LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
FAKULTÄT FÜR PHYSIK METEOROLOGIE
MIM

Doppler Radar's Reflectivity Calibration using Disdrometer at LMU Munich

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ACTRIS CCRES

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1. Site Description: ACTRIS site at MIM, LMU Munich

X-band radar

Ka-band radar

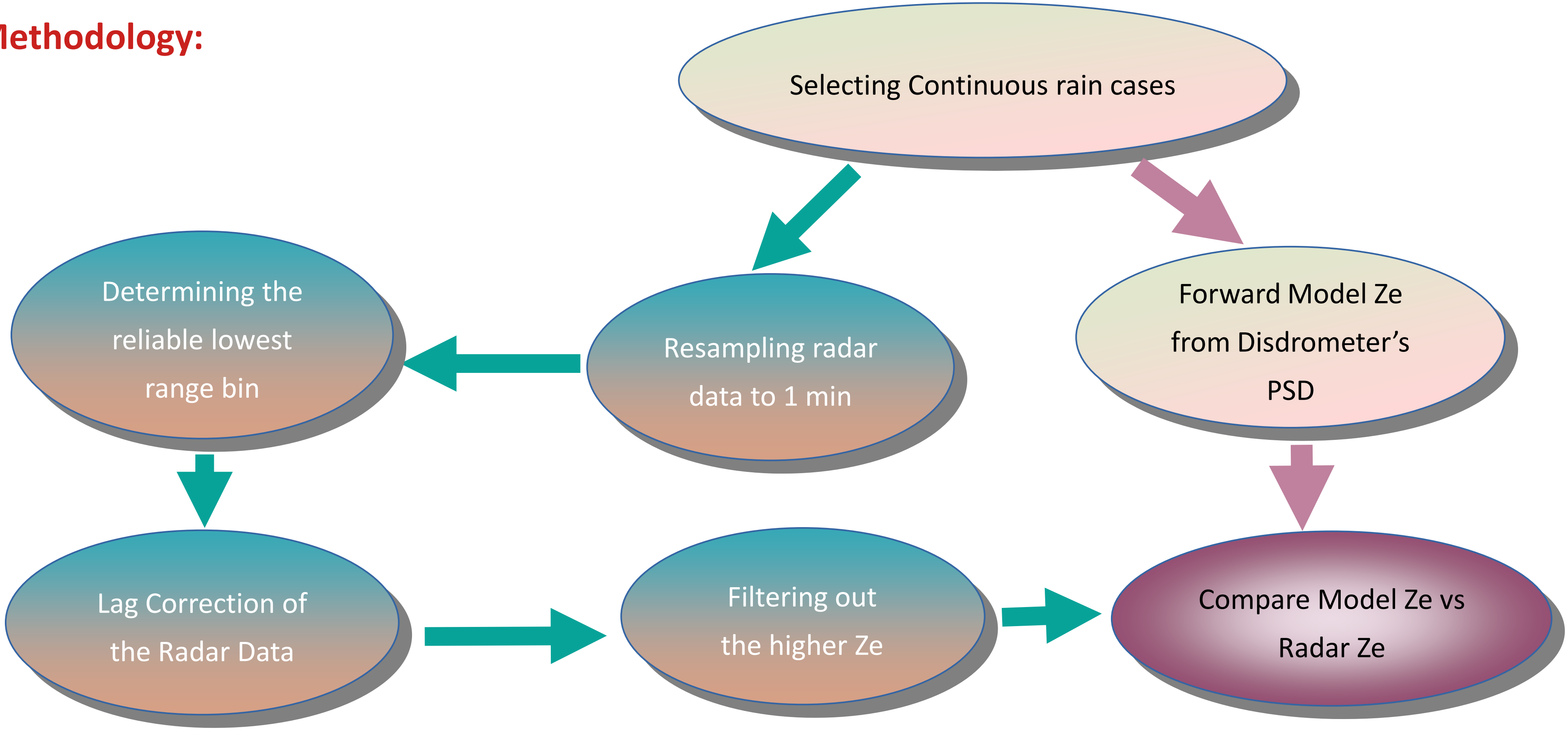
W-band radar

	xmacs	**Kamacs (nominal)**	wmacs
Frequency (GHz)	9.6	35	94
Beam Width (°)	1	0.5	0.6
Resolution(m)	36	36	36
Scanning	No	Yes	Yes
Polarimetry	No	LDR	Full
Attenuation	Negligible	Medium	Strong
Sensitivity at 5 km	-25 dBZ	-35 dBZ	- 40 dBZ

Monitoring of Radar Reflectivity Calibration

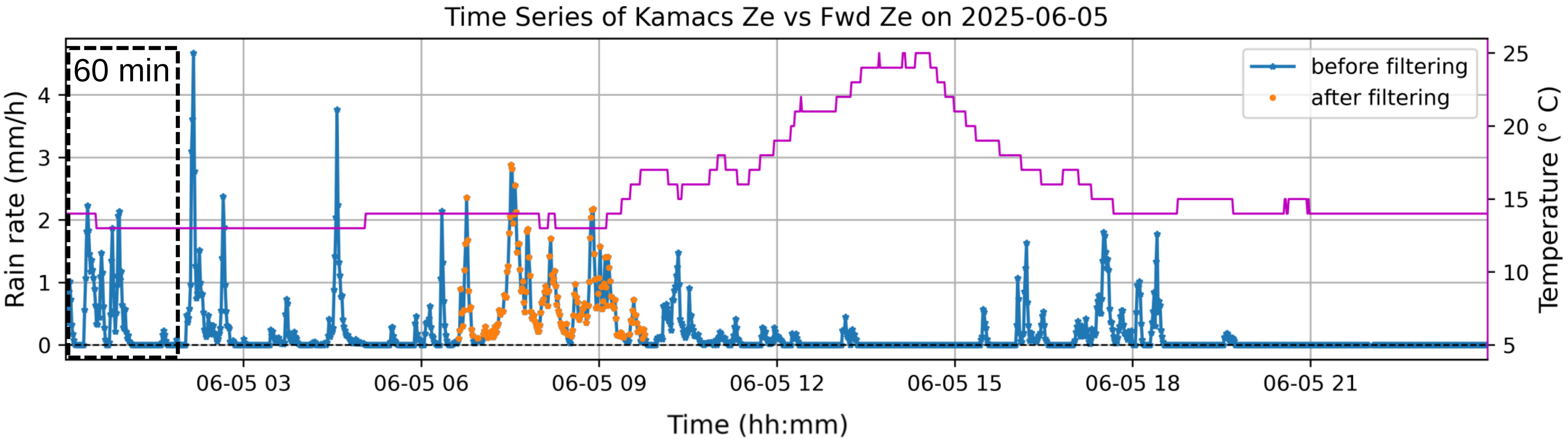
Principle: Use Disdrometer RSD to estimate Ze and compare with Radar Ze *(Myagkov et al., AMT, 2020)*

Methodology:



2.1 Selecting the Rain Cases from Disdrometer:

- Rain rate > 0.1 mm/hr (*Williams et al., 2005).*
- Disdrometer Measurements : at least 25 raindrops per minute.
- Continuous Rain events : a threshold of 50 rain samples (80 %) within a 60 minutes moving window.
- Surface temperature > 5 ºC and the Particle status from Disdrometer : rain drops.



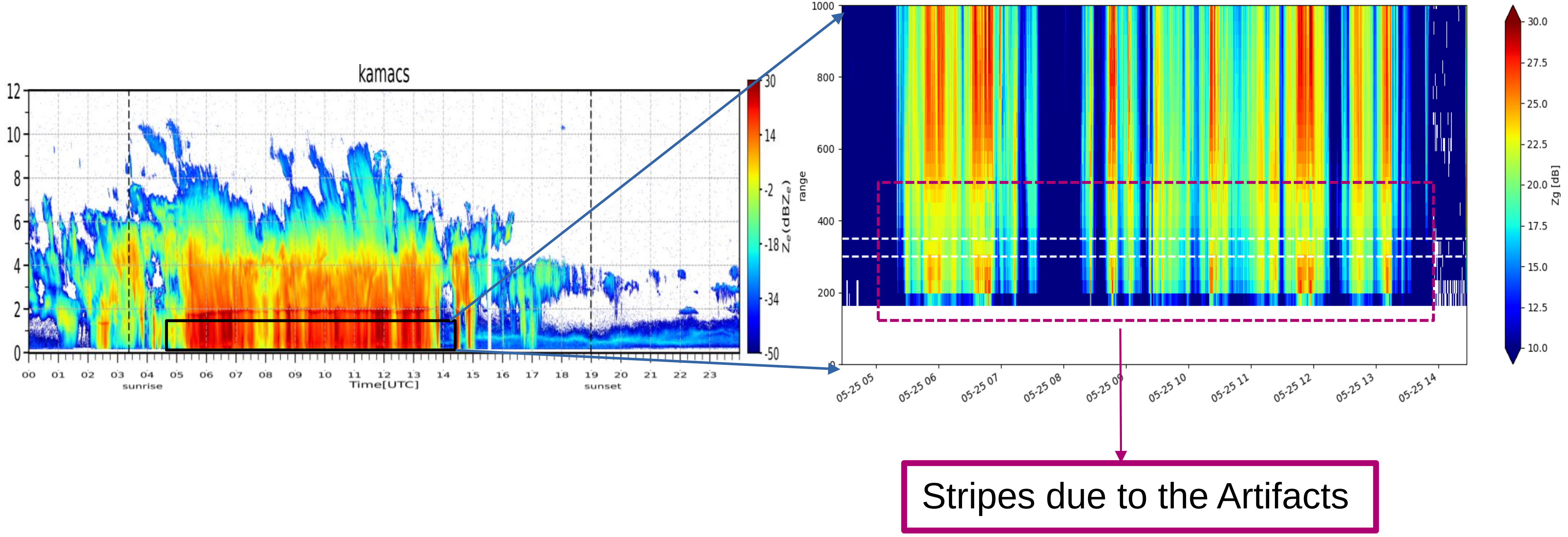
2.2 Reflectivity estimation from Disdrometer:

- For the selected rainy cases reflectivity is calculated using T-Matrix scattering and Parsivel’s drop size distribution.

- Its a free python package (RAINCOAT) available at https://github.com/OPTIMICe-team/raincoat

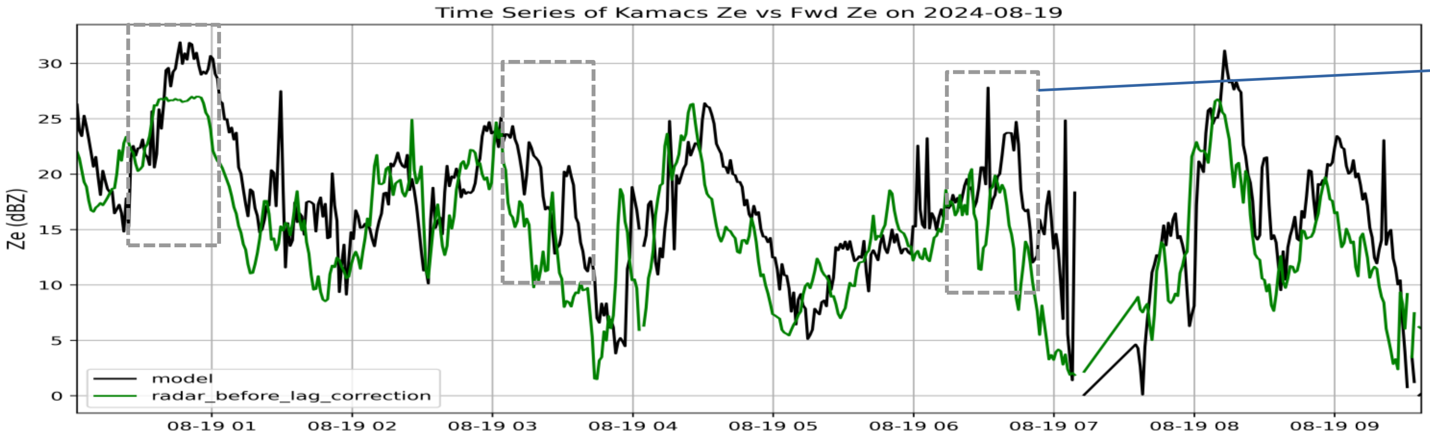
- We adopted RAINCOAT, then modify or add necessary steps to bring the best possible outcome.

2.3 Selecting the Radar lowest Range gate: How ‘low’ in the range gates one can go?



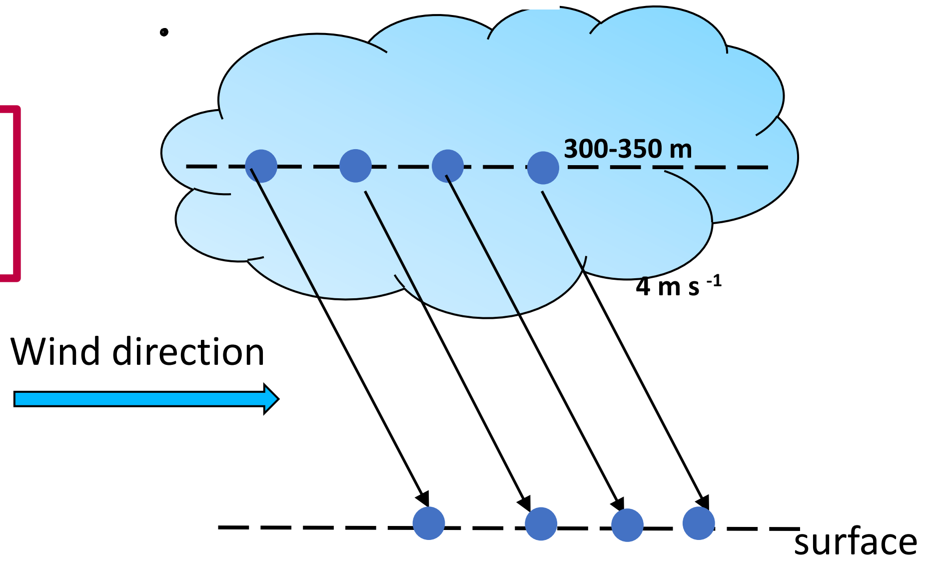
kamacs Ze: 600 to 650 meter and xmacs and wmacs Ze: 300 to 350 meter

2.3 Lag correction between the Radar and Disdrometer reflectivity:



One line is going behind the other

Time Lag : Horizontal Wind + rain drop fall streaks (depending on the velocity)



2.2 Radar Lag correction:

- Wind and drop size change → **Different time lag** within a single rain episodes

- Identify the window with no change of lag:

(i) Select a set of windows (ex: 10 to 100 min).

(ii) Correct the lag within that window.

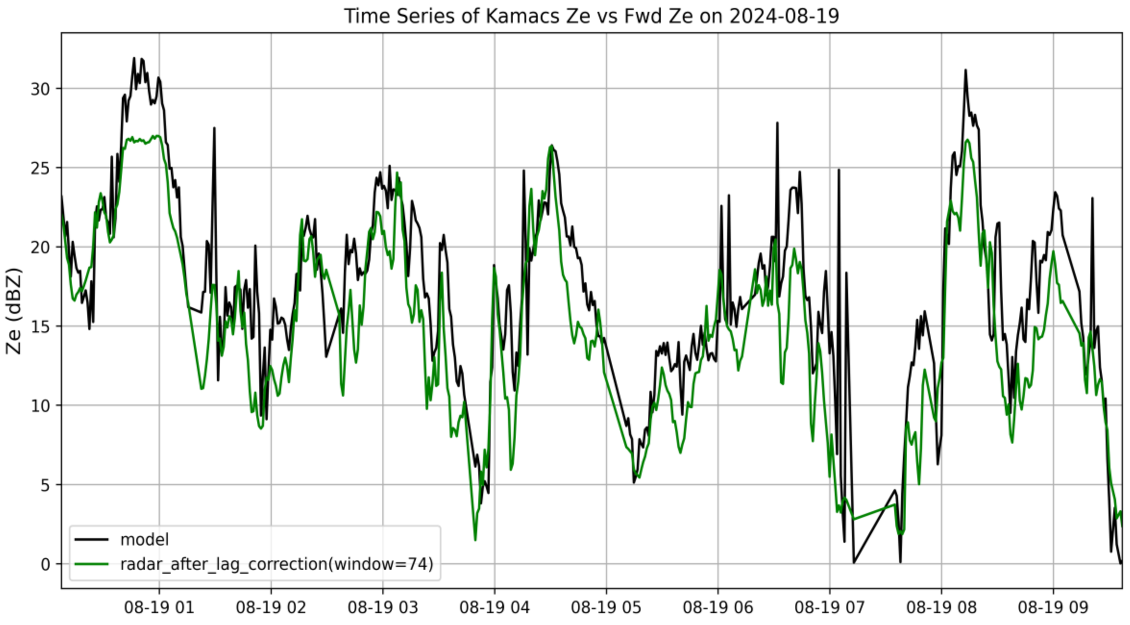
(iii) Estimate the correlation coefficient (CC) for each window.

(iv) Window with highest CC is accepted.

- Multiple rainy episodes : time difference between two rain episodes > 30 mins.

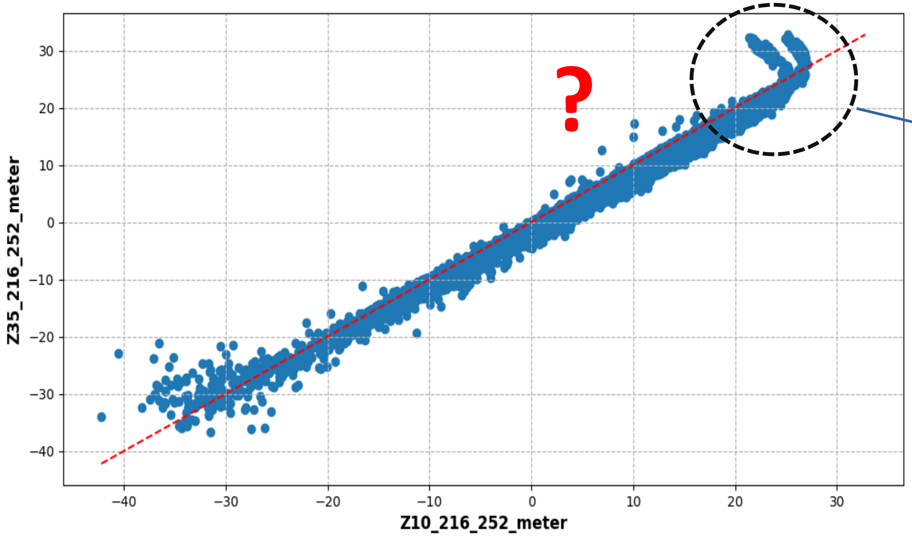
- Lag correction is made separately for the different rainy episodes.

After lag correction



2.3 Filtering higher Ze values:

- Kamacs reflectivity > 20 dBZ removed.
- *Preliminary Check :* Cases when 50% of the entire day Ze is more than 20 dBZ , are eliminated.

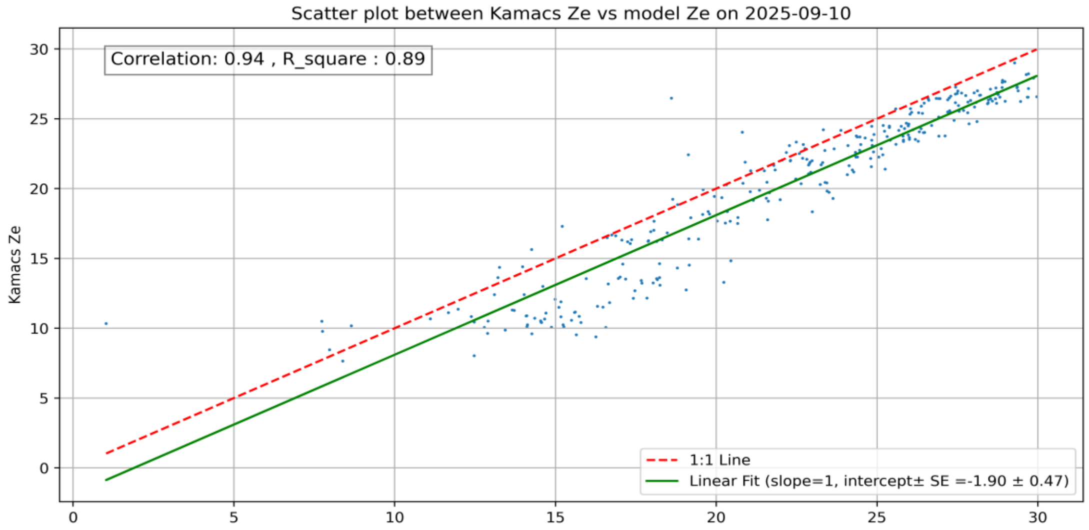


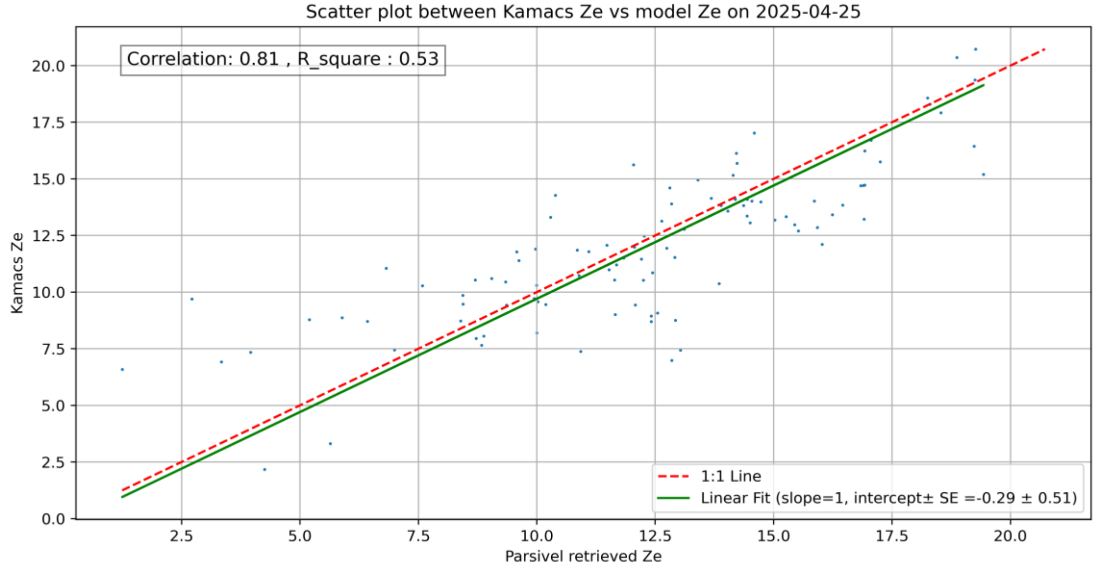
Due to the kamacs Receiver saturation, Ze> 20 dBZ is questionable.

‘STC’ mode by METEK: reduce this effect.

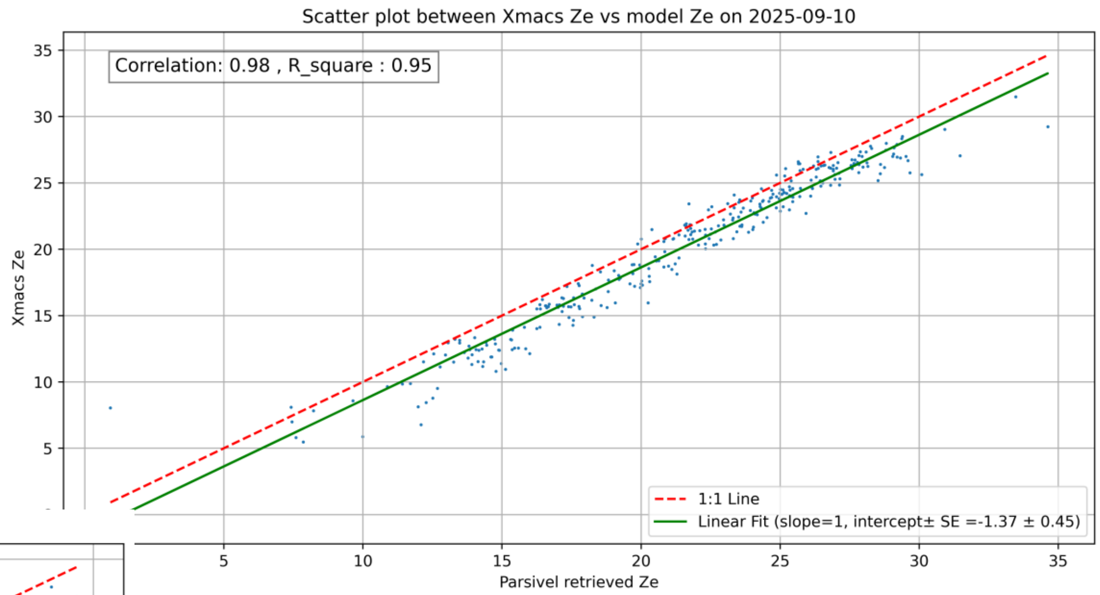
2.4 Scatter Plot between model Ze and radar Ze:

- Linear fit with slope =1: Interception of the line = radar offset value.
- The Coeff. Of determination (R_square) : spread of the Scattered plot.
- 1:1 line (ideal) : understand the deviation from (observed) the fitted line.
- R_square < 0.55 : that case is removed.
- Min. point criteria for scatter plot : no of points > 30.



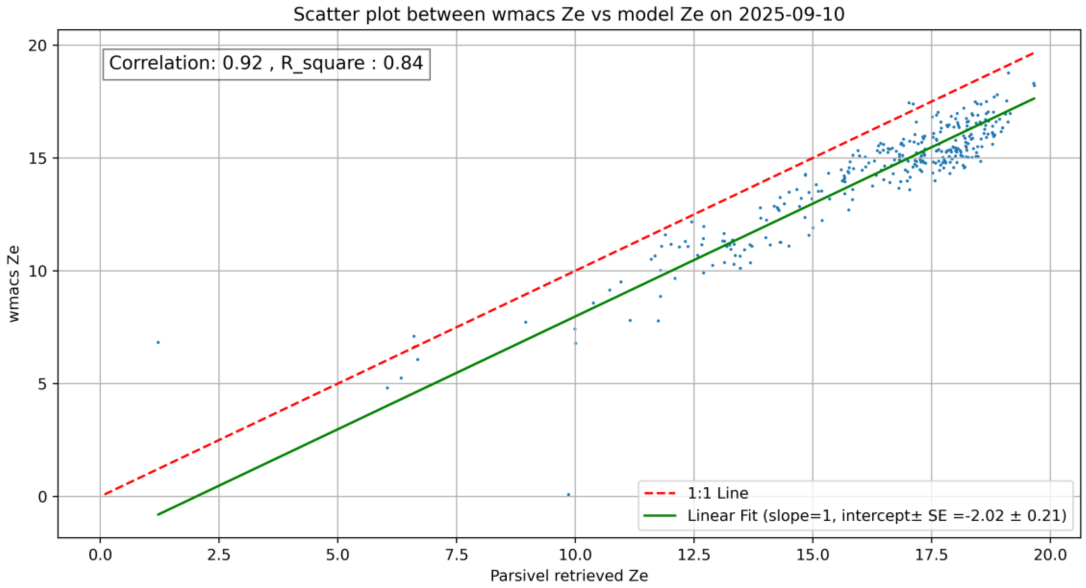


Xmacs Scatter Plot:



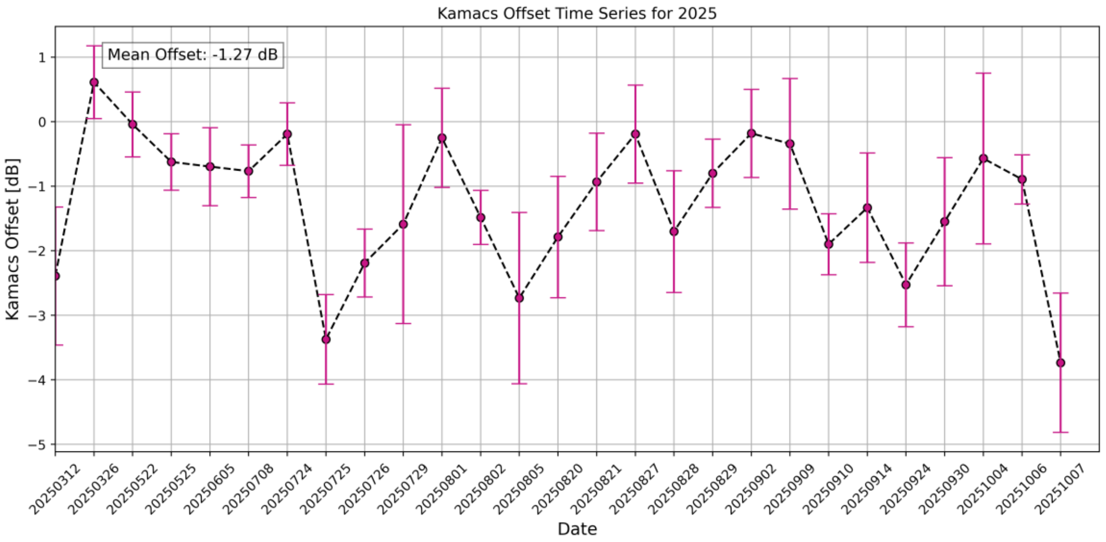
The same methodology has been applied to the other two radars to retrieve their offset values.

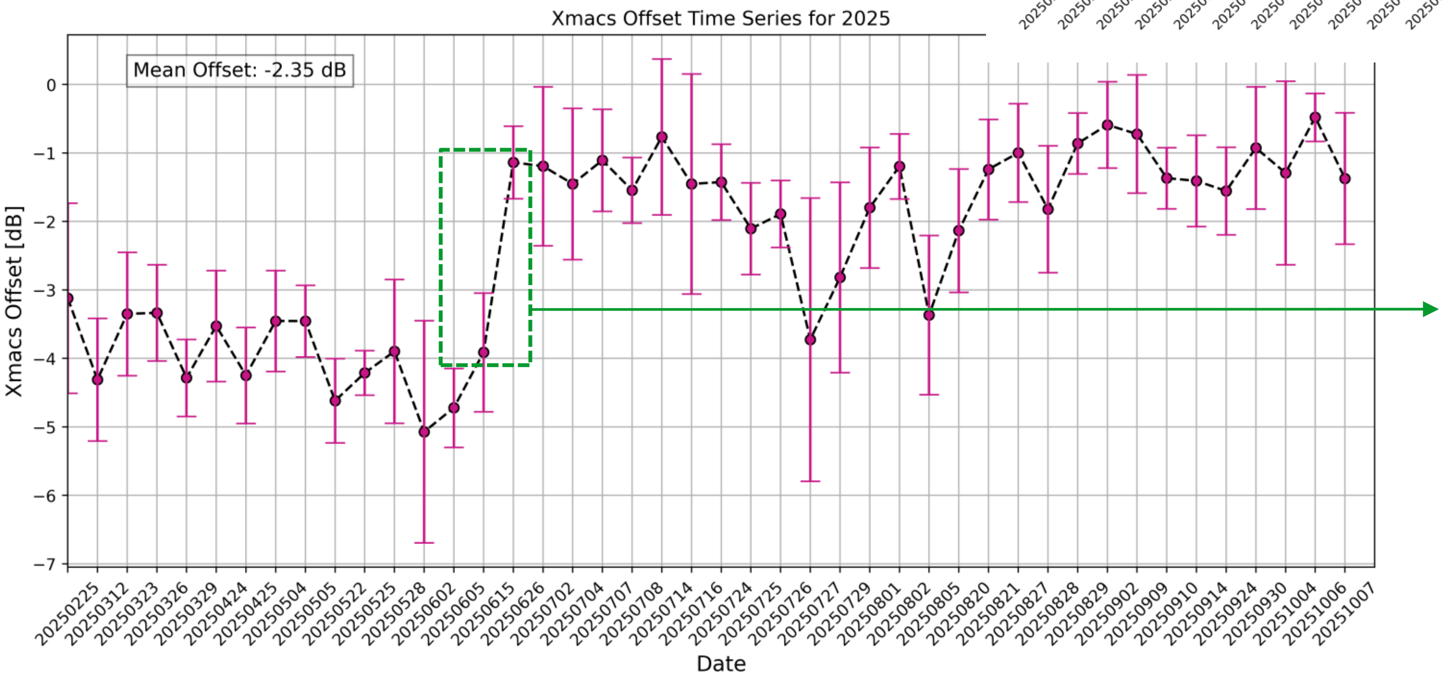
Wmacs Scatter Plot:



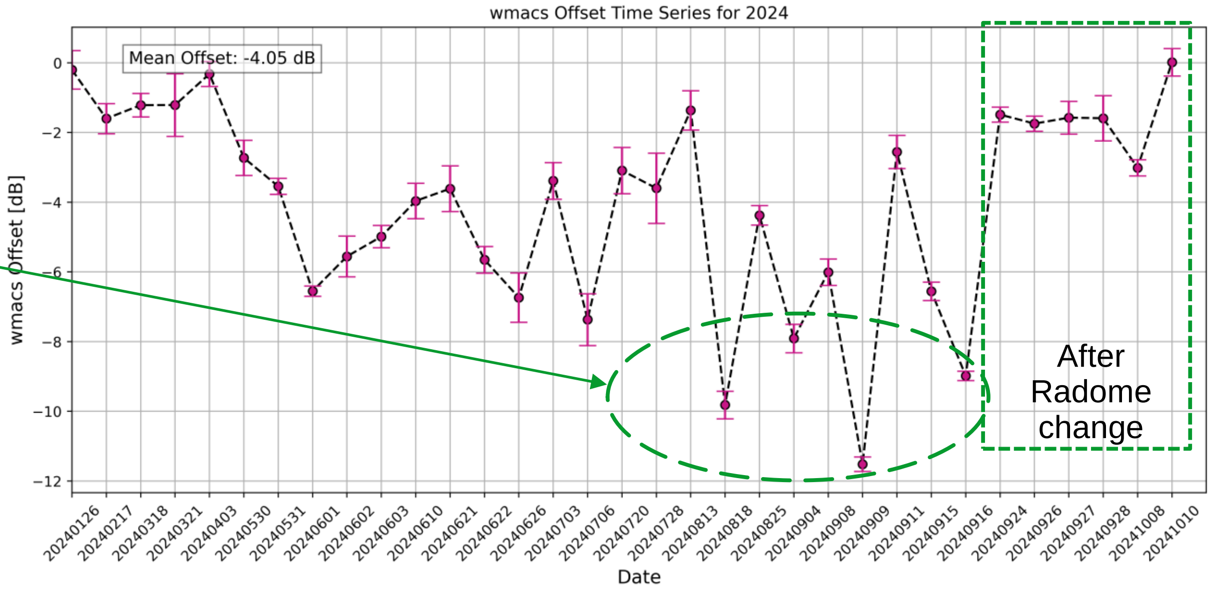
Continuous Calibration Monitoring

The daily offset values plotted for all the months of 2025

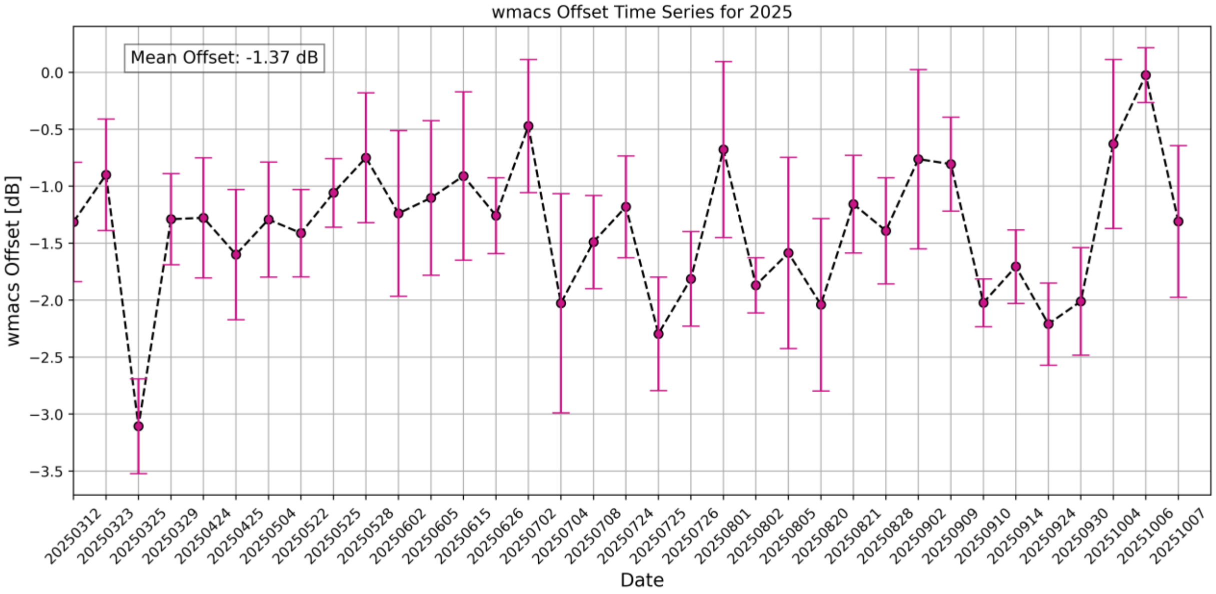




Xmacs calibration changed after switching off/on the transmitter. Reason under investigation!

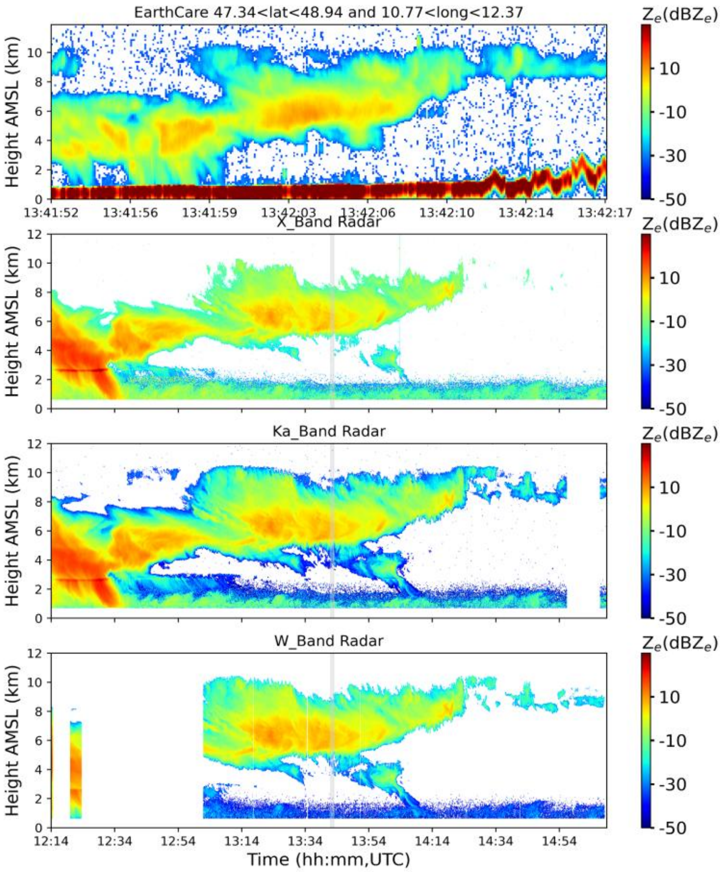


Indication of change of wmacs Radome :
Higher offset indicate bad radome condition!

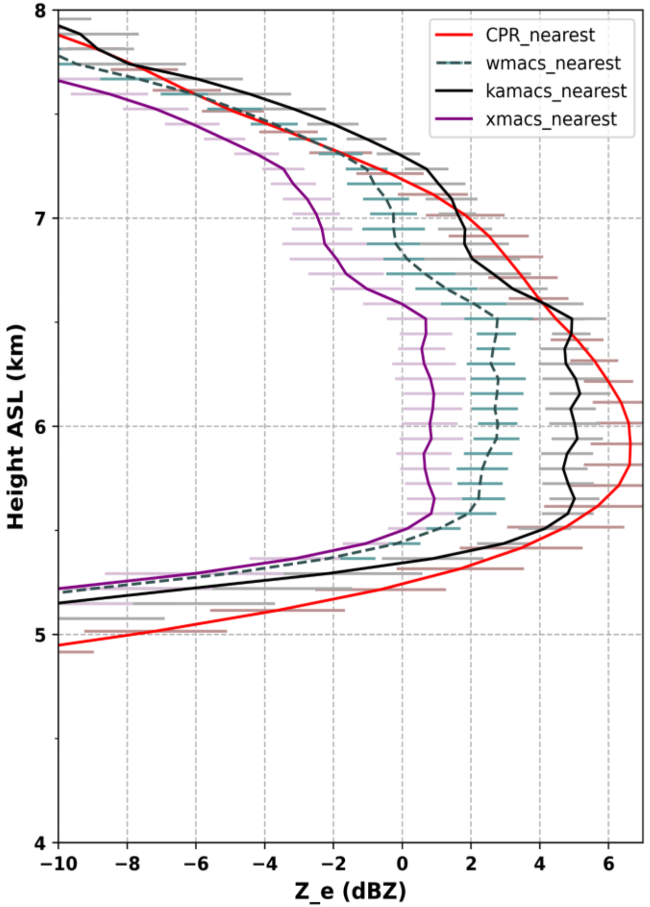


Detect <u>drifts or jumps</u> in the Radar calibration, which could be missed in the normal reflectivity time series plot.

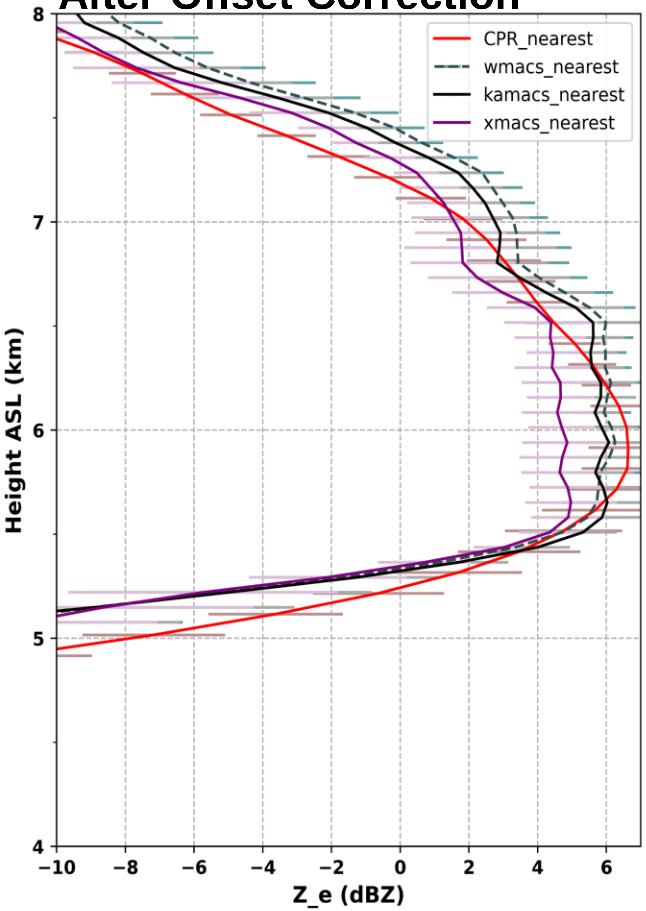
Comparison with EarthCare LV1, CB baseline reflectivity data : 05 April 2025



Before Offset Correction



After Offset Correction



Conclusions:

1. **One single code**: for all the 4 Radars (X, Ka, W, band and MRR) calibration monitoring.

2. The corrected Radar data or the offset value (NetCDF) would be uploaded to CloudNet site soon.

3. CCRES has their own routine for DCR calibration and monitoring (*https://ccres.aeris-data.fr/*). But there are certain important points which needs to be considered too.

   (i) Selecting the reliable lowest range bin is very important but also tricky.

   (ii) Selecting maximum Ze below which there is no saturation issue!

4. Using EarthCare to monitor ground-based radar calibration has limitations:

   (i) Few number of close overpasses with suitable clouds at most sites

   (ii) Different vertical resolution, larger footprint, radar blind zone.

5. The Disdrometer calibration needs to be checked (*Jonathan Rossmanith and Stefan Kneifel [MIM,LMU];* work under progress)

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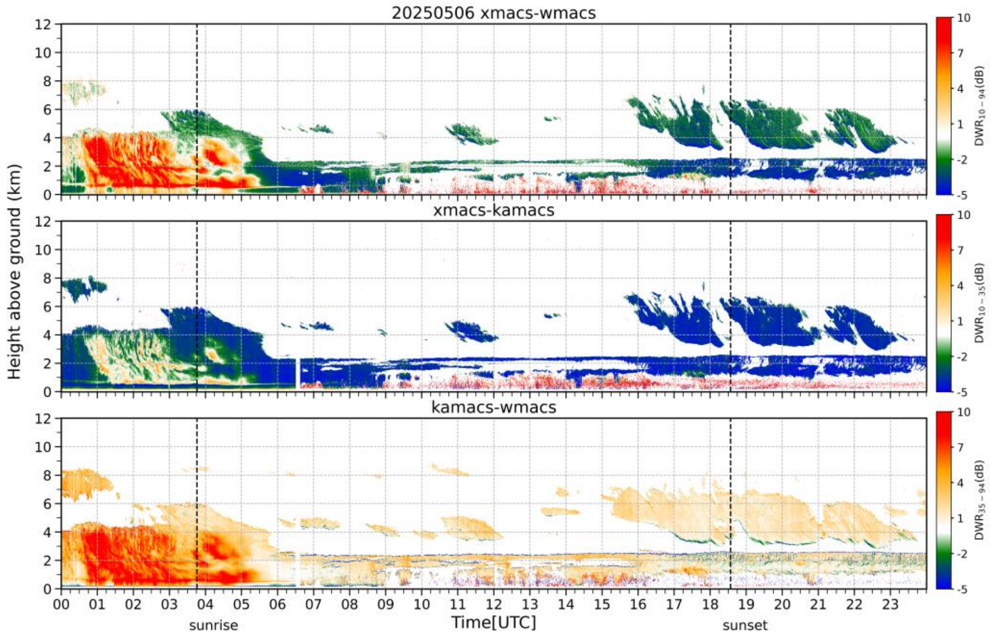
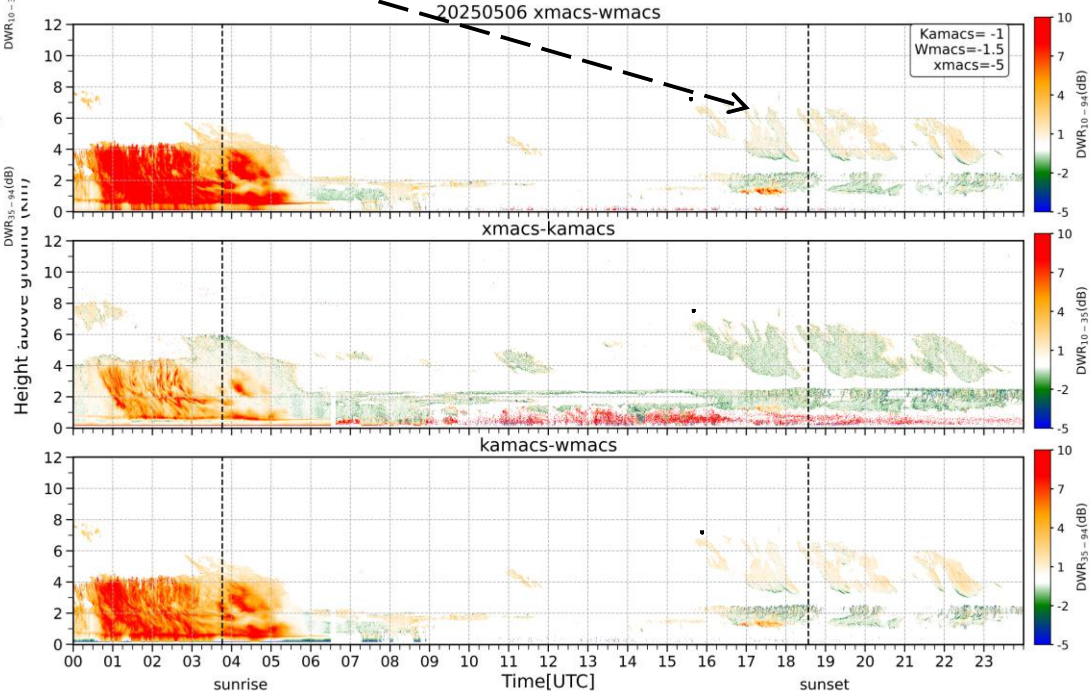
Thank you !

Before offset correction:

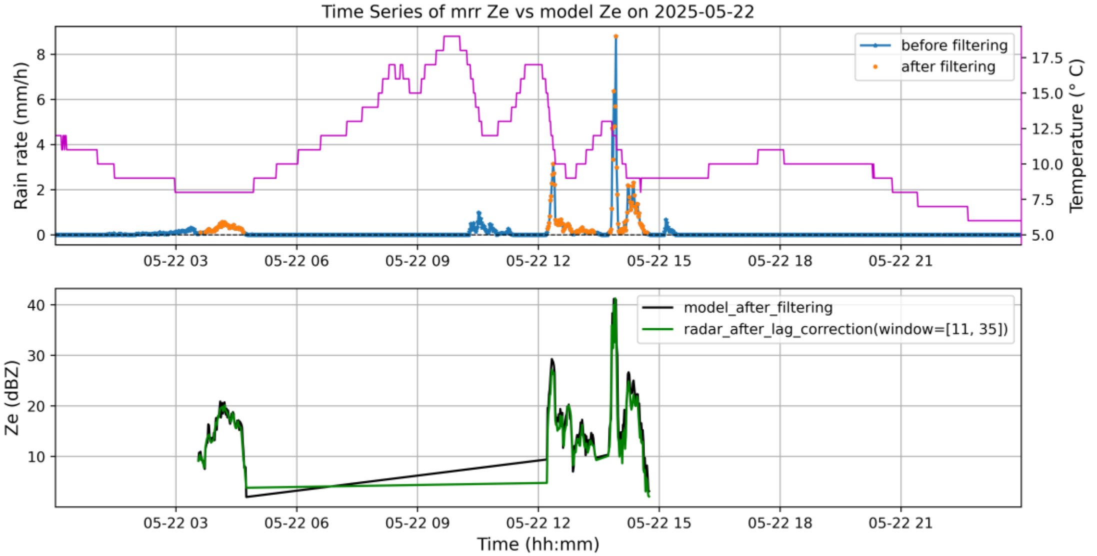


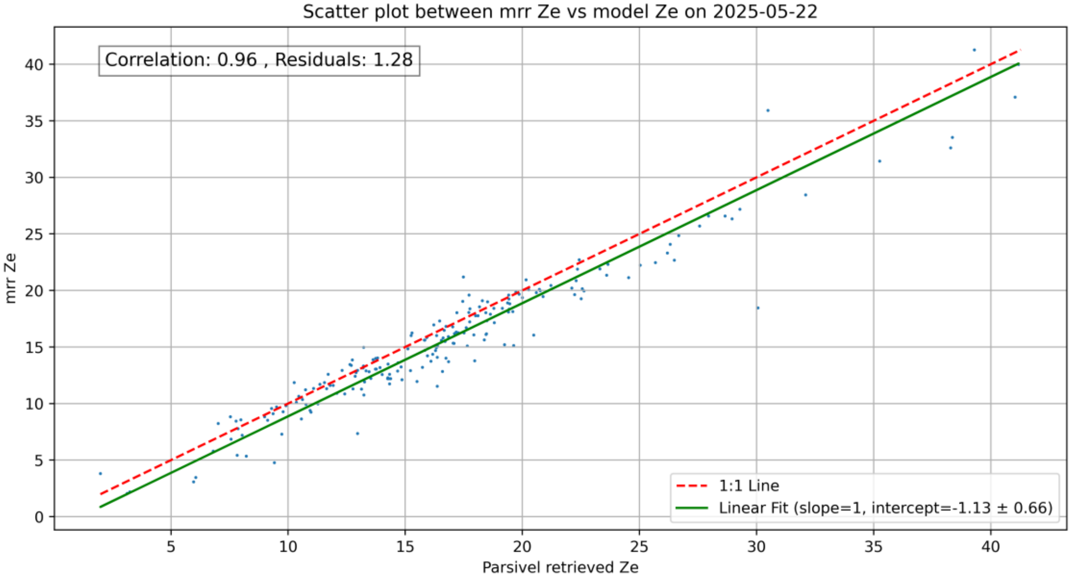
After offset correction:

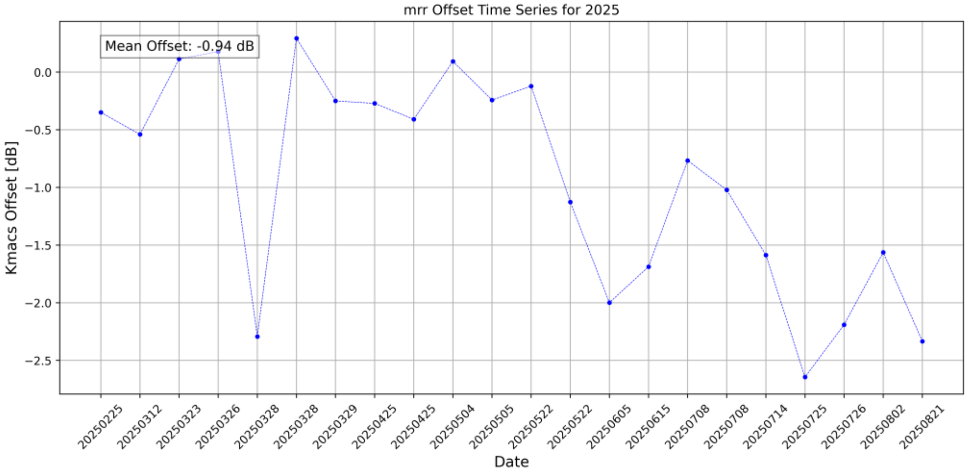
Huge improvement in the Rayleigh Region



Quicklooks for MRR calibration:
(similar methodology)

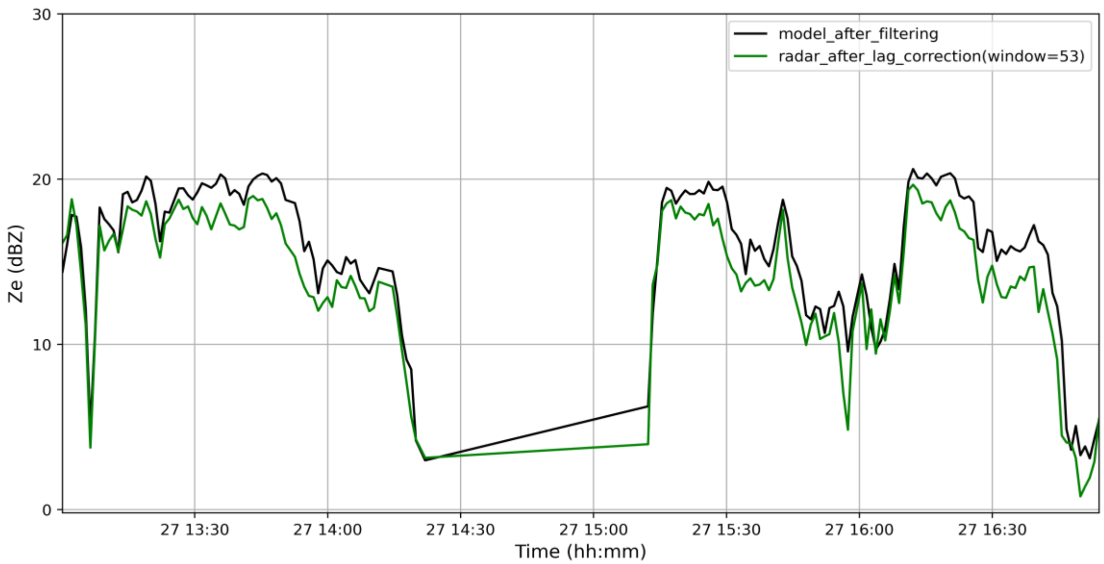


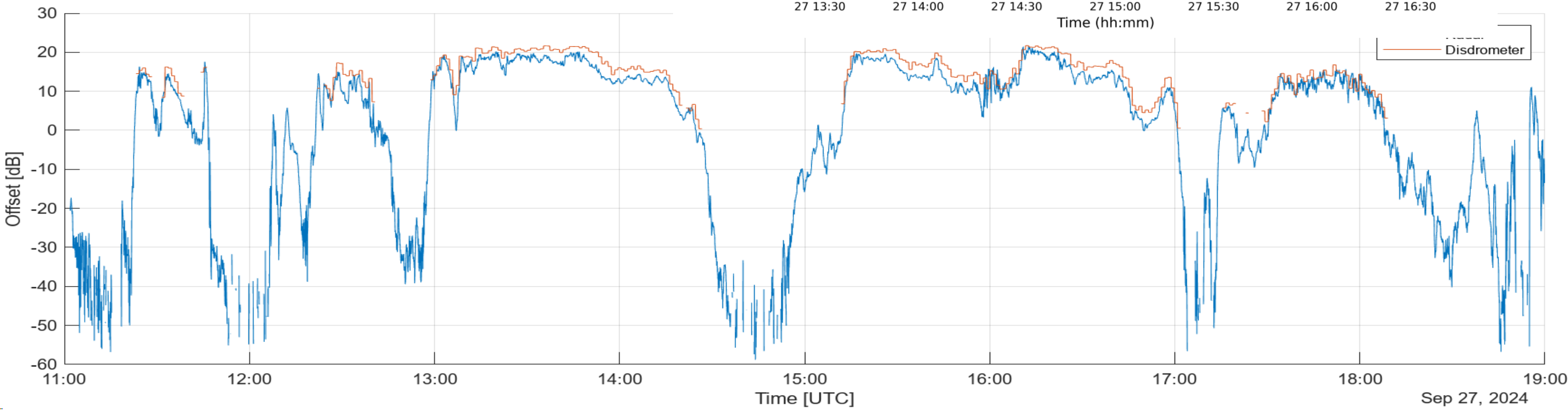


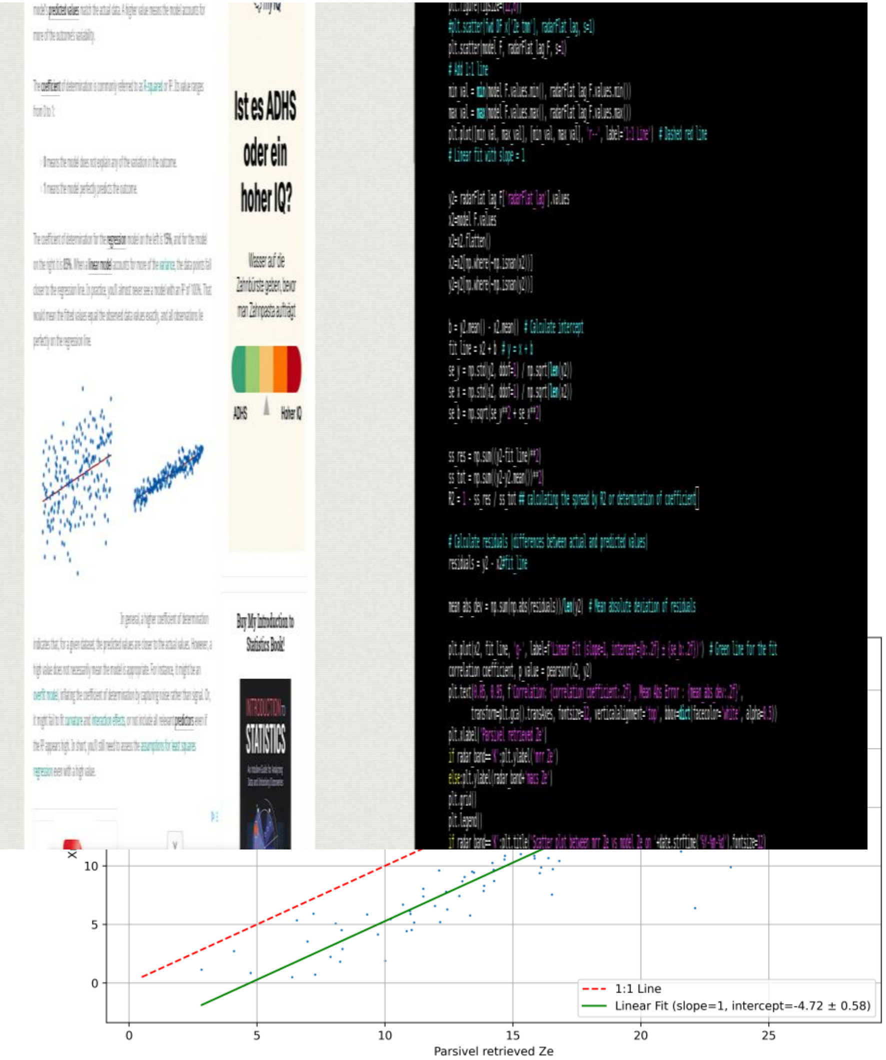


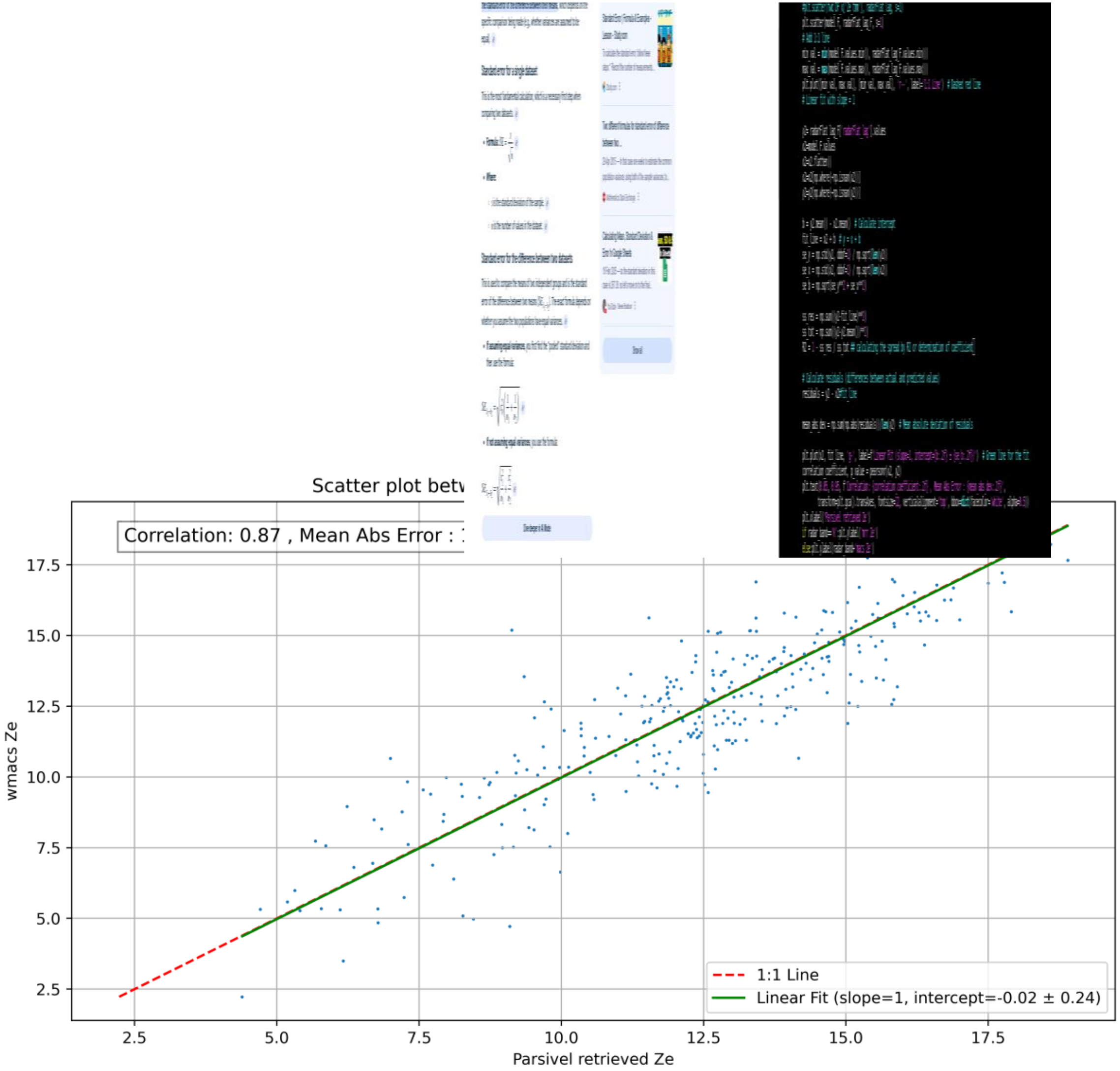
Comparison with RPG's calibration (one day):

RPG software don't do any radar data resampling to match Disdrometer time sampling or no rain filtering.






Ist es ADHS oder ein hoher IQ?
Wasser auf die Zahnbürste geben, bevor man Zahnpasta aufträgt
ADHS
Hoher IQ
Buy My Introduction to Statistics Book!
INTRODUCTION TO STATISTICS
plt.scatter(model_F, radarFlat_lag_F, s=1)
# Add 1:1 line
min_val = min(model_F.values.min(), radarFlat_lag_F.values.min())
max_val = max(model_F.values.max(), radarFlat_lag_F.values.max())
plt.plot([min_val, max_val], [min_val, max_val], 'r--', label='1:1 Line') # Dashed red line
# Linear fit with slope = 1
y2= radarFlat_lag_F['radarFlat_lag'].values
x2=model_F.values
x2=x2.flatten()
x2=x2[np.where(~np.isnan(x2))]
y2=y2[np.where(~np.isnan(y2))]
b = y2.mean() - x2.mean() # Calculate intercept
fit_line = x2 + b # y = x + b
se_y = np.std(y2, ddof=1) / np.sqrt(len(y2))
se_x = np.std(x2, ddof=1) / np.sqrt(len(x2))
se_b = np.sqrt(se_y**2 + se_x**2)
ss_res = np.sum((y2-fit_line)**2)
ss_tot = np.sum((y2-y2.mean())**2)
R2 = 1 - ss_res / ss_tot ## calculating the spread by R2 or determination of coefficient
# Calculate residuals (differences between actual and predicted values)
residuals = y2 - x2#fit_line
mean_abs_dev = np.sum(np.abs(residuals))/len(y2) # Mean absolute deviation of residuals
correlation_coefficient, p_value = pearsonr(x2, y2)
plt.xlabel('Parsivel retrieved Ze')
plt.grid()
plt.legend()
1:1 Line
Linear Fit (slope=1, intercept=-4.72 ± 0.58)
Parsivel retrieved Ze
0
5
10
15
20
25


Scatter plot betv
Correlation: 0.87 , Mean Abs Error :
wmacs Ze
Parsivel retrieved Ze
2.5
5.0
7.5
10.0
12.5
15.0
17.5
1:1 Line
Linear Fit (slope=1, intercept=-0.02 ± 0.24)