Operational Instrument Description and Data Management Plan for Disdrometer Ott Parsivel^2, Geophysical Institute, University of Bergen

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Contents

1 Introduction

This document describes the setup and data management of the disdrometer Parsivel^2 (Ott GmbH, Germany), which is owned, installed and operated by the Meteorology group at the Geophysical Institute (GFI), University of Bergen (UiB), Norway. It is part of a document series covering all instrumentation used for continuous data acquisition and processing at the Geophysical Institute.

The document serves as a reference for the installation of the hardware and software, for needs when shipping the instrumentation to other locations, to understand and modify the data archiving and post-processing if needed, and the file formats and metadata information, and locations used for archiving.

2 Ott Parsivel^2 Disdrometer

The measuring principle and the uncertainties regarding snow and rainfall are extensively described in the published literature (Battaglia et al., 2010; Raupach and Berne, 2015ab).

Table 1: General instrument parameters for the Parsivel^2

Parameter	Description
Instrument	Parsivel^2 drop size disdrometer, Ott GmbH, Germany
Geographical coordinates	60.38N, 5.33E,
Installation location	Rooftop of GFI building
Note	temporal deployment to other locations and field measurements do occur
Instrument serial number	
Start Date	January 2016
Finish Date	ongoing
Funding Source	GFI internal funding
Shipping weight	30 kg
Shipping dimensions	aluminium box (instrument, cable, power/data interface)
Mounting setup	63 mm tubing, 3 screws Mx, hex wrench.
Principal investigator	Harald Sodemann (harald.sodemann@uib.no)
Data owner	Geophysical Institute, University of Bergen, Norway
Measurement period	60 s

Data are in general archived on a network drive mounted at `cyclone.hpc.uib.no` and `leo.hpc.uib.no` the location `/Data/gfi/scratch/metdata/Parsivel_DSD` on the GFI linux system. The drive can be mounted on client PCs and Macs. On a Mac, connect using Finder, Connect to server and then enter the path `smb://uib;<userid>@leo.hpc.uib.no/gfi/scratch/metdata/Parsivel`.

2.1 Measurement description

The Parsivel^2 instrument is a laser disdrometer. The working principle is described in the manual and the references above. In short, an array of laser beams is shaded as rain drops fall past. The time and width of shading is monitored and used to calculate the number, fall speed and size of precipitation particles. The instrument owned by GFI is installed at the top of the Geophysical Institute building, with the laser beam aligned in NW-SE direction, to be orthogonal to the mean wind direction during rainfall events. The instrument is mounted at the southern rim of the tower. During one case, the instrument was deployed on the top of the Greenland ice sheet. Further details are listed in Table 1.

In the categorisation of droplets, 32 bins of fixed with and speed are utilized, defined by the manufacturer (Tab. 2 and 3). The first two size bins are currently unused.

2.2 Data collection

The Parsivel^2 disdrometer is connected to a laptop computer running Windows 10 via a serial/USB interface. Data from the instrument is logged via a COM port using custom data acquisition software written in Python (`read_parsivel.py`). The software is started automatically at logon of the default user using Windows Task Scheduler. After making a connection to the instrument, data are logged to screen and a data file each minute. There is currently no tool installed to plot the data on the Windows PC.

Table 2: Size categories (mm) of the Parsivel^2 disdrometer.

Nr.	Size (mm)	Nr.	Size (mm)
1	6.2E-02	17	3.3E+00
2	1.9E-01	18	3.8E+00
3	3.1E-01	19	4.3E+00
4	4.4E-01	20	4.8E+00
5	5.6E-01	21	5.5E+00
6	6.9E-01	22	6.5E+00
7	8.1E-01	23	7.5E+00
8	9.4E-01	24	8.5E+00
9	1.1E+00	25	9.5E+00
10	1.2E+00	26	1.1E+01
11	1.4E+00	27	1.3E+01
12	1.6E+00	28	1.5E+01
13	1.9E+00	29	1.7E+01
14	2.1E+00	30	1.9E+01
15	2.4E+00	31	2.2E+01
16	2.8E+00	32	2.5E+01

Table 3: Speed categories of the Parsivel^2 disdrometer.

Nr.	Size (mm)	Nr.	Size (mm)
1	5.0E-02	17	2.6E+00
2	1.5E-01	18	3.0E+00
3	2.5E-01	19	3.4E+00
4	3.5E-01	20	3.8E+00
5	4.5E-01	21	4.4E+00
6	5.5E-01	22	5.2E+00
7	6.5E-01	23	6.0E+00
8	7.5E-01	24	6.8E+00
9	8.5E-01	25	7.6E+00
10	9.5E-01	26	8.8E+00
11	1.1E+00	27	1.0E+01
12	1.3E+00	28	1.2E+01
13	1.5E+00	29	1.4E+01
14	1.7E+00	30	1.5E+01
15	1.9E+00	31	1.8E+01
16	2.2E+00	32	2.1E+01

Table 4: Measurement parameters recorded by the Parsivel[2].

Measurement parameter	Unit
Date	DD.MM.YYYY HH:MM:SS
Rainfall rate	$\mathrm{mm\,h^{-1}}$
Accumulated rainfall rate	mm since reset
Radar reflectivity	dBZ
Snowfall rate	$\mathrm{mm\,h^{-1}}$
Weather code according to SYNOP Table 4680	-
Temperature in the sensor housing	°C
MOR visibility in precipitation	m
Kinetic energy	$\mathrm{J\,m^{-2}\,h^{-1}}$
Signal amplitude of the laser strip	1
Number of particles detected and validated	1
Number concentration per size class	$\log(\mathrm{m^{-3}\,mm^{-1}})$
Average particle speed per size class	$\mathrm{m\,s^{-1}}$
Raw counts	1
Additional information in the data files:	
Spectral number concentration density	$\mathrm{m^{-3}\,mm^{-1}}$
Mass-weighted mean diameter	mm

The logged data are set by a command
`"CS/M/S/%20,%20,%01,%02,%35,%03,%07,%08,%34,%12,%10,%11,%18,%90,%91,%93/r/n"<CR>`
issued to the instrument through a COM port during setup. Time can be adjusted in the instrument using the command `"CS/U/01.01.2011 10:55:11"<CR>`. Table 4 lists the parameters archived in the raw files.

The raw files (YYYY-MM-DD.txt) created by the data acquisition program are stored at location `C:\Users\Public\PublicDocuments\Parsivel\Data` with folders named YYYY-MM. The data files from the present and last two days are compressed to gzip format every hour by Python script `sync_parsivel.py` and copied to the linux storage which is mounted as a network disk `Z:`, corresponding to path `\leo.hpc.uib.no\gfi\scratch`, folder `Parsivel_DSD`. The script is also called from Task Scheduler and runs every hour. Nightly mirror backups are maintained for all data on the metdata drive. The scripts are located in `C:\Users\Public\PublicDocuments` on the Windows PC. Copies of the scripts are located in `/Data/gfi/scratch/metdata/scripts/Parsivel` and on the gitlab account UiB-GFI (`https://git.app.uib.no/uib-gfi/gfi_instruments`).

Error sources

Measurement problems have been encountered from electric power variations when the instrument was installed at EastGRIP in Greenland. Connection problems probably cause garbled characters (such as ASCII codes 0-10) in the logged text files, that have to be removed before further processing and conversion of the .txt file by a filtering script.

During setting up the instrument, exposure to wind is a source of measurement error during rainfall. Formation of drops at the housing may be a further source of error, creating large drops. Icing conditions require the housing to be heated for proper functionality.

Table 5: Scripts for acquisition and processing of data from Parsivel[2]

Script name	purpose
read_parsivel.py	acquire data from instrument and store as .txt files
sync_parsivel.py	compress and copy data files to network drive
preprocess_parsivel.py	remove bad characters from .txt files
convert_parsivel2nc.py	convert .txt files to netCDF format with additional parameters
parsivel2nc.ncl	convert .txt files to netCDF format (NCL version, currently not used)
do_convert_parsivel2nc.sh	run conversion script with parameters for different campaigns
parsivel_quicklook.m	create daily quicklook chart with time series etc
parsivel_overview.m	create quarterly summary chart of data availability and rainfall
read_parsivel.m	read parsivel data from netcdf archive structure
aggregate_parsivel.m	average data read in to a specified time interval
plot_parsivel_weekly.m	plot weekly standard plots for parsivel data

Table 6: Variables in netCDF data files for Parsivel[2]

Name	Unit	Long name	Dim	Format
time (dim)	time	days since 0000-01-02 00:00:00	time	double
size (dim)	mm	Volume equivalent diameter	size	float
speed (dim)	mm	Particle speed	speed	float
WC	-	Weather code acc. to SYNOP Table 4680	time	byte
T	deg C	Temperature in the sensor housing	time	byte
RR	mm hr^{-1}	rain intensity	time	float
RTOT	mm	Rain amount accumulated	time	float
SR	mm hr^{-1}	Snow intensity (volume equivalent)	time	float
REFL	dBz	Radar reflectivity	time	float
VIS	m	MOR visibility in precipitation	time	int
KIN	J m^{-2} h^{-1}	Kinetic energy	time	float
SIG	1	Signal amplitude of laser strip	time	int
CNT	1	Number of particles detected and validated	time	int
N	1	Spectral raw counts	time,size,speed	int
ND	log(m^{-3} mm^{-1})	Log of spectral number concentration density	time,size	float
NP	m^{-3} mm^{-1}	Spectral number concentration density	time,size	float
VEL	m s^{-1}	Average particle speed per size class	time,speed	float
Dm	mm	Mass-weighted mean diameter	time	float

2.3 Processing routines

Processing routines for the conversion to netCDF data format in different programming languages are located in `/Data/gfi/scratch/metdata/scripts/Parsivel`.

The conversion to netCDF format is done on the linux system by a combination of bash and python scripts, run as cron service. The main routine for converting the .txt files to netCDF format is `convert_parsivel2nc.sh`. Since the .txt files can occasionally contain bad characters, they require screening before further processing. This is done with the script `preprocess_parsivel.sh`, called within the main conversion script.

Since the data files are mostly used in-house, no stringent transfer to the netCDF-CF standard has been done. The netCDF-CF standard facilitates the interchange with other

Table 7: File sizes for Parsivel^2

Ending	Size	Format
*.txt	6.4 MB	ASCII uncompressed
.txt.gz	30-200 KB	ASCII compressed with gzip
.nc	4.0-6.3 MB	netCDF classic, V1
.nc	4.0-6.3 MB	netCDF4 compressed, V1

data, while making the data less simple to use by an individual users due to the need to convert to different routines. The metadata however is included as extensively as possible.

A previous routine is available that converts daily .txt data files to netcdf format, using the NCL language `parsivel2nc.ncl` (see Table 5). However, in the current setup of the linux system, these routines can only generate uncompressed netCDF data files.

Daily files `parsivel_20180901.nc` are located in a monthly subfolder, contained within yearly folders (YYYY/MM). These are inside the following folders: `/Data/gfi/scratch/metdata/Parsivel_DSD/` for text format, and `/Data/gfi/scratch/metdata/Parsivel_DSD/netcdf` for netCDF format.

The processing routine in current version 1 data creates two additional fields:

1. Spectral number concentration density (m^{-3} mm^{-1}) in non-logarithmic units (as compared to log units produced by the Parsivel^2 algorithm). This calculation follows the procedure in Raupach and Berne (2015), Eq. (5) and (6). This involves calculation of the sampling area S.

2. The mass-weighted mean diameter D_m (mm), following Graf (2017), calculated as

$$\begin{aligned} M_3 &= \sum_{s=0}^{N}(Np_s \cdot D_s^3 \cdot \Delta D_s) \\ M_4 &= \sum_{s=0}^{N}(Np_s \cdot D_s^4 \cdot \Delta D_s) \\ D_m &= M_4/M_3 \end{aligned}$$

These additional fields are included in the data files. Plans for future processing of V2 include a more complete implementation of their correction method, and a specific consideration of snow conditions.

Metadata

The netCDF files contain additional metadata to identify the instrument, dataset owner and references, processing and installation sites. The metadata is specified in the processing routines. The routine is updated with campaign periods to automatically assign the correct metadata to the instrument when it was deployed in the field. For this, the script `do_convert_parsivel2nc.sh` needs to be adjusted after each campaign, adding the relevant details (Table 8).

Table 8: Metadata specification for Parsivel^2 netCDF files. Attributes marked by * are invariable or set by the processing script.

Attribute	Value
serial_number	369157
latitude	60.3837 deg N
longitude	5.3319 deg E
institution	Geophysical Insitute, University of Bergen, Norway
location_name	GFI Institute tower, Geophysical Institute, University of Bergen, Norway
file_creator	Harald Sodemann
data_contact	harald.sodemann@uib.no
description	Ott Parsivel2 drop size disdrometer data file
instrument*	Ott Parsivel2 Present Weather Sensor
version*	1.0
title*	Ott Parsivel2 drop size disdrometer raw data file
source_file*	name of source file
conventions*	NetCDF-CF
creation_date*	date of file creation

2.4 Quicklooks, plotting routines

Selected quicklooks are located in `/Data/gfi/scratch/metdata/Parsivel\_DSD/quicklooks`. The correspondings scripts to create quicklooks are located in `/Data/gfi/scratch/metdata/scripts/Parsivel/plotting` (see Table 5).

- Daily raw spectral scatter (precipitation days only). Produced by matlab routine `parsivel_plots.m`. Produces a density plot of velocity vs. size categories, and a particle size distribution, daily time series of atmospheric measurements, time series of instrument parameters, time series of size and speed histograms. Examples for the figures produced within the routine are shown in Fig. 1-4.
- Annual data availability visualisation. This plot shows the number of data points per day in the category rain, snow, missing, monthly color bar plots, summary table of monthly and annual missing data, rain, snow, total amount (Fig. 5).

2.5 References

Battaglia, A., Rustemeier, E., Tokay, A., Blahak, U. and Simmer, C: PARSIVEL Snow Observations: A Critical Assessment, J. Atmos. Ocean. Tech., 27:333-344, doi: 10.1175/2009jtecha1332.1, 2010.

Raupach, T. H. and Berne, A.:Correction of raindrop size distributions measured by Parsivel disdrometers, using a two-dimensional video disdrometer as a reference, Atmos. Meas. Tech., 8, 343-365, doi:10.5194/amt-8-343-2015, 2015.

Raupach, T. H. and Berne, A.:Corrigendum to "Correction of raindrop size distributions measured by Parsivel disdrometers, using a two-dimensional video disdrometer as a reference" published in Atmos. Meas. Tech., 8, 343365, 2015, Corrigendum to Atmos. Meas. Tech., 8, 343365, doi:10.5194/amt-8-343-2015-corrigendum, 2015.

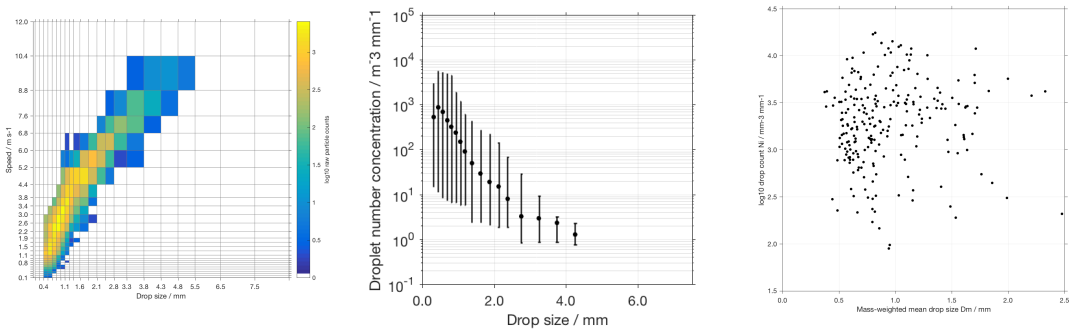

Figure 1: Quicklook image with (a) Raw particle counts, (b) Particle size spectrum, (c) Particle diameter vs. particle number.

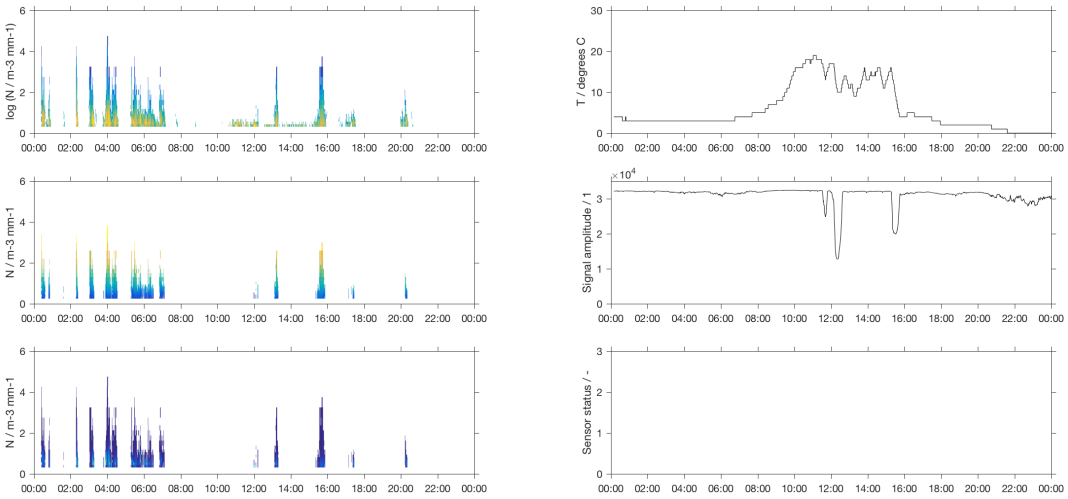

Figure 2: Quicklook image with (a) distribution of N by size, speed and log(N) by size category, (b) time series of instrument status parameters.

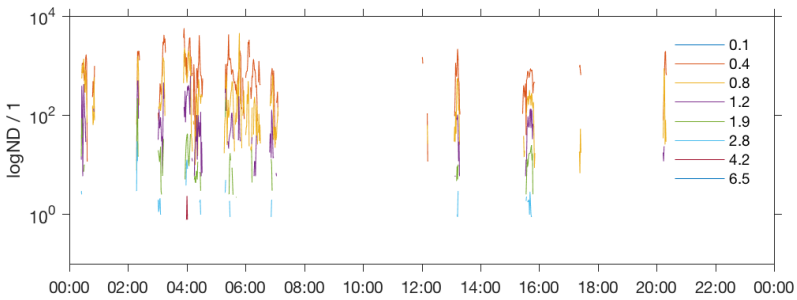

Figure 3: Quicklook image with time series of selected particle size categories.

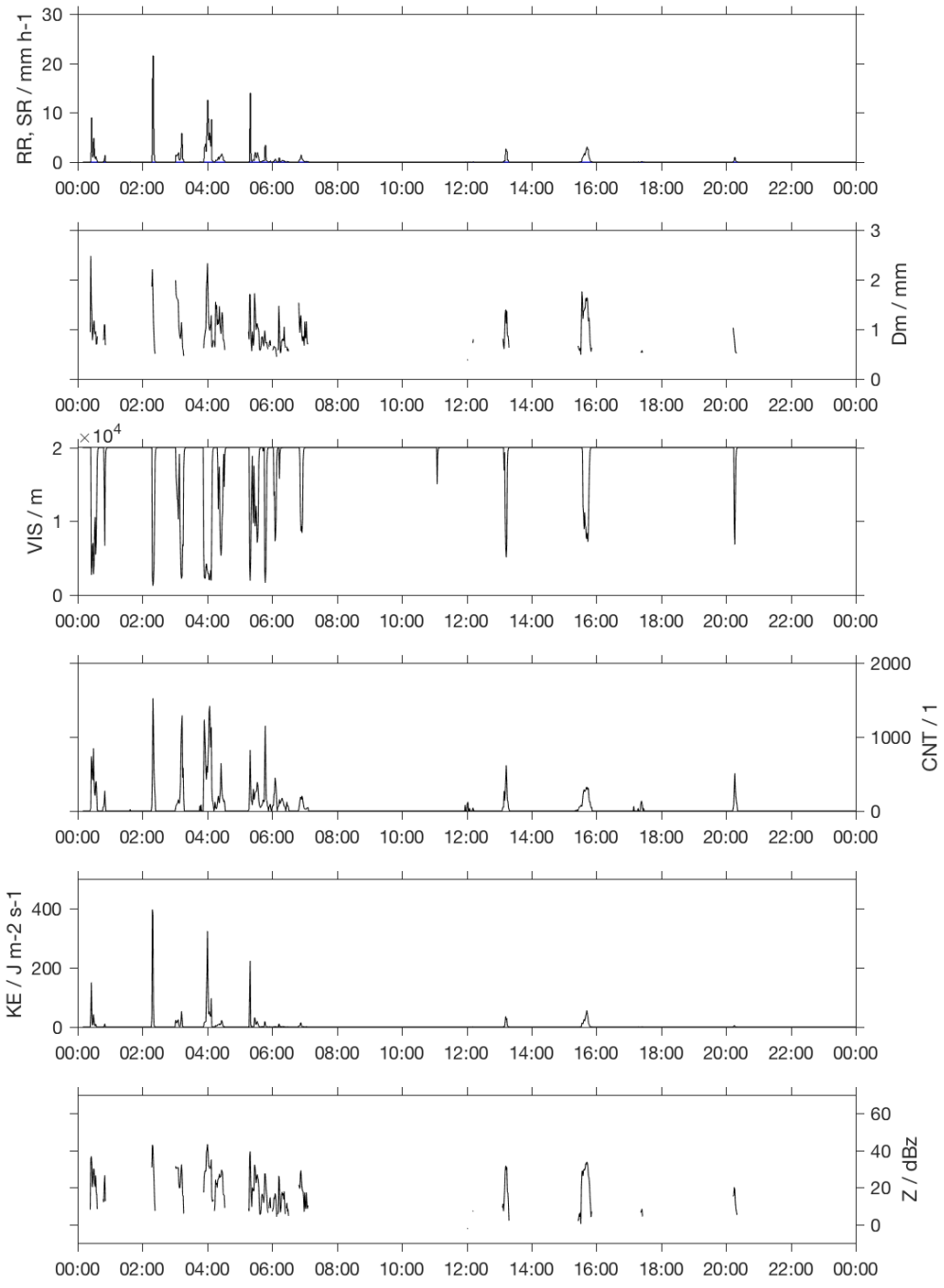

Figure 4: Quicklook image with time series of atmospheric measurement parameters.

2.6 Events log for 2016

The standardised event log for 2016 is show in Fig. 5.

Table 9: Events log for 2016

07.01.2016	Set up instrument with final programming of parameters and data acquisition.
13.06.2016	Rerouted cable through alternative pipe
	Readjusted level and angle to previous settings as good as possible
	Restarted instrument
07.08.2016	Changed output format to include long raw output

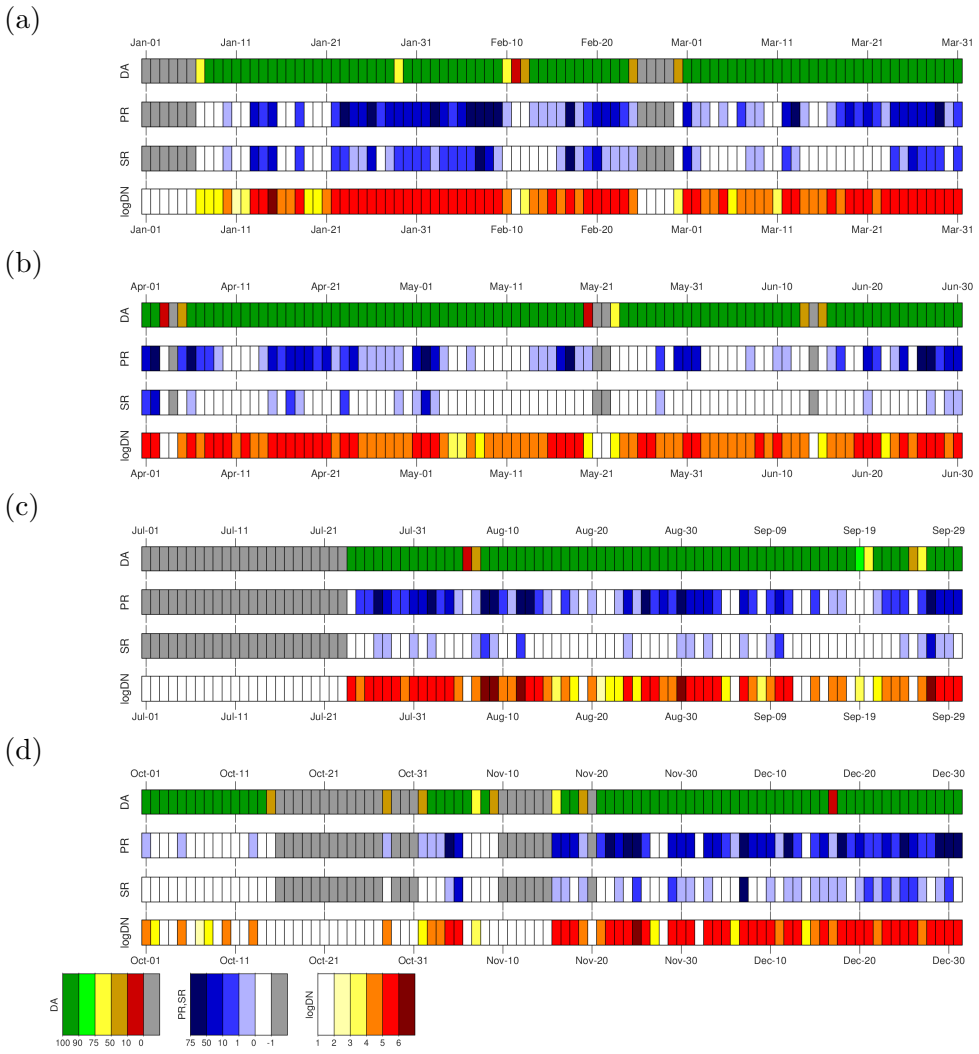

Figure 5: Data availability for the Parsivel^2 during 2016 for (a) JFM (b) AMJ (c) JAS (d) OND.

2.7 Events log for 2017

The standardised event log for 2017 is show in Fig. 6

Table 10: Events log for 2017

19.05.2017	Instrument installed at EastGRIP
12.08.2017	Instrument deinstalled at EastGRIP
24.08.2017	Instrument reinstalled at GFI

(a)

(b)

(c)

(d)

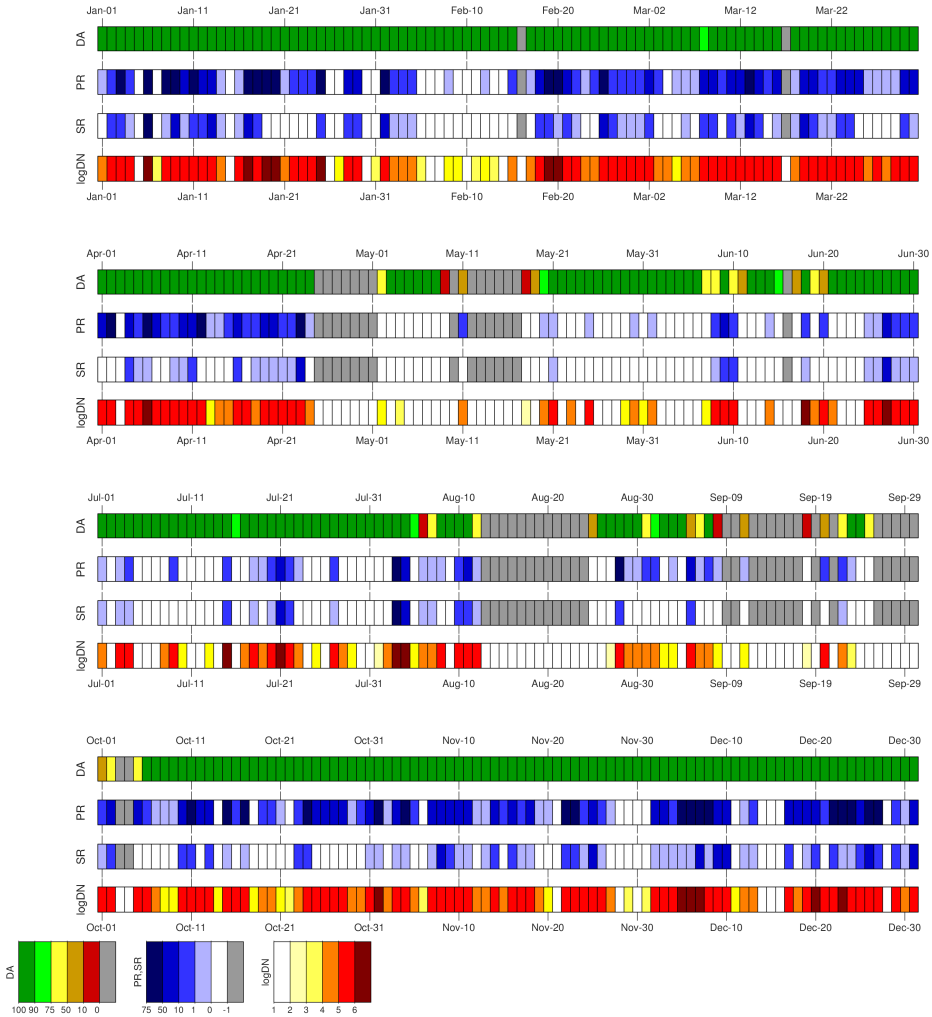

Figure 6: Data availability for the Parsivel^2 during 2017 for (a) JFM (b) AMJ (c) JAS (d) OND.

2.8 Events log for 2018

The standardised event log for 2018 is show in Fig. 7

Table 11: Events log for 2018

16.05.2018 14:08:00	Instrument data acquisition stopped due to power outage, 13 day data gap
29.05.2018 12:16:57	Instrument data collection restarted

(a)

(b)

(c)

(d)

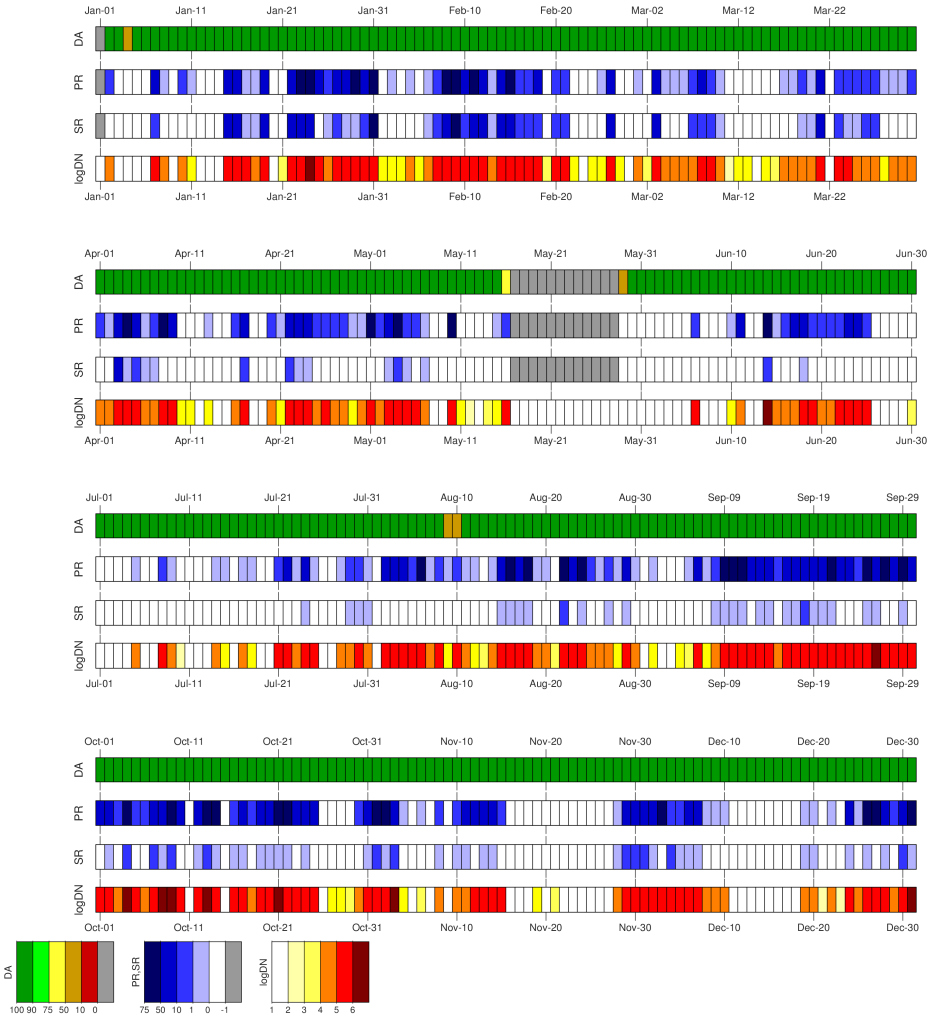

Figure 7: Data availability for the Parsivel^2 during 2018 for (a) JFM (b) AMJ (c) JAS (d) OND.

2.9 Events log for 2019

The standardised event log for 2019 is show in Fig. 8

Table 12: Events log for 2019

no events logged

(a)

(b)

(c)

(d)

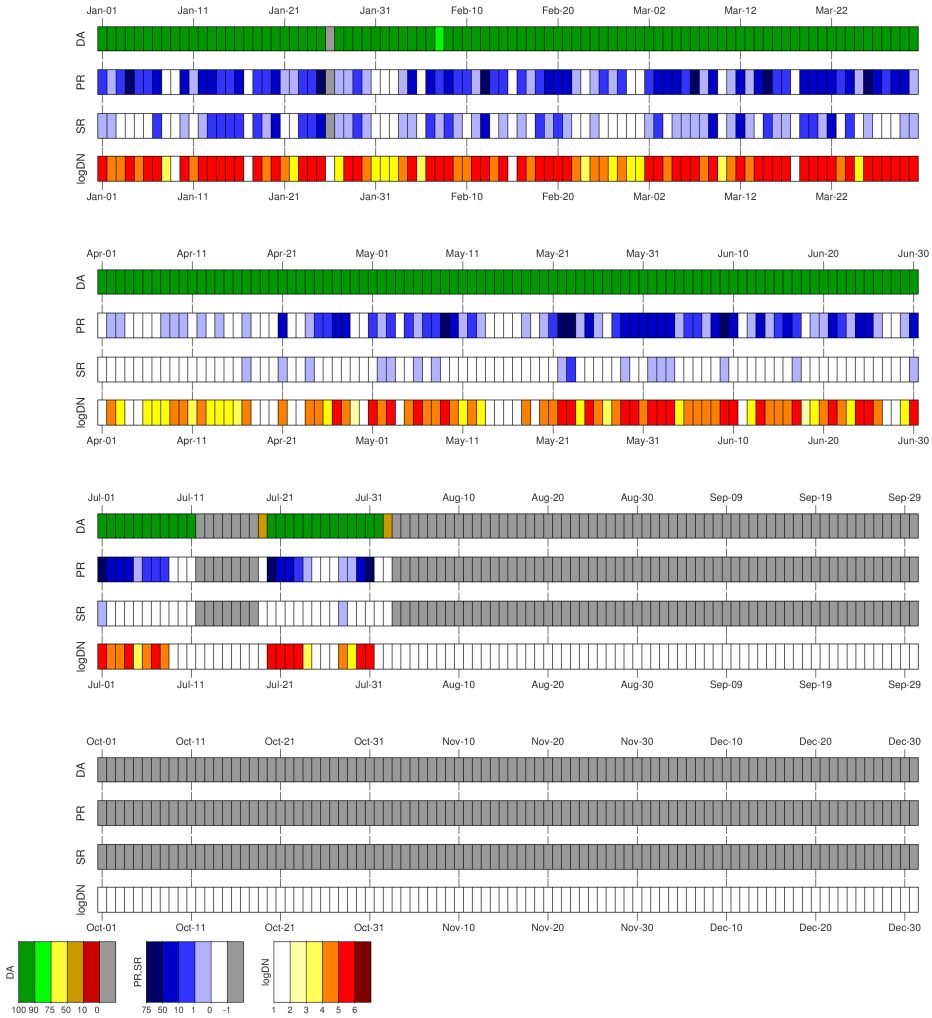

Figure 8: Data availability for the Parsivel^2 during 2019 for (a) JFM (b) AMJ (c) JAS (d) OND.