3.16 INTERCOMPARISON OF CHARM DATA AND WSR-88D STORM INTEGRATED RAINFALL

Gary J. Jedlovec,* Paul J. Meyer, Anthony R. Guillory
Global Hydrology and Climate Center
NASA/Marshall Space Flight Center, Huntsville, Alabama

and

Keith Stellman
Lower Mississippi River Forecast Center
NOAA/NWS, Slidell, LA Kevin Laws

Ashutosh Limaye
Global Hydrology and Climate Center
USRA, Huntsville, Alabama

1. INTRODUCTION

We are all aware of the impact a rainy day has on our daily activities. In some cases, these events turn into catastrophes and cause loss of life and millions of dollars in property damage due to the flooding. NASA has established a volunteer-based precipitation network in the Huntsville and Madison County area in support of local weather and climate research at the Global Hydrology and Climate Center (GHCC). This unique rain gauge network can also be used to help validate remotely sensed measurements of rainfall, soil moisture and related surface parameters. However, often times 24h rainfall totals do not suffice for this type of research. The research presented in this paper uses radar data to interpolated from the 24h rain gauge totals to produce an hourly rain gauge product which is better suited for these types of studies.

2. BACKGROUND

This section describes the data sources and analysis procedures used in this research. Data used in this study come from local rain gauges and from WSR-88D weather radars.

2.1 *Cooperative Huntsville Area Rainfall Measurements (CHARM) Network*

NASA has established a volunteer-based precipitation network in the Huntsville and Madison County area in support of local weather and climate research at the Global Hydrology and Climate Center (GHCC). The Cooperative Huntsville-Area Rainfall Measurement (CHARM) network as it is called has been up and running since January 1, 2001 and is comprised of volunteers (from middle school students and home gardeners to Ph.D. scientists working at the Center) who take daily rainfall measurements. These volunteers take (once) daily rainfall measurements from over 90 different locations. The network also incorporates 20 automated National Weather Service (NWS), NASA, and United States Geological Survey (USGS) automated rain gauges that report data at 1-5 minute intervals on a 24h a day basis. The network covers about a 3600km^2 region, including all of Huntsville and portions of Madison, Jackson, Limestone, and Morgan Counties in northern Alabama. The mean gauge spacing is about one gauge per 6x6km region. Since only limited sites in the

* *Corresponding author address: Gary J. Jedlovec, NASA/MSFC Global Hydrology and Climate Center, 320 Sparkman Drive, Huntsville, Alabama 35805; e-mail: gary.jedlovec@msfc.nasa.gov.*

network report real-time observations, the operational use of this network is limited. The CHARM measurements are used to validate weather radar and lightning data, monitor spatial distributions of precipitation for soil moisture studies for modeling activities, and to support various satellite remote sensing studies. The database will also help in disaster investigations like that of the Aldridge Creek flood of June 1999 where over 6 inches of rain fell over a small water shed in less than an hour and the flooding of the AXAF clean room at NASA/MSFC in 1997.

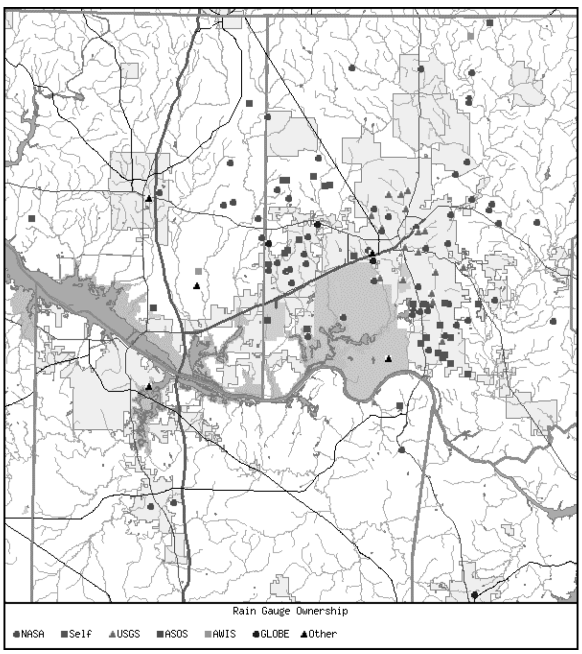

Figure 1. The CHARM Network in northern Alabama. The network covers about 60 x 80 km region.

It has already been used to support several environmental studies for NASA's Marshall Space Flight Center and the Army's Redstone Arsenal. The program also serves as an educational and community outreach activity by directly involving the Huntsville community in a NASA activity. Expansion of the network to over 200 sites with a 4x4km gauge density is envision by 2003. CHARM data can be viewed at http://wwwghcc.msfc.nasa.gov/charm .

2.2 *Stage III WSR-88D Rainfall Data*

Weather radar data (in particular, estimates of precipitation amounts) from a portion of the national network of NWS WSR-88D sites is inter-compared in this study with the CHARM rain gauge rainfall totals. The radar data has been processed in a manner described by Stellman et al. (2001) and is briefly summarized below.

During the stage I process, individual NWS offices produce their own hourly digital precipitation (HDP) product from their local WSR-88D radar. Most offices use a standard Z-R relationship ($300R^{1.4}$), but in some cases a more tropical Z-R relationship is used ($300R^{1.2}$). The HDP product is mapped onto a 4 x 4 km polar stereographic grid for the particular region. The stage II data set consists of stage I data which has been bias-adjusted by hourly rain gauge data from a regional rain gauge network. The stage III data product is a combination of the stage II data from individual radar sites combined onto a 4km grid producing a regional estimate of hourly precipitation that has been adjusted for radar inconsistencies.

3. RESULTS

The results are presented in two parts. The first part presents an inter-comparison of 24h WSR-88D stage III rainfall estimates with totals from the CHARM rain gauges for a similar 24h period. This inter-comparison serves to illustrate the relative agreement between the two datasets. The second part of the results presents an analysis of the hourly radar data adjusted using CHARM totals. This hourly dataset is compared to rainfall data from collocated rain gauge site.

A case study day from June 4-5, 2001 was selected as a test case. On the evening of June 4, several isolated heavy thunderstorms moved through northern Alabama dropping significant rainfall over isolated regions of the CHARM network. The storms began around 2200UTC and remained over the CHARM region until about 0400UTC on June 5. Figure 2 shows an analysis of the rainfall over the CHARM network as a result of the isolated storms. The rainfall totals are maximized in an east-west band over the CHARM network in northern Alabama. Embedded in this region is an isolated maximum of 2.96” to the east-central part of the network with a secondary maximum of 2.40” about 30km to the west. Precipitation amounts fall off rapidly to the north and south of this line. Only small amounts of rain (<0.30”) fell in regions of north Madison County (near the top of the CHARM region).

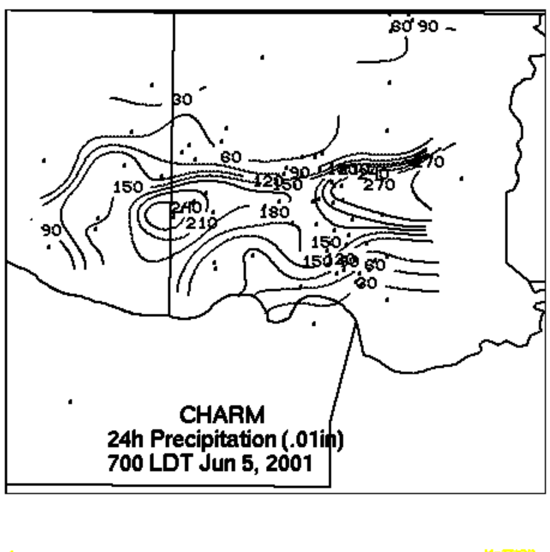

Figure 2. Analysis of 24h rainfall totals from the CHARM precipitation network on June 4 @1200UTC through June 5, 2001 @1200UTC. Units are inches of rain times 100.

The process to produce the stage III hourly rainfall product at the LMRFC includes adjusting the radar estimates based on a relatively small number of NWS rain gauges scatter across the coverage region. The spacing of these sites is typically 50-100km. The adjustment process attempts to remove the bias in an individual radar dataset resulting from antenna mis-calibrations or different ZR relationships. It is useful to look at how well this adjusted stage III data compares with the CHARM rainfall information. Figure 3 presents a scatter plot comparison of CHARM rain gauge storm total measurements with the LMRFC stage III radar estimates for the same time period. In this comparison a 4km radar estimates were matched with the rain gauge site closest to the center of the pixel. Other nearby rain gauge sites were excluded from the analysis. The results show only a small rainfall over-estimate of the radar data on the order of 0.20”. However, the standard deviation of the data is a bit larger than expected with the most variations coming from the heavier rainfall amounts (>1.00”). This variation is probably do to the different spatial resolutions of the datasets (a point measurement versus a 4km averaged amount). The storms were isolated and small in size (spatial diameter) and the dense CHARM rain gauge network recorded large variability even for stations 1-2km apart.

Figure 4 presents an application of stage III hourly radar data to convert rain gauge storm total estimates into hourly values for collocated radar estimate and rain gauge site at NSSTC. The hourly radar stage III data estimate is presented as the solid line. The bias (expressed as the ratio of gauge to radar data) between the radar storm total estimate and the NSSTC rain gauge total was 1.36. This bias factor was applied to the radar data to give bias-corrected hourly rainfall values for this site (dashed line). The actual rain gauge hourly totals are plotted as a dotted line in Figure 4. It is seen that the adjusted stage III hourly rainfall values under estimate the hourly intensity and temporally spread the rainfall duration as compared to the gauge data. This finding will be further explored for other case studies and presented at the conference.

References

Stellman, K. M., H. E. Fuelberg, R. Garza, and M. Mullusky, 2001: An examination of radar and rain gauge-derived mean areal precipitation over Georgia Watersheds, *Wea. Forecasting,* **16**, 133-144.

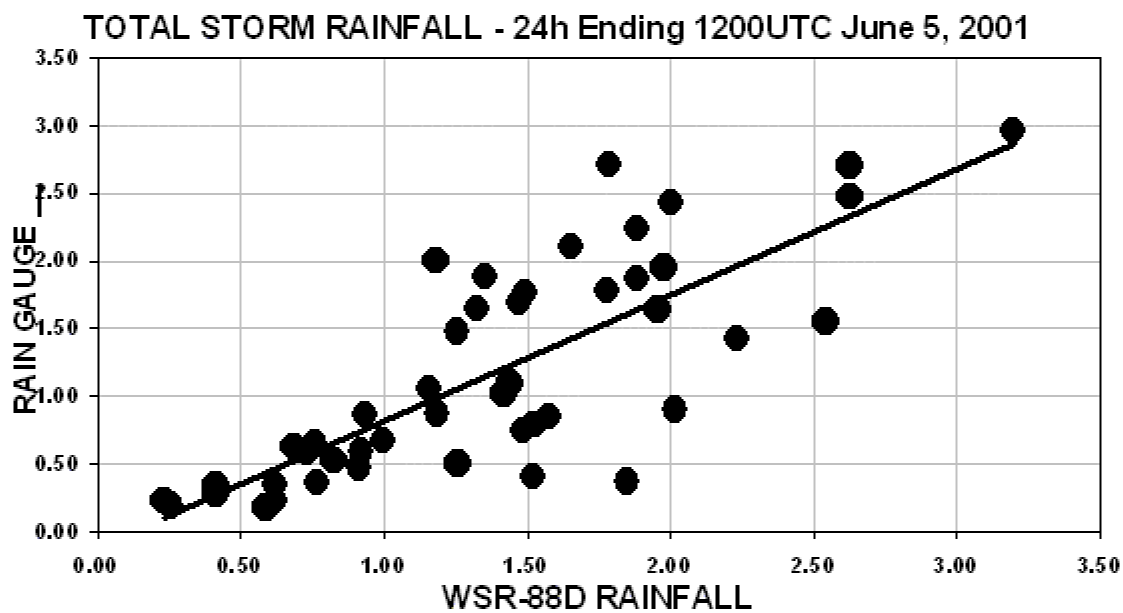

Figure 3. Plot of stage III radar estimates and rain gauge storm rainfall totals for June 4-5, 2001 storm over the CHARM network.

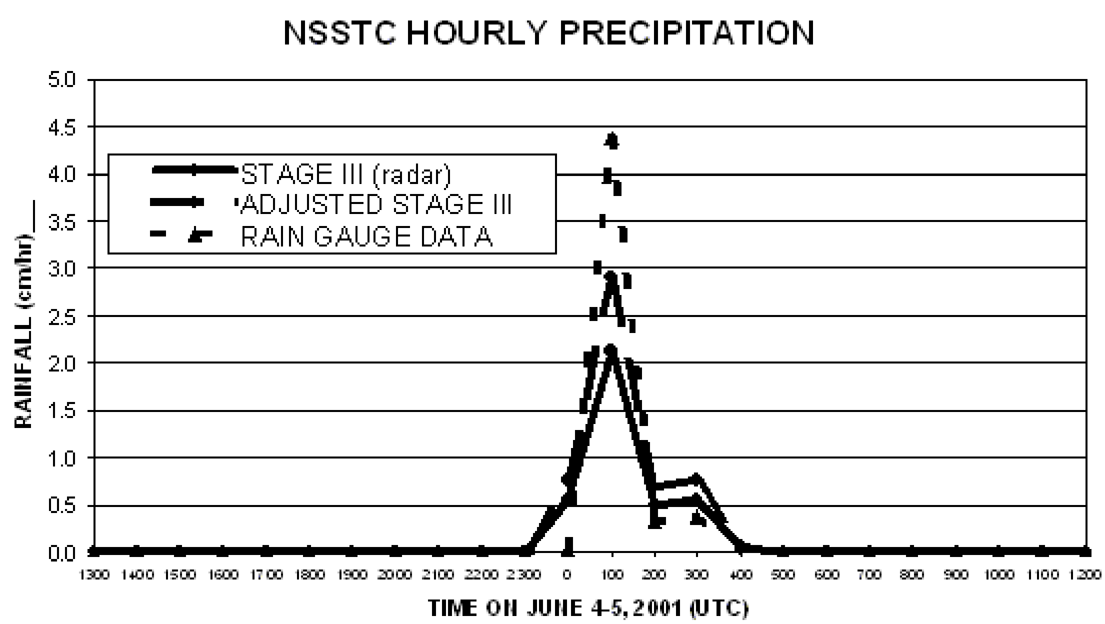

Figure 4. Hourly stage III rainfall data (solid), hourly stage III adjusted data (dashed), and rain gauge data (dotted) for June 4-5, 2001 storm event at NSSTC.