AIRE MRR Report – Risø data

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Content

This report details the processing steps used for calibrating the Micro Rain Radar (MRR) data with respect to data from a rain gauge at Risø site, Roskilde, Denmark.

Data

This report mainly deals with MRR and rain gauge data. Information about each data set is detailed below

	MRR	Rain gauge
Working	Shoots doppler signals vertically and records backscatter reflections from rain.	RIMCO tipping bucket with 0.2mm resolution
Resolution of data	5 sec	10 min
Heights of measurement	Different heights from 50m to 3000m	Ground level measurements
Location of instrument	Risø met mast	Risø met mast
Available years of measurements	Available from 2020	Available from 1995
Output file	netCDF	CSV

The MRR data at the starting heights are not reliable due to measurement errors close to the ground. For the purposes of this analysis, the MRR data from150m are compared to the rain gauge data, which is range gate that will not have any near field effects and is close to the current turbine heights. [1]

The data used for processing was acquired from the MRR Pro stationed at Risø campus since 2020 but only 2023 and 2024 were processed due to inconsistent data in the other three years. The raw netCDF files obtained from the instrument contain data recorded at a frequency of 5s for various heights for a total duration of 1hr. The rain gauge results used for comparing have a resolution of 10min and are available for a longer duration.

Methodology

The processing code developed by Barcelona university called *RaProM_Pro.py* was used to process the MRR data. [2] The processing is performed using the variable Multiplicative Bias (M) which modifies the calibration constant that is available from the raw instrument data. Processing the data using the code involves the following steps:

- Processing step 1: Processing of data assuming multiplicative bias M equals 1.

- Processing step 2: Computing the multiplicative bias based on the results from the first processing step at 150m.
- Processing step 3: Reprocessing data based on newly computed M value.

Each of these steps are explained in detail below:

Processing step 1: Processing with M equals one results in an extreme overestimation of the total precipitation. Multiple trials were conducted on the raw data by computing the multiplicative bias from different approaches. But all the results showed large deviation around 200% larger than the raw data.

Processing step 2: To tackle this issue, the overestimation from the processing step is removed by re-processing the data with a new multiplicative bias. This new bias is computed by comparing the results of total precipitation from the first processing step to the rain gauge data. The following steps are followed to compute the new M:

- Validate the processed files. Some files show a mismatch in time (The size of time stored in the .nc file and size of the precipitation data do not match) and hence all data in that 1hr time frame will be excluded.
- The time series of precipitation from the MRR at a height of 150m and the rain gauge at the ground for one day is extracted. (Note: The rain gauge data from the time frame where MRR files do not exist are ignored)
- The resolution of the extracted MRR data is then changed from 5 sec to 10 min for direct comparison with rain gauge data.
- After resampling, any readings in the MRR less than 0.2mm of total precipitation are assumed to be zero to prevent that these small reading affect the computation of M.
- The final M value is computed for each day. This is assumed to be the optimal resolution at which the lag from the rainfall due to measurements at different heights cannot be observed.

Processing step 3: All the files in one day are processed using the calculated M value. The reason for not using a higher resolution is mentioned above. If the rain gauge data from the day showed no rainfall, all the files from the day were processed with M=1 to prevent division by zero during the calculation. The same measure is used if the total precipitation of the MRR for the day is 0 mm.

Once the files are processed, they are saved with an extension of "*processed_M*" to the original name. The raw files and these processed files are uploaded to NextCloud.

Results

The results from the year 2023 and 2024 were processed and used for verification. The results from the final step are compared to the rain gauge results. Figure 1 shows the monthly sum of rainfall for year 2023 (left panel) and 2024 (right panel). The MRR intermediate calibration results (orange) highly overestimate while the MRR final calibration results (green) corresponds better to the rain gauge data. The MRR raw data values (blue) are in between the two calibrated products.

The linear regression statistic between the daily rainfall observed by rain gauge and three MRR products (raw, intermediate calibrated, final calibrated) are shown in Figure 2. The corresponding statistics for the linear regression results are summarized in Table 1. The results show improvements in statistics for the MRR final calibration compared to the MRR raw data. The MRR intermediate calibration overestimates rainfall and results in poor correlation statistics.

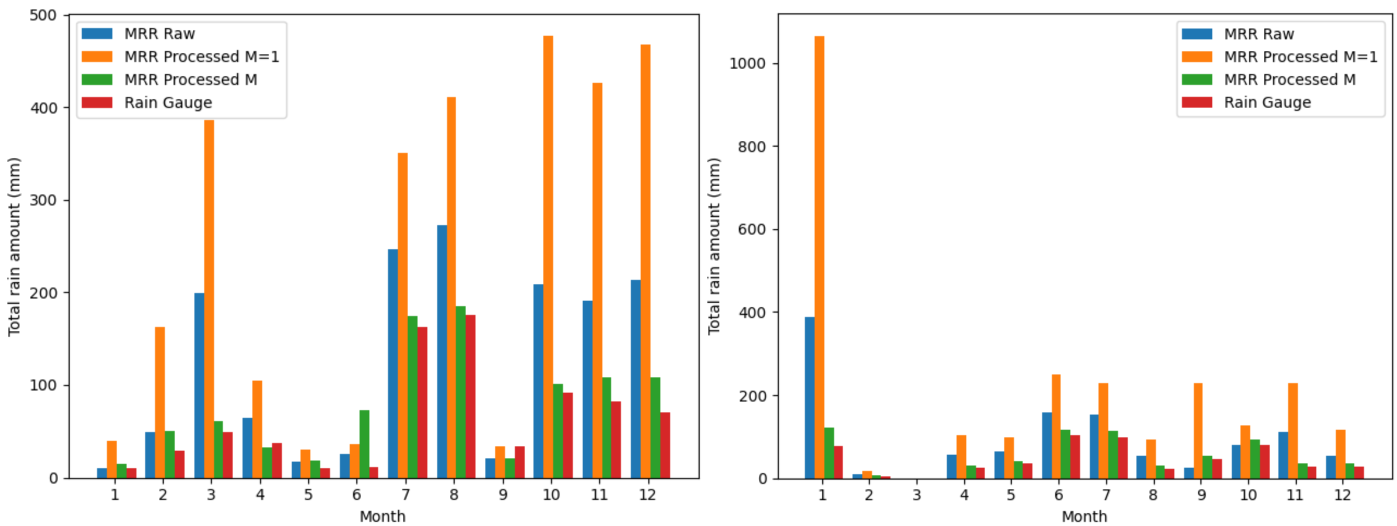

Figure 1 shows the monthly average precipitation for year 2023 (left panel) and 2024 (right panel).

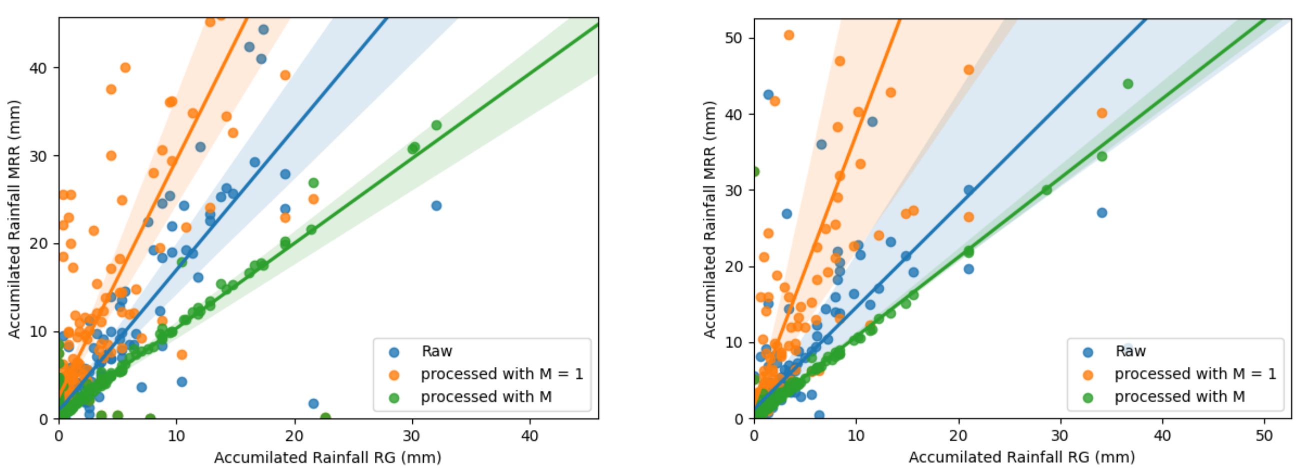

Figure 2. Plots of linear regression between rainfall observed by rain gauge and three MRR products (raw, intermediate calibration and final calibration) results at daily temporal resolution for year 2023 (left panel) and 2024 (right panel).

Table 1 Linear regression results of daily rainfall for year 2023 and 2024 for three MRR products (raw, intermediate calibration and final calibration) versus rain gauge.

Year	Pearson correlation coefficient (R)			Coefficient of determination (R^2)		
	Raw	Intermediate	Final	Raw	Intermediate	Final
2023	0.81	0.73	0.84	0.65	0.53	0.70
2024	0.66	0.65	0.94	0.44	0.42	0.89

Conclusion

Two years of MRR PRO data has been collected at the Risø site. The data has been calibrated a with the rain gauge data, where the key calibration parameter M was varied using a daily time step.

The raw files and the final calibrated data have been uploaded to NextCloud.

BIBLIOGRAPHY

[1] Foth, A., Zimmer, J., Lauermann, F., and Kalesse-Los, H.: Evaluation of micro rain radar-based precipitation classification algorithms to discriminate between stratiform and convective precipitation, Atmos. Meas. Tech., 14, 4565–4574, https://doi.org/10.5194/amt-14-4565-2021, 2021

[2] Garcia-Benadi, A.; Bech, J.; Gonzalez, S.; Udina, M.; Codina, B.; Georgis, J.-F. Precipitation Type Classification of Micro Rain Radar Data Using an Improved Doppler Spectral Processing Methodology. *Remote Sens.* **2020**, *12*, 4113. https://doi.org/10.3390/rs12244113