DISDROMETER RD-80 (Joss-Waldvogel)

Uma imagem contendo ao ar livre, mesa, água, pequeno

Descrição gerada automaticamente

Version 1

**Mentor**

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# Overview

The disdrometer RD-80 or Joss-Waldvogel (JWD) [2] is an instrument widely used to measure the distribution of raindrops over a given time interval. These data can be used to determine several precipitation properties, such as the rain rate and the radar reflectivity factor.

# Instrument Detail, Setup and Specifications

A sensor contained in a metallic cylinder (Figure 1) measures an electrical pulse from the mechanical moment caused by the impact of raindrops on a sensitive surface. The data is processed by a software called disdrodata (download: <https://distromet.com>). For more detailed information, please check the RD-80 user guide [2].

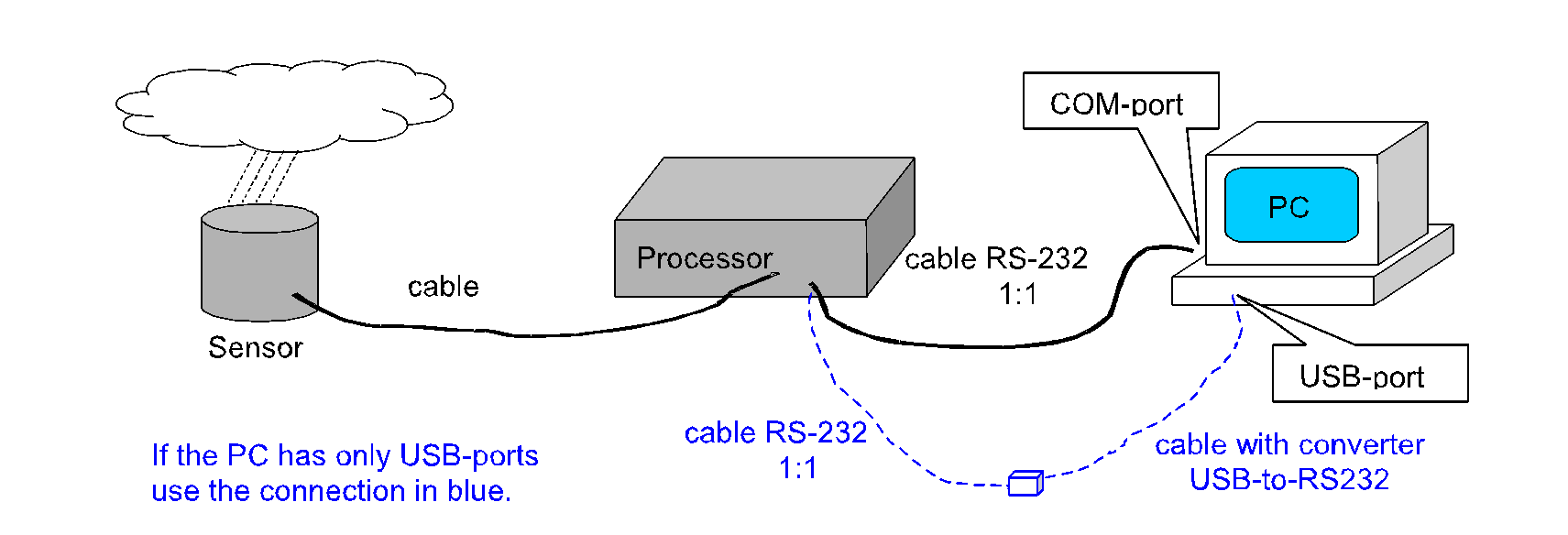


Figure 1. Disdrometer connection scheme. From disdromet [2].

The installation and calibrations were carried out based on [2] and [3]. Figure 2 shows the photos of the instrument at the installation site. As observed in Table 1, the last calibration was carried out in 6/ago/2021. Several pieces were replaced, including: Styrofoam Cone, plastic cap, rubber washer, and rubber o-ring. To keep the instrument working well, periodic inspection of the plastic cap is taking place every 6 month, same as the drop calibration. The plastic foil cap is replaced every three years. Detail about the maintenance is observed in [3].

Uma imagem contendo ao ar livre, mesa, banco, calçada

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Figure 2. RD-80 disdrometer at ATTO-campina site.

The specification for the RD-80 disdrometer is showed in Table 1 [3]. Also, you can find more detailed information about each parameter in [2] and [3].

Table 1. RD-80 specification for ATTO Campina site.

| **Location** | ATTO-Campina |  |
| --- | --- | --- |
| **Latitude (°)** | -2.1815896 |  |
| **Longitude (°)** | -59.0218639 |  |
| **Altitude (m)** | 59 |  |
| **F** | 0.005m2 | Size sentitive area of the sensor to the raindrod impact |
| **Drop diameter Range** | 0.3 – 5 mm (See Table 5) | Range of raindrop diameters |
| **Accuracy** | +/- 5% of measured drop diameter | By [3] |
| **Power requirements** | 100-240 Volts AC, 50/60 Hz, 5.5 VA |  |
| **Operating temperature range** | * 0 to 40°C for processor * 0 to 50°C for sensor |  |
| **Data acquisition cicle** | 1 minute | A daily data is available in netcdf format with missing variable reported (See Table 3) |
| **Data Inspection** | Once week |  |
| **Last calibation** | 6/ago/2021 |  |

The disdrodata software setup applied to the operation of this equipment is described on the Table 2.

Table 2. Configuration applied to RD-80 disdrometer for ATTO Campina site.

| **Parameter** | Setup | Setting/Description |
| --- | --- | --- |
| **T1** | 60s | Configure Logging/Sampling interval for raindrop data |
| **Automatic program start** | Marca de seleção com preenchimento sólido | Configure Logging |
| **Rounding of start time** | On full minute | Configure Logging |
| **RP1** | 24h | Configure Logging/Period for recording data file |
| **T2** | 60s | Time interval for calculate parameters and distributions (e.g. Rain rate, liquid water content, etc) |
| **Device** | RD-80 | Hardware configuration |
| **COM port** | 7 | Hardware configuration |
| **Local data directory** | C:\Documents and Setting\GPM-1\Meus Documentos\DISDROMETER DATA\RECORDED DATA\ | Directory where the data (\*.txt) is created |
| **Generate transfer file** | Marca de seleção com preenchimento sólido | Configure data transfer |
| **Transfer data directory** | C:\ATTO\_CAFÉ\JOSS | Configure data transfer/Directory where the redundant data (\*.trf) is created |
| **Row per transfer line** | 1440 | Configure data transfer/Number of lines of each transfer file (one day in minutes) |

# File Naming Convention

The Atmospheric Radiation Measurement (ARM/DOE) data formatting and filenaming [4] is used here as reference. For this experiments the filename has the following structure.

Diagrama

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# Data level

The data level is based on ARM designation [4, chapter 7]. At this point only two data levels are available: level a0 and b1. In b1, data quality variables are available on the netcdf file (e.g. attdisdrometercam.**b1**.20201014.000000.nc). More information about all variables and quality control, please, check the following sections. Because of the quantification of some fails, quality control variables are include on the b1 netcdf file with one month delay. Also, the raw data is storage and can be find on the local server **(**[**http://ftp.lfa.if.usp.br/ftp/public/ATTO/Campina/JOSS/trf/**](http://ftp.lfa.if.usp.br/ftp/public/ATTO/Campina/JOSS/trf/)) and the whole information about these data are described by [2] and [3].As described by [4]:

* **a0** is the raw data converted to netcdf;
* **b1** is applied a quality control checks to at least one measurement. Missing data (value is -999) are quantify and unrealistics data are identify.

# Variables

The name of every variable and their description are showed in Table 3. Also, the ARM data structure [4,5] was also used as reference.

Table 3. List of variables for RD-80 disdrometer.

| Variable | dimension | interval | unit | description |
| --- | --- | --- | --- | --- |
| base\_time | time | 1 minute | seconds since YYYY-mm-dd XX:XX:XX X:XX | Base time in epoch |
| time\_offset | time | 1 minute | seconds since YYYY-mm-dd XX:XX:XX X:XX | Time offset from base\_time |
| lat | Please, see Table 2 | none | degree | North Latitude |
| lon | Please, see Table 2 | none | degree | East Longitude |
| Alt | Please, see Table 2 | none | m | Altitude (meters above the sea level) |
| serial\_number | 2102502 | none | none | Instrument serial number |
| calib\_date | 20220806 | none | none | Calibration date |
| precip\_dis | time\* | 1 minute | mm | Rain amoun |
| num\_drop | time:class\*\* | 1 minute | none | Number of raindrops measured for each class\* during time interval T1 |
| drop\_class | time:class | 1 minute | mm | Average diameter of drops for every class\* (See Table 4) |
| rain\_rate | time | 1 minute | mm.h-1 | Rain intensity |
| d\_max | time | 1 minute | mm | Largest drop registered during interval t, |
| nd | time:class | 1 minute | mm-3m-1 | Number density of drops of the diameter corresponding to every size class\* per unit volume |
| fall\_vel | class | none | m/s | Fall velocity of drop with diameter D (See Table 4) |
| delta\_diam | class | none | mm | Diameter interval for every drop size class (See Table 4) |
| liq\_water | time | 1 minute | g.m-3 | Liquid water content |
| zdb | time | 1 minute | dB | Radar reflectivity factor |
| ef | time | 1 minute | J.m-2 | Energy flux |
| lambda | time | 1 minute | mm-1 | Slope |
| distribution\_intercept | time | 1 minute | mm-3m-1 | N0 - Intercept |
| qc\_time | time | 1 minute | none | Quality control of the sample time |
| qc\_precip\_dis | time | 1 minute | none | Quality control of the precipitation total (min=0,max=10mm) |
| qc\_numdrop | time | 1 minute | none | Quality control of the number of drops (min=0,max=none) |
| qc\_rain\_rate | time | 1 minute | none | Quality control of the rain rate (min=0,max=none) |

\*time is the number of expected measurements based on the time interval during to the experiment. Missing data are defined as value of -999.

\*\*class is 20 drop size classes (See Table 4)

Table 4 shows the drop classes, fall velocity and diameter interval from [2].

Table 4. Raindrop class specification from [2].

| Drop size class in DISDRODATA program | Output code of processor RD-80 | Lower threshold of drop diameter | Average diameter of drops in class i,  Di mm | Fall velocity of a drop with diameter Di, (1)  v(Di) m/s | Diameter interval of drop size class i,  Delta Di mm |
| --- | --- | --- | --- | --- | --- |
| 1 | 1-13 | 0.313 | 0.359 | 1.435 | 0.092 |
| 2 | 14-23 | 0.405 | 0.455 | 1.862 | 0.100 |
| 3 | 24-31 | 0.505 | 0.551 | 2.267 | 0.091 |
| 4 | 32-38 | 0.596 | 0.656 | 2.692 | 0.119 |
| 5 | 39-44 | 0.715 | 0.771 | 3.154 | 0.112 |
| 6 | 45-54 | 0.827 | 0.913 | 3.717 | 0.172 |
| 7 | 55-62 | 0.999 | 1.116 | 4.382 | 0.233 |
| 8 | 63-69 | 1.232 | 1.331 | 4.986 | 0.197 |
| 9 | 70-75 | 1.429 | 1.506 | 5.423 | 0.153 |
| 10 | 76-81 | 1.582 | 1.665 | 5.793 | 0.166 |
| 11 | 82-87 | 1.748 | 1.912 | 6.315 | 0.329 |
| 12 | 88-93 | 2.077 | 2.259 | 7.009 | 0.364 |
| 13 | 94-98 | 2.441 | 2.584 | 7.546 | 0.286 |
| 14 | 99-103 | 2.727 | 2.869 | 7.903 | 0.284 |
| 15 | 104-108 | 3.011 | 3.198 | 8.258 | 0.374 |
| 16 | 109-112 | 3.385 | 3.544 | 8.556 | 0.319 |
| 17 | 113-117 | 3.704 | 3.916 | 8.784 | 0.423 |
| 18 | 118-121 | 4.127 | 4.350 | 8.965 | 0.446 |
| 19 | 122-126 | 4.573 | 4.859 | 9.076 | 0.572 |
| 20 | 127 | 5.145 | 5.373 | 9.137 | 0.455 |

# Reading and plotting

To make the data friendly for user we provide a list of commands to open the data and plote a specific variables in python. Please, follow the sequence of commands to read the netcdf file and plot one day of measurements for precip\_dis. Also, a jupyter notebook is available in <https://github.com/alancalheiros/datamap-scripts/>.

This repository contains scripts to generate netCDF files from data in .trf format and also to generate figures from netCDF files. Below are the available commands for running the scripts.

## Installation

### Requirements

* Python 3.11 or higher
* git
* pip or
* Anaconda

### Installation

Via pip:

git clone https://github.com/helvecioneto/datamap-curadoria.git

cd datamap-curadoria

pip install -r requirements.txt

Via conda:

git clone https://github.com/helvecioneto/datamap-curadoria.git

cd datamap-curadoria

conda env create -f environment.yml

## Gen netCDF

### Execute for all .trf files in the JOSS/input/data directory

Generates a netCDF file for each day that contains data.

cd JOSS

python JOSS\_gen\_netCDF.py -s

### Execute for a specific date

Generates a netCDF file only with data from the specified date in the command.

python JOSS\_gen\_netCDF.py -s -d 31/01/2000

### Execute for files listed in files.txt

Generates a netCDF file for each day with data from files listed in the files.txt file in the input/JOSS directory.

python JOSS\_gen\_netCDF.py -l

### Execute for a specific date from files listed in files.txt

Generates a netCDF file only with data from the specified date in the command for files listed in files.txt.

python JOSS\_gen\_netCDF.py -l -d 31/01/2000

## Gen Figures

### Execute for all netCDF files in the input/JOSS/data\_figures directory

Generates all figures in PNG and HTML formats.

python JOSS\_gen\_figures.py -s

### Execute for all netCDF files in PNG format

Generates only the figures in PNG format.

python JOSS\_gen\_figures.py -s -p

### Execute for files listed in files\_figures.txt

Generates all figures for the files listed in files\_figures.txt in the input/JOSS directory.

python JOSS\_gen\_figures.py -l

### Execute for files listed in files\_figures.txt in PNG format

Generates only the figures in PNG format.

python JOSS\_gen\_figures.py -l -p

## Directory Structure

* input/JOSS/data/: Contains the .trf files to generate netCDF.
* input/JOSS/data\_figures/: Contains the .nc files to generate figures.
* input/JOSS/files.txt: List of .trf files to be processed.
* input/JOSS/files\_figures.txt: List of .nc files to be processed.

### PATTERN MODE EXPLANATION

#### Example of command:

python JOSS\_gen\_netCDF.py -p "%Y%m%d" -d "01/08/2022"

#### What it does:

1. It receives the parameter -d and treats it as a date. We then have datetime(year=2022,month=8,day=1).
2. It generates three temporary variables:
   * d0 = datetime(year=2022,month=8,day=1)
   * d1 = datetime(year=2022,month=8,day=2)
   * d2 = datetime(year=2022,month=7,day=31)
3. It uses the value received by the -p parameter as a datetime formatter. It formats d0, d1, and d2 as auxiliary strings. See:
   * d0 = "20220801"
   * d1 = "20220802"
   * d2 = "20220731"
4. It searches for all files in the input directory but returns in the list files only those files whose names meet the criteria:
   * 1. The file name ends with the extension specified in variables\_info.json.
     2. The file name contains one of the strings d0, d1, or d2.

The files list is used to read the files, so only the relevant files are read.

#### Important to note:

A. Parameter -p:

* You must pass the format in which the date is recorded in the names of the files placed in the input directory.
* For example, for files:
  + RD-20220731-215400.txt
  + RD-20220801-215400.txt
  + RD-20220802-215400.txt
* Notice that in RD-20220801-215400.txt:
  + ^^^^^^^^ (The date is here)
* The format of the date above is YYYYMMDD.
* However, you must pass this format according to Python's strftime conventions. See details at:<https://strftime.org/>
* So, you should pass the value for the -p parameter -> %Y%m%d.

B. Parameter -d:

* It determines for which day we will read one day before and one day after.
* You must always pass a -d parameter when using the -p parameter.

# Verification

As described by [2] the disdrometer rain rate shoulbe be close to XXX% as compare with a raingauge. To check how realible is the data, some verification were applied to the data in XXX. A comparison between the RD-80 and the closest rain gauge was carried out in XXXX. The values related to precipitation statistics is showed in Table 5. As noted, the Mean Absolute Erro (MAE) was XX mm/h for rain rate. The bias (%) was XX.

Table 5.

# References

[1] Joss, J and A Waldvogel. 1967. “In spektrograph fuer niederschlagstropfen mit automatischer auswertung.” *Pure Applied Geophysics* 68(1): 240-246, doi:10.1007/BF00874898.

[2] DISDROMETER RD-80 User Guide for DISDRODATA 2.0. March, 2009. DISTROMET LTD

[3] DISDROMETER RD-80 operating instructions. January 10, 2015. DISTROMET LTD. Access in December 2020: <http://www.ictinternational.com/content/uploads/2018/07/RD-80-Operating-Instructions-January-2015.pdf>

[4] Palanisamy, G. (2016). *ARM Data File Standards Version 1.2*(No. DOE/SC-ARM-14-010). DOE Office of Science Atmospheric Radiation Measurement (ARM) Program (United States).

[5] Bartholomew, M. J. (2016). Impact Disdrometers Instrument Handbook (No. DOE/SC-ARM-TR-111). DOE Office of Science Atmospheric Radiation Measurement (ARM) Program (United States).