Updated Rainfall Analysis for the May 1995 Southeast Louisiana and Southern Mississippi Flooding

W. Scott Lincoln[1],
1. National Weather Service Lower Mississippi River Forecast Center

Corresponding Author:
W. Scott Lincoln
NWS Lower Mississippi River Forecast Center
62300 Airport Rd, Slidell, LA 70460
scott.lincoln@noaa.gov

ABSTRACT

Very heavy rainfall on 8-10 May 1995 caused significant flooding across portions of southeast Louisiana and southern Mississippi. A post-event technical report, NOAA Technical Memorandum NWS SR-183 (Ricks et al., 1997), provided a meteorological overview and rainfall analysis of the event using rain gauge data. Subsequent changes to the official National Weather Service (NWS) rainfall estimation technique, improved GIS capabilities, and the completion of rainfall frequency estimates for the southern United States have allowed for a new analysis of this event.

Radar-derived estimates of rainfall were bias corrected using techniques currently in use by NWS River Forecast Centers (RFCs). Estimates of rainfall Average Recurrence Interval (ARI) were also made. The area of heaviest storm total rainfall exceeded the 1000 year (0.1% annual chance equivalent) event and many other areas experienced rainfall greater than the 100 year (1% chance equivalent) including portions of the New Orleans and Gulfport-Biloxi metropolitan areas. It was found that with these newer techniques, rainfall estimates were generally similar to SR-183 across the entire analysis area, but did differ on small scales with an inconsistent magnitude and sign. Further analysis suggested that some of these differences were due to how the storm total rainfall was illustrated in SR-183, and were not likely due to issues with the bias corrected radar technique.

1. Introduction

Severe flooding occurred across a large portion of southeast Louisiana and southern Mississippi due to very heavy rainfall on 8-10 May 1995. A frontal boundary moved into southeast Louisiana and stalled, then subsequently became the focus for heavy thunderstorm activity. Two distinct waves of rainfall occurred, with each responsible for substantial flooding. The purpose of this report is to re-evaluate the rainfall estimates for the event using updated data and techniques.

a. Discussion of previous Tech Memo

An overview of the synoptic pattern leading up to the event, rainfall totals, and subsequent flood impacts was provided by NOAA Technical Memorandum NWS SR-183 (Ricks et al., 1997; hereafter SR-183). The report indicates that a squall line ahead of a cold front moved into the New Orleans area the evening of 8 May into the morning of 9 May. By the evening of 9 May, the cold front dissipated as it moved past Baton Rouge and the forward storm movement drastically slowed, causing thunderstorms to train over the New Orleans area and eventually areas just north of Lake Pontchartrain. Rainfall abated on the morning of 9 May but reformed by the evening as the atmosphere destabilized from cold-air advection aloft. Thunderstorm activity during the overnight hours of 9 May into 10 May again moved slowly, although the focus shifted to areas just north of Lake Pontchartrain and coastal Mississippi. Widespread reports of 10-20 inches of storm total rainfall were common and severe flooding – both flash flooding and river flooding –were observed. The report indicates that over 40,000 homes were flooded and damages were estimated at over $3.0 billion.

Rainfall analysis in SR-183 (1997) consisted of manual contour analysis of point rain gauge data (Figure 1 & Figure 2). Although estimates from the recently installed NEXRAD site at the New Orleans/Baton Rouge Weather Forecast Office (WFO LIX) were available to forecasters in realtime and likely aided the contour analysis in SR-183, these radar estimates could not be easily used in the creation of gridded rainfall maps as we see today.

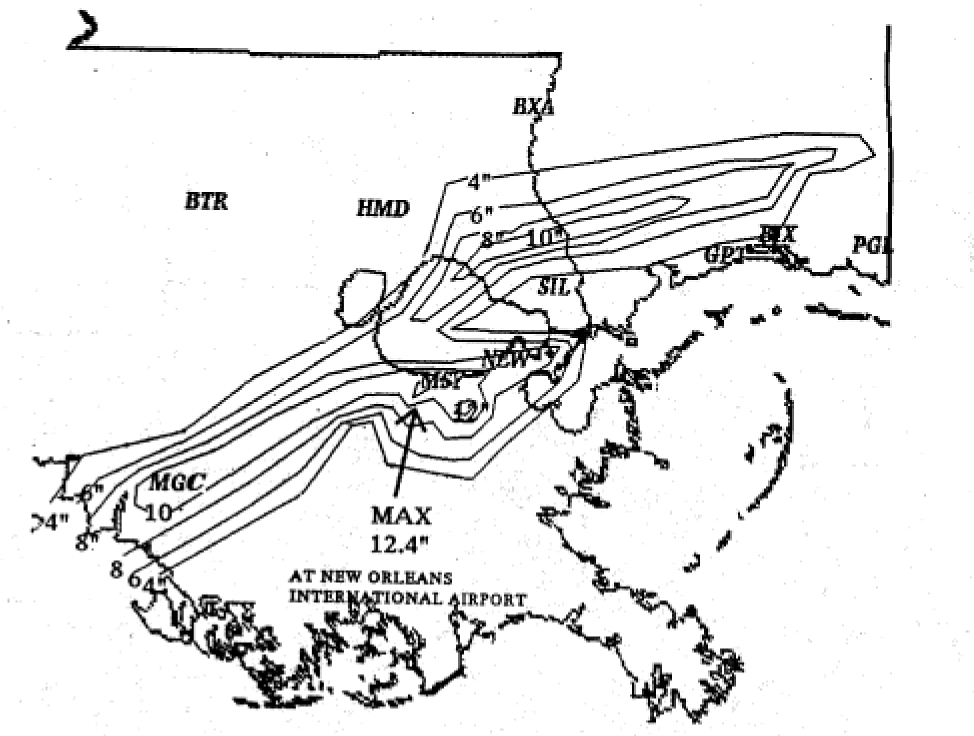

Fig. 5a. 24-hr isohyetal analysis for day 1 event.

Figure 1. The manual contour analysis for 24 hour rainfall ending at 1200 UTC 9 May 1995 presented in SR-183 as Fig. 5a.

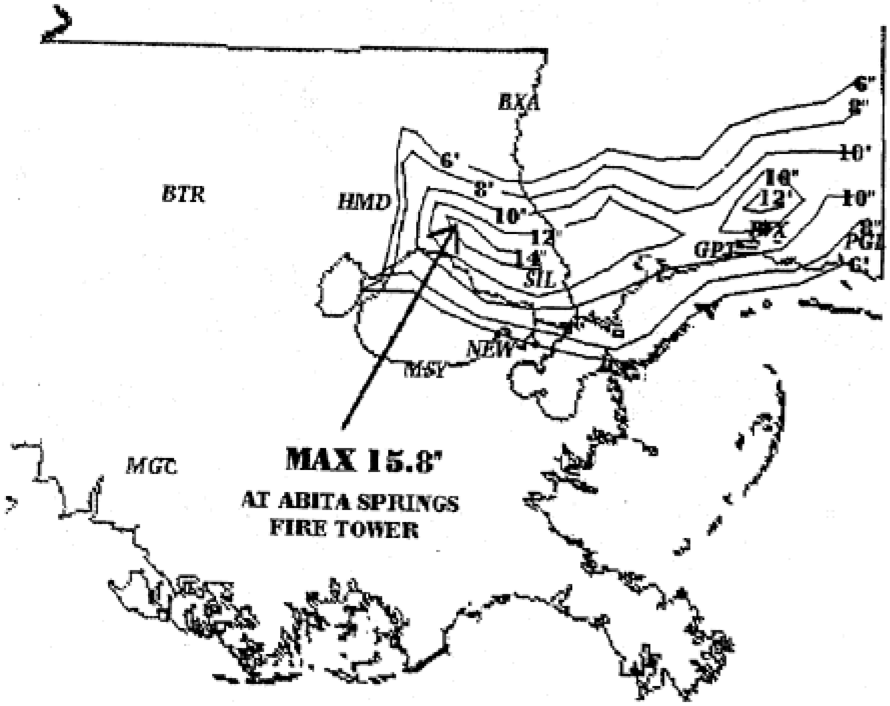

Fig. 5b. 24-hr isohyetal analysis for day 2 event.

Figure 2. The manual contour analysis for 24 hour rainfall ending at 1200 UTC 10 May 1995 presented in SR-183 as Fig. 5b.

b. Summary of new work

The purpose of this analysis was to collect as much rainfall gauge data as possible and use this assumed ground truth data to bias-correct rainfall estimates from the WFO LIX radar. These gridded rainfall estimates were then compared to historical rainfall frequency data provided by NOAA Atlas 14 (National Weather Service, 2013) to estimate the average recurrence interval (ARI) of the 8-10 May 1995 event.

2. Methodology

a. Data Sources

This analysis includes both point rainfall data and gridded rainfall data derived from radar reflectivity. Point data is mostly from NWS Cooperative Observer (COOP) sites and automated airport stations (ASOS). A bucket survey was also conducted for southern Mississippi by the Weather Forecast Office (WFO) out of Jackson, MS; this NWS office covered the entire state of Mississippi during this event.

Radar data for the event was obtained from the National Climatic Data Center (NCDC) via their online Hierarchical Data Storage System (HDSS); http://has.ncdc.noaa.gov/pls/plhas/has.dsselect). Raw, native-resolution radar data for this site was not available prior to 16 May 1995, so the courser resolution "Level III" data was retrieved. Level III data also includes the one (1) hour and storm total rainfall estimates provided by the radar for each volume scan. The one (1) hour rainfall estimates for the volume scan closest to the top of the hour was converted to an ArcGIS raster format with the NOAA Weather and Climate Toolkit.

b. Bias correction of radar rainfall estimates

Official rainfall estimates provided by the NWS are produced by the River Forecast Centers (RFCs) using a combination of radar, gauges, and forecaster QA/QC (Lawrence, Shebsovich, Glaudemans, & Tilles, 2003). These "multisensor best-estimate" rainfall products start with a mosaic of radar-derived rainfall estimates. These radar estimates are compared to rain gauges and a bias is calculated. A gridded bias field is interpolated from the bias at each rain gauge point location, and then a bias correction is applied to the gridded radar data. Forecasters at the RFCs can then manually edit the bias corrected rainfall grids for additional QA/QC. The analysis documented in this report followed the official rainfall estimation process as closely as possible via ArcGIS.

Rain gauge point data was first extracted from the Lower Mississippi River Forecast Center (LMRFC) Daily Precipitation Archive project. The Daily Precipitation Archive was a multi-month effort undertaken by forecasters at the LMRFC and a summer volunteer where daily COOP rainfall data was converted to GIS compatible formats and interpolated to a gridded rainfall estimate via kriging for the 1950-2012 period. Paper rainfall maps were obtained from LMRFC staff and WFO LIX staff who were at the office during the event. These paper maps were scanned and then georeferenced in ArcGIS. It was found that the paper maps and the point COOP data matched very closely. A few additional point rainfall values were found on the paper maps and they were added to the GIS dataset. Additional daily rainfall data was also found for rain gauges operated by the Sewerage and Water Board of New Orleans (SWBNO), and this data was added to the GIS dataset (see supplemental material).

The hourly rainfall estimates derived from the Level III radar data was summed over 24 hour periods ending at 1200 UTC to match the rainfall data. The daily radar-estimated value for each rain gauge location was extracted and a bias correction factor was determined. This bias correction factor was interpolated with a simple inverse distance weighted (IDW) method, which is the same as currently utilized by the NWS RFCs. The bias correction factor was applied to the radar rainfall estimates to produce a multisensor best-estimate.

Rainfall data from the NWS Jackson bucket survey only provided estimates of storm total precipitation and data from SWBNO gauges provided rainfall estimates for local 12AM to

12AM periods (0500 UTC to 0500 UTC). Usage of these datasets to estimate daily (1200 UTC to 1200 UTC) rainfall was thus more difficult. The ratio of rainfall for each day (1200 UTC to 1200 UTC period) compared to the storm total rainfall was estimated for each gauge location from the first bias-corrected estimate (see discussion above). Once a daily estimate of rainfall was obtained for each bucket survey location and SWBNO location, these points were added to the gridded analysis to create the final daily rainfall estimates.

The entire event lasted roughly 52 hours for the entire area and no longer than approximately 48 hours for any particular location. The event could also be broken up into two individual one day events, each lasting approximately 12 hours. This provides numerous ways to estimate the ARI (or return period) of rainfall. The one (1) day rainfall ending at 1200 UTC 9 May 1995 and the one (1) day rainfall ending at 1200 UTC 10 May 1995 were both compared to NOAA Atlas 14 one (1) day frequency analysis data to determine ARIs for each single day event. The storm total rainfall ending at 1600 UTC 10 May 1995 was compared to the NOAA Atlas 14 two (2) day frequency analysis data to determine the ARI for both days combined.

Table 1.Storm total rainfall for 9-11 May 1995 obtained via the NWS Jackson, MS, bucket survey. When a latitude/longitude location was not provided, it was estimated. Daily rainfall values ending at 1200 UTC indicated in the last three columns did not come from the bucket survey but were estimated using the ratio of rainfall from each 1200 UTC to 1200 UTC period derived from radar estimates. A scan of the original bucket survey is provided in the supplemental material.

Name	**Lat**	**Lon**	**Rainfall**	**Comment**	**May 9th***	**May 10th***	**May 11th***
Necaise 8W	30.60	-89.50	27.5	overflow	18.2	9.3	0.0
Cypress Lake Estates	30.57	-89.43	24.0	overflow	15.6	8.4	0.0
Caesar	30.60	-89.53	24.0	overflow	17.0	7.0	0.0
Picayune 7ESE	30.52	-89.55	23.5	overflow	15.0	8.5	0.0
Necaise 2S	30.58	-89.40	23.4		15.0	8.4	0.0
Picayune 3E	30.53	-89.60	21.5		13.6	7.8	0.1
Caesar 1W	30.62	-89.57	21.5		16.1	5.4	0.0
Picayune Water Treatment	30.53	-89.73	21.2		14.5	6.7	0.0
Kiln 5N	30.48	-89.42	20.5		9.9	10.5	0.1
Kiln Firetower	30.47	-89.43	19.5		9.0	10.4	0.1
Picayune 8.5E	30.53	-89.55	19.5		12.4	7.1	0.0
Seller	30.62	-89.33	19.0		14.7	4.3	0.0
Latimer	30.52	-88.87	18.3	est. lat/lon	2.1	16.2	0.0
Lyman 5WNW	30.53	-89.17	18.2		7.1	11.0	0.1
Gulfport	30.38	-89.07	18.0	overflow	1.0	16.9	0.1
Nicholson	30.48	-89.68	17.5		8.9	8.5	0.1
Kiln 2S	30.37	-89.40	17.3		4.7	12.5	0.1
Kiln 2NE	30.42	-89.38	17.1		5.4	11.7	0.0
Stennis Space Center	30.37	-89.58	16.9		4.9	12.0	0.0
Pearlington	30.27	-89.60	16.8		6.0	10.5	0.3
Long Beach	30.37	-89.15	16.8		1.3	15.5	0.0
Saucier Exp. Forest	30.63	-89.05	15.6		8.5	7.1	0.0
Biloxi Keesler AFB	30.42	-88.92	15.5		0.6	14.8	0.1
Bay St. Louis 2NW	30.35	-89.38	15.5		2.3	13.2	0.0
Port Bienville	30.23	-89.55	15.3		4.7	10.4	0.2
Biloxi WLOX	30.38	-88.98	14.1		0.5	13.5	0.1
Picayune SW	30.57	-89.75	14.0	overflow	9.8	4.2	0.0
Lyman 4WSW	30.48	-89.17	13.7		3.7	10.0	0.0
Picayune W	30.58	-89.73	13.0	overflow	9.1	3.9	0.0
Lakeshore 4SW	30.27	-89.45	12.8		2.5	10.1	0.2
Diamondhead	30.38	-89.37	12.0		2.1	9.9	0.0
Lyman	30.52	-89.12	11.5		2.9	8.5	0.1
Necaise 4N	30.65	-89.42	11.5		8.7	2.8	0.0
Diamondhead 3N	30.42	-89.33	11.2		3.1	8.0	0.1
Waveland 1NNW	30.30	-89.38	10.9		1.3	9.5	0.1
Lakeshore	30.28	-89.43	10.9		2.3	8.4	0.2
Waveland 5NW	30.30	-89.43	10.8		2.6	8.1	0.1
Carriere	30.62	-89.65	10.7		7.7	3.0	0.0
Gulfport Lorraine Rd	30.43	-89.02	10.6		0.9	9.7	0.0
Waveland	30.28	-89.40	10.5		1.3	9.1	0.1
McNeill	30.67	-89.62	10.5		7.3	3.2	0.0
Diamondhead	30.40	-89.35	10.5		1.8	8.6	0.0
Bay St. Louis 1W	30.32	-89.35	10.0		0.7	9.2	0.1
Lakeshore	30.28	-89.43	10.0		2.1	7.8	0.2
Bay St. Louis	30.32	-89.33	9.3		0.6	8.6	0.1
Pass Christian	30.33	-89.24	8.5	est. lat/lon	0.7	7.7	0.1
McNeill E	30.67	-89.53	7.6		4.4	3.2	0.0
Millard	30.75	-89.60	6.4		4.3	2.1	0.0
Wiggins 1WSW	30.85	-89.15	4.1		2.4	1.7	0.0

3. Results

a. Bias-corrected rainfall totals for 24 hour period ending 1200 UTC 09 May 1995

Radar-derived rainfall estimates for the 24 hour period ending on 1200 UTC 09 May 1995 (Figure 4, top) were generally much lower than gauge observations for the same period. The vast majority of the area had bias correction factor values of 2.0 or greater (Figure 3), with parts of St. Tammany Parish and Hancock County (among the area of heaviest rainfall) having gauge observations 3.0-5.0 times the radar estimates. Only a few isolated areas required a bias correction factor value less than 1.0; these areas were typically on the periphery of the rainfall swath. After bias-correction, two swaths of rainfall exceeding 10.0 inches were noted on opposite sides of Lake Pontchartrain (Figure 4, bottom).

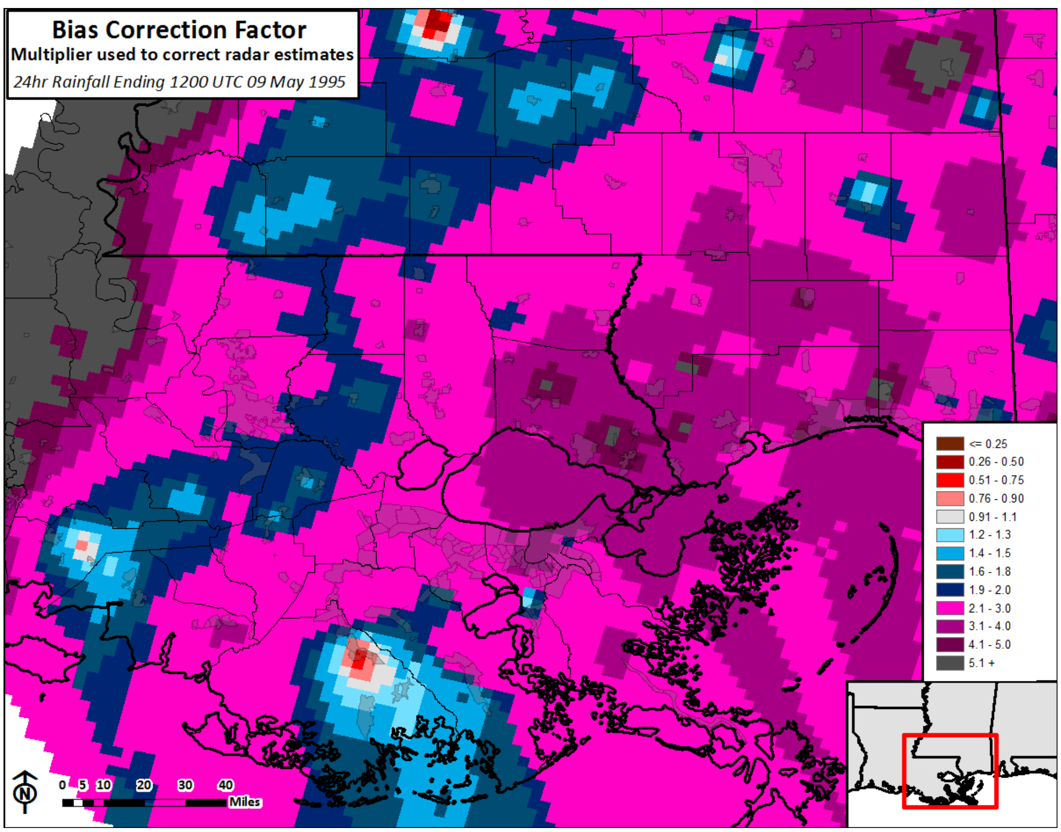

Figure 3. Bias correction factor for the 24 hour period ending at 1200 UTC 09 May 1995. The bias correction factor is the value multiplied by the radar-only rainfall estimate to more closely match gauge observations and produce bias-corrected rainfall estimates.

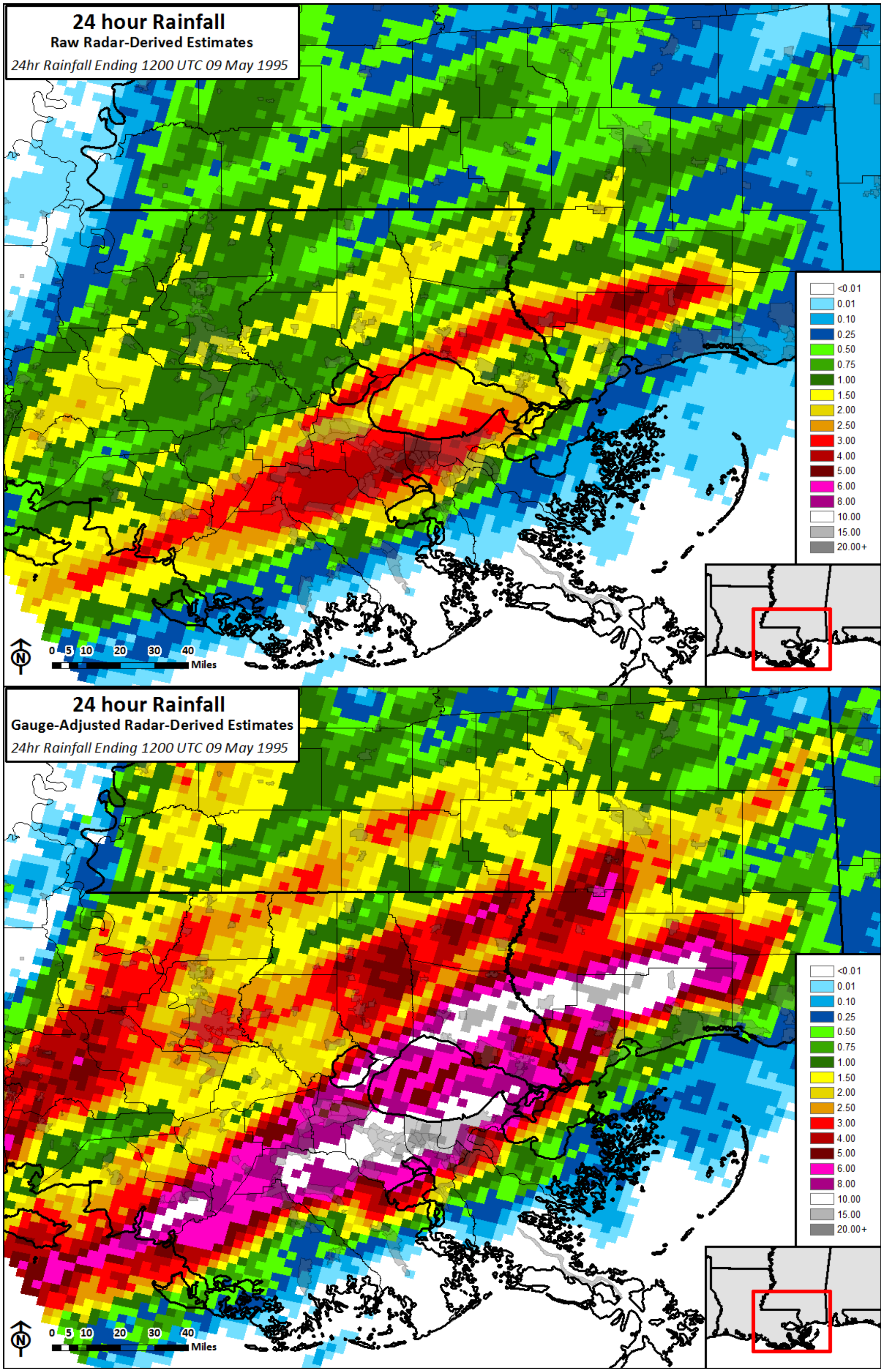

Figure 4. Rainfall estimates for the 24 hour period ending at 1200 UTC 09 May 1995. Radar-only rainfall estimates (top) were substantially lower than gauge bias-corrected rainfall estimates (bottom).

The bias-corrected rainfall estimates were then compared to NOAA Atlas 14 to get an estimate of rainfall ARI. Two swaths of extreme rainfall (defined by a 1% or less annual chance event) were evident (Figure 5). The swath of rainfall to the south of Lake Pontchartrain extended from St. Charles Parish through Jefferson Parish and into Orleans Parish. The heaviest rainfall amounts were in Jefferson Parish where the 24 hour bias-corrected rainfall was analyzed as exceeding the 100 year event (1% annual chance). The swath of rainfall to the north of Lake Pontchartrain extended from St. Tammany Parish through Pearl River and Hancock Counties to portions of Stone and Harrison County. The heaviest rainfall amounts were in St. Tammany Parish where the 24 hour bias-corrected rainfall was analyzed as exceeding the 1000 year event (0.1% annual chance).

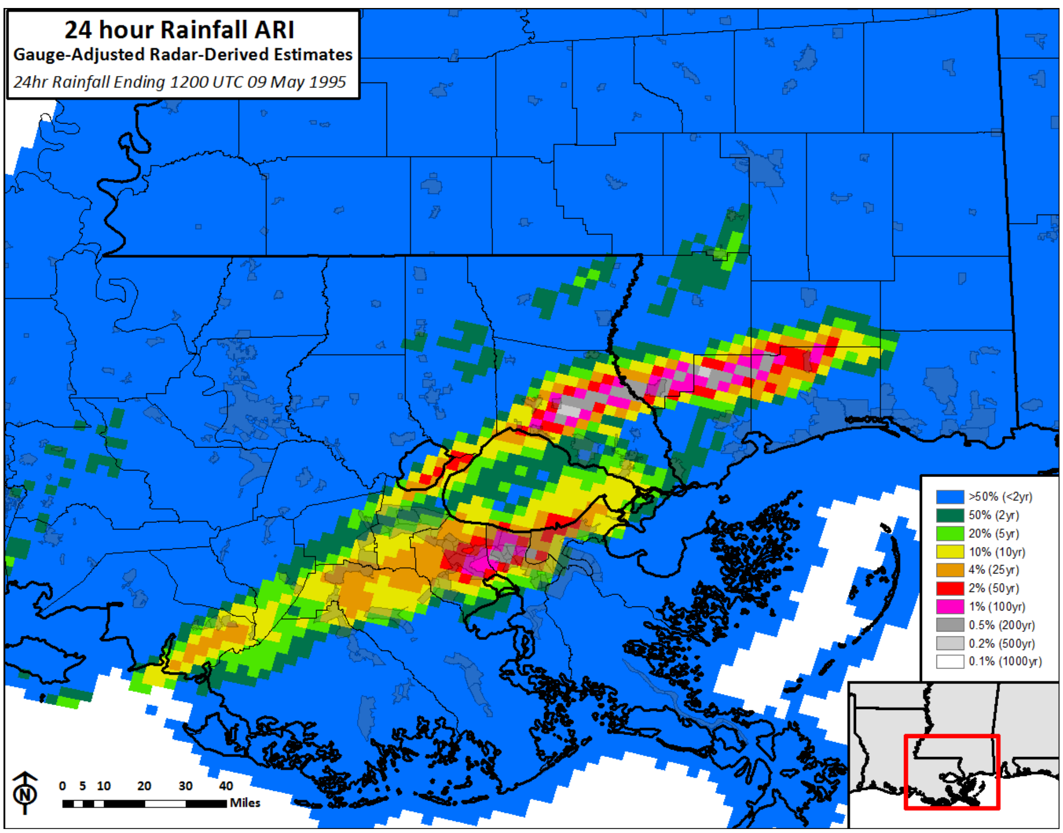

Figure 5. Estimated rainfall ARI for the 24 hour period ending at 1200 UTC 09 May 1995 based upon frequency analysis in NOAA Atlas 14.

b. Bias-corrected rainfall totals for 24 hour period ending 1200 UTC 10 May 1995

Radar-derived rainfall estimates for the 24 hour period ending on 1200 UTC 10 May 1995 (Figure 7, top) were generally much lower than gauge observations for the same period. The vast majority of the area had bias correction factor values of 2.0 or greater (Figure 6), with parts of St. Tammany Parish, Pearl River County, and Hancock County having gauge observations 3.0-4.0 times the radar estimates. Isolated areas required a bias correction factor value less than 1.0; these areas were typically on the periphery of the rainfall swath. After bias-correction, one swath of rainfall exceeding 10.0 inches was noted extending from north of Lake Pontchartrain in Louisiana to the Gulf Coast in Mississippi (Figure 7, bottom).

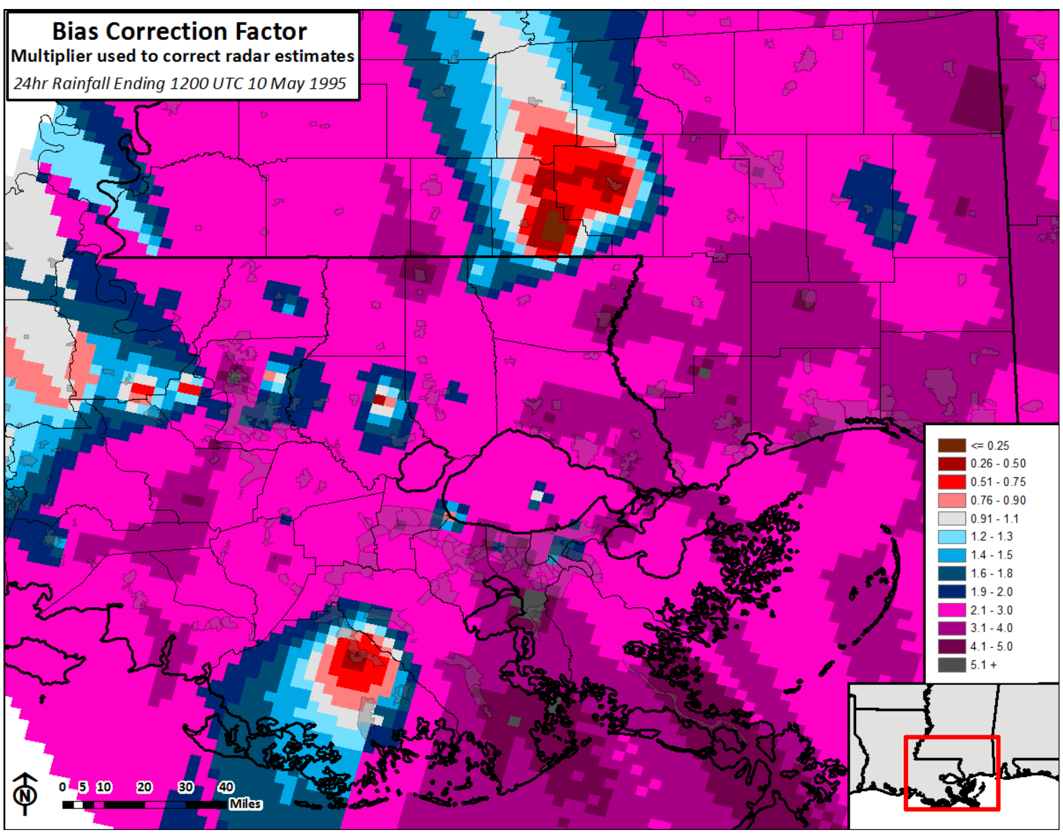

Figure 6. Bias correction factor for the 24 hour period ending at 1200 UTC 10 May 1995. The bias correction factor is the value multiplied by the radar-only rainfall estimate to more closely match gauge observations and produce bias-corrected rainfall estimates.

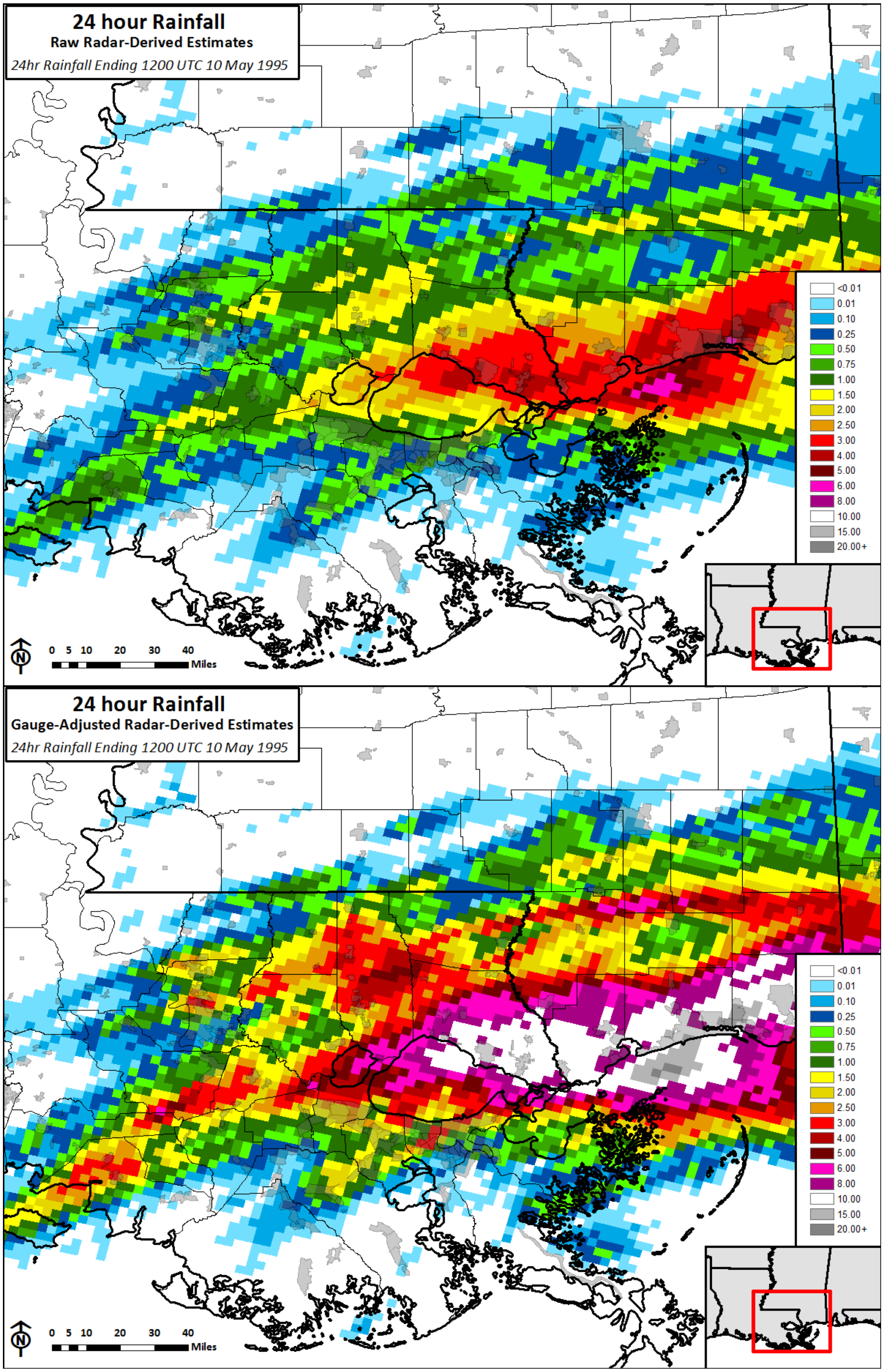

Figure 7. Rainfall estimates for the 24 hour period ending at 1200 UTC 10 May 1995. Radar-only rainfall estimates (top) were substantially lower than gauge bias-corrected rainfall estimates (bottom).

The bias-corrected rainfall estimates were then compared to NOAA Atlas 14 to get an estimate of rainfall ARI. A few areas of extreme rainfall (defined by a 1% or less annual chance event) were evident north of Lake Pontchartrain in St. Tammany Parish and the Mississippi Gulf Coast in Harrison County (Figure 8). The 24 hour bias-corrected rainfall for areas just off the coast of Harrison County was analyzed as exceeding the 1000 year event (0.1% annual chance). The 24 hour bias-corrected rainfall in a few portions of St. Tammany Parish and Hancock County was analyzed as exceeding the 100 year event (1% annual chance).

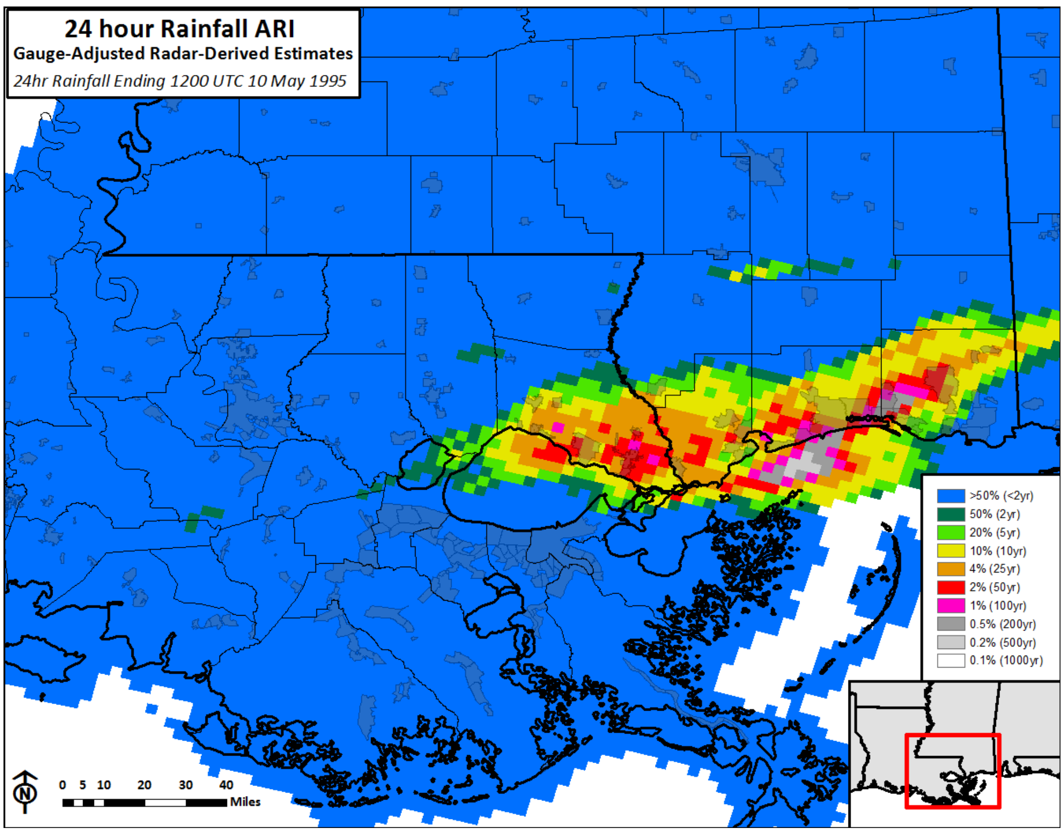

Figure 8. Estimated rainfall ARI for the 24 hour period ending at 1200 UTC 10 May 1995 based upon frequency analysis in NOAA Atlas 14.

c. Bias-corrected storm total rainfall for the 52 hours ending at 1600 UTC 10 May 1995

The bias-corrected rainfall estimates ending at 1200 UTC 09 May 1995 and 1200 UTC 10 May 1995 were added to the radar-derived rainfall estimates for the four (4) hour period ending 1600 UTC 10 May 1995 to produce the 52 hour storm total (Figure 9). This final four (4) hour period was not bias corrected due to the small values at the vast majority of locations and also due to lack of hourly gauge data. The smaller swaths of very heavy rainfall evident in the daily (24 hour) data became one large swath of rainfall exceeding 10 inches in the 52 hour storm total rainfall estimate. Portions of St. Tammany Parish, Pearl River County, Hancock County, and Harrison County had areas exceeding 20 inches of rainfall.

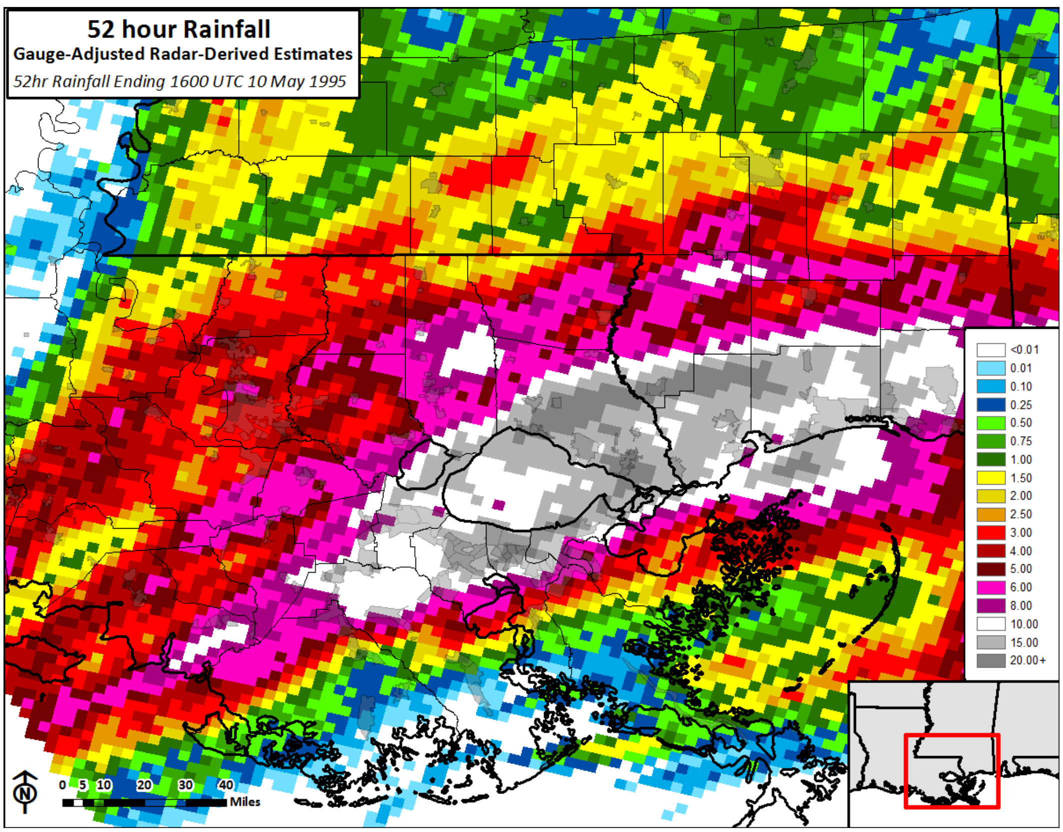

Figure 9. Storm total rainfall estimates for the 52 hour period ending at 1600 UTC 10 May 1995. The storm total rainfall estimate was created by adding the 24 hour bias corrected rainfall from 1200 UTC 09 May 1995 and the 24 hour bias corrected rainfall from 1200 UTC 10 May 1995 to the four (4) hour radar-derived rainfall from 1600 UTC 10 May 1995.

The storm total rainfall estimates were then compared to NOAA Atlas 14 to get an estimate of rainfall ARI. Many areas in southeast Louisiana and south Mississippi experienced two (2) day rainfall that could be classified as extreme (defined by a 1% or less annual chance event), stretching from St. Charles and St John the Baptist Parish in the west to Harrison County in the east (Figure 10). Rainfall in portions of St. Tammany Parish, Pearl River County, and Hancock County was analyzed as exceeding the 1000 year event (0.1% annual chance).

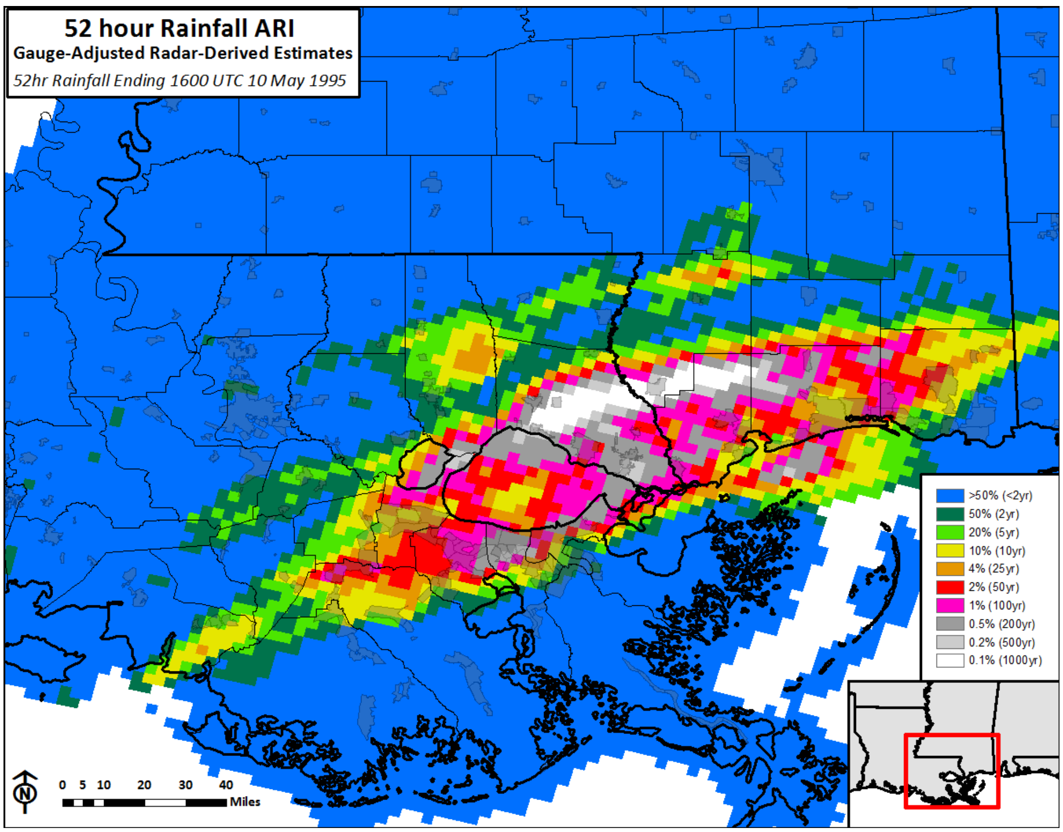

Figure 10. Estimated rainfall ARI for the 52 hour period ending at 1600 UTC 10 May 1995 based upon frequency analysis in NOAA Atlas 14.

4. Discussion

To investigate the impact of this change in rainfall estimation methodology to the storm total rainfall, the storm total bias corrected rainfall was compared to the storm total contour analysis shown in SR-183 (Figure 11, top). This was not a straight-forward task as the original rainfall estimates were not in a gridded format and used a very coarse contour increment (5 inches). Simply geo-referencing the figure and digitizing the contours as plotted would likely add to the uncertainty in the comparison. To mitigate this uncertainty from the contour increment, data between the contours was interpolated via the spline technique using additional gauge data to improve the interpolation of areas with less than 5 inches of rainfall (Figure 11, bottom).

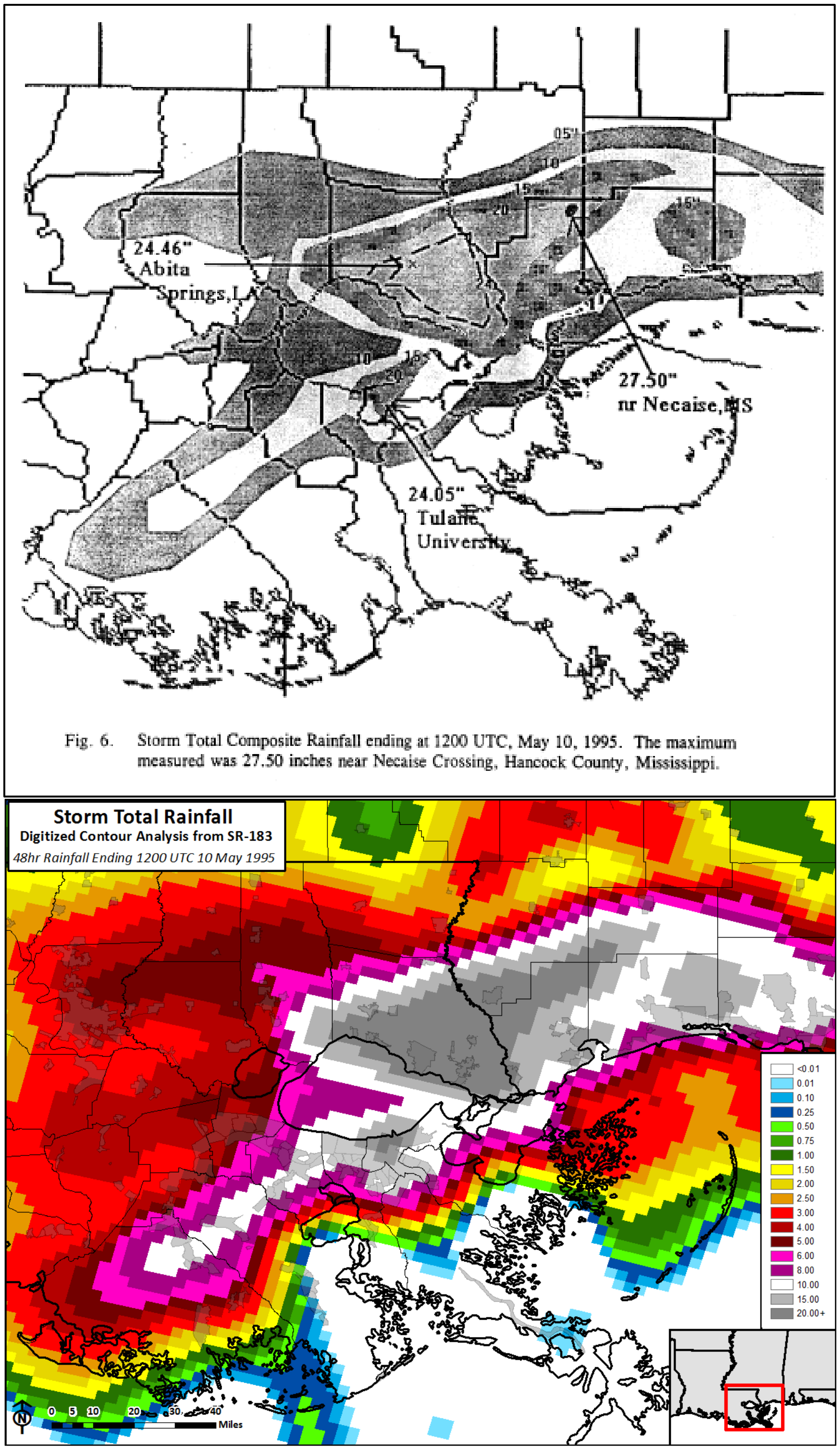

Figure 11. Manual contour analysis of storm total rainfall presented in SR-183 as Fig. 6 (top) and the digitized data interpolated to grid with the spline technique (bottom).

The bias corrected radar rainfall estimates differed from estimates provided in SR-183 (1997), but this difference was not consistent across the analysis area (Figure 12). For the swath of heaviest rainfall (shown as the 1000 year event in Figure 10), rainfall estimates were very similar, however just to the north and south of this band the rainfall estimates were generally lowered by 2-4 inches, with a few isolated areas reduced by 6-8 inches. This appears to be due to a narrowing of the north-south width of the band of heaviest rainfall in the bias corrected analysis when compared to the contour analysis in SR-183. Another notable area of substantial difference was across Terrebonne and Lafourche Parishes in Louisiana where the placement of the rainfall swath moved to the north, thus causing adjacent areas of both increase and decrease. Lake Maurepas and coastal Mississippi just south of Harrison County both showed substantial increases in storm total rainfall, which may be related to the lack of gauge observations in those areas.

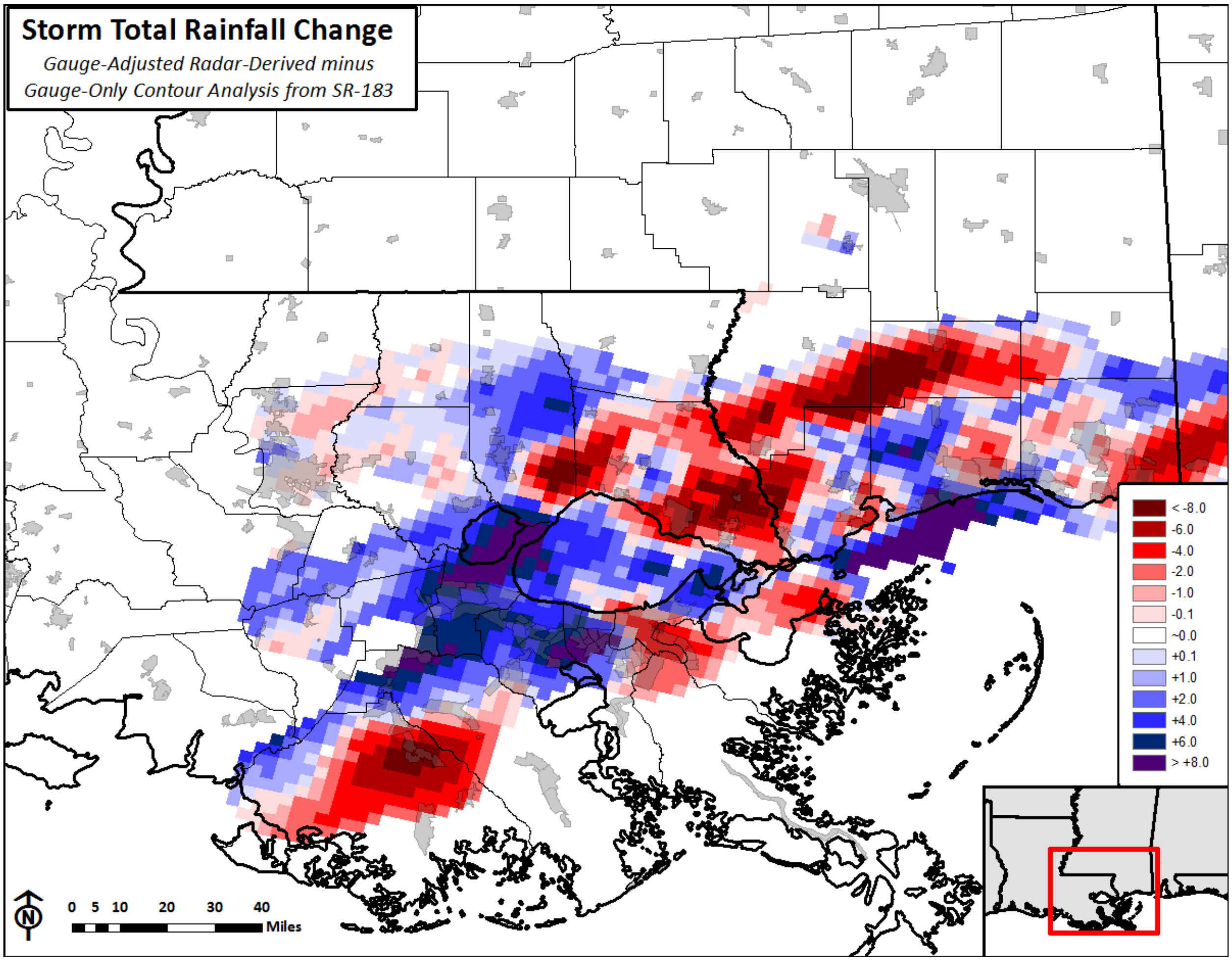

Figure 12. Difference between the bias-corrected storm total rainfall product created by this analysis (Figure 9) and the storm total rainfall contour analysis provided by SR-183.

To further investigate the reason for these differences in the storm total rainfall estimate, an objective interpolation of gauge data was performed with the kriging technique. It was assumed that the manual contour analysis from SR-183 should be similar to the analysis from interpolation because the source of both techniques would be the same – only the gauge data. It was instead found that substantial differences remained between the gauge-only interpolation and the contour analysis done in SR-183 (Figure 13), and many of these differences were similar in both location and magnitude to differences found with the bias corrected radar-derived estimates. This suggests that the high variability in storm total rainfall differences between this analysis and the analysis in SR-183 is not due to the bias correction technique alone. This variability is instead likely due to a combination of 1) adding radar-derived estimates between gauge locations, 2) the large contour increment of SR-183, 3) small errors in placement of heavy rainfall swaths in SR-183, and 4) other unknown factors.

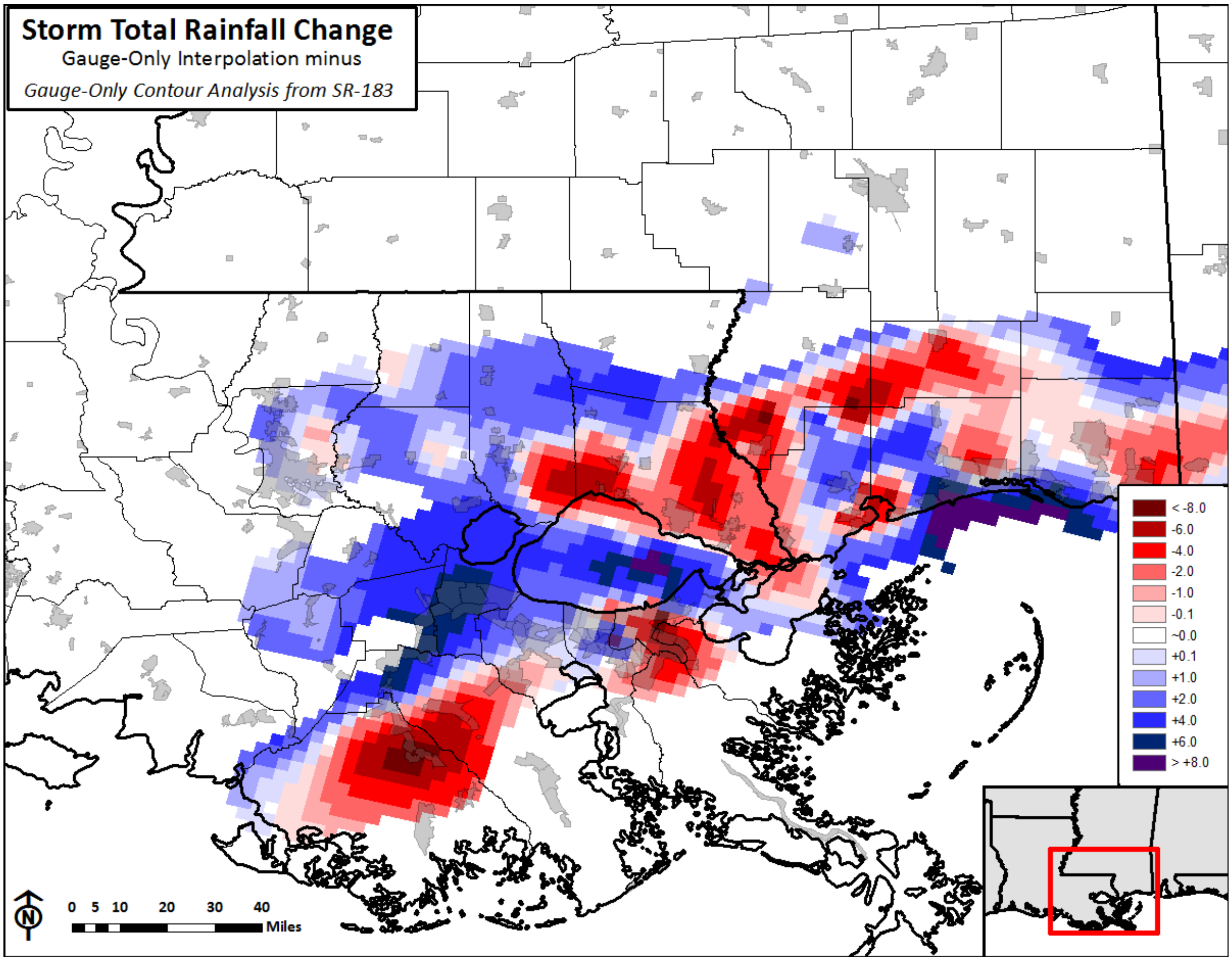

Figure 13. Difference between the kriging interpolation of gauge-only storm total rainfall and the storm total rainfall contour analysis provided by SR-183.

5. Conclusions

Two waves of very heavy rainfall on 8-10 May 1995 caused significant flooding for portions of southeast Louisiana and southern Mississippi. Analysis of the event by NWS forecasters in 1997 (Ricks, et al., 1997) provided rainfall estimates from manual contour analysis of gauge data. Rainfall observations from gauges and bucket surveys, as well as estimates from radar, were collected and re-analyzed. Bias correction techniques currently in use by NWS RFCs to produce the official rainfall products were applied to available data from the May 1995 event. Estimates of rainfall ARI were also generated based upon data from NOAA Atlas 14.

Rainfall estimates provided using this updated technique were generally similar across the entire analysis area, but did differ on small scales with an inconsistent magnitude and sign. The area of heaviest storm total rainfall from northern St. Tammany Parish, LA, to northern Harrison County, MS, was mostly unchanged. The two (2) day rainfall in this swath exceeded the 1000 year (0.1% annual chance equivalent) event as determined by NOAA Atlas 14. Significant portions of southeast Louisiana and southern Mississippi experienced extreme rainfall (as defined by the 100 year/1% chance event) including portions of the New Orleans and Gulfport-Biloxi metropolitan areas.

6. Acknowledgements

The author would like to thank the authors of SR-183 for their work that was the basis of this report. In particular, the staff of NWS Jackson should be thanked for their thorough bucket survey that greatly improved the final storm total rainfall estimate. The author would also like to thank Jeff Graschel, David Schlotzhauer, David Welch, and Frank Revitte for their constructive comments.

7.0 Works Cited

Lawrence, B. A., Shebsovich, M., Glaudemans, M., & Tilles, P. (2003). Enhancing Precipitation Estimation Capabilities at National Weather Service Field Offices Using Multi-Sensor Precipitation Data Mosaics. *19th Conference on Interactive Information Procesing Systems.* American Meteorological Society. Retrieved October 2014, from http://water.weather.gov/precip/p_download_new/AMS_Paper_Feb_2003.pdf

National Weather Service. (2013). *NOAA Atlas 14: Precipitation-Frequency Atlas of the United States.* National Weather Service, Hydrologic Design Studies Center. Silver Spring, MD: NOAA.

Ricks, R. J., Trotter, P., Johnson, G., Revitte, F., Guiney, J., Pfost, R., & Reed, D. (1997). *The Historic Southeast Louisiana and Southern Mississippi Flood of May 8-10, 1995.* NOAA/NWS/SRHQ. Retrieved June 2014, from http://www.srh.noaa.gov/ssd/techmemo/sr183.htm

SPECIAL WEATHER STATEMENT... CONTINUED
NATIONAL WEATHER SERVICE JACKSON MS
245 PM CDT FRI MAY 19 1995

RESULTS OF BUCKET AND FLOOD SURVEY
MISSISSIPPI GULF COAST
MAY 8-10, 1995
NWSFO JACKSON, MS

LOCATION	COUNTY	APPROXIMATE LATITUDE	APPROXIMATE LONGITUDE	TOTAL RAINFALL*
KILN 2NE	HANCOCK	30 25'	89 23'	17.1
KILN FIRETOWER	HANCOCK	30 28'	89 26'	19.45
KILN 5N	HANCOCK	30 29'	89 25'	20.5
NECAISE 2S	HANCOCK	30 35'	89 24'	23.39
CYPRESS LAKE EST.	HANCOCK	30 34'	89 26'	24.00+
PICAYUNE 8.5E	PEARL RIVER	30 32'	89 33'	19.45
KILN 2S	HANCOCK	30 22'	89 24'	17.25
DIAMONDHEAD	HANCOCK	30 23'	89 22'	11.95
BAY ST. LOUIS 2NW	HANCOCK	30 21'	89 23'	15.5
BAY ST. LOUIS 1W	HANCOCK	30 19'	89 21'	10.0
WAVELAND 1NNW	HANCOCK	30 18'	89 23'	10.87
BAY ST. LOUIS	HANCOCK	30 19'	89 20'	9.3
WAVELAND	HANCOCK	30 17'	89 24'	10.5
LAKESHORE COMM.	HANCOCK	30 17'	89 26'	10.0
LAKESHORE 4SW	HANCOCK	30 16'	89 27'	12.75
LAKESHORE COMM.	HANCOCK	30 17'	89 26'	10.87
PORT BIENVILLE	HANCOCK	30 14'	89 33'	15.25
WAVELAND 5NW	HANCOCK	30 18'	89 26'	10.75
PEARLINGTON	HANCOCK	30 16'	89 36'	16.8
NASA TEST FACILITY	HANCOCK	30 22'	89 35'	16.91
DIAMONDHEAD 3N	HANCOCK	30 25'	89 20'	11.18
DIAMONDHEAD	HANCOCK	30 24'	89 21'	10.45
PASS CHRISTIAN	HARRISON	(UNKNOWN)		8.50
LONG BEACH	HARRISON	30 22'	89 09'	16.8
GULFPORT LORRAINE RD	HARRISON	30 26'	89 01'	10.56
PICAYUNE 7ESE	HANCOCK	30 31'	89 33'	23.5+
LATIMER COMM.	JACKSON	(UNKNOWN)		18.30
LYMAN	HARRISON	30 31'	89 07'	11.5
LYMAN 4WSW	HARRISON	30 29'	89 10'	13.7
LYMAN 5WNW	HARRISON	30 32'	89 10'	18.2
SAUCIER EXP FOREST	HARRISON	30 38'	89 03'	15.6
BILOXI (WLOX)	HARRISON	30 23'	88 59'	14.10
BILOXI KEESLER AFB	HARRISON	30 25'	88 55'	15.51
GULFPORT HARRISON CD	HARRISON	30 23'	89 04'	18.0+
MCNEILL	PEARL RIVER	30 40'	89 37'	10.5
CARRIERE	PEARL RIVER	30 37'	89 39'	10.7
MILLARD	PEARL RIVER	30 45'	89 36'	6.4
PICAYUNE W	PEARL RIVER	30 35'	89 44'	13.0+
PICAYUNE WATER TREAT	PEARL RIVER	30 32'	89 44'	21.24
PICAYUNE SW	PEARL RIVER	30 34'	89 45'	14.0+
PICAYUNE 3E	PEARL RIVER	30 32'	89 36'	21.5
CAESAR COMMUNITY	PEARL RIVER	30 36'	89 32'	24.0+
CAESAR 1W	PEARL RIVER	30 37'	89 34'	21.5
NICHOLSON	PEARL RIVER	30 29'	89 41'	17.5
MCNEILL EAST	PEARL RIVER	30 40'	89 32'	7.6
NECAISE 4N	HANCOCK	30 39'	89 25'	11.5
SELLERS COMMUNITY	HARRISON	30 37'	89 20'	19.0
NECAISE 8W	HANCOCK	30 36'	89 30'	27.5+
WIGGINS 1WSW	STONE	30 51'	89 09'	4.1

* RAINFALL IS STORM TOTAL. + INDICATES OVERFLOW. AMOUNTS HAVE BEEN

Supplemental Material: SWBNO Rainfall

RECORD OF PRECIPITATION VARIOUS STATIONS FOR MAY 8, 9 & 10 1995
(Rainfall shown from midnight to midnight for each reading.)

DATE	N.O. WATER PLANT	TU-LANE UNIV.	S&WB	ALG. WATER PLANT	DPS NO. 1	DPS NO. 3	DPS NO. 4	DPS NO. 5	DPS NO. 6	DPS NO. 12	DPS NO. 13	DPS NO. 14	DPS NO. 15	DPS NO. 16.	UNO	AVG.
1																
2																
3																
4																
5																
6																
7																
8	13.94	*	*	8.00	13.80	13.93	14.13	9.37	10.65	11.4	4.58	12.90	8.50	11.57		
9	1.69	20.08	14.36	0.39	.84	1.97	2.87	.60	2.68	.28	.30	2.80	1.45	3.38		
10	1.90	3.97	1.49	1.69	1.84	1.60	2.82	1.87	3.52	⊙	2.32	7.10	5.00	3.92	☆	
11																
TOTAL	17.5	24.1	15.9	10.1	16.48	17.5	19.8	11.8	16.9	11.7	7.2	22.8	15.0	18.9	24.0	
13																
14																
15																
16																
17																
18																
19																
20																
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																
31																
TOT																

* TOTAL FOR TWO DAYS
☆ THREE DAY TOTAL EXCEEDED 24" CAPACITY OF RAIN GAGE
⊙ NOT REPORTED AT THIS TIME

J. S. Parker
5-11-95

NOTE: Penciled-in row labeled "TOTAL" was added to the original document by the authors of this report.