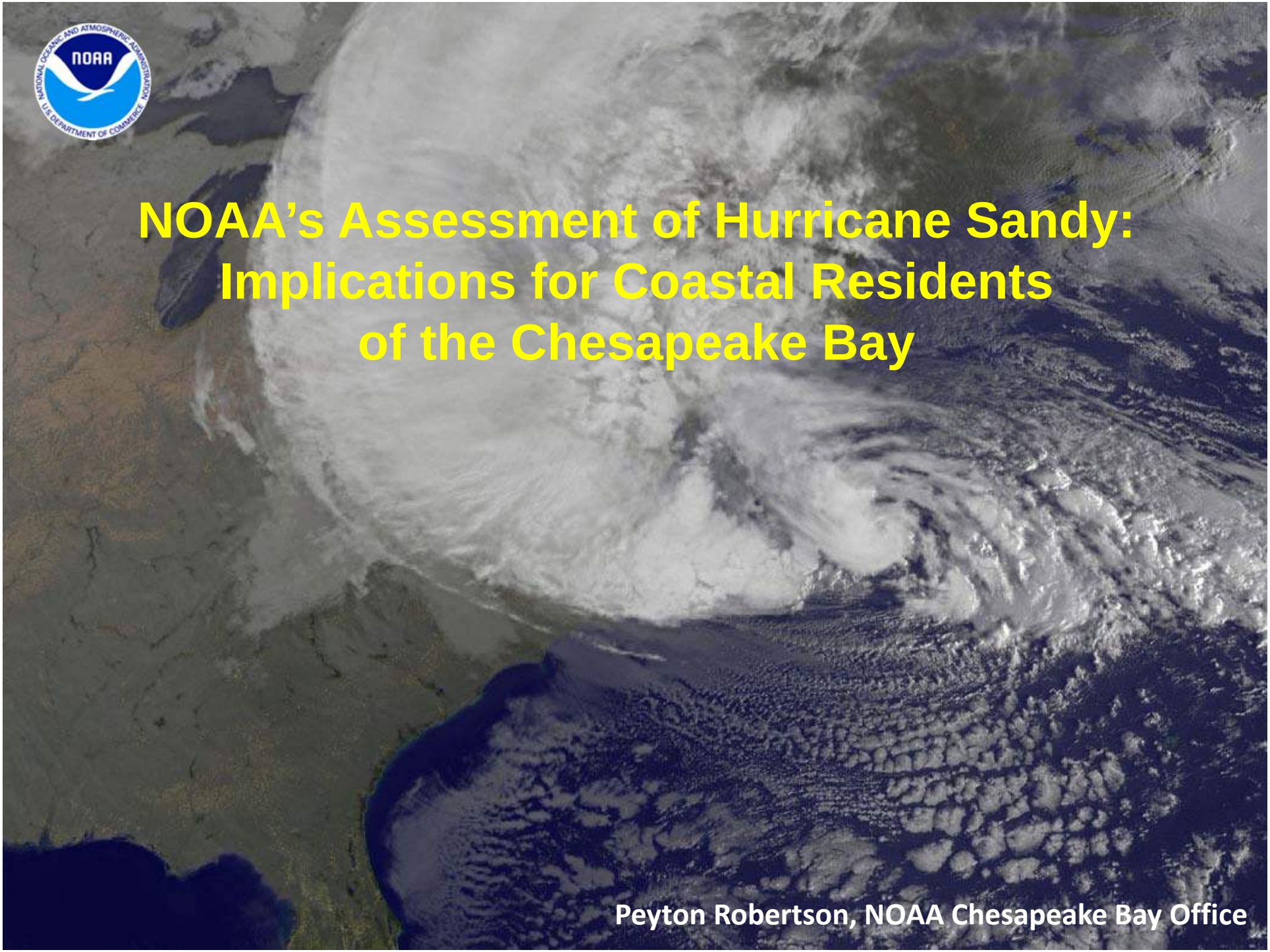


NOAA's Assessment of Hurricane Sandy: Implications for Coastal Residents of the Chesapeake Bay

Peyton Robertson, NOAA Chesapeake Bay Office

Outline

- Event Summary
- Assessment Process
- Common Themes
- Changes at NOAA since Sandy
- Implications for Chesapeake Bay
- Qs and As

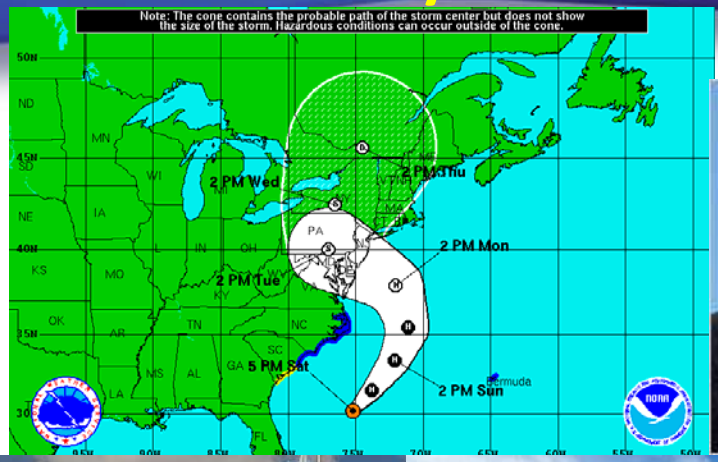
Event Summary

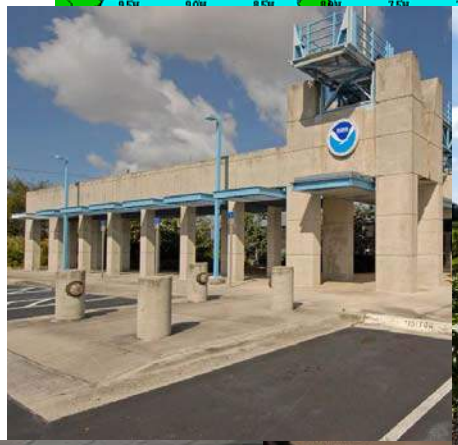
BY THE NUMBERS:

- 72 Direct Deaths in 8 States
- Damage estimates >$50 billion
- 950 miles in diameter
- Surge in excess of 8ft. AGL
- Snowfall up to 3 feet

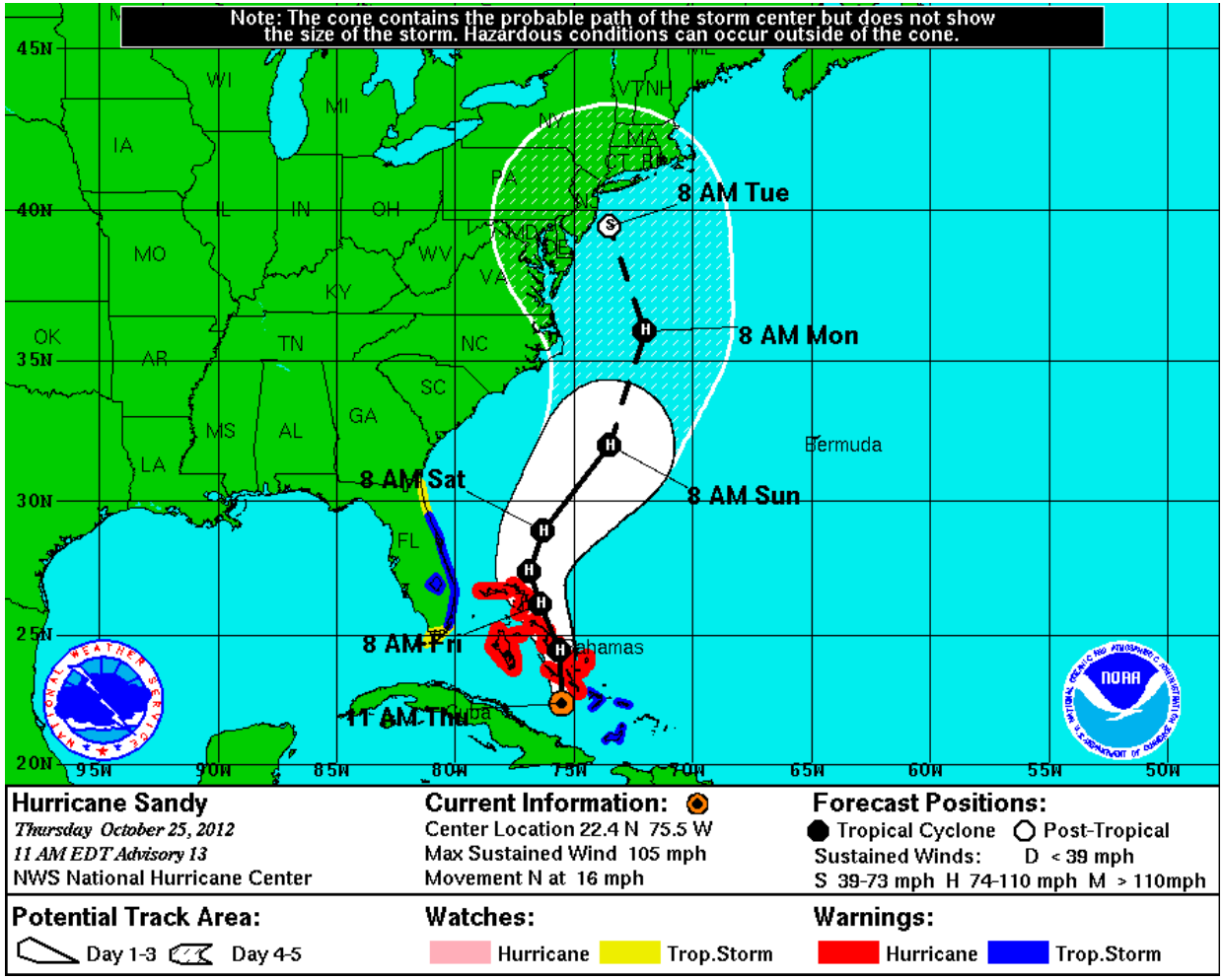
Event Summary

- Great forecast
- Lives saved
- Personal Plea
- Decision Support
- New tools

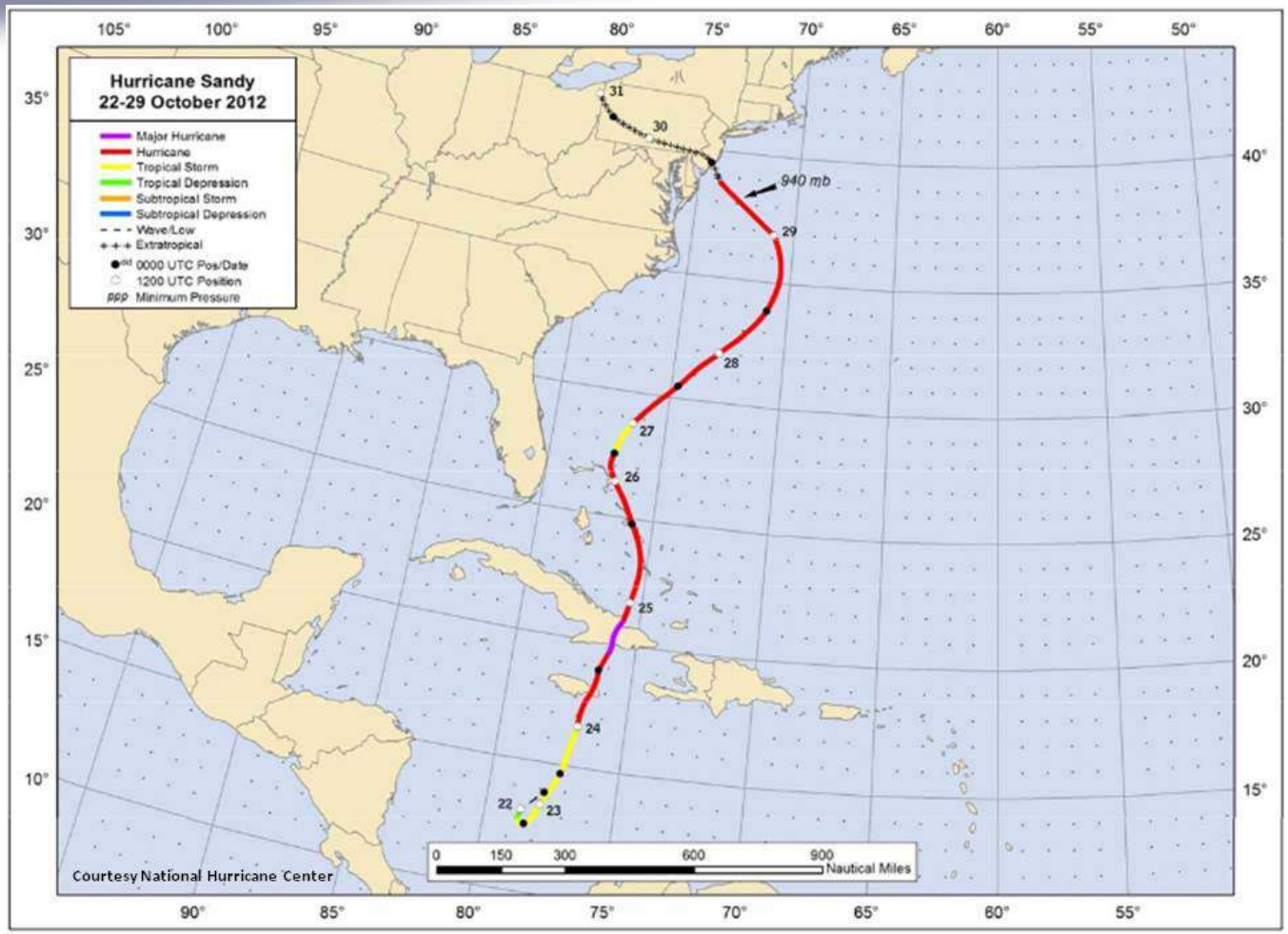




Event Summary

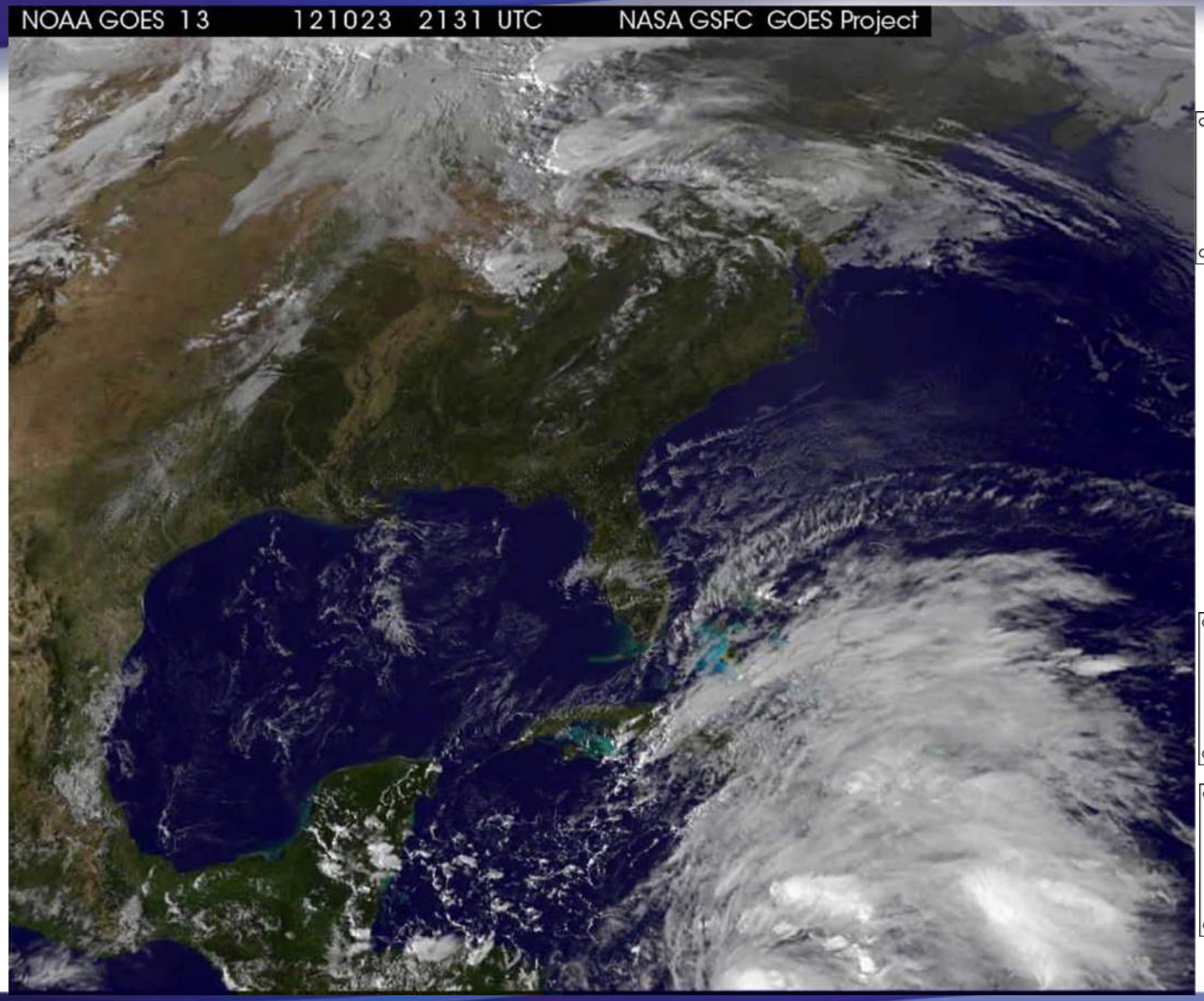


Event Summary



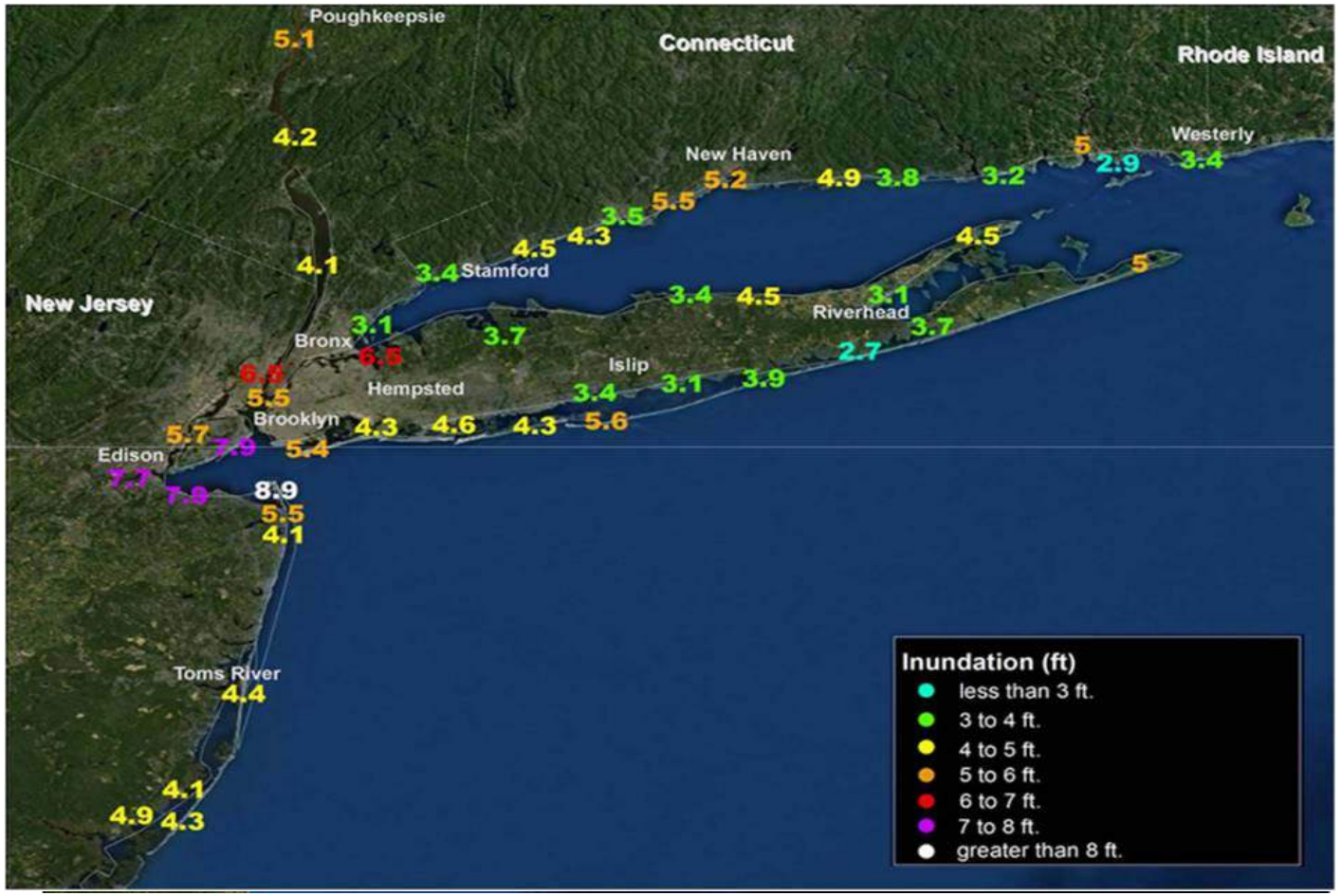
NHC Best-Track Positions for Sandy

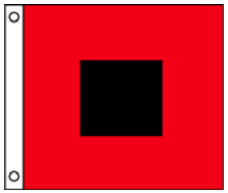
Event Summary

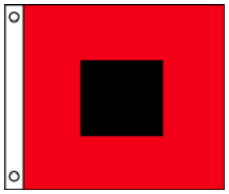


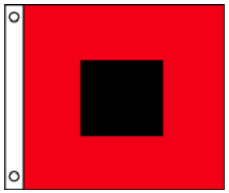
Event Summary

Storm Surge





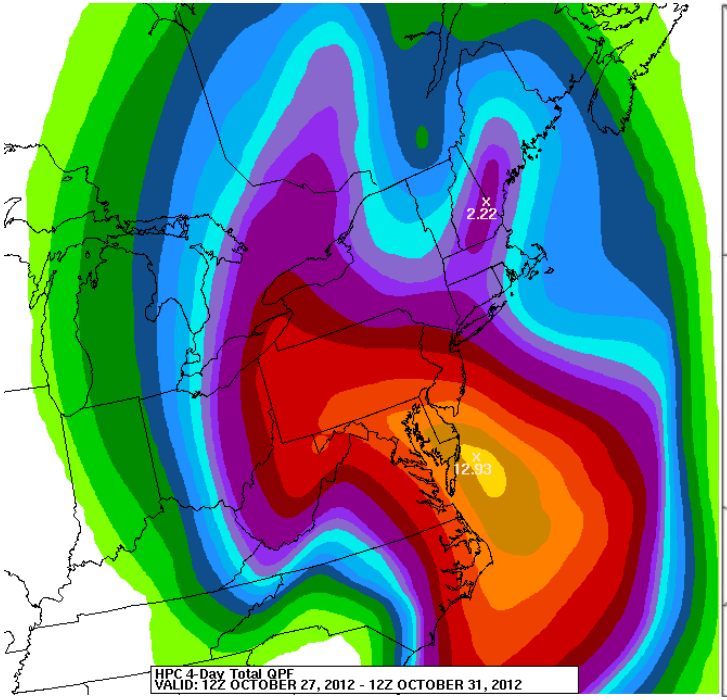




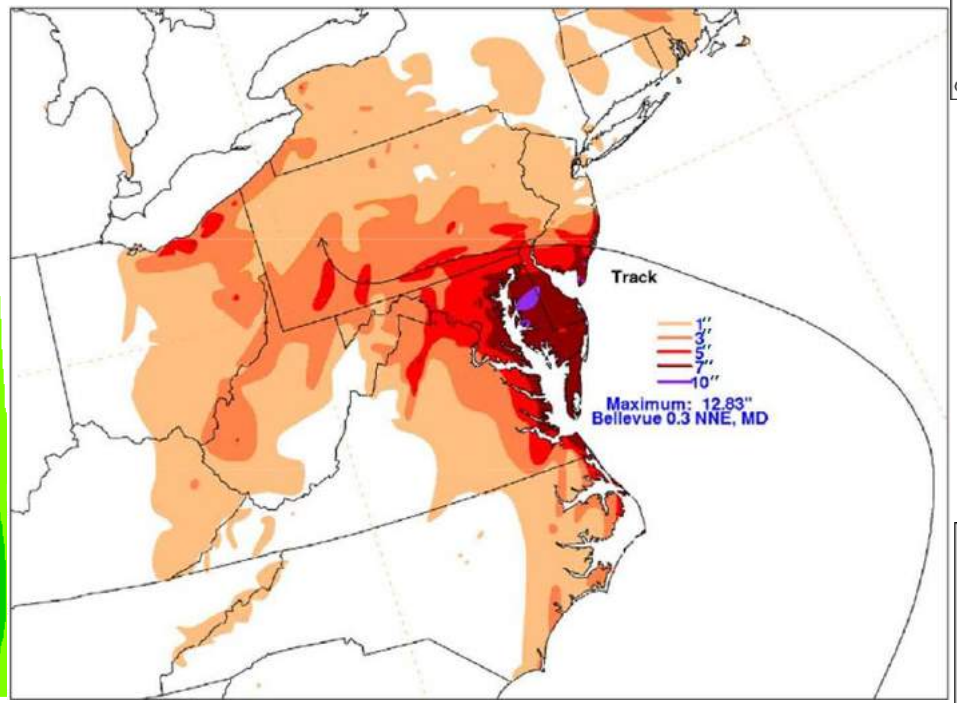
Estimated inundation (feet, AGL) calculated from USGS high-water marks and NOS tide gages in Connecticut, New York, and northern New Jersey.

Event Summary

Rainfall



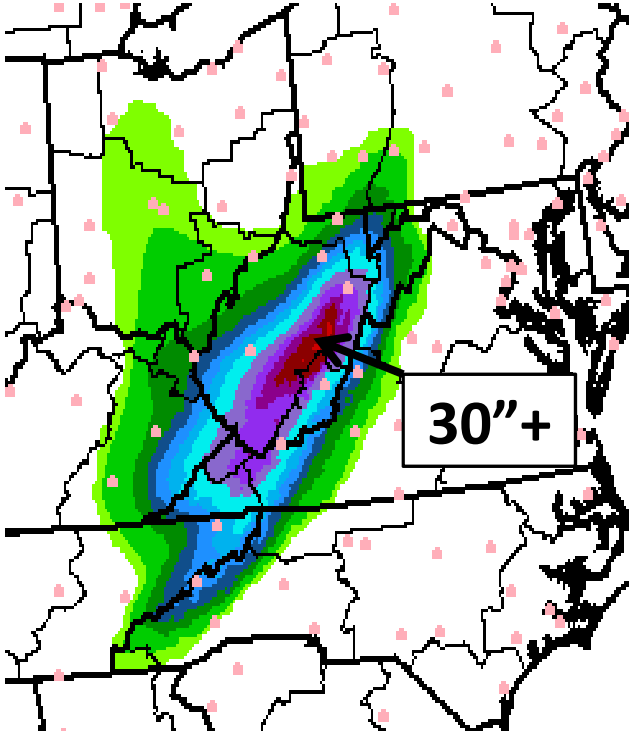
5 Day Precipitation Forecast: Issued Friday morning, Oct 26



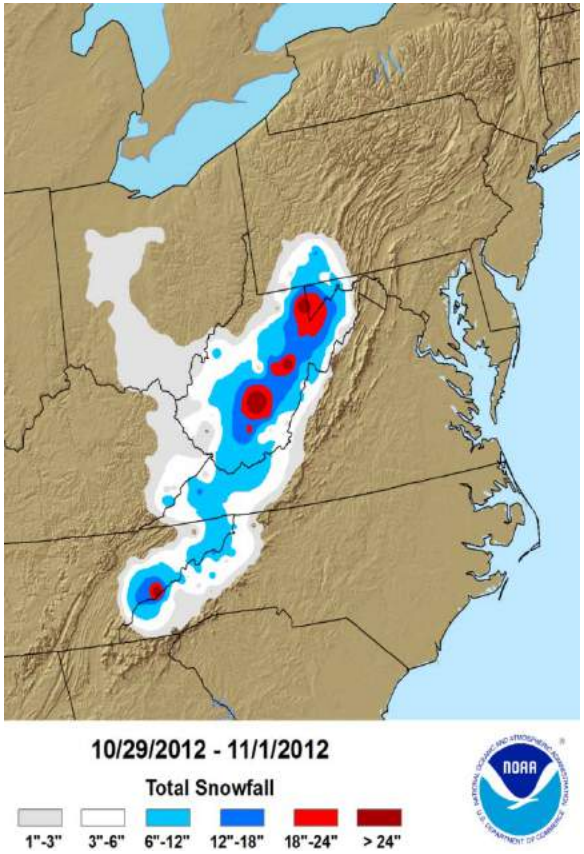
Multi-day event total rainfall (inches) associated with Sandy from October 27-31, 2012.

Event Summary

Snowfall



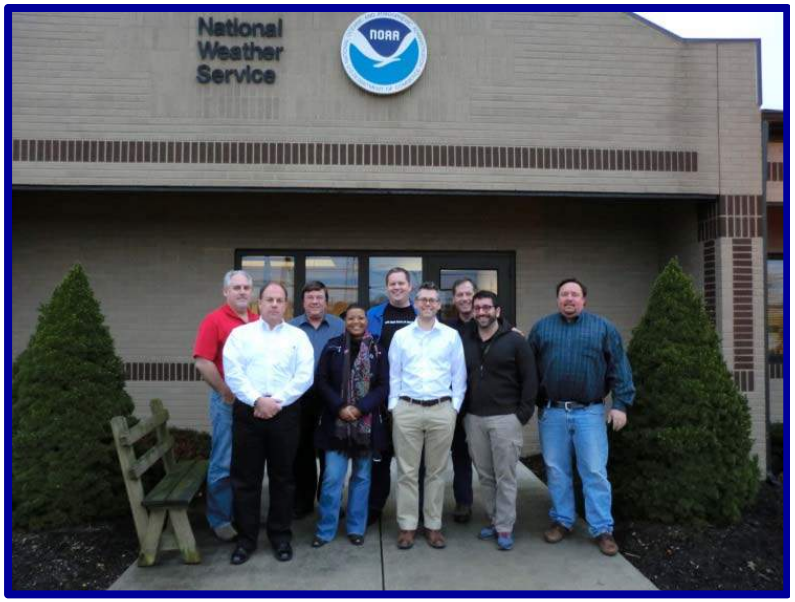
WPC 3 day Snow Total:
Issued Sunday morning, Oct 28



Assessment Process

- Assessment chartered in December 2012
- Team of ten; 7 NOAA representatives and 3 outside federal agencies
- Assessed three product and service areas:

1. the issuance of watches and warnings during a complex storm like Sandy and communication about which NWS offices would issue those watches and warnings;
2. the National Weather Service's use of the Internet to communicate with customers and partners; and
3. the development and communication of storm surge forecasts and information across NOAA.



Team Priority Findings/Recommendations

- Storm surge
  - Surge Warning Products - graphic and warning
  - Surge Information - better understanding and use
- Communications
  - Articulation of Impacts – clear, concise, consistent
  - Optimize web and respond to mobile needs
- Public Response
  - Use social science to ensure best results

Improving Surge Warnings/Products

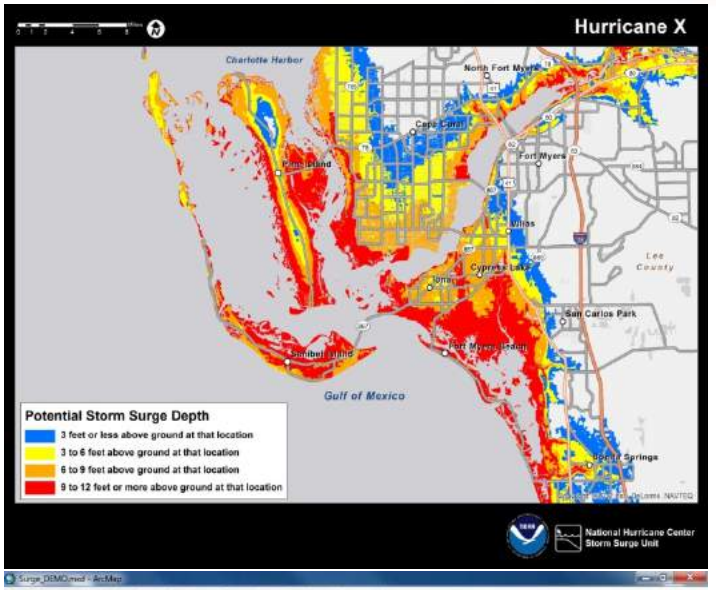
FINDINGS

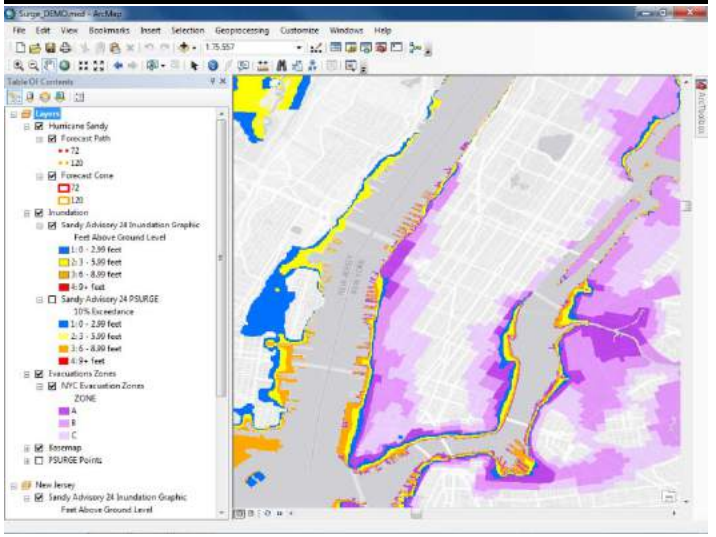
- Storm surge the most damaging aspect of Sandy
- Difficult to predict surge until close to landfall (lead times shorter)
- NWS relied primarily on text products and Coastal Flood Warnings
- Emergency Managers need surge forecasts sooner
- EVERYONE wants the map!

Improving Surge Warnings/Products

RECOMMENDATIONS

- Provide surge information sooner (more than 48 hours out)
- Provide consistent information
- Implement storm surge graphic/including data for GIS applications
- Increase storm surge staffing at NHC to ensure 24/7 operations
- Implement the planned storm surge warning by 2014 season





Understanding Surge Information

FINDINGS

- Partners did not understand surge and how dangerous it can be
- General surprise at extent of surge and rate of rise
- Media challenged to convey impacts
- Use of multiple datums and reference systems confusing
- Lack of understanding may have delayed decisions
- NWS does not provide standardized training on coastal inundation

Understanding Surge Information

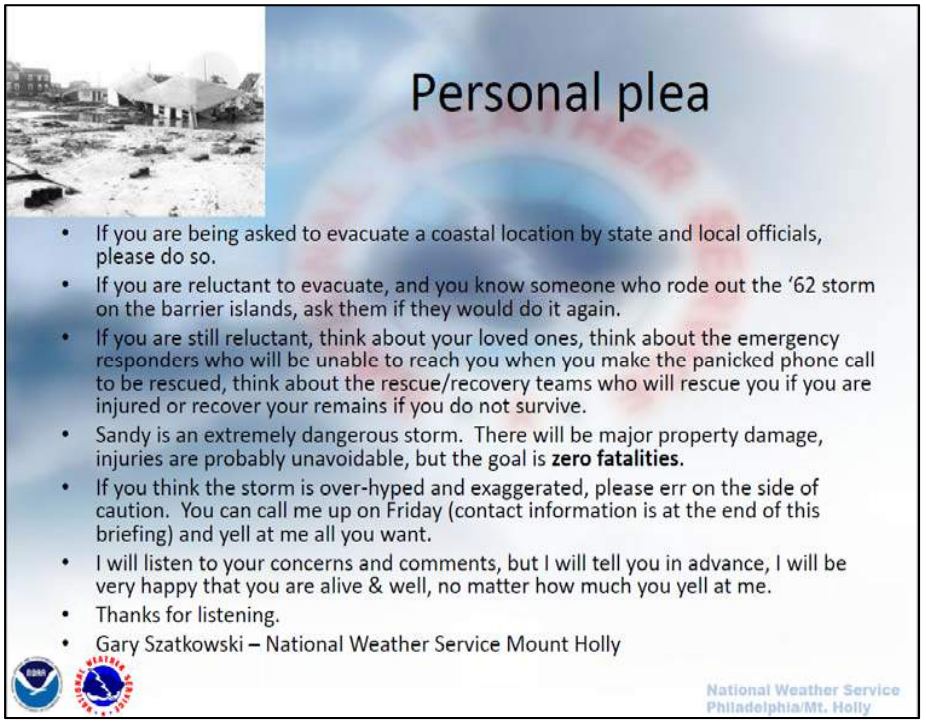
RECOMMENDATIONS

- Present surge forecasts in a single, consistent datum
- Adopt a unified format and language describing impacts
- Develop and deliver standardized training prior to 2014 season
- Start with coastal Weather Forecast Offices, then move on to other parts of NWS
- Make training available to key partners (FEMA, USGS, USACE)

Articulation of Impacts

FINDINGS

- Variety of tools used
- Succinct “briefing packages” with 1-page summaries very well received



- Several text products stood out for potent language

Articulation of Impacts

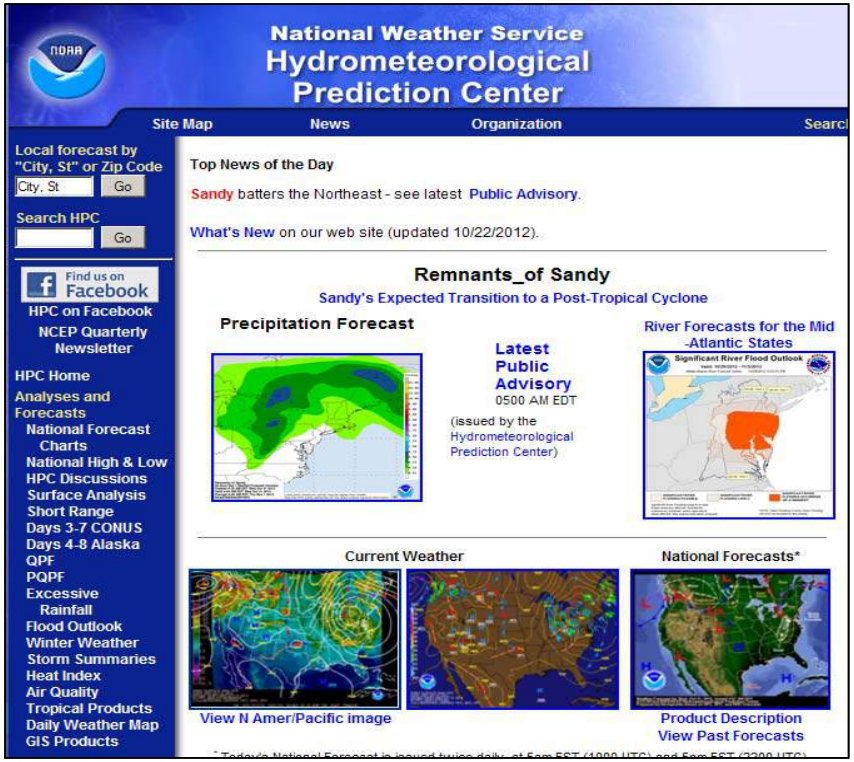
RECOMMENDATIONS

- Standardized approach for communicating impacts
- Concise summaries using non-technical language
- Graphics to illustrate
- Confidence levels and potential worst-case impacts

Websites/Social Media

FINDINGS

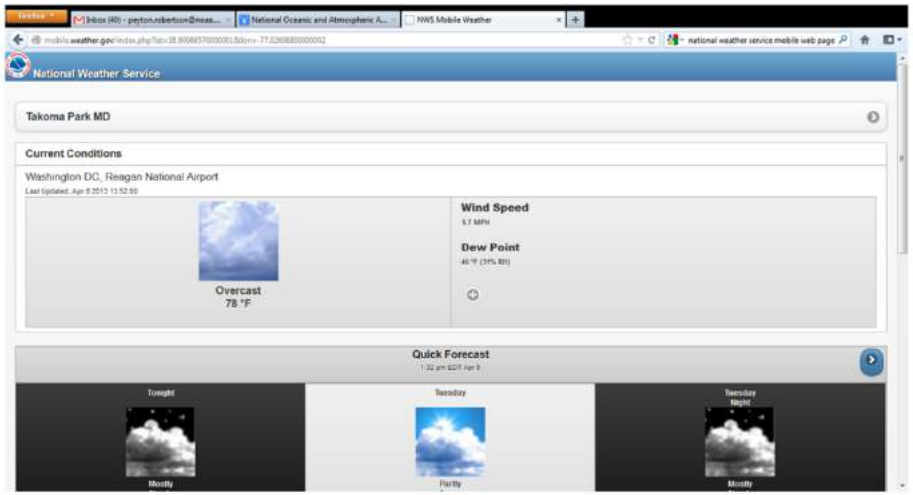
- NWS websites received 1,295,474,429 hits
- NHC accounted for 89% of this traffic
- Users singled out 2 aspects
  1. Web pages based on NOAA/NWS org. chart
  2. Too many clicks to get what you need
- Need better tools for mobile/handheld devices
- Social media is on the rise (though TV is still #1)



Websites/Social Media

RECOMMENDATIONS

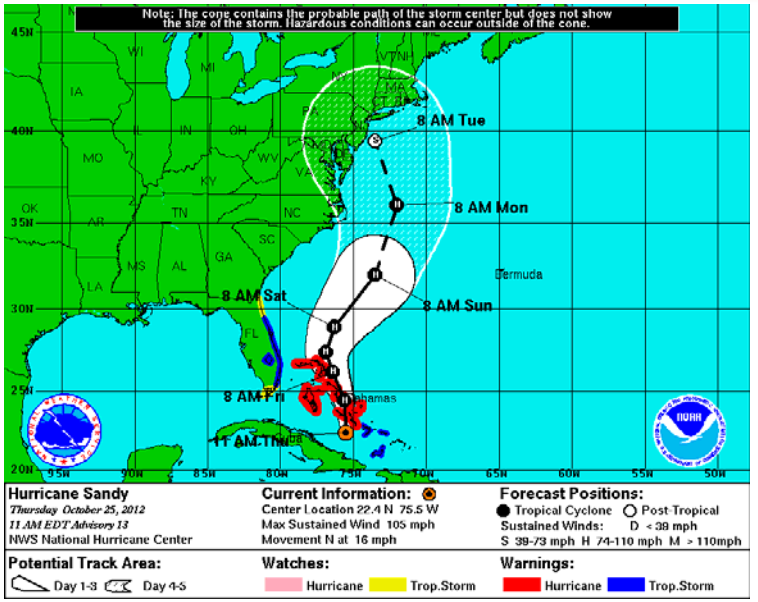
- Single web source for major storms like Sandy
- Base pages on user needs, not NOAA/NWS organization
- Ensure web pages are accessible via smart phones and tablets
- Advance use of social media



Public Response

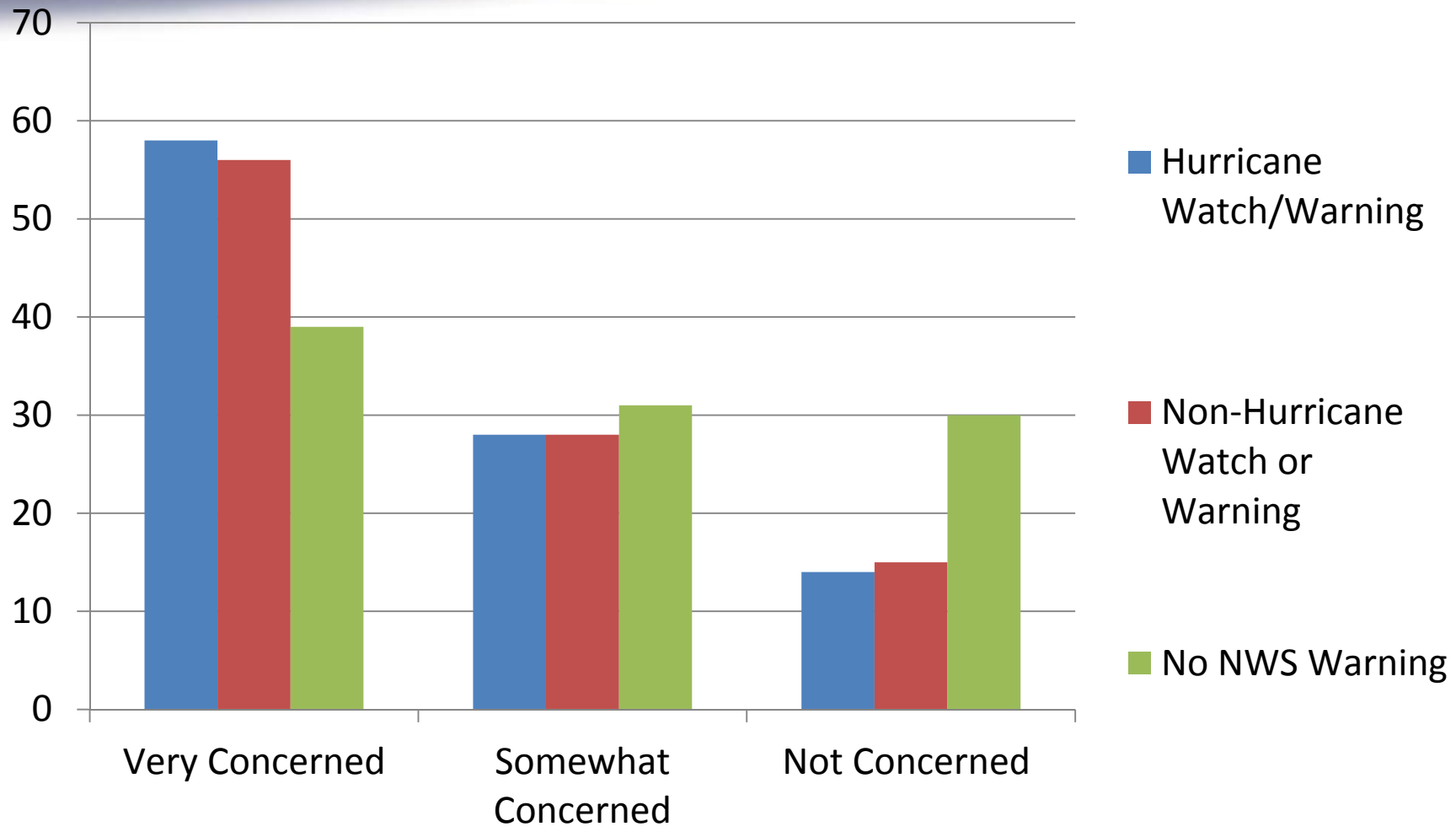
FINDINGS

- Most coastal residents thought they were under a hurricane watch
- More threat perceived from wind than surge



- Reported evacuation actions not significantly different from Irene
- >90% felt the storm was going to be somewhat/very dangerous
- Public response affected by multiple factors – need to understand this complexity

Public Response

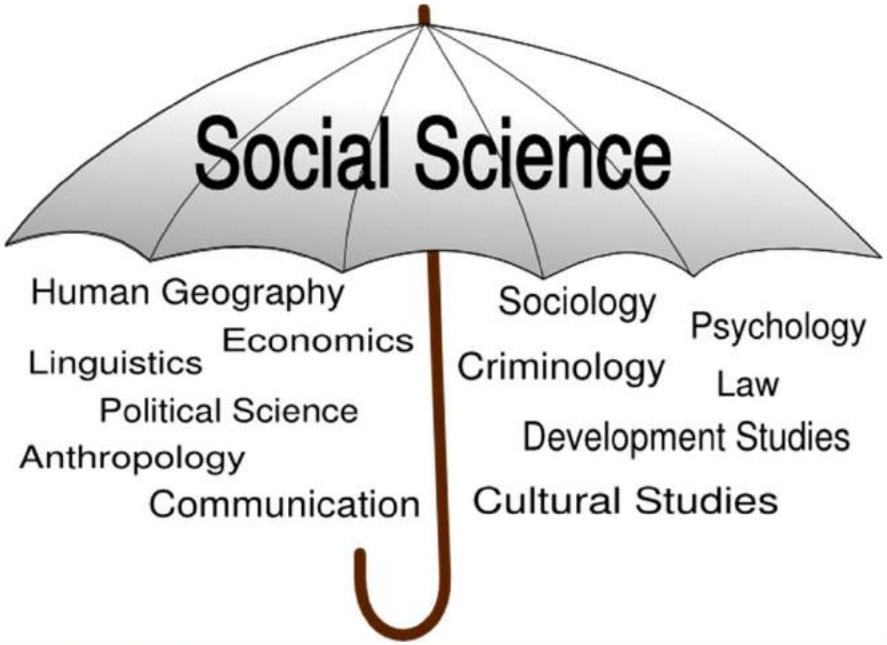


Coastal Residents' Concern: Based Upon Watches or Warnings Perceived to Be in Effect When Sandy Made Landfall *(Gladwin, Morrow & Lazo, 2013)*

Public Response

RECOMMENDATIONS

- Broaden social science capacity
- Use this capacity in design of products, services and communications



Themes in Common w/Irene

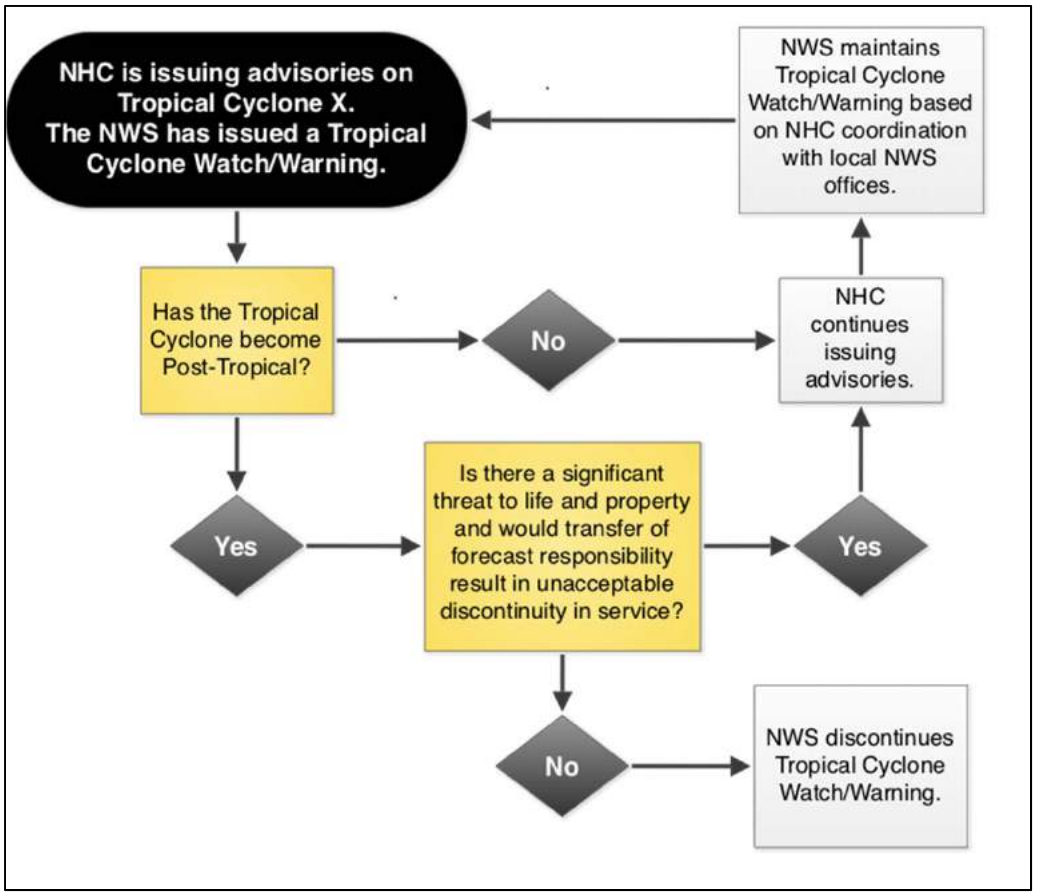
- Simplifying NWS product suite to better communicate
- Creating a single website for access of forecast and warning related information during high impact cyclones
- Demand for mobile access, interactive map viewers and web-based map services
- A recognized demand for high resolution storm surge inundation graphics

Hurricane Irene, August 21–30, 2011
Service Assessment

Changes at NOAA since Sandy

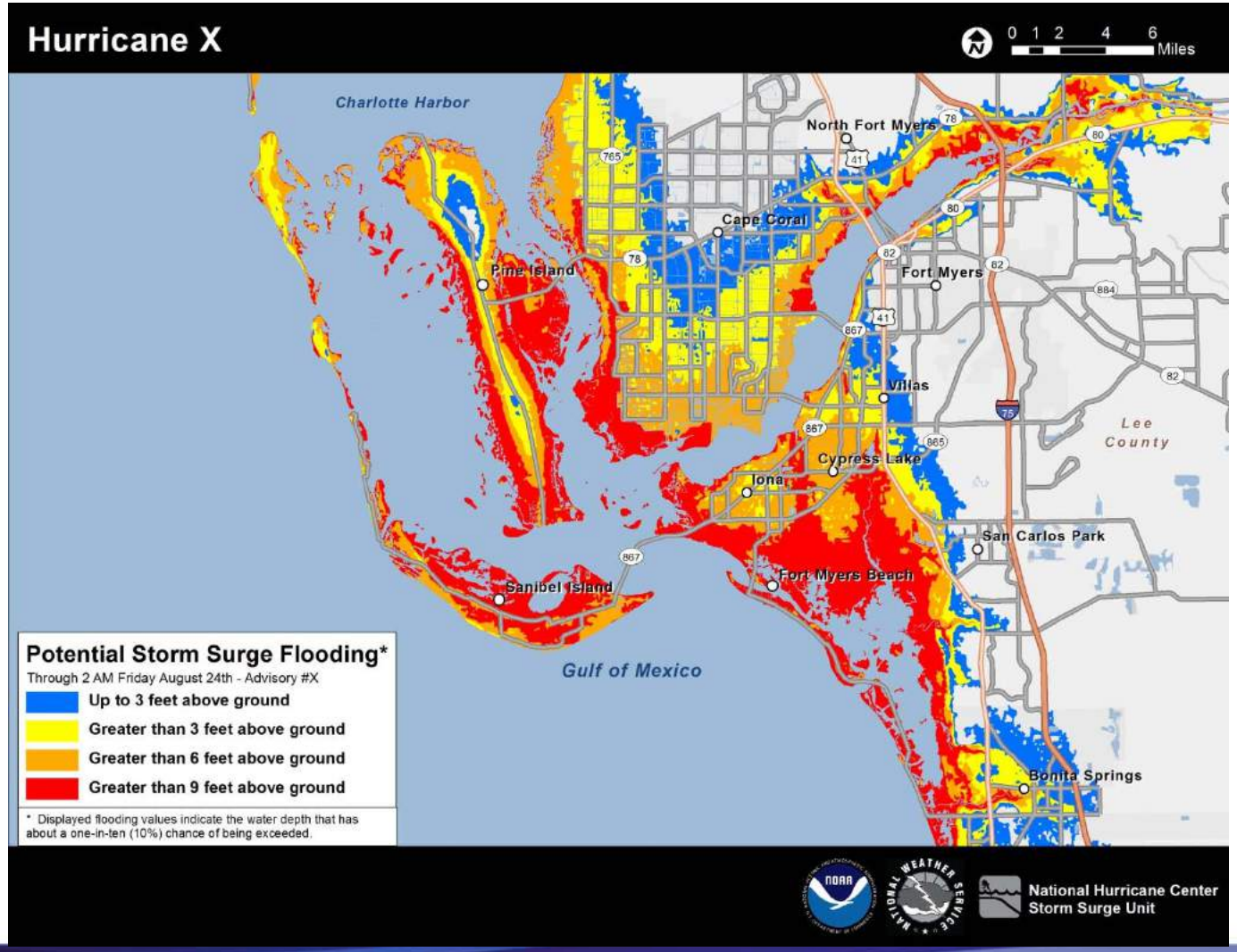
New process for handling "post-tropical" storms

- Four additional steps for a "Sandy":
  1. Emphasize strongest winds and highest surge may be well removed from the storm's center
  2. Focus on substantial hazards, regardless of post-tropical status
  3. Better convey storm surge threat for coastal residents
  4. Simplify the Hurricane Local Statement



Changes at NOAA since Sandy

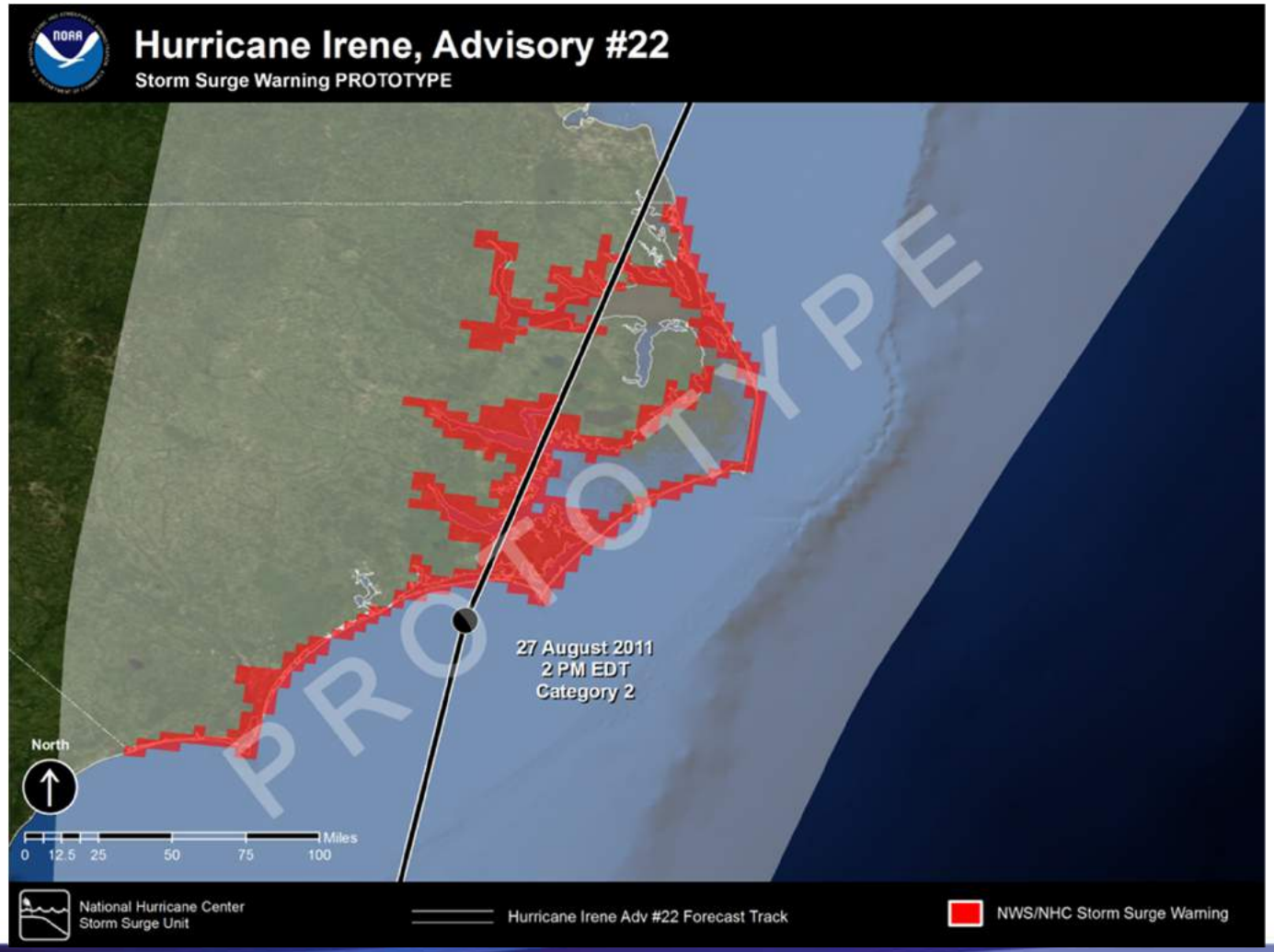
2014 experimental storm surge flooding map



26

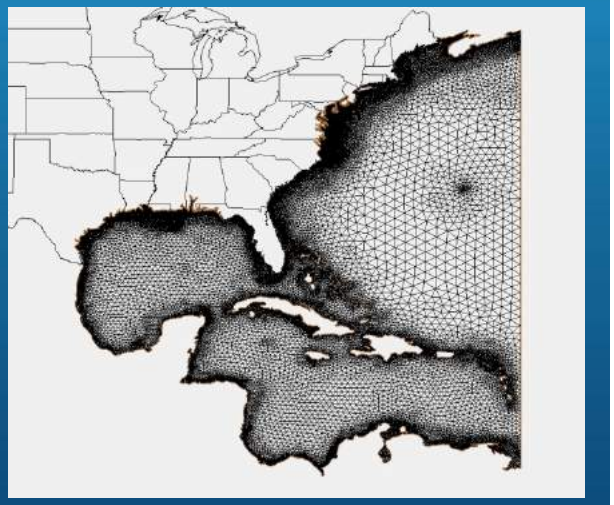
Changes at NOAA since Sandy

2015 prototype example of the storm surge warning graphic

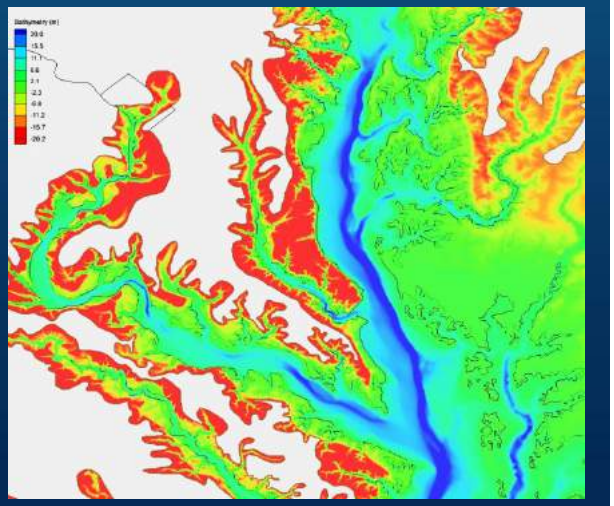


NOS Experimental Surge Modeling

- **NOS is testing advanced surge models**
  - Using ADCIRC Surge Guidance System with large unstructured grids to capturing large storms like Sandy while providing local coastal resolution
  - Predictions combine effects of storm surge and tide
  - An ensemble of 5 members is generated from the official forecast track
  - With Sandy Supplemental funding, an ADCIRC ensemble system with 5 to 10 members will become operational for tropical and extratropical on NWS/NCEP high performance computing in FY16

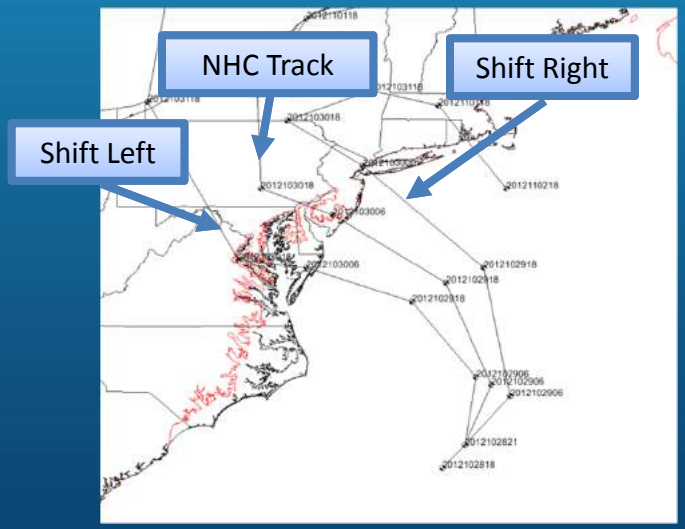


Model grid

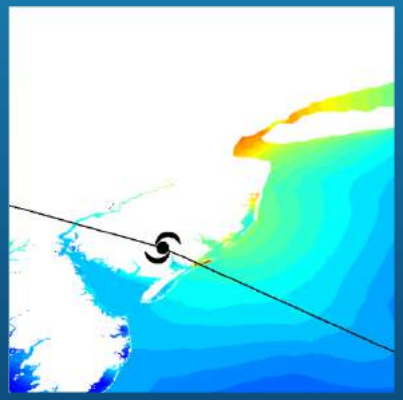


Model topobathy in Chesapeake

NOS Experimental Surge Modeling

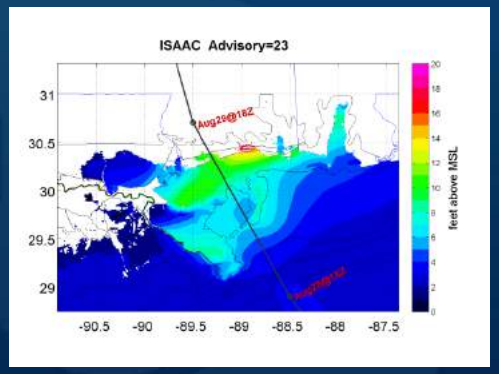


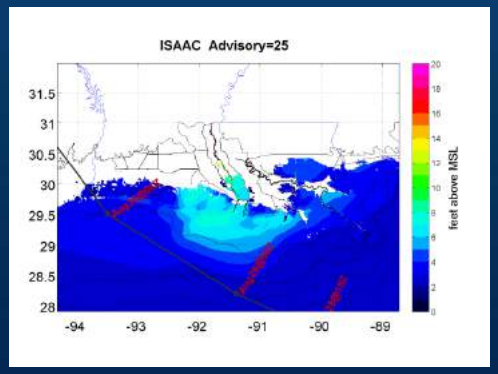
Ensemble members of Sandy (2012)

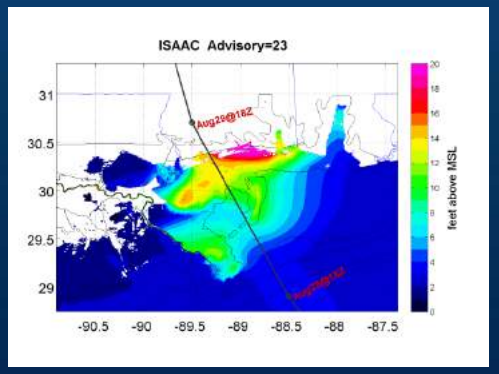


NHC Track

Shifted right within cone of uncertainty

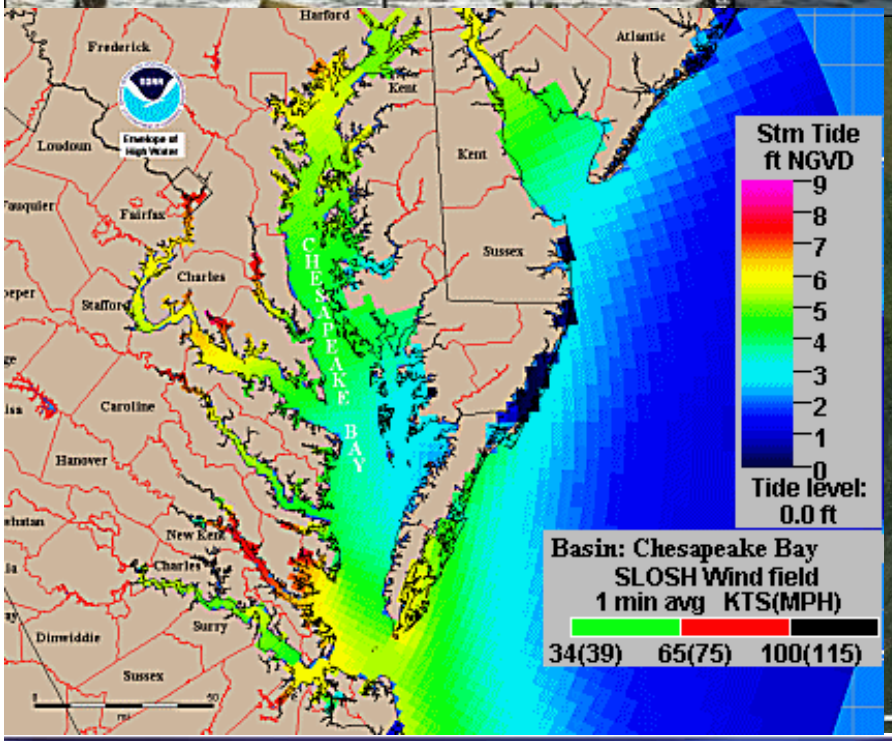


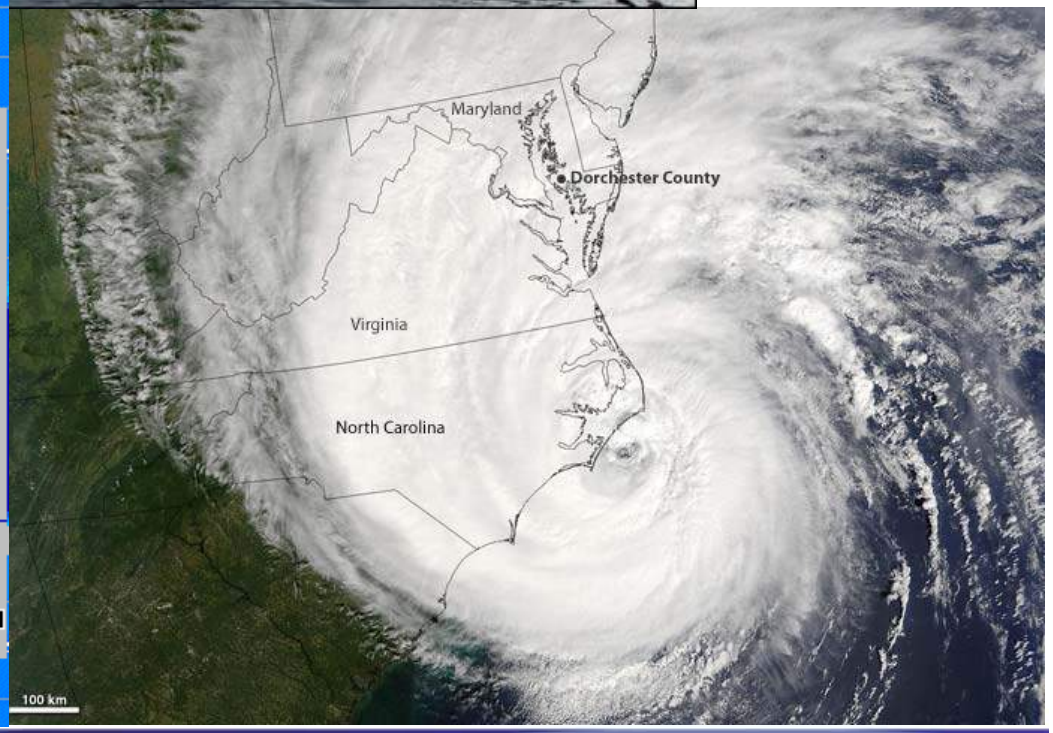




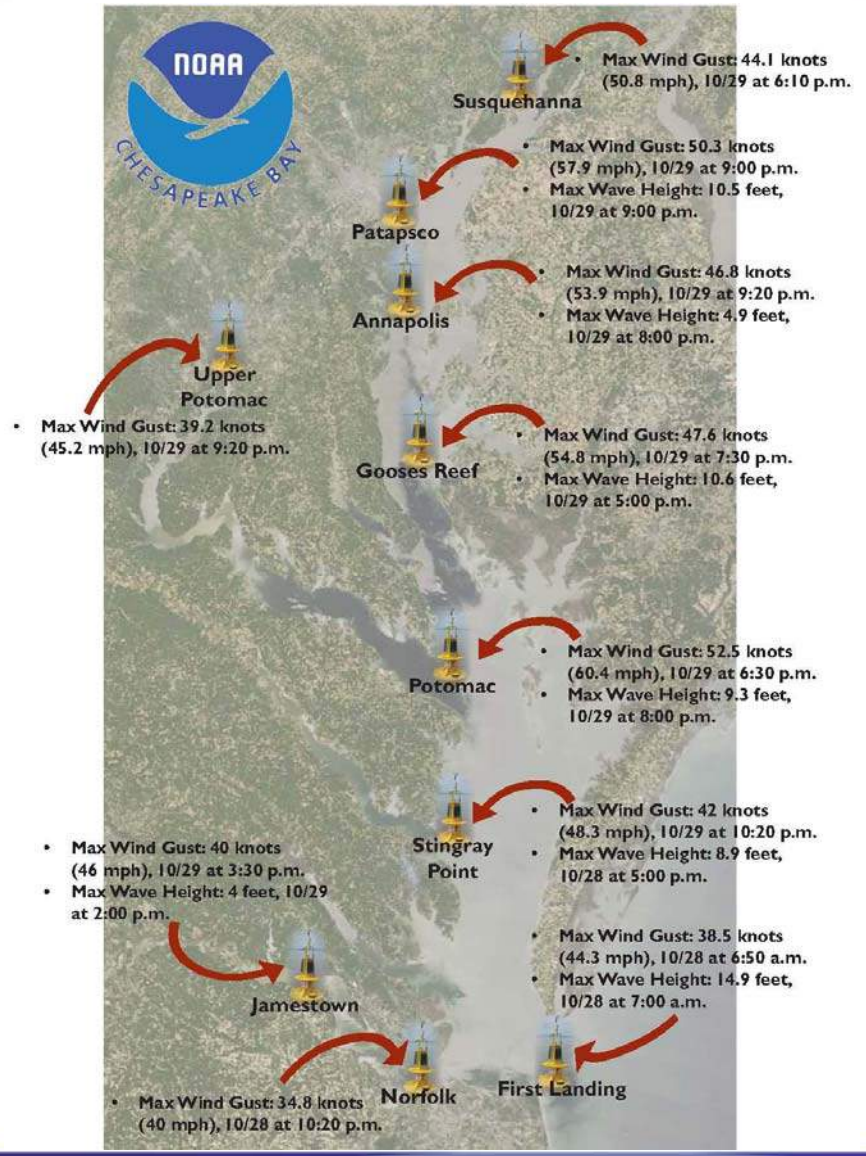
Ensemble members of Hurricane Isaac (2012): NHC track, shifted left, and increased storm intensity

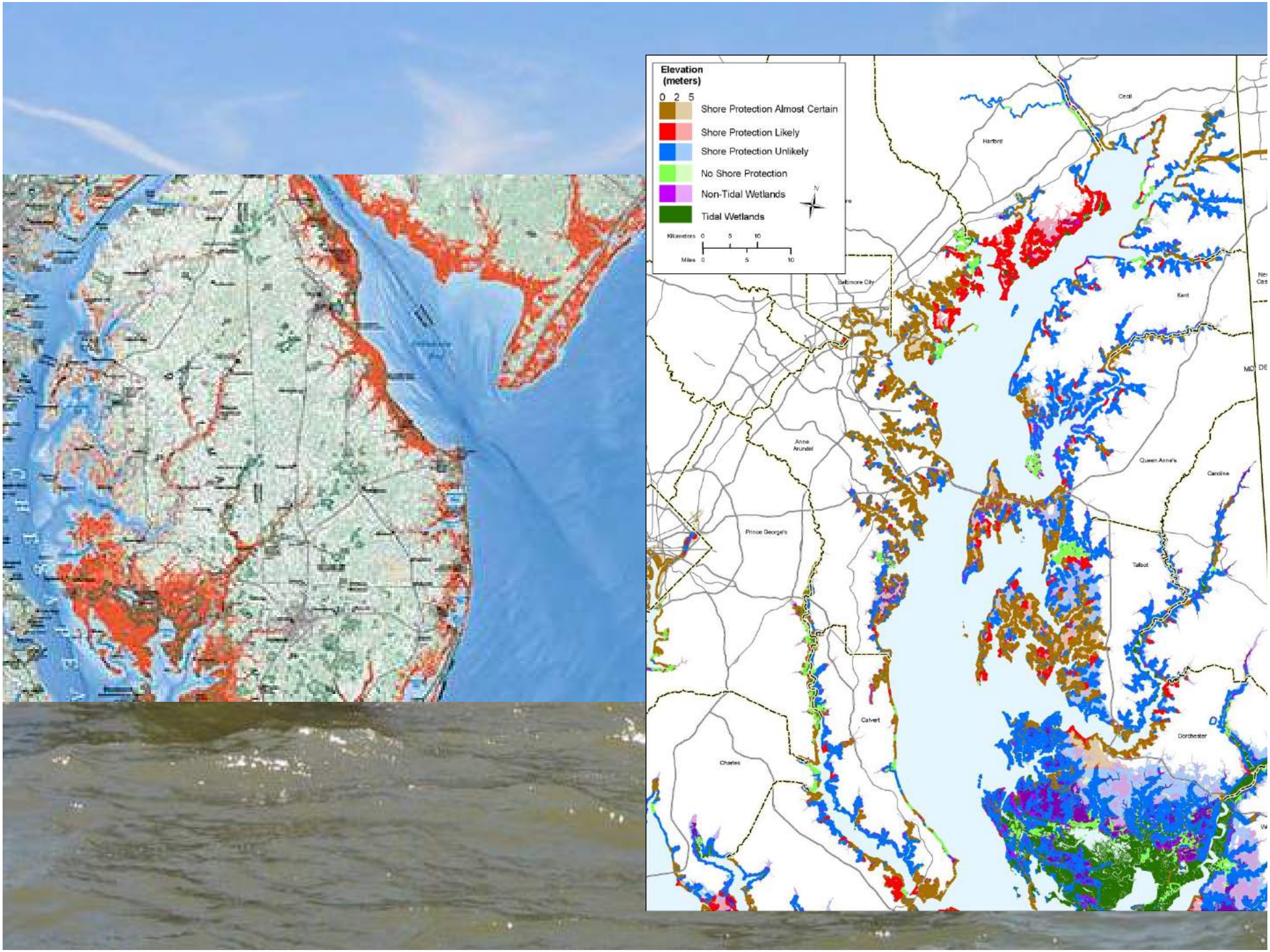
Implications for Chesapeake Bay





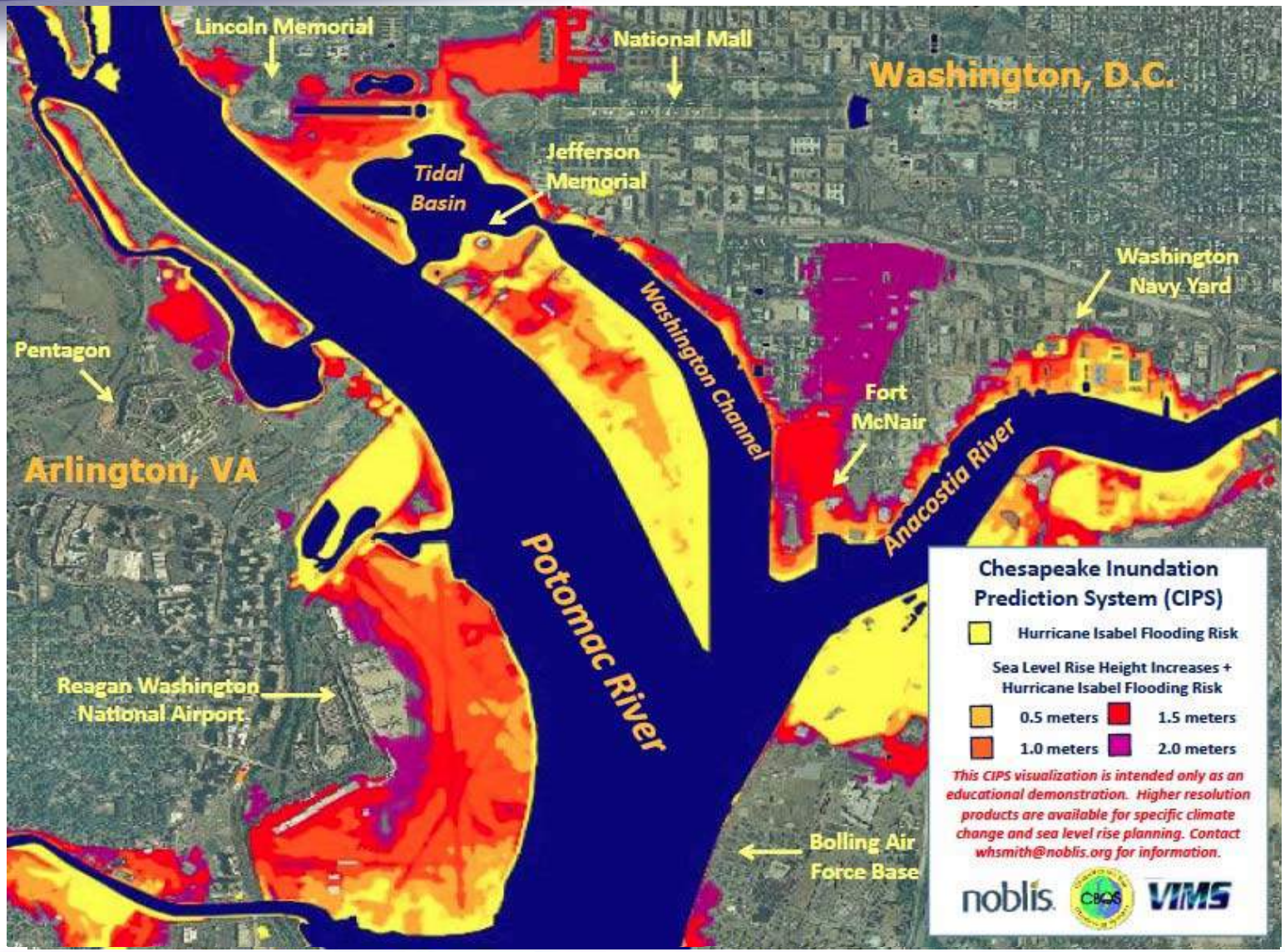
Implications for Chesapeake Bay




Elevation
(meters)
0 2 5
Shore Protection Almost Certain
Shore Protection Likely
Shore Protection Unlikely
No Shore Protection
Non-Tidal Wetlands
Tidal Wetlands
Kilometers 0 5 10
Miles 0 5 10
N
Cecil
Harford
Baltimore City
Kent
Anne Arundel
Queen Anne's
Caroline
Prince George's
Talbot
Calvert
Dorchester
Charles

Sea Level Rise

Sea Level Rise and Coastal Flooding



Questions?

NOAA Information

Terminology

Watch = POSSIBLE: When the risk of a hazardous weather has increased significantly, but its occurrence, location or timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so. A WATCH means that hazardous weather is possible.

Warning = TAKE ACTION: Issued when a hazardous weather is occurring, imminent or likely. A WARNING means weather conditions pose a threat to life or property.

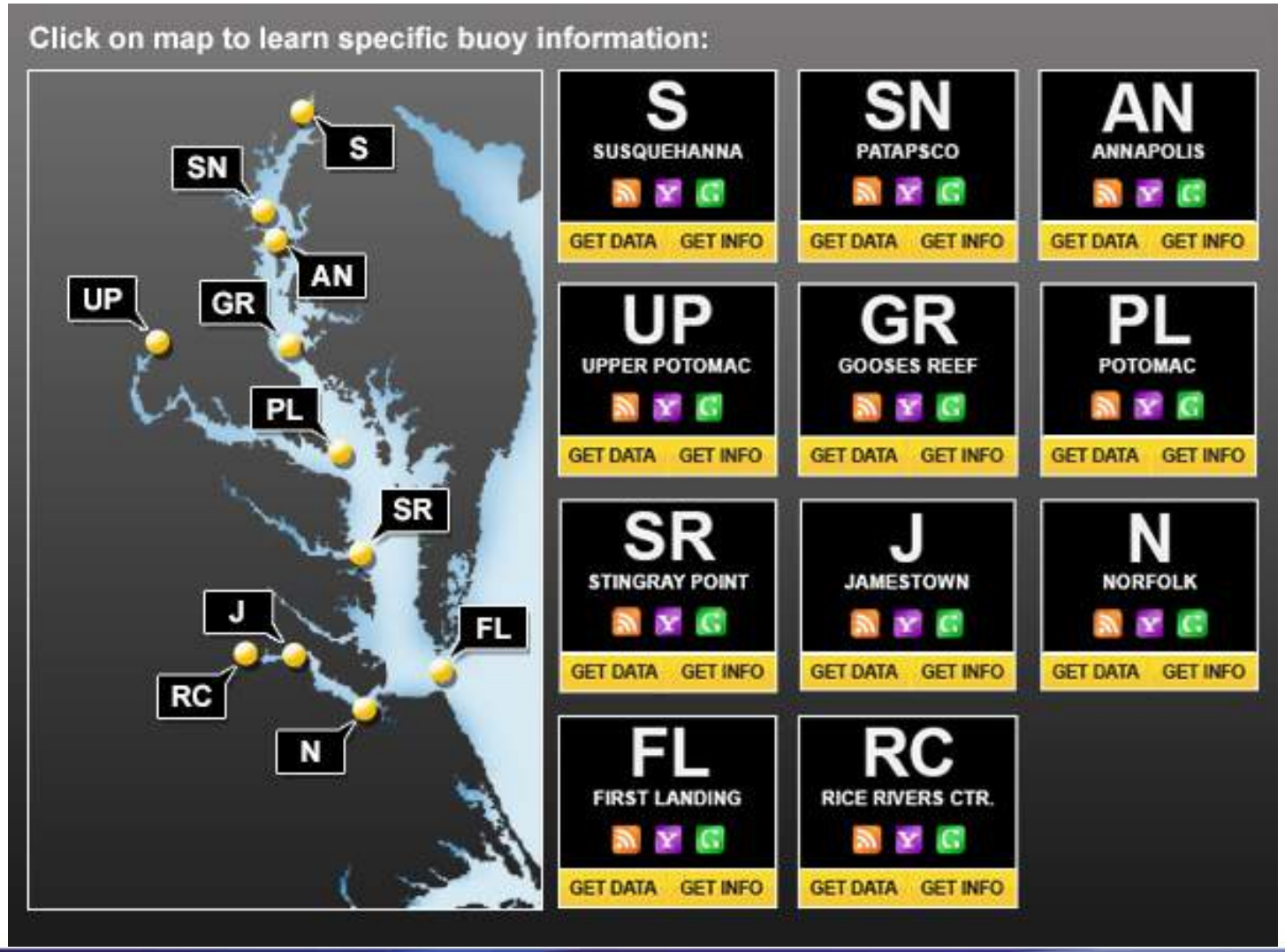
Advisory: Issued when a hazardous weather or hydrologic event is occurring, imminent or likely. Advisories are for less serious conditions than warnings, that cause significant inconvenience and if caution is not exercised, could lead to situations that may threaten life or property.

Hurricane Information

- National Hurricane Awareness Week – May 25-31
- Tropical Cyclone Preparedness Guide: http://www.nws.noaa.gov/os/hurricane/resources/TropicalCyclones11.pdf
- Education Resources: http://www.education.noaa.gov/Weather_and_Atmosphere/Hurricanes.html
- Storm surge information: http://www.nws.noaa.gov/os/hurricane/resources/surge_intro.pdf

Chesapeake Bay Interpretive Buoys

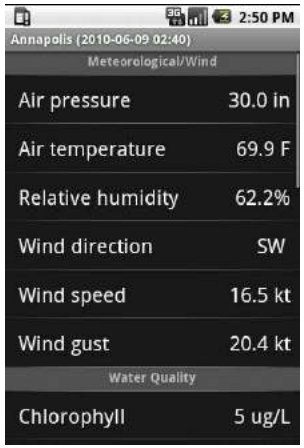
Where the buoys are

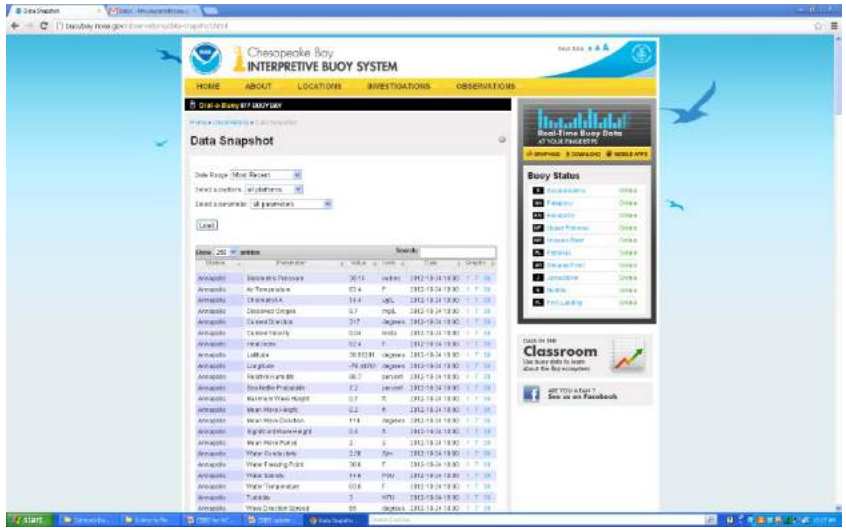


Chesapeake Bay Interpretive Buoys

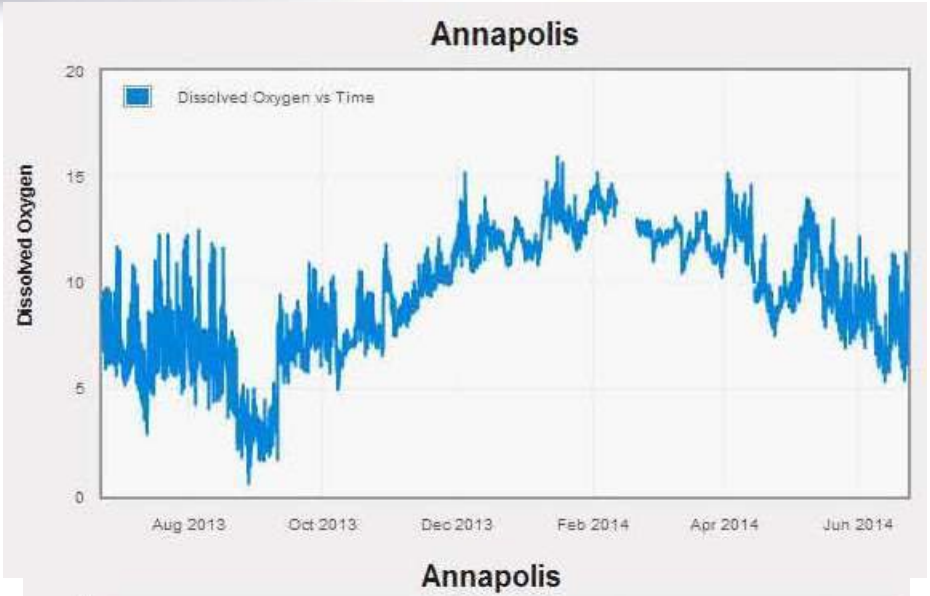
Where can I get buoy information?

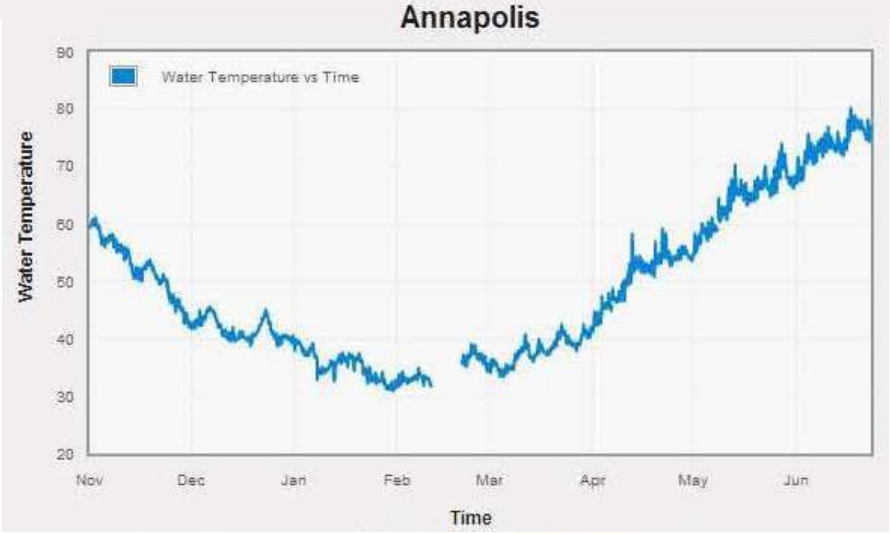
- www.buoybay.noaa.gov
- 877-BUOY-BAY (877-286-9229)
- Free apps for smartphones

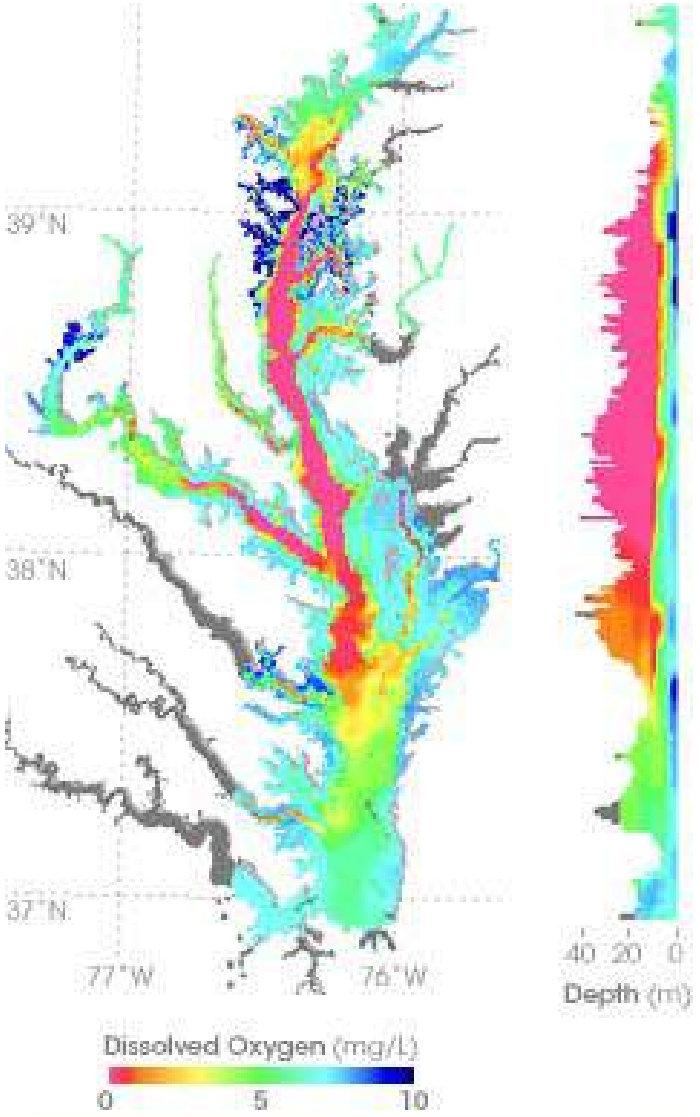




CBIBS Data


Annapolis
Dissolved Oxygen vs Time
Dissolved Oxygen
20
15
10
5
0
Aug 2013
Oct 2013
Dec 2013
Feb 2014
Apr 2014
Jun 2014


Annapolis
Water Temperature vs Time
Water Temperature
90
80
70
60
50
40
30
20
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Time


39°N
38°N
37°N
77°W
76°W
40 20 0
Depth (m)
Dissolved Oxygen (mg/L)
0
5
10

Thank You!

NOAA CHESAPEAKE BAY OFFICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

http://chesapeakebay.noaa.gov/

Peyton Robertson