Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA)

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Data Format Description for
Global Satellite Mapping of Precipitation Microwave-IR Combined Product (GSMaP_MVK) and Gauge-calibrated Rainfall Product (GSMaP_Gauge), Version 8

This document describes data format and information of Global Satellite Mapping of Precipitation Microwave-IR Combined Product (hereafter refers as GSMaP_MVK) for product version 8, which is a reanalysis version of Global Rainfall Map in Near-Real-Time (GSMaP_NRT) distributed from JAXA/EORC, and Gauge-calibrated Rainfall Product (GSMaP_Gauge).

GSMaP_MVK, GSMaP_Gauge and GSMaP_NRT were developed for the Global Precipitation Measurement (GPM) mission based on activities of the GSMaP (Global Satellite Mapping of Precipitation) project. And using the Japanese 55-year Reanalysis (JRA-55) data as ancillary data to produce continuous and homogeneous dataset for the past period from January 1998 to November 2021. Original data of GSMaP_NRT, GSMaP_MVK, and GSMaP_Gauge in HDF5 format is distributed to the public through the JAXA G-Portal (https://www.gportal.jaxa.jp) as the GPM Global Rainfall Map product.

Contents

1. Products Overview

Table 1 Summary of Standard and Reanalysis Products

No	Parameter [unit]	Data format	Coverage	Grid size	Horizontal resolution	Temporal resolution	Section
(1)	Hourly Rain Rate [mm/hr]	4-byte float plain binary, little-endian	Global (60°N-60°S)	3600 x 1200	0.1 x 0.1 degree grid box	Hourly (averaged from 00-minute to 59-minute of the specified hour. For example, 12:00-12:59Z for 12Z data)	See Section 3
(2)	Satellite Information Flag	4-byte singed integer plain binary, little-endian					
(3)	Observation Time Flag	4-byte float plain binary, little-endian					
(4)	Reliability Flag	1-byte integer plain binary					
(5)	Hourly Gauge-calibrated Rain Rate [mm/hr]	4-byte float plain binary, little-endian					See Section 4
(6)	Hourly Rain Rate & Gauge-calibrated Rain Rate in text format [mm/hr]	ASCII, CSV format	Divided to 15 areas	---			See Section 5
(7)	Daily Averaged Rain Rate [mm/hr]	4-byte float plain binary, little-endian	Global (60°N-60°S)	3600 x 1200		Daily (averaged from 00Z to 23Z of the specified day)	See Section 6
(8)						Daily (averaged from 12Z of the previous day to 11Z of the specified day)	
(9)	Daily Averaged Gauge-calibrated Rain Rate [mm/hr]					Same as 7	See Section 7
(10)						Same as 8	
(11)	Daily Averaged Rain Rate & Gauge-calibrated Rain Rate in text	ASCII, CSV format	Divided to 15 areas	---		Same as 7	See Section 8
(12)						Same as 8	

	format [mm/hr]						
(13)	Monthly Averaged Rain Rate [mm/hr]	4-byte float plain binary, little-endian	Global (60°N-60°S)	3600 x 1200	0.1 x 0.1 degree grid box	Monthly (averaged of the specified month)	See Section 9
(14)	Monthly Averaged Gauge-calibrated Rain Rate [mm/hr]						See Section 10
(15)	Monthly Accumulated Rain Rate & Gauge-calibrated Rain Rate in text format [mm/mo]	ASCII, CSV format	Divided to 15 areas	---		Monthly (accumulated of the specified month)	See Section 11
(16)	Hourly Rainfall and major flags	NetCDF	Global (90°N-90°S)	3600 x 1800		Hourly	See Section 12
(17)	Hourly Rainfall and major flags	HDF				Hourly	See Section 13
(18)	Daily Rainfall and major flags					Daily	See Section 14
(19)	Monthly Rainfall and major flags					Monthly	See Section 15

2. Product/Algorithm Versions and Data Period

2.1. Version

Version of product and algorithms are denoted in following format.

Version: v**P.RSKI.J**

where;

P: product version;
R: version of microwave imager algorithm (reset when product version is updated);
S: version of microwave sounder algorithm (reset when product version is updated);
K: version of microwave imager/sounder algorithm (reset when product version is updated);
I: version of microwave-IR combined algorithm (reset when product version is updated); and
J: inclement number of reprocessing.

For example, v8.5133.0 indicates that product version is **8**, microwave imager algorithm version is **8.5**, microwave sounder version is **8.1**, microwave imager/sounder version is **8.3**, microwave-IR combined version is **8.3,** and no inclement number.

Product version will be updated only when there are major updates in algorithms and reprocessing of whole period is done.

2.2. Data Period

Data is in operation with three days latency after the observation since December 2021, and the past period from January 1998 to November 2021 was processed this time.

2.3. FTP/web server

Password protected ftp server same as GSMaP Near Real Time Version (GSMaP_NRT).

3. Hourly Rain Rate and Flag Files in Binary (products (1)-(4))

3.1. Basic Information

Hourly rain rate and some information flags of GSMaP_MVK.

Temporal resolution:	1 hour (hourly data) averaged from 00-minute to 59-minute of the specified hour.
Grid resolution:	0.1 degrees latitude/longitude grid (10km at the equator).
	Latitude and longitude of the first grid [1, 1] is [59.95°N, 0.05°E].
Domain:	Global (60°N-60°S).

3.2. FTP Directory Information

Hourly Rain Rate data;	/standard/v8/hourly/**YYYY**/**MM**/**DD**/
Satellite Information Flag;	/standard/v8/sateinfo/**YYYY**/**MM**/**DD**/
Observation Time Flag;	/standard/v8/timeinfo/**YYYY**/**MM**/**DD**/
Reliability Flag;	/standard/v8/reliability/**YYYY**/**MM**/**DD**/

where;

YYYY: 4-digit year;

MM: 2-digit month; and
DD: 2-digit day.

3.3. File Naming Rules

Data and flag files are named according to the following rules;

For GSMaP_MVK

Hourly Rain Rate data:	gsmap_mvk.**YYYYMMDD**.**HHNN**.v**P.RSKI.J**.dat
Satellite Information Flag:	gsmap_mvk.**YYYYMMDD**.**HHNN**.v**P.RSKI.J**.sateinfo.dat
Observation Time Flag:	gsmap_mvk.**YYYYMMDD**.**HHNN**.v**P.RSKI.J**.timeinfo.dat
Reliability Flag:	gsmap_mvk.**YYYYMMDD**.**HHNN**.v**P.RSKI.J**.reliability.dat

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day;
HH: 2-digit hour;
NN: 2-digit minute (currently fixed as 00); and
P.RSKI.J: version of algorithms (see section 2 for details).

3.4. Data Format

Data format was same as current version of GSMaP_NRT, and previous version of GSMaP_MVK. History of version up is described in GSMaP_MVK_RNL_HISTORY.txt file on the ftp server.

All binary files are produced in little-endian byte order platform, and archived with compressed using “gzip”. Grid of those files consists of 3600 rows x 1200 lines, which are longitude-latitude elements corresponding to a 0.1 x 0.1 degree grid that covers the global region from 60°N to 60°S. The center longitude and latitude of the first pixel [1, 1] (left top corner) are [0.05°E, 59.95°N] (Figure 1).

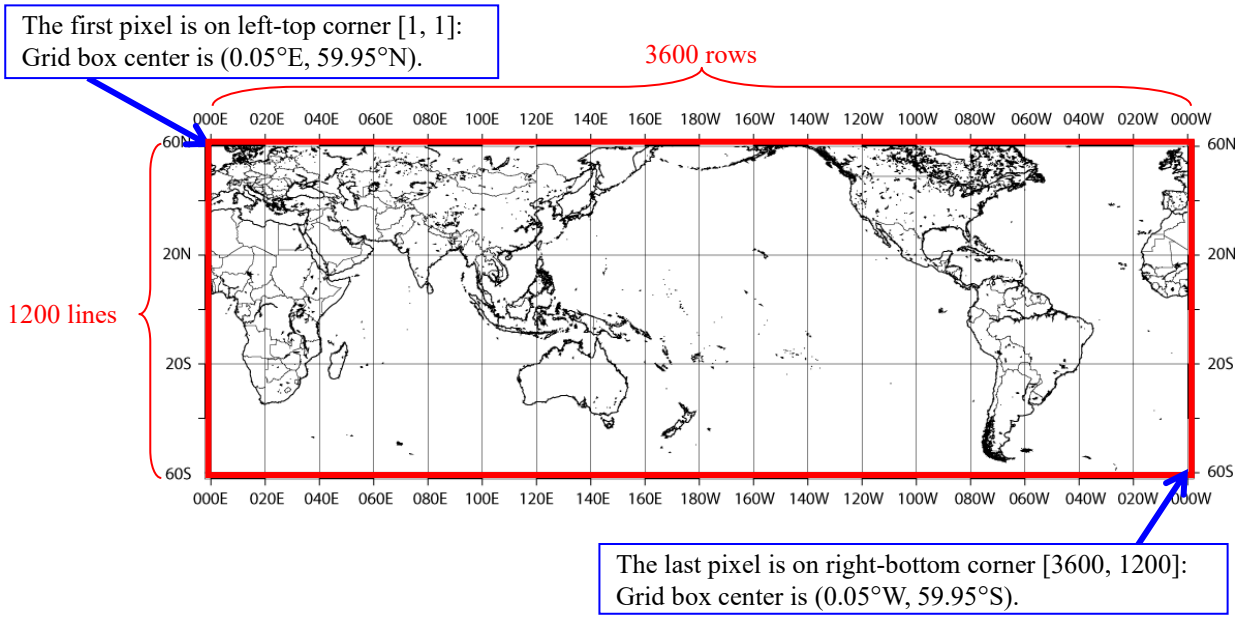

Figure 1 Data Coverage Map (Rain and Flag data)

3.5. Stored Value of Hourly Rain Rate

"Hourly Rain Rate" data are stored in 4-byte float plain binary format. Unit is [mm/hr]. Negative value denotes missing in observation data or no retrieval was done in microwave retrieval algorithm. Detailed description for missing data is shown in Table 2.

Table 2 Stored Value of Hourly Rain Rate

Value	Description
(positive)	Hourly rain rate [mm/hr].
−4	Missing due to sea ice in microwave retrieval algorithm.
−8	Missing due to low temperature in microwave retrieval algorithm.
−99	Missing due to no observation by IR and/or microwave.

3.6. Stored Value of Satellite Information Flag

"Satellite Information Flag" data are stored in 4-byte integer plain binary format. Satellite and sensor name are assigned to each bit, and the flag indicates all satellite/sensor which are used in estimation of rainfall at each pixel during one-hour time period. If the flag shows 0, there is no satellite observation by both microwave and geo-stationary IR. Following meanings are assigned to each bit in 32-bit integer (Table 3).

For example, if the stored value is 8388609, the value is the sum of "Merged IR data (1)" and "NOAA-19 (8388608)".

Table 3 Stored Values of Satellite Information Flag

Pixel Value		Description	
Value	**Bit**	**Sensor Category**	**Satellite/Sensor**
1	0	Infrared Imager aboard Geo-stationary meteorological satellite	NOAA GridSat-B1 or NOAA/CPC Globally Merged IR data
2	1	Microwave imager and/or sounder aboard low orbital satellite	TRMM/TMI
4	2		GPM-Core/GMI
8	3		Megha-Tropiques/MADRAS
16	4		Megha-Tropiques/SAPHIR
32	5		ADEOS-II/AMSR
64	6		Aqua/AMSR-E
128	7		GCOM-W1/AMSR2
256	8		GCOM-W2/AMSR2 f/o (TBD)
512	9		GCOM-W3/AMSR2 f/o (TBD)
1024	10		DMSP-F11/SSM/I
2048	11		DMSP-F13/SSM/I
4096	12		DMSP-F14/SSM/I
8192	13		DMSP-F15/SSM/I
16384	14		DMSP-F16/SSM/I
32768	15		DMSP-F17/SSM/I
65536	16		DMSP-F18/SSM/I
131072	17		DMSP-F19/SSM/I
262144	18		DMSP-F20/SSM/I
524288	19		NOAA-15/AMSU-A/B
1048576	20		NOAA-16/AMSU-A/B
2097152	21		NOAA-17/AMSU-A/B
4194304	22		NOAA-18/AMSU-A/B
8388608	23		NOAA-19/AMSU-A/B
16777216	24		NPP/ATMS
33554432	25		JPSS-1/ATMS
67108864	26		MetOp-A/AMSU-A/MHS
134217728	27		MetOp-B/AMSU-A/MHS
268435456	28		MetOp-C/AMSU-A/MHS
	29−31		Spare

3.7. Stored Value of Observation Time Flag

"Observation Time Information Flag" are in 4-byte float plain binary format. The Flag indicates relative time of nearest microwave radiometer (imager/sounder) observation at each pixel, and 0 means start time of the file (**HH** in file name). Values are stored as indicated in Table 4.

Table 4 Stored Values of Observation Time Flag

Value	Description
$0 \leq X < 1$	If value is positive and smaller than 1, microwave radiometer observation is available at the pixel during current one-hour period. X ($0 \leq X < 1$) indicates relative observation time of latest microwave radiometer, and is stored as differences from the start time of the file. For example, if UTC of the file (**HH**) = "01" and X = 0.2, observation time of the pixel will be 01:12 UTC.
$1 \leq X$	If value is equal or larger than 1, NO microwave radiometer observation is available at the pixel during time period of the file. X ($1 \leq X$) indicates relative observation time of coming microwave radiometer, and stored as differences from the start time of the file. For example, if UTC of the file (**HH**) = "01" and X= 2.5, coming observation time of microwave radiometer at the pixel will be 3:30 UTC.
$X < 0$	If value is negative, NO microwave radiometer observation is available at the pixel during time period of the file. X ($X < 0$) indicates relative observation time of latest microwave radiometer, and stored as differences from the start time of the file. For example, if UTC of the file (**HH**) = "01" and X = −2.5, latest observation time of microwave radiometer at the pixel will be 22:30 UTC of previous day.
X = −999	No microwave observation (Missing)

3.8. Stored Values of Reliability Flag

"Reliability Flag" are in 1-byte integer plain binary format. The Flag indicates a reliability of the precipitation at each pixel in consideration of sensor and algorithm characteristics. Values range from 1 to 10 and these are stored as described in Table 5. Basically, 10 is the best and the 1 is the worst, and, higher values demonstrate higher reliability. Especially, please be careful to use the GSMaP data when the reliability flag is lower than 4.

Table 5 Stored Values of Reliability Flag

Value	Description			
	Microwave radiometer observation		**NO microwave radiometer observation**	
	Over Land / Coast	Over Ocean	Over Land / Coast	Over Ocean
10		● not sounder		
9	●	● sounder		
8				● ~1 hour before/after obs.
7			● ~1 hour before/after obs.	
6				● 1~2 hour before/after obs.
5			● 1~2 hour before/after obs.	
4	● temperature < 2 deg C		● temperature < 2 deg C	● 2~3 before/hour after obs.
3			● 2~3 hour before/after obs.	
2			● 1~2 hour before/after obs. in lower temperature region	● 3~4 hour before/after obs.
1		● Freezing Level<500m	● 3~ hour before/after obs. or 2~ hour before/after obs. in lower temperature region	● 4~ hour before/after obs. or 0~ hour after obs. in lower freezing level region

3.9. File Size

Approximately 1.5 Mbyte (with gzip), and 17 Mbyte (uncompressed) for each file.

4. Hourly Gauge-calibrated Rain Rate in Binary (product (5))

4.1. Basic Information

Same as Hourly Rain Rate Data (product (1)) except for GSMaP_Gauge. See Section 3.1. GSMaP_Gauge is adjusted by the NOAA CPC Unified Gauge-based Analysis of Global Daily Precipitation.

4.2. FTP Directory Information

Hourly Gauge-calibrated Rain Rate data: /standard/v8/hourly_G/**YYYY**/**MM**/**DD**/

where;

YYYY: 4-digit year;
MM: 2-digit month; and
DD: 2-digit day.

4.3. File Naming Rules

Data and flag files are named according to the following rules;

Hourly Gauge-calibrated Rain Rate data
GSMaP_Gauge; gsmap_gauge.**YYYYMMDD**.**HHNN**.v**P**.**RSKI**.**J**.dat

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day;
HH: 2-digit hour;
NN: 2-digit minute (currently fixed as 00); and
P.RSKI.J: version of algorithms (see section 2 for details).

4.4. Data Format

Same as Hourly Rain Rate Data (product (1)). See Section 3.4.

4.5. Stored Value of Hourly Gauge-calibrated Rain Rate

Same as Hourly Rain Rate Data (product (1)). See Section 3.5.

4.6. File Size

Approximately 1.5 Mbyte (with gzip), and 17 Mbyte (uncompressed) for each file.

5. Hourly Rain Rate & Gauge-calibrated Rain Rate in text format (product (6))

5.1. Basic Information

Hourly rain rate (GSMaP_MVK) and Gauge-calibrated rain rate (GSMaP_Gauge) are stored in the same line.

Temporal resolution: 1 hour (hourly data) averaged from 00-minute to 59-minute of the specified hour.
Grid resolution: 0.1 degrees latitude/longitude grid (10km at the equator)
Domain: 15 areas

5.2. FTP Directory Information

Data files are archived at following directories;

Hourly Data: /standard/v8/txt/hourly/**XX_ZZZZZZ**/**YYYY**/**MM**/**DD**/

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit hour; and
XX_ZZZZZZ: 9-digit area name.

5.3. File Naming Rules

Data files are named according to following rules;

Standard Products (GSMaP_MVK & GSMaP_Gauge):

gsmap_mvk_v**PRSKIJ**_**YYYYMMDD**_**HH**00**_XX_ZZZZZZ**.csv

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day;
HH: 2-digit hour;
PRSKIJ: version of algorithms (see section 2 for details); and
XX_ZZZZZZ: 9-digit area name.

5.4. Area definition in text format

The 15 areas for Text format are defined as gray-shaded area in Figure 2. The detail of each area is shown in Table 6.

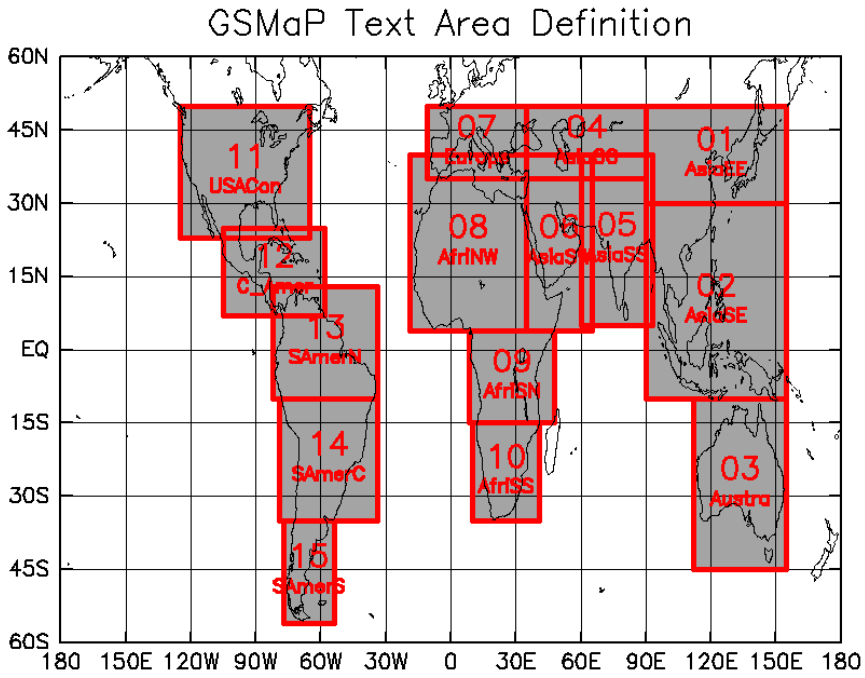

Figure 2 Definition of Text Area

Table 6 Corner latitude and longitude of each area

Area name	Longitude (W)	Longitude (E)	Latitude (S)	Latitude (N)	Description
01_AsiaEE	90	155	30	50	East Asia
02_AsiaSE	90	155	-10	30	South East Asia
03_Austra	112	155	-45	-10	Australia
04_AsiaCC	35	90	35	50	Central Asia
05_AsiaSS	60	93	5	40	South Asia
06_AsiaSW	35	65	4	40	Arabian Penisula and East Africa
07_Europe	-11	35	35	50	Europe
08_AfriNW	-19	35	4	40	North West and Central Africa
09_AfriSN	8.5	48	-15	4	Southern Africa (North)
10_AfriSS	10	41	-35	-15	Southern Africa (South)
11_USACon	-125	-65	23	50	USA (Contiguous)
12_C_Amer	-105	-58	7	25	Central America
13_SAmerN	-82	-34	-10	13	South America (North)
14_SAmerC	-79	-34	-35	-10	South America (Central)
15_SAmerS	-77	-54	-56	-35	South America (South)

5.5. Data Format

Text files are stored in CSV format (see Figure 3). For hourly and daily product, unit is [mm/hr]. For monthly product, unit is [mm/mo]. Missing value is -999.90. All text files are archived with compressed using “zip”. This data format is available in the ArcGIS (ESRI ArcMap 10.0), verified by Mr. Fujioka (ICHARM).

Lat	Lon	RainRate	Gauge-calibratedRain
49.95	89.95	0	0
49.85	89.95	0	0
49.65	89.95	1.1	1.5
……			

Figure 3 Example of text format

5.6. File Size

Approximately 100-700 Kbyte (with zip), and 1.0-5.5 Mbyte (uncompressed) for each file.

6. Daily Averaged Rain Rate in Binary (products (7)-(8))

6.1. Basic Information

Daily averaged rain rate [mm/hr] of GSMaP_MVK (product (1)).

Temporal resolution:	24 hours average (daily average) Two definitions of "daily"; a) 00Z-23Z average: from 00Z to 23Z of the day; and b) 12Z-11Z average: from 12Z of the previous day to 11Z of the day.
Grid resolution:	0.1 degrees latitude/longitude grid (10km at the equator)
Domain:	Global (60°N-60°S)

6.2. FTP Directory Information

Data files are archived at following directories;

Daily data (00Z-23Z average): /standard/v8/daily/00Z-23Z/**YYYYMM**/
Daily data (12Z-11Z average): /standard/v8/daily/p12Z-11Z/**YYYYMM**/

where;
YYYY: 4-digit year; and
MM: 2-digit month.

6.3. File Naming Rules

Data files are named according to following rules;

Daily data (00Z-23Z average):
GSMaP_MVK; gsmap_mvk.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P.RSKI**.**J**.dat

Daily data (12Z-11Z average):
GSMaP_MVK; gsmap_mvk.**YYYYMMDD**.0.1d.daily.p12Z-11Z.v**P.RSKI**.**J**.dat

where;
YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day; and
P.RSKI.J: version of algorithms (see section 2 for details).

6.4. Data Format

All binary files are produced in little-endian byte order platform, and archived with compressed using "gzip". Unit is [mm/hr]. Missing value is -999.9.

Grid of those files consists of 3600 rows x 1200 lines, which are longitude-latitude elements corresponding to a 0.1 x 0.1 degree grid that covers the global region from 60°N to 60°S. The center longitude and latitude of the first pixel [1, 1] (left top corner) is [0.05°E, 59.95°N] (See Figure 1).

6.5. File Size

Approximately 5 Mbyte (with gzip), and 17 Mbyte (uncompressed) for each file.

7. Daily Averaged Gauge-calibrated Rain Rate in Binary (products (9)-(10))

7.1. Basic Information

Same as Daily Averaged Rain Rate (products (7)-(8)) except for GSMaP_Gauge (product (5)). See Section 6.1.

7.2. FTP Directory Information

Data files are archived at following directories;

Daily data
00Z-23Z average: /standard/v8/daily_G/00Z-23Z/**YYYYMM**/
12Z-11Z average: /standard/v8/daily_G/p12Z-11Z/**YYYYMM**/

where;
YYYY: 4-digit year; and
MM: 2-digit month.

7.3. File Naming Rules

Data files are named according to following rules;

Daily data (00Z-23Z average)
GSMaP_Gauge: gsmap_gauge.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P.RSKI.J**.dat

Daily data (12Z-11Z average)
GSMaP_Gauge: gsmap_gauge.**YYYYMMDD**.0.1d.daily.p12Z-11Z.v**P.RSKI.J**.dat

where;
YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day; and
P.RSKI.J: version of algorithms (see section 2 for details).

7.4. Data Format

Same as Daily Averaged Rain Rate Data (products (7)-(8)). See Section 6.4.

7.5. File Size

Approximately 5 Mbyte (with gzip), and 17 Mbyte (uncompressed) for each file.

8. Daily Averaged Rain Rate & Gauge-calibrated Rain Rate in text format (products (11)-(12))

8.1. Basic Information

Daily averaged rain rate (GSMaP_MVK) and gauge-calibrated rain rate (GSMaP_Gauge) are stored in the same line.

Temporal resolution:	24 hours average (daily data) Two definitions of "daily"; a) 00Z-23Z average: from 00Z to 23Z of the day; and b) 12Z-11Z average: from 12Z of the previous day to 11Z of the day.
Grid resolution:	0.1 degrees latitude/longitude grid (10km at the equator)
Domain:	15 areas

8.2. FTP Directory Information

Data files are archived at following directories;

Daily data (00Z-23Z average): /standard/v8/txt/daily/00Z-23Z/**XX_ZZZZZZ**/**YYYY**/**MM**/
Daily data (12Z-11Z average): /standard/v8/txt/daily/p12Z-11Z/**XX_ZZZZZZ**/**YYYY**/**MM**/

where;

YYYY: 4-digit year;
MM: 2-digit month; and
XX_ZZZZZZ: 9-digit area name.

8.3. File Naming Rules

Data files are named according to following rules;

Standard Products (GSMaP_MVK & GSMaP_Gauge)
Daily data (00Z-23Z average):
gsmap_mvk_v**PRSKIJ_YYYYMMDD**_daily_00Z-23Z_**XX_ZZZZZZ**.csv
Daily data (12Z-11Z average):
gsmap_mvk_v**PRSKIJ_YYYYMMDD**_daily_p12Z-11Z_**XX_ZZZZZZ**.csv

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day;
PRSKIJ: version of algorithms (see section 2 for details); and
XX_ZZZZZZ: 9-digit area name.

8.4. Area definition in text format

Same as hourly text file. See section 5.4, Figure 2, and Table 6.

8.5. Data Format

Same as hourly text file. See section 5.5 and Figure 3.

8.6. File Size

Approximately 100-700 Kbyte (with zip), and 1.0-5.5 Mbyte (uncompressed) for each file.

9. Monthly Averaged Rain Rate in Binary (product (13))

9.1. Basic Information

Monthly averaged rain rate [mm/hr] and the number of samples (≧ 0 mm/hr) per month for GSMaP_MVK (product (1)).

Temporal resolution:	Monthly average
Grid resolution:	0.1 degrees latitude/longitude grid (10km at the equator)
Domain:	Global (60°N-60°S)

9.2. FTP Directory Information

Data files are archived at following directories;

Monthly data: /standard/v8/monthly/**YYYY**/

where;

YYYY: 4-digit year.

9.3. File Naming Rules

Data files are named according to following rules;

Monthly data:

GSMaP_MVK; gsmap_mvk.**YYYYMM**.0.1d.monthly.v**P.RSKI.J**.dat

where;

YYYY: 4-digit year;
MM: 2-digit month; and
P.RSKI.J: version of algorithms (see section 2 for details).

9.4. Data Format

All binary files are produced in little-endian byte order platform, and archived with compressed using “gzip”. In each monthly file, there are two global fields: monthly averaged rain rate; and numbers of valid pixel (≧ 0 mm) per month. The former unit is [mm/hr] and the missing value is -999.9. Multiplying of both layers gives the monthly total precipitation [mm/month].

Grid of those files consists of 3600 rows x 1200 lines, which are longitude-latitude elements corresponding to a 0.1 x 0.1 degree grid that covers the global region from 60°N to 60°S. The center longitude and latitude of the first pixel [1, 1] (left top corner) is [0.05°E, 59.95°N] (See Figure 1).

** Please note that the calculations for monthly products take into account not only quality of an hourly rain rate but also a ratio of missing values per month.*

9.5. File Size

Approximately 14 Mbyte (with gzip), and 34 Mbyte (uncompressed) for each file.

10. Monthly Averaged Gauge-calibrated Rain Rate in Binary (product (14))

10.1. Basic Information

Same as Monthly Averaged Rain Rate (product (13)) except for GSMaP_Gauge (product (5)). See Section 9.1.

10.2. FTP Directory Information

Data files are archived at following directories;

Monthly Gauge-calibrated Rain Rate data: /standard/v8/monthly_G/**YYYY**/

where;

YYYY: 4-digit year.

10.3. File Naming Rules

Data files are named according to following rules;

Monthly Gauge-calibrated Rain Rate data

GSMaP_Gauge: gsmap_gauge.**YYYYMM**.0.1d.monthly.v**P.RSKI.J**.dat

where;

YYYY: 4-digit year;
MM: 2-digit month;
P.RSKI.J: version of algorithms (see section 2 for details).

10.4. Data Format

Same as Monthly Averaged Rain Rate Data (product (13)). See Section 9.4.

10.5. File Size

Same as Monthly Averaged Rain Rate Data (product (13)). See Section 9.5.

11. Monthly Accumulated Rain Rate & Gauge-calibrated Rain Rate in text format (product (15))

11.1. Basic Information

Monthly accumulated rain rate (GSMaP_MVK) and gauge-calibrated rain rate (GSMaP_Gauge) are stored in the same line.

Temporal resolution:	monthly data
Grid resolution:	0.1 degrees latitude/longitude grid (10km at the equator)
Domain:	15 areas

11.2. FTP Directory Information

Data files are archived at following directories;

Monthly data: /standard/v8/txt/monthly/**XX_ZZZZZZ**/**YYYY**/

where;

YYYY: 4-digit year;
XX_ZZZZZZ: 9-digit area name.

11.3. File Naming Rules

Data files are named according to following rules;

Standard Products (GSMaP_MVK & GSMaP_Gauge):

gsmap_mvk_v**PRSKIJ_YYYYMM**_monthly_**XX_ZZZZZZ**.csv

where;

YYYY: 4-digit year;
MM: 2-digit month;
PRSKIJ: version of algorithms (see section 2 for details); and
XX_ZZZZZZ: 9-digit area name.

11.4. Area definition in text format

Same as hourly text file. See section 5.4, Figure 2, and Table 6.

11.5. Data Format

Same as hourly text file. See section 5.5 and Figure 3.

11.6. File Size

Approximately 100-700 Kbyte (with zip), and 1.0-5.5 Mbyte (uncompressed) for each file.

12. Hourly Rainfall and major flags (NetCDF) (products (16))

12.1. Basic Information

Hourly rain rate and major flags shown in Table 7 are stored in a NetCDF data.

Data period: January 1998 - present

Table 7 Stored Values in NetCDF data

Parameter [unit]	Type	Grid Size	Horizontal resolution	Temporal resolution
Latitude	Float	3600 x 1800	0.1 x 0.1 degree grid box	Hourly
Longitude	Float			
Hourly Rain Rate [mm/hr]	Float			
Hourly Gauge-	Float			

calibrated Rain Rate [mm/hr]				
Snow Probability	Short			
Observation Time Flag	Float			
Reliability Flag	Signed char			

12.2. FTP Directory Information

Data files are archived at following directories;

Hourly data; /standard/v8/netcdf/**YYYY**/**MM**/**DD**/

where;

YYYY: 4-digit year;
MM: 2-digit month; and
DD: 2-digit day.

12.3. File Naming Rules

Data files are named according to following rules;

Hourly data:
GSMaP_MVK; gsmap_mvk.**YYYYMM**.**HHNN**.v**P.RSKI**.**J**.nc

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day;
HH: 2-digit hour;
NN: 2-digit minute (currently fixed as 00); and
P.RSKI.J: version of algorithms (see section 2 for details).

12.4. Data Format

NetCDF files are produced with grid size 3600 x 1800, which are longitude-latitude elements corresponding to a 0.1° x 0.1° grid that covers the global region from 90°N to 90°S.

Since version 8, retrieval domain has been extended to the poles only when passive microwave radiometer passes.

12.5. File Size

Approximately 5 Mbyte for each file.

13. Hourly Rainfall and major flags (HDF) (product (17))

13.1. Basic Information

Hourly rain rate and major flags are stored in a HDF data.

Data period: January 2024 - present

13.2. FTP Directory Information

Data files are archived at following directories;

Hourly data: /HDF/standard/**VV**/Hourly/**YYYY**/**MM**/**DD**/

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day; and
VV: 2-digit Algorithm version.

13.3. File Naming Rules

Data files are named according to following rules;

Hourly data: GPMMRG_MAP_YYMMDDHHNN_H_L3S_MCH_VVV.h5

where;

YY: 2-digit year;
MM: 2-digit month;
DD: 2-digit day;
HH: 2-digit hour;
NN: 2-digit minute (currently fixed as 00); and
VVV: 3-digit Product version.

13.4. Data Format

(Version 8)
https://www.eorc.jaxa.jp/GPM/doc/product/format/en/07.GPM_GSMaP_Product_Format_V5_E.pdf

13.5. Sample Code

https://www.eorc.jaxa.jp/GPM/en/data_utilization.html#sample

13.6. File Size

Approximately 5 Mbyte for each file.

14. Daily Rainfall and major flags (HDF) (product (18))

14.1. Basic Information

Daily rain rate and major flags are stored in a HDF data.
Data period: January 2024 - present

14.2. FTP Directory Information

Data files are archived at following directories;

Daily data: /HDF/standard/**VV**/Daily/**YYYY**/**MM**/

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day; and
VV: 2-digit Algorithm version.

14.3. File Naming Rules

Data files are named according to following rules;

Daily data: GPMMRG_MAP_YYMMDD_D_L3S_MCD_VVV.h5

where;

YY: 2-digit year;
MM: 2-digit month;
DD: 2-digit day; and
VVV: 3-digit Product version.

14.4. Data Format

Same as Hourly Rainfall and major flags (HDF) (product (17)). See Section 13.4.

14.5. Sample Code

Same as Hourly Rainfall and major flags (HDF) (product (17)). See Section 13.5.

14.6. File Size

Approximately 5 Mbyte for each file.

15. Monthly Rainfall and major flags (HDF) (product (19))

15.1. Basic Information

Monthly rain rate and major flags are stored in a HDF data.
Data period: January 2024 - present

15.2. FTP Directory Information

Data files are archived at following directories;

Monthly data: /HDF/standard/**VV**/Monthly/**YYYY**/

where;

YYYY: 4-digit year; and
VV: 2-digit Algorithm version.

15.3. File Naming Rules

Data files are named according to following rules;

Monthly data: GPMMRG_MAP_YYMM_M_L3S_MCM_VVV.h5

where;

YY: 2-digit year;
MM: 2-digit month; and
VVV: 3-digit Product version.

15.4. Data Format

Same as Hourly Rainfall and major flags (HDF) (product (17)). See Section 13.4.

15.5. Sample Code

Same as Hourly Rainfall and major flags (HDF) (product (17)). See Section 13.5.

15.6. File Size

Approximately 5 Mbyte for each file.

16. Sample code

16.1. Sample Code Directory Information

Some sample codes for GSMaP_MVK are archived at following directory. You can apply same sample code prepared for GSMaP_MVK to GSMaP_Gauge but please replace input file name as appropriate.

Data files are archived at following directories; /standard/v8/sample/

16.2. FORTRAN Sample Code

FORTRAN sample code to read hourly rain rate data (product (1), plain binary) is archived as;

read_GSMaP_MVK_0.1deg.v8.f

16.3. IDL Sample Code

Sample code for Interactive Data Language (IDL) to read hourly rain rate data (product (1), plain binary) is archived as;

GSMaP_MVK_sample.v8.pro

16.4. GrADS Control File

Sample control files of the Grid Analysis and Display System (GrADS) for each product are also archived as follows;

Hourly Rain Rate data:	GSMaP_MVK.hourly.rain.v8.ctl
Satellite Information Flag:	GSMaP_MVK.hourly.sat.v8.ctl
Observation Time Flag:	GSMaP_MVK.hourly.time.v8.ctl
Reliability Flag:	GSMaP_MVK.hourly.reliability.v8.ctl
Daily data (00Z-23Z average);	GSMaP_MVK.daily.00Z-23Z.v8.ctl
Daily data (p12Z-11Z average);	GSMaP_MVK.daily.p12Z-11Z.v8.ctl
Monthly data:	GSMaP_MVK.monthly.v8.ctl

About usage of GrADS tool, please see GrADS home page (http://cola.gmu.edu/grads/grads.php).

16.5. Python Sample Code

Python sample code to read hourly data (product (16), NetCDF) is archived as;

readGSMaP_MVK_netcdf.py

17. Algorithm and references

17.1. Algorithm

Details of the latest GSMaP algorithm are described in following documents and references in Section 17.2.

- "Global Satellite Mapping of Precipitation (GSMaP) for GPM: Algorithm Theoretical Basis Document (ATBD)" (https://sharaku.eorc.jaxa.jp/GSMaP/faq/GSMaP_faq15.html).

17.2. References

Please refer the following paper:

- Kubota, T., K. Aonashi, T. Ushio, S. Shige, Y. N. Takayabu, M. Kachi, Y. Arai, T. Tashima, T. Masaki, N. Kawamoto, T. Mega, M. K. Yamamoto, A. Hamada, M. Yamaji, G. Liu and R. Oki 2020: Global Satellite Mapping of Precipitation (GSMaP) products in the GPM era, Satellite precipitation measurement, Springer, https://doi.org/10.1007/978-3-030-24568-9_20.

(Major papers related to GSMaP algorithms)

- Kubota, T., S. Shige, H. Hashizume, K. Aonashi, N. Takahashi, S. Seto, M. Hirose, Y. N. Takayabu, K. Nakagawa, K. Iwanami, T. Ushio, M. Kachi, and K. Okamoto, 2007: Global Precipitation Map using Satelliteborne Microwave Radiometers by the GSMaP Project : Production and Validation, *IEEE Trans. Geosci. Remote Sens.*, **45**, No. 7, 2259-2275, https://doi.org/10.1109/TGRS.2007.895337.

- Aonashi, K., J. Awaka, M. Hirose, T. Kozu, T. Kubota, G. Liu, S. Shige, S., Kida, S. Seto, N.Takahashi, and Y. N. Takayabu, 2009: GSMaP passive, microwave precipitation retrieval algorithm: Algorithm description and validation. *J. Meteor. Soc. Japan*, **87A**, 119-136, https://doi.org/10.2151/jmsj.87A.119.

- T. Ushio, T. Kubota, S. Shige, K. Okamoto, K. Aonashi, T. Inoue, N., Takahashi, T. Iguchi, M.Kachi, R. Oki, T. Morimoto, and Z. Kawasaki, 2009: A Kalman filter approach to the Global Satellite Mapping of Precipitation (GSMaP) from combined passive microwave and infrared radiometric data. *J. Meteor. Soc. Japan*, **87A**, 137-151, https://doi.org/10.2151/jmsj.87A.137.

- Mega, T., T. Ushio, M. T. Matsuda, T. Kubota, M. Kachi, and R. Oki, 2019: Gauge-adjusted global satellite mapping of precipitation. *IEEE Trans. Geosci. Remote Sens.*, **57.4**, 1928-1935, https://doi.org/10.1109/TGRS.2018.2870199.

18. Contact

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