

Validation of EarthCARE cloud and precipitation products by the Open-Air Laboratory (WEGN4CARE)

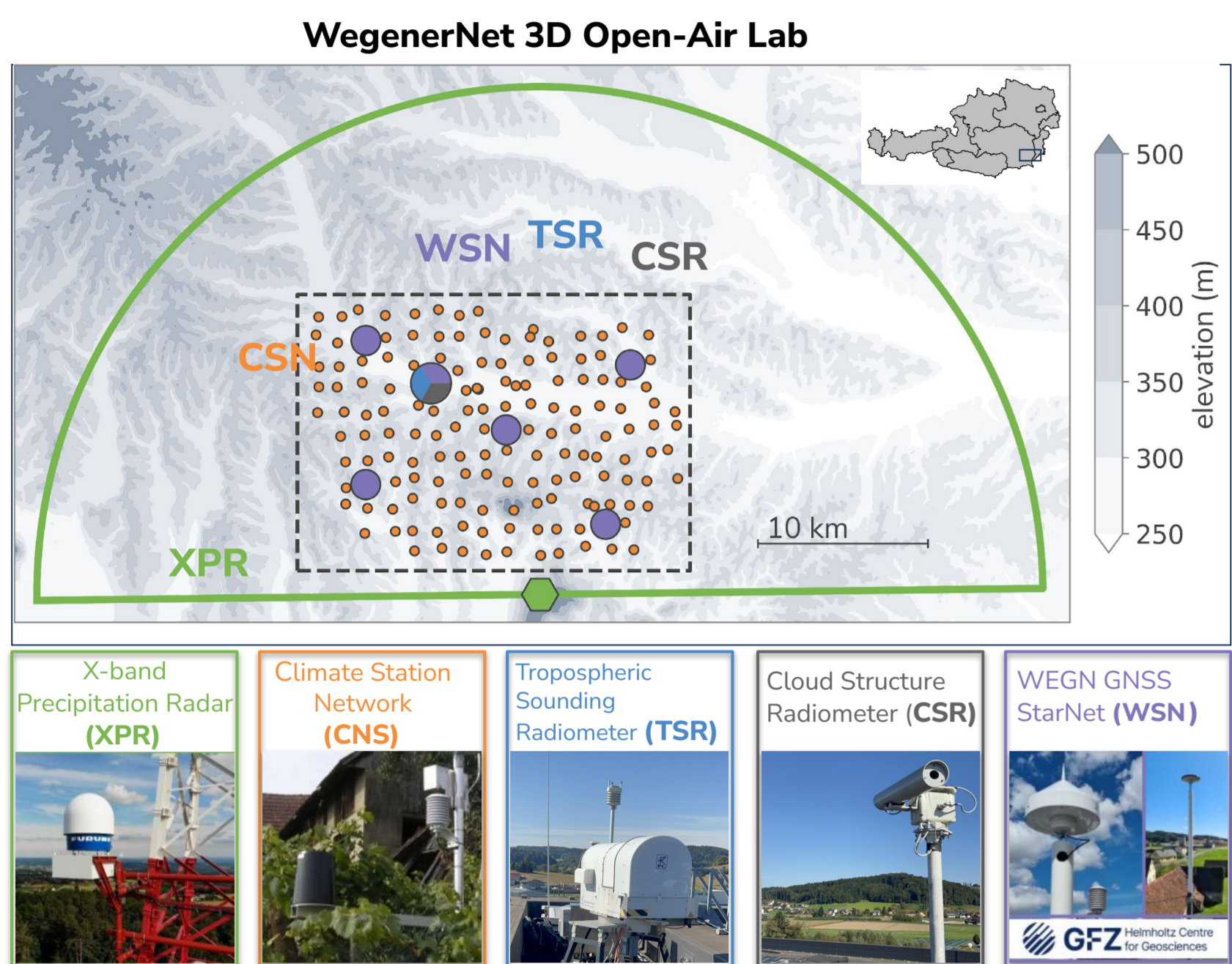
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1. Study area and the ground instruments



Products for this poster:

WEGN Product	Parameter
Level 1 X-band radar (XPR)	reflectivity
Level 2 X-band radar (XPR)	precip_amount
Level 2 Timeseries (TSR)	LWP_zenith

EC Product	Baselines (n_overpass)
ACM_CAP	BA (77), BC (40)
CPR_FMR_2A	AC (11), BA (77), BC (40)
CPR_CLD_2A	AB (13), BA (66), BB (11), BC (40)
CPR_TC_2A	AC (11), BA (77), BC (40)

2. Overpass detection summary

Considering **100 km** radius around the site, we had **118** overpasses for the period of **2024-12-01 to 2026-05-10**

In **64** overpasses where both datasets detected clouds (when the WEGN shows LWP more than 10 g m^{-2} and EC_CPR_FMR shows hydrometeor classes in significant_detection_classification.)

In **19** overpasses where both datasets reported precipitation

comparison	H	M	F	CN	NA	POD	FAR	CSI	HSS	total
CPR_FMR vs WEGN timeseries cloud detection	64	1	25	4	24	0.985	0.281	0.711	0.159	94
ACM_CAP vs WEGN radar precip. detection	19	6	25	18	50	0.760	0.568	0.380	0.154	68

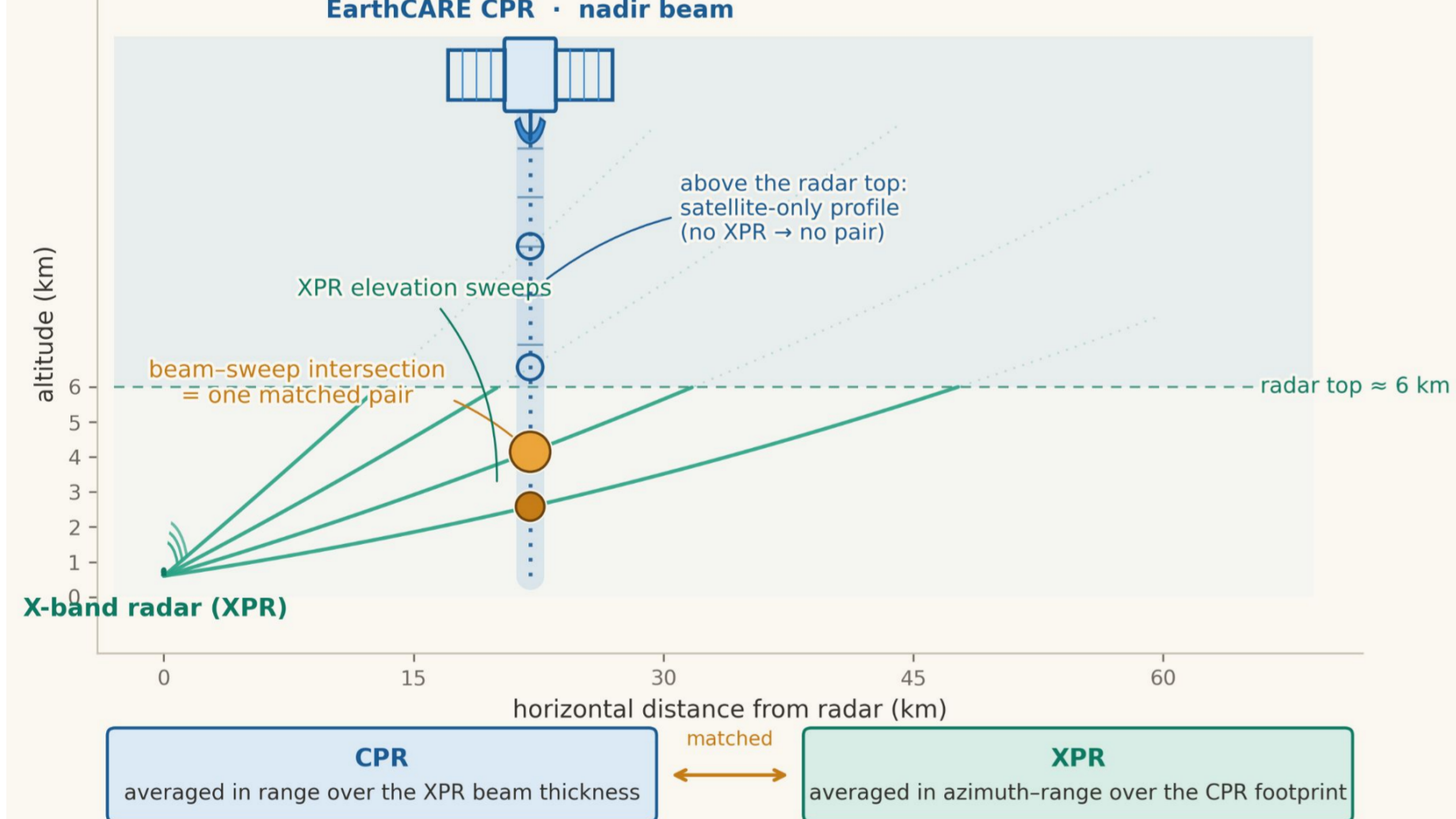
H: hits, M: misses, F: false alarms, CN: correct negatives, NA: not analyzed

POD	Probability of Detection	$H / (H + M)$
FAR	False Alarm Ratio	$F / (H + F)$
CSI	Critical Success Index	$H / (H + M + F)$
HSS	Heidke Skill Score	$2(H \cdot CN - M \cdot F) / [(H+M)(M+CN) + (H+F)(F+CN)]$

3. Volume matching method and Skill scores for matched pixels

Volume matching at one overpass

A single nadir CPR column meets each XPR sweep — one matched pair per crossing

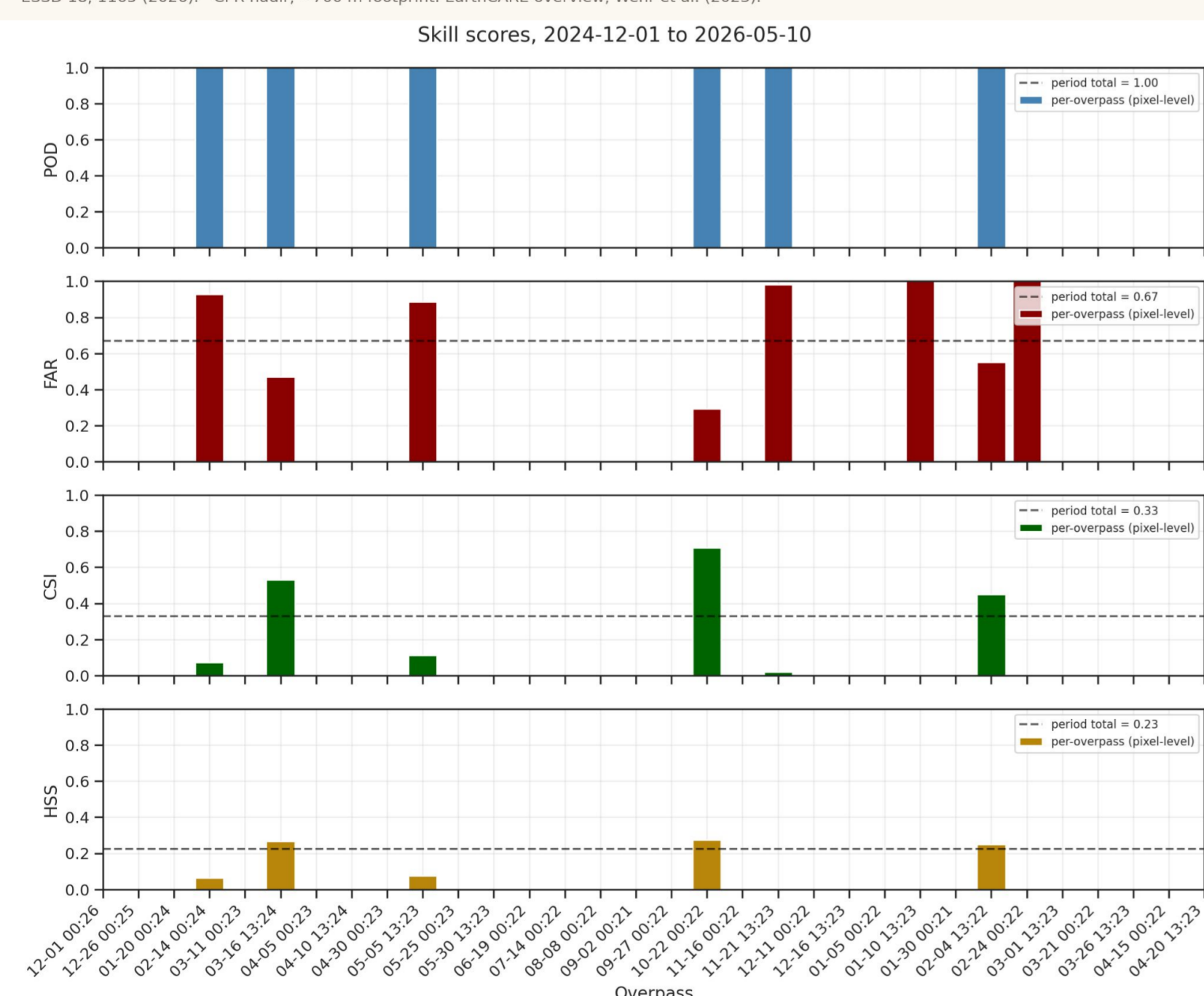


Volume matching is adopted from Schwaller & Morris (2011)

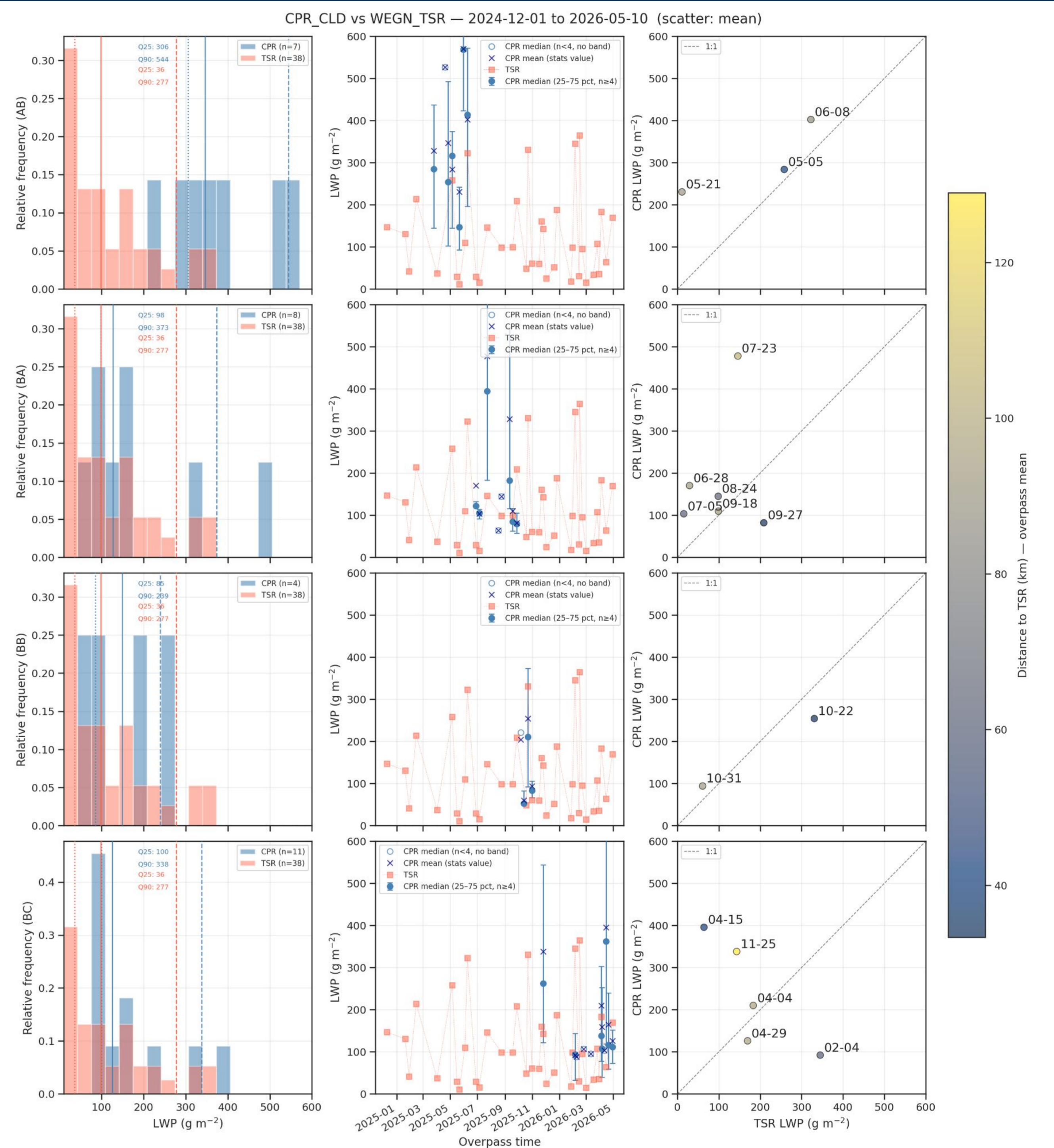
- Identify the geometric intersection of each satellite (CPR) ray with each radar (XPR) elevation sweep surface within the GR domain.
- Average the CPR in range over the vertical thickness of the XPR beam
- Average the XPR reflectivity in the range-azimuth plane over the CPR footprint circle
- Values exist only where both instruments observe. Above the XPR top, the XPR contributes nothing.
- For WegenerNet, the effective domain is the XPR's own coverage (~30 km).
- Output structure: for one overpass, the result is a 2-D array of matched (CPR, XPR) reflectivity pairs with dimensions roughly (along-track footprints, sweeps)

Volume-Level reflectivity agreement

- Matches volumes for CPR_FMR and WEGN XPR (Level 1)
- Considers reflectivity_corrected for CPR_FMR and corrected horizontal reflectivity for WEGN XPR
- Minimum thresholds -15 dB and 0 dB for CPR_FMR and XPR, respectively
- Removes the 5 lowest bins of CPR_FMR



4. Liquid Water Path in CPR_CLD baselines



* dotted, solid, and dashed vertical lines in Histograms represent Q25, median, and Q90, respectively.

Summary

- CPR_FMR cloud detection is in good agreement with WEGN_XPR
- ACM_CAP rain detection shows fair results, yet the false alarm ratio is high
- Volume matching method was used to match CPR_FMR and WEGN_XPR Level 1, the false alarm ratio is high, likely due to resolution-volume mismatch between CPR and XPR. However, sensitivity differences cannot be ruled out.
- Recent baselines show better agreement, though more data with same overpasses processed under each baseline are needed to compare baselines
- When comparing all pixels, the bias shows overestimation at lower LWP (up to $\sim 200 \text{ g m}^{-2}$) and underestimation at higher values. CPR and TSR agree best between 200 and 500 g m^{-2}
- In general, CPR and TSR have a better agreement when LWP is 200 to 500 g m^{-2}

Challenges / Next steps

- Retrieve LWC profiles by combining XPR with the TSR column LWP as a constraint, and CSR cloud base
- Characterize solid hydrometeors using XPR dual-pol parameters

References:

Schwaller, M. R., & Morris, K. R. (2011). A ground validation network for the global precipitation measurement mission. *Journal of Atmospheric and Oceanic Technology*, 28(3), 301-319.

Warren, R. A., Protat, A., Siems, S. T., Ramsay, H. A., Louf, V., Manton, M. J., & Kane, T. A. (2018). Calibrating ground-based radars against TRMM and GPM. *Journal of Atmospheric and Oceanic Technology*, 35(2), 323-346.

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