This document describes data format and information of Global Satellite Mapping of Precipitation Microwave-IR Combined Product (hereafter refers as GSMaP_MVK) for algorithm version 7, 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. The latest version of GSMaP algorithm (Ver.7) became one of the JAXA GPM products, and 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.
1. Products Overview

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

Table 1: Summary of GSMaP_MVK and GSMaP_Gauge Products
<table>
<thead>
<tr>
<th></th>
<th>Monthly Averaged Rain Rate [mm/hr]</th>
<th>Monthly Averaged Gauge-calibrated Rain Rate [mm/hr]</th>
<th>Monthly Averaged Rain Rate &amp; Gauge-calibrated Rain Rate in text format [mm/hr]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>12</strong></td>
<td>4-byte float, plain binary, little-endian</td>
<td>Global (60°N-60°S)</td>
<td>ASCII, CSV format</td>
</tr>
<tr>
<td><strong>13</strong></td>
<td>3600 x 1200</td>
<td>0.1 x 0.1 degree grid box</td>
<td>Divided to 15 areas</td>
</tr>
<tr>
<td><strong>14</strong></td>
<td>Monthly (averaged of the specified month)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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);
- \( J \): inclement number of reprocessing.

For example, \( v7.3112.0 \) indicates that product version is 7, microwave imager algorithm version is 7.3, microwave sounder version is 7.1, microwave imager/sounder version is 7.1, microwave-IR combined version is 7.2, 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 7 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 7 covers the period from March 2000 to February 2014. Data will be updated in order when the processing completed.

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)-(3))

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/v7/hourly/YYYY/MM/DD/

Satellite Information Flag; /standard/v7/sateinfo/YYYY/MM/DD/

Observation Time Flag; /standard/v7/timeinfo/YYYY/MM/DD/

where;
3.3. File Naming Rules

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

Hourly Rain Rate data: \texttt{gsmap\_mvk.YYYYMMDD.HHNN.v.P.RSKI.J.dat}
Satellite Information Flag: \texttt{gsmap\_mvk.YYYYMMDD.HHNN.v.P.RSKI.J.sateinfo.dat}
Observation Time Flag: \texttt{gsmap\_mvk.YYYYMMDD.HHNN.v.P.RSKI.J.timeinfo.dat}

where;

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

3.4. Data Format

Data format was same as current version of GSMaP\_NRT, and previous version of GSMaP\_MVK (Ver.6.5133.0). 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).

\begin{figure}[h]
    \centering
    \includegraphics[width=\textwidth]{data_coverage_map.png}
    \caption{Data Coverage Map (Rain and Flag data)}
\end{figure}

The first pixel is on left-top corner [1, 1]: Grid box center is (0.05°E, 59.95°N).

The last pixel is on right-bottom corner [3600, 1200]: Grid box center is (0.05°W, 59.95°S).
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>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(positive)</td>
<td>Hourly rain rate [mm/hr].</td>
</tr>
<tr>
<td>−4</td>
<td>Missing due to sea ice in microwave retrieval algorithm.</td>
</tr>
<tr>
<td>−8</td>
<td>Missing due to low temperature in microwave retrieval algorithm.</td>
</tr>
<tr>
<td>−99</td>
<td>Missing due to no observation by IR and/or microwave.</td>
</tr>
</tbody>
</table>

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).
# Table 3 Stored Values of Satellite Information Flag

<table>
<thead>
<tr>
<th>Pixel Value</th>
<th>Bit</th>
<th>Sensor Category</th>
<th>Satellite/Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Infrared Imager aboard Geo-stationary meteorological satellite</td>
<td>NOAA/CPC Globally Merged IR data</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td></td>
<td>TRMM/TMI</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td></td>
<td>GPM-Core/GMI</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td></td>
<td>Megha-Tropiques/MADRAS</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td></td>
<td>Megha-Tropiques/SAPHIR</td>
</tr>
<tr>
<td>32</td>
<td>5</td>
<td></td>
<td>ADEOS-II/AMSR</td>
</tr>
<tr>
<td>64</td>
<td>6</td>
<td></td>
<td>Aqua/AMSR-E</td>
</tr>
<tr>
<td>128</td>
<td>7</td>
<td></td>
<td>GCOM-W1/AMSR2</td>
</tr>
<tr>
<td>256</td>
<td>8</td>
<td></td>
<td>GCOM-W2/AMSR2 f/o (TBD)</td>
</tr>
<tr>
<td>512</td>
<td>9</td>
<td></td>
<td>GCOM-W3/AMSR2 f/o (TBD)</td>
</tr>
<tr>
<td>1024</td>
<td>10</td>
<td></td>
<td>DMSP-F11/SSM/I</td>
</tr>
<tr>
<td>2048</td>
<td>11</td>
<td></td>
<td>DMSP-F13/SSM/I</td>
</tr>
<tr>
<td>4096</td>
<td>12</td>
<td></td>
<td>DMSP-F14/SSM/I</td>
</tr>
<tr>
<td>8192</td>
<td>13</td>
<td></td>
<td>DMSP-F15/SSM/I</td>
</tr>
<tr>
<td>16384</td>
<td>14</td>
<td>Microwave imager and/or sounder aboard low orbital satellite</td>
<td>DMSP-F16/SSM/I</td>
</tr>
<tr>
<td>32768</td>
<td>15</td>
<td></td>
<td>DMSP-F17/SSM/I</td>
</tr>
<tr>
<td>65536</td>
<td>16</td>
<td></td>
<td>DMSP-F18/SSM/I</td>
</tr>
<tr>
<td>131072</td>
<td>17</td>
<td></td>
<td>DMSP-F19/SSM/I</td>
</tr>
<tr>
<td>262144</td>
<td>18</td>
<td></td>
<td>DMSP-F20/SSM/I</td>
</tr>
<tr>
<td>524288</td>
<td>19</td>
<td></td>
<td>NOAA-15/AMSU-A/B</td>
</tr>
<tr>
<td>1048576</td>
<td>20</td>
<td></td>
<td>NOAA-16/AMSU-A/B</td>
</tr>
<tr>
<td>2097152</td>
<td>21</td>
<td></td>
<td>NOAA-17/AMSU-A/B</td>
</tr>
<tr>
<td>4194304</td>
<td>22</td>
<td></td>
<td>NOAA-18/AMSU-A/B</td>
</tr>
<tr>
<td>8388608</td>
<td>23</td>
<td></td>
<td>NOAA-19/AMSU-A/B</td>
</tr>
<tr>
<td>16777216</td>
<td>24</td>
<td></td>
<td>NPP/ATMS</td>
</tr>
<tr>
<td>33554432</td>
<td>25</td>
<td></td>
<td>JPSS-1/ATMS</td>
</tr>
<tr>
<td>67108864</td>
<td>26</td>
<td></td>
<td>MetOp-A/AMSU-A/MHS</td>
</tr>
<tr>
<td>134217728</td>
<td>27</td>
<td></td>
<td>MetOp-B/AMSU-A/MHS</td>
</tr>
<tr>
<td>268435456</td>
<td>28</td>
<td></td>
<td>MetOp-C/AMSU-A/MHS</td>
</tr>
<tr>
<td>29–31</td>
<td></td>
<td></td>
<td>Spare</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0 \leq X &lt; 1$</td>
<td>If value is positive and smaller than 1, microwave radiometer observation is available at the pixel during current one-hour period. $X \ (0 \leq X &lt; 1)$ 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.</td>
</tr>
<tr>
<td>$1 \leq X$</td>
<td>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.</td>
</tr>
<tr>
<td>$X &lt; 0$</td>
<td>If value is negative, NO microwave radiometer observation is available at the pixel during time period of the file. $X \ (X &lt; 0)$ 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.</td>
</tr>
<tr>
<td>$X = -999$</td>
<td>No microwave observation (Missing)</td>
</tr>
</tbody>
</table>

3.8. File Size

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

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

4.1. Basic Information

Same as Hourly Rain Rate Data (product (1)) except for GSMaP_Gauge. See Section 3.1.

4.2. FTP Directory Information

Hourly Gauge-calibrated Rain Rate data: /standard/v7/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.YYYYMMDD.HHNN.vP.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 (5))
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/v7/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;
Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA)

Hourly Data: gsmap_mvk_vPRSKIJ_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 5.

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**Figure 2 Definition of Text Area**

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![Figure 2 Definition of Text Area](image-url)
Table 5 Corner latitude and longitude of each area

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

5.5. Data Format

Text files are stored in CSV format (see Figure 3). Unit is [mm/hr]. Missing value is -999.9. 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).

<table>
<thead>
<tr>
<th>Lat</th>
<th>Lon</th>
<th>RainRate</th>
<th>Gauge-calibratedRain</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.95</td>
<td>89.95</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>49.85</td>
<td>89.95</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>49.65</td>
<td>89.95</td>
<td>1.1</td>
<td>1.5</td>
</tr>
</tbody>
</table>

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 (6)-(7))

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/v7/daily/00Z-23Z/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/YYYYMMDD.0.1d.daily.00Z-23Z.vP.RSKI.J.dat
Daily data (12Z-11Z average): gsmap_mvk/YYYYMMDD.0.1d.daily.p12Z-11Z.vP.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 (8)-(9))

7.1. Basic Information
Same as Daily Averaged Rain Rate (products (6)-(7)) except for GSMaP_Gauge (product (4)). See Section 6.1.

7.2. FTP Directory Information
Data files are archived at following directories;

Daily data (00Z-23Z average): /standard/v7/daily_G/00Z-23Z/YYYYMM/

where;
7.3. **File Naming Rules**

Data files are named according to following rules:

- Daily data (00Z-23Z average); gsmap_gauge.YYYYMMDD.0.1d.daily.00Z-23Z.vP.RSKIJ.dat
- Daily data (12Z-11Z average); gsmap_gauge.YYYYMMDD.0.1d.daily.p12Z-11Z.vP.RSKIJ.dat

where:

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

7.4. **Data Format**

Same as Daily Averaged Rain Rate Data (products (6)-(7)). 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 (10)-(11))**

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/v7/txt/daily/00Z-23Z/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;

**Daily data (00Z-23Z average):**

\[ \text{gsmap}_\text{mvk}_v^\text{PRSKIJ}_\text{YYYYMMDD}_\text{daily}_00Z-23Z_{XX_ZZZZZZ}.csv \]

**Daily data (12Z-11Z average):**

\[ \text{gsmap}_\text{mvk}_v^\text{PRSKIJ}_\text{YYYYMMDD}_\text{daily}_p12Z-11Z_{XX_ZZZZZZ}.csv \]

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 5.

### 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 (12))

#### 9.1. Basic Information

Monthly averaged rain rate [mm/hr] and the number of samples (\( \geq 0 \) 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/v7/monthly/YYYY/

where;

- **YYYY:** 4-digit year.

#### 9.3. File Naming Rules

Data files are named according to following rules;

- Monthly data: gsmap_mvk.YYYYMM.0.1d.monthly.vPRSKIJ.dat
where;

\[ \text{YYYY} \]: 4-digit year;
\[ \text{MM} \]: 2-digit month; and
\[ \text{P.RSKI.J} \]: 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 (\( \geq 0 \) 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 (13))

10.1. Basic Information

Same as Monthly Averaged Rain Rate (product (12)) except for GSMaP_Gauge (product (4)). See Section 9.1.

10.2. FTP Directory Information

Data files are archived at following directories;

Monthly data: /standard/v7/monthly_G/YYYY/

where;
\[ \text{YYYY} \]: 4-digit year.

10.3. File Naming Rules

Data files are named according to following rules;

Monthly data: gsmap_gauge.YYYYMM.0.1d.monthly.vP.RSKI.J.dat

where;
\[ \text{YYYY} \]: 4-digit year;
\[ \text{MM} \]: 2-digit month; and
\[ \text{P.RSKI.J} \]: version of algorithms (see section 2 for details).

10.4. Data Format
10.5. **File Size**

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

11. **Monthly Averaged Rain Rate & Gauge-calibrated Rain Rate in text format (product (14))**

11.1. **Basic Information**

- Monthly averaged 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 (Land area only)

11.2. **FTP Directory Information**

Data files are archived at following directories;

- **Monthly data:** /standard/v7/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;

- **Monthly data:** 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 5.

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, but please replace input file name as appropriate.

Data files are archived at following directories;

/standard/v7/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.v7.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.v7.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.v7.ctl
- Satellite Information Flag: GSMaP_MVK.hourly.sat.v7.ctl
- Observation Time Flag: GSMaP_MVK.hourly.time.v7.ctl
- Daily data (00Z-23Z average): GSMaP_MVK.daily.00Z-23Z.v7.ctl
- Monthly data: GSMaP_MVK.monthly.v7.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.


13.2. References
Please refer the following paper:


(Major papers related to GSMaP algorithms)


14. Contact

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