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DCR calibration methods

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CCRES/CLU Training school, Munich, 2-5 Sept. 2025

Outline

Introduction

1. **Power calibration methods**
   a. Absolute calibration
   b. Transfer calibration
   c. Disdrometer monitoring

1st Hands-on session

2. **Antenna pointing accuracy**
   a. Sun tracking calibration

2nd Hands-on session

Context and CCRES' objectives

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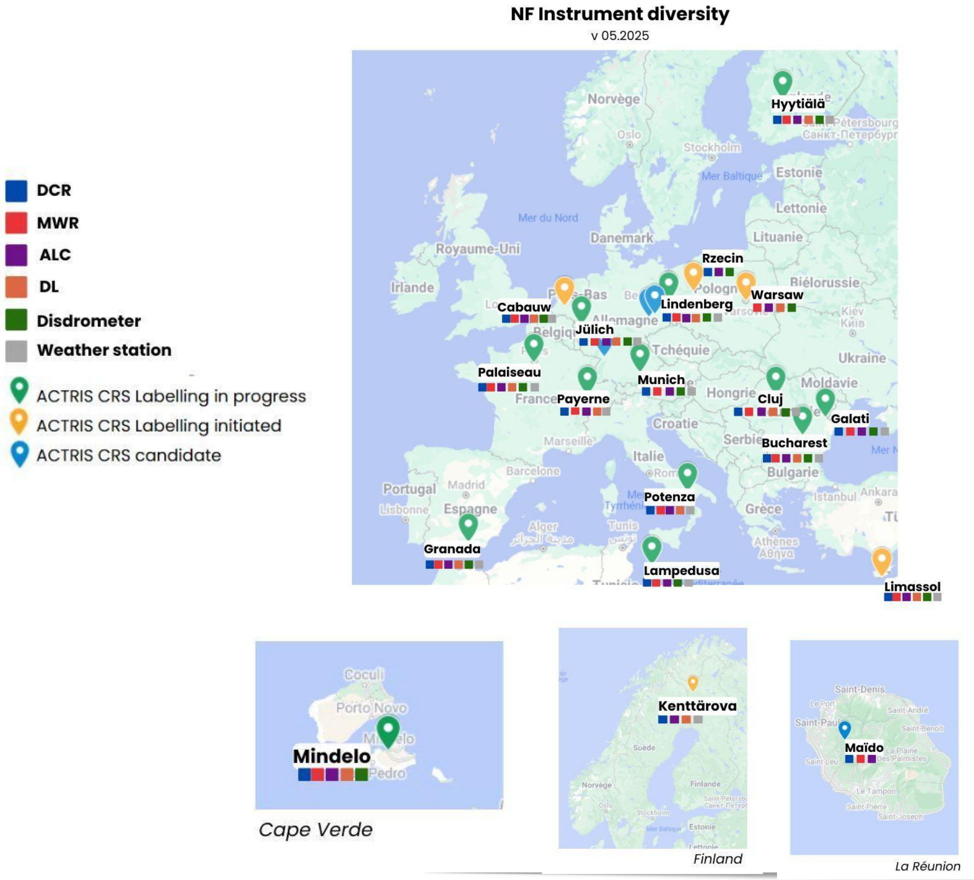
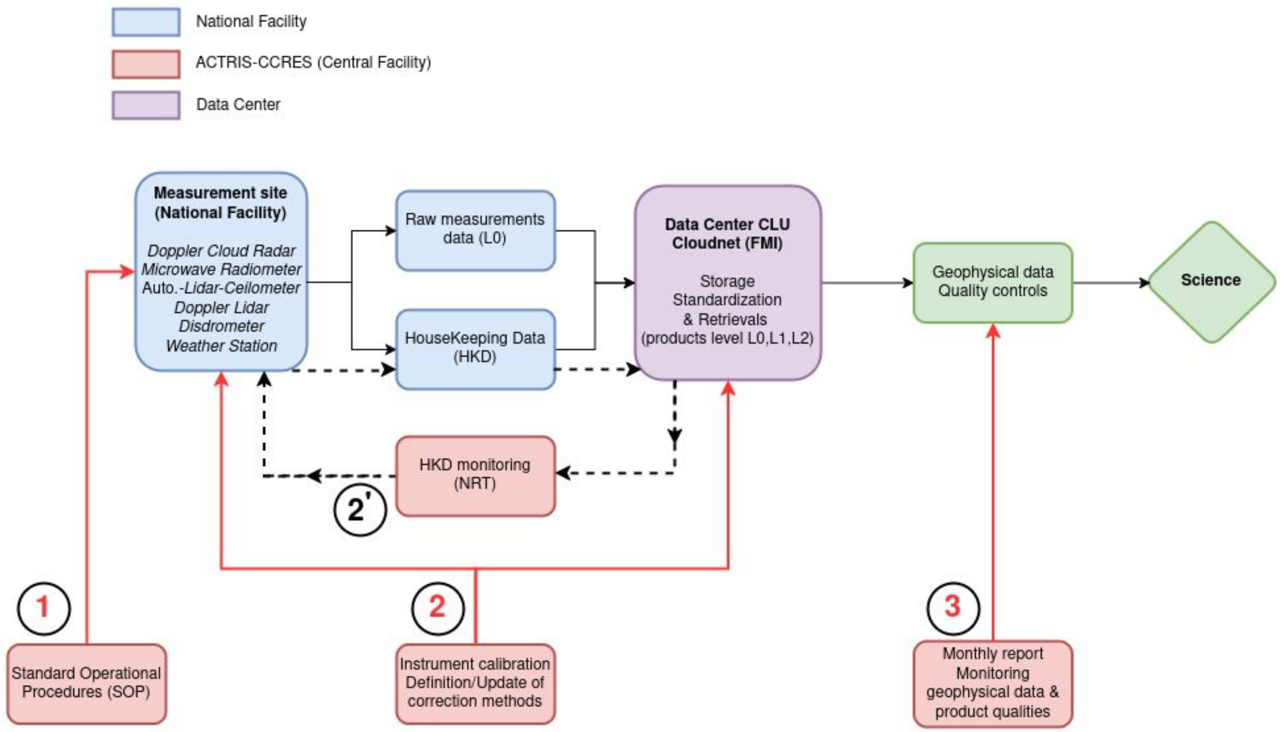
Center for Cloud Remote Sensing (CCRES)

- ~ 20 National Facilities (NFs)
- 1 Central Facility (CF)
- 1 Data Center (DC)





Standardize measurements

Calibrate instruments

Data qualification (QA/QC)

DCR calibration: why ?

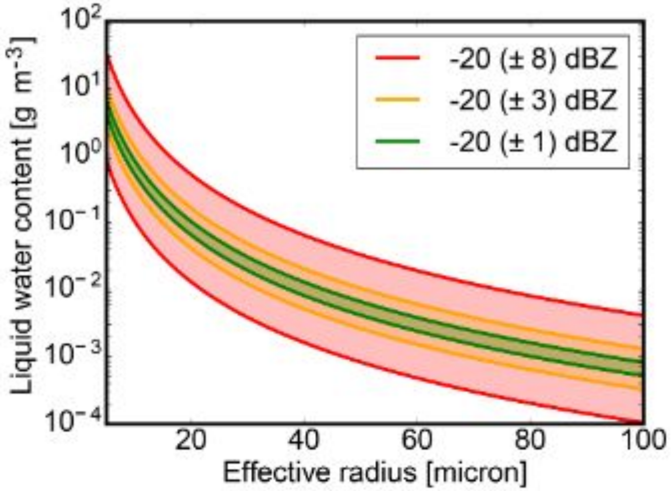
Why ?

- **Consistency** between instruments and **comparability** of output data
  - Crucial for understanding **variability** and **representativeness** of DCR data

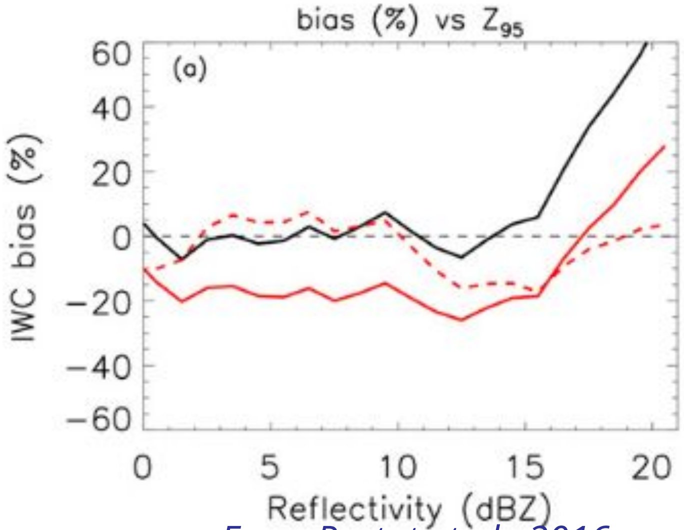
- Important **impact on microphysical retrievals** (Protat et al., 2009; Protat et al., 2016; Ewald et al., 2019)
  - **Error of 1 dB** in horizontal reflectivity → **bias in ice content** by about ~ **15-20%**

- → **CCRES objective** is to **guarantee a network of high-quality observations**
  - Needs of **standardized** and **repeatable** calibrations **methods**

→ Links also with **satellite cal/val activities** → useful to have a set of “community accepted” standards and protocols for maintaining the quality, meta data...



From Ewald et al., 2019



From Protat et al., 2016

Diversity of DCRs set up within the CCRES framework

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Frequency	Total 35GHz	8
	Total 94GHz	14
Scanning or non-scanning	Total scanning	13
	Total non-scanning	7
Polarimetry type	Total single polarisation	11
	Total dual polarisation	5
Manufacturer	Total Metek	8
	Total RPG	11
	Total Copernicus	1
	Total BASTA	2

Complex task !

Reminder: the radar Equation

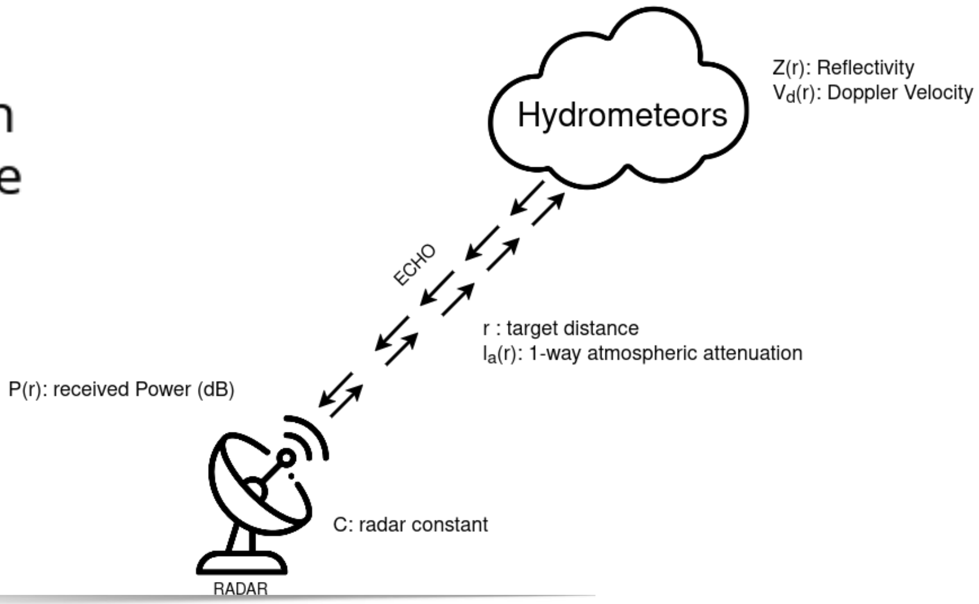
- Definition of radar equivalent reflectivity from the Droplet Size Distribution (DSD):

$$Z = \int_0^{\infty} N(D)\, D^6\, dD\ [m^6 m^{-3}] = 10^{18} \int_0^{\infty} N(D)\, D^6\, dD\ [mm^6 m^{-3}]$$

- The change to mm units is because these values are more commonly found in DSD measurements for precipitation

- Using the definition of Z and Γ_v, we can replace the RCS in the point target equation to get the radar equation for the **reflectivity** of distributed targets :

$$P_r(\vec{r}) = \frac{G_a^2 \lambda^2 P_t}{(4\pi)^3 r^4\, l_a^2(r)} \Gamma_v = \frac{10^{18} \pi^3 \theta^2 G_a^2\, P_t \delta r}{512\, \lambda^2 \ln 2} \frac{K^2}{l_a^2(r)\, r^2} Z(\vec{r})$$



Z in mm^6/m^3

Reminder: the Radar Equation for Real Situation

- For real radars, the emitter and receiver can have different gains and losses that must be accounted for.

In reality $P_t = P_t^{nom}/L_t$; P_t^{nom} : nominal transmitted power ; L_t : Transmitter losses

Example from the BASTA radar system Delanoë et al. 2016

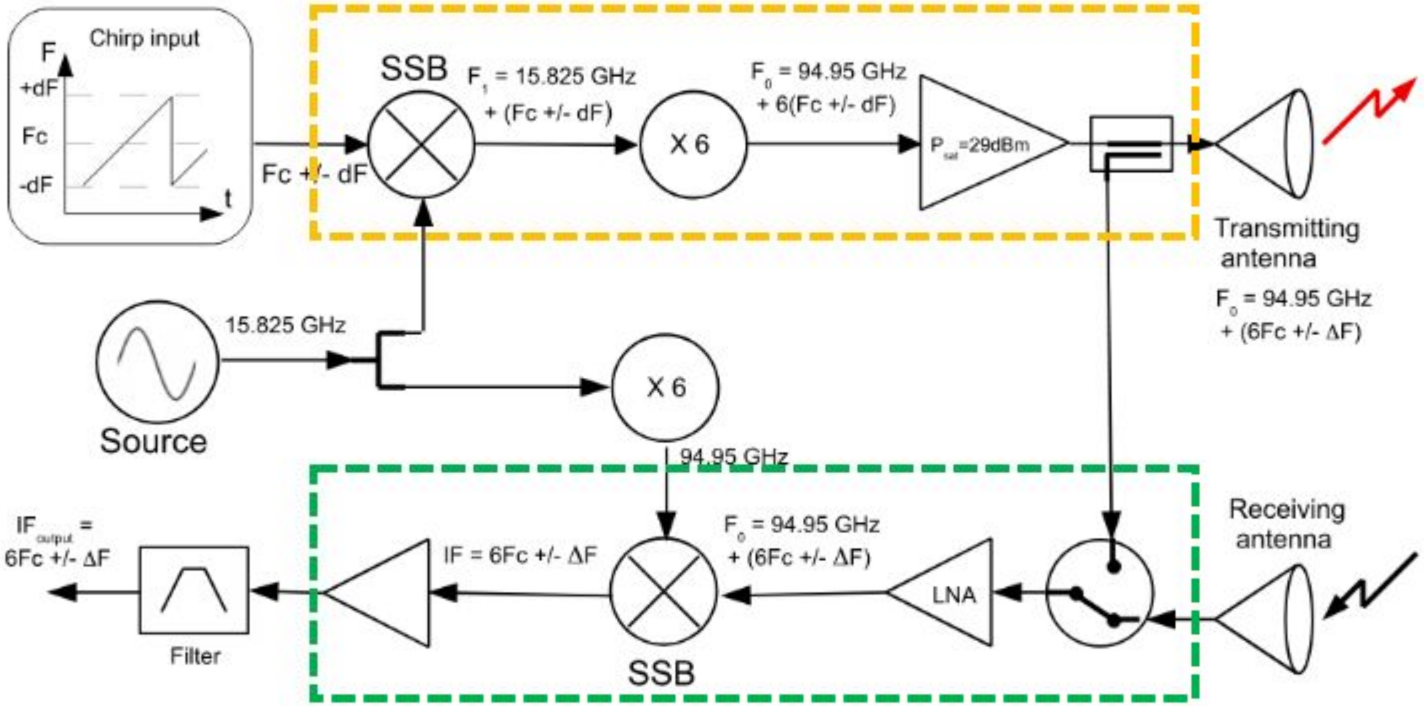


FIG. 8. Radar block diagram.

And similarly $P_r^{meas}(r) = G_r\ P_r(r)$; $P_r^{meas}(r)$: measured received power ; G_r : Receiver gain

Note: $\text{gain} = \frac{1}{\text{loss}}$

Reminder: the Radar Equation for Real Situation

- Considering radar gain and losses, the radar equation for point target becomes :

$$P_r^{meas}(\vec{r}) = \frac{G_a^2 \lambda^2 G_r P_t}{(4\pi)^3 L_t \; l_a^2(r) r^4} \Gamma = \frac{1}{c_\Gamma} \frac{\Gamma(r)}{l_a^2(r)\, r^4} \quad \Rightarrow \quad \Gamma(r) = c_\Gamma \, l_a^2(r)\, r^4 \, P_r^{meas}(\vec{r})$$

- And for reflectivities :

$$P_r^{meas}(\vec{r}) = \frac{10^{18} \pi^3 \theta^2 G_a^2 P_t^{nom} \delta r \, G_r}{512\, \lambda^2 \ln 2 \; L_t} \frac{K^2}{l_a^2(r)\, r^2} Z_e(\vec{r}) = \frac{1}{c_z} \frac{Z_e(\vec{r})}{l_a^2(r)\, r^2} \Rightarrow Z_e(\vec{r}) = c_z \, l_a^2(r)\, r^2 \, P_r^{meas}(\vec{r})$$

- By knowing c_Γ and c_z we can calculate Γ and Z_e from radar measurements!

$\rightarrow$ Radar calibration

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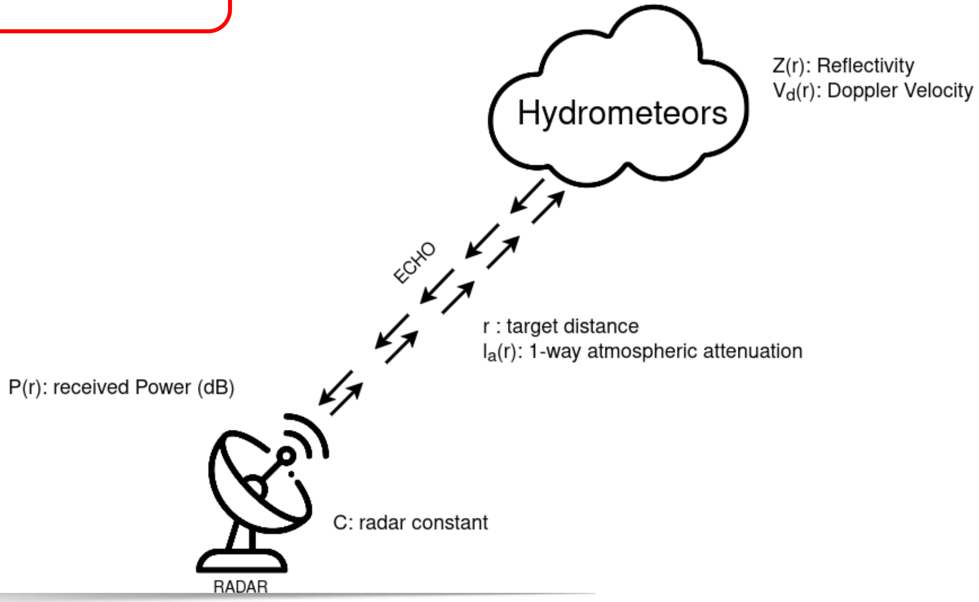
Reminder for the Radar Equation - dB form

- To finalize, usually the radar equations are presented in dB form. Applying $10\log_{10}(\cdot)$ at both sides of the equation we get:

$$\Gamma(r)[dBm^2] = C_\Gamma + 2L_a(\mathbf{r}) + 40\,log_{10}(r[m]) + P_r^{meas}(\vec{r})\ [dBm]$$

$$\mathbf{Z}(\vec{\mathbf{r}})[\mathbf{dBZ}] = C_z + 2\mathbf{L_a}(r) + 20\,log_{10}(r[m]) + P_r^{meas}(\vec{\mathbf{r}})\ [\mathrm{dBm}]$$

- With :
  - $\mathbf{L}_a(\mathbf{r}) = 10\log_{10}(\mathrm{l}_a(\mathbf{r}))$
  - $\mathbf{P_r^{meas}}(\vec{\mathbf{r}}) = 10\log_{10}(\mathrm{P_r^{meas}}(\vec{\mathbf{r}}))$
  - $\Gamma(\mathbf{r}) = 10\log_{10}(\Gamma(\mathbf{r}))$
  - $\mathbf{Z}(\vec{\mathbf{r}}) = 10\log_{10}(\mathrm{Z}(\vec{\mathbf{r}}))$



I. Power calibration methods

Absolute calibration

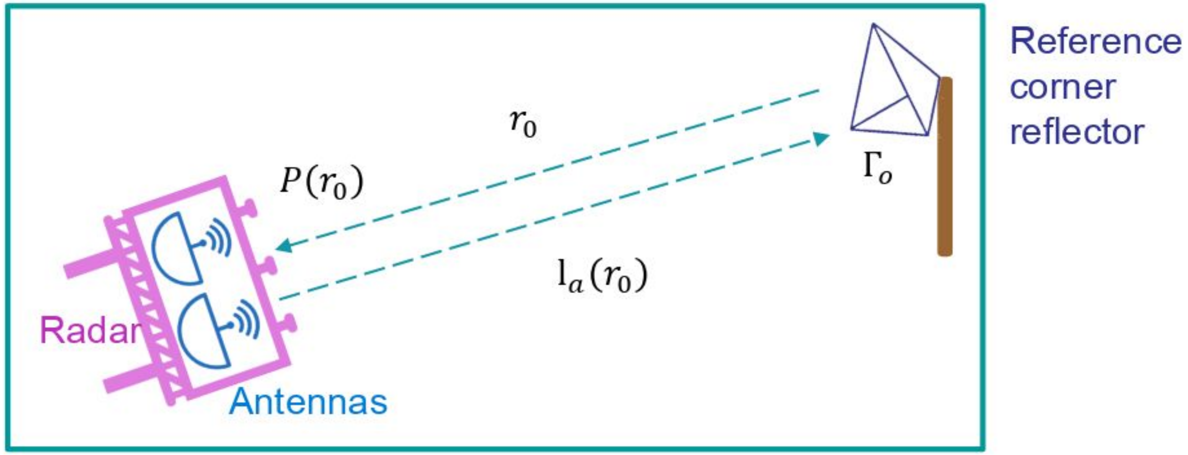
Absolute calibration (Toledo et al., 2020)

- Method developed during 2017, 2018 and 2019 CCRES cloud radar calibration campaigns

- Uses **corner reflectors** as **absolute references** to retrieve the **radar calibration constant**

- Current version of the method enables the **identification** and quantification of most **bias** and **uncertainty** sources

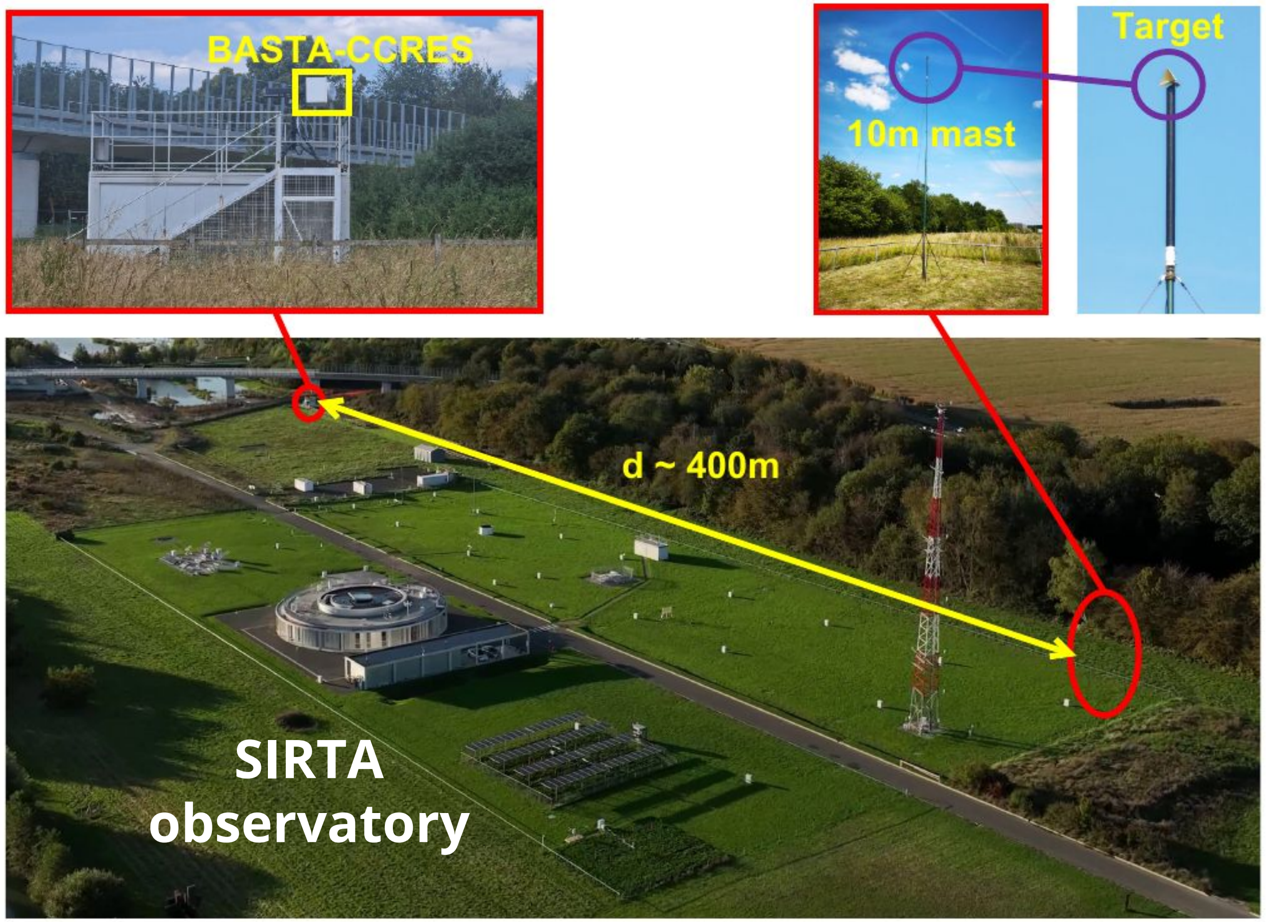
Calibration setup



Absolute calibration (Toledo et al., 2020)

- A typical setup involves the installation of a low cross-sectional mast several hundred meters away from the radar

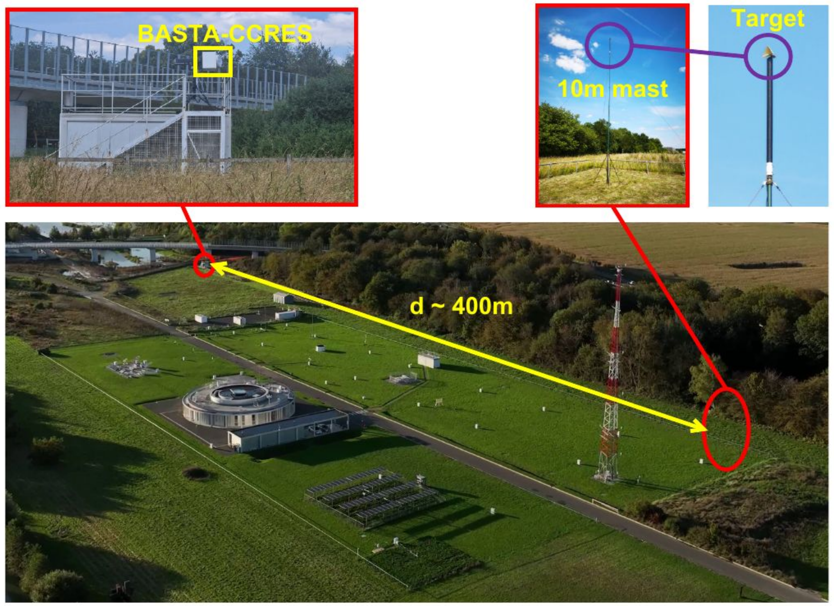
- Relatively controlled conditions enable the quantification and estimation of bias and uncertainty sources

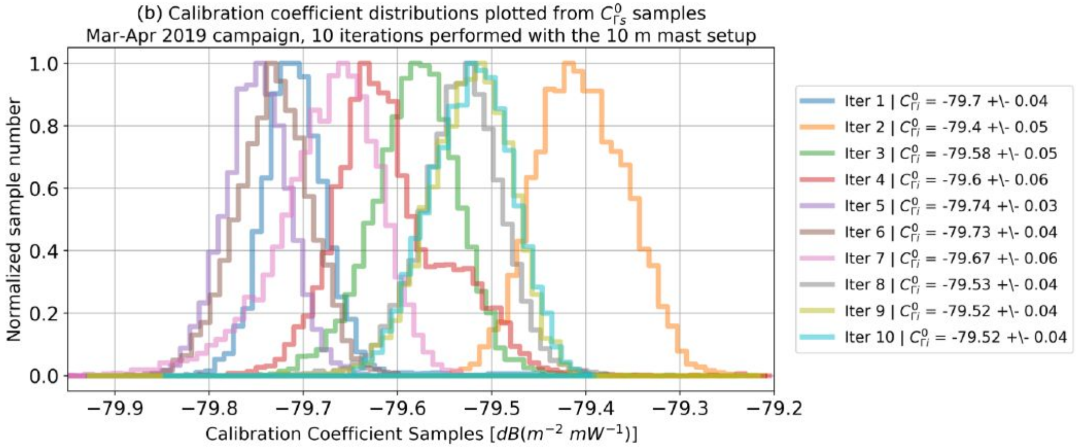


Absolute calibration (Toledo et al., 2021)

- Based on **corner reflectors** mounted on a **mast** (triangular trihedral reflector) → **known Radar Cross Section (RCS)** → RCS calibration → Eq. Reflectivity calibration

- Atmospheric attenuation is corrected with SIRTA local measurements
- Takes into account the radar internal characteristics (saturation, antenna beam width, gain variations at the transmitter and at the receiver IF, near field distance)
- Needs several iterations to quantify the alignment of the system





Reference radar mode	Eq. Reflectivity Calibration constant	Reference radar calibration uncertainty
25m	-181.5 dB	0.8 dB

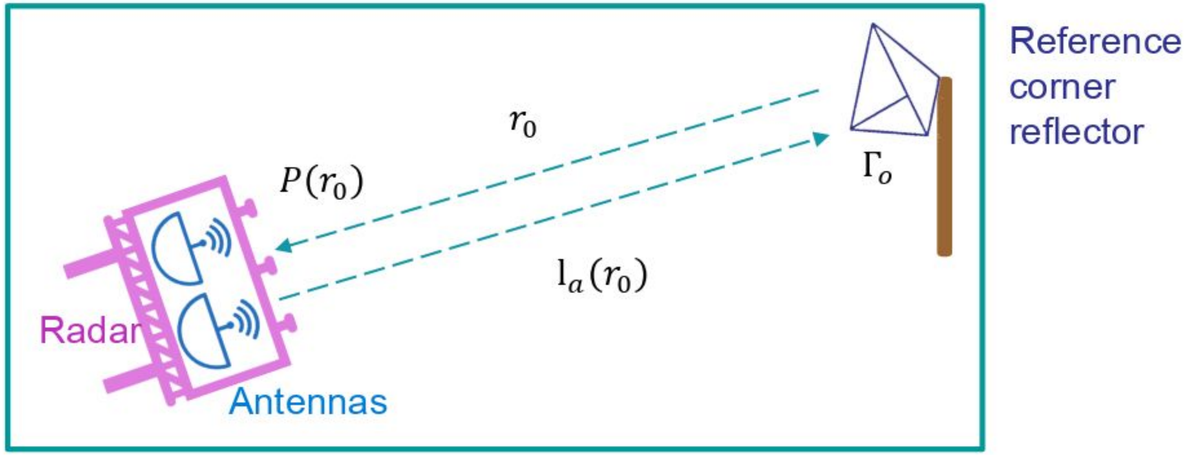
Absolute calibration (Toledo et al., 2021)

Uncertainty sources

$$C = \frac{8 \ln 2 \ \lambda^4 10^{18}}{\theta^2 \pi^6 K^2 \delta r} \frac{\Gamma_0}{l_a^2 r_0^4 \mathrm{P_r}(\mathrm{r_0})}$$

Radar Parameters — Calibration variables

Calibration setup



Antennas properties
- Beam lobe shape
- Beam overlap
- Beam width

Radar

Radar gain variations
- Impact of temperature
- Non ideal IF filters

$P(r)$: Sampled power
- Receiver compression

Reference corner reflector

Γ_o: Reference target Radar Cross Section (RCS)
- Theoretical value
- Clutter
- Alignment

Constant calibration coefficient and uncertainties/bias

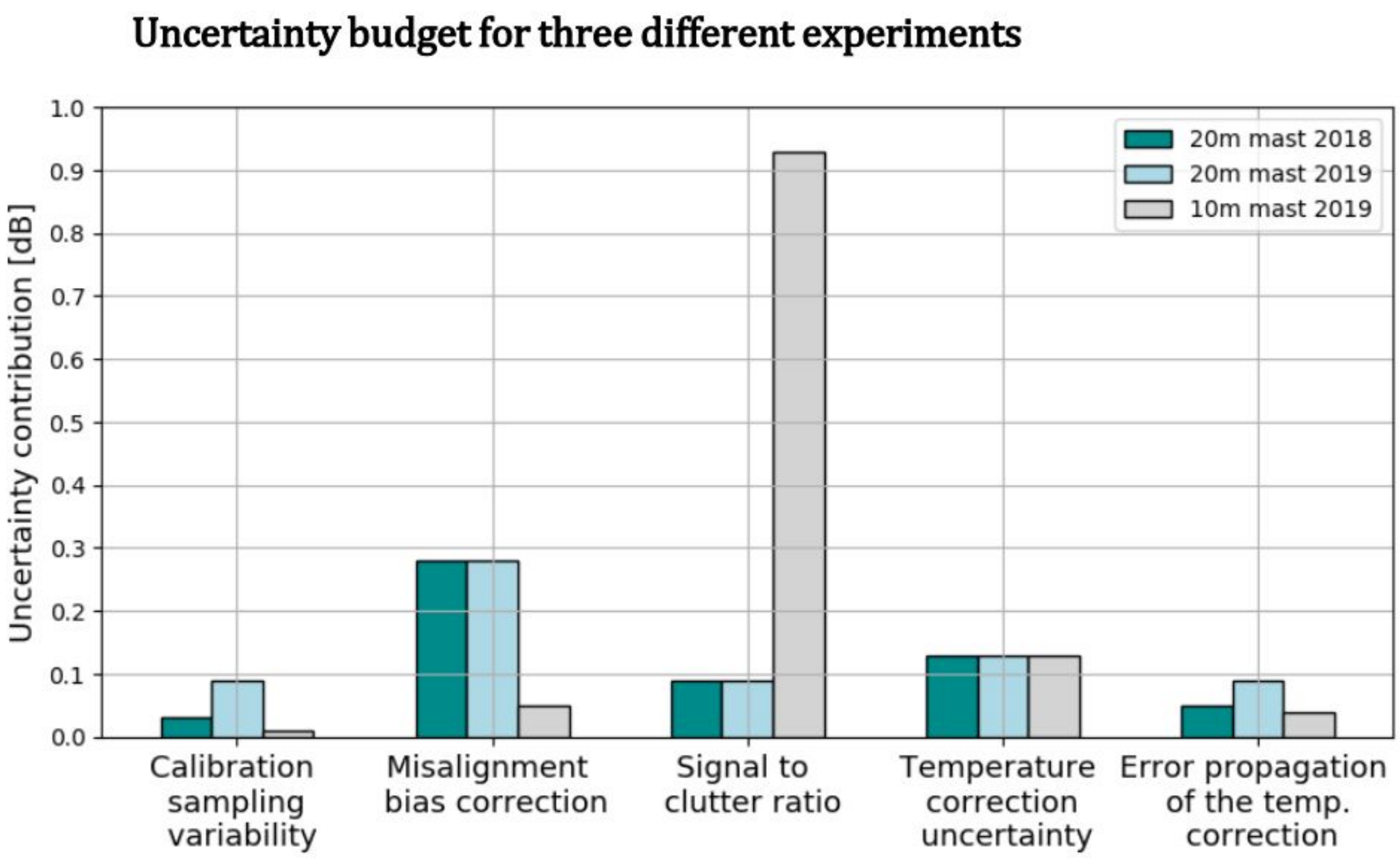
- $C_Z = C_0 + f_{IF}(r) + f_T(T) + \ldots$

C_0 : Constant calibration coefficient ← **what we would like to determine**

Relative corrections (usually given by radar manufacturer):

- **: receiver compression**
- **: antenna properties**
- **: signal to clutter ratio**
- **f_{IF} (r) :** relative variations in receiver loss with distance for Intermediate Frequency (IF)
- **f_T (T):** impact of temperature fluctuation on transmitter/receiver (due to solid-state components)
- **: Misalignment bias**

Absolute calibration (Toledo et al., 2021)

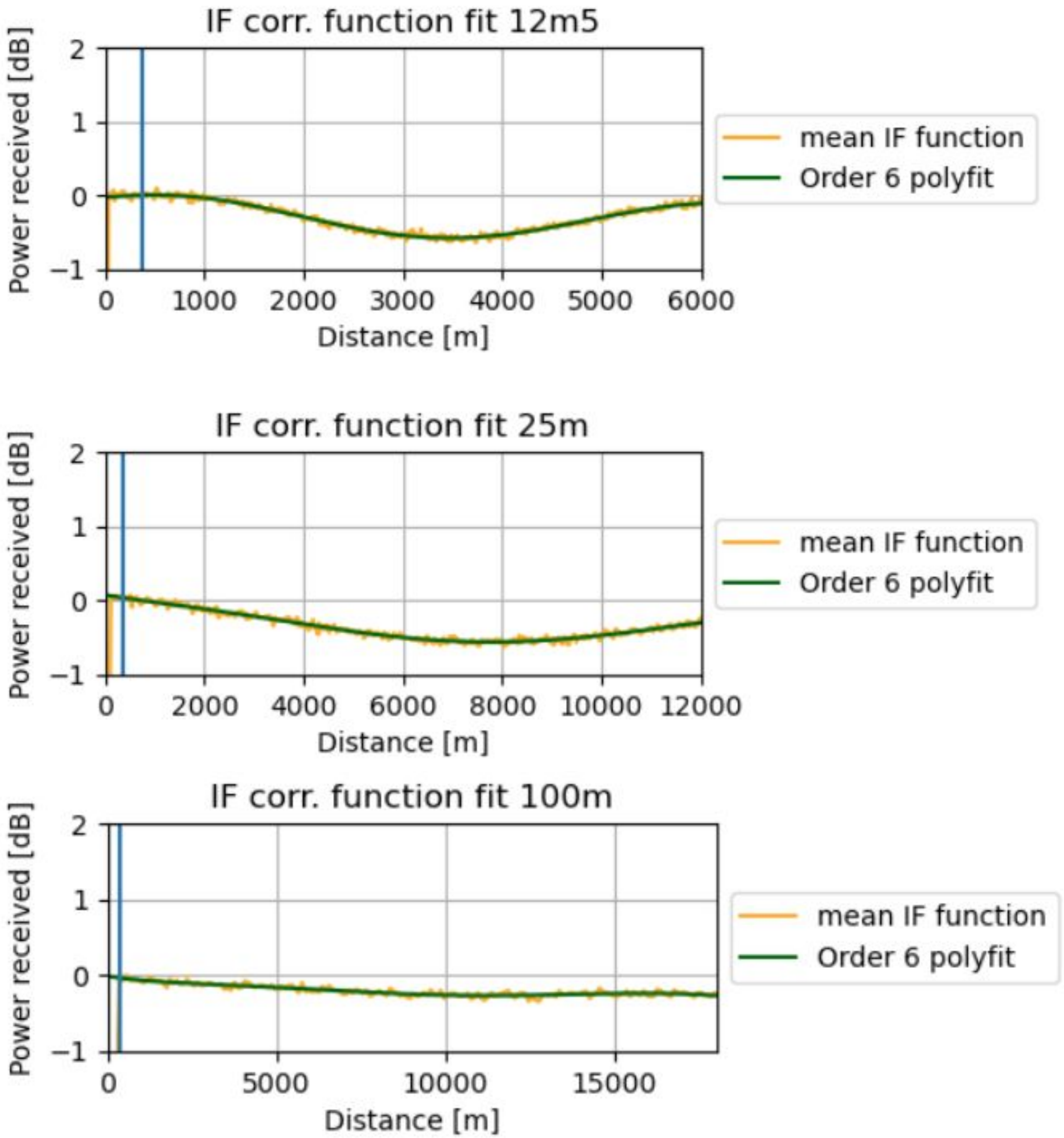


From Toledo et al., 2020

Absolute calibration (Toledo et al., 2021)

- FMCW radars exhibit frequency-dependent gain in the intermediate frequency (IF) chain, which introduces a range-dependent bias in the calibration.

- An IF correction function, derived from measured noise levels, is applied to compensate for these variations and ensure consistent radar calibration across all ranges.

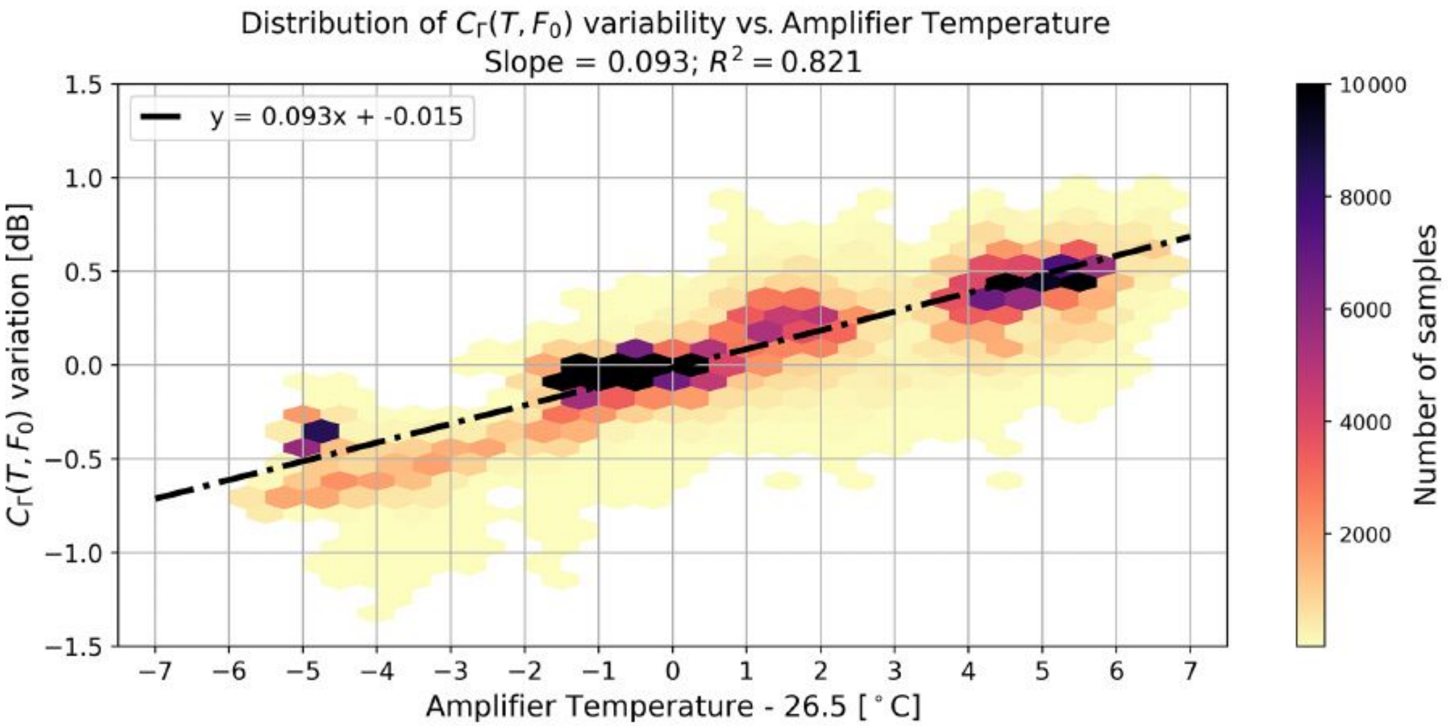


Absolute calibration (Toledo et al., 2021)

Amplifier Temperature

- Temperature fluctuations inside the radar affect the gain of electronic components, leading to variability in the calibration coefficient over time.

- A linear temperature correction function is derived from experimental data, reducing this variability and improving calibration stability.



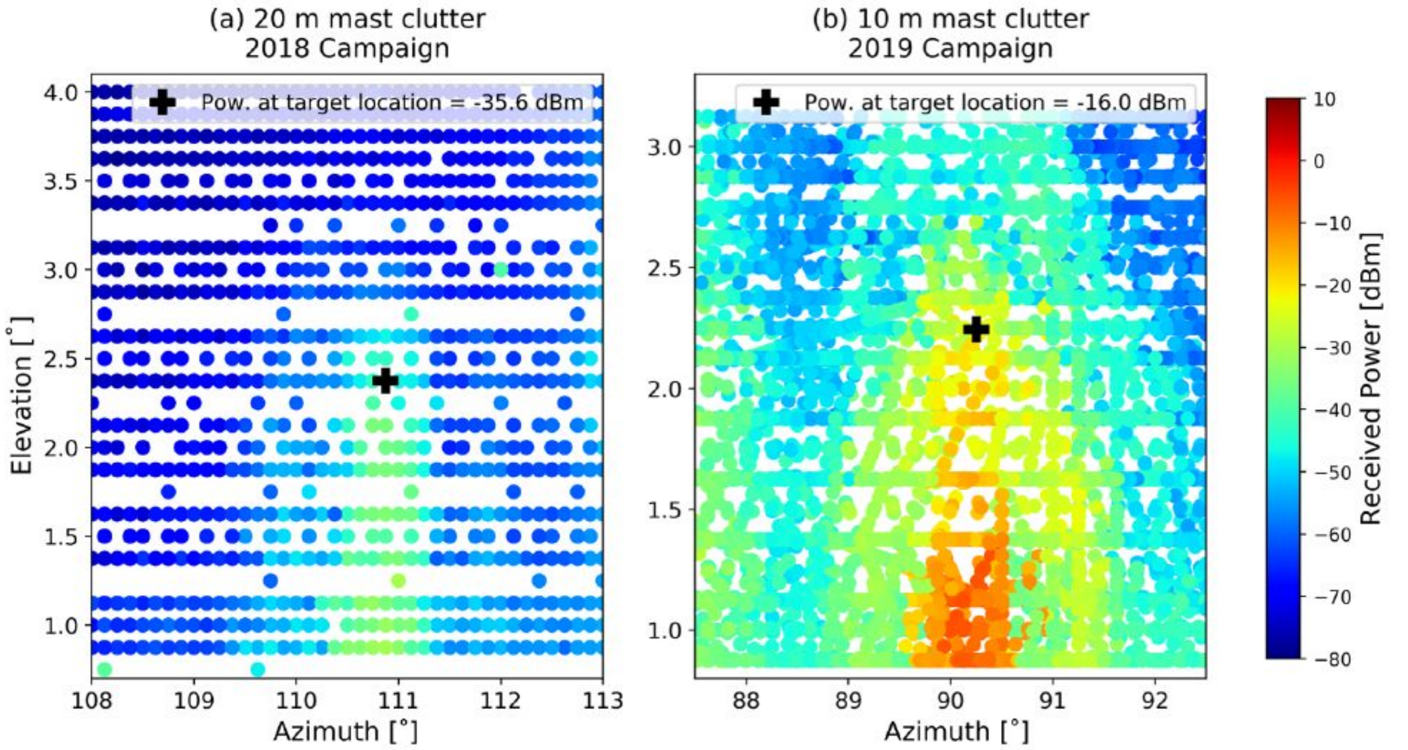
From Toledo et al., 2021

Absolute calibration (Toledo et al., 2021)

Signal to clutter ratio

- Clutter from surrounding objects (e.g., mast, ground) can contaminate the measured signal from the calibration target, introducing uncertainty in the retrieved power.

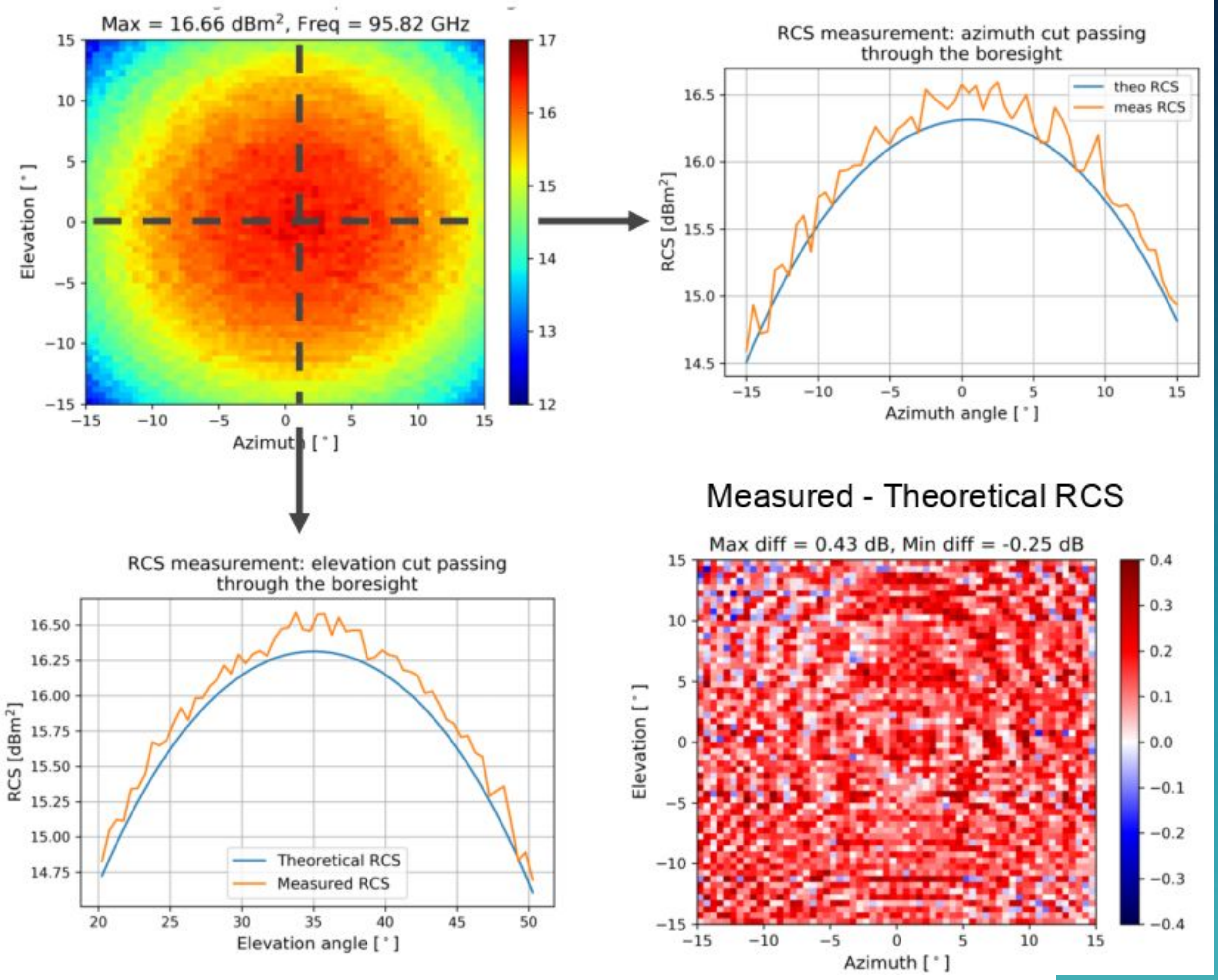
- The Signal-to-Clutter Ratio (SCR) quantifies this contamination, allowing the associated uncertainty to be included in the overall calibration error budget.



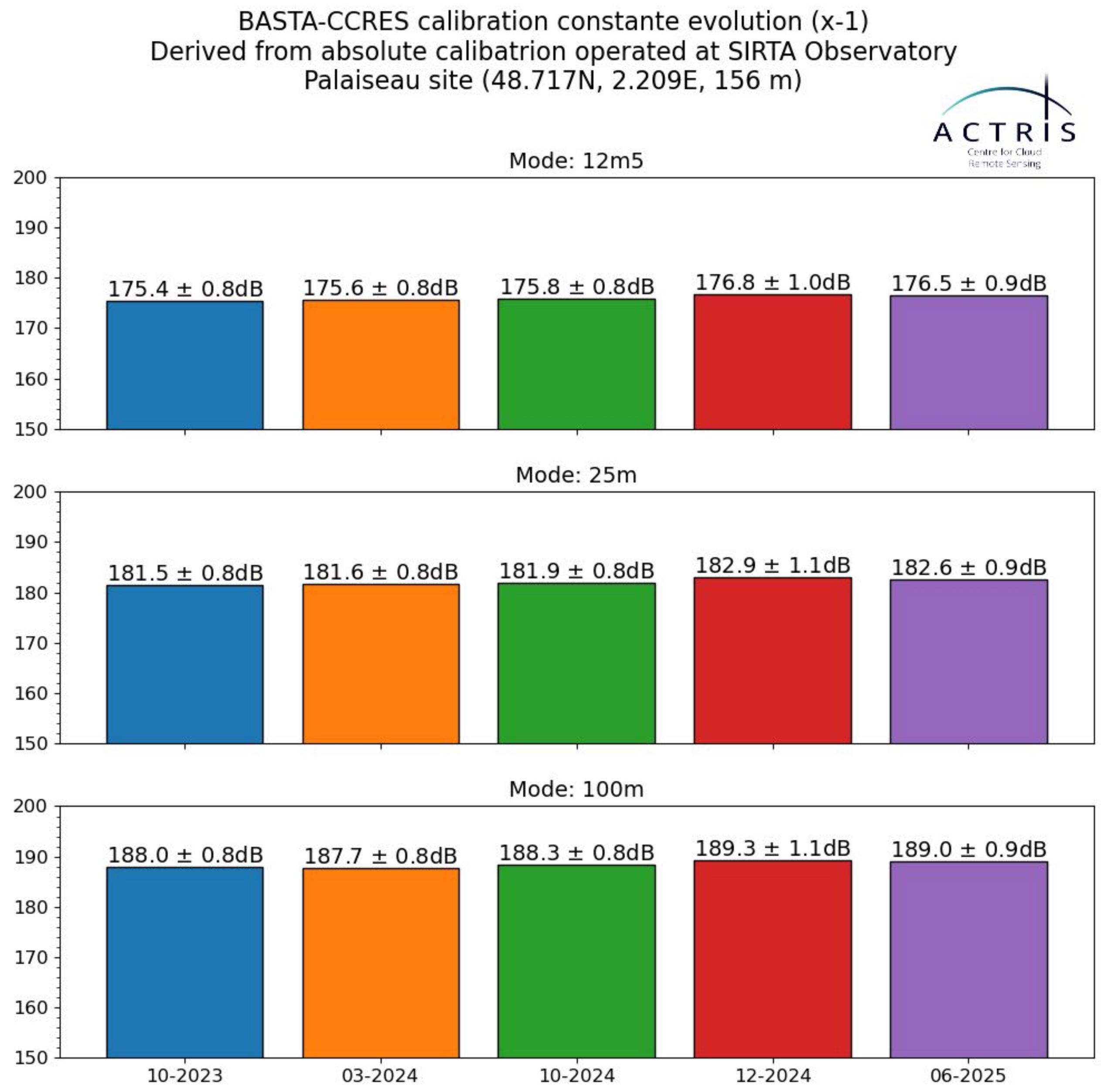
From Toledo et al., 2021

Absolute calibration (Toledo et al., 2021)

- First characterization of the 10 cm corner reflector in an anechoic chamber (University of Rennes)
- Identified a slight misalignment of 0.6° corrected using the theoretical model
- Measured RCS is ~0.4 dB above the theoretical value
- The measured curve shape matches the theoretical RCS with an RMSE of 0.2 dB
- The difference between the measured and theoretical RCS is within the [-0.25, 0.43] dB range



Absolute Calibration (Toledo et al., 2021)



Stability over time

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Absolute calibration (Toledo et al., 2021)

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- **Very reliable method** but is work intensive & hard to carry out
- Does not work with all DCRs
  - **Signal saturation** for RPG & Metek DCRs
- Need another solution → a **two step DCR calibration strategy**
  - 1st step: select one radar as the reference and do absolute calibration → BASTA-CCRES
  - 2nd step: transfer the calibration of BASTA-CCRES to those that are not calibrated
    - How ? By **comparing simultaneous vertical cloud measurements**

      → **BASTA-CCRES** (reference and calibrated) DCR radar **goes to every NF** to **calibrate their instruments**

I. Power calibration methods

Transfer calibration

Main steps for the calibration campaign

Step	Duration	Action
1	1 week	Absolute calibration of the BASTA-CCRES radar (reference) at SIRTA (Toledo et al., 2021)
2	1 week	Preparation of the two transport cases (radar + equipment) + discussion with the transport company + cases departure
3	0.5 week	CCRES team journeys for BASTA-CCRES set-up
4	8 weeks	Data collection + Real-time data transfer to Cloudnet + remote monitoring of the BASTA-CCRES to ensure everything is running smoothly
5	0.5 week	CCRES team journeys for BASTA-CCRES removal
6	1 week	Absolute calibration of the BASTA-CCRES radar (reference) at SIRTA
7	1-2 week-s	Data analysis and calibration report

- Total ~ 3.5 months for a calibration campaign
- Time consuming if properly planned, CCRES has the capacity to conduct 3 to 4 campaigns/year

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Before the DCR Calibration Transfer Campaign

To ensure the smooth progress of the campaign

- Asked to fill in a CCRES document with all relevant information: address, contact person, storage for DCR, map and photos, remote access, …

- Organize a Zoom meeting to discuss technical aspects: radar installation location, possible interferences, schedule of operation, …

- NF should perform radar maintenance before calibration campaign (for RPG: radome replacement, LN2 calibration); create a roadmap with all technical actions (shared with CCRES for post-analysis)

- Check data flow and PIDs on Cloudnet

Close interaction between CCRES, CLU and NF is essential !

Information for Doppler Cloud Radar calibration campaign preparation
[Station name]
[Dates of the campaign]

Station PI:

1. Information needed to ship the CCRES reference DCR to or from your site	
General information	
Proposed delivery date (indicate any restrictions or propose alternative date)	*To be proposed by CCRES*
Opening hours of your site (staff availability) for delivery	
VAT Number of your institution	
Contact person for the delivery	
Name	
First name	
Phone number	
Email	
Address of the delivery	
Institute or company name	
Street/street number	
City	
Zip code	

DCR Calibration Transfer campaign schedule

Previous campaigns
Current campaigns
Future campaigns

Site (NF)	Radar	Calibration period
Juelich (JOYCE)	MIRA 35 GHz	winter 2024
Leipzig (TROPOS) / Melptiz	2 RPG 94 GHz + 2 MIRA 35 GHz	jan-feb 2025
Lindenberg (MOL-RAO) / Rzecin	MIRA 35 GHz + RPG 94 GHz + BASTA 95GHz	mar-may 2025
→ Granada (AGORA)	RPG 35-94 GHz	~ oct-dec 2025
Bucharest (RADO)	RPG 94 GHz + MIRA 35 GHz	~ jan-feb 2026
Cluj (RADO)	RPG 94 GHz	~ mar-may 2026
Galati (RADO)	RPG 94 GHz	~ may-jul 2026
???	???	Fall 2026
Lampedusa ?	Metek 35 GHz	Spring 2027 ??? Otherwise DPOL method ?

DCR calibration transfer methodology (Jorquera et al., 2023)


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Calibration Transfer Methodology for Cloud Radars Based on Ice Cloud Observations

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ABSTRACT: This article presents a calibration transfer methodology that can be used between radars of the same or different frequency bands. This method enables the absolute calibration of a cloud radar by transferring it from another collocated instrument with known calibration, by simultaneously measuring vertical ice cloud reflectivity profiles. The advantage is that the added uncertainty in the newly calibrated instrument can converge to the magnitude of the reference instrument calibration. This is achieved by carefully selecting comparable data, including the identification of the reflectivity range that avoids the disparities introduced by differences in sensitivity or scattering regime. The result is a correction coefficient used to compensate measurement bias in the uncalibrated instrument. Calibration transfer uncertainty can be reduced by increasing the number of sampling periods. The methodology was applied between collocated W-band radars deployed during the ICE-GENESIS campaign (Switzerland 2020/21). A difference of 2.2 dB was found in their reflectivity measurements, with an uncertainty of 0.7 dB. The calibration transfer was also applied to radars of different frequency, an X-band radar with unknown calibration and a W-band radar with manufacturer calibration; the difference found was −16.7 dB with an uncertainty of 1.2 dB. The method was validated through closure, by transferring calibration between three different radars in two different case studies. For the first case, involving three W-band radars, the bias found was of 0.2 dB. In the second case, involving two W-band and one X-band radar, the bias found was of 0.3 dB. These results imply that the biases introduced by performing the calibration transfer with this method are negligible.

KEYWORDS: Cloud retrieval; Data quality control; Radars/radar observations; Weather radar signal processing; Algorithms

1. Introduction

Cloud and precipitation processes occurring in mixed-phase environments are studied with increasing level of priority as their importance covers a broad range of scientific and technical fields. The complex interactions of water vapor, ice crystals, snowflakes, and supercooled liquid water droplets lead numerical weather models to unavoidably simplify the representation of such processes (Rosenfeld and Woodley 2000; Tapiador et al. 2019), which have a very large impact in their final performance (Grabowski et al. 2019). Ice and mixed-phase clouds also present dangerous environments that impact aviation authorities and industries, since it is still hard to evaluate both conceptually and empirically, at the time of design or acceptance of sensitive equipment, the potential risk exposure to these threats (Haggerty et al. 2019; Wang et al. 2012).

Field observations of these cloud types are key to properly assess their physical processes. Yet, such retrievals are usually expensive and hard to gather. This situation motivated the ICE-GENESIS campaign (Billault-Roux et al. 2023), which combined the best available measurement techniques to observe ice and mixed-phase clouds, both in situ and remotely. In this campaign, we highlight the use of one X-band and three different W-band radars retrieving reflectivity, Doppler velocity, and Doppler spectrum observations from the surface. These measurements should prove key in later studies regarding micro- and macrophysical cloud properties, such as their liquid water and ice content, melting-layer height, precipitation rate, and inner cloud turbulence, among others (e.g., Protat et al. 2007; Liao et al. 2009; Trömel et al. 2019).

Radar calibration has an important impact when performing such microphysical retrievals. Errors in the calibration constant value will bias each reflectivity retrieval. For example, a calibration error of 1 dB will bias ice content retrievals by about 15%–20% (Fox and Illingworth 1997; Ewald et al. 2019). However, radar calibration can be difficult to implement. One of the reasons is that, in general, the chosen calibration setup will depend on the specific characteristics of each instrument and on their operating conditions. Along with these technical difficulties, there is also the need to

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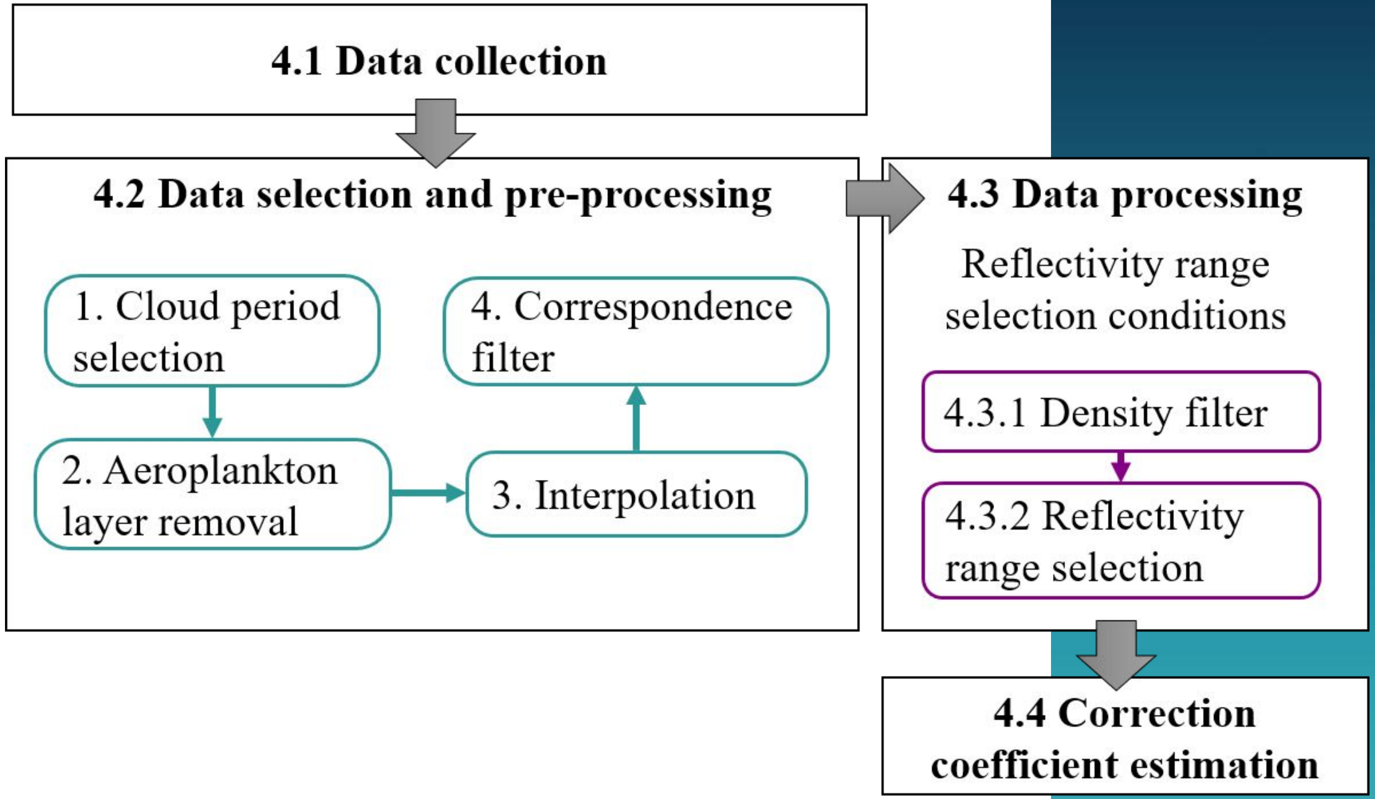
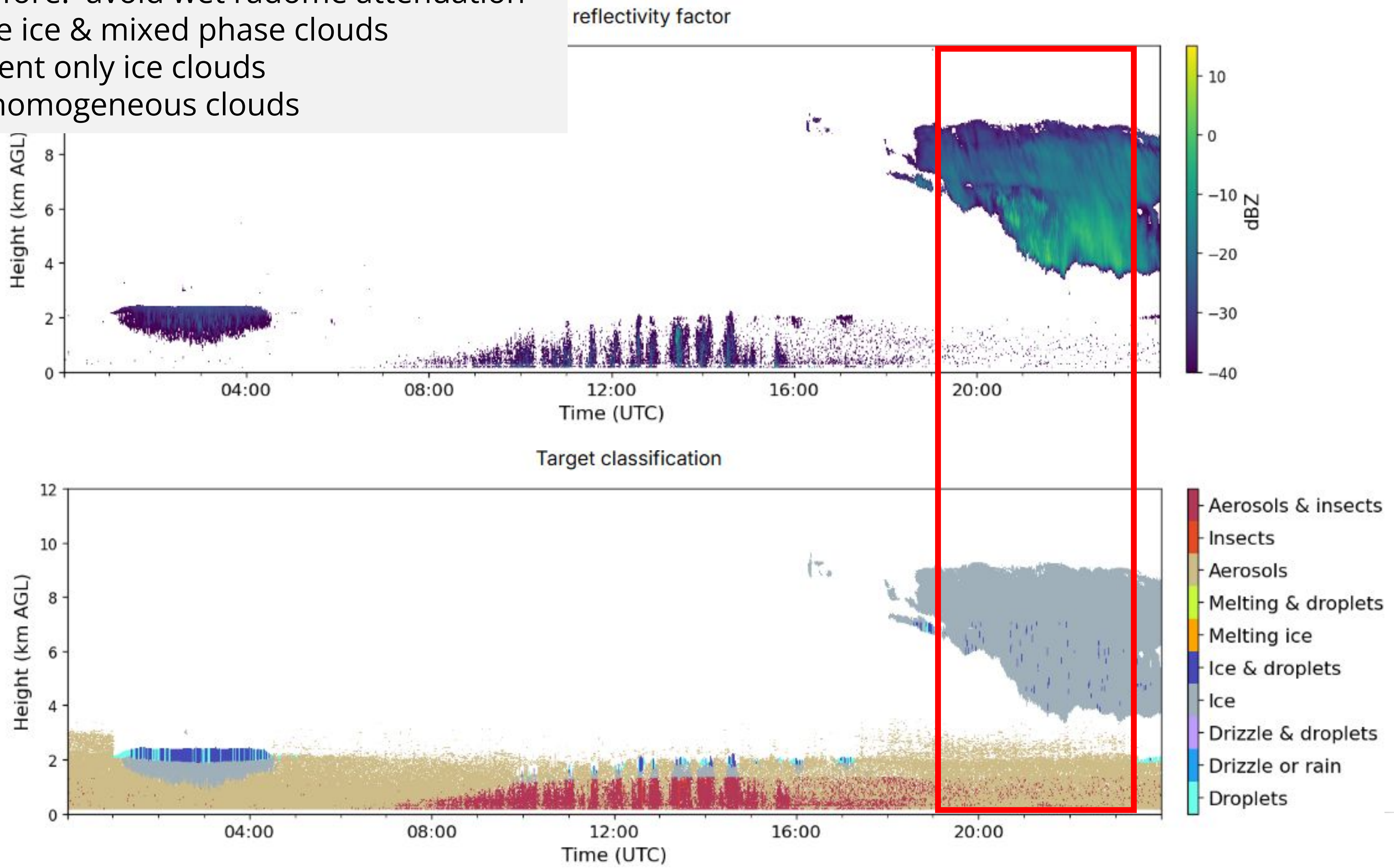


Cloud event selection

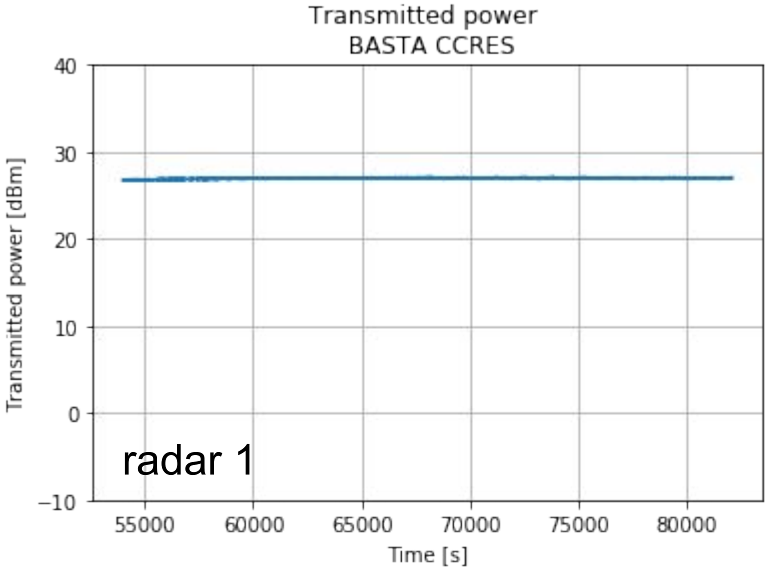
https://cloudnet.fmi.fi/
No rain before: avoid wet radome attenuation
DCRs same ice & mixed phase clouds
DCR different only ice clouds
Focus on homogeneous clouds

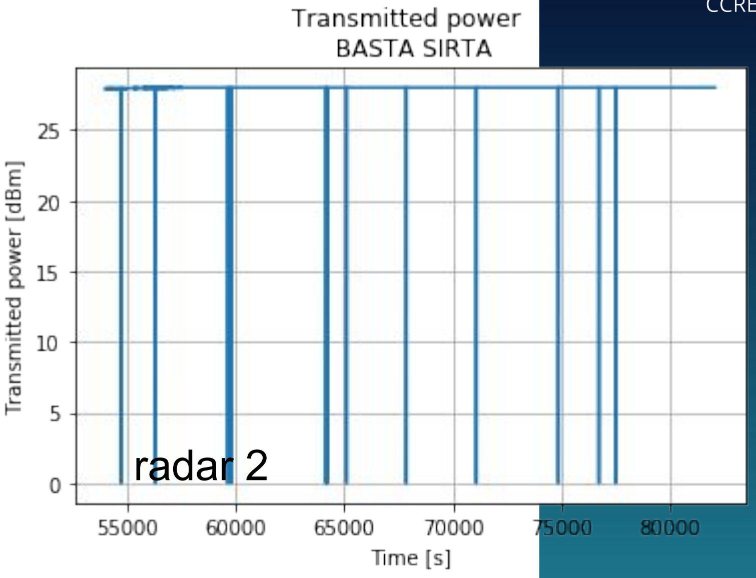


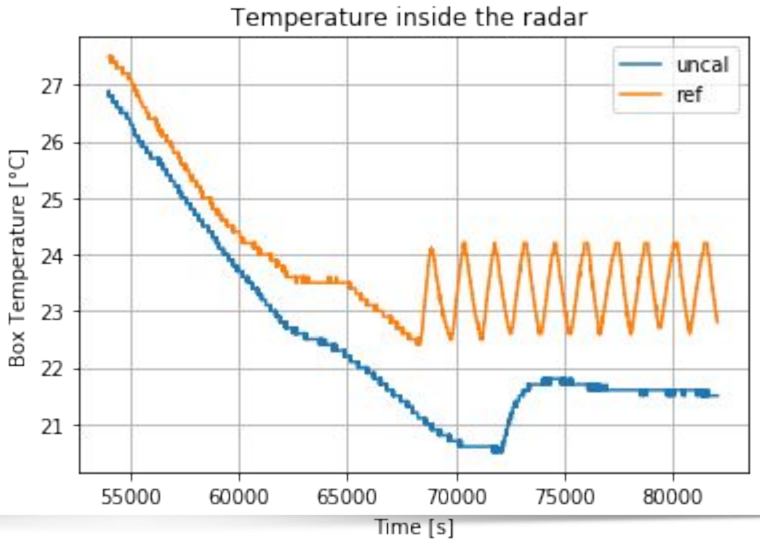
Before applying the methodology

Check list

- Transmitted power should be constant
- Internal radar temperature should be < 40°C





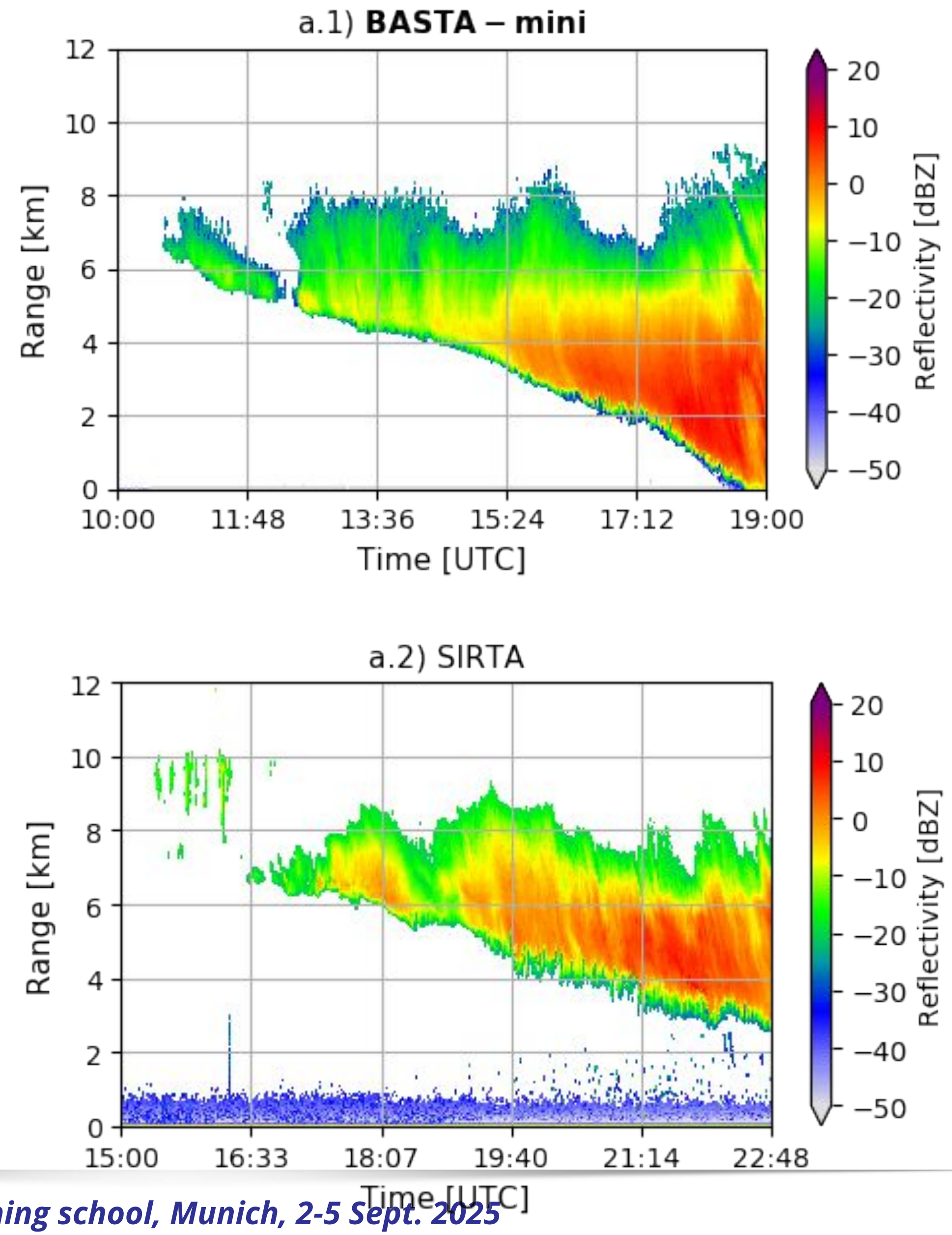


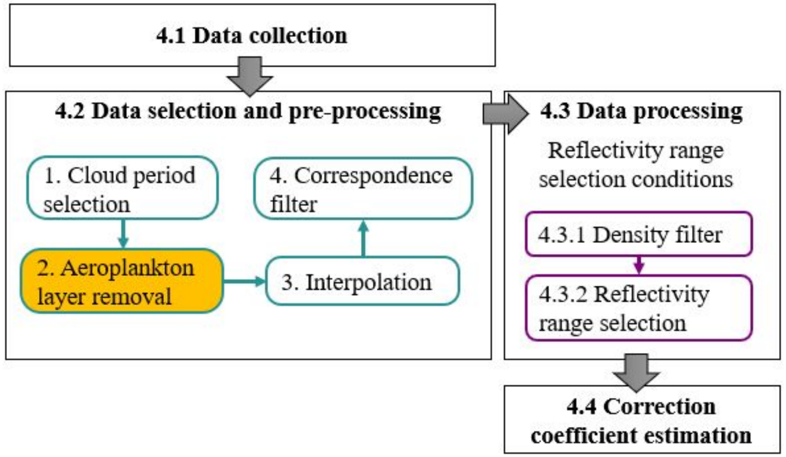
Aeroplankton layer removal

The data must be removed up to the height of the boundary layer

Case 1 : 2m T°C ~ 0°C (winter)

Case 2: 2m T°C ~ 15°C (spring)





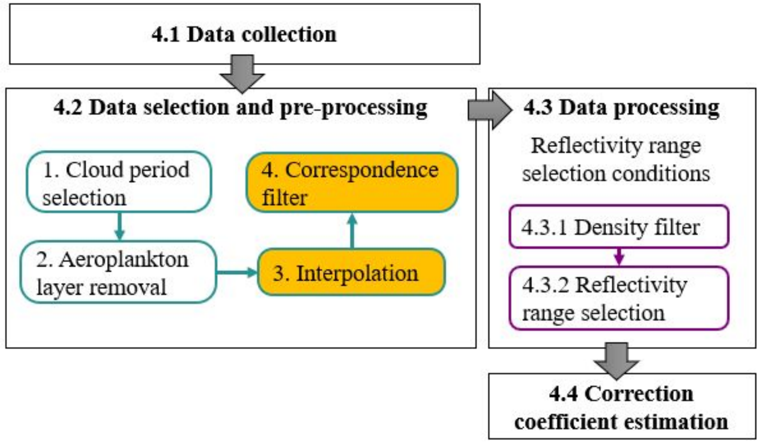
Interpolation and correspondence filter

Interpolation

- The radar data share the same time grid.
- The radar data share the same spatial grid (range).

Correspondence Filter

- Both radars must have the same data grid time/range
- All data not detected by both radars simultaneously is deleted. Both radars thus end up with the same amount of coordinate data.



Before vs after

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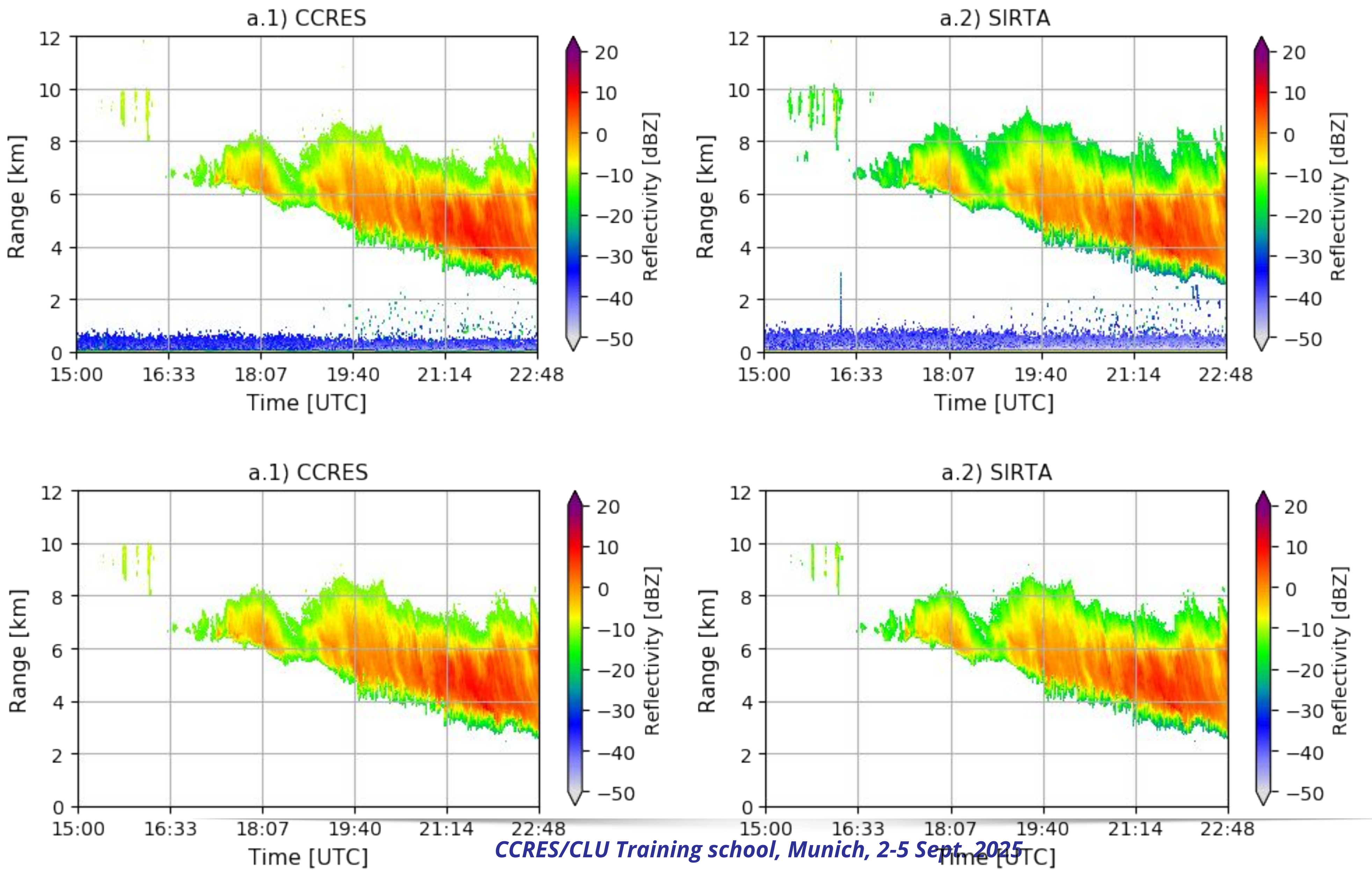
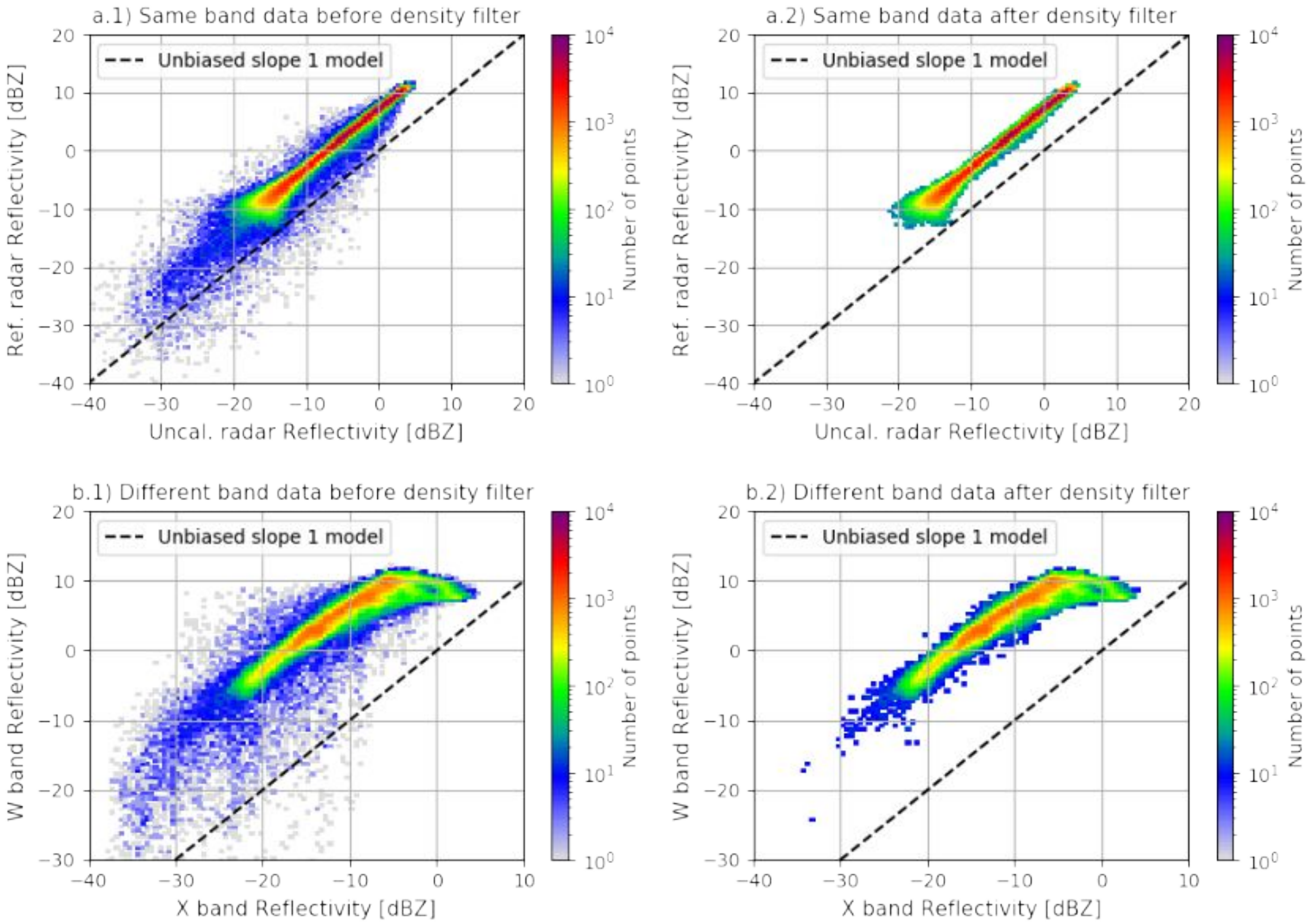
Before

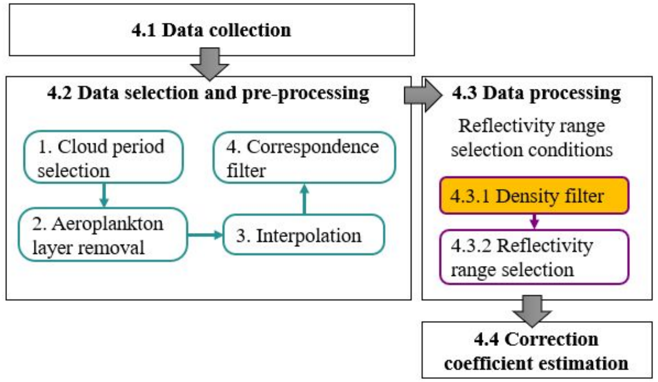
After



Density filter

- The purpose of this filter is to remove uncorrelated data, including outliers that could skew the calibration transfer.
- The filter removes 2.5% of colocalised data pairs with less repeatability.





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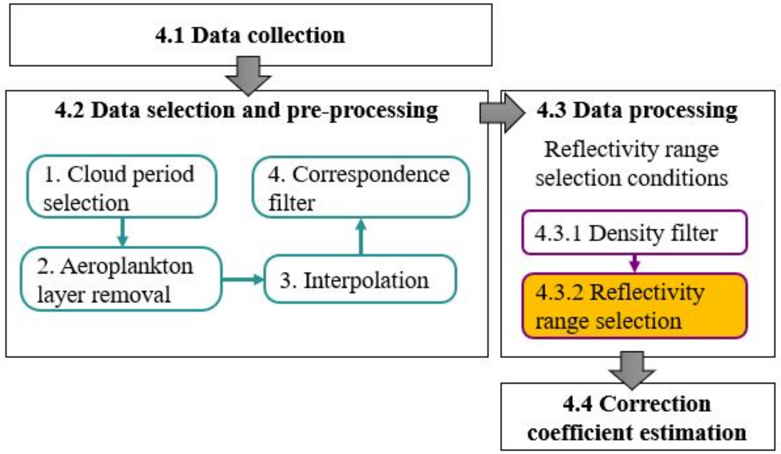
Data selection

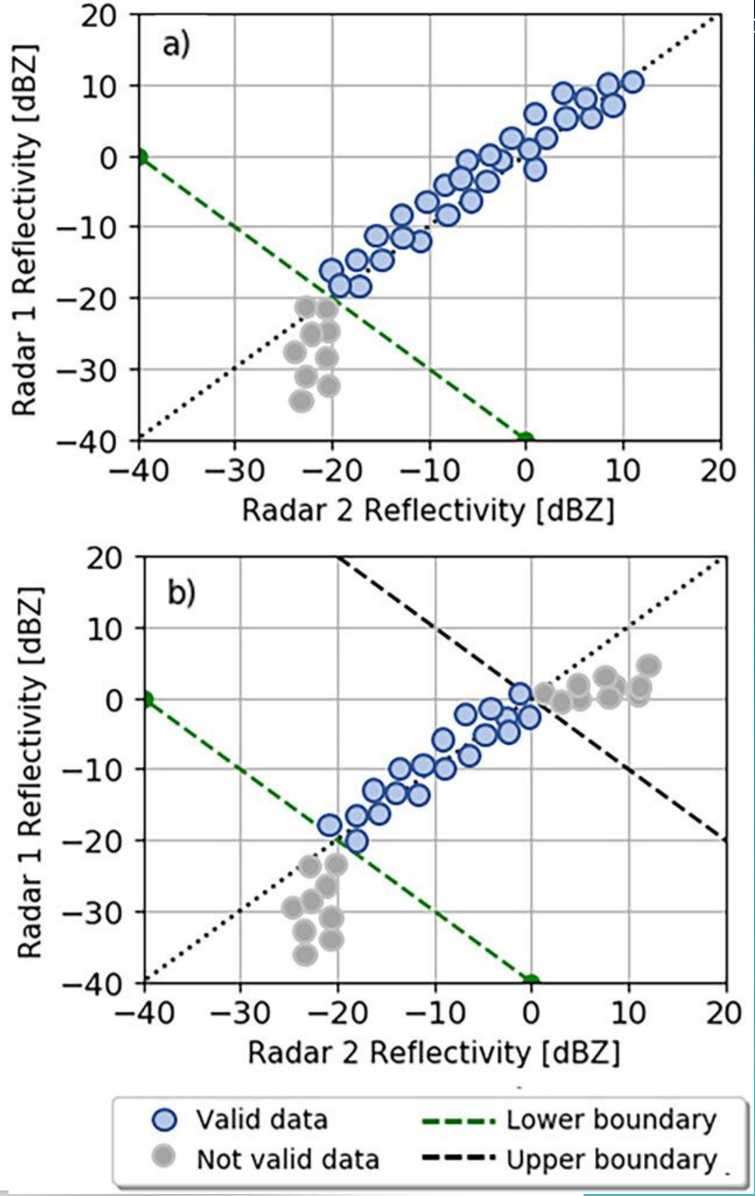
Radar operating at same frequency

- The main source of systematic differences in their measurements comes from instrumental sensitivity:
  - different antenna sizes
  - use of different electronic components

With two radars of different frequencies

- Variations in atmospheric and cloud signal absorption

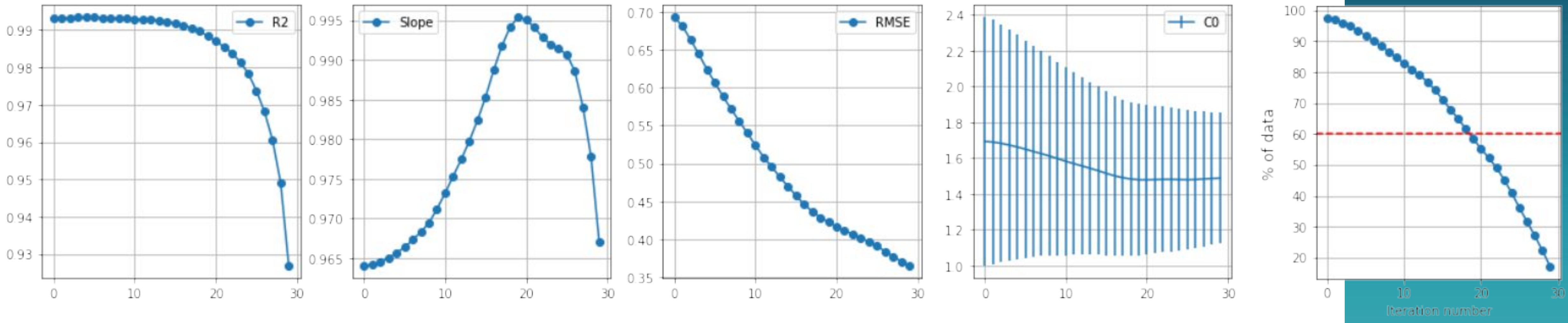




Reflectivity selection

Selection criteria : best compromise

- $R^2 \sim 1$
- Slope ~ 1
- Minimum of RMSE
- % of data > 60%



Application to Leipzig Campaign

Preliminary results for 22nd of February 2025 between 08:00 and 19:00 UTC at LEIPZIG,

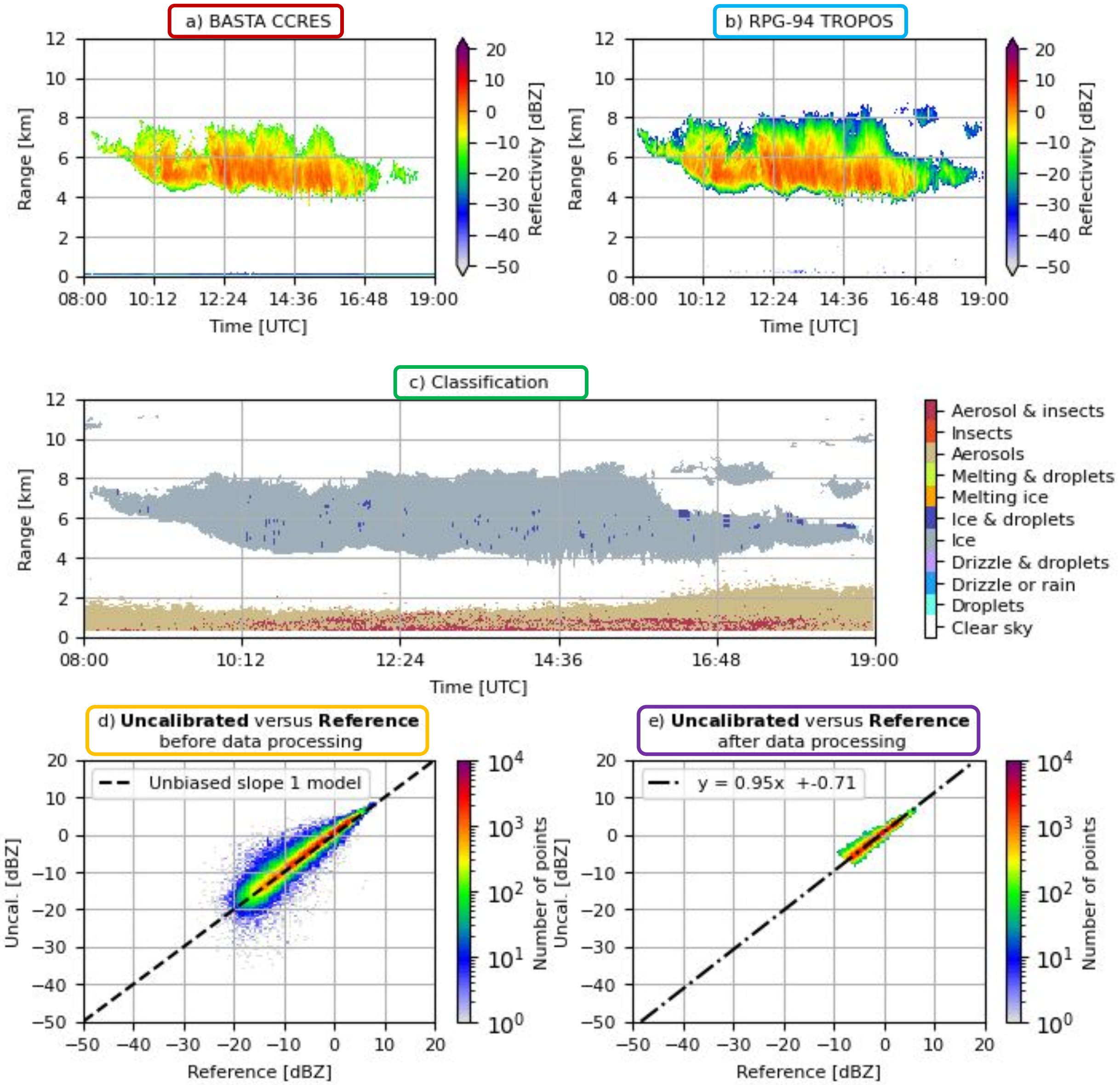
(a) Vertical profiles of reflectivity measured by CCRES reference radar,

(b) Vertical profile of reflectivity measured by the RPG-94 TROPOS cloud radar,

(c) Classification derived by Cloudnet algorithm,

(d) Raw uncalibrated reflectivity versus reference reflectivity,

(e) Processed uncalibrated reflectivity versus reference reflectivity.



Correction coefficient estimation

Correction coefficient estimation for one cloud event

$K_i = mean(Z_{ref} - Z_{uncal})$

$_{Ki} = std\ (Z_{ref} - Z_{uncal})$

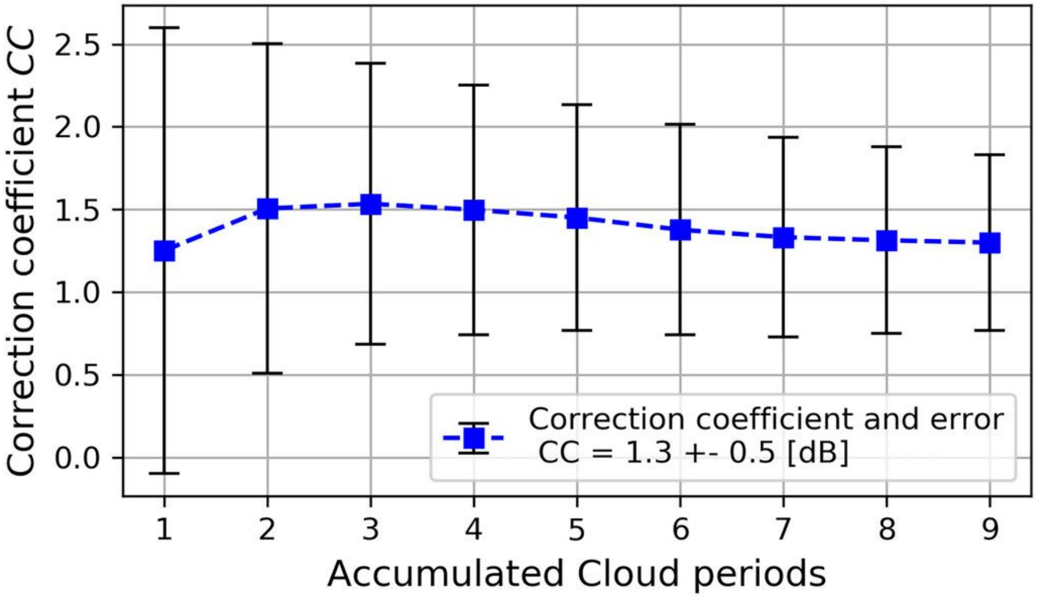
Correction coefficient

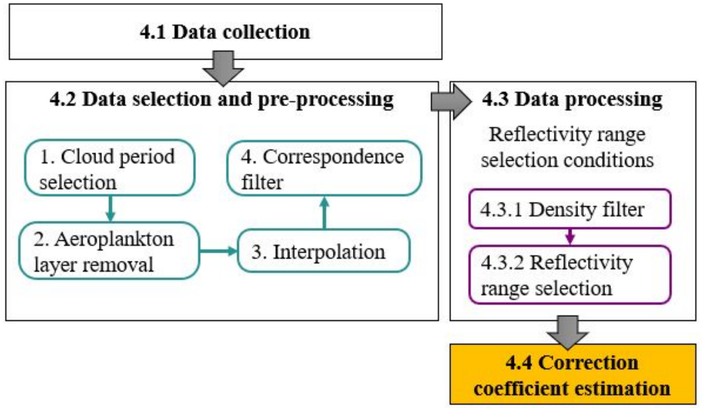
CC =

N : number of cloud events

: radar reference uncertainty

: standard deviation of correction coeff K_i





Calibration transfer report

- Write a synthesis of calibration transfer analysis for each campaign and uncalibrated DCR radar
- Correction Coefficient is transmitted to CLU Data Center https://cloudnet.fmi.fi/

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Calibration transfer report

BASTA-mini CCRES and MIRA

Document status

Indice	Action	Date	Name	Function	Signature
	Prepared	28/05/2024	Susana Jorquera	IR	
	Revised	28/05/2024	Felipe Toledo	IR	
	Approved		Julien Delanoë	Prof.	

Content

I. Resume

The calibration transfer has been carried out between BASTA-mini CCRES and MIRA radar at the Joyce Observatory (Jülich, Germany) with 52 hours of reflectivity measurements divided into 9 periods, between December, 2023 and March 2024. The results are indicated in the following table:

Table 1 : Calibration transfer results.

Correction coefficient (Reference - MIRA)	Uncertainty
- 0.2 dB	0.9 dB

The campaign in Germany has been carried out with the purpose of testing the ACTRIS calibration transfer strategy, between W and Ka band radars. The correction coefficient for MIRA is calculated using Cloudnet reflectivity profiles.

Summary of calibration transfer campaigns in 2025

Preliminary results

Location	*Cloud radar*	*Number of cloud events*	*Periods duration accumulated*	*Correction coefficient [dB]*
Leipzig campaign	MIRA-35 TROPOS	2	8h15	1.48 ± 1.09
	RPG-94 TROPOS	7	38h30	-1.12 ± 0.88
	MIRA-35 Melpitz	7	38h30	-1.96 ± 0.91
	RPG-94 Melpitz	7	38h30	-0.29 ± 0.9
Lindenberg campaign	MIRA-35 MOL-RAO	4	17h30	-0.76 ± 1.09
	RPG-94 MOL-RAO	6	24h20	-0.10 ± 0.98
	BASTA Rzecin	3	14h45	-2.04 ± 0.98

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I. Power calibration methods

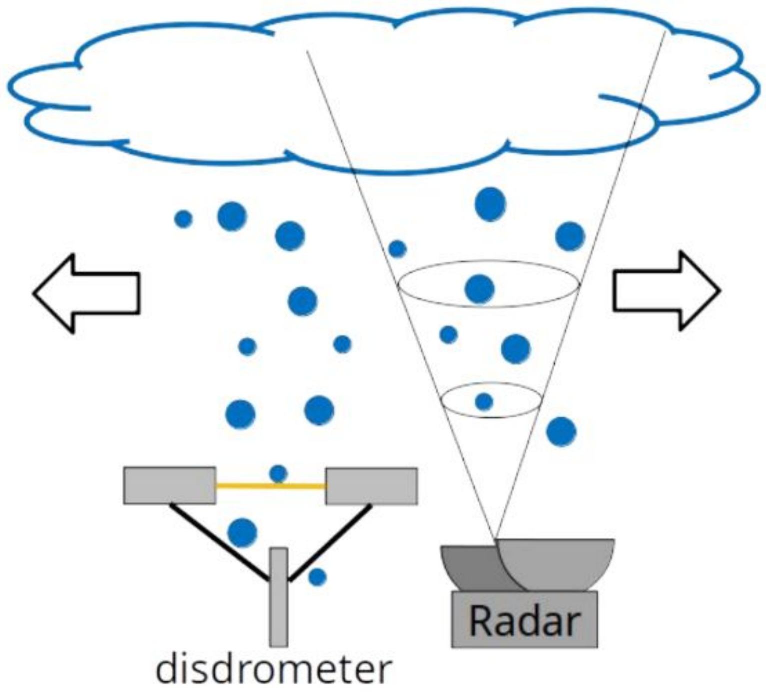
Disdrometer monitoring

Calibration constant monitoring with disdrometer

(Dias Neto et al., 2019; Kollias et al., 2019; Myagkov et al., 2020)

- Automatically compare **DCR Zh** and **derived disdrometer Zh** in **stratiform rain events**
  → Ongoing CCRES activities
    - Aims to monitor time shifts, drifts, DCR calibration constant deviation

- **Disdrometer:** Optical particle counter, provides N(D), the droplet size distribution during a rain event
- Forward modelling of Ze based on measured N(D)
- Allows to compare forward simulated Ze(disdrometer) to radar Ze



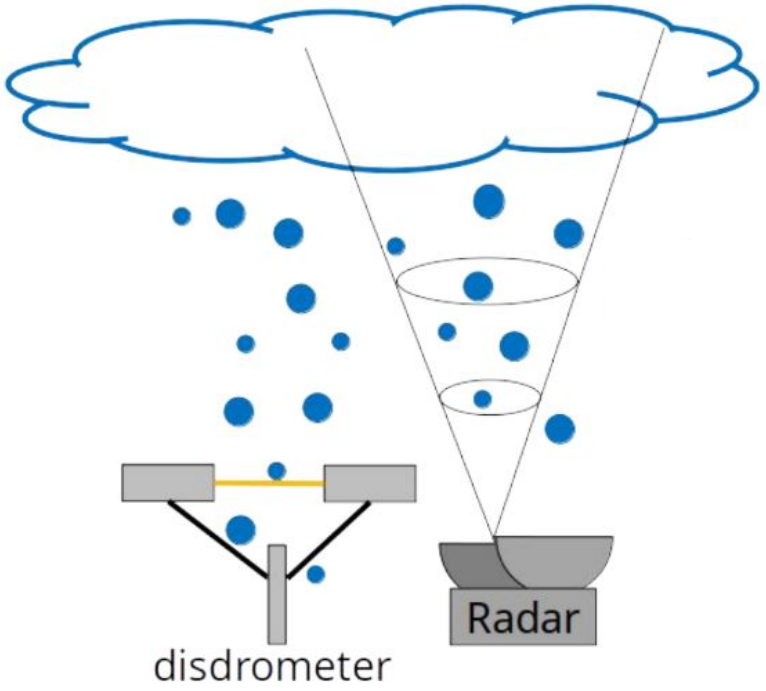
- **Radar:** Measures reflectivity (Ze) of all droplets in a volume
- Ze ~N(D).D^6
- Correction of Ze for attenuation
- Compare Ze to Ze(disdrometer)

Calibration constant monitoring with disdrometer

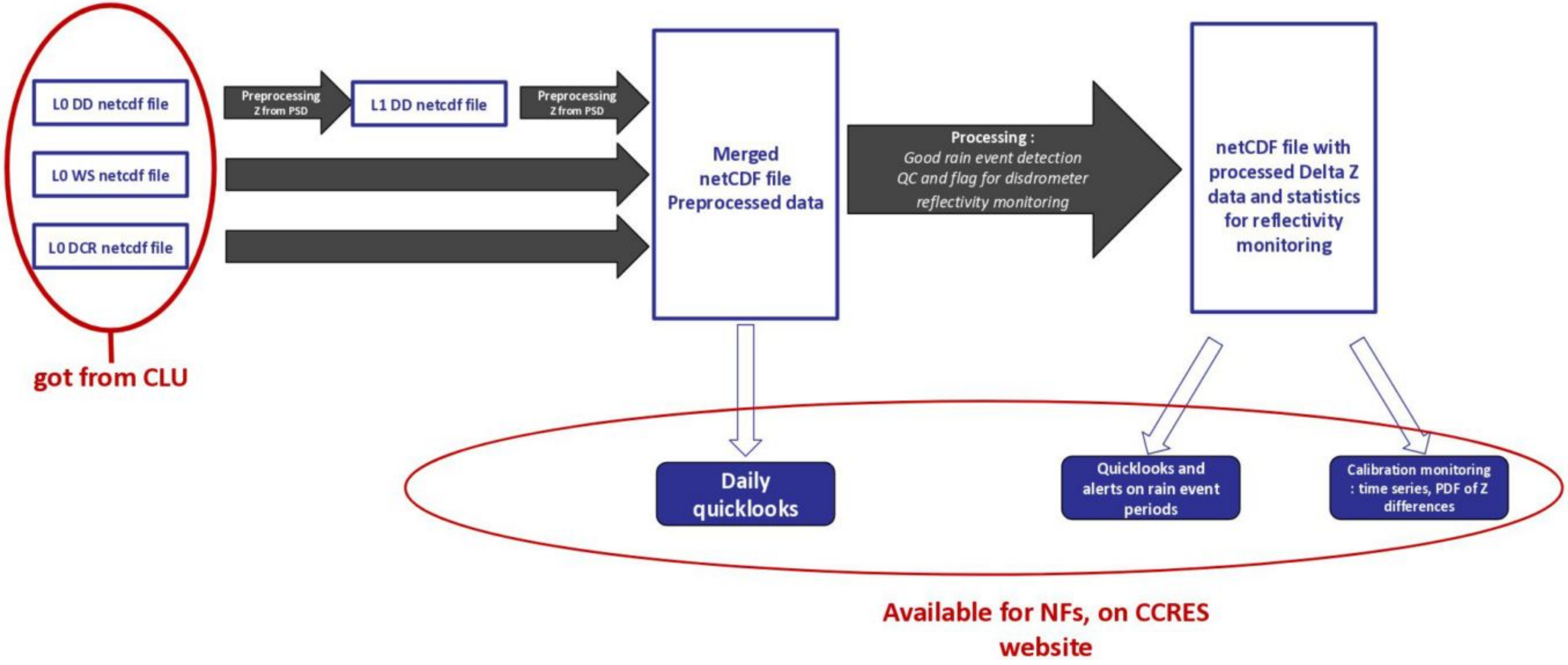
(Dias Neto et al., 2019; Kollias et al., 2019; Myagkov et al., 2020)

- Automatically compare **DCR Zh** and **derived disdrometer Zh** in **stratiform rain events**
  → Ongoing CCRES activities
  - Aims to monitor time shifts, drifts, DCR calibration constant deviation

- **Minimum setup = collocated radar & disdrometer**
- But **weather station is crucial** to better identify best rain periods for more accurate monitoring
- Monitor DD measurement over time while DD calibration techniques are not operational



CCRES disdrometer processing



https://github.com/ACTRIS-CCRES/ccres_disdrometer_processing

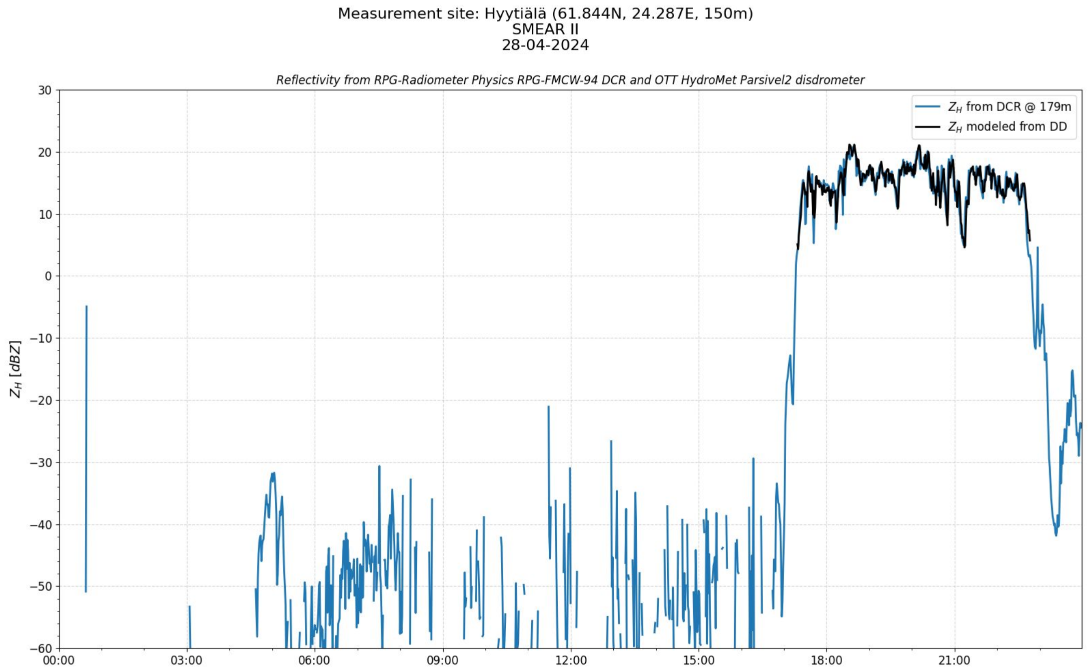
+

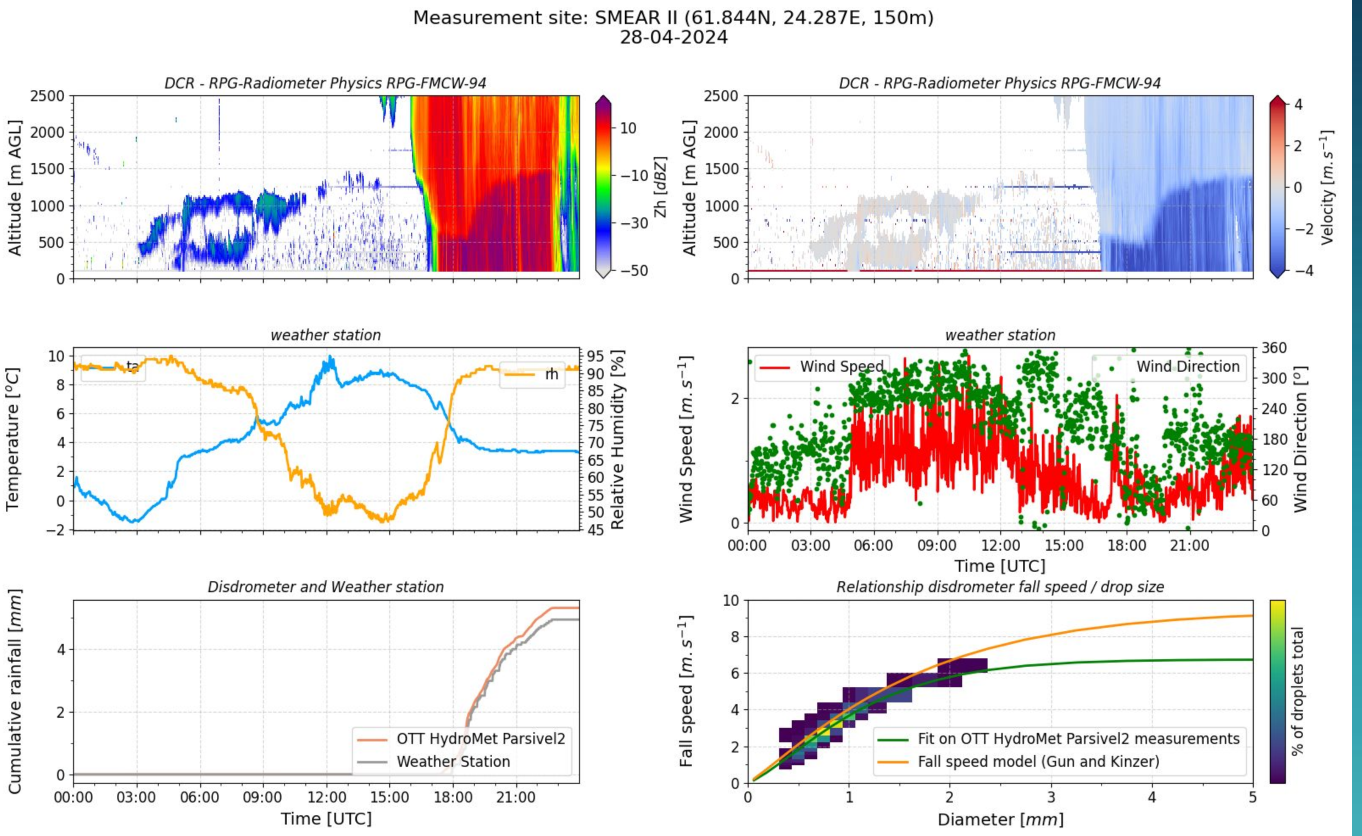
https://ccres-disdrometer-processing.readthedocs.io/en/latest/index.html

First product: daily quicklooks

https://ccres.aeris-data.fr/en/data-visualization/

Overview of weather conditions for a given day, and first comparison of Z from DCR (at a relevant range) and disdrometer, without any quality control





Second product: "rain event quicklooks"

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Criteria used for rain event selection

Weather station data enables more accurate selection of interesting rain periods for calibration monitoring

Variables	Limits	With WS and DD	Only with DD	Objectives
Air temperature	>2°C	✓	✗	Remove solid precipitation
Relative humidity	> 80% < 98%	✓	✗	Avoid fog cases, evaporation
Wind speed	< 7 m/s	✓	✗	Ensure rain continuity
Wind direction	Deviation of less than 45° to the DD axis	✓	✗	Quality control on disdrometer measurement
Relationship fall speed / drop size	< 30% vs Gun and Kinzer	✓	✓	Ensure robustness of Delta Z statistics

Variables	Limits	With WS and DD	Only with DD	Objectives
Rain duration	> 3h	✓	✓	Have significant cumulative precipitation to ensure good statistics
Cumulated rain	> 3mm	✓	✓	
Rain gap	< 1h	✓	✓	Ensure rain continuity
Relative difference in cumulated rain seen by pluviometer and disdrometer	30%	✓	✗	**Quality control to ensure the consistency of disdrometer measurement**
Number of timesteps kept from the identified event for Delta Z monitoring	> 50 points	✓	✓	Ensure robustness of Delta Z statistics

Quality control for timestep selection inside detected rain periods

Second product: “rain event quicklooks”

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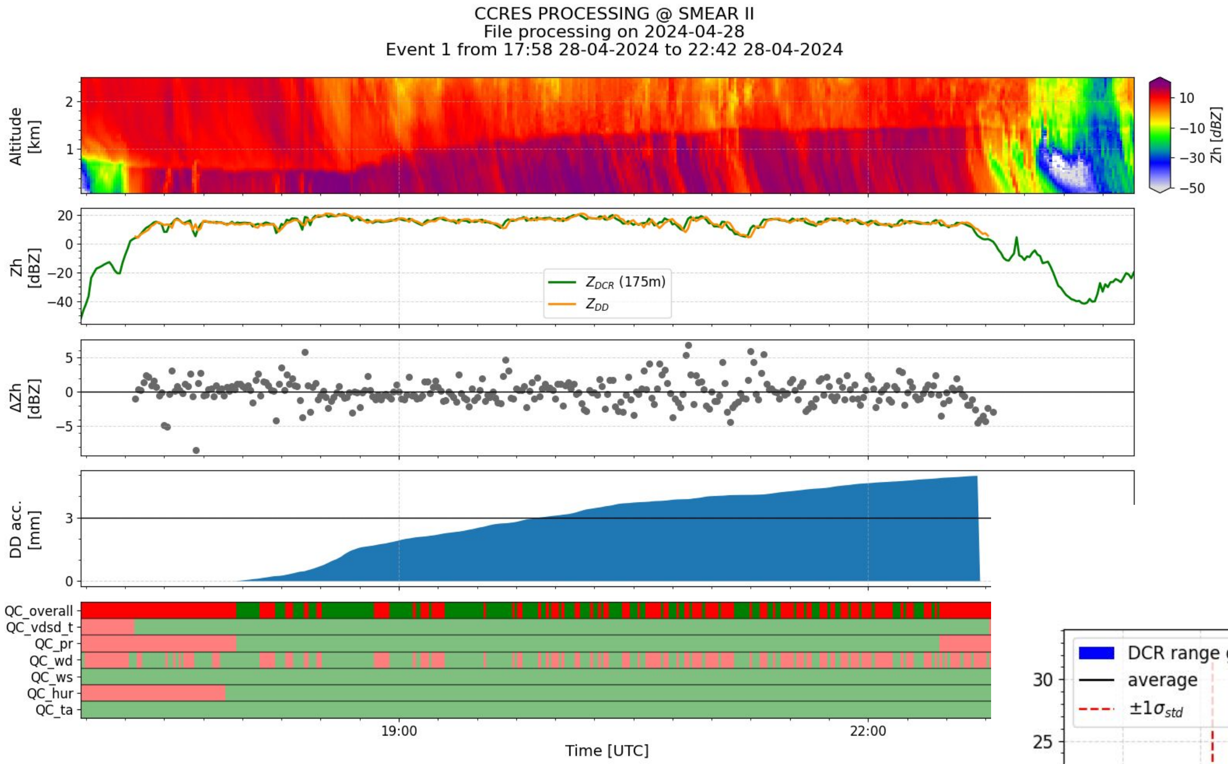
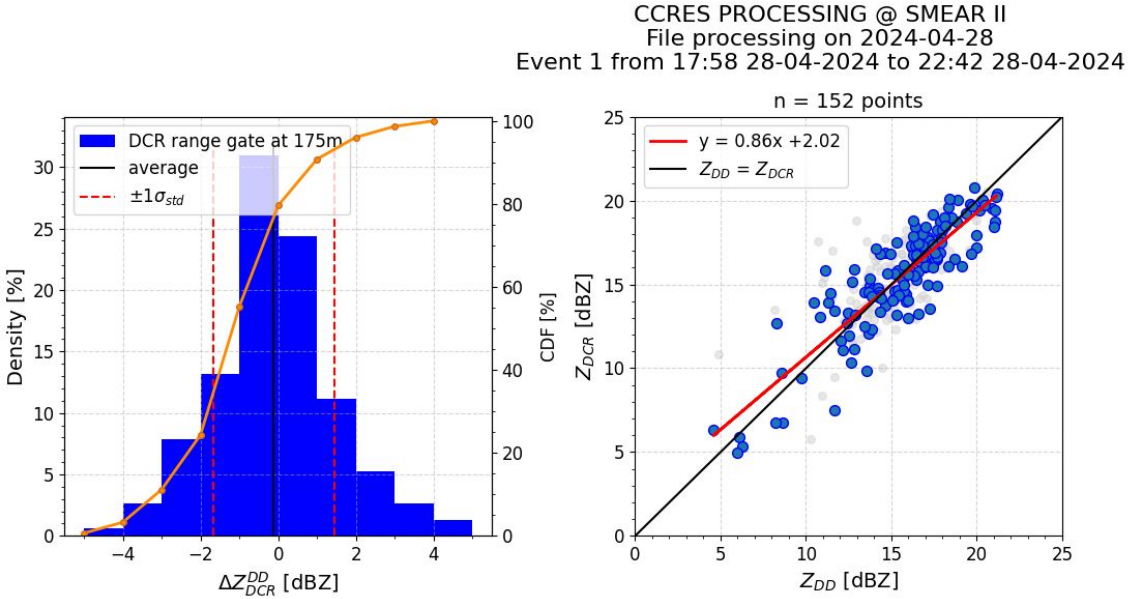
Quicklooks



Views of the event +- 1h, quality control

Summary of the event : overall statistics, ΔZ pdf, ZDD vs ZDCR scatter plot



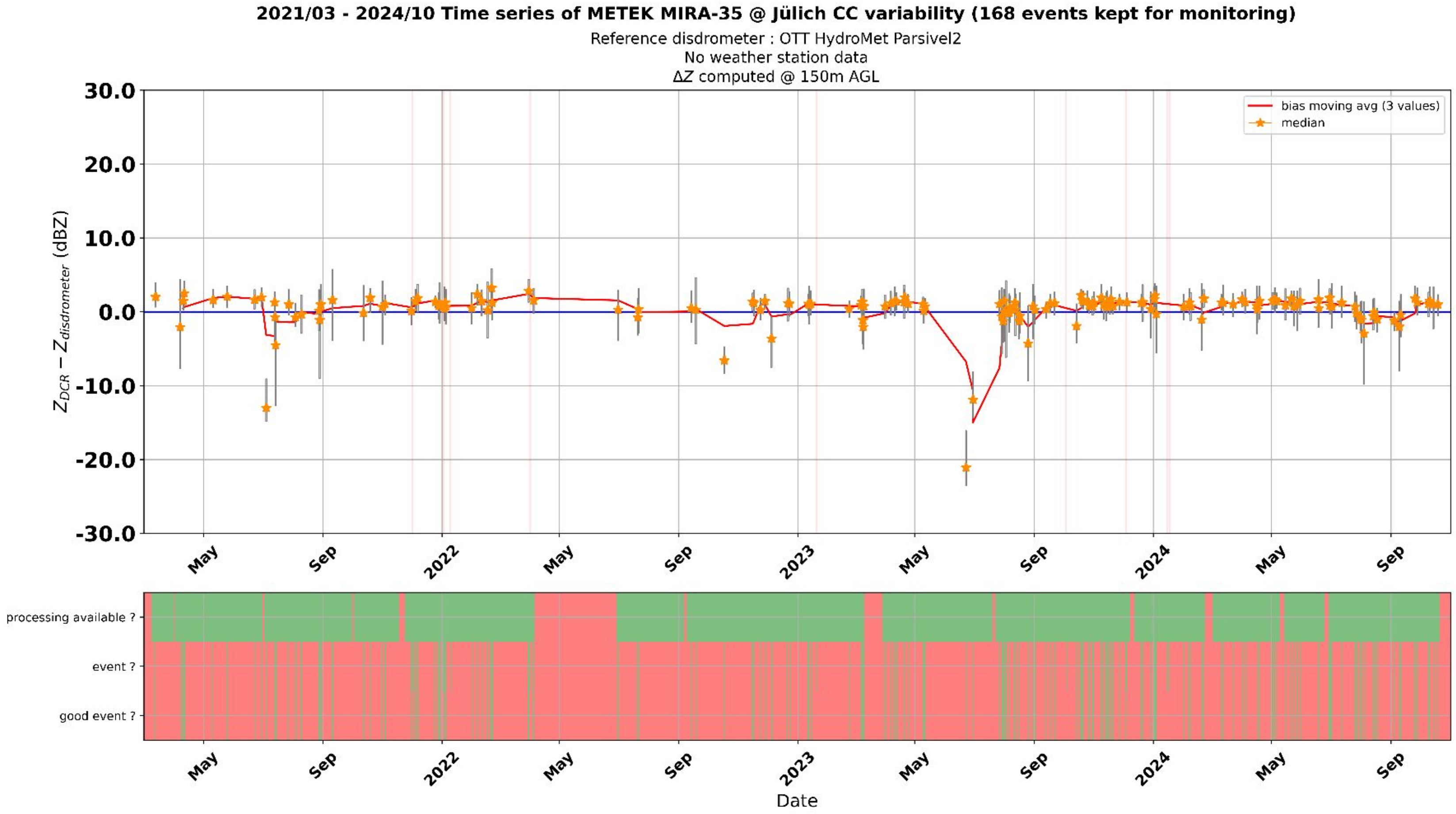
Event duration : 285 minutes

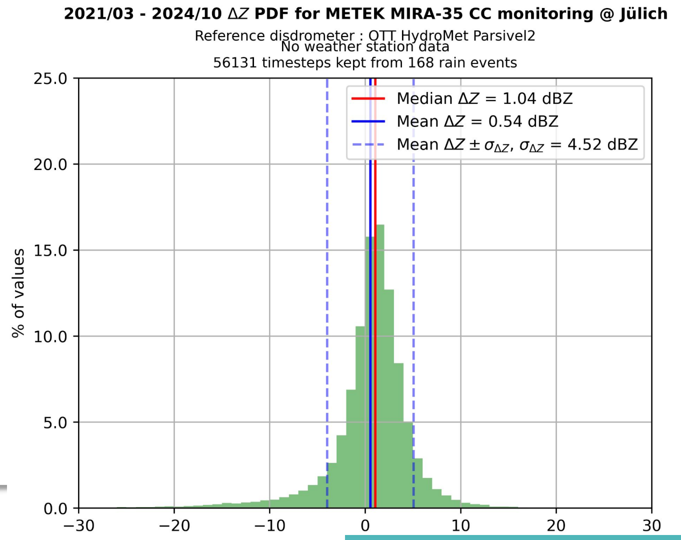
Rainfall accumulation : 4.93mm

Mean ΔZ_{DCR}^{DD} : -0.11dBZ

CCRES/

Third product : long-term monitoring





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Thank you !