NC STATE UNIVERSITY

STORM SURGE PREDICTIONS AT HYPERLOCAL SITES

Jenero Knowles, Casey Dietrich 8th Young Coastal Scientists and Engineers Conference – Americas 4th November, 2022



STORM SURGE PREDICTIONS

- HURRICANE IRENE (2011)
 - 48 Deaths
 - Moved over Coastal NC and Offshore VA
 - MOST COSTLY CATEGORY 1 STORM
 - \$15.8 BILLION (2011 USD)
 - Mostly Due to Inland Flooding
 - MAX STORM SURGE (OREGON INLET, NC.)
 - 2.16M (7.09FT)







STORM SURGE PREDICTIONS

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James River

29.4 mi

Chesapeake Bay

Norfolk Naval Station, VA

Atlantic Ocean

Data SIO, NOAA, U.S. Navy, NGA, GEBCO Image Landsat // Copernicus Tributary Canal

Bay Inlet

Marshes of Virginia

Intercostal Waterways

Barrier Islands



STORM SURGE PREDICTIONS **<u>AT HYPERLOCAL SITES</u>**

NORFOLK NAVAL STATION (NNS)

- MID CONTINENTAL SHELF
- Land subsidence (settling)
- BULKHEADS
- NARROW CHANNELS





Example of Hyperlocal Sites

STORM SURGE PREDICTIONS **<u>AT HYPERLOCAL SITES</u>**



• LARGER PROJECT

- "COMPARATIVE ASSESSMENT OF TOTAL WATER LEVELS FOR COASTAL MILITARY FACILITY READINESS AND RESILIENCE USING NUMERICAL MODELS"
- ESTCP/DOD UNDERSTAND THE POTENTIAL RISK TO MILITARY INSTALLATIONS, COASTLINES AND INFRASTRUCTURE.
- 3 military installations
- OTHER EFFORTS USE A MODELING FRAMEWORK
 - PROPOSE A MODELING FRAMEWORK FROM TESTING A RANGE OF MODELS

STORM SURGE PREDICTIONS **<u>AT HYPERLOCAL SITES</u>**

Model Name	Coupled Component	How Forced	Basic Functions
Class I: Empirical/ Probabilistic			
Empirical Equations	N/A	Wave/ Meteorological Parameters	Storm Surge, Run-up
Class II: Process-based, statistical waves			
ADCIRC	SWAN	Wind, Water Level	Tide, Storm Surge, Wave Setup
Delft3D	SWAN	Wind, Water Level, Waves	Tide, Storm Surge, Wave Setup
NearCoM	SWAN, Morphology	Wind, Water Level, Waves	Tide, Storm Surge, Wave Setup
Class III: Process-based, wave resolving			
CSHORE	Stationary wave model, Morphology	Wind, water level, waves	Wave setup, overtopping, morphological change
FUNWAVE	Morphology	Wind, Water Level, Waves	Phase-resolving waves, wave setup, overtopping, IG
X-Beach	Stationary wave model, Morphology	Wind, water level, waves	Tide, storm surge, wave setup, IG, wave runup, {morphological change}

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STORM SURGE PREDICTIONS AT HYPERLOCAL SITES Preliminary Results



ADCIRC + SWAN

- Uses finite element unstructured grids
- Based on Non-linear shallow water equations
- Resolves Tides, surges and based on statistical wave conditions
- Used successfully for predictions:
 - PRODUCES OUTPUTS FOR OTHER MODELS AND REAL-TIME FORECASTS (NOAA, DHS)
 - DESIGN OF PROTECTION SYSTEMS (USACE)

STORM SURGE PREDICTIONS AT HYPERLOCAL SITES: Preliminary Results





STORM SURGE PREDICTIONS AT HYPERLOCAL SITES: Preliminary Results Chesapeake Bay With Water





STORM SURGE PREDICTIONS AT HYPERLOCAL SITES: On-going Work



3 STAGED DEM

• SRTM AT 500M

- NESTED 30M DEM ADDS ADDITIONAL RESOLUTION TO NC, VA, AND MD.
- Smaller 10m DEM adds resolution to the NNS and surrounding Chesapeake Bay





STORM SURGE PREDICTIONS AT HYPERLOCAL SITES: On-going Work



OFF-THE-SHELF MODEL

CURRENT WORKING MODEL

STORM SURGE PREDICTIONS AT HYPERLOCAL SITES: Conclusions & Future Work

- Observations validate results from off base model
- CURRENT MODEL NEEDS REFINEMENT TO FOCUS ON NNS
- Further simulations needed for Hurricane Irene with current model
- Run other storm tracks and SLR scenarios at NNS
- SHARING FINDINGS IN LARGER PROJECT
 - ADVISE OTHER COASTAL FLOODING MODELS

