

Data Format Description for
Global Satellite Mapping of Precipitation Microwave-IR Combined Product
(GSMaP_MVK) and Gauge-calibrated Rainfall Product (GSMaP_Gauge),
Reanalysis Products (GSMaP_RNL), and
Gauge-calibrated Reanalysis Product (GSMaP_Gauge_RNL)
Version 6

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 6, 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). For the past period before March 1, 2014, we also produced Reanalysis Products (GSMaP_RNL) and Gauge-calibrated Reanalysis Product (GSMaP_Gauge_RNL).

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. GSMaP_RNL and GSMaP_Gauge_RNL use same algorithms as GSMaP_MVK and GSMaP_Gauge, respectively, but using the Japanese 55-year Reanalysis (JRA-55) data as ancillary data to produce continuous and homogeneous dataset for the past period from March 2000 to February 2014.

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 signed 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						
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	0.1 x 0.1 degree grid box	Daily (averaged from 00Z to 23Z of the specified day)	See Section 6	
8	Daily Averaged Rain Rate [mm/hr]					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	Daily Averaged Gauge-calibrated Rain Rate [mm/hr]					Same as 8		
11	Daily Averaged Rain Rate & Gauge-calibrated Rain Rate in text format [mm/hr]	ASCII, CSV format	Divided to 15 areas	---	0.1 x 0.1 degree grid box	Same as 7	See Section 8	
12	Daily Averaged Rain Rate & Gauge-calibrated Rain Rate in text format [mm/hr]					Same as 8		

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]
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

2. Product/Algorithm Versions and Data Period

2.1. Version

Version of product and algorithms are denoted in following format.

Version: **vP.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, v6.5133.0 indicates that product version is **6**, microwave imager algorithm version is **6.5**, microwave sounder version is **6.1**, microwave imager/sounder version is **6.3**, microwave-IR combined version is **6.3**, 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 period for GSMaP_MVK and GSMaP_Gauge product version 6 is currently **from 1 March 2014 to present**. Data will be updated operationally about three days after observation. GSMaP_RNL and GSMaP_Gauge_RNL product version 6 covers the period **from March 2000 to February 2014**.

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 and GSMaP_RNL.

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/v6/hourly/ YYYY/MM/DD/
Satellite Information Flag;	/standard/v6/sateinfo/ YYYY/MM/DD/
Observation Time Flag;	/standard/v6/timeinfo/ YYYY/MM/DD/
Reliability Flag;	/standard/v6/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: gsmmap_mvk.**YYYYMMDD.HHNN.vP.RSKI.J**.dat
Satellite Information Flag: gsmmap_mvk.**YYYYMMDD.HHNN.vP.RSKI.J**.sateinfo.dat
Observation Time Flag: gsmmap_mvk.**YYYYMMDD.HHNN.vP.RSKI.J**.timeinfo.dat

For GSMaP_RNL

Hourly Rain Rate data: gsmmap_rnl.**YYYYMMDD.HHNN.vP.RSKI.J**.dat
Satellite Information Flag: gsmmap_rnl.**YYYYMMDD.HHNN.vP.RSKI.J**.sateinfo.dat
Observation Time Flag: gsmmap_rnl.**YYYYMMDD.HHNN.vP.RSKI.J**.timeinfo.dat
Reliability Flag: gsmmap_rnl.**YYYYMMDD.HHNN.vP.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 (Ver.5.222). 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).

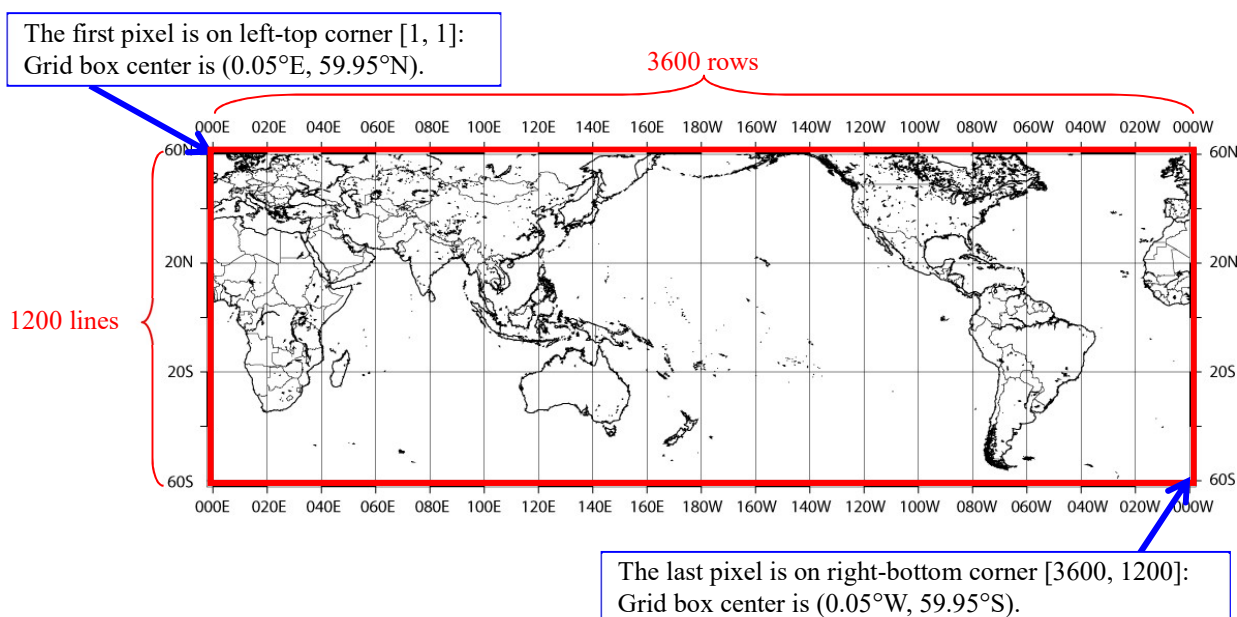


Figure 1 Data Coverage Map (Rain and Flag data)

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. If flag shows negative value, there is NO microwave radiometer observation. Following meanings are assigned to each bit in 32-bit integer (Table 3). Assigned bit to IR imager aboard Geo-stationary meteorological satellite is different to that of GSMaP_NRT, because GSMaP_MVK and GSMaP_RNL uses NOAA/CPC’s Globally Merged IR data, which merges all available meteorological satellite data.

For example, if the stored value is 1073743872, the value is the sum of "Merged IR data (1073741824)" and "NOAA-19 (2048)".

Table 3 Stored Values of Satellite Information Flag

Pixel Value		Description	
Value	Bit	Sensor Category	Satellite/Sensor
1	0	Microwave radiometer (imager/sounder) aboard low orbital satellite	TRMM/TMI
2	1		Aqua/AMSR-E
4	2		DMSP-F13/SSM/I
8	3		DMSP-F14/SSM/I
16	4		DMSP-F15/SSM/I
32	5		DMSP-F16/SSMIS
64	6		DMSP-F17/SSMIS
128	7		NOAA-15/AMSU-A/B
256	8		NOAA-16/AMSU-A/B
512	9		NOAA-17/AMSU-A/B
1024	10		NOAA-18/AMSU-A/MHS
2048	11		NOAA-19/AMSU-A/MHS
4096	12		MetOp-A/AMSU-A/MHS
8192	13		DMSP-F18/SSMIS
16384	14		ADEOS-II/AMSR
32768	15		DMSP-F11/SSM/I
65536	16		GCOM-W/AMSR2
131072	17		MetOp-B/AMSH-A/MHS
262144	18		GPM-Core/GMI
524288	19	DMSP-F19/SSMIS	
1048576 – 536870912	20-29		not used
1073741824	30	Infrared Imager aboard Geo- stationary meteorological satellite	NOAA/CPC Globally Merged IR data
-(negative)	31	No microwave radiometer observation	

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 or sea ice or low-temperature		● 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 or sea ice or low-temperature	● 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 and GSMaP_Gauge_RNL. See Section 3.1. GSMaP_Gauge_RNL and GSMaP_Gauge are adjusted by the NOAA CPC Unified Gauge-based Analysis of Global Daily Precipitation. *Please noted that a sample number of rain gauges within grid boxes is considered in the revised version, while it is not considered in the original version.*

4.2. FTP Directory Information

Hourly Gauge-calibrated Rain Rate data:

(original ver.);	/standard/v6/hourly_G/ YYYY/MM/DD /
(revised ver.);	/standard/v6/hourly_Grev/ 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 (original ver.)

GSMaP_Gauge;	gsmap_gauge. YYYYMMDD.HHNN.vP.RSKI.J .dat
GSMaP_Gauge_RNL;	gsmap_gauge_rnl. YYYYMMDD.HHNN.vP.RSKI.J .dat

Hourly Gauge-calibrated Rain Rate data (revised ver.)

GSMaP_Gauge;	gsmap_gauge. YYYYMMDD.HHNN.vP.rev.J .dat
GSMaP_Gauge_RNL;	gsmap_gauge_rnl. YYYYMMDD.HHNN.vP.rev.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, GSMaP_RNL) and Gauge-calibrated rain rate (GSMaP_Gauge, GSMaP_Gauge_RNL) 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/v6/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_mvkv**PRSKIJ_YYYYMMDD_HH00_XX_ZZZZZZ.csv**

Reanalysis Products (GSMaP_RNL & GSMaP_Gauge_RNL):

gsmap_rnlv**PRSKIJ_YYYYMMDD_HH00_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.

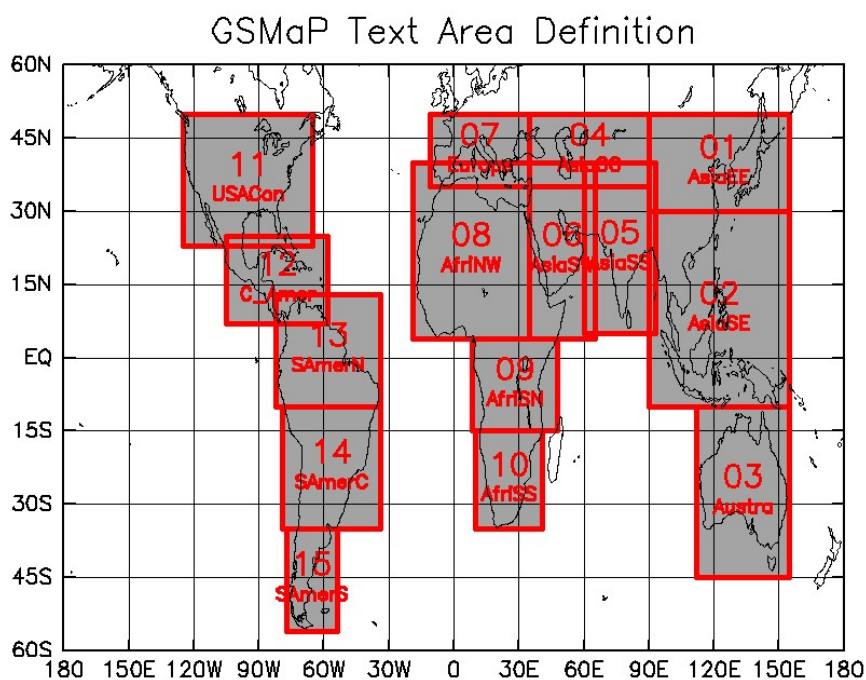


Figure 2 Definition of Text Area

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 Peninsula and East Africa
07_Europe	-11	35	35	50	Europe
08_AfrinW	-19	35	4	40	North West and Central Africa
09_AfrinS	8.5	48	-15	4	Southern Africa (North)
10_AfrinSS	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 and GSMaP_RNL (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/v6/daily/00Z-23Z/**YYYYMM**/
 Daily data (12Z-11Z average): /standard/v6/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; gsmmap_mvk.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P.RSKI.J**.dat
 GSMaP_RNL; gsmmap_rnl.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P.RSKI.J**.dat

Daily data (12Z-11Z average):

GSMaP_MVK; gsmmap_mvk.**YYYYMMDD**.0.1d.daily.p12Z-11Z.v**P.RSKI.J**.dat
 GSMaP_RNL; gsmmap_rnl.**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 and GSMaP_Gauge_RNL (product (5)). See Section 6.1.

7.2. FTP Directory Information

Data files are archived at following directories;

Daily data (original ver.)

00Z-23Z average: /standard/v6/daily_G/00Z-23Z/**YYYYMM**/

12Z-11Z average: /standard/v6/daily_G/p12Z-11Z/**YYYYMM**/

Daily data (revised ver.)

00Z-23Z average: /standard/v6/daily_Grev/00Z-23Z/**YYYYMM**/

12Z-11Z average: /standard/v6/daily_Grev/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, original ver.)

GSMaP_Gauge: gsmmap_gauge.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P.RSKI.J**.dat

GSMaP_Gauge_RNL: gsmmap_gauge_rnl.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P.RSKI.J**.dat

Daily data (12Z-11Z average, original ver.)

GSMaP_Gauge: gsmmap_gauge.**YYYYMMDD**.0.1d.daily.p12Z-11Z.v**P.RSKI.J**.dat

GSMaP_Gauge_RNL: gsmmap_gauge_rnl.**YYYYMMDD**.0.1d.daily.p12Z-11Z.v**P.RSKI.J**.dat

Daily data (00Z-23Z average, revised ver.)

GSMaP_Gauge: gsmmap_gauge.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P**.rev.**J**.dat

GSMaP_Gauge_RNL: gsmmap_gauge_rnl.**YYYYMMDD**.0.1d.daily.00Z-23Z.v**P**.rev.**J**.dat

Daily data (12Z-11Z average, revised ver.)

GSMaP_Gauge: gsmmap_gauge.**YYYYMMDD**.0.1d.daily.p12Z-11Z.v**P**.rev.**J**.dat

GSMaP_Gauge_RNL: gsmmap_gauge_rnl.**YYYYMMDD**.0.1d.daily.p12Z-11Z.v**P**.rev.**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, GSMaP_RNL) and gauge-calibrated rain rate (GSMaP_Gauge, GSMaP_Gauge_RNL) 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/v6/txt/daily/00Z-23Z/**XX_ZZZZZZ/YYYY/MM/**

Daily data (12Z-11Z average): /standard/v6/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):

gsmmap_mvkv_v**PRSKIJ_YYYYMMDD**_daily_00Z-23Z_XX_ZZZZZZ.csv

Daily data (12Z-11Z average):

gsmmap_mvkv_v**PRSKIJ_YYYYMMDD**_daily_p12Z-11Z_XX_ZZZZZZ.csv

Reanalysis Products (GSMaP_RNL & GSMaP_Gauge_RNL)

Daily data (00Z-23Z average):

gsmmap_rnl_v**PRSKIJ_YYYYMMDD**_daily_00Z-23Z_XX_ZZZZZZ.csv

Daily data (12Z-11Z average):

gsmmap_rnl_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 and GSMaP_RNL (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/v6/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.vP.RSKI.J.dat
GSMaP_RNL; gsmap_rnl.YYYYMM.0.1d.monthly.vP.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 and GSMaP_Gauge_RNL (product (5)). See Section 9.1.

10.2. FTP Directory Information

Data files are archived at following directories;

Monthly Gauge-calibrated Rain Rate data:

(original ver.) /standard/v6/monthly_G/YYYY/
(revised ver.) /standard/v6/monthly_Grev/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 (original ver.)

GSMaP_Gauge: gsmap_gauge.YYYYMM.0.1d.monthly.vP.RSKI.J.dat

GSMaP_Gauge_RNL: gsmap_gauge_rnl.YYYYMM.0.1d.monthly.vP.RSKI.J.dat

Monthly Gauge-calibrated Rain Rate data (revised ver.)

GSMaP_Gauge: gsmap_gauge.YYYYMM.0.1d.monthly.vP.rev.J.dat

GSMaP_Gauge_RNL: gsmap_gauge_rnl.YYYYMM.0.1d.monthly.vP.rev.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, GSMaP_RNL) and gauge-calibrated rain rate (GSMaP_Gauge, GSMaP_Gauge_RNL) 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/v6/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_mvkv_vPRSKIY_YYYYMM_monthly_XX_ZZZZZZ.csv

Reanalysis Products (GSMaP_RNL & GSMaP_Gauge_RNL):

gsmmap_rnl_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. Sample code

12.1. 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, GSMaP_RNL, or GSMaP_Gauge_RNL, but please replace input file name as appropriate.

Data files are archived at following directories; /standard/v6/sample/

12.2. FORTRAN Sample Code

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

read_GSMaP_MVK_0.1deg.v6.f

12.3. 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.v6.pro

12.4. 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.v6.ctl
Satellite Information Flag:	GSMaP_MVK.hourly.sat.v6.ctl
Observation Time Flag:	GSMaP_MVK.hourly.time.v6.ctl
Reliability Flag:	GSMaP_RNL.hourly.reliability.v6.ctl
Daily data (00Z-23Z average);	GSMaP_MVK.daily.00Z-23Z.v6.ctl
Daily data (p12Z-11Z average);	GSMaP_MVK.daily.p12Z-11Z.v6.ctl
Monthly data:	GSMaP_MVK.monthly.v6.ctl

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

13. Algorithm and references

13.1. Algorithm

Details of the latest GSMaP algorithm are described in following documents and references in Section 13.2.

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

13.2. 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>.

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