StormSim-CHRP: Metamodeling of Coastal Storm Hazards for Rapid Prediction and Probabilistic Applications

US Army Corps of Engineers
Engineer Research and Development Center
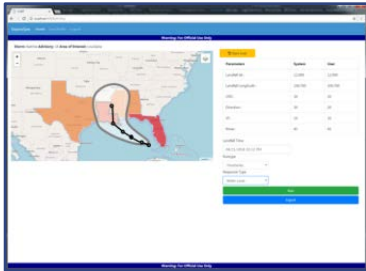
StormSim-CHRP Web tool.

Need
Hurricane storm surge and waves can have devastating flooding effects and adversely affect and threaten the lives of tens of millions of people living along U.S. coastlines. Storm surge forecasting in the United States has improved significantly during the last couple of decades. However, the technologies that are currently employed for these purposes result in either rapid predictions with high uncertainty (low-accuracy meteorological and hydrodynamic modeling) or slow predictions with lower uncertainty. Recent advances in numerical storm surge and wave modeling have resulted in the development of high-fidelity models that produce detailed representation of the simulated *hydrodynamic processes and can support high-accuracy forecasting applications.* Unfortunately, the computational demands of these high-fidelity models make them impractical for real-time emergency management and operational applications. These limitations have lead researchers to examine the viability of state-of-the-art metamodels for forecasting applications.

Approach
The development of a machine learning technique called Gaussian Process Metamodeling (GPM) has made it possible to generate fast coastal hazard predictions using the ERDC-CHL Coastal Hazards System's (CHS) database of synthetic hurricanes and tropical cyclones, while maintaining the accuracy of the high-fidelity hydrodynamic models used to develop the database. The Coastal Hazards Rapid Prediction (StormSim-CHRP) system, currently in development at ERDC-CHL, has capabilities that include:
- Time series predictions
- Forecasting in a matter of seconds
- Scenario analysis
- Risk assessment

Outcomes
For USACE district level emergency management, local decision-makers, and the public, StormSim-CHRP is the first software tool of its kind to offer fast, accurate, time series predictions of hurricane responses, making it an ideal technology for real-time forecasting and long-term risk assessment applications.
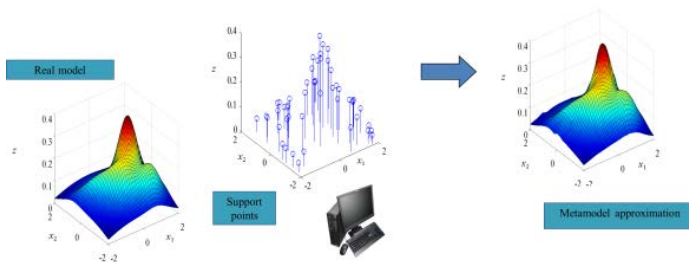
Gaussian Process Metamodels (GPMs) are constructed on CHS high-fidelity hurricane response data and hurricane forcing parameters.
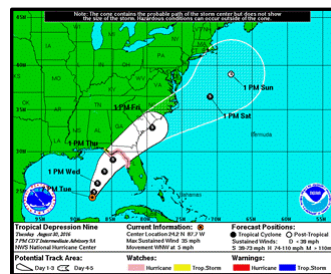
ERDC-CHL utilized the StormSim-CHRP system to provide water level predictions for the TX coast for Hurricane Harvey.
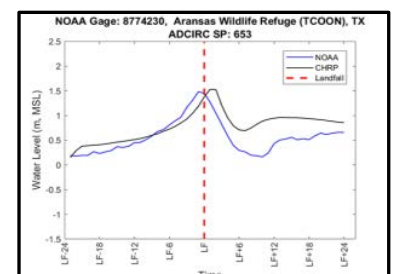
Validation of StormSim-CHRP for Hurricane Harvey.

More Information

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