TRMM Data from the Goddard Earth Sciences (GES) DISC DAAC

Tropical Rainfall Measuring Mission (TRMM)

Data and Information Services Center (DISC) • Distributed Active Archive Center (DAAC)

December 2002

Diurnal Cycle of Precipitation from the TRMM Combined Instrument Algorithm
(January 1998 - December 2000)

The off-diurnal sampling of the TRMM orbit allows the estimation of the diurnal cycle of precipitation over the global tropics and subtropics. The eight panels show the 3 hourly average TRMM Combined Instrument Algorithm (TCA, product ID 2831) rainfall binned into 3 hourly geographical local time and 1 x 1 degree boxes, with the upper left panel showing the average rainfall for 0-259 local time. A nocturnal to early morning maximum occurs over the oceanic rain belts. Rainfall over the continents generally shows a maximum in early afternoon. There is also a dramatic shift of the maximum rainfall over the maritime continent from early morning in the coastal to late afternoon over land. This diurnal data set will be useful for testing Global General Circulation and regional prediction Models.

(Courtesy: L. Chiu and A. Chang)

TRMM Online Analysis System

TRMM Online Analysis System, developed by the GES DAAC Hydrology team, provides users with a friendly web-based interface for quick exploration, analysis, and visualization of the TRMM Level-3 rainfall products, the TRMM near-real-time 3-hourly experimental rainfall product, and the Willmott and Matsuura global climate data. Users can plot area averages (area plot) and time series (time plot) for selected areas and time periods. The TRMM Online Analysis System can be accessed at: http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/hydrology/TRMM_analysis.html

TRMM Views El Niño/La Niña Evolution
(1998 and 1999)

Monthly Rainfall Anomaly Fields
(from TRMM merged analysis)

January 1998:
Height of El Niño, with positive anomalies in the equatorial Pacific; negative values to the north and west.

January 1999:
Height of La Niña, with negative anomalies in the western Pacific; positive values over the Maritime Continent.

(Courtesy: R. Adler et al.)
Tropical rainfall affects the lives and economies of a majority of the Earth's population. Tropical rain systems, such as hurricanes, typhoons, and monsoons, are crucial to sustaining the livelihoods of those living in the tropics. Excess rainfall can cause floods and great property and crop damage, whereas too little rainfall can cause drought and crop failure.

The latent heat release during the process of precipitation is a major source of energy that drives the atmospheric circulation. This latent heat can intensify weather systems, affecting weather thousands of kilometers away, thus making tropical rainfall an important indicator of atmospheric circulation and short-term climate change.

Tropical forests and the underlying soils are major sources of many of the atmosphere's trace constituents. Together, the forests and the atmosphere act as a water-energy regulating system. Most of the rainfall is returned to the atmosphere through evaporation and transpiration, and the atmospheric trace constituents take part in the recycling process. Hence, the hydrological cycle provides a direct link between tropical rainfall and the global cycles of carbon, nitrogen, and sulfur, all important trace materials for the Earth's system.

Because rainfall is such an important component in the interactions between the ocean, atmosphere, land, and the biosphere, accurate measurements of rainfall are crucial to understanding the workings of the Earth-atmosphere system. The large spatial and temporal variability of rainfall systems, however, poses a major challenge to estimating global rainfall. So far, there has been a lack of rain gauge networks, especially over the oceans, which points to satellite measurement as the only means by which global observation of rainfall can be made.

The Tropical Rainfall Measuring Mission (TRMM), jointly sponsored by the National Aeronautics and Space Administration (NASA) of the United States and the National Space Development Agency (NASDA) of Japan, provides visible, infrared, and microwave observations of tropical and subtropical rain systems. The satellite observations are complemented by ground radar and rain gauge measurements to validate satellite rain estimation techniques. Goddard Space Flight Center's involvement includes the observatory, four instruments, integration and testing of the observatory, data processing and distribution, and satellite operations. TRMM has a design lifetime of three years. It is currently in its fifth year of operation.

Data generated from TRMM and archived at the GES DAAC are useful not only for hydrologists, atmospheric scientists, and climatologists, but also for the health community studying infectious diseases, the ocean research community, and the agricultural community.

## TRMM Orbit and Instruments

The TRMM satellite's low inclination (35 degrees), non-sun-synchronous, and high precessing orbit allows it to fly over each position on the Earth's surface at a different local time each day. This kind of sampling allows the examination of the diurnal cycle of precipitation. The orbit was maintained at approximately 350 km before August 7, 2001. During the period of August 7, 2001 to August 24, 2001, the average operating altitude for TRMM was changed from 350 km to 403 km (referred to as TRMM Boost). This has significantly extended the mission lifetime of TRMM. Since the TRMM Boost, its orbit has been maintained at approximately 403 km. The characteristics of the three rain instruments and associated science applications are shown in the following table.

<table>
<thead>
<tr>
<th></th>
<th>Precipitation Radar (PR)</th>
<th>TRMM Microwave Imager (TMI)</th>
<th>Visible/Infrared Scanner (VIRS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency/Wavelength</strong></td>
<td>Vertical polarization: 13.8 GHz</td>
<td>Dual polarization: 10.65, 19.35, 37, 85.5 GHz Vertical polarization: 21 GHz</td>
<td>.63, 1.6, 3.75, 10.8, &amp; 12 μm</td>
</tr>
<tr>
<td><strong>Scanning Mode</strong></td>
<td>Cross track</td>
<td>Conical</td>
<td>Cross track</td>
</tr>
<tr>
<td><strong>Ground Resolution:</strong></td>
<td>Pre-Boost: 4.3 km</td>
<td>4.4 km at 85.5 GHz</td>
<td>2.2 km</td>
</tr>
<tr>
<td></td>
<td>Post-Boost: 5.0 km</td>
<td>5.1 km at 85.5 GHz</td>
<td>2.4 km</td>
</tr>
<tr>
<td><strong>Swath Width:</strong></td>
<td>Pre-Boost: 215 km</td>
<td>760 km</td>
<td>720 km</td>
</tr>
<tr>
<td></td>
<td>Post-Boost: 247 km</td>
<td>878 km</td>
<td>833 km</td>
</tr>
<tr>
<td><strong>Science Applications</strong></td>
<td>3D rainfall distribution over both land and oceans, and latent heat release into the atmosphere</td>
<td>Surface rainfall rate, rain type, distribution, and structure</td>
<td>Cloud coverage, cloud type, cloud top temperature, and precipitation index</td>
</tr>
</tbody>
</table>
Tropical Rainfall Measuring Mission (TRMM) Subsets and Ancillary Data Sets at the GES DAAC

December 2002

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Horizontal Resolution</th>
<th>Temporal Resolution</th>
<th>Spatial Coverage</th>
<th>Data Access</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CSI</strong></td>
<td>Coincidence Subsetted Intermediate products. 9 TRMM orbital CSI products (1B01, 1B11, 1B21, 1C21, 2A12, 2A21, 2A23, 2A25, 2B31); and 4 TRMM Ground Validation CSI products (1C51, 2A53, 2A54, 2A55).</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>2, 3</td>
</tr>
<tr>
<td><strong>PS</strong></td>
<td>Parameter Subsets. Surface rainfall derived from 2A12, 2A25, and 2B31.</td>
<td><strong>PS2A12</strong> 0.25° x 0.25°</td>
<td>*</td>
<td>*</td>
<td>2, 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PS2A25</strong> 0.5° x 0.5°</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PS2B31</strong> 0.1 x 0.1°</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td><strong>G</strong></td>
<td>Gridded Orbital Subsets.</td>
<td><strong>G1B01</strong> 0.25° x 0.25°</td>
<td>*</td>
<td>*</td>
<td>2, 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>G2A12</strong> 0.5° x 0.5°</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>G2B31</strong> 0.1 x 0.1°</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td><strong>RG</strong></td>
<td>Geographical Region Subsets of Gridded Orbital Subsets for field experiment sites, US states, and other regions of interest under TRMM coverage.</td>
<td><strong>RG1B01</strong> 0.25° x 0.25°</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>RG2A12</strong> 0.5° x 0.5°</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>RG2B31</strong> 0.1 x 0.1°</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td><strong>3B4XRT</strong></td>
<td>TRMM Real-time Multi-Satellite Precipitation Data Set.</td>
<td><strong>3B40RT</strong> 0.25° x 0.25° 3-hourly Global</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>3B41RT</strong> 0.25° x 0.25° hourly 60N - 60S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>3B42RT</strong> 0.25° x 0.25° 3-hourly 60N - 60S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GPI</strong></td>
<td>NOAA's GPl IR Rain Data (TRMM 3A44).</td>
<td>1° x 1°</td>
<td>daily</td>
<td>Global</td>
<td>4</td>
</tr>
<tr>
<td><strong>GPCC</strong></td>
<td>GPCC Rain Gauge Analysis for GPCC (TRMM 3A45B).</td>
<td>1° x 1°</td>
<td>monthly</td>
<td>Global</td>
<td>4</td>
</tr>
<tr>
<td><strong>GPCI</strong></td>
<td>GPCC Version 2 Combined Precipitation Data Set.</td>
<td>2.5° x 2.5°</td>
<td>monthly</td>
<td>Global</td>
<td>8</td>
</tr>
<tr>
<td><strong>GOES 8 &amp; GOES 10</strong></td>
<td>GOES radiance data. Contains four IR and one visible channels.</td>
<td>4 km 30 min</td>
<td>Western hemisphere</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>GMS 5</strong></td>
<td>Images of Visible and Infrared Spin Scan Radiometer (VISSR). Contains three IR and one visible channels.</td>
<td>4 km hourly</td>
<td>Eastern hemisphere Europe, the Middle East, Africa, and the Atlantic Ocean</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>METEOSAT 7</strong></td>
<td>Images of the earth and its atmosphere from METEOSAT 7, a geostationary satellite operated by Europe's Meteorological Satellite Organization.</td>
<td>2.5 - 5.0 km 3 per day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>merged global IR</strong></td>
<td>IR brightness temperature data, merged from all available geostationary satellites (GOES-8/10, METEOSAT-7/6 &amp; GMS).</td>
<td>4 km hourly</td>
<td>60N - 60S</td>
<td>1, 4</td>
<td></td>
</tr>
<tr>
<td><strong>GPROF 6.0 (SSMI)</strong></td>
<td>Gridded Orbit-by-Orbit Precipitation Data Sets. Half-degree</td>
<td>0.5° x 0.5°</td>
<td>hourly</td>
<td>Global</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quarter-degree (near-real-time)</td>
<td>0.25° x 0.25°</td>
<td>hourly</td>
<td>Global</td>
</tr>
<tr>
<td><strong>GSTBF</strong></td>
<td>Goddard Satellite-Based Surface Turbulent Fluxes. Version 1</td>
<td>2.0° x 2.5°</td>
<td>monthly</td>
<td>Global</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Version 2</td>
<td>1.0° x 1.0°</td>
<td>monthly</td>
<td>Global</td>
</tr>
<tr>
<td><strong>GSSRB</strong></td>
<td>Goddard Satellite-Retrieved Surface Radiation Budget.</td>
<td>0.5° x 0.5°</td>
<td>monthly</td>
<td>40N - 40S 90E - 170W</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOVS</strong></td>
<td>Contains temperature/humidity profiles, cloud cover information, and surface parameters, derived from NOAA-11 and NOAA-14.</td>
<td>1° x 1°</td>
<td>daily</td>
<td>Global</td>
<td>4</td>
</tr>
<tr>
<td><strong>AVHRR</strong></td>
<td>NDVI product, and atmospherically corrected channel radiance.</td>
<td>8 km Daily &amp; 10-day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NCEP</strong></td>
<td>NCEP 4-time daily analyses.</td>
<td>1° x 1° 6-hourly</td>
<td>Global</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><strong>CAMS</strong></td>
<td>Climate Analysis and Monitoring System.</td>
<td>0.5° x 0.5°</td>
<td>monthly</td>
<td>Global</td>
<td>10</td>
</tr>
<tr>
<td><strong>ETOPOS</strong></td>
<td>The Earth Topography Five Minute Grid Data.</td>
<td>5 min n/a</td>
<td>Global</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Data Access:
1: http://lake.nascom.nasa.gov/data/dataset/TRMM/01_Data_Products/06_Ancillary/
2: http://lake.nascom.nasa.gov/data/dataset/TRMM/01_Data_Products/04_Subset/
3: ftp://lake.nascom.nasa.gov/data/TRMM/Geographic_Region/Subsets/CSI/1
4: ftp://lake.nascom.nasa.gov/data/TRMM/Ancillary/
5: ftp://lake.nascom.nasa.gov/data/TRMM/Orbital/
6: ftp://lake.nascom.nasa.gov/data/TRMM/Grided/
7: ftp://lake.nascom.nasa.gov/data/TRMM/Geo_Region/
8: ftp://daac.gsfc.nasa.gov/data/hydrology/precip/gpcc/gpcc_v2_combined/
9: ftp://aeolus.nascom.nasa.gov/pub/merged/

<table>
<thead>
<tr>
<th>Temporal Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRMM Subset Data: Dec. 1997 - Present</td>
</tr>
<tr>
<td>TRMM Reference Data: Jan. 2002 - Present</td>
</tr>
</tbody>
</table>

* Refer to TRMM Standard Products (on the reverse side).
<table>
<thead>
<tr>
<th>Product ID</th>
<th>Parameter</th>
<th>Horizontal Resolution (Pre-boost)</th>
<th>Vertical Resolution</th>
<th>Temporal Resolution</th>
<th>Units</th>
<th>Spatial Coverage (Pre-boost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B01</td>
<td>VIRS rad. 0.63, 1.6, 3.75, 10.8 &amp; 12 µm</td>
<td>2.2 km</td>
<td>n/a</td>
<td>swath</td>
<td>mW cm-2 um-1 sr-1</td>
<td>720 km</td>
</tr>
<tr>
<td>1B11</td>
<td>TMI TB' 10.65, 19.35, 21, 37, 85.5 GHz</td>
<td>4.4 km @ 85.5 GHz</td>
<td>n/a</td>
<td>swath</td>
<td>K</td>
<td>760 km</td>
</tr>
<tr>
<td>1B21</td>
<td>PR (14 GHz) returned power</td>
<td>4.3 km</td>
<td>250m</td>
<td>swath</td>
<td>dBm</td>
<td>215 km</td>
</tr>
<tr>
<td>1C21</td>
<td>PR reflectivity</td>
<td>4.3 km</td>
<td>250m</td>
<td>swath</td>
<td>dBz</td>
<td>215 km</td>
</tr>
<tr>
<td>1B51</td>
<td>GV (4 radar sites): #</td>
<td>2 km</td>
<td>5-10 min</td>
<td>dBz</td>
<td>400 km radius</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GV reflectivity</td>
<td>2 km</td>
<td>5-10 min</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GV differential reflectivity ZDR</td>
<td>2 km</td>
<td>5-10 min</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GV mean vel.</td>
<td>2 km</td>
<td>5-10 min</td>
<td>m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1C51</td>
<td>GV calibration reflectivity</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td></td>
</tr>
<tr>
<td>2A12</td>
<td>TMI profile:</td>
<td>4.4 km</td>
<td>14 layers</td>
<td>swath</td>
<td>g/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cloud/precipitation water and ice</td>
<td>n/a</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>latent heat</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>surface rain</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2A21</td>
<td>PR surface cross section</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>dB</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>PR path attenuation</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>dB</td>
<td>220 km</td>
</tr>
<tr>
<td>2A23</td>
<td>rain qualitative:</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>dB</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>rain type, strati./conv./warm rain</td>
<td>n/a</td>
<td></td>
<td></td>
<td>dB</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>storm, freezing and bright band height</td>
<td>n/a</td>
<td></td>
<td></td>
<td>mm</td>
<td>220 km</td>
</tr>
<tr>
<td>2A25</td>
<td>PR profile:</td>
<td>4.3 km</td>
<td>250 m</td>
<td>swath</td>
<td>deg C/day</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>rain rate</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>dB</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>reflectivity</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>dB</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>attenuation</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>dB</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>rain top/bottom height</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>m</td>
<td>220 km</td>
</tr>
<tr>
<td>2B31</td>
<td>TRMM combined</td>
<td>4.3 km</td>
<td>250 m</td>
<td>swath</td>
<td>deg C/day</td>
<td>220 km</td>
</tr>
<tr>
<td></td>
<td>rain rate</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>drop size distribution parameters</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>path integrated attenuation</td>
<td>4.3 km</td>
<td></td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>2A52</td>
<td>GV site rain existence (% rain)</td>
<td>300 km</td>
<td></td>
<td></td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>2A53</td>
<td>GV site rain map</td>
<td>2 km</td>
<td></td>
<td></td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>2A54</td>
<td>GV site conv./strat. map</td>
<td>2 km</td>
<td></td>
<td></td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>2A55</td>
<td>GV site 3-D reflectivity</td>
<td>2 km</td>
<td>1.5 km</td>
<td></td>
<td>dBz</td>
<td>#</td>
</tr>
<tr>
<td></td>
<td>contoured freq. by altitude dia. (CFAD)</td>
<td></td>
<td></td>
<td></td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>2A56</td>
<td>rain gauge</td>
<td>2 km</td>
<td></td>
<td></td>
<td>1 min</td>
<td>mm/hr</td>
</tr>
<tr>
<td>3A11</td>
<td>TMI emission</td>
<td>5x5 deg</td>
<td>n/a</td>
<td></td>
<td>monthly</td>
<td>40N-40S</td>
</tr>
<tr>
<td></td>
<td>rain accumulation</td>
<td>5x5 deg</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>conditional rain rate</td>
<td>5x5 deg</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rain frequency</td>
<td>5x5 deg</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>freezing height</td>
<td>5x5 deg</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td>3A25</td>
<td>PR rainfall (monthly avg of 2A25)</td>
<td>5x5 and 0.5x5.0 deg</td>
<td>n/a</td>
<td></td>
<td>monthly</td>
<td>40N-40S</td>
</tr>
<tr>
<td></td>
<td>rain rate at 2, 4, 6, 10, 15 km</td>
<td>5x5</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fractional rain</td>
<td>5x5</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>histogram of storm height, bright band</td>
<td>5x5</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>snow ice layer</td>
<td>5x5</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>surface rain rate</td>
<td>5x5</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>path attenuation</td>
<td>5x5</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td>3A26</td>
<td>surface rain rate</td>
<td>5x5 deg</td>
<td></td>
<td></td>
<td>monthly</td>
<td>40N-40S</td>
</tr>
<tr>
<td>3B31</td>
<td>rainfall combined</td>
<td>5x5 deg</td>
<td>14 layers</td>
<td></td>
<td>monthly</td>
<td>40N-40S</td>
</tr>
<tr>
<td></td>
<td>surface rain accumulation</td>
<td>5x5 deg</td>
<td></td>
<td></td>
<td>monthly</td>
<td>40N-40S</td>
</tr>
<tr>
<td></td>
<td>cloud water and ice, rain, graupels</td>
<td>5x5 deg</td>
<td></td>
<td></td>
<td>mm/hr</td>
<td></td>
</tr>
<tr>
<td>3B42</td>
<td>TRMM and other GPI calibration</td>
<td>1x1 deg</td>
<td></td>
<td>daily</td>
<td>g/m³</td>
<td>40N-40S</td>
</tr>
<tr>
<td>3B43</td>
<td>TRMM and other data source</td>
<td>1x1 deg</td>
<td></td>
<td>monthly</td>
<td>mm/hr</td>
<td>40N-40S</td>
</tr>
<tr>
<td>3A53</td>
<td>5 day GV site rain map</td>
<td>2 km</td>
<td></td>
<td></td>
<td>5 day</td>
<td>mm</td>
</tr>
<tr>
<td>3A54</td>
<td>GV site rainfall</td>
<td>2 km</td>
<td></td>
<td></td>
<td>monthly</td>
<td>mm</td>
</tr>
<tr>
<td>3A55</td>
<td>monthly 3-D map</td>
<td>2 km</td>
<td></td>
<td></td>
<td>monthly</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td>vert. profile of reflectivity</td>
<td>2 km</td>
<td></td>
<td></td>
<td>monthly</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td>contoured frequency by altitude diagram</td>
<td>2 km</td>
<td></td>
<td></td>
<td>monthly</td>
<td>mm</td>
</tr>
<tr>
<td>3A46</td>
<td>SSM/I rain</td>
<td>1x1 deg</td>
<td></td>
<td></td>
<td>monthly</td>
<td>mm/hr</td>
</tr>
</tbody>
</table>

# GV sites: Darwin, Kwajalein, Melbourne, Houston, and Guam.

Multiple radar sites are Florida and Texas. They have combined radar products by merging all radars within the site.

## Nominally 2 VOSs/hr except when there is TRMM satellite coincidence.

### Coverage is 300 x 300 km for single sites, 724 x 568 km for Texas site and 512 x 704 km for Florida site.

*All TMI channels have both vertical and horizontal polarization except 21 GHz which has only vertical polarization.

**Corresponding post-boost information are given in the "TRMM Orbit and Instruments" section of the TRMM Brochure.
In addition, a Lightning Imaging Sensor (LIS) and a Clouds and Earth’s Radiant Energy System (CERES) are carried on the TRMM satellite. The LIS is a calibrated optical sensor operating at 0.7774 μm and observes distribution and variability of lightning. The horizontal resolution of LIS at nadir is 5 km and the swath width is 590 km (pre-boost). The CERES is a visible/infrared sensor which measures emitted and reflected radiative energy from the surface of the Earth and the atmosphere and its constituents. The TRMM CERES operates at 0.3 to 5.0 μm in the shortwave range and 8.0 to 12.0 μm in the longwave range. LIS data are available from the Global Hydrology Resource Center: http://ghrc.msfc.nasa.gov and CERES data are available from the NASA Langley DAAC: http://eosweb.larc.nasa.gov/.

TRMM Ground Track for 35° Orbit
With Ground Truth Verification Sites

Ground Validation (GV) radar sites include Darwin, Australia; Thailand; Israel; Taiwan; Sao Paolo, Brazil; Guam; Kwajalein; Melbourne, Miami, Key West, and Tampa Bay in Florida; Lake Charles in Louisiana; and New Braunfels, Corpus Christi, and the Texas A&M research radar in Texas.

TRMM Science Data Products at the GES DAAC

The GES DAAC archives and distributes TRMM standard products, processed from the TRMM science data by the TRMM Science Data and Information System (TSDIS). Level 1 products are the VIRS calibrated radiances, the TMI brightness temperatures, and the PR return power and reflectivity measurements. Level 2 products are derived geophysical parameters (e.g., rain rate and latent heat) at the same resolution and location as those of the Level 1 data. Level 3 products are space-time averaged parameters. Level 4 products are analyzed products or those produced from merging measurements from TRMM and other sources. TRMM standard products are listed in the table in the insert of this brochure.

Also included as TRMM standard products are surface-based observations of rainfall from rain gauges and ground radars, which are used to calibrate and validate the satellite measurements.

TRMM Data Access and Services at GES DAAC

TRMM standard products are available to the general public at http://lake.nascom.nasa.gov/data/dataset/TRMM/. In addition, subsets of the TRMM data are available to facilitate analyses and processing by users, including satellite-ground coincidence subsets, gridded orbital data at various resolutions, parameter subsets, regional subsets, and others as needed. Data related to various TRMM validation experiments are available from http://daac.gsfc.nasa.gov/fieldep/trmm_fe/. Data sets are distributed via ftp or sent via tapes.

Potential TRMM data users, especially those with specific needs, are urged to contact the GES DAAC Hydrology Data Support Team:

Email: hydrology@daac.gsfc.nasa.gov
Toll Free: 1-877-422-1222
Fax: 301-614-5268

To stay informed about the latest developments in TRMM data products and services at the GES DAAC, please visit our Hydrology Web site at http://daac.gsfc.nasa.gov/hydrology/
GIS Application of TRMM Data

The GES DAAC has developed several tools to make TRMM data more easily available to the GIS community, including an automated data converter to GIS formats, as well as a web-based mapping tool (http://daac.gsfc.nasa.gov/WEBGIS/). The latter implements the interoperable standards set by the Open GIS Consortium (OGC). This mapping tool allows users to combine TRMM rainfall layers with multiple layers generated either from other GES DAAC data or from externally created maps.

Selected Applications of TRMM Data

<table>
<thead>
<tr>
<th>Country</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Environmental causes of diabetes: comparing annual diabetes incidence with annual rainfall (crop moisture and toxins).</td>
</tr>
<tr>
<td>Australia</td>
<td>Historical rainfall data for Southeast Asia for climate regionalization and stream flow.</td>
</tr>
<tr>
<td>France</td>
<td>Daily historical rainfall in Dominican Republic - used by a bank for crop insurance.</td>
</tr>
<tr>
<td>Germany</td>
<td>Regionalization of marginality of agricultural land in West Africa.</td>
</tr>
<tr>
<td>Iran</td>
<td>ENSO impacts on climate in southeast Iran.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Simulating precipitation events in Florida.</td>
</tr>
<tr>
<td>United Nations</td>
<td>World Food Program: using TRMM monthly rainfall for monitoring maize yield potential in Southeast Asia and southern Africa.</td>
</tr>
<tr>
<td>USA</td>
<td>Comparing 3B42 daily 1x1 deg. rainfall with Acoustic Rain Gauge estimates at deep ocean TAO mooring sites.</td>
</tr>
<tr>
<td>USA</td>
<td>Blending 3B43 monthly rainfall with weather station data.</td>
</tr>
<tr>
<td>USA</td>
<td>Correlating TOMS Aerosol Index data with TRMM rainfall rates.</td>
</tr>
<tr>
<td>USA</td>
<td>Tropical rainfall and dust transport.</td>
</tr>
<tr>
<td>USA</td>
<td>Rainfall data and drought conditions in Afghanistan.</td>
</tr>
<tr>
<td>USA</td>
<td>Correlating U.S. monthly rainfall with Pacific and other SSTs.</td>
</tr>
<tr>
<td>USA</td>
<td>Monsoons over Southeast Asia.</td>
</tr>
<tr>
<td>USA</td>
<td>Monsoons over Ethiopia.</td>
</tr>
<tr>
<td>USA</td>
<td>Early warning systems for mosquito-borne diseases (temperature and rain).</td>
</tr>
<tr>
<td>USA</td>
<td>Precipitation over Upper Oconee Basin, GA.</td>
</tr>
<tr>
<td>USA</td>
<td>TRMM monthly rainfall for Amazon Basin, used together with tree plot data to derive climatic correlates of species diversity, biomass, and community structure in rain forests. TRMM data helpful in filling in the gaps between measuring stations.</td>
</tr>
</tbody>
</table>

TRMM Data Application at United Nations (U.N.)

The Vulnerability Analysis and Mapping (VAM) unit of the U.N. World Food Program (WFP) uses TRMM precipitation data and rainfall plots for drought/flood assessments and crop yield estimates.

Left panel is a page from the Current Conditions Report by the WFP VAM unit. It shows the progression of the 2002 monsoon compared to the same 2-month period of the previous year.

(Courtesy: L. Milich)