Data Format Documentation

Instrument: Micro rain radar 2nd generation (MRR2), IFloodS

Overview:

This dataset contains measurements by the MRR (2nd generation; Peters 2005) during the Iowa Flood Study (IFloodS), which took place eastern Iowa during the spring of 2013. A total of four MRRs were deployed, each adjacent to a two-dimensional video disdrometer (Table 1). Each MRR-2DVD site had one or more Autonomous Parsivel2 Unit (APU) with tipping bucket rain gauges either collocated or within 4-8 km away. The dataset covers the period of April 11, 2013 through June 16, 2013, but each MRR deployed may not contain data during the entirety of this period. The MRR instruments which collected the dataset described herein are owned and operated by the National Aeronautics and Space Administration (NASA), and their participation in this experiment was funded by NASA's Global Precipitation Measurement Mission (GPM) Project Office.

Table 1. MRR locations during IFloodS. Instruments co-located with or clustered around each MRR are indicated in parenthesis.

MRR (co-located instruments)	Latitude	Longitude	Altitude (m)
MRR2 (2DVD-SN25, APU-01)	N42°14'19.7"	W92°27'49.1"	287
MRR2 (2DVD-SN36,APU-03)	N42°07'33.6"	W92°16'54.3"	286
MRR2 (2DVD-SN37)	N41°59'30.0"	W92°04'18.6"	280
MRR2 (2DVD-SN38, APU-10, TB)	N41°51'37.5"	W91°52'26.5"	253

2DVD=2D-Video Disdrometer; APU=Autonomous Parsivel Unit ; TB = Tipping Bucket rain gauge

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Data Organization:

The MRR2 data set is contained within daily tar archives. The daily archive is named with the following convention,

ifloods_mrr_[site]_[date]_[latitude_longitude].tar

where [site] = serial number of 2dvd at site of MRR deployment
[date] = YYYYmmDD (e.g., 20110422)
[latitude_longitude]=geographic location of instrument
(e.g., N363442.07_W0972640.90 is North 36°34'42.07" and West 97°26'40.90")

and consists of ASCII formatted files containing measurements of the received spectral power and parameters derived from the measurements.

The following files may be contained within the tar archive and follow a similar naming convention, but these files have been compressed with gzip:

- *.pro.gz: (i.e., processed or instantaneous data) spectral reflectivity corrected for noise and attenuation, drop size distribution, spectral drop density, fall velocity, attenuation, radar reflectivity, and integral rainfall parameters (e.g., rain rate, liquid water content) derived from one raw spectrum (methods described in Peters et al. 2005 and Peters et al. 2010)
- *.ave.gz: (i.e., averaged data) contains the same parameters as the processed data derived except from multiple raw spectra integrated over 60 seconds

The following raw data files recorded by the MRR are not contained within the tar archive, but they have compressed with gzip:

- *.raw.gz: (i.e., raw data or raw spectrum) raw mean spectral power received by the radar over 10 seconds for each height step

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File Format:

Format of each file in MRR data set:

Level 0: raw spectrum data (*.raw)

Format: ASCII

Format of each line:
SEE APPENDIX

Level 1: processed or instantaneous data (*.pro)

Format: ASCII

Format of each line:
SEE APPENDIX

Level 2: averaged data (*.ave)

Format: ASCII

Format of each line:
SEE APPENDIX

Disclaimer:

Since the derived fields (e.g., attenuation, radar reflectivity, rain rate, liquid water content) in level 1 and 2 data assume rain and no vertical wind, caution should be used when using these derived fields if any snow may have been falling or in the presence of strong vertical motions (Peters et al. 2005). Attenuation correction is only performed for PIA ≤ 10 dB (Peters et al. 2010).

References:

Peters, Gerhard, Bernd Fischer, Hans Münster, Marco Clemens, Andreas Wagner, 2005: Profiles of Raindrop Size Distributions as Retrieved by Microrain Radars. *J. Appl. Meteor.*, **44**, 1930–1949.
doi: http://dx.doi.org/10.1175/JAM2316.1

Peters, Gerhard, Bernd Fischer, Marco Clemens, 2010: Rain Attenuation of Radar Echoes Considering Finite-Range Resolution and Using Drop Size Distributions. *J. Atmos. Oceanic Technol.*, **27**, 829–842.
doi: http://dx.doi.org/10.1175/2009JTECHA1342.1

APPENDIX

The pages included in this Appendix are taken from the MRR-2 User Manual (METEK GmbH 2008) with expressed written consent of METEK GmbH.

METEK GmbH, 2008: MRR-2 Micro rain radar User Manual. METEK GmbH, Elmshorn, Germany, 46 pp.

6.4 Processed and averaged data

6.4.1 Format description

Processed and averaged data are archived in two separate directory structures (see chapter 7.1.2 Data Recording on page 46). Optional recording of so called raw spectra which represent the unprocessed measuring data of the MRR-2, is possible.

The data format is human readable ASCII text. Each data set consists of one line. The order of the data lines and the used identifiers are listed below:

Identifier	**Meaning**	**Unit**	**Remark**
MRR	*Header Line*	n.A.	
H	*Height*	m	
TF	*Transfer Function*	dimensionless	
F*nn*	*Spectral Reflectivities*	dB	$10 \cdot \log \eta_{nn}$ with η_{nn} in m^{-1} *nn* from $nn_{\min}(h)$ to $nn_{\max}(h)$ [3]
D*nn*	*Drop Size*	mm	Center of size class
N*nn*	*Spectral Drop Densities*	m^{-4}	$N(D_{nn})$ [4]
PIA	*Path Integrated Attenuation*	dB	
Z	*Radar Reflectivity*	dBZ	$10\log\left(10^{-3}\sum_{nn=nn_{\min}(h)}^{nn=nn_{\max}(h)} \frac{N_{nn}D_{nn}^6 + N_{nn-1}D_{nn-1}^6}{2}(D_{nn}-D_{nn-1})\right)$ with $N_{nn_{\min}(h)-1} = 0 \quad ; \quad D_{nn_{\min}(h)-1} = 0$
z	*Attenuated Radar Reflectivity*	dBZ	The attenuated radar reflectivity factor z is calculated in the same way as Z except that attenuated spectral drop densities $N_{nn,a}$ are used. They differ from N_{nn} by the constant factor $a = 10^{\mathrm{PIA}/10}$: $N_{nn,a} = N_{nn}/a$
RR	*Rain Rate*	mm h^{-1}	
LWC	*Liquid Water Contents*	g m^{-3}	
W	*Fall Velocity*	m s^{-1}	

[3] *See MRR-Physical Basics for details*.
[4] *See MRR-Physical Basics for details*.

The measured data are displayed in lines following the header. For each measured variable there is one line starting with a 3-character identifier of the variable. Each line represents a profile of this variable, i.e. a function versus height. Each data entry is 7 characters wide. Height is running from left to right in increments according to the chosen height resolution of the MRR. Invalid or not calculable values are coded as 7 consecutive space characters.

MRR – Header Line

The header line marks the beginning of a data set. It starts with the identifying string ”MRR“, a space character and a date/time stamp. The date/time stamp consists of 12 digits (format *YYMMDDhhmmss*), a single space character and the name of the time zone. This name starts with the string „UTC“ and is optionally followed by an offset value (format ±*hh* or ±*hhss*). The time stamp is generated from the PC time. Then several parameters follow:

“AVE” **Ave**raging time in seconds (“AVE”),

“STP” height resolution in meters (“STP”),

“ASL” height of the ground level **A**bove **S**ea **L**evel in meters (“ASL”),

“SMP” **s**a**mp**ling rate of the RADAR signal in the time domain (unit: Hz),

“SVS” version number of the MRR Service (service version number),

“DVS” version number of the MRR firmware (device version),

“DSN” serial number of the MRR (device serial number)

“CC” calibration constant

“MDQ” data quality parameter consisting of the identifying string. This number is the percentage of valid spectra collected during the averaging interval. Spectra can be invalid due to saturation of the AD converter – caused either by extreme precipitation or by some interference.

“TYP” indentifier for the kind of data: AVE-averaged data, PRO-processed data or RAW-raw spectra

Each of the parameters in the header line starts with a delimiting space character, the 3-character identifier as shown above in the parentheses and a field of 6 characters for the numerical value (except of the serial number, which can consist of up to 10 numeric characters between 0 and 9).

Example (Each entry of the header line is shown in a separate line of the table) :

`MRR␣110124040200␣UTC`	The header line dates from January 24th, 2011, 4:02 AM, timezone ‘UTC’.
`AVE␣␣␣␣60`	Averaging time is 60 seconds.
`STP␣␣␣␣35`	Height resolution is 35 meters.
`ASL␣␣␣147`	The radar is sited 147 meters above sea level.
`SMP␣125e3`	Sampling rate is 125,000 Hz.
`SVS␣6.0.0.1`	Version number of the MRR Service is 6.0.0.1
`DVS␣6.00`	Version number of the MRR firmware is 6.00.
`DSN␣0502082121`	Serial number of the MRR is 050208121.
`CC␣2066000`	Calibration constant is 2066000.
`MDQ␣100`	Percentage of valid spectra is 100
`TYP␣AVE`	data are averaged data

H - Height

Argument of the following data profiles corresponding to the settings described in chapter 6.3.3, page 26, and chapter 6.3.4, page 28. The units are meters above the radar system.

TF - Transfer Function

To each height step a value of the Transfer Function is assigned by which raw spectra are divided.

Fnn with nn from 0 to 63 - FFT Spectra

Each line represents a profile of spectral reflectivity corresponding to the spectral bin *nn*. As **Fnn** is corrected for the receiver noise floor negative values can occur, if the signal to noise ratio is low. These entries cannot be presented in the logarithmic domain and are replaced by space characters.

Dnn with nn from min(h) to max(h) - Drop Sizes

The drop size is described by the diameter of an equivolumic sphere. The spectral bins of drop numbers are of variable width in the size domain (in contrast with spectral bins in the frequency- and velocity-domain). In addition, the widths of the size bins are slightly height dependent. Therefore the assignment of frequency-bin-index nn to diameter D is listed explicitly for each bin and height. The center of each size class is displayed.

Nnn with nn from min(h) to max(h) - Spectral Drop Densities

With the knowledge of the frequency of the Doppler-shift the calculation of the corresponding drop fall velocity is possible (equation 1.4.3.2 in MRR Physical Basics). Thus each FFT-line stands for a drop size interval. Chapter 2 in the Physical Basics shows how to derive from the received spectral power the number of drops for this drop size class, and finally – by division through the variable class width – the spectral drop densities.
Only a sub-set of all 64 spectral bins is considered for the calculation. The lower (min(h)) and upper limit (max(h)) depends on the height as described in MRR Physical Basics (Fig. 7).
In case of negative values of Fnn negative drop number densities are calculated. Although they have no physical meaning they are retained in order to avoid statistical biases.

PIA - Path Integrated Attenuation

The two-way Path integrated attenuation by rain drops is calculated as described in chapter 3.2 “MRR-Physical Basis” and is used for correction of Nnn, Z, RR and LWC.

z - Attenuated Radar Reflectivity[1)]

z is the radar reflectivity factor (see chapter 3.1 MRR-Physical Basics) without attenuation correction

Z - Radar Reflectivity[1)]

Z is the radar reflectivity factor (see chapter 3.1 MRR-Physical Basics)

RR - Rain Rate[1)]

RR is the rain rate (see chapter 3.3 MRR-Physical Basics)

LWC - Liquid Water Content[1)]

LWC is the liquid water content (see equation 3.2.1 MRR-Physical Basics)

1) *In case of low signal to noise ratio negative values can occur. Although they have no physical meaning they are retained in order to avoid statistical biases.*

W - Fall Velocity

W is the characteristic falling velocity.
(First Moment of the Doppler spectrum, see chapter 3.4 MRR-Physical Basics).
The width of velocity-bins can be derived from the maximum number of height steps, the sampling rate (as shown in the header line) and the wave length of the RADAR signal. 32 height steps and 64 lines per step are calculated. For a sampling frequency of 125 kHz and a transmit frequency of 24.23 GHz, the resolution of the fall velocity can be calculated as:

$$\frac{125\,\mathrm{kHz}}{2}\frac{1}{32\cdot 64}\frac{299700\ \mathrm{km/s}}{2\cdot 24.23\,\mathrm{GHz}} = 0{,}1887\ \mathrm{m/s}$$

6.4.2 Processed and averaged data example

Processed and **averaged data** files have the same structure including the header lines. Only the data type identifier “TYP PRO” resp. “TYP AVE” at the end of the header line is different.

```
MRR 110124085700 UTC AVE    60 STP    10 ASL     0 SMP 125e3 SVS 6.0.0.1 DVS 6.00 DSN
0200708021 CC 2079868 MDQ 100 TYP AVE
H       35     70    105   …      1015   1050   1085
TF  0.0115 0.0420 0.0999   …    0.6890 0.6406 0.4225
F00 -65.29 -74.53 -82.05   …    -82.32 -87.28 -83.34
F01 -66.94 -76.22 -84.02   …    -80.55 -85.48 -84.48
F02 -72.75 -81.78 -88.82   …    -79.20 -84.64 -84.43
F03 -82.02 -88.54 -91.72   …    -79.97 -85.73 -84.42
F04 -88.10 -89.28 -91.25   …    -81.30 -87.44 -89.43
F05 -87.30 -88.16 -90.08   …    -81.83 -92.29
F06 -86.28 -87.67 -89.08   …    -81.55 -91.37
F07 -85.61 -87.55 -87.62   …    -80.73 -86.27 -90.26
F08 -85.09 -86.74 -85.56   …    -80.90 -83.80 -86.63
F09 -83.82 -85.29 -84.11   …    -83.05 -86.41 -87.24
F10 -81.72 -83.85 -83.09   …    -87.40        -86.95
F11 -80.23 -82.49 -81.94   …    -84.87-101.37 -83.71
F12 -79.40 -81.17 -80.57   …    -81.59 -86.14 -78.92
F13 -78.57 -79.85 -79.34   …    -80.78 -81.78 -74.26
F14 -77.86 -78.66 -78.36   …    -79.66 -76.73 -69.46
F15 -77.06 -77.59 -77.41   …    -77.10 -71.53 -65.20
F16 -75.62 -76.37 -76.39   …    -73.66 -66.92 -61.51
F17 -74.28 -75.27 -75.46   …    -70.42 -63.54 -58.70
F18 -73.30 -74.28 -74.44   …    -67.66 -61.18 -56.98
F19 -72.19 -73.25 -73.11   …    -65.18 -59.40 -56.03
F20 -71.06 -71.94 -71.65   …    -62.92 -57.99 -55.55
F21 -70.02 -70.51 -70.34   …    -61.00 -56.68 -55.21
F22 -68.79 -69.29 -69.18   …    -59.54 -55.98 -55.17
F23 -67.82 -68.28 -67.92   …    -58.11 -55.69 -55.47
F24 -67.15 -67.36 -66.44   …    -56.56 -55.26 -55.78
F25 -66.05 -66.05 -65.20   …    -55.36 -54.98 -56.32
F26 -64.87 -64.49 -64.33   …    -54.80 -55.01 -56.92
F27 -63.97 -63.27 -63.33   …    -54.55 -55.34 -57.81
F28 -62.71 -62.26 -62.06   …    -54.59 -55.99 -59.16
F29 -61.64 -61.26 -60.96   …    -54.97 -57.05 -60.88
F30 -60.93 -60.35 -60.19   …    -55.43 -58.37 -62.82
F31 -60.03 -59.37 -59.43   …    -56.19 -59.79 -64.76
F32 -59.11 -58.53 -58.62   …    -57.31 -61.23 -66.56
F33 -58.30 -57.67 -57.79   …    -58.70 -63.05 -68.60
F34 -57.80 -56.89 -57.20   …    -60.24 -65.50 -71.44
F35 -57.42 -56.24 -56.86   …    -61.53 -67.89 -74.75
F36 -56.94 -55.77 -56.65   …    -63.32 -70.14 -77.61
F37 -56.69 -55.63 -56.60   …    -65.92 -73.07 -79.88
F38 -56.67 -55.72 -56.69   …    -68.62 -76.39 -79.07
F39 -56.58 -55.70 -56.72   …    -71.30 -79.54 -76.80
F40 -56.55 -55.55 -56.81   …    -74.26 -83.17 -75.03
F41 -56.89 -55.67 -57.11   …    -77.12 -85.09 -73.43
F42 -57.52 -56.04 -57.47   …    -80.29 -87.09 -71.92
F43 -58.26 -56.73 -58.05   …    -85.37 -86.62 -70.68
F44 -59.10 -57.69 -59.07   …    -91.70 -83.35 -69.50
F45 -60.47 -58.85 -60.52   …    -92.25 -81.10 -68.44
F46 -62.44 -60.31 -62.11   …    -86.14 -80.06 -67.83
F47 -64.36 -62.11 -63.82   …    -83.99 -79.82 -67.78
F48 -66.33 -64.24 -66.10   …    -83.16 -79.51 -68.51
F49 -68.08 -66.65 -68.83   …    -81.42 -79.59 -69.91
F50 -68.54 -68.91 -71.61   …    -79.92 -78.87 -71.48
F51 -69.15 -71.09 -75.12   …    -78.53 -78.05 -73.16
F52 -72.35 -74.64 -79.86   …    -77.95 -78.44 -75.32
F53 -78.57 -80.07 -85.16   …    -77.73 -79.02 -76.51
F54 -86.06 -86.09 -90.41   …    -77.82 -78.91 -77.15
F55 -92.17 -93.58 -98.15   …    -78.16 -78.58 -77.54
F56 -95.49-101.59-100.05   …    -78.48 -78.98 -77.33
F57 -95.83-102.37-101.13   …    -78.59 -79.24 -77.07
```

```
F58 -97.76-109.34         …     -78.03 -79.33 -77.51
F59-101.35-109.38         …     -77.11 -78.68 -78.96
F60 -97.25 -98.23-106.60  …     -76.41 -77.96 -79.56
F61 -85.64 -91.97 -96.80  …     -76.73 -78.26 -79.12
F62 -74.68 -83.22 -89.67  …     -77.84 -79.75 -80.12
F63 -67.85 -76.90 -84.03  …     -79.80 -82.65 -81.75
D00
D01
D02
D03
D04 0.2456 0.2454 0.2452  …     0.2404 0.2402 0.2400
D05 0.2817 0.2814 0.2812  …     0.2750 0.2748 0.2746
D06 0.3185 0.3182 0.3179  …     0.3104 0.3101 0.3098
D07 0.3562 0.3559 0.3555  …     0.3465 0.3462 0.3458
D08 0.3948 0.3944 0.3940  …     0.3835 0.3831 0.3827
D09 0.4343 0.4338 0.4334  …     0.4212 0.4208 0.4203
D10 0.4747 0.4742 0.4737  …     0.4599 0.4594 0.4588
D11 0.5162 0.5156 0.5150  …     0.4995 0.4989 0.4983
D12 0.5587 0.5580 0.5574  …     0.5400 0.5393 0.5386
D13 0.6023 0.6016 0.6008  …     0.5815 0.5808 0.5800
D14 0.6471 0.6463 0.6455  …     0.6241 0.6233 0.6225
D15 0.6931 0.6922 0.6913  …     0.6678 0.6669 0.6660
D16 0.7405 0.7395 0.7385  …     0.7127 0.7117 0.7108
D17 0.7892 0.7881 0.7870  …     0.7589 0.7578 0.7567
D18 0.8394 0.8382 0.8370  …     0.8063 0.8051 0.8040
D19 0.8911 0.8898 0.8886  …     0.8552 0.8539 0.8526
D20 0.9445 0.9431 0.9417  …     0.9055 0.9041 0.9027
D21 0.9997 0.9982 0.9967  …     0.9574 0.9559 0.9544
D22 1.0568 1.0551 1.0535  …     1.0109 1.0093 1.0077
D23 1.1159 1.1141 1.1123  …     1.0662 1.0645 1.0627
D24 1.1771 1.1752 1.1733  …     1.1235 1.1216 1.1197
D25 1.2407 1.2386 1.2365  …     1.1827 1.1807 1.1786
D26 1.3068 1.3046 1.3023  …     1.2442 1.2420 1.2398
D27 1.3757 1.3732 1.3708  …     1.3080 1.3056 1.3032
D28 1.4475 1.4449 1.4422  …     1.3743 1.3718 1.3692
D29 1.5226 1.5197 1.5168  …     1.4434 1.4406 1.4379
D30 1.6012 1.5980 1.5949  …     1.5155 1.5125 1.5095
D31 1.6836 1.6803 1.6769  …     1.5908 1.5876 1.5844
D32 1.7704 1.7668 1.7631  …     1.6697 1.6662 1.6627
D33 1.8620 1.8580 1.8540  …     1.7526 1.7488 1.7450
D34 1.9588 1.9545 1.9501  …     1.8397 1.8356 1.8315
D35 2.0617 2.0569 2.0521  …     1.9317 1.9272 1.9228
D36 2.1713 2.1661 2.1608  …     2.0291 2.0242 2.0193
D37 2.2887 2.2829 2.2771  …     2.1324 2.1271 2.1218
D38 2.4149 2.4085 2.4021  …     2.2427 2.2368 2.2310
D39 2.5515 2.5443 2.5372  …     2.3607 2.3542 2.3478
D40 2.7002 2.6922 2.6842  …     2.4877 2.4806 2.4735
D41 2.8636 2.8546 2.8455  …     2.6253 2.6173 2.6094
D42 3.0448 3.0344 3.0241  …     2.7752 2.7663 2.7574
D43 3.2480 3.2361 3.2242  …     2.9399 2.9298 2.9198
D44 3.4796 3.4655 3.4516  …     3.1227 3.1112 3.0998
D45 3.7485 3.7317 3.7149  …     3.3281 3.3148 3.3016
D46 4.0694 4.0485 4.0279  …     3.5623 3.5467 3.5312
D47 4.4672 4.4402 4.4135  …     3.8350 3.8162 3.7977
D48 4.9907 4.9530 4.9161  …     4.1612 4.1379 4.1149
D49 5.7582 5.6977 5.6392  …     4.5672 4.5369 4.5071
D50                       …     5.1050 5.0624 5.0210
D51                       …                   5.7677
D52
D53
D54
D55
D56
D57
D58
D59
D60
D61
D61
D62
D63
N00
```

```
N01
N02
N03
N04 1.7e+7 1.3e+7 8.3e+6   …     9.3e+7 2.3e+7 1.4e+7
N05 8.9e+6 7.3e+6 4.7e+6   …     3.6e+7 3.3e+6-5.7e+6
N06 5.2e+6 3.8e+6 2.8e+6   …     1.8e+7 1.9e+6-2.7e+6
N07 3.1e+6 2.0e+6 1.9e+6   …     1.1e+7 3.1e+6 1.3e+6
N08 1.8e+6 1.2e+6 1.6e+6   …     5.7e+6 3.0e+6 1.6e+6
N09 1.3e+6 964959 1.3e+6   …     1.9e+6 907918 754334
N10 1.3e+6 768728 923905   …     414979 -20941 465284
N11 1.0e+6 621685 711679   …     443056 9440.2 584411
N12 767281 512404 592273   …     577617 202885 1.1e+6
N13 576843 431121 488397   …     436064 347849 2.0e+6
N14 429862 359385 388558   …     360912 713077 3.8e+6
N15 333126 296551 311766   …     422713 1.5e+6 6.7e+6
N16 304136 257262 258238   …     616336 2.9e+6 1.0e+7
N17 274365 219690 212223   …     868205 4.3e+6 1.3e+7
N18 230314 184889 179919   …     1.1e+6 5.0e+6 1.3e+7
N19 200924 158461 165180   …     1.3e+6 5.1e+6 1.1e+7
N20 177710 146166 157718   …     1.6e+6 4.9e+6 8.7e+6
N21 155008 139360 146398   …     1.7e+6 4.6e+6 6.5e+6
N22 140816 126587 130999   …     1.6e+6 3.8e+6 4.6e+6
N23 121124 109708 120646   …     1.6e+6 2.8e+6 3.0e+6
N24  97263  93412 116639   …     1.6e+6 2.2e+6 1.9e+6
N25  86051  86804 106888   …     1.5e+6 1.6e+6 1.2e+6
N26  77397  85316  89612   …     1.2e+6 1.1e+6 727434
N27  65034  77233  77047   …     851860 718282 412021
N28  59026  66127  70259   …     584131 428478 209074
N29  50985  56198  61063   …     367922 231057  96781
N30  40194  46466  48851   …     225946 116619  42418
N31  32791  38667  38739   …     128777  57111  18438
N32  26779  30998  30818   …      67060  27643 8231.6
N33  21174  24803  24561   …      32615  12167 3448.5
N34  15543  19429  18430   …      15240 4622.4 1196.3
N35  11074  14746  13021   …     7517.4 1769.8 372.01
N36 8063.7  10718 8927.8   …     3299.7 699.22 127.95
N37 5579.9 7232.0 5896.5   …     1201.5 236.46 50.288
N38 3660.6 4631.9 3782.0   …     428.02 73.016 40.260
N39 2451.6 3052.0 2462.6   …     153.45 23.465 45.138
N40 1619.3 2074.6 1583.4   …     51.607 6.7670 45.100
N41 982.38 1326.3 973.26   …     17.781 2.8902 43.531
N42 559.59 801.97 590.94   …     5.7216 1.2082 41.131
N43 311.72 452.26 341.63   …     1.1879 0.9027 36.637
N44 169.68 239.35 178.44   …     0.1858 1.2911 32.235
N45 81.786 121.41 84.666   …     0.1087 1.4566 27.688
N46 34.401 57.447 38.938   …     0.2992 1.2458 21.402
N47 14.599 25.105 17.415   …     0.3312 0.8860 14.571
N48 6.0655 10.083 6.7792   …     0.2702 0.6419 8.2911
N49 2.5061 3.6136 2.2706   …     0.2706 0.4230 4.0321
N50                        …     0.2527 0.3298 1.8604
N51                        …                   0.7945
N52
N53
N54
N55
N56
N57
N58
N59
N60
N61
N62
N63
PIA  0.000  0.028  0.054   …      0.743  0.833  0.939
z    32.52  33.54  32.65   …      33.37  33.36  33.33
Z    32.52  33.56  32.69   …      34.10  34.18  34.25
RR    2.93   3.25   3.09   …      12.16  16.29  20.79
LWC   0.17   0.18   0.17   …       0.76   1.07   1.49
W     6.57   6.73   6.57   …       5.11   4.61   4.16
```

6.5 Raw Spectra

6.5.1 Format Description

Each data block in a **raw spectra** file begins with a header line.

Example:

```
MRR 090612024311 UTC DVS 6.00 DSN 200708021 BW 37300 CC 2079868 MDQ 100 58 58 TYP RAW
```

<	Identifier for MRR data
090612024311	date/time stamp in format YYMMDDhhmmss
UTC	time zone information
DVS␣6.00	Device version number (firmware)
DSN␣200708021	Device serial number
BW␣37300	Bandwidth
CC␣2079868	Calibration constant
MDQ␣100 58 58	Micro Rain Radar Data quality: percentage of valid spectra, number of valid spectra and number of total spectra
TYP␣RAW	Identifier for data type (raw)

The next data lines contain the measuring heights. It begins with the capital letter H (H means height) and two space characters. The following numbers (9 digits decimal each) represent the measuring heights in meters.

The height line is followed by the line of the transfer function. It starts with the capital characters TF (Transfer Function) and one space character. The rest of that line represents the values of the transfer function for each height step (9 digits decimal each).

The line of the transfer function is followed by 64 data lines. Each one starts with the capital character F and a 2-digit number of the spectra line (0 to 63). The rest of these lines represent the received spectral signal power in engineering units for each height step (9 digits decimal each).

The raw spectra include the receiver noise floor.

6.5.2 Raw Spectra Example

```
MRR 090612024311 UTC DVS 6.00 DSN 0200708021 BW 37300 CC 2079868 MDQ 100 58 58 TYP RAW
H          0        35        70      …        1015      1050      1085
TF  0.003292 0.011523 0.041975      …    0.689026 0.640604 0.422497
F00     4798      2205       166      …           6         6         4
F01     2780      1272       107      …           8         7         5
F02      541       246        33      …          10         8         6
F03       39        22        17      …          11         8         6
F04        4         9        18      …          12         9         6
F05        3         9        19      …          12        11         7
F06        3         9        20      …          13        12         7
F07        3         9        21      …          12        12         7
F08        3        10        23      …          10        11         6
F09        4        11        28      …           9        10         6
F10        5        13        34      …          12         9         5
F11        4        16        44      …          14         8         4
F12        5        18        55      …          13         7         4
F13        7        19        65      …          13         6         5
F14        9        23        84      …          15         9         6
F15       12        34       139      …          17        12         7
F16       15        52       236      …          19        12         8
F17       24        75       325      …          22        12         7
F18       48       120       374      …          23        12         7
F19       98       215       526      …          25        15         9
F20      177       377       803      …          29        19        11
F21      290       582      1054      …          38        24        12
F22      492       873      1270      …          48        31        16
F23      814      1437      1629      …          61        40        22
F24     1103      2015      2193      …          88        55        33
F25     1215      2304      3049      …         130        81        48
F26     1202      2861      4088      …         162       106        61
F27     1692      3945      4978      …         200       124        79
F28     3428      4611      6013      …         282       146        97
F29     6270      5873      8179      …         355       166       105
F30     9754      9622     11394      …         369       204       128
F31    13520     15729     15559      …         331       251       187
F32    15274     23192     21914      …         289       266       227
F33    13520     26471     25550      …         276       245       176
F34     9754     21874     22408      …         273       218       116
F35     6270     15310     16602      …         237       211       110
F36     3428      9683     12461      …         176       178       103
F37     1692      5905     11128      …         119       114        68
F38     1202      4727     11416      …          64        53        32
F39     1215      4582     11578      …          25        21        16
F40     1103      4033     10911      …          15        14        10
F41      814      3225      9611      …          14        13         9
F42      492      2421      7508      …          12        12         8
F43      290      1436      4351      …          12        13         7
F44      177       675      2171      …          13        14         8
F45       98       318      1386      …          14        12         7
F46       48       149       828      …          13        11         7
F47       24        60       332      …          11        11         7
F48       15        21        96      …          10        10         8
F49       12        10        33      …          10         9         7
F50        9         8        19      …          11        10         7
F51        7         7        14      …          11        11         6
F52        5         7        12      …          13        13         7
F53        4         6        11      …          14        13         8
F54        5         8        13      …          14        10         8
F55        4        10        15      …          12         9         6
F56        3         9        15      …          11        10         6
F57        3        10        19      …          11         9         6
F58        3        11        24      …           9         8         6
F59        3        10        24      …          10         8         6
F60        4         9        21      …          10        10         6
F61       39        25        18      …          10        11         6
F62      541       254        29      …          11        10         6
F63     2780      1279        95      …          10         8         4
```