



Data User Guide

GPM Ground Validation Validation Network (VN)

Introduction

The GPM Ground Validation Validation Network (VN) dataset contains reflectivity, hydrometeor identification, rain rate, correlation coefficient, and quality control variables and estimates. This data product was created using the Validation Network (VN), which performs a direct match-up of the Global Precipitation Mission (GPM)'s space-based Dual-frequency Precipitation Radar (DPR) and Microwave Imager (GMI) data with ground radar data from NOAA Weather Surveillance Radar-1988 Doppler (WSR-88D) radars. These data are available from March 10, 2014 through April 16, 2020 in netCDF-3 format, though it should be noted that this dataset will be updated periodically.

Citation

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Keywords:

NASA, GHRC, GPM, VN, DPR, GMI, ground radars, reflectivity, hydrometeor identification, rain rate, correlation coefficient

Campaign

The Global Precipitation Measurement (GPM) mission Ground Validation (GV) campaign used a variety of methods for validating GPM satellite constellation measurements prior to and after launch of the GPM Core Satellite, which occurred on February 27, 2014. The GPM instrument validation effort included numerous GPM-specific and joint agency/international external field campaigns, using state of the art cloud and precipitation observational infrastructure (polarimetric radars, profilers, rain gauges, and disdrometers). Surface rainfall was measured by very dense rain gauge and disdrometer

networks at various field campaign sites. These field campaigns accounted for the majority of the effort and resources expended by GPM GV. This dataset results from a continuous effort as part of the GPM GV program. More information about the GPM mission is available on the [NASA GPM webpage](#).

Product Description

This data product was created by the Validation Network (VN), which performs a direct match-up of the Global Precipitation Mission (GPM)'s space-based Dual-frequency Precipitation Radar (DPR) and Microwave Imager (GMI) data with ground radar (GR) data from NOAA Weather Surveillance Radar-1988 Doppler (WSR-88D) radars. At present, 75 WSR-88D sites are included in the VN operational network. Information and locations of these ground radar sites can be located in Table 1-1 within the [GPM VN Data Product User's Guide](#). The VN match-up will help evaluate the reflectance attenuation correction algorithms of the DPR and will identify biases between ground observations and satellite retrievals as they occur in different meteorological regimes.

More information about the VN data product can be found in the [GPM VN Data Product User's Guide](#) and [Schwaller and Morris, 2011](#).

Investigators

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Data Characteristics

The GPM Ground Validation Validation Network (VN) data files are available in netCDF-3 format in support of the GPM Ground Validation project. These data files are available at a Level 2 processing level. More information about the NASA data processing levels are available on the [EOSDIS Data Processing Levels](#) webpage. Table 1 shows the characteristics of these data files.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground station and Global Precipitation Measurement (GPM) Core Observatory
Instrument	WSR-88D, GPM Microwave Imager (GMI), Dual-frequency Precipitation Radar (DPR)
Projection	Equirectangular
Spatial Coverage	N: 65.634, S: -31.818, E: 169.839, W: -169.499 (Northern Hemisphere)
Spatial Resolution	100 km
Temporal Coverage	March 10, 2014 - April 16, 2020

Temporal Resolution	Hourly -< Daily (by orbit)
Sampling Frequency	<1 minute
Parameter	Reflectivity, hydrometeor identification, rain rate, correlation coefficient
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation VN data files are available at a Level 2 processing level in netCDF-3 format. These data files have the file naming convention shown below.

Data files: GRtoDPR.<site>.YYMMDD.xxxx.V###.TT.SS.F_f.nc.gz
 GRtoDPR.<site>.YYMMDD.xxxx.V###.TT.SS.F_f.RHI.nc.gz
 GRtoDPRGMI.<site>.YYMMDD.xxxx.V###.F_f.15dBZ_7km.nc.gz
 GRtoGPROF.<site>.YYMMDD.xxxx.V###.F_f.nc.gz

Table 2: File naming convention variables

Variable	Description
<site>	Ground radar site name (See Table 1-1 in GPM VN Data Product User's Guide)
YY	Two-digit year
MM	Two-digit month
DD	Two-digit day
xxxx	GPM orbit number
V###	GPM product algorithm version
TT	DPR 2A data type (DPR, KA, KU). Field does not apply to GRtoGPROF or GRtoDPRGMI matchup filenames. DPR: GPM Dual-frequency Precipitation Radar KA: Ka-band precipitation radar KU:Ku-band precipitation radar
SS	Type of swath used in the GR-DPR matchup (HS, MS, or NS). Field does not apply to GRtoGPROF and GRtoDPRGMI filenames. HS: high-resolution scan MS: matched scan NS: normal scan
F_f	Geometry match file version indicator
nc.gz	Gzipped netCDF-3 data format

Data Format and Parameters

Geometry matching netCDF-3 data files are formatted with 6 dimensions: 4 for data arrays and 2 for character variables. There are 116 regular variables and 19 attributes in the

GRtoDPR matchup files and 114 regular variables and 11 attributes in the GRtoGPROF matchup files. DPR reflectivity and rain rate profile data are obtained from the standard Level 2 GPM DPR products. A surface type flag, near-surface rain rate, bright band height, rain type, rain/no-rain flag and other variables are also included from these DPR products. These DPR files contain all three of the swath types: high-resolution scan (HS), matched scan (MS), and normal scan (NS). The Ka files contain HS and MS swaths, and the Ku files contain only the NS swath. In contrast, the GRtoDPRGMI matchup files contain volume-matched data for all instrument/swath combinations: HS, MS, and NS.

Table 3 lists and describes the data fields for GRtoDPR data files, Table 4 lists and describes the data fields for GRtoGPROF data files, and Table 5 lists and describes the data fields for GRtoDPRGMI data files. More information about these data parameters are available in the [GPM VN Data Product User’s Guide](#).

Table 3: Data Fields for GRtoDPR

Field Name	Description	Data Type	Unit
atimeNearestApproach	Text version of timeNearestApproach	char	UTC
atimeSweepStart	Text version of timeSweepStart	char	UTC
BBheight	DPR Bright Band Height above mean sea level	float	m
BBstatus	Bright Band Quality indicating the status of the bright band detection: 1 = Good 0 = bright band not detected with rain present -1111 = No-rain value -9999 = Missing data	short	-
bottomHeight	Data sample bottom height above ground level	float	km
clutterStatus	Clutter region sample adjustment status: 0 = all geometry-matched DPR gates above surface clutter region, no substitution or truncation 1 = one or more geometry-matched DPR gates below lowest clutter-free gate, DPR average truncated to include only those range gates in the clutter-free region 2 = all geometry-matched DPR gates below lowest clutter-free gate, value for vertically-averaged DPR variables set to value of the lowest DPR clutter-free gate In addition, if DPR_decluttered is set to 1 (ON), then additional DPR clutter detection	short	-

	along the DPR rays above the lowest clutter-free gate is performed. If any clutter range gates are detected and rejected from a geometry-match sample average, then 10 will be added to the clutterStatus values listed above, resulting in clutterStatus values of 10, 11, or 12.		
Dm	DPR diameter from paramDSD	float	mm
DPR_dBZ_min	Minimum DPR bin dBZ required for a complete DPR vertical average	float	dBZ
DPR_decluttered	Decluttered flag for DPR volume average data fields	short	-
DPRLatitude	Latitude of DPR surface bin	float	Degrees North
DPRLongitude	Longitude of DPR surface bin	float	Degrees East
elevationAngle	Radar sweep elevation angles	float	degrees
Epsilon	DPR Epsilon	float	-
FlagPrecip	DPR FlagPrecip 0 = No Precipitation 1 = Precipitation -9999 = Missing Value in DPR product	short	-
GR_blockage	Ground radar blockage fraction	float	-
GR_dBZ_min	Minimum ground radar bin dBZ required for a complete ground radar horizontal average	float	dBZ
GR_Dm	Dual Polarization (DP) radar retrieved median diameter	float	mm
GR_Dm_Max	Sample maximum DP retrieved median diameter	float	mm
GR_Dm_StdDev	Standard deviation of DP retrieved median diameter	float	mm
GR_Dzero	DP median volume diameter	float	mm
GR_Dzero_Max	Sample maximum DP median volume diameter	float	mm
GR_Dzero_StdDev	Standard deviation of DP median volume diameter	float	mm
GR_HID	DP hydrometeor identification MISSING = No Precipitation or Unclassified (UC) DZ = drizzle RN = rain CR = ice crystals DS = dry snow/aggregates WS = wet snow VI = vertical ice LDG = low density graupel HDG = high density graupel HA = hail BD = big drops	short	-

	HR = mixed Rain/Hail		
GR_Kdp	DP specific differential phase	float	degrees/km
GR_Kdp_Max	Sample maximum DP specific differential phase	float	degrees/km
GR_Kdp_StdDev	Standard deviation of DP specific differential phase	float	degrees/km
GR_N2	Tokay normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_N2_Max	Sample maximum Tokay normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_N2_StdDev	Standard deviation of Tokay normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_Nw	DP normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_Nw_Max	Sample maximum DP normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_Nw_StdDev	Standard deviation of DP normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_RC_rainrate	Ground radar Cifelli algorithm rain rate	float	mm/h
GR_RC_rainrate_Max	Sample maximum ground radar Cifelli algorithm rain rate	float	mm/h
GR_RC_rainrate_StdDev	Standard deviation of ground radar Cifelli algorithm rain rate	float	mm/h
GR_RHOhv	DP co-polar correlation coefficient	float	-
GR_RHOhv_Max	Sample maximum DP co-polar correlation coefficient	float	-
GR_RHOhv_StdDev	Standard deviation of DP co-polar correlation coefficient	float	-
GR_RP_rainrate	Ground radar pol Z-R rain rate	float	mm/h
GR_RP_rainrate_Max	Sample maximum ground radar pol Z-R rain rate	float	mm/h
GR_RP_rainrate_StdDev	Standard deviation of ground radar pol Z-R rain rate	float	mm/h
GR_RR_rainrate	Ground radar DROPS rain rate	float	mm/h
GR_RR_rainrate_Max	Sample maximum ground radar DROPS rain rate	float	mm/h
GR_RR_rainrate_StdDev	Standard deviation of ground radar DROPS rain rate	float	mm/h
GR_Z	Ground radar quality-controlled reflectivity	float	dBZ
GR_Z_Max	Sample maximum ground radar quality-controlled reflectivity	float	dBZ
GR_Z_StdDev	Standard deviation of ground radar quality-controlled reflectivity	float	dBZ
GR_Zdr	DP differential reflectivity	float	dB
GR_Zdr_Max	Sample maximum DP differential reflectivity	float	dB
GR_Zdr_StdDev	Standard deviation of DP differential reflectivity	float	dB

have_BBheight	Data exists flag for BBheight	short	-
have_BBstatus	Data exists flag for BBstatus	short	-
have_clutterStatus	Data exists flag for clutterStatus	short	-
have_Epsilon	Data exists flag for DPR Epsilon variable	short	-
have_FlagPrecip	Data exists flag for FlagPrecip	short	-
have_GR_blockage	Data exists flag for ground radar blockage fraction	short	-
have_GR_Dm	Data exists flag for GR_Dm	short	-
have_GR_Dzero	Data exists flag for GR_Dzero	short	-
have_GR_HID	Data exists flag for GR_HID	short	-
have_GR_Kdp	Data exists flag for GR_Kdp	short	-
have_GR_N2	Data exists flag for GR_N2	short	-
have_GR_Nw	Data exists flag for GR_Nw	short	-
have_GR_RC_rainrate	Data exists flag for GR_RC_rainrate	short	-
have_GR_RHOhv	Data exists flag for GR_RHOhv	short	-
have_GR_RP_rainrate	Data exists flag for GR_RP_rainrate	short	-
have_GR_RR_rainrate	Data exists flag for GR_RR_rainrate	short	-
have_GR_Z	Data exists flag for GR_Z	short	-
have_GR_Zdr	Data exists flag for GR_Zdr	short	-
have_heightStormTop	Data exists flag for heightStormTop	short	-
have_LandSurfaceType	Data exists flag for LandSurfaceType	short	-
have_paramDSD	Data exists flag for paramDSD variables (Dm and Nw)	short	-
have_piaFinal	Data exists flag for piaFinal	short	-
have_PrecipRate	Data exists flag for PrecipRate	short	-
have_PrecipRateSurface	Data exists flag for PrecipRateSurface	short	-
have_qualityData	Data exists flag for qualityData	short	-
have_SurfPrecipTotRate	Data exists flag for SurfPrecipTotRate	short	-
have_TypePrecip	Data exists flag for TypePrecip	short	-
have_ZFactorCorrected	Data exists flag for ZFactorCorrected	short	-
have_ZFactorMeasured	Data exists flag for ZFactorMeasured	short	-
heightStormTop	Dual -pol ratio estimated storm top height	short	m
LandSurfaceType	DPR LandSurfaceType 0-99 = Water 100-199 = Land 200-299 = Coast	short	-

	300-399 = Inland Water -9999 = Missing in DPR product -888 = Point not coincident with PR		
latitude	Latitude of data sample	float	Degrees North
longitude	Longitude of data sample	float	Degrees East
n_dpr_corr_r_rejected	Number of bins below rain_min in PrecipRate average	short	-
n_dpr_corr_z_rejected	Number of bins below DPR_dBZ_min in ZFactorCorrected average	short	-
n_dpr_epsilon_rejected	Number of bins below 0.0 in Epsilon average	short	-
n_dpr_expected	Number of bins in DPR averages	short	-
n_dpr_meas_z_rejected	Number of bins below DPR_dBZ_min in ZFactorMeasured average	short	-
n_dpr_nw_rejected	Number of bins with missing Nw in DPR Nw average	short	-
n_gr_dzero_rejected	Number of bins with missing D0 in GR_Dzero average	short	-
n_gr_expected	Number of bins in GR_Z average	short	-
n_gr_hid_rejected	Number of bins with undefined HID in GR_HID histogram	short	-
n_gr_kdp_rejected	Number of bins with missing Kdp in GR_Kdp average	short	-
n_gr_n2_rejected	Number of bins with missing N2 in GR_N2 average	short	-
n_gr_nw_rejected	Number of bins with missing Nw in GR_Nw average	short	-
n_gr_rc_rejected	Number of bins below rain_min in GR_RC_rainrate average	short	-
n_gr_rhohv_rejected	Number of bins with missing ROHhv in GR_ROHhv average	short	-
n_gr_rp_rejected	Number of bins below rain_min in GR_RP_rainrate average	short	-
n_gr_rr_rejected	Number of bins below rain_min in GR_RR_rainrate average	short	-
n_gr_z_rejected	Number of bins below GR_dBZ_min in GR_Z average	short	-
n_gr_zdr_rejected	Number of bins with missing Zdr in GR_Zdr average	short	-
numRays	Number of DPR rays per scan in original datasets	short	-
numScans	Number of DPR scans in original datasets	int	-
Nw	DPR Nw from paramDSD	float	dB mm ⁻¹ m ⁻³
piaFinal	DPR path integrated attenuation	float	dBZ
PrecipRate	DPR estimated rain rate profile	float	mm/h
PrecipRateSurface	DPR near-surface precipitation rate	float	mm/h

qualityData	DPR FLG group qualityData	int	-
rain_min	Minimum DPR rain rate required for a complete DPR vertical average	float	mm/h
rangeThreshold	Dataset maximum range from radar site	float	km
rayNum	Product-relative zero-based array index of DPR ray number	short	-
scanNum	Product-relative zero-based array index of DPR scan number	int	-
site_elev	Elevation of ground radar site above mean sea level	float	km
site_ID	ID of ground radar site	char	-
site_lat	Latitude of ground radar site	float	Degrees North
site_lon	Longitude of ground radar site	float	Degrees East
SurfPrecipTotRate	2B-DPRGMI near-surface estimated rain rate	float	mm/h
timeNearestApproach	Seconds since 01-01-1970 00:00:00	double	s
timeSweepStart	Seconds since 01-01-1970 00:00:00	double	s
topHeight	Data sample top height above ground level	float	km
TypePrecip	<p>DPR precipitation type, expressed by an 8-digit number. When value is greater than zero:</p> <p>Major rain type = TypePrecip/10000000 where: 1 = stratiform 2 = convective 3 = other</p> <p>If value is less than 0: -1111 = No rain -9999 = Missing data -888 = No data</p>	short	-
version	Geo match file version	float	-
xCorners	Data sample x corner coordinates	float	km
yCorners	Data sample y corner coordinates	float	km
ZFactorCorrected	DPR attenuation-corrected reflectivity	float	dBZ
ZFactorMeasured	DPR uncorrected reflectivity	float	dBZ

Table 4: Data Fields for GRtoGPROF

Field Name	Description	Data Type	Unit
atimeNearestApproach	Text version of timeNearestApproach	char	UTC
atimeSweepStart	Text version of timeSweepStart	char	UTC
bottomHeight	Data sample bottom height above ground level	float	km

bottomHeight_vpr	Data sample bottom height above ground level along local vertical	float	km
elevationAngle	Radar sweep elevation angles	float	degrees
freezingHeight	Freezing height	short	m
gprof_rain_min	Minimum XMI rain rate required	float	mm/h
GR_blockage_slantPath	Ground radar blockage fraction	float	-
GR_blockage_VPR	Ground radar blockage fraction along local vertical	float	-
GR_dBZ_min	Minimum ground radar bin dBZ required for a complete ground radar horizontal average	float	dBZ
GR_Dzero_Max_slantPath	Sample maximum DP median volume diameter	float	mm
GR_Dzero_Max_VPR	Sample maximum DP median volume diameter along local vertical	float	mm
GR_Dzero_slantPath	DP median volume diameter	float	mm
GR_Dzero_StdDev_slantPath	Standard deviation of DP median volume diameter	float	mm
GR_Dzero_StdDev_VPR	Standard deviation of DP median volume diameter along local vertical	float	mm
GR_Dzero_VPR	DP median volume diameter along local vertical	float	mm
GR_HID_slantPath	DP hydrometeor identification MISSING = No Precipitation or Unclassified (UC) DZ = drizzle RN = rain CR = ice crystals DS = dry snow/aggregates WS = wet snow VI = vertical ice LDG = low density graupel HDG = high density graupel HA = hail BD = big drops HR = mixed Rain/Hail	short	-
GR_HID_VPR	DP hydrometeor identification along local vertical MISSING = No Precipitation or Unclassified (UC) DZ = drizzle RN = rain CR = ice crystals DS = dry snow/aggregates WS = wet snow VI = vertical ice LDG = low density graupel	short	-

	HDG = high density graupel HA = hail BD = big drops HR = mixed Rain/Hail		
GR_Kdp_Max_slantPath	Sample maximum DP specific differential phase	float	degrees/k m
GR_Kdp_Max_VPR	Sample maximum DP specific differential phase along local vertical	float	degrees/k m
GR_Kdp_slantPath	DP specific differential phase	float	degrees/k m
GR_Kdp_StdDev_slantPath	Standard deviation of DP specific differential phase	float	degrees/k m
GR_Kdp_StdDev_VPR	Standard deviation of DP specific differential phase along local vertical	float	degrees/k m
GR_Kdp_VPR	DP specific differential phase along local vertical	float	degrees/k m
GR_Nw_Max_slantPath	Sample maximum DP normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_Nw_Max_VPR	Sample maximum DP normalized intercept parameter along local vertical	float	mm ⁻¹ m ⁻³
GR_Nw_slantPath	DP normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_Nw_StdDev_slantPath	Standard deviation of DP normalized intercept parameter	float	mm ⁻¹ m ⁻³
GR_Nw_StdDev_VPR	Standard deviation of DP normalized intercept parameter along local vertical	float	mm ⁻¹ m ⁻³
GR_Nw_VPR	DP normalized intercept parameter along local vertical	float	mm ⁻¹ m ⁻³
GR_RC_rainrate_Max_slantPath	Sample maximum ground radar Cifelli algorithm rain rate	float	mm/h
GR_RC_rainrate_Max_VPR	Sample maximum ground radar Cifelli algorithm rain rate along local vertical	float	mm/h
GR_RC_rainrate_slantPath	Ground radar Cifelli rain rate	float	dBZ
GR_RC_rainrate_StdDev_slantPath	Standard deviation of ground radar Cifelli algorithm rain rate	float	dBZ
GR_RC_rainrate_StdDev_VPR	Standard deviation of ground radar Cifelli algorithm rain rate along local vertical	float	dBZ
GR_RC_rainrate_VPR	Ground radar Cifelli rain rate along local vertical	float	dBZ
GR_RHOhv_Max_slantPath	Sample maximum DP co-polar correlation coefficient	float	-
GR_RHOhv_Max_VPR	Sample maximum DP co-polar correlation coefficient along local vertical	float	-
GR_RHOhv_slantPath	DP co-polar correlation coefficient	float	-
GR_RHOhv_StdDev_slantPath	Standard deviation of DP co-polar correlation coefficient	float	-

GR_RHOhv_StdDev_VPR	Standard deviation of DP co-polar correlation coefficient along local vertical	float	-
GR_RHOhv_VPR	DP co-polar correlation coefficient along local vertical	float	-
GR_RP_rainrate_Max_slantPath	Sample maximum ground radar pol Z-R rain rate	float	dBZ
GR_RP_rainrate_Max_VPR	Sample maximum ground radar pol Z-R rain rate along local vertical	float	dBZ
GR_RP_rainrate_slantPath	Ground radar pol Z-R rain rate	float	dBZ
GR_RP_rainrate_StdDev_slantPath	Standard deviation of ground radar pol Z-R rain rate	float	dBZ
GR_RP_rainrate_StdDev_VPR	Standard deviation of ground radar pol Z-R rain rate along local vertical	float	dBZ
GR_RP_rainrate_VPR	Ground radar pol Z-R rain rate along local vertical	float	dBZ
GR_RR_rainrate_Max_slantPath	Sample maximum ground radar DROPS rain rate	float	dBZ
GR_RR_rainrate_Max_VPR	Sample maximum ground radar DROPS rain rate along local vertical	float	dBZ
GR_RR_rainrate_slantPath	Ground radar DROPS rain rate	float	dBZ
GR_RR_rainrate_StdDev_slantPath	Standard deviation of ground radar DROPS rain rate	float	dBZ
GR_RR_rainrate_StdDev_VPR	Standard deviation of ground radar DROPS rain rate along local vertical	float	dBZ
GR_RR_rainrate_VPR	Ground radar DROPS rain rate along local vertical	float	dBZ
GR_Z_Max_slantPath	Sample maximum ground radar quality-controlled reflectivity	float	dBZ
GR_Z_Max_VPR	Sample maximum ground radar quality-controlled reflectivity along local vertical	float	dBZ
GR_Z_slantPath	Ground radar quality-controlled reflectivity	float	dBZ
GR_Z_StdDev_slantPath	Standard deviation of ground radar quality-controlled reflectivity	float	dBZ
GR_Z_StdDev_VPR	Standard deviation of ground radar quality-controlled reflectivity along local vertical	float	dBZ
GR_Z_VPR	Ground radar quality-controlled reflectivity along local vertical	float	dBZ
GR_Zdr_Max_slantPath	Sample maximum DP differential reflectivity	float	dB
GR_Zdr_Max_VPR	Sample maximum DP differential reflectivity along local vertical	float	dB
GR_Zdr_slantPath	DP differential reflectivity	float	dB
GR_Zdr_StdDev_slantPath	Standard deviation of DP differential reflectivity	float	dB

GR_Zdr_StdDev_VPR	Standard deviation of DP differential reflectivity along local vertical	float	dB
GR_Zdr_VPR	DP differential reflectivity along local vertical	float	dB
have_freezingHeight	Data exists flag for freezingHeight	short	-
have_GR_blockage_slantPath	Data exists flag for ground radar blockage fraction	short	-
have_GR_blockage_VPR	Data exists flag for ground radar blockage fraction along local vertical	short	-
have_GR_Dzero_slantPath	Data exists flag for GR_Dzero_slantPath	short	-
have_GR_Dzero_VPR	Data exists flag for GR_Dzero_VPR	short	-
have_GR_HID_slantPath	Data exists flag for GR_HID_slantPath	short	-
have_GR_HID_VPR	Data exists flag for GR_HID_VPR	short	-
have_GR_Kdp_slantPath	Data exists flag for GR_Kdp_slantPath	short	-
have_GR_Kdp_VPR	Data exists flag for GR_Kdp_VPR	short	-
have_GR_Nw_slantPath	Data exists flag for GR_Nw_slantPath	short	-
have_GR_Nw_VPR	Data exists flag for GR_Nw_VPR	short	-
have_GR_RC_rainrate_slantPath	Data exists flag for GR_RC_rainrate_slantPath	short	-
have_GR_RC_rainrate_VPR	Data exists flag for GR_RC_rainrate_VPR	short	-
have_GR_RHOhv_slantPath	Data exists flag for GR_RHOhv_slantPath	short	-
have_GR_RHOhv_VPR	Data exists flag for GR_RHOhv_VPR	short	-
have_GR_RP_rainrate_slantPath	Data exists flag for GR_RP_rainrate_slantPath	short	-
have_GR_RP_rainrate_VPR	Data exists flag for GR_RP_rainrate_VPR	short	-
have_GR_RR_rainrate_slantPath	Data exists flag for GR_RR_rainrate_slantPath	short	-
have_GR_RR_rainrate_VPR	Data exists flag for GR_RR_rainrate_VPR	short	-
have_GR_Z_slantPath	Data exists flag for GR_Z_slantPath	short	-
have_GR_Z_VPR	Data exists flag for GR_Z_VPR	short	-
have_GR_Zdr_slantPath	Data exists flag for GR_Zdr_slantPath	short	-
have_GR_Zdr_VPR	Data exists flag for GR_Zdr_VPR	short	-
have_pixelStatis	Data exists flag for pixelStatus	short	-
have_PoP	Data exists flag for PoP	short	-
have_surfacePrecipitation	Data exists flag for surfacePrecipitation	short	-
have_surfaceTypeIndex	Data exists flag for surfaceTypeIndex	short	-
have_Tc	Data exists flag for Tc	short	-
latitude	Latitude of data sample	float	Degrees North

longitude	Longitude of data sample	float	Degrees East
n_gr_dzero_rejected	Number of bins with missing D0 in GR_Dzero average	short	-
n_gr_dzero_vpr_rejected	Number of bins with missing D0 in GR_Dzero_VPR average	short	-
n_gr_expected	Number of bins in GR_Z average	short	-
n_gr_hid_rejected	Number of bins with undefined HID in GR_HID histogram	short	-
n_gr_hid_vpr_rejected	Number of bins with undefined HID in GR_HID_VPR histogram	short	-
n_gr_kdp_rejected	Number of bins with missing Kdp in GR_Kdp average	short	-
n_gr_kdp_vpr_rejected	Number of bins with missing Kdp in GR_Kdp_VPR average	short	-
n_gr_nw_rejected	Number of bins with missing Nw in GR_Nw average	short	-
n_gr_nw_vpr_rejected	Number of bins with missing Nw in GR_Nw_VPR average	short	-
n_gr_rc_rejected	Number of bins below rain_min in GR_RC_rainrate average	short	-
n_gr_rc_vpr_rejected	Number of bins below rain_min in GR_RC_rainrate_VPR average	short	-
n_gr_rhohv_rejected	Number of bins with missing ROHhv in GR_ROHhv average	short	-
n_gr_rhohv_vpr_rejected	Number of bins with missing ROHhv in GR_ROHhv_VPR average	short	-
n_gr_rp_rejected	Number of bins below gprof_rain_min in GR_RP_rainrate_slantPath average	short	-
n_gr_rp_vpr_rejected	Number of bins below gprof_rain_min in GR_RP_rainrate_VPR average	short	-
n_gr_rr_rejected	Number of bins below gprof_rain_min in GR_RR_rainrate_slantPath average	short	-
n_gr_rr_vpr_rejected	Number of bins below gprof_rain_min in GR_RR_rainrate_VPR average	short	-
n_gr_vpr_expected	Number of bins in GR_Z_VPR, GR_rainrate_VPR averages	short	-
n_gr_z_rejected	Number of bins below GR_dBZ_min in GR_Z_slantPath average	short	-
n_gr_z_vpr_rejected	Number of bins below GR_dBZ_min in GR_Z_VPR average	short	-
n_gr_zdr_rejected	Number of bins with missing Zdr in GR_Zdr_slantPath average	short	-
n_gr_zdr_vpr_rejected	Number of bins with missing Zdr in GR_Zdr_VPR average	short	-
pixelStatus	2A-GPROF pixelStatus 0 = Valid pixel	short	-

	1 = Boundary error in landmask 2 = Boundary error in sea-ice check 3 = Boundary error in sea surface temperature 4 = Invalid time 5 = Invalid latitude/longitude 6 = Invalid brightness temperature 7 = Invalid sea surface temperature -99 = Missing value		
PoP	2A-GPROF probability of precipitation	short	%
Quality	1C-R-XCAL common calibrated brightness temperature quality	short	-
radiusOfInfluence	Radius of influence for distance weighting of ground radar bins	float	km
rangeThreshold	Dataset maximum range from radar site	float	km
rayIndex	XMI product-relative ray, scan IDL 1-D array index	int	-
site_elev	Elevation of ground radar site above mean sea level	float	km
site_ID	ID of ground radar site	char	-
site_lat	Latitude of ground radar site	float	Degrees North
site_lon	Longitude of ground radar site	float	Degrees East
surfacePrecipitation	2A-GPROF estimated surface rain rate	float	mm/h
surfaceTypeIndex	2A-GPROF surfaceTypeIndex 1 = Ocean 2 = Sea-Ice 3 = Maximum vegetation 4 = High vegetation 5 = Moderate vegetation 6 = Low vegetation 7 = Minimal vegetation 8 = Maximum snow 9 = Moderate snow 10 = Low snow 11 = Minimal snow 12 = Standing water and rivers 13 = Water/Land coast boundary 14 = Water/Ice boundary 15 = Land/Ice boundary -99 = Missing value	short	-
Tc	1C-R-XCAL common calibrated brightness temperature	float	K
Tc_channel_names	Tc channel frequency/polarization names	char	-

Tc_names	Tc channel names	char	-
timeNearestApproach	Seconds since 01-01-1970 00:00:00	double	s
timeSweepStart	Seconds since 01-01-1970 00:00:00	double	s
topHeight	Data sample top height above ground level	float	km
topHeight_vpr	Data sample top height above ground level along local vertical	float	km
version	Geo match file version	float	-
xCorners	Data sample x corner coordinates	float	km
XMIlatitude	Latitude of XMI surface bin	float	Degrees North
XMIlongitude	Longitude of XMI surface bin	float	Degrees East
yCorners	Data sample y corner coordinates	float	km

Table 5: Data Fields for GRtoDPRGMI

Field Name	Description	Data Type	Unit
elevationAngle	Radar sweep elevation angles	float	degrees
have_swath_MS	Data exists flag for MS swath	short	-
Year_MS	Year of DPR MS scan	short	-
Month_MS	Month of DPR MS scan	byte	-
DayOfMonth_MS	DayOfMonth of DPR MS scan	byte	-
Hour_MS	Hour of DPR MS scan	byte	-
Minute_MS	Minute of DPR MS scan	byte	-
Second_MS	Second of DPR MS scan	byte	-
Millisecond_MS	Millisecond of DPR MS scan	short	-
Year_NS	Year of DPR NS scan	short	-
Month_NS	Month of DPR NS scan	byte	-
DayOfMonth_NS	DayOfMonth of DPR NS scan	byte	-
Hour_NS	Hour of DPR NS scan	byte	-
Minute_NS	Minute of DPR NS scan	byte	-
Second_NS	Second of DPR NS scan	byte	-
Millisecond_MS	Millisecond of DPR NS scan	short	-
startScan_MS	Starting DPR MS overlap scan in original dataset, zero-based	int	-
endScan_MS	Ending DPR MS overlap scan in original dataset, zero-based	int	-
numRays_MS	Number of DPR MS rays per scan in original datasets	short	-
startScan_NS	Starting DPR NS overlap scan in original dataset, zero-based	int	-
endScan_NS	Ending DPR NS overlap scan in original dataset, zero-based	int	-
numRays_NS	Number of DPR NS rays per scan in original datasets	short	-

rangeThreshold	Dataset maximum range from radar site	float	km
DPR_dBZ_min	Minimum DPR bin dBZ required for *complete* DPR vertical average	float	dBZ
GR_dBZ_min	Minimum GR bin dBZ required for a *complete* GR horizontal average	float	dBZ
rain_min	Minimum DPR rainrate required for a *complete* DPR vertical average	float	mm/h
have_GR_Z	Data exists flag for GR_Z	short	-
have_GR_Zdr	Data exists flag for GR_Zdr	short	-
have_GR_Kdp	Data exists flag for GR_Kdp	short	-
have_GR_RHOhv	Data exists flag for GR_RHOhv	short	-
have_GR_RC_rainrate	Data exists flag for GR_RC_rainrate	short	-
have_GR_RP_rainrate	Data exists flag for GR_RP_rainrate	short	-
have_GR_RR_rainrate	Data exists flag for GR_RR_rainrate	short	-
have_GR_HID	Data exists flag for GR_HID	short	-
have_GR_Dzero	Data exists flag for GR_Dzero	short	-
have_GR_Nw	Data exists flag for GR_Nw	short	-
latitude_MS	Latitude of 3-D data sample	float	Degrees North
longitude_MS	Longitude of 3-D data sample	float	Degrees East
xCorners_MS	Data sample x corner coords.	float	km
yCorners_MS	Data sample y corner coords.	float	km
topHeight_MS	Data sample top height AGL	float	km
bottomHeight_MS	Data sample bottom height AGL	float	km
GR_Z_MS	GV radar QC reflectivity	float	dBZ
GR_Z_StdDev_MS	Standard deviation of GV radar QC reflectivity	float	dBZ
GR_Z_Max_MS	Sample Maximum GV radar QC reflectivity	float	dBZ
GR_Zdr_MS	DP differential reflectivity	float	dB
GR_Zdr_StdDev_MS	Standard deviation of DP differential reflectivity	float	dB
GR_Zdr_Max_MS	Sample maximum DP differential reflectivity	float	dB
GR_Kdp_MS	DP specific differential phase	float	deg/km
GR_Kdp_StdDev_MS	Standard deviation of DP specific differential phase	float	deg/km
GR_Kdp_Max_MS	Sample maximum DP specific differential phase	float	deg/km
GR_RHOhv_MS	DP co-polar correlation coefficient	float	-

GR_RHOhv_StdDev_MS	Standard deviation of DP co-polar correlation coefficient	float	-
GR_RHOhv_Max_MS	Sample maximum DP co-polar correlation coefficient	float	-
GR_RC_rainrate_MS	GV radar Cifelli rainrate	float	mm/h
GR_RC_rainrate_StdDev_MS	Standard deviation of GV radar Cifelli rainrate	float	mm/h
GR_RC_rainrate_Max_MS	Sample maximum GV radar Cifelli rainrate	float	mm/h
GR_RP_rainrate_MS	GV radar PolZR rainrate	float	mm/h
GR_RR_rainrate_MS	GV radar DROPS rainrate	float	mm/h
GR_RR_rainrate_StdDev_MS	Standard deviation of GV radar DROP rainrate	float	mm/h
GR_RR_rainrate_Max_MS	Sample maximum GV radar DROPS rainrate	float	mm/h
GR_HID_MS	DP hydrometeor identification	short	-
GR_Dzero_MS	DP median volume diameter	float	mm
GR_Dzero_StdDev_MS	Standard deviation of DP median volume diameter	float	mm
GR_Dzero_Max_MS	Sample maximum DP median volume diameter	float	mm
GR_Nw_MS	DP normalized intercept parameter	float	$1/(\text{mm}^3 \cdot \text{m}^3)$
GR_Nw_StdDev_MS	Standard deviation of DP normalized intercept parameter	float	$1/(\text{mm}^3 \cdot \text{m}^3)$
GR_Nw_Max_MS	Sample maximum DP normalized intercept parameter	float	$1/(\text{mm}^3 \cdot \text{m}^3)$
n_gr_z_rejected_MS	Number of bins below GR_dBZ_min in GR_Z average	short	-
n_gr_zdr_rejected_MS	Number of bins with missing Zdr in GR_Zdr average	short	-
n_gr_kdp_rejected_MS	Number of bins with missing Kdp in GR_Kdp average	short	-
n_gr_rhohv_rejected_MS	Number of bins with missing RHOhv in GR_RHOhv average	short	-
n_gr_rp_rejected_MS	Number of bins below rain_min in GR_RP_rainrate average	short	-
n_gr_rr_rejected_MS	Number of bins below rain_min in GR_RR_rainrate average	short	-
n_gr_hid_rejected_MS	Number of bins with undefined HID in GR_HID histogram	short	-
n_gr_dzero_rejected_MS	Number of bins with missing D0 in GR_Dzero average	short	-
n_gr_nw_rejected_MS	Number of bins with missing Nw in GR_Nw average	short	-
n_gr_expected_MS	Number of bins in Gr_Z average	short	-

precipTotPSDparamHigh_MS	2B-DPRGMI precipTotPSDparamHigh for MS swath	float	mm_Dm
precipTotPSDparamLow_MS	2B-DPRGMI precipTotPSDparamLow for MS swath	float	Nw_mu
precipTotRate_MS	2B-DPRGMI precipTotRate for MS swath	float	mmh
precipTotWaterCont_MS	2B-DPRGMI precipTotWaterCont for MS swath	float	g/m ³
n_precipTotPSDparamHigh_rejected_MS	Number of bins below rain_min in precipTotPSDparamHigh average for MS swath	short	-
n_precipTotPSDparamLow_rejected_MS	Number of bins below rain_min in precipTotPSDparamLow average for MS swath	short	-
n_precipTotRate_rejected_MS	Number of bins below rain_min in precipTotRate average for MS swath	short	-
n_precipTotWaterCont_rejected_MS	Number of bins below rain_min in precipTotWaterCont average for MS swath	short	-
precipitationType_MS	2B_DPRGMI precipitationType for MS swath	int	-
surfPrecipTotRate_MS	2B_DPRGMI surfPrecipTotRate for MS swath	float	mm/h
surfaceElevation_MS	2B_DPRGMI surfaceElevation for MS swath	float	m
surfaceType_MS	2B-DPRGMI surfaceType for MS swath	int	-
phaseBinNodes_MS	2B-DPRGMI phaseBinNodes for MS swath	short	-
DPRlatitude_MS	Latitude of DPR surface bin for MS swath	float	Degrees North
DPRlongitude_MS	Longitude of DPR surface bin for MS swath	float	Degrees East
scanNum_MS	Product-relative zero-based DPR scan number for MS swath	short	-
rayNum_MS	Product-relative zero-based DPR ray number for MS swath	short	-
ellipsoidBinOffset_MS	2B-DPRGMI Ku and Ka ellipsoidBinOffset for MS swath	float	m
lowestClutterFreeBin_MS	2B-DPRGMI Ku and Ka lowestClutterFreeBin for MS swath	short	-
precipitationFlag_MS	2B-DPRGMI Ku and Ka precipitationFlag for MS swath	int	-
surfaceRangeBin_MS	2B-DPRGMI Ku and Ka surfaceRangeBin for MS swath	short	-
correctedReflectFactor_MS	2B-DPRGMI Ku and Ka corrected reflectivity factor for MS swath	float	dBZ
pia_MS	2B-DPRGMI Ku and Ka path integrated attenuation for MS swath	float	dB

n_correctedReflectFactor_rejected_MS	Numbers of Ku and Ka bins below DPR_dBZ_min in correctedReflectFactor average for MS_swath	short	-
n_dpr_expected_MS	Numbers of expected Ku and Ka bins in DPR averages for MS swath	short	-
latitude_NS	Latitude of 3-D data sample	float	Degrees North
longitude_NS	Longitude of 3-D data sample	float	Degrees East
xCorners_NS	Data sample x corner coords.	float	km
yCorners_NS	Data sample y corner coords.	float	km
topHeight_NS	Data sample top height AGL	float	km
bottomHeight_NS	Data sample bottom height AGL	float	km
GR_Z_NS	GV radar QC reflectivity	float	dBZ
GR_Z_StdDev_NS	Standard deviation of GV radar QC reflectivity	float	dBZ
GR_Z_Max_NS	Sample Maximum GV radar QC reflectivity	float	dBZ
GR_Zdr_NS	DP differential reflectivity	float	dB
GR_Zdr_StdDev_NS	Standard deviation of DP differential reflectivity	float	dB
GR_Zdr_Max_NS	Sample maximum DP differential reflectivity	float	dB
GR_Kdp_NS	DP specific differential phase	float	deg/km
GR_Kdp_StdDev_NS	Standard deviation of DP specific differential phase	float	deg/km
GR_Kdp_Max_NS	Sample maximum DP specific differential phase	float	deg/km
GR_RHOhv_NS	DP co-polar correlation coefficient	float	-
GR_RHOhv_StdDev_NS	Standard deviation of DP co-polar correlation coefficient	float	-
GR_RHOhv_Max_NS	Sample maximum DP co-polar correlation coefficient	float	-
GR_RC_rainrate_NS	GV radar Cifelli rainrate	float	mm/h
GR_RC_rainrate_StdDev_NS	Standard deviation of GV radar Cifelli rainrate	float	mm/h
GR_RC_rainrate_Max_NS	Sample maximum GV radar Cifelli rainrate	float	mm/h
GR_RP_rainrate_NS	GV radar PolZR rainrate	float	mm/h
GR_RR_rainrate_NS	GV radar DROPS rainrate	float	mm/h
GR_RR_rainrate_StdDev_NS	Standard deviation of GV radar DROP rainrate	float	mm/h
GR_RR_rainrate_Max_NS	Sample maximum GV radar DROPS rainrate	float	mm/h

GR_HID_NS	DP hydrometeor identification	short	-
GR_Dzero_NS	DP median volume diameter	float	mm
GR_Dzero_StdDev_NS	Standard deviation of DP median volume diameter	float	mm
GR_Dzero_Max_NS	Sample maximum DP median volume diameter	float	mm
GR_Nw_NS	DP normalized intercept parameter	float	$1/(\text{mm}^3 \cdot \text{m})$
GR_Nw_StdDev_NS	Standard deviation of DP normalized intercept parameter	float	$1/(\text{mm}^3 \cdot \text{m})$
GR_Nw_Max_NS	Sample maximum DP normalized intercept parameter	float	$1/(\text{mm}^3 \cdot \text{m})$
n_gr_z_rejected_NS	Number of bins below GR_dBZ_min in GR_Z average	short	-
n_gr_zdr_rejected_NS	Number of bins with missing Zdr in GR_Zdr average	short	-
n_gr_kdp_rejected_NS	Number of bins with missing Kdp in GR_Kdp average	short	-
n_gr_rhohv_rejected_NS	Number of bins with missing RHOhv in GR_RHOhv average	short	-
n_gr_rp_rejected_NS	Number of bins below rain_min in GR_RP_rainrate average	short	-
n_gr_rr_rejected_NS	Number of bins below rain_min in GR_RR_rainrate average	short	-
n_gr_hid_rejected_NS	Number of bins with undefined HID in GR_HID histogram	short	-
n_gr_dzero_rejected_NS	Number of bins with missing D0 in GR_Dzero average	short	-
n_gr_nw_rejected_NS	Number of bins with missing Nw in GR_Nw average	short	-
n_gr_expected_NS	Number of bins in Gr_Z average	short	-
precipTotPSDparamHigh_NS	2B-DPRGMI precipTotPSDparamHigh for NS swath	float	mm_Dm
precipTotPSDparamLow_NS	2B-DPRGMI precipTotPSDparamLow for NS swath	float	Nw_mu
precipTotRate_NS	2B-DPRGMI precipTotRate for NS swath	float	mmh
precipTotWaterCont_NS	2B-DPRGMI precipTotWaterCont for NS swath	float	g/m^3
n_precipTotPSDparamHigh_rejected_NS	Number of bins below rain_min in precipTotPSDparamHigh average for NS swath	short	-
n_precipTotPSDparamLow_rejected_NS	Number of bins below rain_min in precipTotPSDparamLow average for NS swath	short	-
n_precipTotRate_rejected_NS	Number of bins below rain_min in precipTotRate average for NS swath	short	-

n_precipTotWaterCont_rejected_NS	Number of bins below rain_min in precipTotWaterCont average for NS swath	short	-
precipitationType_NS	2B-DPRGMI precipitationType for NS swath	int	-
surfPrecipTotRate_NS	2B-DPRGMI surfPrecipTotRate for NS swath	float	mm/h
surfaceElevation_NS	2B-DPRGMI surfaceElevation for NS swath	float	m
surfaceType_NS	2B-DPRGMI surfaceType for NS swath	int	-
phaseBinNodes_NS	2B-DPRGMI phaseBinNodes for NS swath	short	-
DPRlatitude_NS	Latitude of DPR surface bin for NS swath	float	Degrees North
DPRlongitude_NS	Longitude of DPR surface bin for NS swath	float	Degrees East
scanNum_NS	Product-relative zero-based DPR scan number for NS swath	short	-
rayNum_NS	Product-relative zero-based DPR ray number for NS swath	short	-
ellipsoidBinOffset_NS	2B-DPRGMI Ku and Ka ellipsoidBinOffset for NS swath	float	m
lowestClutterFreeBin_NS	2B-DPRGMI Ku and Ka lowestClutterFreeBin for NS swath	short	-
precipitationFlag_NS	2B-DPRGMI Ku and Ka precipitationFlag for NS swath	int	-
surfaceRangeBin_NS	2B-DPRGMI Ku and Ka surfaceRangeBin for NS swath	short	-
correctedReflectFactor_NS	2B-DPRGMI Ku and Ka corrected reflectivity factor for NS swath	float	dBZ
pia_NS	2B-DPRGMI Ku and Ka path integrated attenuation for NS swath	float	dB
n_correctedReflectFactor_rejected_NS	Numbers of Ku and Ka bins below DPR_dBZ_min in correctedReflectFactor average for NS_swath	short	-
n_dpr_expected_NS	Numbers of expected Ku and Ka bins in DPR averages for NS swath	short	-
timeNearestApproach	Seconds since 01-01-1970 00:00:00	double	seconds
atimeNearestApproach	Text version of timeNearestApproach, UTC	char	-
timeSweepStart	Seconds since 01-01-1970 00:00:00	double	seconds
atimeSweepStart	Text version of timeSweepStart, UTC	char	-
site_ID	ID of ground radar site	char	-
site_lat	Latitude of ground radar site	float	Degrees North
site_lon	Longitude of ground radar site	float	Degrees East

site_elev	Elevation of Ground Radar Site above MSL	float	km
version	Geo Match File Version	float	-

Algorithm

The approaches to the DPR-to-GR data matching developed for the VN is a geometry matching technique based on determining the intersection of the individual DPR rays with each of the elevation sweeps of the circularly-scanning ground radar. A separate but nearly identical matchup technique performs a geometry matching of GR data to the GPM 2B-DPRGMI “Combined” product. A GMI-to-GR geometry matching technique has also been developed. For this product, the GMI near-surface rain rate field from the 2A-GPROF algorithm is matched to the GR reflectivity and dual-polarization fields in two manners. First, the GR data are matched to the GMI at the intersections of the GMI line-of-sight with the GR elevation sweeps, in a similar manner to how the DPR ray intersections with the GR sweeps are computed. Second, the GR sweep intersections along a vertical column above the GMI surface footprint are computed to give the vertical profile of GR reflectivity above the location where the GMI rain rate estimate is assigned in the GPM 2A-GPROF product.

Details about the basic processing algorithms and steps used for match-up sampling can be found in the [GPM VN Data Product User’s Guide](#). More information about the methods of VN can be found in [Schwaller and Morris, 2011](#), [Anagnostou et al., 2001](#), and [Bolen and Chandrasekar, 2000](#).

Quality Assessment

Ground radar data included in these files are normally derived from the horizontal-sweep-scanning (PPI) radar data that has been quality-controlled and processed into an intermediate 1C-UF product data file in Universal Format (UF). An alternate matchup method for the GRtoDPR product uses vertically-scanned (RHI) data from the ground radar in the UF format. The output GRtoDPR netCDF-3 file format is the same for either type of GR scan. Quality control flags for certain attributes can be found in Tables 3 and 4. Data files have been subject to both automated and human quality control. More information about the quality assessments performed on this data product can be found in the [GPM VN Data Product User’s Guide](#) and [Schwaller and Morris, 2011](#).

Software

These data are available in netCDF-3 format, so no software is required to view these data; however, [Panoply](#) can be used to easily view the data.

Known Issues or Missing Data

Some attributes have special values for missing data, which can be found and described in Tables 3 through 5. For example, data with values of -9999.0 are considered to be missing data. These missing data values include 'no precipitation' data. More information about these missing data can be found in the [GPM VN Data Product User's Guide](#).

References

Anagnostou, Emmanouil N., Carlos A. Morales, and Tufa Dinku (2001). The Use of TRMM Precipitation Radar Observations in Determining Ground Radar Calibration Biases, *Journal of Atmospheric and Oceanic Technology*, 18, 616-628. doi: [https://doi.org/10.1175/1520-0426\(2001\)018%3C0616:TUOTPR%3E2.0.CO;2](https://doi.org/10.1175/1520-0426(2001)018%3C0616:TUOTPR%3E2.0.CO;2)

Bolen, Steven M. and V. Chandrasekar (2000). Quantitative Cross Validation of Space-Based and Ground-Based Radar Observations, *Journal of Applied Meteorology*, 39, 2071-2079. doi: [https://doi.org/10.1175/1520-0450\(2001\)040%3C2071:QCVOSB%3E2.0.CO;2](https://doi.org/10.1175/1520-0450(2001)040%3C2071:QCVOSB%3E2.0.CO;2)

Schwaller, Mathew R. and K. Robert Morris (2011). A Ground Validation Network for the Global Precipitation Measurement Mission, *Journal of Atmospheric and Oceanic Technology*, 28, 301-319. doi: <https://doi.org/10.1175/2010JTECHA1403.1>

Related Data

All data from other instruments collected during the GPM Ground Validation project are related to this dataset. Other GPM Ground Validation data can be located using the [GHRC HyDRO 2.0 search tool](#).

Contact Information

To order these data or for further information, please contact:

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