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Improving X-Band Weather Radar Moments by Minimizing Radome Influence through Adaptive FFT Filtering

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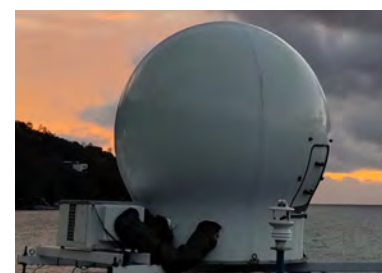
Introduction

In complex terrains, the cost-effective transportable X Band Radar is widely adopted for orography precipitation measurement.

Transport-friendly radome protecting the Radar have four joined panels connected by metal screws, are impacting radar measurement quality.

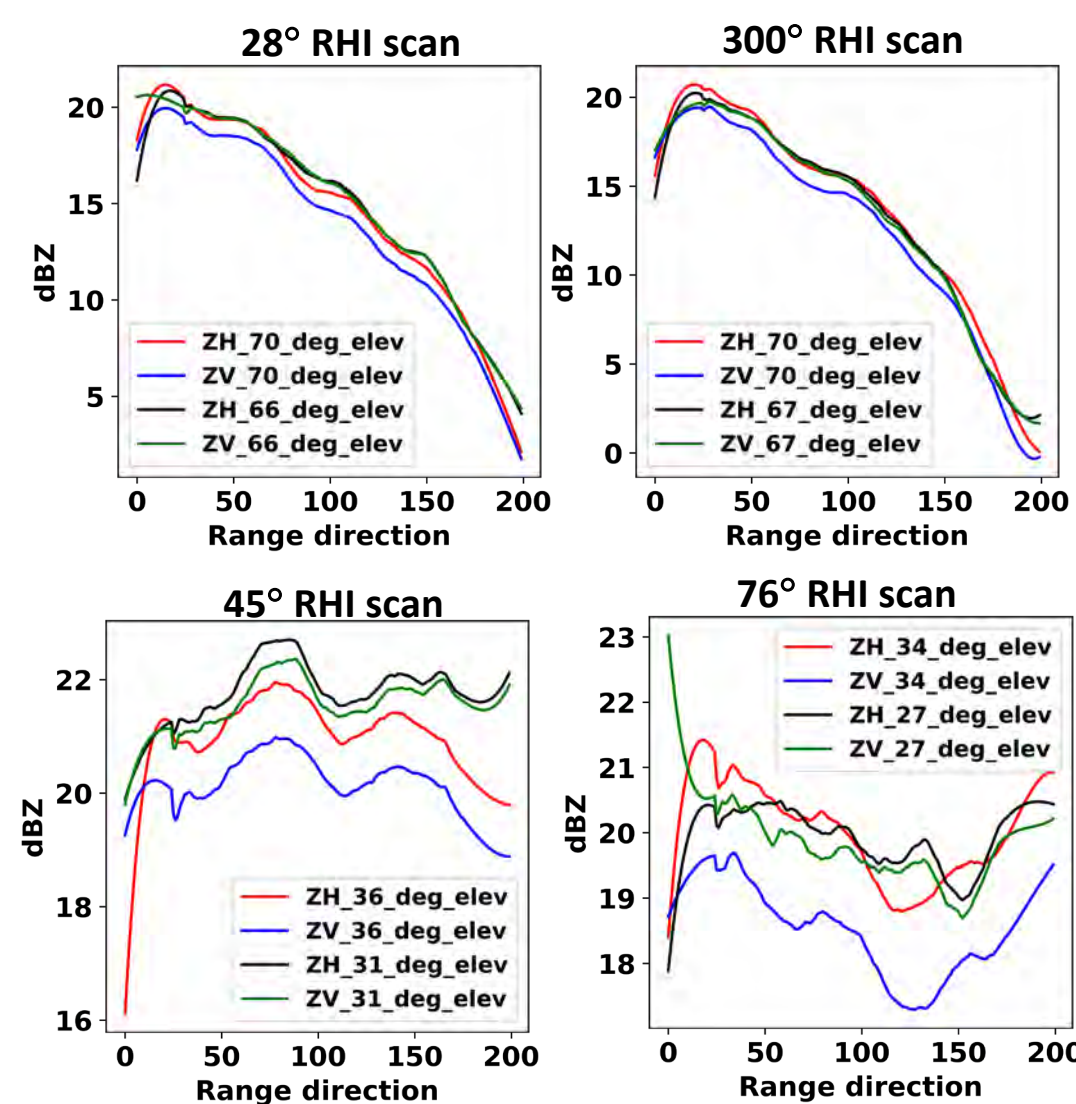
Purpose: To correct the radome induced bias in the measured polarimetric moments.

Objective: To develop a novel adaptive algorithm that effectively identifies and mitigates the spatial bias induced by the metallic joints of the radome.

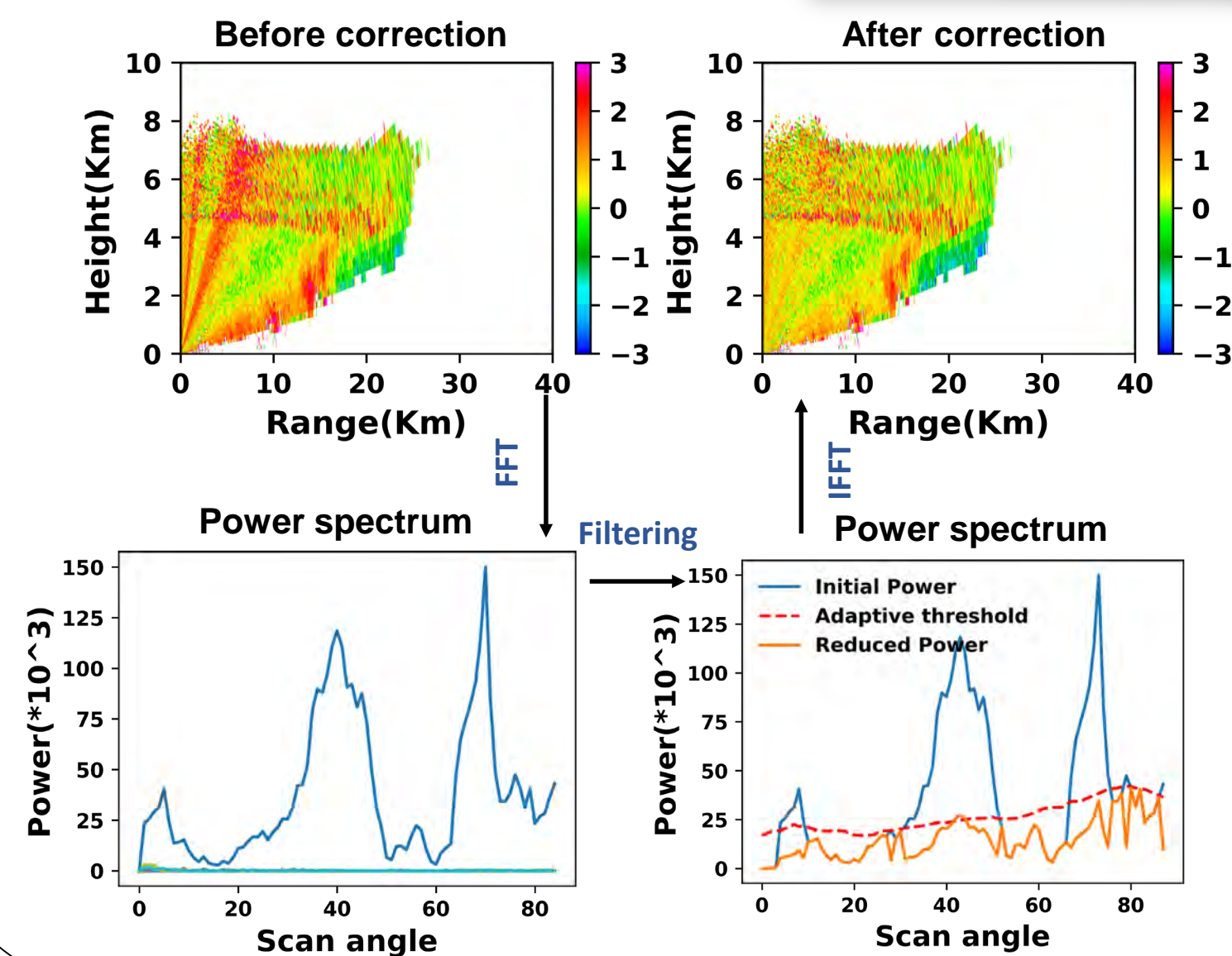


Source of Bias

- Biased elevation angle's vertical reflectivity (blue) has a negative offset compared to the unbiased elevation angle's vertical reflectivity (green).
- The primary source of ZDR spatial bias originates from the decrease in vertical polarization reflectivity.



Methodology



Adaptive FFT algorithm

FFT:
 $F = FFT(I) \dots\dots(1)$

Filtering:
$$F(1)' = \begin{cases} F(1) \times \frac{S}{N} & \text{if } P(1) > Median(P(1)) \\ F(1) & \text{otherwise} \end{cases} \dots\dots(2)$$

where,
 $S = Median(F(1)) | P(1) < Median(P(1))$
 $N = Median(F(1)) | P(1) > Median(P(1))$

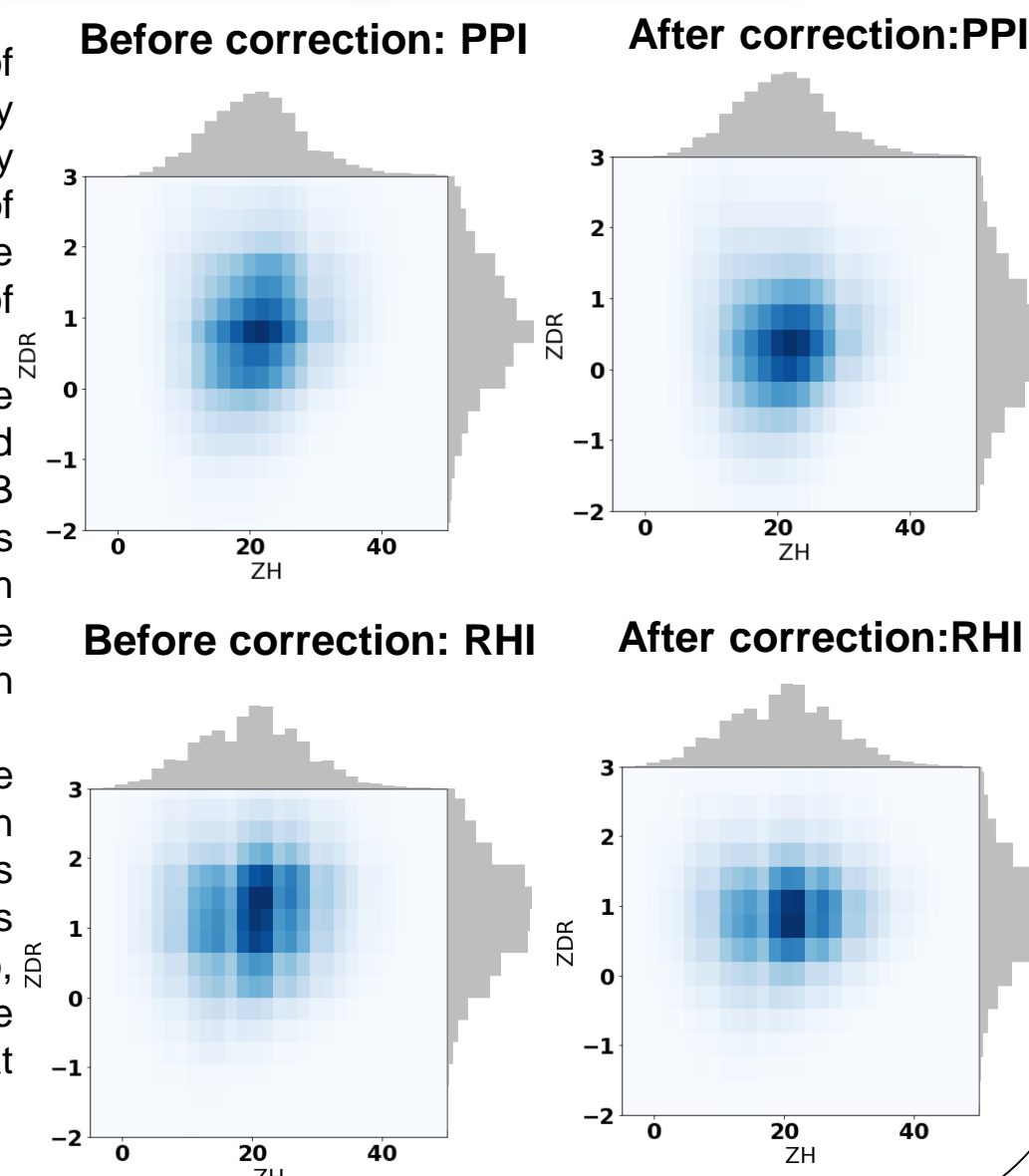
$$P(1) = \sqrt{Real(F(1))^2 + Img(F(1))^2}^2$$

IFFT:
 $I' = IFFT(F') \dots\dots(3)$

* Single radar scan (I), Fourier transform values (F), First frequency (F(1)) First frequency power (P(1)), Power values below the threshold (S), Power values above the threshold (N), Inverse Fourier transform values (I')

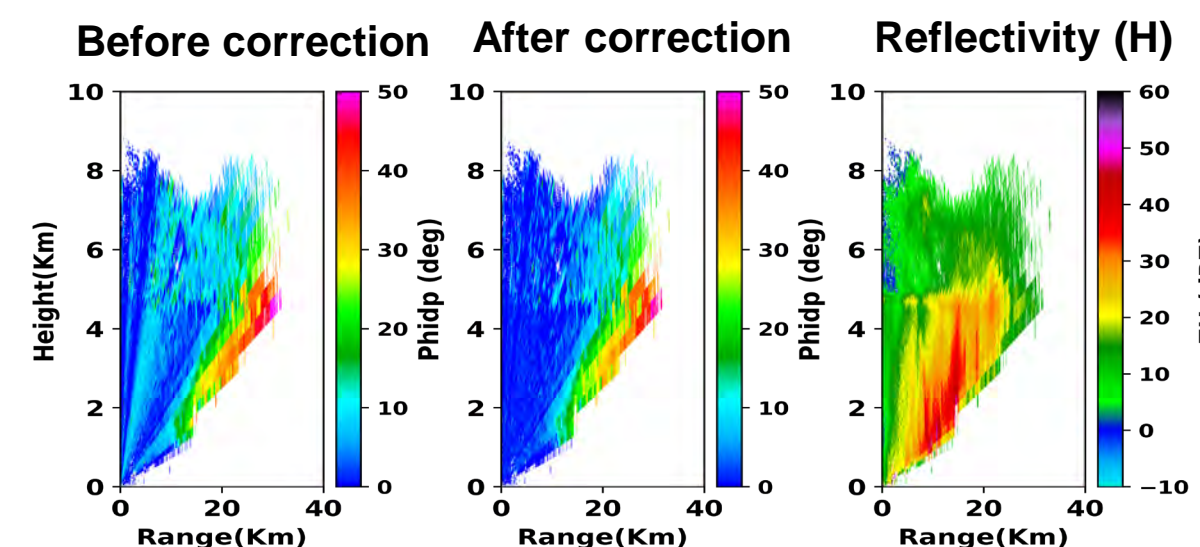
Joint Histogram Analysis

- For lower values of horizontal reflectivity (<30 dBZ), we generally expect a ZDR value of nearly zero dB due to the near spherical shape of small drops.
- Before correction, the ZDR distributions extend significantly beyond 2dB for reflectivity values below 30 dBZ. Such increases arise from the spatial positive bias in ZDR.
- Following the correction, the mean ZDR distributions exhibits a shift towards values closer to zero, approaching the theoretical values at lower reflectivity.



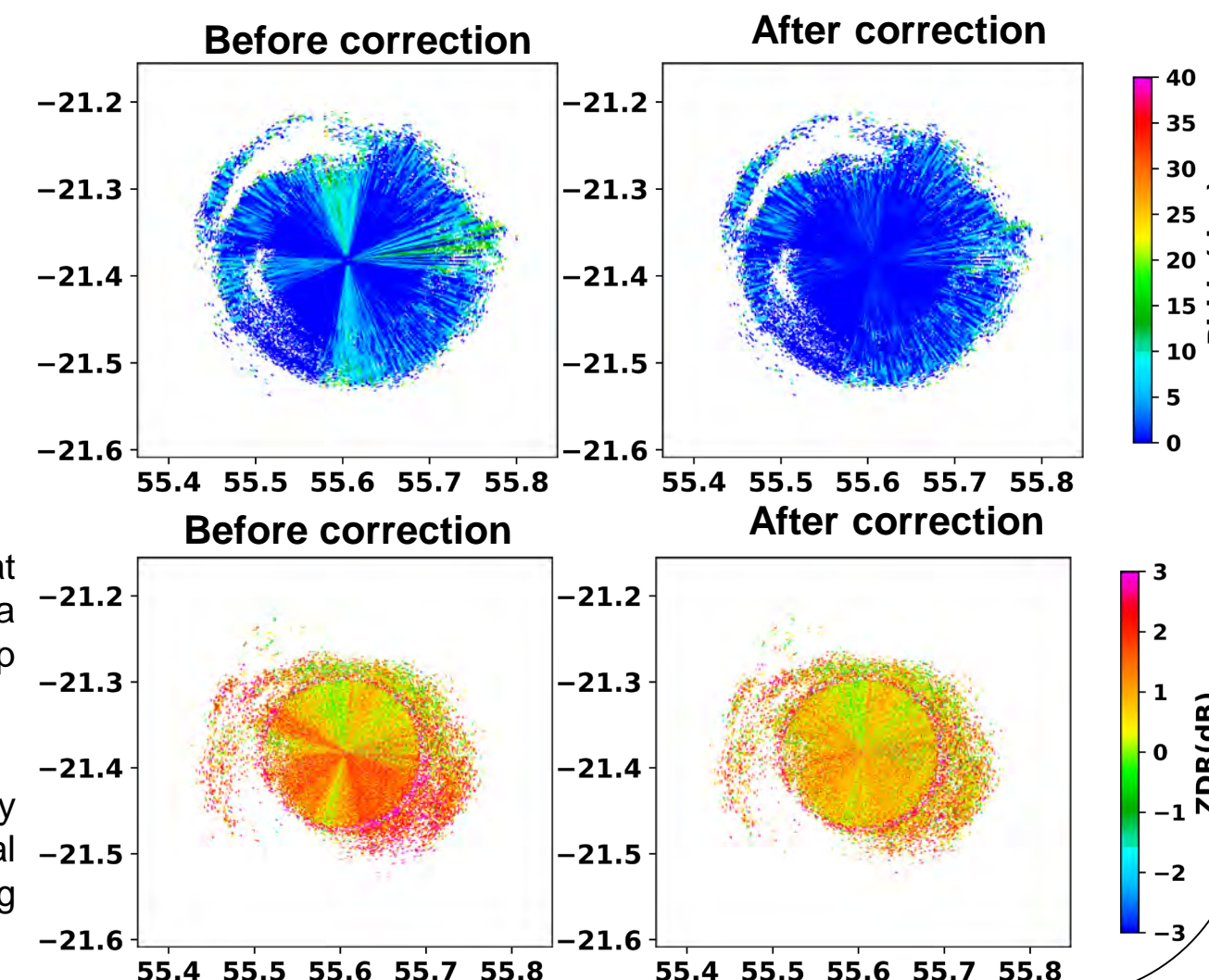
Assesment of Algorithm efficiency

28° RHI of PHIDP and ZH: 3 Feb 2022_01:28 UTC



- Figures show the presence of increased spatial variability of ZDR and Phidp at certain azimuth and elevation angles of RHI and PPI scans, respectively, with a maximum variability of around 1.5-2 dB, 8-10 degrees for ZDR and Phidp respectively .
- The application of the algorithm led to a substantial reduction in variability indicating the effectiveness of the algorithm in mitigating the issue of spatial variability in both ZDR and PHIDP values across all elevation angles and scanning strategies.

29° PPI of PHIDP,ZDR : 3 Feb 2022_1:50 UTC



Summary

- We observe that joints connecting the radome panels cause power loss at certain angles resulting in a bias in ZDR and PHIDP values.
- To correct for this bias, we have developed a novel algorithm based on Fast Fourier Transform.
- Unlike previous methods that applied a single correction value across all elevation scans or azimuths, our algorithm adjusts for biases at each specific azimuth and elevation angle, ensuring a more precise correction.

Acknowledgment

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