Data Format Documentation

Instrument: PARSIVEL^2

Overview:

At each GCPEx instrument site two Parsivel^2 sensors were located side-by-side and oriented perpendicular to one another within a wind abatement fence, which was constructed similar to a Double-Fence Intercomparison Reference (DFIR). This dataset does not contain any precipitation identification since it is not possible to separate rain and snow particles from each unique Parsivel^2 measurement. However, the data was processed for rain, snow, and mixed type precipitation allowing the end-user to select which type to employ.

Data Organization:

The Parsivel^2 data set is contained within daily tar archives. The daily archive is named with the following convention,

parsivel_[sn]_gcpex_[site]_[latitude_longitude]_[date].tar

where [sn] = serial number of parsivel instrument (e.g., apu01)
[site] = site name
[latitude_longitude]=geographic location of instrument
(e.g., N363442.07_W0972640.90 is North 36°34'42.07" and West 97°26'40.90")
[date] = YYYYmmDD (e.g., 20110422)

and consists of ASCII encoded files containing information on the drop size distribution and integral precipitation parameters such as precipitation rate, reflectivity and mass-weighted mean diameter.

The following files may be contained within the tar archive and follow a similar naming convention as above:

- *_raw.txt: Parsivel calculated parameters and unfiltered drop spectrum
  - contains the temperature, integral rain parameters and the present weather codes (see APPENDIX C) as calculated by the Parsivel firmware
  - also contains the number of particles measured within each of the 32 diameter bin and 32 velocity bins (see APPENDIX A for bin definitions)

- *_dropCounts.txt: quality-controlled number of hydrometeors in each diameter bin each minute hydrometeors were detected (see APPENDIX B for bin definitions)
- *_flakeCounts.txt: quality-controlled number of snowflakes in each diameter bin each minute snow was detected (see APPENDIX B for bin definitions)
- *_DSD.txt: quality-controlled particle size distribution (based on measured fall velocities) for each diameter bin each minute hydrometeors were detected (see APPENDIX B for bin definitions)
- *_rainDSD.txt: quality-controlled raindrop size distribution (based on measured fall velocities) for each diameter bin each minute rain was detected (see APPENDIX B for diameter bin definitions)
- *_rainDSD_vT.txt: quality-controlled raindrop size distribution (based on terminal fall velocities) for each diameter bin each minute rain was detected (see APPENDIX B for bin definitions)
- *_snowDSD.txt: quality-controlled snowflake size distribution (based on measured fall velocities) for each diameter bin each minute snow was detected (see APPENDIX B for diameter bin definitions)
- *_Params.txt: quality-controlled integral parameters (based on measured fall velocities) for each minute hydrometeors were detected
- *_rainParams.txt: quality-controlled integral parameters (based on measured fall velocities) for each minute hydrometeors were detected
- *_rainParams_vT.txt: quality-controlled integrated parameters for rain (based on terminal fall velocities) for each minute hydrometeors were detected
- *_snowParams.txt: quality-controlled integral parameters for snow (based on measured fall velocities) for each minute hydrometeors were detected

Note: Each daily tar archive may not contain all the above listed files. If an instrument did not collect data, then no data file is present for that instrument in the tar archive. If there was no precipitation, then the level 3 files will not be present in the tar archive, but the raw files will as long as the instrument collected data.

Additional Parsivel data sets, which are not contained within a daily tar archive but use a similar file naming convention, provide a summary of the rainfall and snowfall events for the entire campaign.

- *_rainEvents.txt: quality-controlled total rainfall measured for a continuous period of precipitation
- *_snowEvents.txt: quality-controlled total snowfall measured for a continuous period of precipitation

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File Format:

Level 1A: raw files (*_raw.txt)

Format: ASCII

Format of each line:
YYYYmmDDHHMMSS;[sn], sensor status, temperature (°C), number of particles detected, rain rate (mm/hr), reflectivity (dBz), MOR Visibility (m), Weather code according to SYNOP WaWa Table 4680 (see APPENDIX C), Weather Code according to SYNOP WW Table 4677 (see APPENDIX C), number of particles within each diameter and velocity class (1,024 total classifications with bin1=[D[1],v[1]],bin2=[D[1],v[2]],…bin33=[D[2],v[1]],etc.; see APPENDIX A for bin definitions)

Note: The integration period in the level 3 data begins at the minute specified on each line

Level 3: drop and flake count files (*_dropCounts.txt, *_flakeCounts.txt)

Filtering methods:
- No filtering is performed in producing the 1-minute particle counts

Format: ASCII

Format of each line:
year, day of year, hour, minute, number of drops (flakes) in each of the 32 diameter bins corrected for drop shape (see APPENDIX B)

Level 3: drop size distribution (DSD) files (*DSD.txt, *DSD_vT.txt)

Filtering methods:
- No filtering is performed in producing the 1-minute DSD spectra

Format: ASCII

Format of each line:
year, day of year, hour, minute, particle concentration ($m^{-3}mm^{-1}$) in each of the 32 diameter bins

Level 3: Integral parameters (*_Params.txt, *_rainParams.txt, *_rainParams_vT.txt)

Filtering methods:
- No filtering is performed in producing the files containing all precipitation types (i.e., *_Params.txt).

- Diameter bins are corrected for oblateness (see APPENDIX B) in producing rain files
- Raindrops exceeding 50% of their terminal fall speed (Gunn and Kinzer 1949) are removed from rain files to eliminate spurious measurements (e.g., splash drops, insects, etc.). This is similar to the threshold used by Tokay et al. (2001) and Jaffrain and Berne (2011).
- Minutes with fewer than 10 drops and rainfall rate below 0.01 mm/hr are also removed from the rain files to eliminate noise.

Format: ASCII

Format of each line:
year, day of year, hour, minute, temperature (°C), total number of drops, total drop concentration (m^{-3}), liquid water content ($g\ m^{-3}$), rain rate ($mm\ h^{-1}$), reflectivity in Rayleigh regime (dBZ), mean mass-weighted diameter (mm), standard deviation of mean mass-weighted diameter, maximum drop diameter (mm)

Level 3: Integral snow parameters (*_snowParams.txt)

Filtering methods:

- Observations with measured velocity faster than 4 m/s are excluded
- Minutes with fewer than 10 flakes and rainfall rate below 0.01 mm/hr are also removed to eliminate noise.
- Density used to calculate integral parameters for snow was obtained from hourly accumulations measured by Pluvio^2 weighing precipitation gauge.

Format: ASCII

Format of each line:
year, day of year, hour, minute, temperature (°C), total number of snowflakes, total snowflake concentration (m^{-3}), rain rate ($mm\ h^{-1}$), reflectivity in Rayleigh regime (dBZ), mean mass-weighted diameter (mm), standard deviation of mean mass-weighted diameter, maximum snowflake diameter (mm)

Level 3: Event summaries: rainEvent and snowEvent files

Processing methods:

- Events are separated by one or more hours of rain (snow)-free periods based on the rain (snow) rates calculated from the one-minute particle counts (integral parameters).
- Events must persist more than 3 minutes or have at least 0.1 mm of liquid accumulation.

Format: ASCII

Format of each line:

year, day of year precipitation begins, beginning of precipitation (HH:MM), day of year precipitation ends, ending of precipitation (HH:MM), number of rainfall (snowfall) observations (minutes), event maximum rainfall rate (mm/hr), event total liquid water accumulation (mm), and event mean temperature (°C)

APPENDIX A: Level 1A Data

Volume-equivalent diameter classification:

Bin Number	Bin Average (mm)	Bin Spread (mm)
1	0.062	0.125
2	0.187	0.125
3	0.312	0.125
4	0.437	0.125
5	0.562	0.125
6	0.687	0.125
7	0.812	0.125
8	0.937	0.125
9	1.062	0.125
10	1.187	0.125
11	1.375	0.250
12	1.625	0.250
13	1.875	0.250
14	2.125	0.250
15	2.375	0.250
16	2.750	0.500
17	3.250	0.500
18	3.750	0.500
19	4.250	0.500
20	4.750	0.500
21	5.500	1.000
22	6.500	1.000
23	7.500	1.000
24	8.500	1.000
25	9.500	1.000
26	11.000	2.000
27	13.000	2.000
28	15.000	2.000
29	17.000	2.000
30	19.000	2.000
31	21.500	3.000
32	24.500	3.000

Velocity classification:

Bin Number	Bin Average (m/s)	Bin Spread (m/s)
1	0.050	0.100
2	0.150	0.100
3	0.250	0.100
4	0.350	0.100
5	0.450	0.100
6	0.550	0.100
7	0.650	0.100
8	0.750	0.100
9	0.850	0.100
10	0.950	0.100
11	1.100	0.200
12	1.300	0.200
13	1.500	0.200
14	1.700	0.200
15	1.900	0.200
16	2.200	0.400
17	2.600	0.400
18	3.000	0.400
19	3.400	0.400
20	3.800	0.400
21	4.400	0.800
22	5.200	0.800
23	6.000	0.800
24	6.800	0.800
25	7.600	0.800
26	8.800	1.600
27	10.400	1.600
28	12.000	1.600
29	13.600	1.600
30	15.200	1.600
31	17.600	3.200
32	20.800	3.200

APPENDIX B: Level 3 Data

Volume-equivalent diameter classification (corrected for drop shape):

Bin Number	Bin Average (mm)	Bin Spread (mm)
1	0.064	0.129
2	0.193	0.129
3	0.321	0.129
4	0.450	0.129
5	0.579	0.129
6	0.708	0.129
7	0.836	0.129
8	0.965	0.129
9	1.094	0.129
10	1.223	0.129
11	1.416	0.257
12	1.674	0.257
13	1.931	0.257
14	2.189	0.257
15	2.446	0.257
16	2.832	0.515
17	3.347	0.515
18	3.862	0.515
19	4.378	0.515
20	4.892	0.515
21	5.665	1.030
22	6.695	1.030
23	7.725	1.030
24	8.755	1.030
25	9.785	1.030
26	11.330	2.060
27	13.390	2.060
28	15.450	2.060
29	17.510	2.060
30	19.570	2.060
31	22.145	3.090
32	25.235	3.090

Note: Correction of diameter bins, D, for drop shape follows Beard (1976) methodology for D≤6.0mm and a linear interpolation is performed for D>6.0mm (bins 22 through 32).

Terminal velocity classification:

Bin Number	Bin Average (m/s)	Bin Spread (m/s)
1	0.089	0.05
2	0.659	0.15
3	1.239	0.25
4	1.803	0.35
5	2.353	0.45
6	2.889	0.55
7	3.404	0.65
8	3.892	0.75
9	4.329	0.854
10	4.705	0.962
11	5.217	1.128
12	5.833	1.354
13	6.389	1.588
14	6.886	1.828
15	7.326	2.075
16	7.878	2.398
17	8.424	2.782
18	8.785	3.15
19	9.002	3.502
20	9.117	3.838
21	9.173	4.4
22	9.248	5.2
23	9.323	6
24	9.398	6.8
25	9.473	7.6
26	9.586	8.8
27	9.735	10.4
28	9.885	12
29	10.035	13.6
30	10.185	15.2
31	10.372	17.6
32	10.597	20.8

Note: Correction of diameter bins, D, for drop shape follows Beard (1976) methodology for D≤6.0mm and a linear interpolation is performed for D>6.0mm (bins 22 through 32).

APPENDIX C: SYNOP Weather Codes

Table 4680	Table 4677	Rain Rate (mm/hr)	Intensity	Precipitation Type
00	00			No precipitation
51	51	≤0.2	light	Drizzle
52	53	0.2-0.5	moderate	Drizzle
53	55	≥0.5	strong	Drizzle
57	58	≤0.2	light	Drizzle with rain
58	59	0.2-0.5	moderate	Drizzle with rain
58	59	≥0.5	strong	Drizzle with rain
61	61	≤0.2	light	Rain
62	63	0.2-4.0	moderate	Rain
63	65	≥4.0	strong	Rain
67	68	≤0.5	light	Rain, drizzle with snow
68	69	>0.5	moderate	Rain, drizzle with snow
71	71	≤0.5	light	Snow
72	73	0.5-4.0	moderate	Snow
73	75	≥4.0	strong	Snow
77	77	≤0.5	light	Snow grains
77	77	0.5-4.0	moderate	Snow grains
77	77	≥4.0	strong	Snow grains
87	87	≤0.4	light	Freezing rain
88	88	>0.4	moderate	Freezing rain
89	89	≤7.5	light	Hail
89	90	>7.5	moderate	Hail

Note: Precipitation code is determined by the Parsivel[2] from the number of particles in the measurement range and from the precipitation rate (water amount equivalent).

References:

Beard, K. V., 1976: Terminal velocity and shape of cloud and precipitation drops aloft. *J. Atmos. Sci.*, **33**, 851–864.

Gunn, R. and G. D. Kinzer. 1949. The terminal velocity of fall for water drops in stagnant air. *J. Meteor.*, **6**, 243–248.

Jaffrain, Joël, Alexis Berne, 2011: Experimental quantification of the sampling uncertainty associated with measurements from PARSIVEL Disdrometers. *J. Hydrometeor*, **12**, 352–370.

Tokay, A., A. Kruger, and W. Krajewski, 2001: Comparison of drop size distribution measurements by impact and optical disdrometers. *J. Appl. Meteor.*, **40,** 2083–2097.