Global Rainfall Map in Near Real Time (GSMaP_NRT) 
and Gauge-calibrated Rainfall Product (GSMaP_Gauge) 

Data Format Description

This document describes data format and information of Global Rainfall Map in Near Real Time (hereafter refers as GSMaP_NRT) distributed from JAXA Global Rainfall Watch, and Gauge-calibrated Rainfall Product (GSMaP_Gauge), which was developed based on activities of the GSMaP (Global Satellite Mapping of Precipitation) project. The GSMaP project is based on the heritage of the study "Production of a high-precision, high-resolution global precipitation map using satellite data," sponsored by Core Research for Evolutonal Science and Technology (CREST) of the Japan Science and Technology Agency (JST) during 2002-2007. Since 2007, GSMaP project activities are promoted by the JAXA Precipitation Measuring Mission (PMM) Science Team.
1. **Product Overview**

Table 1 Summary of GSMaP_NRT Products

<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>FTP directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hourly Rain Rate [mm/h]</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 degree grid box</td>
<td>Hourly</td>
<td>Latest 24-hr: /realtime_ver/VV/ latest/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Archive: /realtime_ver/VV/archive/YYYY/MM/DD/</td>
</tr>
<tr>
<td>2</td>
<td>Satellite Information Flag</td>
<td>4-byte singed integer plain binary, little-endian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/realtime_ver/VV/sateinfo/YYYY/MM/DD/</td>
</tr>
<tr>
<td>3</td>
<td>Observation Time Flag</td>
<td>4-byte float plain binary, little-endian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/realtime_ver/VV/timeinfo/YYYY/MM/DD/</td>
</tr>
<tr>
<td>4</td>
<td>Reliability Flag</td>
<td>1-byte integer plain binary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/realtime_ver/VV/reliability/YYYY/MM/DD/</td>
</tr>
<tr>
<td>5</td>
<td>Hourly Gauge-calibrated Rain Rate [mm/h]</td>
<td>4-byte float plain binary, little-endian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/realtime_ver/VV/gauge_hr/YYYY/MM/DD/</td>
</tr>
<tr>
<td>6</td>
<td>Hourly Rain Rate in text format (old) [mm/h]</td>
<td>ASCII, CSV format</td>
<td>Global but divided to 54 areas</td>
<td>200 rows x 400 lines</td>
<td></td>
<td></td>
<td>/realtime_ver/VV/txt/AAABBBB/YYYY/MM/DD/</td>
</tr>
<tr>
<td>7</td>
<td>Hourly Rain Rate &amp; Gauge-calibrated Rain Rate in text format (new) [mm/h]</td>
<td>ASCII, CSV format</td>
<td>Divided to 15 areas</td>
<td>--</td>
<td></td>
<td></td>
<td>/realtime_ver/VV/txt/XX_ZZZZZZ/YYYY/MM/DD/</td>
</tr>
<tr>
<td>8</td>
<td>Daily Rainfall in 0.25-deg [mm/h]</td>
<td>4-byte float plain binary, little-endian</td>
<td>Global (60°N-60°S)</td>
<td>1440 x 480</td>
<td>0.25 degree grid box</td>
<td>Daily (averaged from 00Z to 23Z of the specified day)</td>
<td>/realtime_ver/VV/daily/00Z-23Z/YYYY/MM/</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Daily (averaged from 12Z of previous day)</td>
<td>/realtime_ver/VV/daily/p12Z-11Z/YYYY/MM/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Gauge-calibrated Rainfall in 0.25-deg [mm/h]</td>
<td>1440 x 480</td>
<td>0.25 degree grid box</td>
<td>to 11Z of the specified day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Daily Rainfall in 0.1-deg [mm/h]</td>
<td>Global (60°N-60°S)</td>
<td>3600 x 1200</td>
<td>0.1 degree grid box</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Gauge-calibrated Rainfall in 0.1-deg [mm/h]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Daily Rainfall in 0.25-deg [mm/h]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Daily Rainfall in 0.1-deg [mm/h]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Daily (averaged from 00Z to 23Z of the specified day)
/gauge_dy/00Z-23Z/YYYYMM/

Daily (averaged from 12Z of previous day to 11Z of the specified day)
/gauge_dy/p12Z-11Z/YYYYMM/

Daily (same as 7)
/daily0.1/00Z-23Z/YYYYMM/

Daily (same as 8)
/daily0.1/p12Z-11Z/YYYYMM/

Daily (same as 9)
/gauge_dy0.1/00Z-23Z/YYYYMM/

Daily (same as 10)
/gauge_dy0.1/p12Z-11Z/YYYYMM/

Note: YYYY: 4-digit year, MM: 2-digit month, DD: 2-digit day, AAA: latitude of the corner of left-top position (2-digit latitude + S or N), BBBB: longitude of the corner of left-top position (3-digit longitude + E or W), XX_ZZZZZZ: area name (9-digit), and VV: 2-digit Algorithm version.
2. Hourly Rainfall and Flag Files in Binary (products (1)-(3))

2.1. Basic Information

Temporal resolution: 1 hour (hourly data)
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)
Data latency: 4 hours after observation
Data archived period: File will be removed when reanalysis data (GSMaP_MVK) is uploaded (about 3 days).

2.2. FTP Directory Information

Hourly Rain Rate data;
Latest 24 hour data: /realtime_ver/VV/latest/
Archive: /realtime_ver/VV/archive/YYYY/MM/DD/
Satellite Information Flag: /realtime_ver/VV/sateinfo/YYYY/MM/DD/
Observation Time Flag: /realtime_ver/VV/timeinfo/YYYY/MM/DD/
Reliability Flag: /realtime_ver/VV/reliability/YYYY/MM/DD/

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

2.3. File Naming Rules

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

Hourly Rain Rate data: gsmap_nrt.YYYYMMDD.HHNN.dat
Satellite Information Flag: gsmap_nrt.YYYYMMDD.HHNN.sateinfo.dat
Observation Time Flag: gsmap_nrt.YYYYMMDD.HHNN.timeinfo.dat
Reliability Flag: gsmap_nrt.YYYYMMDD.HHNN.reliability.dat

where;
YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day;
HH: 2-digit hour; and
NN: 2-digit minute (currently fixed as 00).

2.4. Data Format

Data format was slightly changed since 10 Oct. 2008 due to algorithm version up. Satellite Information Flag and Observation Time Flag are newly added after 10 Oct. 2008. History of version up is described in GSMaP_NRT_HISTORY.txt file in 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).

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

3600 rows

1200 lines

The last pixel is on right-bottom corner [3600, 1200]: Grid box center is (0.05°W, 59.95°S).

Figure 1 Data Coverage Map (Rain and Flag data)

2.5. Stored Values 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 Values of Hourly Rain Rate

<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>

Please note that specification of missing value has changed since 10 October 2008. Products prior to 10
October 2008, no missing value is defined (all set to zero).

2.6. Stored Values of Satellite Information Flag

2.6.1. Version 6

“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-A).
Table 3-A Stored Values of Satellite Information Flag (old)

<table>
<thead>
<tr>
<th>Pixel Value</th>
<th>Sensor Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value</strong></td>
<td><strong>Bit</strong></td>
<td><strong>Satellite/Sensor</strong></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>TRMM/TMI</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Aqua/AMSR-E</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>DMSP-F13/SSM/I</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>DMSP-F14/SSM/I</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td>DMSP-F15/SSM/I</td>
</tr>
<tr>
<td>32</td>
<td>5</td>
<td>DMSP-F16/SSMIS</td>
</tr>
<tr>
<td>64</td>
<td>6</td>
<td>DMSP-F17/SSMIS</td>
</tr>
<tr>
<td>128</td>
<td>7</td>
<td>NOAA-19/AMSU-A/MHS</td>
</tr>
<tr>
<td>256</td>
<td>8</td>
<td>MetOp-A/AMSU-A/MHS</td>
</tr>
<tr>
<td>512</td>
<td>9</td>
<td>DMSP-F18/SSMIS</td>
</tr>
<tr>
<td>1024</td>
<td>10</td>
<td>GCOM-W/AMSR2</td>
</tr>
<tr>
<td>2048</td>
<td>11</td>
<td>GPM-Core/GMI</td>
</tr>
<tr>
<td>4096</td>
<td>12</td>
<td>NOAA-18/AMSU-A/MHS</td>
</tr>
<tr>
<td>8192</td>
<td>13</td>
<td>MetOp-B/AMSU-A/MHS</td>
</tr>
<tr>
<td>16384</td>
<td>14</td>
<td>DMSP-F19/SSMIS</td>
</tr>
<tr>
<td>32768</td>
<td>15</td>
<td>not used</td>
</tr>
<tr>
<td>65536</td>
<td>16</td>
<td>GOES-EAST</td>
</tr>
<tr>
<td>131072</td>
<td>17</td>
<td>GOES-WEST</td>
</tr>
<tr>
<td>262144</td>
<td>18</td>
<td>INDEX</td>
</tr>
<tr>
<td>524288</td>
<td>19</td>
<td>METEOSAT</td>
</tr>
<tr>
<td>1048576</td>
<td>20</td>
<td>MTSAT</td>
</tr>
<tr>
<td>2097152–536870912</td>
<td>21–29</td>
<td>not used</td>
</tr>
<tr>
<td>1073741824</td>
<td>30</td>
<td>Infrared Imager aboard Geo-stationary meteorological satellite (since 23Z 28 Mar. 2012)</td>
</tr>
<tr>
<td>–(negative)</td>
<td>31</td>
<td>No microwave radiometer observation</td>
</tr>
</tbody>
</table>

2.6.2. Version 7

“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-A).
<table>
<thead>
<tr>
<th>Pixel Value</th>
<th>Description</th>
<th>Sensor Category</th>
<th>Satellite/Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Bit</td>
<td>Infrared Imager aboard Geo-stationary meteorological satellite</td>
<td>NOAA/CPC Globally Merged IR data</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td></td>
<td></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/AMSRE</td>
</tr>
<tr>
<td>64</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>128</td>
<td>7</td>
<td></td>
<td>GCOM-W1/AMSRE2</td>
</tr>
<tr>
<td>256</td>
<td>8</td>
<td></td>
<td>GCOM-W2/AMSRE2 f/o (TBD)</td>
</tr>
<tr>
<td>512</td>
<td>9</td>
<td></td>
<td>GCOM-W3/AMSRE2 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></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>
2.7. Stored Values of Observation Time Flag

“Observation Time Information Flag” are in 4-byte float plain binary format. The Flag indicates relative time of latest microwave radiometer 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 ≤ X &lt; 1</td>
<td>If value is positive, microwave radiometer observation is available at the pixel during current one-hour period. X (0 ≤ 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>X ≤ 0</td>
<td>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.</td>
</tr>
<tr>
<td>X = −999</td>
<td>No microwave observation (Missing)</td>
</tr>
</tbody>
</table>
2.8. Stored Values of Reliability Flag

2.8.1. Version 6

"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-A. 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-A Stored Values of Reliability Flag

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Microwave radiometer observation</th>
<th>NO microwave radiometer observation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Over Land / Coast</td>
<td>Over Land / Coast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over Ocean</td>
<td>Over Ocean</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>● not sounder</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>● sounder</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>● ~1 hour after obs.</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>● ~1 hour after obs.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>● 1~2 hour after obs.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>● 1~2 hour after obs.</td>
</tr>
<tr>
<td>4</td>
<td>temperature &lt; 2 deg C</td>
<td>● temperature &lt; 2 deg C</td>
<td>● 2~3 hour after obs.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>● 2~3 hour after obs.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>● 1~2 hour after obs. in lower temperature region</td>
</tr>
<tr>
<td>1</td>
<td>Freezing Level&lt;500m</td>
<td>● 3~ hour after obs. or 2~ hour after obs. in lower temperature region</td>
<td>● 4~ hour after obs. or 0~ hour after obs. in lower freezing level region</td>
</tr>
</tbody>
</table>
2.8.2. Version 7

“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-B. 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-B Stored Values of Reliability Flag

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Microwave radiometer observation</th>
<th>NO microwave radiometer observation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Over Land / Coast</td>
<td>Over Ocean</td>
</tr>
<tr>
<td>10</td>
<td>● not sounder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>● sounder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>● ~1 hour after obs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>● ~1 hour after obs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>● temperature &lt;2 deg C</td>
<td>● Freezing Level&lt;500m</td>
<td>● temperature &lt;2 deg C</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.9. GrADS Control File
Sample control files of the Grid Analysis and Display System (GrADS) for each product are also available from ftp server.

Hourly Rain Rate data: /realtime_ver/\texttt{VV}/archive/GSMaP\textunderscore{}NRT\textunderscore{}hourly\textunderscore{}rain.ctl
Satellite Information Flag: /realtime_ver/\texttt{VV}/sateinfo/GSMaP\textunderscore{}NRT\textunderscore{}hourly\textunderscore{}sat.ctl
Observation Time Flag: /realtime_ver/\texttt{VV}/timeinfo/GSMaP\textunderscore{}NRT\textunderscore{}hourly\textunderscore{}time.ctl
Reliability Flag: /realtime_ver/\texttt{VV}/timeinfo/GSMaP\textunderscore{}NRT\textunderscore{}hourly\textunderscore{}reliability.ctl

where;
\texttt{VV}: 2-digit Algorithm version.

About usage of GrADS tool, please see GrADS home page (http://grads.iges.org/grads/head.html).

2.10. File Size
Approximately 800 Kbyte (with gzip), and 17 Mbyte (uncompress) for each file.

3. Hourly Gauge-calibrated Rain Rate (GSMaP\textunderscore{}Gauge) in Binary (product (4))

3.1. Basic Information
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 Gauge-calibrated Rain Rate data: /realtime_ver/\texttt{VV}/gauge\textunderscore{}hr/\texttt{YYYY}/\texttt{MM}/\texttt{DD}/

where;
\texttt{YYYY}: 4-digit year;
\texttt{MM}: 2-digit month;
\texttt{DD}: 2-digit day; and
\texttt{VV}: 2-digit Algorithm version.

3.3. File Naming Rules
Data and flag files are named according to the following rules;

Hourly Gauge-calibrated Rain Rate data: \texttt{gsmap\_gauge.YYYYMMDD.HHNN.dat}

where;
\texttt{YYYY}: 4-digit year;
\texttt{MM}: 2-digit month;
\texttt{DD}: 2-digit day;
\texttt{HH}: 2-digit hour; and
\texttt{NN}: 2-digit minute (currently fixed as 00).
3.4. **Data Format**
Same as Hourly Rain Rate Data (product (1)). See Section 2.4.

3.5. **Stored Value of Hourly Gauge-calibrated Rain Rate**
Same as Hourly Rain Rate Data (product (1)). See Section 2.5.

3.6. **File Size**
Same as Hourly Rain Rate Data (product (1)). See Section 2.6.

4. **Hourly rainfall in text format (old) (product (5))**

4.1. **Basic Information**
- Temporal resolution: 1 hour (hourly data)
- Grid resolution: 0.1 degrees latitude/longitude grid (10km at the equator).
- Domain: Global (60°N-60°S), but data are divided into 54 subset area files (area of 40 degree for latitude, 20 degree for longitude).
- Data latency: 4 hours after observation
- Data archived period: Stored only one week on the ftp server.

4.2. **FTP Directory Information**
Data files are archived at following directory; `/realtime_ver/VV/txt/AAABBBB/YYYY/MM/DD/

where;
- **YYYY**: 4-digit year;
- **MM**: 2-digit month;
- **DD**: 2-digit day;
- **AAA**: The corner of left-top position is appeared with Latitude (2-degit latitude + S or N);
- **BBBB**: The corner of left-top position is appeared with Longitude (3-degit longitude + E or W); and
- **VV**: 2-digit Algorithm version.

4.3. **File Naming Rules**
Data files are named according to following rules; `gsmap_nrt.YYYYMMDD.HHNN.AAABBBB.csv`

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);
- **AAA**: The corner of left-top position is appeared with Latitude (2-degit latitude + S or N); and
- **BBBB**: The corner of left-top position is appeared with Longitude (3-degit longitude + E or W).

4.4. **Data Format**
Text files are stored in CSV format. Unit is [mm/hr]. Negative value denotes missing in observation data or no retrieval same as binary format data (see Table 2).
Each file is one of global coverage fractionated 54 areas and consists of 200 rows x 400 lines which is longitude-latitude elements corresponding to a 0.1 x 0.1 degree grid that covers each fractionated area. The number of effective digits is zero pint two digits. This file is available to open using Microsoft Excel directory. Figure 2 is example of data coverage for the case of AAABBBB = 60N140E.

List of area code AAABBBB and its corresponding latitude and longitude of left-top and right-bottom pixels are stored in following file; /realtime_ver/VV/txt/area_list.pdf.

**Figure 2 Example of Data Coverage (Text file)**

4.5. **File Size**
Approximately 5 Kbyte (with gzip), and 560 Kbyte (uncompress) for each file.

4. **Hourly Rain Rate & Gauge-calibrated Rain Rate (GSMaP_Gauge) in text format (new) (product (6))**

4.1. **Basic Information**
Temporal resolution: 1 hour (hourly data)
Grid resolution: 0.1 degrees latitude/longitude grid (10km at the equator).
Domain: 15 areas (see 4.4)
Data latency: 4 hours after observation
Data archive period: File will be removed when reanalysis data (GSMaP_MVK) is uploaded (about 3days).

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

Hourly Data; /realtime_ver/VV/txt/XX_ZZZZZZ/YYYY/MM/DD/

where;

**YYYY**: 4-digit year;
**MM**: 2-digit month;
**DD**: 2-digit hour;
4.3. File Naming Rules
Data files are named according to following rules;

Hourly Data;

\[ \text{gsmap}\_nrt.YYYYMMDD\_HH00\_XX\_ZZZZZZ.csv} \]

where;

- \( YYYY \): 4-digit year;
- \( MM \): 2-digit month;
- \( DD \): 2-digit day;
- \( HH \): 2-digit hour; and
- \( XX\_ZZZZZZ \): 9-digit area name.

4.4. Area definition in text format
15 areas are defined for Text format as in Figure 3.
4.5. Data Format

Text files are stored in CSV format (see Figure 4). Unit is [mm/hr]. Data with missing value are omitted. 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>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 Peninsular 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>

<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 4 Example of text format

4.6. File Size

Approximately 200 Kbyte (with zip), and 1.6 Mbyte (uncompress) for each file.

5. Daily rainfall in 0.25-deg (products (7)-(8))

5.1. Basic Information

Temporal resolution: 24 hours average (daily data)

Two definition of “daily”:

- 00Z-23Z average: from 00Z to 23Z of the day
- 12Z-11Z average: from 12Z of the previous day to 11Z of the day

Grid resolution: 0.25 degrees latitude/longitude grid (25km at the equator)

Domain: Global (60°N-60°S)

Data latency: 4 hours after the end of accumulation period

Data archived period: File will be removed when reanalysis data (GSMaP_MVK) is uploaded (about 3 days).

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

Daily data (00Z-23Z average);
/realtimed Ver/VV/daily/00Z-23Z/YYYYMM/

Daily data (12Z-11Z average);
/realtimed Ver/VV/daily/p12Z-11Z/YYYYMM/

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

5.3. File Naming Rules
Data files are named according to following rules;

Daily data (00Z-23Z average);
gsmap_nrt.YYYYMMDD.0.25d.daily.00Z-23Z.dat

Daily data (12Z-11Z average);
gsmap_nrt.YYYYMMDD.0.25d.daily.p12Z-11Z.dat

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

5.4. 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 1440 x 480 pixels, which are longitude-latitude elements corresponding to a 0.25 x 0.25 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 [0.125°E, 59.875°N].

5.5. GrADS Control File
Sample control files of the Grid Analysis and Display System (GrADS) for each product are also available from ftp server.

Daily data (00Z-23Z average);
/realtimed Ver/VV/daily/00Z-23Z/GSMaP_NRT.daily.00Z-23Z.ctl

Daily data (12Z-11Z average);
/realtimed Ver/VV/daily/p12Z-11Z/GSMaP_NRT.daily.p12Z-11Z.ctl

where;
VV: 2-digit Algorithm version.

About usage of GrADS tool, please see GrADS home page (http://grads.iges.org/grads/head.html).
5.6. **File Size**
Approximately 800 Kbyte (with gzip), and 2.7 Mbyte (uncompress) for each file.

6. **Gauge-calibrated rainfall in 0.25-deg (products (9)-(10))**

6.1. **Basic Information**
Daily averaged rain rate [mm/hr] of GSMaP_Gauge (product (4)).

Temporal resolution: 24 hours average (daily data)
Two definition of “daily”:
00Z-23Z average: from 00Z to 23Z of the day
12Z-11Z average: from 12Z of the previous day to 11Z of the day

Grid resolution: 0.25 degrees latitude/longitude grid (25km at the equator)
Domain: Global (60°N-60°S)
Data latency: 4 hours after the end of accumulation period

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

Daily data (00Z-23Z average);
/realtimerver/\VV/gauge_dy/00Z-23Z/YYYYMM/

Daily data (12Z-11Z average);
/realtimerver/\VV/gauge_dy/p12Z-11Z/YYYYMM/

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

6.3. **File Naming Rules**
Data files are named according to following rules;

Daily data (00Z-23Z average);
gsmap_gauge.YYYYMMDD.0.25d.daily.00Z-23Z.dat

Daily data (12Z-11Z average);
gsmap_gauge.YYYYMMDD.0.25d.daily.p12Z-11Z.dat

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

6.4. **Data Format**
Same as Daily rainfall in 0.25-deg (product (7)-(8)). See Section 5.4.
6.5. **GrADS Control File**
Sample control files of the Grid Analysis and Display System (GrADS) for each product are also available from ftp server.

Daily data (00Z-23Z average);
`/realtime_ver/VV/gauge_dy/00Z-23Z/GSMaP_GAUGE.daily.00Z-23Z.ctl`

Daily data (12Z-11Z average);
`/realtime_ver/VV/gauge_dy/p12Z-11Z/GSMaP_GAUGE.daily.p12Z-11Z.ctl`

where;
- **VV**: 2-digit Algorithm version.

About usage of GrADS tool, please see GrADS home page (http://grads.iges.org/grads/head.html).

6.6. **File Size**
Approximately 800 Kbyte (with gzip), and 2.7 Mbyte (uncompress) for each file.

7. **Daily rainfall in 0.1-deg (products (11)-(12))**

7.1. **Basic Information**
- Temporal resolution: 24 hours average (daily data)
- Two definition of “daily”:
  - 00Z-23Z average: from 00Z to 23Z of the day
  - 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)
- Data latency: 4 hours after the end of accumulation period
- Data archived period: File will be removed when reanalysis data (GSMaP_MVK) is uploaded (about 3days).

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

Daily data (00Z-23Z average);
`/realtime_ver/VV/daily0.1/00Z-23Z/YYYYMM/`

Daily data (12Z-11Z average);
`/realtime_ver/VV/daily0.1/p12Z-11Z/YYYYMM/`

where;
- **YYYY**: 4-digit year;
- **MM**: 2-digit month; and
- **VV**: 2-digit Algorithm version.

7.3. **File Naming Rules**
Data files are named according to following rules;
Daily data (00Z-23Z average);  
gsmap_nrt.YYYYMMDD.0.1d.daily.00Z-23Z.dat

Daily data (12Z-11Z average);  
gsmap_nrt.YYYYMMDD.0.1d.daily.p12Z-11Z.dat

where;

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

7.4. 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 x 1200 pixels, 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].

7.5. GrADS Control File
Sample control files of the Grid Analysis and Display System (GrADS) for each product are also available from ftp server.

Daily data (00Z-23Z average);  
/realt ime_ver/VV/daily0.1/00Z-23Z/GSMaP_NRT.daily0.1.00Z-23Z.ctl

Daily data (12Z-11Z average);  
/realt ime_ver/VV/daily0.1/p12Z-11Z/GSMaP_NRT.daily0.1.p12Z-11Z.ctl

where;

VV: 2-digit Algorithm version.

About usage of GrADS tool, please see GrADS home page (http://grads.iges.org/grads/head.html).

7.6. File Size
Approximately 800 Kbyte (with gzip), and 17 Mbyte (uncompress) for each file.

8. Gauge-calibrated rainfall in 0.1-deg (products (13)-(14))

8.1. Basic Information
Daily averaged rain rate [mm/hr] of GSMaP_Gauge (product 4)).

Temporal resolution: 24 hours average (daily data)
Two definition of “daily”:
00Z-23Z average: from 00Z to 23Z of the day
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)
Data latency: 4 hours after the end of accumulation period
Data archived period: File will be removed when reanalysis data (GSMaP_MVK) is uploaded (about 3 days).

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

Daily data (00Z-23Z average); /realtime_ver/VV/gauge_dy0.1/00Z-23Z/YYYYMM/
Daily data (12Z-11Z average); /realtime_ver/VV/gauge_dy0.1/p12Z-11Z/YYYYMM/

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

8.3. File Naming Rules
Data files are named according to following rules;

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

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

8.4. Data Format
Same as Daily rainfall in 0.1-deg (product (11)-(12)). See Section 7.4.

8.5. GrADS Control File
Sample control files of the Grid Analysis and Display System (GrADS) for each product are also available from ftp server.

Daily data (00Z-23Z average);
/realtime_ver/VV/gauge_dy0.1/00Z-23Z/GSMaP_GAUGE.daily0.1.00Z-23Z.ctl
Daily data (12Z-11Z average);
/realtime_ver/VV/gauge_dy0.1/p12Z-11Z/GSMaP_GAUGE.daily0.1.p12Z-11Z.ctl

where;
VV: 2-digit Algorithm version.

About usage of GrADS tool, please see GrADS home page (http://grads.iges.org/grads/head.html).
8.6. **File Size**
Approximately 800 Kbyte (with gzip), and 17 Mbyte (uncompress) for each file.

9. **Algorithm and references**

9.1. **Algorithm**
The dataset of “Global Rainfall Map in Near Real Time” is near-real-time version of GSMaP algorithm. Details of the latest GSMaP algorithm are described in following documents and references in Section 6.2.


9.2. **References**
Papers describing the GSMaP project and algorithm are as follows.

**(About GSMaP project)**

**(About microwave imager algorithm)**

**(About microwave sounder algorithm)**


(About microwave imager/sounder algorithm)


(About microwave-IR combined algorithm)


(About NRT system)


Additional related papers are listed on the JST/CREST GSMaP Project Website


10. Contact

TRMM Real-Time Office
Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA)
2-1-1, Sengen, Tsukuba-city, Ibaraki 305-8505 Japan
Fax +81-29-868-2961
E-mail: Z-trmm_real@ml.jaxa.jp

Please contact us at the TRMM Realtime office (Z-trmm_real@ml.jaxa.jp) if you have any questions.