NF Lindenberg for cloud remote sensing

Monitoring of calibration, Radar comparison

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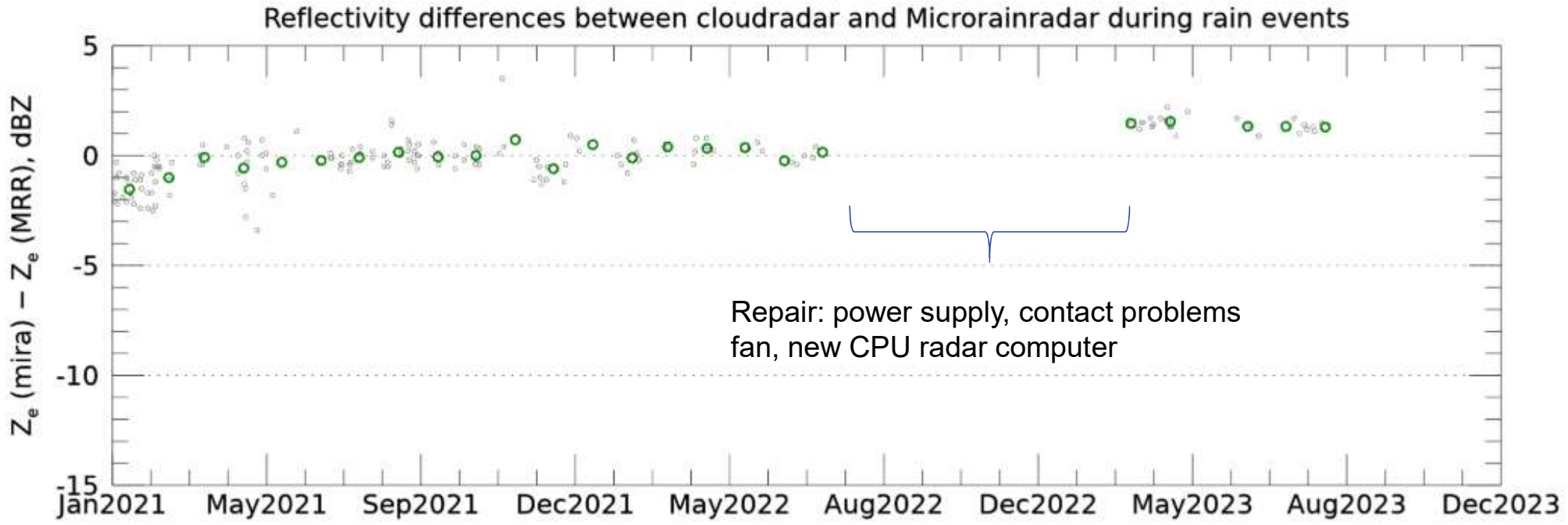
Deutscher Wetterdienst

Monitoring Z_e – Comparison against MRR

70 Jahre Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Calculation of mean Z_e differences between MIRA and MRR for rain events

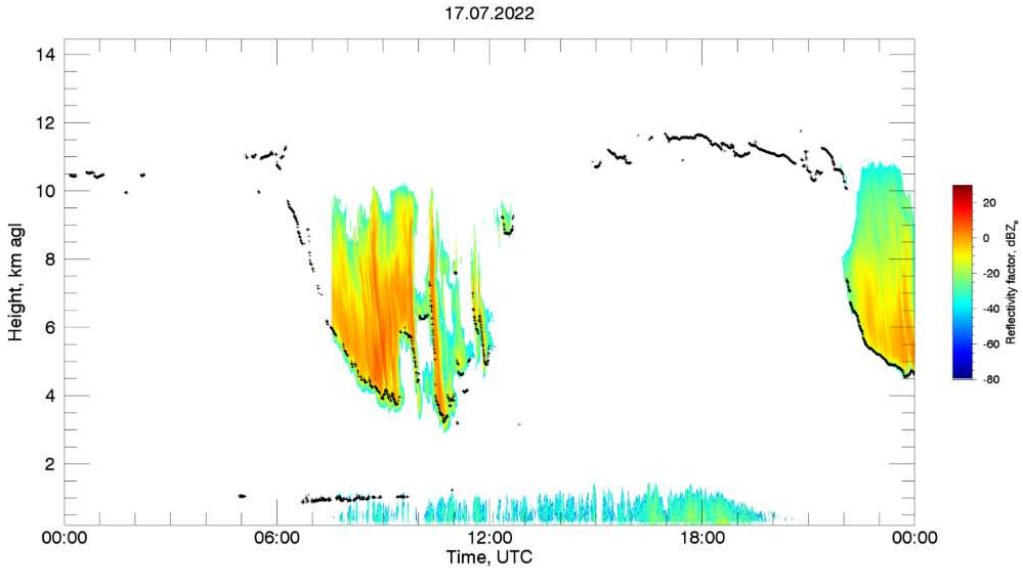
Criterions: 500 m height level, rain duration > 60 min, STD of differences < 1.5 dBZ

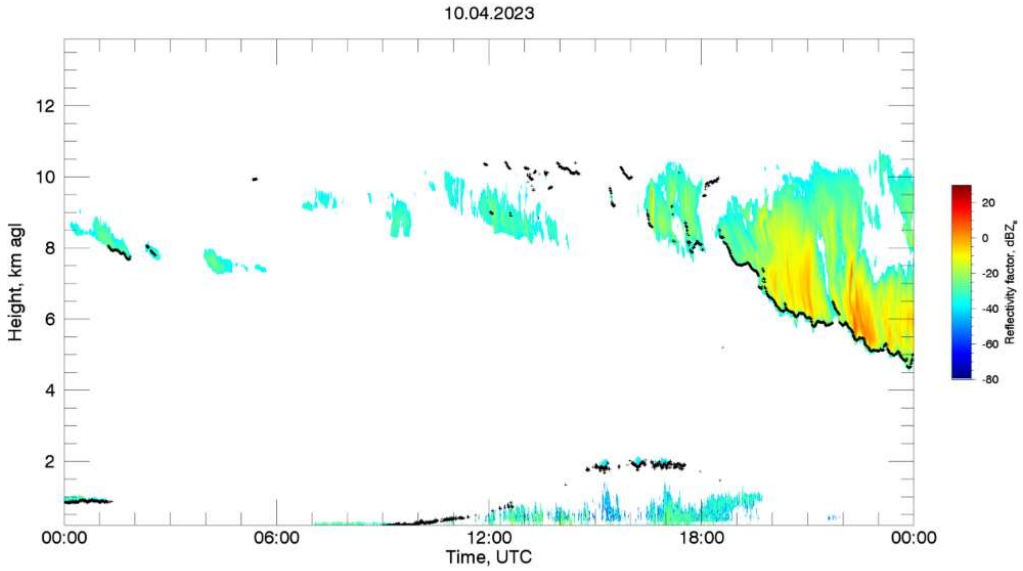


Comparison of reflectivities between the 35 GHz radar (MIRA) and the 94 GHz radar (MOLRAD94)

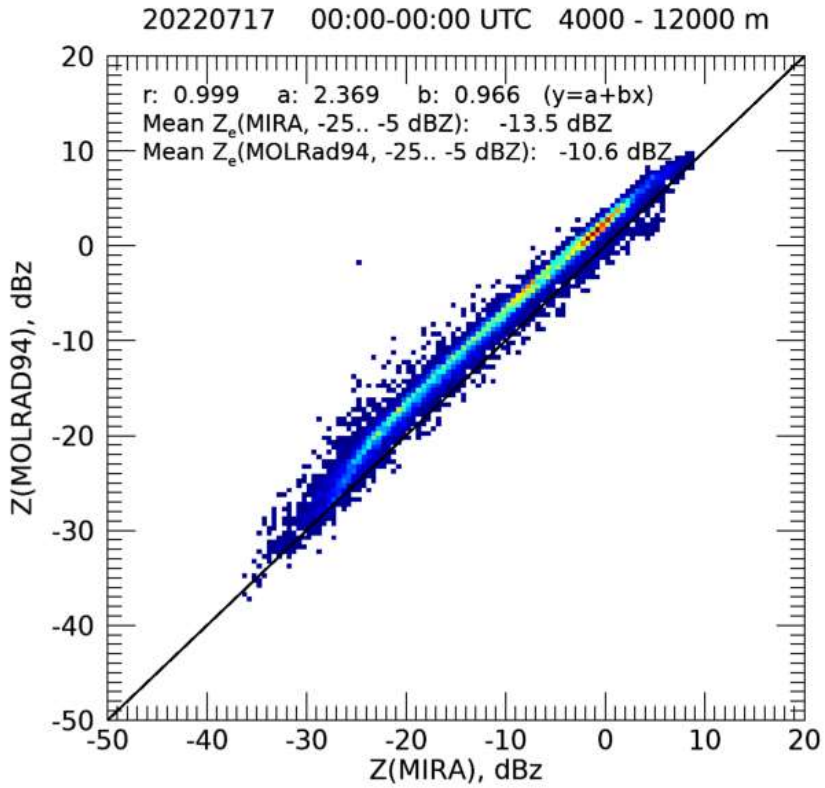
- For ice water clouds only, or for ice clouds with insignificant liq. water clouds below, similar to *Jorquera, S., and Coauthors, 2023: Calibration transfer methodology for cloud radars based on ice cloud observations. J. Atmos. Oceanic Technol., https://doi.org/10.1175/JTECH-D-22-0087.1, in press*
- For liquid water clouds (shallow Stratocumulus, Rayleigh scattering condition should be fulfilled for both radars)
- Using Cloudnet processed data, where Z has been corrected for attenuation by gaseous attenuation (using the thermodynamic variables from a forecast model) and liquid attenuation (using liquid water path from a microwave radiometer)

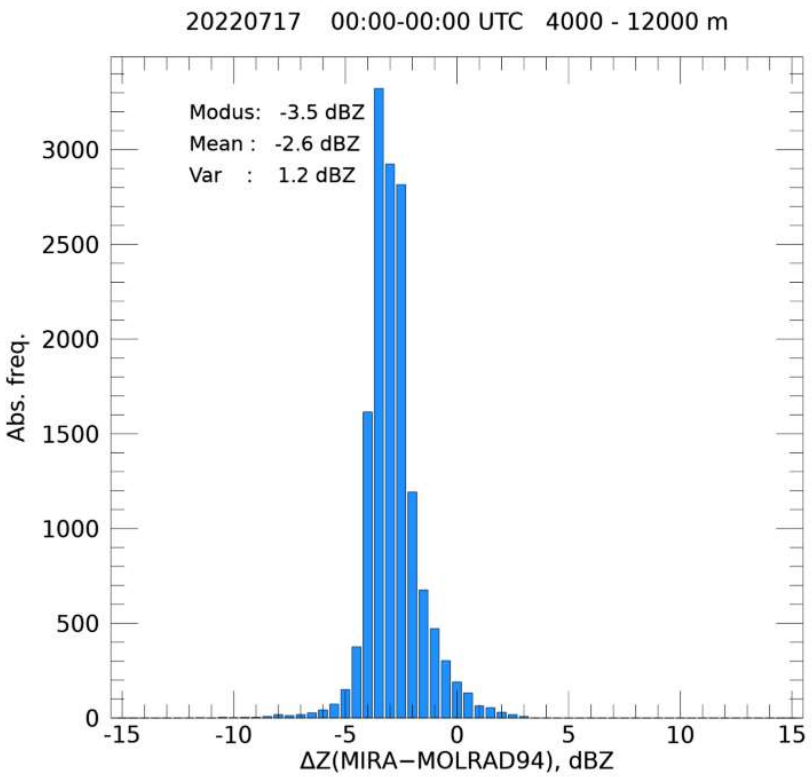
Comparison for ice clouds for one day in summer 2022 (before the repair of MIRA) and one day in spring 2023 (after the repair of MIRA)



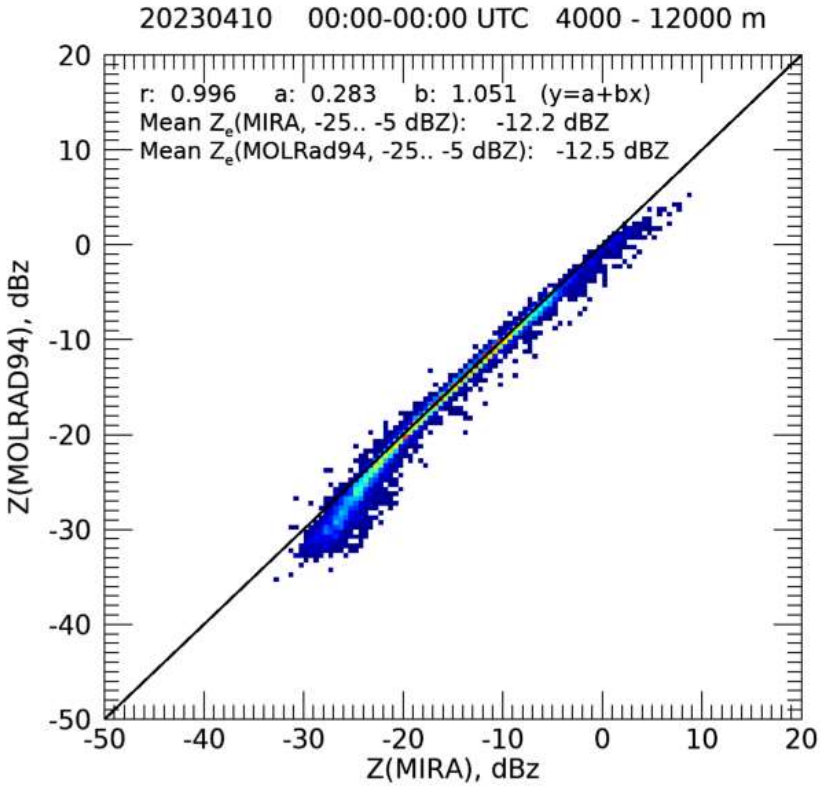


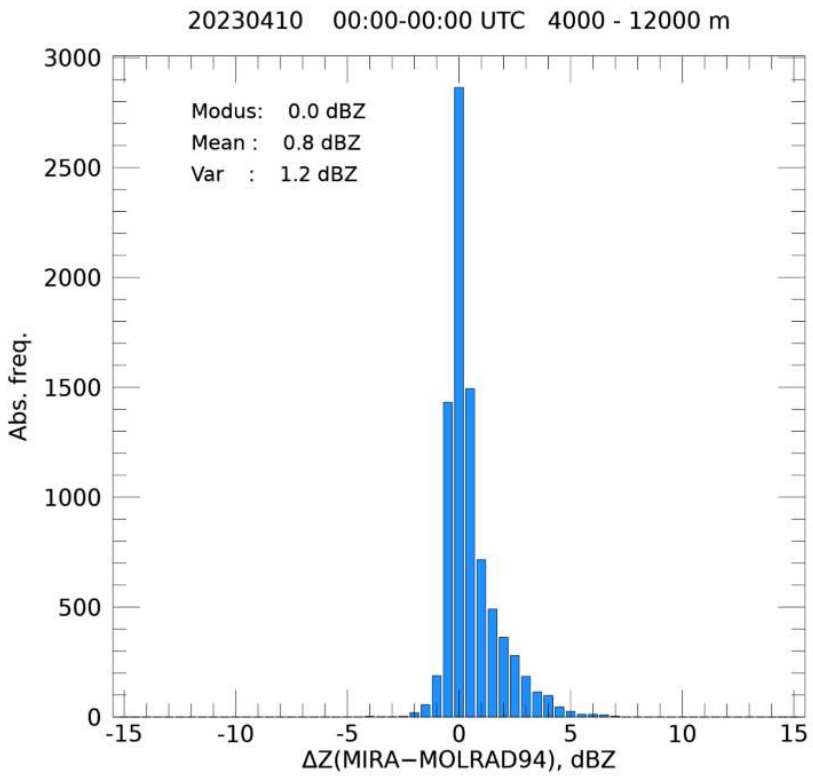
17.07.2022


20220717 00:00-00:00 UTC 4000 - 12000 m
r: 0.999 a: 2.369 b: 0.966 (y=a+bx)
Mean Ze(MIRA, -25.. -5 dBZ): -13.5 dBZ
Mean Ze(MOLRad94, -25.. -5 dBZ): -10.6 dBZ
Z(MOLRAD94), dBz
Z(MIRA), dBz
20
10
0
-10
-20
-30
-40
-50

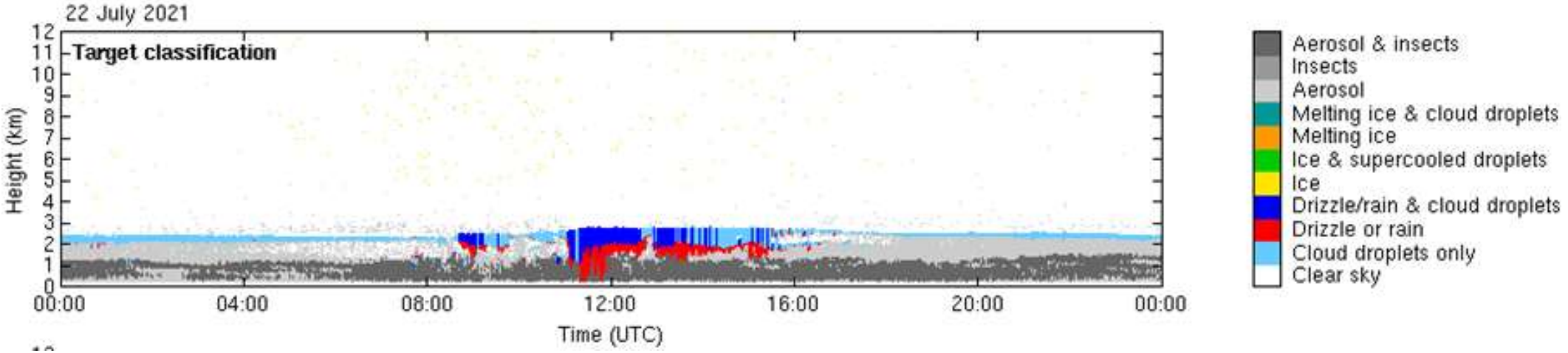

20220717 00:00-00:00 UTC 4000 - 12000 m
Modus: -3.5 dBZ
Mean : -2.6 dBZ
Var : 1.2 dBZ
Abs. freq.
ΔZ(MIRA−MOLRAD94), dBZ
3000
2500
2000
1500
1000
500
0
-15
-10
-5
0
5
10
15

10.04.2023

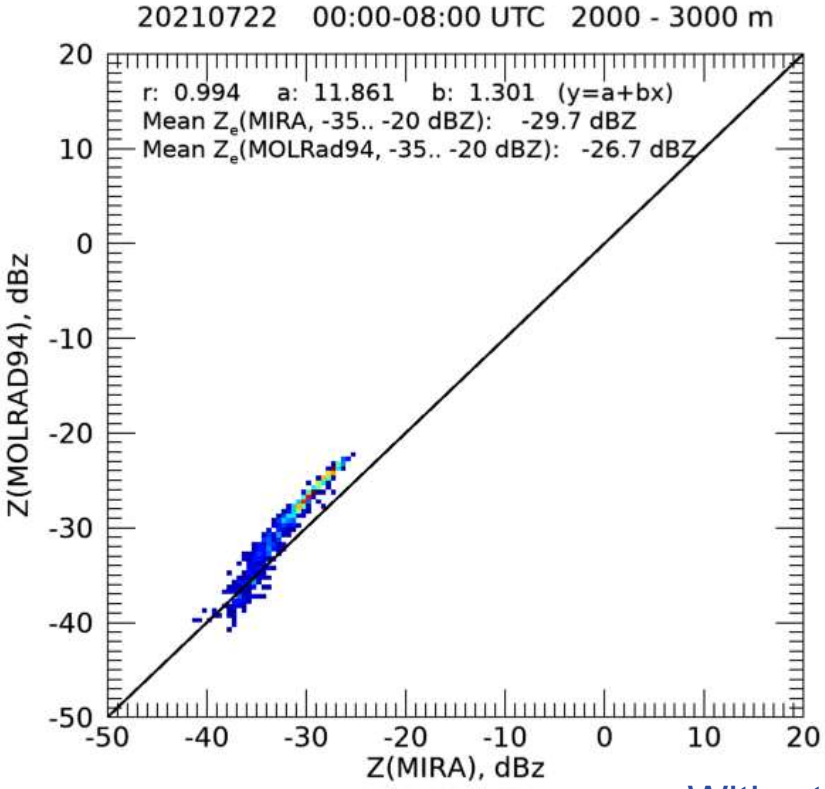

20230410 00:00-00:00 UTC 4000 - 12000 m
r: 0.996 a: 0.283 b: 1.051 (y=a+bx)
Mean Ze(MIRA, -25.. -5 dBZ): -12.2 dBZ
Mean Ze(MOLRad94, -25.. -5 dBZ): -12.5 dBZ
Z(MOLRAD94), dBz
Z(MIRA), dBz
20
10
0
-10
-20
-30
-40
-50

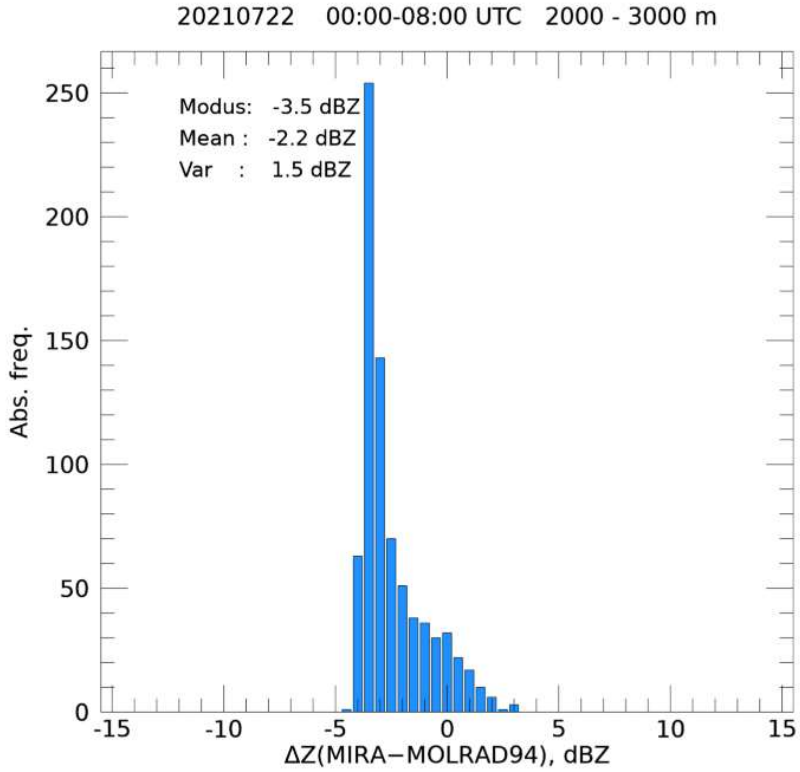

20230410 00:00-00:00 UTC 4000 - 12000 m
Modus: 0.0 dBZ
Mean : 0.8 dBZ
Var : 1.2 dBZ
Abs. freq.
ΔZ(MIRA−MOLRAD94), dBZ
3000
2500
2000
1500
1000
500
0
-15
-10
-5
0
5
10
15

Comparison for liquid water clouds for one day in summer 2021 and 2022 (before the repair of MIRA) and one day in spring 2023 (after the repair of MIRA)



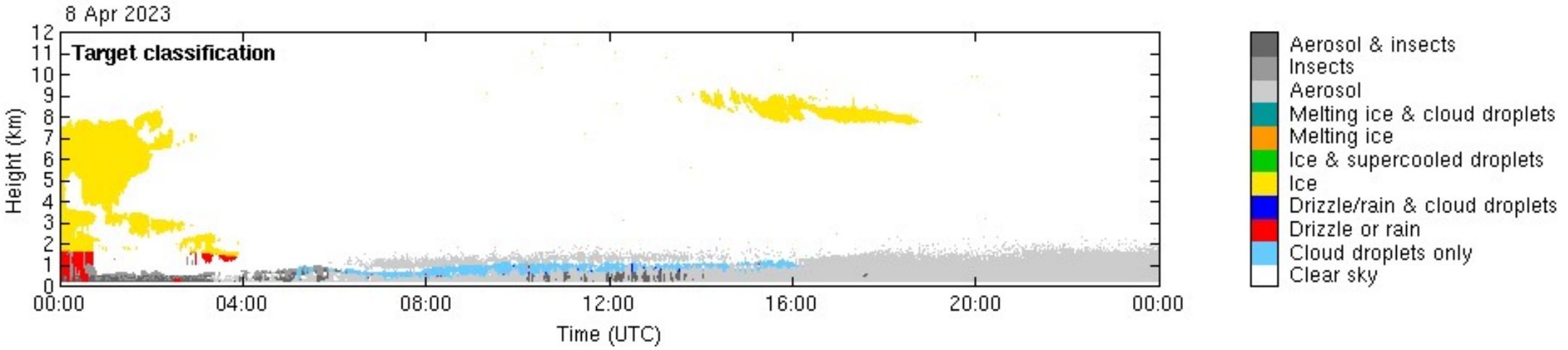
22.07.2021



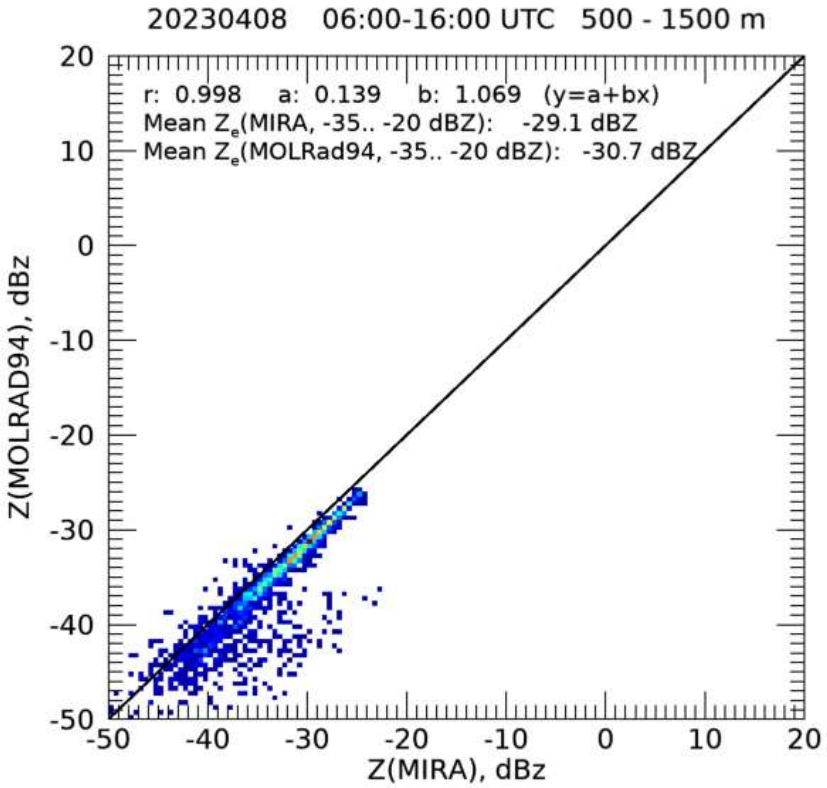


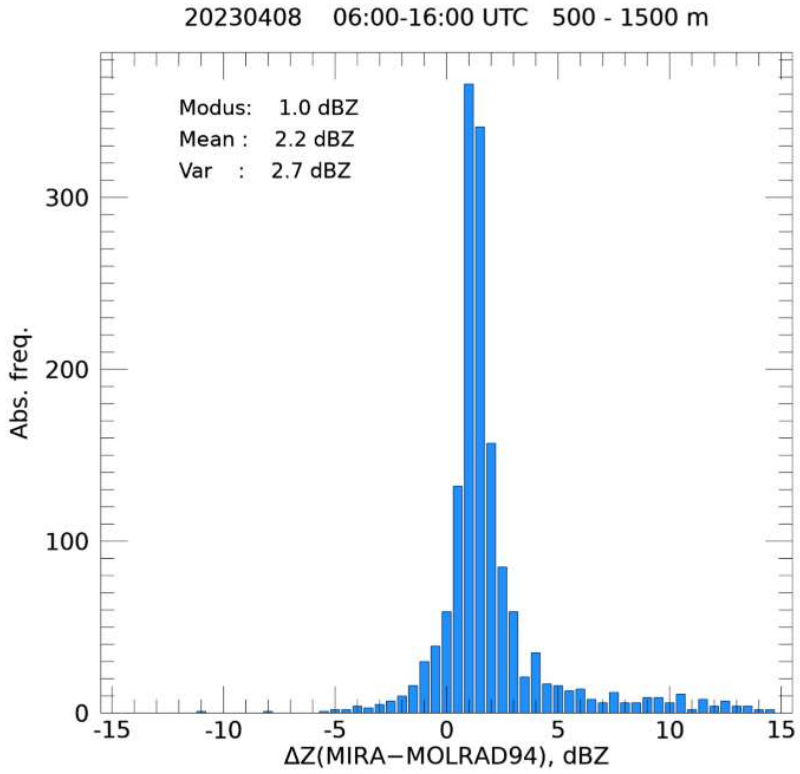
With attenuation correction

08.04.2023


8 Apr 2023
Target classification
Height (km)
0
1
2
3
4
5
6
7
8
9
10
11
12
00:00
04:00
08:00
12:00
16:00
20:00
00:00
Time (UTC)
Aerosol & insects
Insects
Aerosol
Melting ice & cloud droplets
Melting ice
Ice & supercooled droplets
Ice
Drizzle/rain & cloud droplets
Drizzle or rain
Cloud droplets only
Clear sky

08.04.2023


20230408 06:00-16:00 UTC 500 - 1500 m
r: 0.998 a: 0.139 b: 1.069 (y=a+bx)
Mean Ze(MIRA, -35.. -20 dBZ): -29.1 dBZ
Mean Ze(MOLRad94, -35.. -20 dBZ): -30.7 dBZ
Z(MOLRAD94), dBz
Z(MIRA), dBz
20
10
0
-10
-20
-30
-40
-50


20230408 06:00-16:00 UTC 500 - 1500 m
Modus: 1.0 dBZ
Mean : 2.2 dBZ
Var : 2.7 dBZ
Abs. freq.
ΔZ(MIRA−MOLRAD94), dBZ
300
200
100
0
-15
-10
-5
0
5
10
15

Summary

70 Jahre Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- The various comparisons show a change in the calibration of the 35 GHz cloud radar after repair by the manufacturer
  - Based on comparisons versus MRR, MIRA35 shows an calibration offset of about 1.5 dBZ after repair, whereas the Ze differences previously fluctuated around zero.
- Direct comparisons between both cloud radars for ice and liquid water clouds confirm this calibration change, not completely in terms of amount, but in its tendency
  - In July 2022 the reflectivities measured by MIRA were about 3.5 dBZ lower than those measured by MOLRAD94
  - If MOLRAD94 Ze measurements are assumed to be unbiased, the MIRA Ze bias is consistent with disdrometer calibration results (see Yanis et al.)
  - In April 2023 the reflectvity differences between both radars are about 0 dBZ