USACE-ERDC Coastal Storm Modeling System in Support of Hurricane Sandy Operations

ERDC
Engineer Research and Development Center

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ERDC Modeling Support for Hurricane Sandy

- CSTORM-MS Description
- Pre-landfall
  - Surge and flood modeling estimates
- Post-landfall
  - Questions about flooding of the Brooklyn-Battery Tunnel
  - Nor'easter Modeling

ERDC's Coastal Storm-Modeling System

(ERDC CSTORM-MS)

Application of high-resolution, highly skilled numerical models in a tightly integrated modeling system with user friendly interfaces

Not just hurricanes and not just in the Gulf of Mexico.

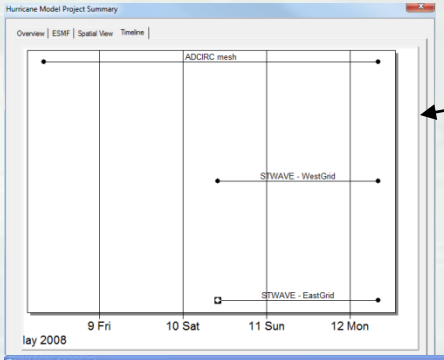
Next Generation Workflow

Expandable and upgradeable system.

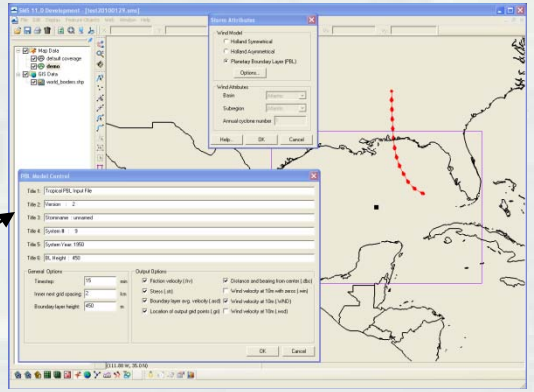
Provides for a robust, standardized approach to establishing the risk of coastal communities to future occurrences of storm events.

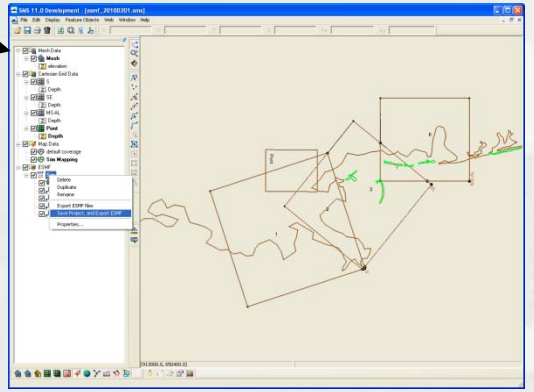
SMS GUI's

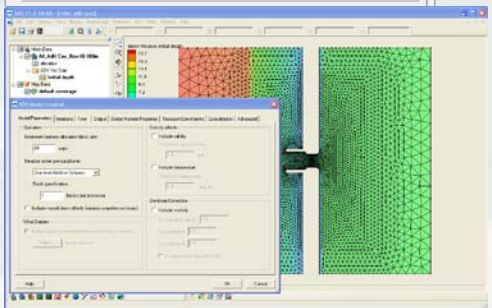
Through the SMS GUI's users can setup and execute models as well as visualize model results.

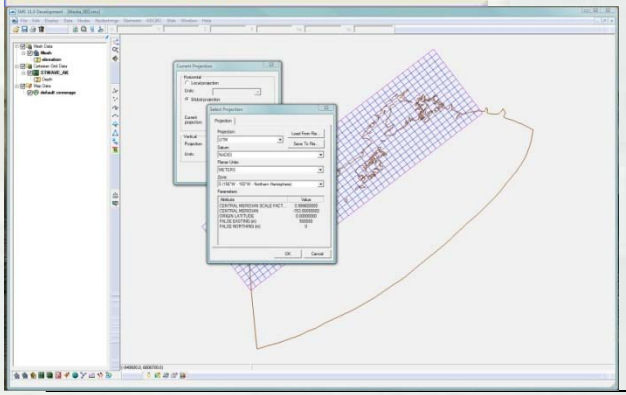


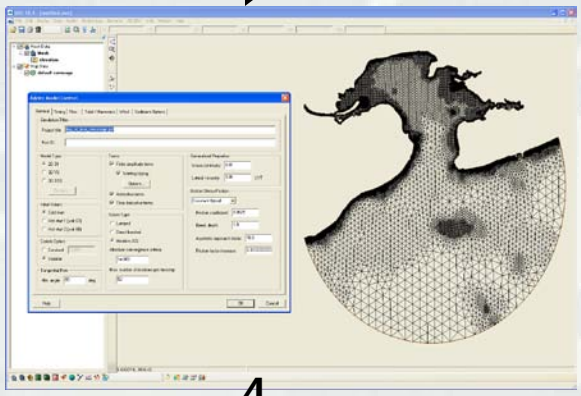
- New GUI for Project Overview
- New GUI for MORPHOS PBL Cyclone Model
- New GUI for CSTORM Coupled Models
- Updated GUI for AdH
- New GUI for WAM Wave Model
- Updated GUI for STWAVE
- Updated GUI for ADCIRC

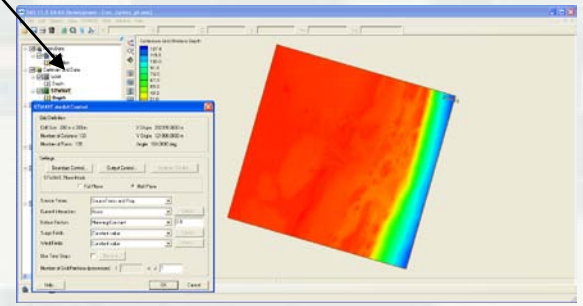












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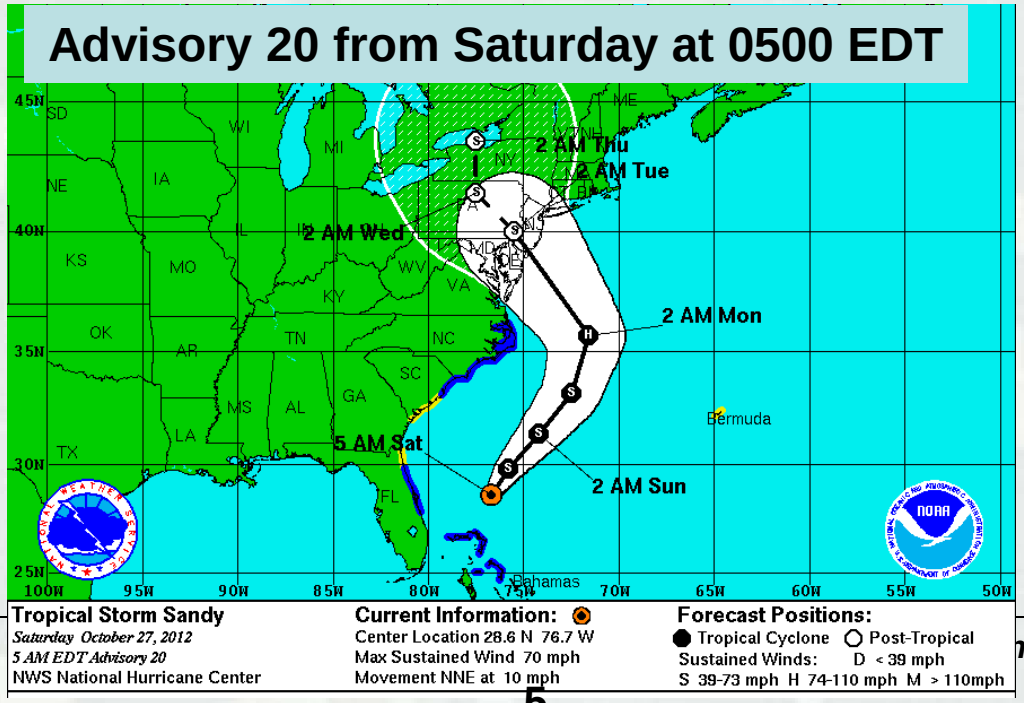
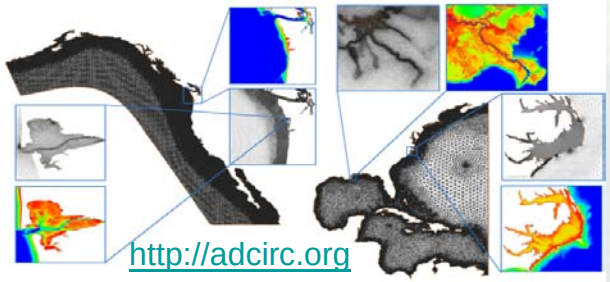
CHL's Modeling Efforts

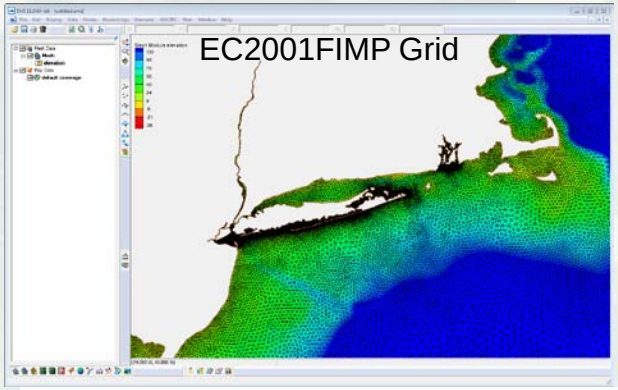
- On Saturday Oct. 27, 2012, ERDC CHL was asked by the New York District (NAN) through the UROC to provide estimates to potential flooding in the New York City area before 1200 EDT on Monday October, 29, 2012.
- Provide potential coastal storm surge estimates using the hydrodynamic model **ADCIRC**
- Provide potential inland flooding estimates using the overland flow model **GSSHA**

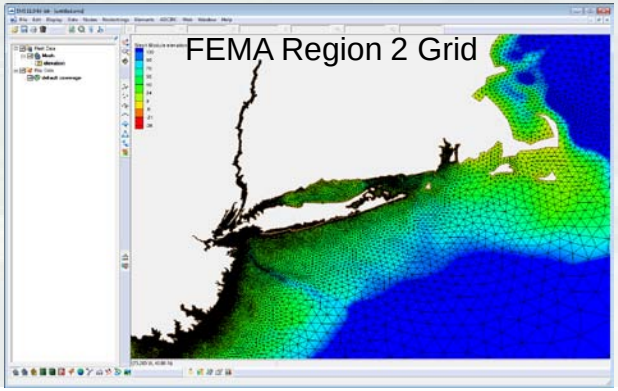


ADCIRC Coastal Circulation and Storm Surge Model



- An unstructured finite element hydrodynamics model
- 2D and 3D simulations
- Wetting/Drying algorithm allows for storm surge inundation over previously dry land
- Highly portable code
- A part of ERDC's Coastal Storm Modeling System





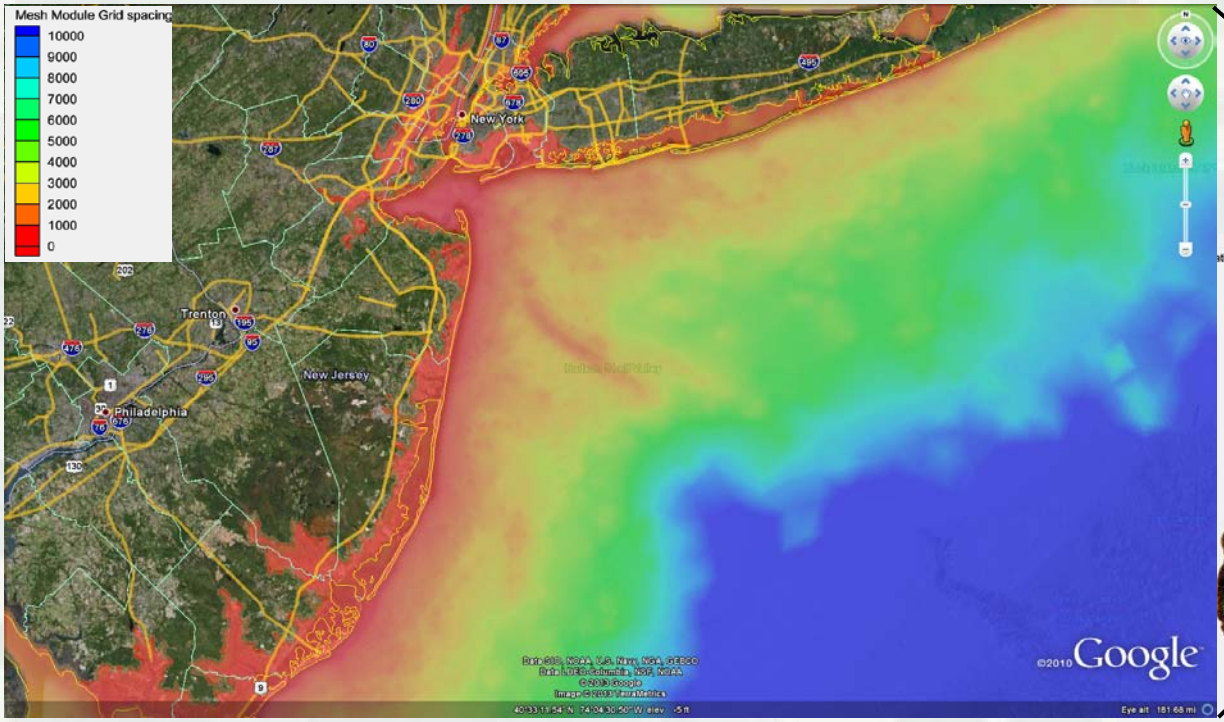
Surge Modeling for Sandy

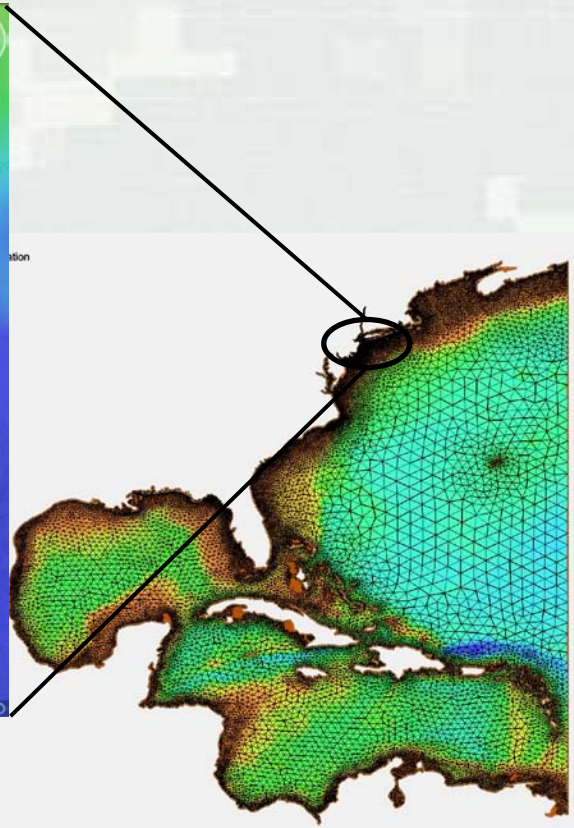
- Used two meshes
  - EC2001FIMP Grid
  - FEMA Region 2 Grid
- Used tidal forcing and the imbedded asymmetric vortex Holland wind/pressure model
- Wind model inputs derived from the NHC forecast using the ASGS
- Advisories 22 – 31 were simulated
- Advisory 26 results sent to NAN.

CSTORM-MS COASTAL STORM MODELING SYSTEM

Mesh Details

Colors Represent Element Size in Meters



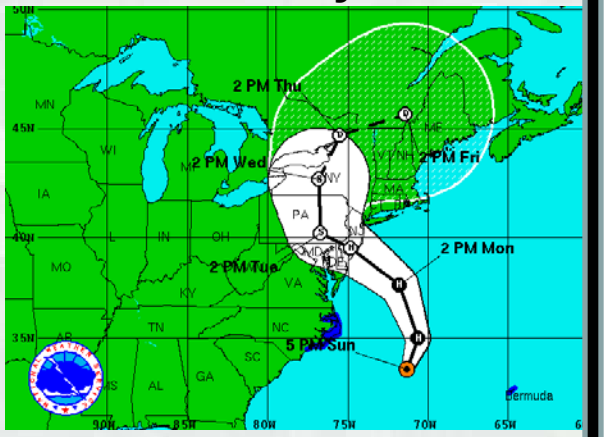


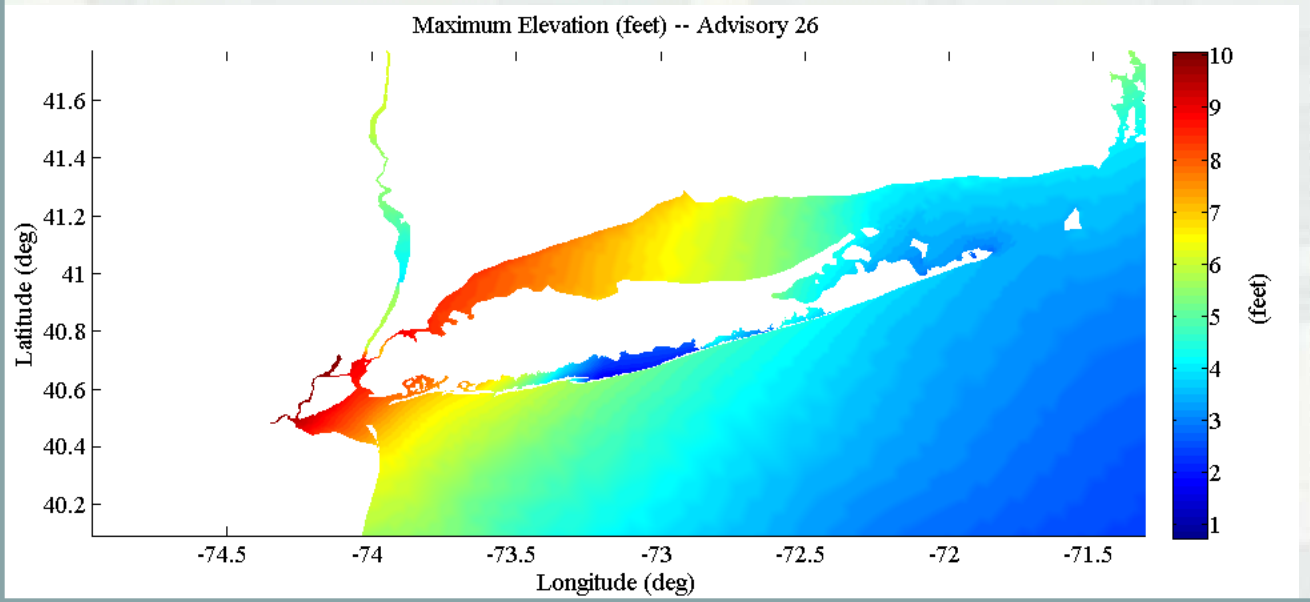
Disclaimer

- The study presented has been performed using the best information available at the time.
- Actual conditions during a flood event may vary from those assumed. The limits of flooding described should only be used as a guideline for planning purposes. Actual areas of inundation will depend on specific flooding conditions and may differ from the areas portrayed.
- For internal use only. Use with sensitivity. Not to conflict with official National Weather Service forecast."

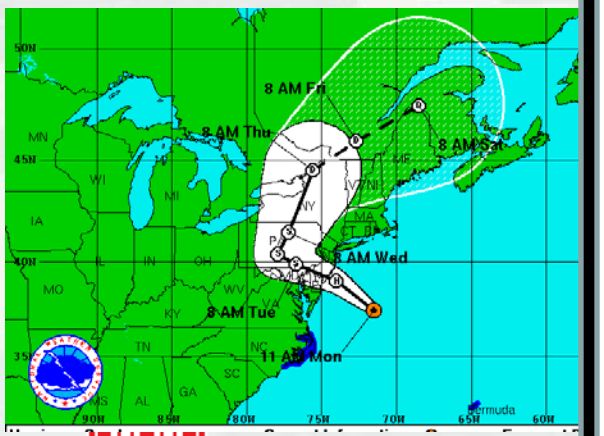
Max Elevation (ft MSL)

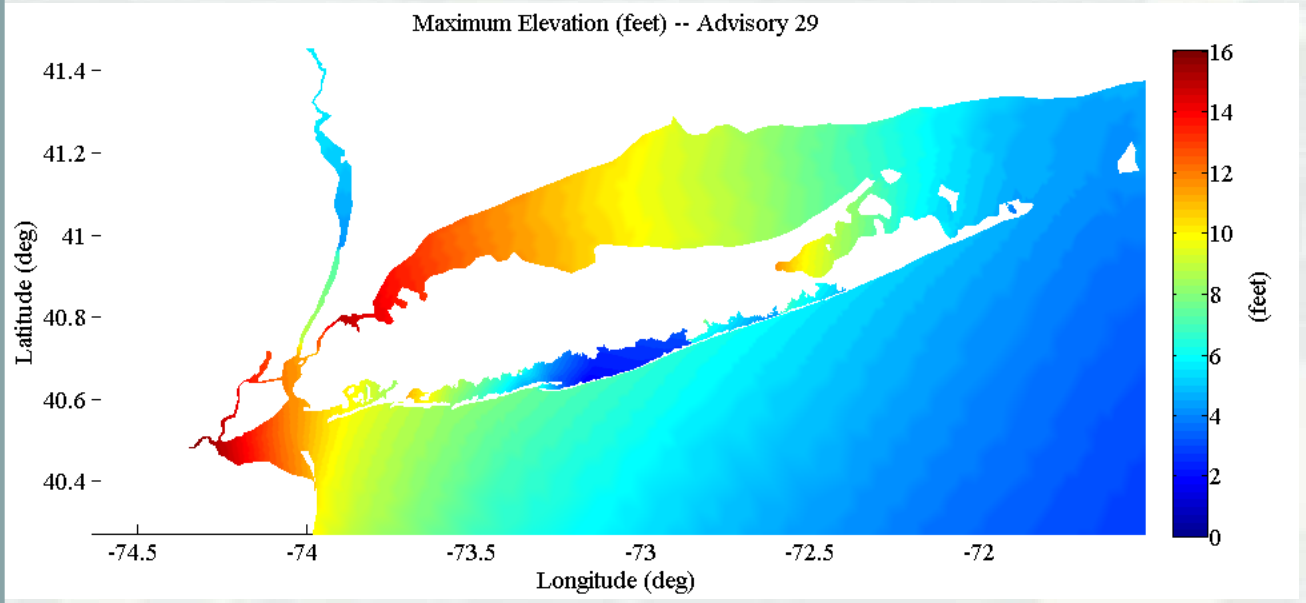
Advisory 26





Advisory 29



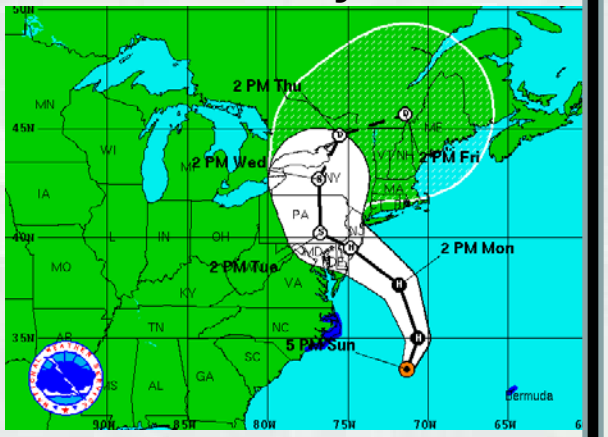


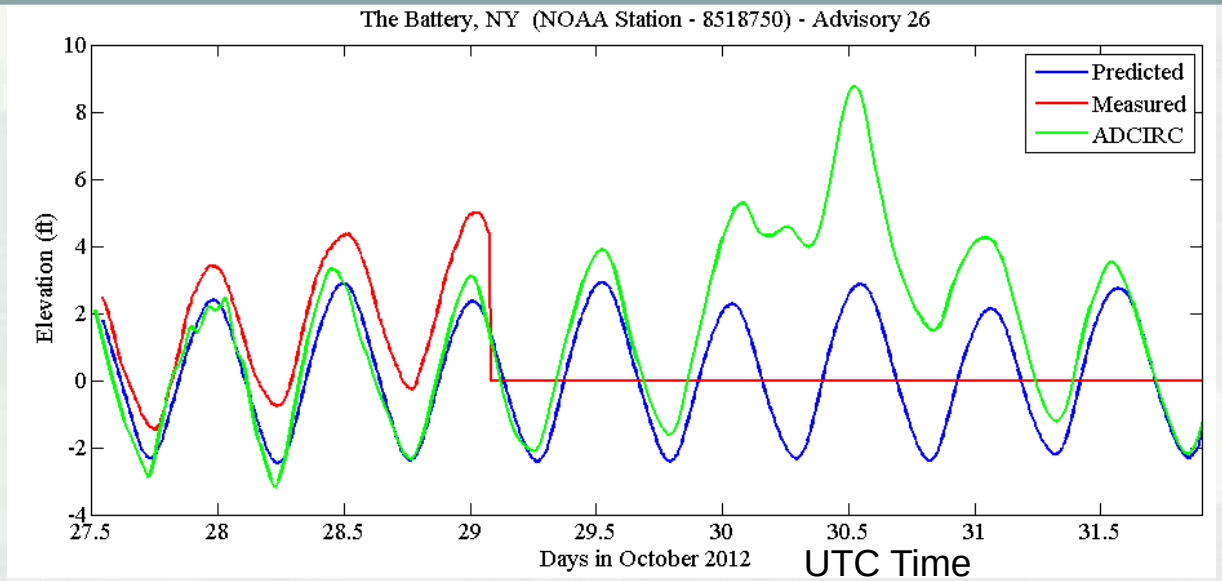
BUILDING STRONG®

EC2001FIMP Grid

The Battery, NY Elevation (ft MSL)

Advisory 26





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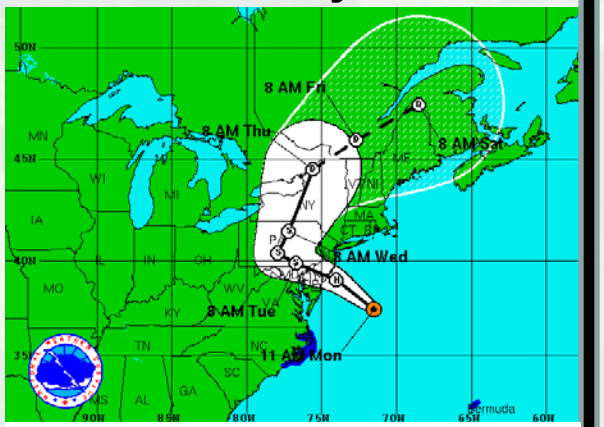
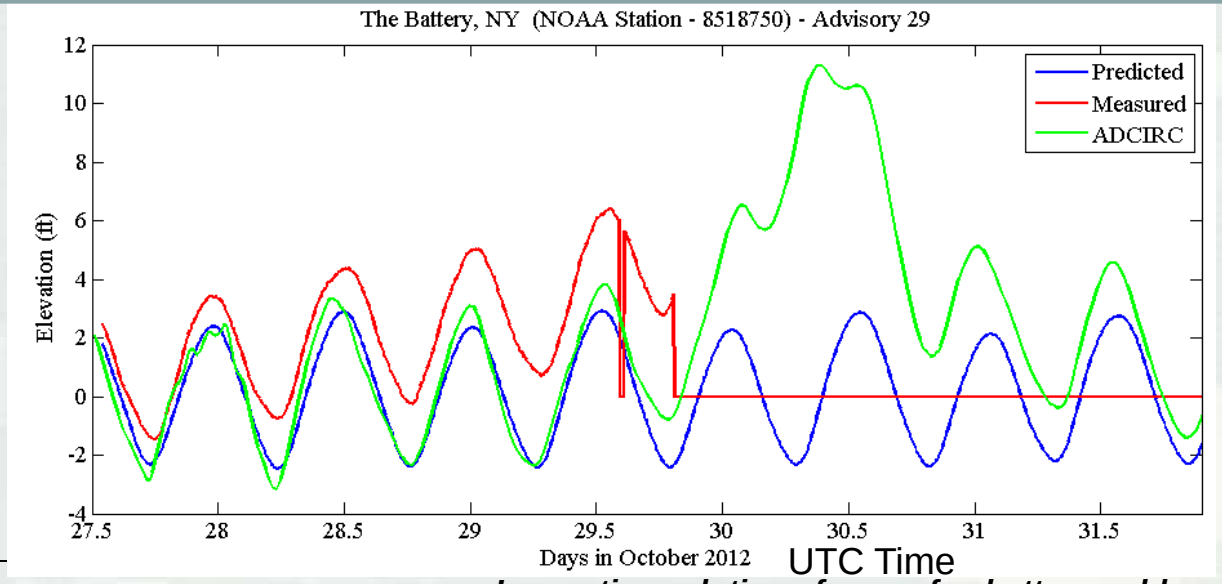


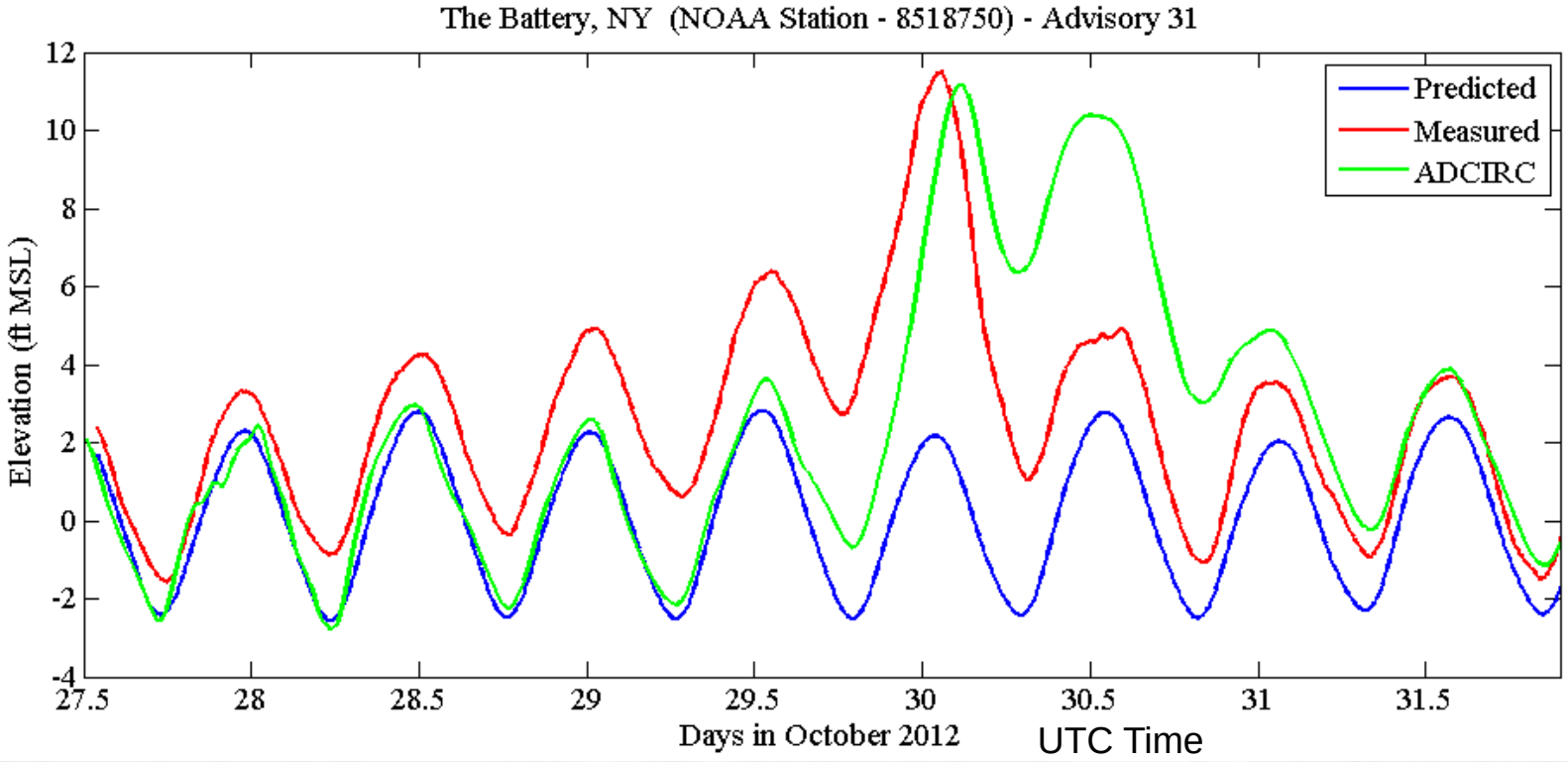


Datum Conversions at this Location
MSL to NAVD88 subtract 0.21 ft
MSL to MLLW add 2.57 ft

Innovative solutions for a safer, better world

EC2001FIMP Grid

Comparison of Hurricane Sandy Water Elevations (ft MSL) at the NOAA Gauge at the Battery, NY



Datum Conversions at this Location
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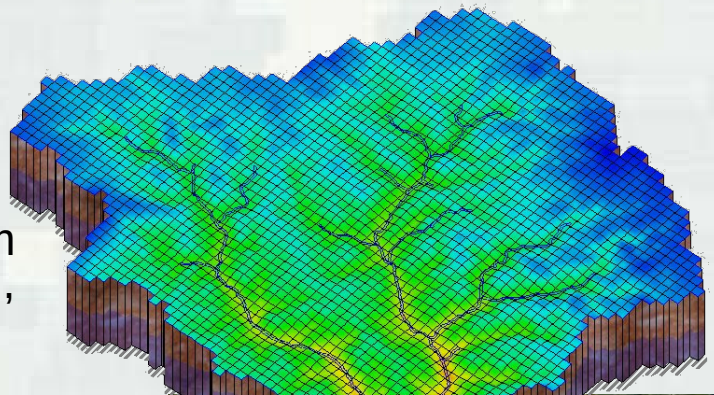
MSL to MLLW add 2.57 ft

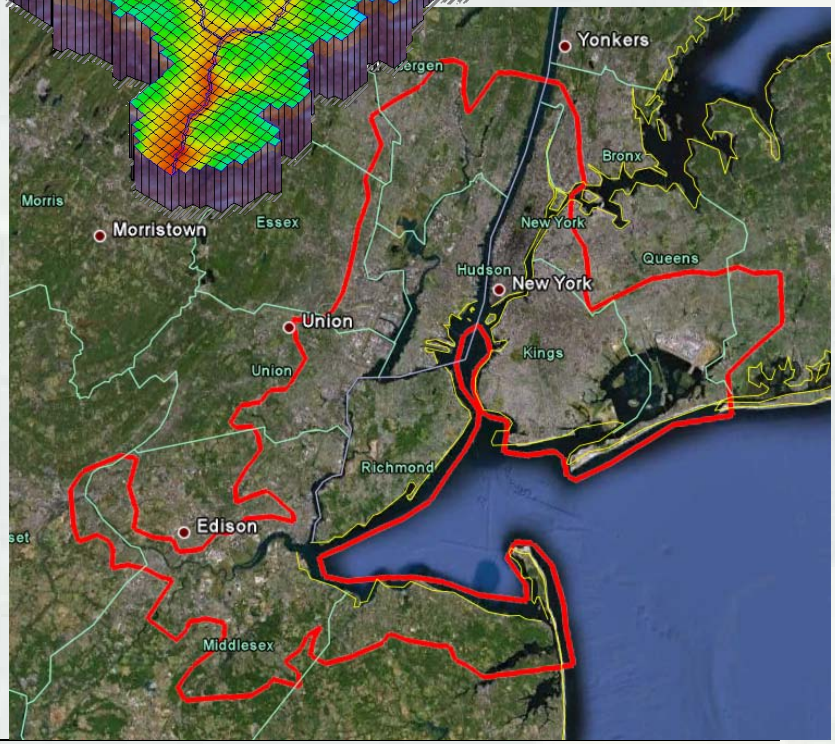
ERDC

Innovative solutions for a safer, better world

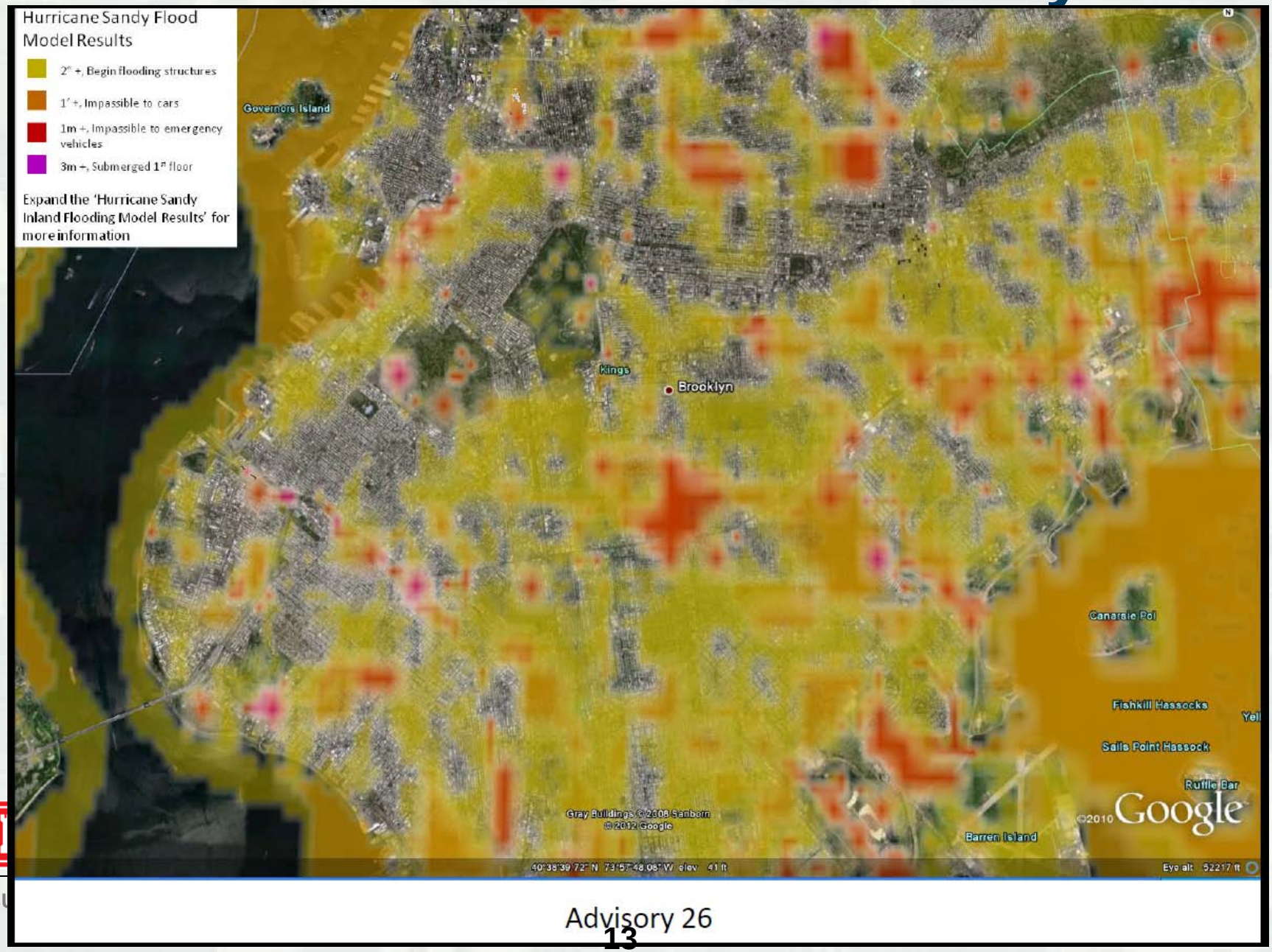
GSSHA New York Models

- GSSHA is a gridded, physics-based full hydrology model
  - Overland flow, stream flow, groundwater, vadose zone, storm and tile drains, wetlands, erosion, constituent transport
- GSSHA 2D Overland Flow Model used to predict inland flood inundation
  - Use time-varying specified head condition for storm surge
- 2 Models:
  - Central NY Model @75m (right)
  - Long Island Model @150m
- Rainfall estimated from NWS plots
- Storm surge from ADCIRC



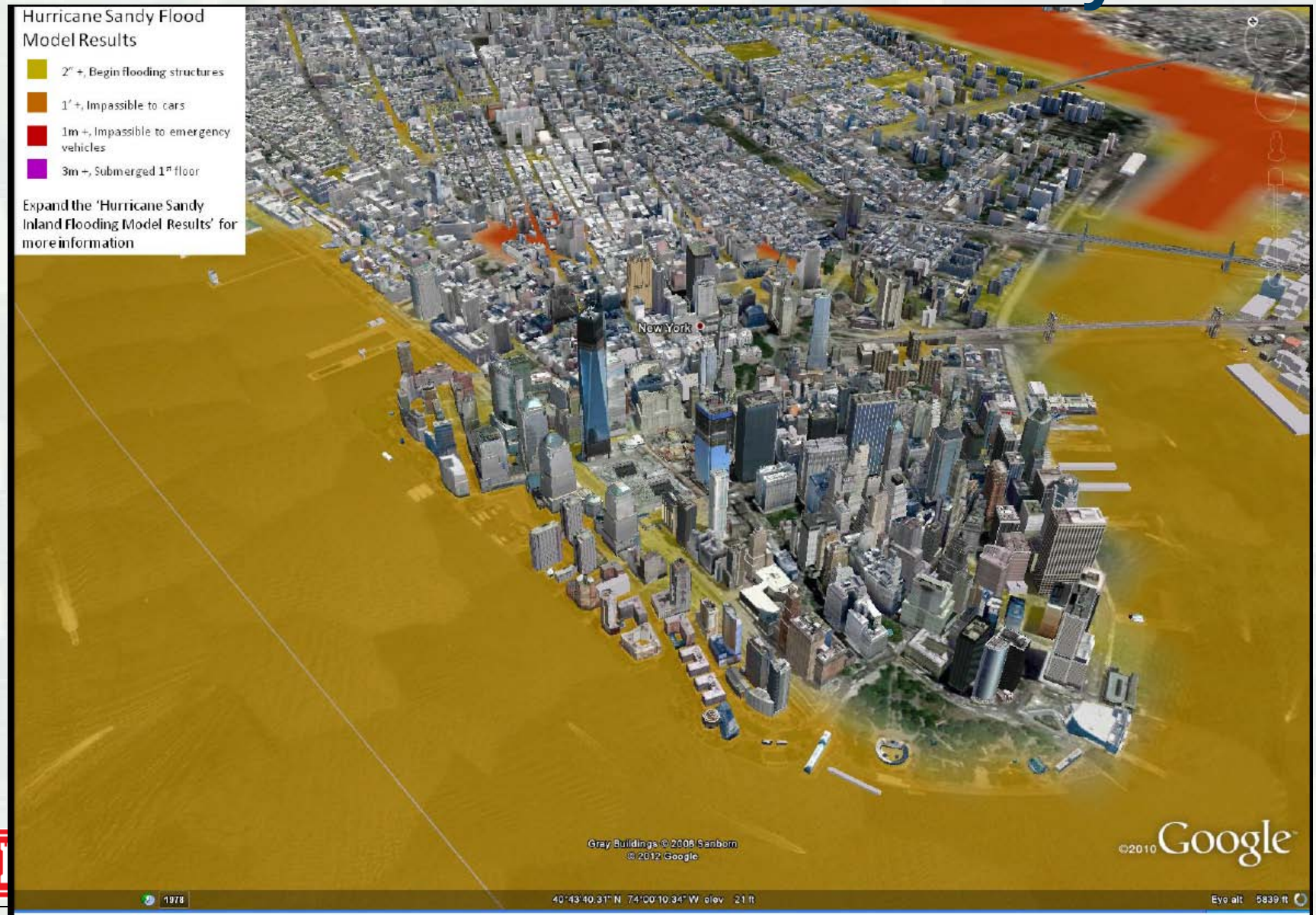


GSSHA Results from Advisory 26



Advisory 26

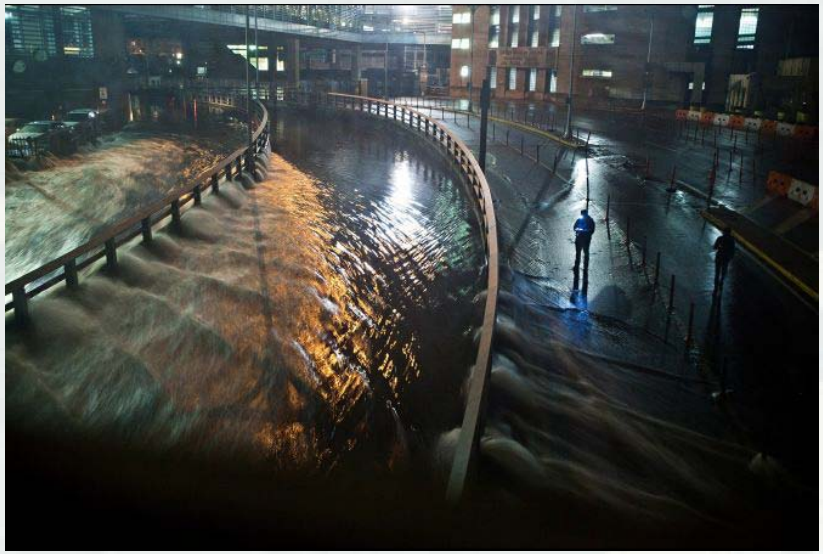
GSSHA Results from Advisory 26



Advisory 26

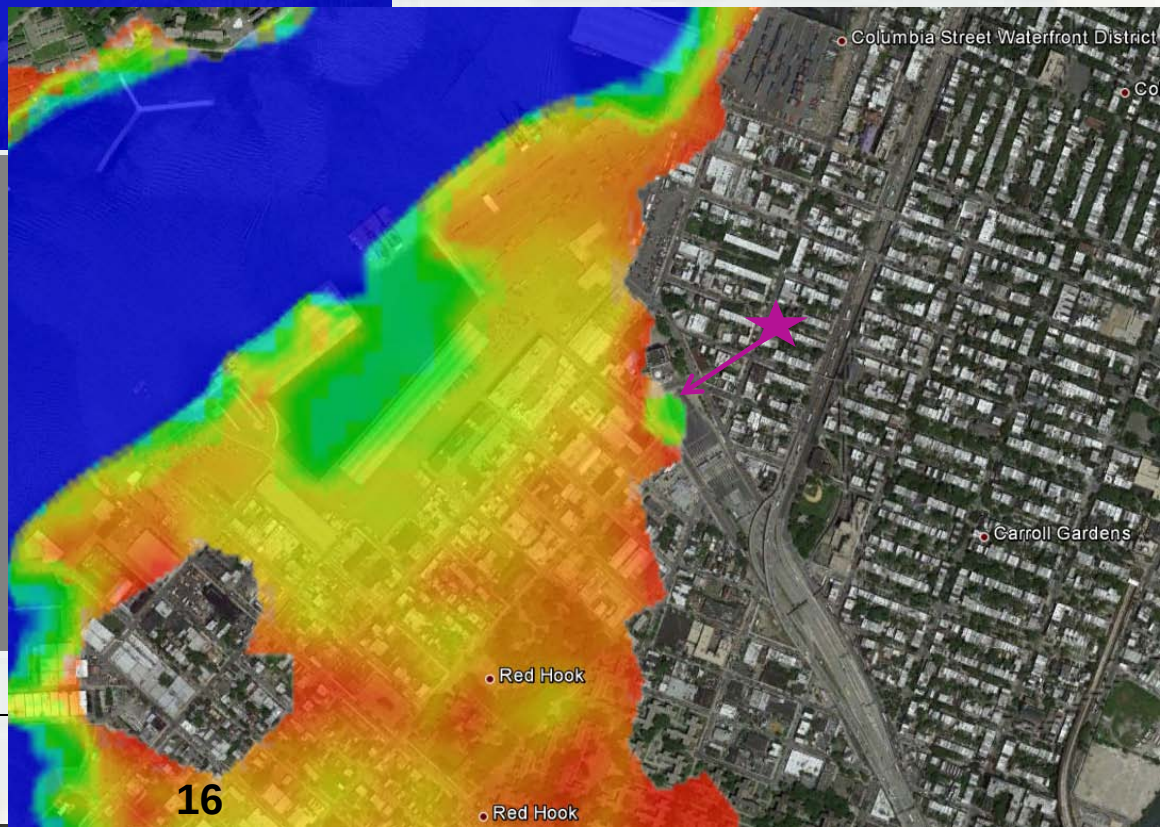
Post-Sandy

- Questions about flooding of the Brooklyn-Battery Tunnel
- Nor'easter Modeling



ADCIRC Total Water Depth (feet MSL)

Results from ADCIRC, using the FEMA Region 2 Mesh and NWS Forecast Winds from Advisory 31 of Hurricane Sandy.



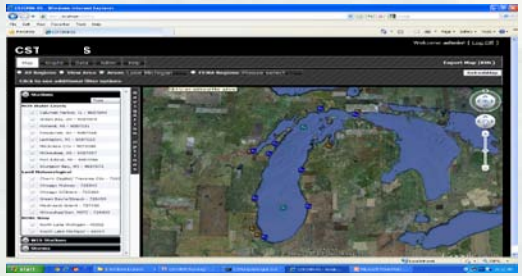
Total Water Depth (ft MSL)

20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0

★ Location of Tunnel Entrance/Exit

Datum Conversions at this Location
MSL to NAVD88 subtract 0.21 ft
MSL to MLLW add 2.57 ft

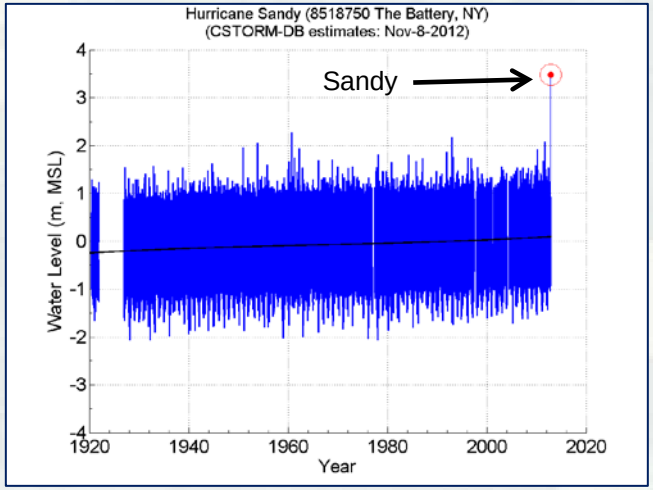
Return Period Estimates for Sandy (CSTORM-DB)

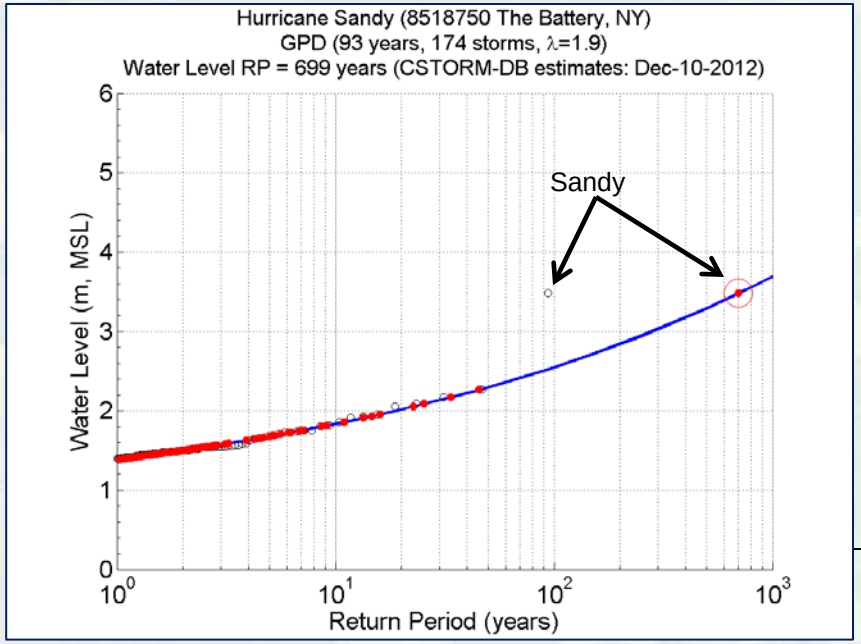


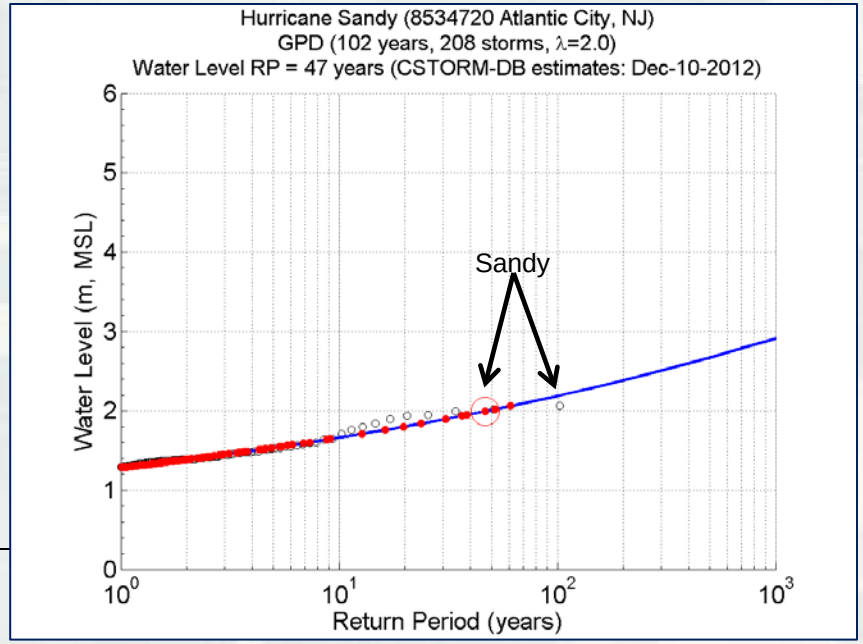
Coastal Storm Database Statistical Products

- Storm screening using peaks-over-threshold
- Extremal analysis
- MLM fit with generalized Pareto distribution
- Quantile-Quantile optimization
- Standard products updated annually and following major storms

Water level return periods were requested by NAN and subsequently supplied to NAN and other NE Atlantic divisions following Hurricane Sandy.







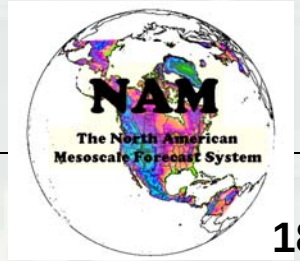
Surge/Flood Modeling for the Nor'easter Following Sandy

ADCIRC Surge Modeling

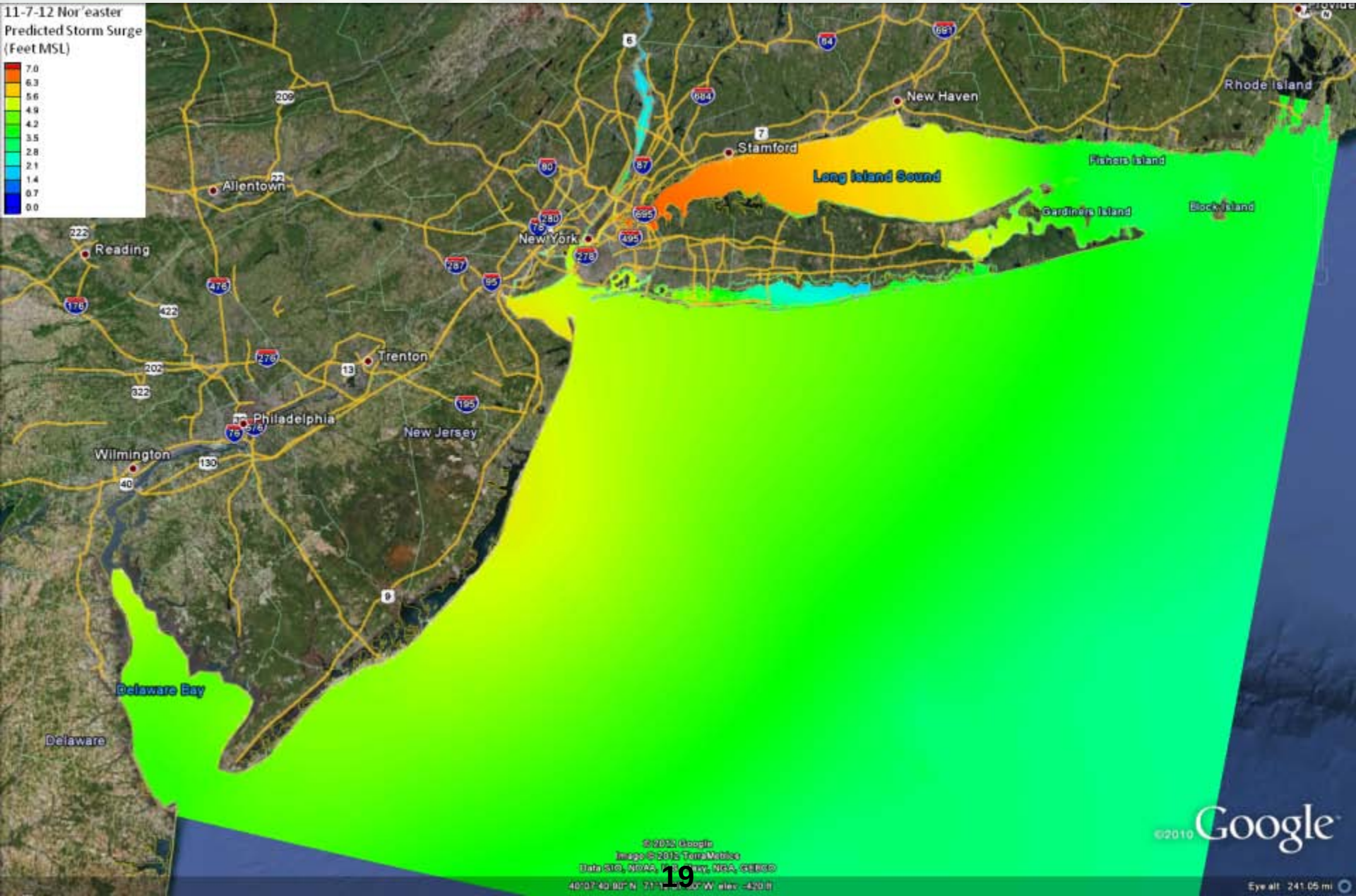
- Used two ADCIRC meshes
  - EC2001FIMP Grid
  - FEMA Region 2 Grid
- Used tidal forcing and NAM wind fields
- In collaboration with the ASGS team, used winds derived from the North American Mesoscale Forecast System (NAM) which is part of the NWS's NCEP.
- Two forecast wind sets 2012/11/06 00Z and 2012/11/07 12Z
- 2012/11/07 12Z results sent forward

Maximum Storm Surge Predicted Values at Requested Locations

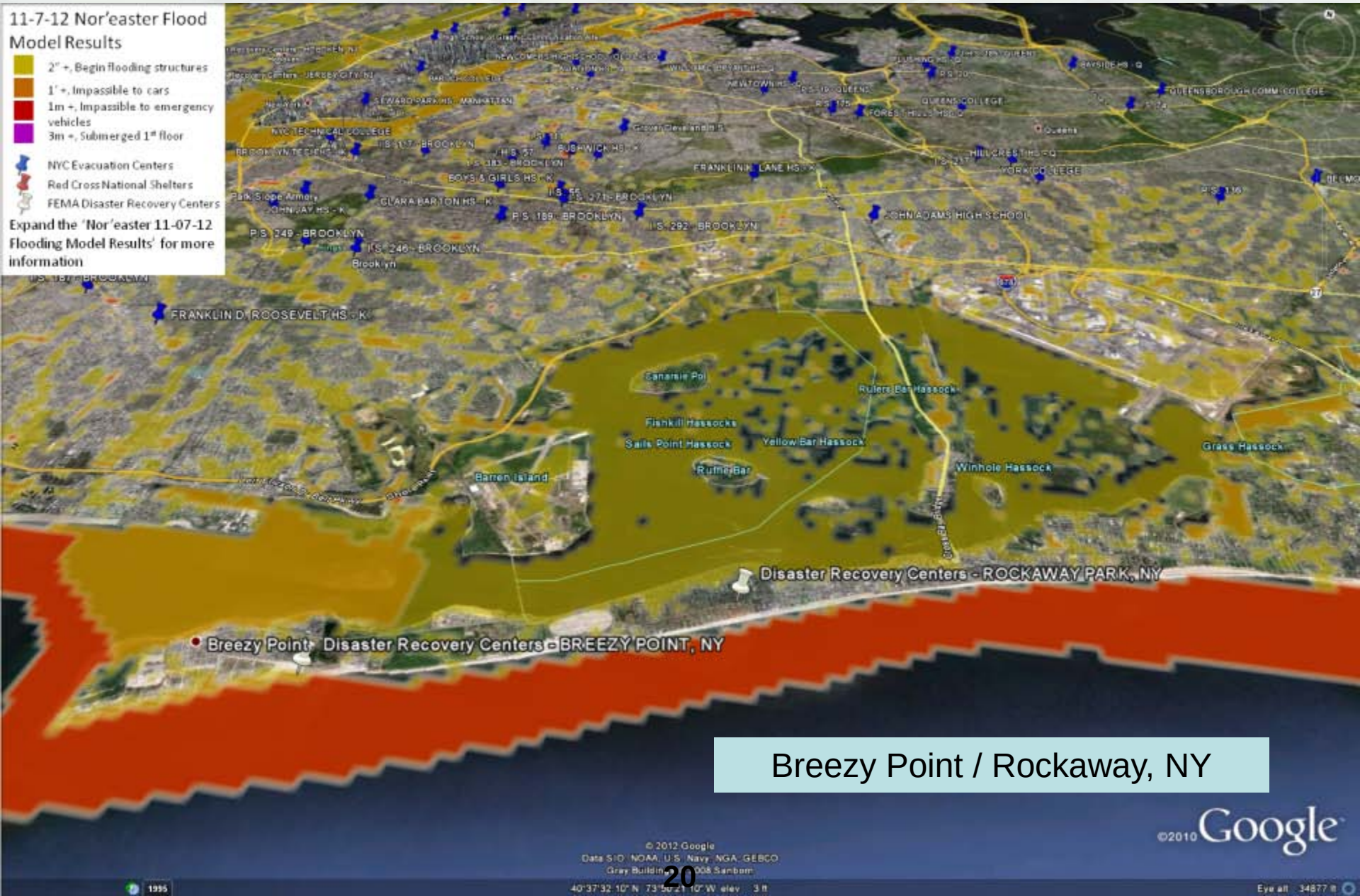
Longitude (deg)	Latitude (deg)		Location Name	Maximum Water Elevation (ft MSL)
-73.8439	40.5728		Rockaway, NY	4.6176
-74.1449	40.5313		South Staten Island NY	5.0079
-74.1786	40.4464		Union Beach, NJ	5.2931
-73.9642	40.3503		Sea Bright, NJ	4.8505
-74.0161	40.1278		Manasquan, NJ	4.9942
-74.0359	40.0461		Mantoloking, NJ	5.0448
-74.0624	39.9261		Seaside Park, NJ	5.1055
-74.1778	39.6318		Long Beach Island, NJ	4.8897
-74.4183	39.355		Atlantic City, NJ	4.4804



Nor’easter Surge Estimates



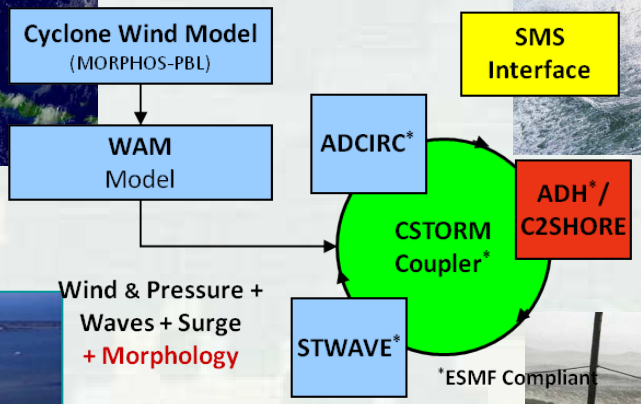
Inland Flood Model Results (Nor'easter)



Breezy Point / Rockaway, NY

CSTORM-MS

- Expandable
- Upgradeable
- Multi-Scale
- Multi-platform PC to HPC
- More than Hurricanes
- Relocatable to your area



Spiral 2

Next Generation Workflow