Intercomparison of Ground-based RaXPol Mobile Radar and WSR-88D Operational Radar with the GPM Spaceborne Radar during Hurricane Ian

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1. Introduction

- The Rapid scan X-band Polarimetric (RaXPol) mobile radar offers unique scan flexibility with vast advantages compared to operational S-band WSR-88D radars but have yet to be validated for consistency.
- The Global Precipitation Measurement (GPM) satellite onboard Dual-frequency Precipitation Radar (DPR) can be used as a stable platform for on-field calibrations.

Goals

- Evaluate consistency in bright band height retrievals from each radar system.
- Quantitatively analyze differences between ground radar systems against DPR through numerical cross-validation. Results from comparison to DPR will be interpolated to find differences between ground radars.
- Demonstrate GPM/DPR feasibility as a platform for ground radar calibration.

2. Data & Methods

- RaXPol: 0.001° x 0.001° / 30 km range.
  - 8 Az-154° / 8 Az- 64° scans
- WSR-88D: 0.01° x 0.01° / 230 km range.
- GPM/DPR: 0.045° x 0.045° / 245 km swath
  - KuPR (13.6 GHz) / KaPR (35.5 GHz)

Matching

- RaXPol is matched with DPR through intersecting RHI scans along angle bins from DPR overpass.
- KTBW is matched with DPR through volume-matching with radar beam intersections.

Cross-validation

- Visual Comparison of the bright band height between radars using reflectivity (dBz) and cross-correlation coefficient (RHOHV) and the Dual-Frequency Ratio (DFR) for DPR.
- Differences in reflectivity (dB) across radar systems are compared using **correlation coefficient (CC), bias, and RMSE** evaluated through linear regression line and distribution.
- Interpolated results between WSR-88D and RaXPol using DPR.

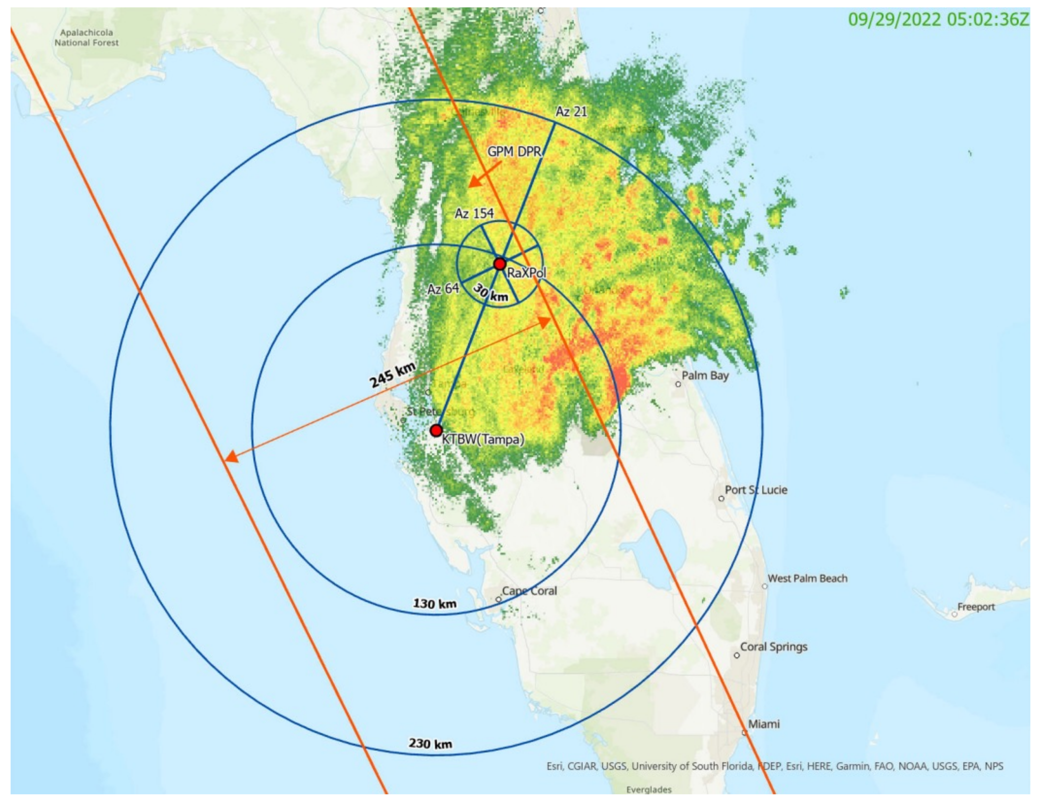

Fig. 2.1 locations of ground-based radars and the GPM/DPR overpass and their radar ranges relative to each other. RaXPol azimuths depict the position of the vertical scans relative to the overpass and range of KTBW and GPM/DPR

Fig. 2.2 RaXPol observing Florida sea breeze thunderstorm activity as part of the collaborative campaign between the University of Florida and Oklahoma University in September 2022

3. GPM/DPR Reflectivity/Bright Band Height Comparison to RaXPol

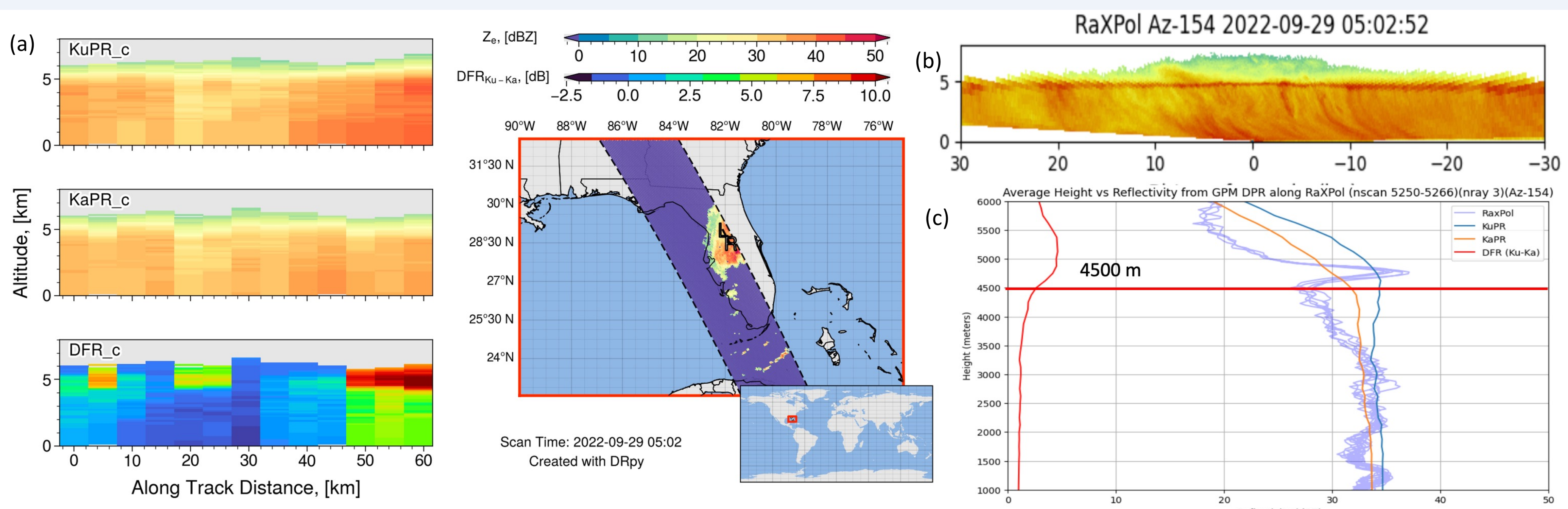

Fig. 3.1 (a) DPR along path reflectivity and brightband heights compared to (b) RaXPol RHI scan mode at azimuth 154° matched based on GPM overpass at nray 4 and nscan ranges 5250-5265 (0-60 km). (c) RaXPol height over reflectivity plotted throughout the entire scan volume compared to averaged DPR reflectivity's matched over RaXPol RHI

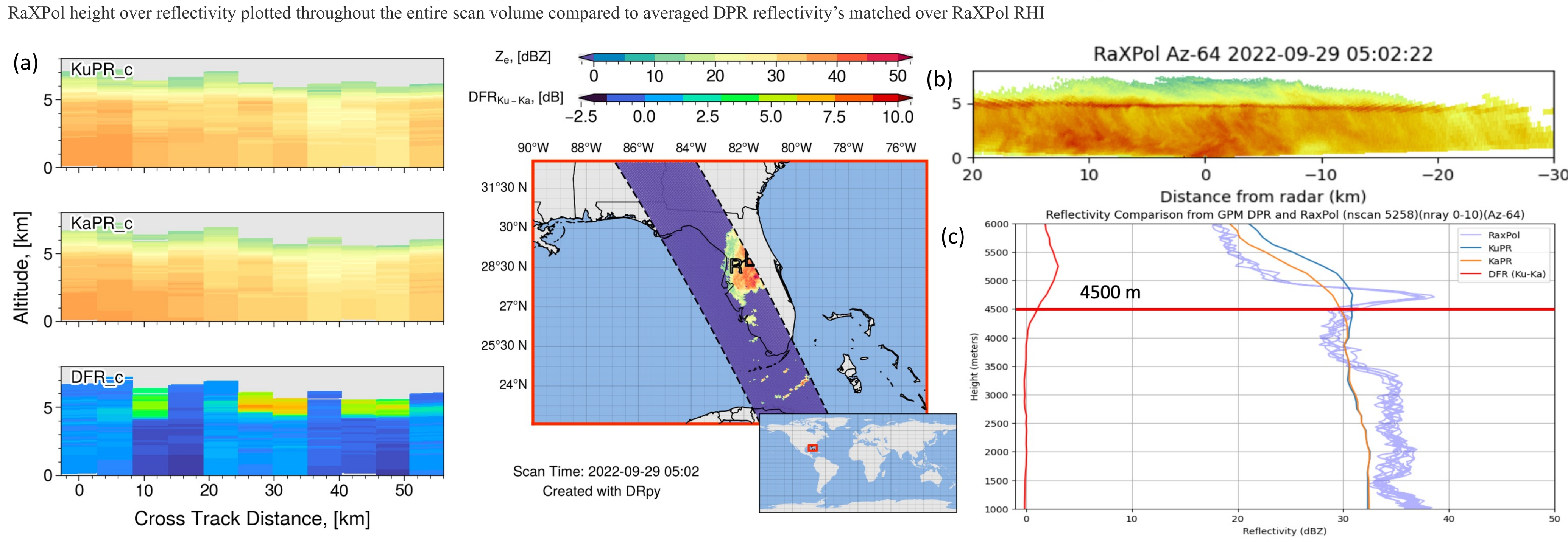

Fig. 3.2 (a) DPR cross path reflectivity and brightband heights compared to (b) RaXPol RHI scan mode at azimuth 64° matched based on GPM overpass at nray ranges 1-9 (0-50 km) and nscan 5258. (c) RaXPol height over reflectivity plotted throughout the entire scan volume compared to averaged DPR reflectivity's matched over RaXPol RHI

- RaXPol RHI consistently identified a bright band height of ~4500 meters through reflectivity with high peaks. DPR also identified similar bright band heights using Dual-Frequency Ratio (DFR) with lower peaking values for grids along the scan path.
- RaXPol is able to discern the precipitation structure of the hurricane to a much higher degree compared DPR. Az- 154° had reflectivity values more in line with DPR along track while Az- 64° had reflectivity values higher than DPR cross track.

4. GPM/DPR Volume-matched Reflectivity Data Comparison to WSR-88D (KTBW)

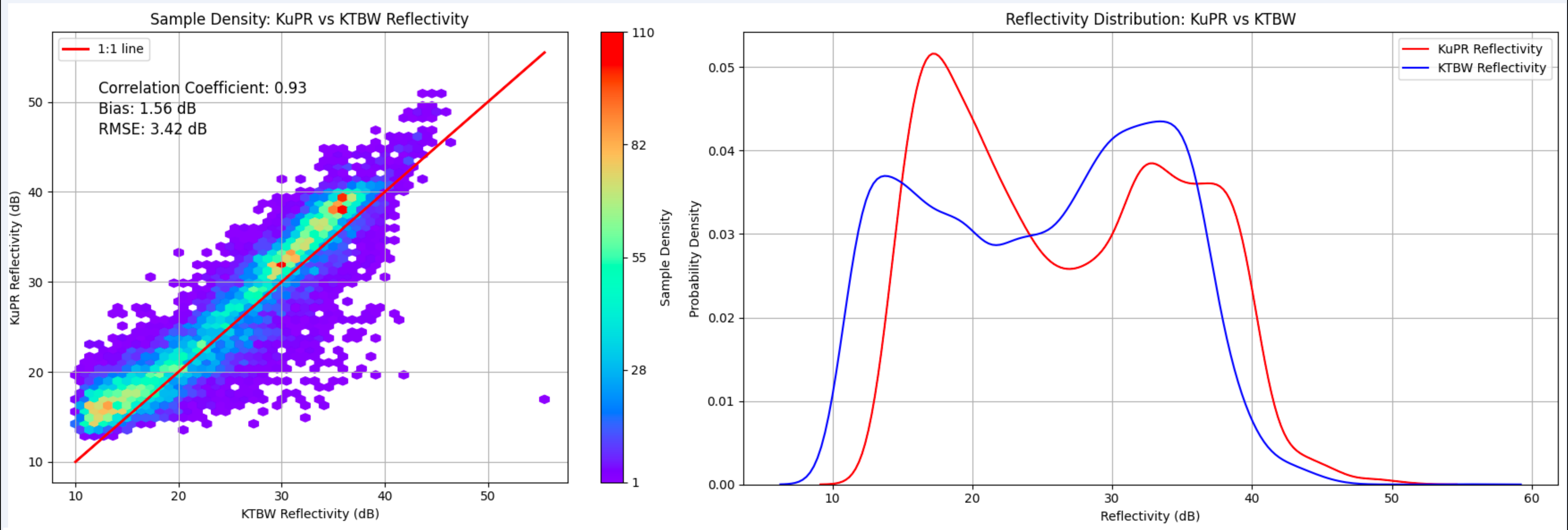

Fig. 4.1 (left) KuPR reflectivity sample density scatter plot compared to KTBW radar represented by the linear line along with (right) reflectivity density distributions after volume match and attenuation correction. CC and bias values indicate close agreement between radars falling around 1.5 dB

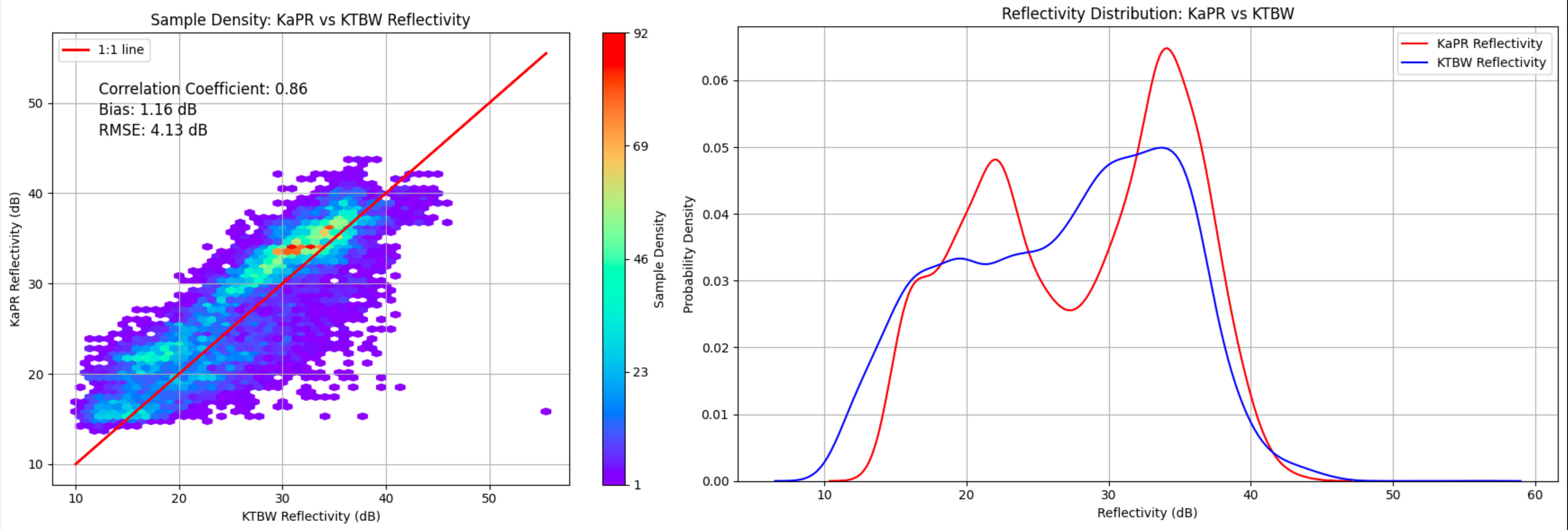

Fig. 4.2 (left) KaPR reflectivity sample density scatter plot compared to KTBW radar represented by the linear line along with (right) reflectivity density distributions post volume match and attenuation correction. CC are and bias values are weaker compared to KuPR but fall in line under 1.5 dB

- Values yield similar results to other studies comparing DPR to the NEXRAD network with CC values close to the mean and bias under 1.5 dB
- Distributions resemble more convective precipitation with a storm structure more similar to stratiform precipitation scenarios.
- Both KuPR and KaPR exhibited underestimations in the middle reflectivity values. KuPR had higher densities on the lower while KaPR had higher densities on both lower and higher end of reflectivity.

5. Future Work

- Perform numerical cross-validation between RaXPol scans to DPR to examine retrieval closeness. Retrievals from RaXPol will be averaged in resolution grids matching DPR of 5000 m horizontally and 125 m vertically.
- Interpolate results between RaXPol and WSR-88D by examining cross-validation results gather from DPR. Differences gathered from comparison could be translated to ground radars given stability of DPR.
- Interpolation results will determine the viability of DPR as a platform to perform calibrate ground radars outside the NEXRAD network as a proof-of-concept. Further research can be done on this topic.

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