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ONLINE ANALYSIS AND VISUALIZATION OF TRMM AND OTHER PRECIPITATION DATA SETS

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1. INTRODUCTION

Precipitation is a very important environmental parameter that influences many aspects of our daily life. Flooding is among one of natural disasters that cost the United States about $1 billion per week between 1992 and 1996, according to the White House Office of Science and Technology Policy. A recent example is the great flood in Houston, Texas, on Saturday, June 9, 2001. At least 22 people died after the remnants of the tropical storm Allison dumped an estimated 28 inches of rain in the area and hundred homes were flooded. Damage was estimated at $4.88 billion, according to the Houston Chronicle. A recent study in environment and human health [Colwell and Patz, 1998] indicates that precipitation, especially in the form of rainfall, can affect disease transmission. They show that increased amounts of rainfall and/or flooding have been linked to outbreaks of leptospirosis, Rift Valley fever, hantavirus pulmonary syndrom, malaria, and Ross River virus, among other diseases. In a recent study, Patz et al. (2001) reveal the association between water-borne diseases and extreme precipitation events in the United States: 1940-1994.

Currently, most precipitation data sets available focus on local or regional scales. There are only few internet web sites that offer global data sets. Most of these sites provide data for download and few provides browse images which are often too small and difficult to read. Users have to download and process the data and develop visualization and analysis tools themselves. To help users to easily access and quickly evaluate the precipitation data archived by the GSFC Earth Sciences Data and Information Services Center (GDISC), we are developing a simple CGI (Common Gateway Interface) for on-line visualization and analysis. Section 2 describes the precipitation data. A brief description of the system is given in Section 3. Some examples are given in Section 4.

2. TRMM AND OTHER PRECIPITAITON DATA

The Tropical Rainfall Measuring Mission (TRMM) is a joint U.S.-Japan satellite mission to monitor tropical and subtropical (40 S - 40 N) 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 tropics and subtropics . The TRMM satellite was launched on November 27, 1997. Data from the TRMM satellite are archived and distributed by the GDISC. Details regarding TRMM instrument characteristics and products can be found in Liu et al. (2002, this volume). The prototype visualization and analysis system is developed for 1 degree by 1 degree daily and monthly rainfall products (TRMM 3B42 and 3B43) that cover the region 40S to 40N respectively.

The TRMM 3B42 product contains TRMM-adjusted merged-infrared (IR) precipitation and root-mean-square (RMS) precipitation-error estimates. Details regarding the product can be found in the Algorithm 3B-42 User's Guide (URL: http://tsdis02.nascom.nasa.gov/tsdis/Documents/3B42_Users_Guide). The TRMM 3B43 product contains the "TRMM and Other Data" best-estimate precipitation rate and root-mean-square (RMS) precipitation-error estimates (3B-43). These gridded estimates are on a calendar month . Details about the product can be found in the Algorithm 3B43 User's Guide (URL: http://tsdis02.nascom.nasa.gov/tsdis/Documents/3B43_Users_Guide).

In addition to the TRMM rainfall products, we also include the precipitation data developed by Willmott and Matsuura at the Center for Climatic Research at the University of Delaware [Legates and Willmott, 1990a, 1990b; Willmott et al. 1985; Willmott and Matsuura, 1995; Willmott and Robeson, 1995]. This global dataset covers the period 1950 to 1999. The temporal resolution of the

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dataset is a calendar month and the spatial resolution is 0.5 degree by 0.5 degree.

3. SYSTEM DESCRIPTION

The online analysis and visualization system was designed to allow users to easily and quickly access precipitation information around the world. The interface will allow users to

- Select area of interest and time interval
- Perform data subsetting
- Obtain rainfall (rain rate or accumulated rainfall) for the area of interest
- Conduct simple analyses, such as area average and time series
- Compute anomalies and conduct map differencing
- Display output in graphic or ASCII
- Download data in ASCII for their customized analyses or applications
- Access related documentation and published articles

To complete these tasks, we use the Grid Analysis and Display System (GrADS) to do analyses and data subsetting. GrADS is an interactive desktop tool that is used for easy access, manipulation, and visualization of earth science data. GrADS has been implemented worldwide on a variety of commonly used operating systems and is freely distributed over the Internet. For more details about GrADS, please visit the GrADS web site: http://grads.iges.org/grads/. The CGI was written in Perl and a form was used to collect user's input.

4. EXAMPLES

1) Flood in Mozambique

In February, 2000, parts of Mozambique received rainfalls of over 300 mm in one day, causing extensive erosion and urban infrastructure damage in Matola and Maputo cities, according to the Ministry of Public Works and Housing (2000). The rainfalls made the rivers Umbeluzi, Incomati, Limpopo and Buzi to spring its banks. Before the water levels receded, a tropical depression Eline brought in record rainfall in the upstream catchment areas of these rivers. More than 300 people died and about 2 million had been displaced or affected. Agricultural lands and most of the infrastructure in the affected areas were destroyed.

Figure 1 shows the monthly rainfall for February 2000 derived from TRMM 3B43 over Mozambique using the on-line visualization and analysis system. The figure shows that there are three areas with heavy rainfall. The largest area is found in south Mozambique. The second largest is found at the border between Mozambique and Swaziland/South Africa. The third area is found in the northeast corner of South Africa. Detailed daily rainfall time series from the daily TRMM 3B42 rainfall data (Figure 2) reveals that two major precipitation events dominate the rainfall in February. The first event happened in early February with the maximum rainfall occurring on February 4. This event caused extensive damage in the southern cities mentioned earlier. The second major event occurred in late February. The maximum rainfall is on February 22, caused by the landfall of the tropical depression Eline. A plot of daily 3B42 rainfall between 1998 and 2000 (not shown here) reveals that the year 2000 has the most heavy rainfall days during the three year period. Similar studies can be performed using the data from Willmott and Matsuura for the past 50 years.

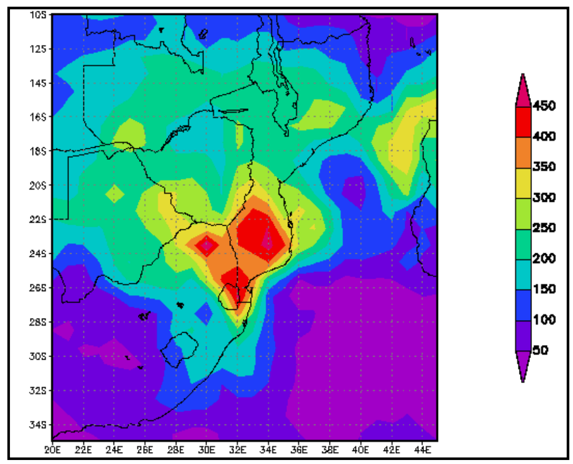

Figure 1. Regional accumulated rainfall for February 2000.

Figure 2. Time series of daily TRMM 3B42 rainfall total for the southern part of Mozambique.

2) Floods in China

In the summer, 1998, severe floods, the worst since 1954, occurred along the Yangtze River. 290 million people were affected in 28 provinces. 3656 people were killed and over 17 millions of houses were destroyed. 21.8 million hectares of farmland were swamped. The total economic loss exceeded 30 billion US dollars.

The regional rainfall for July and August, 1998 was plotted using the TRMM 3B43 data and the online system. Figures 3 and 4 are the regional rainfall for July and August, respectively. Figure 3 shows that most rainfall in July is concentrated on the areas between Dongting Lake and Poyang Lake. By contrast, most rainfall in August is found in the upstream areas of the Yangtze River (Figure 4).

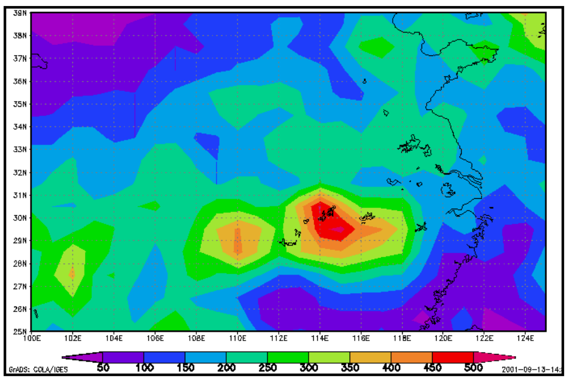

Figure 3. Regional accumulated rainfall for July, 1998.

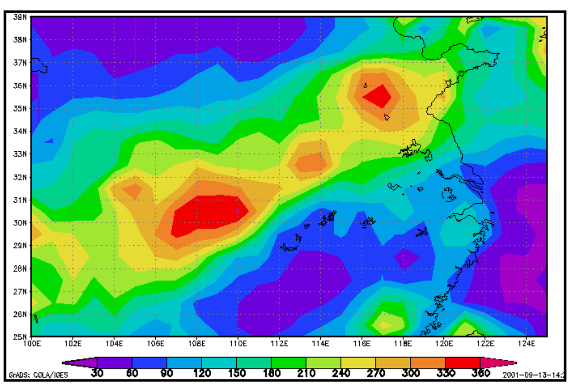

Figure 4. Regional accumulated rainfall for August, 1998.

Daily rainfall product, the TRMM 3B42, reveals that weather systems, such as, the one shown in Figure 5, played an important role to the regional flooding.

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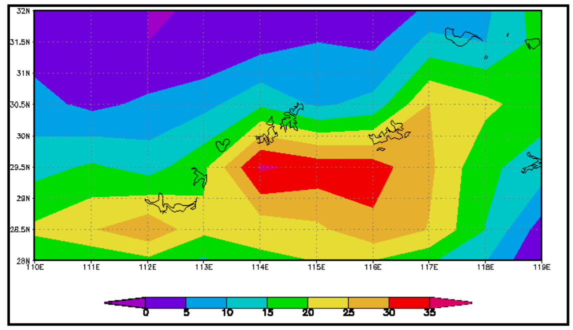

Figure 5. Daily accumulated rainfall for July 17, 1998

REFERENCES:

Colwell R. R. and J. A. Patz(eds), 1998: Climate, Infectious Disease and Human Health: an Interdisciplinary Perspective. Report from the American Academy of Microbiology, Washington.

Legates, D. R. and C. J. Willmott, 1990a: Mean Seasonal and Spatial Variability Global Surface Air Temperature. Theoretical and Applied Climatology , 41, 11-21.

Legates, D. R. and C. J. Willmott, 1990b: Mean Seasonal and Spatial Variability in Gauge-Corrected, Global Precipitation. International Journal of Climatology, 10, 111-127.

Liu, Z., L. Chiu, W. Teng, G. Serafino and R. Yang, 2002: Examples of Climate Applications of TRMM Data. In this preprint.

Ministry of Public Works and Housing, Mozambique Flood Damages in the Water Supply and Sanitation Services and in Other Waterworks: A Summary of Needs, March 2000.

Patz J, Curriero F, Lele S, Daeschner S, Craun G, Rose J., 2001: Association between water-borne diseases and extreme precipitation events in the United States: 1940-1994. Am J Public Health, 8.

Rose J. B., A Huq, and E. K. Lipp, 1999: Health, Climate and Infectious Disease: a Global Perspective. Report from the American Academy of Microbiology, Washington.

Willmott, C. J. and K. Matsuura, 1995: Smart Interpolation of Annually Averaged Air Temperature in the United States. Journal of Applied Meteorology, 34, 2577-2586.

Willmott, C. J. and S. M. Robeson, 1995: Climatologically Aided Interpolation (CAI) of Terrestrial Air Temperature. International Journal of Climatology, 15, 221-229.