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ONLINE INTERCOMPARISON OF TRMM AND GLOBAL GRIDDED PRECIPITATION PRODUCTS

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1. INTRODUCTION

Precipitation data have been widely used in many earth science applications ranging from crop yield estimates (e.g., the United Nations Food Program), tropical infectious diseases (e.g., Anyamba et al., 2000; Zhou et al., 2002; Masuoka et al., 1998; Liu et al. 2002a; 2002b), drought and flood monitoring (Liu et al. 2002c), etc. However, in many tropical regions and parts of the mid-latitudes, rainfall estimates still remain a major challenge due to sparse rain gauges. To better develop applications for these regions, it is necessary to have rainfall data with adequate spatial and temporal resolutions.

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.

Despite the relatively short history, the TRMM rainfall products have been widely used in many areas, such as, monitor the recent severe drought in Afghanistan (Liu et al., 2002c); estimate maize yield potential in SE Asia. To detect climate changes/anomalies, it is necessary to have climate data for comparisons. Willmott and Matsuura (1995) applied various techniques to estimate global climate data based on surface observations taken between 1950 - 1999. Because the observational methods of the surface and satellite products are very different, comparisons are needed to understand existing biases. We are developing a system that will allow users select different rainfall products, an area of interest and a time period and generate graphic (scatter, line, area) output.

2. DATA AND METHODS

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).

For users who do not use TRMM data to develop algorithms, the Level-3 products are normally their first choice. For this reason, we include two most popular TRMM Level-3 rainfall products, 3B42 (daily rainfall) and 3B43 (monthly rainfall) in this online intercomparison tool. Both products are 1x1 degree in grid size. For intercomparison, the daily product, 3B42, will be used to compute its monthly accumulated rainfall and rain rate.

To detect climate changes/anomalies, it is necessary to have climate data for comparisons. Willmott and Matsuura (1995) (WM) applied various techniques to estimate global monthly climate variables based on surface observations taken between 1950 – 1999. The resolution for all their products are 0.5x0.5 degree in grid size. As we can see, there are only two years, 1998 and 1999, when both TRMM and the WM products are available. For this reason, intercomparison between the TRMM and the WM products will be limited in these two years.

The online intercomparison of TRMM and other global gridded precipitation products is a web based application. Via an interface or a form, users can select

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an area of interest, a time period and a plot type (e.g., area, time series, scatter, 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. Details of the system is described in Liu et al. (2002).

	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, & grauples; combined instruments calibration, global gridded rainfall	Rain map, 3-D map

Table 1. TRMM standard products at Goddard DAAC .

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 use the ongoing severe drought in Afghanistan (Figure 1) as an example.

The Afghanistan's worst drought in the past 30 years has been reported by many news organizations. Due to the continuous military conflicts, meteorological observations have been interrupted for many years. With rainfall data from TRMM, we are able to continuously monitor the drought condition. Detailed analyses can be found in Liu et al. (2002c).

To compute the regional rainfall and anomalies, we define a box (29º - 39º N, 60º - 75º E) that covers Afghanistan. To assess the drought condition, it is necessary to have climate rainfall data. Willmott and Matsuura (1995) applied various techniques to estimate global rainfall based on surface observations taken between 1950 – 1999, as described above. Because the observational methods of the surface and satellite products are very different, comparisons are needed. The plot (Figure 2) is the comparison of the time series of the regional average rainfall for the period between 1998 and 1999. It is seen that there is a good agreement between the two products. The average regional monthly rainfall values for the two products in the two year's period are, 22.5 mm (3B43) and 20.9 mm (WM) respectively. However, the plot (Figure 3) of accumulated rainfall difference shows that large differences exist in many areas for the same period. Figure 4 is the scattergram of the WM accumulated precipitation vs. the TRMM 3B43 between Jan. 1998 and Dec. 1999 shows biases. Though there is a good agreement between the two data products, it is seen that there is a tendency toward overestimation in areas of low accumulated precipitation.

Figure 1. A map of Afghanistan.

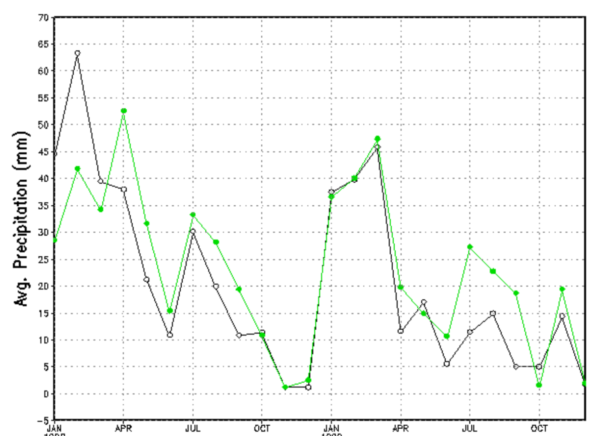

Figure 2. The time series of the regional (29º - 39º N, 60º - 75º E) average monthly rainfall derived from the WM (black line) and 3B43 (green line) products for the period between 1998 and 1999.

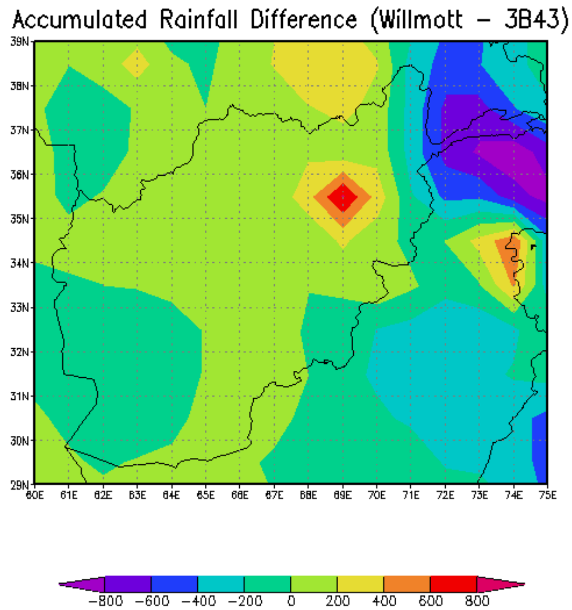

Figure 3. The accumulated rainfall difference between the WM and 3B43 products (WM – 3B43) in mm for the period between 1998 and 1999.

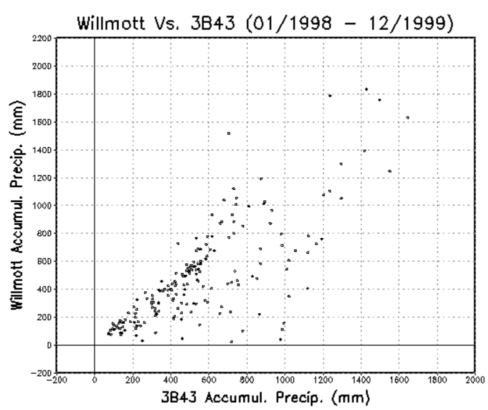

Figure 4. The scattergram of the WM accumulated precipitation vs. the TRMM 3B43 between Jan. 1998 and Dec. 1999 shows biases. Though there is a good agreement between the two data products, it is seen that there is a tendency toward overestimation in areas of low accumulated precipitation.

4. CONCLUSION AND FUTURE PLANS

The concept and an example of the online intercomparison of TRMM and other global gridded products have introduced. The tool allows users compare different precipitation products in a given region via map differencing, time series, and scattergram. With this tool, users will be able to easily and quickly assess the different precipitation products and make decisions regarding which product they should choose.

Future plans will include more gauge data and the near-real-time TRMM rainfall product, 3B42RT.

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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

Questions and comments, please email to:
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