HMTAP Task Order 18 - Task 4 (Storm Surge Analysis)

Mississippi Coastal Analysis Project

Production Run Report

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The production phase is responsible for conducting Advanced Circulation (ADCIRC) model simulations for each of the 228 storms that were developed as part of the Joint Probability Method-Optimum Sampling (JPM-OS) approach. The basis for selecting 228 storms and the range of storm parameters, track lines, and other relevant storm characteristics are described in the *Main Coastal Documentation Report*. Prior to beginning the production phase, an ADCIRC model grid was generated with approximately 950,000 nodes, and was calibrated to three historic storms, Hurricanes Camille (1969), Betsy (1965), and Katrina (2005) using historic measured high-water marks to guide the ADCIRC model calibration. The details of the mesh generation can be found in the project report *Grid Development Report*. The details of the model calibration and validation can be found in the project report *Calibration and Validation of Model Report*. This calibrated model was used for the production phase. The ADCIRC model simulates the time-dependent surge in response to time varying wind and pressure fields, and wave forces. Each model simulation is used to provide the maximum elevation of the storm surge, referred to as the peak water surface elevation for the associated storm at selected locations of interest throughout the study area. The outputs (peak water surface elevations) from the production phase were then analyzed to develop surge elevations associated with discrete return intervals.

This report documents the work completed to facilitate, implement, and assure the quality assurance/quality control (QA/QC) of the 228 production runs. Storm surge simulations using a large mesh with ADCIRC typically require a massive computing capacity to provide effective simulation times. For this project, the model was implemented on a 256-node, parallel-processing platform. Despite this computation power, typical storm simulations could still take 6 to 8 hours to execute. Thus, for 228 storms, the basic computational time was estimated to be up to 76 days. This estimate does not include “down” time for maintenance, power failures, and other unexpected events. Therefore, any steps that would reduce the computational time for each individual storm could have a significant impact on the production run schedule. Consequently, the first part of the production run phase focused on identifying time-saving options in the production run program. The steps used to facilitate and reduce the storm computational time are discussed in Section 2.0.

Each storm simulation required pre-processing, model execution, and post-processing of numerous input files, many of which are relatively large (up to 200 megabytes). The combined output file size is on the order of 4 gigabytes. The handling of these files through each model simulation is described in Section 3.0. Finally, a detailed QA/QC was developed and implemented to assure quality through every step in the production phase. The QA/QC is described in section 4.0.

In order to facilitate the production run phase and minimize the time for each individual storm simulation, the production run process was analyzed and key aspects of the simulations which might be amenable to optimization were identified. Three attributes of the storm simulations that were identified are:

- Duration of the storm simulation
- The method of including tide phase
- The method of including wave forcing

Each of these is discussed below.

2.1 DURATION OF STORMS SIMULATION

The first analysis was designed to determine the number of days of meteorological forcing prior to storm landfall that was necessary to provide valid surge simulation. By finding the minimum duration required for a valid simulation, the total time required for the production phase could be minimized. The analysis consisted of comparing surge results from a sequence of storm simulations with the identical storm parameters, varying only the length of time before landfall. As a baseline for a typical simulation, the calibration simulations for Katrina comprised a total of 5.5 days, with approximately 4.5 days representing the storm forcing prior to landfall. A total of six simulations were executed for the duration analysis, corresponding to starting the meteorological forcing 0.5, 1.5, 2.5, 3.0, 3.5, and 5.5 days prior to landfall. The Katrina storm was used for the analysis because it was a large, broad storm, and relatively slow moving. Thus, its affect while still offshore would be more pronounced, making the tests more sensitive to such a storm.

Ideally, other storms with a variety of characteristics could be tested. For instance, a faster moving storm could be also tested. However, in other surge sensitivity analyses conducted with the SLOSH model, as part of the JPM-OS development, it was shown that the surges were least sensitive to forward speed. With these results and the use of a more prominent storm (i.e., Katrina), the results of the duration analysis are expected to be robust. Also, as will be shown, a degree of safety was added to the final storm duration to assure sufficient time for storm generation, while still minimizing the total time for the production phase.

Each of the five model simulations required a spin-up period to allow the Mississippi River flow to stabilize. This spin-up period was executed once and used as the starting point for each of the test simulations. The 3.0 period is retained in the time stamp of the model outputs, and therefore the landfall for the 0.5-day scenario corresponds to 3.5 days, and subsequently landfall for the other scenarios occur at 4.5, 5.5, 6.0, 6.5, and 8.5 days.

An example of the results from the five simulations is shown in Figure 2-1. The plot shows the time-dependent hydrograph at a typical point along the Mississippi coastline near Horn Island. The results indicate that these particular point simulations, with meteorological forcing for 2.5 or more days (corresponding to peaks occurring 5.5 days or later in Figure 2-1), are not effected by the starting time. A more detailed summary of the results is available in Appendix A, where it is shown that these results are characteristic and representative of results all along the Mississippi coastline. The results indicate that simulations with forcing 2.5 days prior to landfall yield valid results.

For the production run simulations, the meteorological forcing was used at least 3.5 days prior to landfall (rather than 2.5) to provide assurance that the duration was sufficient.

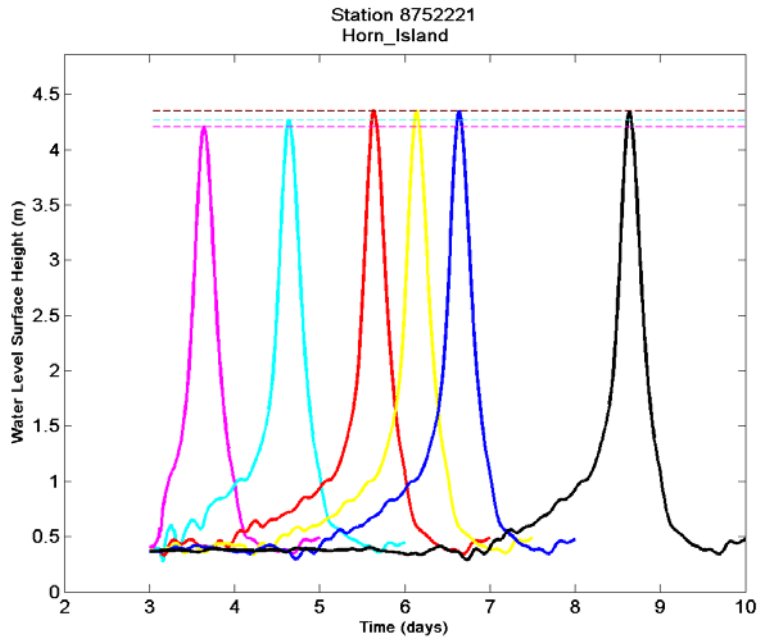


Figure 2-1. Water surface elevation plots from the ADCIRC model output at Horn Island, MS

2.2 INTERACTION OF SURGE AND TIDE

The interaction of the storm surge and the tide is an important consideration in the surge analysis, but the approach used for representing this interaction provides an opportunity to reduce the total number of storm simulations. A formal and rigorous approach for the surge analysis would require each storm simulation to be executed two or more times to account for the randomness associated with the time of storm landfall relative to the tide phase. One storm simulation would be configured so that the storm makes landfall at high tide, and then with the same storm, the simulation would be configured so that the storm would make landfall at low tide. A third simulation may also be warranted, in which the storm makes landfall at mean tide. Thus, a single storm identified in the JPM-OS development would require two or three simulations. This rigorous approach, herein referred to as the "coupled" approach to the surge and tide interaction, includes all potential non-linear coupling between the tide and surge dynamics, but will require two to three times the number of storm simulations. Thus, for 228 JMP-OS storms, 456 to 684 actual simulations may be needed to represent the range of surge results that might actually occur.

The tide range along the Mississippi coast is typically on the order of 1.0 foot. This is a relatively low tidal range and suggests that the non-linear coupling of the surge and tide may be insignificant. This potential provides a basis for reducing the number of storm surge simulations

to the original 228. Thus, if the surge and tide interaction can be shown to be linear, then a single surge simulation can be made for each storm. The effect of the tide can then be superimposed linearly, using a “non-coupled” approach, on the surge results of a single storm to effectively represent any landfall–tide phase condition, thereby eliminating the need for multiple simulations for each JPM-OS storm.

The analysis consisted of comparing surge hydrographs obtained with the “coupled” approach and using the “non-coupled” approach. The comparison was made for two scenarios: one in which the storm made landfall at high tide, and one in which the storm made landfall at low tide. For the “coupled” simulations, the tide was included in the simulation, and the meteorological forcing was synchronized such that the simulated storm landfall occurred at the time of high or low tide. For the “non-coupled” case, only one simulation was made, with no tide and an ambient water level set to mean tide level. Then, the amplitude of the high tide and the low tide were added to the surge simulation results to obtain the estimated surge at high and low tides.

The results for a typical point along the Mississippi coast, near Horn Island, are shown in Figure 2-2. The results for the both the high-tide and low-tide landfall scenarios indicate that the difference between using the coupled approach and the non-coupled approach is insignificant. The differences between the peaks for the point shown in Figure 2-2 is are less than one centimeter. These results are typical for points along the coastline and inland, and demonstrate that, for the simulations of the surges along the Mississippi coastline, there is an insignificant difference between the coupled and non-coupled approach. A detailed description of the coupled and non-coupled comparisons can be found in Appendix B.

The successful comparisons of the coupled and non-coupled methods allow for each of the 228 production run storm simulations to be executed using mean tide conditions, and eliminate the need to make additional simulations for each storm with high-tide and low-tides. In the post-processing of the storm results, the non-coupled method was not applied directly, but rather the randomness associated with the timing of storm landfall and tide phase was added using a generalized, random variable approach that accounted for other random processes. The validity of the random-variable approach for tide phase is still dependent on the demonstration provided above, indicating that the non-linear effects associated with the coupled approach were not significant. Details of the random variable approach for accounting for the tide phase can be found in the project report *Joint Probability Analysis of Hurricane Flood Hazards for Mississippi* and the project report *Main Coastal Documentation Report*.

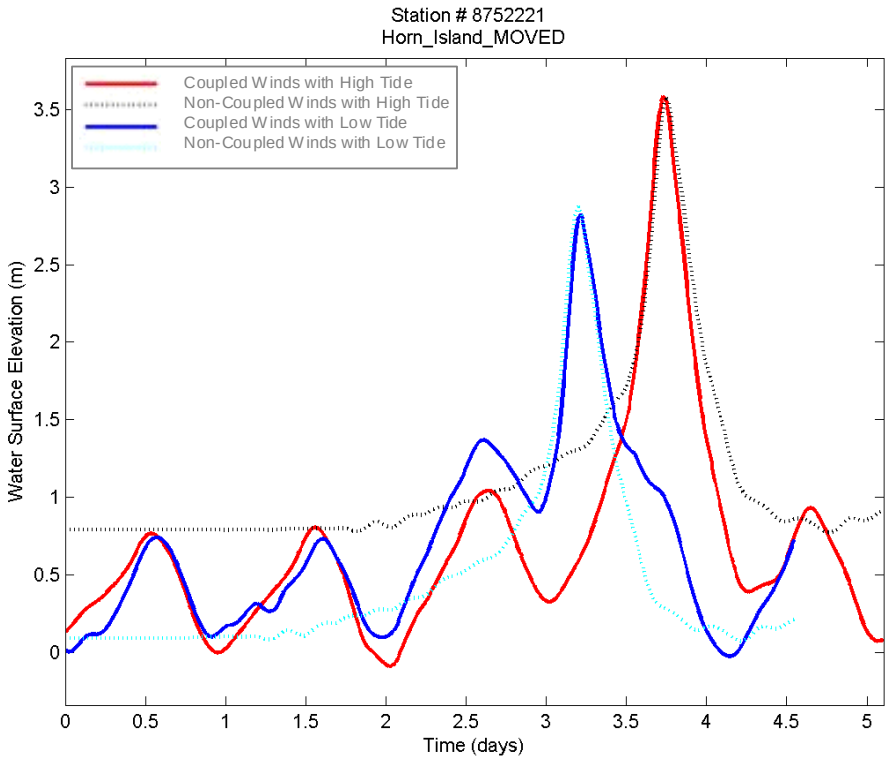


Figure 2-2. Water Levels from Coupled and Non-Coupled Approaches for Horn Island, MS

2.3 WAVE SETUP

Wave setup occurs when wave energy is transferred from the wave motion to the water column. This typically occurs in the surf zone, where the energy of breaking waves is transformed to a body force on the water column directed in the direction of the wave propagation. The body force imposed by the breaking waves, referred to as the wave force, pushes the water onto the beach. This causes the mean water surface to slope upward onto the beach. Eventually, the surface slope becomes sufficiently steep that the offshore-directed hydrostatic pressure gradient associated with the sloping surface balances the wave force. The height of the final setup is dependent on the size of the waves and the steepness of the beach profile. For ambient waves, typically less than a meter in height, the setup along a beach is on the order of a few centimeters. However, during severe storm conditions the setup can be much larger and can potentially contribute to the total surge height.

The interaction of waves and storm surge is dynamically coupled. The wave heights that occur near the shoreline are dependent on the water depth, and during surge conditions, larger waves can propagate to the shoreline. When they break, they create wave forces that add to the surge, increase the water depth, and potentially allow even larger waves to develop.

The ideal approach for modeling the effect of the wave force is a fully-coupled wave and surge model. However, there is currently no coupled model that is suitable for applications in this project. A coupled model is actually available, which consists of running ADCIRC and the steady state spectral wave (STWAVE) iteratively within the Surface Modeling System (SMS) Graphical User Interface, but this model can only be applied on desktop platforms. Furthermore,

the wave model Simulating Waves Nearshore (SWAN) has been selected for simulating wave conditions in this project.

The effect of including wave forces in the surge calculation can be accomplished "manually" by iteratively running ADCIRC and SWAN. The ADCIRC model is used first to estimate the surge elevation with wind forcing only. The estimated water elevations are then used as inputs into the SWAN model and the waves and wave forcing are estimated. The wave forcing is then used in a second ADCIRC simulation along with the wind forcing to estimate a new surge elevation. This iterative process can be repeated until the waves, wave forces, and surge elevation converge. The difficultly with this approach is that it requires numerous ADCIRC simulations of each of the 228 production run simulations. It has been demonstrated that only one iteration is necessary to obtain a valid and converged solution to the coupled wave force-surge simulation (see the project report *Wave Setup Methodology for the FEMA Mississippi Flood Study*). This is due to the relatively small contribution of the wave setup to the total surge height, which is typically on the order of 5 percent of the total surge height for conditions along the Mississippi coastline. Thus, if a second iteration was performed, the ADCIRC simulated surge elevations would be 5 percent higher, and subsequently the wave forces would be 5 percent higher (assuming a relatively linear response for small changes). Then, using wave forces in the third ADCIRC simulation would increase the setup by 5 percent, but 5 percent of a 5 percent term is about 0.25 percent. Thus, a third ADCRIC simulation is expected to only increase the total surge height by 0.25 percent, which is insignificant, and does not warrant another 228 ADCIRC production runs.

Nevertheless, even a single iteration of the wave-surge coupling requires two sets of 228 ADCRIC production simulations, and therefore, would have a significant effect on the project schedule. There is opportunity for further reduction in the computational effort when it is noted that the first ADCIRC surge simulation is required primarily to provide an estimate of the surge elevation to insure that the water depths in the wave simulations are representative of surge conditions. Within this context, any method that provides a sufficiently accurate initial surge elevation is valid. A less computationally intense approach for estimating the initial surge elevation has been developed using a much smaller ADCIRC grid. This grid is comprised of about 60,000 nodes and can run efficiently on a desktop computer. However, the grid does not include representation of the Mississippi topography above mean sea level, and only simulated the surge offshore and up to the coastline. Therefore, additional procedures needed to represent the surge inland of the coastline. The method used was to extend the maximum surge surface from the coastline inland until the surge elevation intersected the topography. The resulting surface was then used in the SWAN wave model to simulate the wave characteristics and wave forcing. The wave forcing file was then used in the final ADCIRC production runs.

This approach provided for a rapid calculation of the wave forces for each of the 228 production run storms that could be completed on a desktop computing platform. Thus, only one set of 228 production runs was required. However, the validity of the approach is based on two basic assumptions: (1) that the 60,000 node ADCIRC simulation could reproduce surges along the coastline sufficiently similar to the 950,000 node ADCIRC simulation, and (2) that the surge surface inland of the coastline is relatively level. Both of these assumptions have been tested and validated. The details of the final approach for calculating the wave forces and documentation of the validity of the assumptions are provided in the project report *Wave Setup Methodology for the FEMA Mississippi Flood Study*. The slope of the surge elevation inland of the Mississippi coastline is demonstrated in Figures 2-3 and 2-4. Figure 2-3 shows two transects for which the

surge for the Katrina simulation, using the 950,000 node ADCIRC model, is plotted. Figure 2-4 shows the actual surge, both offshore and inland of the coastline, for both Transect 1 (Figure 2-4a) and Transect 2 (Figure 2-4b). As the curves indicate, the assumption of a level surface is warranted. A comparison of the simulated and measured surge heights for the 60,000 node mesh simulation of Katrina is shown in Figure 2-5. The corresponding comparison for the Katrina simulation using the 950,000 node, high-resolution mesh is also shown for reference. The plots demonstrate that, although the results using the 60,000 node mesh are not as accurate as those using the high-resolution grid, they are sufficient for providing water depths in the wave modeling for the purpose of estimating the wave forces.

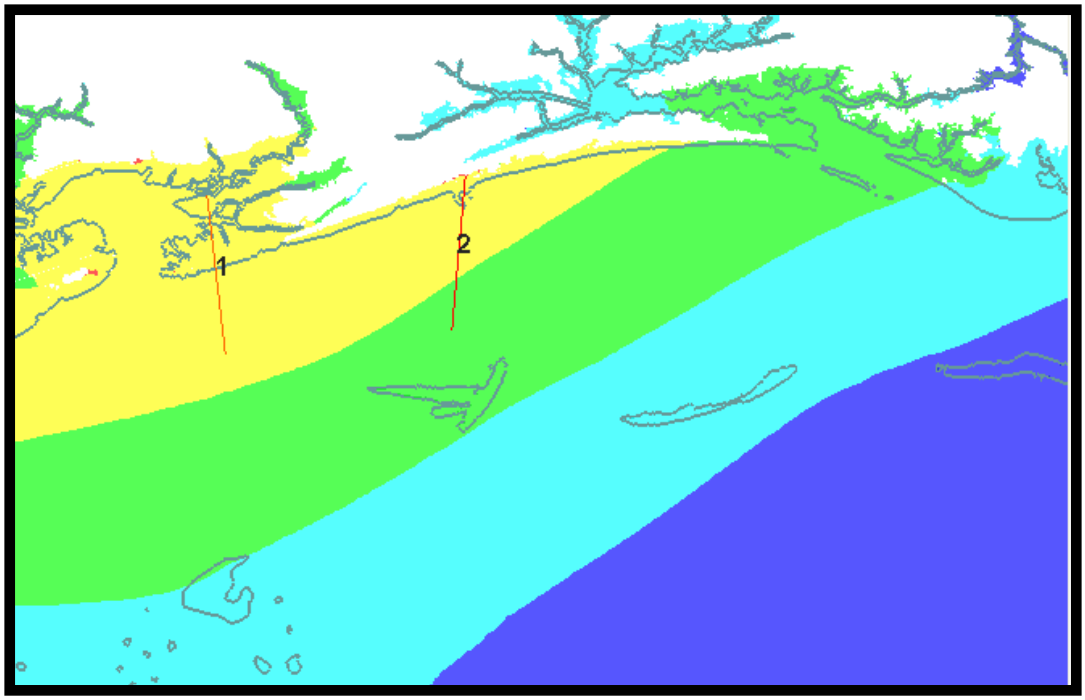
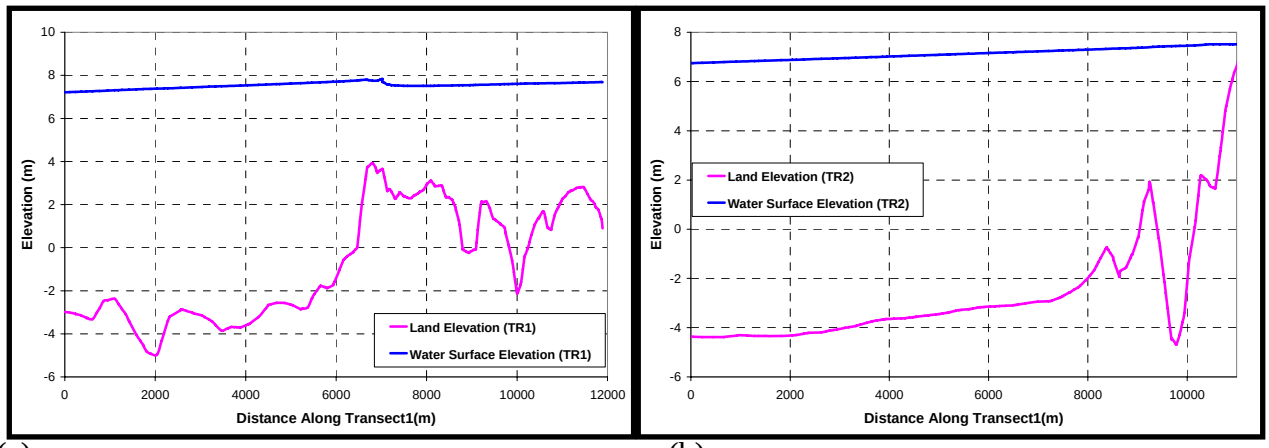


Figure 2-3. Transect Locations for Katrina Simulations.



(a) (b)

Figure 2-4. Water Surface Elevation for Model Simulations. a) Transect 1 b) Transect 2

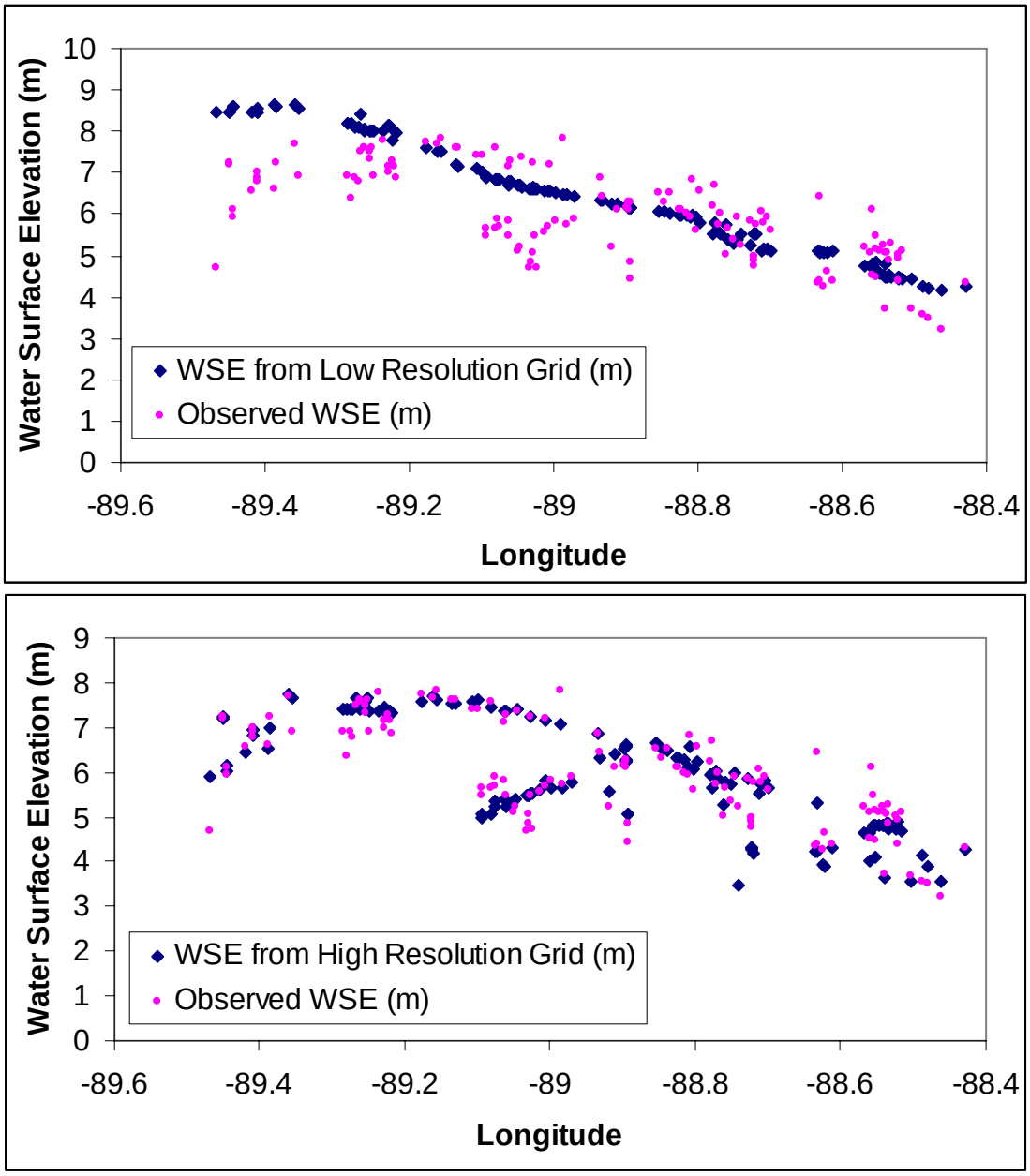


Figure 2-5. A Comparison of the Simulated and Measured Surge Heights for the Low-Resolution 60K Mesh (Top) and the High-Resolution 950K Mesh (Bottom) Katrina Simulations

3.1 PRODUCTION RUNS

The execution of 228 ADCIRC storm simulations required the coordination between the ADCIRC model and its input and output files on two 128-node parallel processing clusters. The files, their pre- and post–processing, and related processing management activities are described in this section.

3.2 ADCIRC MESH

The finite element mesh used for the production runs is described in detail in the project report *Grid Development Report*. Two version of the mesh were developed, one that represented topography and bathymetry prior to Katrina, referred to as MS11g_Pre, and one that represented bathymetry and topography after Katrina, referred to as MS11g_Post. The pre-Katrina mesh was needed for calibrating the ADCIRC model with high water marks for the two earlier hurricanes, Camille and Betsy. The post-Katrina mesh was used for the calibration of the ADCIRC model to Hurricane Katrina. Federal Emergency Management Agency (FEMA) policy is to represent present conditions, so no changes were made to the existing mesh bathymetry and topography in anticipation of barrier island recovery or other post-storm response. The MS11g_Post grid was used for all ADCIRC runs carried out during the production phase of this project.

3.3 ADCIRC CODE VERSION

The ADCIRC model version ADC_46.52_03, which is the same that was used during the calibration and validation phase of the project, was used for all ADCIRC production run simulations.

3.4 CLUSTER DESIGN

A key component of the production run process was the high-performance cluster designed and constructed by the project team, which consisted of 256 IBM Levnovo 32-bit processors. The processors were divided into two 128-node systems, called Medusa and Poseidon. Each system had a front-end node that handles I/O operations. The front end nodes were connected to a Lenox workstation comprised of a 64-bit processor and approximately 500 gigabytes of storage, called Pegasus. All of the input and output file pre- and post-processing and the transfer of files into the system were managed on Pegasus. The large output files generated by the model were downloaded from Pegasus to external hard-drives and distributed for additional post-processing, QA/QC, and archiving. For extraction of the large output files, the data were transferred to an external hard drive connected to Pegasus. Details of the cluster and its operation can be found at http://medusa.ursdcmetro.com.

The division of the cluster into two 128-processor systems provided two general benefits. First, if a particular processor failed; only one simulation would be jeopardized, while the other simulation would finish successfully. Also, after some benchmark testing of simulation times, it was found that two simulation running separately on two 128-node systems executed approximately 20 percent faster than running the same two simulations serially on one 256-node system. This benefit was due to the input/output demands associated with information transfer between nodes.

3.5 STORM SELECTION

During the production phase, a representative population of hypothetical storm tracks and parameters specific to the Mississippi coast were identified through a series of rigorous studies. The details of these studies are provided in the project reports *Main Coastal Documentation Report* and *Joint Probability Analysis of Hurricane Flood Hazards for Mississippi*. The analysis, referred to as JPM-OS, was designed to provide a minimum set of storms but yield stable statistical estimates of surge levels. The methods, when applied to the Mississippi coastline, yielded 228 individual storms. Details of the JPM-OS method, testing, and application can be found in the referenced reports.

The 228 individual storms were divided into two sets to help meet the project schedule. The first set, referred to as the "greater" storms, consisted of storms that were expected to influence the surge elevations at a 1 percent probability of occurrence (i.e., the 100-year event). The surge levels associates with the 100-year event are the basis for the FEMA flood map designations, and therefore were needed for a significant amount of the map generation procedures. The greater storm set consisted of 152 storms, and by executing these storm simulations first, estimates of the 100-year surge levels could be made before the complete production run sequence was completed. The second set of storms, referred to as the "lesser" storms, consisted of 76 additional storms that were required to make estimates of the 2 percent and 10 percent (i.e., 50-year and 10-year) events.

The greater storms consisted of 19 individual sets of storm parameters. The storm tracks were distributed along the Louisiana, Mississippi, and Alabama coastline, with track spacing related to the storms radius to maximum wind. The total tracks for each storm varied between 3 and 14, and yielded a total of 152 storms. The parameter values for the 19 storms are listed in Table 3-2. The set of 152 storm tracks are shown in Figure 3-1.

The lesser storms consisted of 13 individual sets of storm parameters. The storm tracks were distributed along the Louisiana, Mississippi, and Alabama coastline, with track spacing related to the storms radius to maximum wind. The total tracks for each storm varied between 2 and 9, and yielded a total of 76 storms. The parameter values for the 13 storms are listed in Table 3-2. The set of 76 storm tracks are shown in Figure 3-1.

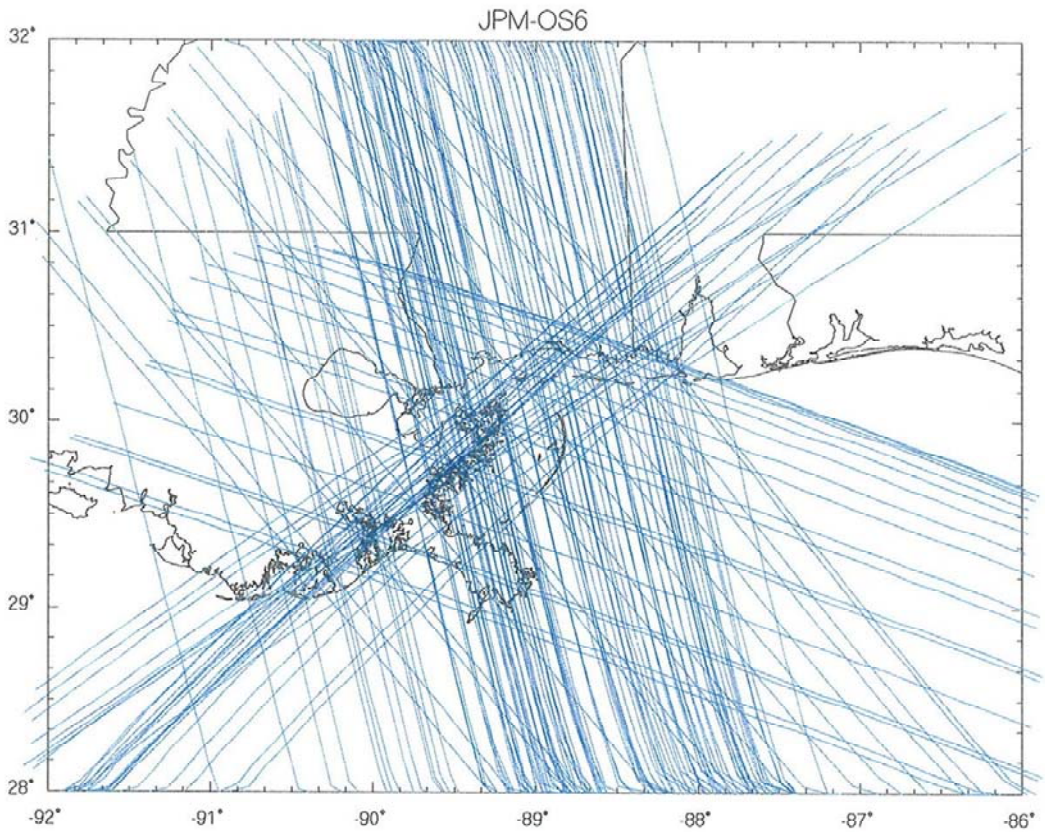


Figure 3-1. Track Paths for the 152 Greater Storm Set

Table 3-1. Summary of Greater Storms

StormID (OWI notation)	dp(mb;coast)	Rp(nmi;offshore)	Vf(m/s)	theta(deg)	Prob.	Annual Rate (each JOS6###% track)
JOS6001%	66.69	18.61	6.047	-38.91	1.33E-01	1.32E-03
JOS6002%	57.17	39.82	6.047	-13.49	1.20E-01	2.55E-03
JOS6003%	49.72	22.93	6.047	-38.92	1.33E-01	1.63E-03
JOS6004%	57.17	10.83	6.047	-13.49	1.20E-01	6.94E-04
JOS6005%	57.17	20.77	6.047	56.66	1.08E-01	1.19E-03
JOS6006%	92.95	14.7	5.943	-12.81	3.42E-02	2.68E-04
JOS6007%	78.59	30.8	6.014	-12.82	5.34E-02	8.77E-04
JOS6008%	78.59	16.56	4.349	47.33	4.20E-02	3.71E-04
JOS6009%	78.59	8.904	6.014	-12.82	5.34E-02	2.54E-04
JOS6010%	78.59	16.56	14.54	-12.86	3.49E-02	3.08E-04
JOS6011%	70.02	17.98	5.943	-12.82	3.42E-02	3.28E-04
JOS6012%	78.59	16.56	4.346	-71.04	4.20E-02	3.71E-04
JOS6013%	128.7	11.66	5.943	-12.81	1.06E-02	6.58E-05
JOS6014%	103.7	25.3	6.014	-12.82	1.65E-02	2.23E-04
JOS6015%	103.7	13.6	4.349	47.33	1.30E-02	9.44E-05
JOS6016%	103.7	7.313	6.014	-12.82	1.65E-02	6.44E-05
JOS6017%	103.7	13.6	14.54	-12.86	1.08E-02	7.83E-05
JOS6018%	94.47	14.53	5.943	-12.82	1.06E-02	8.20E-05
JOS6019%	103.7	13.6	4.346	-71.04	1.30E-02	9.43E-05

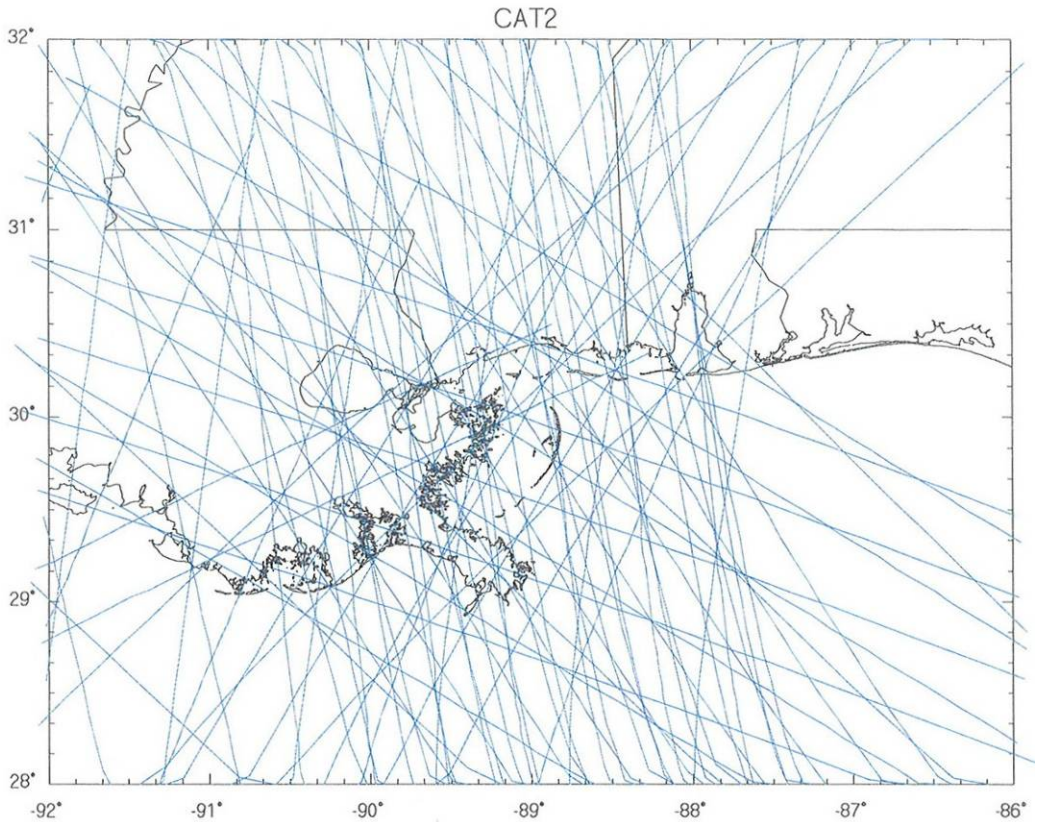


Figure 3-2: Track Paths for the 76 Lesser Storm Set

Two different naming conventions were used for the storms sets. The naming convention was JOS###% for greater storms and CAT###% for lesser storms, where ### is the reference storm number and % is a character (A-Z) representing shifted tracks from west (A) to east (Z), where the number of shifted tracks varies from storm to storm (Ref: *Hindcast Wind and Wave in Support of URS FEMA Mississippi Coastal Flood Map Update*, Ocean Weather, Inc. [OWI] Report).

Table 3-2. Summary of Lesser Storms

REI name	StormID (OWI notation)	dp(mb;coast)	Rp(nmi;offshore)	Vf(m/s)	theta(deg)	Prob.	Annual Rate (each *% track)
JPM-CAT2001	*001%	46.38	41.59	5.416	8.758	7.29E-02	1.80E-03
JPM-CAT2002	*002%	37.75	53.63	2.995	23.55	6.45E-02	2.05E-03
JPM-CAT2003	*003%	44.28	21.64	3.4	63.87	7.18E-02	9.23E-04
JPM-CAT2004	*004%	40.71	12.72	4.931	-9.324	9.11E-02	6.88E-04
JPM-CAT2005	*005%	31.78	44.24	4.881	-11.27	6.85E-02	1.80E-03
JPM-CAT2006	*006%	32.11	17.19	6.096	31.22	4.98E-02	5.08E-04
JPM-CAT2007	*007%	34.67	24.32	6.941	-71.07	7.55E-02	1.09E-03
JPM-CAT2008	*008%	47.53	16.94	4.378	-31.63	5.07E-02	5.10E-04
JPM-CAT2009	*009%	42.09	27.82	3.71	-59.19	1.18E-01	1.95E-03
JPM-CAT2010	*010%	34.67	24.31	2.458	-5.25	7.55E-02	1.09E-03
JPM-CAT2011	*011%	44.28	21.64	10.5	-13.83	7.18E-02	9.23E-04
JPM-CAT2012	*012%	37.75	53.63	7.894	-45.75	6.45E-02	2.05E-03
JPM-CAT2013	*013%	37.04	29.79	6.644	46.64	1.26E-01	2.22E-03

3.6 SURGE OBSERVATION LOCATIONS

The maximum surge elevations for each storm simulation were recorded at discrete points throughout the Mississippi coastal zone. The points were selected by merging points created using two approaches. First, a relatively uniform mesh was generated with nodal spacing about 500 meters. The nodal locations, which did not necessarily correspond to node locations in the ADCIRC mesh, were used for the output points. This mesh was intended to provide broad coverage over the Mississippi inland areas and coastal regions. A second set of output points were identified in all inland bays, estuaries, and major rivers and streams. These points were used to provide sufficient coverage along the coastlines and shorelines of inland water bodies. The two data sets were merged, and any time one of the points from the broad coverage was within 20 meters of the second set of points, it was removed from the set. This processes yielded 7,898 output points. Locations of the Joint Probability Method (JPM) points for Hancock, Harrison, and Jackson Counties are shown in Figures 3-3a, 3-3b, and 3-3c, respectively.

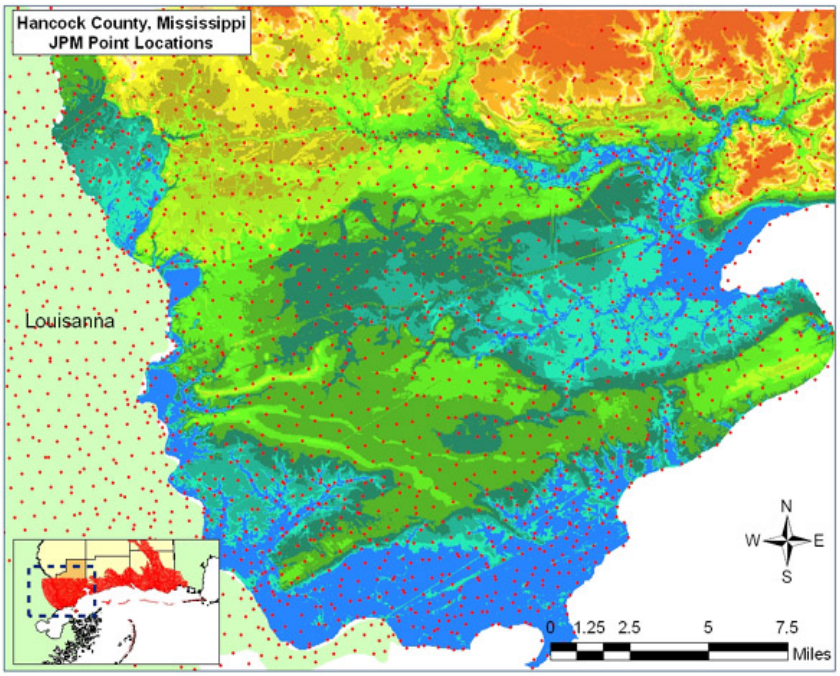


Figure 3-3a. Location of JPM Points in Hancock County and Border

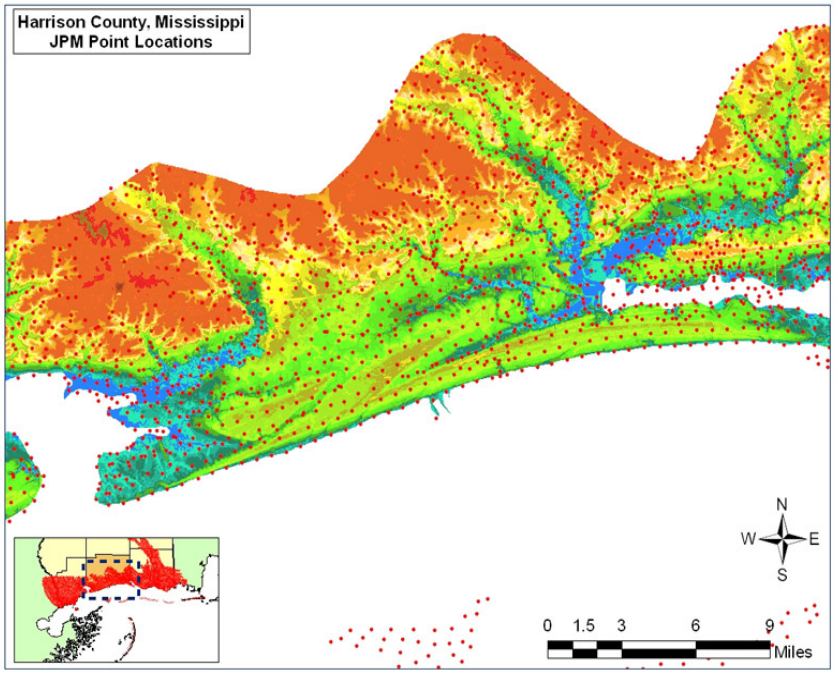


Figure 3-3b. Location of JPM Points in Harrison County

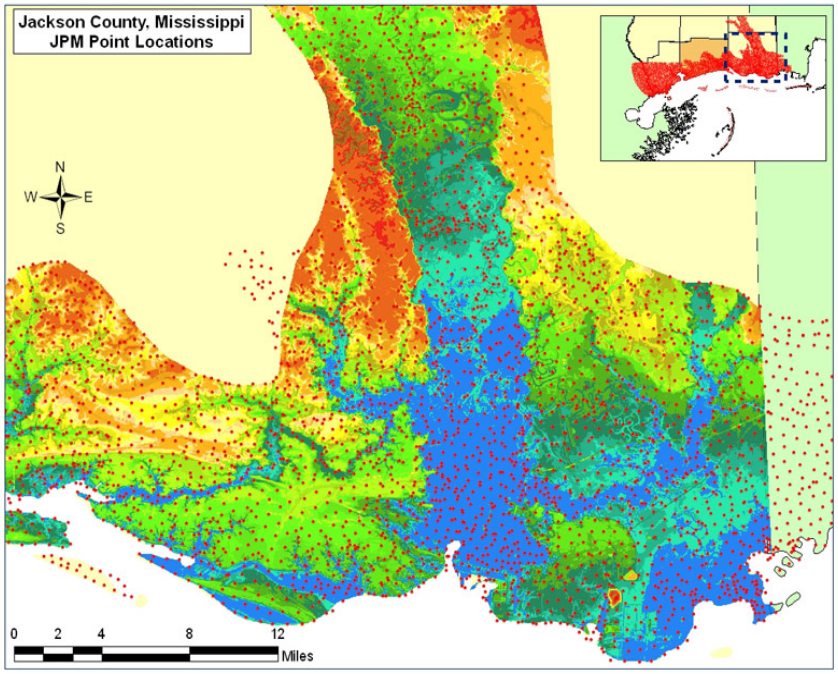


Figure 3-3c. Location of JPM Points in Jackson County

3.7 PRODUCTION RUN FILE HANDLING AND PROCESSING

There are numerous input files and output files required for each simulation. The files and related processing are described below for one simulation. The processing was repeated 228 times, for each of the 228 JPM-OS storms.

- The Wind/Pressure and Wave Spectra files for the storm were generated by OWI and transferred via DVD to the contractors.
- The Wind/Press and Wave Radiation Stress files were then transferred via DVD to the party responsible for QA/QC of all model input files.
- The Wind/Pressure data Wave Radiation Stress files were transferred to the Pegasus via ftp and SCP (secure copy) utilities.
- Wave Radiation Stresses were further corrected to include vegetation effects.
- Static input files and variable input files were combined in one directory and preprocessed on Pegasus.
- The preprocessed input files were transferred to Medusa or Poseidon to be run.
- At the completion of the ADCIRC model run, the output files were post-processed and transferred to the external hard drive connected to Pegasus.
- The external hard dive was disconnected from the system, and the output files were copied onto a local area network storage area.
- The output files were also sent on the hard drive to the party conducting the QA/QC of the output.

Further details of the file processing are provided in block flow diagrams in Appendix C.

3.7.1 ADCIRC Static Input Files

Several input files used with the ADCIRC model simulations were identical for all 228 simulations. These files include the grid file (fort.14), the parameter input file (fort.13), and the model control file (fort.15).

The ADCIRC model grid file (fort.14) was designed during the calibration and validation phase of the project. The same model grid was used for these production runs, as explained in section 3.2. Details of the design and quality control of this grid can be found in the *ADCRIC Grid Development* report.

The parameter input file (fort.13) contains information about the following model parameters: (1) primitive weighting in the continuity equation, (2) Manning's n value at the sea floor, (3) surface submergence state, (4) surface canopy coefficients, (5) surface directional effective roughness length, and (6) sea surface height above geoid. Details on the physical meaning of these parameters, as well as descriptions of the specific values used for this modeling project, are discussed in the ADCIRC Grid Development report.

The model control file (fort.15) lists many of the basic parameters used to control the ADCRIC model simulation. Table 3-3 lists the parameter names, descriptions, and values used for all the production runs.

Table 3-3. Parameter name, description, and value for the ADCIRC fort.15 file used for all model runs.

PARAMETER NAME	PARAMETER DESCRIPTION	PARAMETER VALUE	PARAMETER JUSTIFICAITON
ICS	Parameter controlling whether the model is run in (1) spherical or (2) Cartesian coordinates.	2	Standard recommended value.
NOLIBF	Parameter controlling the type of bottom stress parameterization: (0) linear, (1) quadratic, or (2) hybrid nonlinear.	1	Quadratic parameterization is required for the use of the “mannings_n_at_sea_floor” parameter in the fort.13 file.
NOLIFA	Parameter controlling the finite amplitude terms: (0) finite amplitude terms are not included, (1) finite amplitude terms are included but wetting and drying of elements is disabled, or (2) finite amplitude terms are included and wetting and drying of elements is enabled.	2	Standard recommended value.
NOLICA	Parameter controlling the advective terms (with the exception of the time derivative portion that occurs in the GWCE form of the continuity equation): (0) advective terms are not included, or (1) advective terms are included.	0	The advective terms were not included to provide additional model stability.
NOLICAT	Parameter controlling the time derivative portion of the advective terms that occurs in the GWCE form of the continuity equation: (0) time derivative portion of the advective terms that occur in the GWCE continuity equation are not included, or (1) time derivative portion of the advective terms that occur in the GWCE continuity equation are included.	0	The advective terms were not included to provide additional model stability.
NWP	Number of nodal attributes used in the run (described in the fort.13 input file).	6	The six parameters in the fort.13 file are **described in the separate parameterization report (submitted separately).**
NCOR	Parameter controlling whether the Coriolis parameter: (0) read in a spatially constant Coriolis parameter, or (1) compute a spatially variable Coriolis parameter.	1	Standard recommended value.
DT	Time step (in seconds).	1.0	The timestep is Courant Number limited and based on the smallest element size in the model grid.
WTIMINC, RSTIMINC	Time interval (in seconds) between successive meteorological wind forcing and wave radiation stress forcing.	900, 1800	This is based on the wind and radiation stress input files.

Table 3-3. Parameter name, description, and value for the ADCIRC fort.15 file used for all model runs.

PARAMETER NAME	PARAMETER DESCRIPTION	PARAMETER VALUE	PARAMETER JUSTIFICAITON
RNDAY	Total length of model simulation (days)	6.5	3.0 days of setup time and then 3.5 days of run time with wind and radiation stress forcing.
DRAMP, DRampExtFlux, FluxSettlingTime	Ramp function applied to ADCIRC forcings (in decimal days), ramp function for nonzero external flux boundary conditions (in decimal days), and the time for the river flux boundary condition and river bottom friction to equilibrate (in decimal days).	0.5, 0.5, 2.0	Based on previous studies, 2.0 days is needed to stabilize the Mississippi River boundary.
A00, B00, C00	Time weighting factors at time levels k+1, k, and k-1 in the GWCE.	0.35, 0.30, 0.35	Standard recommended value.
H0, NODEDRYMIN, NODEWETMIN, VELMIN	(for NOLIFA=2): Nominal water depth for a node to be considered dry (in meters), minimum number of time steps after a node dries that it must remain dry before it can wet again, minimum number of time steps after a node wets that it must remain wet before it can dry again, and minimum velocity for wetting (in meters per second).	0.10, 0.0, 0.0, 0.10	Standard recommended value.
SLAMO, SFEAO	Longitude and latitude on which the CPP coordinate projection is centered.	265.5, 29.0	This is the approximate center of the model grid.
ESLM	Spatially constant horizontal eddy viscosity for the momentum equations.	50.0	This value of horizontal eddy viscosity matches that used in previous storm surge studies with ADCIRC.
ANGIN	Minimum angle for tangential flow.	110	Standard recommended value.
ITITER, ISLDIA, CONVCR, ITMAX	Parameters that provide information about the solver that will be used for the GWCE: ITIER = 1 – JCG solver (from ITPACKV 2D), ISLDIA = 0 = fatal error messages only from ITPACKV 2D, CONVCR = absolute convergence criteria, ITMAX = maximum number of iterations each time step.	1, 0, 1.0E-7, 25	Standard recommended value.

The parameter descriptions are from the ADCIRC manual, available at the Web site: http://adcirc.org/documentv46/fort_15.html. The standard recommended values, when used, were obtained from the online ADCIRC user's manual. The justifications for the other parameter values are provided in the table. As explained in Section 2.2, no tides were used in the production runs, so no open boundary forcing by tides was required.

3.7.2 ADCIRC Variable Input Files

The remaining input files varied for each storm simulation. They include the files containing the time-dependent wind, pressure, and radiation stress forces. Each of these files is described below.

3.7.2.1 Meteorological Forcing Files from OWI

OWI provided multiple sets of pressure and wind files for each storm simulation. A file with the extension ".pre" contained atmospheric pressure fields, whereas a file with extension ".win" contained wind velocity fields. The first set of files had a relatively coarse resolution, and covered the entire Gulf of Mexico basin. The second set of files were provided which covered a smaller area, referred to as regional scale, and provided more detailed pressure and wind inputs along the general vicinity of the storm track. In ADCIRC, these files were activated through the NWSET parameter, which controls the number of sets of atmospheric pressure files and wind velocity files used by the model. OWI also provided the Wave Spectra files to Slinn Engineering for use as boundary conditions for input to the SWAN wave model at the offshore boundary.

3.7.2.2 Radiation Stress Forcing Files from Slinn Engineering

Wave forcing files for each storm were provided for each storm by Slinn Engineering. The wave forcing files, which contain the radiation stress gradients, were developed using the procedure summarized in Section 2.3. The files were supplied as a boundary input file (fort.23) to the ADCIRC model.

However, prior to use in each storm simulation, the wave forcing input files were modified to account for vegetation effects. The adjustments were required to account for wave dissipation due to vegetation that was not directly accounted for by the SWAN model. The vegetation effect and a procedure for accounting for it are addressed in a project white paper by R. Dean (*Wave set-up: A White Paper with Emphasis to Application of the Mississippi Coastline*).

The procedure requires information about the vegetation across the coastal region of Mississippi. U.S. Geological Survey (USGS) land use data and vegetation data from the Gap Analysis Program (GAP) were compiled by Ayres and Assoc. and used to estimate vegetation heights at each of the ADCIRC mesh nodes. The details of this procedure can be found in the project report *Summary of Work Performed by Ayres and Associates in Support of URS Storm Surge Modeling for FEMA, Region 4.* An example of the data is shown in Figure 3-4. The method also requires the water surface elevation during the storm simulation. Since the surge elevation is calculated during the simulation, the elevations are not known a-priori. As an approximation to the simulated surge elevations, the surge elevations developed using the 60,000 node ADCIRC simulation with inland extrapolation were used for making the wave force adjustments. These were the same data used in generating the original (unadjusted) wave forces.

The wave forcing adjustment procedure was automated in a Formula Translation (FORTRAN) code which applied the adjustment to the input wave forcing files. The input files contained the wave force value for each ADCIRC node at 30-minute intervals. For each interval, the water elevation from the 60,000 node simulation at the corresponding time was compared to the vegetation height at the node. If the vegetation was flooded but not overtopped, a reduction factor of 1/3 was applied to the wave force. This value of the reduction factor was used to account for the variability in real wave heights and shapes along with local variability in the height of the vegetation. The original wave force input file was then replaced with one containing the adjustments.

3.7.3 ADCIRC Output Files

For each ADCIRC model run, the following output files were collected and archived.

- Elevation time series at specified elevation recording stations (fort.61). The water surface elevation was recorded at all 7,898 JPM point locations every 15 minutes from day 3.0 (at the start of the wind, pressure, and radiation stress inputs) until the completion of the run, typically at day 6.5. Depending on the forward speed of the individual storms, the duration of the run varied slightly.
- Elevation time series at all nodes in the model grid (fort.63). The water surface elevation was recorded at all nodes in the grid every 30 minutes from day 4.25 to day 6.5.
- Atmospheric pressure time series at specified meteorological recording stations (fort.71). The atmospheric pressure time series was recorded at all 7,898 JPM point locations every 15 minutes from day 3.0 (at the start of the wind, pressure, and radiation stress inputs) until the completion of the run at day 6.5.
- Wind velocity time series at specified meteorological recording stations (fort.72). The wind velocity time series was recorded at all 7,898 JPM point locations every 15 minutes from day 3.0 (at the start of the wind, pressure, and radiation stress inputs) until the completion of the run at day 6.5.
- Maximum water surface elevation at all nodes in the model grid (maxele.63). The program recorded the maximum water surface elevation at every time step throughout the run, and produced this file at the end of the model simulation.
- Maximum water surface velocity at all nodes in the model grid (maxvele.63). The program recorded the maximum water surface velocity at every time step throughout the run, and produced this file at the end of the model simulation.
- Maximum wind velocity at all nodes in the model grid (maxwvele.63). The program recorded the maximum wind velocity at every time step throughout the run, and produced this file after the last model time.
- Maximum radiation stress at all nodes in the model grid (maxrs.63). The program recorded the maximum radiation stress at every time step throughout the run, and produced this file after the last model time.

- Minimum pressure at all nodes in the model grid (minpr.63). The program recorded the minimum pressure at every time step throughout the run, and produced this file after the last model time.

The ADCIRC production run phase included an extensive QA/QC process. The basic QA/QC process involved checking all model input files for accuracy and consistency, and then assessing all model output files for stability and acceptability. The QA/QC team consisted of consultants and individual experts from URS, Dewberry, Watershed Concepts, OWI, and Slinn Engineering.

The project team developed QA/QC forms to standardize the methods for determining and reporting QA/QC events. After the review was complete, the reviewer filled out the appropriate form and submitted it to the data originator for issue resolution. The issues were investigated by the originator of the file and resolved. The issues were rechecked to confirm resolution. Details of the production run QA/QC process are described in the following sections. A block diagram of the QA/QC processes with responsible parties is attached in Appendix C.

4.1 INPUT FILE QA/QC (FORM #1)

OWI and Slinn Engineering developed the meteorological and radiation force inputs respectively. The project team needed to comply with FEMA guidelines, and therefore cross-checked the input data, even though OWI and Slinn Engineering had an extensive QA/QC procedure (shown in Figures 4-1 and 4-2). Further details of the QA/QC can be found in the project reports *Hindcast Wind and Wave Forcing in Support of URS FEMA Mississippi Coastal Flood Map Update* and *Wave Setup Methodology for the FEMA Mississippi Flood Study*.

The meteorological data needed to have an acceptable duration of wind and pressure was placed in files and scanned for anomalous values. The project team developed a FORTRAN program to extract the maximum wind speeds and minimum pressure deficits from each storm and determine the storm duration. The data was then displayed in two-dimensional contours in SMS. The inputs to the FORTRAN program were a) OWI Basin Scale Wind Field, b) OWI Regional Scale Wind Field, c) OWI Basin Scale Pressure Field, and d) OWI Regional Scale Pressure Field. The program then scanned through the entire duration of the OWI forcing files to detect any anomalous values.

Radiation forcing files (fort.23) were processed similar to the meteorological data, but through a separate FORTRAN program. The distribution of maximum surface forces was displayed graphically to detect any anomalies. The magnitude and distributions of radiation forces from three validation storms (Hurricanes Katrina, Betsy, and Camille) were used as a qualitative guidance to validate the magnitude and distribution of forces generated by the production run storms. For each model run, the input file QA/QC process was documented in a QA/QC form (QA/QC Form #1, shown in Figure 4-3) with supporting plots (example plots are shown in Figure 4-4 and 4-5). The process was repeated for all 228 ADCIRC production runs. Due to document size constraints for this report, copies of all 228 model run input file QA/QC forms and supporting documentation could not be included. However, sample copies of two input file QA/QC forms, with supporting documents, are attached in Appendix D. All other input file QA/QC forms and supporting documents are available upon request.

4.2 PRODUCTION RUN LOG (FORM #2)

After verification, input files were transferred to the modeling team to pre-process and execute ADCIRC runs in Medusa or Poseidon. The modeling team maintained a daily run log (QA/QC Form #2, Figure 4-6) showing the progress and successful completion of ADCIRC runs. Due to document size constraints for this report, copies of all 228 model daily run logs (QA/QC Form

#2) could not be included. However, sample copies of two daily run logs (QA/QC Form #2) are attached in Appendix E. All other daily run logs are available upon request.

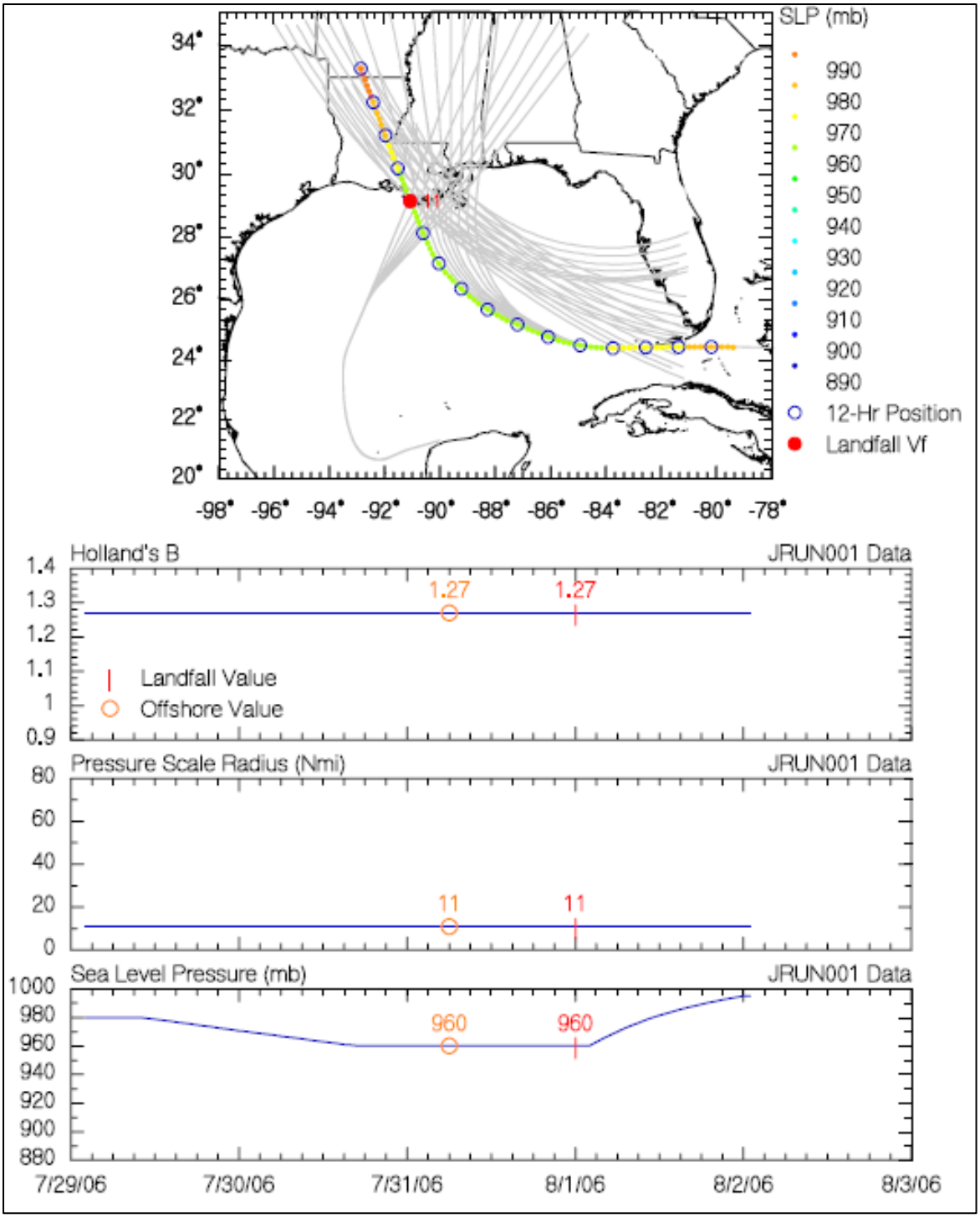


Figure 4-1. OWI QA/QC of Meteorological Data (JRUN 001)

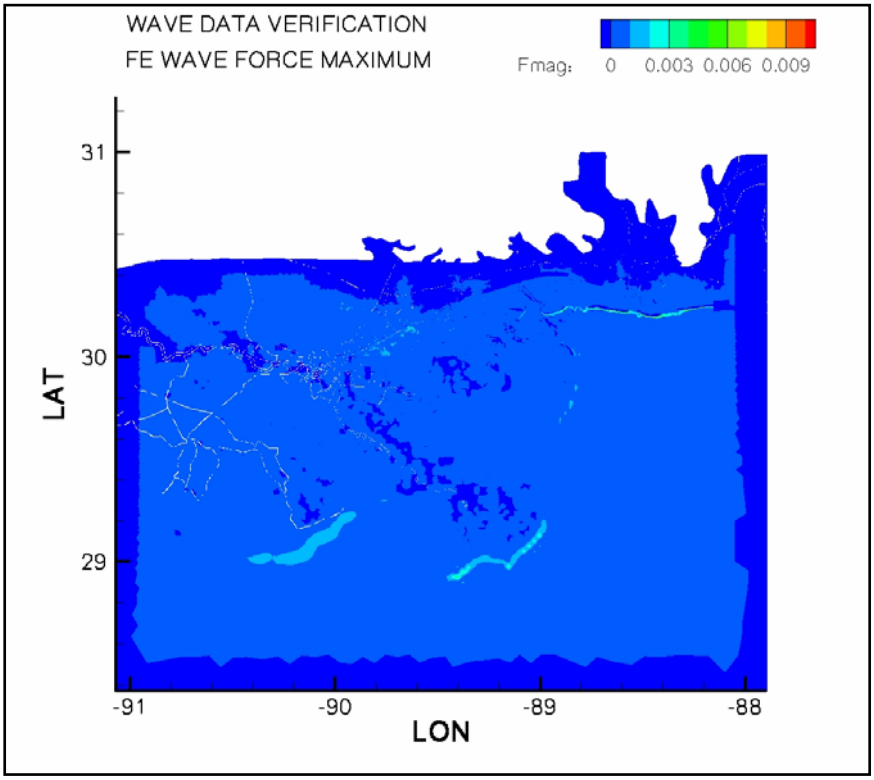


Figure 4-2. Radiation Force QA/QC from Slinn Engineering (JRUN 001A)

4.3 OUTPUT FILE QA/QC (FORM #3)

The QA/QC process for investigating ADCIRC output files was performed in three steps. The following steps were used to validate production runs:

Step 1 – To check for irregular water surface oscillations

Step 2 – To investigate the water surface elevation (WSE) sharp gradients of surrounding adjacent ADCIRC nodes

Step 3 – To inspect the rapid elevation changes in the data

Two FORTRAN routines were developed to automate each of the QA/QC steps. The routines and methods are described in the following sections. Figure 4-7 shows an example QA/QC form used for checking ADCIRC output files (QA/QC Form #3). Due to document size constraints for this report, copies of all 228 model run output file QA/QC forms and supporting documentation could not be included. However, sample copies of two output file QA/QC forms, with supporting documents, are attached in Appendix F. All other output file QA/QC forms and supporting documents are available upon request.

QA-QC FORM #1 (Input File Analyses Log)

URS

ORIGINATOR

CLIENT: FEMA Region IV	PROJECT NUMBER: 15707018	PROJECT NAME HMTAP Coastal Analysis for Mississippi	
DOCUMENT BEING REVIEWED: Input Files for RUN ID: ##			
FILE INFORMATION (Fort23): Radiation Stress File: ##			
FILE INFORMATION (REGIONAL): Wind File: ##		Pressure File: ##	
FILE INFORMATION (BASIN): Wind File: ##		Pressure File: ##	
REVIEW TYPE: ☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP			
DATE:	INPUT FILE STATUS: ☒ Good ☐ Bad ☐ Other_____		
FILE ANALYSES (CONTOUR, AVI): ##			

REVIEWER:	ORGANIZATION: ☐ URS ☐ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____

RESOLUTION	REVIEWER Sign & Date	REVIEWER COMMENT

PROJECT MANAGER/ PRINCIPLE–IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Disp.	Response	Ver.
1					
2					
3					
4					
5					
6					

INITIAL DISPOSITION CODES: C = Will Comply D = Delete Comment F = Further Clarify

FINAL DISPOSITION CODES: C D

Ver: Incorporation of C (Initials)

CC: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Figure 4-3: QA/QC Form used for Documenting ADCIRC Input Files

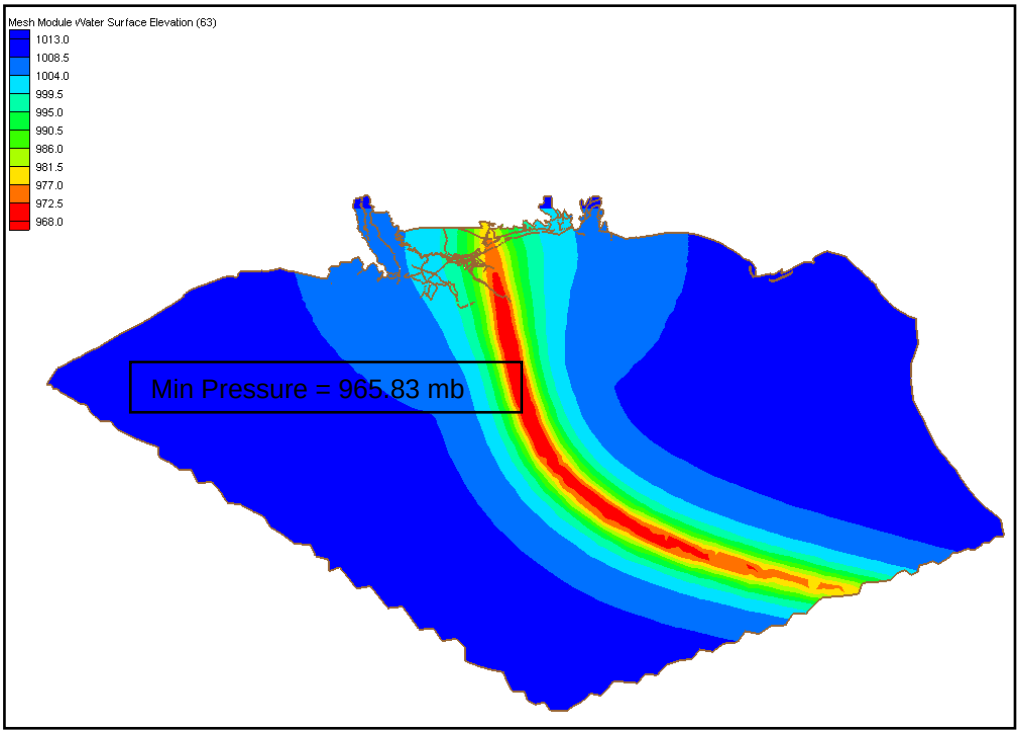


Figure 4-4. URS QA/QC of Meteorological Data (CAT 2004C)

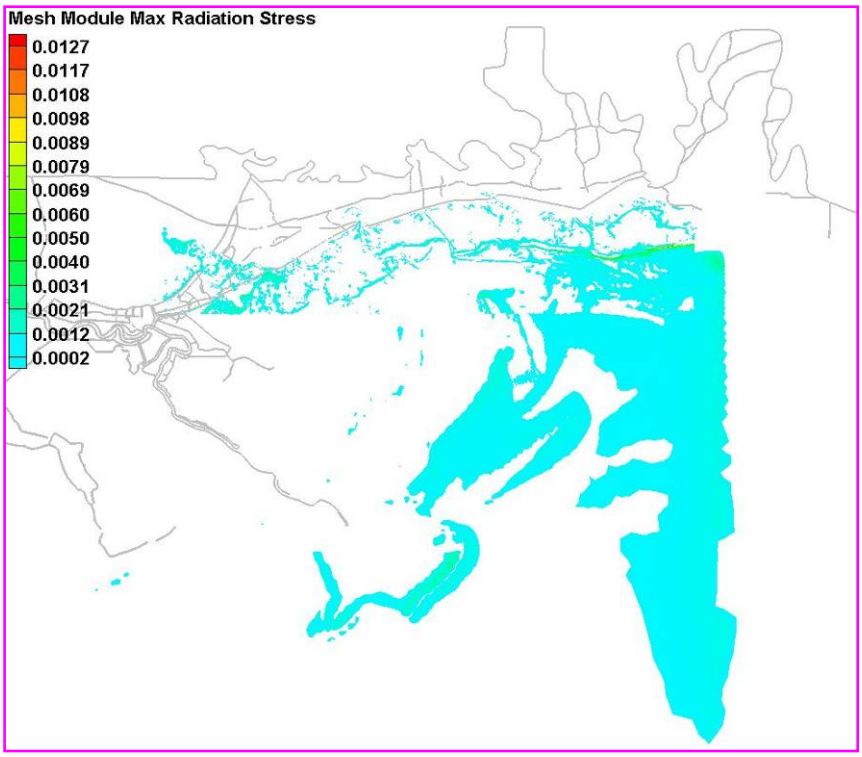


Figure 4-5. URS QA/QC of Radiation Stress File (Fort.23, CAT 2004C)

QA-QC FORM #2 (Run Status Log)

URS

ORIGINATOR

CLIENT: FEMA Region IV	PROJECT NUMBER: 15707018	PROJECT NAME HMTAP Coastal Analysis for Mississippi	
DOCUMENT BEING REVIEWED: RUN STATUS for RUN ID(DIRECTORY): ##			
RUN IDENTIFICATION:	☒ MEDUSA ☐ POSEIDON ☐ DOE		NO. OF PROCESSORS:
FILE INFORMATION:	Grid File: ##		Met. File: ##
RUN INFORMATION:	Start Date & Time:		End Date & Time:
RUN STATUS	☒ Stable ☐ Unstable ☐ Other_____		
CLUSTER STATUS			
REVIEW TYPE: ☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP			
DATE:	NAME & ORGANIZATION:		
GENERAL COMMENT			

DETAILED QA/QC: ☐ SUCCESS ☐ FAIL ☐ Other_____	
REVIEWER:	ORGANIZATION: ☐ URS ☐ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____

RESOLUTION	REVIEWER Sign & Date	REVIEWER COMMENT

PROJECT MANAGER/ PRINCIPLE-IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Disp.	Response	Ver.
1					
2					
3					
4					
5					

INITIAL DISPOSITION CODES: C = Will Comply D = Delete Comment F = Further Clarify

FINAL DISPOSITION CODES: C D

Ver: Incorporation of C (Initials)

C: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Figure 4-6: QA/QC Form used for Documenting ADCIRC Run Logs

QA-QC FORM #3 (DETAILED CHECK OF ADCIRC RUNS) URS

ORIGINATOR

CLIENT: *FEMA Region IV* PROJECT NUMBER: *15707018* PROJECT NAME *HMTAP Coastal Analysis for Mississippi*

DOCUMENT BEING REVIEWED: *Detailed Check for RUN ID: ##*

INPUT FILES (Gr. 1): *Global WSE File: ##*

INPUT FILES (Gr. 2): *Global Velocity File: ##*

INPUT FILES (Gr. 3): *Time Series File: ##*

FILE ANALYSES :

REVIEW TYPE: ☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP

DATE: ADC RUN STATUS: ☒ Good ☐ Bad ☐ Other_____

GENERAL COMMENT:

REVIEWER: ORGANIZATION: ☐ URS ☐ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____

RESOLUTION REVIEWER Sign & Date REVIEWER COMMENT

PROJECT MANAGER/ PRINCIPLE-IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Disp.	Response	Ver.
1					
2					
3					
4					
5					
6					

INITIAL DISPOSITION CODES: C = Will Comply D = Delete Comment F = Further Clarify FINAL DISPOSITION CODES: C D Ver: Incorporation of C (Initials)

CC: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Figure 4-7: QA/QC Form for Detailed Check of ADCIRC Output Files.

4.3.1 Step One

Irregular water surface oscillations lead to model instability to downstream nodes. The ADCIRC model produces a "fort.61" file, which is a highly-resolved time series of water elevations for each specified node in the ADCIRC grid. Instead of inspecting all the 7,898 hydrographs for irregular oscillations, a FORTRAN routine (Process_time_series_WSE_os.exe) was executed to read the fort.61 file and parse water elevations from 19 predefined points defined in the "station.dat" file. These predefined points were representative locations for coastal, inland, and riverine locales, and were monitored for each simulation to illustrate basic storm trends.

The FORTRAN routine produces a "mytimeseries.dat" file. TecPlot software is used to produce the time series hydrographs for each of the predefined points. TecPlot uses the layout file, (plot_timeseries_hydrographs.lay) built at the earlier ADCIRC runs to read the FORTRAN-generated WSE file. The hydrographs are then categorized into the three representative locations (inland, coastal, and riverine). The output graph was either exported as a figure or saved as a screen shot for inclusion in the QA/QC files.

4.3.2 Step Two

Step two investigates if there are any stations which experience more than three water surface elevation oscillations of a significant magnitude. The Process_time_series_WSE_os.exe routine simultaneously investigates if these oscillations occur. Stations meeting these criteria are recorded in the frequency.dat file. In order to create timeseries plots of these stations, the FORTRAN routine is executed with the new station.dat file, which identifies stations meeting the criteria.

This is done by inspecting the first column of the frequency.dat file to see if station IDs are listed. The second column of the file has the associated number of oscillations. If station IDs are listed in the frequency.dat file, these station IDs are copied and pasted in the station.dat file, and line two is amended to reflect the new number of stations now identified in the new station.dat file. The FORTRAN executable is re-run using the "Timeseries_WSE_oscillation.lay" Tecplot layout file to plot the identified hydrographs. The frequency plots are saved and placed in PowerPoint slides for analysis. However, if no station IDs are listed in the frequency.dat file, the process proceeds to Step 3.

Please note, if no access to TecPlot software exists, time series plots can be made in Excel graphs. Output from the "mytimeseries.dat" is organized with each station time series placed in consecutive order.

4.3.3 Step Three

Step 3 investigates if there are any significant WSE jumps or "Hot Spots" between surrounding nodes from the "Max_Elev_fort.63" file. A FORTRAN routine was written to facilitate the process. The program identifies zones (nodes) associated with sharp water surface elevation changes. The output file was then inserted in SMS using the SMS import wizard to identify the location, surface elevation, and node name. The reviewer would then visually inspect the elevation changes bounded by topographical boundaries or rivers. If elevation changes between two surrounding nodes exceeded greater than 0.5 feet, the node was identified as questionable. The exception to the rule was if the identified node was adjacent to structures, levees, roads,

sharp topographic gradients, or a channel terminus. If so, then higher differences would be expected, but if the difference exceeded the 1.5-foot range within this criteria, the node was identified as a questionable point.

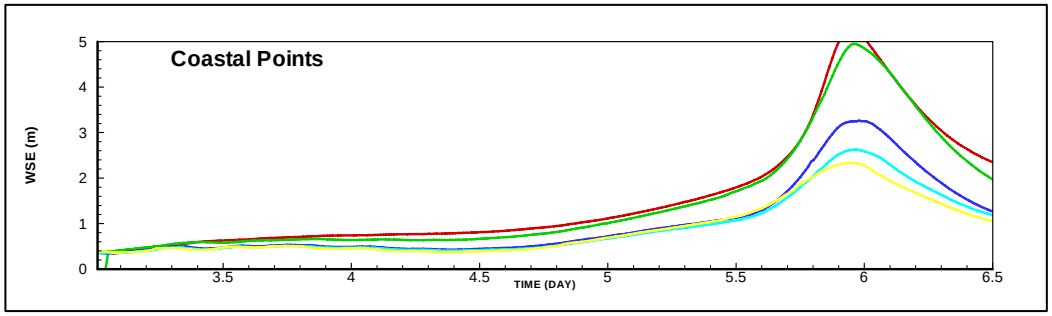
These questionable points were then identified to the production run modeler, who documented the points in screen shots, and identified if the maximum WSE was anomalous, amendable, or acceptable. The QA/QC reviewer was notified and a consensus was reached. All anomalous points are put in PowerPoint slides and placed in the QA/QC files.

4.4 VERIFICATION OF RUN DURATION

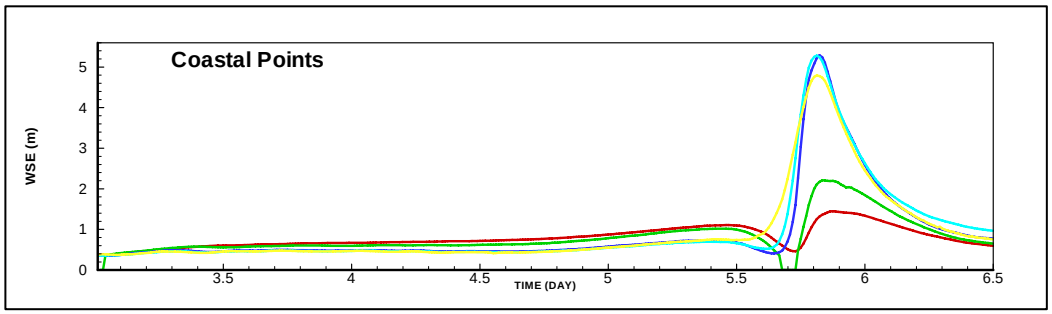
Run Duration was also tested and verified during the QA/QC process. Examples are shown in Figure 4-8, where two different storms tracks (JOS6002C and JOS6011E) are used as illustrations. Figure 4-8(a) shows WSE hydrographs for five selected observation points along the Mississippi coast during the storm simulation JOS6002C, and Figure 4-8(a) shows the same for storm JOS6011E. This figure, along with other similar plots in Appendix F, demonstrates the run durations are long enough to capture the full wind effects of each storm (i.e. the peak of each storm surge is reached prior to the end of the each model simulation).

4.5 SUMMARY (QA/QC PROCESS)

In summary, during the QA/QC process, we did not notice any systematic trends of anomalies. Most of the issues were related to places where the ADCIRC model experiences frequent drying and wetting. These anomalies were fairly common in places where there were sharp topographic changes (e.g., high channel banks, roads crossing, edges of a narrow channels and levees). Figure 4-9 shows very localized depressions in the computed WSE in a node adjacent to dry nodes. It can be correlated with Figure 4-10. It was found that sharp changes in topography were the obvious reasons for such a sharp changes in the computed WSE front. These types of behavior were observed in numerous ADCIRC simulations. However, the drying/wetting anomalies seemed to be very localized and did not propagate to a larger domain. The project team paid special attention such that none of the JPM points were placed on such hotspots. An example of the QA/QC process highlighting the effect of Singing River Island is shown in the *Grid Development Report*.



(A



(B

Figure 4-8. Water Surface Elevation Hydrographs Indicating That the Storm Duration Captures Peak Surge. (a) Storm simulation JOS6002C (a) Storm simulation JOS6011E

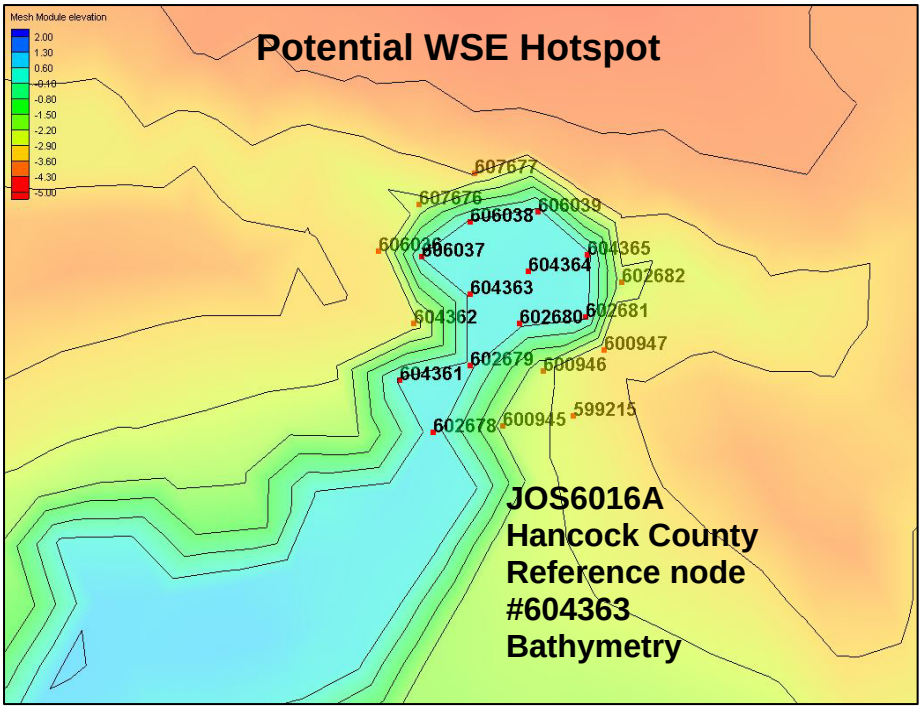


Figure 4-9. Localized Depression in the Computed Water Surface Elevation (WSE) in a Wet Node Adjacent to Dry Nodes

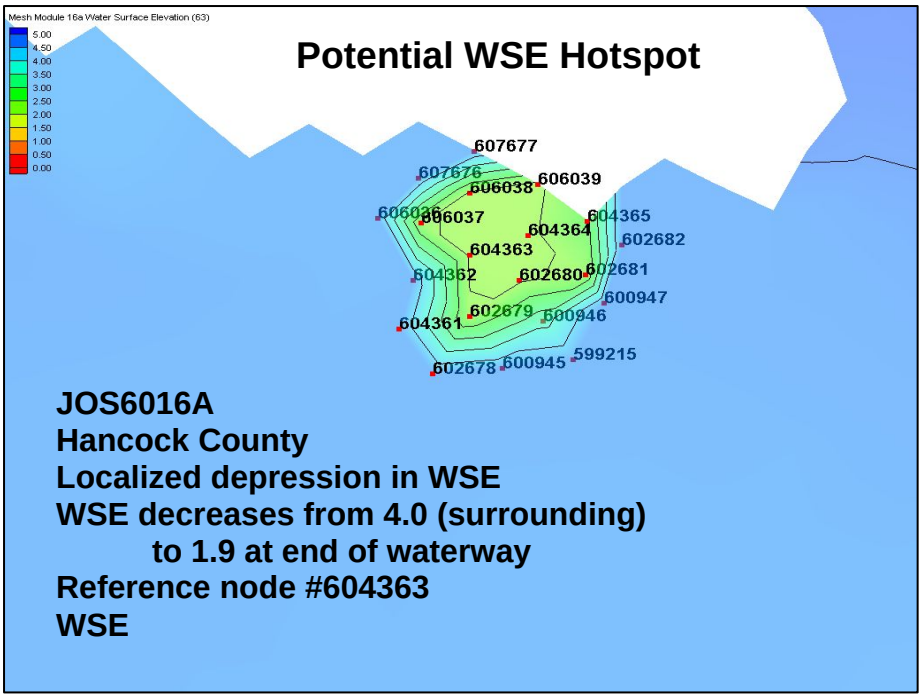


Figure 4-10. Sharp Changes in Topography Indicate Obvious Reasons for a Sharp Change in the Computed WSE Identified in Figure 4.9

Appendix A
Sensitivity Analysis of Wind Duration

Sensitivity of Wind Durations on Storm Surge

1. Objective

A study was conducted to determine the effects on hurricane storm surge due to variations in the length of wind forcing. One objective was to determine the minimum duration of wind forcing necessary to produce the maximum storm surge.

2. Variations in the Duration of Wind Files

2.1. Methodology

For the wind duration phase of the study, a 3.0 day "ramp-up" period was used and output results were recorded in a hotstart file at day 3.0. The flux settling time parameter for the river boundary on the Mississippi River was set for 2.0 days, during which time the only forcing used was the water surface elevation (WSE) at the river boundary. The 2.0 day period allowed sufficient time for the WSE to reach an equilibrium point. After 2.0 days, the 0.5 day ramp was applied to the open boundary forcing, also referred to in this study as the "STEADY" constituent with zero amplitude. The equilibrium argument and node factor were set to 0.0 and 1.0, respectively. Another 0.5 days ramp was added before the wind and radiation stress forcings were applied.

In the original Katrina wind and radiation stress files, the peak surge reaches shore after 5.5 days. This model was used as the "baseline" model. Therefore, in order to test the effects of wind duration, the landfall time of the peak surge was varied. The peak surge was timed to reach shore 0.5, 1.5, 2.5, 3.0, 3.5, and 5.5 days after the 3.0 day set up period, meaning that the surge reached the shore at 3.5, 4.5, 5.5, 6.0, 6.5, and 8.5 days from the beginning of the model simulation. In the fort.22 input file, the user can designate at which timestep the wind file will be read by manipulating the NWBS (number of wind blank snaps) parameter. For hotstart runs, each timestep is designated with a negative or positive value, which can be ignored or interpreted as a "blank snap" respectively. These initial time steps will be added to the beginning of the run after the hotstart time and before the wind file is read. For these runs, the time step interval for the wind input was 900 seconds.

For the radiation stress forcing, ADCIRC does not use a "blank snap" parameter, and therefore, the files require manual manipulation. For the baseline model run where the peak surge reached shore at 5.5 days, no changes were made. For all other runs, where the peak reached shore sooner, records from the beginning of the files were deleted and new files were created. The time step interval between each radiation stress snapshot was 1800 seconds. Therefore, when the peak surge was designated to reach shore at 4.5 days, the first 48 time steps were eliminated (48 time steps * 1,800 seconds/time step = 86,400 seconds = 1 day).

Table A-1 lists the run name by peak surge after the hotstart time, the NWBS's, the number of time steps added or removed from the radiation stress file and the total number of days in the run.

Table A-1. Timing of the peak surge reaching land from the hotstart time and the beginning of the run and the adjustment factors for the winds and radiation stress.

Timing of Peak Surge After the Hotstart (days)	Timing of Peak Surge from the Beginning of the Run (days)	Winds (fort.22): NWBS	Radiation Stress (fort.23): Time Steps Removed	Total Run Time (days)	Graph Color
0.5	3.5	-480	-240	5.0	**PINK**
1.5	4.5	-384	-192	6.0	**CYAN**
2.5	5.5	-288	-144	7.0	**RED**
3.0	6.0	-240	-120	7.5	**YELLOW**
3.5	6.5	-192	-96	8.0	**BLUE**
5.5	8.5	0	0	10.0	**BLACK**

2.2. Results

The water surface elevation was recorded every 15 minutes at locations throughout Mississippi. The locations of the stations, as well as their identification numbers, are shown in Figure A-1. The 7-digit numbers show the locations of National Ocean Service (NOS)/National Oceanic and Atmospheric Administration (NOAA) stations. The 4-digit numbers show the locations of high water marks recorded after Katrina reached shore in late August, 2005. Sample surge elevations of 12 stations are shown in Figure A-2.

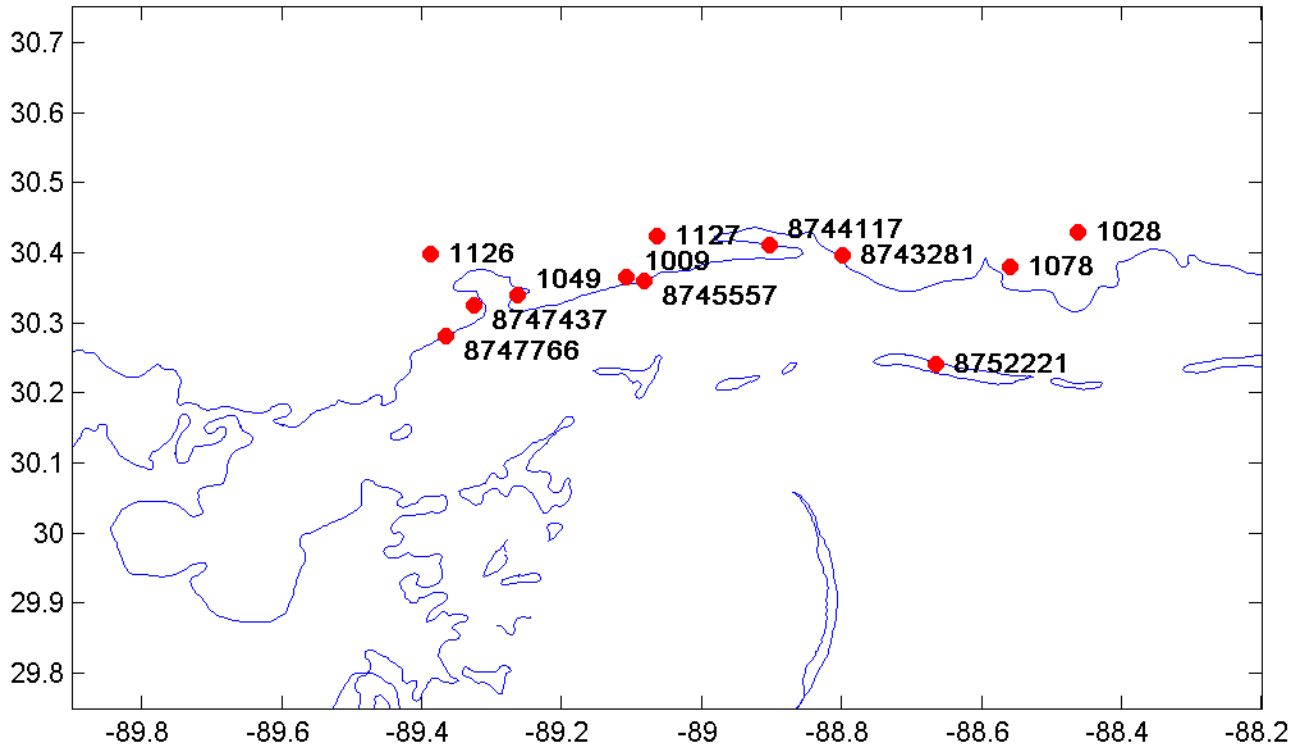
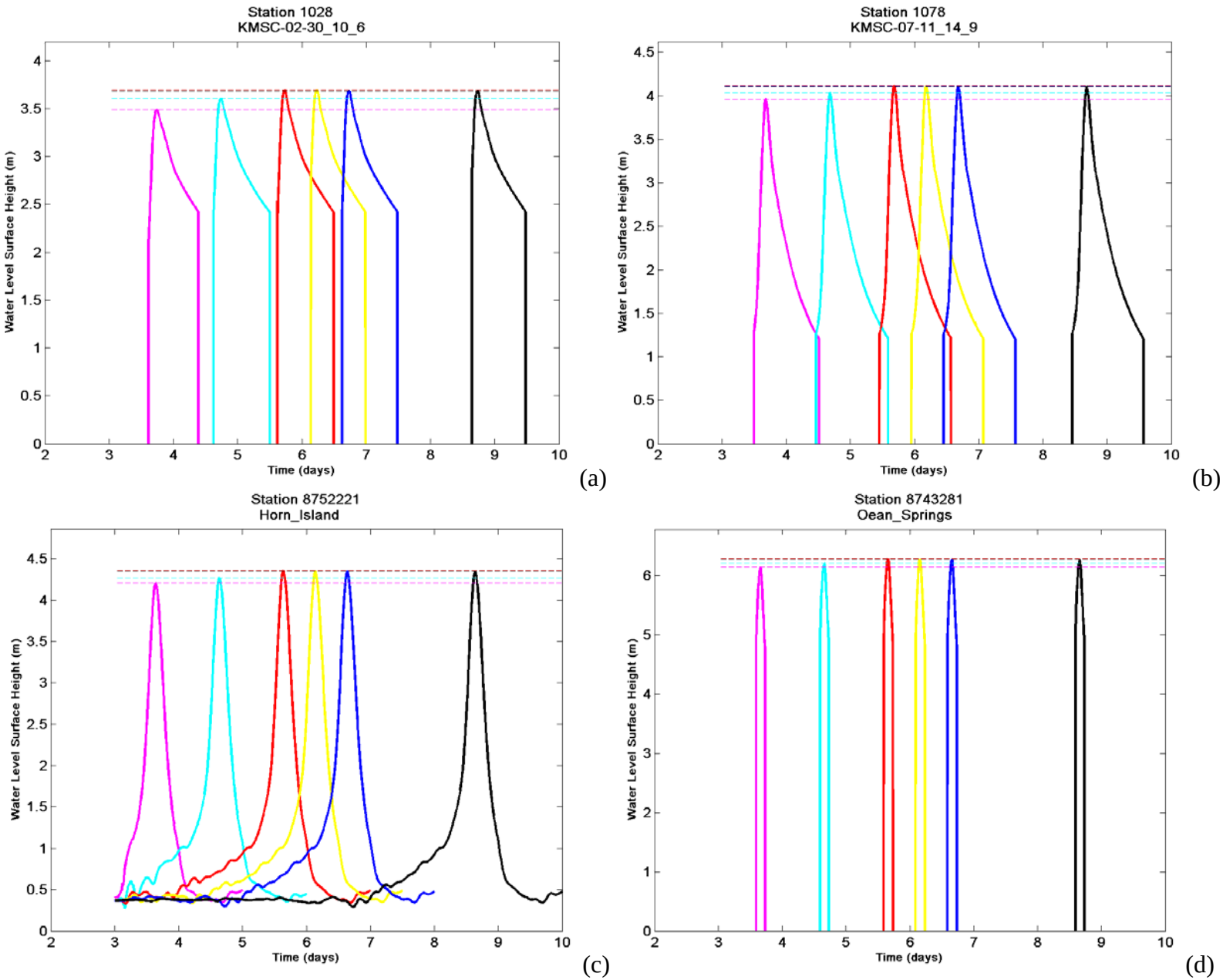
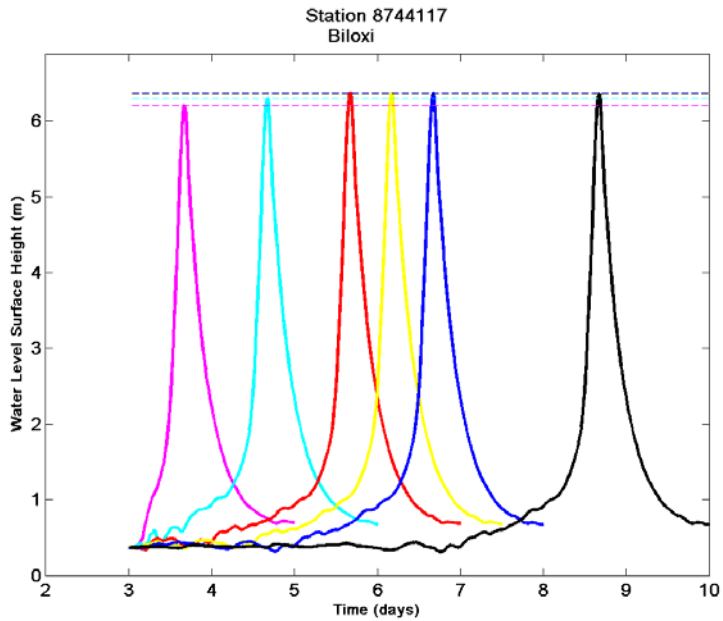
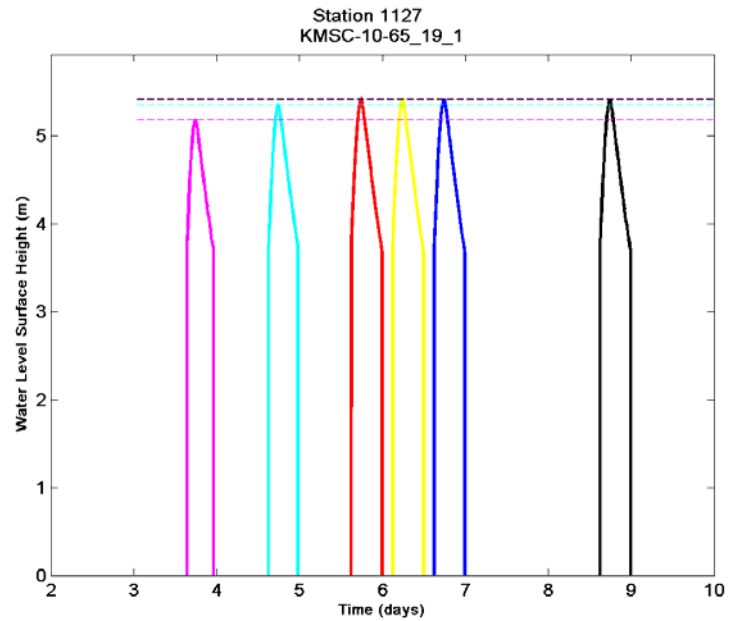


Figure A-1. Station locations with basic outline of coastal Mississippi and Louisiana.

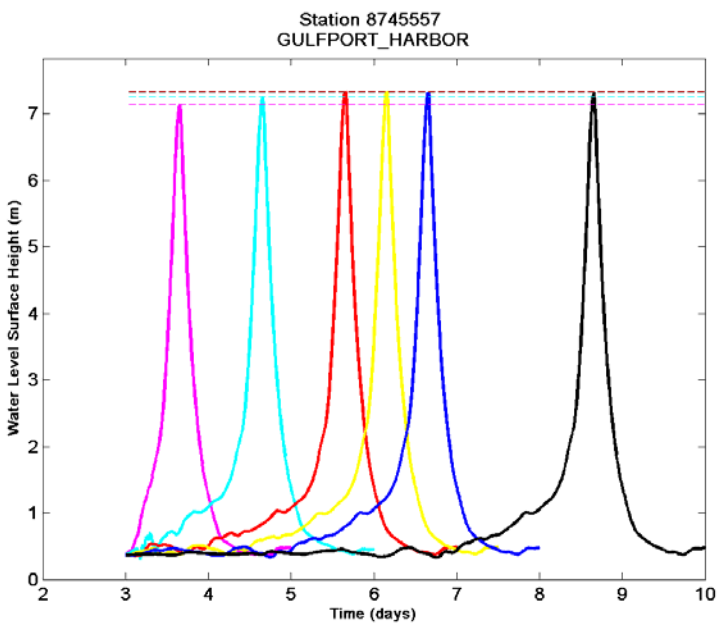

Station 1028
KMSC-02-30_10_6
Water Level Surface Height (m)
Time (days)
(a)
Station 1078
KMSC-07-11_14_9
Water Level Surface Height (m)
Time (days)
(b)
Station 8752221
Horn_Island
Water Level Surface Height (m)
Time (days)
(c)
Station 8743281
Oean_Springs
Water Level Surface Height (m)
Time (days)
(d)


Station 8744117
Biloxi
Water Level Surface Height (m)
Time (days)

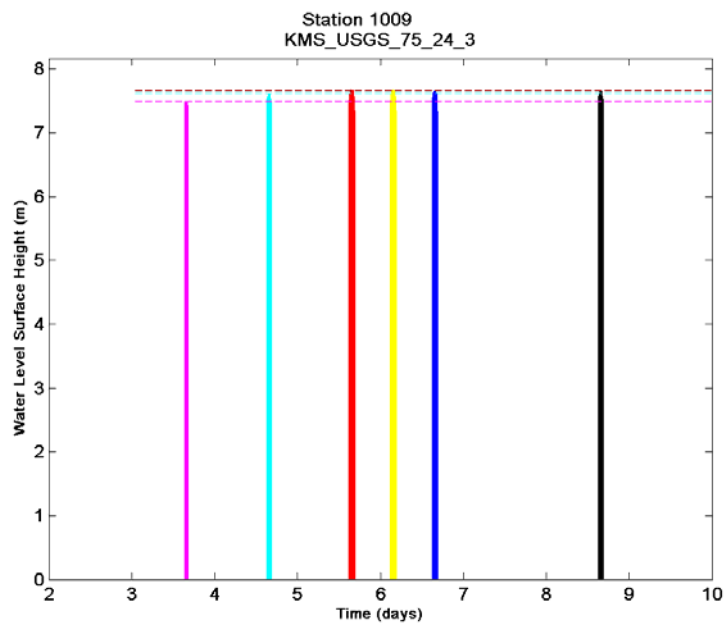
(e)


Station 1127
KMSC-10-65_19_1
Water Level Surface Height (m)
Time (days)

(f)


Station 8745557
GULFPORT_HARBOR
Water Level Surface Height (m)
Time (days)

(g)


Station 1009
KMS_USGS_75_24_3
Water Level Surface Height (m)
Time (days)

(h)

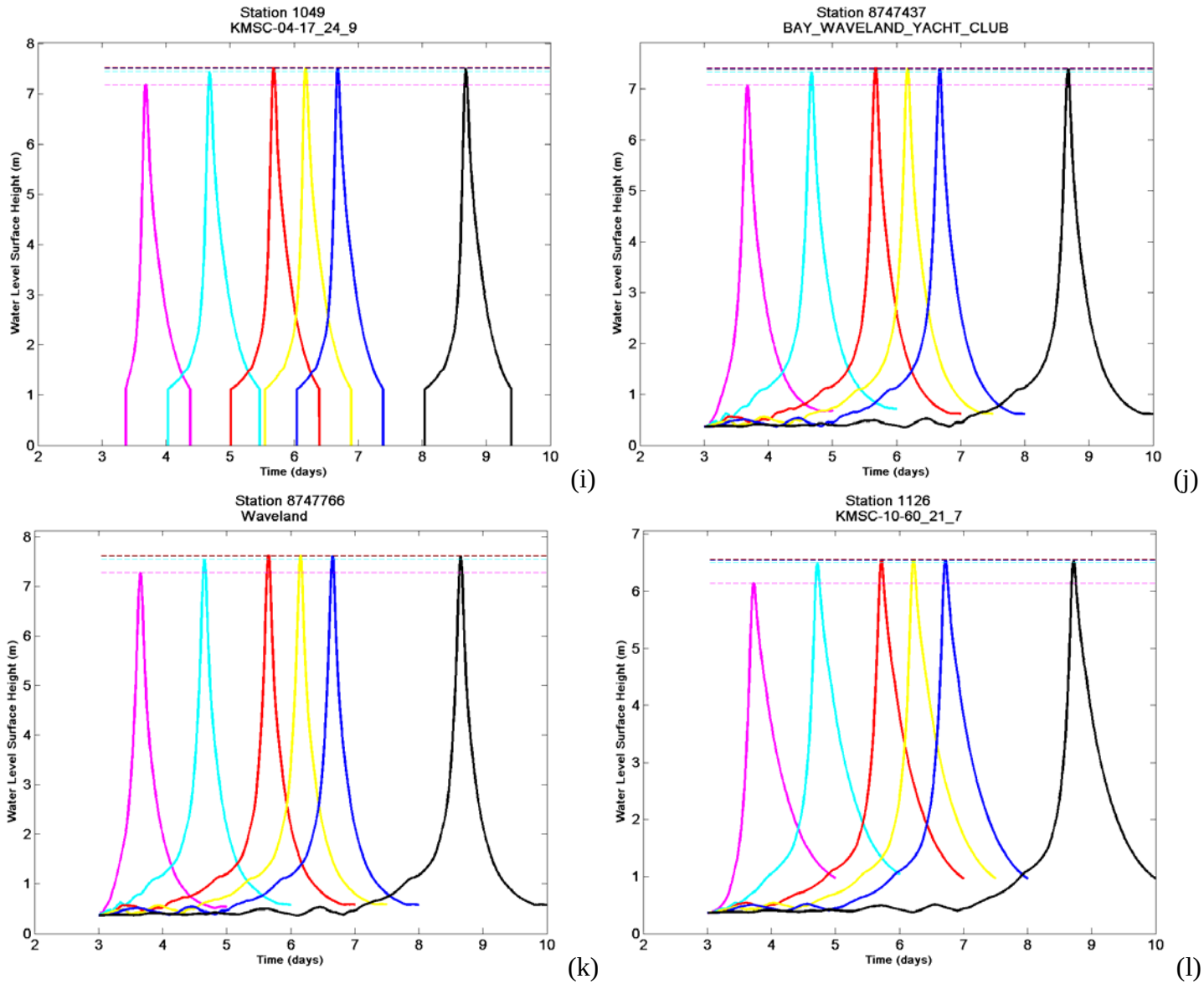
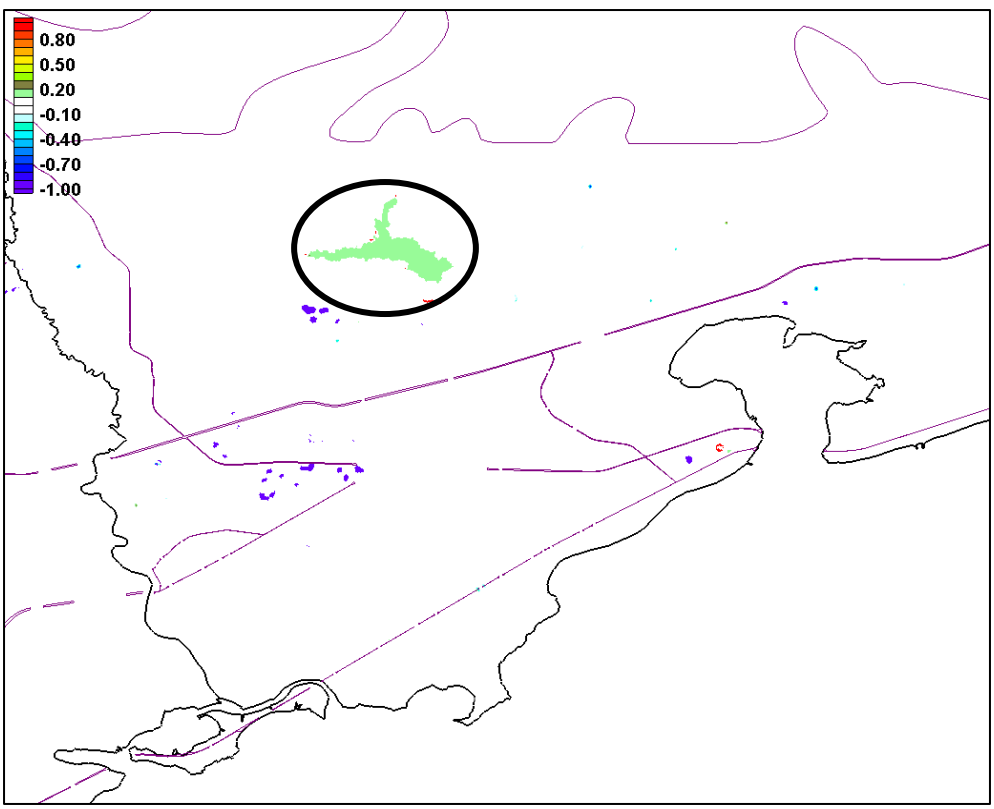


Figure A-2. Water surface elevation plots from the ADCIRC model output at 12 stations (labeled (a)-(l)) in Mississippi, as the surge reaches shore at 3.5, 4.5, 5.5, 6.0, 6.5, and 8.5 days with an initial 3.0 day spin-up period.

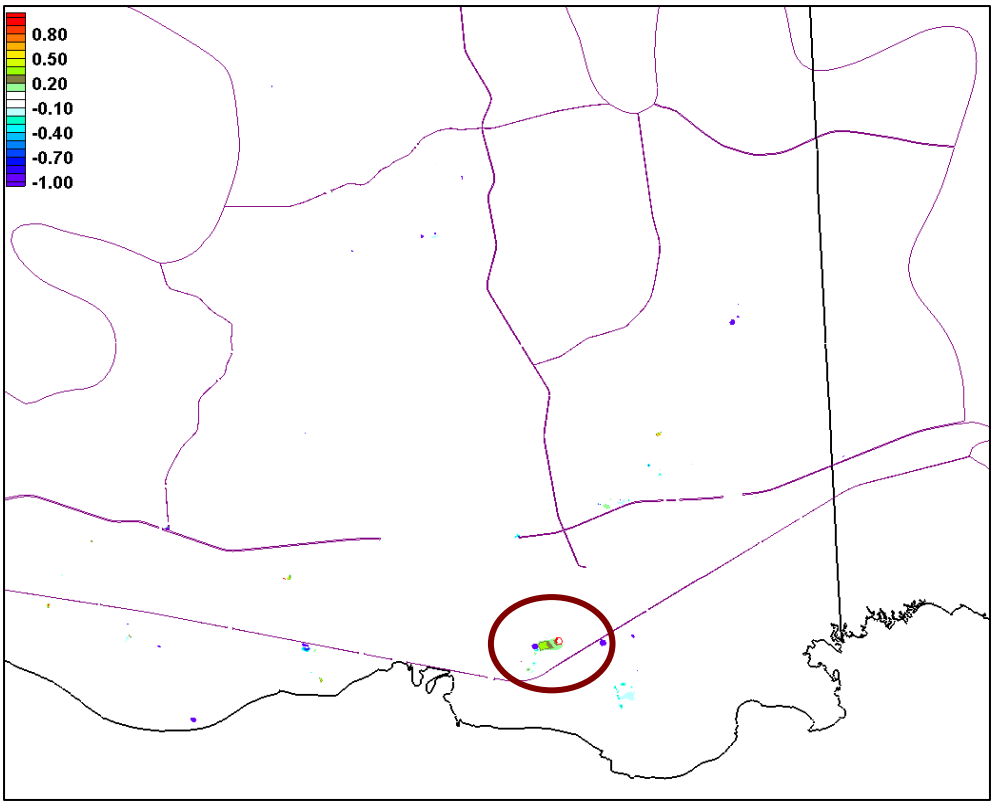
The results at all stations showed a similar trend. With the baseline storm reaching peak surge at 5.5 days (after the hotstart at day 3.0), eliminating the first 3-days of the winds and radiation stress did not significantly change the total peak surge. However, eliminating any portion of the last 2.5 days from the wind and radiation stress files prior to the storm making landfall resulted in a reduction in the total storm surge height. Thus, for a storm of the magnitude of Katrina, it is recommended that there must be a minimum of 2.5 days of winds and radiation stress forcings (after the initial set-up used to stabilize the river boundaries) to generate the maximum surge. Figure 2.2 clearly illustrates that the height of the peak surge (shown as a dashed line) does not significantly change between the baseline storm in black with a total run time of 8.5 days, and the simulations with a total run time 6.5, 6.0, or 5.5 days. A drop in the total surge height starts to occur for the 5.5 and 4.5 day runs. (Note: The stations that are further inland will have the peak delayed by up to 0.5 days, with the 5.5 day surge peaking as late as 6.0 days.)

These results show that a minimum of 2.5 days of winds and radiation stresses following the set-up period (Model Spin-up) are necessary to generate maximum surge heights. To confirm this globally, the difference between the maximum water surface elevations from the 5.5 day peak surge and 2.5 day peak surge model runs is plotted in Figure A-3. Model output data was displayed in SMS using a contour color scheme that would enhance the display of problem areas while filtering out acceptable differences. A value of 10 cm is considered acceptable for this study. Therefore, water column differences of -10 cm to 10 cm were colored white, with greater positive difference plotted in warm tones and greater negative values plotted in cool tones. As evident in the figures, most areas are colored white and have less than 10 cm difference, agreeing with results presented in Figure A-2.



(a)

(b)



(c)

Figure A-3. Differences in meters between the water column depths from the 5.5 day peak surge and 2.5 day peak surge model runs in (a) Western , (b) Central, and (c) Eastern coastal Mississippi.

Although the vast majority of the study area experiences an acceptable model difference of less than 10 cm, a few anomalies do exist. Several areas appear that are deep red or dark purple along the edge of the maximum surge, which is an indicator of one model run wetting a node while the other model run keeps the node dry. These differences are acceptable based on the differences in the wind and radiation stress forcing in the model runs. Areas with less than a 30 cm difference, like the area circled in Figure A-3(a), are again probably due to minor differences in the forcing in the runs and are an acceptable level of difference. In about a dozen areas (like the area circled in Figure A-3(c), the difference between the runs varies between 30 and 75 cm. Further investigation determined that the differences are most likely attributed to topographic variations. In these areas, the flow paths delineated by the topography are either (1) not smooth and allow no clear flow path or (2) are smooth, but are only one node wide. For either case, the wetting and drying algorithm in ADCIRC makes different choices for each of the runs allowing flow down one path in the 2.5 day peak surge run and down another path in the 5.5 day peak surge run. These differences could be eliminated by adjusting or smoothing the topography to allow clear flow paths that are a minimum of 2 nodes wide.

Appendix B
Sensitivity Analysis of Astronomical Tide

Effect of Coupled and Non-Coupled Tides on Storm Surges

1. OBJECTIVE

The objective of this study is to determine the difference between the non-coupled and coupled combination of wind and tide forcing in the ADCIRC model. For the "non-coupled" case, wind and tide forcing were computed in separate model runs and a representative high tide water level was simply added to the wind driven water level. In the "coupled" case, the tide and wind forcing were used in the same run. These runs are then compared to demonstrate the effects of the interaction of these forces.

2. METHODOLOGY

The ADCIRC model was used in all simulations. The model was run on the URS high performance computer, Medusa.

2.1 Tides only run

The first step was to run a 24-day model simulation using only tidal forcing. Seven harmonic constituents (K_1, O_1, Q_1, M_2, S_2, N_2, and K_2) were forced at the ocean boundary as a reconstructed tide series. The initial ramp period consisted of the first fifteen days. After that, the data was used to find the high and low tides at Waveland, MS. The high tide occurred at day 21.7500 and the low tide reached Waveland at day 21.2083.

2.2 Winds only run

A six-day run was conducted with only wind forcing from the Katrina storm. The peak surge made landfall at 4.6458 days. It is assumed that winds only runs are made at the mean tide level.

2.3 Coupled Tides and Winds run

The tide data was used to determine the time at which the highest and lowest tides would reach Waveland, MS. The model was then configured to run with tides only for the first 17.1 days. At that point, the Katrina wind forcings were added so that the peak surge would hit the coast at the time of the highest tide at Waveland, MS on approximately day 21.75. Another run was set up with tides only for the first 16.5625 days. At that point the same wind forcing was added so that the peak surge would hit the coast at the time of the lowest tide at Waveland, MS, on approximately day 21.2083.

2.4 Non-Coupled Tides and Winds run

For the non-coupled case, the winds-only time series were adjusted by adding the value of the high tide at Waveland, MS (0.4234 meters) to the results. To simulate the peak surge coinciding with the low tide, the low tide at Waveland, MS (0.2751 meters) was subtracted from the water level time series results.

3. MODEL DOMAIN

The 900,450 node grid called MS11_WPRE.grd was used for this study. This grid matches the node and element configuration of the grid used by the Army Corps of Engineers (ACOE) for their coastal inundation study in the Mississippi region. The bathymetry and topography match that same grid. Outside of Mississippi, the MS11_WPRE.grd grid has a lower level of resolution than the grid used by the ACOE, which has over two million nodes.

4. RESULTS AND DISCUSSION

The results of these model runs were compared by examining the extent of the inundation, as well as the height of the peak surge. For the extent of the inundation, the comparison was made between the coupled model run, where the winds were timed to reach Waveland at high tide, and the winds-only model run. To compute the peak surge, the high tide value at Waveland, MS was added to the winds-only surge value only at the nodes in the grid that were flooded (or continually wet) from the winds-only surge. Thus, nodes that were not wet by the winds-only surge were not made wet by adding the Waveland, MS high tide value. Figure B-1 shows a comparison of the extent of the surge for the winds-only forcing case (in red) compared to the inundation created by the model run with the winds and the tides (reaching shore at high tide in Waveland) in three regions of the grid: St. Louis Bay (near Waveland), the Bay of Biloxi, and Pascagoula. The bathymetry contours are shown in blue. (Please note that the coupled case with the winds timed to reach Waveland at low tide are not shown.)

In general, the extent of the inundation is not dramatically different between the winds-only model run and the Coupled winds and tides run. In areas where the topography is flatter, the limits of the coupled flooding extend further inland than the winds-only flooding. This result is to be expected, since the surge that includes winds and tides should be greater than the surge from only the winds.

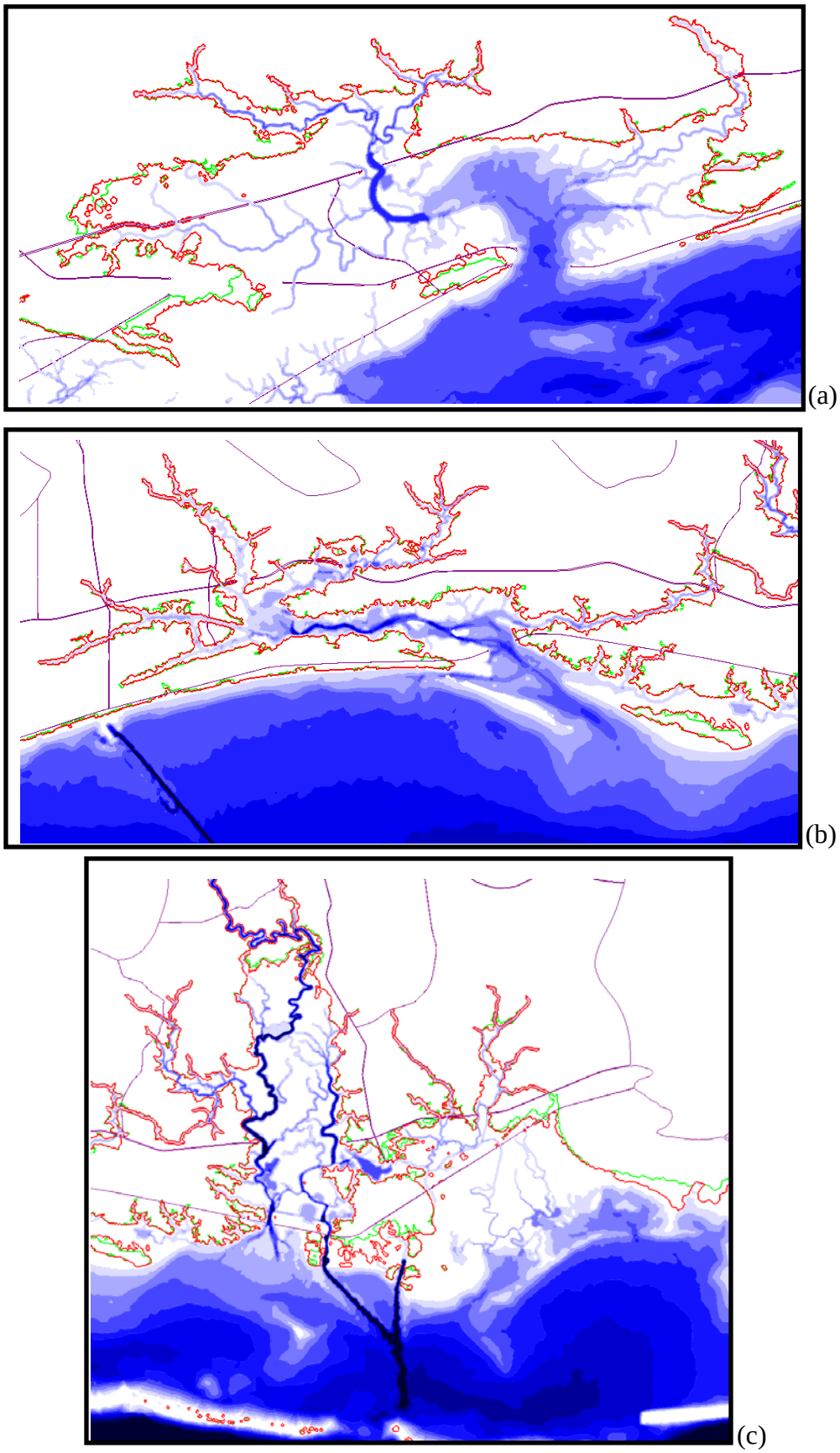


Figure B-1. Inundation differences between the maximum surge from a coupled winds and tides model run (green) and a winds only model run (red) near (a) St. Louis Bay, (b) the Bay of Biloxi, and (c) Pascagoula with bathymetric contours in blue.

The second analysis compared the water level time series at pre-specified locations. This analysis includes the coupled tests where the winds were timed to reach Waveland at both high tide and low tide. For the images shown in this section, the non-coupled case time series were adjusted so that the peak of the surge occurred at the time of the high tide in Waveland for the winds plus high tides case and the water level was increased by the amount of that high tide. For the low tide case, the peak surge was adjusted in the plot to coincide with the time of the low tide in Waveland and the water level was decreased by the amount of that low tide. Figure B-2 shows the location of the stations where the time series plots were extracted. These stations were divided into three categories. In the figure, the red dots show the stations in Mississippi that were wet throughout the model run. The green dots show the stations in Mississippi that were initially dry. The blue dots show the stations outside of Mississippi, but in the two nearest states – Louisiana and Alabama.

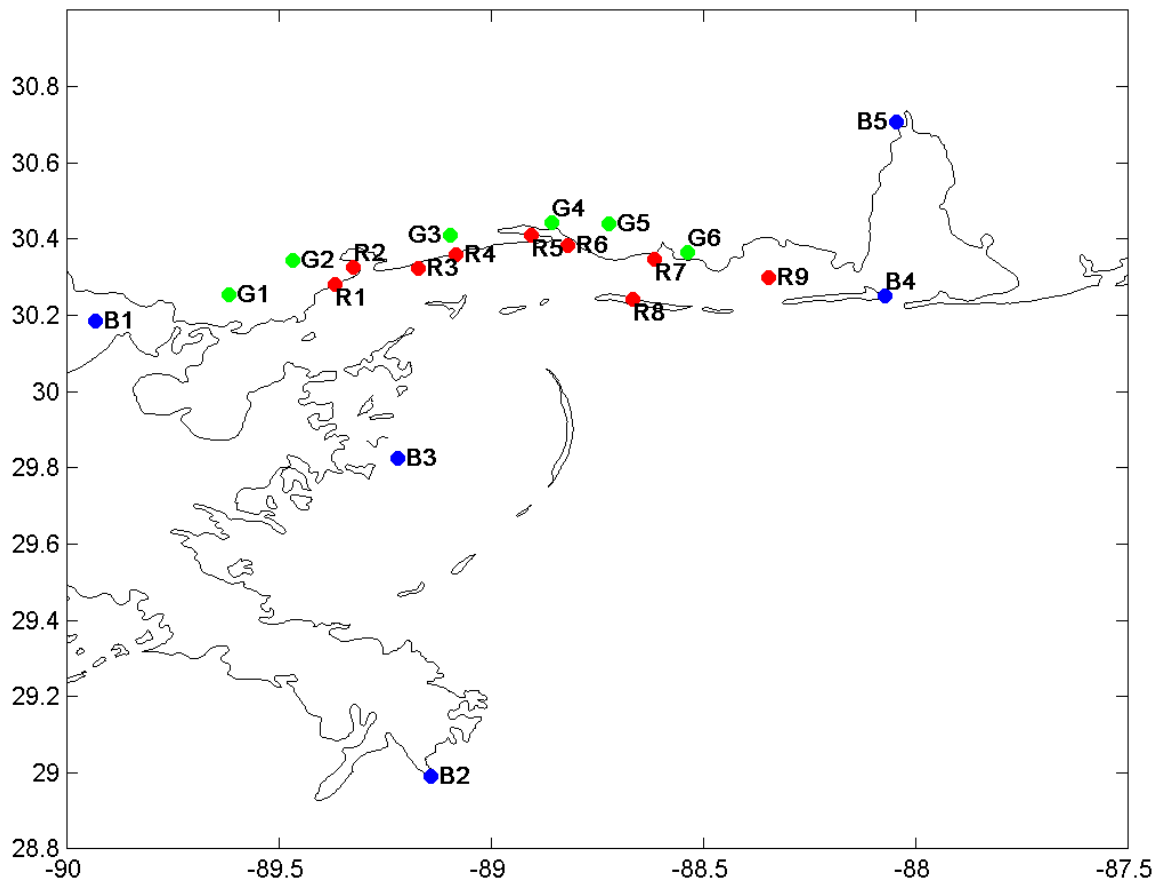


Figure B-2. Locations of the monitoring stations. Red stations are the always-wet stations in Mississippi. Green stations are the stations in Mississippi that started dry. Blue stations are the stations outside of Mississippi.

The water level time series plots in Figures B-3 through B-21 correspond to the locations shown in Figure B-2. The coupled wind and tide runs are shown in red and the non-coupled case is shown as a dashed black line where the base elevation was adjusted to high tide at Waveland, MS. Table B-1 lists the peak at all of the stations shown below from the non-coupled and coupled cases. This table also lists the differences between the runs where negative values mean the non-coupled case resulted in a higher peak value than the coupled case.

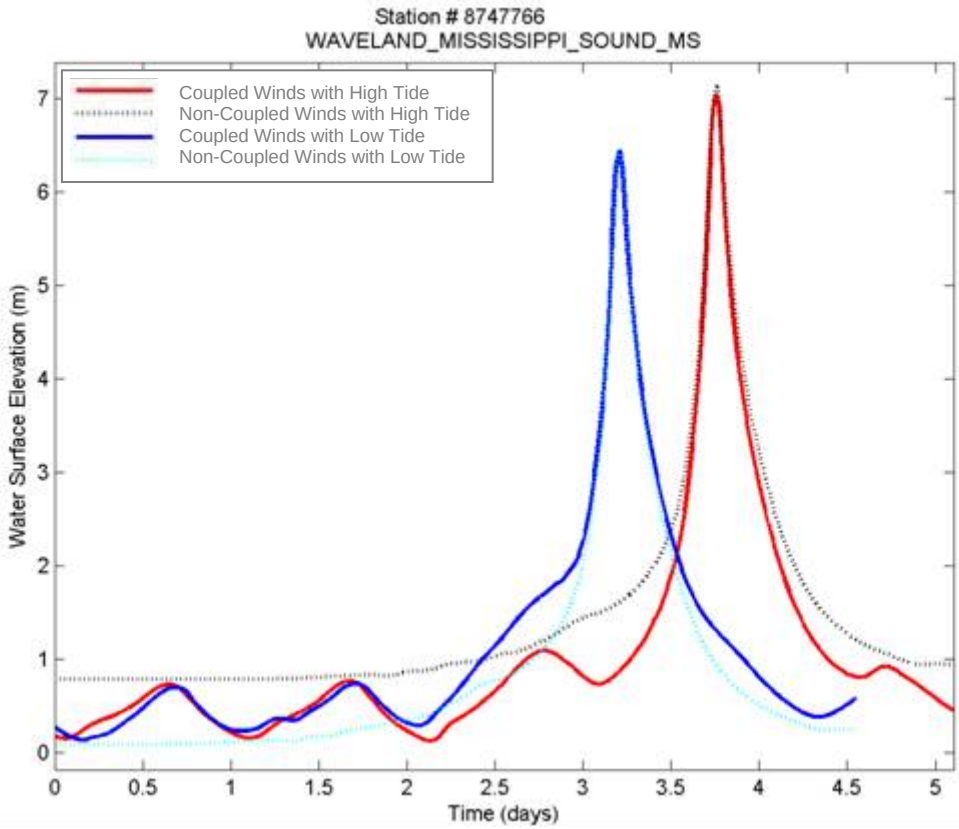


Figure B-3. Water level from non-coupled and coupled model runs at Waveland, Mississippi (station R1 in Figure B-2).

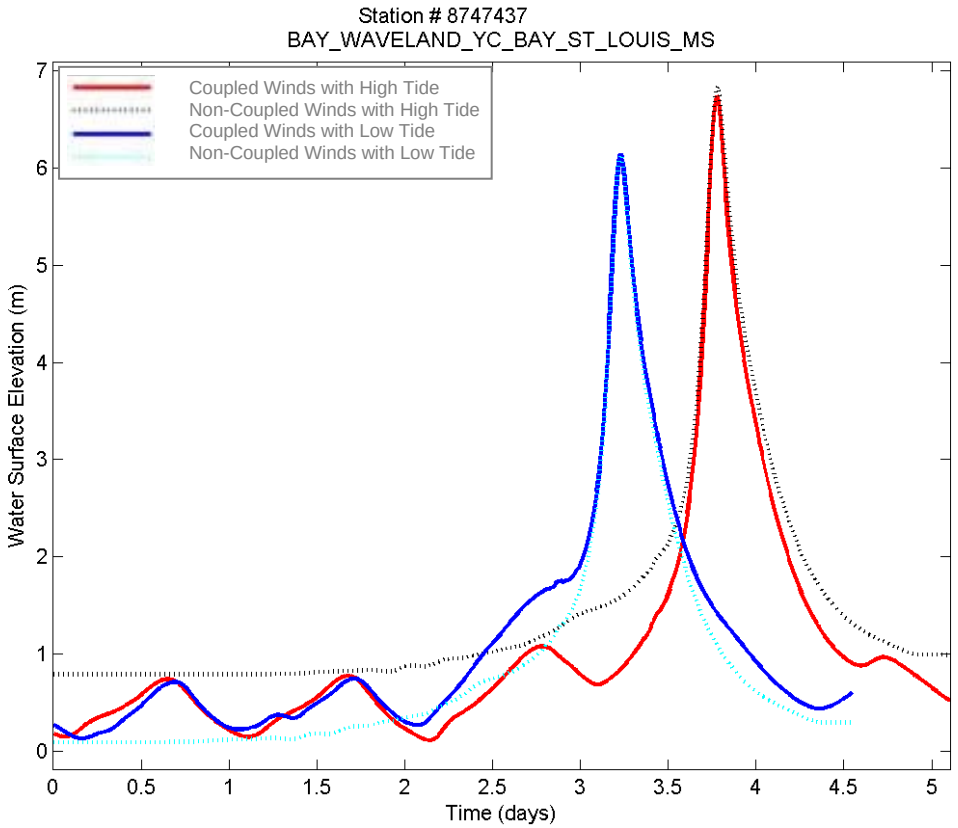


Figure B-4. Water level from non-coupled and coupled model runs at Bay Waveland, Mississippi (station R2 in Figure B-2).

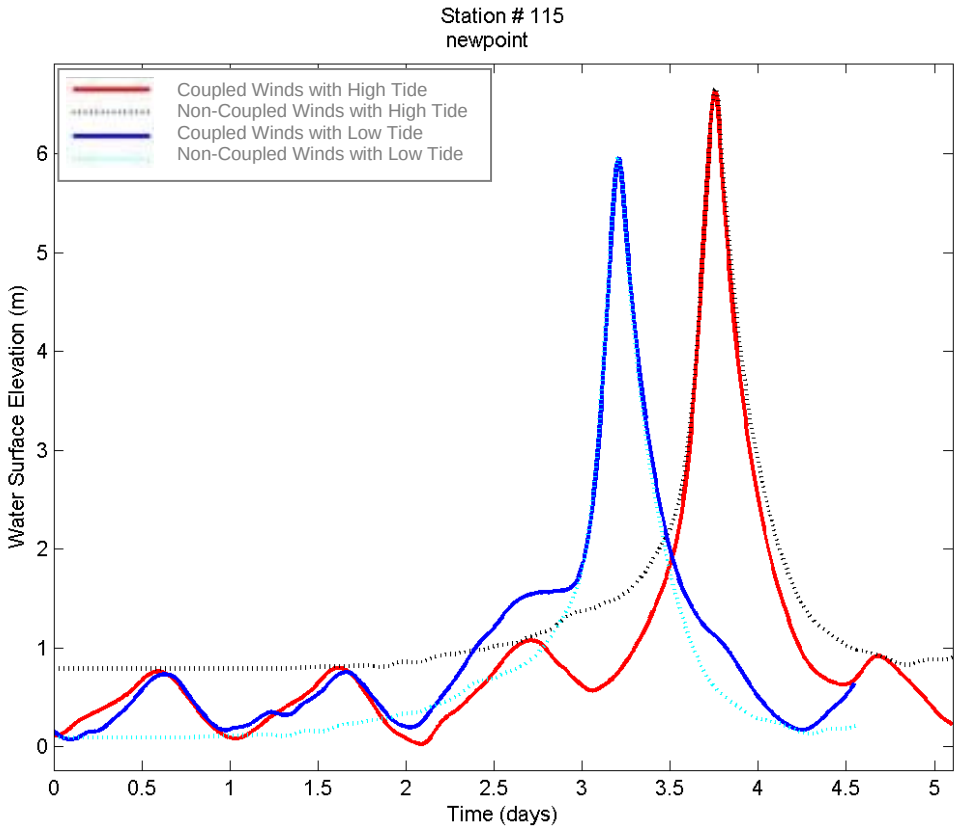


Figure B-5. Water level from non-coupled and coupled model runs at a location along the Mississippi coast (station R3 in Figure B-2).

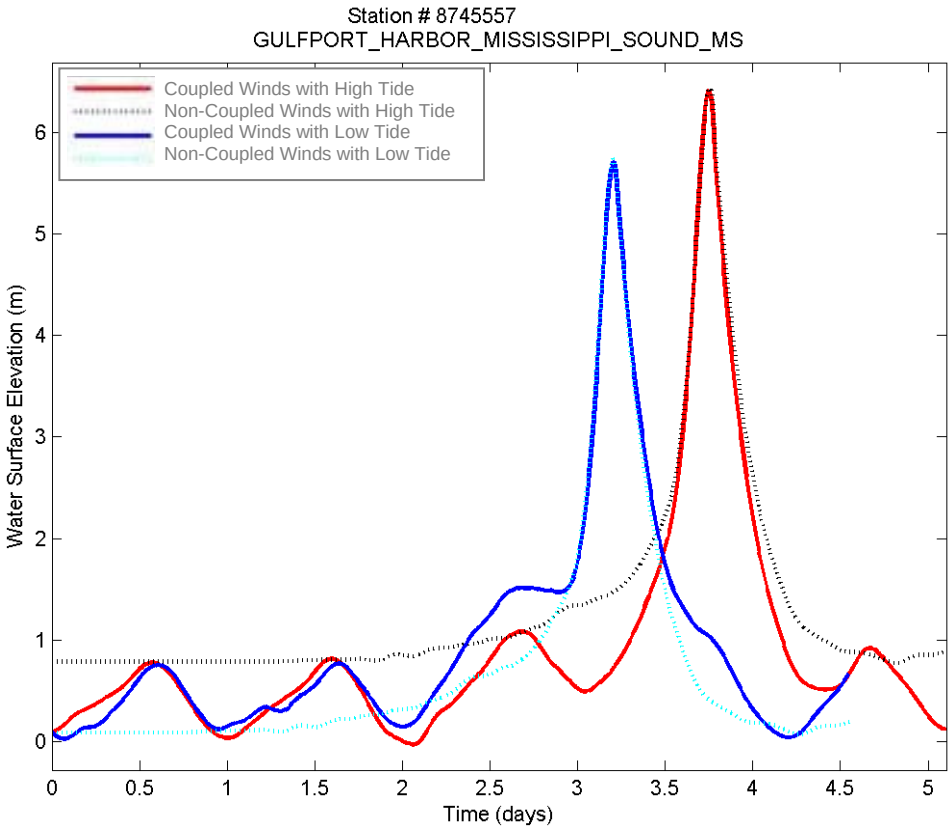


Figure B-6. Water level from non-coupled and coupled model runs at Gulfport Harbor, MS (station R4 in Figure B-2).

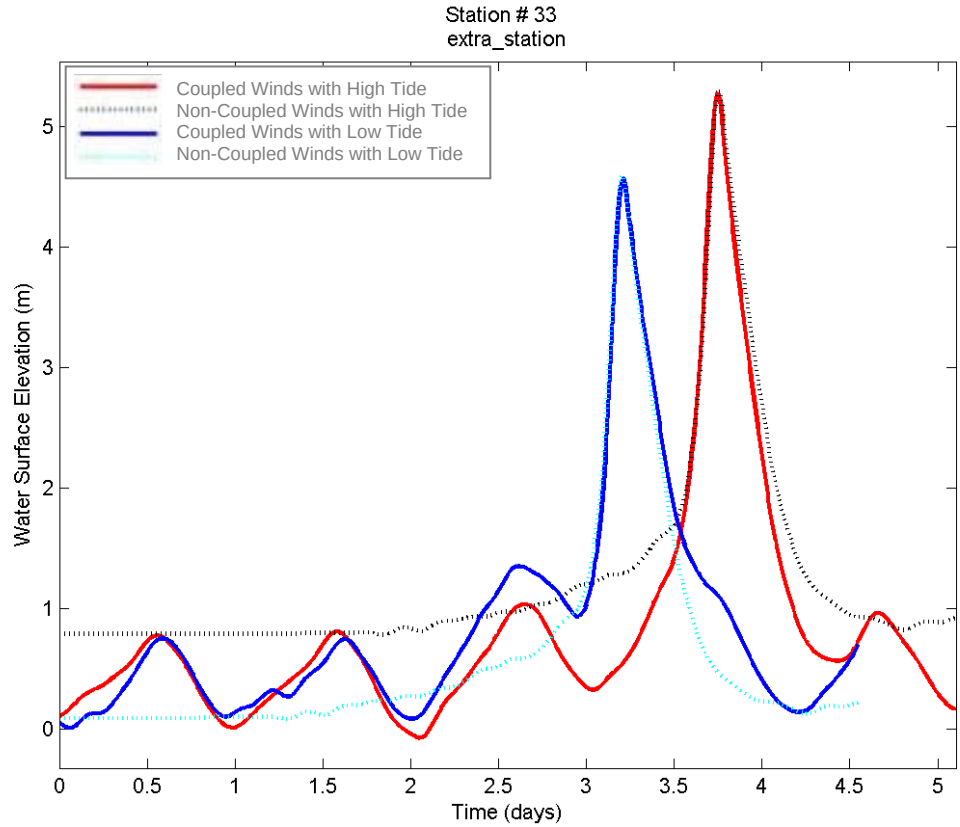


Figure B-7. Water level from non-coupled and coupled model runs at a station in Biloxi Bay, MS (station R6 in Figure B-2).

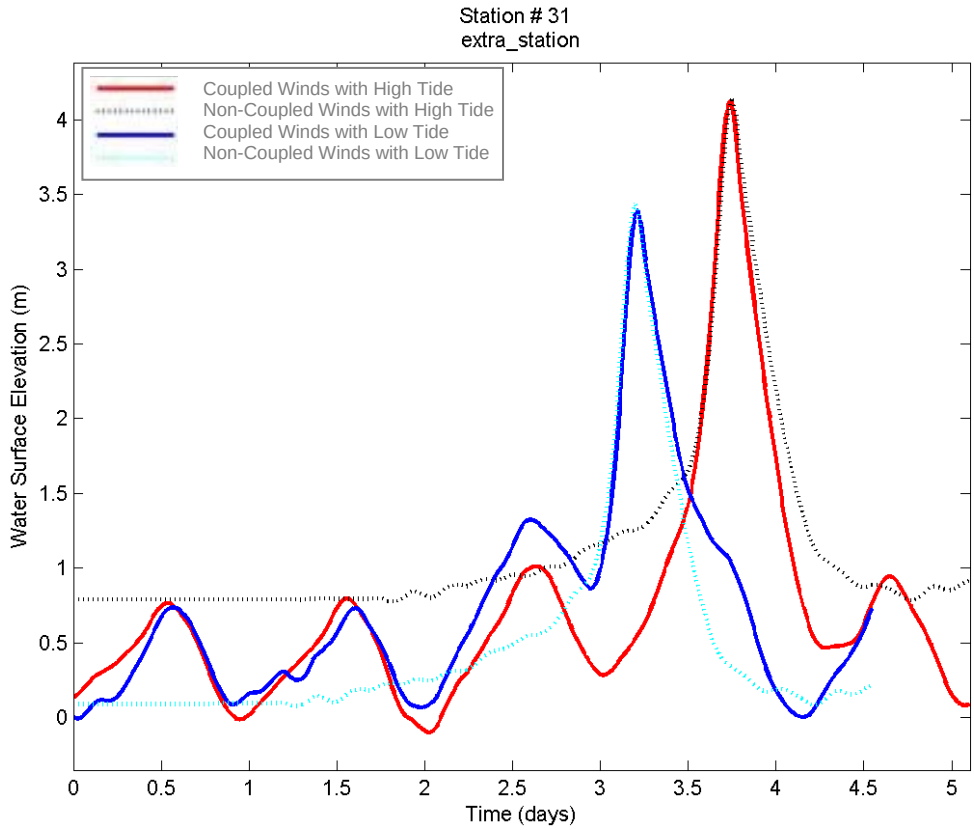


Figure B-8. Water level from non-coupled and coupled model runs at a station along the Mississippi coast (station R7 in Figure B-2).

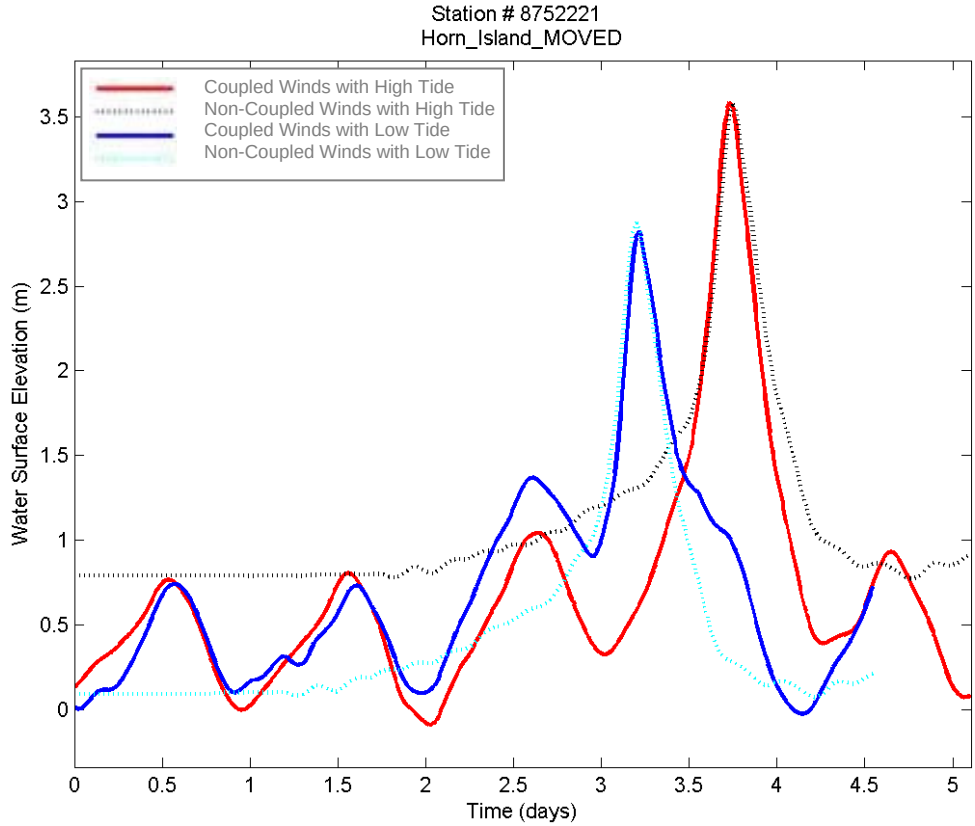


Figure B-9. Water level from non-coupled and coupled model runs at Horn Island, MS (station R8 in Figure B-2).

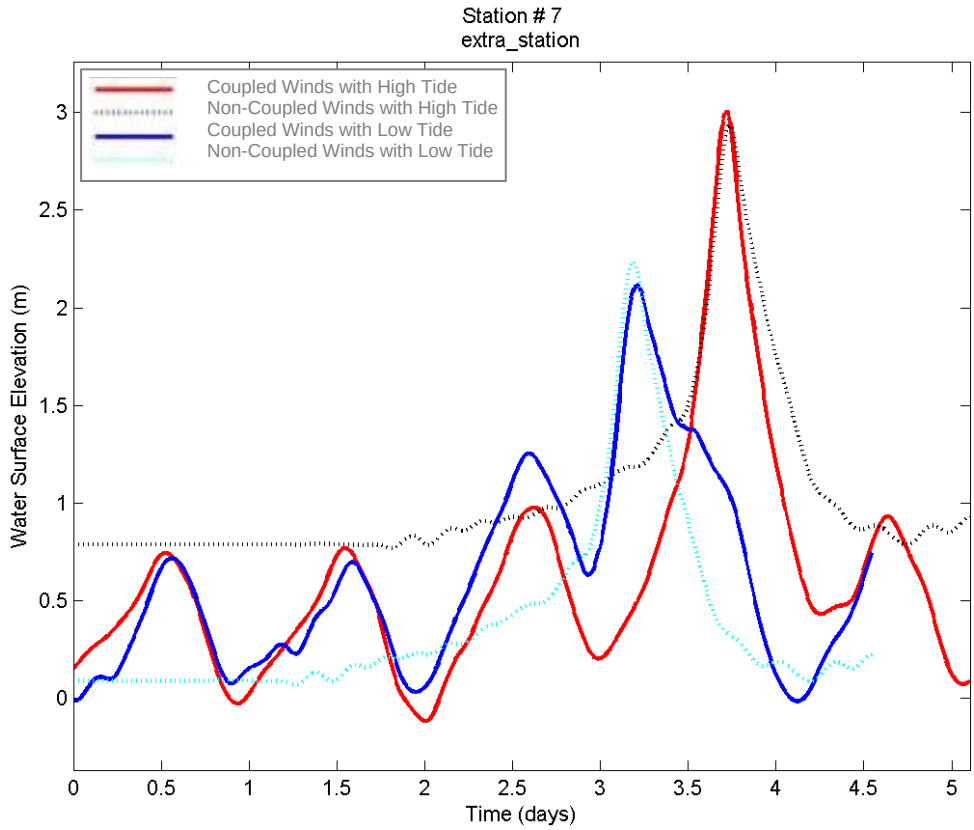


Figure B-10. Water level from non-coupled and coupled model runs in Mississippi Sound (station R9 in Figure B-2).

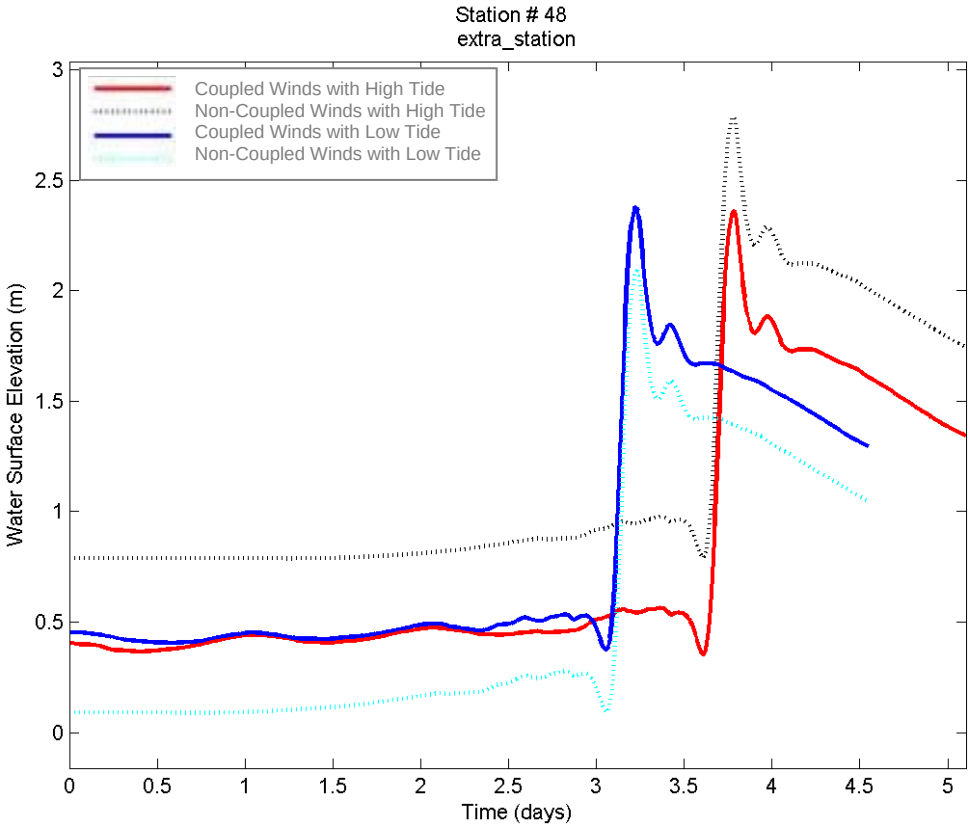


Figure B-11. Water level from non-coupled and coupled model runs in Lake Pontchartrain, LA (station B1 in Figure B-2).

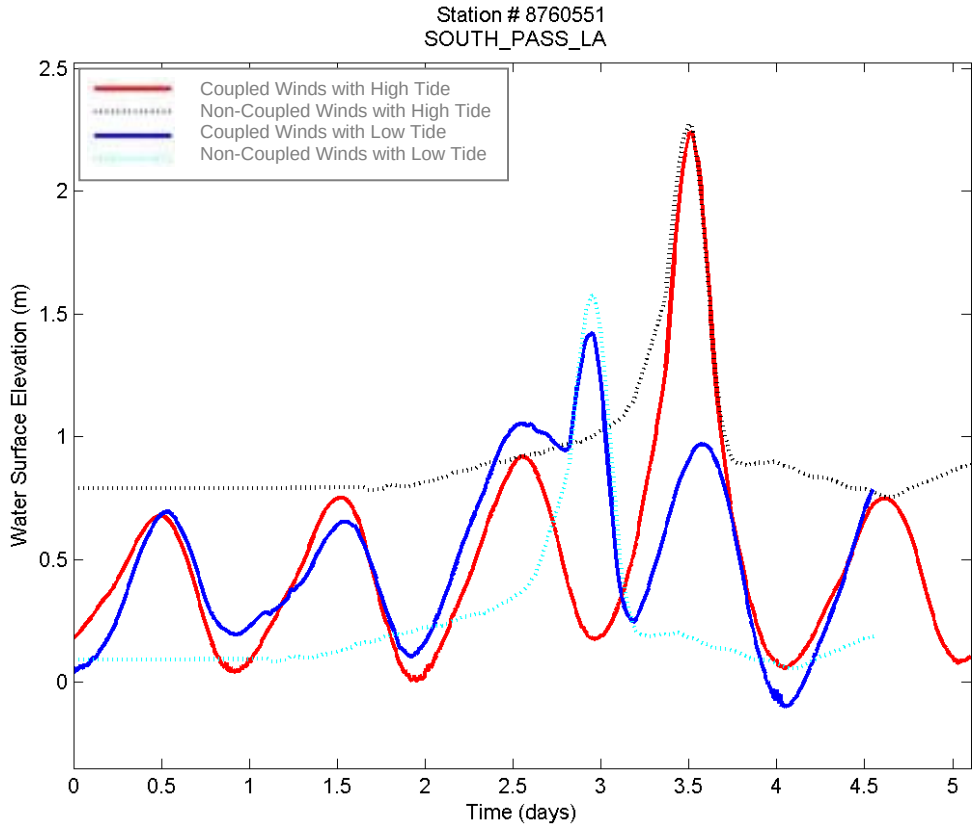


Figure B-12. Water level from non-coupled and coupled model runs at South Pass, LA (station B2 in Figure B-2).

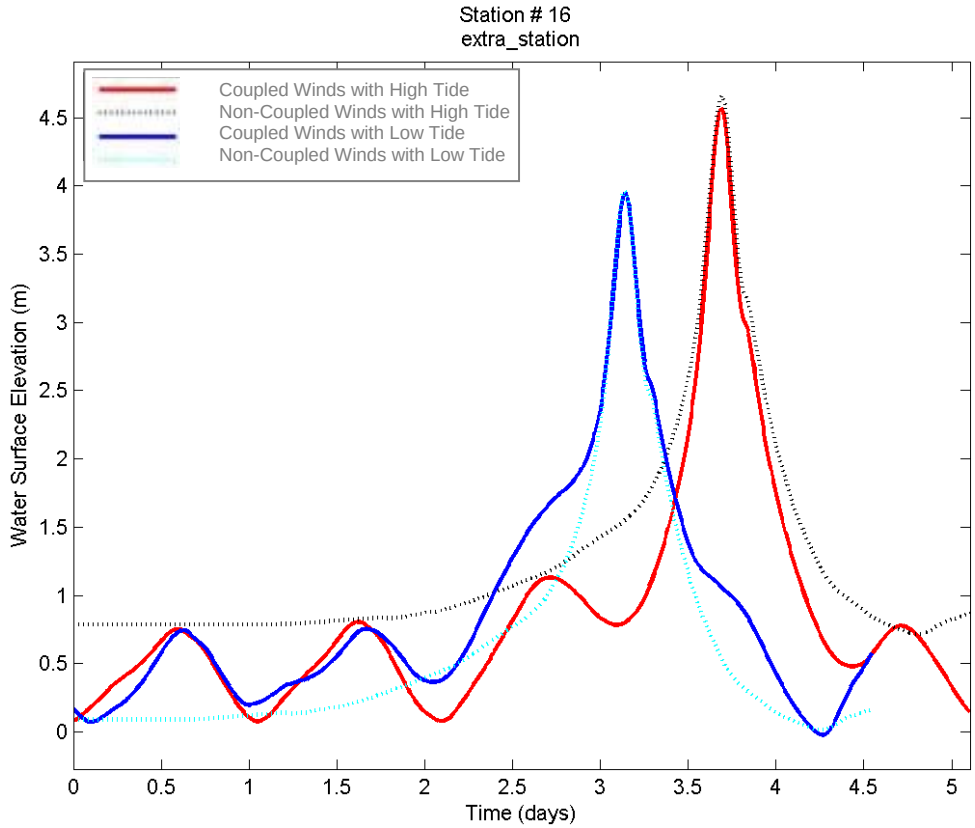


Figure B-13. Water level from non-coupled and coupled model runs in Chandeleur Sound, LA (station B3 in Figure B-2).

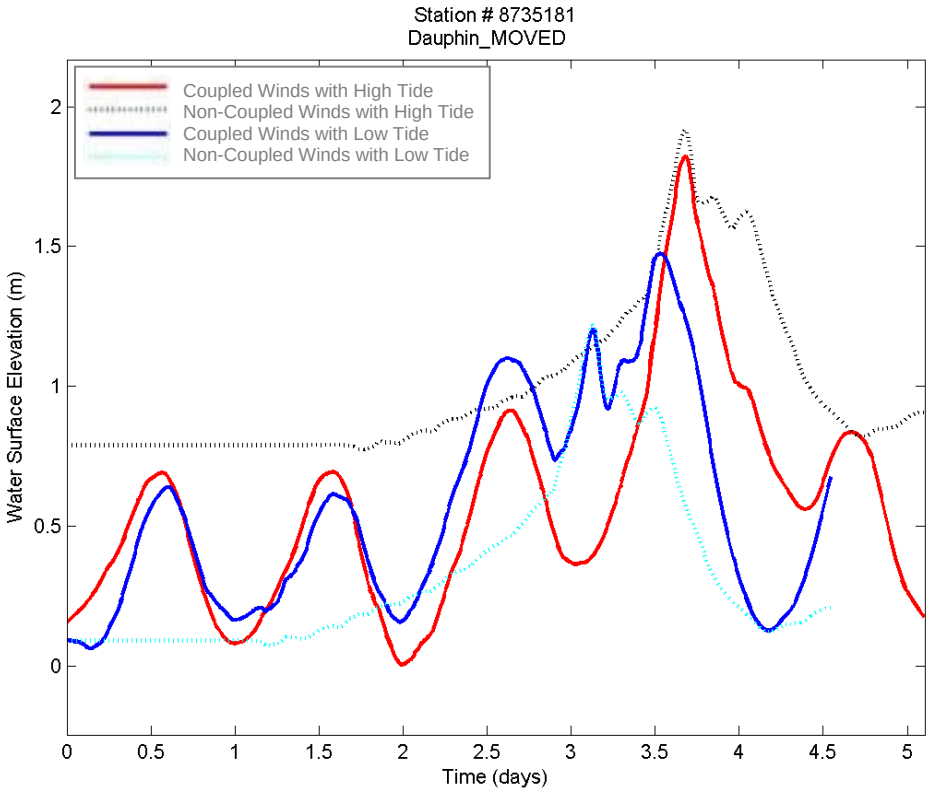


Figure B-14. Water level from non-coupled and coupled model runs at Dauphin Island, AL (station B4 in Figure B-2).

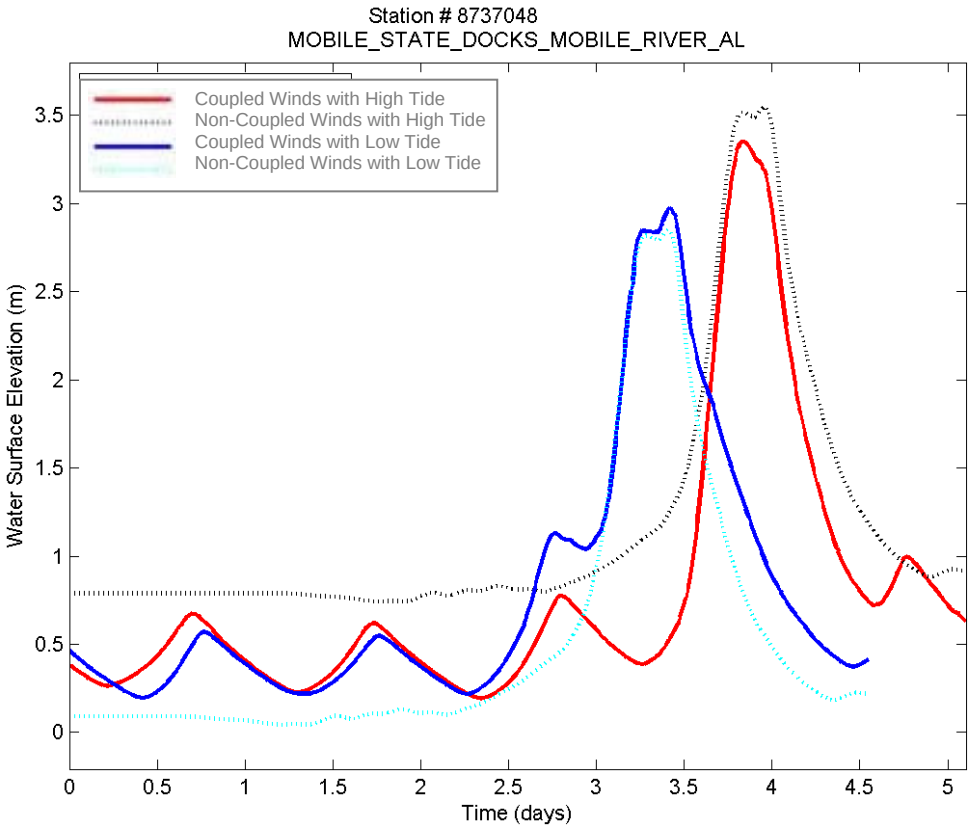


Figure B-15. Water level from non-coupled and coupled model runs at Mobile Bay State Docks, AL (station B5 in Figure B-2).

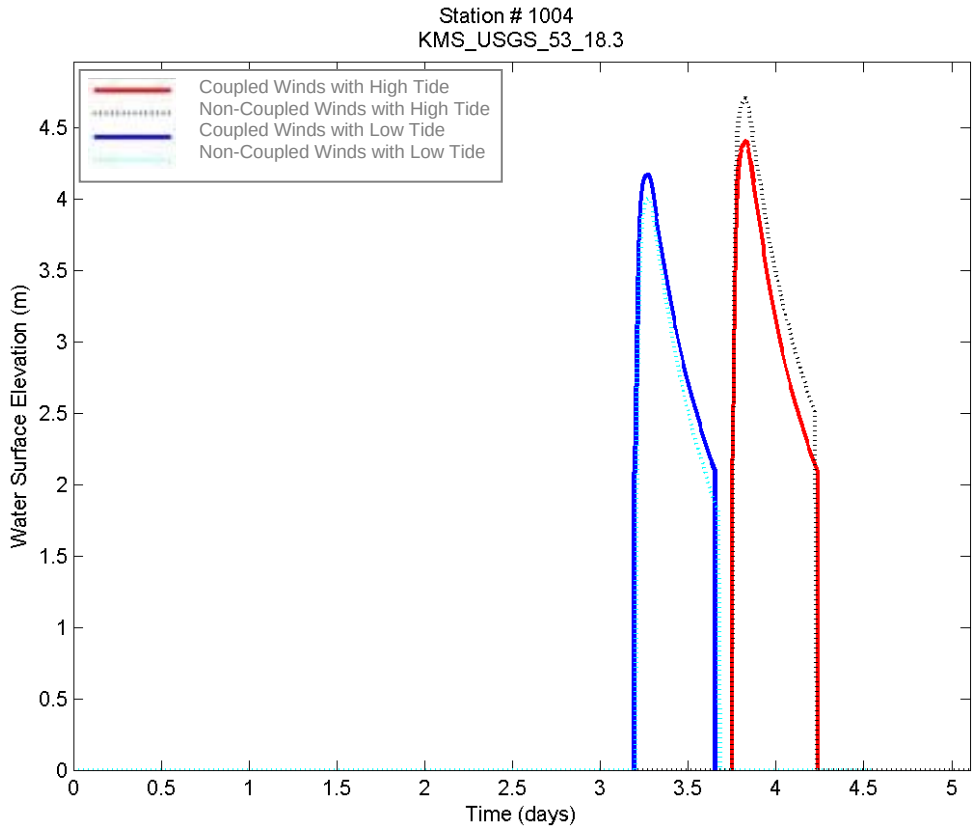


Figure B-16. Water level from non-coupled and coupled model runs at High Water Mark KMS USGS 53-18.3 in Mississippi (station G1 in Figure B-2).

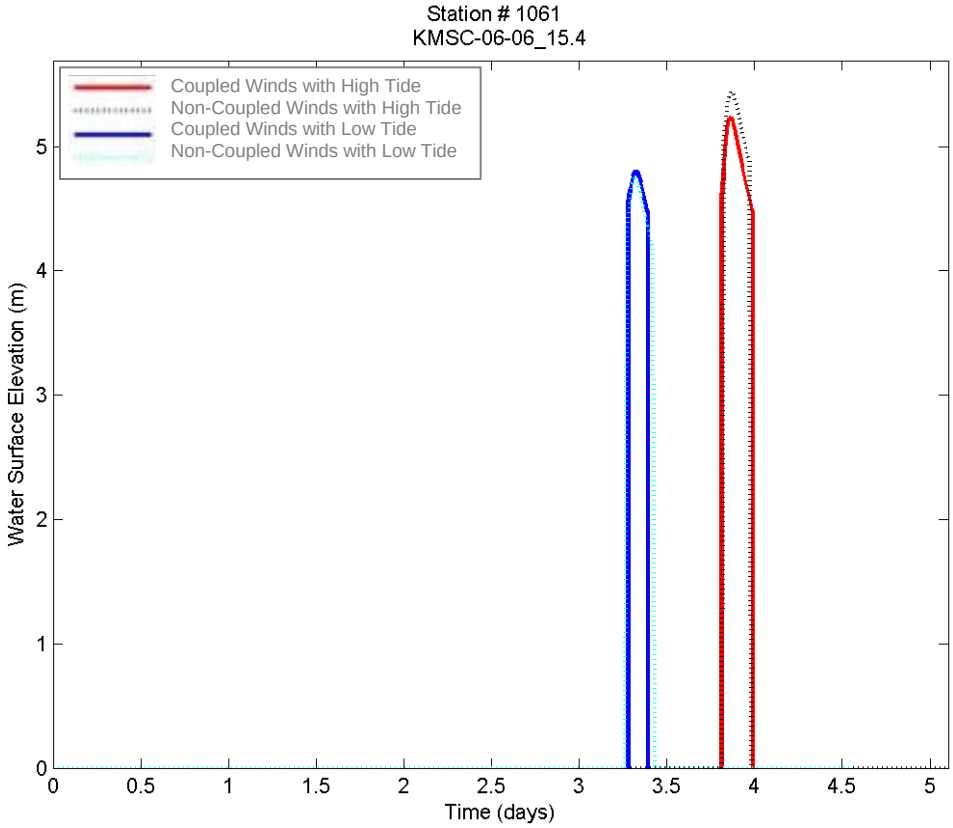


Figure B-17. Water level from non-coupled and coupled model runs at High Water Mark KMS USGS 06-06-15.4 in Mississippi (station G2 in Figure B-2).

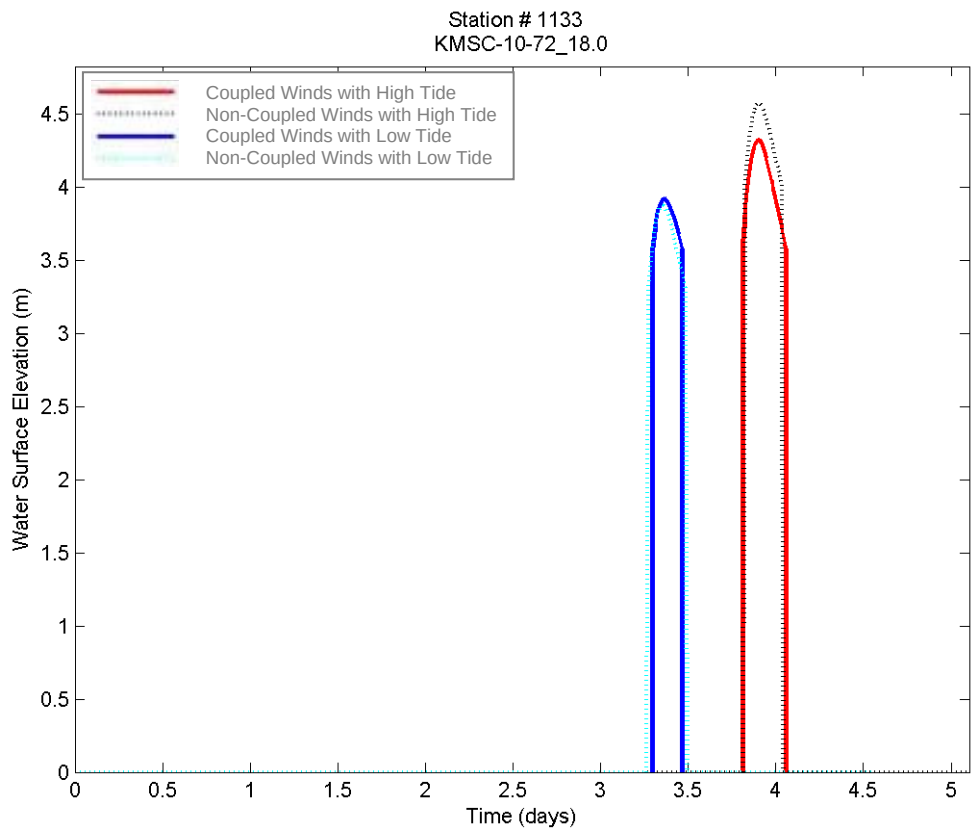


Figure B-18. Water level from non-coupled and coupled model runs at High Water Mark KMSC-1-72-18.0 in Mississippi (station G3 in Figure B-2).

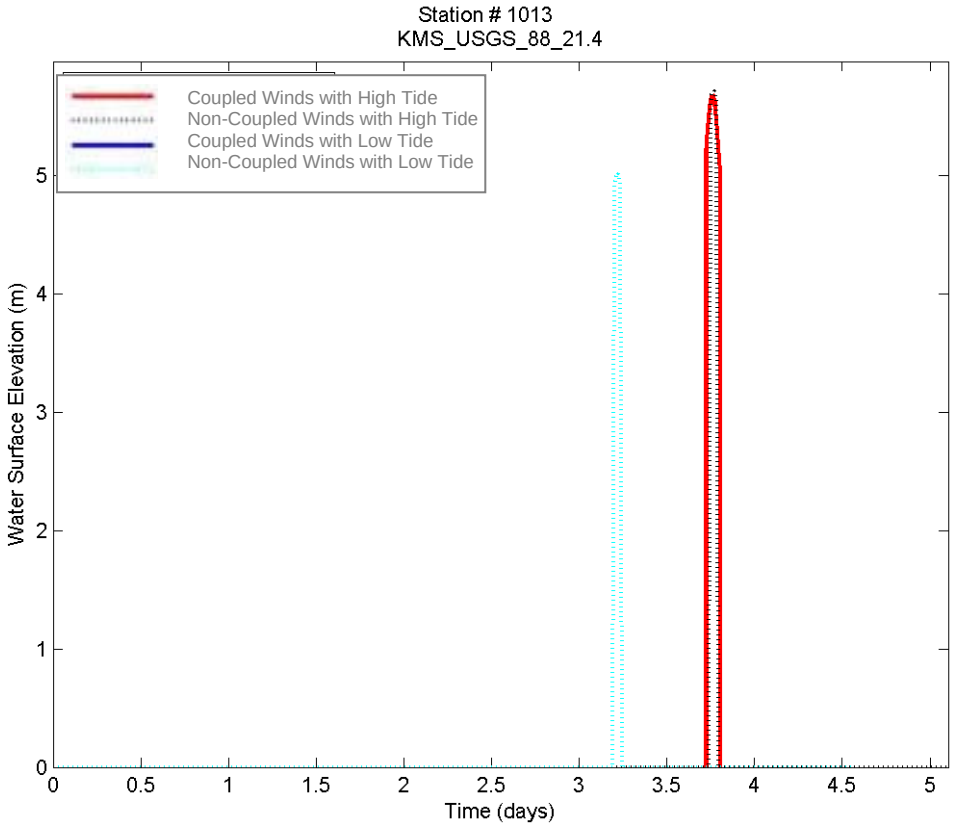


Figure B-19. Water level from non-coupled and coupled model runs at High Water Mark KMSC-88-21.4 in Mississippi (station G4 in Figure B-2).

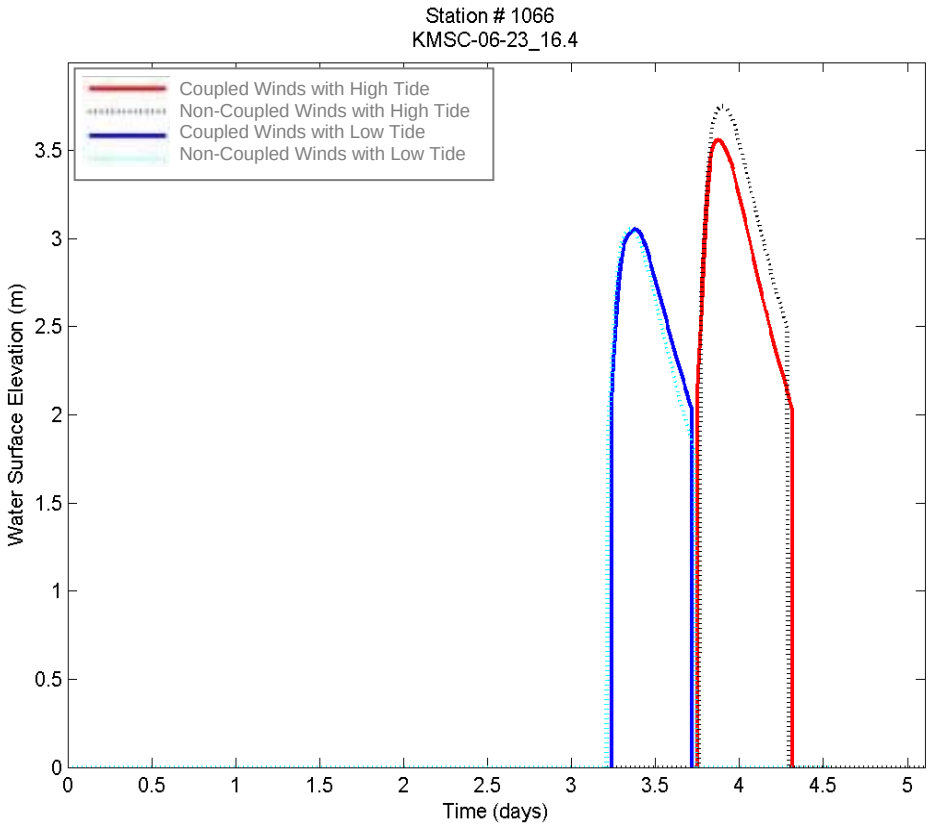


Figure B-20. Water level from non-coupled and coupled model runs at High Water Mark KMSC-6-23-16.4 in Mississippi (station G5 in Figure B-2).

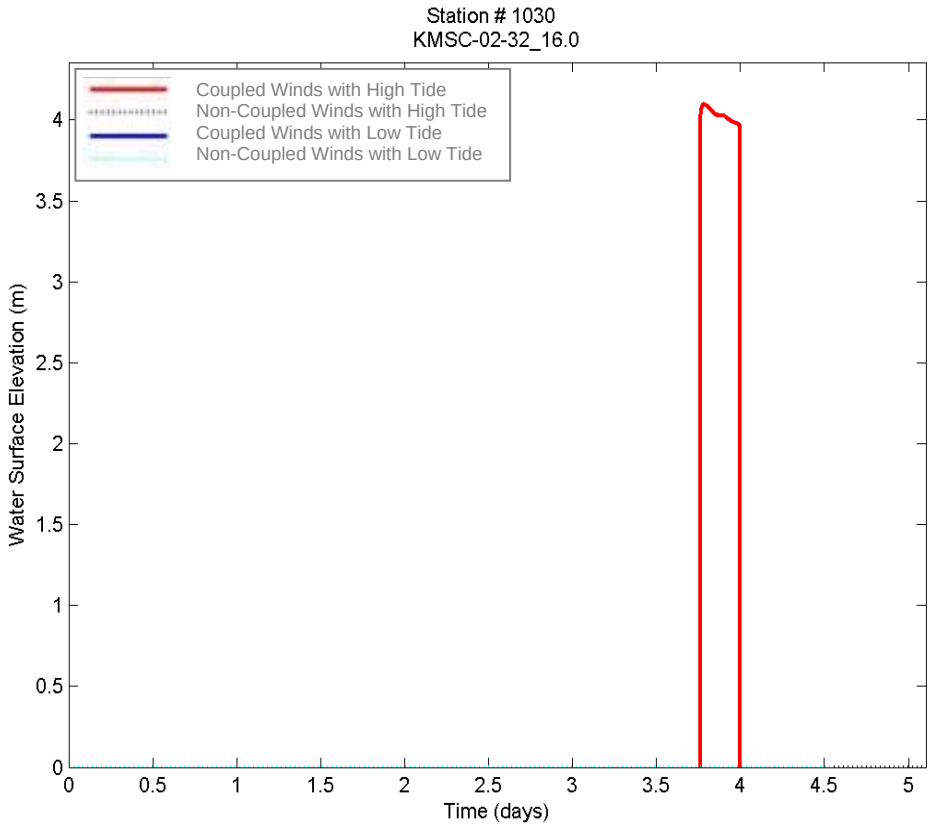


Figure B-21. Water level from non-coupled and coupled model runs at High Water Mark KMSC-02-32 16.0 in Mississippi (station G6 in Figure B-2).

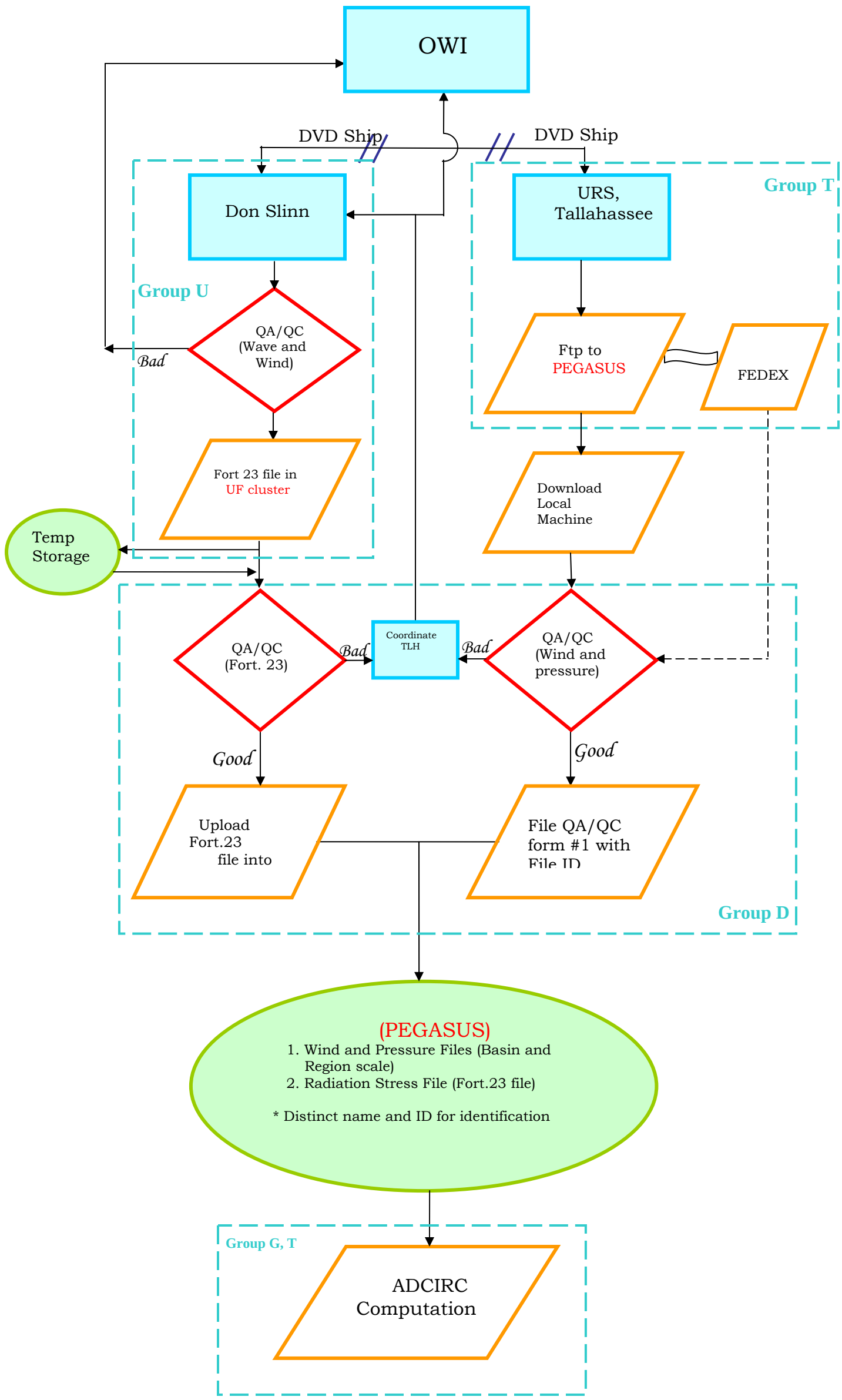
Within Mississippi, the non-coupled and coupled cases are very similar (within 10 centimeters), with the non-coupled case generally overpredicting the coupled winds and tides results (listed as a negative difference in Table B-1). In the locations where the nodes initially began dry, in some cases the non-coupled and coupled cases record the surge within a couple of centimeters. In other cases, the surge can be nearly 30 centimeters different. At station G6, the coupled model run timed at high tide produces enough surge to wet the initially dry location, but the non-coupled case (and for both low tide cases) (where the model was run with just winds and then the high tide value from Waveland added only to the nodes that got wet), the node remains dry. This case is also illustrated in Figure B-1 where the boundary of the surge from the coupled case extends beyond that of the non-coupled case. Outside of Mississippi, the difference between the coupled and non-coupled cases increases. There are some locations where this difference is close to 10 centimeters, but in other cases, such as in Lake Pontchartrain, where the tidal effects are much smaller than those near Waveland, the difference is greater than 40 centimeters. Overall, the difference between the coupled and non-coupled cases at high tide is generally greater than the difference between the coupled and non-coupled cases at low tide.

Table B-1. List of Stations shown in Figure B-2. along with the peak surge from the coupled and non-coupled tests at high tide and the coupled and non-coupled tests at low tide and the difference between those in meters.

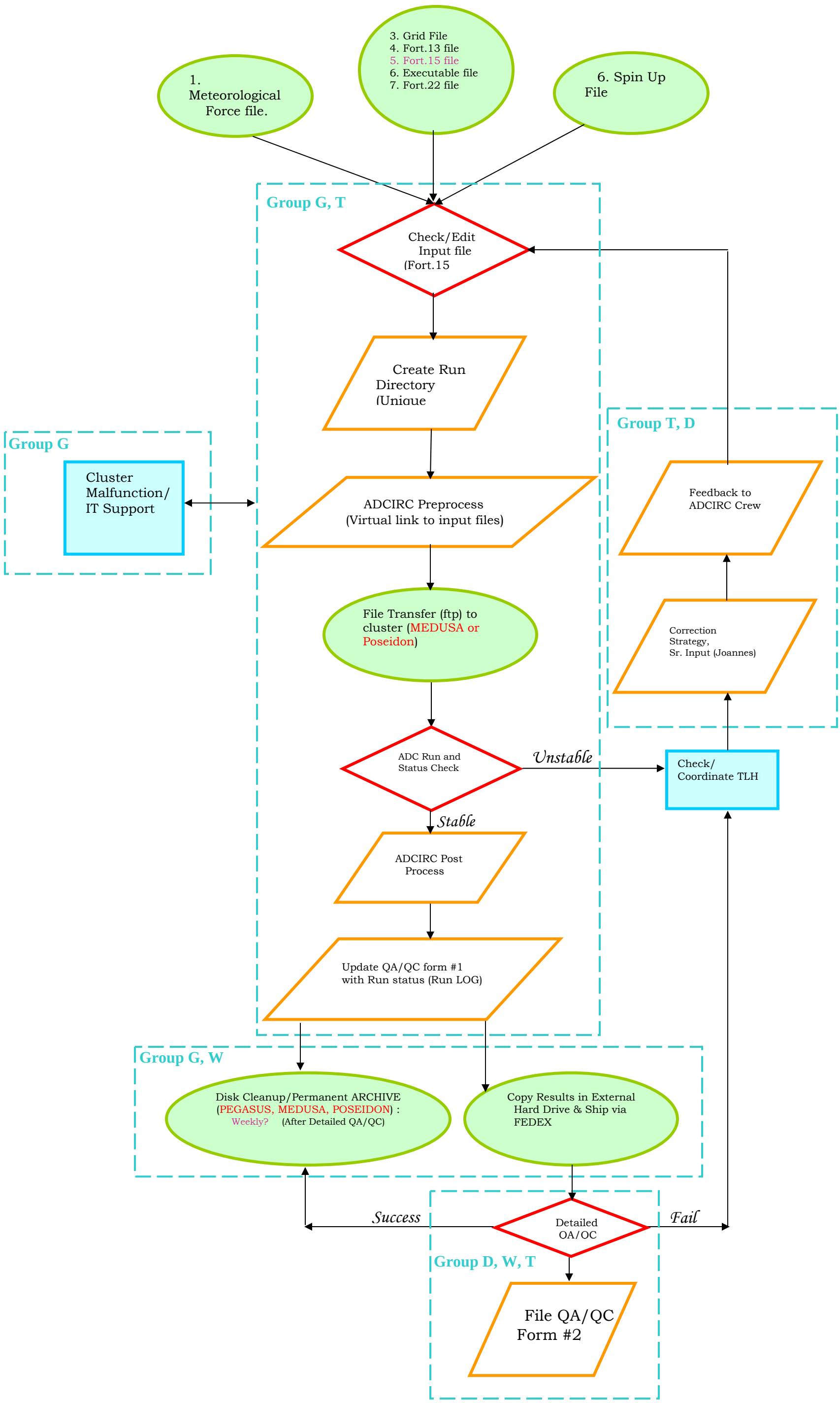
Figure 4.2 ID	Station ID #	Coupled Peak Surge at High Tide (m)	Non-coupled Peak Surge at High Tide (m)	Difference at High Tide (m)	Coupled Peak Surge at Low Tide (m)	Non-coupled Peak Surge at Low Tide (m)	Difference at Low Tide (m)
R1	8747766	7.0271	7.1110	-0.0839	6.4247	6.4125	0.0122
R2	8747437	6.7400	6.8391	-0.0990	6.1425	6.1406	0.0019
R3	115	6.6321	6.6660	-0.0339	5.9588	5.9675	-0.0087
R4	8745557	6.4147	6.4367	-0.0219	5.7058	5.7382	-0.0324
R6	33	5.2739	5.2869	-0.0130	4.5691	4.5884	-0.0193
R7	31	4.1232	4.1332	-0.0100	3.3887	3.4347	-0.0459
R8	8752221	3.5847	3.5716	0.0131	2.8206	2.8731	-0.0525
R9	7	3.0060	2.9351	0.0709	2.1158	2.2366	-0.1208
B1	48	2.3611	2.7867	-0.4256	2.3763	2.0882	0.2881
B2	8760551	2.2406	2.2744	-0.0338	1.4217	1.5759	-0.1542
B3	16	4.5629	4.6602	-0.0973	3.9450	3.9617	-0.0167
B4	8735181	1.8220	1.9183	-0.0963	1.4745	1.2198	0.2547
B5	8737048	3.3486	3.5486	-0.2000	2.9727	2.8501	0.1226
G1	1004	4.4049	4.7028	-0.2979	4.1687	4.0043	0.1644
G2	1061	5.2369	5.4429	-0.2060	4.8020	4.7444	0.0577
G3	1133	4.3200	4.5737	-0.2537	3.9177	3.8752	0.0424
G4	1013	5.6820	5.7175	-0.0356	dry	5.0190	
G5	1066	3.5585	3.7492	-0.1907	3.0506	3.0507	-0.0001
G6	1030	4.1061	dry		dry	dry	

Appendix C
Production Run Block Diagram

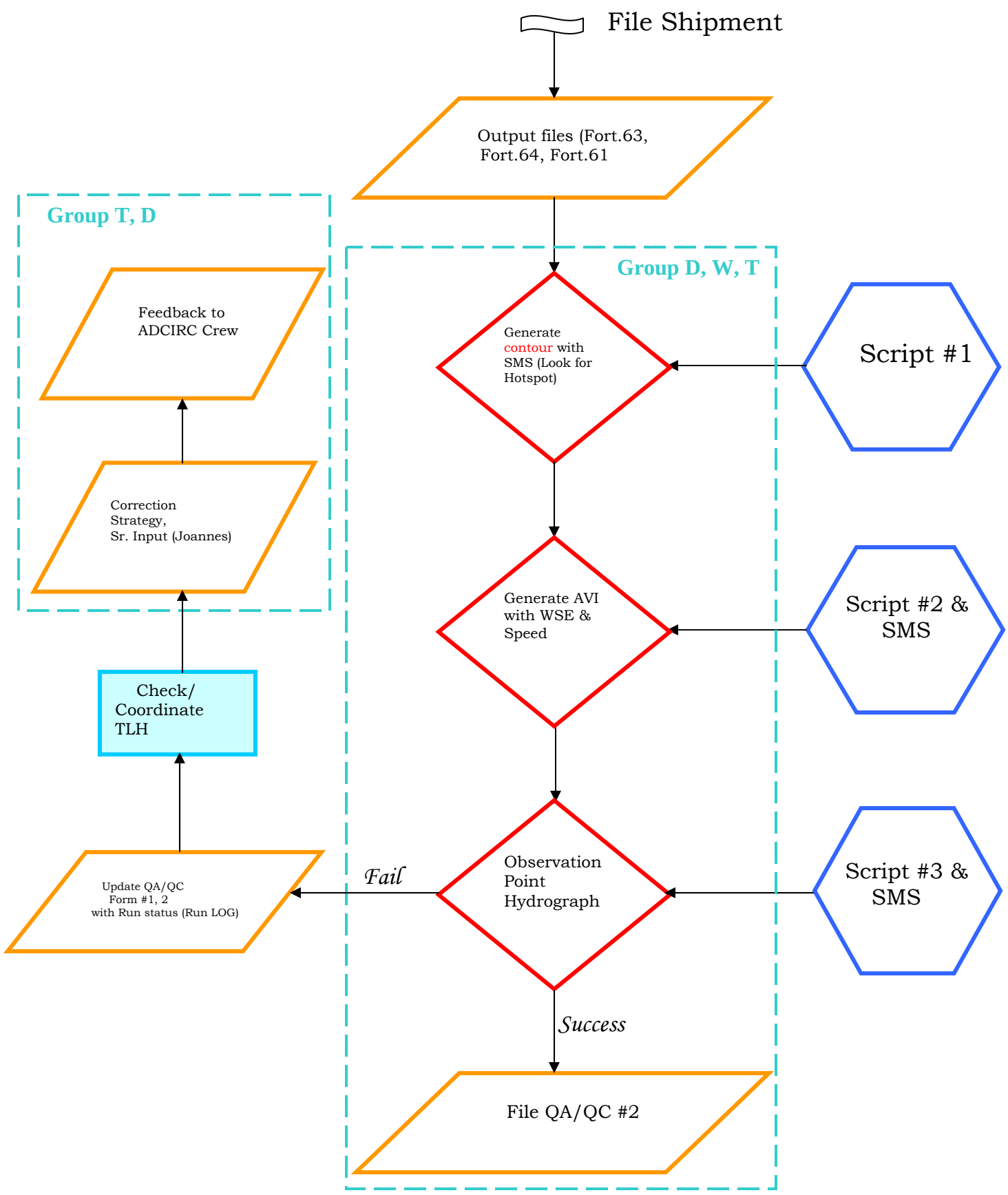
Input File Process & QA/QC



ADCIRC Pre and Post



ADCIRC Detailed



Appendix D
Production Run Input File QA/QC Forms

Sample Input File QA/QC (Run ID JOS6001A)

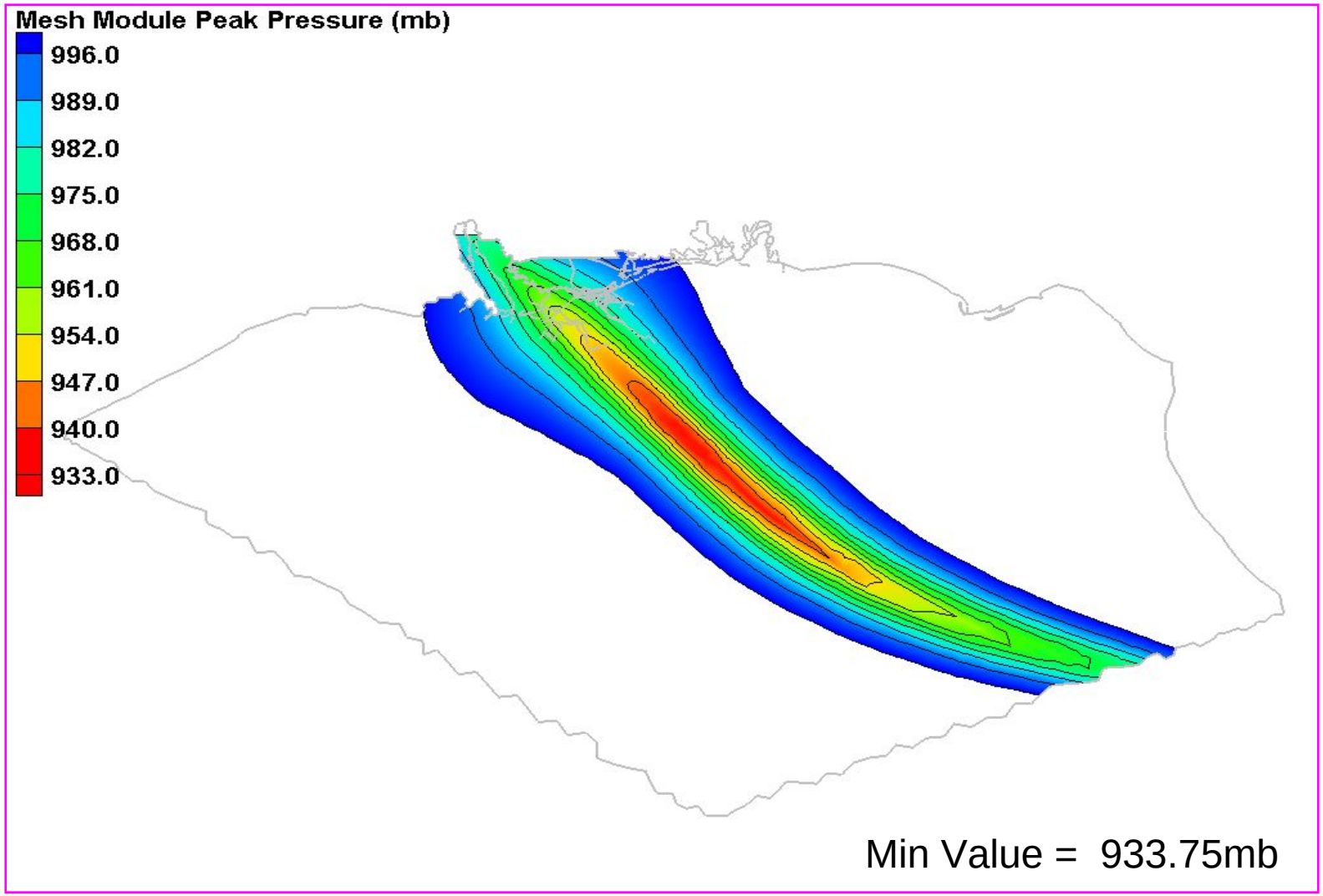


Figure D-1: Peak Pressure from the OW Met Files (Extended Domain)
Run ID : JOS 6001 A

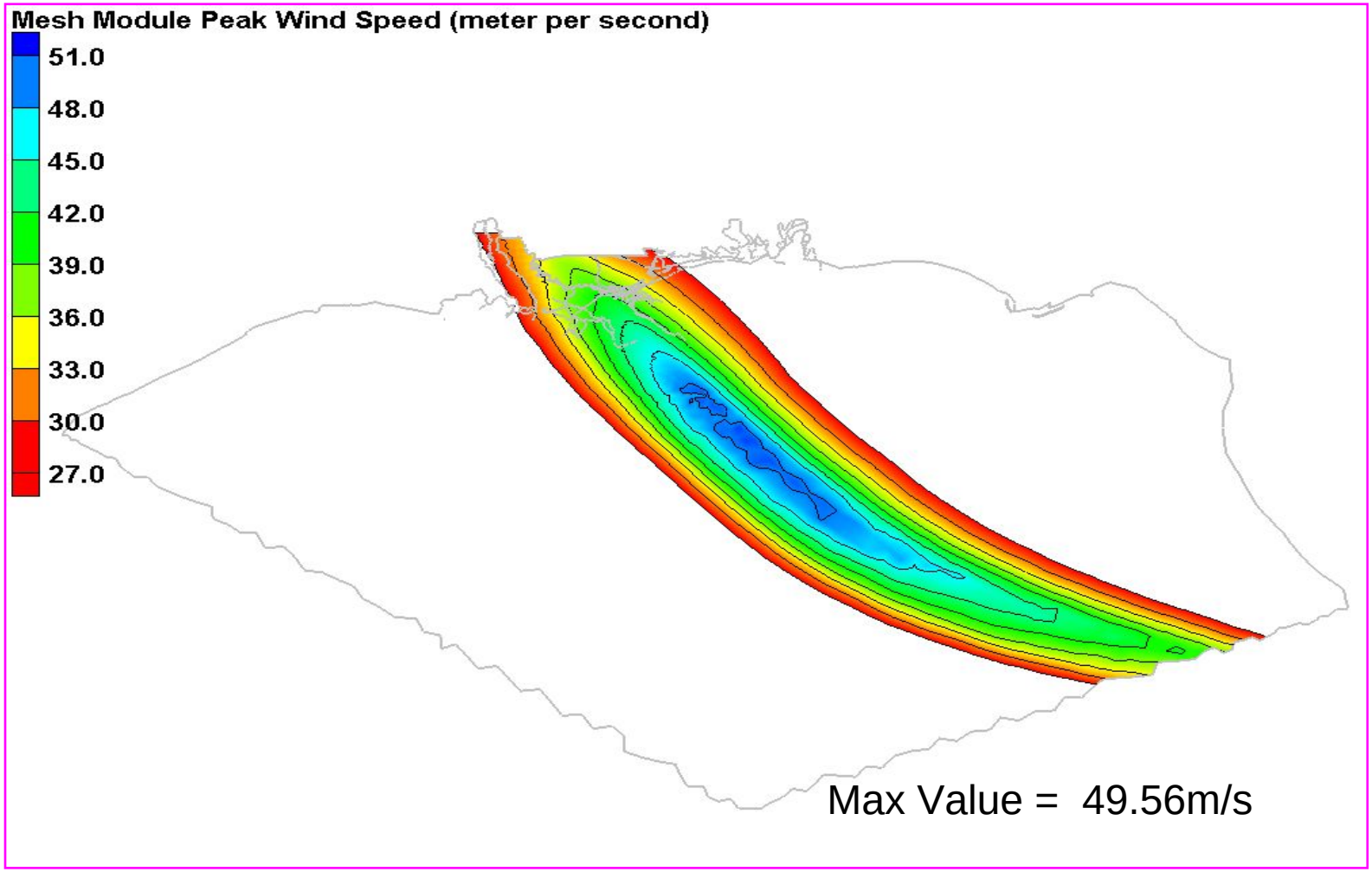


Figure D-2: Peak Wind Speed from the OW Met Files (Extended Domain)
Run ID : JOS 6001 A

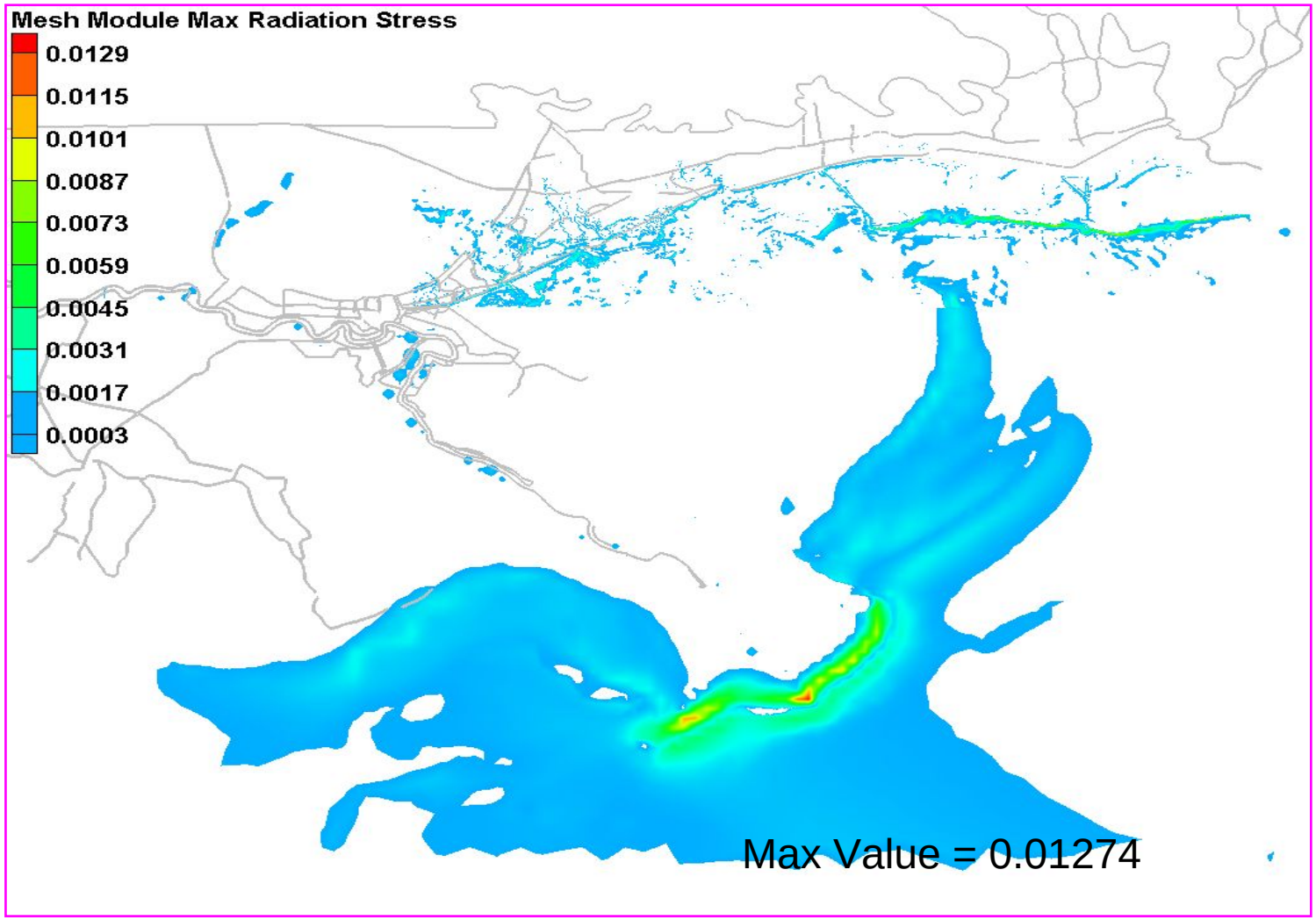


Figure D-3: Maximum Radiation Stress from fort.23 (Extended Domain)
Run ID: JOS 6001 A

Sample Input File QA/QC Form (Run ID JOS6001A)

QA-QC FORM #1 (Input File Analyses Log)

URS

ORIGINATOR

CLIENT:	FEMA Region IV	PROJECT NUMBER: 15707018	PROJECT NAME HMTAP Coastal Analysis for Mississippi
DOCUMENT BEING REVIEWED:	Input Files for RUN ID: JOS6001A		
FILE INFORMATION (Fort.23):	Rad. Stress File: JOS6001A.msgrid.23		File Size: 1.347GB
FILE INFORMATION (REGIONAL):	Wind File: JOS6001A_Region.win		Pressure File: JOS6001A_Region.pre
FILE INFORMATION (BASIN):	Wind File: JOS6001A_Basin.win		Pressure File: JOS6001A_Basin.pre
STORM DURATION (Day)	Total Duration: 3.590		Landfall Time: 2.590
RAD FILE DURATION (Day)	Total Duration: 3.625		Peak Time: 2.625
REVIEW TYPE:	☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP		
DATE: 02/20/2007	INPUT FILE STATUS: ☒ Good ☐ Bad ☐ Other		
FILE ANALYSES (CONTOUR, AVI):			

ORIGINATOR:	H. Das & A. Whitworth	ORGANIZATION:	☒ URS ☐ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____
REVIEWER:	Yi Zheng & E. Drei-Horgan	ORGANIZATION:	☐ URS ☐ Client ☐ FEMA ☒ Dewberry ☐ Watershed ☐ Other_____

RESOLUTION	ORIGINATOR	Sign & Date	REVIEWER	Sign & Date
	[signature]	2/28/2007	Yi zheng	03/02/2007

PROJECT MANAGER/ PRINCIPLE–IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Disp.	Response	Ver.
1	Slide 4 in Chk_Inputfiles_JOS6001A.ppt	Irregular contours approximate the max peak wind speed near the coast.	D	Irregular fluctuations are produced during the interpolation between the coarser Basin domain and the finer Region domain. These fluctuations are well within acceptable limits.	AW
2					
3					

INITIAL DISPOSITION CODES: C = Will Comply D = Delete Comment F = Further Clarify

FINAL DISPOSITION CODES: C D Ver: Incorporation of C (Initials)

CC: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Sample Input File QA/QC (Run ID CAT2001A)

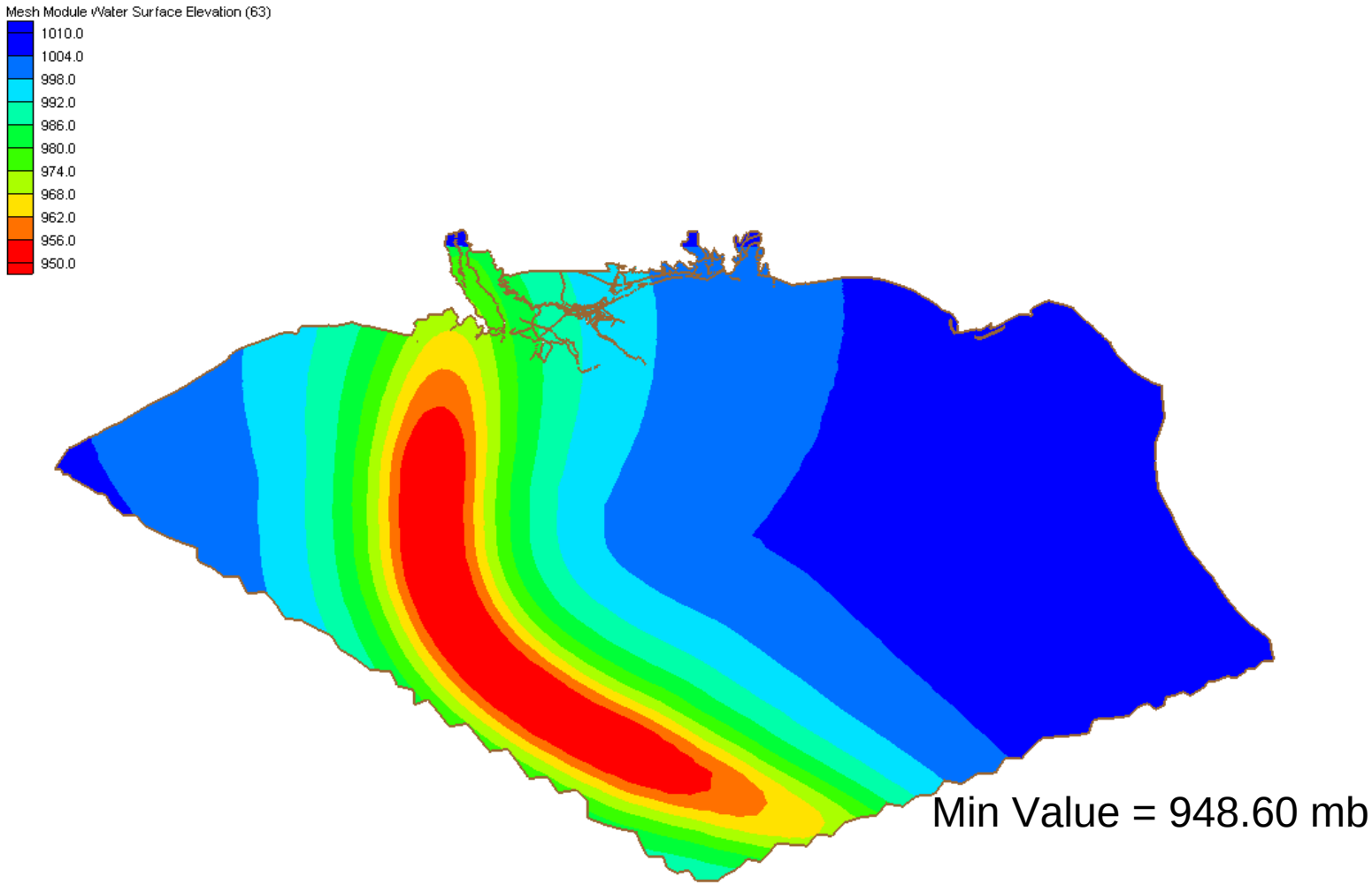


Figure D-4: Peak Pressure from the OW Met Files (Extended Domain)
Run ID: Cat2001A

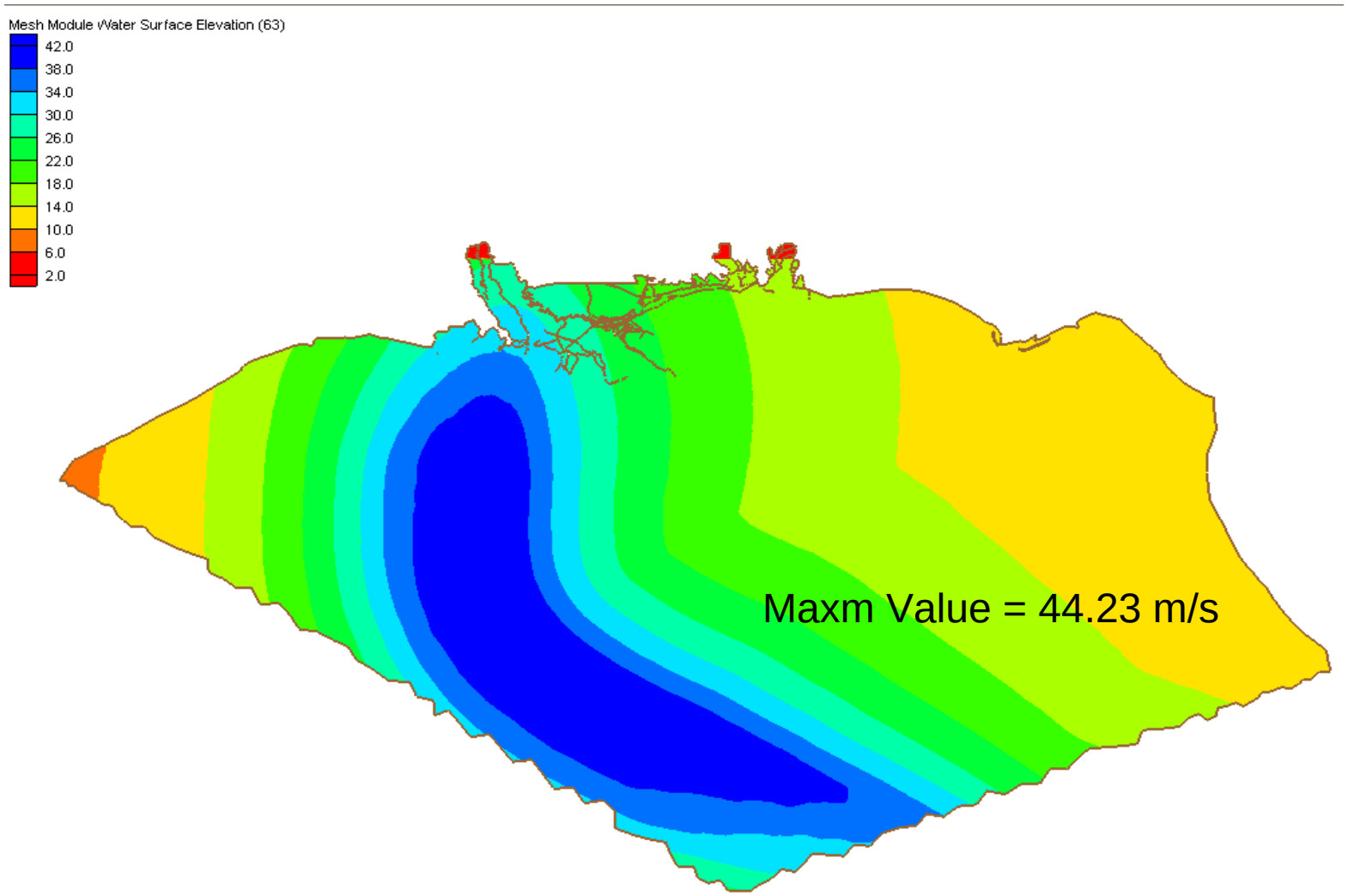


Figure D-5: Peak Wind Speed from the OW Met Files (Extended Domain)
Run ID : Cat2001A

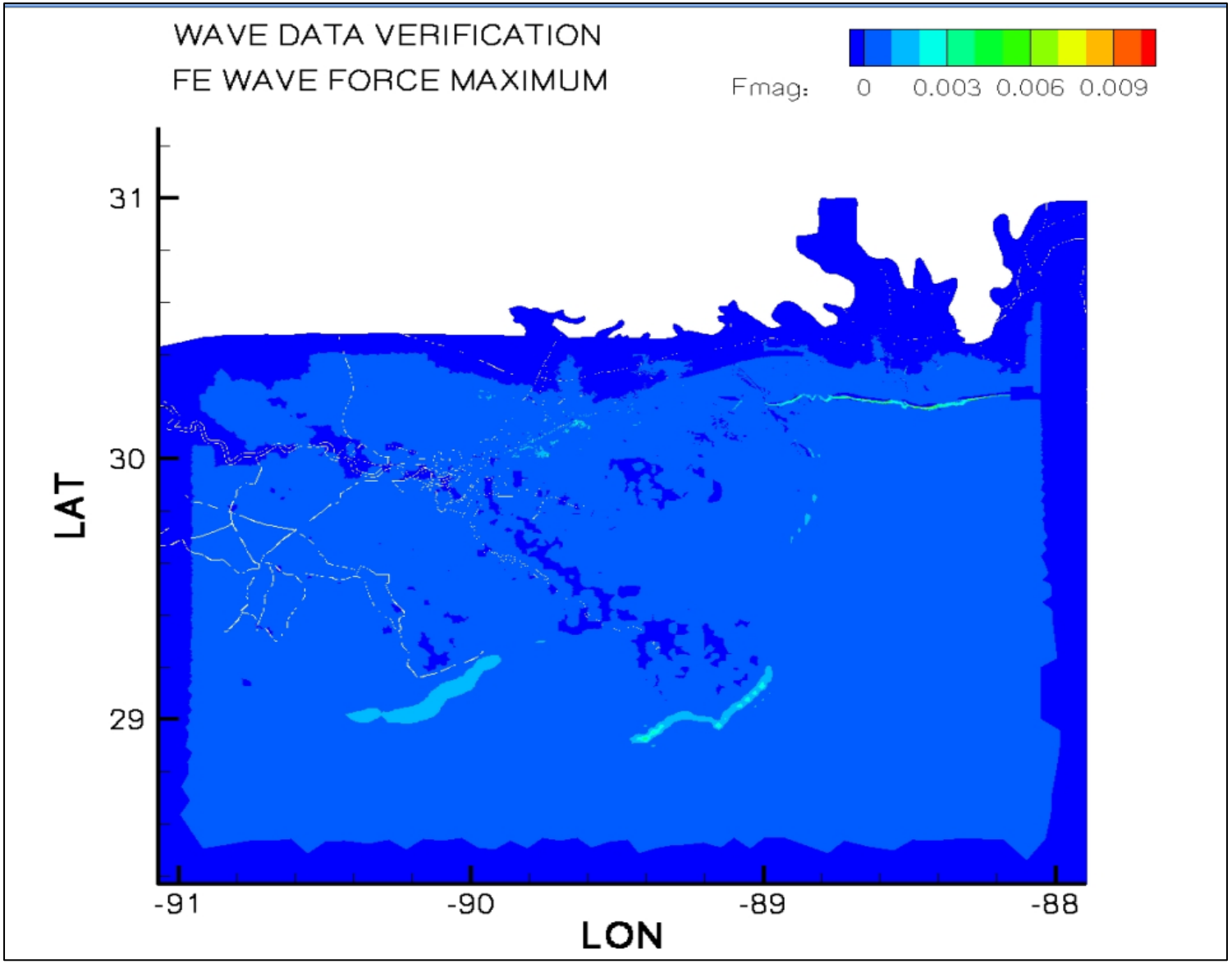


Figure D-6: Maximum Radiation Stress from fort.23 (Extended Domain)
Run ID: JOS 6001 A

Sample Input File QA/QC Form (Run ID CAT2001A)

QA-QC FORM #1 (Input File Analyses Log)

URS

ORIGINATOR

CLIENT:	*FEMA Region IV*	PROJECT NUMBER: *15707018*	PROJECT NAME *HMTAP Coastal Analysis for Mississippi*
DOCUMENT BEING REVIEWED:	*Input Files for RUN ID: CAT2001A*		
FILE INFORMATION (Fort.23):	*Rad. Stress File:*		*File Size:*
FILE INFORMATION (REGIONAL):	*Wind File: CAT2001A_Region.win*		*Pressure File: CAT2001A_Region.pre*
FILE INFORMATION (BASIN):	*Wind File: CAT2001A_Basin.win*		*Pressure File: CAT2001A_Basin.pre*
STORM DURATION (Day)	*Total Duration: 4.01*		*Landfall Time: 3.01*
RAD FILE DURATION (Day)	*Total Duration: xx*		*Peak Time:*
REVIEW TYPE:	☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP		
DATE: *04/03/2007*	INPUT FILE STATUS: ☒ Good ☐ Bad ☐ Other _____		
FILE ANALYSES (CONTOUR, AVI):	*contour*		

ORIGINATOR:	*Andrew Cox, Rob Weaver*	ORGANIZATION:	☐ URS ☒ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☒ OceanWeatherInc
REVIEWER:	*Saiduz zaman*	ORGANIZATION:	☒ URS ☐ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____

RESOLUTION	ORIGINATOR Sign & Date	REVIEWER A.K.M. Saiduzzaman 04/03/2007 Sign & Date

PROJECT MANAGER/ PRINCIPAL–IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Disp.	Response	Ver.
1					
2					
3					

INITIAL DISPOSITION CODES: **C** = Will Comply **D** = Delete Comment **F** = Further Clarify

FINAL DISPOSITION CODES: **C** **D**

Ver: Incorporation of **C** (Initials)

CC: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Appendix E
Production Run Logs

Sample Run Logs QA/QC (Run ID JOS6001A)

QA-QC FORM #2 (Run Status Log)

URS

ORIGINATOR			
CLIENT: *FEMA Region IV*	PROJECT NUMBER: *15707018*	PROJECT NAME *HMTAP Coastal Analysis for Mississippi*	
DOCUMENT BEING REVIEWED: *RUN STATUS for RUN ID(DIRECTORY): JOS6001A*			
RUN IDENTIFICATION:	☒ *MEDUSA* ☐ *POSEIDON* ☐ *DOE*	NO. OF PROCESSORS: 128	
FILE INFORMATION:	*Grid File: MS11g_WPOST.grd*	*Met. File:JOS6001A*	
RUN INFORMATION:	*Start Date & Time: 02/11/07 18:49:29*	*End Date & Time: 2/12/07 2:01:05*	
RUN STATUS	☒ *Stable* ☐ *Unstable* ☐ *Other*_____		
CLUSTER STATUS	FULLY OPERATIONAL		
REVIEW TYPE: ☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP			
DATE: *2/15/07*	NAME & ORGANIZATION: Emily Dhingra, URS-Gaithersburg		
GENERAL COMMENT			

DETAILED QA/QC:	☒ SUCCESS	☐ FAIL	☐ Other_____
REVIEWER: *HD*	ORGANIZATION:	☒ URS ☐ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____	

RESOLUTION	ORIGINATOR Sign & Date	Emily Dhingra 3/19/2007	REVIEWER Sign & Date	3/19/2007

PROJECT MANAGER/ PRINCIPLE–IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Disp.	Response	Ver.
1					
2					
3					
4					
5					

INITIAL DISPOSITION CODES: **C** = Will Comply **D** = Delete Comment **F** = Further Clarify

FINAL DISPOSITION CODES: **C** **D**

Ver: Incorporation of **C** (Initials)

C: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Sample Run Logs QA/QC (Run ID JOS6001A)

QA-QC FORM #2 (Run Status Log)

URS

ORIGINATOR

CLIENT: *FEMA Region IV* PROJECT NUMBER: *15707018* PROJECT NAME *HMTAP Coastal Analysis for Mississippi*

DOCUMENT BEING REVIEWED: *RUN STATUS for RUN ID(DIRECTORY): CAT2001A*

RUN IDENTIFICATION: ☒ *MEDUSA* ☐ *POSEIDON* ☐ *DOE* | NO. OF PROCESSORS: 64

FILE INFORMATION: *Grid File: MS11i_WPOST.grd* | *Met. File: Cat2001A*

RUN INFORMATION: *Start Date & Time: 04/06/07 14:16:11* | *End Date & Time: 04/07/07 02:58:35*

RUN STATUS ☒ *Stable* ☐ *Unstable* ☐ *Other*_____

CLUSTER STATUS FULLY OPERATIONAL

REVIEW TYPE: ☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP

DATE: *04/09/07* *NAME & ORGANIZATION: Emily Dhingra, URS-Gaithersburg* Emily Dhingra

GENERAL COMMENT

DETAILED QA/QC: ☒ SUCCESS ☐ FAIL ☐ Other_____

REVIEWER: *HD* ORGANIZATION: ☒ URS ☐ Client ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____

RESOLUTION ORIGINATOR Sign & Date Emily Dhingra 4/20/2007 | REVIEWER Sign & Date 4/27/2007

PROJECT MANAGER/ PRINCIPLE–IN-CHARGE/ DESIGNEE Sign & Date 3/19/2007

No.	Reference	Comment	Disp.	Response	Ver.
1					
2					
3 4					
5					

INITIAL DISPOSITION CODES: **C** = Will Comply **D** = Delete Comment **F** = Further Clarify | **FINAL DISPOSITION CODES:** **C** **D** | **Ver:** Incorporation of **C** (Initials)

C: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Appendix F
Production Run Output File QA/QC Forms

Sample Output File QA/QC (Run ID JOS6001B)

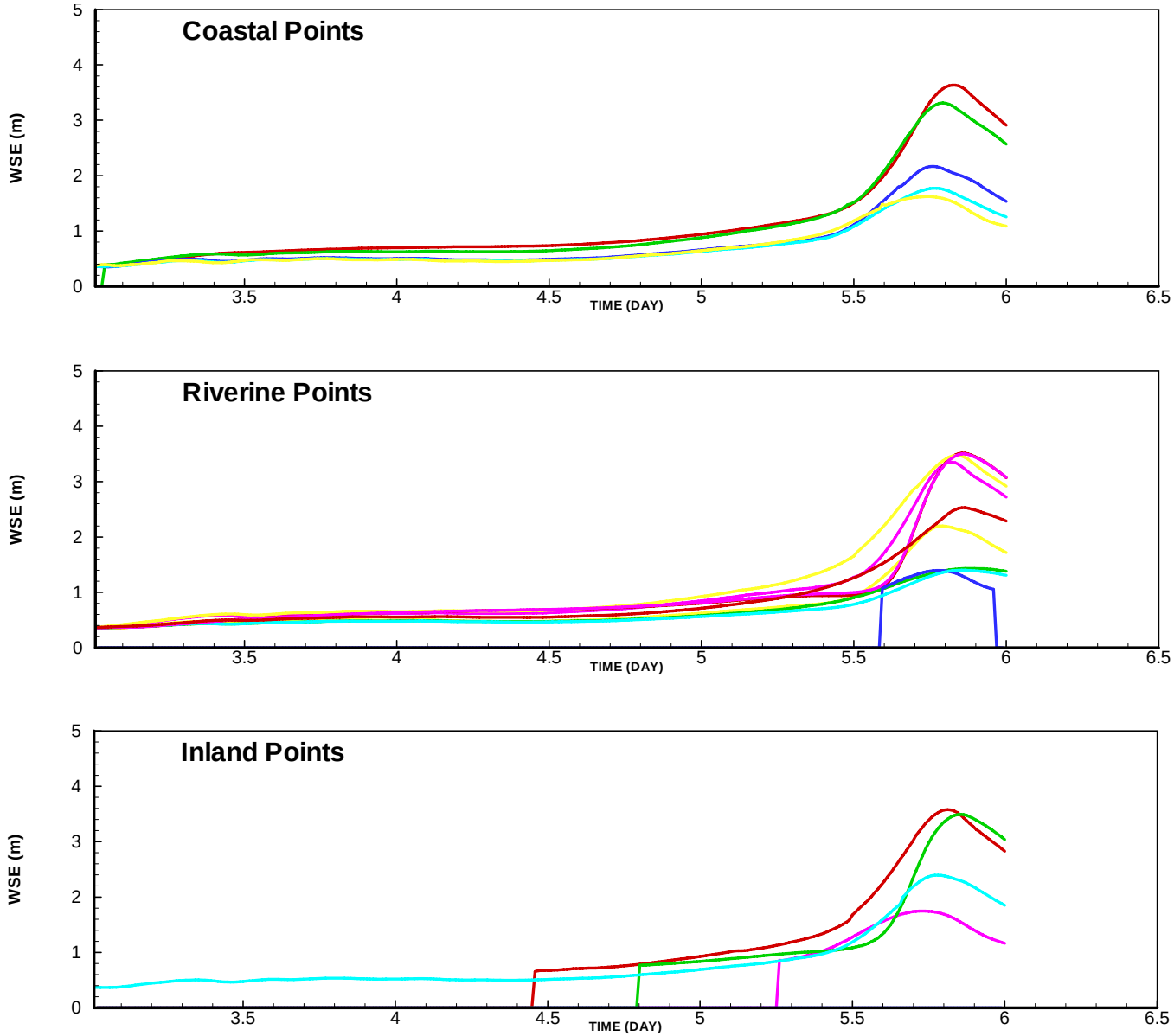


Figure F-1. Hydrographs of selected points

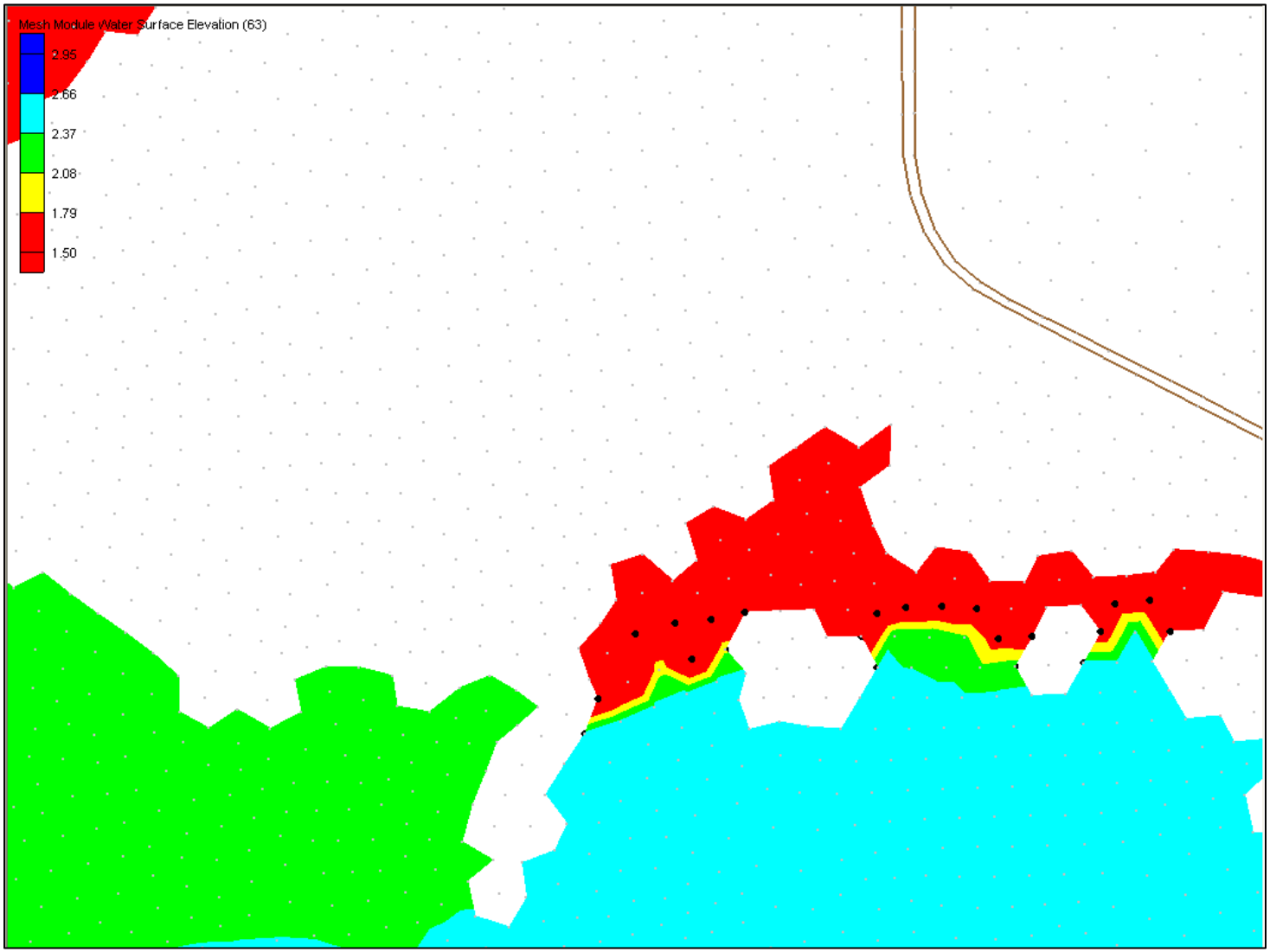


Figure F-2. Location of Hot Spots

QA-QC FORM #3 (DETAILED CHECK OF ADCIRC RUNS)

URS

ORIGINATOR	CLIENT: *FEMA Region IV*	PROJECT NUMBER: *15707018*	PROJECT NAME *HMTAP Coastal Analysis for Mississippi*
	DOCUMENT BEING REVIEWED: *Detailed Check for RUN ID: JOS6001B_output*		
	INPUT FILES (Gr. 1): *Global WSE File:*	*Global Spd File:*	
	INPUT FILES (Gr. 2): *Time Series File: JOS6001B.fort.61*		
	INPUT FILES (Gr. 3): *Maxm WSE File: JOS6001B_maxele.63*	*Maxm Spd File: JOS6001B_maxvel.63*	
	FILE ANALYSES : *JOS6001B_mytimeseries.dat, JOS6001B_frequency.dat, JOS6001B_station.dat*		
	REVIEW TYPE: ☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP		
	DATE:	ADC RUN STATUS: ☒ Good ☐ Bad ☐ Other_____	
	GENERAL COMMENT:	*Select JPM Hydrographs appear normal based on JOS6001B_fort.61 file.*	

ORIGINATOR: *Himangshu Das*	ORG: ☒ URS ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____	Sign & Date 3/19/2007
REVIEWER1(R1) *Saiduz Zaman*	ORG: ☒ URS ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____	Sign & Date A.K.M. Saiduzzaman 3/19/2007
REVIEWER2(R2) *Kulvir Singh*	ORG: ☐ URS ☐ FEMA ☐ Dewberry ☒ Watershed ☐ Other_____	Sign & Date 3/26/2007

PROJECT MANAGER/ PRINCIPLE–IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Rev#	Disp.	Response	Ver.
1	JPM3226	Portion of hydrograph oscillates between 0.7 to 0.0 m	R2	D	Oscillation from wetting/drying, not instability. High Land Elev	KS
2	JPM6692	Portion of hydrograph oscillate between 0.0 and 3.2 m	R2	D	Oscillation from wetting/drying, not instability. High Land Elev	KS
3	ID 428150	Sudden drop in WSE	R2	D	Points lie in MRGO Channel (Out of study area)	KS
4	ID 312514	Sudden drop in WSE	R1	D	Proximity to the Dry-Wet zone	SZ

INITIAL DISPOSITION CODES: **C** = Will Comply **D** = Delete Comment **F** = Further Clarify | **FINAL DISPOSITION CODES:** **C** **D** | **Ver:** Incorporation of **C** (Initials)

CC: PROJECT QUALITY ASSURANCE FILE, OFFICE QUALITY ASSURANCE OFFICE

Figure F-3. QA-QC Form.

Sample Output File QA/QC (Run ID CAT2001B)

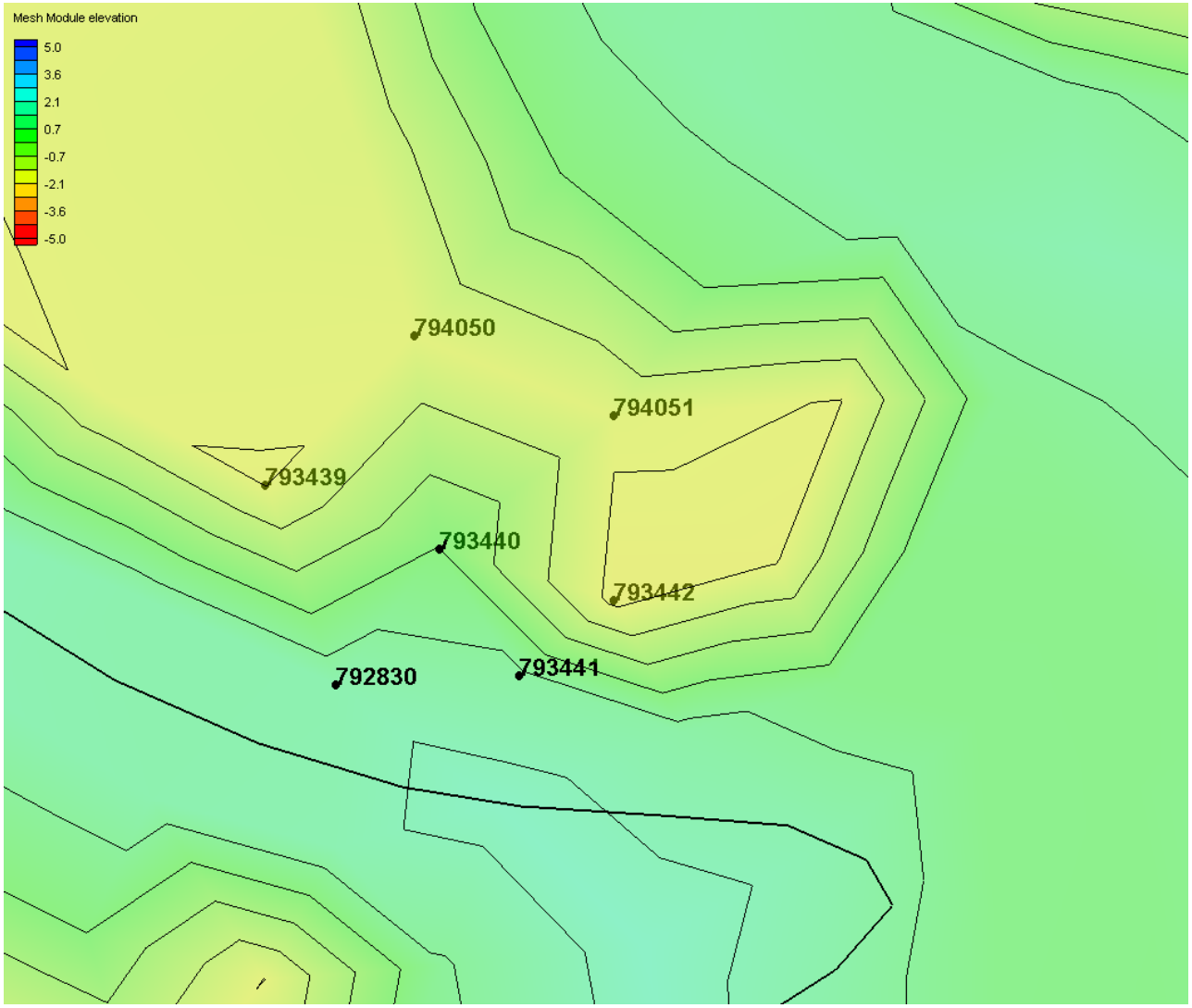


Figure F-4. Location of Hot Spots.

QA-QC FORM #3 (DETAILED CHECK OF ADCIRC RUNS)

URS

ORIGINATOR	CLIENT: *FEMA Region IV*	PROJECT NUMBER: *15707018*	PROJECT NAME *HMTAP Coastal Analysis for Mississippi*
	DOCUMENT BEING REVIEWED: *Detailed Check for RUN ID: CAT2001B_output*		
	INPUT FILES (Gr. 1): *Global WSE File:*	*Global Spd File:*	
	INPUT FILES (Gr. 2): *Time Series File: CAT2001B _fort.61*		
	INPUT FILES (Gr. 3): *Maxm WSE File: CAT2001B_maxele.63*	*Maxm Spd File:*	
	INPUT FILES (Gr. 4): *Maxm Wind Speed File:*	*Min Pressure File:*	
	FILE ANALYSES : *CAT2001B_mytimeseries.dat, CAT2001B_Frequency.dat, CAT2001B_Station.dat*		
	REVIEW TYPE: ☒ Detailed Check ☐ ITR ☐ Client ☐ FEMA/NSP		
	DATE: *04/14/07*	ADC RUN STATUS: ☐ Good ☐ Bad ☒Other_____	
	GENERAL COMMENT:	*Low spot(anomalous WSE) detected while analyzing CAT2001B_maxele.63. Hydrographs, plotted*	
		based on the ANALYSES FILES, does not show any problem.	

ORIGINATOR: *Himangshu Das*	ORG: ☒ URS ☐ FEMA ☐ Dewberry ☐ Watershed ☐ Other_____	Sign & Date 5/13/2007
REVIEWER1(R1) *Yi Zheng & Long Xu*	ORG: ☐ URS ☐ FEMA ☒ Dewberry ☐ Watershed ☐ Other_____	Sign & Date Verified on 8/24/07
REVIEWER2(R2) *Saiduz Zaman*	ORG: ☐ URS ☐ FEMA ☐ Dewberry ☒ Watershed ☐ Other_____	Sign & Date A.K.M. Saiduzzaman 5/13/2007

PROJECT MANAGER/ PRINCIPLE–IN-CHARGE/ DESIGNEE
Sign & Date

No.	Reference	Comment	Rev#	Disp.	Response	Ver.
1	Slide 1&2 in WSE_CAT2001B.ppt	Low spot of WSE at node# 793440	1	D	This spot is due to drastic change in topography and close proximity to adjacent channel. Z values of surrounding nodes average -1.0954755 as opposed to 0.019957 at node# 793440. This anomaly, however, is of localized nature. Therefore it does not indicate any model instability. See WSE_CAT2001B_urs.ppt	EDH

INITIAL DISPOSITION CODES: **C** = Will Comply **D** = Delete Comment **F** = Further Clarify

FINAL DISPOSITION CODES: **C** **D**

Ver: Incorporation of **C** (Initials)

Figure F-5: QA-QC Form.