P2.14 TRMM DATA REPROCESSING (VERSION 6): IMPROVEMENTS AND NEW DATA PRODUCTS

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1. INTRODUCTION

Satellite precipitation data from the Tropical Rainfall Measuring Mission (TRMM) have been, to date, continuously acquired for more than eight years since its launch in November 1997. TRMM, a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA), was originally designed to operate for only three years. NASA, after an extensive review, has recently extended TRMM science operations through September 2009. TRMM has completed its latest data reprocessing (Version 6), which had begun on June 1, 2004, including many improvements and several new data products. All TRMM standard products are processed by the TRMM Science Data and Information System (TSDIS) and archived and distributed to the general users by the NASA Goddard Earth Sciences Data and Information Services Center Distributed Active Archive Center (GES DISC DAAC). The GES DISC has provided user-focused TRMM data support since the beginning of the mission. The eight years of TRMM data have proven invaluable to thousands of users in diverse communities, ranging from research to operational applications.

In part to align with NASA's paradigm shift from mission- to measurement-based, the GES DISC created the Precipitation Data and Information Services Center (PDISC), which provides an integrated view of rainfall estimation basic research, rainfall estimation from space, and contributions to the understanding of the Earth's energy and water balance and long-term climate prediction. PDISC encompasses Giovanni-TOVAS (GES DISC Interactive Online Visualization and Analysis Infrastructure-TRMM Online Visualization and Analysis System), a highly popular, research-enabling tool (e.g., over 10,000 hits during October 2005, likely due to the occurrence of Hurricane Wilma).

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The following sections discuss the improvements of TRMM Version 6 reprocessing, the larger context of PDISC, and what PDISC can do for users of precipitation data, through the TRMM extension period and beyond into the Global Precipitation Measurement (GPM) mission era.

2. TRMM VERSION 6 REPROCESSING

The operational processing and reprocessing of the TRMM science data are performed by TSDIS. Raw instrument data are received in near-real-time by TSDIS and then processed with the first tier TRMM science algorithms to produce calibrated, swath-level, instrument data. With the latter, the second tier algorithms are used to compute geophysical parameters, such as precipitation rate, also at the swath-level resolution. Finally, the third tier algorithms are used to produce gridded geophysical parameters from the first- and second-tier instrument data. TRMM instrument algorithms are shown in Figure 1 (TRMM Data Processing Overview). Detailed information about TRMM algorithms and product status can be found at http://trmm.gsfc.nasa.gov/data_dir/ProductStatus.html.

The TRMM satellite algorithms are continually being evaluated and improved by the TRMM Science Team. The algorithms are frequently modified (with corresponding changes to their Algorithm Version) to satisfy evolving requirements and achieve the highest possible data quality. With improved science algorithms, the TRMM data are reprocessed on a scheduled basis. Major differences between TRMM Product Version 6 and its predecessor Version 5 are summarized in Table 1. These differences vary with the product and include additional parameters and variables, extended spatial coverage, increased spatial resolution, and new products related to latent heating. More detailed, side-by-side comparisons between Versions 6 and 5, as well as updated product "readme" files are available from http://daac.gsfc.nasa.gov/precipitation/TRMM_README/.

All TRMM satellite standard data products and their short names can be found in Figure 1. These

standard TRMM products are available to the general public at http://lake.nascom.nasa.gov/data/dataset/TRMM/.

To date, there have been six versions of TRMM data. Additional information about prior versions has been provided by Rui et al. (2003). Table 2 summarizes the temporal coverage and reprocessing start dates for most TRMM satellite data products. The first public release (of orbital products) occurred with the third TRMM reprocessing. The current TRMM product (Version 6) started on April 1, 2004. A major product change for Version 6 was the change of the daily 1^{o}x1^{o} gridded rainfall product 3B42 to a 3-hourly 0.25^{o}x 0.25^{o} gridded rainfall product.

Table 2. TRMM Data Product Versions.

Product Version	Temporal Coverage	Reprocessing Start Date
1	Launch – 02/28/1998	Early 12/1998
2	Launch – 05/31/1998	03/01/1998
3	Launch – 08/31/1998	06/01/1998
4	Launch – 10/31/1999	09/01/1998
5	Launch – 08/06/2001	11/01/1999
5A	08/24/01 – 03/31/04	---
6	Launch – Present	04/01/2004

3. PDISC, PRECIPITATION DATA AND INFORMATION SERVICES CENTER: FROM MISSION TO MEASUREMENT

TRMM data and related services (e.g., web-based, interactive visualization and analysis tools) are part of an ongoing GES DISC measurement-based effort to develop a Precipitation Data and Information Services Center (PDISC). The latter is a contribution from the GES DISC to the scientific and public user communities interested in precipitation and related data sets and products (Vicente et al., 2005).

PDISC addresses various rainfall estimation products derived from visible/infrared (VIS/IR), and passive and active microwave (MW) measurements acquired by polar; geosynchronous; and, for TRMM, circular, non-sun-synchronous satellites. Special attention is given to the 8-year (to date) collection of data and products derived from the TRMM Precipitation Radar (PR) and Microwave Imager (TMI). All TRMM data and related products are archived, distributed, and accessible to users through various GES DISC PDISC user-friendly ordering systems, with visualization and analysis tools, documentation, and data read software. The goal is to make TRMM and other precipitation-related data and products more widely usable and used for climate, health, environment, agriculture, and interdisciplinary research and applications.

The PDISC provides a collection of global rainfall data at satellite instrument pixel resolution and on regular grids from satellites, ground-based instruments, and assimilation and analysis results. The most popular data sets are listed in http://disc.gsfc.nasa.gov/precipitation/data_products.shtml. Of these, the most accessed are those available from the TRMM Online Visualization and Analysis System (TOVAS; http://lake.nascom.nasa.gov/tovas/). The user friendliness of TOVAS makes it a particularly powerful, research-enabling online tool. Figure 2 is an example output plot from TOVAS, showing accumulated rainfall from Hurricane Katrina, derived from the Multi-Satellite Precipitation Analysis-Real Time (MPA-RT) product (Huffman et al., 2003). The image shows Katrina making landfall on New Orleans on August 29, 2005.

TOVAS is an instance of a family of similar online tools, i.e., the Giovanni family (GES DISC Interactive Online Visualization and Analysis Infrastructure), http://disc.gsfc.nasa.gov/techlab/giovanni/, including a related instance customized for the agricultural applications community (e.g., USDA Foreign Agricultural Service and UN World Food Program), http://agdisc.gsfc.nasa.gov/Giovanni/.

4. CONCLUSIONS

Successful science data support for Earth observing satellite missions and their data systems requires a large, well-coordinated set of activities that spans more than the lifetime of the missions. The GES DISC has been providing such science data support for numerous satellite missions since 1993. These activities include those associated with periodic reprocessing campaigns, such as that for TRMM Version 6. The GES DISC support for TRMM data, like that for other mission data sets, remains, at all times, responsive to user needs, accommodating to unanticipated demands, and innovative in availing the users of the latest appropriate technology.

This user-focused approach is just as relevant and appropriate with the new measurement-based paradigm as it was with the mission-based paradigm. Similarly, the concept of a “mini-DISC” (e.g., PDISC), focusing customized support and services for a specific sector of the user community (e.g., precipitation), is just as relevant and appropriate in the TRMM era as it will be in the GPM era. PDISC will provide a bridge between TRMM and GPM for GES DISC users.

For more information about PDISC and its precipitation data services, please visit http://disc.gsfc.nasa.gov/precipitation/. To find out how you can collaborate with PDISC and what PDISC can do for you, please contact hydrology@disc.sci.gsfc.nasa.gov.

5. REFERENCES

Huffman, G.J., R.F. Adler, E.F. Stocker, D.T. Bolvin, and E.J. Nelkin, 2003: Analysis of TRMM 3-hourly multi-satellite precipitation estimates computed in both real and post-real time. Combined Preprints CD-

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Rui, H., B. Teng, J. Bonk, L. Chiu, Z. Liu, P. Hrubiak, N. Pollack, and L. Lu, 2003: TRMM data reprocessing and new data products. In Proc. 83rd AMS Annual Meeting, Feb. 9-13, 2003, Long Beach, CA.

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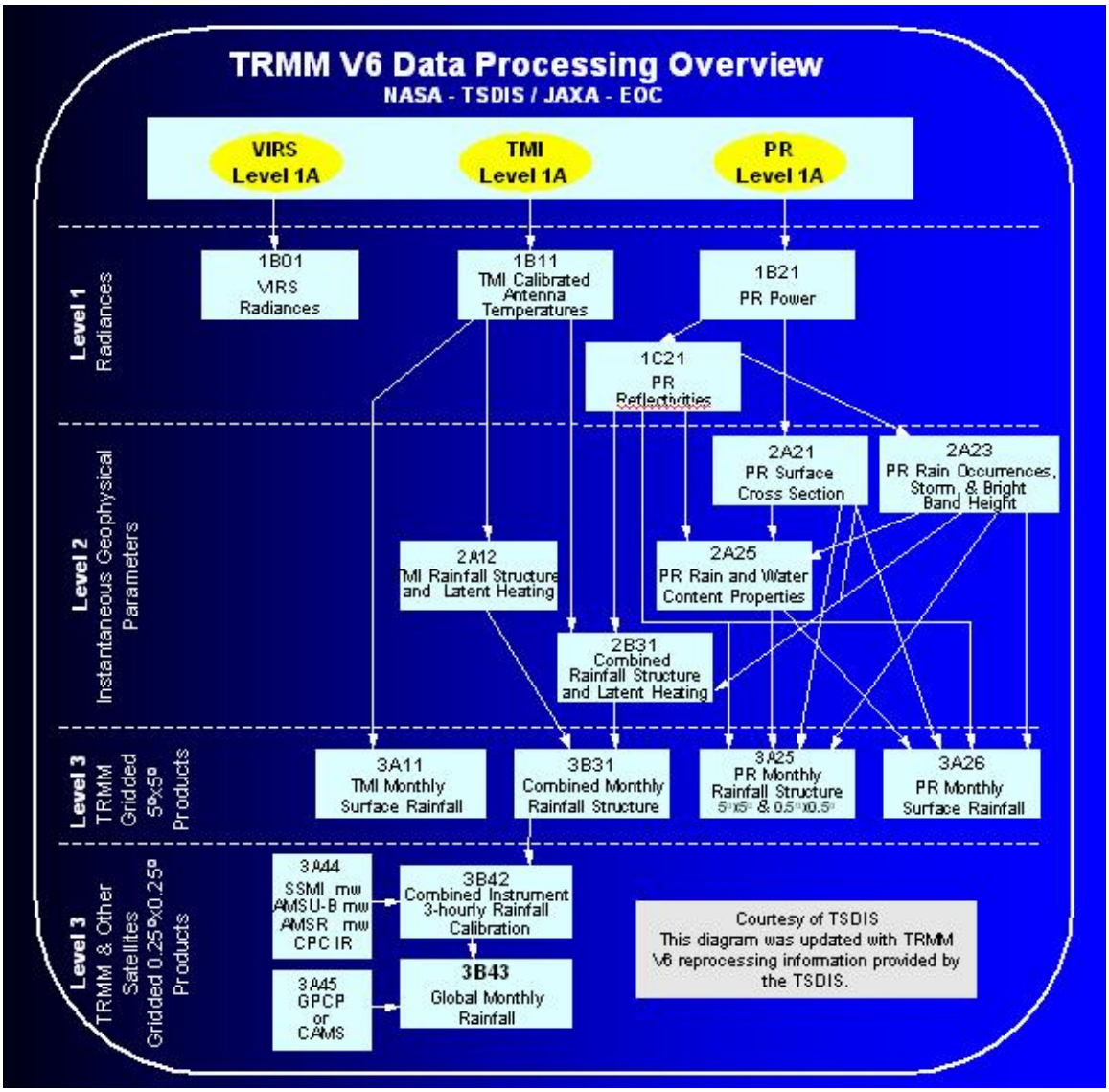

Figure 1. TRMM Data Processing Overview (http://daac.gsfc.nasa.gov/precipitation/TRMM_v6.shtml).

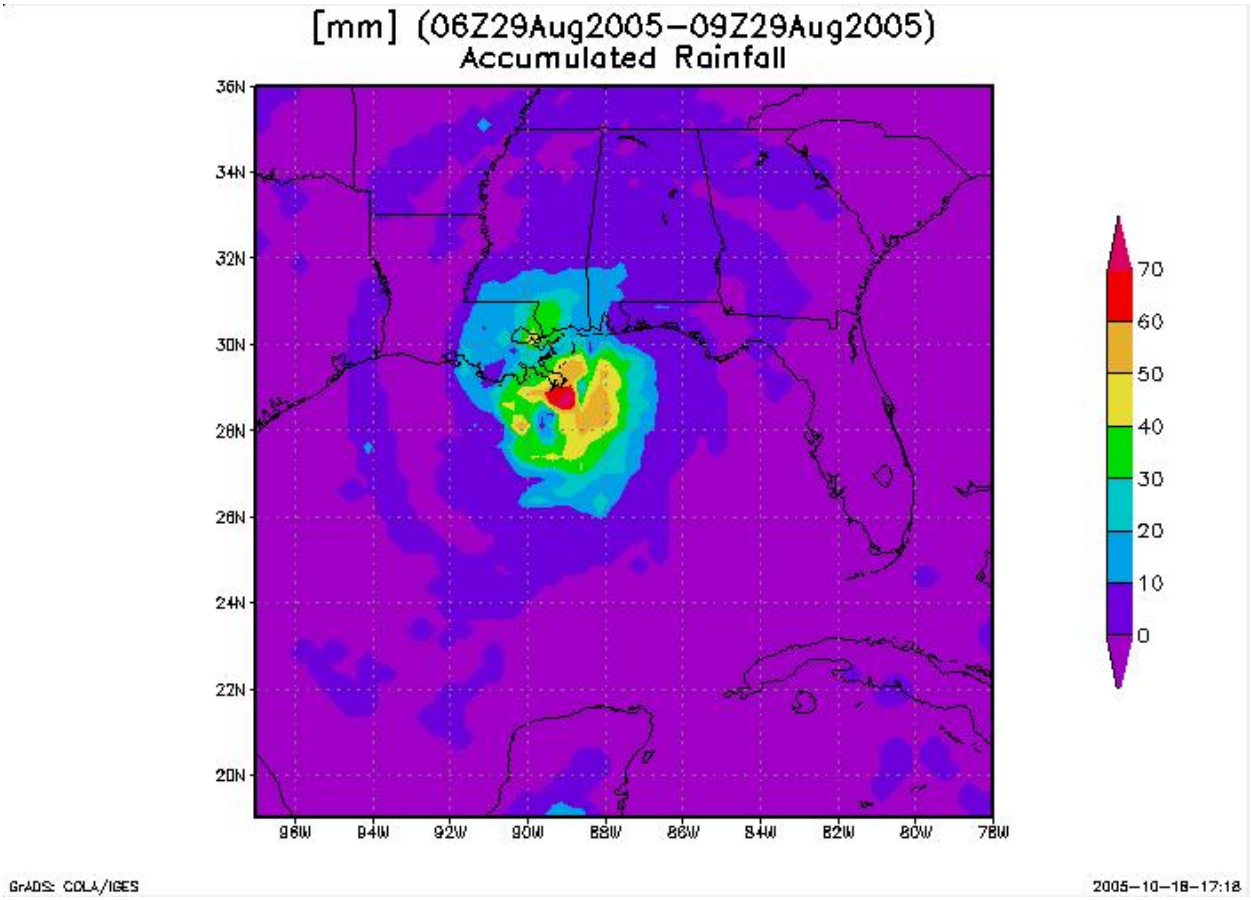

Figure 2. Image of Hurricane Katrina accumulated rainfall, generated by the GES DISC TRMM Online Visualization and Analysis System (TOVAS; http://lake.nascom.nasa.gov/tovas/).

Table 1. Major differences between TRMM Product Version 6 and its predecessor Version 5 (http://daac.gsfc.nasa.gov/precipitation/TRMMV5-V6Changes.shtml).

Algorithm ID	TRMM V5 to V6 Major Changes (Minor format changes are not listed)	Volume Changes
1B21	Added Land/Ocean Flag values for high attenuation pixels.	--
2A12	Latent Heating is calculated. (It was filled with "missing" in V5.)	--
2A23	Added additional Bright Band parameters. Rain Type became 3-digit to add more detail.	19.8%
2A25	Added Estimated Surface Rain. Added Epsilon_0, the adjustment parameter computed from the surface reference and a priori attenuation assumptions. Added precipitation water parameters. Added copy of Rain Type from 2A23. Added Final PIA and PIA from 2A21.	+9.2%
2B31	Added Latent Heating.	+15.8% ~ +17.3%
3A25	Added 140 variables, mostly statistics, on the new 2A23 Bright Band variables and the new 2A25 Estimated Surface Rain.	+54.6%
3B42	Extended spatial coverage to 50°S - 50°N, spatial resolution to 0.25° (V5 was 40°S - 40°N, 1.0°), and temporal resolution (granule size) to 3 hours. (V5 was 1 day.)	6 MB/file 8 file/day
3B43	Extended spatial coverage to 50°S - 50°N and spatial resolution to 0.25° (V5 coverage was 40°S - 40°N, resolution 1.0°).	8 Mb/day
CSH	CSH An experimental monthly gridded product, Convective/Stratiform Heating at 0.5° is added. *(CSH is not a TRMM Standard Product.)*	