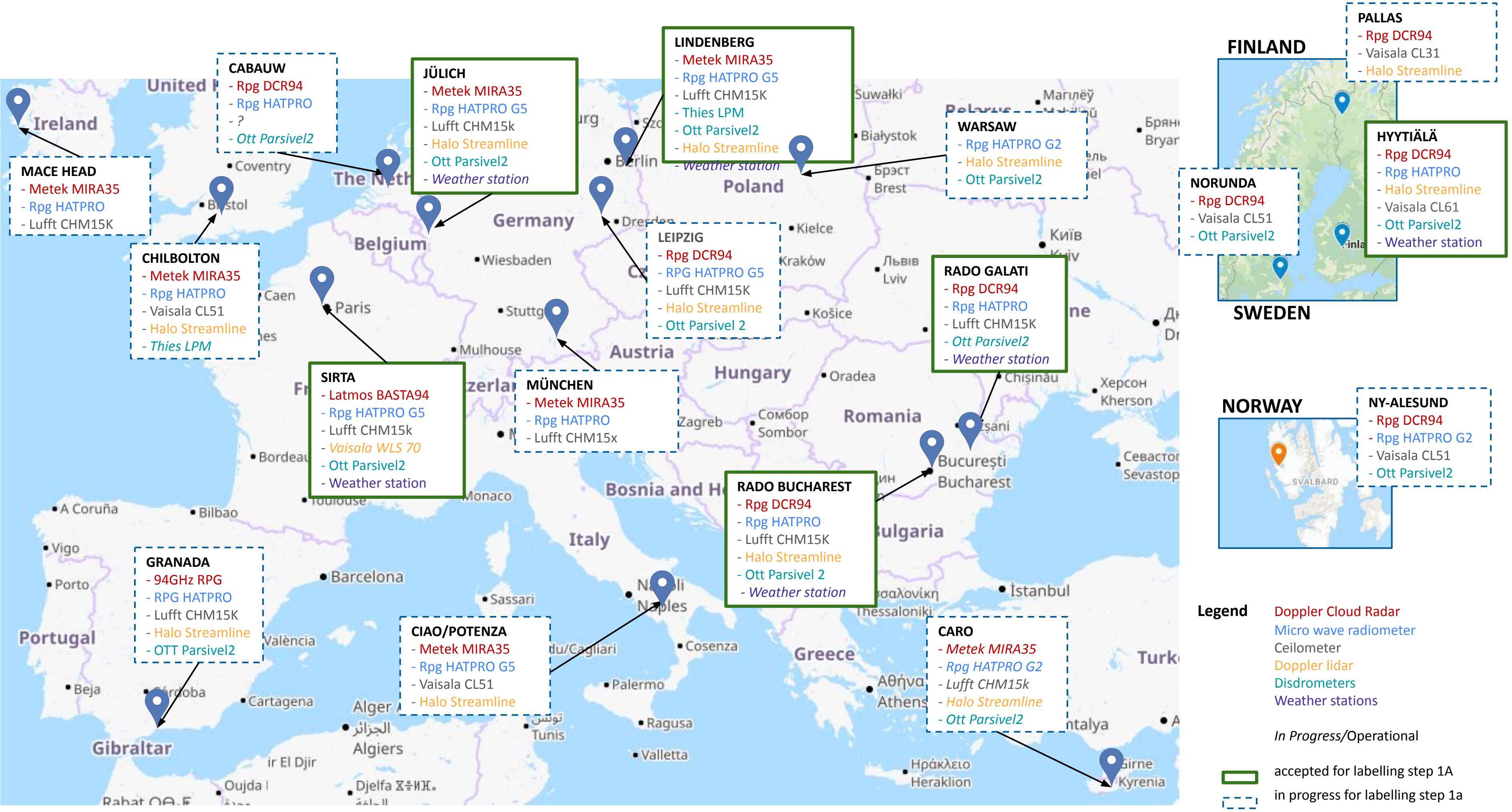
Monitoring of cloud radar stability with disdrometer

Methodology — *Processing, Workflow*

Monitoring — ***EU map**, Time series, PDF*

Discussions — *QC/Filter, Outliers, Perspectives*

Setup requirements



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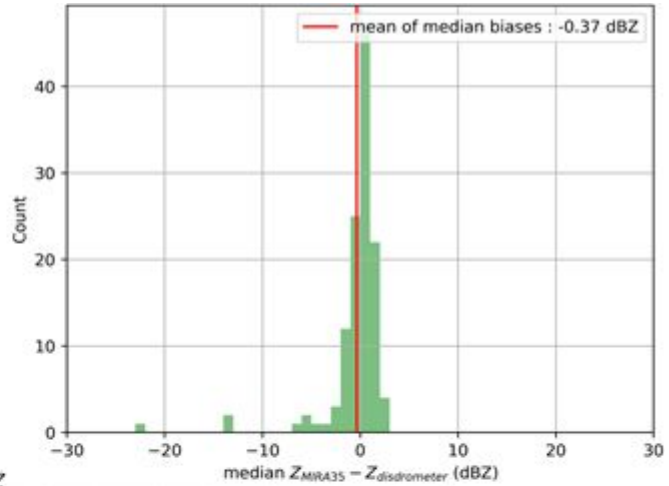
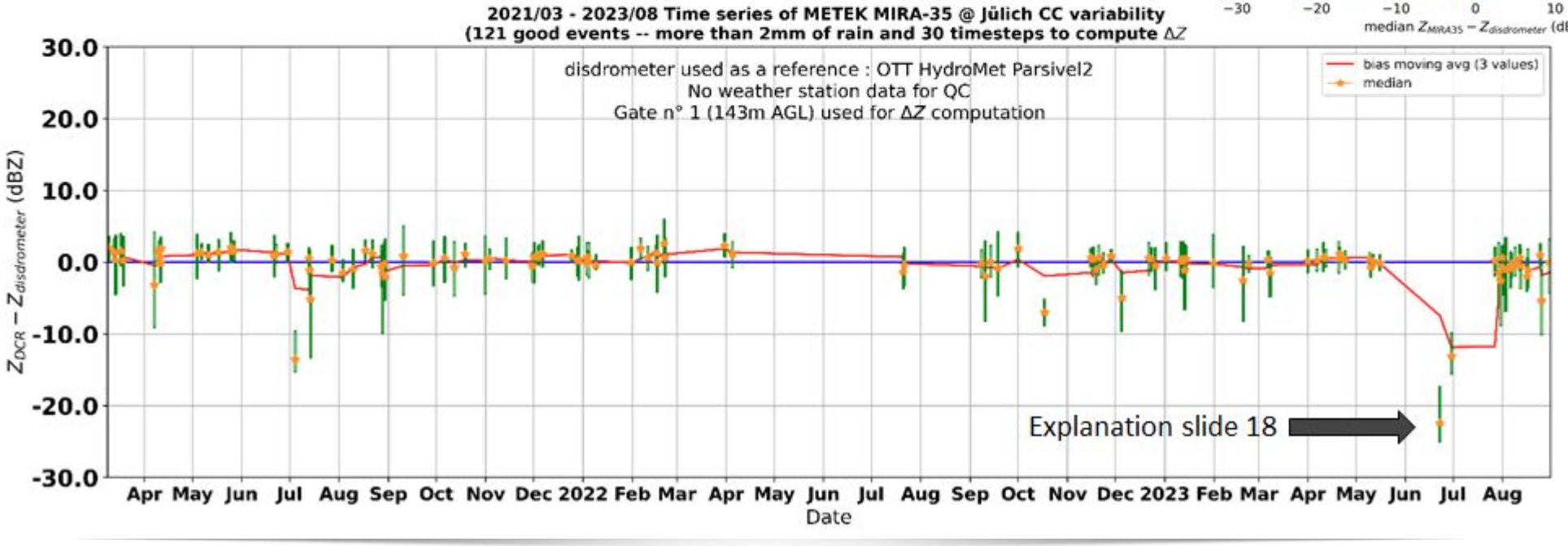
Monitoring of cloud radar stability with disdrometer

Methodology — *Processing, Workflow*
Monitoring — *EU map,* ***Time series, PDF***
Discussions — *QC/Filter, Outliers, Perspectives*
Setup requirements

METEK MIRA35
OTT Parsivel2

Message: No bias in DCR calibration constant over 2.5years



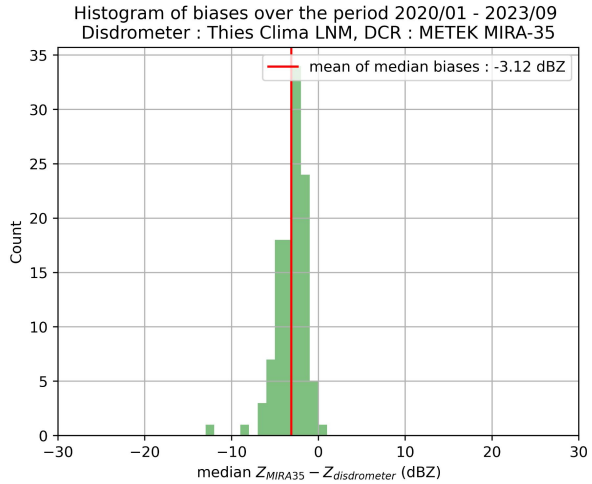


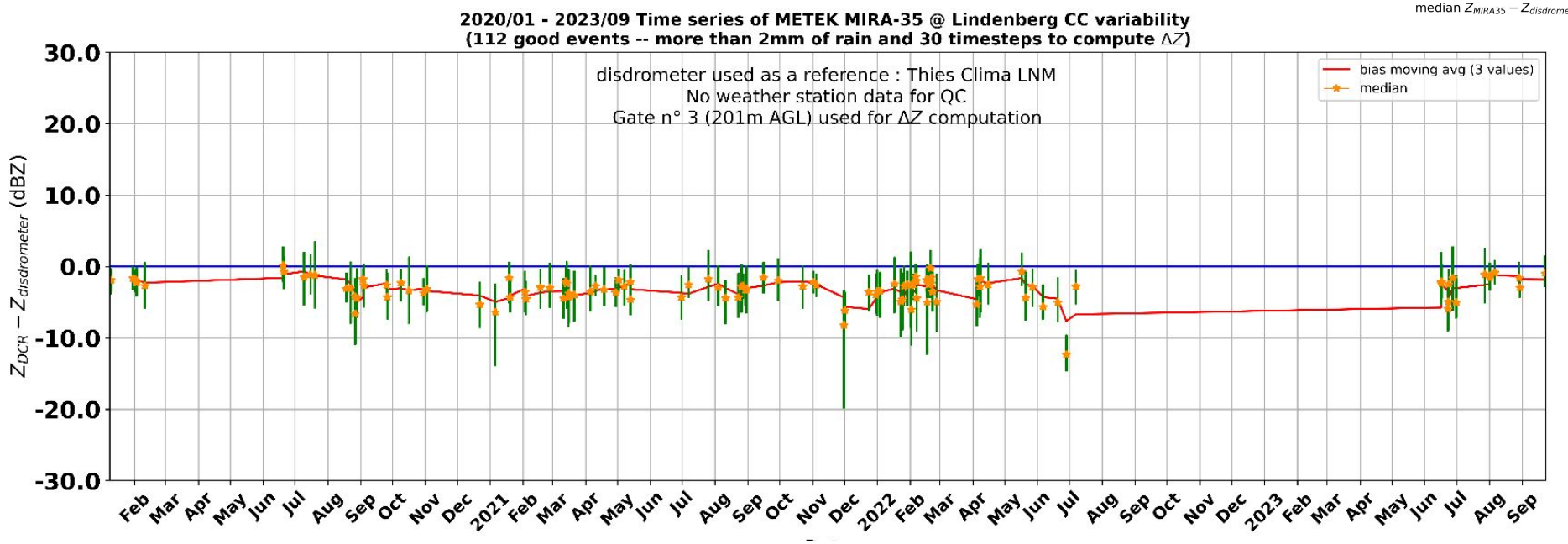
Monitoring of cloud radar stability with disdrometer

Methodology — *Processing, Workflow*
Monitoring — *EU map,* ***Time series, PDF***
Discussions — *QC/Filter, Outliers, Perspectives*
Setup requirements

METEK MIRA35
THIES LPM

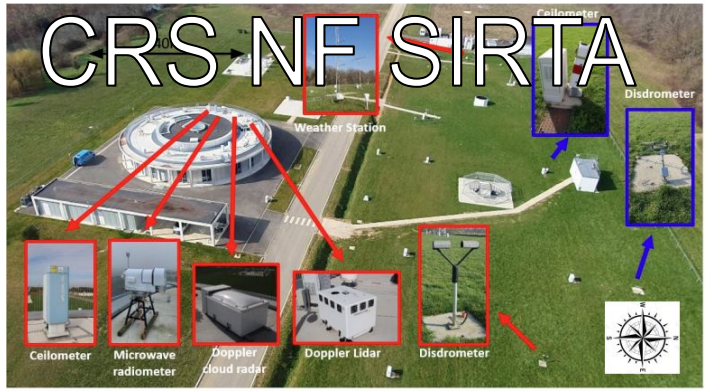
Message: -3dBz but constant bias in DCR calibration constant over 2.5years





Monitoring of cloud radar stability with disdrometer

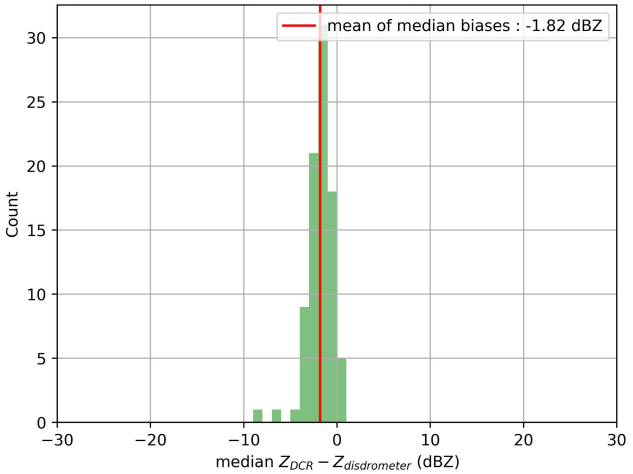
Methodology — *Processing, Workflow*
Monitoring — *EU map,* ***Time series, PDF***
Discussions — *QC/Filter, Outliers, Perspectives*
Setup requirements

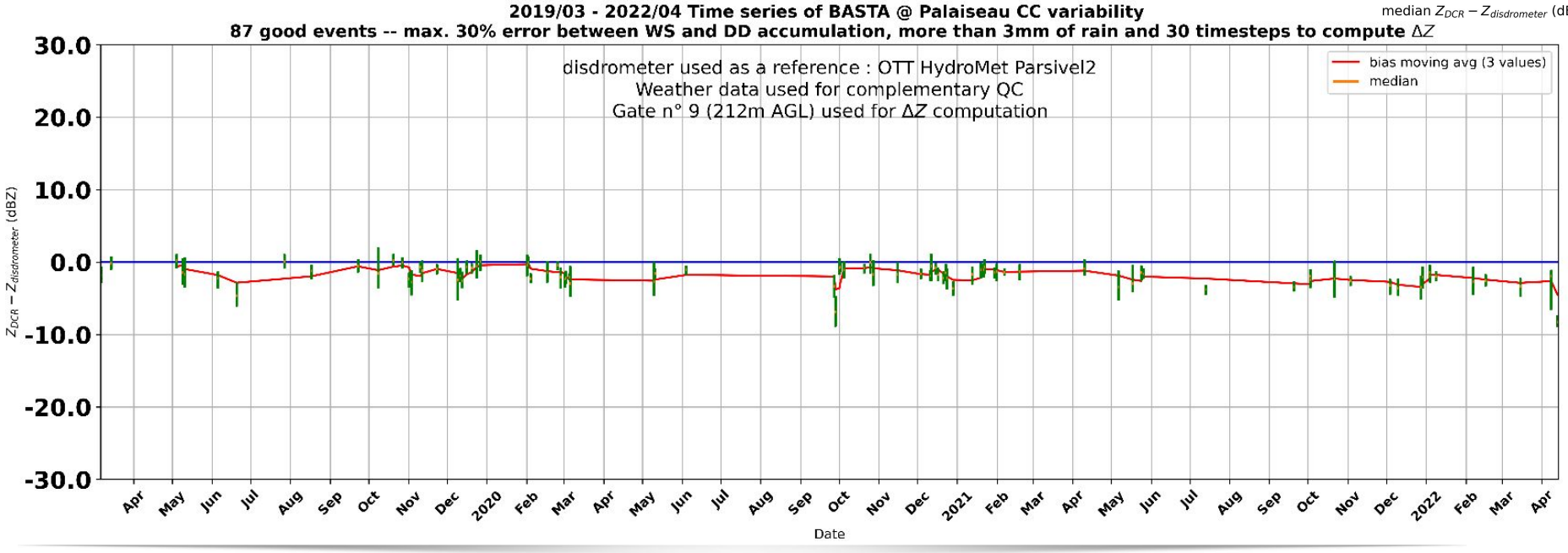


LATMOS BASTA94

OTT Parsivel2

Message: -1.8dBz but constant bias in DCR calibration constant over 3years





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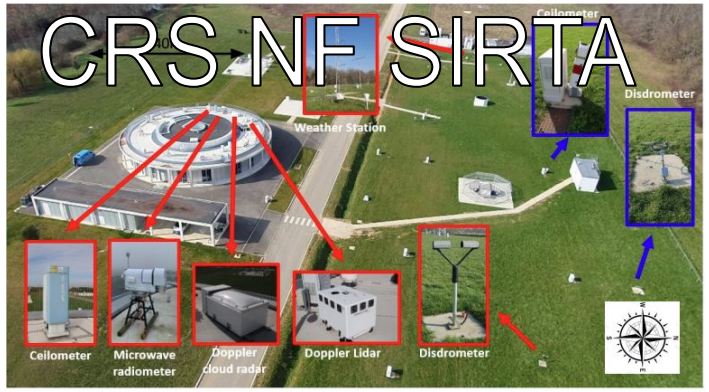
Monitoring of cloud radar stability with disdrometer

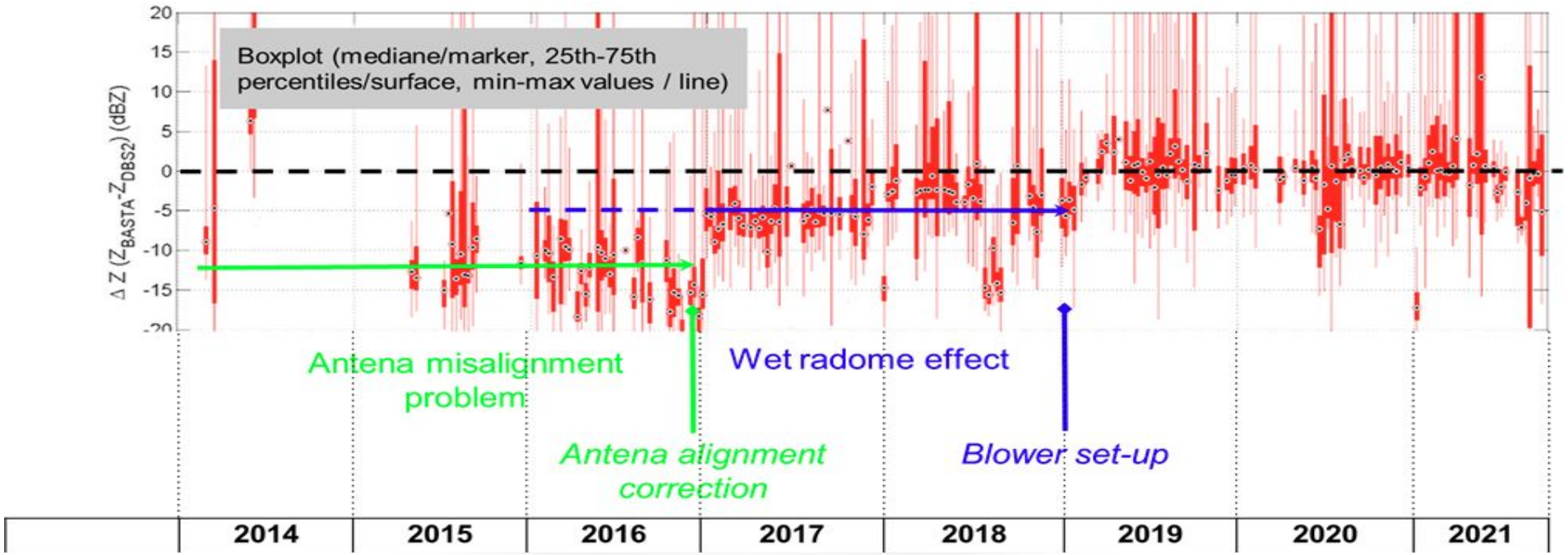
Methodology — Processing, Workflow | ***Monitoring*** — EU map, ***Time series, PDF*** | *Discussions* — QC/Filter, Outliers, Perspectives | *Setup requirements*



LATMOS BASTA94

DBS2 disdrometer

Message : on long term time series, it is possible to retrieve evolutions of the calibration by identifying shifts



Criteria to select a « good » rain event : filters definitions

Variables	Limits	With WS and DD	Only with DD	Objectives
Temperature	> 2°C	✓	✗	Remove solid precipitations
Wind speed	Max < 10 m/s Average < 7 m/s	✓	✗	Ensure good quality of disdrometer measurements
Wind direction	Main wind + / - 45°	✓	✗	
Rain gap	< 1 hour	✓	✓	Ensure rain continuity
Rain rate	> 0 mm/h < 3 mm/h	✓	✓	Have “moderate” precipitations
Cumulated rain	> 3 mm	✓	✓	Have significant cumulative precipitation to ensure good statistics
Rain duration	> 3 hours	✓	✓	
Relationship fall speed / drop size	Difference with Gunn and Kinzer < 30%	✓	✓	Remove solid precipitations

Criteria to select a « good » rain event : Quality check

Variables	Limits	With WS and DD	Only with DD	Objectives
Relationship rain rate (rain gauge vs DD)	Difference < 30%	✓	✗	QC on DD acquisition
Cumulated rain rate on a long term period		✓	✗	Monitoring the DD stability

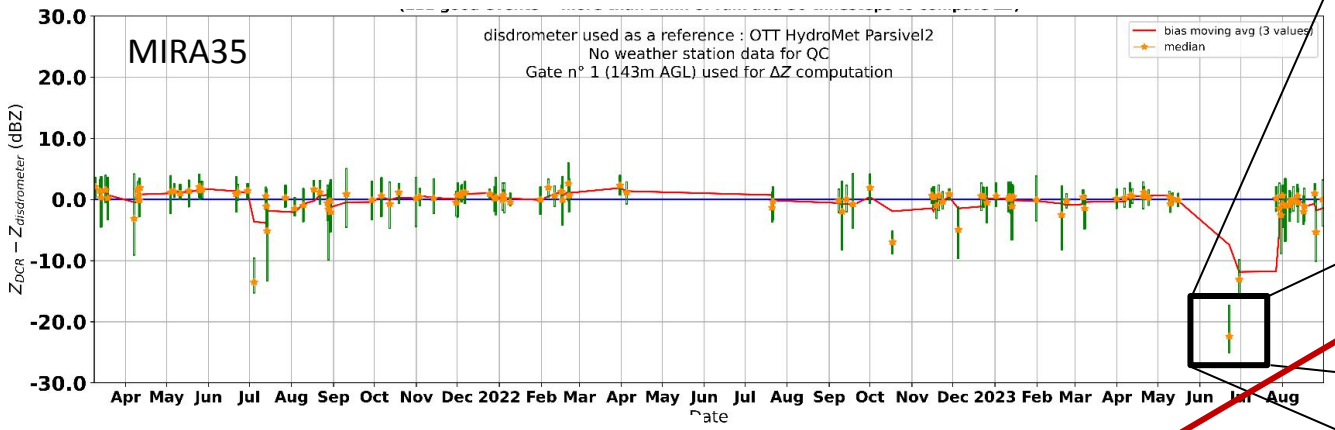
Monitoring of cloud radar stability with disdrometer

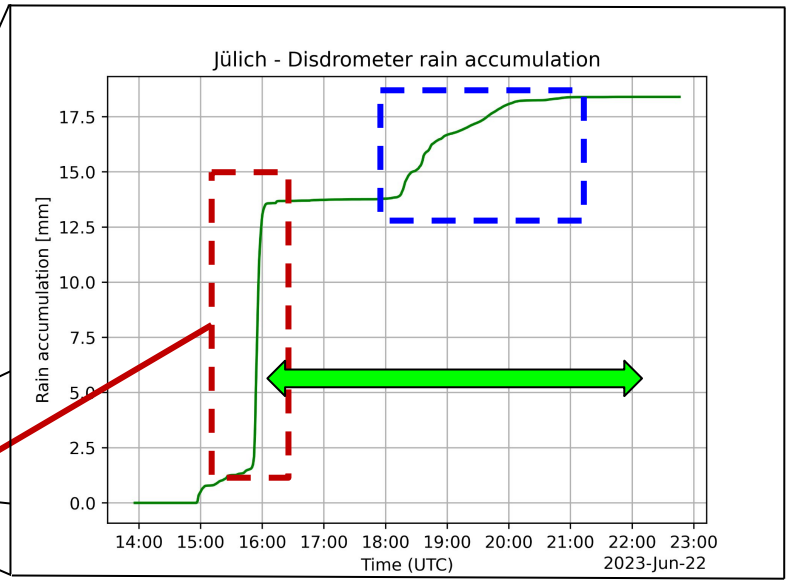
Methodology *Monitoring* ***Discussions*** *Setup requirements*

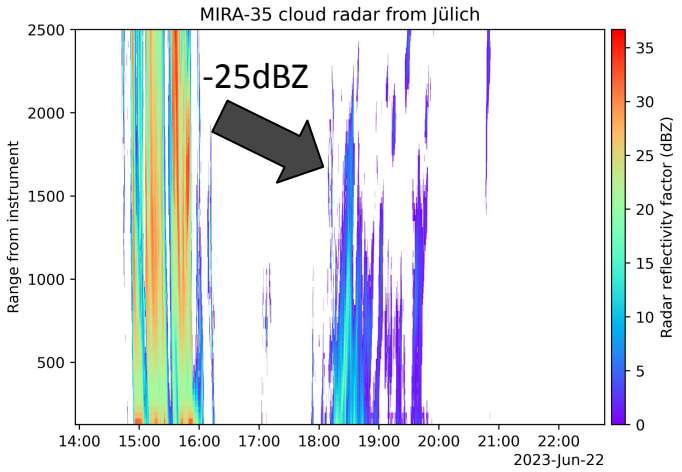
Processing, Workflow *EU map, Time series, PDF* *QC/Filter, **Outliers**, Perspectives*

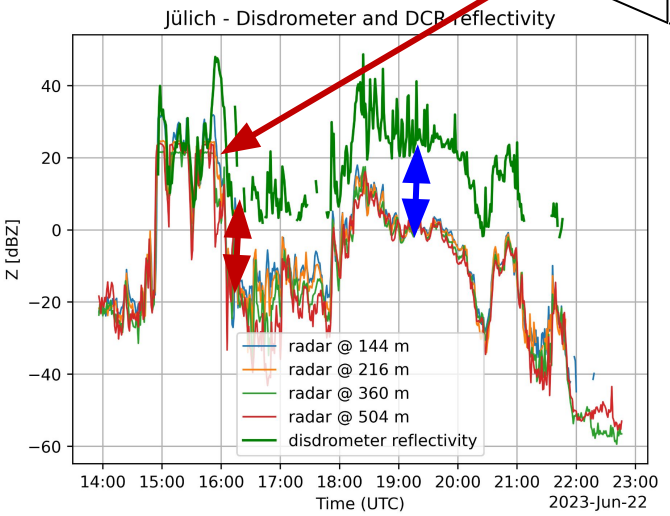
Message : impact of wet radome, ex at Jülich site

=> underestimation of Z_radar









Easy to flag, currently flagged

Not currently removed of the dataset

thunderstorm => wet radome

=> underestimation of Z_radar

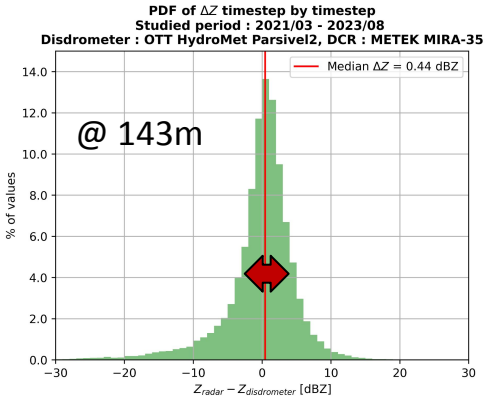
Monitoring of cloud radar stability with disdrometer

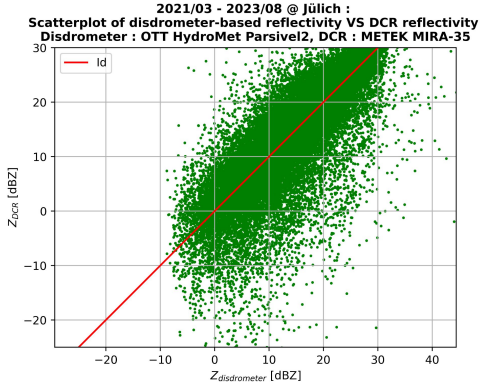
Message : impact of radar gate number on the monitoring, ex at Jülich for **MIRA35**

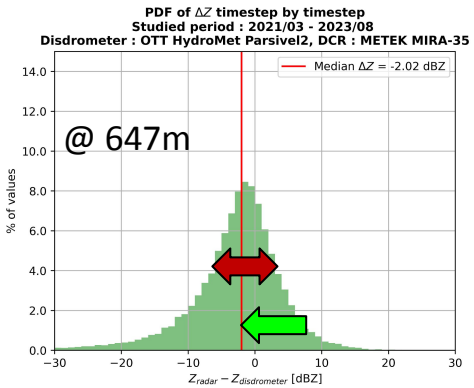
=> negative bias @ some hundreds of meters

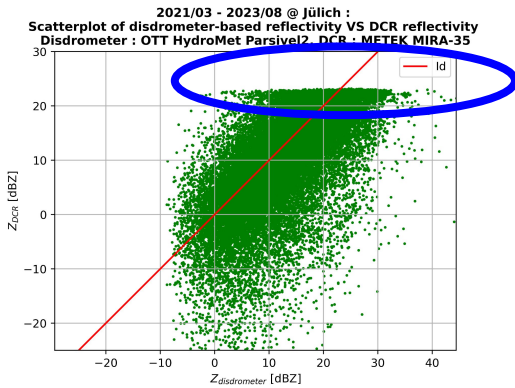
=> much bigger variability @ some hundreds of meters

Gate number	Advantages	Drawbacks
1	• ~collocated measurement with disdrometer (no time shift) • full dynamic range of reflectivity, no saturation	• antenna near-field effect : nothing at Jülich site but observed at Lindenberg…
>1	• limited antenna near-field effects • limited switching between transmitting and receiving	• limited dynamic range of reflectivity (max ~20dBZ) i.e saturation • rain attenuation effect • no collocated measurement with the surface (effect of wind…)









Monitoring of cloud radar stability with disdrometer

Methodology *Monitoring* ***Discussions*** *Setup requirements*

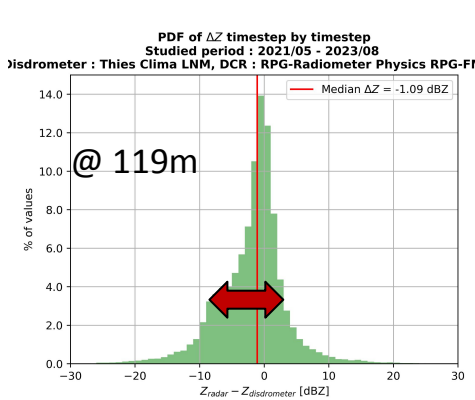
Processing, Workflow *EU map, Time series, PDF* *QC/Filter, Outliers,* ***Perspectives***

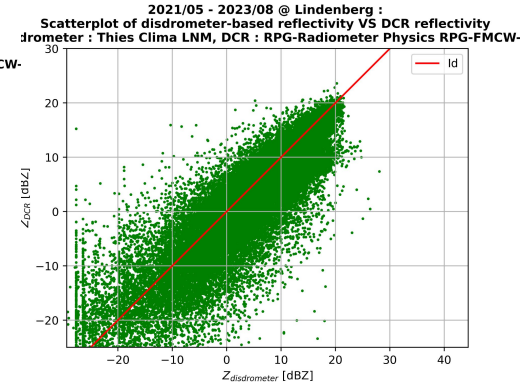
Message : impact of radar gate number on the monitoring, at Lindenberg for **RPG94**

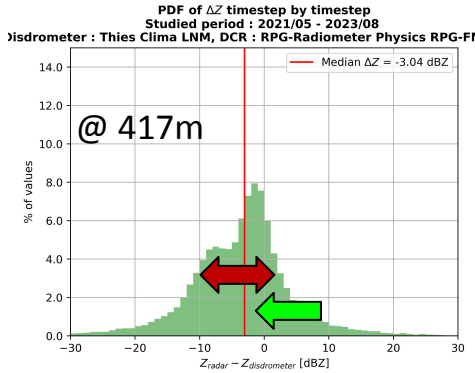
=> negative bias @ some hundreds of meters

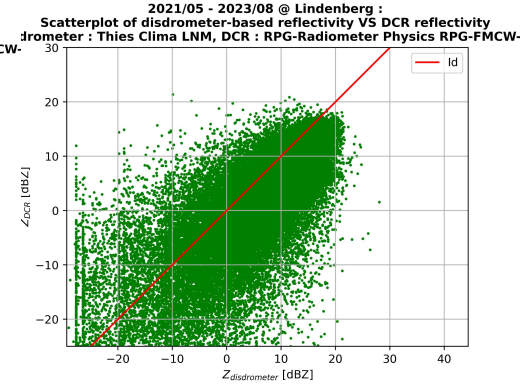
=> much bigger variability @ some hundreds of meters

Gate number	Advantages	Drawbacks
1	• ~collocated measurement with disdrometer (no time shift)	• antenna near-field effects
>1	• limited antenna near-field effects • limited switching between transmitting and receiving	• rain attenuation effect • no collocated measurement with the surface (effect of wind…)









Monitoring of cloud radar stability with disdrometer

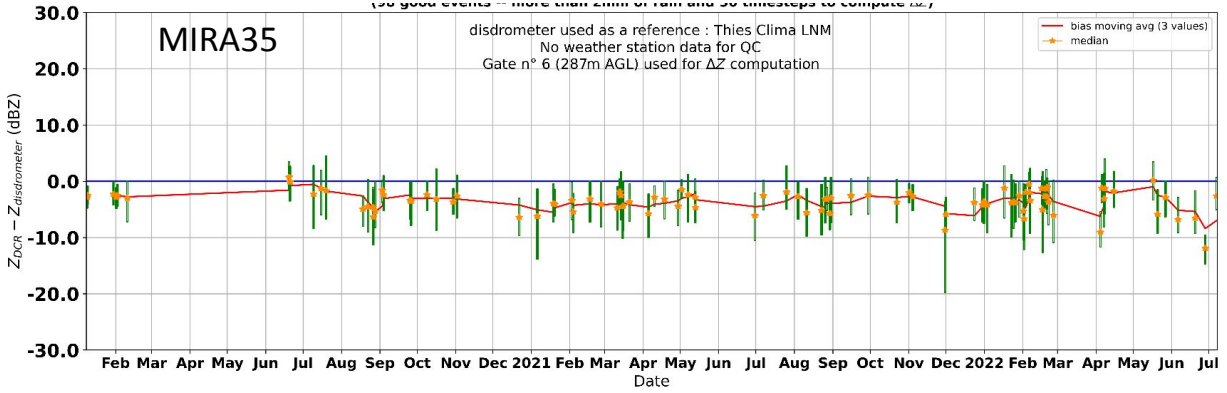
Methodology *Monitoring* ***Discussions*** *Setup requirements*

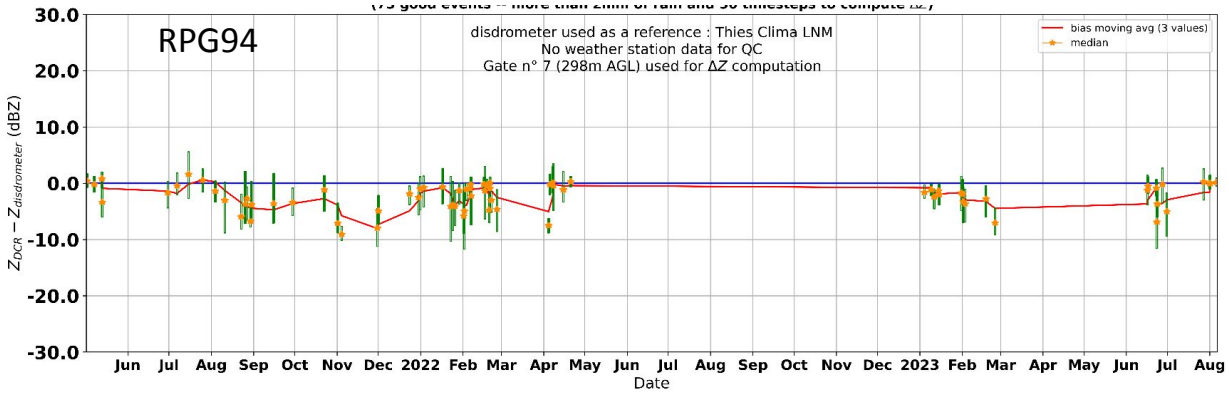
Processing, Workflow *EU map, Time series, PDF* *QC/Filter, Outliers,* ***Perspectives***

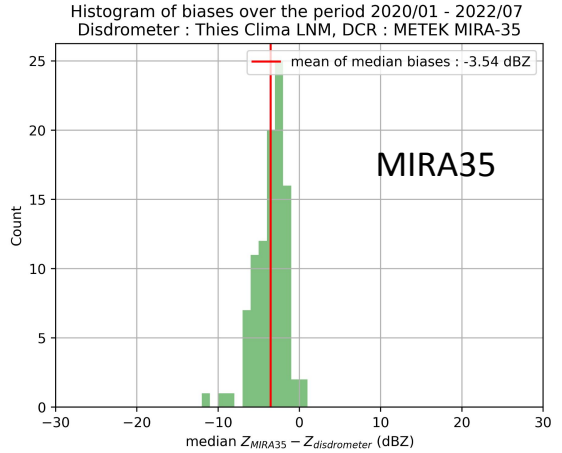
Message : comparison of the methodology for one site with two Doppler cloud radars, ex. Lindenberg site, Thies with MIRA35 and Thies with RPG94.

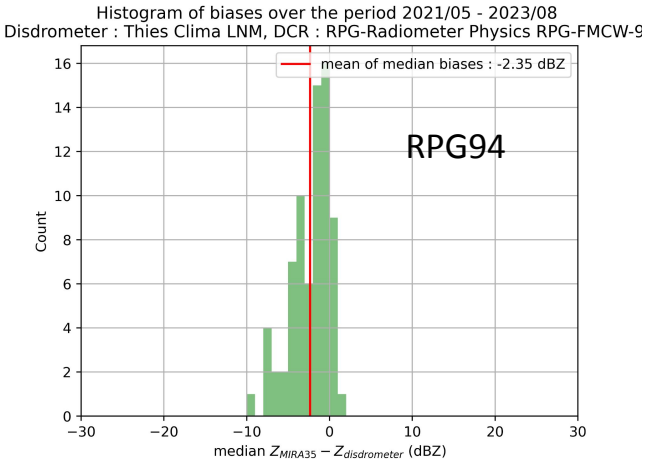
=> stable bias around -2/-3 dBZ calibration offset over time

=> methodology OK for MIRA35 AND RPG94









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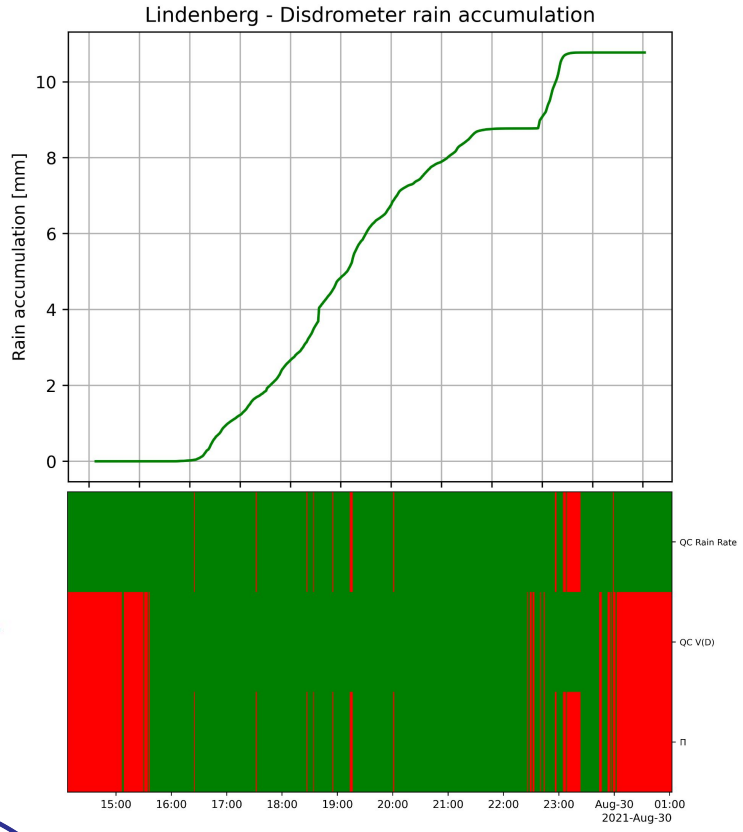
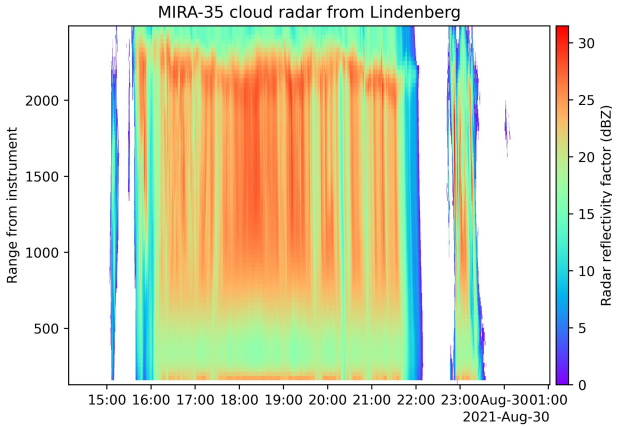
Monitoring of cloud radar stability with disdrometer

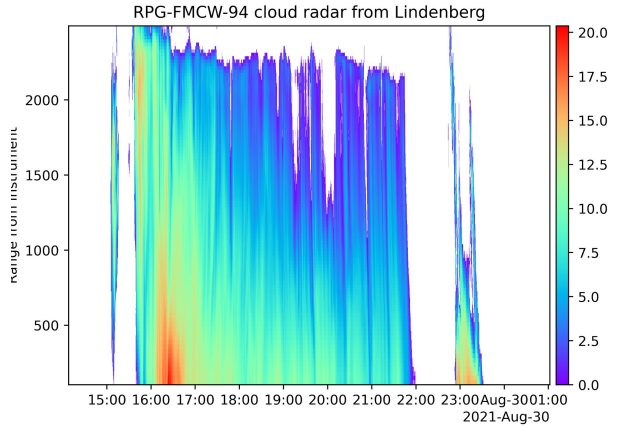
Methodology *Monitoring* ***Discussions*** *Setup requirements*

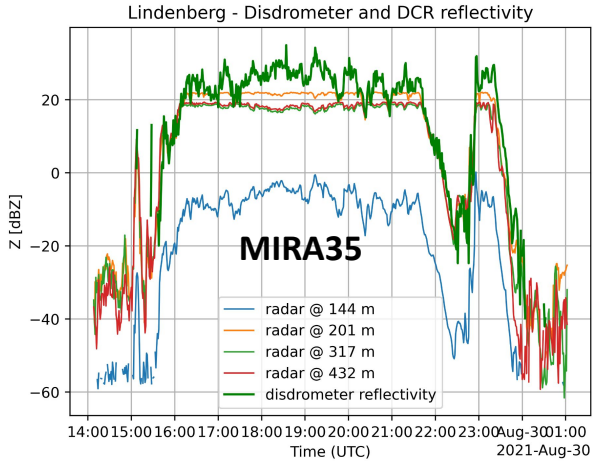
Processing, Workflow *EU map, Time series, PDF* *QC/Filter, Outliers,* ***Perspectives***

Message : some current limits of the methodology, one example 2021 August 30th @ Lindenberg for MIRA35 and RPG94

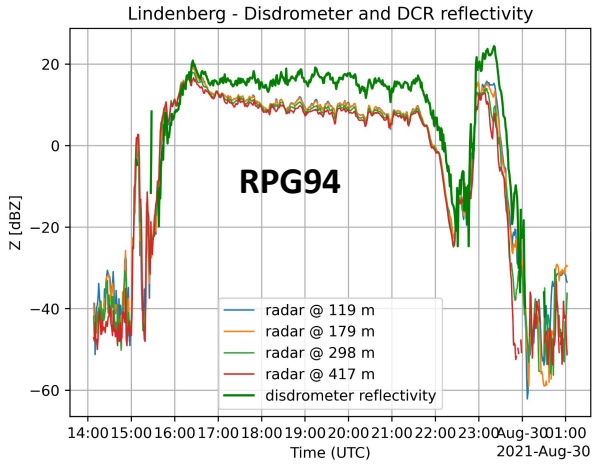








Saturation effect



Wet radome effect

Monitoring of cloud radar stability with disdrometer

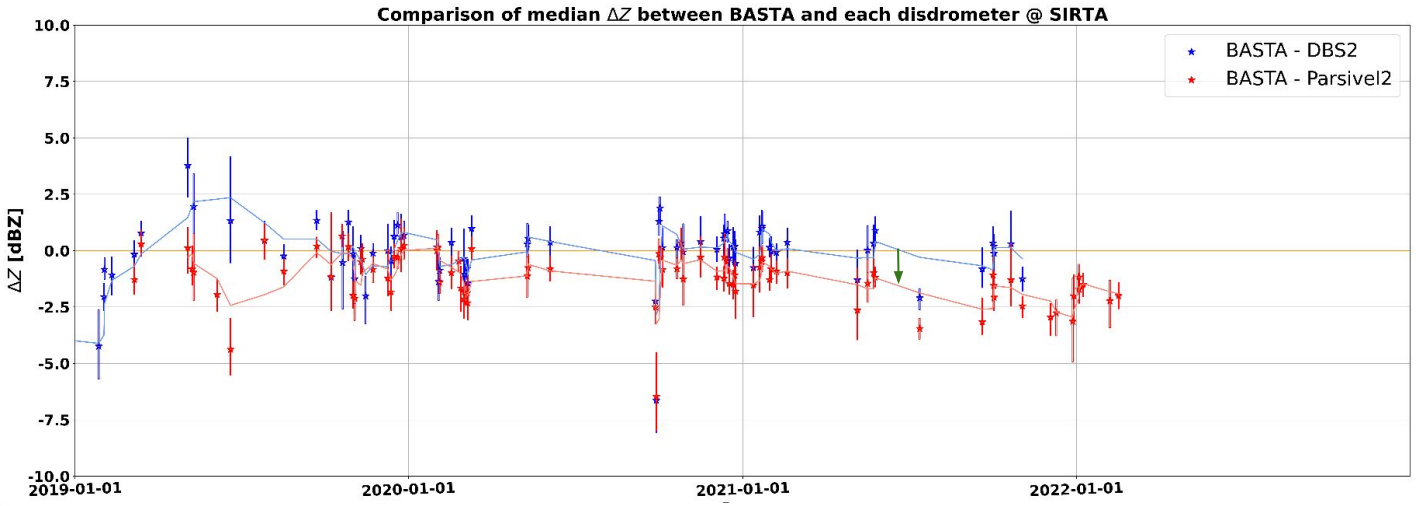
Methodology *Monitoring* ***Discussions*** *Setup requirements*

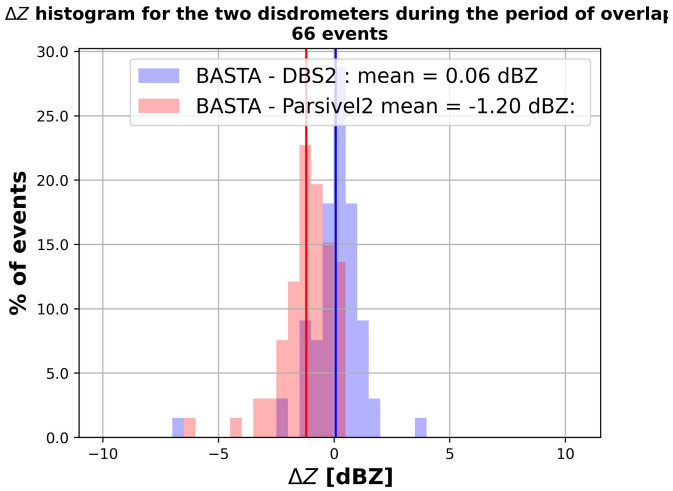
Processing, Workflow *EU map, Time series, PDF* *QC/Filter, Outliers,* ***Perspectives***

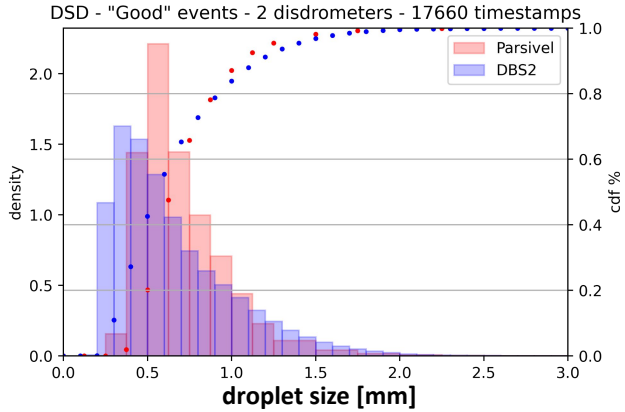
Message : comparison of the methodology for one site with two disdrometers, ex. SIRTA site with BASTA-DCR

=> No significant temporal difference for the 2 DD

=> Impact of DD sensitivity on the Delta_Z processing







The two disdrometers have a different sensitivity to the droplet size (DBS2 more sensitive to smaller droplets) - the bias between the two disdrometers is not critical, so far as we only need to do a **relative calibration**

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Monitoring of cloud radar stability with disdrometer

To summarise

- Some choices still need to be fixed (**gate choice** for DCR, improvement of **Quality flags**, comparing **ΔZ histograms** over time subsets…) → *In progress*

- The constant monitoring method seems to already provide **good results** to identify evolutions in the stability of the DCR calibration for 3 sites / 4 DCR and 5 DD

- Sine qua non condition : the **instruments** installed and the **data** provided (by the NFs) follow the Standard Operating Procedures

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Monitoring of cloud radar stability with disdrometer

DISDROMETER (DD)

<u>Two most frequent instruments in the network</u> :

- OTT Parsivel2
- ThiesCLIMA LPM

Standard Operating Procedures available here.

Take home message

Instrumental set-up	- laser beam perpendicular to the main wind direction - distance <100m with cloud radar and weather station
Acquisition requirements	- Universal Time - 1min sampling - ascii files + header or netcdf
Geophysical variables	- precipitation rate - drop size distribution - drop velocity distribution
Technical data	- automatic and laser status - temperature…
Calibration	- under discussion - monitoring the stability of the rain rate with rain gauge

DOPPLER CLOUD RADAR (DCR)

<u>Three most frequent instruments in the network</u> :

- RPG 94DCR
- METEK MIRA35
- LATMOS BASTA

Standard Operating Procedures available here.

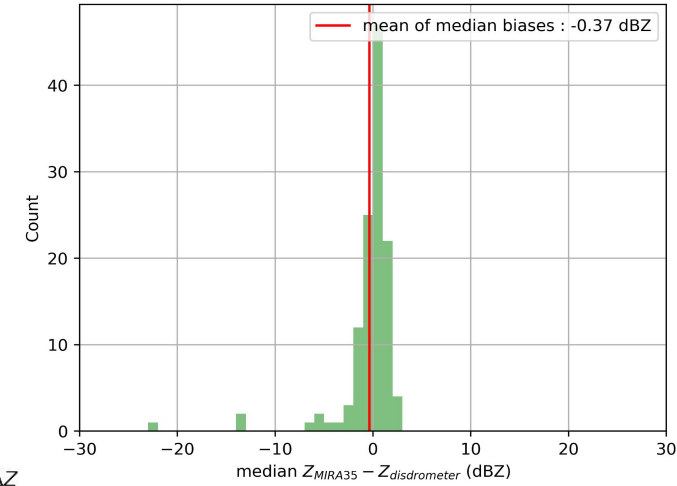
Take home message

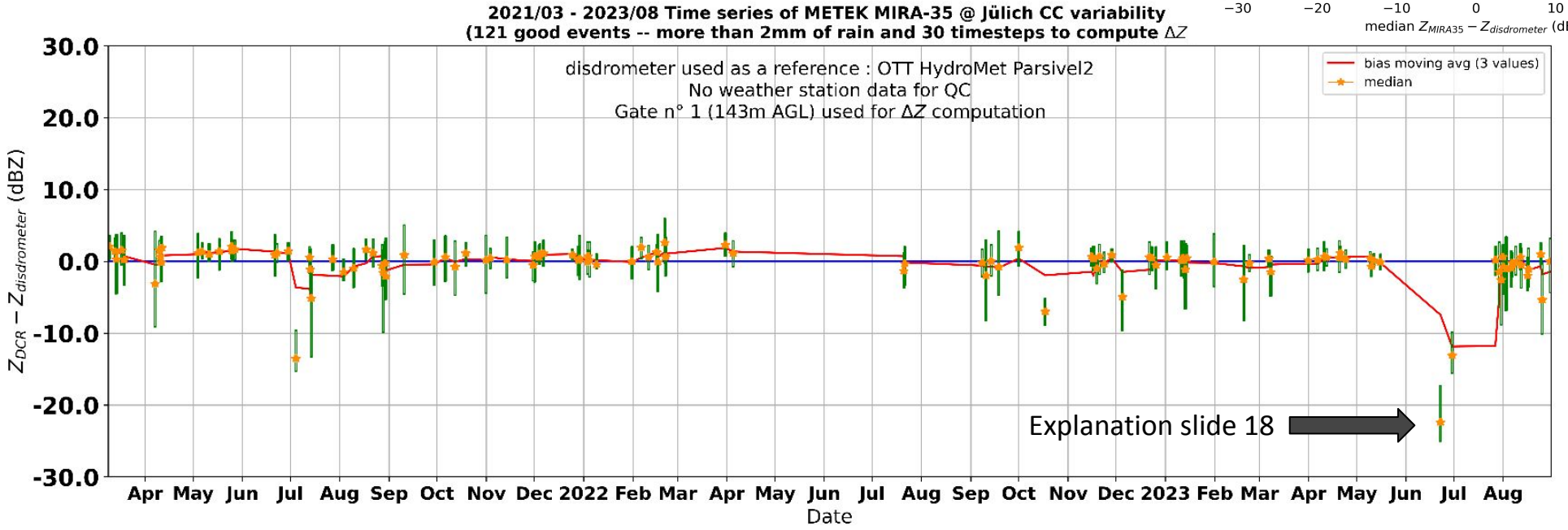
Instrumental set-up	- vertical pointing mode - blower if possible
Acquisition requirements	- Universal Time - 1min sampling - vertical resolution <40m
Geophysical variables	- reflectivity profiles - Doppler velocity profiles
Technical data	- all that is possible
Calibration	- absolute with transfer - monitoring the stability with DD

Monitoring of cloud radar stability with disdrometer

METEK MIRA35
OTT Parsivel2

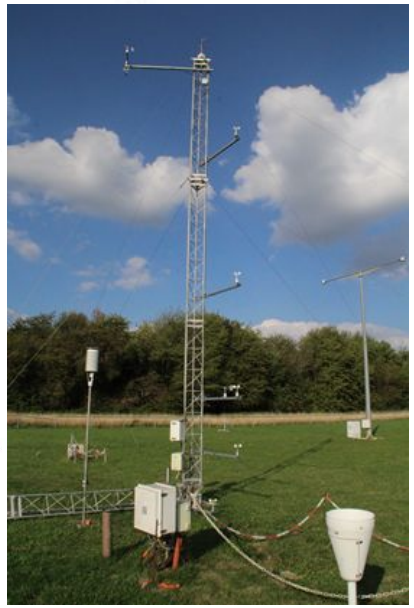
Message: No bias in DCR calibration constant over 2.5years





Monitoring of cloud radar stability with disdrometer

WEATHER STATION (WS)



Many instruments in the network :

- Temperature and relative humidity sensor
- Wind speed and direction sensor
- Rain Gauge (tipping bucket or weighing)

Standard Operating Procedures available here.

Take home message

Instrumental set-up	- collocation (distance<100m) - 10m agl for wind - ventilated shelter for T/RH
Acquisition requirements	- Universal Time - 1min or 10min sampling - ascii files + header or netcdf
Geophysical variables	- min air temperature - max wind speed - average wind direction - precipitation rate
Technical data	- all that is possible
Calibration	- every 6 months for RG : comparison between a known volume (1L for 7-13min) and output data

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Thank you

Monitoring of cloud radar stability with disdrometer

Annex : Quicklooks for a rain event – overviews of Z_e and Doppler velocity data and time series for variables monitored by quality checks