



ACTRIS  
CCRES

The logo features the word 'ACTRIS' in a teal, sans-serif font, with a teal circle inside the letter 'O'. A teal vertical line extends upwards from the top of the 'O' to a teal circle. To the right of this line are three more teal circles of increasing size, arranged in a diagonal line. A dark blue arc curves over the top of the text.

Calibration transfer experiment  
JOYCE Observatory, Germany

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# Motivation

- Cloud radar absolute calibration is complex
  - Requires specific setups for each radar model
  - Can be time-intensive for the operators
  - Difficult to implement uniformly over a network setting
- Calibration Transfer can alleviate this problem
  - Works between radars of different models
  - Uncertainty in the calibration transfer comparable to other absolute methods
  - Takes time for profile sampling, but requires very little intervention from the operators



# Motivation

- **Calibration strategy**

- Calibrate a reference radar with precision using an absolute method
- Move the reference radar to transfer its calibration to other instruments in the network

- **Questions**

- How reliable is the reference instrument calibration after travel
- What are the resources needed when applying this procedure **operationally**



# The campaign

- **Objective:** To test the calibration transfer service at the JOYCE observatory, in Germany.
  - Calibration transfer to a MIRA radar
    - Ka Band
    - Follows ACTRIS guidelines, data available in Cloudnet
- Reference radar:
  - BASTA-Mini CCRES from the SIRTA observatory, in France.
    - W band
    - Pre and post-campaign calibration done using a reference corner reflector
    - Calibration uncertainty of 0.8 dB



# Experimental setup

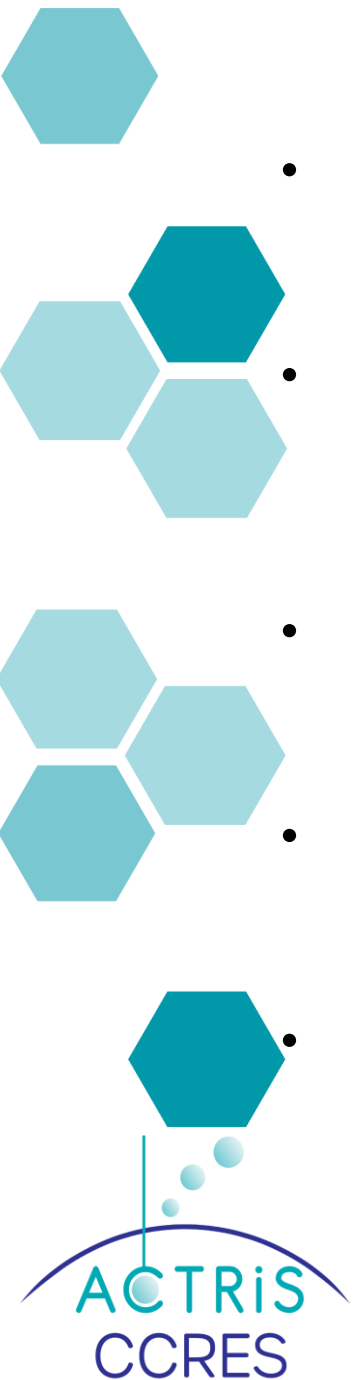
- One day for the setup of the reference radar, need a minimum of two people (radar operator and site expert)
- Max. distance of 25 meters between BASTA-Mini and its control electronics (PC and power supply).
  - The PC and power supply must be indoors.
  - Internet access is recommended for surveillance.
- Distance between the radars was less than 10 meters, but this distance can be greater. Calib. transfers within ~50 m of separation have been done before.
- Cloudnet data used for MIRA
  - 36 meters and 3 seconds resolution
  - Wind scans every 30 minutes
- Calibrated data used for BASTA-Mini CCRES
  - 25 meters and 3 seconds resolution
  - Vertically pointing
  - Periodic radome blower



**Joyce Obs. Radar**  
MIRA  
Ka Band

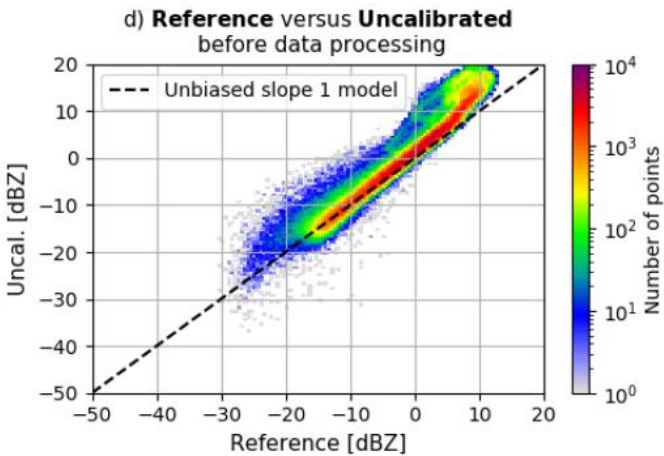
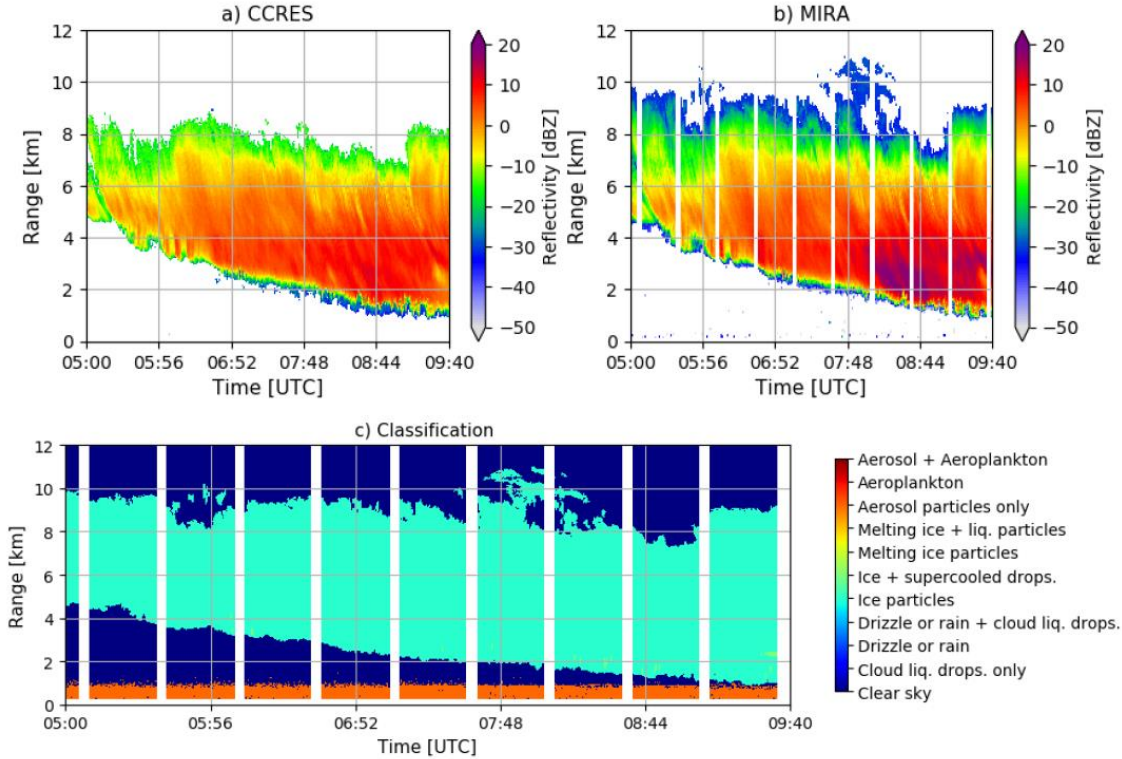


**Reference Radar**  
BASTA-Mini CCRES  
W Band

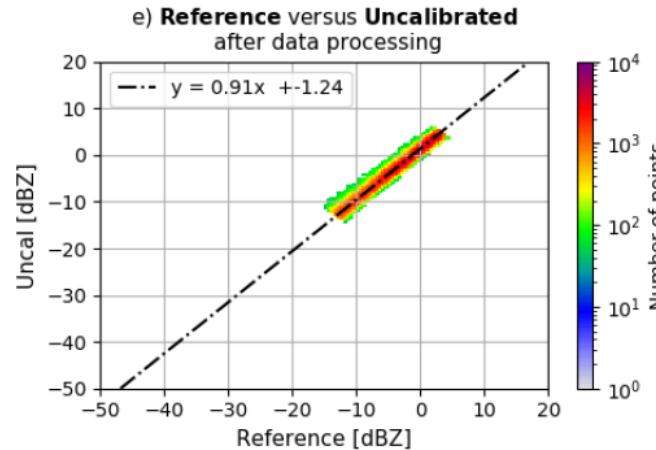


# Data analysis

- Hydrometeor classification and signal attenuation caused by atmospheric gasses are obtained from Cloudnet products
- Only periods with pure ice clouds are selected for comparison
  - Liquid water attenuates the Ka and W band radars differently
  - Puts a strong constrain on the amount of usable data
- Samples are interpolated to match the MIRA grid



Data processing



Assuming slope-1 model  
Correction coefficient CC + RMSE

$$Z_r(r) = Z_u(r) + CC.$$

Calibrated Reflectivity

Uncalibrated Reflectivity

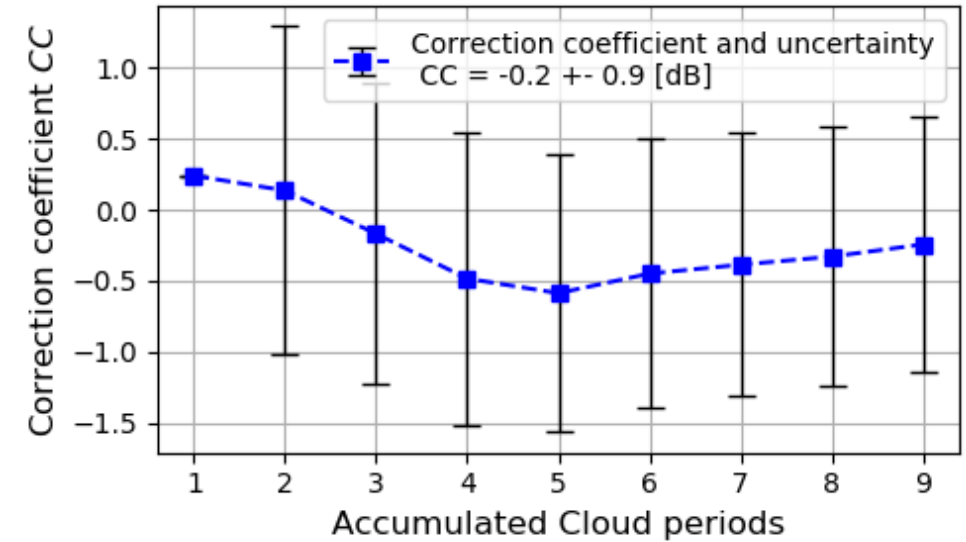
# Results

**Calibration transfer based on the methodology published in:**  
 Jorquera, S., and Coauthors, 2023: Calibration Transfer Methodology for Cloud Radars Based on Ice Cloud Observations. *J. Atmos. Oceanic Technol.*, **40**, 773–788, <https://doi.org/10.1175/JTECH-D-22-0087.1>.

- After several comparison periods are collected, their results are accumulated to estimate the final CC and its uncertainty
- A calibration transfer report is prepared with information about the experiment, relevant data and the main results


Table 2 : Correction coefficient result.

Reference radar Mode	Reference radar calibration uncertainty	Correction coefficient (Reference - MIRA)	Correction coefficient uncertainty
25m	0.8 dB	- 0.2 dB	0.9 dB



## Time constrains:

- During the JOYCE campaign, 9 suitable cloud periods are found during ~ 12 weeks of sampling in winter
  - Accurate results are obtained from the third period
  - At least 4 weeks of sampling would be needed for calibration transfer between different band radars
    - Double than for the same-band case
    - Probably very season dependent



**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..... 1
- II. Calibration transfer principle..... 2
- III. Calibration transfer setup..... 3
- IV. Results..... 4
- V. Selection of periods and results after filters..... 5

# Verification of the reference radar calibration



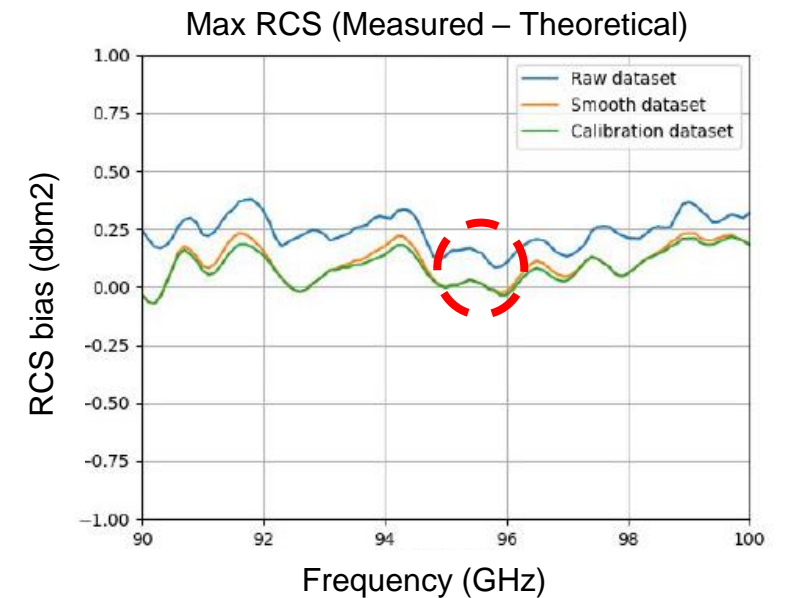
BASTA-Mini CCRES aiming at a 10 cm Corner Reflector 376 m away

Reflector on top of a fiberglass mast



The reflector has been characterized in an Anechoic chamber.

**RCS within 0.3 dB from the theoretical value**





# Verification of the reference radar calibration

## Absolute calibration results:

- Before the Joyce campaign:
  - CZ =  $-175.4 \pm 0.8$  dB @12m5 mode
- After the Joyce campaign:
  - CZ =  $-175.6 \pm 0.8$  dB @12m5 mode
- Difference of  $\sim 0.2$  dB for the 12.5 m mode, well under the uncertainty of 0.8 dB
- Same result for the 25 m mode, used for the calibration transfer
- The radar remained calibrated during the whole period



# Summary and lessons



- The reference radar calibration is stable when the radar is handled with normal care.
  - Calibration transfer to other sites is possible
- Planning to do before the campaign:
  - Selecting a site for the radar
  - Checking distances to an available shelter (less than 25 m)
  - Preparation of the material for transport takes about one day
- The experimental setup requires a minimum of two people: a radar operator and a site expert. It takes:
  - One full day for the setup
  - One full day for the removal
  - Transport time for the operator
- The minimum recommended co-located sampling time for same-band radars is of 2 to 4 weeks.
- This time can be significantly longer when comparing different-band radars.
  - The frequency of pure ice clouds determines the time needed for different-band calibration transfer.
- Data processing and preparation of the report takes 2-3 days if the NF provides CloudNet data files. Requires a calibration expert or a trained operator.

# Outlook

- Possible calibration transfer campaign at Lindenberg this fall.
- Seasonality of Ice-Clouds should be observed when planning calibration transfer campaigns between different-band radars
- Validation of the Calibration Transfer Report format for official use in future campaigns
- Use this information to evaluate and plan the application of calibration transfer in the ACTRIS network.





**Thank you**