

DIETRICH, NCSU
DHS COASTAL RESILIENCE CENTER
RESEARCH PROJECT WORKPLAN
January 1, 2016 – December 31, 2017

1. Project Title.

Improving the Efficiency of Wave and Surge Models via Adaptive Mesh Resolution

2. Principal Investigator.

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3. Other Research Participants/Partners.

Clint Dawson, Professor, University of Texas at Austin

4. Short Project Description.

Coastal communities rely on predictions of waves and flooding caused by storms. These predictions are used during the storm to make decisions about resource deployment and evacuation, and these predictions are also used between storms for design and to establish insurance rates for local homeowners. Computational models are essential for making these predictions, but they can be costly. A typical prediction can require hundreds or even thousands of computational cores in a supercomputer, and several hours of wall-clock time. In this project, we will improve the performance of a widely-used, predictive model. Its representation of the coastal environment will adapt during the storm, to better utilize the computing resources and ultimately provide a faster prediction. This speed-up will benefit coastal communities, including emergency management personnel, who will have more time to make decisions during the storm event. It will also benefit long-range planners, such as flood mappers, who will be able to consider larger, more-accurate models in the same amount of time.

5. Abstract.

Storm-induced waves and flooding can be predicted using computational models such as the ADCIRC+SWAN modeling system, which has been used by DHS and its constituent agencies for mapping of floodplain flood risk and forecasting of storm surge and inundation. This modeling system has been shown to be efficient in parallel computing environments. It is implemented on static meshes and with a static parallelization, and thus it does not evolve as a storm approaches and inundates a coastal region. This implementation can be inefficient when large portions of the mesh remain dry during the simulation.

In this project, we will optimize the parallel implementation of ADCIRC by using a large-scale adaptivity, in which a mesh will be refined by incorporating entire portions of another, higher-resolution mesh. Instead of subdividing an individual element, we will increase resolution by adding elements from a pre-existing mesh that has been well-validated. This procedure will leverage the existing suites of meshes for the same geographic region. The adapted mesh will be rebalanced among the computational cores so that geographic regions with increased resolution will not be concentrated on a disproportionately-small number of cores, and so that the time spent on inactive regions is minimized. These technologies will decrease the computational cost and better utilize the available resources.

This project will develop technologies to improve the efficiency of ADCIRC+SWAN simulations, thus allowing for more model runs in ensemble-based design applications, and for faster simulations in time-sensitive applications such as operational forecasting. These outcomes will increase the accuracy of flood risk products used in building design and the establishment of flood insurance rates, and thus lessen the impact of a disaster. These outcomes will also improve the communication and understanding of potential hazards..