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Overview, Update and Science of the GPM Validation Network Radar Database

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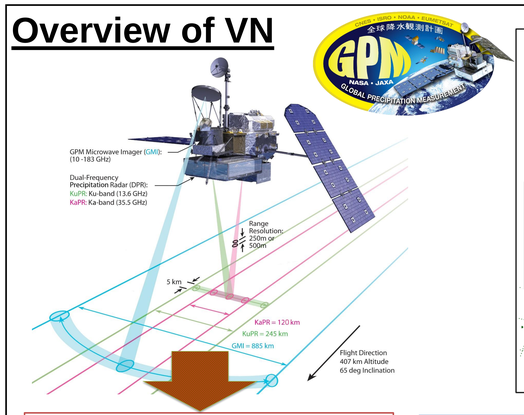
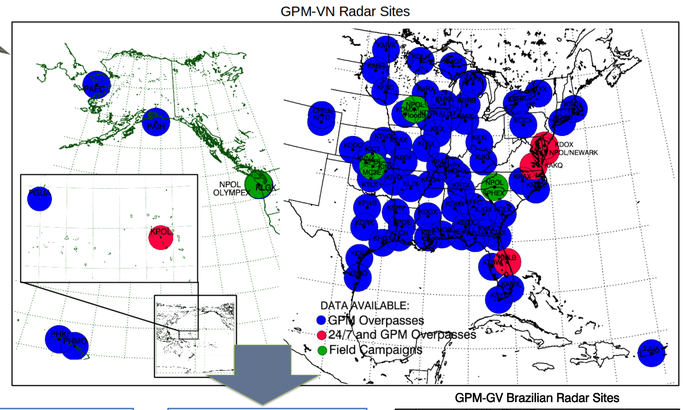
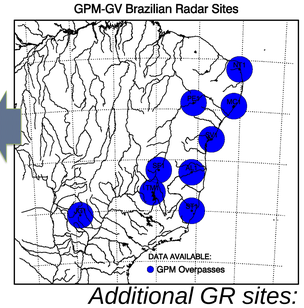
Abstract. A critical component of the Global Precipitation Measurement (GPM) Mission validation strategy involves use of dual-polarimetric (DP) ground-based radar (GR) products. Both operational and research DP radars across the U.S. and several international locations are used with coincident GPM dual-frequency precipitation radar (DPR) data in a signficant expansion of the original TRMM-based "validation network architecture" (VN; Schwaller and Morris, 2011, J.Tech.). The VN radar databases consist of millions of geometrically matched DPR and GR precipitation volumes. Not only does it serve as a tool for validation of satellite-based precipitation retrieval algorithms and GR calibration but also a valuable resource for precipitation science and for complimenting future convective precipitation-related satellite missions.

Overview of VN

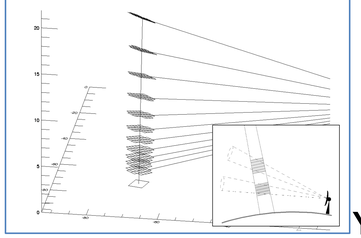






2ADPR (Iguchi et al. 2018)
- Attenuation Correction
- G.V. Retrievals

DPR+GR Volume Matching (Schwaller & Morris 2011)



Retrieval of GVs (Pippitt et al. 2015)
- RainRate
- DSD — *Field Campaigns*
- Hydrometeor ID

Quality Control (Pippitt et al. 2013)
- Automated
- Manual

Additional GR sites: La Reunion (MeteoFrance), Darwin-CPOL (BoM/V.Louf/S.Collis),

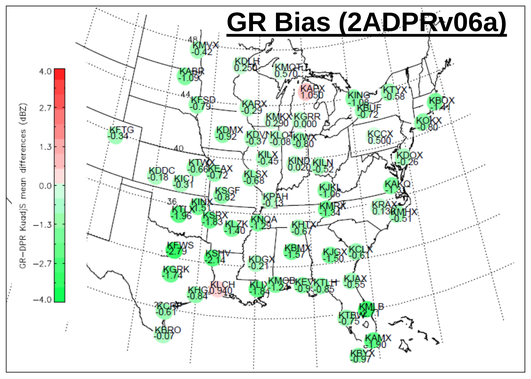
Years: 2014-*2019*

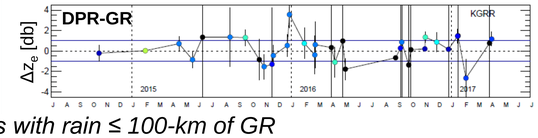
Total number of GR bins Matched	**6,339,462**
HID=Drizzle/Rain	36.8%
HID=Ice Crystals/Vert. Ice	27.2%
HID=Wet Snow	9.9%
HID=Aggregates	7.0%
HID=Hail/HDGR	7.9%
HID=Big Drops	1.7%

Number of Matched Profiles (DPR+GR)	**2,022,983**
Stratiform	75.5%
Convective	12.8%

Based on "100-in-100" criterion: ≥ 40x40km² of DPR pixels with rain ≤ 100-km of GR

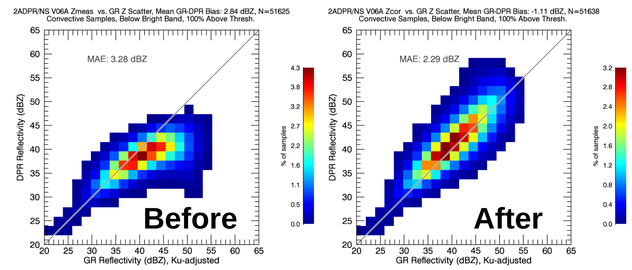
GR Bias (2ADPRv06a)



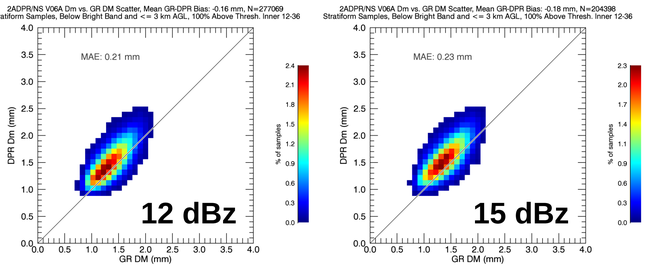


Validation of Satellite Radar Algorithms

Attenuation Correction (2ADPRv6a)

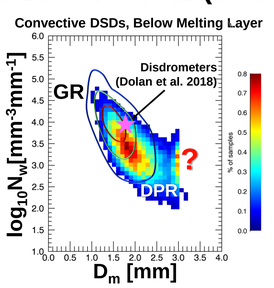


DPR Sensitivity



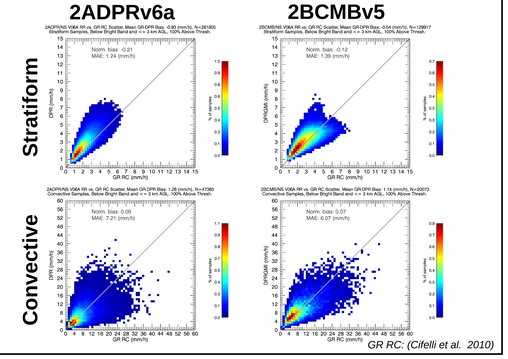
- About 35% more matched volumes included at 3 dB lower DPR sensitivity threshold
- Very slight reduction in D_m bias

DSD Retrieval (2ADPRv6a)



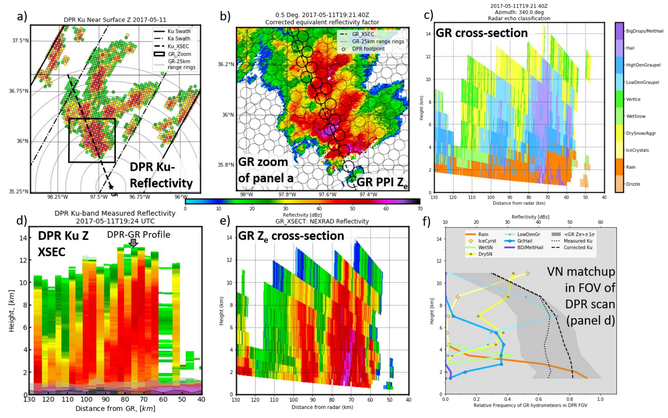
- DPR has high bias in D_m (and low bias in N_w) relative to GR but N_w-D_m behavior is similar from two independent measurements
- Questionable behavior of 2ADPR near D_m=3.0 mm is due to inclusion of 2AKa, which limits D_m≤3.0mm; 2AKu does not exhibit such peaked behavior at high D_m

Rainfall Retrieval (DPR/GMI)



GR RC: (Cifelli et al. 2010)

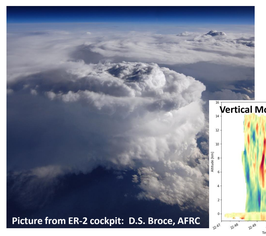
Example of Science Use

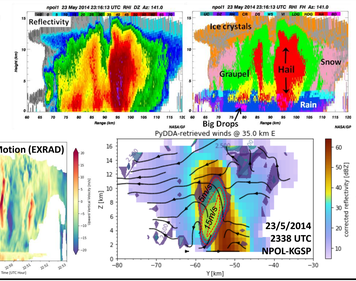


- The VN captures both the rich information provided by the GR and higher vertical resolution provided by the DPR. As a result it is being used to improve the representation of microphysical processes in retrieval algorithms.
- The example at left shows a DPR overpass of intense precipitation in northern Oklahoma when the 2ADPR rainfall retrieval was severely underestimated. Using the geo-matched DPR+GR measurements, we find a relatively large portion of the DPR profile consists of grapuel/hail. Such information can help better identify and correct for such multiple scattering effects.

Coming Soon…*Vertical Motion*

3-D winds will be added to the DPR-GR matchups in the VN database.





- Numerous GRs in the VN have baselines acceptable for the retrieval of vertical motion via a 3DVAR dual-Doppler wind analysis technique (Shapiro et al., 2009; Potvin et al., 2012) that was ported to Python (Lang et al. 2017) and recently made available in the PyDDA package: https://github.com/openradar/PyDDA
- The image to the left shows an example of the 3D wind retrieval from two of the VN radars—NPOL and KGSP (40-km baseline)—through a hailstorm sampled during GPM GV's IPHEx field campaign.
- Observations of this deep convective event from a 144-km baseline Doppler radar pair (KGSP/KCAE) resulted in maximum vertical winds around 20 m/s, which have been corroborated with the ER-2 X-band Doppler Radar (EXRAD)→Many VN GR baselines acceptable

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