JP2.3

ONLINE ANALYSIS AND VISUALIZATION OF TRMM AND QUIKSCAT PRODUCTS

Zhong Liu*[1], L. Chiu[1], W. Teng[2], and H. Rui[2]
GSFC Earth Sciences Data and Information Services Center
Distributed Active Archive Center (DAAC)
NASA/Goddard Space Flight Center, Greenbelt Maryland, USA 20771
[1] CEOSR, George Mason University, Fairfax, VA
[2] SSAI, Lanham, MD

1. INTRODUCTION

Precipitation and sea surface winds are two important meteorological parameters in climate studies. Both data sets are scarce over the vastly undersampled tropical and subtropical oceans. The Tropical Rainfall Measuring Mission (TRMM) is a joint U.S.-Japan satellite mission to monitor tropical and subtropical (40ºS - 40ºN) precipitation and to estimate its associated latent heating. The TRMM satellite provides the first detailed and comprehensive dataset on the four dimensional distribution of rainfall and latent heating over vastly undersampled tropical and subtropical oceans and continents. The TRMM satellite was launched on November 27, 1997. Data from the TRMM satellite are archived and distributed by the NASA Goddard DAAC. On 19 June 1999, NASA launched the NASA's Quick Scatterometer (QuikSCAT) satellite. The SeaWinds instrument on the QuikSCAT satellite is a specialized microwave radar that measures near-surface wind speed and direction at a 25-km resolution. The instrument is capable of measuring winds over approximately 90% of the ice-free ocean on a daily basis. The data are archived and distributed by the NASA JPL.

A tool for online analysis and visualization of TRMM and QuikSCAT data is being developed. The simple tool will allow investigators to analyze Level-3 TRMM rainfall and QuikSCAT sea surface winds and examine their relationship. An example of using this tool will be given.

2. DATA AND SYSTEM DESCRIPTION

The TRMM satellite flies at an altitude of 350 km with a period of 91.5 minutes. The TRMM satellite carries three rain-measuring instruments. NASA GSFC provided the TRMM Microwave Imager (TMI), the Visible Infrared Scanner (VIRS), and the observatory, and operates the TRMM satellite via the Tracking and Data Relay Satellite System (TDRSS). The National Space Development Agency (NASDA) of Japan provided the Precipitation Radar (PR), the first space-borne precipitation radar, and launched the TRMM observatory. Table 1 summarizes the TRMM standard products available at the Goddard DAAC. 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 at the same resolution and location as those of the Level 1 source data. Level 3 products are the time-averaged parameters mapped onto a uniform space-time grid. An evaluation of the sensor, algorithm performance and first major TRMM results appear in the Special Issue on the Tropical Rainfall Measuring Mission (TRMM), the combined publication of the Journal of Climate and Journal of Applied Meteorology (2000).

	Visible Infrared Scanner	TRMM Microwave Imager	Precipitation Radar	Combined Products	Ground Validation (GV)
Level 1	Visible & IR radiances	Microwave brightness temperatures	Radar return power & reflectivity	NA	Cal. radar reflectivity at each GV site
Level 2	NA	TMI profile for CLW, prec. water, cloud ice, prec. ice, latent heat, & surface rain	PR surface cross-section & path attenuation, rain type, storm, & freezing height, PR profile for rain rate, reflec., attenuation, & rain top/bottom height	Rain rate, drop size dist. parameters, path integrated attenuation	Rain existence, rain map, rain type, 3-D reflectivity, rain gauge, disdrometer
Level 3	NA	TMI monthly rainfall, rain rate, rain frequency, & freezing height	PR monthly surface rain total, rain profile at 2, 4, 6, 10 & 15 km, fractional rain, storm height histogram, snow ice layer, surface rain rate, & path attenuation	Monthly surface rainfall, CLW, rain water, cloud ice, & graupler; combined instruments calibration, global gridded rainfall	Rain map, 3-D map

Table 1. TRMM standard products at Goddard DAAC .

The QuikSCAT satellite flies on a Sun-synchronous, 803 km, 98.6° inclination orbit. The SeaWinds instrument on the QuikSCAT is a specialized microwave radar operating at 13.4 gigahertz. The radar antenna is a 1-

* *Corresponding author address*: Zhong Liu, GMU/DAAC, NASA/GSFC, Code 902, Greenbelt, MD 20771; Email: zliu@daac.gsfc.nasa.gov

meter-diameter rotating dish that produces two spot beams, sweeping in a circular pattern. The average data rate is 40 kilobits per second. The swath of the radar is 1800 km. The instrument provides approximately 90-percent coverage of Earth's oceans every day. The instrument is capable of measuring sea surface wind speeds ranging from 3 to 20 meters per second with an accuracy of 2 meters per second. For wind direction, the accuracy is 20 degrees. For more details, visit the URL listed at the end of the article.

The online analysis system being built is a web based application. The system is a part of the efforts (Liu et al., 2002a; 2002b; and 2002c) that allow users quickly and easily evaluate the TRMM and QuikSCAT products. Via an interface or a form, users can select an area of interest, a time period and a plot type (e.g., area, time series, etc.). When the user clicks on the submit button, the information of the form will be passed to a cgi (the common gateway interface) script. The script, in this application written in Perl and GrADS (the Grid Analysis and Display System, developed by COLA, see http://grads.iges.org for details), will process the information and generate the graphic output. The details of the system is described in Liu et al. (2002).

3. AN EXAMPLE

The best way to demonstrate the usefulness of an earth science application tool is to give an example and describe how the tool is used. We will present the Tropical Storm 06W (Utor) over the South China Sea near the Philippines (Figure 1) on July 4, 2001 as an example.

To illustrate the storm and its cloud system, a GMS RGB image on July 5 is presented in Figure 2. Figures 3a, 3b and 3c, respectively, show the QuikSCAT wind vectors on July 4 at the original (0.25 degree), 0.5 degree and 1.0 degree resolutions. It is seen that the wind vectors in the figure (Figure 3a) with the original resolution are too dense to be legible. At the reduced 0.5 degree resolution, it is improving, but there are several clustering areas near the Luzon Island. At the 1.0 degree resolution, the clustering areas disappear. The interface will use an internal scheme to automatically decide the plotting resolution. Figure 4a is the daily precipitation on July 4. It is seen that the heavy precipitation is over the ocean on the west side of the Luzon Island. Figure 4b is the daily precipitation on July 4 with the QuikSCAT wind vector overlay. It is seen that the sea surface winds are nearly perpendicular to the mountains of the Luzon Island (Figure 1). It appears that the precipitation was enhanced by the blocking. Figure 4c shows the precipitation with the streamlines from the QuikSCAT winds. In addition to the daily plots and the overlays, the online analysis system will allow users to generate time-averaged rainfall and sea surface wind and examine their relationship. Interested readers should check the poster in the conference, or the URLs listed at the end of this article for the latest information.

Figure 1. A map of the Philippines (courtesy of http://www.lib.utexas.edu/maps/).

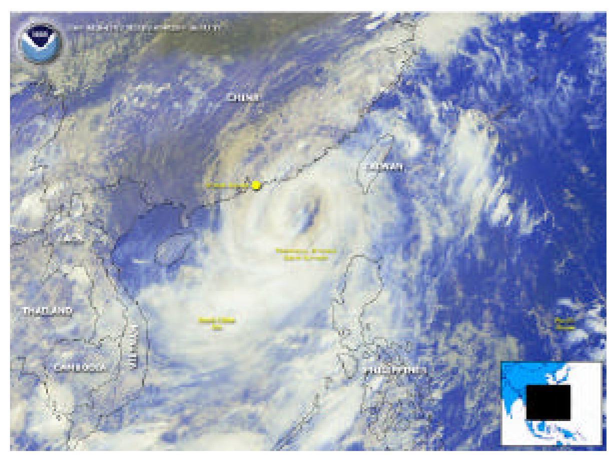

Figure 2. A GMS RGB (CH1, CH2, CH4) image on July 5, 2001 showing Tropical Storm 06W (Utor). Courtesy of http://www.osei.noaa.gov/

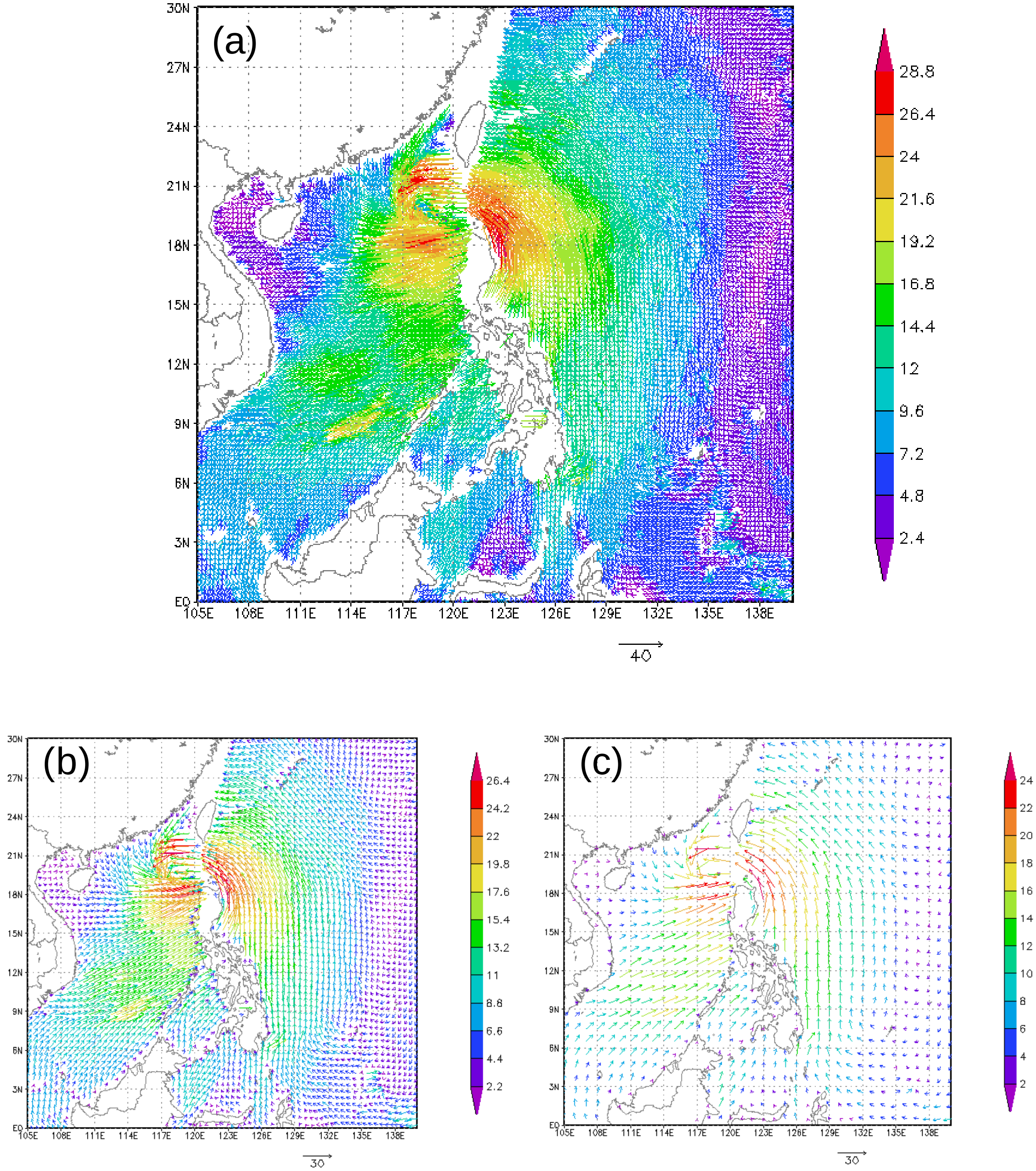

Figure3. QuikSCAT wind vectors at different horizontal resolutions: a) the original (0.25 degree); b) 0.5 degree; and c) 1.0 degree. Wind speeds (m/s) are represented by the colors in the color bars.

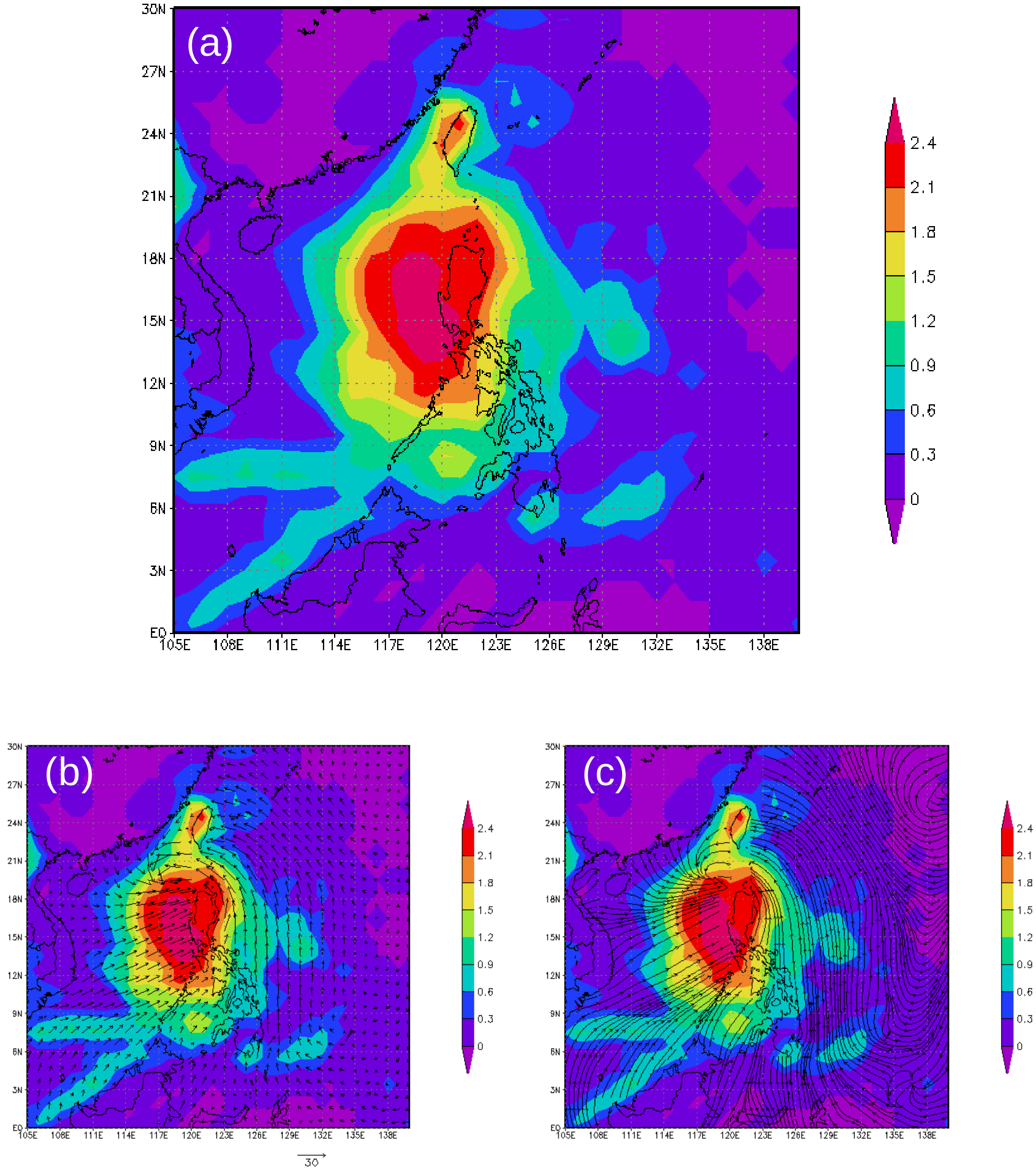

Figure 4. Precipitation (mm/hour) of the TRMM daily rainfall product, 3B42, on July 4, 2001: a) without the QuikSCAT wind vector overlay; b) with the QuikSCAT wind vector overlay at the 1.0 degree resolution; and c) with the streamlines derived from the QuikSCAT winds at the 1.0 degree resolution.

4. CONCLUSION AND FUTURE PLANS

With the system for online analysis and visualization of TRMM and QuikSCAT products, users can easily and quickly assess precipitation and sea surface wind products and examine their relationship. Future plans will include TRMM sea surface temperature, online data subsetting, and more customized plot options.

REFERENCES:

Liu, Z., L. Chiu, W. Teng, H. Rui and G. Serafino, 2002a, TRMM Rainfall Products and Tools for Tropical Infectious Disease Studies. The 15th Conf. On Biometerology/Aerobiology and 16th Congress of Biometeorology, Kansas City, MO.

Liu, Z., L. Chiu, W. Teng, H. Rui, and G. Serafino, 2002b, TRMM Rainfall for Human Health and Environment Applications. *The International Tropical Rainfall Measuring Mission (TRMM) Science* Conference, Honolulu, Hawaii.

Liu, Z., L. Chiu, W. Teng, H. Rui, and G. Serafino, 2002c, TRMM Rainfall Data for Ecosystem Studies and Applications in Arid and Semiarid Regions. *AGU Spring Meeting*, Washington, DC.

Liu, Z., L. Chiu, W. Teng, and G. Serafino, 2002, A Simple Online Analysis Tool for Visualization of TRMM and Other Precipitation Data Sets. *Science Data Processing Workshop* 2002, Greenbelt, Maryland.

Special Issue on the Tropical Rainfall Measuring Mission (TRMM), combined publication of the December 2000 Journal of Climate and Part 1 of the December 2000 *Journal of Applied Meteorology*, American Meteorological Society, Boston, MA.

INFORMATION:

Online analysis tools for TRMM rainfall products, NDVI, TOMS aerosols and Willmott climate data:
http://esip.gmu.edu/esip/ES_gridded_online_analysis_gmu.html

Data in higher temporal and spatial resolutions:
http://eosdata.gsfc.nasa.gov/data/

All TRMM standard data can be searched and ordered via:
http://lake.nascom.nasa.gov/data/dataset/TRMM

For further details about TRMM, visit:
http://trmm.gsfc.nasa.gov

For further details about QuikSCAT, visit:
http://winds.jpl.nasa.gov/missions/quikscat/quikindex.html

Questions and comments, please email to:
hydrology@daac.gsfc.nasa.gov