

Hydrometeor partitioning ratios for polarimetric ground-based and dual-frequency space-borne radar observations

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SPP 2115



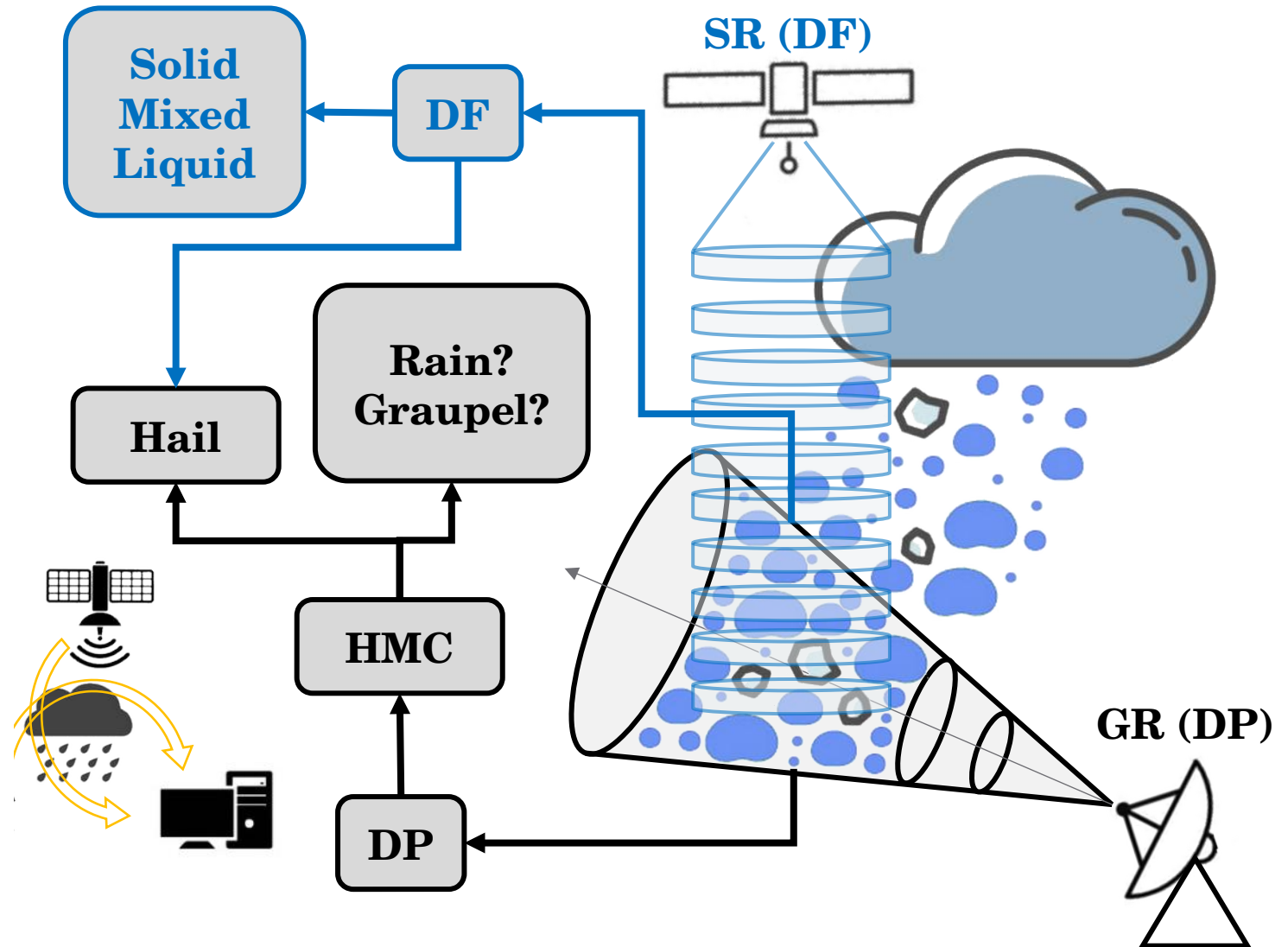
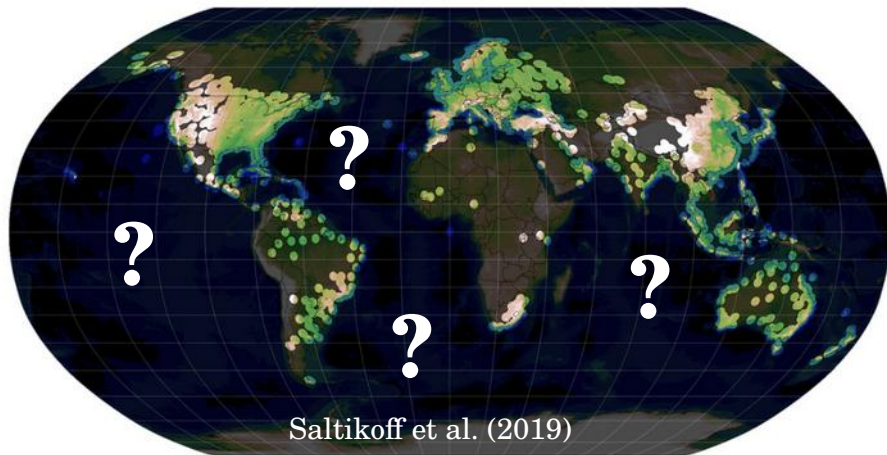
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METEOROLOGIE



PrePEP

Objectives/Motivation

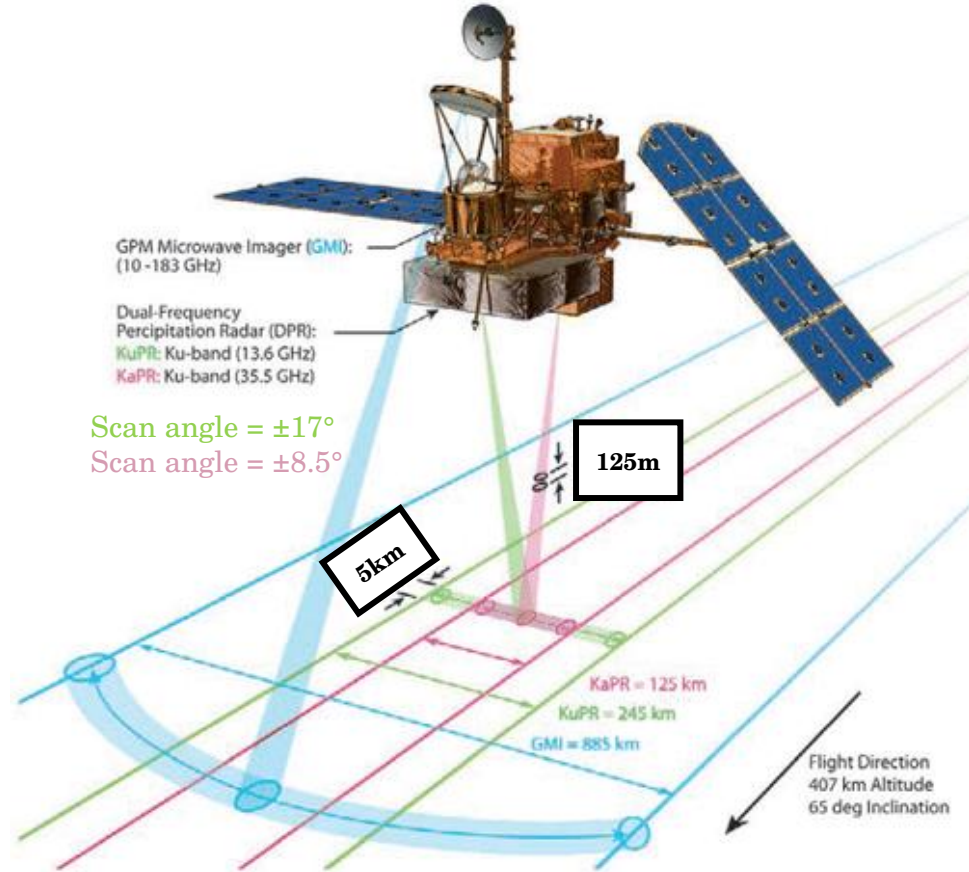
Derivation and **validation** of hydrometeor partitioning ratios (**HPR**) estimated with hydrometeor classifications (**HMC-P**) based on dual-frequency (**DF**) or dual polarization (**DP**) measurements by combining ground-based (**GR**) and space borne radar (**SR**) observations.



Data

SR

Global Precipitation Mission Core Satellite (GPM)

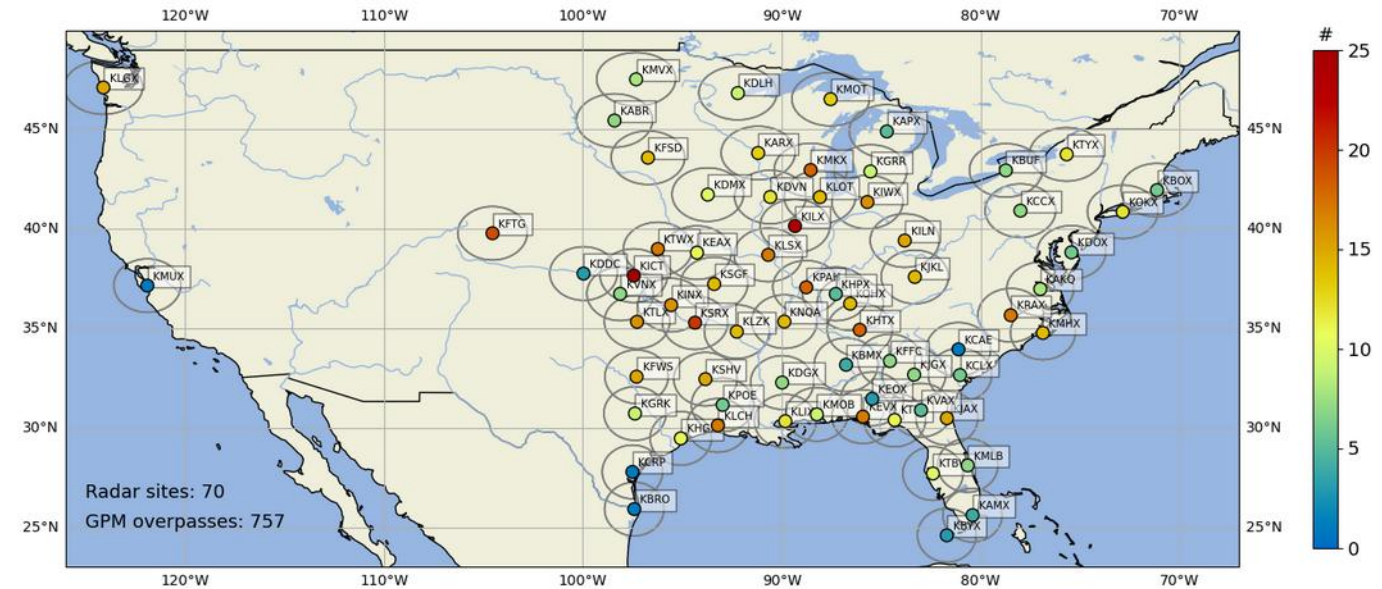


JAXA/NASA
Furukawa et al. 2013

Ku-band : 13.6 GHz
Ka-band : 35.5 GHz

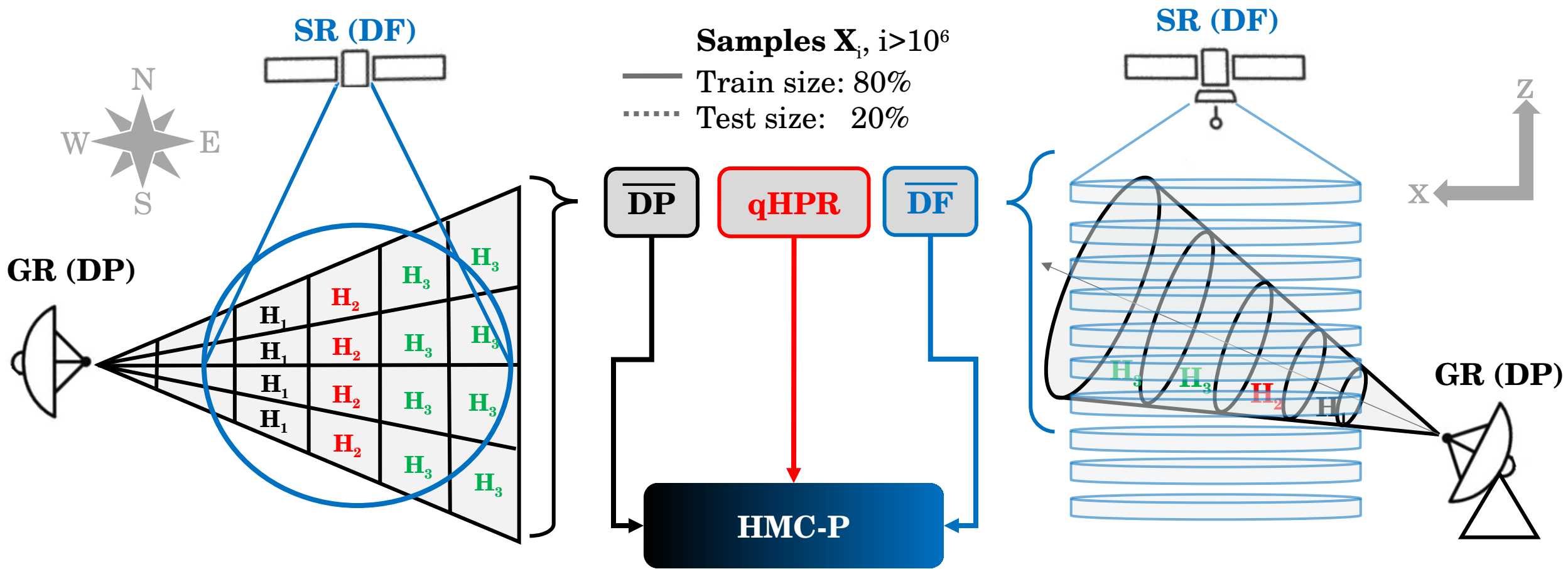
GR

NEXRAD

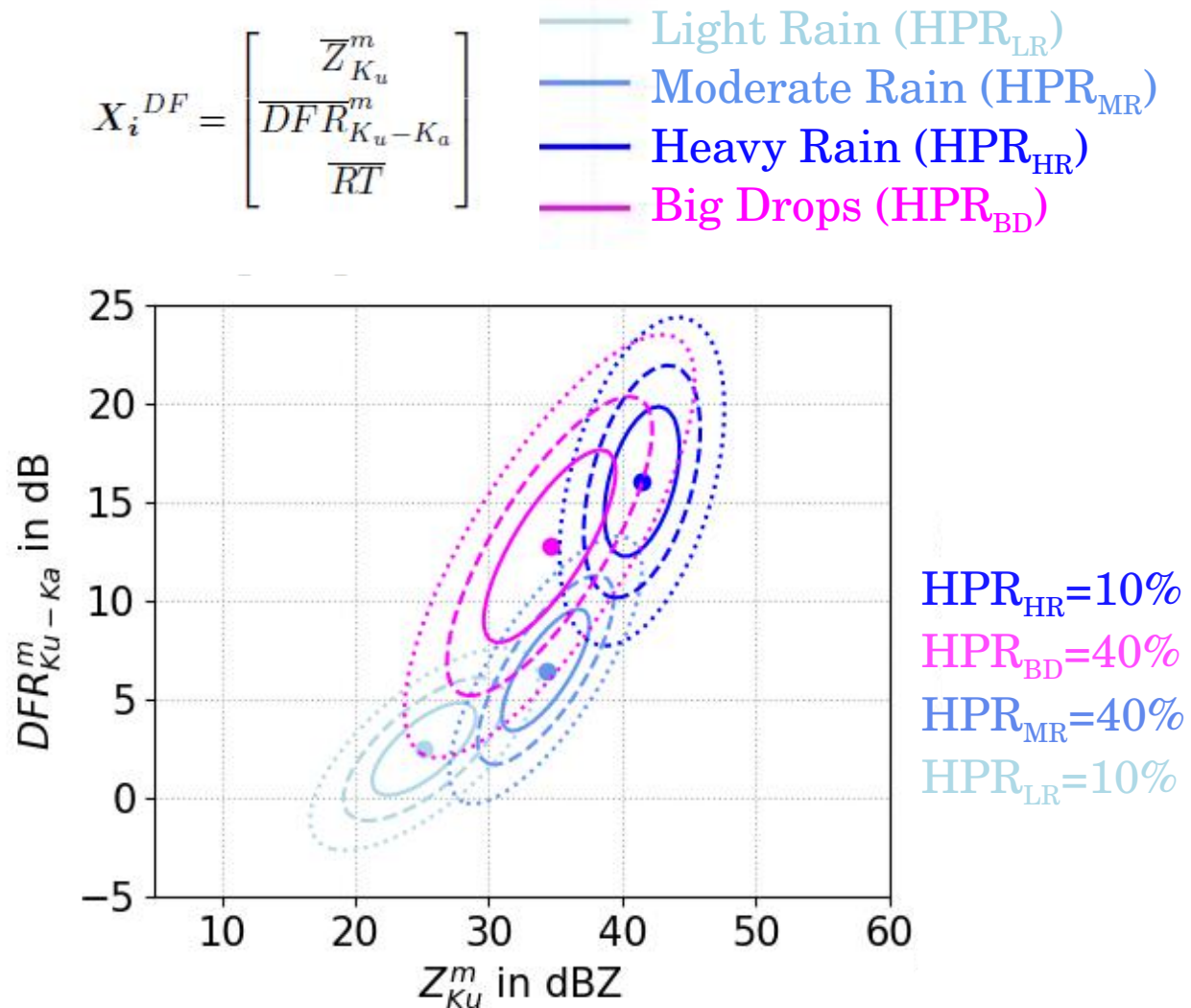


- **S-band (~3GHz) DP weather radar data**
- **Resolution:** Δr : 250m, $\Delta \varphi$: 1° , $\Delta \theta$: 0.5° - 19°
- **757** volume scans between **2014** and **2023** with GPM overpass are used.

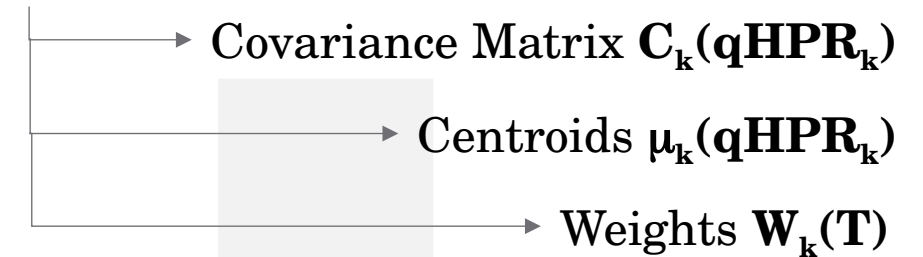
Quasi-HPRs (of SR, GR, and G) Observations



Estimation of HPR with HMC-P



Samples $\mathbf{X}_i, i > 10^6$



Multivariate Normal Distribution (MVND):

Refined approach of Besic et al. (2018)

$$p_k(X | \mu_k, C_k) = \Lambda \exp \left(-\frac{1}{2} (X - \mu_k)^T C_k^{-1} (X - \mu_k) \right)$$

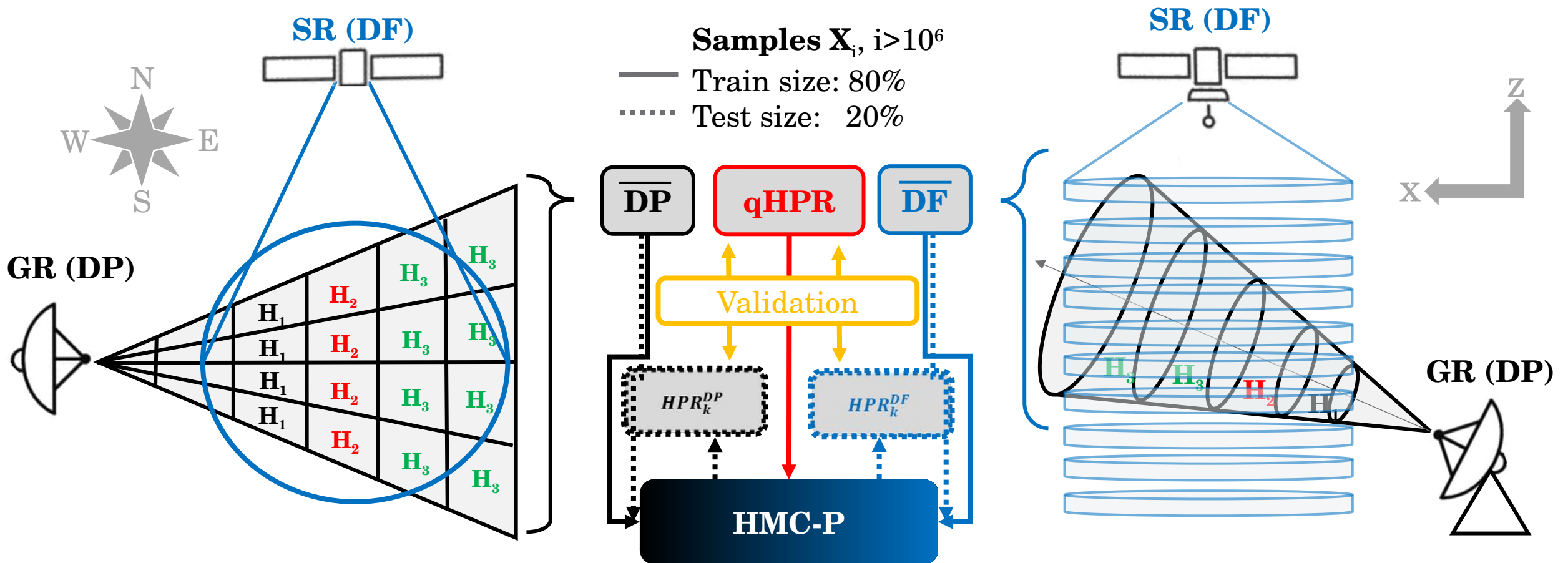
$$\tilde{p}_k = \frac{p_k(X)}{p_k(\mu_k)}$$

$$\Lambda = 1 / \sqrt{(2\pi)^d |C_k|}$$

Hydrometeor Partitioning Ratio (HPR):

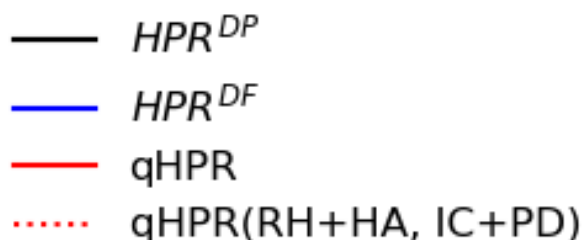
$$HPR_k = \frac{W_k(T) \tilde{p}_k}{\sum_{k=1}^n W_k(T) \tilde{p}_k}$$

Validation of $\text{HPR}_S^{\text{DP/DF}}$



Validation of HPR^{DP/DF}

Test size: 20%

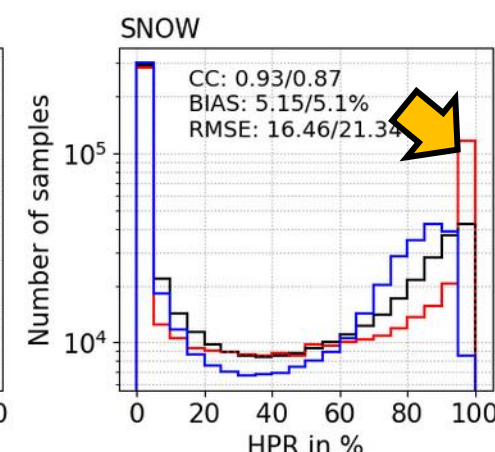
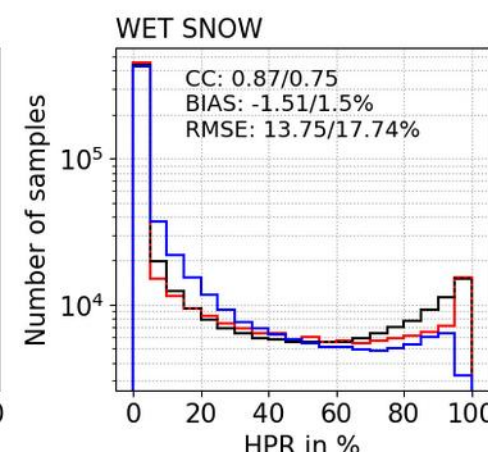
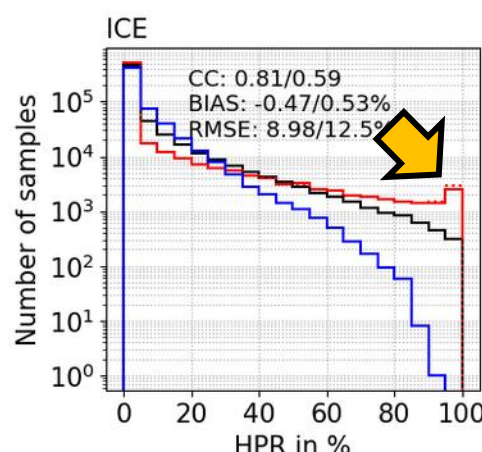
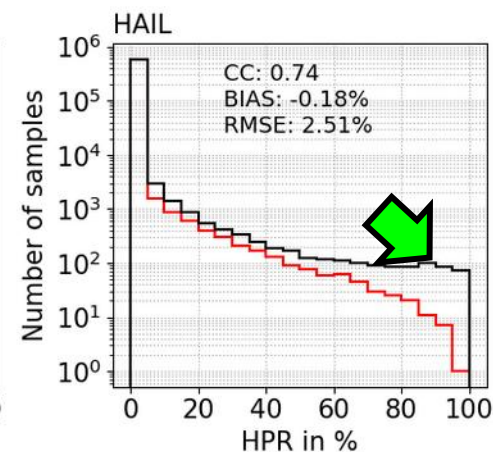
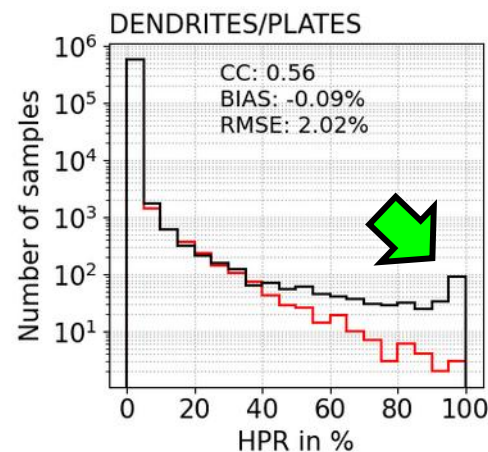
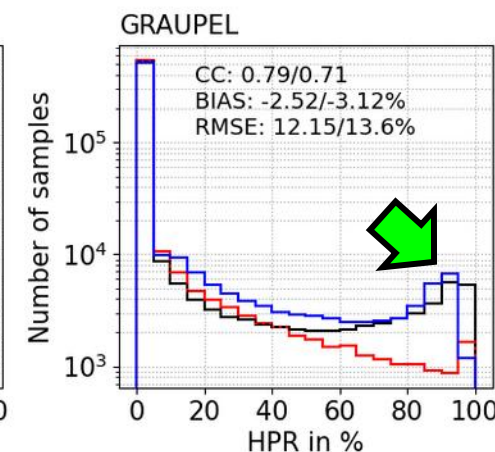
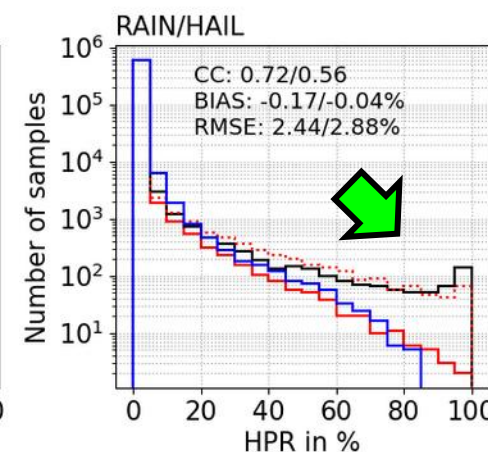
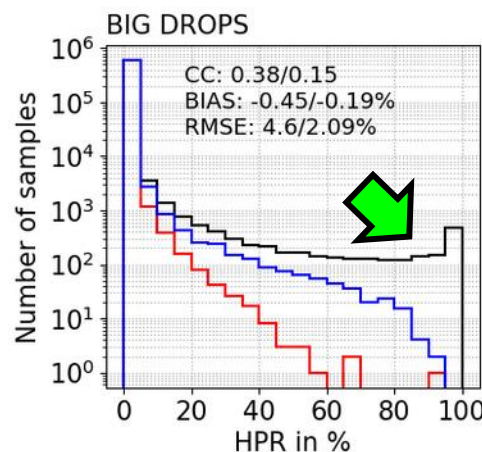
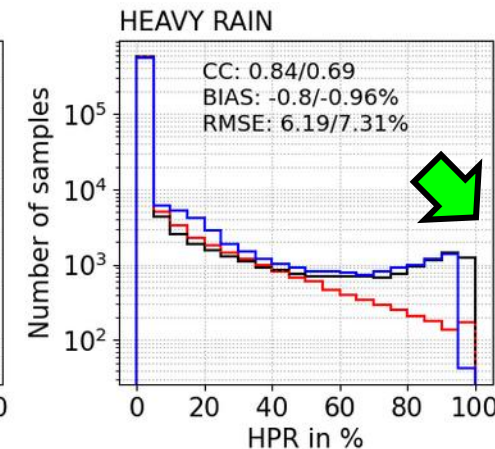
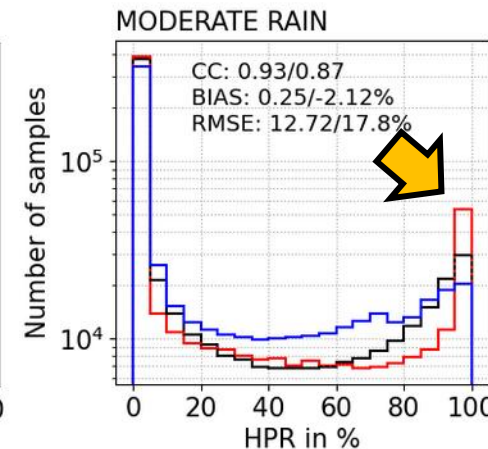
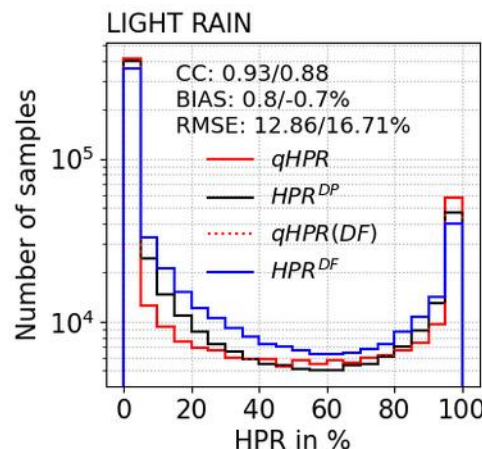


Overestimation



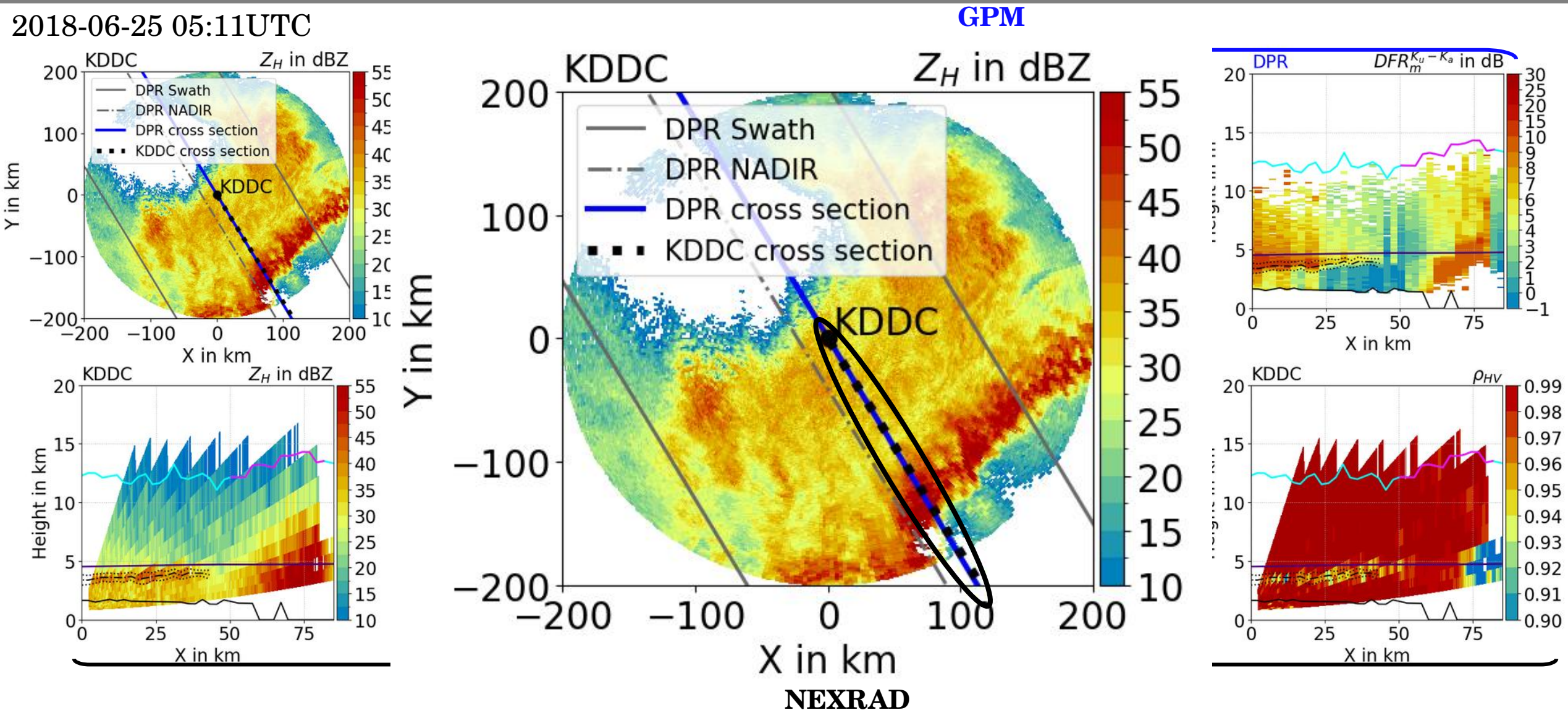
Underestimation

➤ Performance: DP > DF



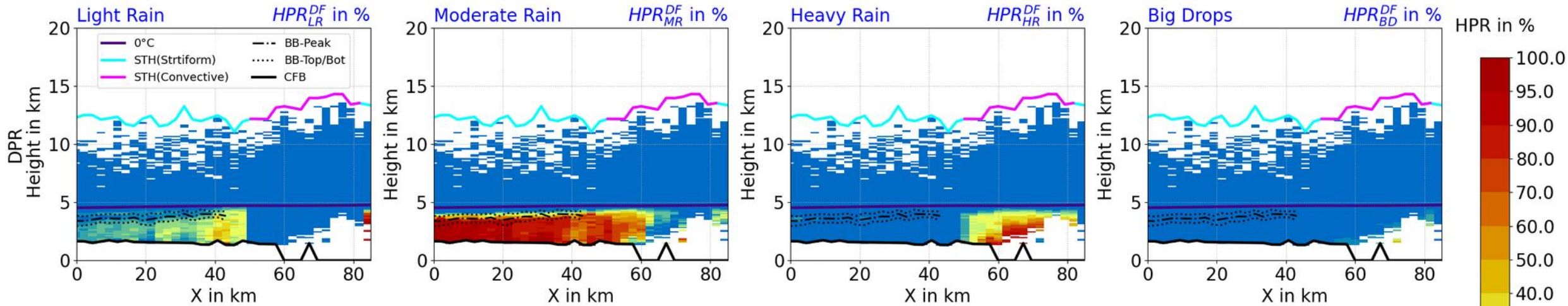
Comparison between GPM and NEXRAD

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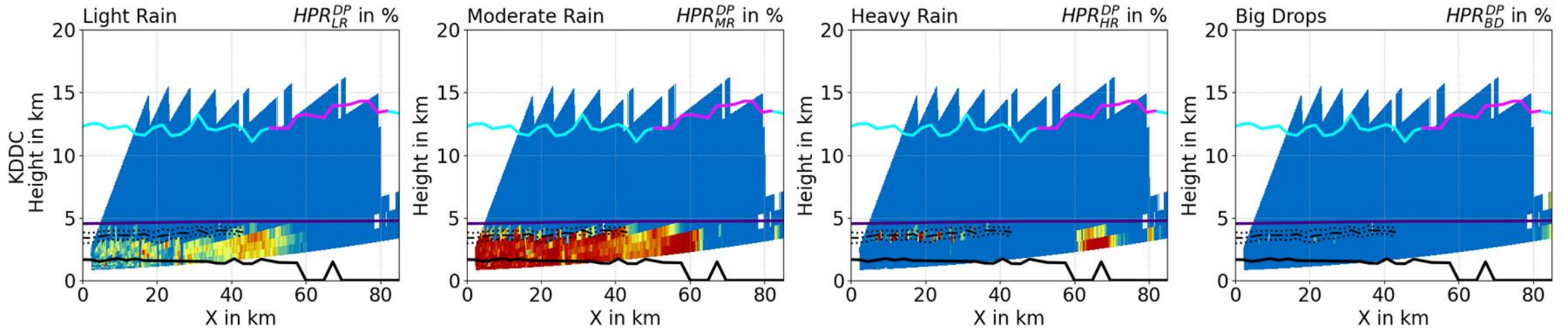


$\text{HPR}^{\text{DF/DP}}$ -Estimates for liquid hydrometeors

GPM

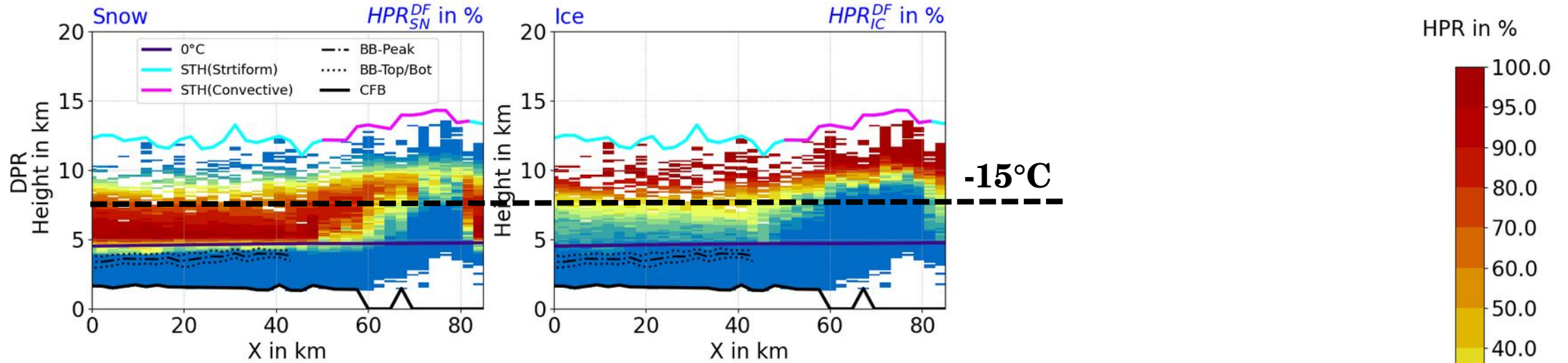


NEXRAD

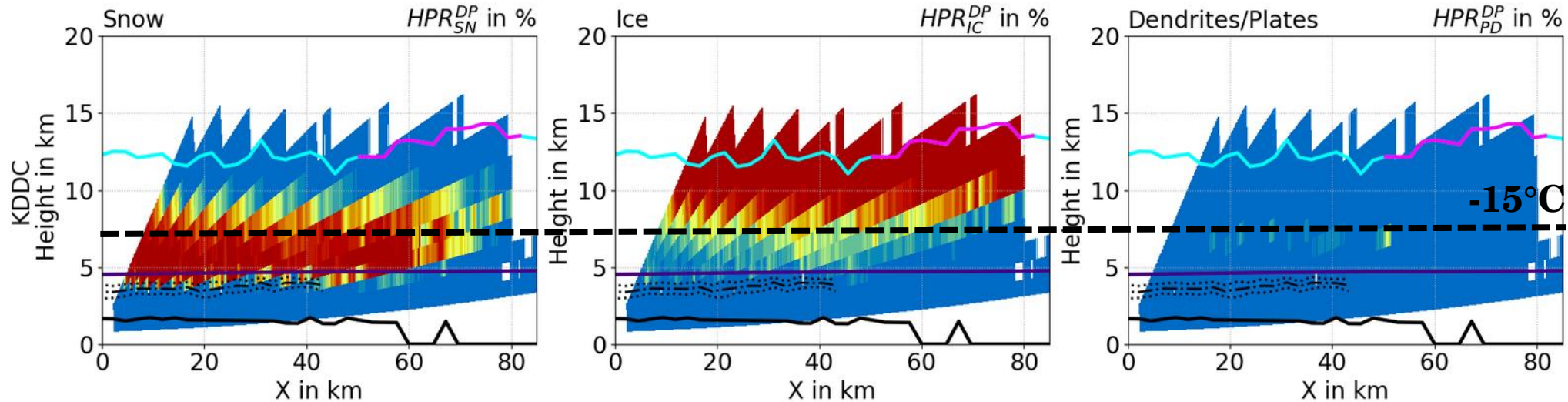


$\text{HPR}^{\text{DF/DP}}$ -Estimates for solid hydrometeors

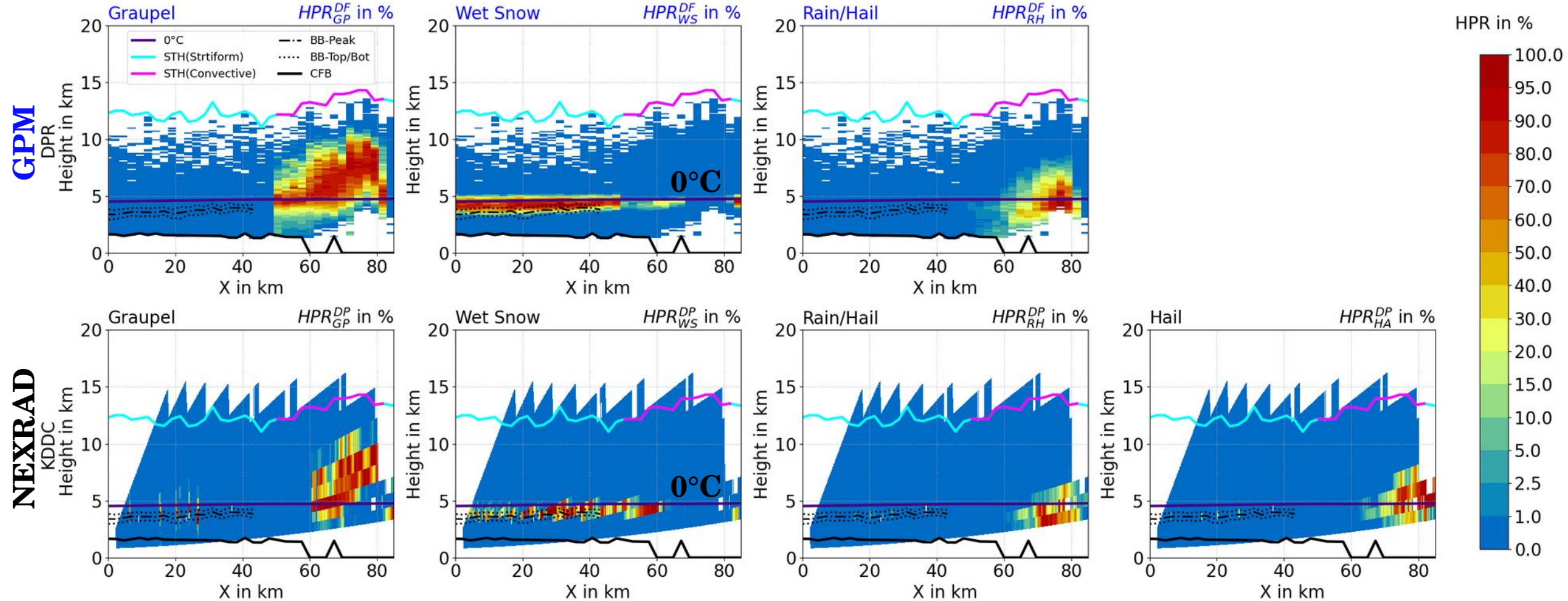
GPM



NEXRAD



$HPR^{DF/DP}$ -Estimates for mixed hydrometeors

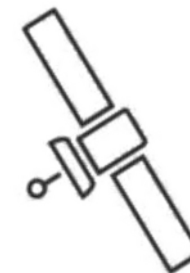
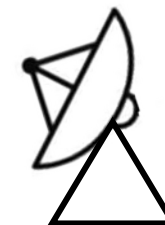


Summary

- We derived **HPR** based only on DF or DP observations.
- **HMC-P reproduces** the **qHPR** ("ground truth") to a **high degree**.
- Direct comparisons of HPR^{DF} and HPR^{DP} show **consistent results**.
- **Performance:** $\text{DP} > \text{DF}$
- **Overestimation** of **higher HPRs values** for hail, graupel, big drops, heavy rain and dendrites/plates and **underestimation** of moderate rain, ice and snow.

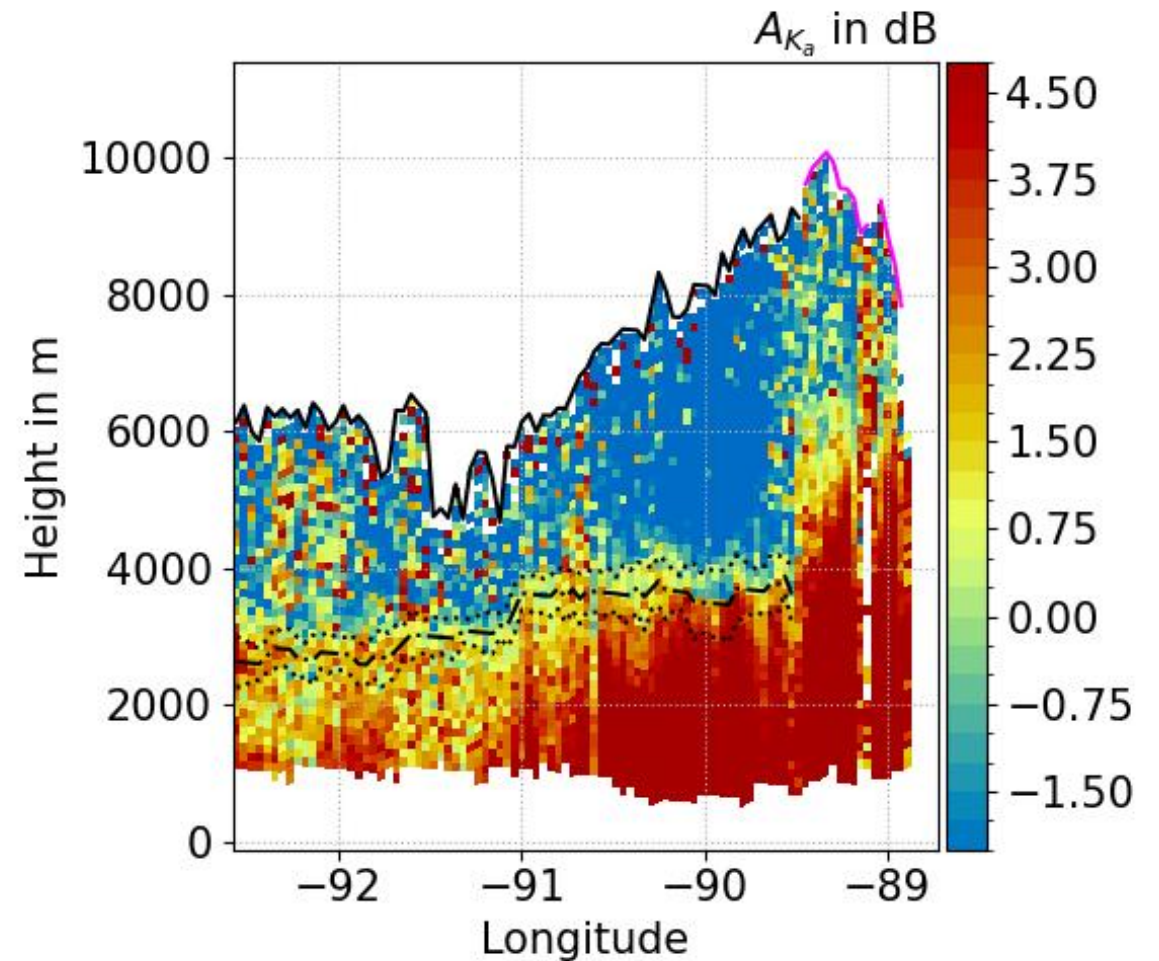
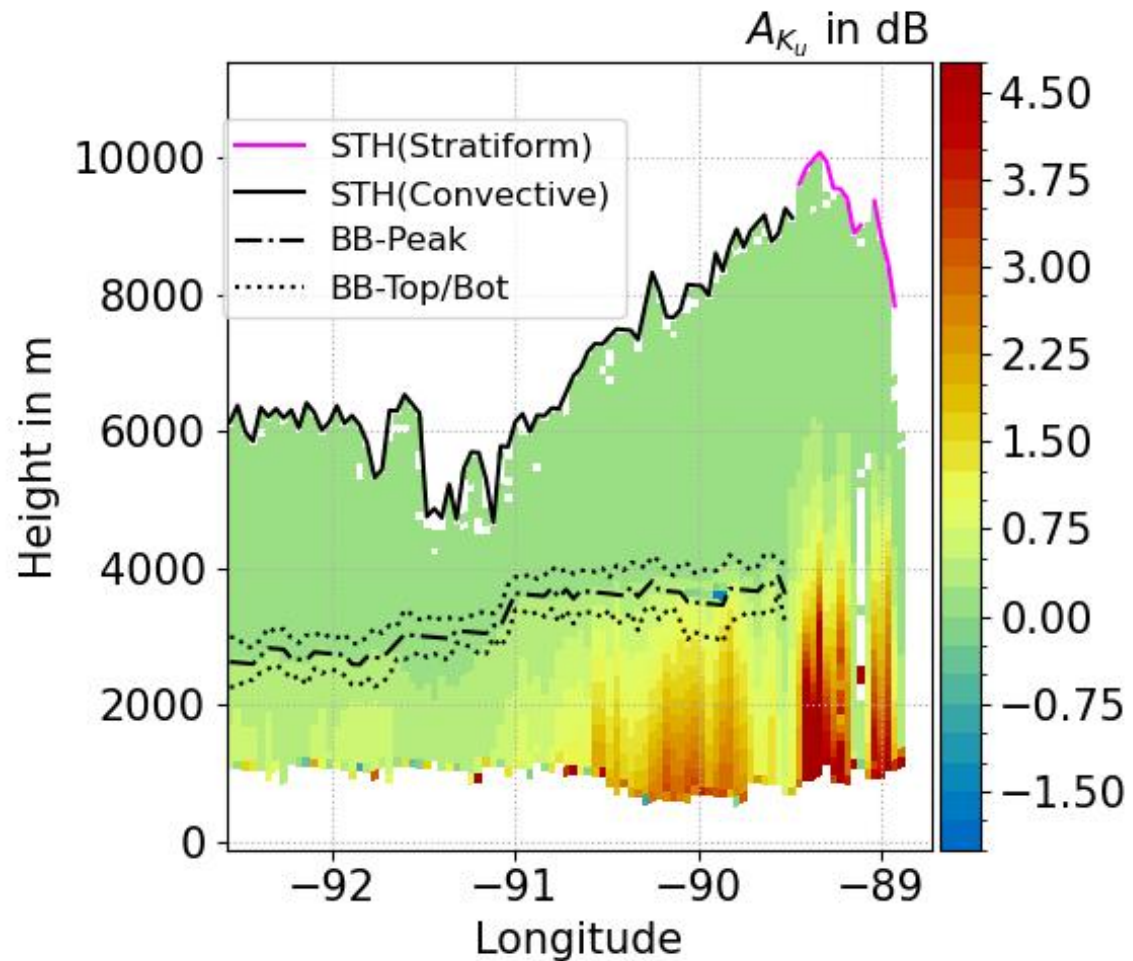


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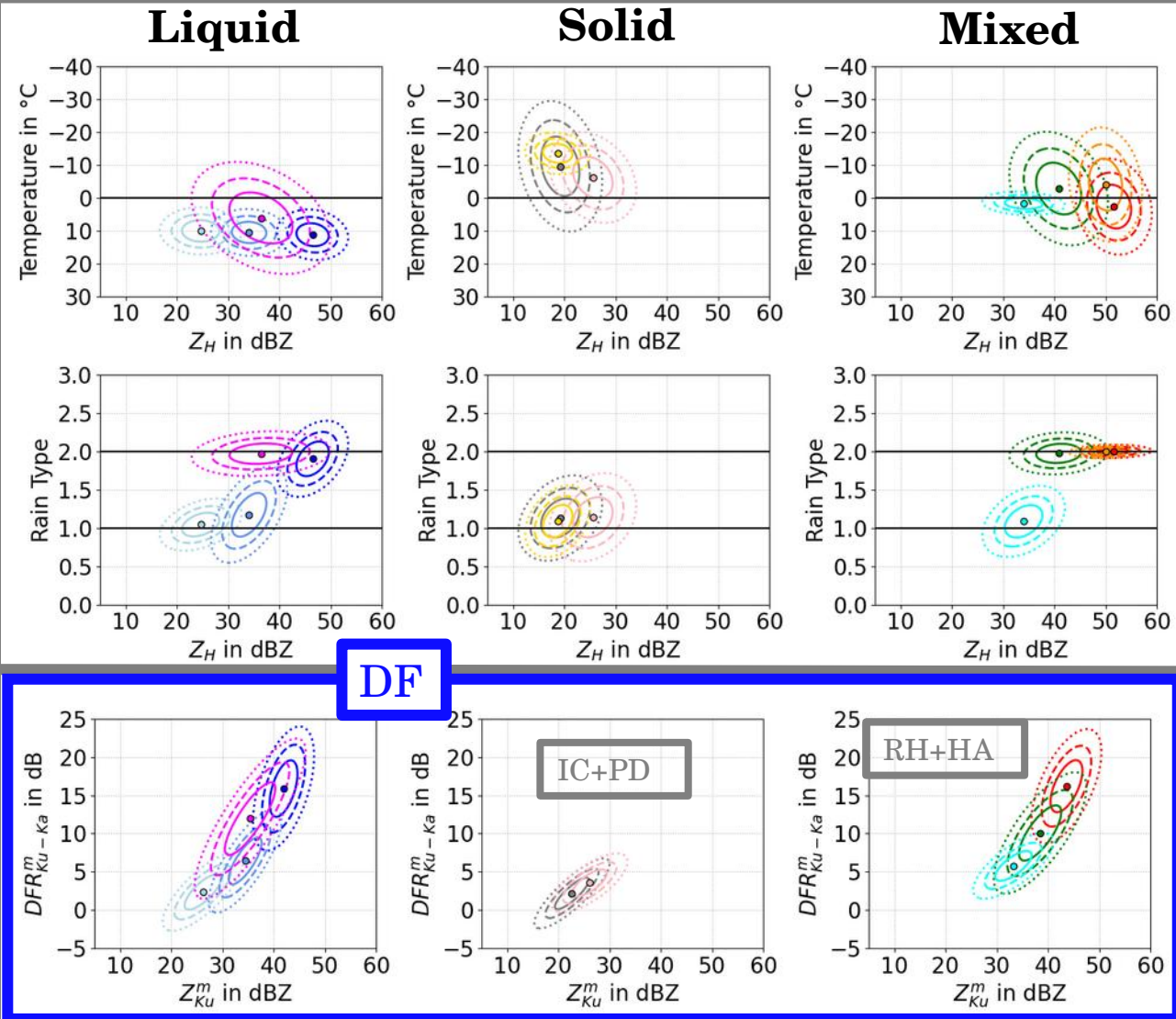
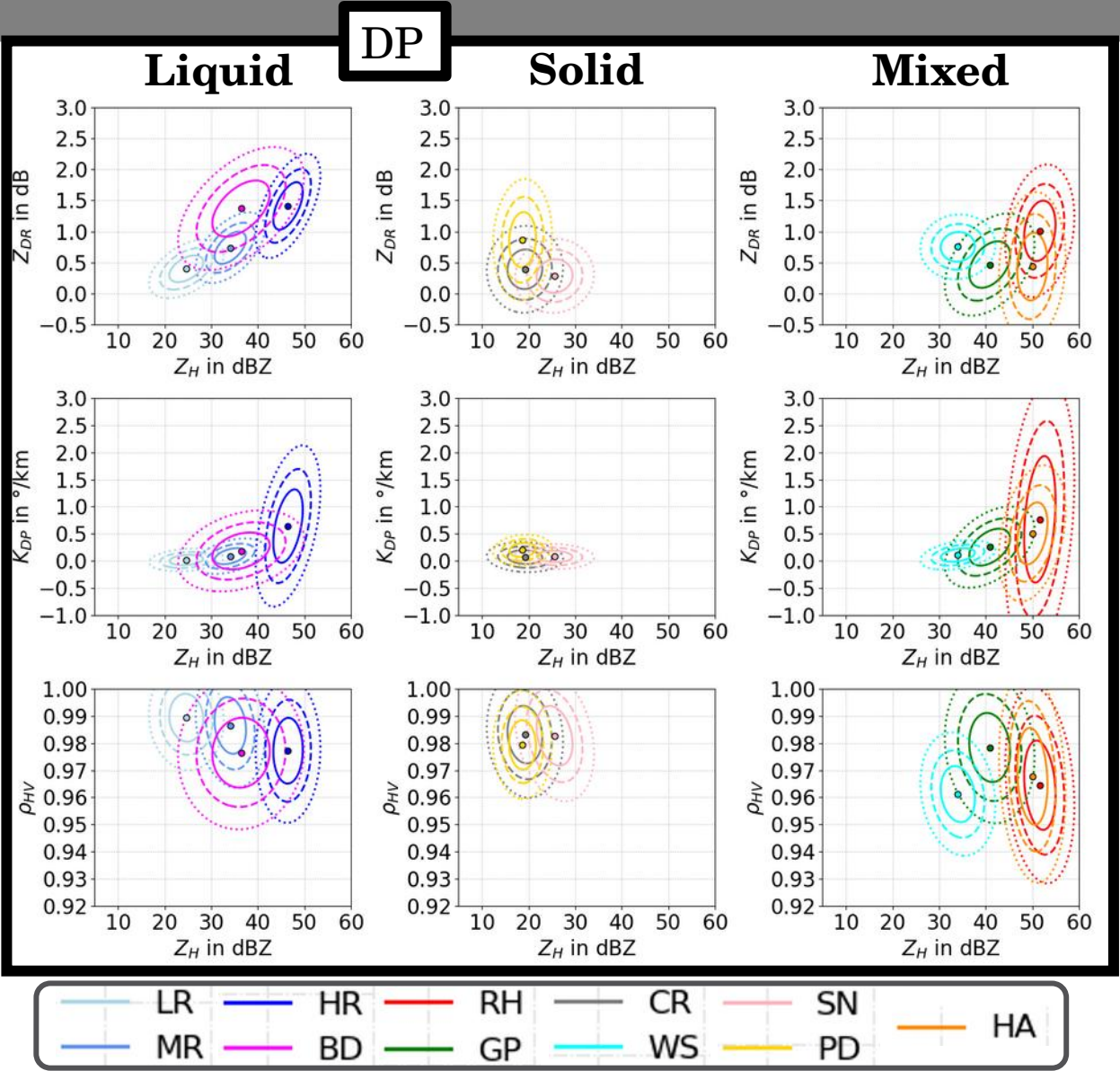


APPENDIX

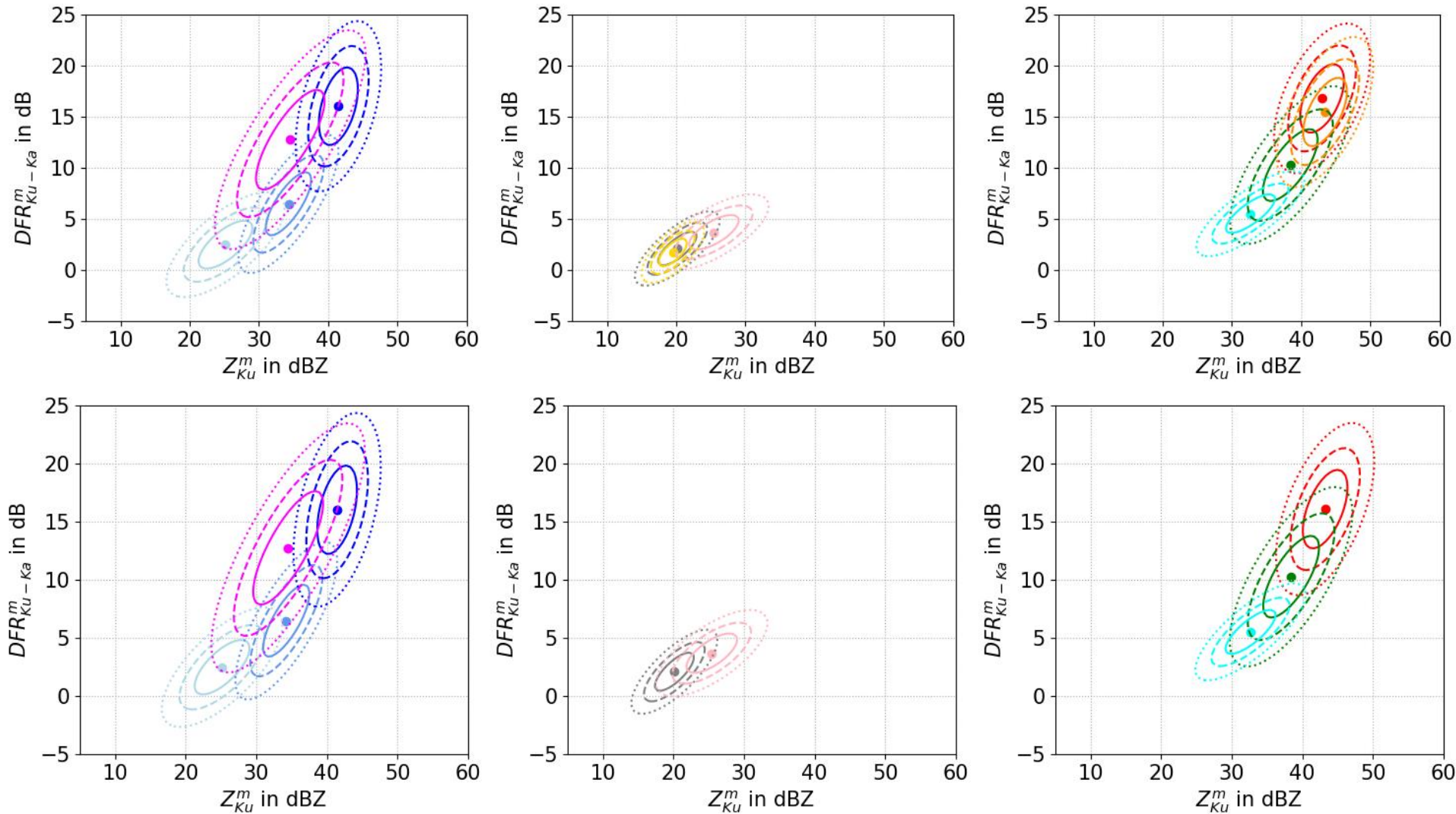
DPR – Attenuation Correction



MVND for DP and DF

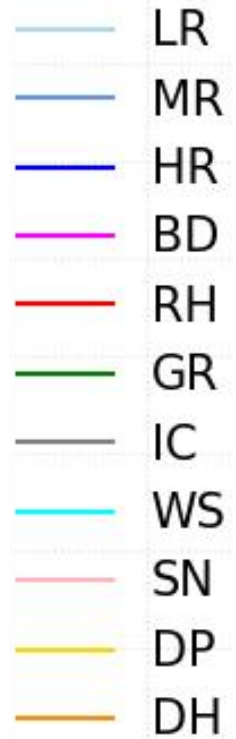


DP-MVND



Strong overlapping
DF-MVND for RH
and HA and IC and
PD!

RH + HA
IC + PD!



Comparison of HPR Models and GR Models

