The GPM Validation Network: Validating IMERG and GPROF with Ground-Based Radars

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Overview

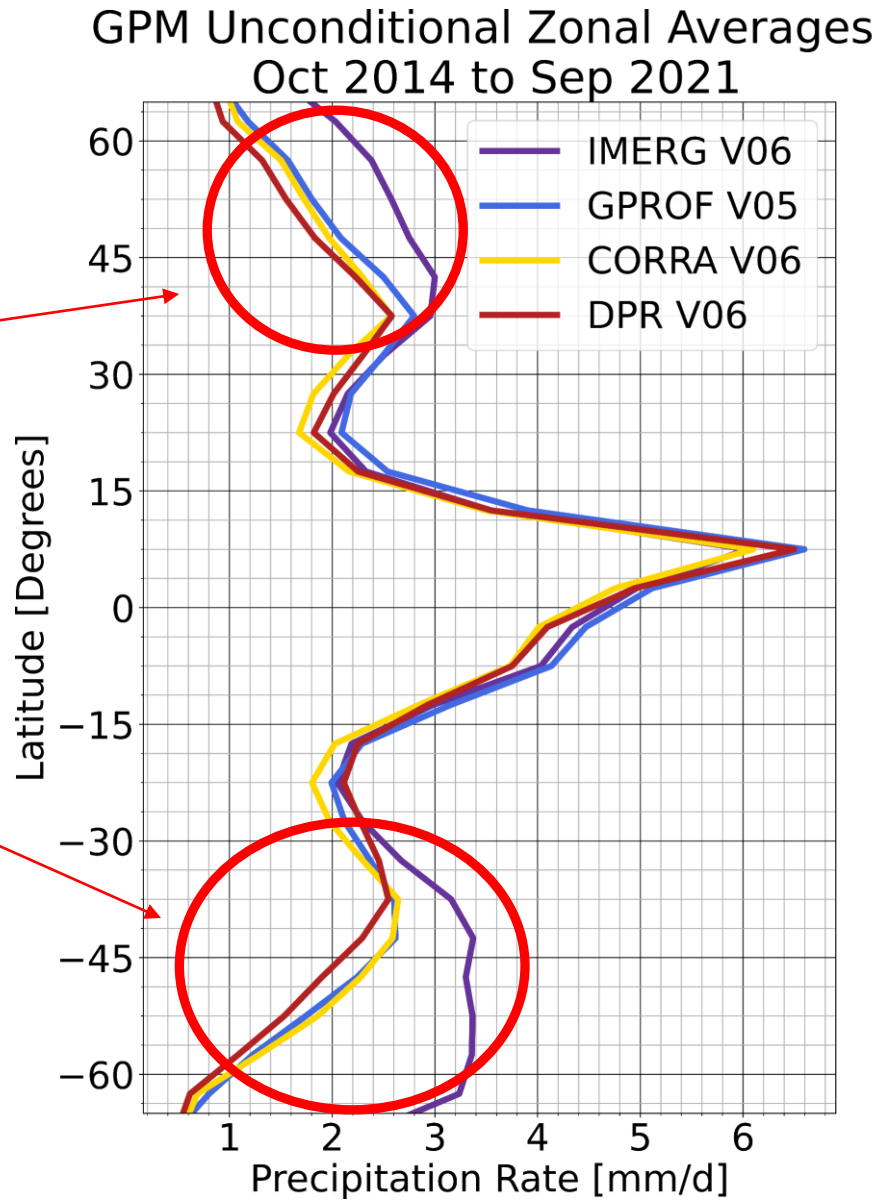
- Motivation
- The GPM Validation Network
- Oceanic Validation with the Validation Network
  - Results from:
    - Hawaii [PHKI, PHMO]
    - Alaska's Middleton Island [PAIH]
    - Kwajalein [KWAJ]
- Conclusions and Future Studies

Aims:

- To conduct oceanic validation of the IMERG and GPROF products for GMI measurements;
- To trace errors from the L2 GPROF product through to the L3 IMERG product.

Motivation

- Significant zonal differences in the mid-latitudes between GPM Core products and IMERG

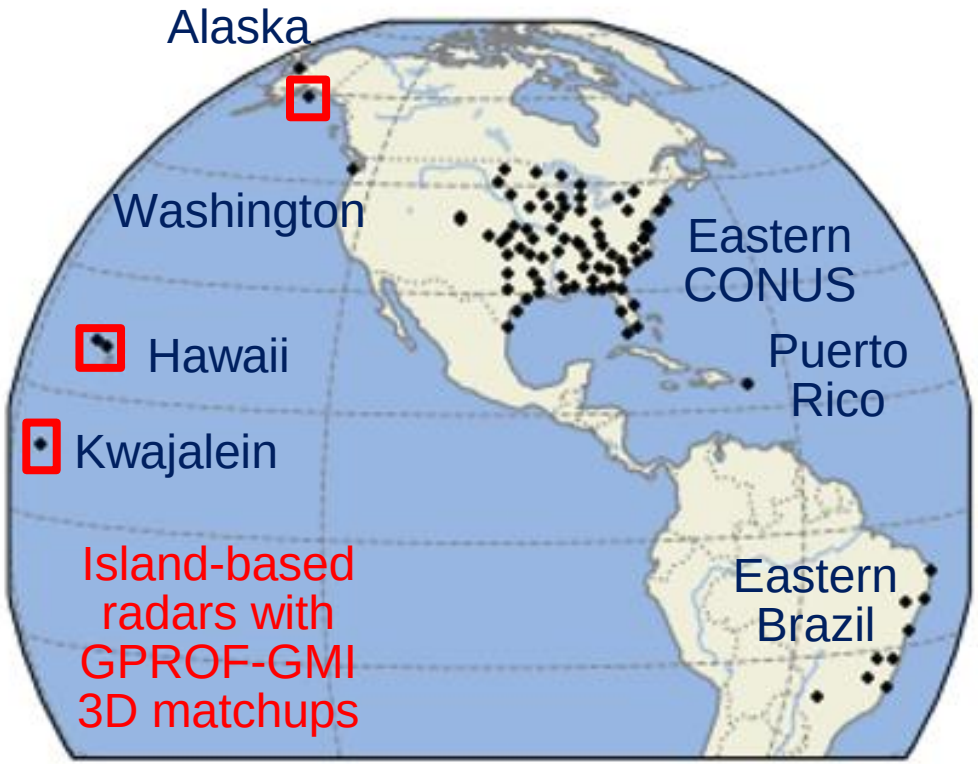


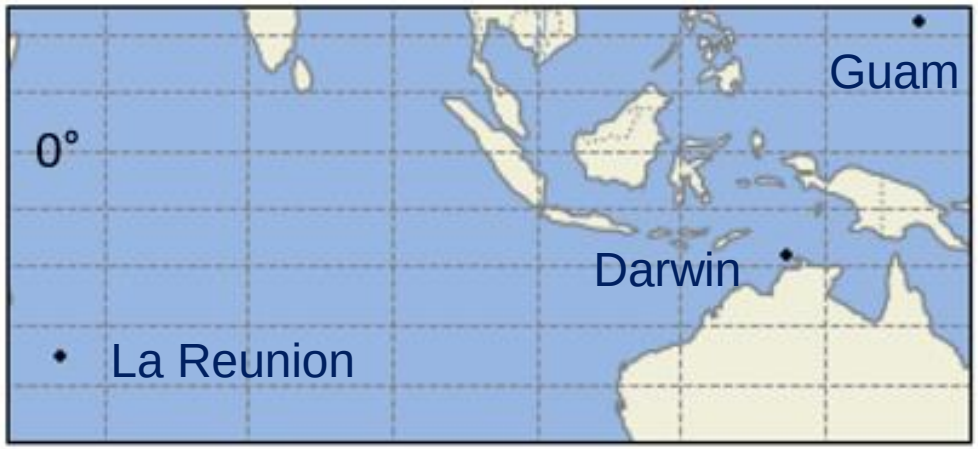
- GPROF-GMI – An IMERG-PMW input
- CORRA – An IMERG-PMW calibrator
- Validation with error tracing from GPROF-GMI to IMERG is required to better constrain products

Note: GPROF V05 is the penultimate GPROF version to latest V07

The GPM Validation Network

Validation Network Ground Radar (GR) Sites





Adapted from Gatlin et al. (2020)

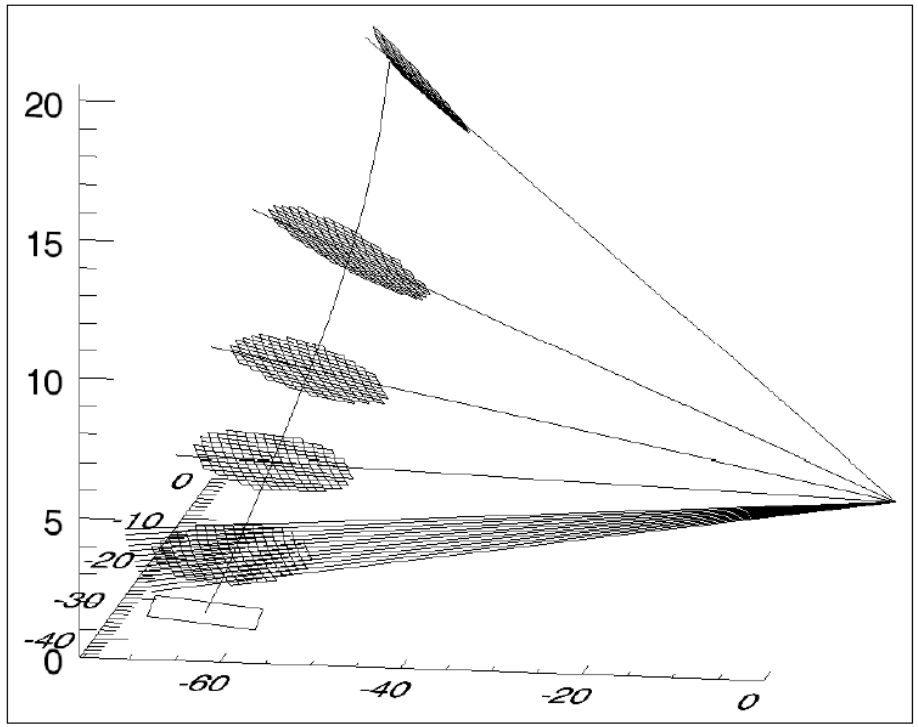
A NASA software system run at Marshall Space Flight Center that geometrically matches 3D precipitation retrievals from GPM Core sensors to ground-based radars.

The GPM Validation Network

GR to GPROF-GMI Matchup

Line of Sight

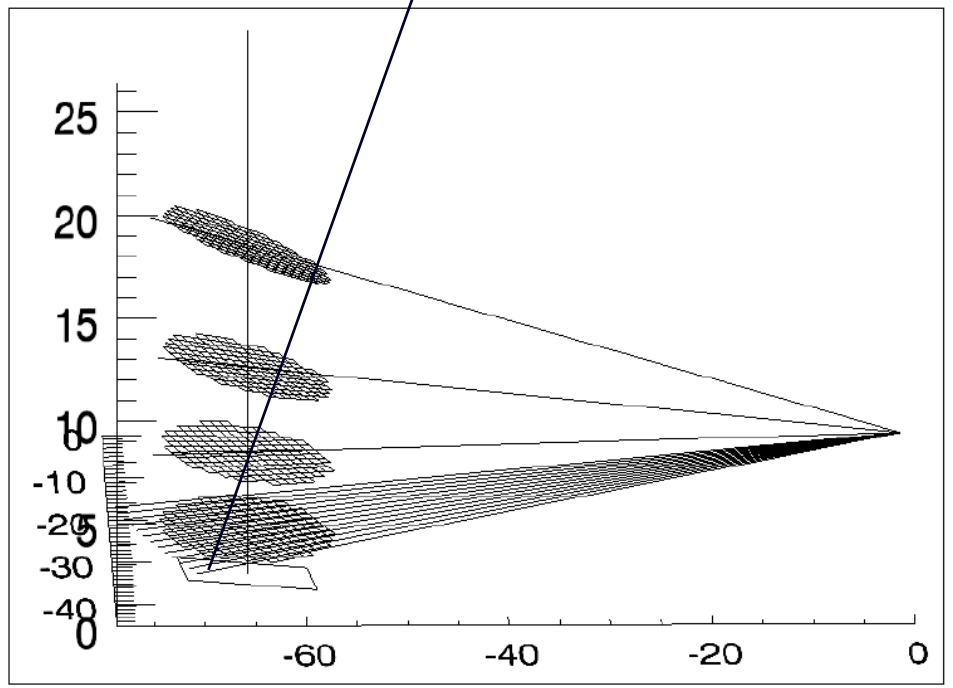
GPM Core



GR

Vertical Profile

GPM Core



GR

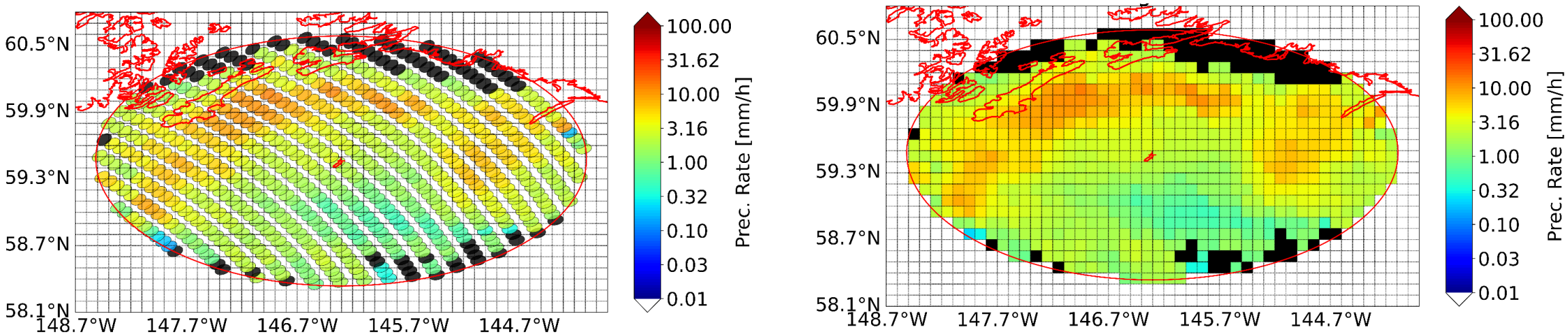
Adapted from NASA's GPM Validation Network Guide (2021)

The GPM Validation Network

GR to GPROF-GMI to IMERG Matchup

Approximation of the IMERG backward gridding technique for gridding precipitation at the GPROF-footprint scale.

GR [GPROF Footprints] → GR [0.1-Deg. Grid]



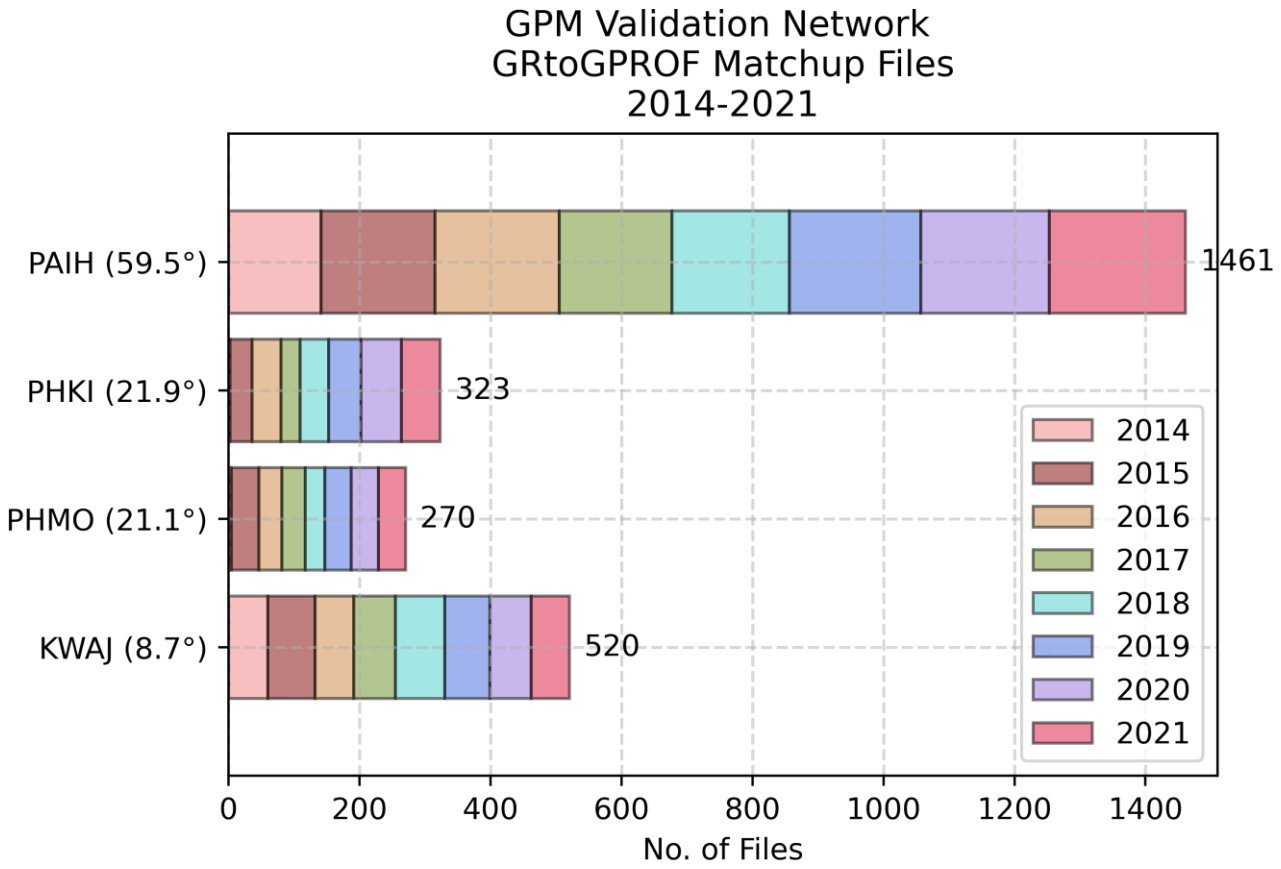
Public matchup files (GRtoGPROFtoIMERG) to be added to the Validation Network later in 2022.

The GPM Validation Network

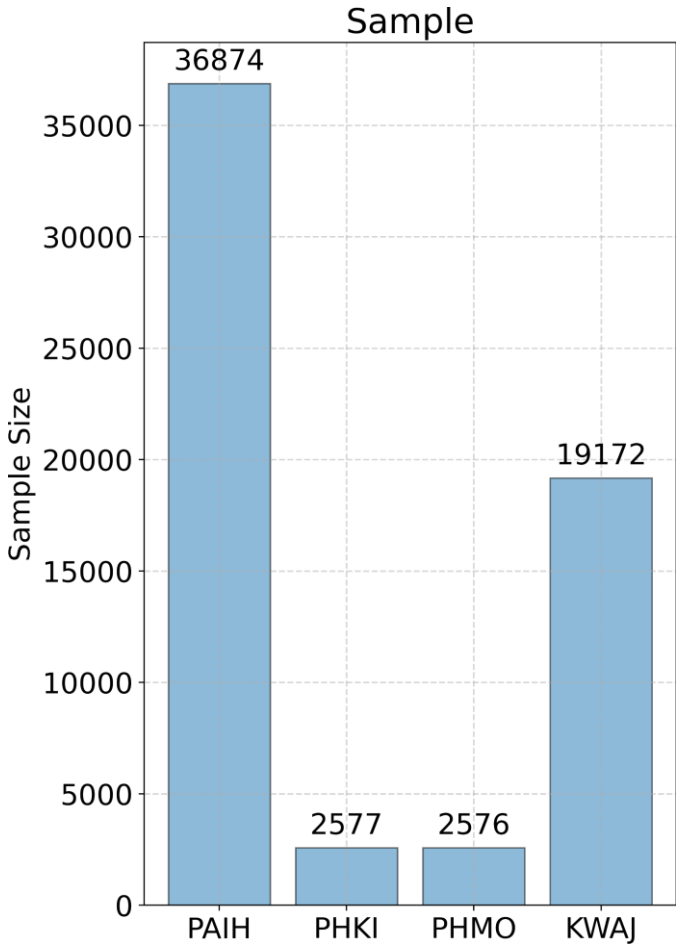
Oceanic Validation using Island Sites

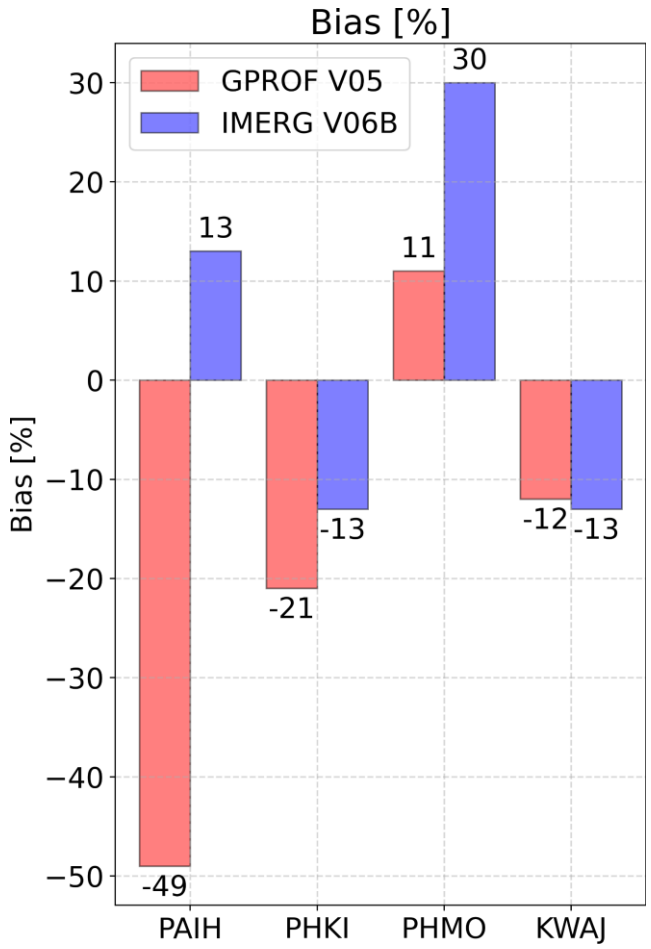
Validate IMERG V06B and GPROF V05A/B over:

- Alaska's Middleton Island [PAIH]
- Hawaii [PHKI; PHMO]
- Kwajalein Atoll [KWAJ]



Oceanic Validation with the Validation Network





- IMERG decreases GPROF oceanic mean biases for PAIH and PHKI, whilst increasing them for PHMO and KWAJ.

Rain-No Rain Threshold: 0.2 mm/h

PAIH: <75-km range only to prevent inclusion of frozen precipitation.

KWAJ: 2018 & 2019 data removed due to GR calibration offset.

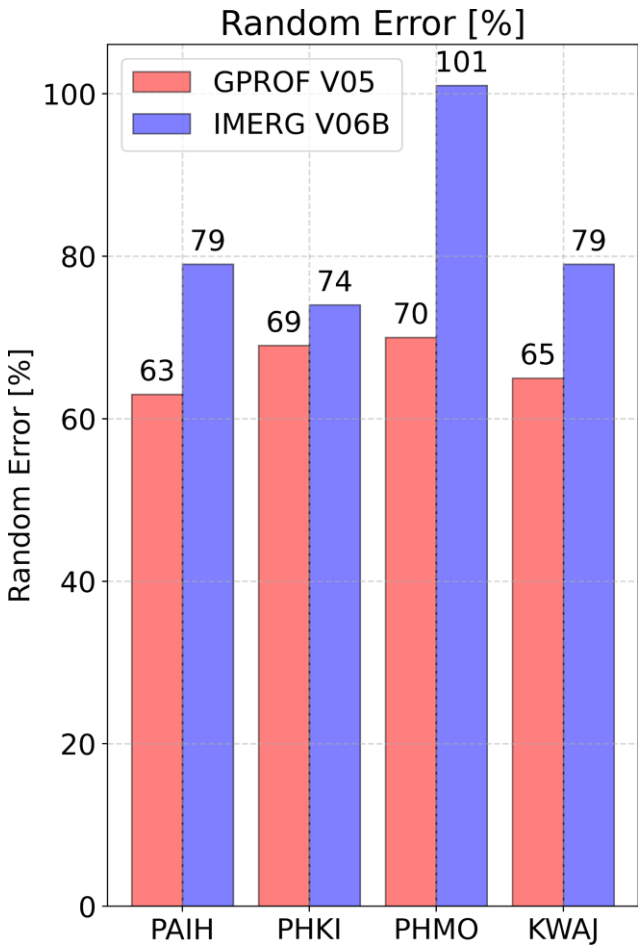
Oceanic Validation with the Validation Network

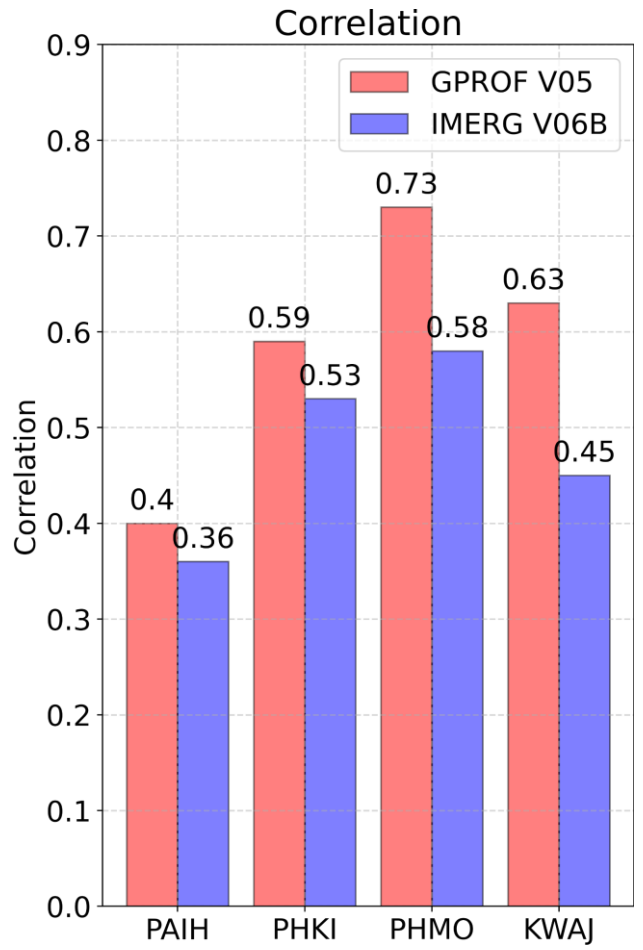
- IMERG has more variable oceanic biases and weaker correlation with GRs than GPROF.

Rain-No Rain Threshold: 0.2 mm/h

PAIH: <75-km range only to prevent inclusion of frozen precipitation.

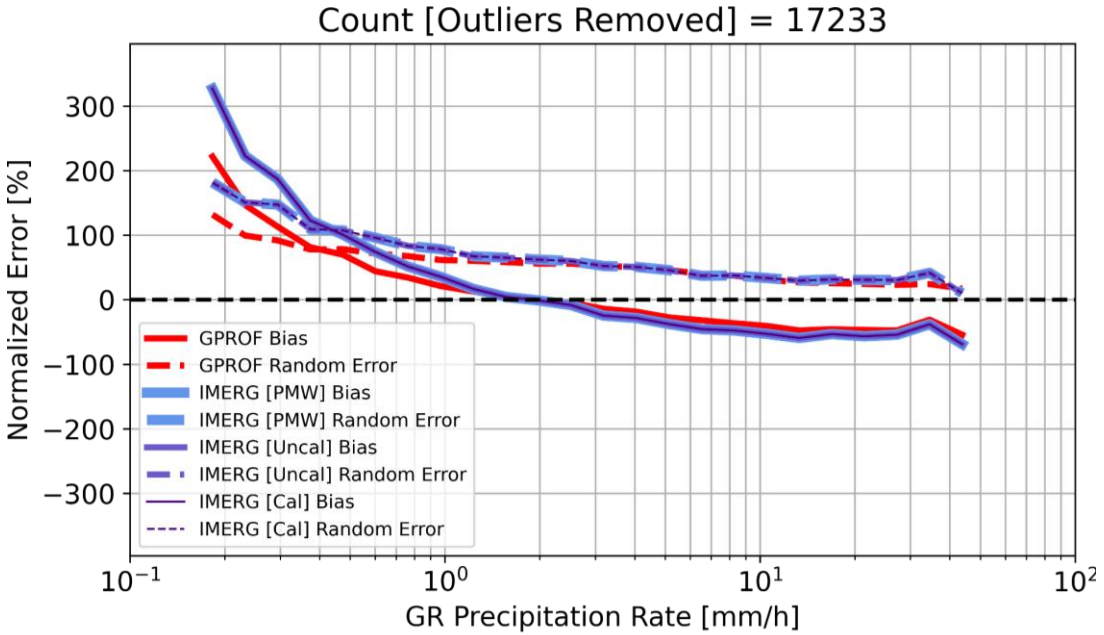
KWAJ: 2018 & 2019 data removed due to GR calibration offset.

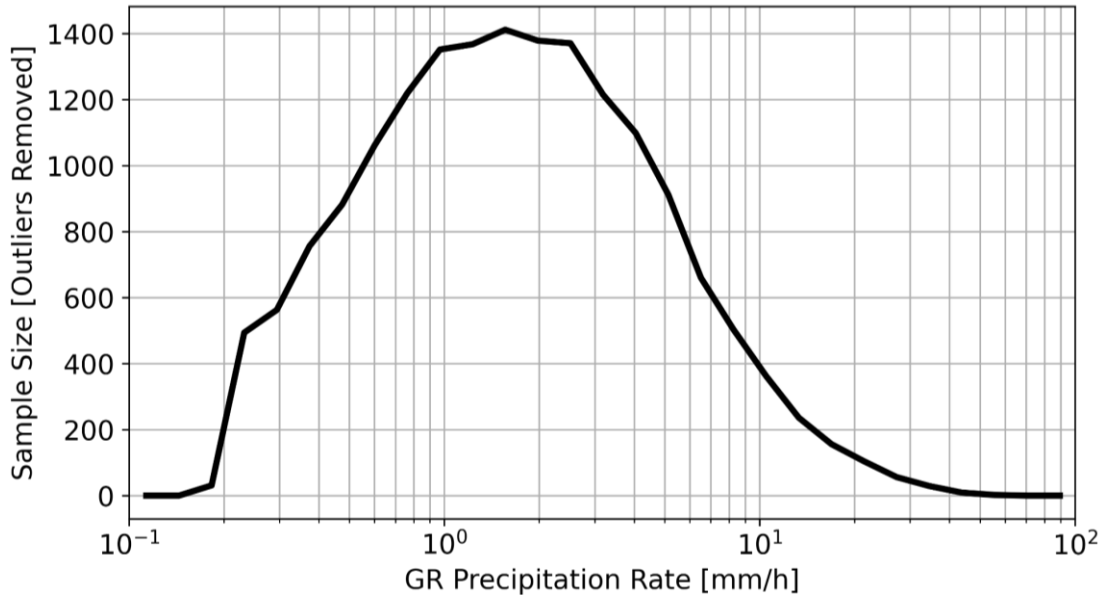




Oceanic Validation with the Validation Network

KWAJ
Jun 2014 - Aug 2021





- IMERG appears to increase overestimating bias from GPROF for light precipitation rates across all sites.
- IMERG V06B and GPROF V05 showcase overestimation of light rain and underestimation of heavy rain across all sites (except PHMO where heavy rain estimates are in close agreement with GR). V07 should address these biases across the rainfall spectrum.
- The IMERG GMI tropical biases may vary from those for IMERG estimates without passive microwave observations, for which the frequency of light precipitation rates is higher and heavy precipitation rates is lower (Rajogopal et al., 2021).

Conclusions and Future Work

- **IMERG and GPROF exhibit varying performance for GMI measurements over different oceanic regions** – highlights requirement for more oceanic evaluation of spaceborne precipitation products.
- IMERG decreases GPROF oceanic mean biases for PAIH and PHKI, whilst increasing them for PHMO and KWAJ. IMERG has more variable oceanic biases and weaker correlation with GRs than GPROF.
- **GRtoGPROFtoIMERG matchup files to be produced and available publicly later in 2022.**
- Next steps - Include Validation Network's 3D reflectivity, water content and hydrometeor identification profiles in analysis.

References

- Gatlin, P.N., Petersen, W.A., Pippitt, J.L., Berendes, T.A., Wolff, D.B. and Tokay, A. (2020). The GPM Validation Network and Evaluation of Satellite-Based Retrievals of the Rain Drop Size Distribution. *Atmosphere, 11*(9), p.1010. https://doi.org/10.3390/atmos11091010

- NASA (2021). Global Precipitation Measurement (GPM) Mission Ground Validation System – Validation Network Data Product User's Guide – Volume 2 – GPM Data Products. Accessed May 5, 2022, https://gpm.nasa.gov/sites/default/files/document_files/Val_Network_Users_Guide_Vol_2_Nov2015.pdf.

- Rajagopal, M., Zipser, E., Huffman, G., Russell, J. and Tan, J., 2021. Comparisons of IMERG version 06 precipitation at and between passive microwave overpasses in the tropics. *Journal of Hydrometeorology*, *22*(8), pp.2117-2130. https://doi.org/10.1175/JHM-D-20-0226.1

Supplementary Material

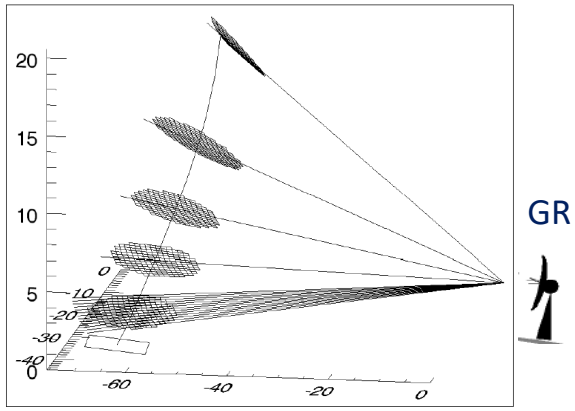
The GPM Validation Network

Ground Radar (GR) to GPROF-GMI Matchup

- Matchup event criterion: GPM Core 2AKu product identifies certain rain for >100 grid pixels (4 km x 4 km) within 100 km of GR
- 3D spatial matchups: GPROF near-surface precipitation field is matched to GR reflectivity and dual-polarization fields along:
  - Line of sight
  - Vertical profile
- Temporal matchups: GR scan set with first sweep closest in time to GPM Core overpass time is selected.

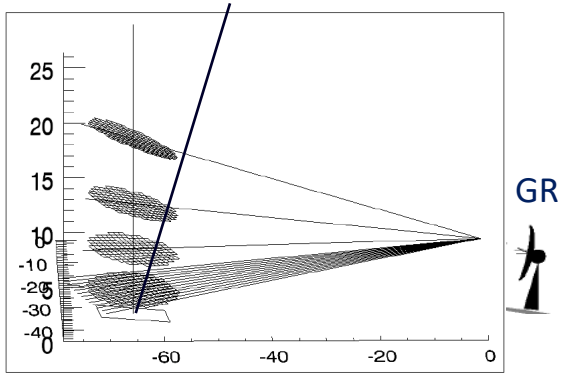
Line of Sight

GPM Core



Vertical Profile

GPM Core



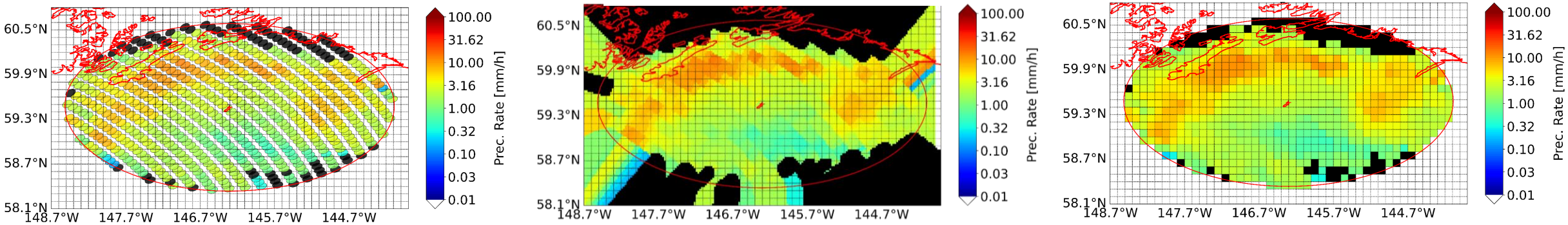
The GPM Validation Network

GR to GPROF-GMI to IMERG Matchup

Uses an approximation of the IMERG backward gridding technique for gridding precipitation at the GPROF-footprint scale.

1. Assign footprint precipitation rates to a 0.025-degree grid using a nearest neighbor population technique;
2. Coarsen the 0.025-degree precipitation grid to the IMERG 0.1-degree resolution.

GR [GPROF Footprints] → GR [0.025-Deg. Grid] → GR [0.1-Deg. Grid]



Directly comparable to IMERG

Public matchup files (GRtoGPROFtoIMERG) to be added to the Validation Network later in 2022.