

README file for the Global Precipitation Measurement (GPM) Validation Network  
(VN) DPR/GR geometry-matching software, Version 1.1, September 2014  
(First GPM Public Data Release Version)

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Overview:

The GPM VN software package for performing geometric matching (mapping to common 3-D spatial volumes) of GPM Dual-frequency Precipitation Radar (DPR) and scanning Ground Radar (GR) data exists as a collection of Interactive Data Language (IDL) procedures and functions. The GPM VN is being developed to assess the first-order differences between GPM DPR data and (primarily) the U.S. national network of operational S-band weather radars (Weather Service Radar-1988 Doppler, or WSR-88D) operated by NOAA/National Weather Service. The core GPM satellite carries instrumentation similar to TRMM, and GPM data processing and products mirror those of TRMM. The VN software package supports GPM algorithm development and future ground validation procedures.

Source Code and Precompiled Binary:

The DPR-GR geometry-matching procedure is named POLAR2DPR. This IDL procedure processes GPM Dual-frequency Precipitation Radar (DPR) and coincident ground radar (GR, also called GV) data into a common set of spatial data volumes using a geometry-matching algorithm, and writes the geometry-matched data to a netCDF file. The complete set of IDL source code required to build and run POLAR2DPR, and a precompiled binary (IDL SAVE file) version of the POLAR2DPR procedure are provided in the unix tar file, ***GPM\_VN\_DPR\_geo\_match\_v1\_1.tar***. See the file ***README.GPM\_VN\_DPR\_geo\_match\_v1\_1.txt*** for a description and listing of this *tar* file's contents. **This document describes the initial public data release version (Version 1.1, September 2014) of the POLAR2DPR program.**

Test Data:

Inputs to POLAR2DPR include GPM DPR products 2A-Ka, 2A-Ku, and 2A-DPR (only one of the three types at a time), and optionally, a matching 2B-DPRGMI product; and GR data in either a Universal Format (UF) file, a 1C-51 HDF file, or a WSR-88D Level-II Archive data file for one or more overpassed GR sites, with each GR file containing a single volume scan taken in Continuous PPI mode. Any other Continuous PPI ground radar data formats that are handled by the TRMM Radar Software Library in IDL (RSL in IDL) are also acceptable, since POLAR2DPR uses the RSL to read the data files into a standard data structure. A separate program (not described here) performs GR-DPR volume matching for GR data taken in RHI scan mode.

Other required inputs to POLAR2DPR are: (1) a plain-text control file specifying the DPR and GR product names and selected metadata, and (2) a set of formal IDL parameters, specified on the command line, which provide program control and data file localization (path/name) information to the POLAR2DPR procedure. A full set of test input files and a sample output file are provided in the unix tar file ***GPM\_VN\_geo\_match\_test\_data.tar***. See the file ***README.GPM\_VN\_DPR\_geo\_match\_test\_data.txt*** for a description and listing of this file's contents.

The GPM 2B-DPRGMI products are optional, and POLAR2DPR can run successfully with only a DPR 2A-Ku, 2A-Ka, or 2A-DPR data file, and the matching GR data products. See the POLAR2DPR Control File section below for instructions on running the procedure without 2B-DPRGMI data.

### Installation and Configuration:

In the descriptions to follow, a basic knowledge of unix/linux shell commands, configuration of IDL, and compilation and running of IDL procedures and functions is assumed. A working, licensed copy of IDL is a prerequisite for running the **POLAR2DPR** procedure. This document assumes that the user knows the basics of running programs in IDL. Beginners can become familiar with IDL by reviewing the IDL online documentation at (old URL, may no longer exist) <http://www.ittvis.com/portals/0/pdfs/idl/getstart.pdf>.

- 1) Copy or move the unix tar file, ***GPM\_VN\_DPR\_geo\_match\_v1\_1.tar***, to a target directory in the IDL path. Be sure that IDL is configured to Search Subdirectories under the directory where the source code will reside. NOTE: The VN source code and the binary version of POLAR2DPR will reside in five new subdirectories created under the current working directory from which the tar file is restored in step 2:

```
geo_match/  
common_utils/  
vn_include/  
rsl_in_idl/  
bin/
```

If a subdirectory with one of these names is already present in the target install directory, consider renaming the conflicting directory or installing the VN code in another directory.

- 2) Extract the contents of the tar file, using a utility program or by running the following unix/linux command from the command line, making sure that the

current working directory is the target install directory, and the tar file is in this directory:

```
tar -xvf GPM_VN_DPR_geo_match_v1_1.tar
```

Verify that the five new subdirectories are created, and that they are populated with the files listed in **README.GPM\_VN\_DPR\_geo\_match\_v1\_1.txt**.

- 3) If using the test data provided, copy or move the unix tar file **GPM\_VN\_geo\_match\_test\_data.tar** into the desired top-level data directory (this directory directly pertains to the discussion of the IDL variables **GPMDATA\_ROOT** and **GVDATA\_ROOT**, which follows). Note that 6 files and five new subdirectory trees will be created under the top-level target data directory from which the tar file is restored:

```
/control_files/DPR_files_sites4geoMatch.140603.txt  
  
/GPM/Ku/2AKu/V03B/CONUS/2014/06/03/2A-CS-CONUS.GPM.Ku.V5-  
20140829.20140603-S195546-E200412.001496.V03B.HDF5  
  
/ground_radar/KDOX/1CUF/2014/0603/KDOX_2014_0603_195905.uf.gz  
  
/ground_radar/KTYX/1CUF/2014/0603/KTYX_2014_0603_200004.uf.gz  
  
/test_output/GRtoDPR.KDOX.140603.1496.V03B.KU.NS.1_1.nc.gz  
/test_output/GRtoDPR.KTYX.140603.1496.V03B.KU.NS.1_1.nc.gz
```

- 4) Restore the contents of the tar file, using a utility program or by running the following unix/linux command from the command line, making sure that the current working directory is the target data directory, and the tar file is located in this directory:

```
tar -xvf GPM_VN_geo_match_test_data.tar
```

Verify that the five new subdirectory trees are created, and that they are populated with the files listed in (3), above.

The 2AKa, 2AKu, 2ADPR, and 2BDPRGMI data file types are stored in a common top-level directory (/GPM in the case of supplied test data) under subdirectory pairs indicating the instrument type and product level within the operational GPM Validation Network (VN) database. Each holds GPM DPR data files of the type indicated by the file and directory names (e.g., GPM 2A-Ku products in Ku/2AKu directories). These four subdirectory pairs have their default values (IDL variables **DIR\_2AKA**, **DIR\_2AKU**, **DIR\_2ADPR**, and **DIR\_COMB**, respectively) defined in the IDL source code file **vn\_include/environs.inc** (see code file listings in **README.GPM\_VN\_DPR\_geo\_match\_v1\_1.txt**). Their values may be overridden at run time by specifying values for four optional keyword parameters (**DIRKA**,

**DIRKU**, **DIRDPR**, and **DIRCOMB**, respectively) for the POLAR2DPR IDL procedure, in cases where these products are stored in a different subdirectory tree structure on the local host. Unless the test data files are moved from their default subdirectories, no local configuration will be necessary for these four lower-level DPR data file paths.

It is assumed that the subdirectories Ka/2AKa, Ku/2AKu, DPR/2ADPR, and DPRGMI/2BDPRGMI are located under a common root directory (**/data/gpmgv/orbit\_subset/GPM** in the VN database system). This default directory is defined by the variable **GPMDATA\_ROOT** in the **environs.inc**, and may be overridden by specifying a value for the **GPM\_ROOT** keyword parameter for the POLAR2DPR procedure, or by modifying the **GPMDATA\_ROOT** definition in the **environs.inc** file. In general, the **GPMDATA\_ROOT** value will need to be locally configured in one of these two manners when running POLAR2DPR in IDL.

The ground radar data files in Universal Format (UF) are stored in a directory tree of the structure: **station/filetype/year/monthday** in the tar file, and in the operational VN database. These individual directory trees for each ground radar station are stored under a common root directory (**/data/gv\_radar/finalQC\_in**) in the VN database system). This default directory is defined by the variable **GVDATA\_ROOT** in **environs.inc**, and may be overridden at run time by specifying a value for the **DIRGV** keyword parameter for the POLAR2DPR procedure, or permanently, by modifying the **GVDATA\_ROOT** definition in the **environs.inc** file. In general, the **DIRGV** value will need to be locally configured in one of these two manners when running POLAR2DPR in IDL. For example, the full, default filepath specification for one of the ground radar data files provided as test data is:

***/data/gv\_radar/finalQC\_in/KTYX/1CUF/2014/0603/KTYX\_2014\_0603\_200004.uf.gz***

in the operational VN database, where the default-value part of the path defined by **DIRGV** is indicated in bold italics. Note that the station/type/date varying parts of the directory tree (e.g., KTYX/1CUF/2014/0603/), or whatever other lower-level directory structure is used locally, must then be included and precede the base name of the GR radar data file (KTYX\_2014\_0603\_200004.uf.gz in the example) within the POLAR2DPR input control file (see file **DPR\_files\_sites4geoMatch.140603.txt** in the test data set for examples).

All paths (relative or absolute) specified as keyword parameters to the POLAR2DPR procedure or defined in the **environs.inc** file must include the leading '/' character (e.g., '/data/gpmgv/orbit\_subset', '/Ku/2AKu') and the values must be contained within single or double quotes. The path values are case-sensitive, but the IDL keywords and variable names are not. For example, **DIRKA='/Ka/2AKa'** and **dirka='/Ka/2AKa'** are equivalent specifications of the value for the DIR2A keyword parameter, while **DIRKA='/KA/2AKA'** and **DIRKA='/Ka/2Aka'** are different file path specifications for the same keyword parameter.

### Compiling and running the POLAR2DPR procedure:

It is necessary to assure that the IDL search path is configured to find the source code directories where the POLAR2DPR code is located before compiling and running POLAR2DPR. If necessary, start the IDL Development Environment (IDLDE), search the menus for the Preferences option, click on the arrow next to the "IDL" option in the Preferences menu, and select the "PATHS" option. Make sure that the directory above where the four POLAR2DPR source code directories and the /bin directory are located is listed as one of the paths, and that it is checkmarked to include subdirectories.

Following installation of IDL source code and suitable test data, the IDL procedure POLAR2DPR may be compiled and run. Note that it is not necessary to compile **POLAR2DPR** in order to run it, since the program (IDL procedure) is provided as a precompiled binary in the form of an IDL 'Save' file, named **polar2dpr.sav**. The Save file is located in the **/bin** subdirectory under the target directory. First, start IDL or the IDL Development Environment (IDLDE). Instructions for compiling the procedure are given below only for informational purposes, for users who are familiar enough with IDL to compile and run the source code from scratch, or for cases where the source code is to be modified.

#### Option 1: Compiling the procedure polar2dpr.pro:

To compile POLAR2DPR, enter the following command at the IDL Prompt:

```
.compile polar2dpr.pro
```

If the IDL path has been properly set up (see text box, above), the POLAR2DPR procedure should compile with no errors and display the diagnostic output:

```
% Compiled module: POLAR2DPR.
```

This is a partial compilation of the full set of code involved in the POLAR2DPR procedure. The remaining procedures and functions will be compiled as they are called, when POLAR2DPR is run.

#### Option 2: Loading the precompiled procedure polar2dpr.sav:

If running the precompiled, binary version of POLAR2DPR, it is not necessary to compile POLAR2DPR with the `.compile` command. Instead, at the IDL> prompt simple enter the following command:

```
restore, file='/path/to/bin/polar2dpr.sav'
```

where `/path/to/bin/` is the full pathname to where the `polar2dpr.sav` file was installed when `GPM_VN_DPR_geo_match_v1_1.tar` was un-tarred.

Any configuration changes made to `environs.inc` or other `vn_include/` files will not take effect if running the precompiled version of POLAR2DPR. In this case, the necessary file path and other variables may be configured via the keyword parameters supplied to `polar2dpr` on the IDL command line, as shown below.

NOTE: The precompiled `polar2dpr.sav` file was compiled and saved in IDL Version 8.1. **It will only run in IDL 8.1 or later IDL versions.** The source code file `polar2dpr.pro` can be compiled and run in any IDL versions from 8.0 or later, but will not run in IDL versions prior to 8.0.

### Running polar2dpr:

Running `polar2dpr` is the same from this point forward, whether the procedure was compiled or loaded from the precompiled file. For the sake of this example, assume that the tar file `GPM_VN_geo_match_test_data.tar` has been restored (untarred) on the IDL host machine under the top-level data directory `/user/data`, and the resulting files and directories are left as-is. Also, assume that we desire to write the output netCDF files from POLAR2DPR to the directory `/user/data/VN_netcdf`. Note that if this output directory does not yet exist, it will be created when the procedure runs. Run the POLAR2DPR procedure, specifying the mandatory and keyword parameters (described in the next section) required for the local file configuration, by entering the following lines at the IDL prompt (the trailing '\$' characters are continuation characters and allow you to enter a single, lengthy IDL command over several lines):

```
polar2dpr, $  
'/user/data/control_files/DPR_files_sites4geoMatch.140603.txt', $  
100, GPM_ROOT='/user/data/GPM', DIRGV='/user/data/ground_radar', $  
NC_DIR='/user/data/VN_netcdf', NC_NAME_ADD='test', PLOT_PPIS=1
```

Be careful to enter the matching quotes around the file and path name specifications, and commas between the parameters. Also be sure to change `/user/data` to whatever local directory location was used to restore the test data tar file.

If the procedure runs, and depending on the version of IDL running and your operating system, you may be prompted to confirm deletion of temporary file copies. Respond "y" to these prompts to proceed with the procedure execution. Otherwise, the procedure should run to completion on its own if there are no errors

in the command line parameters or the file installations. Given these parameters, the two netCDF files:

```
/user/data/VN_netcdf/GRtoDPR.GRtoDPR.KDOX.140603.1496.V03B.KU.NS.1_1.test.nc.gz  
/user/data/VN_netcdf/GRtoDPR.GRtoDPR. KTYX.140603.1496.V03B.KU.NS.1_1.testnc.gz
```

should be produced as the output from the routine\*. The format and contents of these netCDF files will be described in detail in an upcoming version the *GPM GVS Validation Network Product Data User's Guide*, available from the GPM GV web site (<http://pmm.nasa.gov/science/ground-validation>).

\*If IDL returns NC\_ERROR=-31 and indicates that it is unable to create the GRtoDPR netCDF file, it is likely due to a permissions problem in the directory chosen for the NC\_DIR parameter. Either change the permissions on the indicated directory, or specify a different directory for NC\_DIR that has open WRITE privileges.

## POLAR2DPR Mandatory and Optional Keyword Parameters:

The POLAR2DPR procedure requires two mandatory parameters, and up to 15 optional (IDL keyword) parameters. Here is a synopsis of the complete POLAR2DPR calling sequence in IDL, showing all parameters:

```
polar2dpr, control_file, max_range_km, GPM_ROOT=gpmroot, $  
DIRDPR=dir2adpr, DIRKU=dir2aku, DIRKA=dir2aka, DIRCOMB=dircomb, $  
DIRGV=dirgv, SCORES=run_scores, PLOT_PPIS=plot_PPIS, $  
PLOT_BINS=plot_bins, NC_DIR=nc_dir, NC_NAME_ADD=nc_name_add, $  
MARK_EDGES=mark_edges, DPR_DBZ_MIN=dpr_dbz_min, DBZ_MIN=dbz_min, $  
DPR_RAIN_MIN=dpr_rain_min, NON_PPS_FILES=non_pps_files
```

Mandatory parameters are those where only the value of the parameter appears on the command line. Two mandatory parameters must be specified for POLAR2DPR to run successfully: **control\_file** and **max\_range\_km**. Optional parameters are those of the format “KEYWORD=value”, where KEYWORD is as shown in the synopsis (e.g., **SCORES**), and value is the value to be assigned to the keyword variable (e.g., **run\_scores**). Depending on the configuration of the machine where POLAR2DPR is run (specifically, where input DPR and GR data file locations differ from the default paths), one or more of the optional parameters may also need to be specified for POLAR2DPR to run correctly. A description of each of the parameters follows:

**polar2dpr** – the name of the IDL procedure itself (case-insensitive)

**control file** – the fully-qualified file pathname to the control file (see next section). It must be the first non-keyword parameter after the procedure name. The name is case sensitive and must be contained within ‘single’ or “double” quotes.

**max\_range\_km** – maximum range in km from the ground radar for which matchups will be computed and output. This value is normally set to 100. It must be the second non-keyword parameter after the procedure name. Note: It is called **range\_threshold\_km** in the source code file **polar2dpr.pro**.

**GPM\_ROOT** – specifies a non-default, absolute, common local path to the DPR files specified in the control file. If unspecified, defaults to “/data/gpmgv/orbit\_subset/GPM”, or whatever is specified for the variable GPMDATA\_ROOT in the **environs.inc** file. There are generally two additional “fixed” subdirectory levels between GPM\_ROOT and the varying parts of the DPR file paths listed in the control file, that are specific to the DPR product type (e.g., /Ku/2AKu, /DPR/2ADPR). See keywords **DIRKA**, **DIRKU**, **DIRDPR**, **DIRCOMB**, below. The assigned value must be enclosed in matching quotes, as shown in the example.

**EXAMPLE:** **GPM\_ROOT= ' /data/GPM\_VN/dpr\_products '**



**DIRKA, DIRKU, DIRDPR, DIRCOMB** – specify non-default subdirectories under which DPR product files of type 2A-Ka, 2A-Ku, 2A-DPR, and 2B-DPRGMI, respectively, are located. If unspecified, default to “/Ka/2AKa”, “/Ku/2AKu”, “/DPR/2ADPR”, and “/DPRGMI/2BDPRGMI” respectively, or whatever values are defined for variables **DIR\_2AKA**, **DIR\_2AKU**, **DIR\_2ADPR**, and **DIR\_COMB** in the **environs.inc** file. The assigned value must be enclosed in matching quotes, and be preceded by “/” (forward slash).

**DIRGV** – specifies a non-default local path to the GR files specified in the control file. If unspecified, defaults to “/data/gpmgv/gv\_radar/finalQC\_in”, or whatever is specified for the variable **GVDATA\_ROOT** in the **environs.inc** file. The assigned value must be enclosed in matching quotes. **DIRGV** is the “common path” under which the site- and date-varying directory components for the GR files are located (e.g., **KTYX/1CUF/2014/0603/** in the case of the test data file provided).

**SCORES** - Optional binary keyword parameter, defaults to 0 (do not compute difference statistics on-the-fly). If set to “on” (SCORES=1 or /SCORES), then mean DPR-GV reflectivity differences from the matchup data will be computed and output as the matchup data for each elevation sweep of the GV radar is completed.

**PLOT\_PPIS** - Optional binary keyword parameter, defaults to 0 (disable PPI plots). If set to “on” (PLOT\_PPIS=1 or /PLOT\_PPIS), then Plan Position Indicator (PPI) plots of the matched DPR and GV reflectivity fields sweep-by-sweep on a map background will be temporarily displayed as the matchup data for each elevation sweep of the GV radar is completed.

**PLOT\_BINS** - Optional binary keyword parameter, defaults to 0 (disable radar bin plots). If set to “on”, then the horizontal outlines of the GV bins being averaged to produce the GV reflectivity value for the common 3-D volume at the location of each DPR footprint, overlaid on the outline of the DPR footprint itself, will be plotted. This was developed strictly as a diagnostic capability. ***It is highly recommended that this option NOT be enabled in runs of POLAR2DPR, as it can be computationally intensive (i.e., SLOW) and displayed results can vary.*** If it is enabled, the program will prompt you for a chance to override the keyword selection before starting the computations, and if you go ahead with plotting of the bins, it will again prompt you after a few plots have completed to allow you to disable the plotting in mid-run.

**NC\_DIR** - specifies a non-default, absolute, local path to which the output netCDF files from the POLAR2DPR procedure will be written. If unspecified, defaults to “/data/gpmgv/netcdf/geo\_match”, or whatever current value exists for the appended combination of the two variables **NCGRIDS\_ROOT** and **GEO\_MATCH\_NCDIR** defined in the **environs.inc** file. The assigned value must be enclosed in matching quotes.

**NC\_NAME\_ADD** – An optional string of characters to be inserted into the output netCDF file name generated by the POLAR2DPR procedure. This allows multiple runs of the same case to be made, with different output file names. If NC\_NAME\_ADD is specified, then the output netCDF filename is of the format:

**GRtoDPR.station.yymmdd.orbit.p.type.swath.V\_v.nc\_name\_add.nc.gz**

otherwise the output netCDF filename has the default format:

**GRtoDPR.station.yymmdd.orbit.p.type.swath.V\_v.nc.gz**

where:

GRtoDPR.	a fixed filename prefix, defined by the variable DPR_GEO_MATCH_PRE in the <b>environs.inc</b> file. The trailing period is part of the prefix
station	the station ID of the ground radar, as specified in the control file
yymmdd	the year (2 digit), month, and day of the matchup event, as specified in the control file
orbit	the orbit number of the matchup event, as specified in the control file
p	DPR product version (e.g., V02A)
type	2A product type: Ka, Ku, or DPR
swath	DPR data swath used in the matchup: HS, MS, or NS
V_v	geometry match file version (2_1 = file version 2.1)
nc_name_add	the (optional) text string to be added to the output file name, for all netCDF files output in the current run of POLAR2DPR. It must be enclosed in matching quotes when specified as a keyword parameter. EXAMPLE: NC_NAME_ADD='version1'
.nc	a fixed filename extension indicating that it a netCDF file. Its value is defined by the variable NC_FILE_EXT in the <b>environs.inc</b> file. The leading period is part of the extension
.gz	the filename extension indicating that the file is compressed using gzip (POLAR2DPR compresses the completed file by default).

**MARK\_EDGES** - Optional binary keyword parameter, defaults to 0 (do not mark edges). If set to “on” (MARK\_EDGES=1 or /MARK\_EDGES), then the area of actual DPR/GR matchup data (overlap area) will be surrounded by a border of “bogus” matchup data with special values and meaning. These bogus data points can be used to prevent the area of actual matchup data from being extrapolated beyond the actual DPR/GR overlap area if the matchup data are subsequently analyzed to a fixed grid.

**DPR\_DBZ\_MIN** – Optional parameter available to override the default value (18.0 dBZ) for the DPR reflectivity detection threshold. In the averaging of DPR range

gates in the volume matching, the algorithm tallies the number of “rejected” gates below the `dpr_dbz_min` value, and excludes these gates from the averaging. The DPR volume average value is accompanied by variables indicating the number of DPR gates expected (from a geometry match standpoint) and the number rejected due to being below the `dpr_dbz_min` threshold. Together these give an estimate of data quality.

**DBZ\_MIN** – As in `DPR_DBZ_MIN`, but for averaging of ground radar range gates. For GR, the number of below-threshold gates based on `dbz_min` is tallied, but below-threshold gates are excluded from the GR volume average only if at or below a fixed value of 0.0 dBZ. If not specified, defaults to 15.0 dBZ.

**DPR\_RAIN\_MIN** – As in `DPR_DBZ_MIN`, but for the 3-dimensional DPR rain rate volume average. If not specified, defaults to 0.01 mm/h.

**NON\_PPS\_FILES** – Binary parameter. If set to On, then the checking of the DPR filename in the control file against the PPS file naming convention is disabled, and the `DPR_Type` field in the control file is used to determine the type of DPR level 2A data file (DPR, Ka, or Ku) being processed. This allows DPR files from a source other than the PPS to be used in the volume matching as long as the files follow the GPM baseline HDF5 file formats. If unset, then an error occurs if the first three components of a DPR file basename in the control file do not match one of the expected PPS conventions (`*2A*.GPM.DPR*`, `*2A*.GPM.Ku*`, `*2A*.GPM.Ka*`, or `*2B*.GPM.DPRGMI*`).

POLAR2DPR control file:

The control file is a text file of fixed format, with mandatory fields delimited by a vertical bar character, '|'. ***The format and contents of a control file are critical to a successful run of POLAR2DPR, and the rules must be followed to the letter.***

There are two types of lines in the control file, and at least one line of each type must be present. The first type of line pertains to DPR data files and parameters for a given GPM orbit, and has the following format:

**orbit|nsites|yymmdd|subset|version|DPR\_type|swath|2A\_filepath|2B\_filepath**

where the eight mandatory fields and one optional field in the DPR line are as defined in the following table:

FIELD	DESCRIPTION
<b>orbit</b>	GPM orbit number
<b>nsites</b>	number of ground radar sites for which matchup data are to be produced for this orbit's DPR files. It also indicates the number of GV-type data lines immediately following this DPR orbit line in the control file
<b>yymmdd</b>	year (2-digit), month, and day (UTC) of the GPM orbit. Value becomes part of the output netCDF file names
<b>subset</b>	Product orbital subset identifier of the listed DPR products. This parameter can have any name, as it is not currently used
<b>version</b>	Version of DPR product files used as inputs to the procedure. Value becomes part of the output netCDF file names. Does not control/affect the opening and reading of the actual DPR data files – all current DPR data versions will work
<b>DPR_type</b>	Either Ka, Ku, or DPR, depending on the type of GPM DPR 2A product to be processed
<b>swath</b>	Type of swath to be processed in the DPR-GR data matchup. Either HS, MS, or NS. Swath types present in the data are dependent on the DPR_type. Only one swath type can be processed for a given matchup. However, the same DPR file and GV radar sites can be specified again in the control file, with a different swath type for the DPR file.
<b>2A_filepath</b>	Partial file pathname of the DPR 2A-Ka, 2A-Ku, or 2A-DPR file to process for this orbit. The combination of the parameters GPM_ROOT+DIRxxx followed by 2A_filepath specifies the complete file pathname to the DPR 2A data file. The POLAR2DPR DIRxxx parameter used to assemble the full file pathname depends on the DPR_type of the product to be matched: the DIRKA parameter is used for a 2A-Ka matchup, DIRKU is used for a 2A-Ku matchup, and DIRDPR is used for a 2A-DPR matchup.

<b>2B_filepath</b>	Partial file pathname of the 2B-DPRGMI (combined DPR/GMI rain rate) file to process for this orbit. The combination of the parameters GPM_ROOT+DIRxxx followed by 2B_filepath specifies the complete file pathname to the DPRGMI data file. The POLAR2DPR DIRxxx parameter used to assemble the full file pathname is DIRCOMB for this file type. <b>2B_filepath is an optional parameter and does not need to be present on the line in the control file. If 2B_filepath is not given, matchup processing will proceed using only the mandatory 2A data, and the near surface rain rate for the 2B-DPRGMI data source will be left as undefined in the output netCDF file.</b>
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The second type of line in the control file pertains to the ground radar (GV) sites overpassed by the DPR in this orbit, and for which matchup data are to be produced. Typically these lines are included in the control file only for the GV radar sites at which significant precipitation echoes existed at the time of the DPR overflight for this GPM orbit. The GV-type lines in the control file have the format:

**siteID | YYYY-MM-DD hh:mm:ss | lat | lon | elev | GV\_pathname**

where the six mandatory fields in the GV lines are as defined in the following table:

FIELD	DESCRIPTION
<b>siteID</b>	ICAO call letters of the GV radar site, or any other unique radar site identifier. This field will be included in the output netCDF filename
<b>YY-MM-DD hh:mm:ss</b>	date and time of the GPM orbital subtrack's closest approach to the GV radar site, in UTC time, and in the format shown. The date and time must be separated by a space. See Note 1.
<b>lat</b>	latitude of the GV radar site, decimal degrees, north positive
<b>lon</b>	longitude of the GV radar site, decimal degrees, east positive
<b>elev</b>	elevation above MSL of the GV radar site, kilometers. <i>If the value in the control file is <math>\geq 4.0</math>, it is assumed that the 'elev' units are meters, and the value will be divided by 1000 to convert it to km.</i>
<b>GV_pathname</b>	partial pathname to the ground radar UF, 1C-51, or NEXRAD Level-II data file containing the reflectivity data for the volume scan nearest in time to the GPM overpass. The full, absolute pathname to the file must be the result of prepending the <b>DIRGV</b> common path specification (see the Keyword Parameters section, above) to <b>GV_pathname</b> . POLAR2DPR will add the necessary '/' between the two

	paths. If the GV file is not available, the value <b>'no_1CUF_file'</b> (without quotes) is used as a placeholder and processing will be skipped for this site overpass event
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**Note 1:** The date and time of the DPR closest approach to pre-configured GV radar sites is provided to users in a daily “coincidence table” (CT) file, by the Precipitation Processing System (PPS), (<http://pps.gsfc.nasa.gov/pps/>). This file contains overflight information (orbit numbers, date/times, distances) for GV sites that have been requested by registered science team users of PPS data products. In the GPM Validation Network, only those overflights with a closest approach within 250 km of a VN GV radar site are considered.

The organization of the control file is that it begins with a DPR-type data line, immediately followed by “**nsites**” number of GV-type data lines. This group sequence is repeated in the file for as many orbits one wishes to process in the POLAR2DPR run. In the operational VN system, a new control file is produced for each date where rainy overpass events are to be processed, but this is not a requirement for the program. The **multi\_event\_control\_file\_example.txt** file, included in the sample data tar file, shows how a control file is organized for multiple orbits, with a varying number of GV sites to be processed for each orbit.

Every mandatory field in the control file for each line type must have a value specified, even if it is a placeholder value. Do **not** enclose any of the control file field values within quotes.

The VN data set normally includes DPR “orbit subset” products, which are data for portions of a GPM orbit covering a specific area of interest. Full-orbit DPR products are also acceptable as input to the POLAR2DPR procedure.

The POLAR2DPR control file encapsulates the One-to-Many relationship between DPR orbit subset products and ground radar sites and products. The typical DPR orbit subset area of coverage includes the spatial domain of multiple ground radars, so POLAR2DPR reads one DPR orbit subset product for an orbit, and then holds these data while processing DPR-GV matchups for one or more (**=nsites**) ground radar sites, as listed in the control file. Each matchup netCDF file output by POLAR2DPR is then associated with a single ground radar site, for the time of one GPM orbital overpass. In the operational GPM VN prototype, all DPR and GV product file names, the relationship between the DPR products orbital subsets and the GV stations, and metadata describing the precipitation echo status for each site overpass event are stored in a PostgreSQL relational database. A set of shell scripts and SQL command files query the database to produce the information contained in the control files in a semi-automated manner.

The information in the database describes the state of the data and the data ingest procedures used on the GPM GV host machine, and so is not directly transferable to other sites. Therefore, neither the database nor the scripts and SQL used to create

the control files are provided in this software distribution. However, if users decide to request DPR and GV data present in the VN data set for their own use, then matching control files useful for running POLAR2DPR can be created and provided upon request. Contact a member of the GPM Ground Validation group: [kenneth.r.morris@nasa.gov](mailto:kenneth.r.morris@nasa.gov) or [mathew.r.schwaller@nasa.gov](mailto:mathew.r.schwaller@nasa.gov) for information.

### Constraints:

- 1) *A licensed copy of IDL, running under Unix/Linux or Mac OS X, is required to compile and run the software. POLAR2DPR may compile and run in part in IDL demo mode, but will not be allowed to produce an output netCDF data file. Refer to the file **README.GPM\_VN\_DPR\_geo\_match\_v1\_1.txt** for additional input data, software, and runtime environment constraints that pertain to the POLAR2DPR procedure.*
- 2) POLAR2DPR will NOT run in IDL versions prior to 8.0, due to incompatibility with the HDF5 format of the DPR data files. POLAR2DPR has been tested in a Linux environment with IDL Version 8.1.
- 3) The precompiled version of POLAR2DPR in the binary file **polar2dpr.sav** will only run in IDL version 8.1 or later.
- 4) If processing ground radar data in Universal Format (UF) for new radar sites not known to the VN software, then the reflectivity field to be analyzed must be tagged with the field identifier 'CZ'. Otherwise, the CASE statement in the IDL source code file **common\_utils/get\_site\_specific\_z\_volume.pro** must be modified to associate the new site ID to the reflectivity field ID to be read from the UF files for the site, and then **polar2dpr.pro** must be recompiled before running (i.e., the precompiled version will not reflect the changes).

### Other Resources:

An online source for computing GPM DPR overflights of a ground radar location is the NASA LARC Satellite Overpass Predictor at:

<http://www-air.larc.nasa.gov/tools/predict.htm>

PR data products for full orbits and for previously-defined orbital subset areas will be available from the NASA/Goddard MIRADOR web site once they are released to the public:

<http://mirador.gsfc.nasa.gov>

All DPR and GR data sets ingested and archived by the GPM Validation Network, and information on how and where to download matchup netCDF data files computed from the DPR and GR data for active precipitation cases is available at the GPM Ground Validation web site:

<http://pmm.nasa.gov/science/ground-validation>

IDL-language software tools to produce displays and perform statistical analyses of the data in the matchup netCDF files produced by POLAR2DPR are available as open-source software. Contact one of the individuals listed on the GPM Ground Validation web site to obtain the latest code version for these tools.