A Detailed Examination of the GPM Core Satellite Gridded Text Product

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1. Background

The Global Precipitation Measurement (GPM) mission quarter-degree gridded-text product has a similar file format and a similar purpose as the Tropical Rainfall Measuring Mission (TRMM) 3G68 quarter-degree product. The GPM textgrid format is an hourly summary of surface precipitation retrievals from various GPM instruments and combinations of GPM instruments. The GMI Goddard Profiling (GPROF) retrieval provides the widest swath (800 km) and does the retrieval using the GPM Microwave Imager (GMI). The Ku radar provides the widest radar swath (250 km swath) and also provides continuity with the TRMM Ku Precipitation Radar. GPM's Ku+Ka band matched swath (125 km swath) provides a dual-frequency precipitation retrieval. The "combined" retrieval (125 km swath) provides a multi-instrument precipitation retrieval based on the GMI, the DPR Ku radar, and the DPR Ka radar. While the data are reported in hourly grids, all hours for a day are packaged into a single text file that is gzipped to reduce file size and to speed up downloading. The data are reported on a 0.25° x 0.25 ° grid.

2. Metadata Header Lines Content

The first 5 lines in the file are header lines that contain metadata, as listed below:

(1) ProductID AlgorithmVersion GPMdataCredit GenerationDate ShortDOI LongDOI

(2) (Universal grid:) Rows Columns MinimumLatitude MinimumLongitude GridResolution ObservationDate

(3) (For GPM observations:) MinimumLatitude MaximumLatitude MinimumLongitude MaximumLongitude

(4) Grid_First_Row Grid_Center_Latitude Grid_First_Column Grid_Center_Longitude Grid_Cell_Resolution Duration

(5) (Variable names for data lines:) hour minute row column
GMI_{ totalPixels | precipPixels | meanPrecip | convFraction | liquidFraction | retrievalQuality }
Ku_{ totalPixels | precipPixels | meanPrecip | convFraction | liquidFraction | retrievalQuality }
DPR_MS_{ totalPixels | precipPixels | meanPrecip | convFraction | liquidFraction | retrievalQuality }
COMBINED_MS_{ totalPixels | precipPixels | meanPrecip | convFraction | liquidFraction | retrievalQuality }

3. General Data Line Format

There is one data line per grid box, each hour. Each data line starts with the hour and minute of the first pixel accumulated into that gridbox for that hour. The next two fields in the line provide the row and the column identifiers for the gridbox within a global 0.25° x 0.25 ° grid. The remaining fields of each data line provide the following precipitation information for the following combinations of instruments:

Combination of instruments
- GMI only
- Ku radar only
- Ku+Ka radar
- Combined GMI+Ku+Ka

Data values for each combination of instruments
- Count of all pixels in cell
- Count of precipitation pixels in cell
- Mean precipitation rate (mm/hr)
- Fraction of precip. calculated to be convective
- Fraction of precipitation calculated to be liquid
- Retrieval quality indicator

While the GPM satellite has a 65° inclination orbit, the grid row and column numbers in the textgrid are based on a 90S-90N "universal" grid that will enable researchers to more easier combine the textgrid with data from other satellites. In this universal grid, 90S 180W is located at the southwest corner of the southern-most row. Similarly, 90N 180E is the northeast corner of the northern-most row. In the universal grid, the row index represents latitude such that the grid cells in row 0 cover 90.00S to 89.75S. The row index increases northward to the maximum 719, which covers 89.75N to 90.00N. In the universal grid, the column index represents longitude such that the grid cells in column 0 cover 180.00W to 179.75W. The column index increases eastward to a maximum of 1439, covering 179.75E to 180.00E.

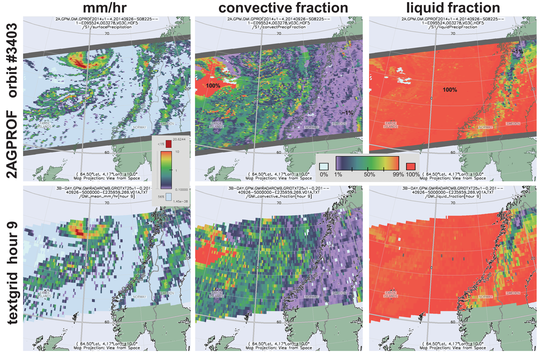


Fig. 1. Comparison of the textgrid with the GMI swath product. At 9 UTC on 26 Sept 2014, GMI observed this synoptic cyclone with a rainband over Norway. Source: http://pmm.nasa.gov/articles/gpm-satellite-sees-windstorm-over-norway

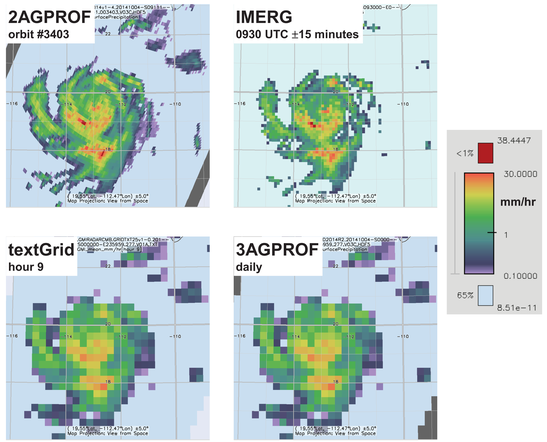


Fig. 2. Comparison of the textgrid with swath and gridded products. At 0940 UTC on 4 Oct 2014, GMI observed Hurricane Simon rapidly intensifying west of Mexico. Source: http://www.nasa.gov/content/goddard/nasas-gpm-satellites-find-before-hurricane-simon-was-caught-rapidly-intensifying/

Fig. 3. A Ku radar comparison with the textgrid. The same overflight for Hurricane Simon is shown here as was shown in Fig. 2.

Eq. 1. Pixel count for the gridbox at row i and column j

$$totalPixels_{ij} = \sum_{n=1}^{n_{max}} pixel_{n_{ij}} \quad (1a)$$

$$totalPrecip_{ij} = \sum_{n=1}^{n_{max}} precipRate_{n_{ij}} \quad (1b)$$

Eq. 2. GMI accumulations

$$precipPixel_{ij} = \sum_{n=1}^{n_{max}} pixel_{n_{ij}}[prob > .5] \quad (2a)$$

$$convective_{ij} = \sum_{n=1}^{n_{max}} precipRate_{n_{ij}} \; convFraction_{n_{ij}}[type = conv] \quad (2b)$$

$$liquid_{ij} = \sum_{n=1}^{n_{max}} precipRate_{n_{ij}} \; liquidFraction_{n_{ij}}[species = liquid] \quad (2c)$$

Eq. 3. Radar and combined accumulations

$$precipPixel_{ij} = \sum_{n=1}^{n_{max}} pixel_{n_{ij}} \quad (3a)$$

$$convective_{ij} = \sum_{n=1}^{n_{max}} precipRate_{n_{ij}}[type = conv] \quad (3b)$$

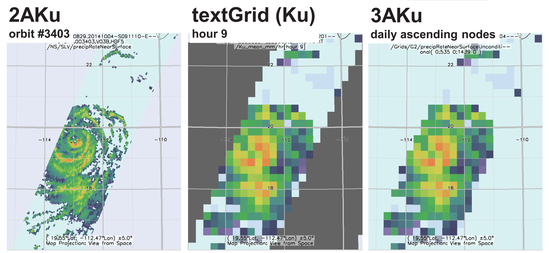
$$liquid_{ij} = \sum_{n=1}^{n_{max}} precipRate_{n_{ij}}[species = liquid] \quad (3c)$$

Eq. 4. Grid cell values

$$meanPrecip_{ij} = totalPrecip_{n_{ij}} / totalPixel_{n_{ij}} \quad (4a)$$

$$convFraction_{ij} = convective_{n_{ij}} / totalPrecip_{n_{ij}} \quad (4b)$$

$$liquidFraction_{ij} = liquid_{n_{ij}} / totalPrecip_{n_{ij}} \quad (4c)$$



4. Data Line Content Details

Each data line has a value for each item named in line 5 of the header and c cribed in section 3. Hour values start at 0 as do minutes. Time in this product is prese ed in UTC. As a reminder, the grid-cell row index for the hourly grid matrix starts at 0 as es the grid-cell column index.

Users can be assured that each data line has the same number of fields n it, but users should check whether a field contains the missing-data value (-9) before usi that field in their calculations. If any instrument group has a 0 value for the total-pixels fi that would indicate that the instrument group has no observations falling within that grid ox for that hour. In this situation, the textgrid has the precip-pixels field set to zero and subsequent fields for that instrument group set to -9. Any occurrence of -9 always indica s that a value is not available for this item for the particular grid box and hour. When a leve retrieval product does not provide the information necessary for determining the field lue in the gridded text product then the missing value indicator is used for the field.

Currently, the retrieval quality flag for the grid is determined by the pixel th the lowest retrieval quality (i.e., rotten apple selection), which maps to the highest integ value of the data-quality flag. For the "at launch" version the GMI algorithm currently bei run at PPS in April of 2015, the retrieval quality is set to 2 everywhere. It is anticipated tha uture versions of the GMI algorithm will provide values of 0, 1, or 2, as defined in the table b ow. At this time both, the Ku radar and DPR (Ku+Ka) algorithms are providing no mean ful ordinal retrieval-quality indicator, so these fields are set to -9 in the textgrid product. t this time, the combined (GMI+Ku+Ka) algorithm can provide values of 0, 1, or 9 for ret val quality, as defined below.

GMI retrieval quality (for future version of GMI algorithm)
0 = Retrieval is good for climate research
1 = In general, the quality is suitable for weather applications but not climate pplications
2 = The user must keep in mind the limitations of this retrieval when using it research

Combined (GMI+Ku+Ka) retrieval quality
0 = GMI retrieval and radar retrieval
1 = Radar-only retrieval
9 = No retrieval possible

5. Calculation of Data Lines

All calculations are done in hourly quarter-degree grid cells. The hourly grids e maintained separately but then packaged into a single daily text file. The calculations fo he textgrid are done in two steps. The first step is to accumulate each appropriate pixel of a vath into the appropriate hour and grid location (**Equations 1-3**). The second step is to ca ulate the appropriate mean for mean precipitation, convective fraction, and liquid fract (**Equation 4**). **Figures 1-3** show comparisons between the textgrid and other GPM dat products.

6. Obtaining the Data

The GPM gridded text product may be retrieved using FTP to arthurhou.pps.eosdis.nasa.gov or using the Science Team Online Resource odule (STORM). Within STORM, users may find and order the gridded product ba d on the time range desired, and they may establish standing orders for the product so tha hey are notified via email when the textgrid is produced. The notification email also i ludes scripts for retrieving the product from the PPS server. The URL for STORM is http://storm.pps.eosdis.nasa.gov.

Prior to retrieving data from the FTP site or via STORM, a user must reg er with PPS at http://registration.pps.eosdis.nasa.gov. Users are asked for their email addre , their affiliation, and their data access interests. Next, the user will receive an ema nd be asked to verify that the email was received. Each time that the user downloads dat iles, the user will be asked to enter the registered email address as both the user name ar password. For users desiring FTP access and using either Linux or Mac OS, they may ke a .netrc entry for the PPS server; this will allow them to have scripts that do not requi the manual input of username and password.

For additional information, please contact Dr. Erich Franz Stocker at NAS /GSFC Code 610.2, erich.f.stocker@nasa.gov.

7. Software Tools

Perhaps the most useful tool for display and simple analysis of the gridded te product is the PPS data viewer THOR, which may be downloaded from http://pps.gsfc. sa.gov. Also available is a C program that takes a list of daily gridded text files and combi s all of the files in the list into a single gridded text file, either maintaining the hourly grid r collapsing all of the hours into a single hour. This C program provides a simple way to a gregate many daily gridded text files (e.g., into a monthly product).