

IMPROVED NUBF PARAMETERIZATION FOR THE GPM COMBINED ALGORITHM

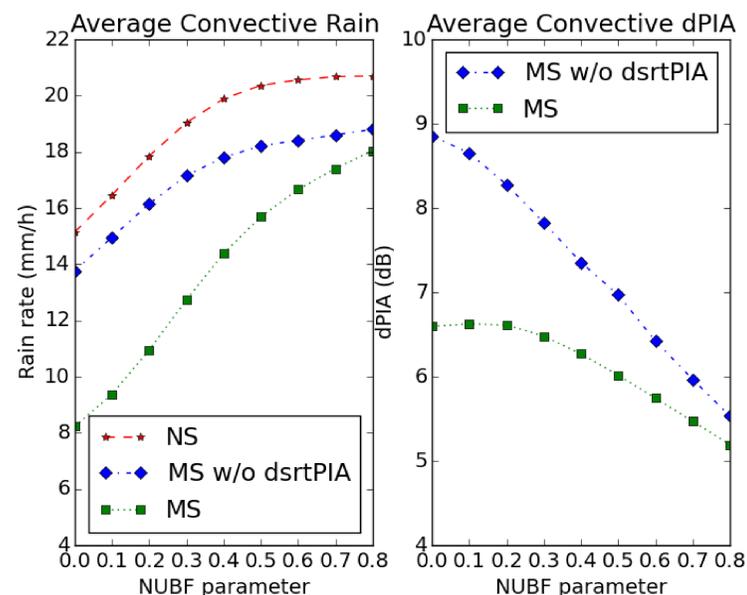
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PROBLEM

Non-uniform beam-filling (NUBF) may significantly impact the accuracy of dual-frequency space-borne radar retrievals. This is because precipitation tends to exhibit more variability in horizontal than in vertical direction, which may result in

1. Relatively large observed reflectivity Z_m associated with large accumulated attenuation, i.e. $\int_{top}^{surf} k(s)ds$, extinction at Ka-band
2. Small Path Integrated Attenuation (PIA) estimated from the Surface Reference Technique (SRT) associated with large integrated attenuation.

A NUBF parameterization was introduced in V4 of the combined algorithm. Comparison with independent estimates and sensitivity tests suggest that while facilitating the derivation of consistent NS and MS precipitation estimates, the V4 NUBF parameterization is conducive to significant overestimation of convective precipitation.



OBJECTIVES

Objectives of this project are:

1. Investigate the impact of NUBF on SRT PIA using synthetic observations derived from high-resolution S-band radar observations.
2. Derive and evaluate new NUBF parameterization.
3. Implement new NUBF parameterization in the GPM combined algorithm and assess outcome.

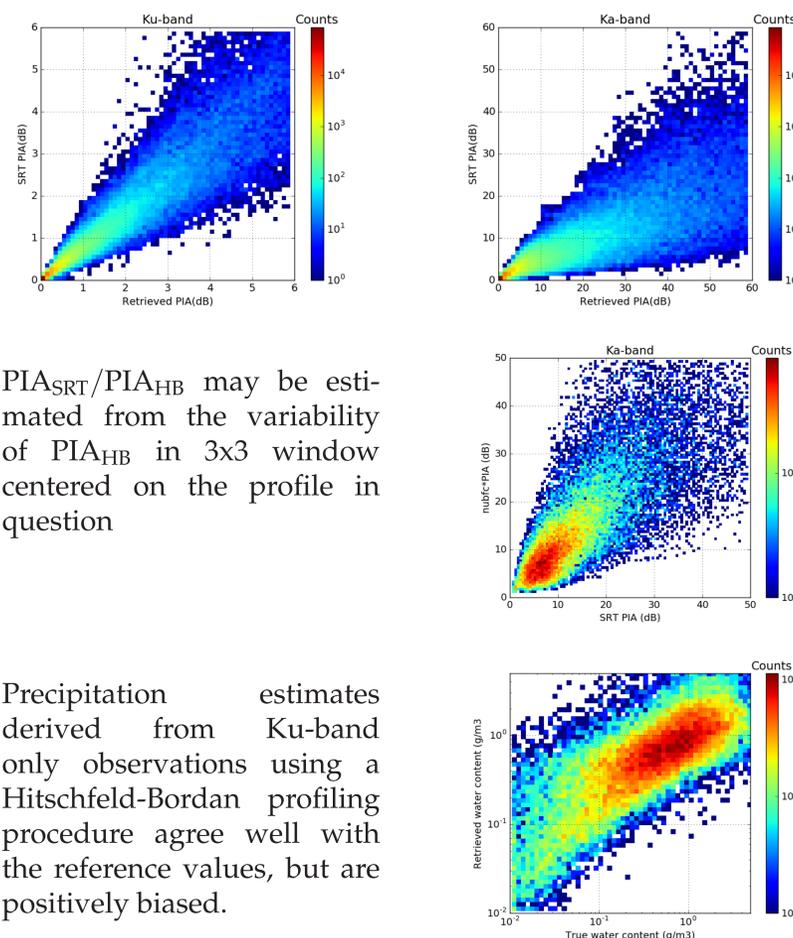
APPROACH

To investigate the impact of NUBF on SRT PIA and, consequently, GPM combined NEXRAD radar observations from around the country are used. The NEXRAD observations are selected for GPM overpasses that exhibit significant convection. The specific procedure is detailed below.

for S-band radar volume in radar data set **do**
 Resample S-band radar volume observations on a $1 \text{ km} \times 1 \text{ km} \times 0.25 \text{ km}$ grid;
 Do S-band radar retrievals;
 Simulate Ku-and Ka-band reflectivity and SRT PIA observations;
 Apply Hitschfeld-Bordan profiling algorithm to synthetic Ku-band observations;
 Evaluate SRT PIA against HB PIA;

Derive parameterization to estimate $\text{PIA}_{\text{SRT}}/\text{PIA}_{\text{HB}}$ from NUBF parameters derivable from DPR observations;

Simulation Results



$\text{PIA}_{\text{SRT}}/\text{PIA}_{\text{HB}}$ may be estimated from the variability of PIA_{HB} in 3×3 window centered on the profile in question

Precipitation estimates derived from Ku-band only observations using a Hitschfeld-Bordan profiling procedure agree well with the reference values, but are positively biased.

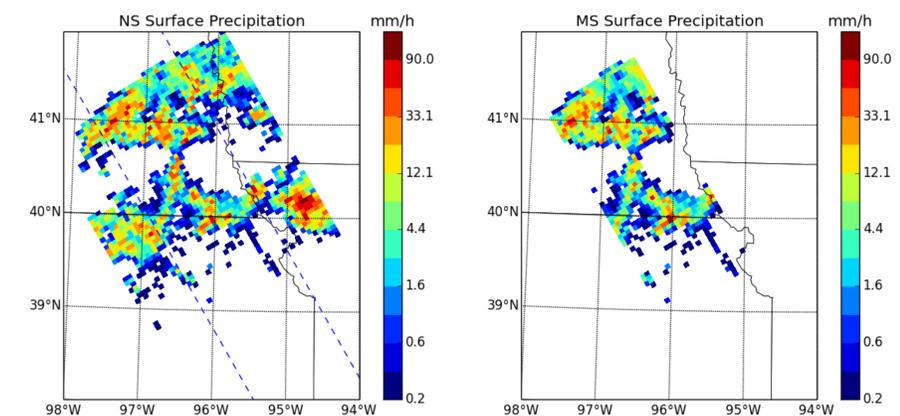
Various Machine Learning (ML) techniques to predict PIA_{SRT} from PIA_{HB} and additional DPR reflectivity observations were investigated, but ML did not perform better than the ratio of $-(\log_{10}(10^{-0.1 * \text{PIA}}))$ to $\langle \text{PIA} \rangle$.

IMPACT ON GPM COMBINED RETRIEVALS

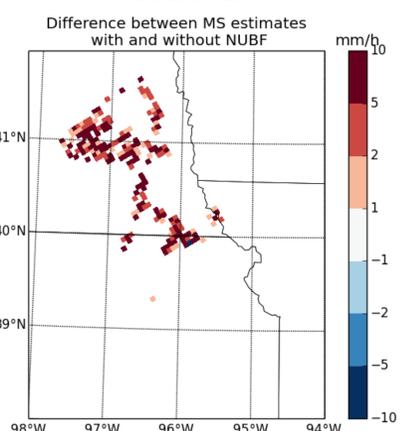
The V4 NUBF parameterization improves the consistency between NS and MS surface precipitation estimates at the expense of large overestimation of convective. When the V4 NUBF parameterization is tuned to produce NS estimates consistent with MRMS products, the MS estimates are significantly lower than both the NS and MRMS estimates. The new NUBF parameterization is based on the variability in 3×3 windows of the HB PIA at Ka-band derived from Ku-band-only DPR observations and is more robust. It can be used in conjunction with current Z_m downscaling technique, as well as independently.

Example of GPM combined retrievals

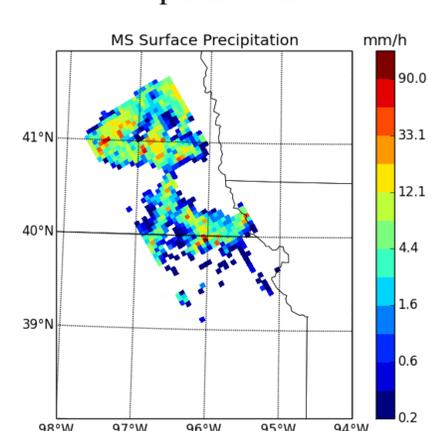
NS retrievals MS retrievals with V5 NUBF parameterization



Difference between MS retrievals



MS retrievals without V5 NUBF parameterization



ACKNOWLEDGMENTS

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