Operational Storm Surge Forecasting at the National Hurricane Center

Jersey City

loboken

Manhattar

Long Island City

Roxbu

Elizabeth

Irvington

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Arthur Taylor Meteorological Development Laboratory

Potential Storm Surge Flooding*

Through 2 AM Friday August 24th - Advisory #X

Carteret

Up to 3 feet above ground

Greater than 3 feet above ground

Greater than 6 feet above ground

Greater than 9 feet above ground

* Displayed flooding values indicate the water depth that has about a one-in-ten (10%) chance of being exceeded.

Lower New York Bay



National Hurricane Center Mission

 Provide accurate real-time storm surge forecasts during tropical cyclone events
Lead National Weather Service official forecast process

- Provide briefings and decision support

 Support coastal community preparedness and resiliency through storm surge vulnerability and risk analysis

- Drives U.S. evacuation zones and planning
- Increase awareness through outreach and education







Operational Forecast Guidance

Pre-Computed Storm Surge Simulations MEOWs Maximum Envelopes Of Water

MOMs Maximum Of the MEOWs

Real-Time Storm Surge Simulations

P-Surge Probabilistic Storm Surge

Basic Operational Model Requirements

- Provide probabilistic storm surge model forecasts that fully samples the meteorological forecast uncertainty
 - Deterministic simulations and small ensemble runs do not meet this criteria at medium-to-long range lead times
- Probabilistic storm surge model forecast must run on NWS operational supercomputer WCOSS in under 1 wall clock hour using less than ~1000 CPUs (current computing standard)
- Model output resolution must be ~2.5 km for ingest into AWIPS II and CAVE (current resolution standard)
 - Fundamental program for NOAA/NWS operational weather forecasting
 - High-resolution model output must be re-sampled to meet this requirement



NWS/NHC Operational Model: SLOSH

 Computationally efficient surge model that has provided the foundation for reliable NWS storm surge forecasts for decades

• SLOSH does include:

- Wetting and drying
- Sub-grid scale water features, topographic obstructions, levees, etc.
- Overtopping of barrier systems, levees, and roads
- Captures shelf waves and coastal trapped waves
- New grid resolutions of 250-500 m in critical areas
- Astronomical tide and initial water level anomaly
- SLOSH does not include:
 - Wave setup or wave run-up
 - Experimental version coupled to SWAN
 - Experimental version coupled to 2nd Gen Wave Model
 - River flow, rainfall, and inland freshwater flooding
 - Part of the long-term strategic plan



SLOSH-Based Probabilistic Storm Surge Guidance (P-Surge 2.5)



P-Surge 2.5

- Fundamental data used to create NWS/NHC storm surge products
- Real-time probability products based on the NHC official advisory information
- Accounts for meteorological uncertainty in:
 - Track (cross- and along-track)
 - Intensity (Vmax)
 - Size (Rmax)
- Uncertainties in track and intensity are based on the 5-year average NHC historical forecast errors
- Simulate astronomical tide using 2015 ADCIRC tidal database







NHC Track and Intensity Forecast Errors

Track Errors (1989-2014)



2010-2014 Year Average Error: 24-hr: 45.0 nm (83 km) 48-hr: 77.1 nm (143 km)

Intensity Errors (1990-2014)



2010-2014 Year Average Error: 24-hr: 9.4 kts (4 m/s) 48-hr: 13.3 kts (6 m/s)



Sampling the Meteorological Uncertainty

- Samples error distributions in discrete pieces to create a representative set of hypothetical storms
 - Ensemble centered on NHC official advisory
 - Error spaces are based on normal distributions
- Meteorological perturbations in P-Surge 2.5:
 - Variable number of cross-track
 - 7 variations in storm speed
 - 3 variations in storm size
 - 3 variations in storm intensity
- About 500-1000 unique storm scenarios
- Total number of simulations increases when applied to various SLOSH basins
- Future modeling development will explore ways to improve reliability scores

Hurricane Katrina (2005) Advisory 23





P-Surge 2.5 Products

- Probability product
 - Probability of surge greater than 1-20 ft
 - Available as above ground level and above NAVD88
- Exceedance product
 - Storm surge height exceeded by 10-90% of storms
 - Available as above ground level and above NAVD88
 - Cumulative and incremental probabilities
- Output sent over SBN to NHC and WFOs
- Viewer/data available on MDL website







NHC Storm Surge Products

- New NHC storm surge products use P-Surge 2.5 exceedance probability product data
 - Experimental potential storm surge flooding graphic
 - Prototype storm surge watch and warning
- The 10% exceedance level provides a reasonable worst-case scenario of flooding
- Other exceedance levels can be used for specific applications and advanced users
- Probabilistic nature of these products are transparent to the less informed users of the information
- Underlying data can change and products remain the same



Experimental Potential Storm Surge Flooding Graphic

- Provides a quantitative risk assessment for decision makers and to help guide evacuation decisions
- Social science has guided nearly all aspects of the graphic
- Inundation values binned into 4 ranges with zoom level restrictions
- First map issued at the same time as the initial hurricane watch or in some cases, with a tropical storm watch
- Available about 60 to 90 minutes following the advisory release







Prototype Storm Surge Watch / Warning Graphic

- Intended to enhance public response to instructions from local officials, and, ultimately, to help guide EM decisions
- Highlights areas that have a significant risk of life-threatening inundation from surge
- Introduces the concept of a storm surge watch/warning. Intended as a visualization aid, a call to action, and to stimulate feedback from users
- Issued 48 hours before possibility of lifethreatening surge, or other hazards that would hinder evacuations
- Represents collaboration of NHC's Hurricane Specialists, Storm surge experts, and local NWS WFOs





NHC's Storm Surge Unit

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