Seeded and Natural Orographic Wintertime clouds—the Idaho Experiment (SNOWIE)
U. of Colorado Micro Rain Radar (MRR) @ Packer John

1. **Dataset Title:** Radar - CU Micro Rain Radar (MRR) at Packer John Site [CU]

2. **Dataset Author(s):**

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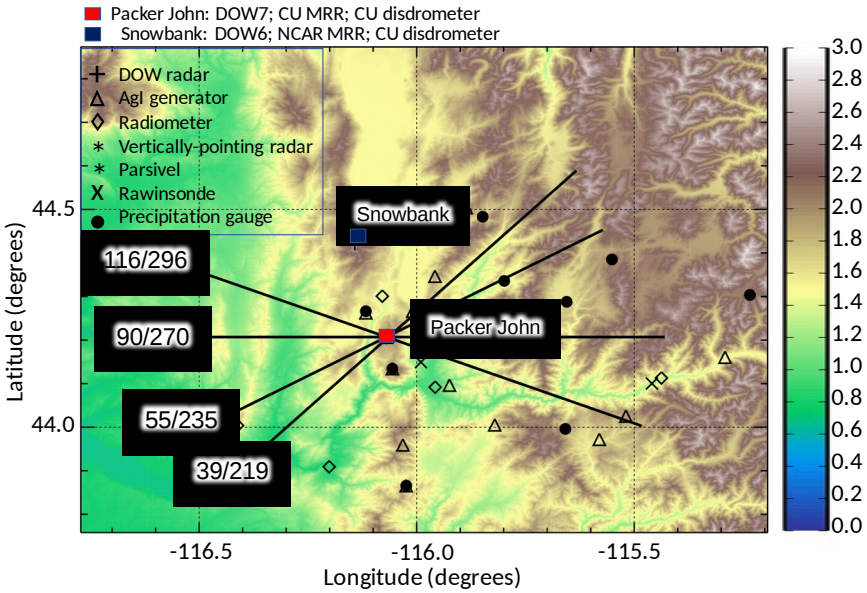
3. **Time of Interest –**

2017/01/08 00:00:00 to 2017/01/08 23:59:00
2017/01/09 00:00:00 to 2017/01/09 07:03:00
2017/01/11 01:05:00 to 2017/01/11 18:28:00
2017/01/18 00:03:00 to 2017/01/19 23:59:00
2017/01/19 00:00:00 to 2017/01/19 23:59:00
2017/01/20 00:00:00 to 2017/01/20 16:40:00
2017/01/21 18:47:00 to 2017/01/21 23:04:00
2017/01/22 00:00:00 to 2017/01/22 23:04:00
2017/01/23 00:00:00 to 2017/01/23 15:09:00
2017/01/31 01:00:00 to 2017/01/31 23:59:00
2017/02/01 00:00:00 to 2017/02/01 20:17:00
2017/02/02 20:18:00 to 2017/02/02 23:59:00
2017/02/03 00:00:00 to 2017/02/03 23:59:00
2017/02/04 00:00:00 to 2017/02/04 21:04:00
2017/02/05 00:43:00 to 2017/02/05 17:22:00
2017/02/07 17:57:00 to 2017/02/07 23:59:00
2017/02/08 00:00:00 to 2017/02/08 21:16:00
2017/02/16 00:59:00 to 2017/02/16 23:59:00
2017/02/17 20:18:00 to 2017/02/17 18:04:00
2017/02/18 19:19:00 to 2017/02/18 23:59:00
2017/02/19 00:00:00 to 2017/02/19 23:59:00
2017/02/20 00:00:00 to 2017/02/20 23:59:00
2017/02/21 00:00:00 to 2017/02/21 23:59:00
2017/02/22 00:00:00 to 2017/02/22 16:27:00
2017/03/01 00:03:00 to 2017/03/01 17:25:00
2017/03/03 22:47:00 to 2017/03/03 23:59:00

2017/03/04 00:00:00 to 2017/03/04 23:59:00
2017/03/05 00:00:00 to 2017/03/05 17:03:00
2017/03/06 00:02:00 to 2017/03/06 19:51:00
2017/03/07 19:35:00 to 2017/03/07 23:59:00
2017/03/08 00:00:00 to 2017/03/08 23:59:00
2017/03/09 00:00:00 to 2017/03/09 23:59:00
2017/03/10 00:00:00 to 2017/03/10 16:10:00
2017/03/15 18:46:00 to 2017/03/15 23:59:00
2017/03/16 00:00:00 to 2017/03/16 15:4

4. **Area of Interest** –

Packer John Site: 44.207637;-116.069203 @ 2138 m MSL



Left panel: View to the west (Packer John radar in the background); right panel: view to the east

5. **Data Frequency** - Frequency of data collection continuously during IOPs; data sampled every 1 minute.

6. **Data Spatial Type** - readable ASCII text

The user manual including a description of the data format can be found here: https://www.ncas.ac.uk/en/documents/amf/manuals/1030-mrr-user-manual/file

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 min(*h*) to max(*h*) ^{3}
D*nn*	*Drop Size*	mm	Center of size class
N*nn*	*Spectral Drop Densities*	$m^{-3}mm^{-1}$	$N(D_{nn})$ ^{3}
PIA	*Path Integrated Attenuation*	dB	
Z	*Radar Reflectivity*	dBZ	$10 \log\left(\sum_{nn=\min(h)}^{nn=\max(h)} N(D_{nn}) D_{nn}^{6}\right)$ *nn* from min(*h*) to max(*h*)
z	*Attenuated Radar Reflectivity*	dBZ	Z-PIA
RR	*Rain Rate*	mm h^{-1}	
LWC	*Liquid Water Contents*	g m^{-3}	
W	*Fall Velocity*	m s^{-1}	

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. Space characters at the end of a line are omitted in order to save disk space. So lines can have different lengths although representing the same number of height steps.

MRR – Header Line

Entries common to instantaneous and averaged data:

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 end of the header line shows a data quality parameter consisting of the identifying string “MDQ”, a single space character and a 3digit number be- tween 0 and 100. It 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.

Entries only in averaged data:

Averaging time in seconds (“AVE”), height resolution in meters (“STP”), height of the ground level above sea level in meters (“ASL”), sampling rate (“SMP”) of the RADAR signal in the time domain (unit: Hz), parameters for the automatic noise level adjustment (“NF0” and “NF1” without unit), version number of the MRR Service (“SVS”), version number of the MRR firmware (“DVS”), serial number of the MRR (“DSN”) and the calibration constant (“CC”).

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*090612040200 UTC	The header line dates from June 12th, 2009, 4:02 AM, 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.
NF0*1.000	Noise level 0 set to 1.000 (used only in older versions).
NF1*0.000	Noise level 1 set to 0.000 (used only in older versions).
SVS*5.20	Version number of the MRR Service is 5.20.
DVS*5.10	Version number of the MRR firmware is 5.10.
DSN*020704	Serial number of the MRR is 020704.
CC*2066000	Calibration constant is 2066000.
MDQ*100	Percentage of valid spectra is 100.

H - Height

Argument of the following data profiles corresponding to the settings de- scribed in chapter 6.2.3, page 20, and chapter 6.2.4, page 23. 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 data 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 1)

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

z - Attenuated Radar Reflectivity2)z is the radar reflectivity factor (see chapter 3.1 MRR-Physical Basics) without

attenuation correction

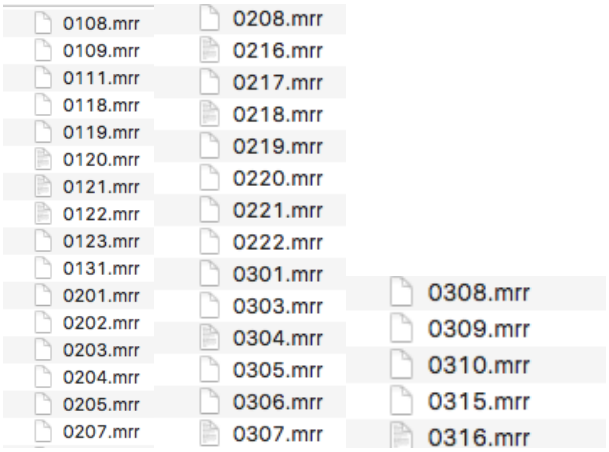
Z - Radar ReflectivityZ is the radar reflectivity factor (see chapter 3.1 MRR-Physical Basics)

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

7. **General Dataset Description**

The MRR dish was heated during all IOPs and we cannot recall an incidence where large amount of snow accumulated on the dish. Each file was visually examined and no major quality issues were discovered. To recover effective reflectivity, Doppler velocity and spectral width we recommend using the improved MRR processing tool (https://github.com/maahn/IMProToo). The method features a noise removal based on recognition of the most significant peak and a dynamic dealiasing routine which allows observations even if the Nyquist velocity range is exceeded.

8. **File Names**



9. **Data restrictions** – no data restriction