1. Rapid Response Plan

***1.4 Rapid Warning System Enhancements**: develop a synthesis of current storm flood warning practices and forecast systems in coastal and upstate New York, including a demonstration product for an improved warning system for coastal or inland flooding --*

Co-led by Keith Tidball (NYU -Cornell)/Brian Colle (SBU)

NYU - Cornell
Rod Howe
Zywia Wojnar
Toby Ault
Susan Riha
grad students TBD

SBU
Charlie Flagg
Henry Bokuniewicz
Malcolm Bowman
Jian Kuang (grad student)
Keith Roberts (grad student)
Charilaos Papadopoulos (grad student)
Mark Lang
Arie Kaufman

Task 1.4 Objectives

- Met with NYC National Weather Service and NWS Eastern Region Headquarters to discuss warning system and process (obtain reports from Irene and Sandy). **Recommendation**: Best visualization and Need Improving Communication for Warning Decision Support
- NYU-Cornell will catalog and assess other existing rapid warning systems (e.g., USGS Water Gauging System).
- Improvements to real-time atmospheric and storm surge predictions systems for the upcoming hurricane season.
- Improvements in visualization for atmospheric, hydrological, and storm surge predictions.
- Enhance Partnerships and Education Networks

Real-time WRF to 4-km grid spacing:
http://dendrite.somas.stonybrook.edu/LI_WRF

SoMAS
School of Marine and Atmospheric Sciences

Operational WRF-ARW

Coastal Meteorology and Atmospheric Prediction Group
School of Marine and Atmospheric Sciences

Stony Brook University

SBU WRF-ARW Forecasts

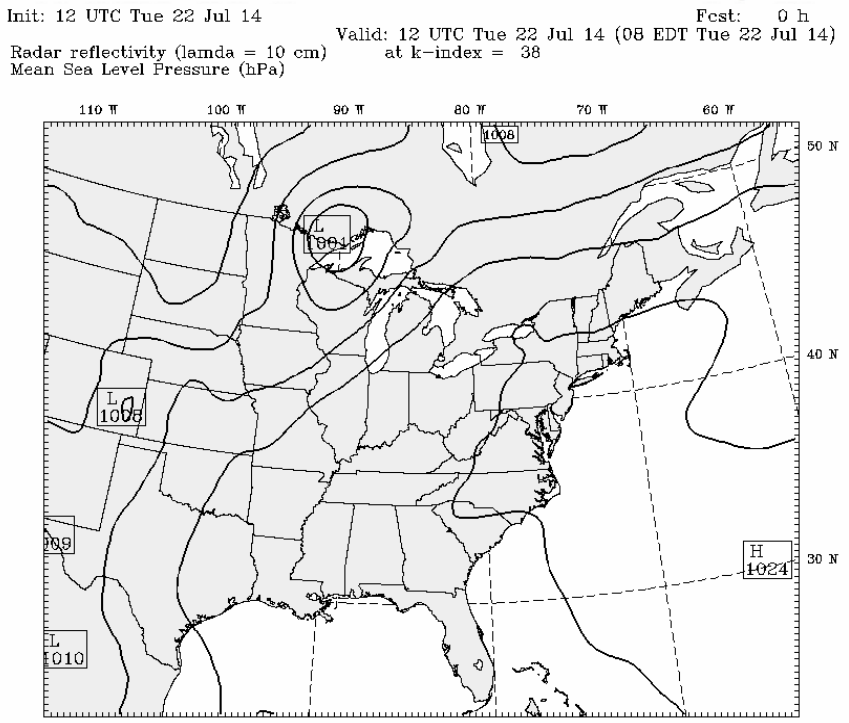
Available Model Runs

Currently the NAM-WRF does not include a 4-km domain

NAM-WRF	both	GFS-WRF
00 UTC Wed 26 Mar 2014	compare	00 UTC Wed 26 Mar 2014
12 UTC Tue 25 Mar 2014	compare	12 UTC Tue 25 Mar 2014
00 UTC Tue 25 Mar 2014	compare	00 UTC Tue 25 Mar 2014
12 UTC Mon 24 Mar 2014	compare	12 UTC Mon 24 Mar 2014
00 UTC Mon 24 Mar 2014	compare	00 UTC Mon 24 Mar 2014
12 UTC Sun 23 Mar 2014	compare	12 UTC Sun 23 Mar 2014
00 UTC Sun 23 Mar 2014	compare	00 UTC Sun 23 Mar 2014
12 UTC Sat 22 Mar 2014	compare	12 UTC Sat 22 Mar 2014
00 UTC Sat 22 Mar 2014	compare	00 UTC Sat 22 Mar 2014
12 UTC Fri 21 Mar 2014	compare	12 UTC Fri 21 Mar 2014
00 UTC Fri 21 Mar 2014	compare	00 UTC Fri 21 Mar 2014
12 UTC Thu 20 Mar 2014	compare	12 UTC Thu 20 Mar 2014
00 UTC Thu 20 Mar 2014	compare	00 UTC Thu 20 Mar 2014
12 UTC Wed 19 Mar 2014	compare	12 UTC Wed 19 Mar 2014

The WRF-ARW (v3.5.1) is run twice daily, using the 00z and 12z NAM and GFS forecasts as initial and boundary conditions. The 36-km outer domain one-way nests down to 12- and 4-km inner domains. Model physics include Thompson microphysics, YSU boundary layer scheme, and the SAS cumulus parameterization.

Latest GFS-WRF Simulated Reflectivity



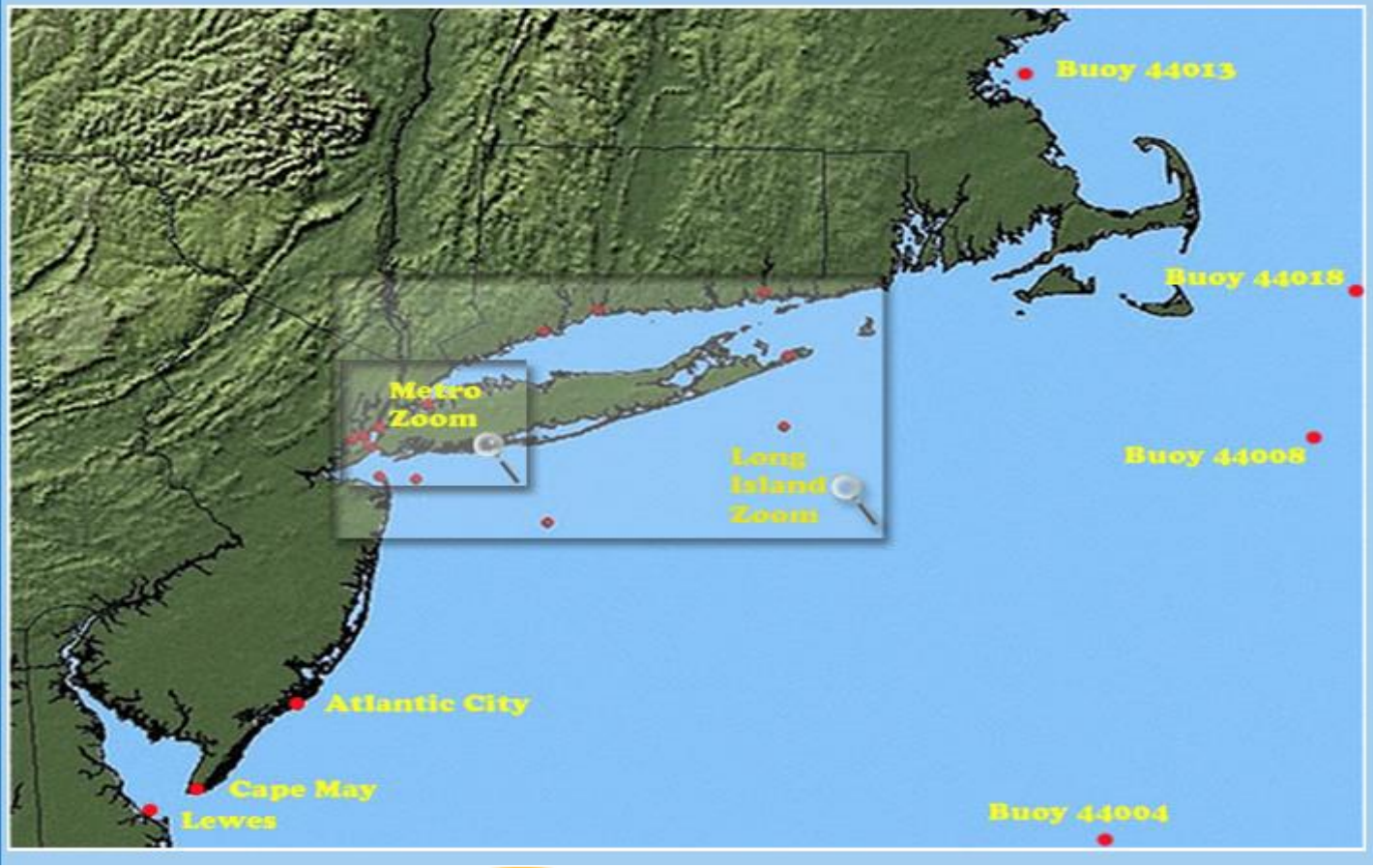
SoMAS
School of Marine and Atmospheric Sciences

Stony Brook Storm Surge Research Group

Stony Brook University

HOME | WRF/MM5 | ADCIRC | MEDIA COVERAGE | NEWS ARCHIVE | LINKS | THE TEAM

- Coastal Alerts
- New York Harbor
- LI South Shore
- LI Sound
- NJ & South
- Buoy Stations
- Animations
- Maximum Surge
- Waves



NYS RISE

Resiliency Institute for Storms & Emergencies

Advanced Circulation Model (ADCIRC) Upgrade/Testing

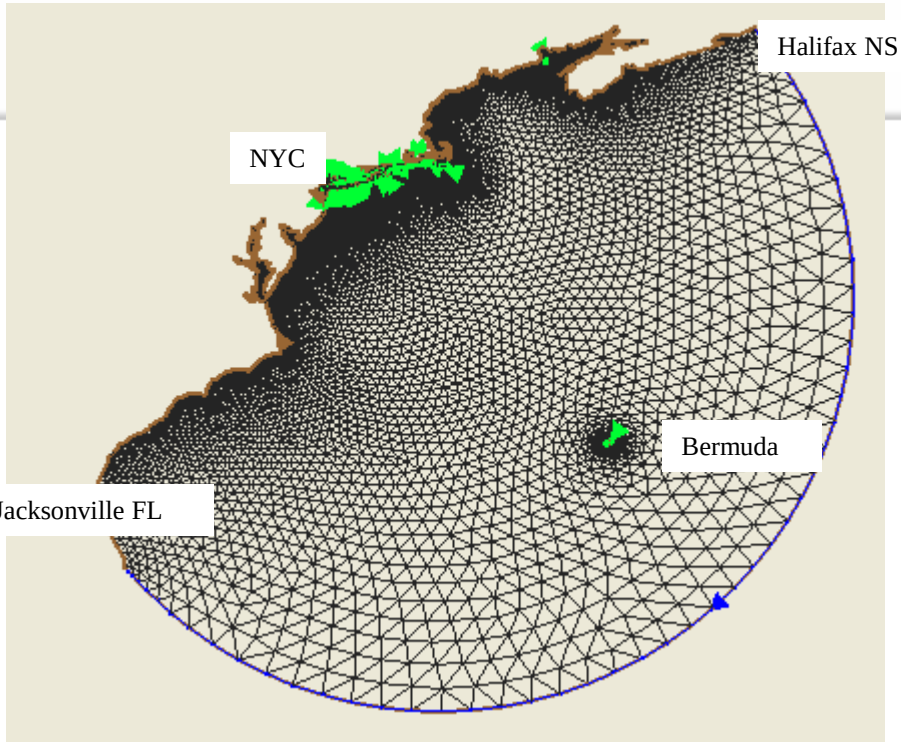
** => New things tested…

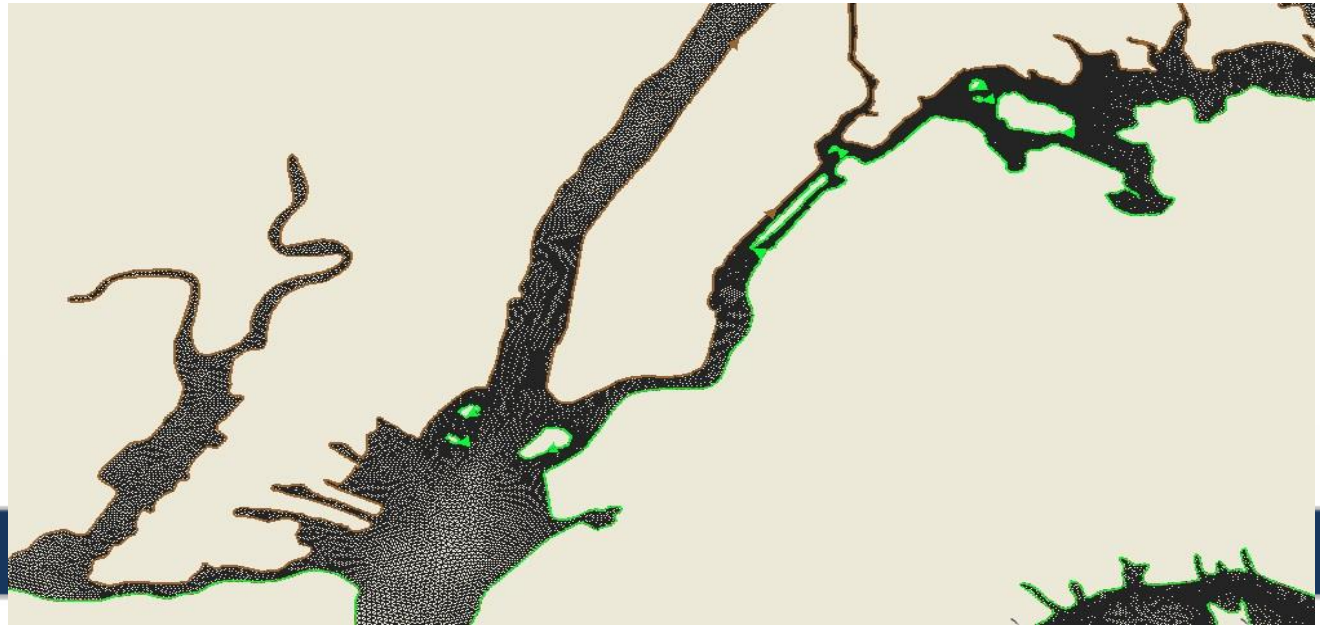
** Run 3D Mode (3 or 5-levels)

- 184,534 nodes
  -> 20 m to 70 km

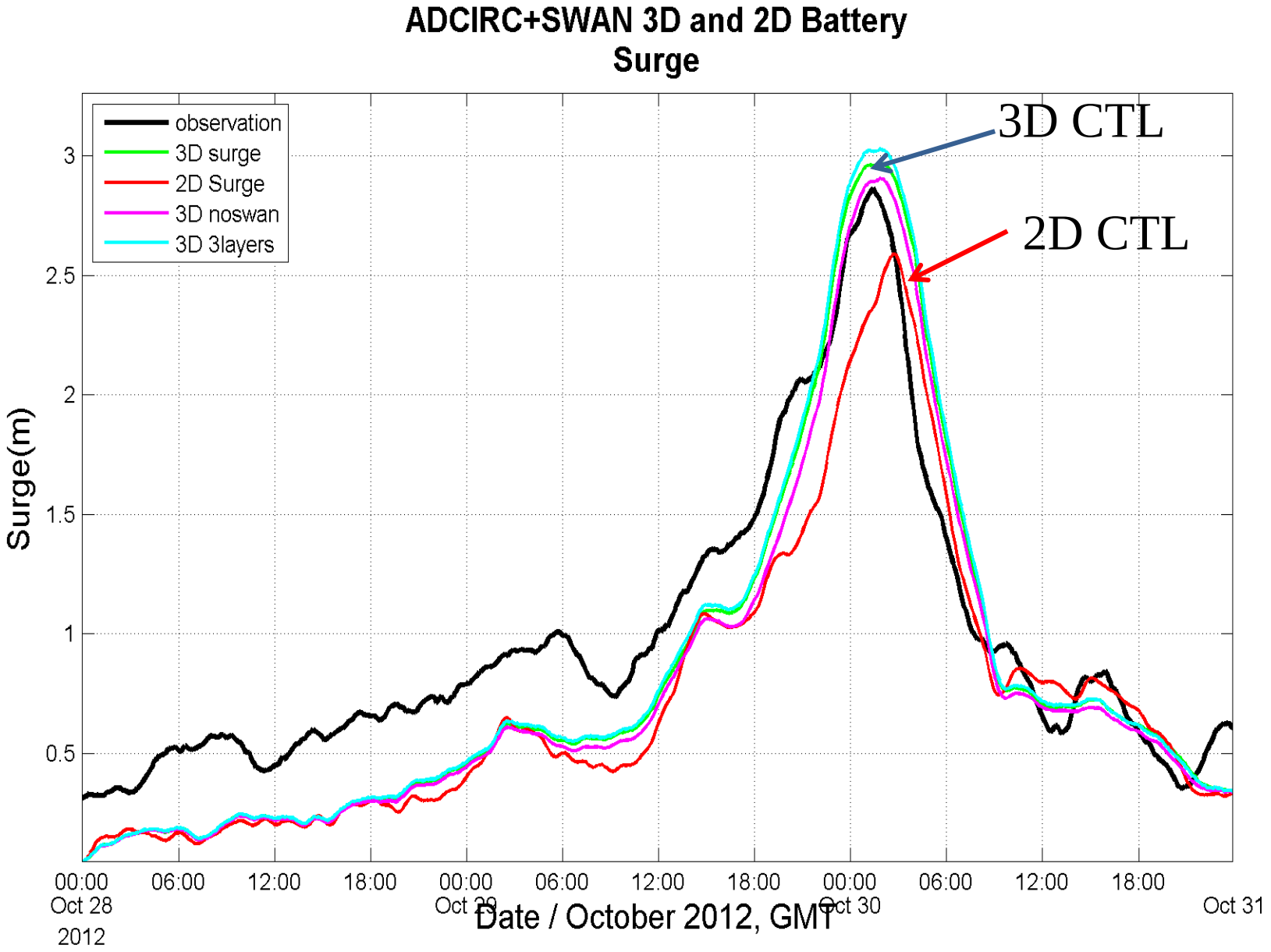
** Couple with

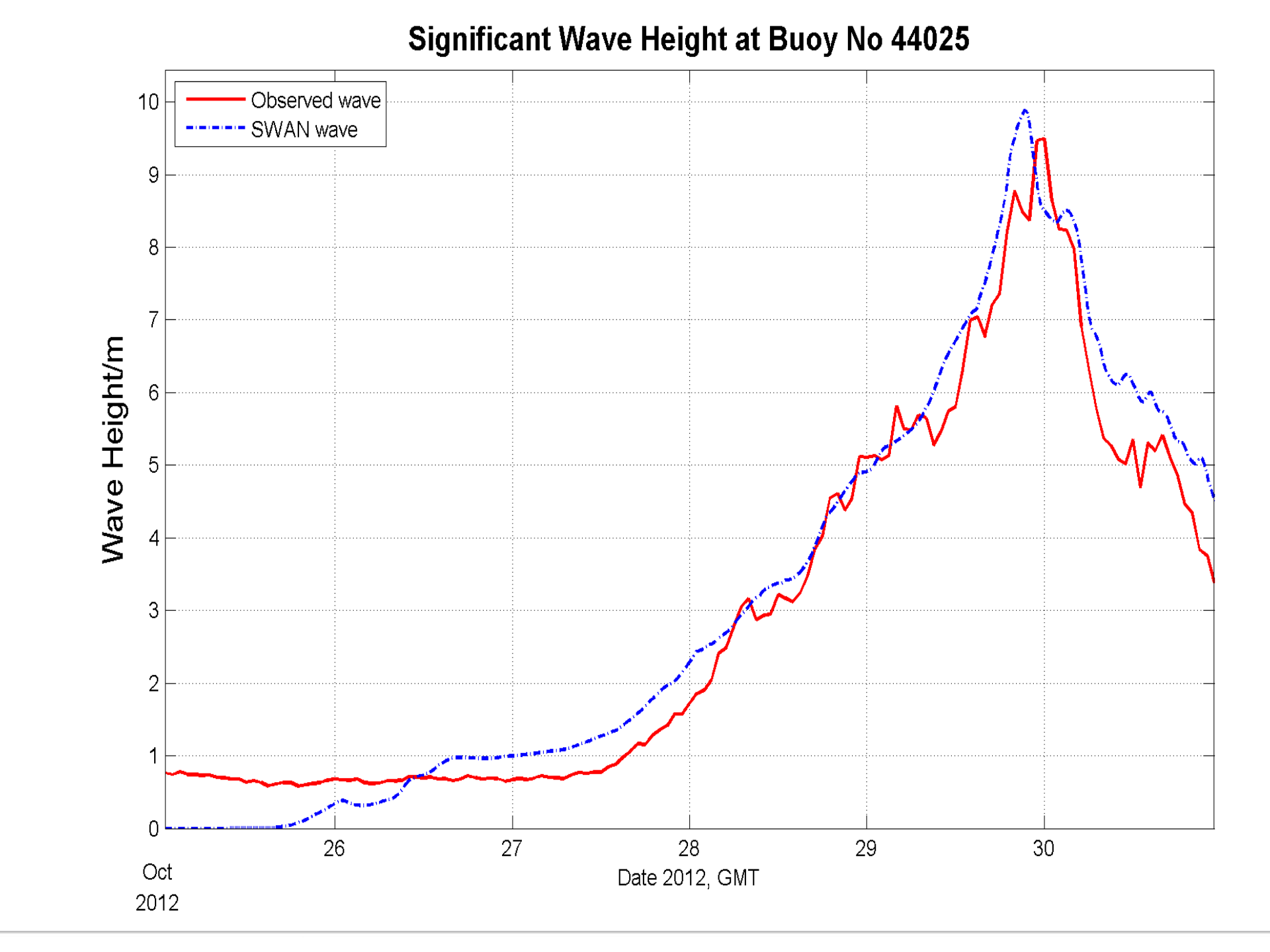
SWAN wave model





ADCIRC 2D vs 3D vs SWAN for Sandy




Significant Wave Height at Buoy No 44025
Observed wave
SWAN wave
Wave Height/m
0
1
2
3
4
5
6
7
8
9
10
26
27
28
29
30
Oct
2012
Date 2012, GMT

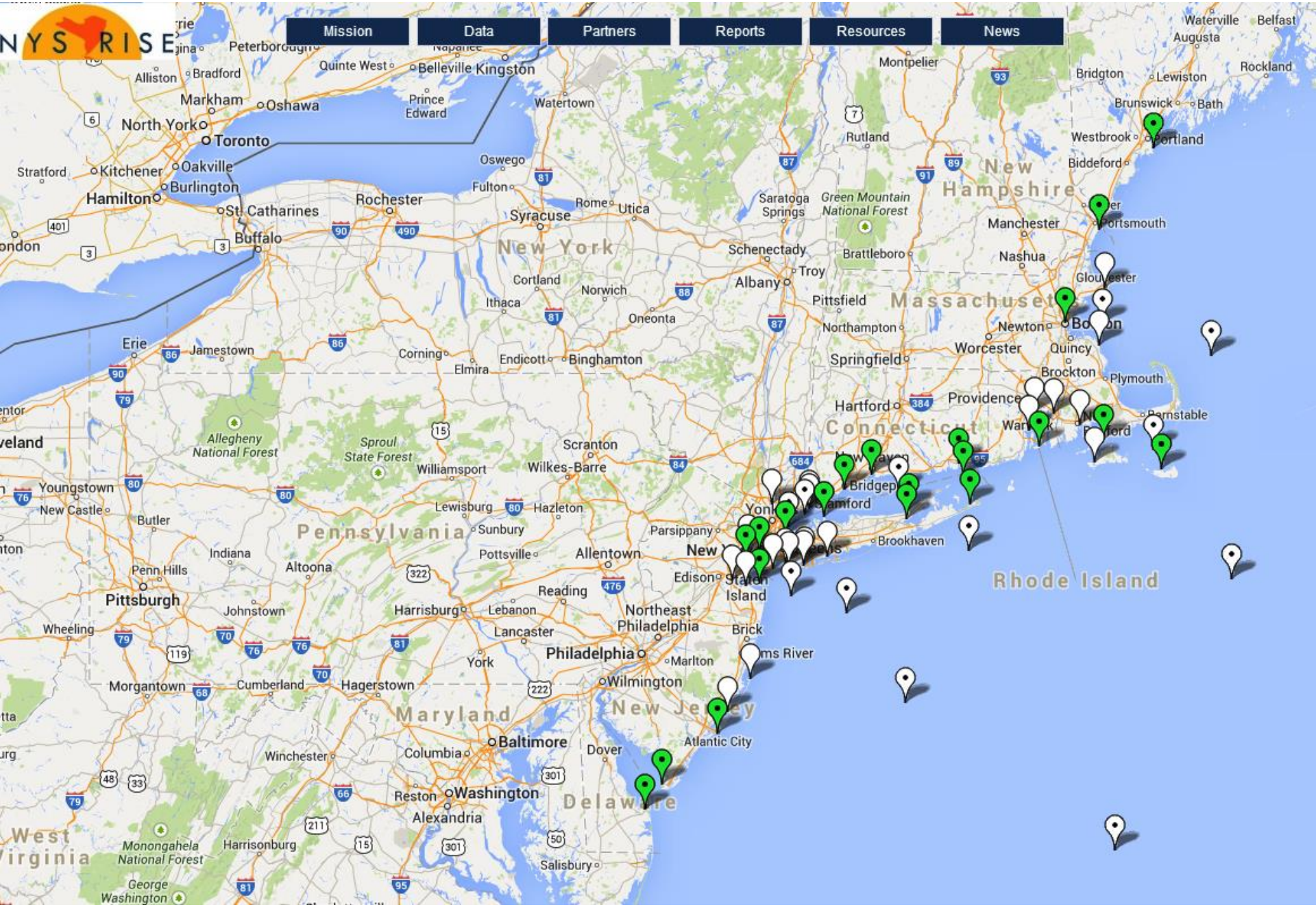
- Coastal Alerts
  - Metro New York
  - Regional
  - Eastern Seaboard
  - Max. Water Level Table
- New York Harbor
- LI South Shore
- LI Sound
- NJ & South
- Buoy Stations
- Animations
- Maximum Surge
  - Metro New York
  - Regional
  - Eastern Seaboard
- Waves

Coastal Alert Advisory System

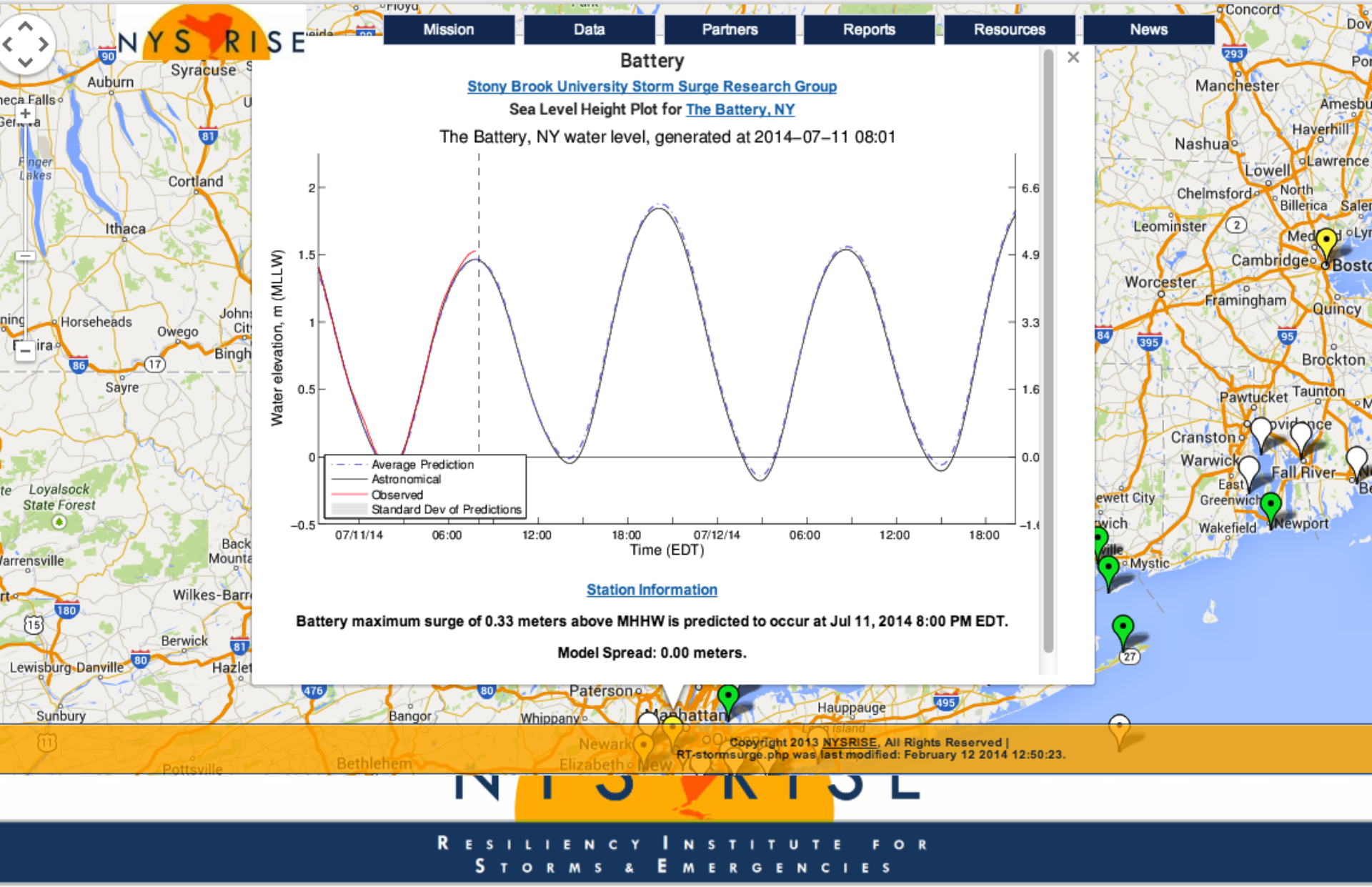
NYS RISE

Resiliency Institute for Storms & Emergencies

Stony Brook Storm Surge Predictions in Google Earth (Mark Lang)



Stony Brook Storm Surge Predictions in Google Earth (Mark Lang)



Ensemble Storm-Surge Predictions Using NWS Short-Range Ensemble Prediction System (16-km grid spacing) and Keith Roberts Statistical Model:

http://nystormsurges.weebly.com/statistical-predictions-sref.html

Surge Predictions forced via SREF

Here are surge predictions for Battery Park, NY forced with a regression model using the SREF 10-m wind and MSLP data.

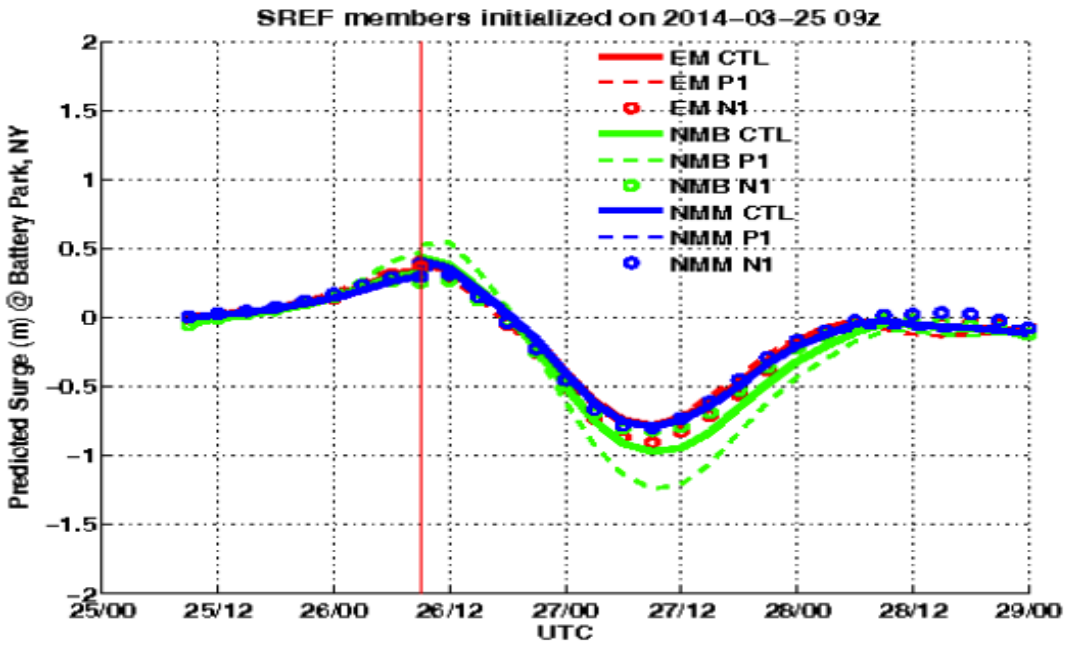
- **Forecast starts at model hour 24 because moving sums are utilized.**
- **This is an experimental product and not intended as forecast guidance.**

Surge Predictions (meters)

10-m wind vector (m/s) mean and std of 10-m wind speed (m/s)

Predicted Water Level (MLLW meters)

Wind vector (m/s) of 10-m Spatial (-74 W to 70 W; 39.5 to 40.5 N) Mean Wind



Center for Visual Computing

- Research Center at
  Stony Brook Computer Science
- Contributing Members:
  - Prof. Arie E. Kaufman – Lead
  - C. Papadopoulos – PhD Researcher
  - S. Mirhosseini – PhD Researcher
- Visualization, Virtual Reality and Medical Imaging
- Contributions to Work Units:
  - 1.2
  - 1.4
  - 4.1

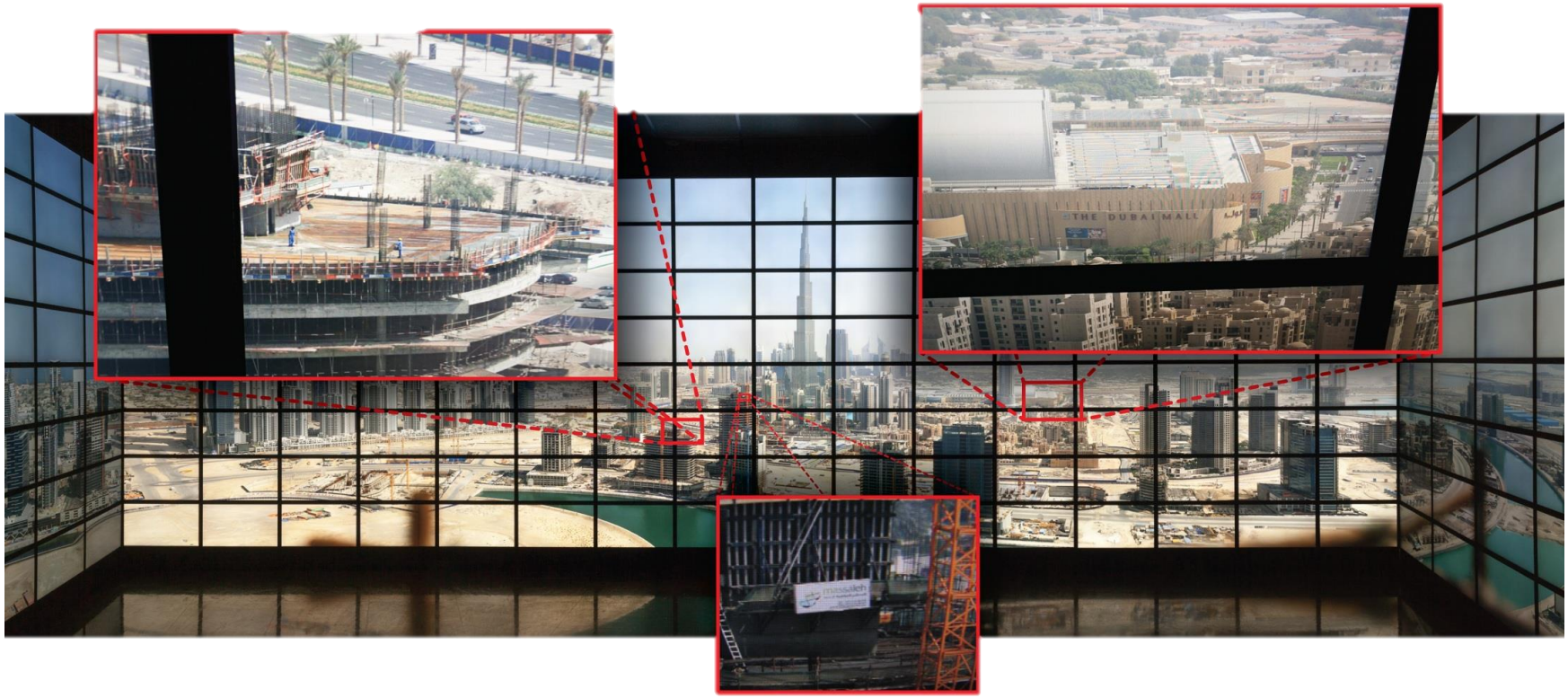
Stony Brook University

Center for Visual Computing

Center of Excellence
WIRELESS AND INFORMATION TECHNOLOGY
AT STONY BROOK UNIVERSITY

NYS RISE
Resiliency Institute for Storms & Emergencies

The Reality Deck



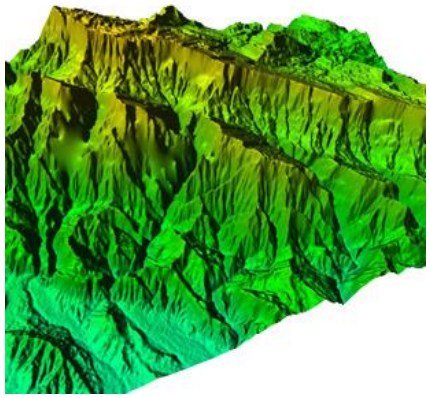
- Reality Deck – Immersive Gigapixel Display
- 416 Monitors – 18-node cluster
- Supports interactive 3D visualization applications

Data Sources

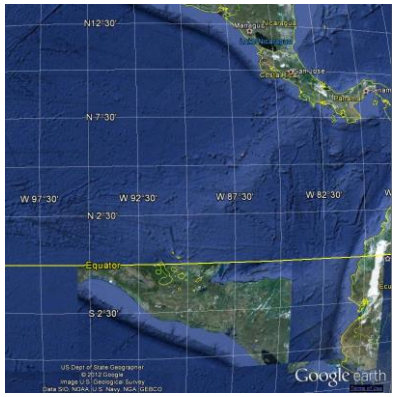
ADCIRC Output (ASCII)

```
-60.0387996040 45.8226938574 48.9426383972
-59.9215808231 45.6698242994 140.1360321045
-59.7746747280 45.4771106011 159.7015533447
-59.5908198112 45.2341576473 99.9141998291
-59.3648688784 44.9264880149 123.8999099731
-59.0919710634 44.5353855741 64.2552642822
-58.7701733998 44.0366239873 119.7898330688
-58.4060934951 43.3966232439 3319.0651855469
-58.0025048292 42.5772139363 4282.5419921875
-57.6521047427 41.7286121102 4876.9824218750
-57.3723895292 40.8682029145 5157.5976562500
-57.1381616136 40.0012908169 5238.0751953125
-56.9824851905 39.1258663143 5300.8364257813
-56.8622607874 38.2478176428 5231.4663085938
-56.8258821775 37.3662364056 5269.6635742188
-56.8186266338 36.4846815007 5222.4760742188
-56.8995939586 35.6060392532 5291.0659179688
-57.0061265976 34.7296241936 2898.9511718750
-57.2030562068 33.8639773960 5021.1118164063
-57.4246437068 33.0030539028 5060.5454101563
-57.7364817299 32.1618474784 5432.7138671875
-58.0750785284 31.3291188184 5269.3759765625
-58.4990563346 30.5250159789 5694.0688476563
-58.9573262656 29.7365325674 5710.8388671875
-59.4871954451 28.9821911847 5763.4057617188
```

LiDAR DEM



Tiled Imagery



Building Outlines

NYS RISE

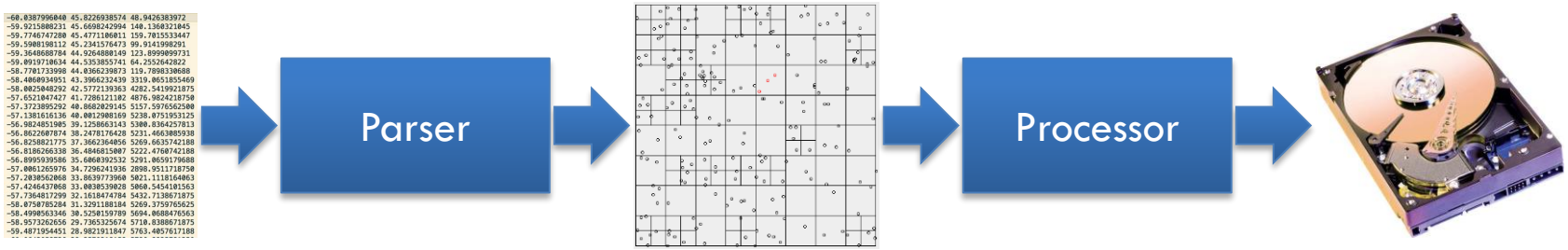
Resiliency Institute for Storms & Emergencies

Data Processing

ADCIRC Output (ASCII)

Optimized Quad-tree Data Structure

Reusable GeoDataSource



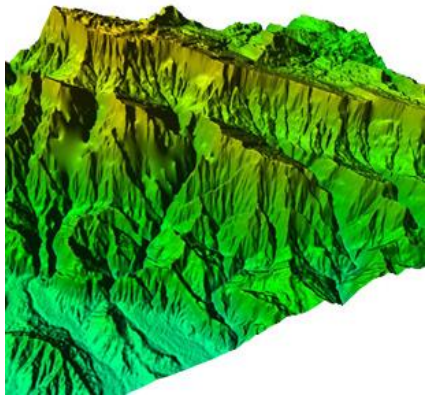
- ADCIRC Output is converted to quad-tree spatial database
- Can perform rapid spatial queries in real-time
- Maintains underlying data semantics, resolution and time-variability
- More space efficient than high-res pre-rasterized overlays

NYS RISE

Resiliency Institute for Storms & Emergencies

Data Processing

LiDAR
DEM

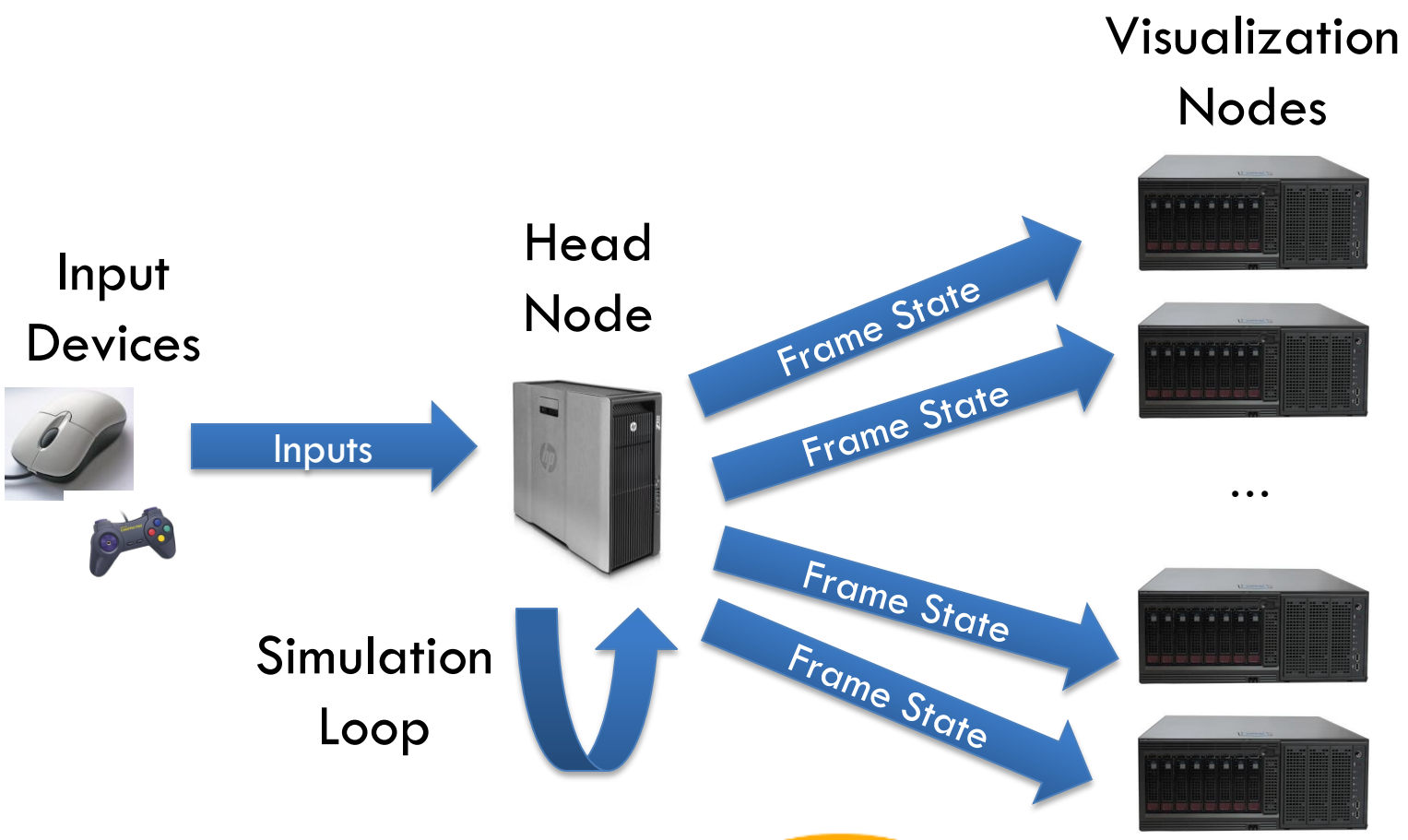


- Acquired from NYC OpenData
- Converted to GeoTIFF
- Reprojected to EPSG:4326
- Also used, subsampled version (thanks Hamish!)

Building Outlines

- Acquired from NYC OpenData
- Recentered to match DEM
- Reprojected to EPSG:4326
- Reduced in size (focused on Manhattan)

ARCHITECTURE



NYS RISE

RESILIENCY INSTITUTE FOR STORMS & EMERGENCIES

Visualization Software

- Input handling, window creation and data distribution by Equalizer
- OpenGL rendering via OpenSceneGraph (supporting multiple asset types)
- GIS Rendering using osgEarth
- ADCIRC Model Visualization Implemented as osgEarth driver
  - Integrated with osgEarth database streaming
  - Can create visualizations via .earth files (simple XML description)
  - Multiple layers, data types, overlays and levels-of-detail can be mixed and matches as required
- Real-time, interactive, arbitrary viewport positioning
- Multi-scale enabled visualization

Equalizer

OpenSceneGraph

osgEarth pelican mapping

NYS RISE

Global Scale

Satellite Photography

NYS RISE

Resiliency Institute for Storms & Emergencies

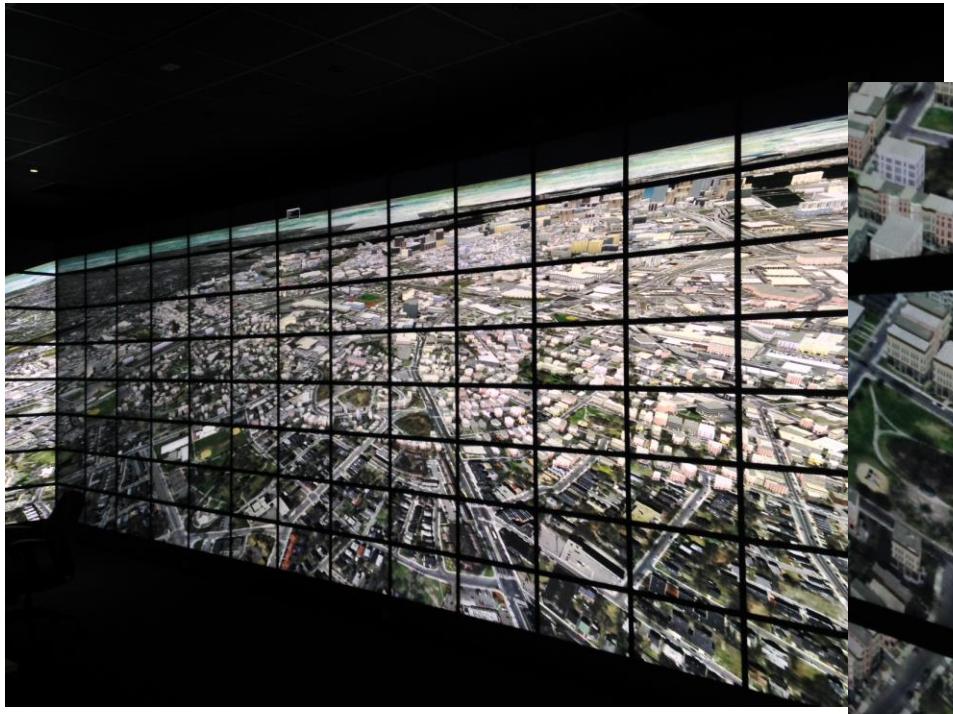
State Scale

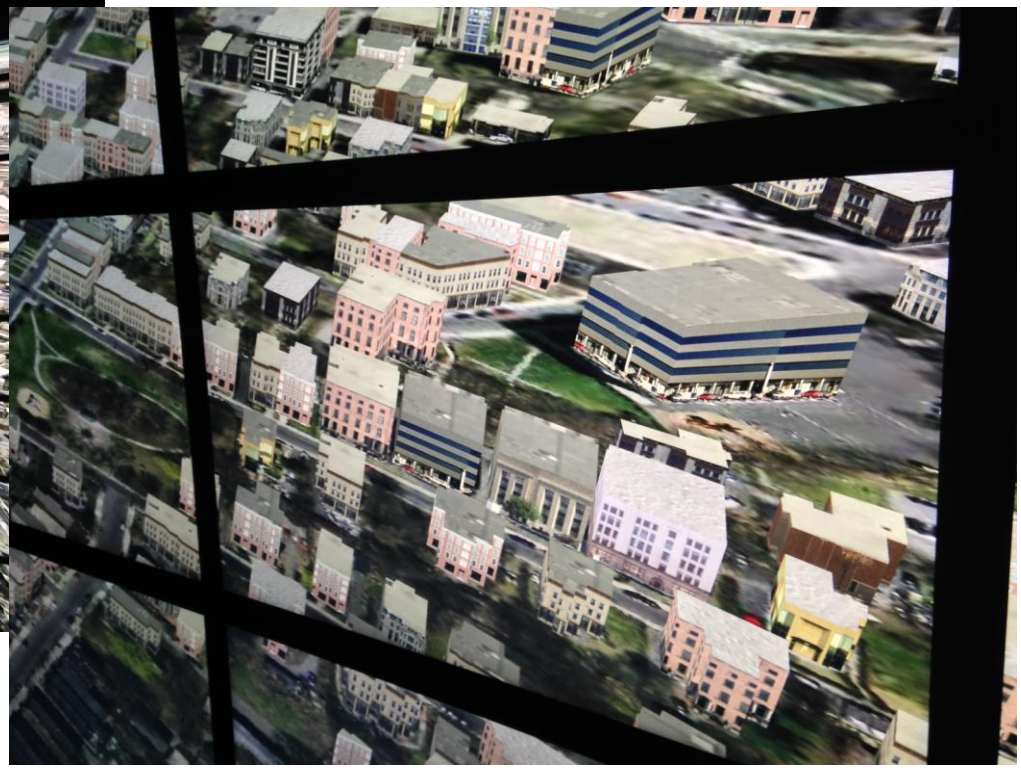
High Resolution Insets

NYS RISE

Resiliency Institute for Storms & Emergencies

Procedural Buildings



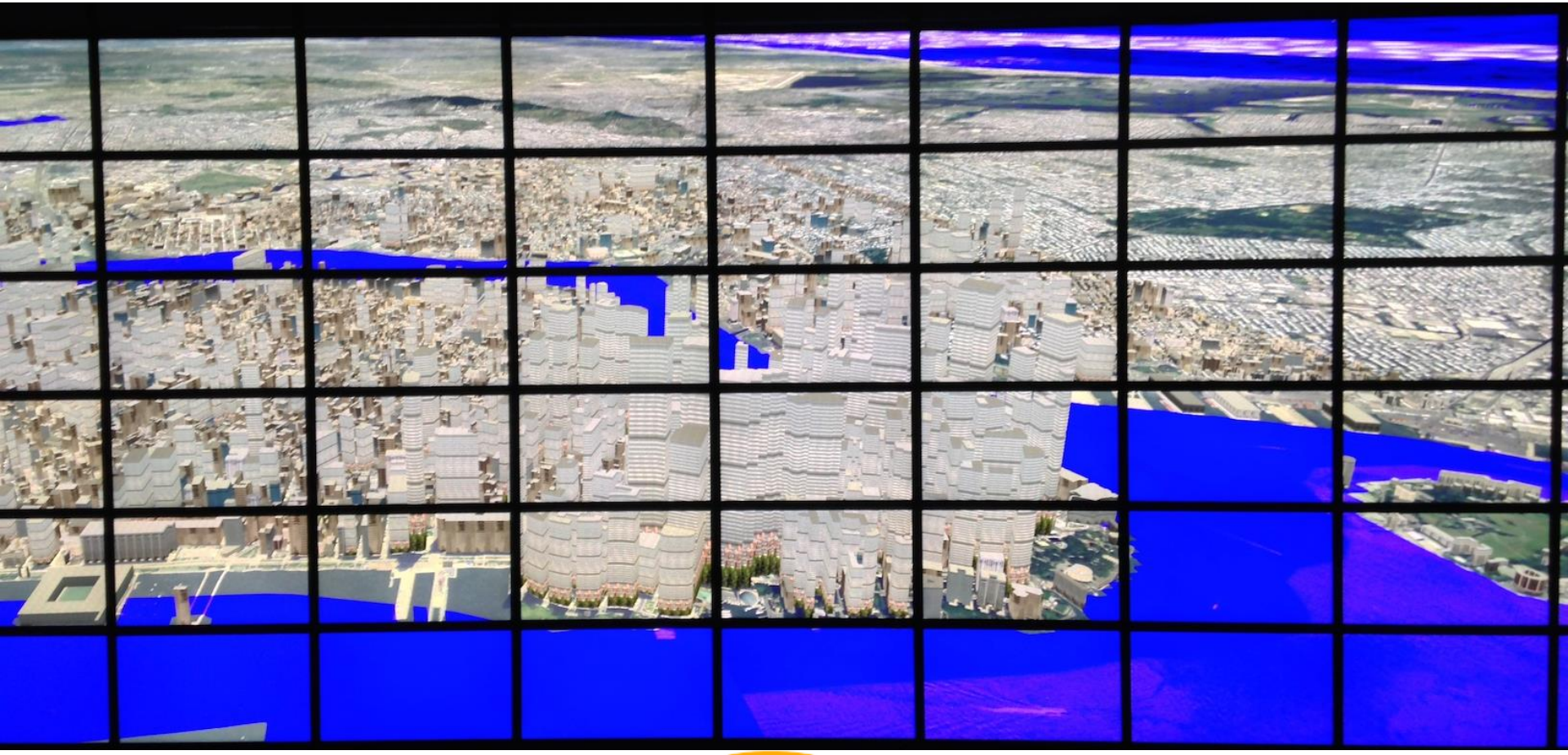


High Resolution Ground Imagery and Building Outlines in Boston, MA

NYS RISE

Resiliency Institute for Storms & Emergencies

ADCIRC MODEL (1)

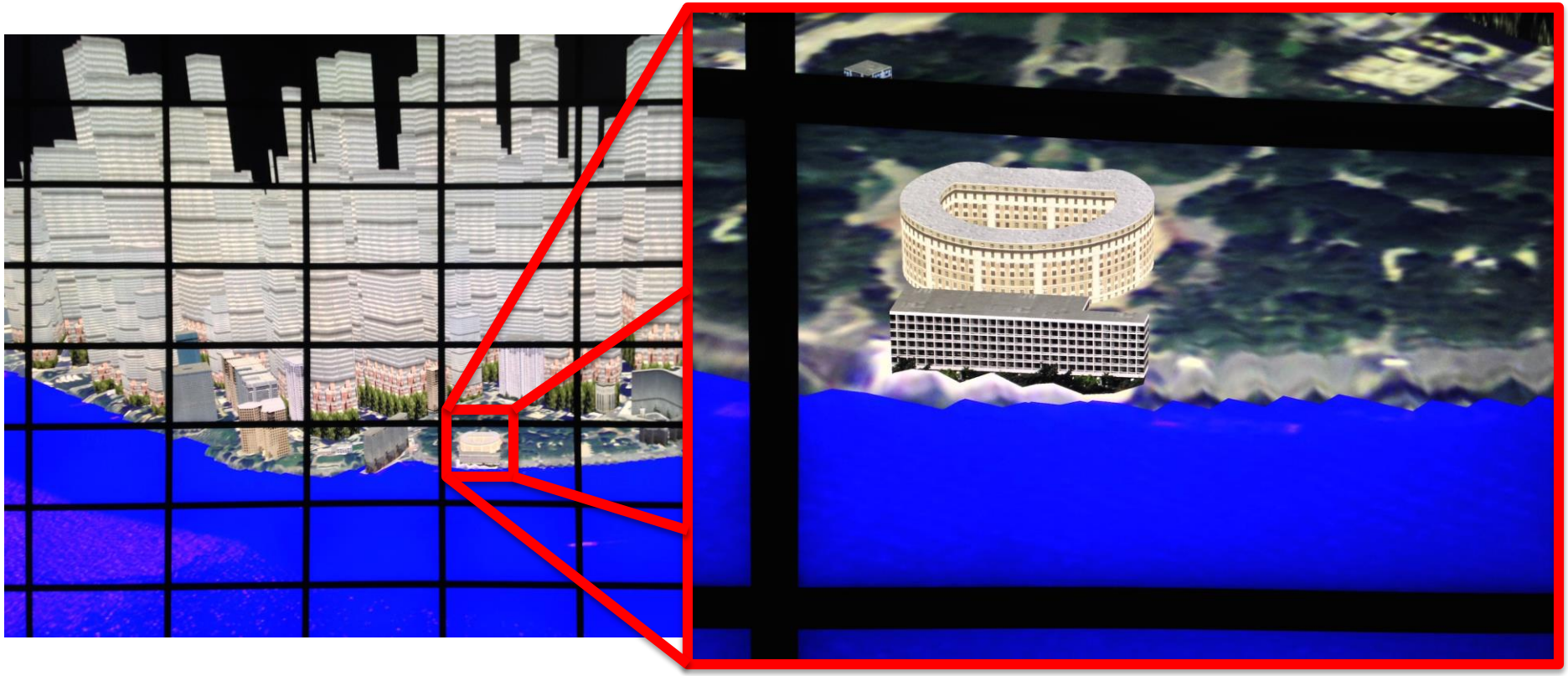


Satellite Imagery (Mapquest Open)
LiDAR DEM (NYC OpenData)
Building Outlines (NYC OpenData)
Manhattan

NYS RISE

RESILIENCY INSTITUTE FOR STORMS & EMERGENCIES

ADCIRC MODEL (2)



Satellite Imagery (Mapquest Open)
LiDAR DEM (NYC OpenData)
Building Outlines (NYC OpenData)
Manhattan

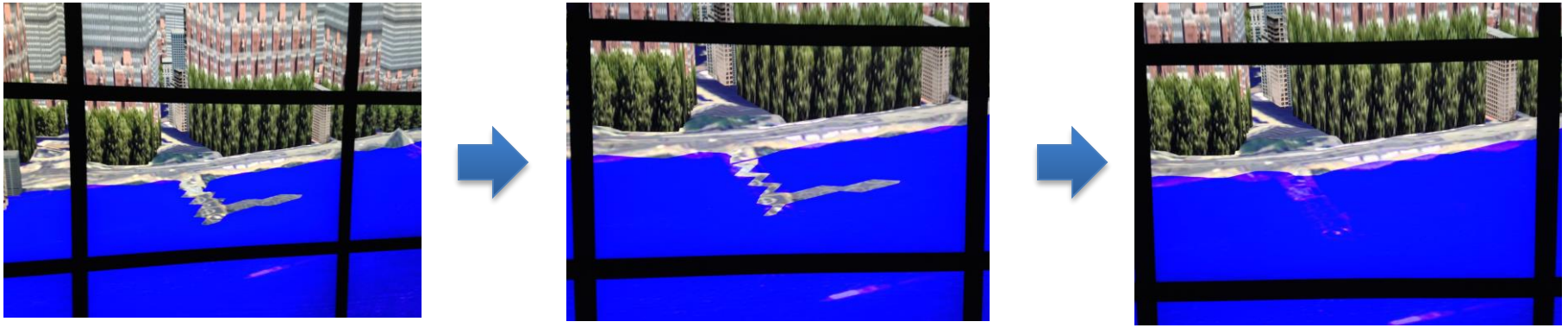
Building detail in
South Manhattan

NYS RISE

RESILIENCY INSTITUTE FOR STORMS & EMERGENCIES

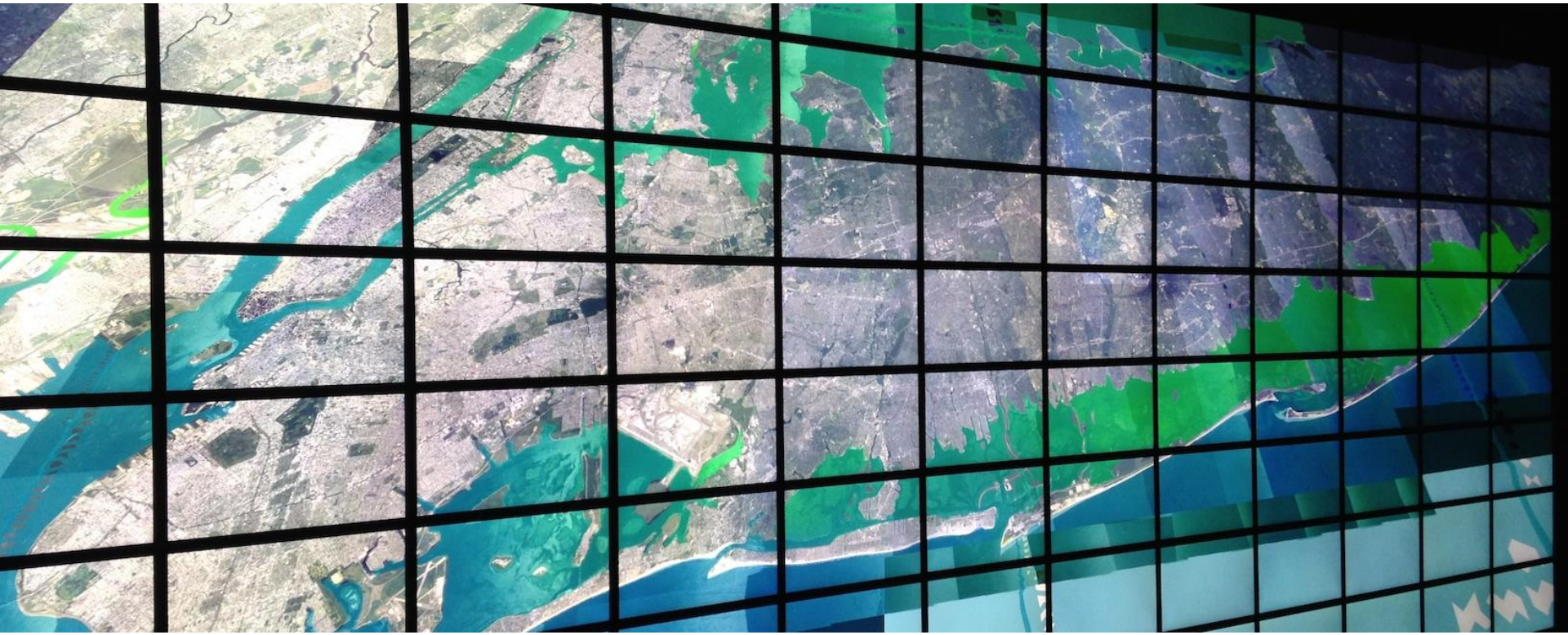
ADCIRC MODEL (3)

Surge Progression near the Battery



ADCIRC – DEM Interaction
in South Manhattan

ADCIRC MODEL (4)

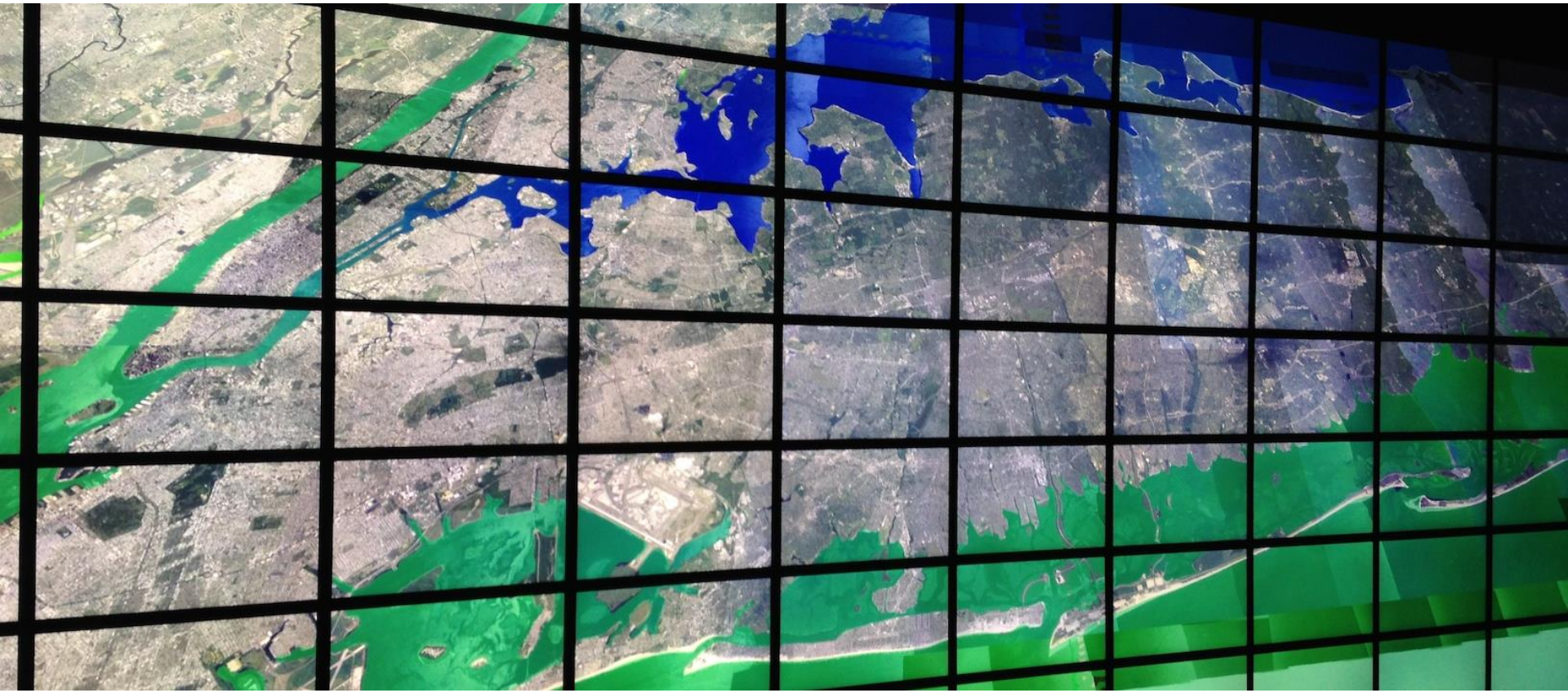


Green [-0.482,3.347] **Blue**

NYS RISE

RESILIENCY INSTITUTE FOR STORMS & EMERGENCIES

ADCIRC MODEL (5)

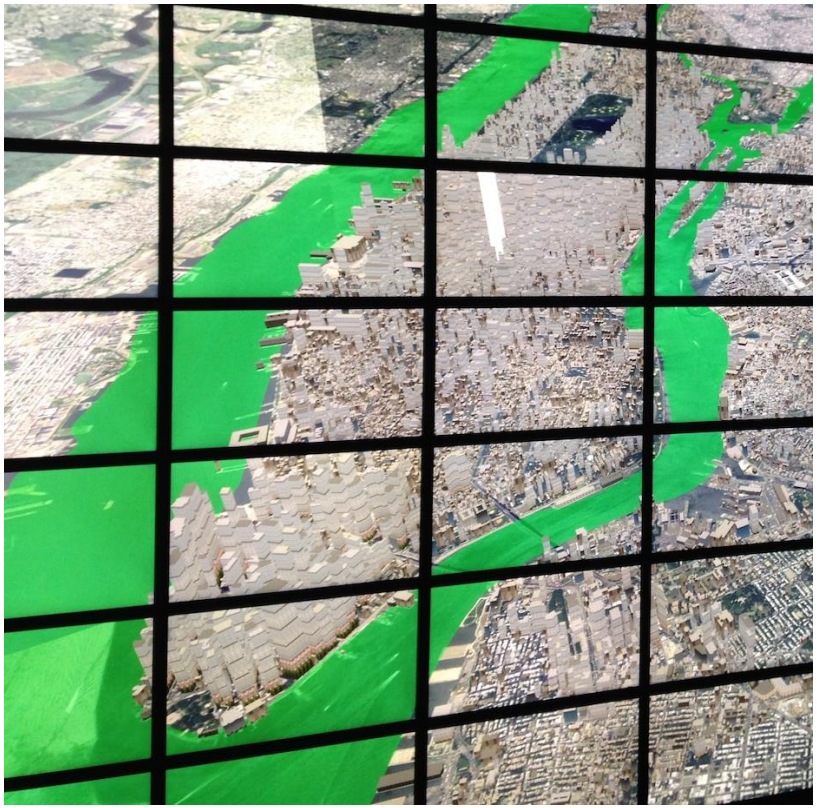


Green [-0.482,3.347] **Blue**

NYS RISE

Resiliency Institute for Storms & Emergencies

ADCIRC MODEL (6)



Green [-0.482,3.347] **Blue**

NYS RISE

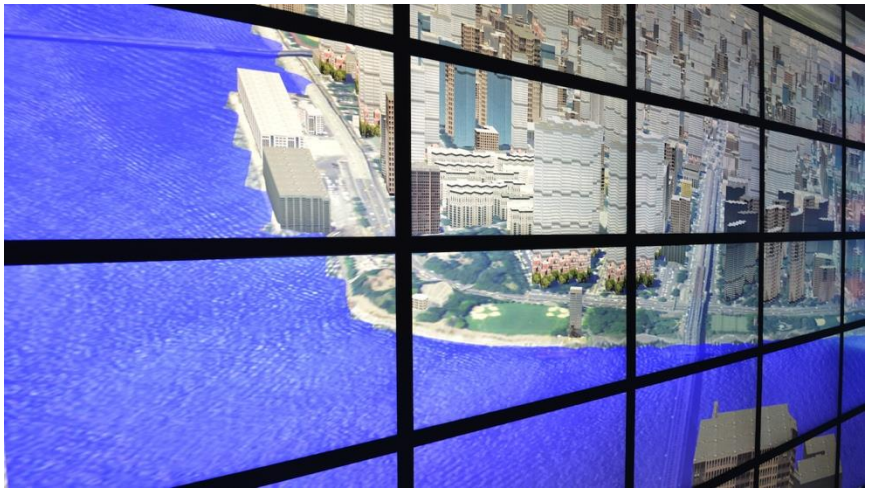
RESILIENCY INSTITUTE FOR STORMS & EMERGENCIES

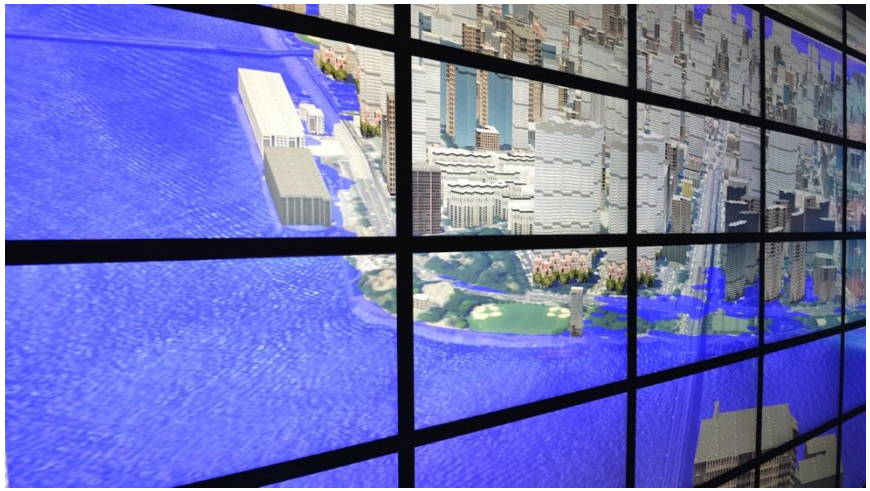
Inland Flooding Simulation

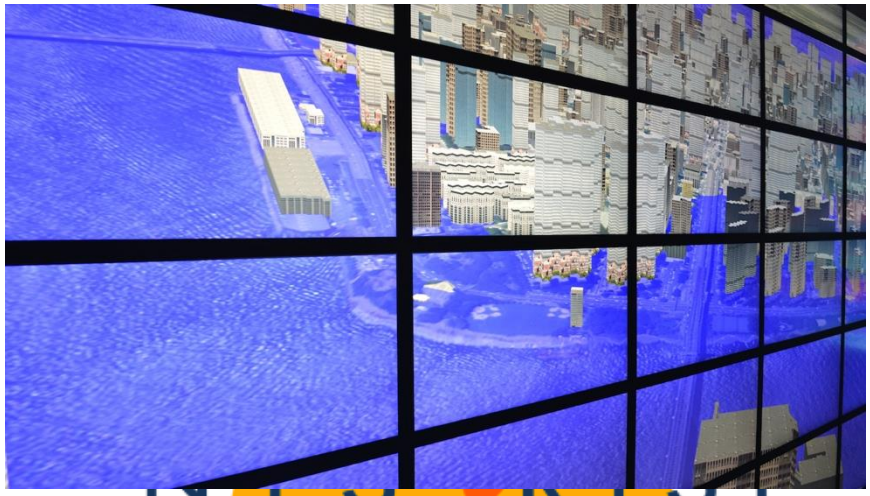
Inland Flooding Simulation

Inland Flooding Simulation

Inland Flooding Closeup







Demo Videos