Macquarie Island – ARM Datasets Interim Summary – R. Marchand - 11/19/2017

Overview

The purpose of this document is to briefly summarize the state of the ARM datasets collected at Macquarie Island as part of the Macquarie Island Cloud and Radiation Experiment (MICRE; https://www.arm.gov/research/campaigns/osc2016micre). The experiment began in late March of 2016 and will end in March of 2018.

This document doesn't cover the many important non-ARM datasets that are being collected including surface met and radiosondes (BOM), cloud radar (Alain Protat), polarization lidar (Simon Alexander), surface CCN (Melita Keywood), and ceilometer (Adrian McDonald). Reports from these collaborators are generally positive. A more complete description of data collected will be generated after the experiment is completed. The instrument and datasets examined here are listed below in table #1.

ARM Instruments	ARM Data Stream
Surface up (sky) and downward (ground) looking broadband radiometers (direct & diffuse)	mcqskyrad60sS1.b1, mcqgndrad60sS1.b1
Multi-Filter Rotating Shadowband Radiometer (MFRSR)	mcqmfrsrS1.b1
Ceilometer	mcqceilS1.b1
Parsivel laser disdrometer	mcqpars2S1.b1, mcqpars2s2.00
3-Channel Microwave Radiometer (23, 30, 90 GHz)	Raw data : PR-2289C
2-Channel Microwave Radiometer (23, 30 GHz)	mcqmwrlosS1.b1

Table #1 - ARM instruments and datasets/datastreams

Summary of Availability & Problems

A summary of the availability and problems associated with each instrument datastream is provided in table #2, below, and with some problems discussed in more detail following the table.

Beyond this summary, for each of the datastreams listed in table #1, I have (1) plotted a time series of one or two key variables in order to depict data availability and to visually display periods with major data quality issues and (2) I have generated a text file that list all the periods with missing or problematic data. An example plots and text files are shown in the next subsection, and plot for all datastreams are available at http://www.atmos.washington.edu/~roj/nobackup/MICRE_plots_and_notes/.

As regards table #2, small problems such as periods where data are missing for a few hours (typically less than 24 hours), or small processing errors (which are likely to be fixed or which have little science impact) are not included in table #2. Periods that are coded purple are problems that have not yet be sufficiently investigated, yellow, are problems that might be fixed or are consider to be minor (by me), and periods coded red are serious problems where extended periods of data have been permanently lost or data is of poor quality and unlikely to be correctable.

ARM Datastream / Instrument	**Summary of Availability & Problems of note**
mcqskyrad60sS1.b1 / Upward looking LW and SW broadband radiometers.	The data record begins on 2016-04-03 05:42:59 and is ongoing. Downward **longwave** prior to 2016/8/15 appears to be biased high (DQPR 6225), while all **shortwave** measurements appear reasonable. The cause of the apparent LW bias remains a topic of discussion. What is the source of the bias, can the data be used with a simple bias correction. This raises concerns about the quality of the calibration even after 2016/08/15. Two radiometers for broadband LW were deployed. The ratio of LW down reported by the two radiometers is very good except in two time windows, where radiometer 2 has a value that is 2% lower than radiometer 1. The windows are 11/21/2106 to 12/29/2016 and 2/5/2017 to 2/11/2017 (DPQR 6517). The data record is reasonably complete. • The longest period of missing data is only 33 hours from 2016-12-14 16:50:00 to 2016-12-16 02:15:00 (DQR D170524.6). There are no other periods longer than 24 hours missing. • Between 2017-05-05 01:59:01 and 2017-10-04 14:59:59, an error developed in data logger set up (for unknown reasons) and there is 1 hour of missing data every 2 days and 13 hours (DQR D171013.3).
mcqgndrad60sS1.b1 / Downward looking broadband radiometers	The data record begins on 2016-04-03 05:42:59 and is ongoing. Upward **longwave flux** from the start of experiment, until 2016/8/15 is bad (badly biased and noisy) due to a faulty ground connection and/or open IRT connectors. These data re likely unrecoverable (DQR: D160927.1). Upward **longwave flux** between 2016-08-31 00:00:00 and 2016-09-08 15:00:00 is suspect, and contains intermittent step changes (DQR: D170810.3). I am concerned that that the Upward LW fluxes gathered between 2016/08/15 and 2016/08/31 are also problematic (see data jumps on 2016/8/19 & 20) Owing to the above initial bias and later jumps, I am concerned

	about the calibration/quality of these data INCLUDING data collected after 2016-09-08. The data record is reasonably complete. There are a two periods with permanent data loss of more than 24 hours • Data is missing for ~101 hours from 2016-10-26 23:59:00 to 2016-10-31 05:15:59 (DQR D170814.4) • Data is missing for ~ 208 hours from 2017-03-22 06:59:00 to 2017-03-30 23:09:59 (DQR D170616.3) • As with the skyrad data, between 2017-05-05 01:59:01 and 2017-10-04 14:59:59 an error in the data logger set up resulted in 1 hour of missing data every 2 days and 13 hours (DQR D171013.4).
mcqmfrsrS1.b1 / Multi-Filter Rotating Shadowband Radiometer (MFRSR)	The data record begins on 2016-03-31 01:06:00 and is ongoing. Rotating band alignment was off. Diffuse, direct and total (given by sum) are incorrect . • 2016-10-28 to 2016-11-15 (DQR D170224.6). • 2017-03-30 to present There are several periods longer than 24 hours with missing data (DQR D170707.8): 2016-08-10 23:59:40 to 2016-09-15 00:00:00 (837.7 hours) 2016-11-24 06:48:20 to 2016-12-03 06:52:40 (215.5 hours) 2016-12-14 17:01:20 to 2016-12-16 02:14:20 (33 hours)
mcqceilS1.b1 / Ceilometer	The data record begins on 2016-04-02 at 6:27:53 and data collection is ongoing. The data quality appears reasonable, except for the period between 2017-10-18 07:11:00 and 2017-10-26 00:24:00 where it appears the lidar windows has some contamination and these data should be used with caution (DQR D171027.1). As regards completeness, the record has three periods of missing data with a duration longer than 24 hours, one of which is quite large (1685 hours). • 2016-04-09 12:15:11 to 2016-04-07 00:00:05 for a duration of 35 hours. • There is an extended period with missing data from 2016-12-14 16:49:18 to 2017-02-22 23:00:08 for a duration of 1685 hours (DQR D170512.11). • 2017-05-22 01:00:00 to 2017-06-02 00:04:00 for a duration of 263 hours (DQR: D170728.8)
mcqpars2S1.b1 / Parsivel laser disdrometer	The data record begins on 2016-03-31 23:53:00 and is ongoing. Starting on 2016-10-31 there is bad/corrupt data in several

	fields. Most notably this includes the precipitation rate, liquid water content, and total number of particles. The raw data appear to be scrambled by OK, and it is expected this will be fixed in later processing (D170524.7 / DPQR 6227). There are several periods longer than 24 hours with missing data: DQR D170512.9: 2016-12-14 16:48:01 to 2016-12-18 22:30:59 (101 hours) 2016-04-09 11:57:59 to 2016-04-21 05:06:59 (280 hours) 2016-05-02 12:59:59 to 2016-05-04 23:07:59 (58 hours) DPQR 6675: 2017-05-22 01:04:00 to 2017-08-14 14:15:59 (2029.2 hours)
mcqmwrlosS1.b1 / 2-Channel Microwave Radiometer (23, 30 GHz)	Data collection with this instrument began in a 2016-12-10 but due to problems with ground faults, there was little data collected before 2016-12-18 and collection of data was sporadic between 2016-12-19 and 2016-12-28. As regards the data quality, there are intermittent spikes of varying intensity in the 23.8 GHz data (but not at 30 GHz) due to interference from some unknown source, see Figure #3 below (DQR: D171013.7). Special processing will needed to filter out these spikes. Since 2016-12-28, the data record is fairly compete but with several periods with missing data that exceeded 24 hours, as listed below: D170224.11: 2017-01-01 12:59:08 to 2017-01-03 02:04:12 (37 hours) 2017-01-08 00:59:26 to 2017-01-09 21:36:57 (45 hours) 2017-01-17 18:00:08 to 2017-01-19 02:44:26 (33 hours) NO DQPR or DQR ? 2017-05-17 20:57:43 to 2017-05-22 00:15:19 (99 hours) D170919.1: 2017-08-13 01:00:00 to 2017-08-14 01:00:00 (23 hours) 2017-09-24 12:00:00 to 2017-09-28 21:39:00 (75 hours) D171107.4: 2017-09-24 12:00:00 to 2017-09-28 21:39:00 (105 hours) NO DQPR or DQR ? 2017-10-12 21:00:02 to 2017-10-15 22:31:20 (74 hours)
3-Channel Microwave Radiometer (23, 30, & 89	Data collection began on 2014-04-02 at 04:48:32. The instrument had serious failures and data collection was ended

GHz)	on 2016-11-19 at 10:10:43. There are intermittent spikes in 23/30 & 89 GHz data due to interference from some unknown source. An example is shown in Figure #3. The spikes exist at all three frequencies. Spike aside, good data was acquired at all 3 frequencies from 2016-04-02 04:48:34 to 2016-06-13 03:09:00 The instrument had a major failure on 2016-06-13 in the K-band (23 and 30 GHz) receiver: *K-Band: 23 and 30 GHz* After 2016-06-13, 23 and 30 GHz data were acquired only between 2016-06-19 14:27:25 and 2016-06-22 23:12:43 and again between 2016-06-24 00:08:43 and 2016-06-28 10:10:44. After 2016-06-28, all K-band data collection stopped and no further data was collected at 23 or 30 GHz. Data for the period after 2016-06-19 may be invalid, and will require careful vetting. *W-band: 90 GHz* A time series for the 90 GHz data is shown in Figure #1. Shortly after the K-band failure, the gain setting in the W-band receiver was corrupted. W-band data collected between 2016-06-15 and 2016-10-07 are not calibrated and likely unsalvageable. The gain settings where fixed and reasonable 89 GHz data was collected between 2016-10-07 and 2016-11-19 10:10:43, after which the instrument was removed for repair. Data quality for this later period is suspect and requires careful analysis.

Table #2 – Known problems with ARM datastreams

Example of time series plots & text files

Shown below is the time series plot (Figure #1) and text file (Figure #2) for the 89 GHz brightness temperatures observed by the 3-channel Microwave Radiometer. Colored blocks indicate periods where there are problems (with notes in the associated text file, table #1). Similar files have been generated for all of the above datastreams.

Passive Microwave Radiometer (MWR) datasets

The MWR data record is the most problematic of the ARM datasets. A 3-channel radiometer was deployed to Macquarie in March 2016, but mostly failed in June of 2016. The 3-channel instrument was replaced in November of 2106, with a 2-channel instrument, but problems with the power supply stability (ground faults) resulted in limited data collection until near the end of December (12/28/2016) but now seems be working well.

Figure #1 - Time series of 89 GHz Brightness temperature (from Raw instrument files). Blue indicates missing data, red means data is badly corrupted and likely not useable, other colors (purple or yellow) indicate usable data but with some data-quality issues (see table/ARM DQ site).

Data starts on : 2016-04-02 04:48:34

Note : 2016-04-02 04:48:34 : There are intermittent spikes in 23/30 & 89 GHz data due to interference from some unknown source.
End : 2016-11-19 10:10:43

2016-04-02 22:57:34	2016-04-03 00:42:34	Data missing (duration = 1.74522 hours)
2016-04-03 22:46:26	2016-04-04 00:08:44	Data missing (duration = 1.36793 hours)
2016-04-09 12:11:07	2016-04-10 02:36:54	Data missing (duration = 14.3903 hours)
2016-05-02 12:11:07	2016-05-03 03:20:46	Data missing (duration = 15.1194 hours)
2016-05-31 23:13:53	2016-06-02 00:08:46	Data missing (duration = 24.8466 hours)
2016-06-13 03:09:15	2016-06-14 00:08:46	Data missing (duration = 20.9346 hours)
2016-06-22 23:12:46	2016-06-24 00:08:46	Data missing (duration = 24.8652 hours)
2016-06-27 22:11:12	2016-06-28 00:08:46	Data missing (duration = 1.95412 hours)
2016-06-28 10:10:47	2016-07-03 02:49:35	Data missing (duration = 112.339 hours)
2016-08-22 23:12:45	2016-08-23 00:50:26	Data missing (duration = 1.62359 hours)
2016-09-14 23:09:28	2016-09-15 00:38:13	Data missing (duration = 1.47511 hours)
2016-09-18 23:12:47	2016-09-21 00:08:47	Data missing (duration = 48.7996 hours)
2016-10-07 15:09:10	2016-10-07 19:38:12	Data missing (duration = 4.47164 hours)
2016-11-02 23:09:04	2016-11-10 00:08:46	Data missing (duration = 168.533 hours)

Note : 2016-06-13 03:09:00 : K-band on radiometer failed, 23/30 GHz data is bad/missing, 89 GHz Data suspect (+interference spikes remain).
End : 2016-06-15 00:00:00

Note : 2016-06-15 00:00:00 : W-band Radiometer gain settings corrupted
End : 2016-10-07 19:58:00

Note : 2016-10-07 19:58:00 : K-band on radiometer failed, 23/30 GHz data is bad/missing, 89 GHz Data suspect (+interference spikes remain).
End : 2016-11-19 10:10:43

Data ends on : 2016-11-19 10:10:43

Text #1 – Example of summary file for 3-Channel MWR, 89 GHz measurements

Spikes/Interference in MWR data

There are intermittent spikes in 23/30 & 89 GHz data due to interference from some unknown source. An example is shown below in Figure #3. The spikes exist at all three frequencies in the 3-channel radiometer. While the spikes are obvious during periods with little cloud water (e.g. on the right half of the figure) they are difficult to see during periods with significant variation in cloud water (i.e. on the right half). However the spikes are regularly spaced, and it should be possible to at least infer when the data may be contaminated and screen this in in later processing. My (PI Marchand's) intend is to run retrievals for cloud microphysics using a physical iterative retrieval approach (e.g. Marchand 2003) and I will need to carefully screen the data when doing this.

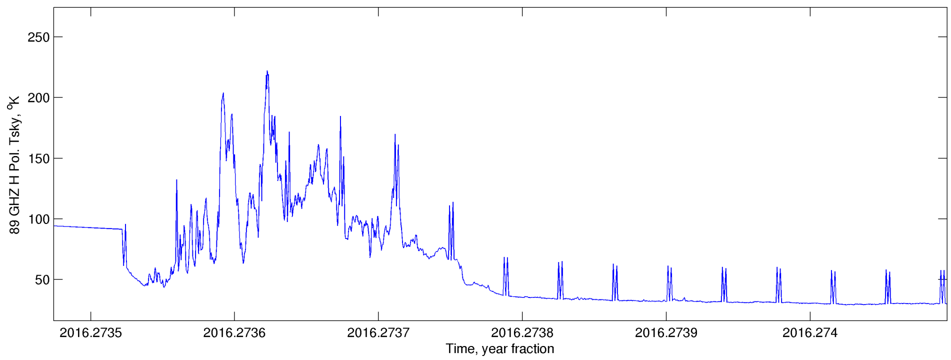

Figure #3 – Example of noise spikes in 3-channel 89 GHz data.

Interference is also visible in the later ARM 2-channel data (Figure #4). For the 2-channel instrument, the spikes (or drops) appear only in the 23.8 GHz channel (not 31) and are significantly more subtle – but will cause significant errors in the derived PWV and LWP and special processing will be needed to screen out the effects.

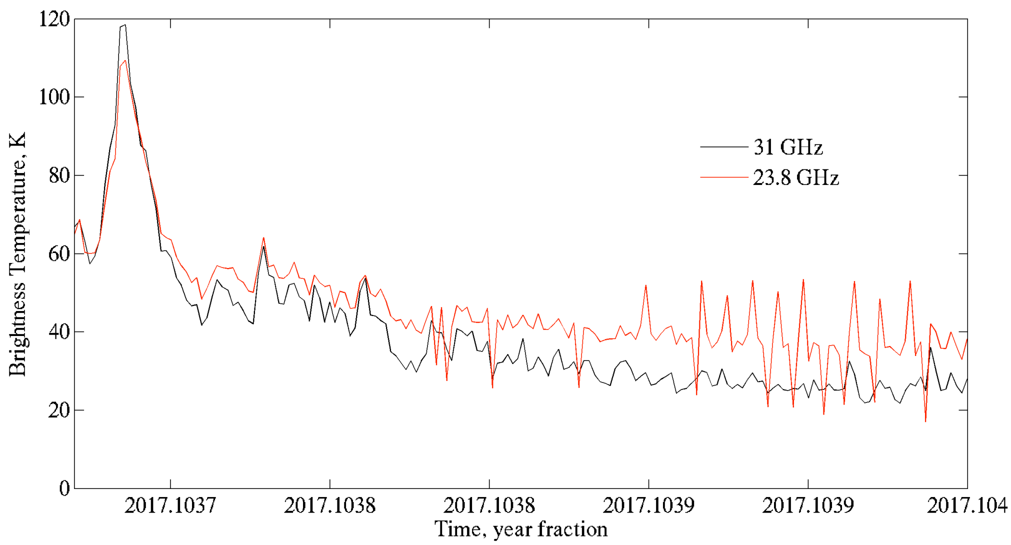

Figure #4 – Example of noise spikes in 2-channel MWR data