

IMERG and GPROF Validation with the GPM Validation Network

Daniel Watters¹, Patrick Gatlin², Pierre Kirstetter^{3,4,5,6}, George Huffman⁷, Jackson Tan^{7,8}, Dave Bolvin^{7,9}, Eric Nelkin^{7,9}, Dave Wolff¹⁰, Jianxin Wang^{7,9}, Bob Joyce^{7,9}, Sarah Ringerud^{7,11}

1 - NASA Postdoctoral Program, NASA Marshall Space Flight Center, Huntsville, Alabama

2 - NASA Marshall Space Flight Center, Huntsville, Alabama

3 - Advanced Radar Research Center, University of Oklahoma, Norman, Oklahoma

4 - School of Civil Engineering and Environmental Sciences, University of Oklahoma, Norman, Oklahoma

5 - School of Meteorology, University of Oklahoma, Norman, Oklahoma

6 - NOAA/National Severe Storms Laboratory, Norman, Oklahoma

7 - NASA Goddard Space Flight Center, Greenbelt, Maryland

8 - University of Maryland, Baltimore County, Baltimore, Maryland

9 - Science Systems and Applications, Inc., Lanham, Maryland

10 - NASA Wallops Flight Facility, Wallops Island, Virginia

11 - Earth Systems Science Interdisciplinary Center, University of Maryland, College Park, Maryland

Overview

- 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

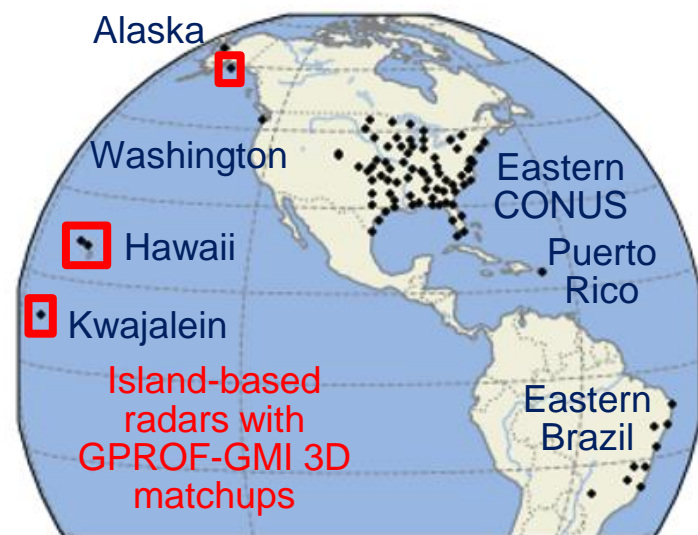
Aims:

- 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.



The GPM Validation Network

Validation Network Ground Radar (GR) Sites

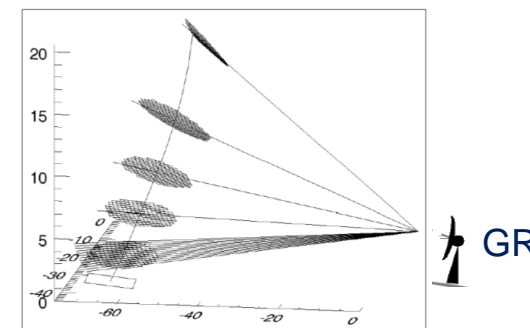


Adapted from Gatlin et al. (2020)

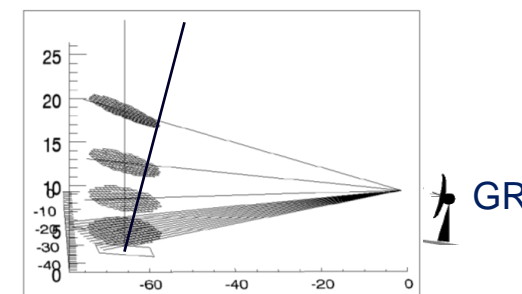
A NASA software system run at Marshall Space Flight Center that geometrically matches 3D precipitation retrievals from GPM Core sensors to ground-based radars.

GR to GPROF-GMI Matchup

Line of Sight
GPM Core



Vertical Profile
GPM Core



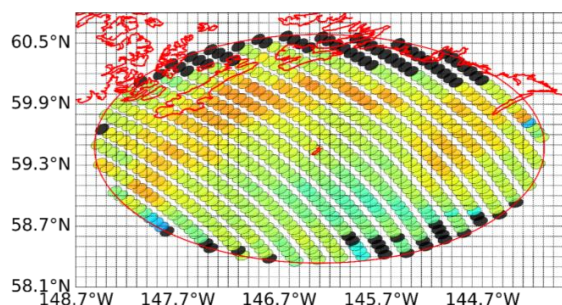
Adapted from NASA's GPM Validation Network Guide (2021)

The GPM Validation Network

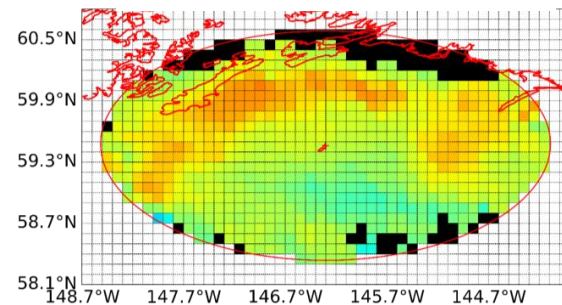
GR to GPROF-GMI to IMERG Matchup

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

GR [GPROF Footprints]



GR [0.1-Deg. Grid]



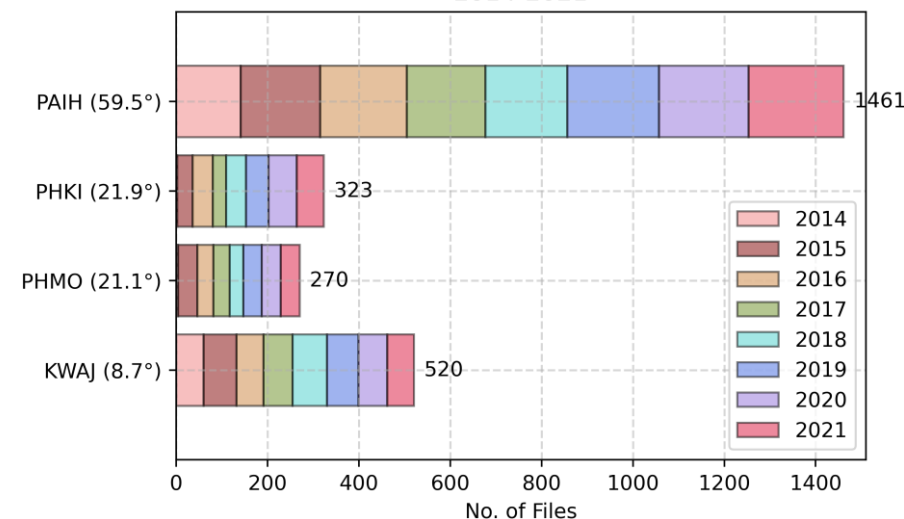
Public matchup files (GRtoGPROFtoIMERG) to be added to the Validation Network later in 2022.

Oceanic Validation using Island Sites

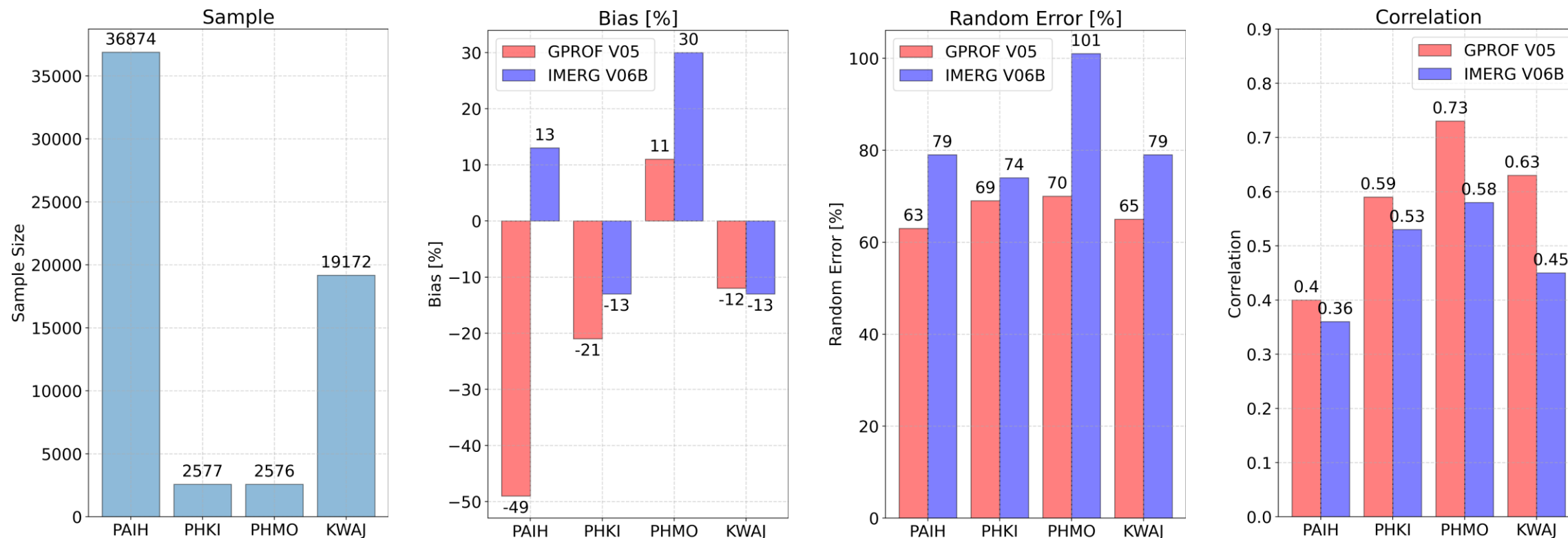
Validate IMERG V06B and GPROF V05A/B over :

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

GPM Validation Network
GRtoGPROF Matchup Files
2014-2021



Oceanic Validation with the Validation Network



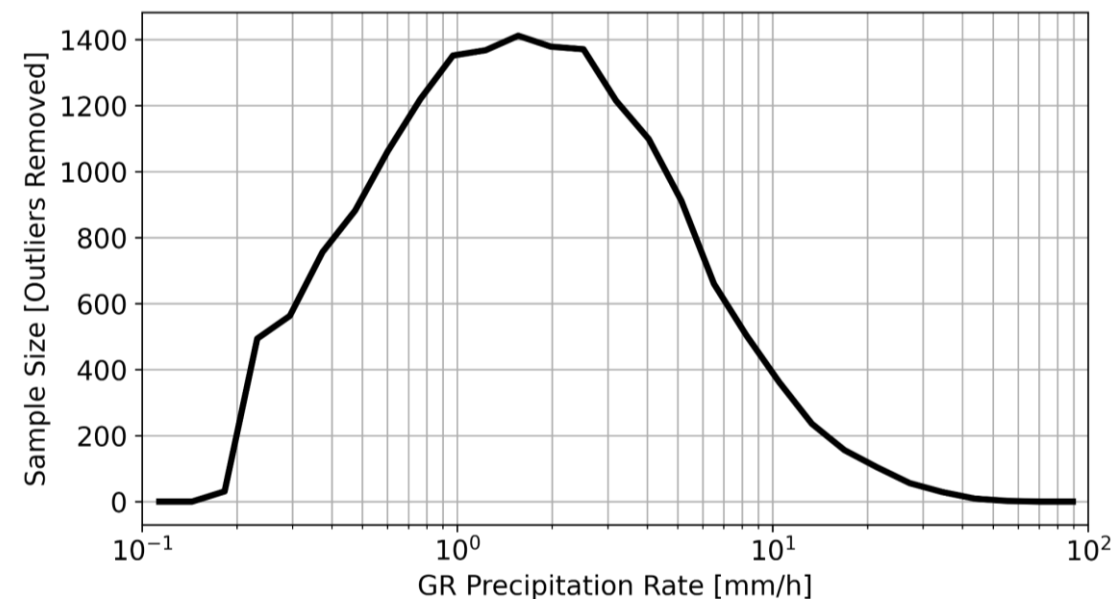
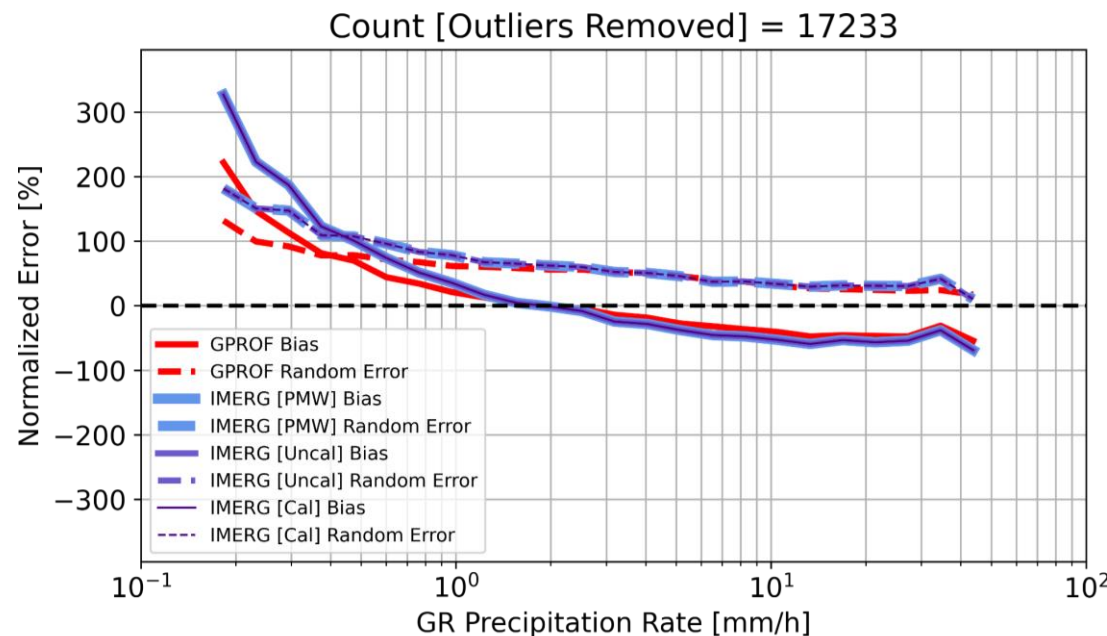
- IMERG decreases GPROF oceanic mean biases for PAIH and PHKI, whilst increasing them for PHMO and KWAJ.
- IMERG has more variable oceanic biases and weaker correlation with GRs than GPROF.

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>

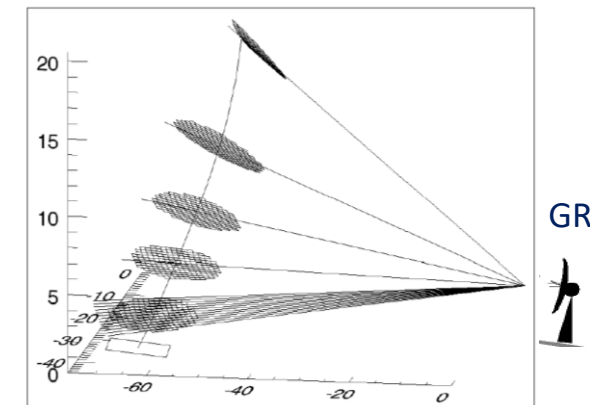
Supplementary Material

The GPM Validation Network

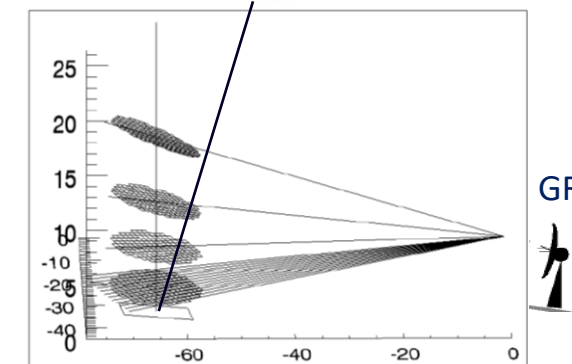
Ground Radar (GR) to GPROF-GMI Matchup

- 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



Vertical Profile

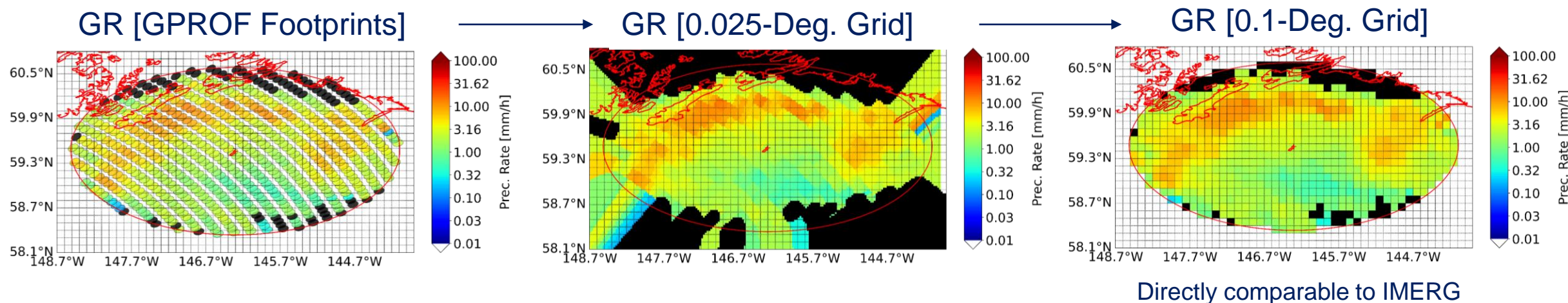


The GPM Validation Network

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.



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