Technical Report III

ASSESSMENT OF THE HURRICANE GUSTAV HYDRODYNAMIC CONDITIONS AND EROSION OF MRGO REACH 2 EBSBs

Report to

Katrina Canal Breaches Consolidated Litigation

[Civil Action Number: 05-4182 "K" (2)]

United States District Court

Eastern District of Louisiana

Pertains to MR-GO, Robinson

[No. 06-2268]

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January 29, 2009

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Introduction

As part of his activities at LSU and in support of information requests from The Louisiana Governor's Office and Louisiana State Police Dr van Heerden ran a series of ADCIRC storm surge model assimilations during the Hurricane Gustav emergency. Immediately prior to landfall this surge model data (www.hurricane.lsu.edu/floodprediction/) suggested that surge elevations along the Reach 2 levees could be as high as 11 feet above sea level.

The state of Louisiana's concern was that the Gustav surge would overwhelm some of the levee systems surrounding greater New Orleans. We feared the same issue but also that the Gustav waves would erode the Reach 2 levees and those facing Lake Borgne along the Citrus Back Levee.

Prior to the storm Dr van Heerden went by boat and videotaped and photographed sections of the MRGO Reach 2, especially along Reach 2. His main concern was the very long sections of this levee that lacked a good grass cover and were covered by vertical erosion rills or runnels generated by rainfall - not a very comfortable situation given the approach of a storm that initial looked like it would make landfall as a category 4 storm with surges up to 20 feet. Immediately after the storm Drs Kemp and van Heerden went by boat to view the Reach 2 and Citrus Back levees to check for any erosion. Significant areas of erosion were found along Reach 2 and were photographed and videotaped. A preliminary assessment of the hydrodynamic conditions during the storm was then undertaken to better understand the levee erosion caused by Gustav.

Gustav Winds

The wind recorder that best captured the conditions along the Reach 2 levees during Gustav was the NOAA gage located at Shell Beach (Figure 1). This recorder reveals that in the vicinity of Reach 2 and Dr Bea's study site the maximum sustained winds were about 52 knots (60 mph) with gusts up to 68 knots (77 mph). The direction during the peak of the storm changed from winds blowing from the east (090 deg) to south east (150 deg). At the peak of the wind event the winds were blowing from ESE or 110 deg. As no wave data are available it is important to know the wind directions and strengths during the storm in our area of interest.

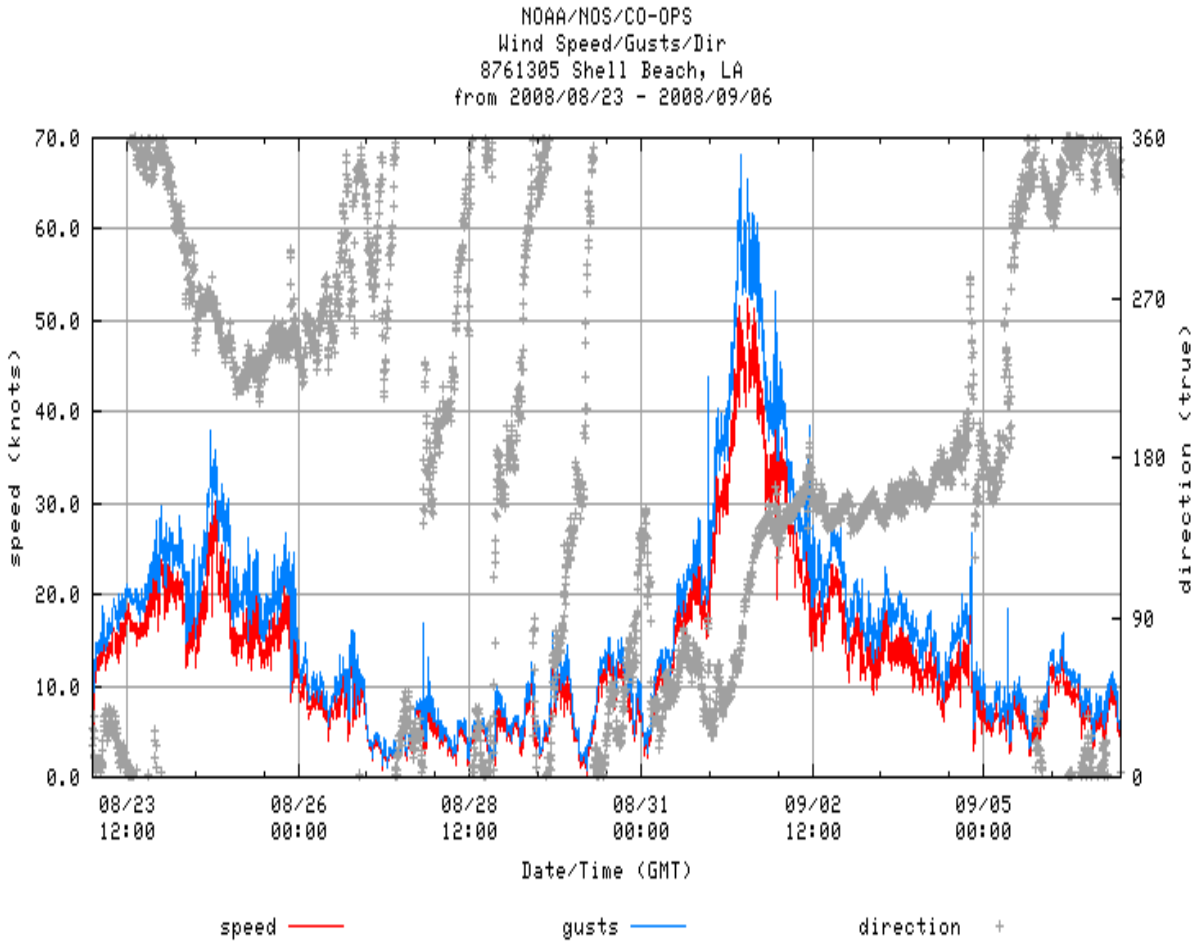


Figure 1: Recorded wind speeds during Hurricane Gustav

Gustav Surge

Figure 2 is a plot of the variation in water level overtime for the NOAA Shell Beach location which is fairly indicative of conditions along Reach 2 of the MRGO. This is based on MLLW. To get to NAVD you need to add 2.71-2.38 = 0.33 ft. Therefore max surge was approximately NAVD88 = 10.8 ft at this station.

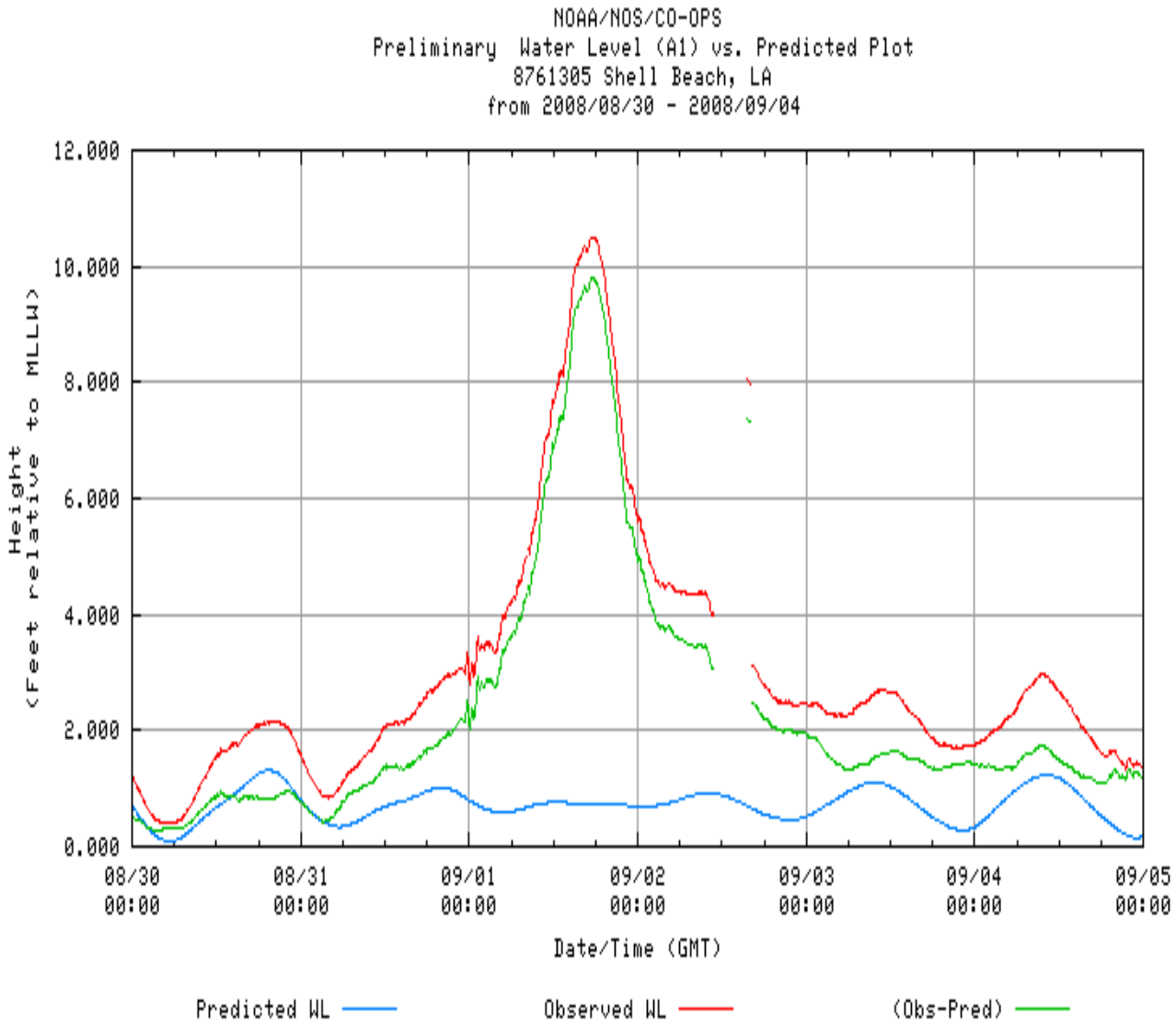


Figure 2. NOAA water level record Shell Beach during Gustav.

Figure 3 was generated from the LSU Hurricane Center's ADCIRC model and represents hindcast hydrographs for 3 locations along Reach 2 of the MRGO. The curve for Bayou Bienvenue would be most representative of the surge conditions at Shell Beach. The data in Figure 3 reveals that the surge at a point halfway between bayou Bienvenue and Bayou Dupree, Dr Bea's study site, would have been about 1.2 ft higher than at Shell Beach, therefore at his site the maximum surge was 12 feet.

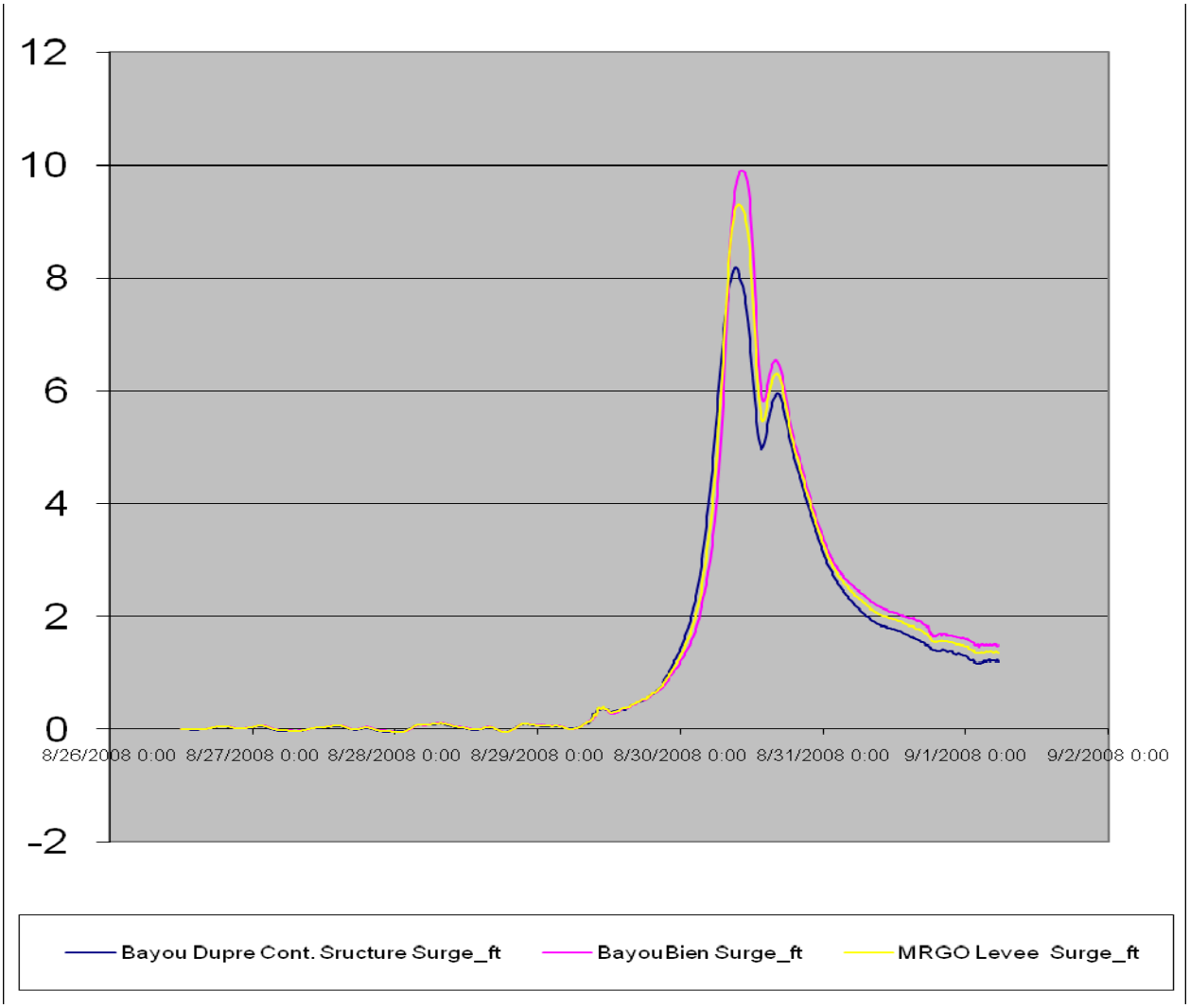


Figure 3. ADCIRC Hindcast of surge conditions along MRGO Reach 2.

Gustav Waves

There is no wave data to be had so one has to deduce the wave regime from available data such as the SWAN data generated by Delft University for the MRGO Litigation Team (Gautier, 2008) and through use of wave/fetch/depth tables as contained in the Shore Protection Manual.

The SWAN data previously generated for the MRGO Litigation Team by scientists and engineers from Delft University in the Netherlands has some applicability in understanding Gustav's waves. Their Scenario 1 reflects conditions on the ground in 2005 which would have not be too different to the present, and the surge level, winds and waves for the time step 04:00am LT (Figure 4, 5, 6 and 7) is a great fit for maximum wind situation and surge elevation in Gustav. Here we see that maximum waves are about 5 feet in MRGO with 3-5 sec period.

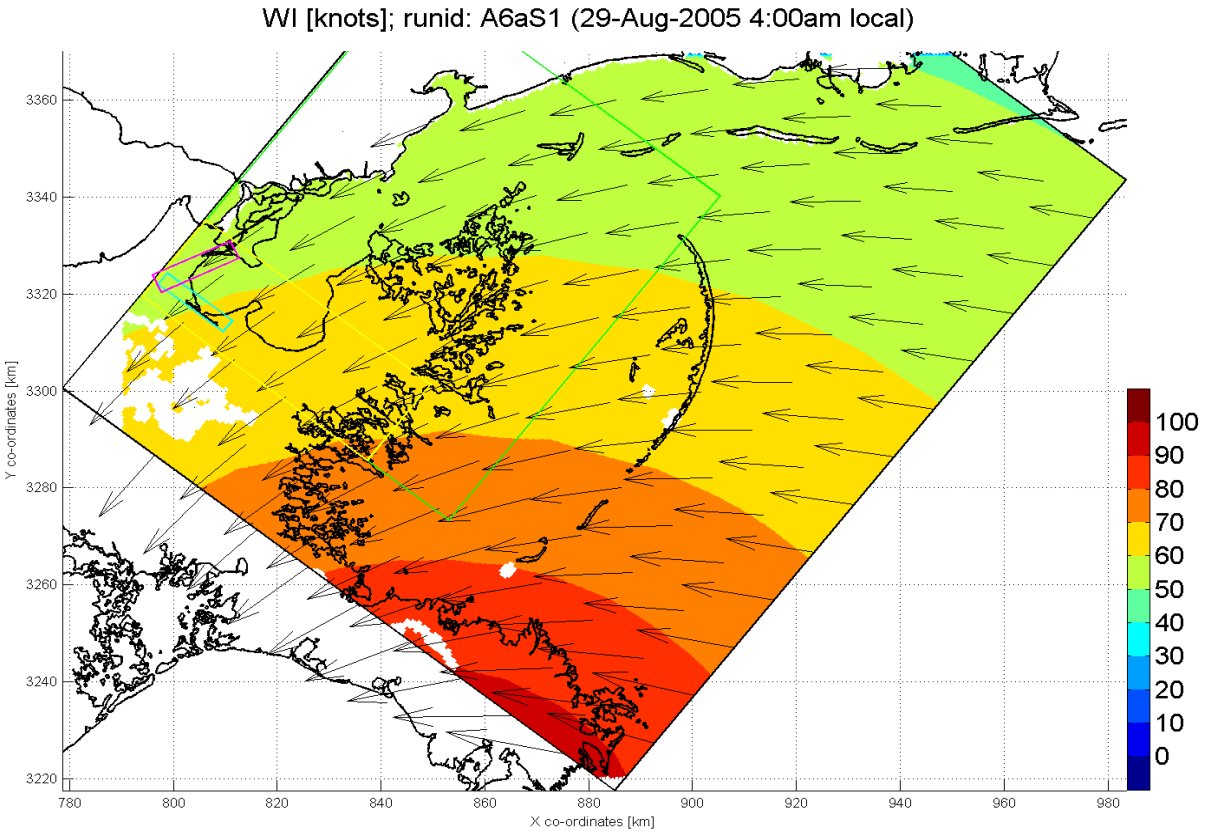


Figure 4. Scenario 1 (Katrina) 04:00am wind in knots

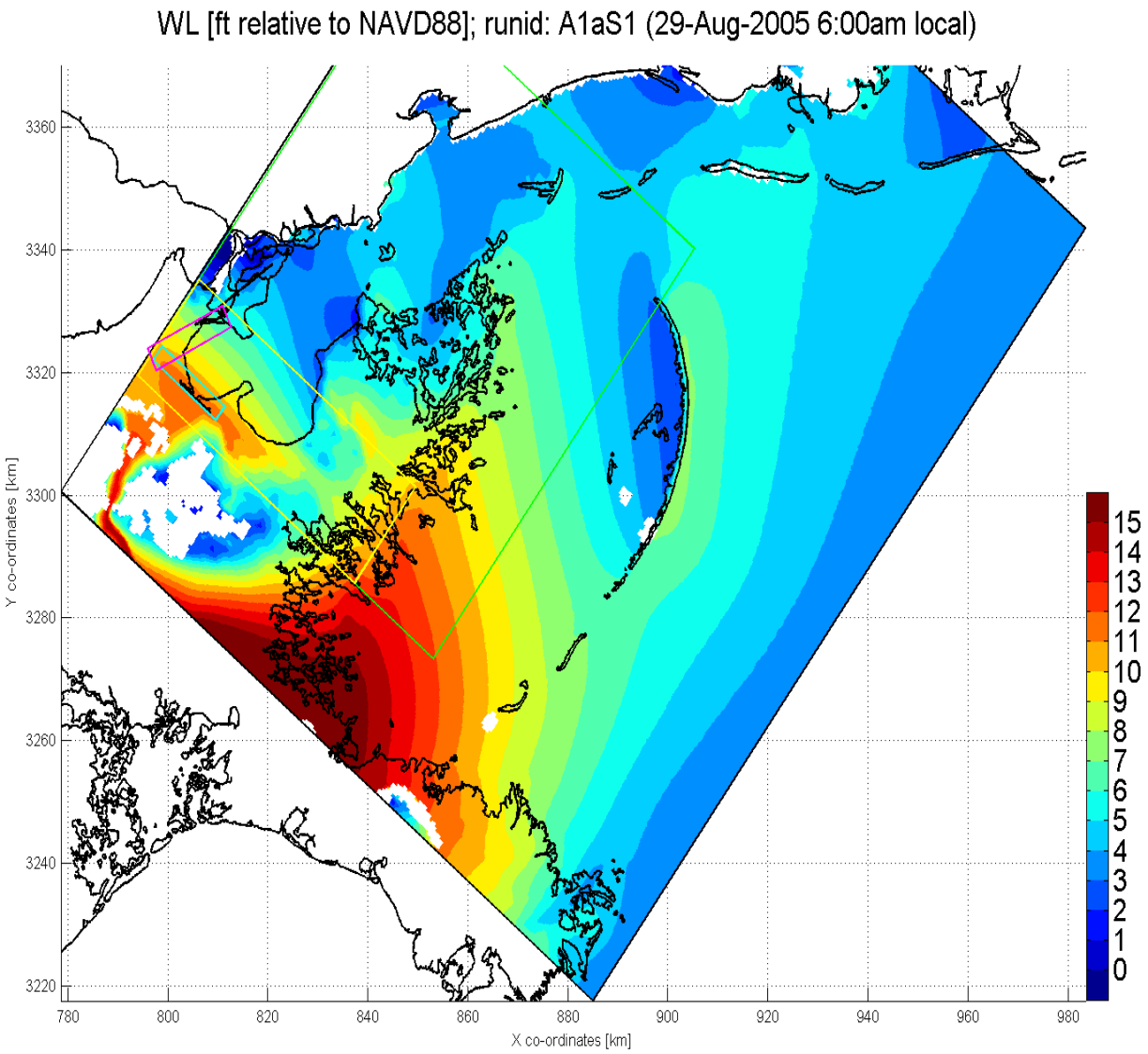


Figure 5. Hurricane Katrina maximum surge elevation (+ feet)

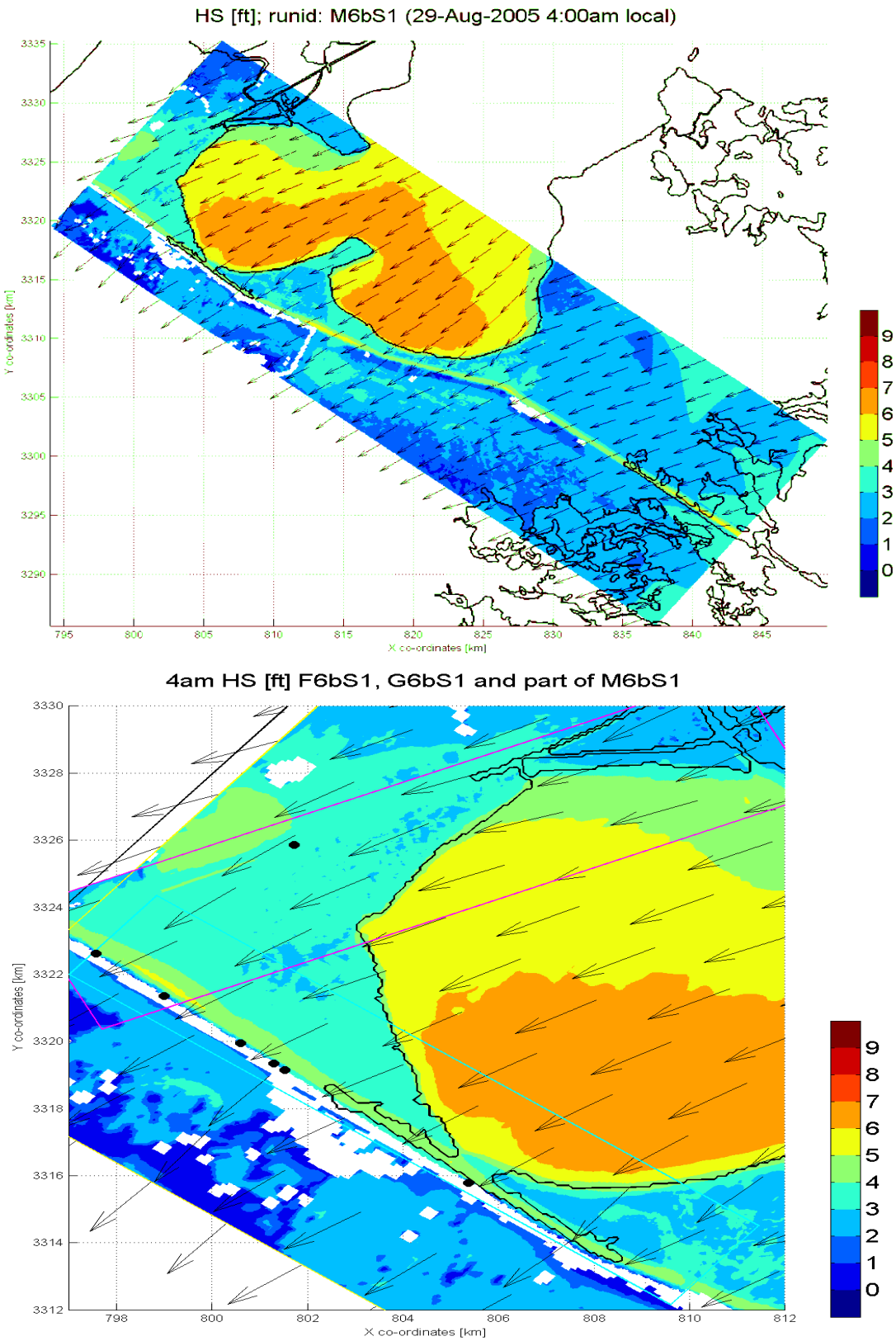


Figure 6. Wave heights (feet)

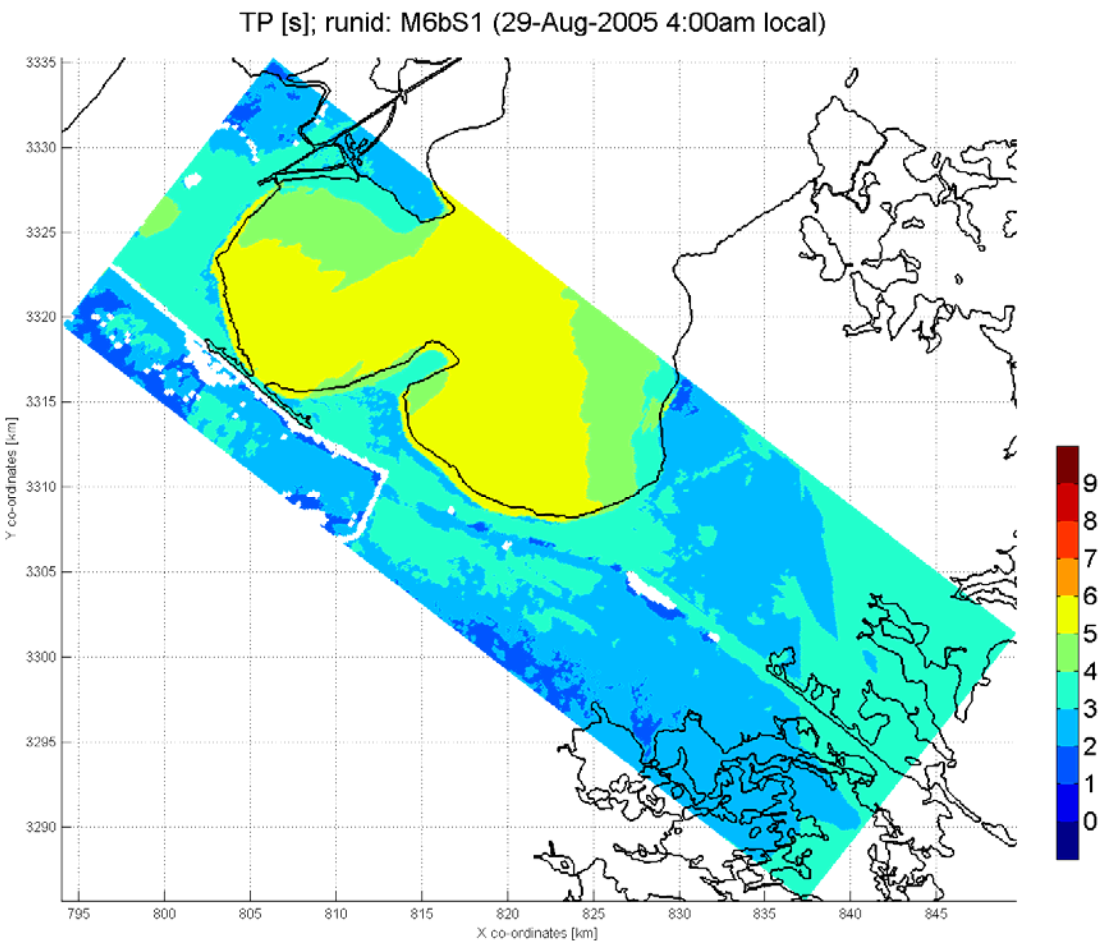


Figure 7. Wave periods (seconds)

Summary of wave data

Combining wave data as interpreted from the US Army Corps of Engineers Shore Protection Manual TR-4 (1966) Figures 1-33 to 1- 42 (pages 57 to 62) and the SWAN data already mentioned allows one to generated a time series of wave heights and directions for the Gustav storm (Table 1).

Table 1. Wave Conditions that are thought to have been present during Hurricane Gustav mid-channel along the MRGO Reach 2.

Time GMT	Wind Speed kn	Wind and wave dir - Degrees from north	Surge ht	Wave ht (Lake Borgne only)	Wt ht (MRGO only)	Wave ht for calculations	Wave Period sec
0h00-9/1	18	035	3.0	2.6	0.75	1.5	4.4
06h00	32	040	4.2	4.4	1.4	3.0	4.8
12h00	45	115	7.8	6.4	2.0	5.1	5.8
18h00	40	140	10.4	6.1	1.8	4.8	5.7
0h00-9/2	34	140	5.7	4.7	1.5	3.2	5.4
06h00	24	160	4.3	3.0	0.9	2.1	4.5

Note: - Wave direction is the same as wind direction.

Dr Kemp generated wave height data from a statistical analysis of the SWAN data from Gautier (2008). The results are summarized in Figure 9. Dr Kemp's data are based on sampling SWAN results on toe and levee positions on 6 wave rays that cross the MRGO EBSBs. All waves either break or otherwise dissipate in less than 2 ft of water (1.97 ft intercept).

If the EBSB toe elevation is at +8, then the maximum depth during Gustav is 3 ft or less, assuming peak surge of +11. According to this regression, the maximum significant wave height - Hs in 3 ft depth is 2.78 ft. So this gives you a maximum bound. If the water depth is 2 ft, Hs is 2.5 ft.

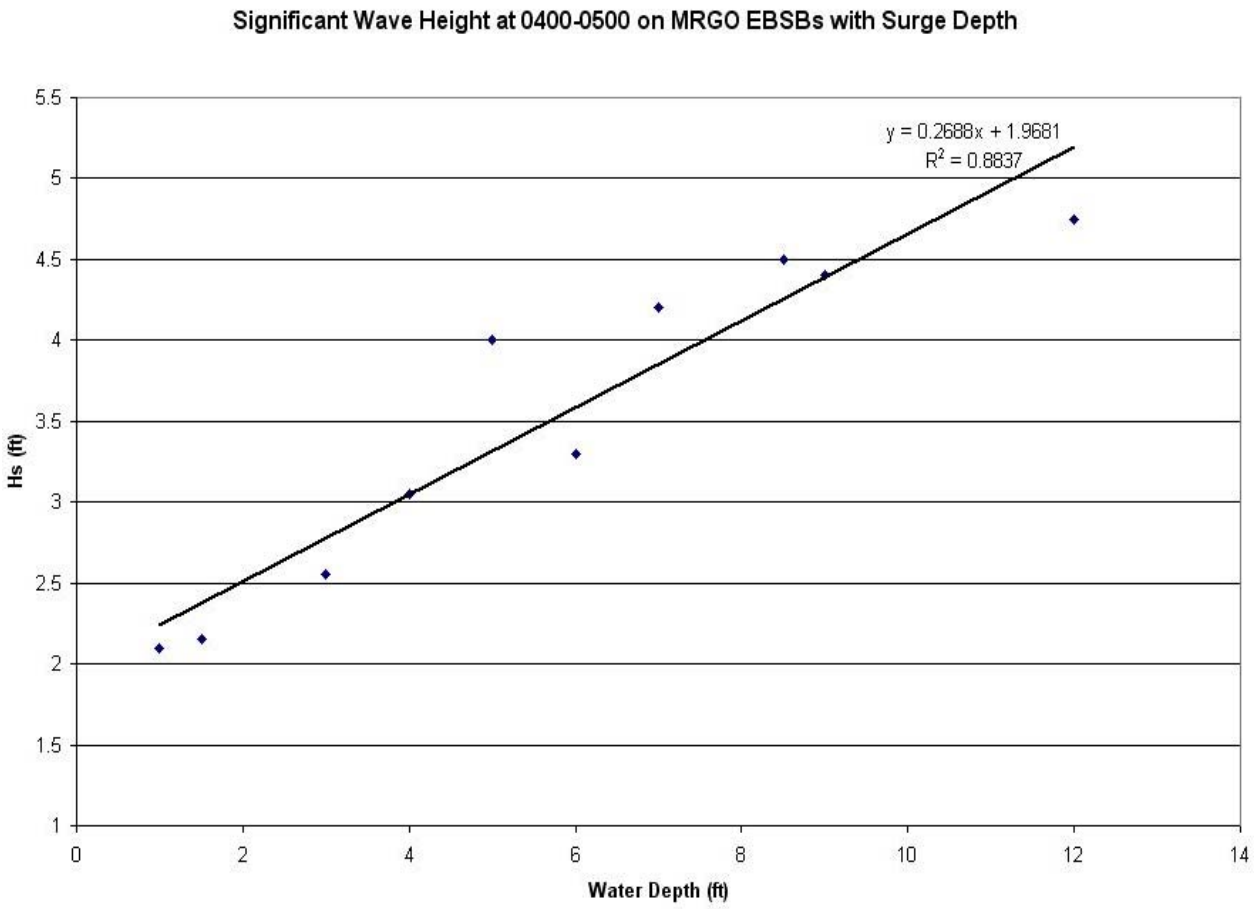


Figure 9. Statistical analysis of SWAN data. y = 0.2688x + 1.9681; R2 = 0.8837

Reach 2 site visit pre Gustav

Figures 9 and 10 were taken two days before Gustav struck of sections of the Reach 2 levees. In some cases the grass cover was not very healthy.



Figure 9. Photograph of section of MRGO Reach 2 levee pre Hurricane Gustav



Figure 10. Photograph of section of MRGO Reach 2 levee pre hurricane Gustav.

Reach 2 site visit post Gustav

Figures 11 and 12 are indicative of wave scour and erosion beneath the wrack along the central section of the MRGO Reach 2 levees. This scour was up to 30 feet wide and in places had scoured down about 9 inches.



Figure 11. Photograph of MRGO Reach 2 levee post Hurricane Katrina showing wave scour at levee toe.



Figure 12. Photograph of MRGO Reach 2 levee post Hurricane Katrina showing wave scour at levee toe.

Conclusions

Even though the wave field during Hurricane Gustav was not well developed and the waves were approaching the levees mostly from the south, there was nevertheless measurable erosion of the toe of the levee

References

Gautier et al, 2008. Wave Modeling New Orleans - Mississippi River Gulf Outlet, Hurricane Katrina August 2005. FINAL REPORT. July 9th, 2008

Shore Protection Manual – TR- 4, 1966. US Army Corps of Engineers.