FEASIBILITY ANALYSIS OF MONITORING A C-BAND WEATHER RADAR REFLECTIVITY CALIBRATION USING A K-BAND DOPPLER RADAR PROFILER

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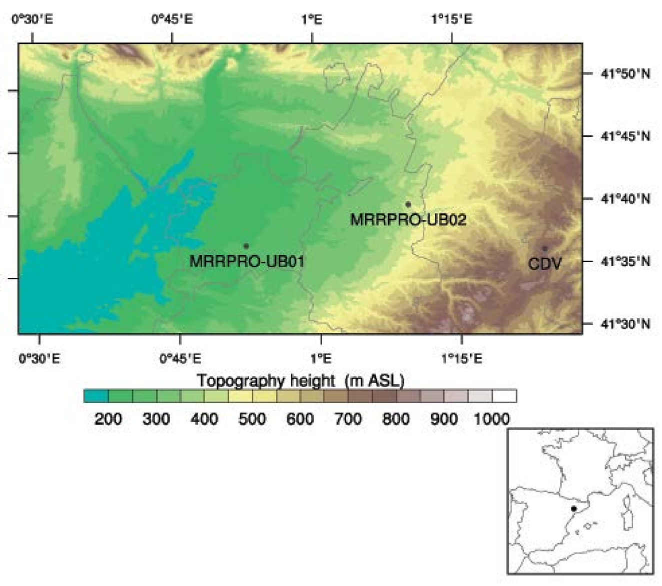
1. Introduction

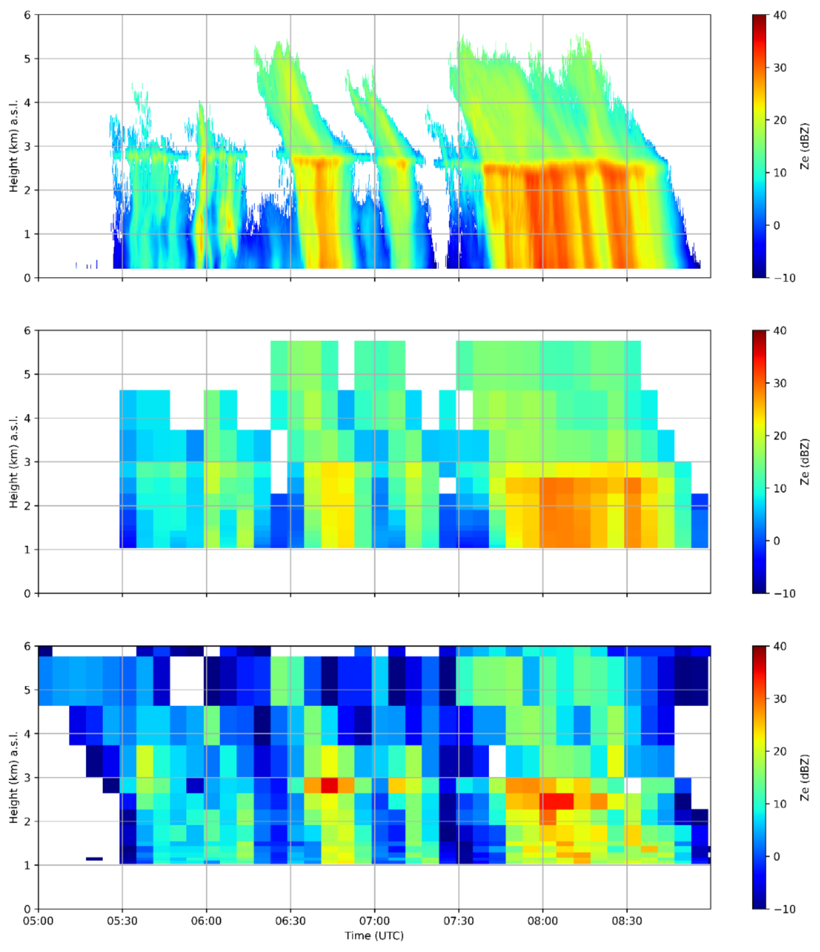
This presentation examines the feasibility of monitoring the radar reflectivity calibration of a conventional scanning C-band weather radar using a nearby K-band Doppler radar profiler MRR-Pro [1-2]. Vertically pointing Doppler weather radars may provide direct estimates of precipitation particle fall speeds assuming vertical air motion is negligible [3-4]. Derived rainfall amounts at the lowest bin profile are compared with co-located rain gauge measurements to check absolute calibration of the vertically pointing radar. Then, radar reflectivity observations from the vertically pointing intersecting the scanning radar beams can be compared considering differences in the observed radar volumes.

2. Equipment and location

MRR-Pro locations in Mollerussa (UB01) and Tàrrega (UB02), and C-band weather radar at Creu del vent (CDV) XRAD radar during LIAISE campaign [5]. MRR-Pros were first tested in Barcelona.



Range time display of MRR-Pro radar reflectivity original observations (top), downgraded to XRAD temporal and spatial resolution (middle) and XRAD observations (bottom). Data correspond to 23 Sept 2021 at Tàrrega.



3. Data and Results

a). Firstly, MRR-Pro units are calibrated with co-located rain-gauges from XEMA network (records > 0.1 mm), computing the ratio *M* between MRR-Pro estimates of the lowest valid bin and 30 min rainfall from the rain-gauge following [2], being *M* equal to 1 in the ideal case. Uncertainty *U* is also calculated assuming a 95% interval of confidence with a coverage factor *k* and *u* combined standard uncertainty. *M* is then used to obtain a corrected Drop Size Distribution N(D) estimated with the MRR-Pro.

b). Secondly, with the corrected N(D) a corrected version of MRR-Pro radar reflectivity $Ze_{MRR\text{-}Pro}$ is obtained and compared with the matched XRAD C-band weather radar observation, considering two MRR-Pro conditions (Fall speed > 4 m/s and Z_e > 10 dBZ) to ensure that rainfall is being observed. Then the ratio *W* between radar reflectivities and associated uncertainty *U* are calculated. This part was performed considering two different periods, separated by XRAD radar receiver calibrations.

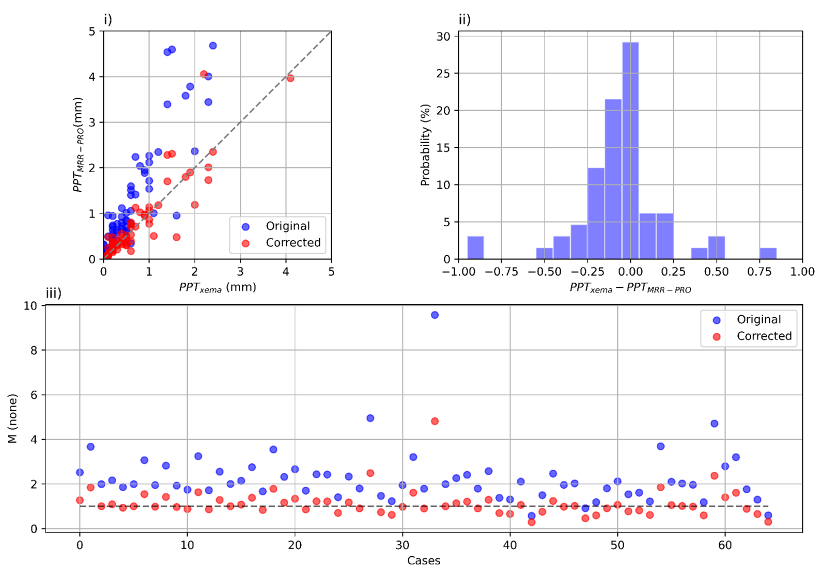
$$M = \frac{PPT_{MRR-Pro}}{PPT_{xema}}$$

$$U = k \cdot u$$

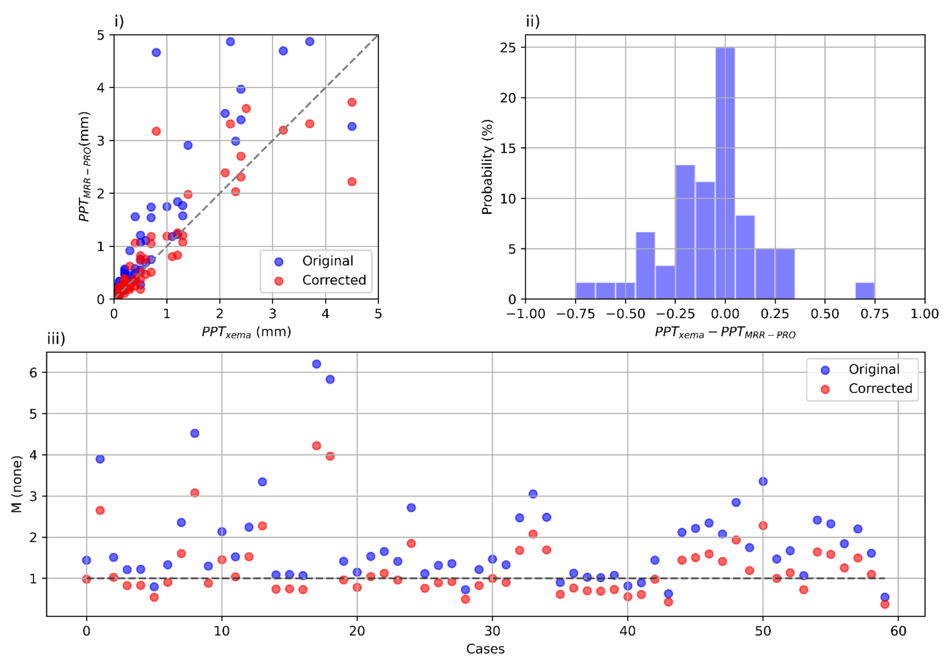
$$W = \frac{Ze_{XRAD}}{Ze_{MRR-Pro}}$$

a. Calibration of MRR-Pro with rain-gauge

Mollerussa
Number cases: 65
Precipitation: 64.7 mm
Before Calibration
M=1.99
IQR=0.82
After Calibration
M=1.00
IQR=0.41
k=2.00
U(M)=0.66



Tàrrega
Number cases: 59
Precipitation: 90.7 mm
Before Calibration
M=1.47
IQR=1.14
After Calibration
M=1.00
IQR=0.78
k=2.00
U(M)=0.49



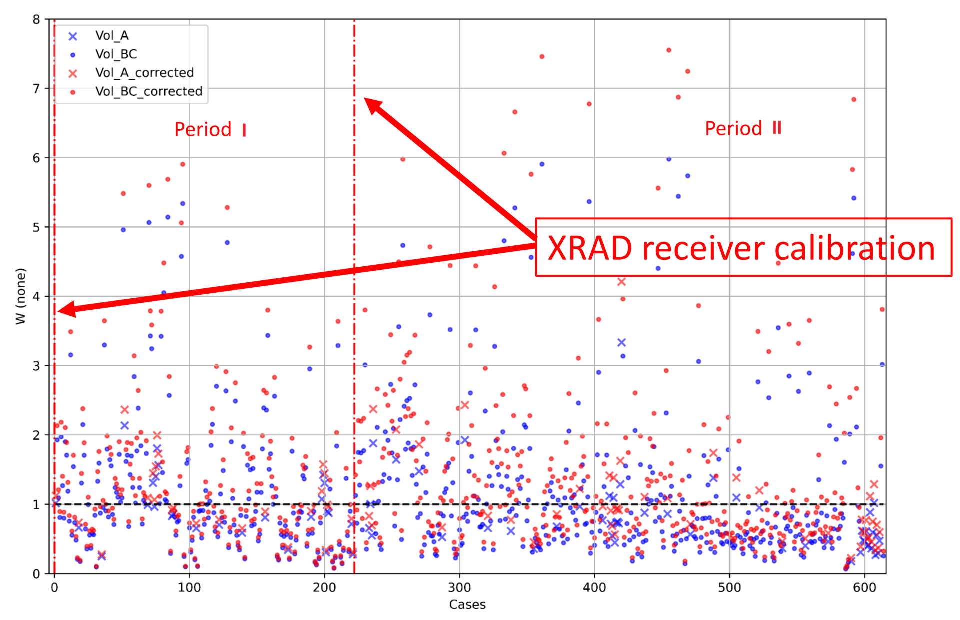
b. Correction of XRAD radar with MRR-Pro

Mollerussa
Number of cases: 615
Before Correction

Period I	Period II
W=0.91	W=0.79
IQR=0.99	IQR=0.90

After Correction

Period I	Period II
W=1.00	W=1.00
IQR=1.09	IQR=1.14
K=2.00	k=2.00
U(W)= 0.77	U(W)= 0.70

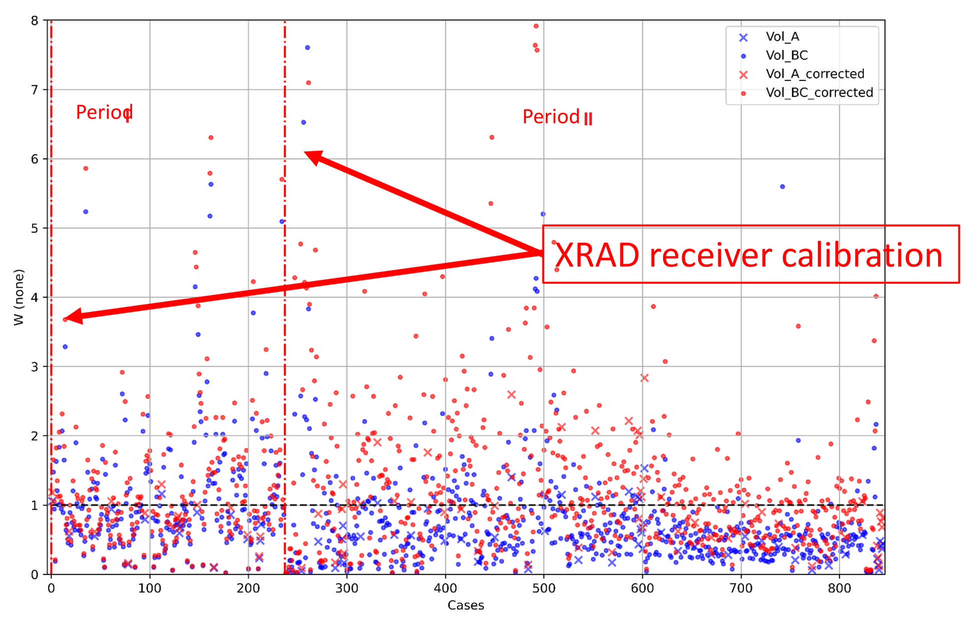


Tàrrega
Number of cases: 845
Before Correction

Period I	Period II
W= 0.89	W= 0.54
IQR= 0.78	IQR= 0.53

After Correction

Period I	Period II
W= 1.00	W= 1.00
IQR= 0.88	IQR= 0.98
K=2.00	K=2.00
U(W)= 0.64	U(W)= 0.46



4. Final Remarks

- A procedure to monitor C-band radar reflectivity observations using MRR-Pro data has been tested during the LIAISE field campaign, during the period March to September 2021, considering two steps: first step, calibration of MRR-Pro; and second step, correction of C-band data.
- First step found rain-gauge to MRR-Pro rainfall estimated ratios M (perfect value: 1) ranging from 1.99±0.66 to 1.47±0.49 (-2.9 to -1.7 dB).
- Second step comparing radar reflectivity ratios W (perfect value: 1) of C-band radar and MRR-Pro considered two different periods, separated by C-band receiver calibrations: in Period I W ranged from 0.91±0.77 to 0.89±0.64 (0.5 dB in both cases); in Period II W ranged from 0.79±0.70 to 0.54±0.46 (1.0 to 2.6 dB).
- The method was able to detect differences in the two different C-band radar receiver calibration periods, complementing the monitoring of Ze XRAD radars.
- Future work may include the use of co-located disdrometer data to better calibrate MRR-Pro units and the effect upon subsequent XRAD corrections.

References

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