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Calibration of the Doppler Cloud Radar

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1. DCR calibration strategy

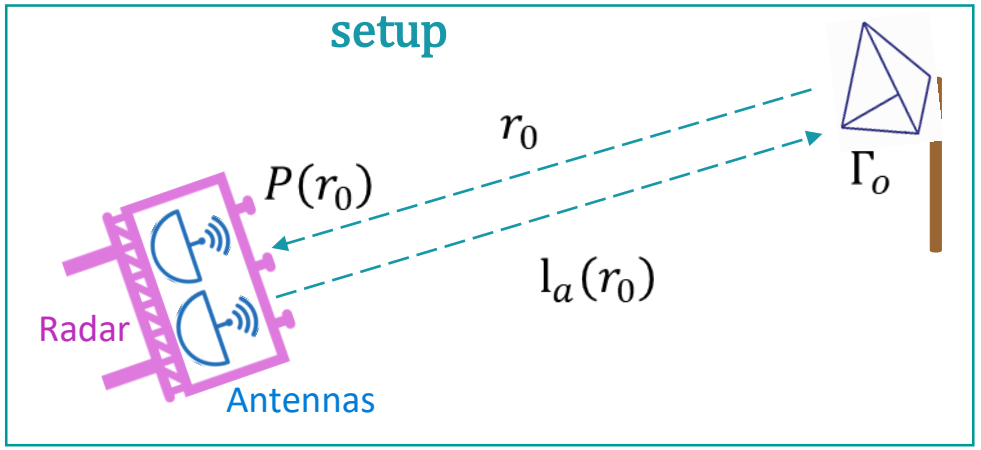
Calibration methods

- Absolute calibration using corner reflectors (absolute references)
- Absolute calibration using calibration transfer
- Other calibration methods recommended by manufacturer
- Monitoring of stability of DCR reflectivity using disdrometers

Absolute calibration using corner reflectors

- Method developed during 2017, 2018 and 2019 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



Reference corner reflector

Calibration constant (C.C.) retrieval based on an absolute reference

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

Radar Parameters

Calibration variables

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Absolute calibration using corner reflectors

Uncertainty sources

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

Radar

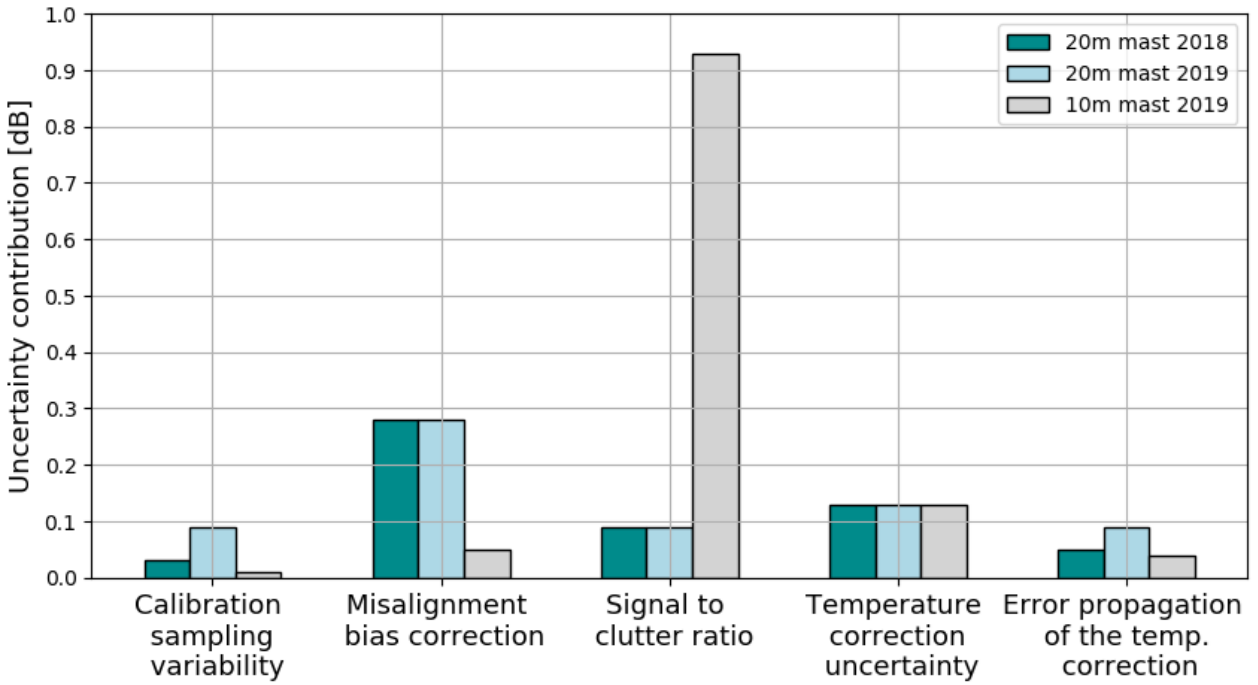
Radar gain variations
- Impact of temperature
- Non ideal IF filters

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

Reference corner reflector

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

Uncertainty budget for three different experiments



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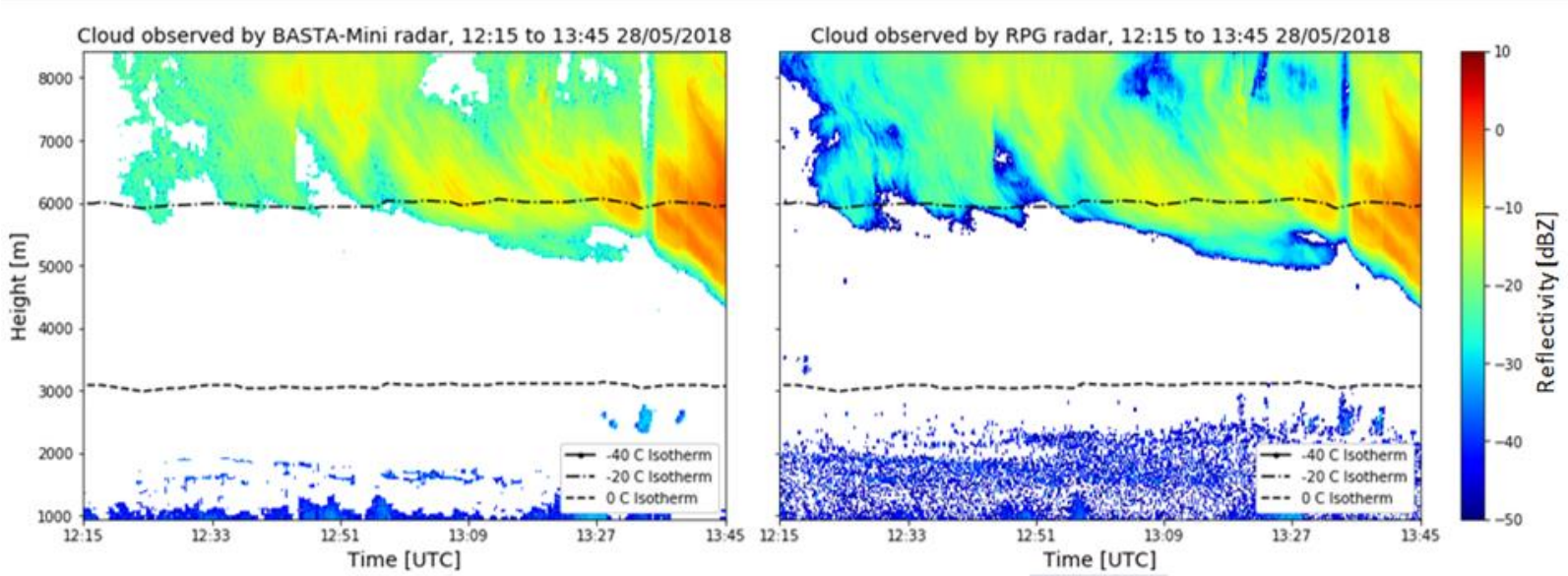
Calibration Transfer

- Objective: To correct the measurements of a cloud radar based on a reference instrument:

$$Z^{uncalib}(r) + K = Z^{corrected}(r)$$

- Method: The comparison of simultaneous cloud measurements



In this example:
Reference radar: 95 GHz BASTA-Mini
Uncalibrated radar: 94 GHz RPG

Reference radar

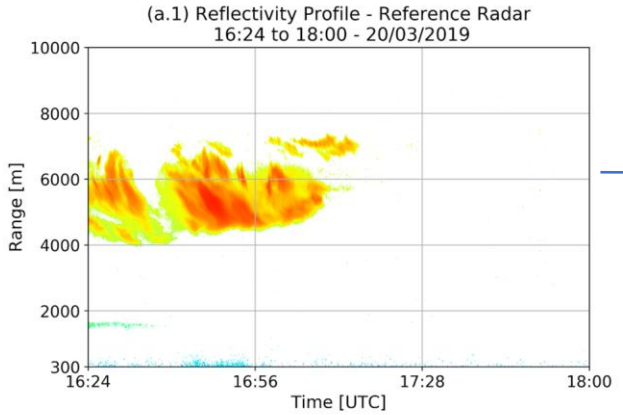
Uncalibrated radar

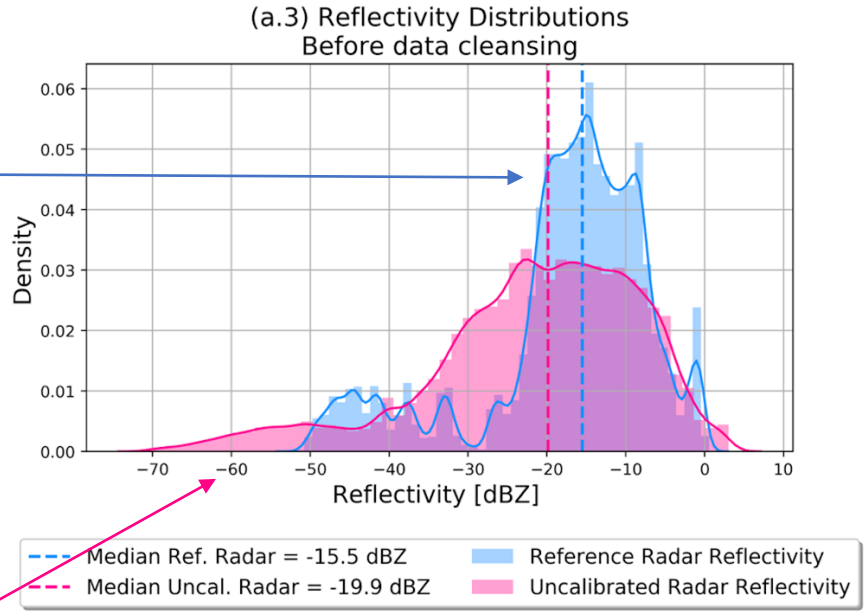
Calibration Transfer

- When radars do not have the same sensitivity, data comparison is not straightforward

Reference radar

Uncalibrated radar



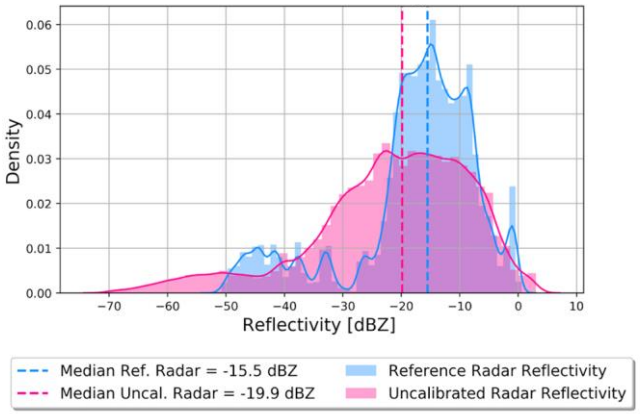


Differences between the instruments
→ Reflectivity distributions do not have the same shape

Reflectivity distributions cannot be directly compared, data must be processed

Calibration Transfer: Methodology

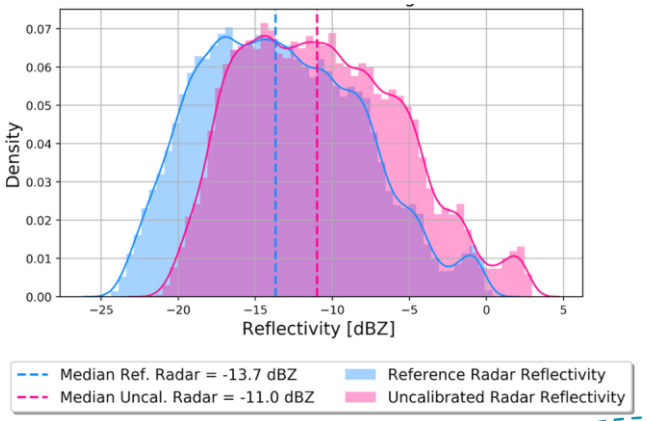
Original reflectivity distributions (different shape)



$\text{median}(Z^{ref})\text{-median}(Z^{uncal}) = 4.4\ dB$

Data processing to remove non comparable measurements

Reflectivity distributions are now comparable



$\text{median}(Z^{ref})\text{-median}(Z^{uncal}) = -2.7 \pm 0.6\ dB$

$= K_i \pm \sigma_{K\,i}$ correction coefficient sample

Correction coefficient $K = \overline{K_i} \pm \delta K$

Correction coefficient uncertainty

Correction of uncalibrated measurements

$$Z^{corrected} = Z^{uncal} + K$$

DCR calibration strategy - 2022

Promote methods that can be implemented at each NF site

- Strive to implement disdrometer measurements at all CRS NFs (CCRES/CLU/NFs)
- Start continuous monitoring of Disdro-DCR comparisons

Continue development / implementation of absolute calibration

- Qualify CCRES reference DCRs (FR, NL) and corner reflectors
- Implement absolute calibration at a few “pilot NFs”
  - Identify “pilot NF”
  - Apply Reflector/Mast calibration or Calibration transfer

Stability monitoring of DCR reflectivity using disdrometers

1. CCRES objective and instrumental set-up
2. CCRES Standard Operating Procedures for technical set-up and data acquisition
3. CCRES reader and preprocessor of raw data
4. Current monitoring of DCR reflectivity at SIRTA site for long-term dataset
5. Disdrometer long term observations and data processing at TU Delft (M. Schleiss)
6. Disdrob: an Api to standardize optical disdrometer data processing developed at EPFL (G. Ghiggi)
7. An example of new type of disdrometer analyzed at UK Research Innovation Center (C. Walden)
8. Conclusions and perspectives

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Objective and instrumental set-up

- **Objective** : develop a method to compare reflectivity (Ze) (1) measured by the Doppler Cloud Radar (DCR) with (2) derived from disdrometers to frequently monitor in time shifts, drifts and deviations of the DCR Calibration Constant (CC)
- **Instrumental setup** :

Disdrometer (DD) : measure the rain drop size distribution and fall velocity to derive the reflectivity (Ze) at the surface

Rain-Gauge (RG) : check the DD measurement and detect start/end of the rain event

Doppler Cloud Radar (DCR) : measure profile of Ze (between some tens of meters and several km) with an « a-priori » Calibration Constant that will be checked

——— : *already analyze with python code developped by MA. Drouin*

- - - : *to be done*

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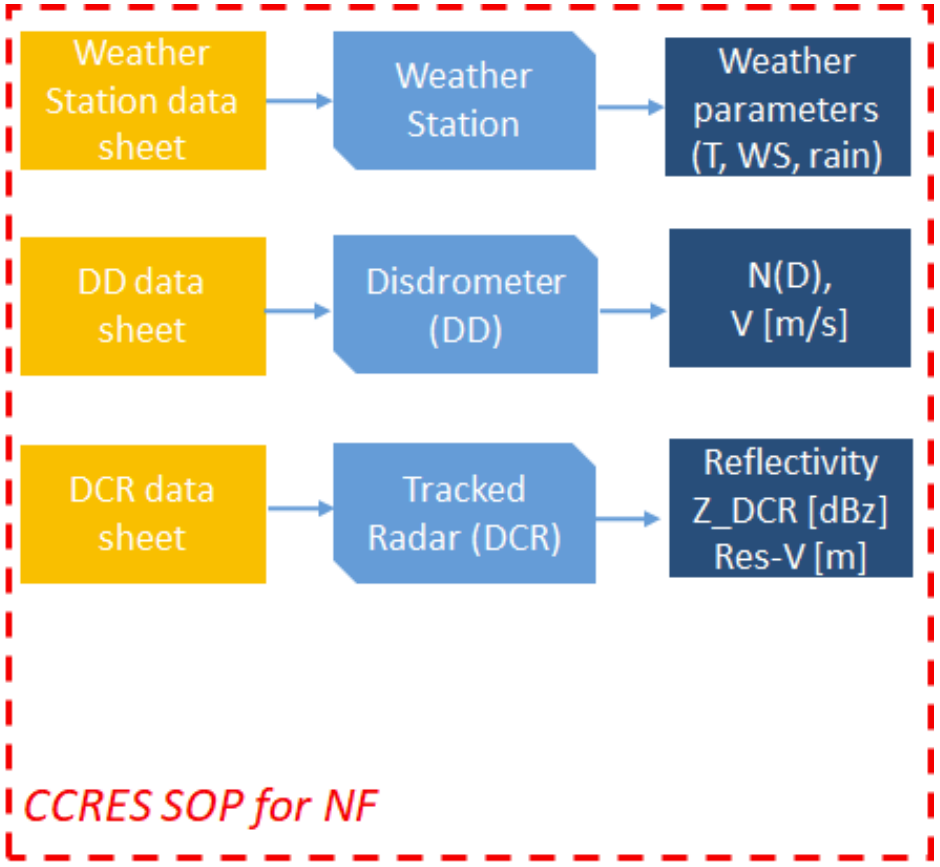
Standard operating Procedures

Technical set-up and sampling mode

3 instruments



Technical Set-up

Version 2, 23/03/2022
Contact : J-C Dupont

Standard Operating Procedures
Disdrometer

ACTRIS web link

This document describes the **Standard Operating Procedures (SOPs)** that must be applied to all disdrometers contributing measurements to the ACTRIS Cloud Remote Sensing Data Centre.

Plan

Sampling mode

1 : Manufacturer software

Version 1, 23/03/2022
Contact : J-C Dupont

Disdrometer software configuration
OTT Parsivel 2

ACTRIS web link

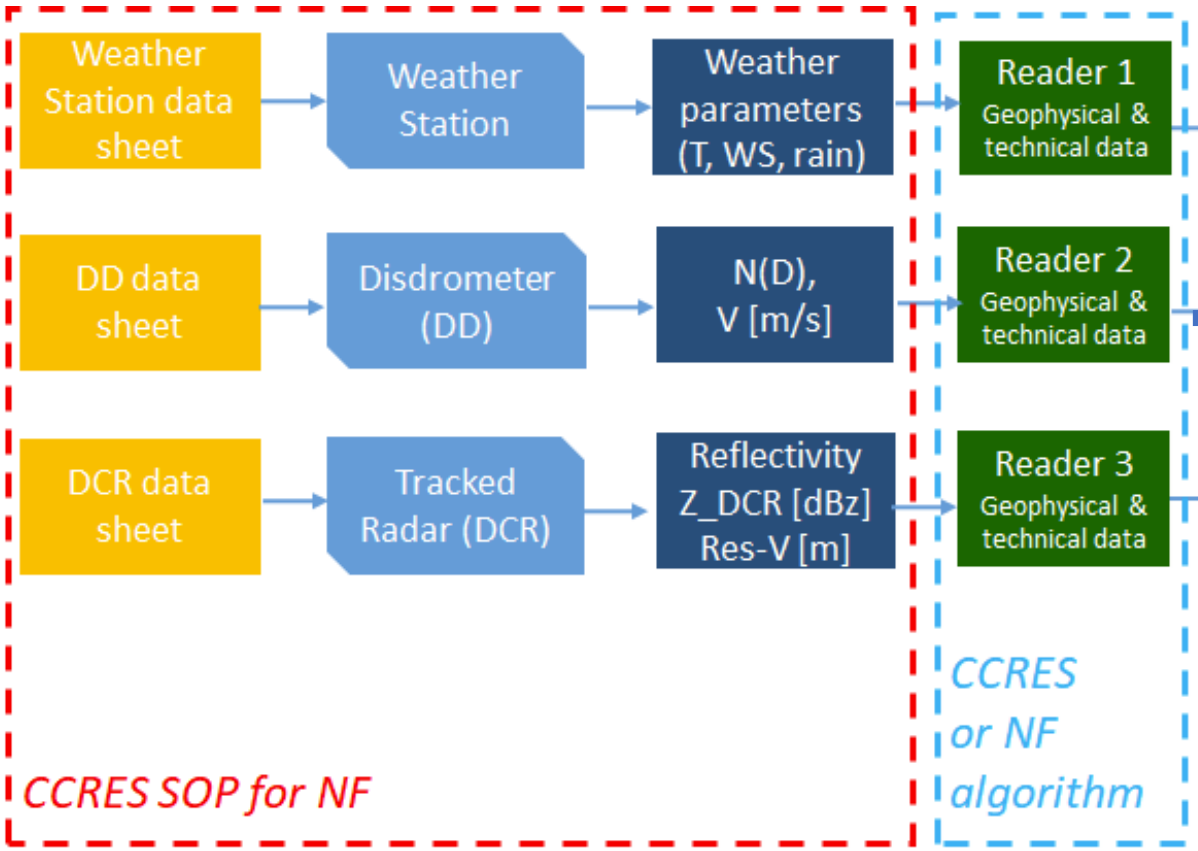
Plan

2 : Direct communication (Raspberry Pi + Python script)

see next slides by Gionata

Readers and disdrometer preprocessing

Simple readers for Met Station and DCR, **BUT** reader and pre-processor for disdrometers



Read ascii file and convert it in netcdf

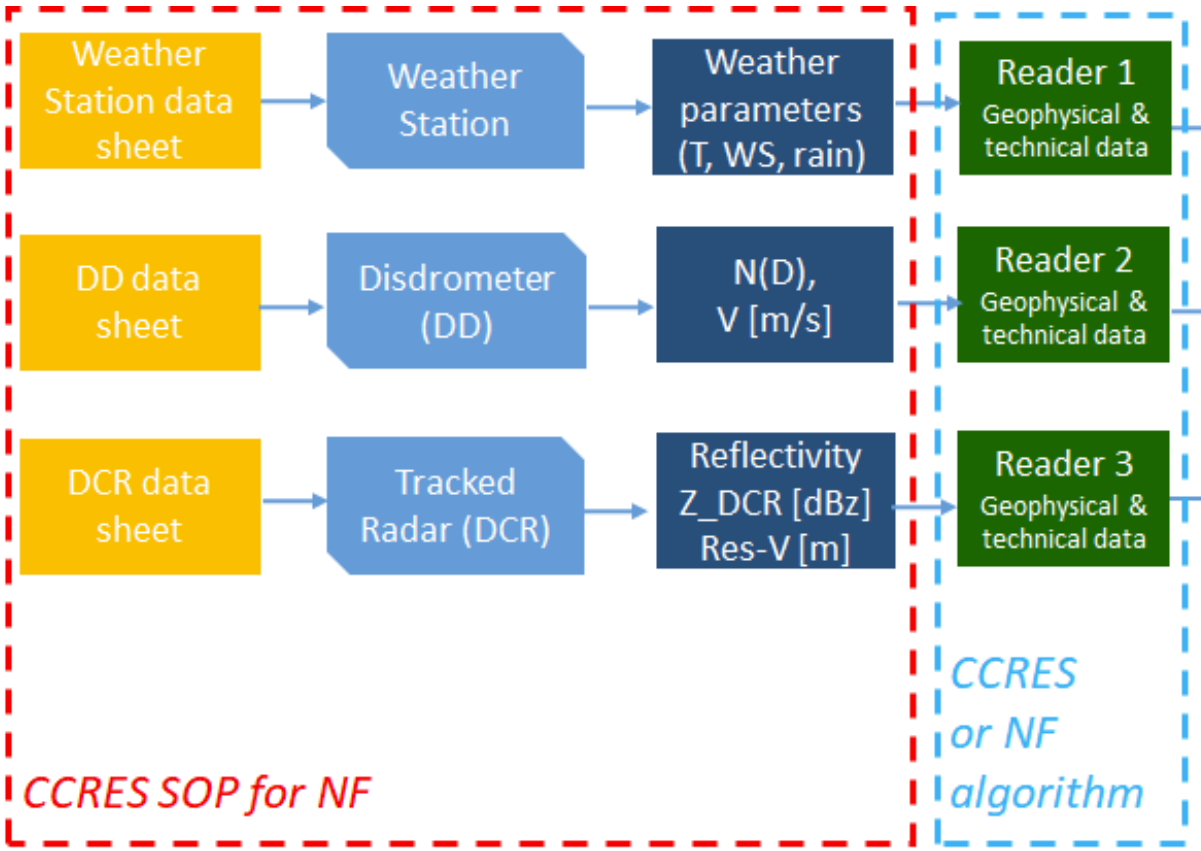
Read ascii file and convert it in netcdf file

Read “raw and NRT” Z and DV at several altitude

Have an universal <u>reader 2</u> for all the disdrometers, *see M. Schleiss and G. Ghiggi*

Readers and disdrometer preprocessing

Simple readers for Met Station and DCR **BUT** reader and pre-processor for disdrometers



To select “good” rain event (rain rate, duration, T, WS)

To derive DD reflectivity with size distribution at 10, 35 and 95 GHz

To be used for monitoring

Apply quality check to DD and filter to select optimal comparison period

Discuss/Validate the L1 data format

https://docs.google.com/spreadsheets/d/17lbHUlnRKpu-Ngd1FTP1f8wt4OgdHLbt/edit?usp=sharing&ouid=105609349844014987218&rtpof=true&sd=true

Monitoring of DCR reflectivity at SIRTA site for long-term dataset

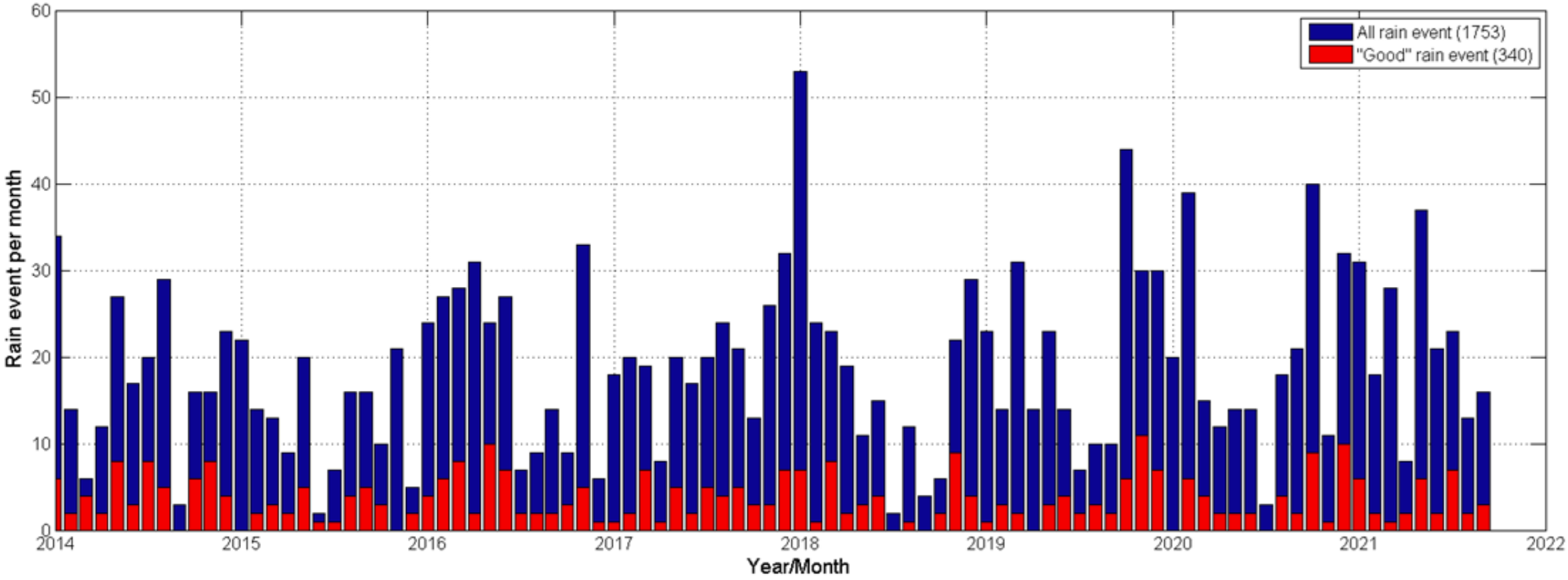
Criteria to select a "good" rain event

Variables	Limits	Objectives
Temperature	> 2°C	Remove solid precipitations
Wind speed	Max < 10 m/s Average < 7 m/s	Ensure good quality of disdrometer measurements
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	

Select the best periods for the monitoring of DCR reflectivity during rain events

Monitoring of DCR reflectivity at SIRTA site for long-term dataset

“ALL” and “GOOD” rain events at SIRTA

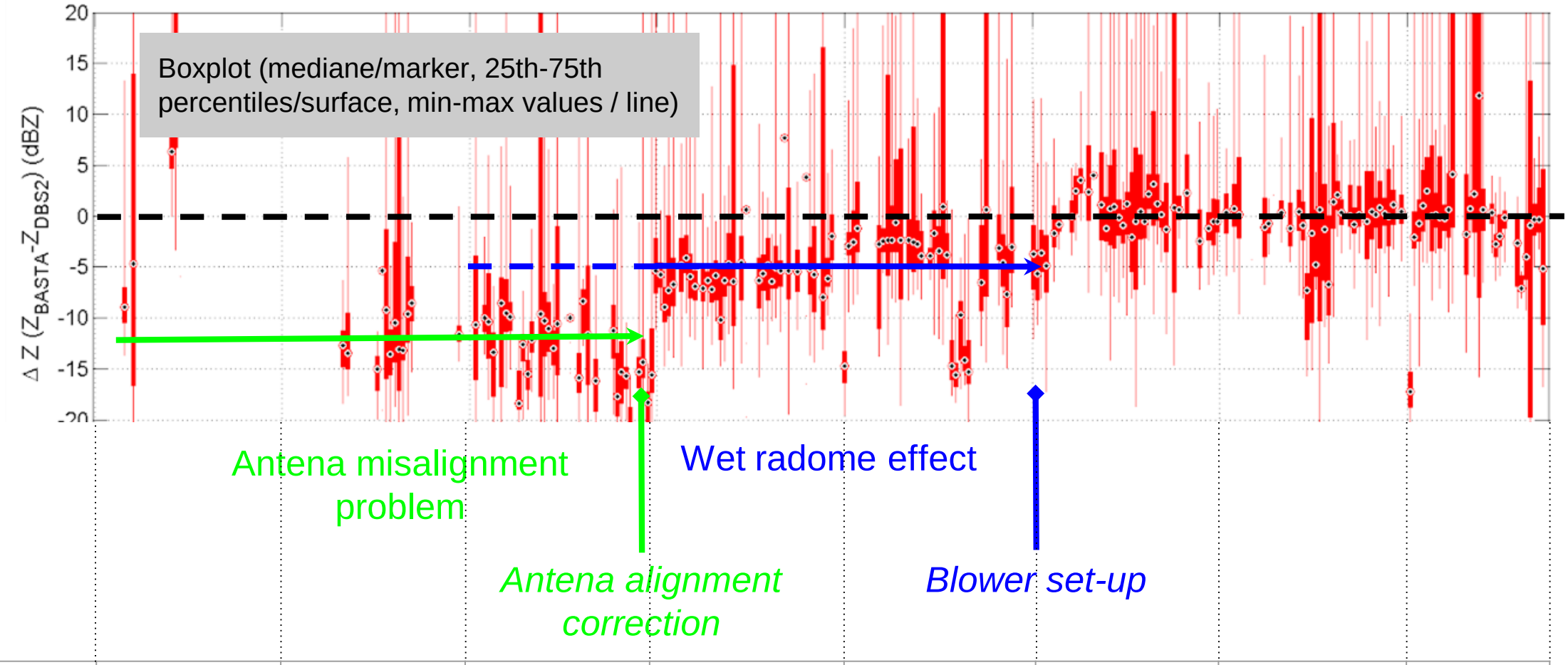


All = 1753 , Good = 340 events

Around 40 events /year, OK for DCR-Z monitoring

Monitoring of DCR reflectivity at SIRTA site for long-term dataset

Raw DCR-Z (@194m) monitoring with DD

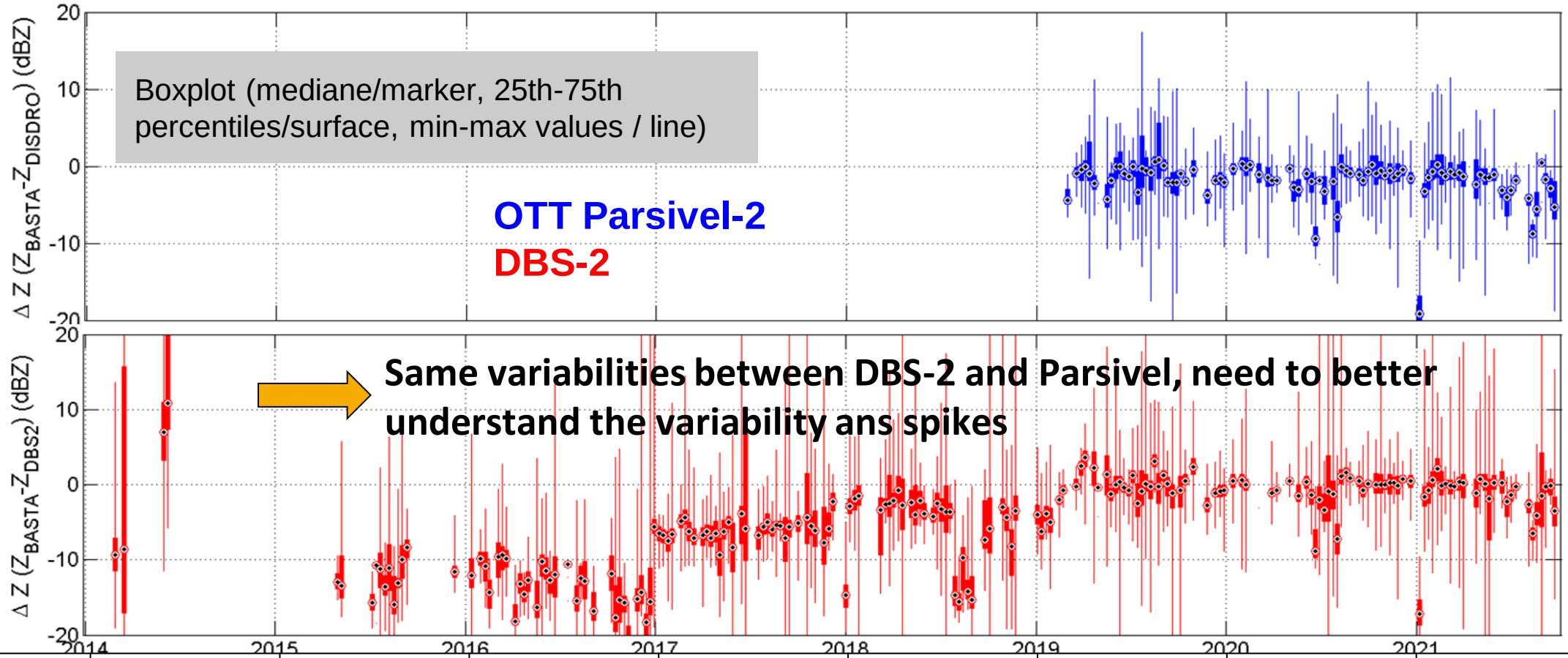


	2014	2015	2016	2017	2018	2019	2020	2021
Avg.	-	-11.3	-12.1	-4.9	-4.9	0.5	-1.2	-0.2
Std.	-	2.9	3.8	3.8	4.5	1.6	3.7	3.4

Two major changes on SIRTA DCR have been detected

Monitoring of DCR reflectivity at SIRTA site for long-term dataset

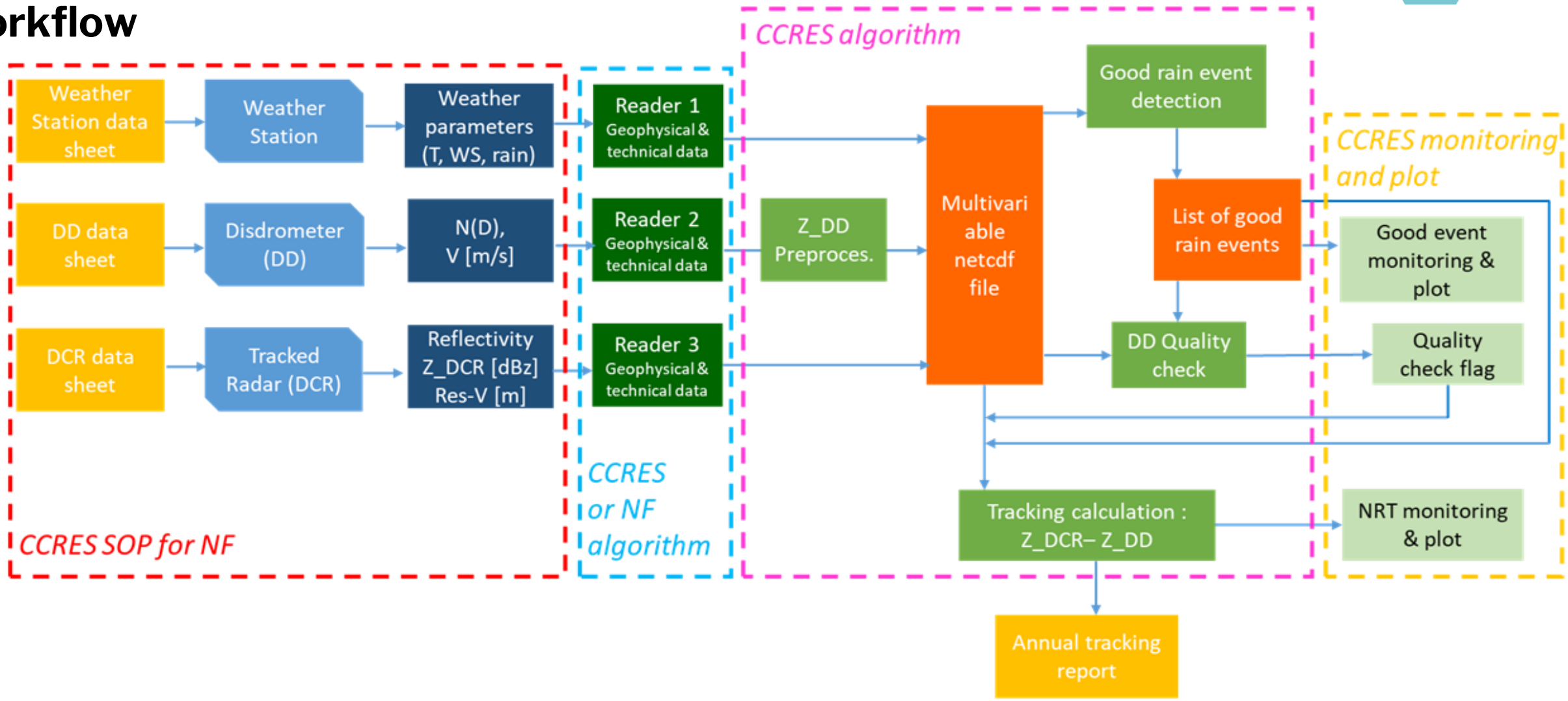
Raw DCR-Z (@194m) monitoring with DD



	2014	2015	2016	2017	2018	2019	2020	2021
Mean	- -	- -11.3	- -12.1	- -4.9	- -4.9	-1.3 0.5	-2.2 -1.2	-2.2 -0.2
Std	- -	- 2.9	- 3.8	- 3.8	- 4.5	1.3 1.6	3.6 3.7	2.1 3.4

Monitoring of DCR reflectivity at SIRTA site for long-term dataset

Workflow



Legend

National Facility Instruments | Data | Python code | Real time output monitoring and plot | Real time output file | Reporting according CRESS template : to be delivered

Longt-term observations at TU Delft

Long-term observations at Cabauw, Delft, Rotterdam, Lutjewad for the Ruisdael observatory of atmospheric science. Started in 2020. Goal is **10 years**. We put strong emphasis on sensor **synergy** and **collaborative** sensing.

- **Super Site** (Cabauw)

  - 3 Parsivels ; 1 Thies Clima ; 1 radiometer ; 1 micro-rain radar 1 dual-freq/pol cloud radar ; 1 X-band radar ; 1 S-band radar

- **Test Site** (Delft)

  - 1 Parsivel, 1 radiometer ; 1 MRR ; 1 dual-pol cloud radar

- **Urban network** (Rotterdam)

  - 5 Parsivels ; 5 MRRs + air quality sensors (TNO + RIVM)

Super site at Cabauw

TU Delft Parsivel network

- **Raw data acquisition + processing:**

  - **All** 99 fields logged at **1 min** using Raspberry Pi + Python script.

  - Custom-made **logger software** "disdroDL" (by TUD computer science students)

  - We have a solution for logging **Field 61** (individual drop diameters + arrival times)

- **Data format + dissemination** Can we all agree on naming conventions?

  - Raw data stored as daily **csv files** with ";" separator (internal use)

  - Conversion to **daily NetCDF** using "disdrodb" (https://github.com/ghiggi/disdrodb)

  - Dissemination on KNMI data platform (once everyone agrees on naming conventions)

Disdrob: an Api to standardize optical disdrometer data processing

Disdrob: an Api to standardize optical disdrometer data processing

Project Idea

- An API to standardize optical disdrometer data processing
- Instruments: OTT Parsivel 1 & 2 (& APUs), LPM, ODM470, 2DVD, JWD

Product Levels

L0: Source data into CF-1.9 compliant netCDF4 (raw txt data, ApacheParquet netCDF4)

L1 : Instantaneous corrected spectra

L2 : DSD statistics, other products

L3 : Aggregated product (1 min, 2 min, 5 min, 10 min, 30 min)

L4: Simulated reflectivities at specific radar bands

Code structure

- Components
  - Raw Data Parser
    - Search files to be processed (glob)
    - File reading settings (reader_kwargs)
    - Custom dataframe sanitizer function (df_sanitizer)
  - Logger
  - Metadata checker
  - Standards checker
  - L0, L1, L2, L3 processing chain
  - L0, L1, L2, L3 products checker

- Features
  - Command Line Interface (CLI) to process each campaign separately
  - Campaign Batch Processing
  - Debugging mode, local vs. distributed, in-memory/lazy processing

Disdrob: an Api to standardize optical disdrometer data processing

Command Line Interface

```
(disdrodb) kcandolf@enacit-node01:~/disdrodb/disdrodb/readers/EPFL$ python3 parser_HPICONET_2010.py --help
Usage: parser_HPICONET_2010.py [OPTIONS] <raw_dir> <processed_dir>

  Script to process raw data to L0 and L1.

Options:
  -l0, --l0_processing BOOLEAN  Perform L0 processing  [default: True]
  -l1, --l1_processing BOOLEAN  Perform L1 processing  [default: True]
  -zarr, --write_zarr BOOLEAN   Write L1 to zarr  [default: False]
  -nc, --write_netcdf BOOLEAN   Write L1 netCDF4  [default: True]
  -f, --force BOOLEAN           Force overwriting  [default: False]
  -v, --verbose BOOLEAN         Verbose  [default: False]
  -d, --debugging_mode BOOLEAN  Switch to debugging mode  [default: False]
  -l, --lazy BOOLEAN            Use dask if lazy=True  [default: True]
  --help                        Show this message and exit.
```

Disdrob: an Api to standardize optical disdrometer data processing

L0 product generation

```
(disdrodb) kcandolf@enacit-node01:~/disdrodb/disdrodb/readers/EPFL$ python3 parser_HPICONET_2010.py --verbose=True --force=True /ltenas3
/0_Data/ParsivelDB/Raw/EPFL/HPICONET_2010 /ltenas3/0_Data/ParsivelDB/Processed/EPFL/HPICONET_2010
 - L0 processing of station_id 33 has started.
 - 256 files to process in /ltenas3/0_Data/ParsivelDB/Raw/EPFL/HPICONET_2010
 - Conversion to Apache Parquet started.
 - Conversion to Apache Parquet ended.
 - The following columns have values outside the expected data range: ['sensor_temperature']
 - The following columns have values outside the expected data range: ['datalogger_voltage']
 - L0 processing of station_id 33 ended in 352.59s
 - L1 processing of station_id 33 has started.
 - Reading L0 Apache Parquet file at /ltenas3/0_Data/ParsivelDB/Processed/EPFL/HPICONET_2010/L0/HPICONET_2010_s33.parquet started
 - Reading L0 Apache Parquet file at /ltenas3/0_Data/ParsivelDB/Processed/EPFL/HPICONET_2010/L0/HPICONET_2010_s33.parquet ended
 - Retrieval of L1 data matrix started.
 - Retrieval of L1 data matrix finished.
 - L1 processing of station_id 33 ended in 4332.61s
 ------------------------------------------------
 - L0 processing of station_id 32 has started.
 - 209 files to process in /ltenas3/0_Data/ParsivelDB/Raw/EPFL/HPICONET_2010
 - Conversion to Apache Parquet started.
 - Conversion to Apache Parquet ended.
 - The following columns have values outside the expected data range: ['sensor_temperature']
 - The following columns have values outside the expected data range: ['datalogger_voltage']
 - L0 processing of station_id 32 ended in 413.96s
 - L1 processing of station_id 32 has started.
 - Reading L0 Apache Parquet file at /ltenas3/0_Data/ParsivelDB/Processed/EPFL/HPICONET_2010/L0/HPICONET_2010_s32.parquet started
 - Reading L0 Apache Parquet file at /ltenas3/0_Data/ParsivelDB/Processed/EPFL/HPICONET_2010/L0/HPICONET_2010_s32.parquet ended
 - Retrieval of L1 data matrix started.
 - Retrieval of L1 data matrix finished.
 - L1 processing of station_id 32 ended in 2948.68s
 ------------------------------------------------
 - L0 processing of station_id 31 has started.
 - 257 files to process in /ltenas3/0_Data/ParsivelDB/Raw/EPFL/HPICONET_2010
 - Conversion to Apache Parquet started.
 - Conversion to Apache Parquet ended.
 - The following columns have values outside the expected data range: ['sensor_temperature']
 - The following columns have values outside the expected data range: ['datalogger_voltage']
 - L0 processing of station_id 31 ended in 422.36s
 - L1 processing of station_id 31 has started.
 - Reading L0 Apache Parquet file at /ltenas3/0_Data/ParsivelDB/Processed/EPFL/HPICONET_2010/L0/HPICONET_2010_s31.parquet started
 - Reading L0 Apache Parquet file at /ltenas3/0_Data/ParsivelDB/Processed/EPFL/HPICONET_2010/L0/HPICONET_2010_s31.parquet ended
 - Retrieval of L1 data matrix started.
```

Disdrob: an Api to standardize optical disdrometer data processing

Raw data directory structure

Filename	Filesize	Filetype	Last modified	Permission	Owner/Group
..					
data		Directory	11.01.2022 13:16:58	drwxrwx...	ghiggi LTE-unit
info		Directory	19.10.2021 13:29:36	drwxrwx...	ghiggi LTE-unit
metadata		Directory	11.01.2022 13:17:23	drwxr-xr-x	kcandolf LTE-unit

Filename	Filesize	Filetype	Last modified	Permission	Owner/Group
..					
10.yml	1.1 KB	yml-file	11.01.2022 13:17:23	-rwxr-x---	kcandolf LTE-unit

Filename	Filesize	Filetype	Last modified	Permission	Owner/Group
..					
10		Directory	11.01.2022 13:16:58	drwxr-xr-x	kcandolf LTE-unit

Filename	Filesize	Filetype	Last modified	Permission	Owner/Group
..					
7481_ascii_20070725_Parsiv1.dat.gz	754.1 KB	gz-file	25.07.2007 14:28:16	-rwxrwx...	ghiggi LTE-unit
7481_ascii_20070814_Parsiv1.dat.gz	727 B	gz-file	14.08.2007 15:33:04	-rwxrwx...	ghiggi LTE-unit
7481_ascii_20070816_Parsiv1.dat.gz	406.0 KB	gz-file	16.08.2007 10:10:30	-rwxrwx...	ghiggi LTE-unit
7481_ascii_20070822_Parsiv1.dat.gz	931.9 KB	gz-file	22.08.2007 16:41:52	-rwxrwx...	ghiggi LTE-unit

Processed campaign directory structure

Filename	Filesize	Filetype	Last modified	Permission	Owner/Group
..					
L0		Directory	11.01.2022 13:20:01	drwxr-xr-x	kcandolf LTE-unit
L1		Directory	11.01.2022 13:20:50	drwxr-xr-x	kcandolf LTE-unit
info		Directory	11.01.2022 13:19:47	drwxr-xr-x	kcandolf LTE-unit
metadata		Directory	11.01.2022 13:19:47	drwxr-xr-x	kcandolf LTE-unit
11-01-2022_13-19-47_parser_PARSIVEL_2007.log	3.7 KB	log-file	11.01.2022 13:24:07	-rw-r--r--	kcandolf LTE-unit

Disdrob: an Api to standardize optical disdrometer data processing

Metadata YAML file

```yaml
title: 'HPICONET_2010'
description: ''
source: ''
history: ''
conventions: ''
campaign_name: 'HPICONET_2010'
project_name: 'HPICONET_2010'
station_id: '10'
station_name: ''
station_number: '10'
location: ''
country: ''
continent: ''
latitude: -9999
longitude: -9999
altitude: -9999
crs: WGS84
proj4_string: +proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs
EPSG: 4326
latitude_unit: DegreesNorth
longitude_unit: DegreesEast
altitude_unit: MetersAboveSeaLevel
sensor_name: Parsivel
sensor_long_name: OTT Hydromet Parsivel
sensor_wavelegth: ''
sensor_serial_number: ''
firmware_IOP: ''
firmware_DSP: ''
firmware_version: ''
sensor_beam_width: ''
sensor_nominal_width: ''
temporal_resolution: ''
measurement_interval: ''
contributors: ''
authors: ''
institution: 'Laboratoire de Teledetection Environnementale -  Ecole Polytechnique Federale de Lausanne'
reference: ''
documentation: ''
website: ''
source_repository: ''
doi: ''
contact: ''
contact_information: http://lte.epfl.ch
source_data_format: ''
obs_type: ''
level: ''
disdrodb_id: '10'
```

Disdrob: an Api to standardize optical disdrometer data processing

Dealing with bad data

- Listed in a bad_timestamp YAML file Tractable !!!
- Removed on the fly during DISDRODB L0 product generation
- Enable specification of
  - Time steps
  - Time interval

bad_timestamp - Notepad

File Edit Format View Help

```
# This file store dates to be dropped by the DISDRODB parser
# Two keys are accepted
#  - timestamp: list of timestamps
# - time_period: list of timestamps interval
#
# Example usage:
#
#
# timestamp: ['2007-12-18 14:15:00','2007-12-18 14:17:00','2007-12-18 14:19:00']
# time_period: [['2018-08-01 12:00:00', '2018-08-01 14:00:00'],
#               ['2018-08-01 15:44:30', '2018-08-01 15:59:31'],
#               ['2018-08-02 12:44:30', '2018-08-02 12:59:31']]

time_period: []
timestamp: []
```

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Disdrob: an Api to standardize optical disdrometer data processing

Logger

```
2022-01-20 13:14:51,974 - HPICONET_2010 - INFO - ### Script started ###
2022-01-20 13:14:51,974 - disdrodb.io - DEBUG - Created SharedVM/Campagne/EPFL/Processed/HPICONET_2010/metadata
2022-01-20 13:14:51,974 - disdrodb.io - DEBUG - Created SharedVM/Campagne/EPFL/Processed/HPICONET_2010/info
2022-01-20 13:14:51,974 - disdrodb.io - DEBUG - Created SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0
2022-01-20 13:14:51,974 - disdrodb.io - DEBUG - Created SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L1
2022-01-20 13:14:51,975 - HPICONET_2010 - INFO -  - Processing of station_id 10 has started
2022-01-20 13:14:51,978 - HPICONET_2010 - INFO -  - L0 processing of station_id 10 has started.
2022-01-20 13:14:51,979 - disdrodb.L0_proc - INFO -  - 3 files to process in /SharedVM/Campagne/EPFL/Raw/HPICONET_2010
2022-01-20 13:14:52,209 - disdrodb.L0_proc - DEBUG - 1 / 3 processed successfully. File name: /SharedVM/Campagne/EPFL/Raw/HPICONET_2010/data/10/10_ascii_20101007.dat
2022-01-20 13:14:52,487 - disdrodb.L0_proc - DEBUG - 2 / 3 processed successfully. File name: /SharedVM/Campagne/EPFL/Raw/HPICONET_2010/data/10/10_ascii_20101009.dat
2022-01-20 13:14:52,717 - disdrodb.L0_proc - DEBUG - 3 / 3 processed successfully. File name: /SharedVM/Campagne/EPFL/Raw/HPICONET_2010/data/10/10_ascii_20101010.dat
2022-01-20 13:14:52,717 - disdrodb.L0_proc - INFO - ---
2022-01-20 13:14:52,718 - disdrodb.L0_proc - INFO - 0 of 3 have been skipped.
2022-01-20 13:14:52,718 - disdrodb.L0_proc - INFO - ---
2022-01-20 13:14:52,718 - disdrodb.L0_proc - INFO - Concatentation of dataframes started.
2022-01-20 13:14:52,760 - disdrodb.L0_proc - INFO - Concatentation of dataframes has finished.
2022-01-20 13:14:52,760 - disdrodb.L0_proc - INFO -  - Conversion to Apache Parquet started.
2022-01-20 13:14:53,926 - disdrodb.L0_proc - INFO - The Dask Dataframe has been written as an Apache Parquet file to SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s10.parquet.
2022-01-20 13:14:53,926 - disdrodb.L0_proc - INFO -  - Conversion to Apache Parquet ended.
2022-01-20 13:14:53,966 - HPICONET_2010 - INFO -  - L0 processing of station_id 10 ended in 1.99s
2022-01-20 13:14:53,966 - HPICONET_2010 - INFO -  - L1 processing of station_id 10 has started.
2022-01-20 13:14:53,966 - disdrodb.io - INFO - Found parquet file: SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s10.parquet
2022-01-20 13:14:53,966 - disdrodb.io - INFO -  - Reading L0 Apache Parquet file at SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s10.parquet started
2022-01-20 13:14:53,973 - disdrodb.io - INFO -  - Reading L0 Apache Parquet file at SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s10.parquet ended
2022-01-20 13:14:53,973 - disdrodb.L1_proc - INFO -  - Retrieval of L1 data matrix started.
2022-01-20 13:14:59,242 - disdrodb.L1_proc - INFO -  - Retrieval of L1 data matrix finished.
2022-01-20 13:15:12,148 - HPICONET_2010 - INFO -  - L1 processing of station_id 10 ended in 18.18s
2022-01-20 13:15:12,148 - HPICONET_2010 - INFO -  - Processing of station_id 11 has started
2022-01-20 13:15:12,152 - HPICONET_2010 - INFO -  - L0 processing of station_id 11 has started.
2022-01-20 13:15:12,152 - disdrodb.L0_proc - INFO -  - 3 files to process in /SharedVM/Campagne/EPFL/Raw/HPICONET_2010
2022-01-20 13:15:12,328 - disdrodb.L0_proc - DEBUG - 1 / 3 processed successfully. File name: /SharedVM/Campagne/EPFL/Raw/HPICONET_2010/data/11/11_ascii_20101007.dat
2022-01-20 13:15:12,542 - disdrodb.L0_proc - DEBUG - 2 / 3 processed successfully. File name: /SharedVM/Campagne/EPFL/Raw/HPICONET_2010/data/11/11_ascii_20101009.dat
2022-01-20 13:15:12,722 - disdrodb.L0_proc - DEBUG - 3 / 3 processed successfully. File name: /SharedVM/Campagne/EPFL/Raw/HPICONET_2010/data/11/11_ascii_20101010.dat
2022-01-20 13:15:12,722 - disdrodb.L0_proc - INFO - ---
2022-01-20 13:15:12,722 - disdrodb.L0_proc - INFO - 0 of 3 have been skipped.
2022-01-20 13:15:12,722 - disdrodb.L0_proc - INFO - ---
2022-01-20 13:15:12,722 - disdrodb.L0_proc - INFO - Concatentation of dataframes started.
2022-01-20 13:15:12,756 - disdrodb.L0_proc - INFO - Concatentation of dataframes has finished.
2022-01-20 13:15:12,757 - disdrodb.L0_proc - INFO -  - Conversion to Apache Parquet started.
2022-01-20 13:15:13,597 - disdrodb.L0_proc - INFO - The Dask Dataframe has been written as an Apache Parquet file to SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s11.parquet.
2022-01-20 13:15:13,597 - disdrodb.L0_proc - INFO -  - Conversion to Apache Parquet ended.
2022-01-20 13:15:13,620 - HPICONET_2010 - INFO -  - L0 processing of station_id 11 ended in 1.47s
2022-01-20 13:15:13,621 - HPICONET_2010 - INFO -  - L1 processing of station_id 11 has started.
2022-01-20 13:15:13,621 - disdrodb.io - INFO - Found parquet file: SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s11.parquet
2022-01-20 13:15:13,621 - disdrodb.io - INFO -  - Reading L0 Apache Parquet file at SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s11.parquet started
2022-01-20 13:15:13,627 - disdrodb.io - INFO -  - Reading L0 Apache Parquet file at SharedVM/Campagne/EPFL/Processed/HPICONET_2010/L0/HPICONET_2010_s11.parquet ended
2022-01-20 13:15:13,627 - disdrodb.L1_proc - INFO -  - Retrieval of L1 data matrix started.
2022-01-20 13:15:16,830 - disdrodb.L1_proc - INFO -  - Retrieval of L1 data matrix finished.
2022-01-20 13:15:25,066 - HPICONET_2010 - INFO -  - L1 processing of station_id 11 ended in 11.45s
```

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Disdrob: an Api to standardize optical disdrometer data processing

Customizable configs/standards

main ▾ disdrodb / disdrodb / configs / Go to file Add file ▾ ···

KimCandolfi Merge branch 'main' of github.com:ltelab/disdrodb into main 39326ff 5 days ago History

..		
OTT_Parsivel	Fix nan values into configs for all devices	18 days ago
OTT_Parsivel2	Merge branch 'main' of github.com:ltelab/disdrodb into main	5 days ago
Thies_LPM	Fix nan values into configs for all devices	18 days ago

main ▾ disdrodb / disdrodb / configs / OTT_Parsivel2 / Go to file Add file ▾ ···

KimCandolfi Merge branch 'main' of github.com:ltelab/disdrodb into main 39326ff 5 days ago History

..		
L0_data_format.yml	Fix variable name 'rainfall_rate_16bit_30' -> 'rainfall_rate_16_bit_3...	5 days ago
L0_dtype.yml	Fix the variable names from like below:	2 months ago
L1_netcdf_encodings.yml	Merge branch 'main' of github.com:ltelab/disdrodb into main	5 days ago
diameter_bins.yml	Refactoring standards	2 months ago
variable_explanations.yml	Fix the variable names from like below:	2 months ago
variable_units.yml	Fix the variable names from like below:	2 months ago
variables.yml	Fix the variable names from like below:	2 months ago
velocity_bins.yml	Refactoring standards	2 months ago

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Disdrob: an Api to standardize optical disdrometer data processing

L0 NetCDF4

```
<xarray.Dataset>
Dimensions:                    (time: 53889, diameter_bin_center: 32, velocity_bin_center: 32)
Coordinates: (12/13)
  * diameter_bin_center        (diameter_bin_center) float64 0.062 ... 24.5
    diameter_bin_lower         (diameter_bin_center) float64 ...
    diameter_bin_upper         (diameter_bin_center) float64 ...
    diameter_bin_width         (diameter_bin_center) float64 ...
  * velocity_bin_center        (velocity_bin_center) float64 0.05 0.15 ... 20.8
    velocity_bin_lower         (velocity_bin_center) float64 ...
    ...                         ...
    velocity_bin_width         (velocity_bin_center) float64 ...
  * time                       (time) datetime64[ns] 2007-07-23T14:15:30 ......
    latitude                   int64 ...
    longitude                  int64 ...
    altitude                   int64 ...
    crs                        object ...
Data variables: (12/17)
    FieldN                     (time, diameter_bin_center) float32 ...
    FieldV                     (time, velocity_bin_center) float32 ...
    RawData                    (time, diameter_bin_center, velocity_bin_center) int64 ...
    id                         (time) uint32 ...
    rain_rate_32bit            (time) float32 ...
    rain_accumulated_32bit     (time) float32 ...
    ...                         ...
    n_particles                (time) uint32 ...
    sensor_temperature         (time) uint8 ...
    sensor_heating_current     (time) float32 ...
    sensor_battery_voltage     (time) float32 ...
    sensor_status              (time) uint8 ...
    rain_amount_absolute_32bit (time) float32 ...
Attributes: (12/47)
    title:                  PARSIVEL_2007
    description:
    source:
    history:
    conventions:
    campaign_name:          PARSIVEL_2007
    ...                     ...
    contact:
    contact_information:    http://lte.epfl.ch
    source_data_format:
    obs_type:
    level:
    disdrodb_id:            10
```

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ACTRIS format (DISDRODB vs LACROS-TROPOS)

Comparison of variable name :

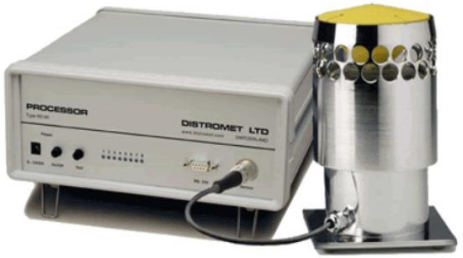
https://docs.google.com/spreadsheets/d/1tHXC8ZH6_v_SaR1tRffSZCphZL6Y6ktDYp6y4ysE0gg/edit?usp=sharing

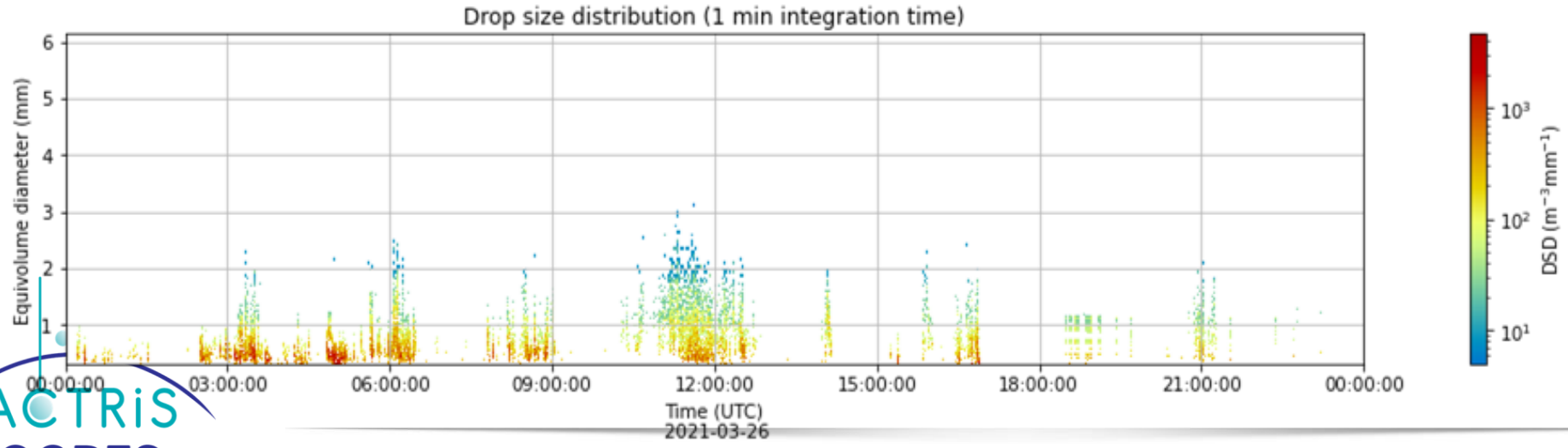
A new type of disdrometer analyzed at UK Research Innovation Center

Recent work to look at dBZ prediction from Joss-Waldvogel RD-80 impact disdrometer

Multi-year dataset available from Chilbolton for this class of instrument (>18 years)

- Automated conversion of raw data to NetCDF
- 127 size bins (size thresholds 0.313mm to 5.145mm), 10sec resolution
- Files contain counts in each size bin.
- Conversion to DSD assumes Gunn-Kinzer terminal fall speeds





A new type of disdrometer analyzed at UK Research Innovation Center

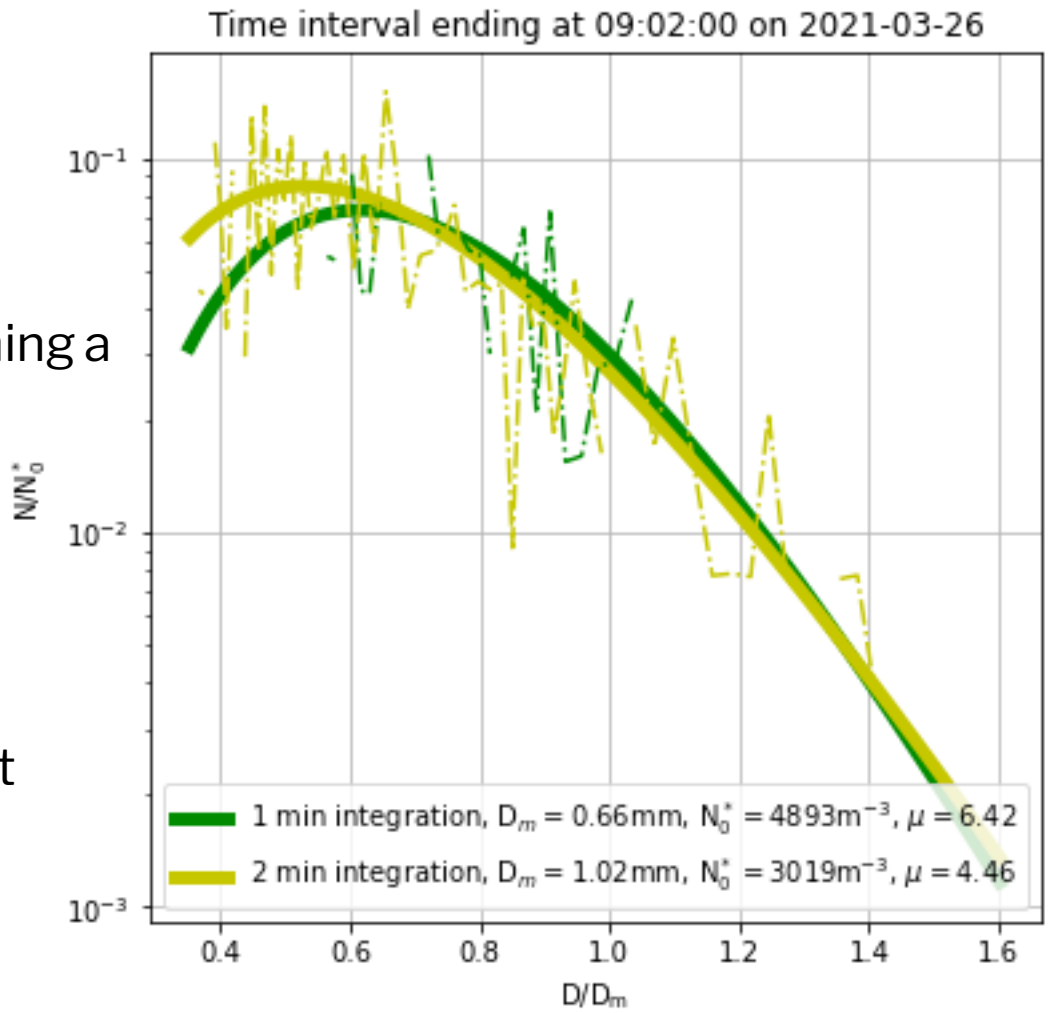
Questions to address

Minimum drop size bin has lower threshold of 0.313mm

- Is this small enough?
- Can we extrapolate to smaller sizes by assuming a normalised gamma DSD?

Work performed with student intern

- Event selection
  - 1min rainrate ≥ 0.2mm/h
  - Duration ≥ 10min
- DSD fitted to normalised gamma on per event basis – free parameter μ (relates to width of distribution)



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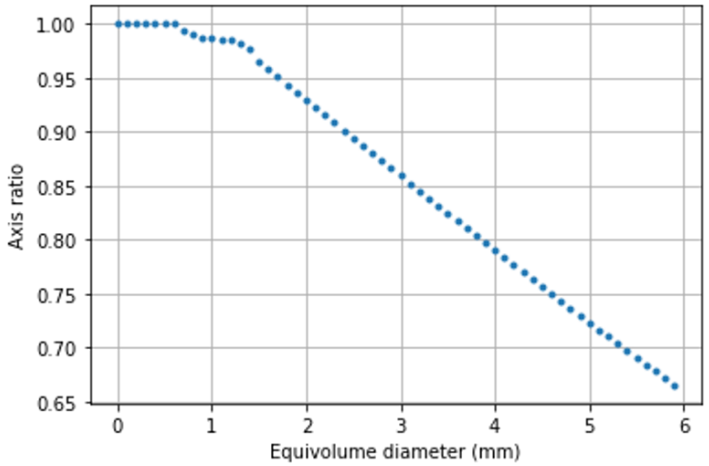
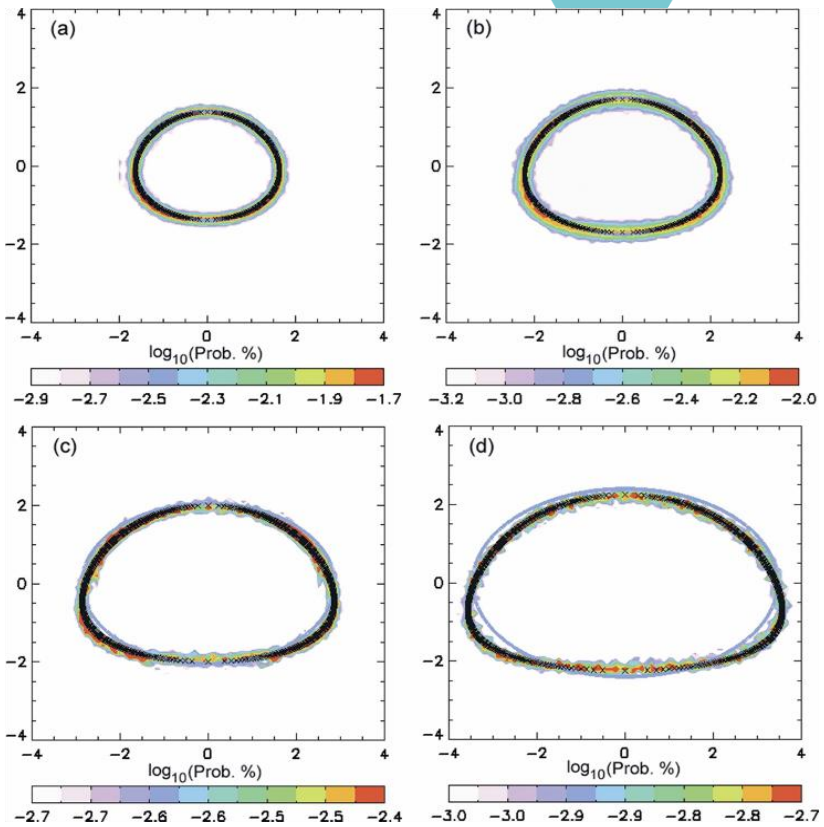
dBZ calculation

Use of Python PyTmatrix module (https://github.com/jleinonen/pytmatrix.git) to derive dBZ values

- Drop shape model – Oblate spheroids with axis ratio based on Thurai et al. 2007, DOI: 10.1175/JTECH2051.1 – What are other people using?
- Orientation fixed – Should we use a canting angle distribution?





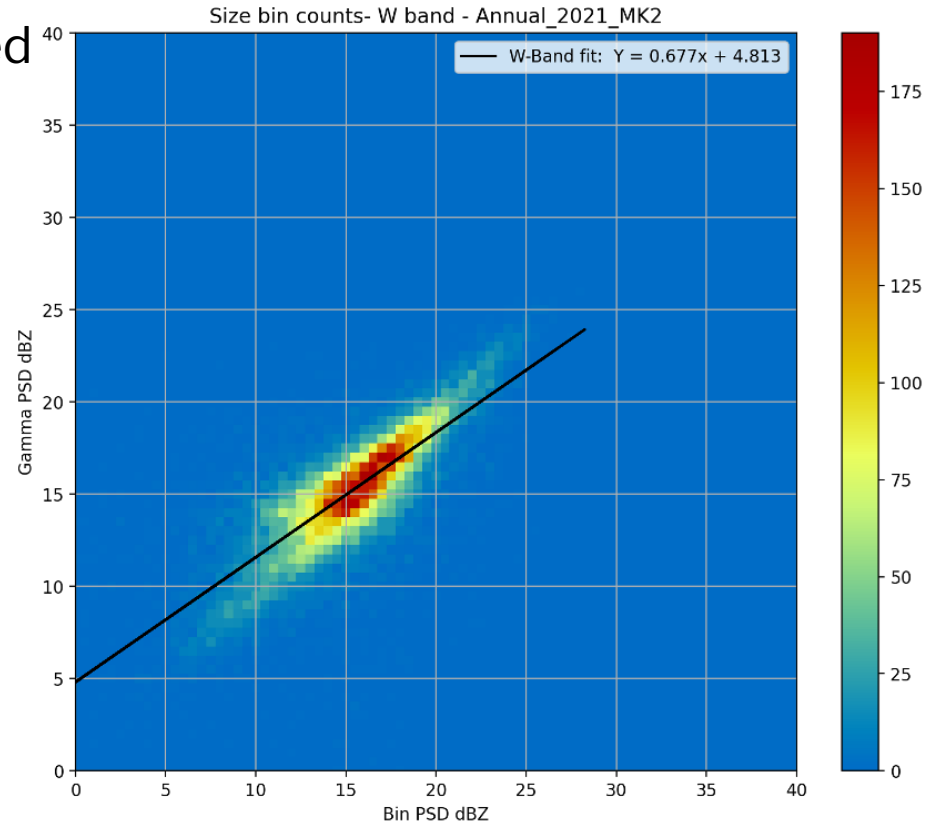
Thurai et al.

A new type of disdrometer analyzed at UK Research Innovation Center

94 GHz

PyTmatrix PSD module – two approaches compared

- psd.GammaPSD - using fitted Nw, Dw, μ
- psd.BinnedPSD - using binned DSD directly



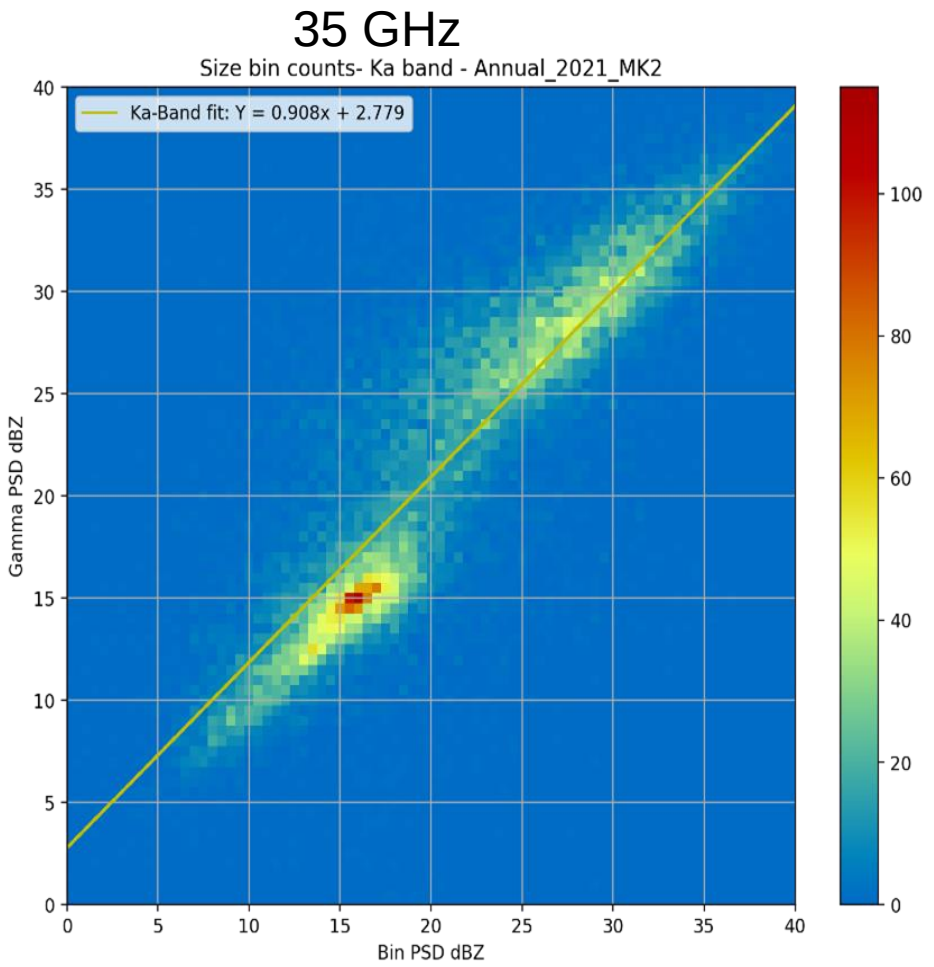
A new type of disdrometer analyzed at UK Research Innovation Center

Puzzles to resolve

- 35GHz results need further understanding.

Further work

- **Implement comparison with 35GHz and 94GHz radars**
- Refine event selection
  - Temperature > 4°C, max wind speed
  - Max rainrate cutoff
- Compare with
  - **Thies disdrometer** deployed at Chilbolton for DiVeN project (Pickering et al https://doi.org/10.5285/602f11d9a2034dae9d0a7356f9aeaf45
  - Campbell Scientific **PWS-100**



Conclusions and perspectives

SOP

1. CCRES SOPs are ready for DD and DCR technical set-up
2. CCRES procedures for OTT software is ready
3. CCRES procedures for command-line configurations **have to be done**

DATA

1. **L0** : Data format and metadata **have to be discussed** (ACTRIS, DISDRODB vs LACROS-TROPOS)
2. **L1** : discuss / validate the quality check on disdrometer
3. **L1** : discuss / validate the data format-unit and metadata for the multivariables files with MET, DD and DCR data

TEST & METH.

1. CCRES pre-processing on DD (to derive Z starting from drop distributions) **has to be applied** on other dataset
2. Refine the good rain event selection
3. Success of the monitoring of DCR reflectivity at SIRTA site for long-term dataset (significant absolute shift, low variability and good frequency)
4. Methodology of DCR-Z monitoring **has to be test** on other sites (Cabauw, etc.)

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Thank you

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ALC calibration

Simone Kotthaus (IPSL), Ina Mattis (DWD)
& Ewan O'Connor (FMI)

CCRES Workshop, Online –May 3-5th, 2022

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No 871115

Processing: RCS → attenuated backscatter

Corrections/processing to be implemented by CLU

- **Optical overlap**, e.g. temperature-dynamic model for Lufft CHM15k (Hervo et al. 2016)
- Vaisala: near-range artefacts & instrument-related **background** (Kotthaus et al. 2016)
- **Water vapour** effects ALC ~910 nm (Wiegner and Gasteiger 2015; Wiegner et al. 2019)

- **Absolute calibration** necessary based on atmospheric quantities

Rayleigh method (e.g. Wiegner and Geiß 2012)

- Reference: Rayleigh scattering profile in upper atmosphere
- Careful selection of profiles is key
- Sensitivity to molecular scattering is required!
- Not suitable for e.g. Vaisala CL31

Liquid cloud method (O'Connor et al. 2004, Hopkin et al. 2019)

- Reference: liquid clouds (lidar ratio 18.8 sr)
- Careful selection of profiles is key
- Special care must be taken if signal saturates in thick clouds (e.g. Lufft CHM15k)

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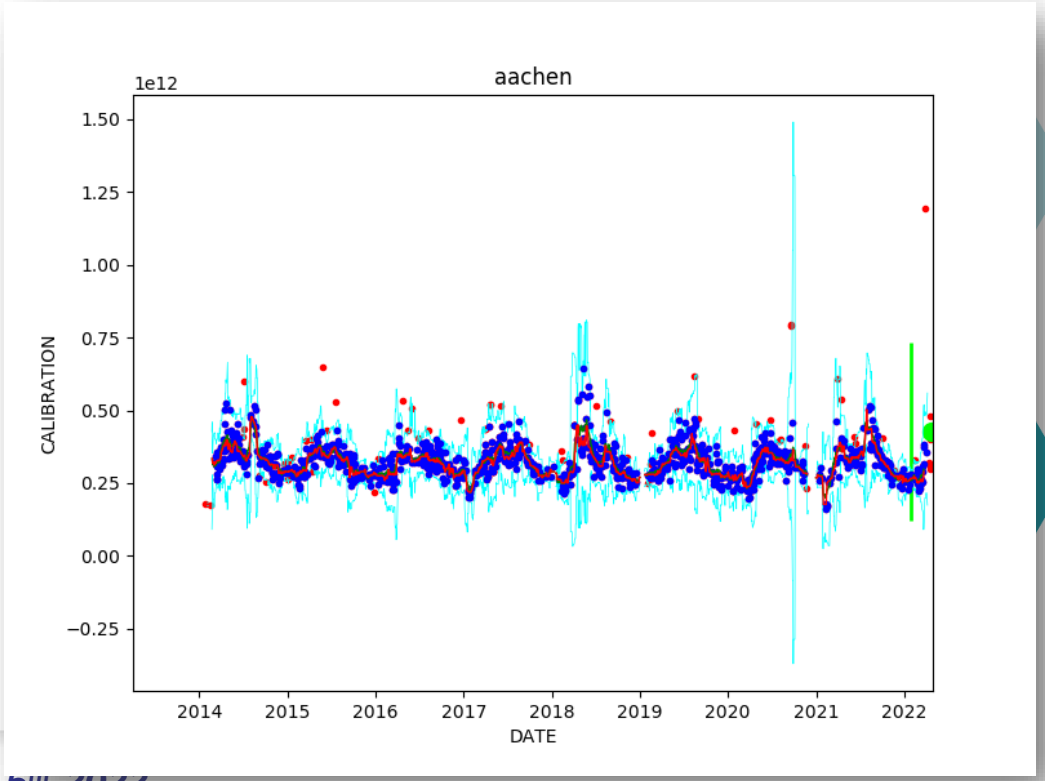
Automatic calibration procedures

Rayleigh calibration

- Case selection is important
- Several implementations are being compared
- Scientific investigation of seasonal cycle in calibration coefficient ongoing (background aerosol?, laser-related issue?, …)

Liquid cloud calibration

- Case selection is important
- Several implementations are being compared



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Thank you

Microwave Radiometer Calibration within ACTRIS

Bernhard Pospichal
University of Cologne

MWR calibration

Measurement of downwelling radiation emitted mainly by atmospheric gases (O_2, H_20) and hydrometeors (cloud liquid water) between 20-100 GHz

Measured radiances are expressed as brightness temperatures and need to be calibrated

Types of calibrations:

- **Automatic (relative) calibrations**
  - „Hot load“ calibration using internal blackbody at ambient temperature
  - Noise diode calibration (HATPRO G5 – Noise switching with 50Hz)

  according to MWR SOPs during standard measurements

- **Absolute calibrations**
  - Liquid nitrogen calibration every 6 months
  - Sky-tipping calibration not recommended within ACTRIS

Absolute radiometer calibration

- Absolute calibrations using liquid nitrogen (LN_2) have to be performed every 6 months or after relocation of the instrument

- New developments for the HATPRO calibration load
  - old open load (before 2016) not to be used for ACTRIS due to various uncertainties (reflection, evaporation, etc.)
  - PT-V1 load since 2017 (closed load which has to be turned during calibration)
  - PT-V2 load which is easier to handle (no turning necessary, less LN2 needed)

- LN2 calibration document will be available soon

- New developments in RPG-Software

Absolute radiometer calibration

- Impressions from different calibration intercomparison campaigns
  Lindenberg 2014, 2021
  Meckenheim 2015
  Jülich 2019

MWR data quality assurance strategy in ACTRIS

- Common standards for automatic calibration depending on instrument type and generation (MWR SOPs)
- Absolute calibration to be performed every 6 months
- Continuous performance monitoring at ACTRIS data centre
  - housekeeping parameters
  - calibration log-files
  - O-B statistics with model
  - spectral consistency checks

may determine and change calibration intervals

- Random error determination done via regular blackbody target observations (channel noise and covariances, i.e. correlated noise) during LN2 calibrations
- MWR software will provide files with brightness temperatures during calibration, as well as covariance matrices for calibration and performance monitoring
- Data files will include random and systematic uncertainties
  - close collaboration with E-Profile and German Weather Service (DWD)

Universität zu Köln

ACTRiS

Thank you for your attention!

https://cloudnet.fmi.fi

https://actris.eu/topical-centre/ccres

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