In addition to the previously reported work with regards to the St. Johns River, the University of Central Florida is cooperating with the Hydrology Laboratory of the NWS Office of Hydrologic Development and the LM RFC (Lower Mississippi River Forecast Center) to develop a two-dimensional storm tide model for the Pascagoula River. The major goals of this research are: 1) To include the Pascagoula River in a modification of an existing modeling domain that incorporates the entire East Coast of the United States, Gulf of Mexico and Caribbean Sea such that astronomic tides and storm surge can be accurately modeled. 2) To develop a shelf-based domain for the Pascagoula River that will produce results comparable to the large-scale domain from Goal 1. This research will result in a model that directly incorporates a full accounting of the hydraulic conditions for flood/river forecasting, especially with regards to flood forecasts and flood forecast mapping in the study area.

The hydrodynamic model employed for calculating tides and surges is ADCIRC-2DDI (ADvanced CIRCulation Model for Shelves, Coasts and Estuaries, Two-Dimensional Depth Integrated). The finite element based model solves the shallow water equations in their full nonlinear form. It can be forced with elevation boundary conditions, flux boundary conditions, and tidal potential terms, all of which result in the full simulation of astronomic tides. In addition, dynamic wind fields for a given hurricane or tropical storm event (e.g. Hurricane Katrina) are converted to spatially variable and time-independent wind surface stresses and incorporated into the ADCIRC-2DDI model along with atmospheric pressure variations to permit the simulation of a storm tide.

The overall work is comprised by the following four tasks: 1) Modification of an existing unstructured, finite element mesh for the WNAT (Western North Atlantic Tidal) model domain by adding the Pascagoula riverine systems to produce a basis model, such that astronomic tides and storm surge can be accurately modeled. 2) Development of a shelf-based model for the Pascagoula River that can produce results comparable to the large-scale domain from Task 1. 3) Verification of a coarse resolution WNAT model which can be employed to provide boundary conditions for the open water locations of a continental shelf-based model. 4) Improvement of the shelf-based model by investigating the influence of estuarine marshes, barrier islands and bottom drag coefficient assignment.
methodology. Such improvements will provide higher accuracy and more flexibility due
to a more complete consideration of the physics.

Since the last report, a 1.5-m floodplain mesh was constructed to allow for the
overlapping of the river banks. This floodplain model was applied in an astronomic tide
simulation to show improvement upon earlier model results which involved an in-bank-
only hydrodynamic description. It is learned from these model intercomparisons that the
floodplains become important towards modeling astronomic tides within the Pascagoula
River. It is further concluded that a 1.5-m boundary is sufficient to capture any tidally
driven storage because of the minimal tidal amplitudes within the Pascagoula River (less
than 1 m).

Next, the inlet-based floodplain mesh was incorporated into the WNAT-53K model
domain to produce a large-scale computational mesh that focuses on the local region of
interest. The resulting large-scale modeling domain employs a refined coastline and has
the barrier islands located along the Gulf Coast meshed over in order to allow for the
wetting and drying of elements. Winds and pressures associated with Hurricane Katrina
(August 23 to 30, 2005) are applied over the large-scale computational mesh which
included a high resolution of the Pascagoula River.

The localized domain is tested by imposing the hydrograph boundary condition together
with local winds and pressures. It is demonstrated that a hydrograph generated from the
WNAT-53K model can be applied on the open-ocean boundary of the localized
floodplain mesh in order to produce results in the interior that are identical to those
produced by the comprehensive mesh. If a localized domain is demanded, it is necessary
to account not only for the local wind and pressure forcing, but also for the remote effects
of the wind and pressure forcing. These remote effects of the meteorological forcings can
only be captured by a large-scale model domain. However, the remote meteorological
effect can be incorporated into a localized domain through a storm surge hydrograph that
is calculated by a large-scale computational domain. The local winds and pressures
together with the hydrograph boundary forcing (generated by a large domain) then
become sufficient to drive the localized mesh.

The following journal publications/manuscripts, dissertations and theses acknowledge
NA04NWS4620013 as a direct result of research performed up to the end of this
reporting period.

1. Parrish, D.M. and S.C. Hagen, “Incorporating spatially variable bottom stress and
Coriolis force into 2D, a posteriori, unstructured mesh generation for nonlinear
oceanic and coastal tidal models,” International Journal of Numerical Methods in
Fluids, In Publication (July 2008).

2. Funakoshi, Y., S.C. Hagen, and P. Bacopoulos “Coupling of Hydrodynamic and
Waterway, Port, Coastal, and Ocean Engineering, Scheduled: Vol. 134, Issue 6
(November 2008).


