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Evolution of the USGS Storm Tide Network

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Monitoring Inland Storm Tide History

- Monitoring was a post-event activity by collection of High Water Marks (HWMs)
- Many issues with HWMs
  - Difficult to identify
  - Difficult to accurately survey
  - Water elevation can vary due to:
    - Physical appearances
    - Continuity
    - Proximity to landfall

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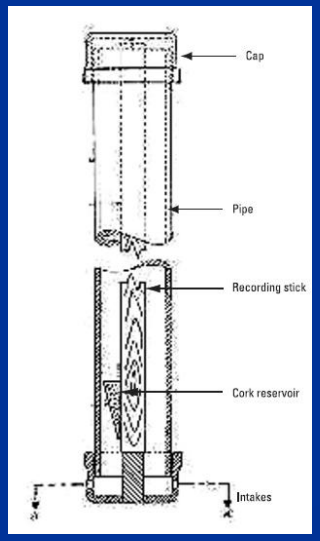
Alternatives to High Water Marks

- Proposal for an extensive network of crest-stage gages in 2005



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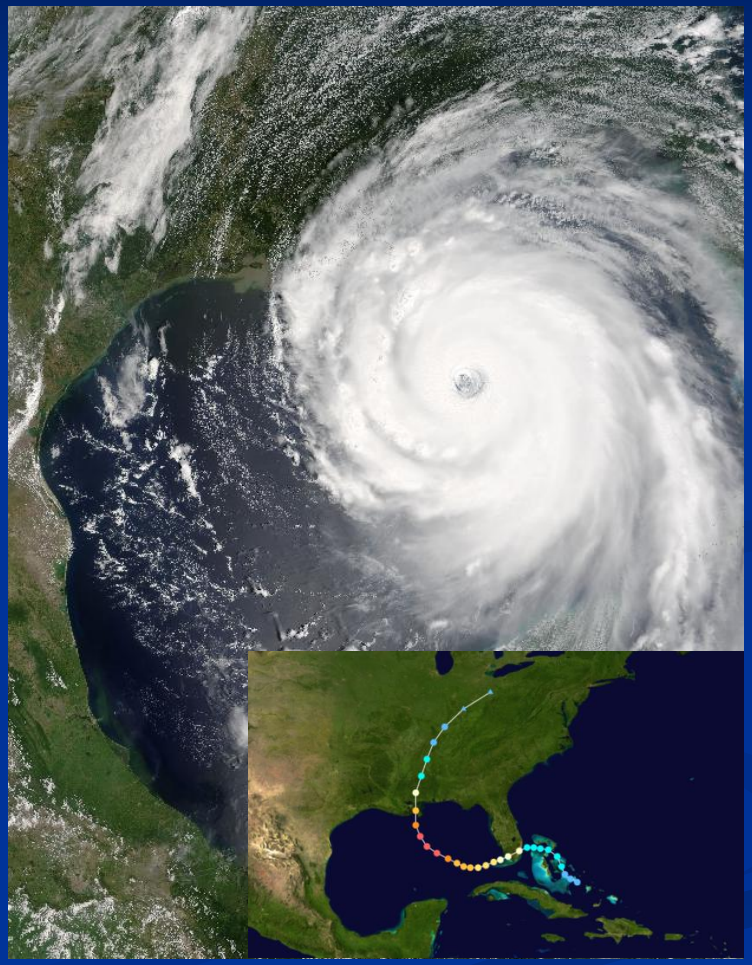
Hurricane Katrina



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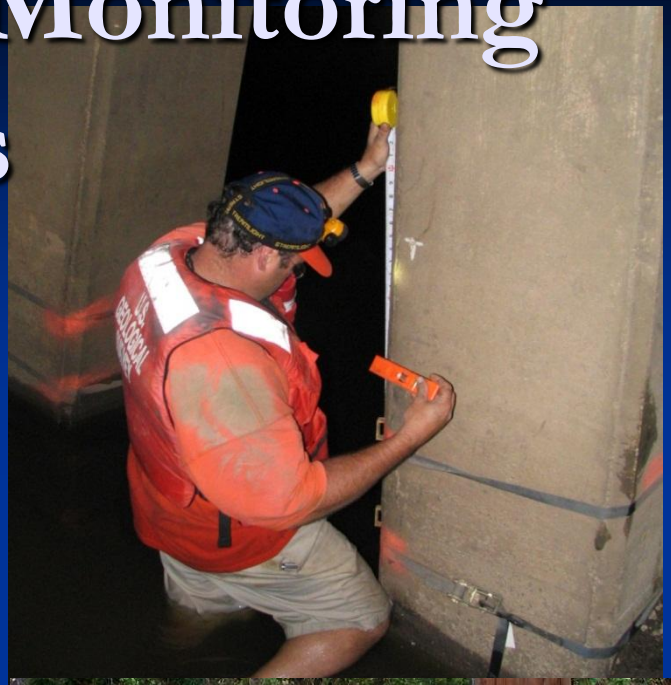
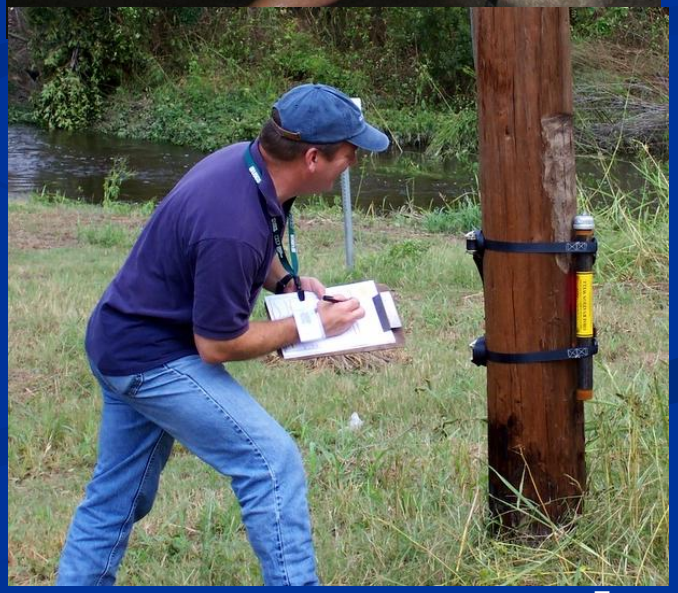
Mobile Storm-Tide Monitoring Networks





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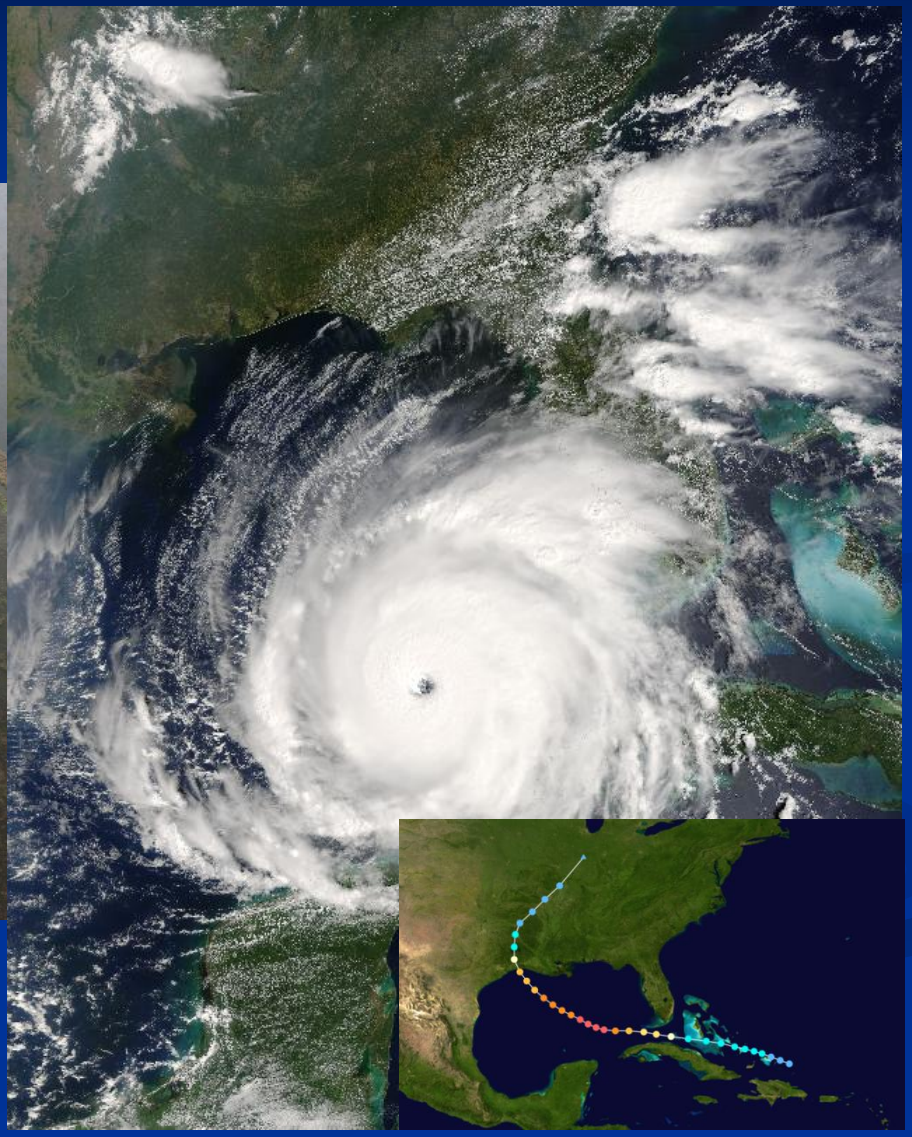
Hurricane Rita



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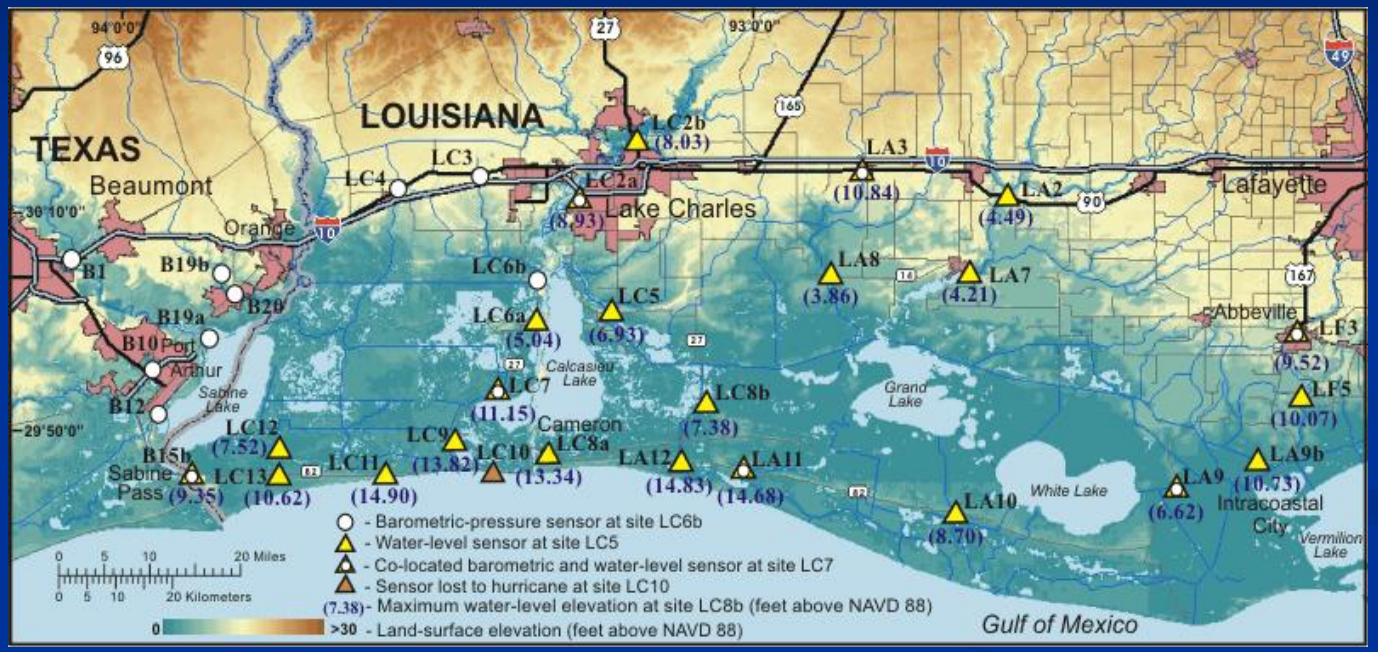
Hurricane Rita Deployment



47 sensors deployed
34 water level & 13 barometric pressure

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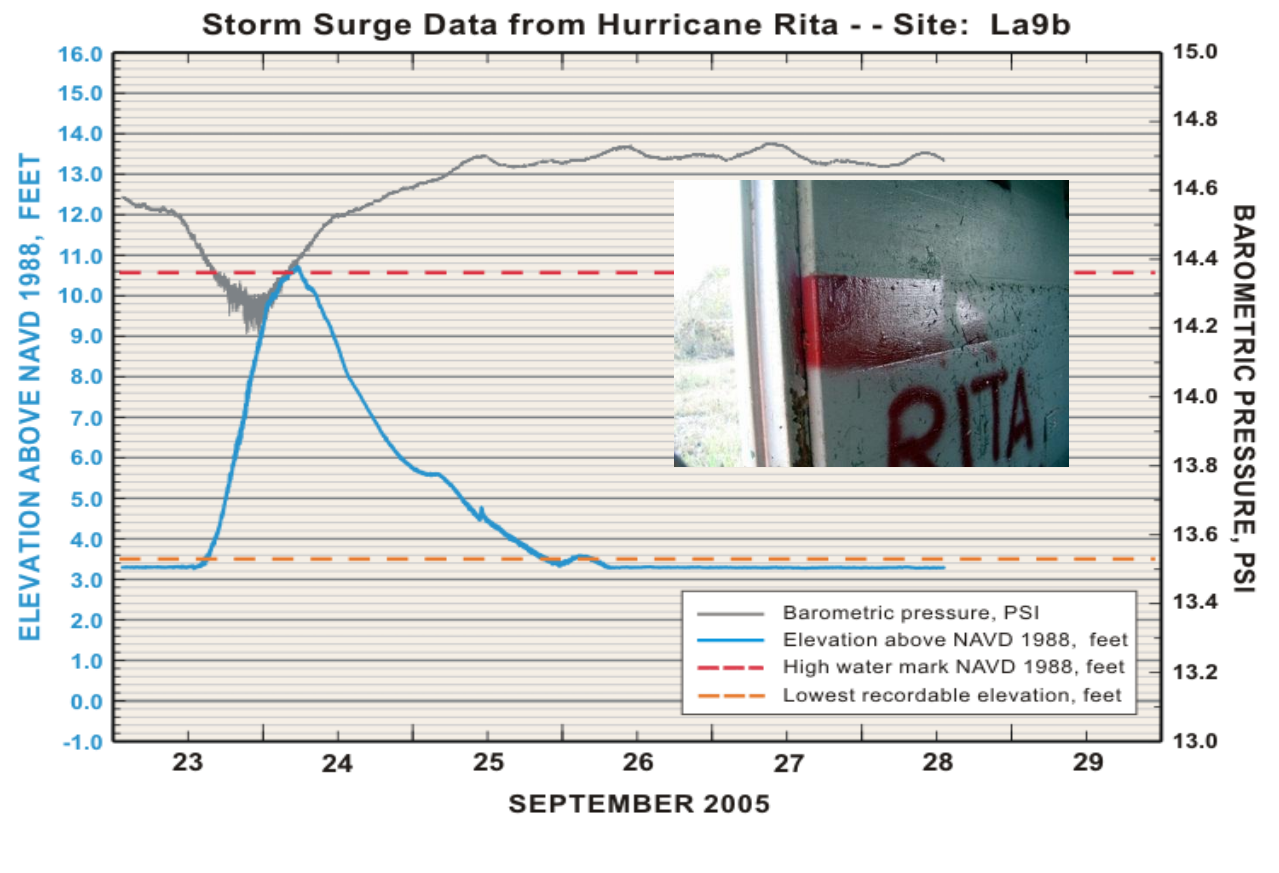
Storm Tide Sensor vs. HWM



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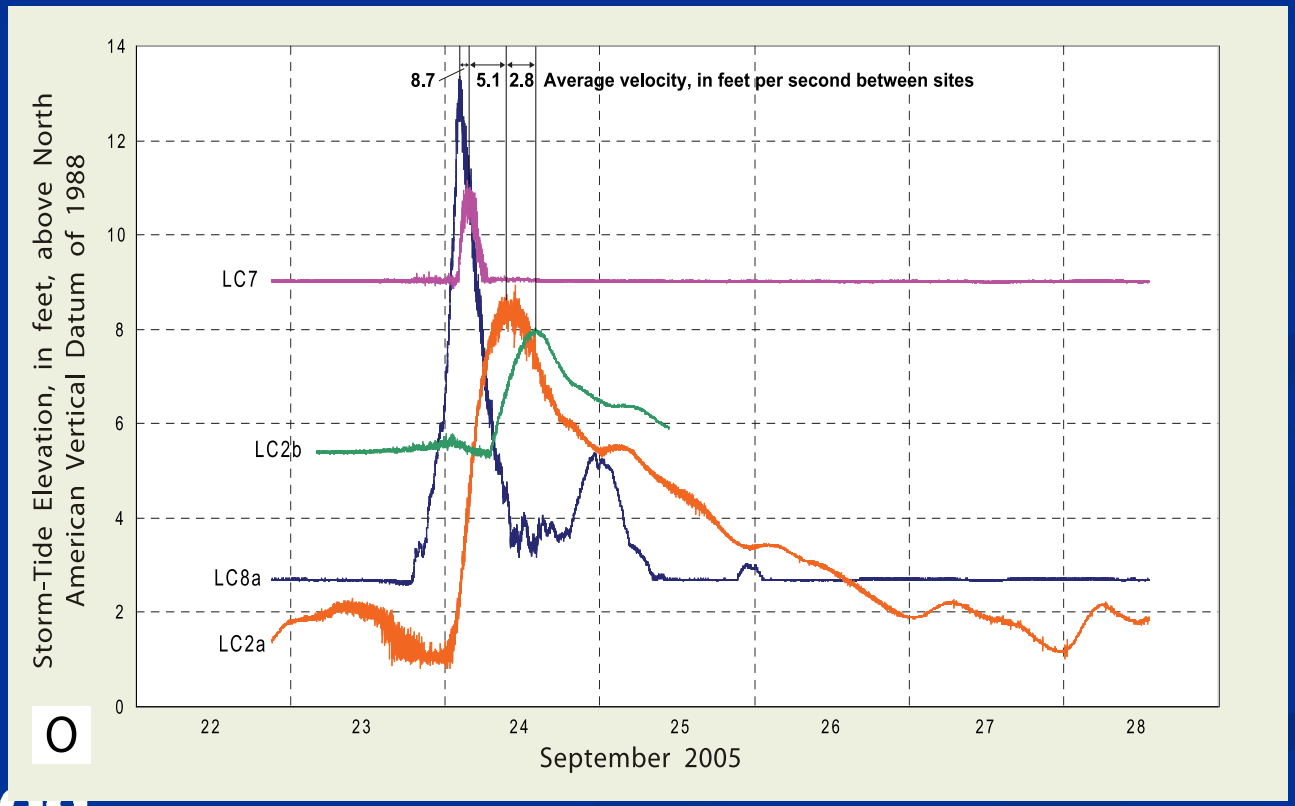
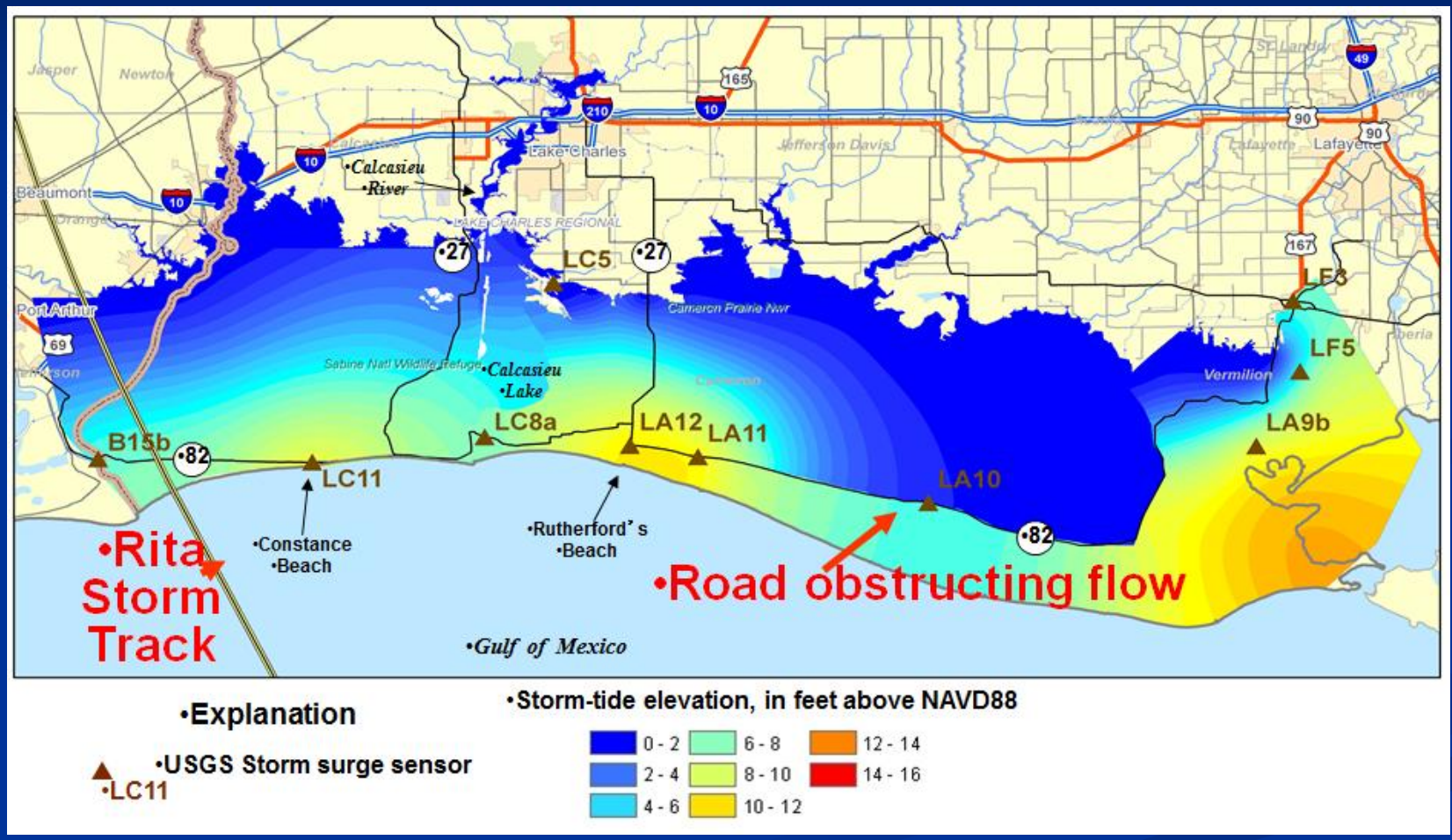
Calcasieu River, SW LA

Average velocity (ft/s) between sites

8.7, 5.1 & 2.8 ft/s



Storm-tide at 12:00 am



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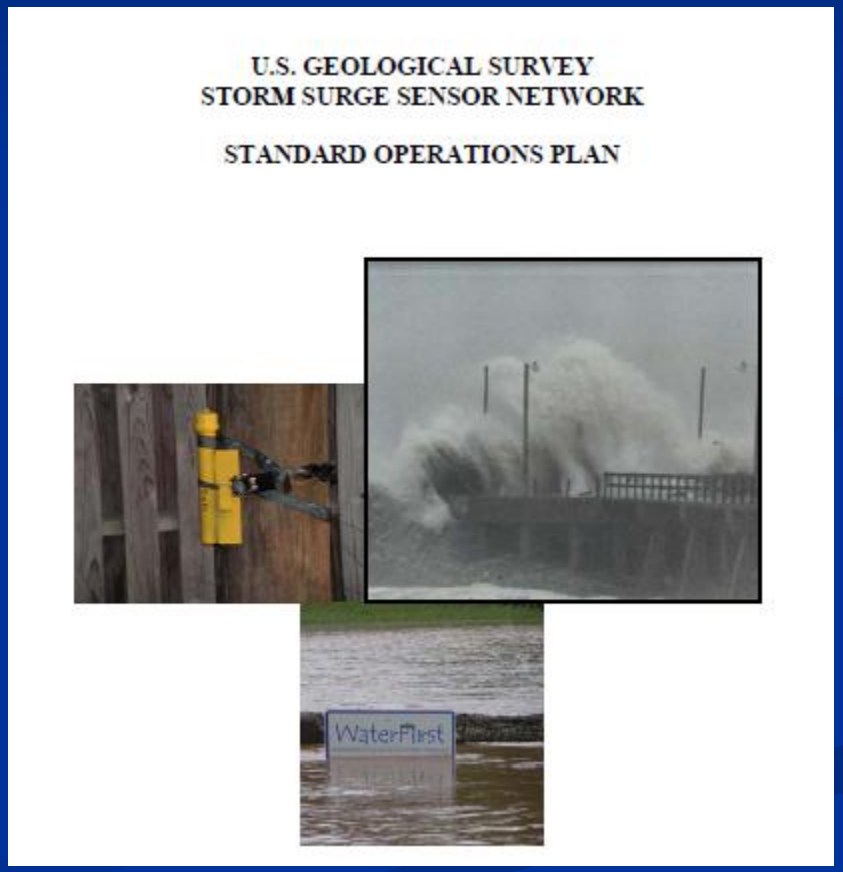
Monitoring Inland Storm Tide Planning for Deployments

- Standard Operating Procedures

- USGS Water Science Centers and Storm Tide Centers along the Gulf and Atlantic Coasts



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Monitoring Inland Storm Tide Planning for Deployments

- Mobile network of temporary gages
- Small, inexpensive, portable
- Late pre-landfall deployment
- Dense network
- Rapid recording intervals
- QA against HWMs
- Level-in to datum after storm
- Collaborate to build complementary datasets

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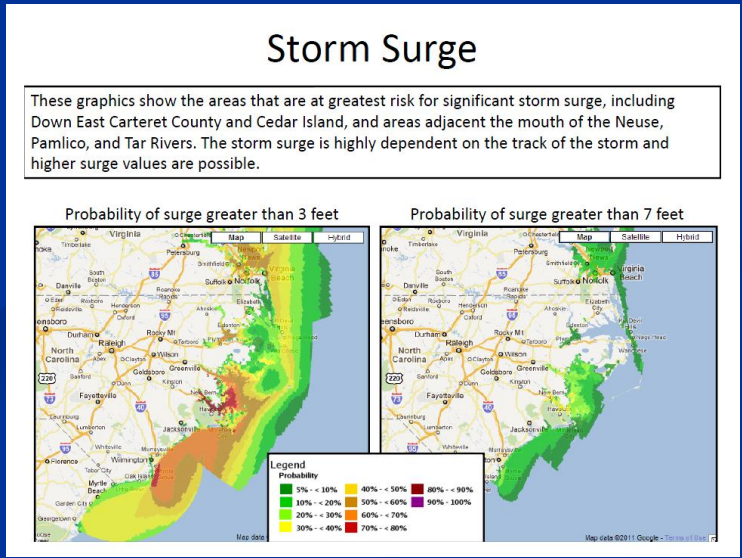
Monitoring Inland Storm Tide Planning for Deployment

Deployments largely based on:

- Forecasted surge
- Past deployment locations
- Pre-planned and opportunistic additional locations
- Collaboration with other agencies



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Sensor Deployment - Technology

- Unvented pressure transducers can record temperature and pressure for 8 days at 30 second intervals
  - Mobile
  - Self-contained
  - Relatively inexpensive
  - Accurate (0.01 ft)
- Secured in steel-pipe housing units
- Entire hydrograph—not just peak

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Sensor Deployment

- Generally 2-person crews
- Deploy 24-36 hours prior to landfall
- Strap-on sensors, mark Ref Pts, take pictures, get GPS coordinates
- Check-in each hour
- “Clear out” at 12 to 24 hours to landfall

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Sensor Recovery

- Retrieve sensors, flag HWMs, tape-down to H_2O, run local levels, download, adjust data for barometric pressure, salinity, and upload to web
- Follow-on GPS crews determine local datum for corrected data adjustment

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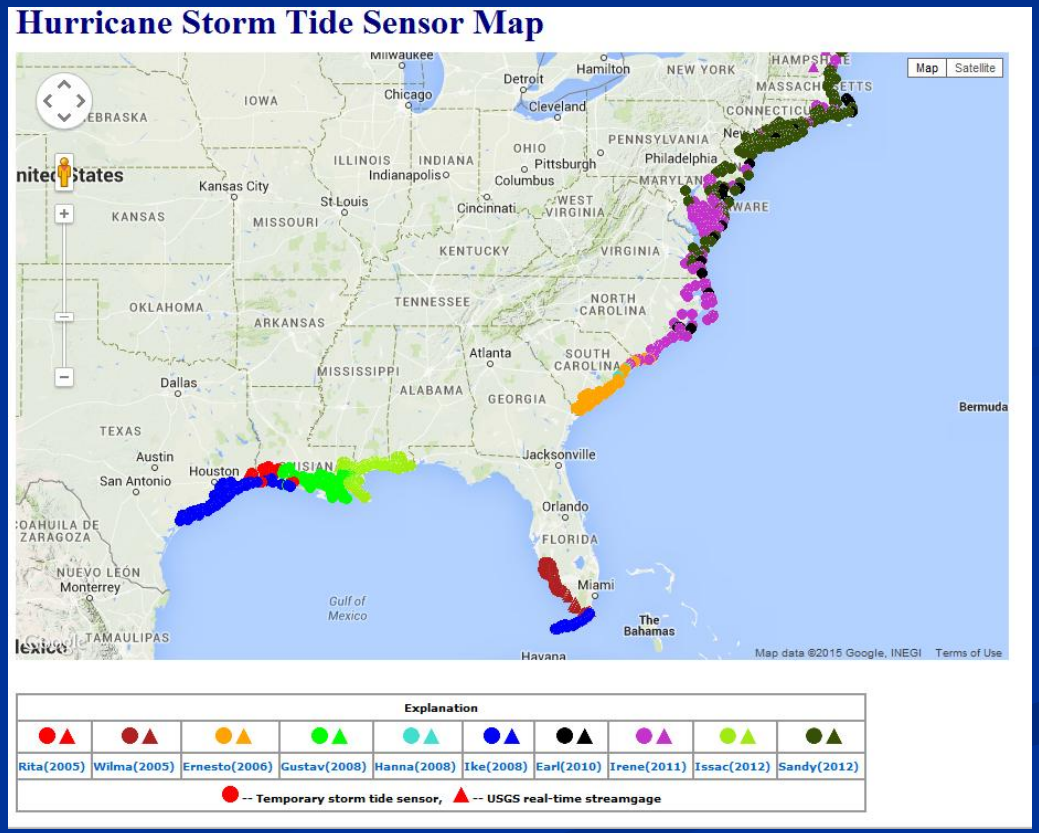
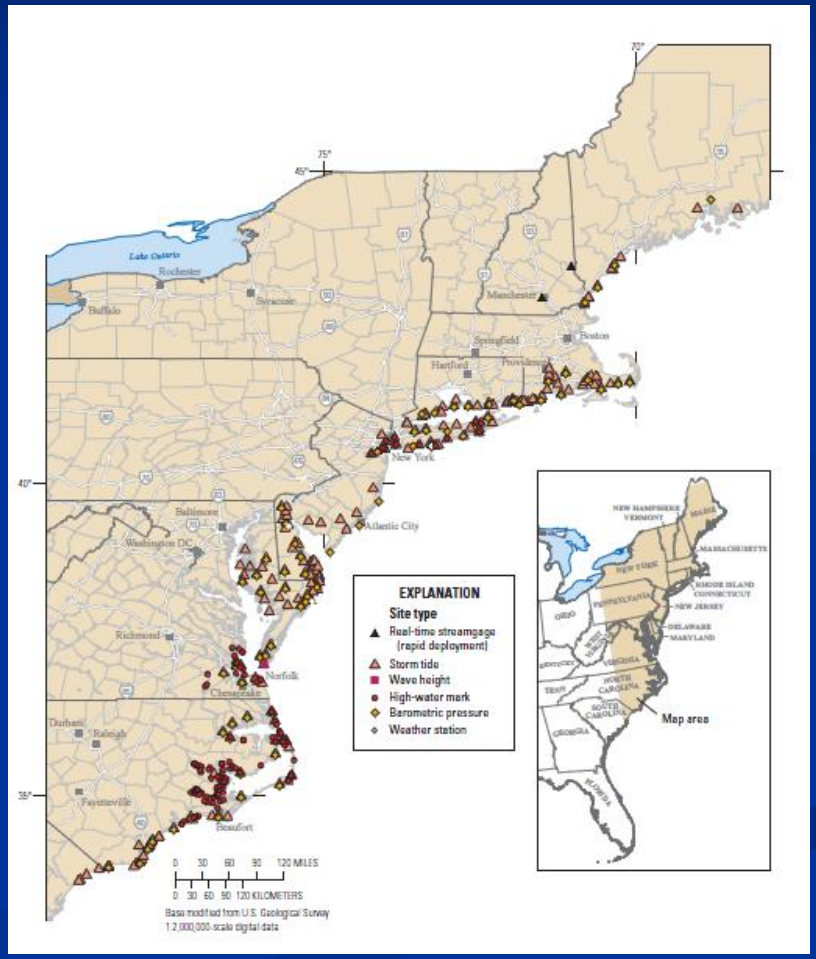
Monitoring Inland Storm Tide History of Deployments

- Rita (2005)
- Wilma (2005)
- Ernesto (2006)
- Gustav (2008)
- Hana (2008)
- Ike (2008)
- Earl (2010)
- Irene (2011)
- Isaac (2012)
- Sandy (2012)



Monitoring Inland Storm Tide Irene Deployment

- Storm Tide Sensors
  - USGS at 212 locations
  - UNC Sea Grant and UNC IMS at 13 locations
- Independent HWMs at 137 locations (104 in North Carolina)



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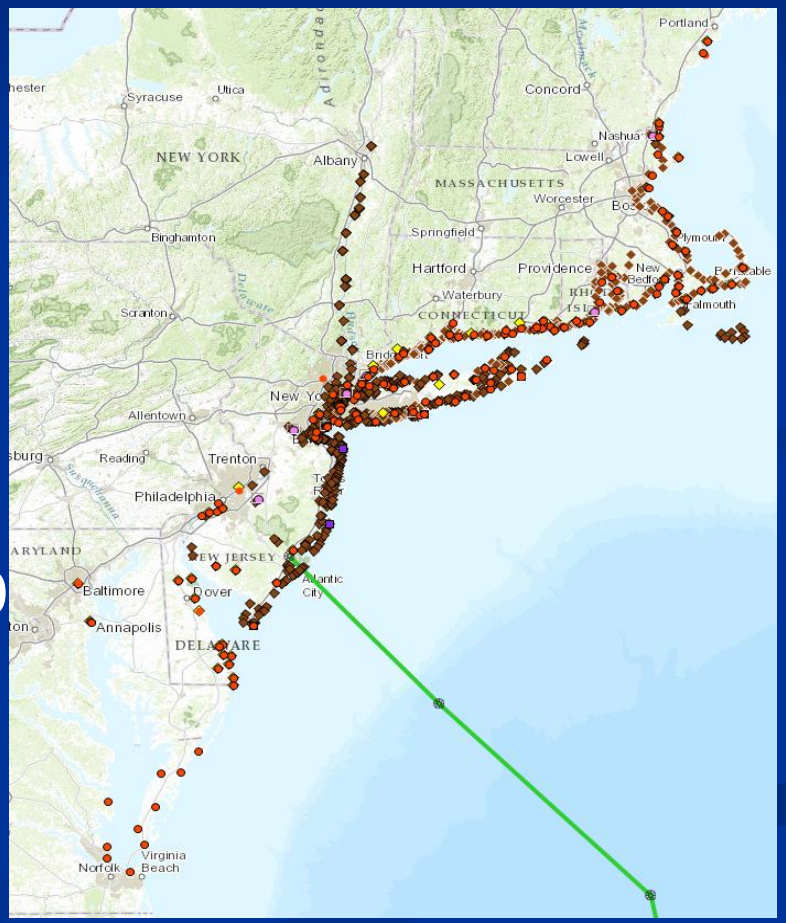
Monitoring Inland Storm Tide Sandy Deployment

- Storm Tide Sensors
  - USGS at 230 locations
  - 9 Wave Height Sensors
  - 8 Rapid Deployment Gages
- Independent HWMs also flagged at more than 900 locations



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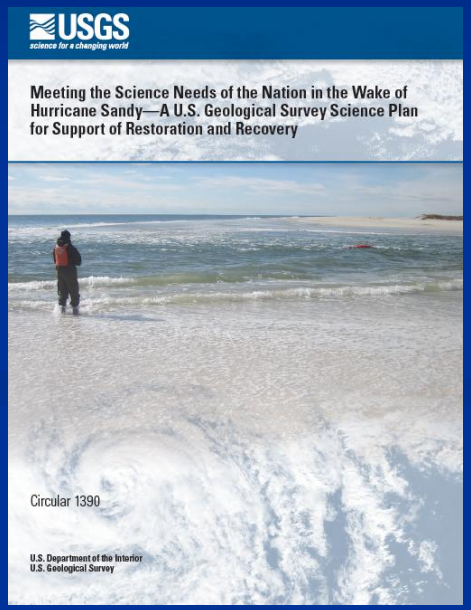
Post Sandy Developments and Response

- USGS Science Plan for Support of Restoration and Recovery
  - **Theme 1: Coastal Topographic and Bathymetric Data to Support Hurricane**
  - **Theme 2: Impacts to Coastal Beaches and Barriers**
  - **Theme 3: Impacts of Storm Surge, Including Disturbed Estuarine and Bay Hydrology**
  - **Theme 4: Impacts on Environmental Quality, Including Exposure to Chemical and Microbial Contaminants**
  - **Theme 5: Impacts to Coastal Ecosystems, Habitats, and Fish and Wildlife**



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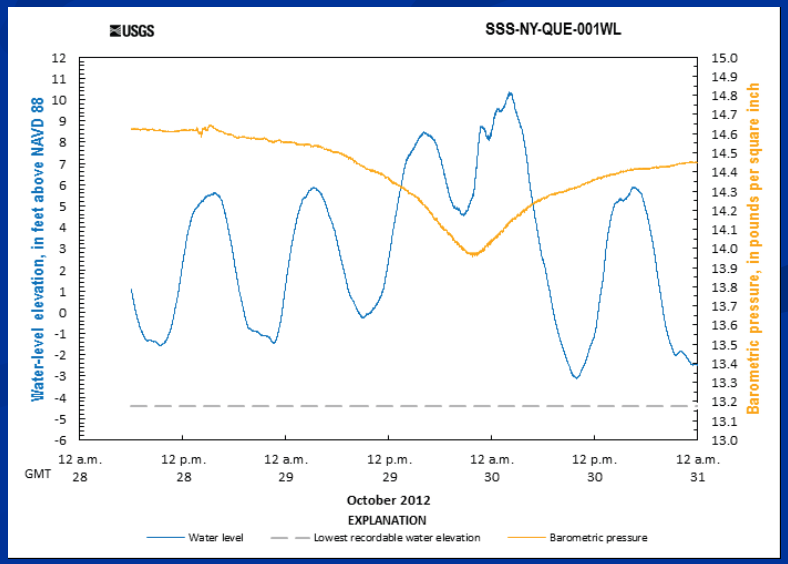
Theme 3 – Development of SWaTH

Storm Wave and Tide Hydrodynamic Network

- Sites are pre-determined and pre-surveyed, many with installed fixed-place brackets for easy storm deployment and recovery.
- Non-vented pressure transducers deployed in advance of storms within pipe housings of varying lengths from 2 to 12 feet in order to capture entire tidal cycle.
- Uses advanced sensors collecting data at up to 4 Hz (4 times per second) to both capture tide and wave.



SWaTH Network Design and Implementation

- Increase real-time footprint with the development of more robust and easy to install rapid-deployment gages.
- Storm-deployed rapid-deployment gages will transmit tide stage and meteorological data over GOES satellite every 15 min, or more frequently as needed.
- Installation of additional long-term coastal-monitoring stations in areas currently lacking coverage.
- Network developed to complement existing data collection by NOAA, USGS, and others.

RDG installed on bridge over State Boat Channel at Captree Island, NY for Hurricane Irene.

Long-term coastal-monitoring station at Rockaway Inlet at Floyd Bennett Field, NY.

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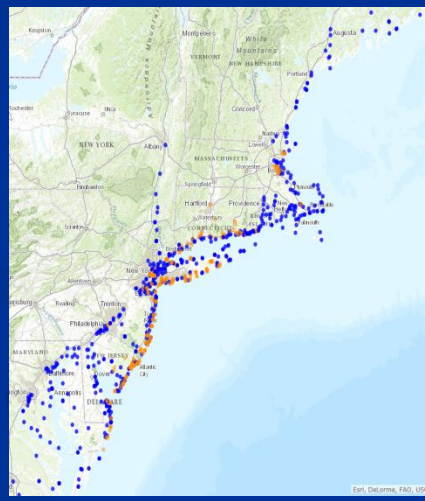
SWaTH Network
Enhancing Past Monitoring

- Expands upon the existing USGS storm-tide program.
- Developed for Northeast Coast from North Carolina to Maine.
- Expanded to include deployment for major Nor'easters, in addition to tropical systems.
- Collaborative effort with Federal, State and local partners, emergency managers, coastal researchers, and modelers.
- Includes both long-term and temporary stations operated by the USGS and other partners.



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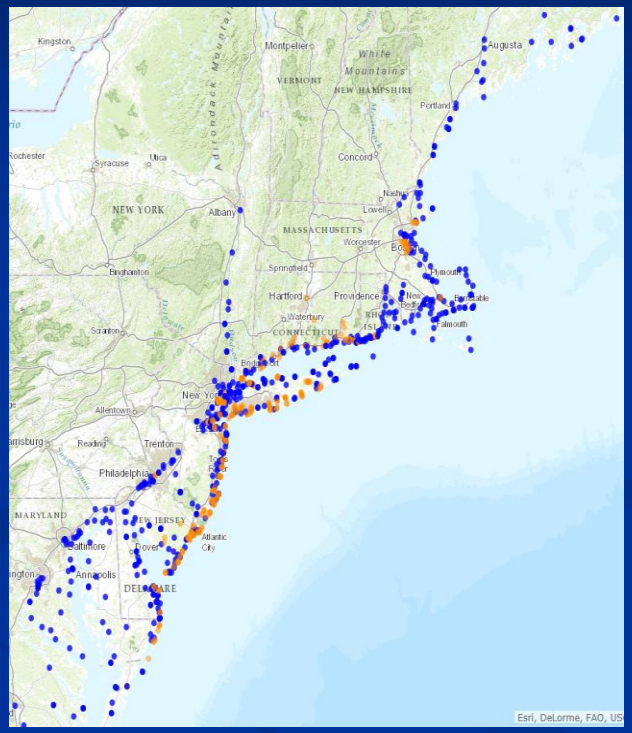
SWaTH Network

- Entire proposed network consists of about 900 sites or locations:
  - 75 non-USGS stations,
  - 115 coastal stations/tidal streams,
  - 530 storm-tide/wave sensors,
  - 85 rapid-deployment gages,
  - 30 tidal crest-stage gages,
  - 65 temporary barometric-pressure sensors.
- **Not all stations will be fitted with sensors for any one storm.**
- Data distributed through an online mapper in near-real time or as data is collected.



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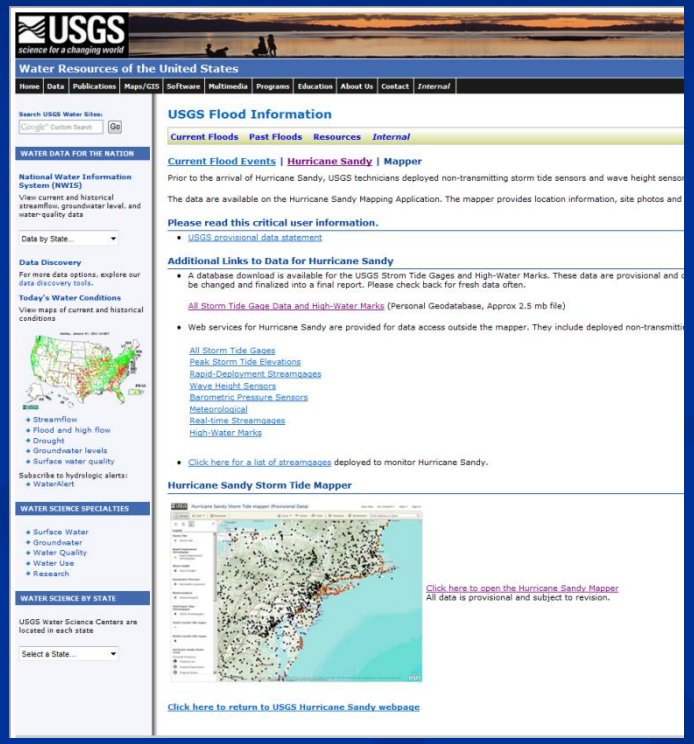
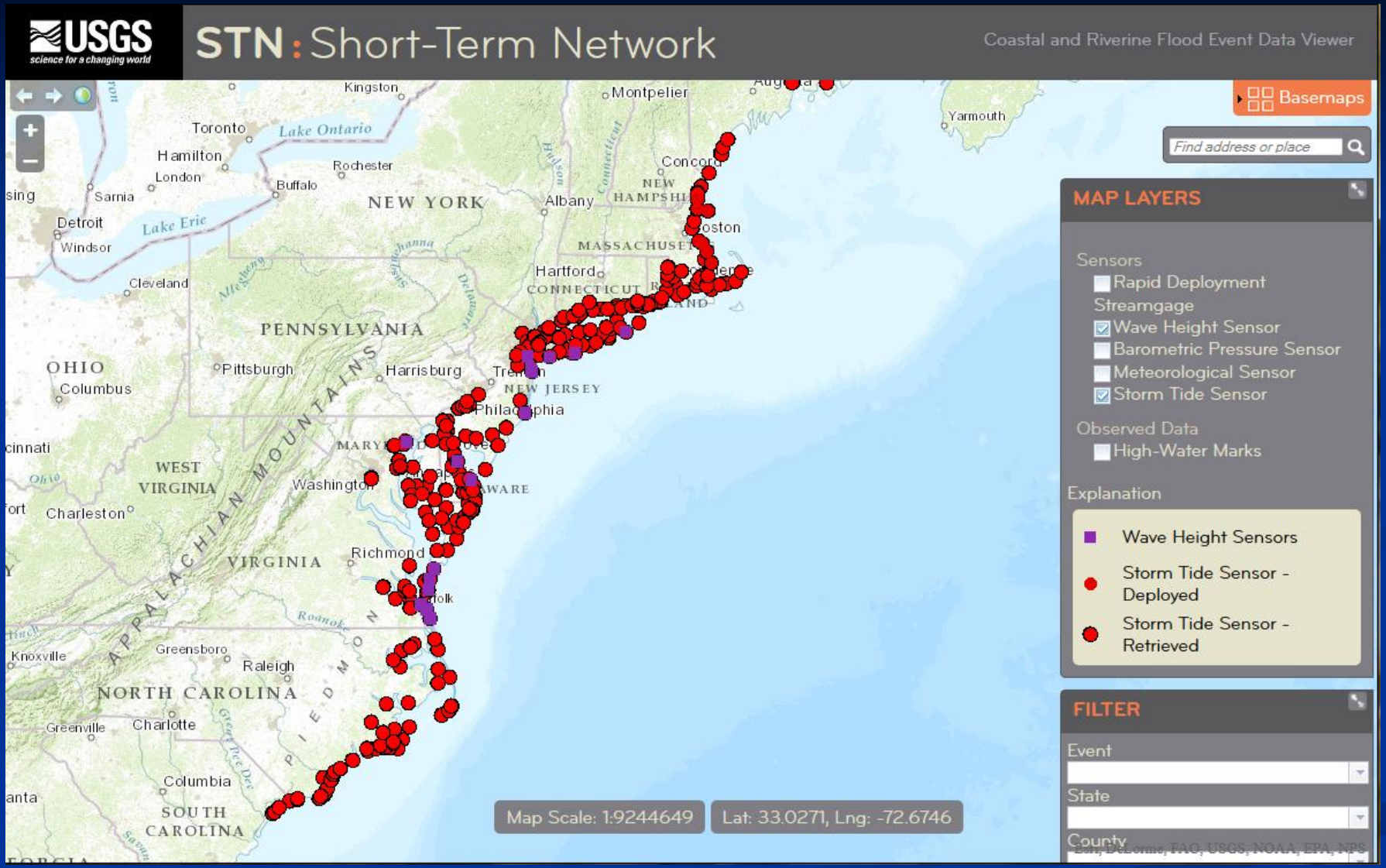
SWaTH Network Data Dissemination

Short-Term Network (STN) Mapper:

- Provide real-time data before, during, and after storm.
- Processing of storm tide and wave data performed seamlessly and available on mapper soon after the event.
- Mapper includes site data, hydrologic-data files, hydrographs, and photographs.
- Includes links to non-USGS data.
- Can be delivered directly into other operational computers using web services.

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STN: Short-Term Network
Coastal and Riverine Flood Event Data Viewer
Basemaps
Find address or place
MAP LAYERS
Sensors
Rapid Deployment Streamgage
Wave Height Sensor
Barometric Pressure Sensor
Meteorological Sensor
Storm Tide Sensor
Observed Data
High-Water Marks
Explanation
Wave Height Sensors
Storm Tide Sensor - Deployed
Storm Tide Sensor - Retrieved
FILTER
Event
State
County
Map Scale: 1:9244649
Lat: 33.0271, Lng: -72.6746
Kingston
Montpelier
Yarmouth
Toronto
Lake Ontario
Hamilton
London
Rochester
Buffalo
Sarnia
Detroit
Windsor
Lake Erie
NEW YORK
Albany
Concord
NEW HAMPSHIRE
Boston
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Harrisburg
NEW JERSEY
Philadelphia
Cincinnati
WEST VIRGINIA
Washington
Charleston
APPALACHIAN MOUNTAINS
VIRGINIA
Richmond
Roanoke
Knoxville
Greensboro
Raleigh
NORTH CAROLINA
Greenville
Charlotte
PIEDMONT
Columbia
SOUTH CAROLINA

SWaTH Network Opportunities

- Validate riverine flood forecasts
- Overwash and storm-surge modeling
  - Wave metrics
  - Water quality
  - Water velocity
- Coastal resiliency assessment
- High water mark assessments and re-evaluations
- Enhanced early warning
- Collaborative observing system for coastal hazards and ecosystem health.

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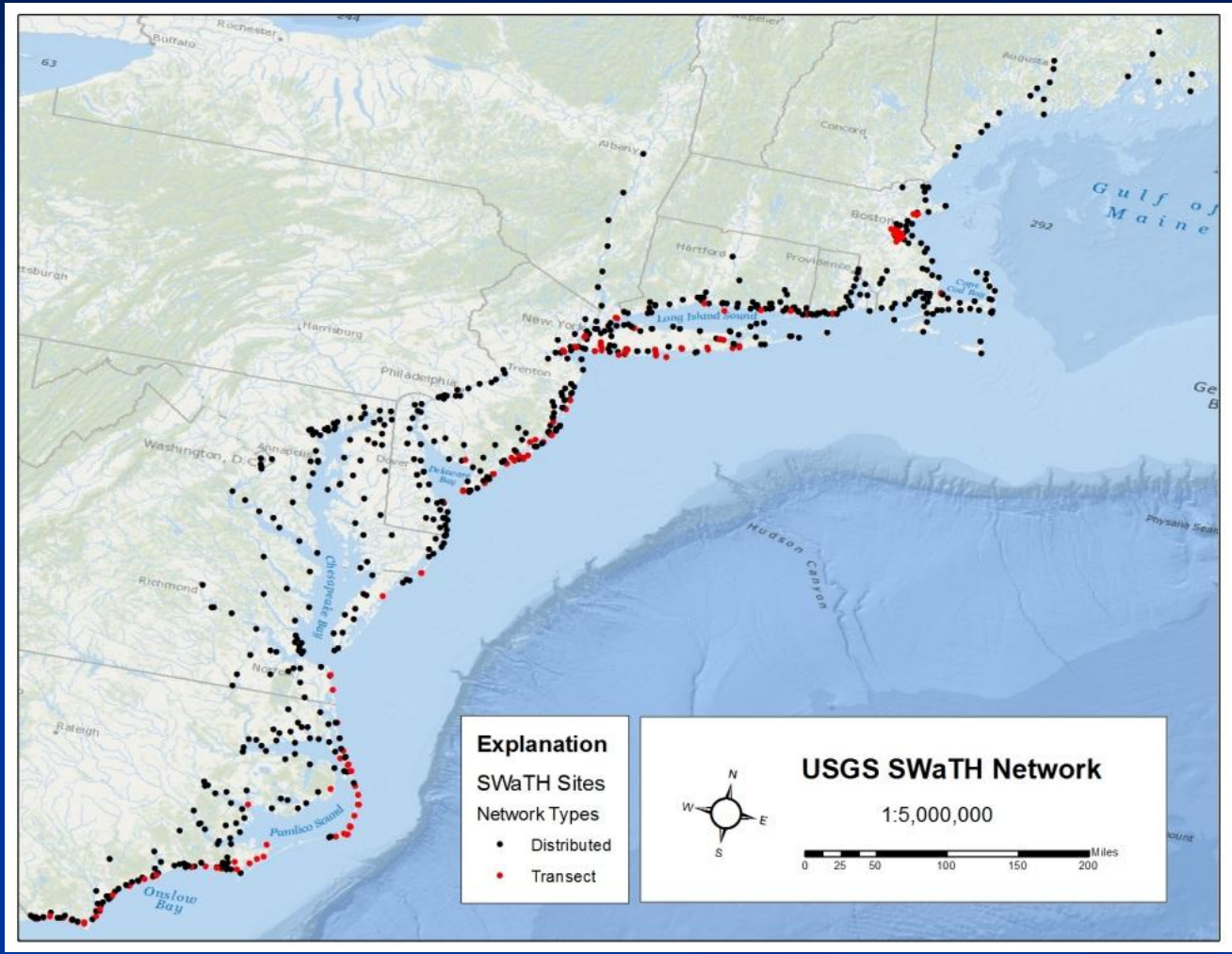
USGS SWaTH Network



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