



# **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:

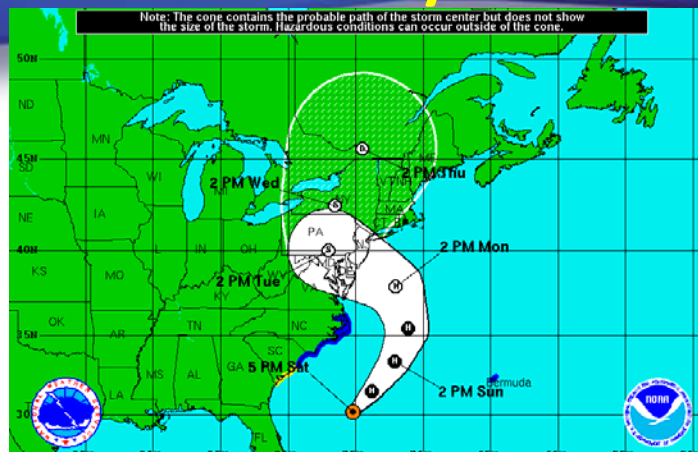
- 72 Direct Deaths in 8 States
- Damage estimates >\$50 billion
- 950 miles in diameter
- Surge in excess of 8ft. AGL
- Snowfall up to 3 feet





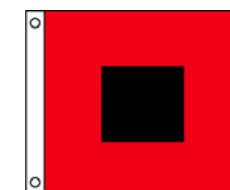
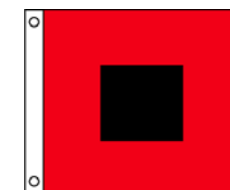
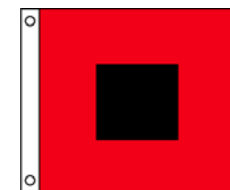
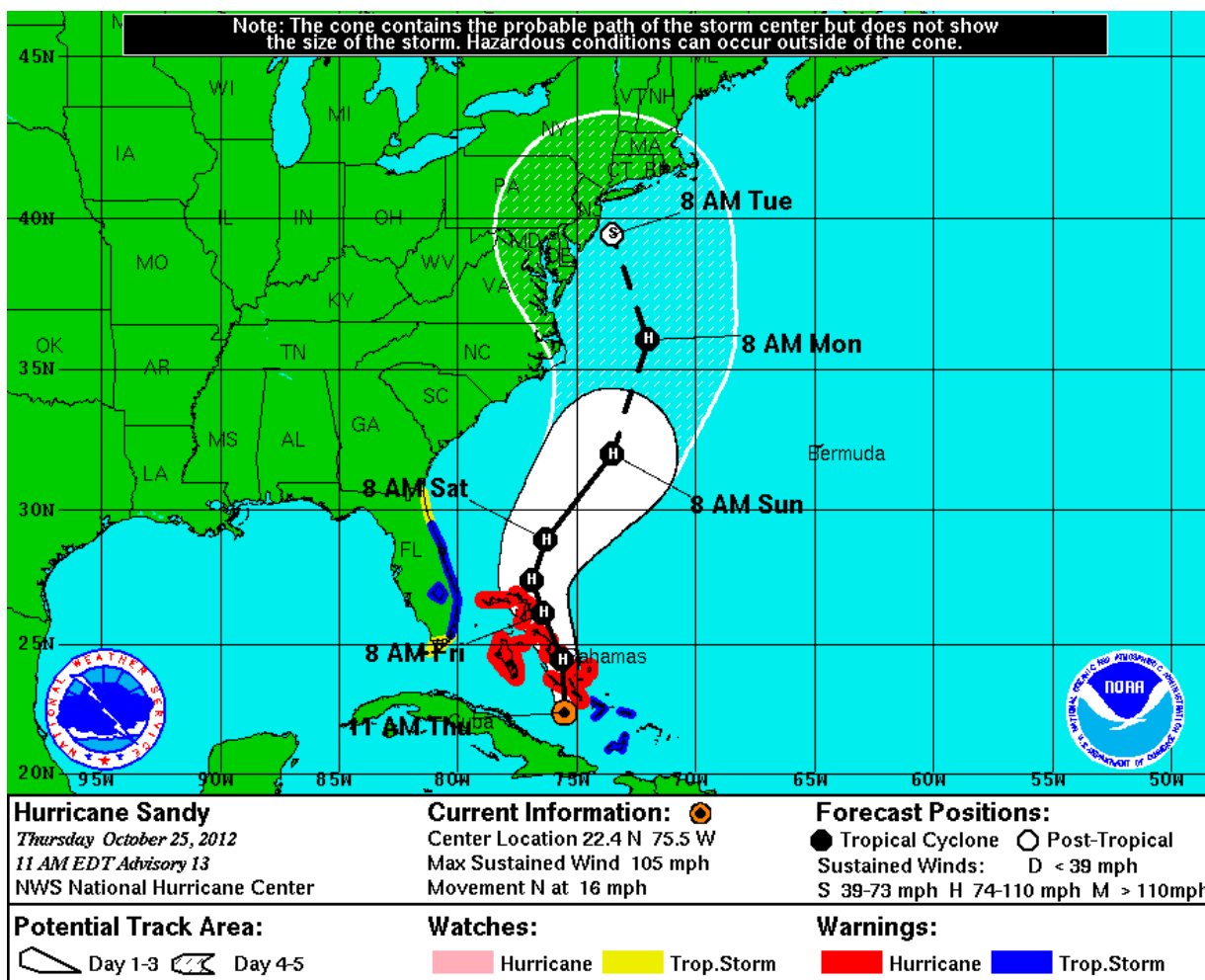
# Event Summary

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



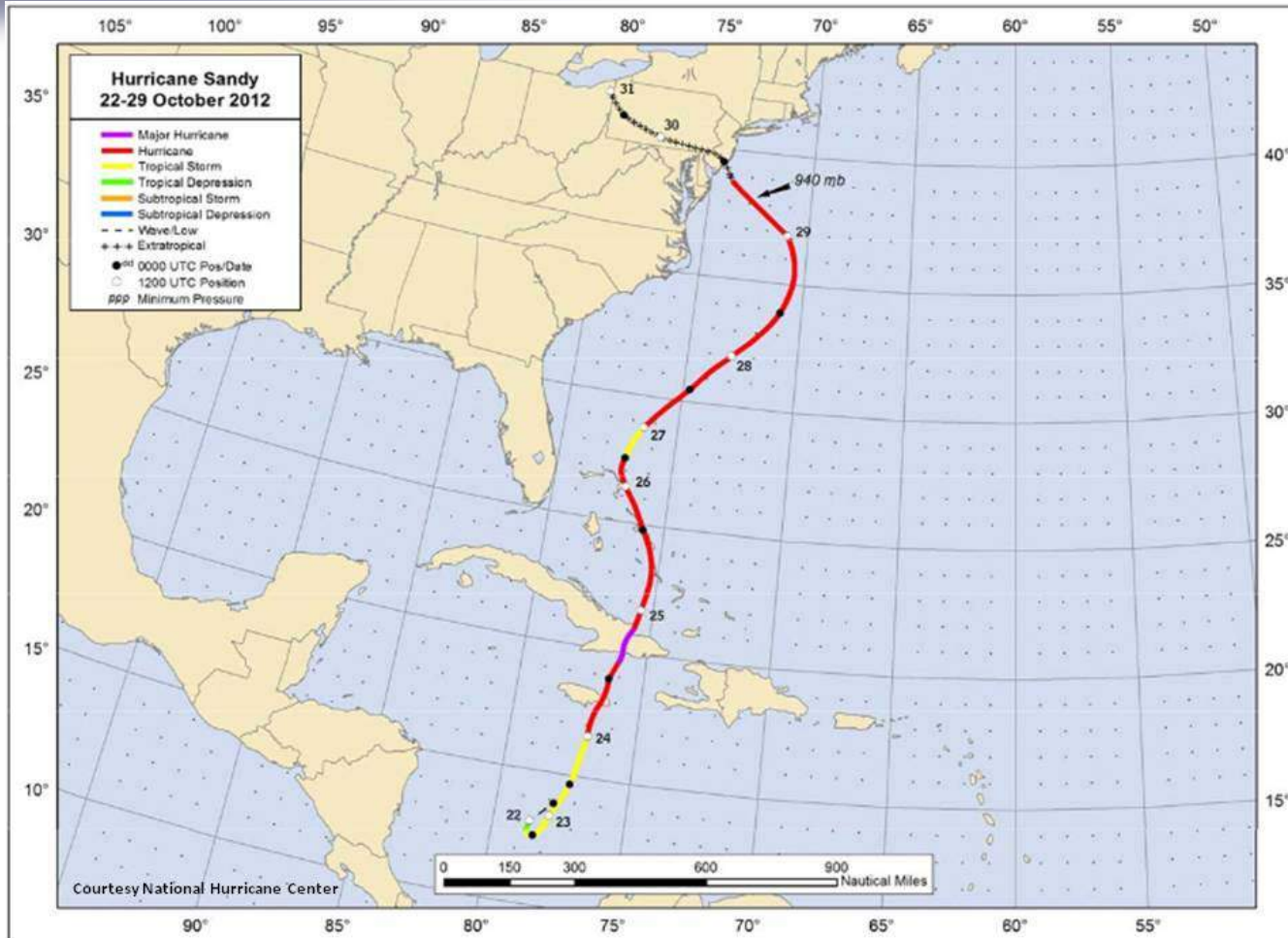


# Event Summary

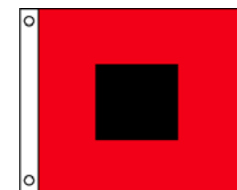
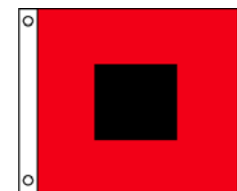
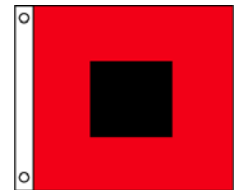




# Event Summary



NHC Best-Track Positions for Sandy



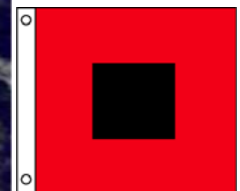
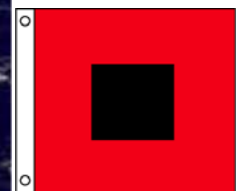
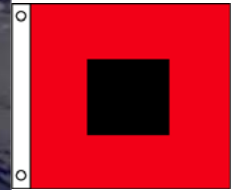
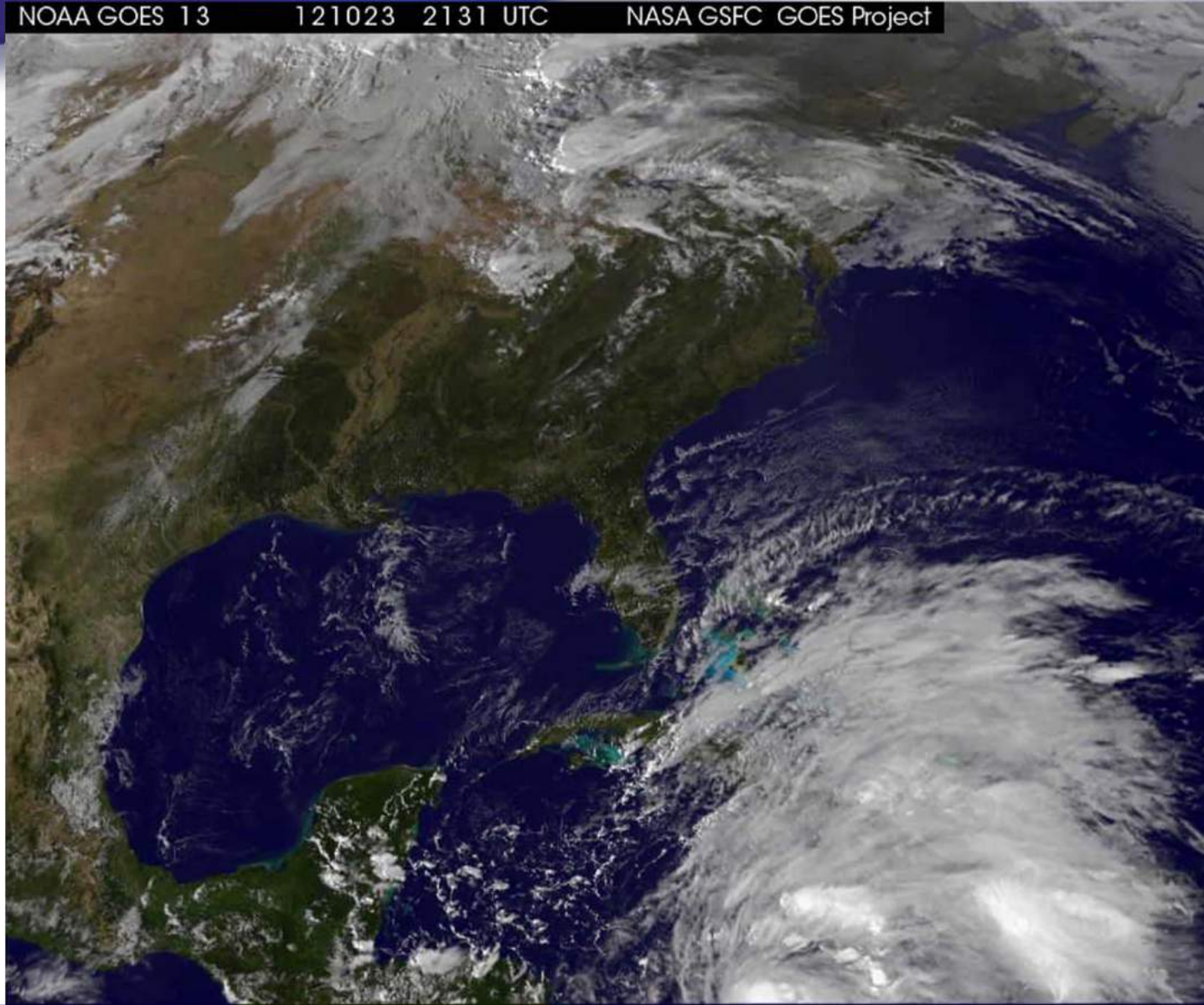


# Event Summary

NOAA GOES 13

121023 2131 UTC

NASA GSFC GOES Project



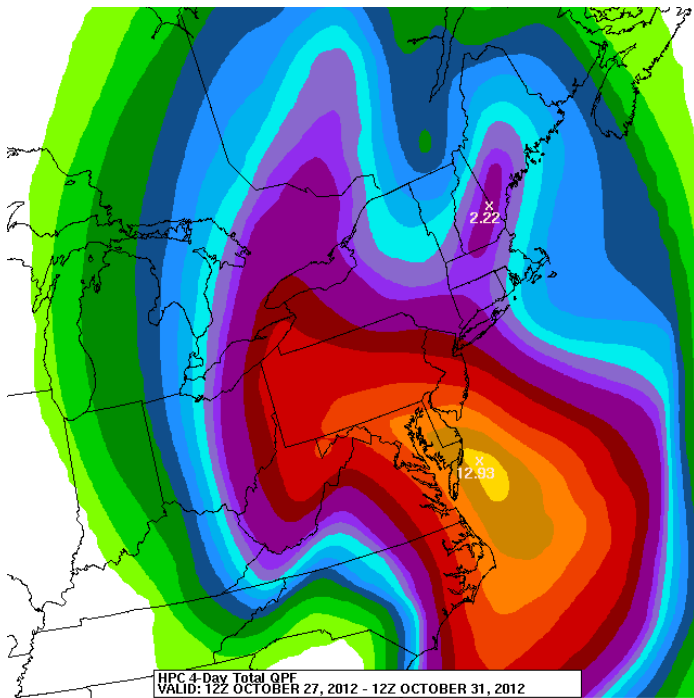




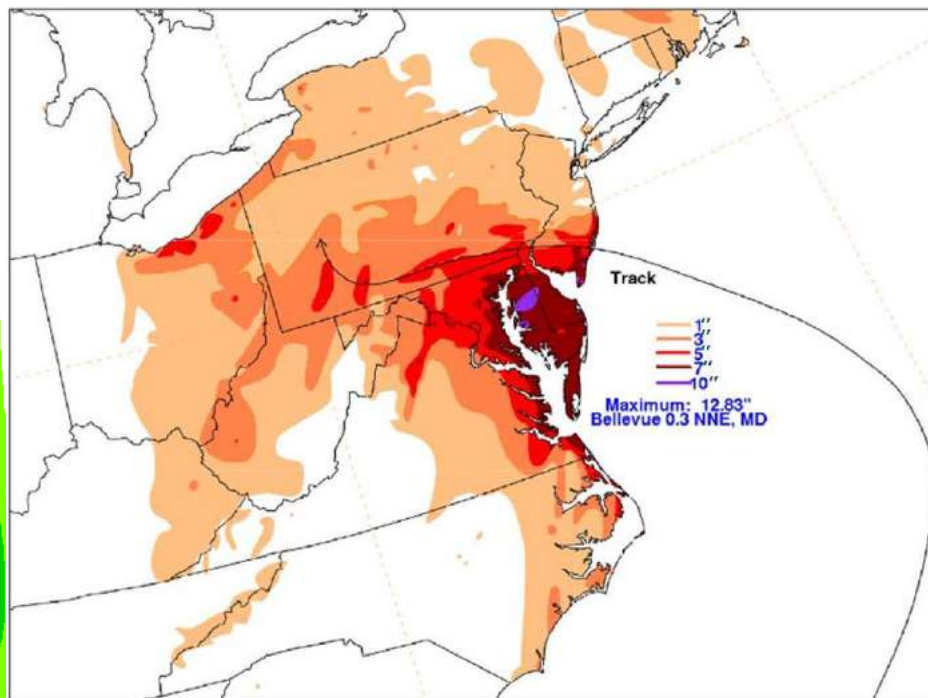


# Event Summary

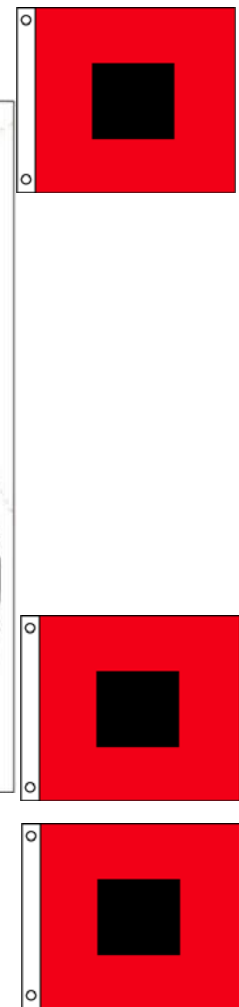
## Rainfall



**5 Day Precipitation Forecast:  
Issued Friday morning, Oct 26**



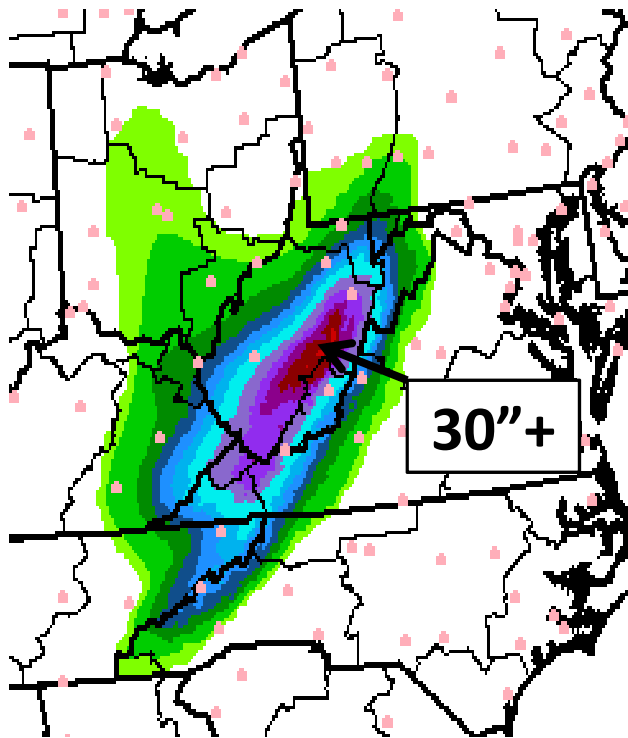
**Multi-day event total rainfall (inches) associated with  
Sandy from October 27-31, 2012.**



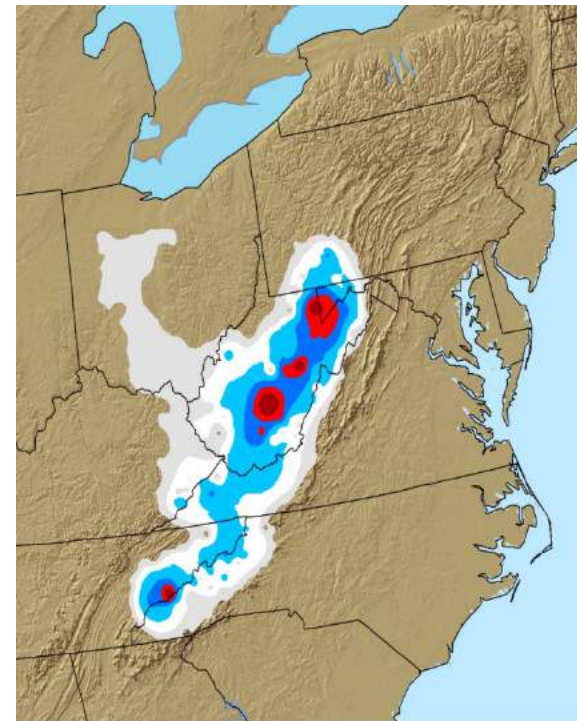


# Event Summary

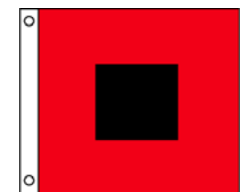
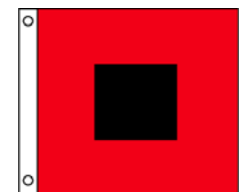
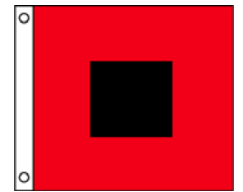
## Snowfall



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



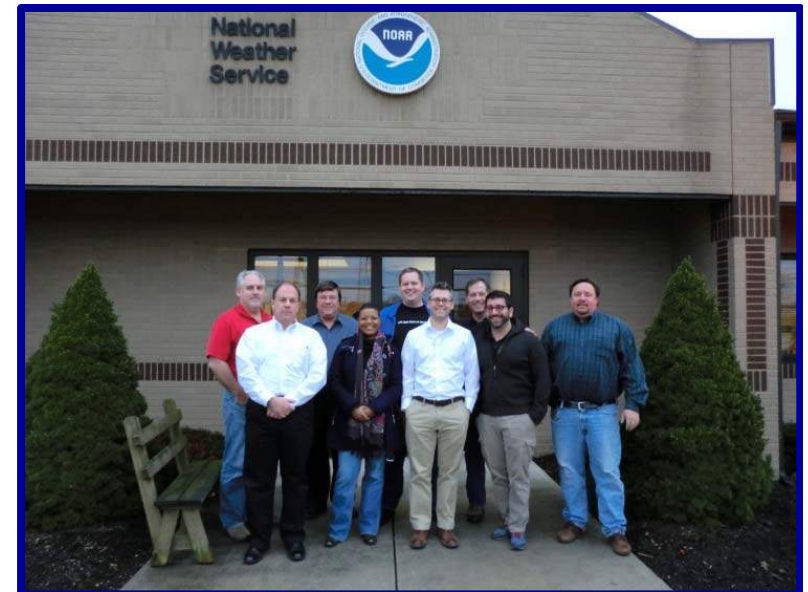
10/29/2012 - 11/1/2012  
Total Snowfall  
1"-3" 3"-6" 6"-12" 12"-18" 18"-24" > 24"





# 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!







# 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

### Personal plea

- If you are being asked to evacuate a coastal location by state and local officials, please do so.
- If you are reluctant to evacuate, and you know someone who rode out the '62 storm on the barrier islands, ask them if they would do it again.
- If you are still reluctant, think about your loved ones, think about the emergency responders who will be unable to reach you when you make the panicked phone call to be rescued, think about the rescue/recovery teams who will rescue you if you are injured or recover your remains if you do not survive.
- Sandy is an extremely dangerous storm. There will be major property damage, injuries are probably unavoidable, but the goal is **zero fatalities**.
- If you think the storm is over-hyped and exaggerated, please err on the side of caution. You can call me up on Friday (contact information is at the end of this briefing) and yell at me all you want.
- I will listen to your concerns and comments, but I will tell you in advance, I will be very happy that you are alive & well, no matter how much you yell at me.
- Thanks for listening.
- Gary Szatkowski – National Weather Service Mount Holly



National Weather Service  
Philadelphia/Mt. Holly



# 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

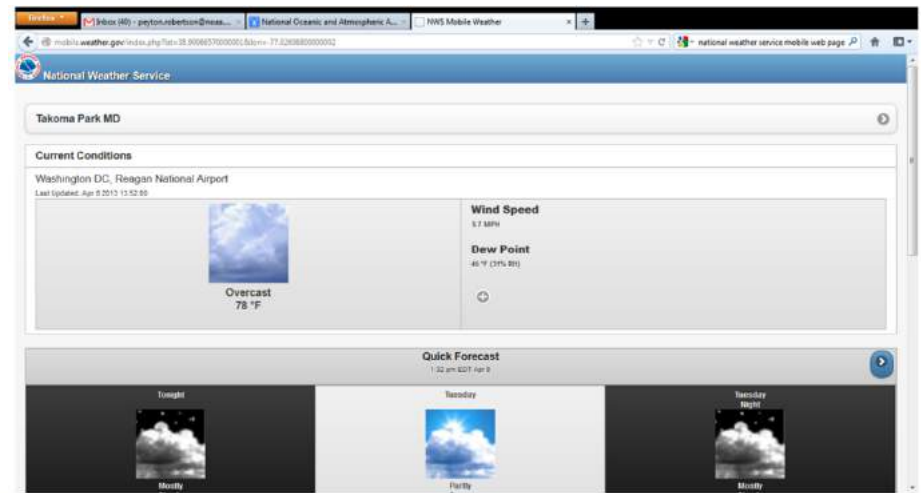
- NWS websites received 1,295,474,429 hits
- NHC accounted for 89% of this traffic
- Users singled out 2 aspects
  1. Web pages based on NOAA/NWS org. chart
  2. Too many clicks to get what you need
- Need better tools for mobile/handheld devices
- Social media is on the rise (though TV is still #1)



# 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

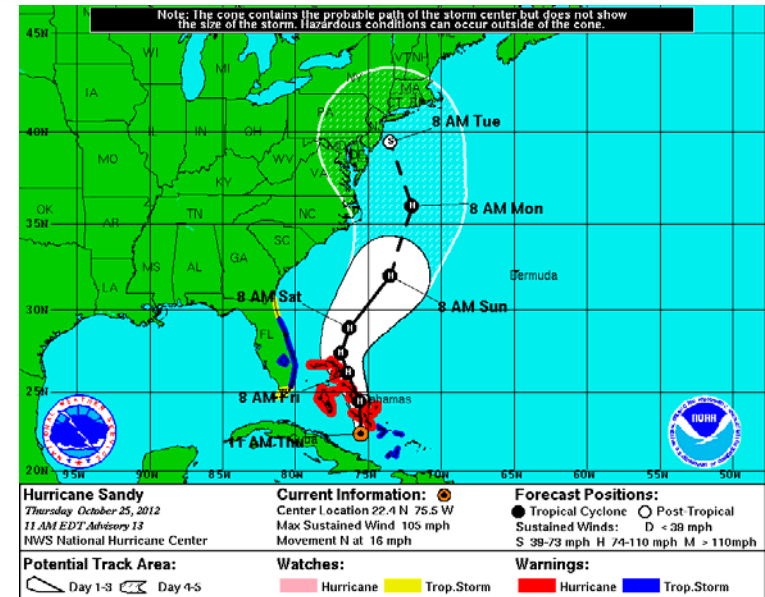




# Public Response

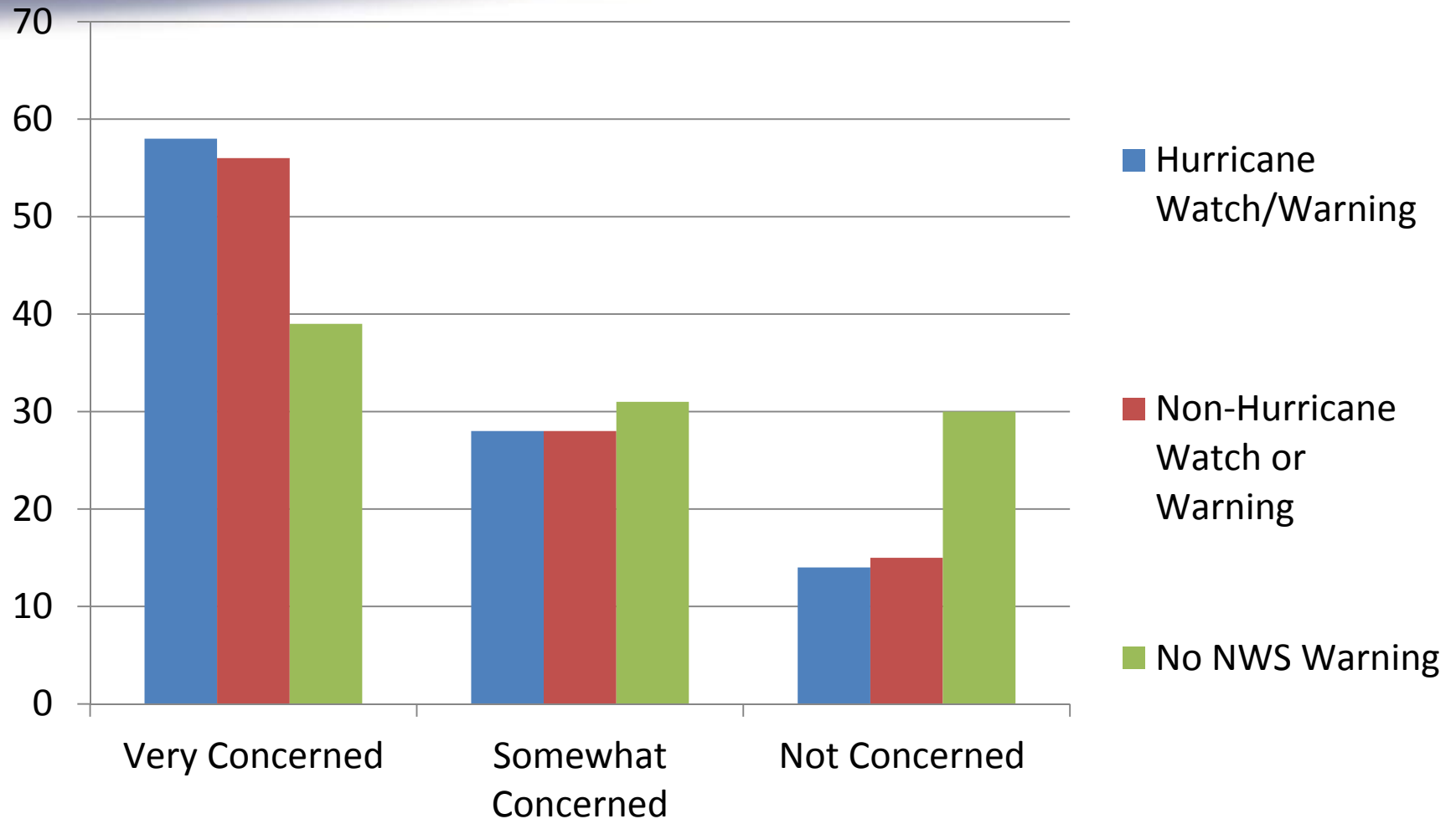
## FINDINGS

- 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



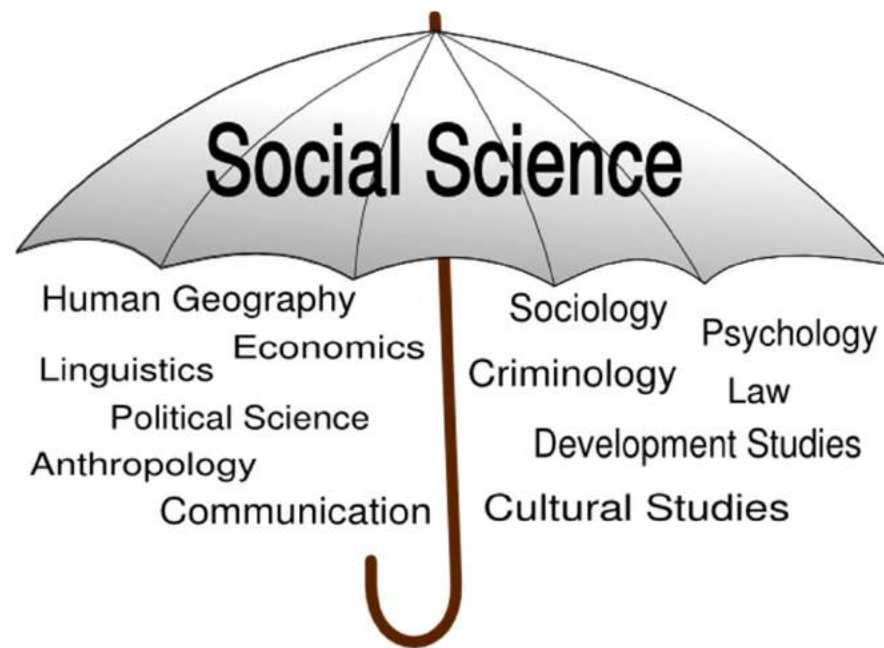
**Coastal Residents' Concern: Based Upon Watches or Warnings Perceived to Be in Effect When Sandy Made Landfall (*Gladwin, Morrow & Lazo, 2013*)**



# Public Response

## RECOMMENDATIONS

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



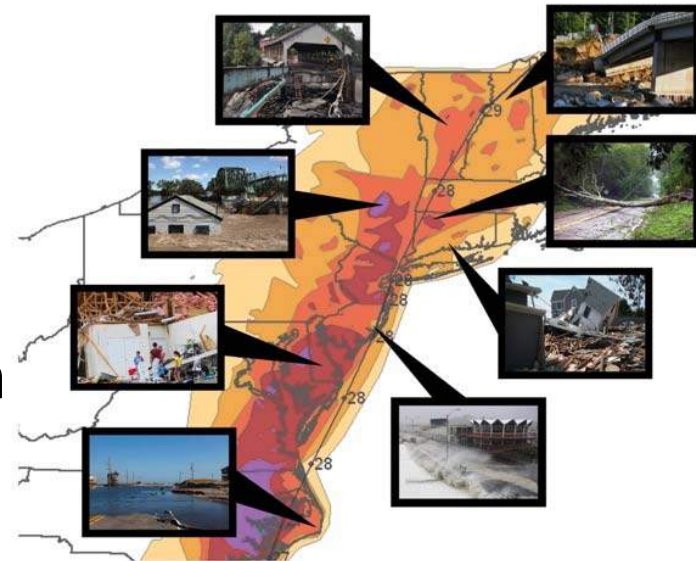


# Themes in Common w/Irene

- 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*





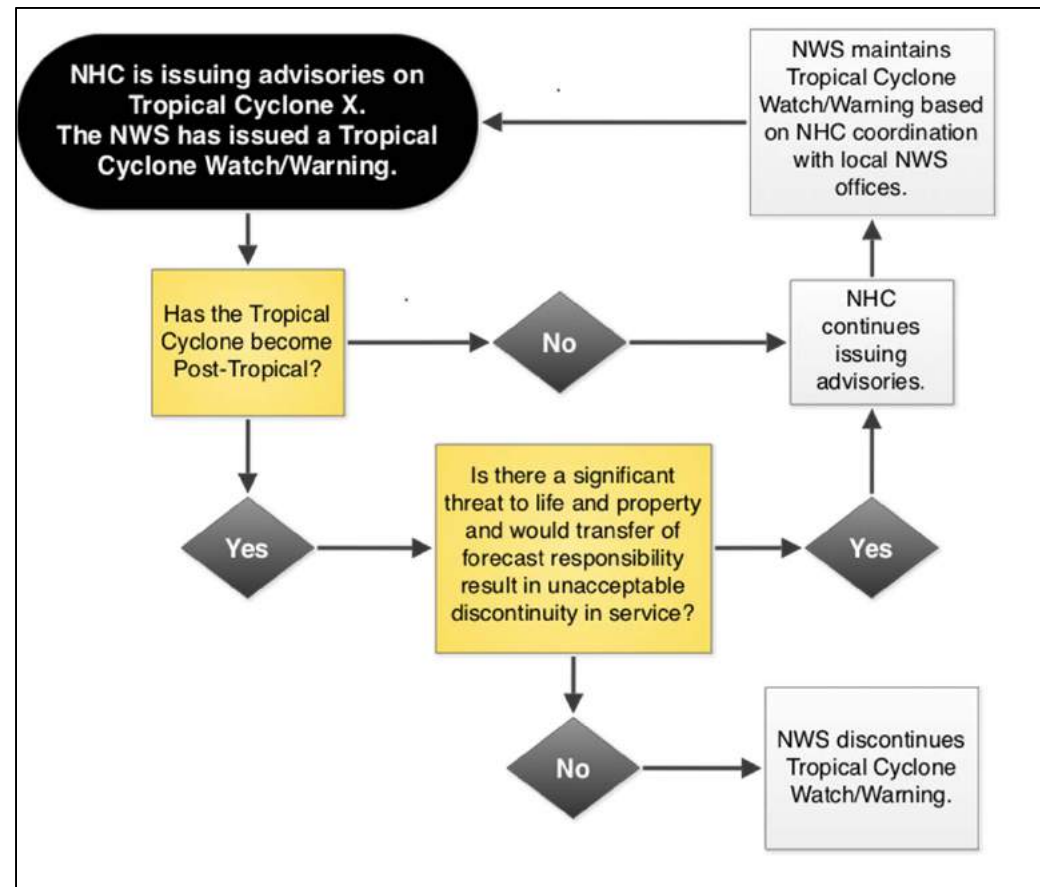


# Changes at NOAA since Sandy

## New process for handling “post-tropical” storms

- Four additional steps for a “Sandy”:

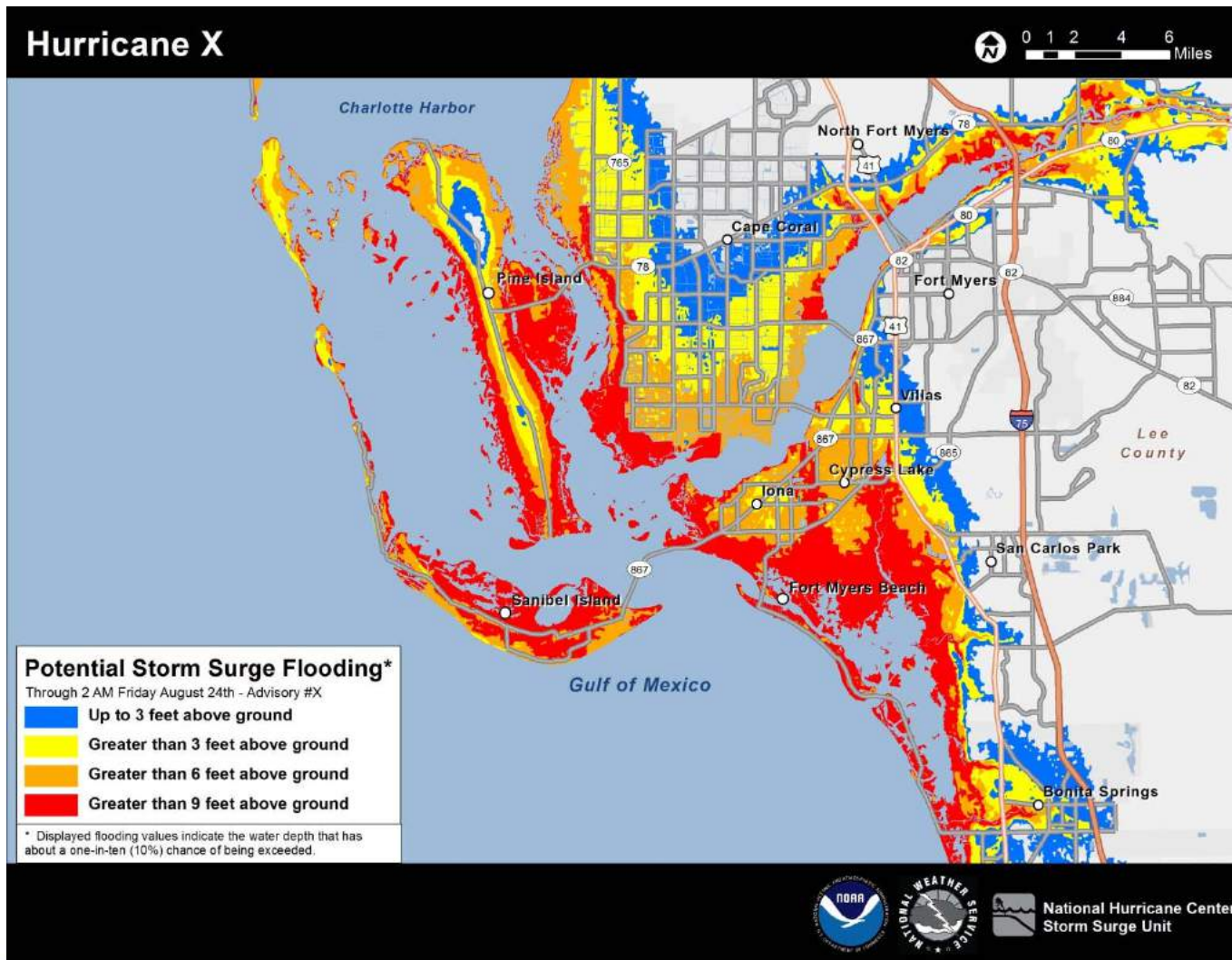
1. Emphasize strongest winds and highest surge may be well removed from the storm’s center
2. Focus on substantial hazards, regardless of post-tropical status
3. Better convey storm surge threat for coastal residents
4. Simplify the Hurricane Local Statement





# Changes at NOAA since Sandy

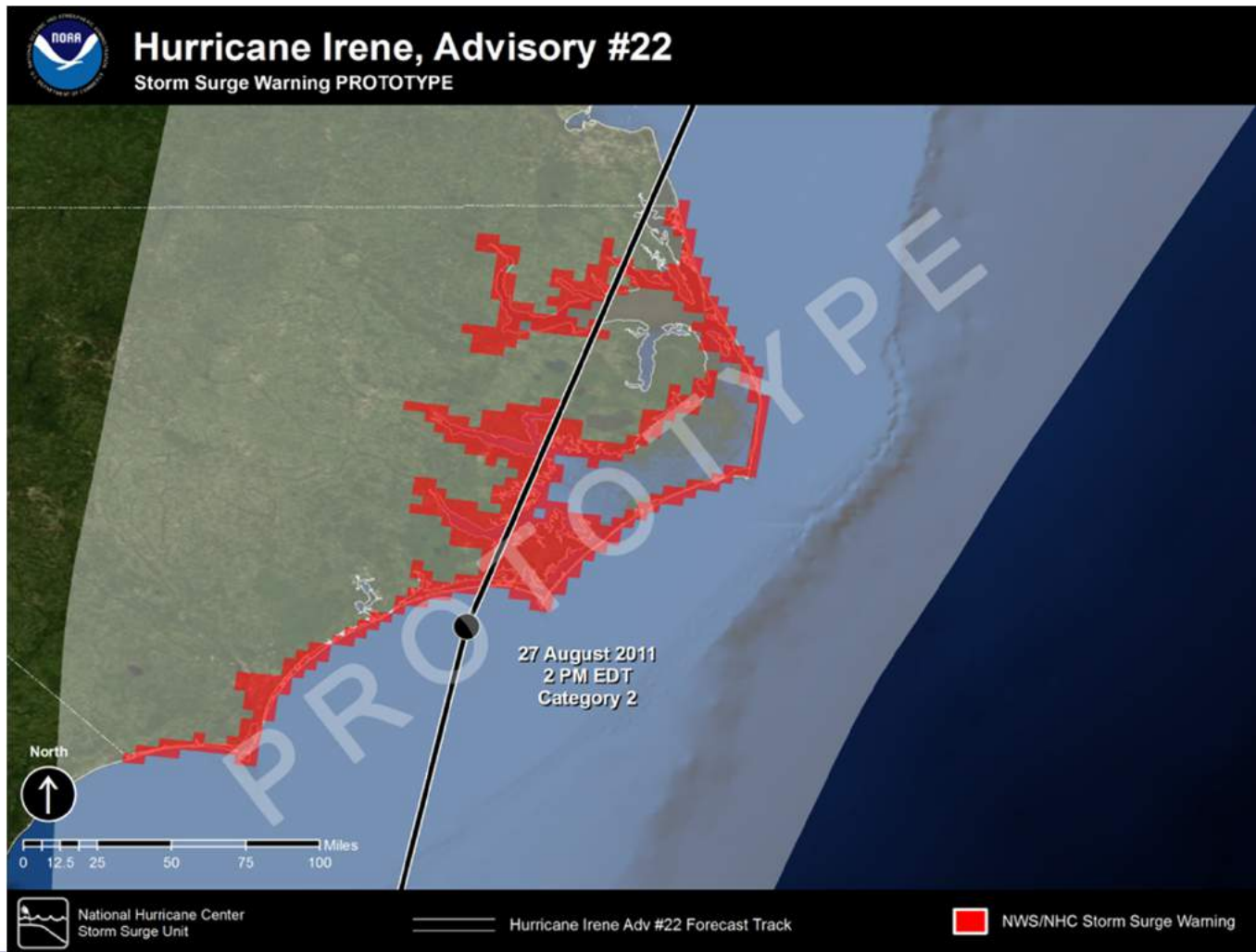
## 2014 experimental storm surge flooding map





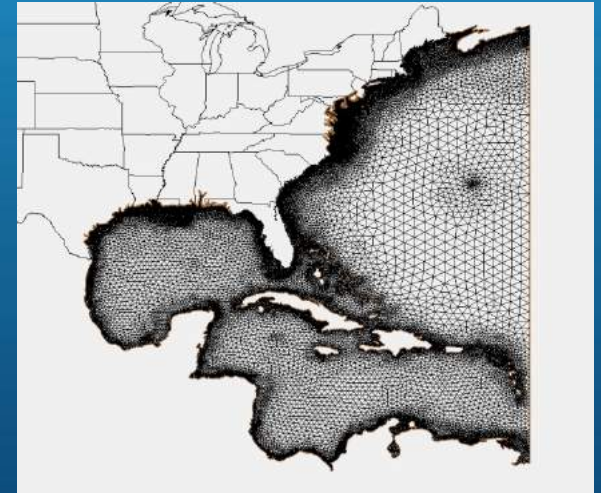
# Changes at NOAA since Sandy

2015 prototype example of the storm surge warning graphic

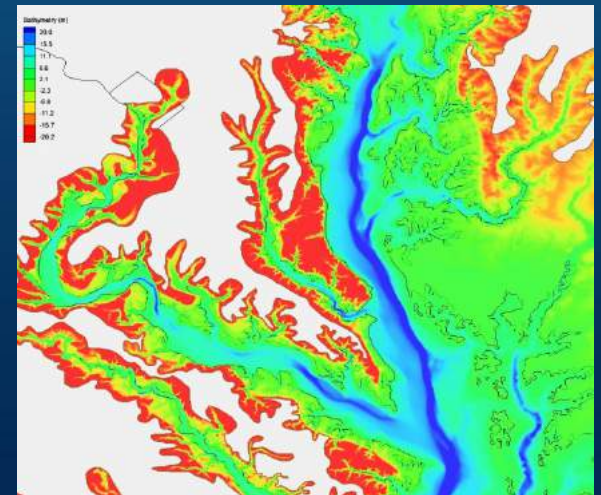


# NOS Experimental Surge Modeling

- 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



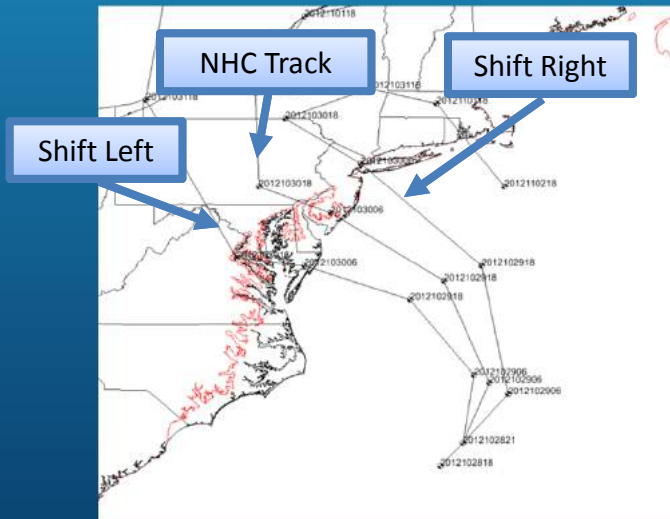
*Model grid*



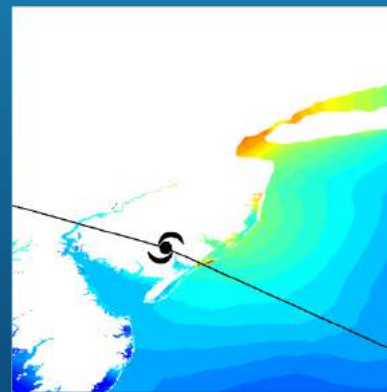
*Model topobathy in Chesapeake*



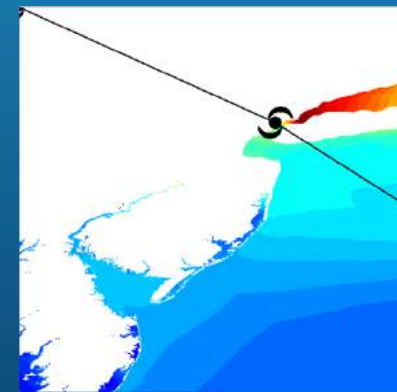
# NOS Experimental Surge Modeling



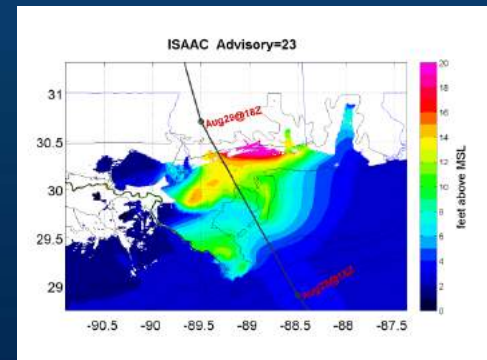
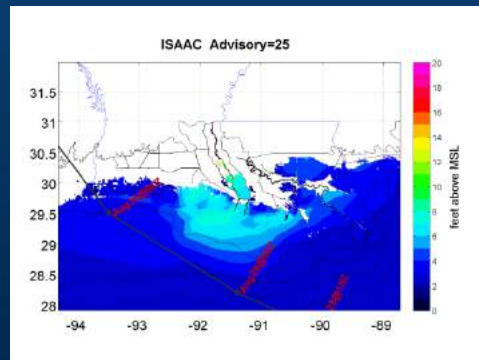
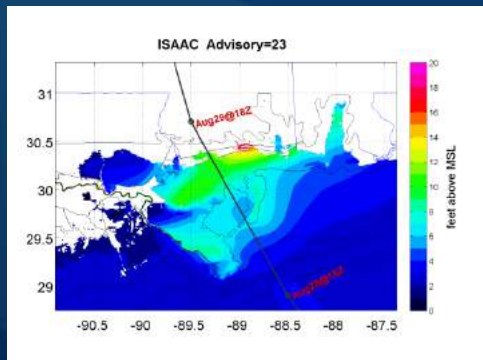
Ensemble members of Sandy (2012)



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

**Chesapeake Bay INTERPRETIVE BUOY SYSTEM**

*Delivering real-time weather and water data about the Chesapeake Bay*

**Cellular Antenna:**  
Sends data to computer on shore

**Anemometer:**  
Measures wind speed, gusts, and direction

**Temperature and Humidity Sensor:**  
Measures air temperature and relative humidity

**GPS Receiver and Satellite Transmitter:**  
Tracks buoy's precise location

**Navigation Light:**  
Keeps the buoy visible at night

**Solar Panels:**  
Solar energy charges the batteries

**Computer and Communications:**  
Compiles information from all the sensors into a data package to be sent to shore; also includes barometric pressure sensor

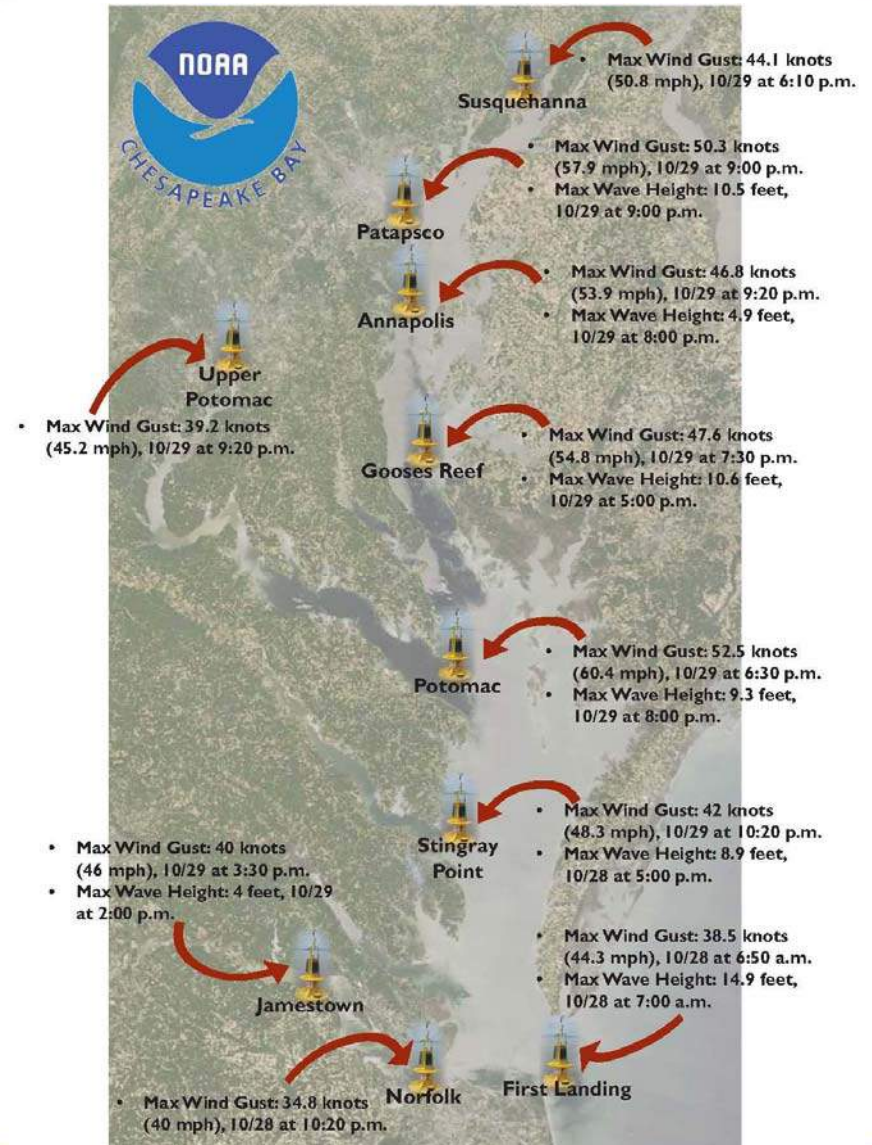
**Acoustic Current Profiler:**  
Monitors current speed and direction

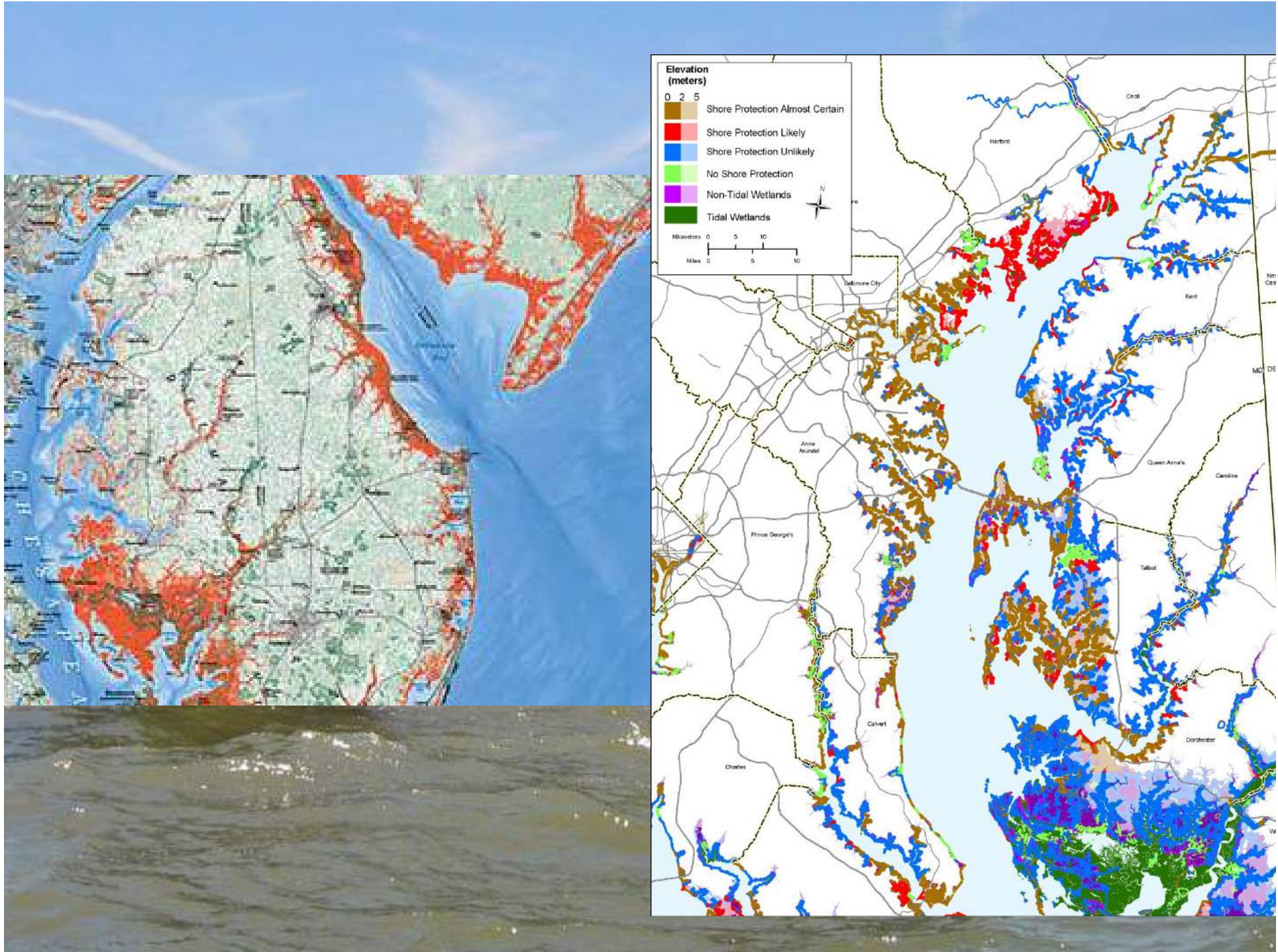
**Water Quality Monitor:**  
Tracks dissolved oxygen, turbidity, water temperature, salinity, chlorophyll-a

**Wave Measurement System:**  
Tracks wave height, direction, and spread

**Batteries:**  
Powers the buoy's sensors, computer, and transmissions

www.buoybay.noaa.gov | 877-BUOY-BAY (877-286-9229) | Mobile Apps Available









# Sea Level Rise

Sea Level Rise Confidence Marsh  
Vulnerability Flood Frequency

## Sea Level Rise ?

4 ft SLR

### Legend

- Water Depth
- Low-lying Areas
- Area Not Mapped
- Visualization Location

[View Levels](#)

### Overview

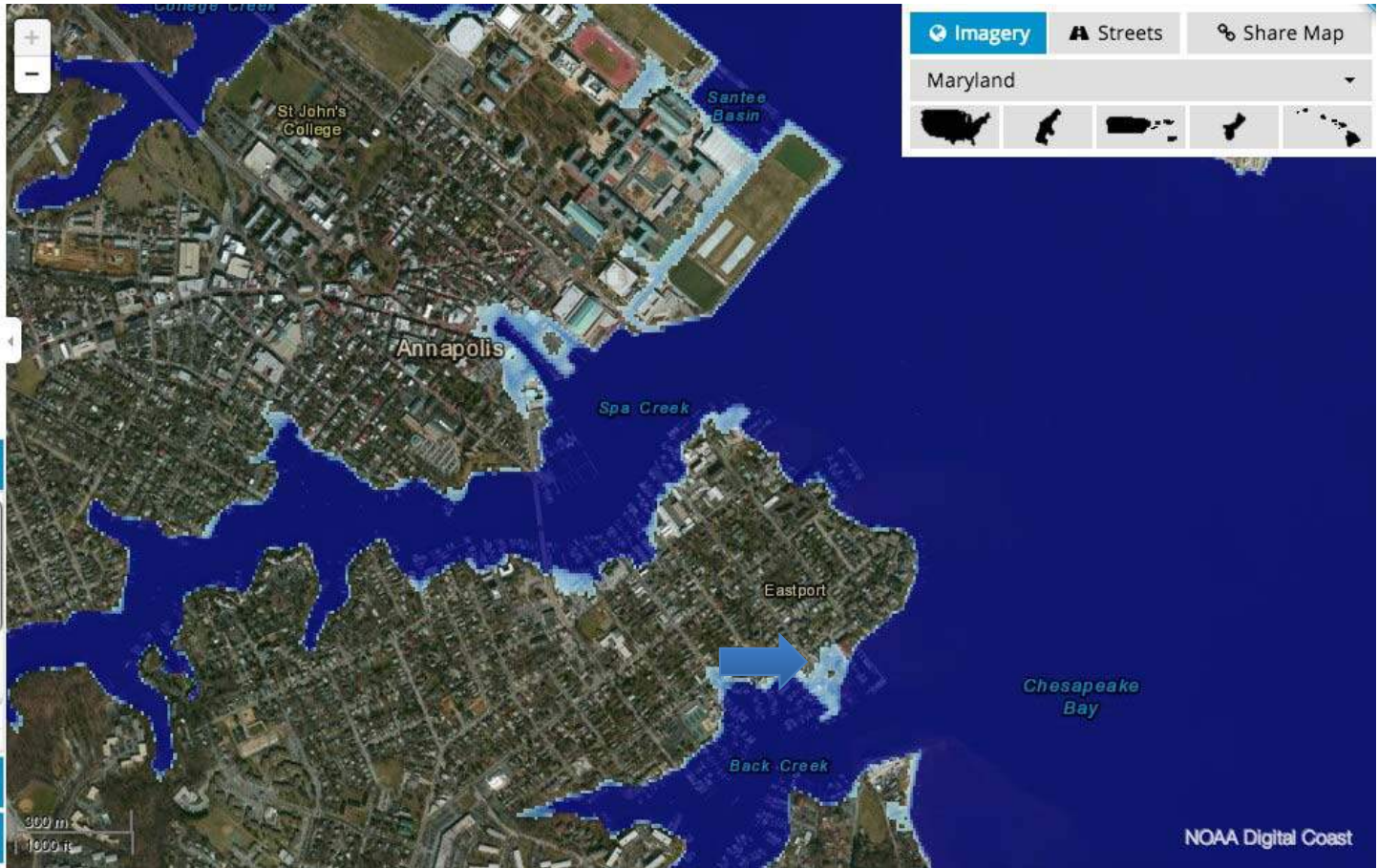
Use the slider bar above to see how various levels of sea level rise will impact this area.

Levels represent inundation at high tide. Areas that are hydrologically connected are shown in shades of blue (darker blue = greater depth).

Low-lying areas, displayed in green, are hydrologically "unconnected" areas that may flood. They are determined solely by how well

### Understanding The Map

### Additional Information

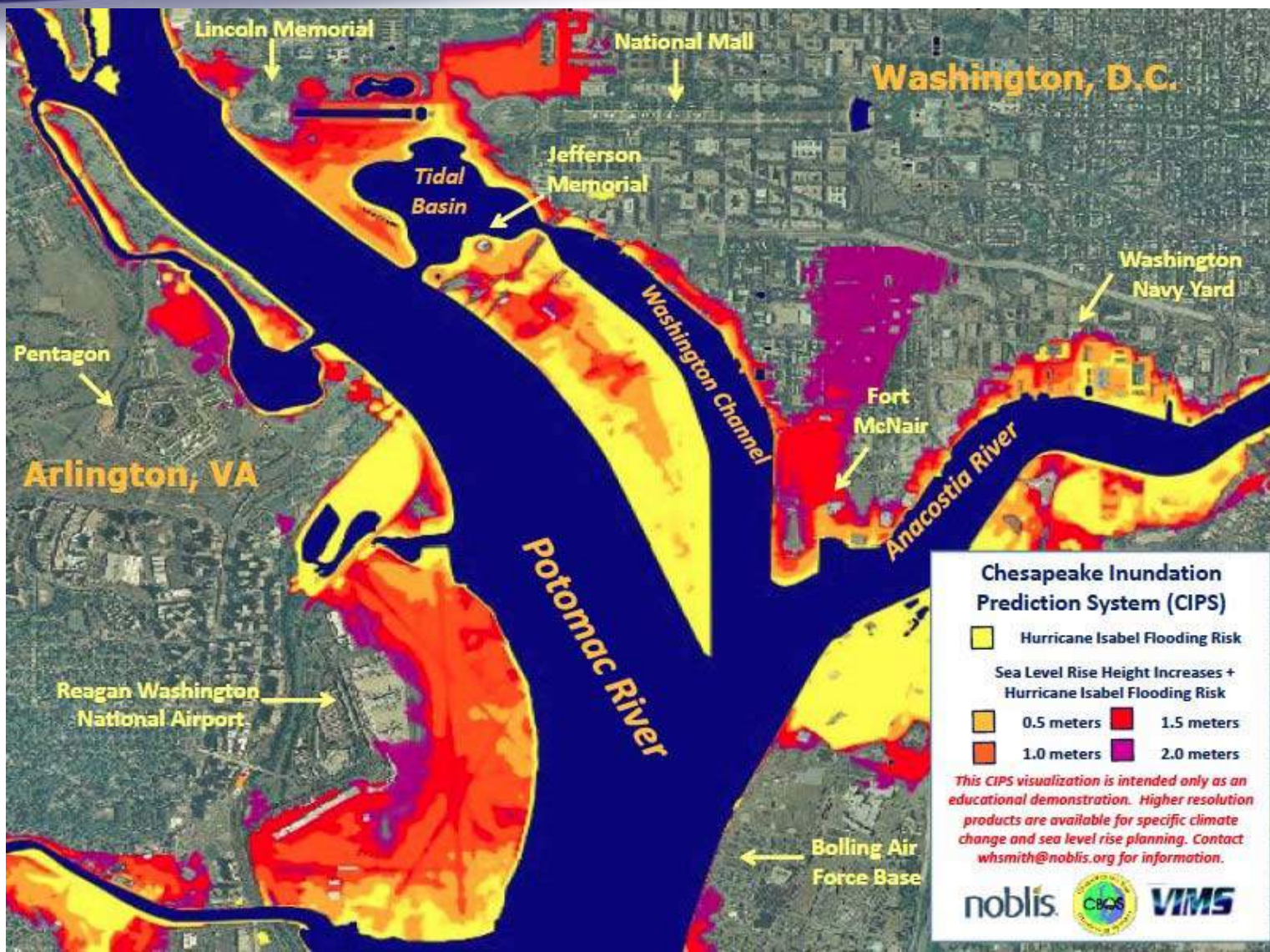


Imagery Streets Share Map  
Maryland





# 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](http://www.education.noaa.gov/Weather_and_Atmosphere/Hurricanes.html)
- Storm surge information:  
[http://www.nws.noaa.gov/os/hurricane/resources/surge\\_intro.pdf](http://www.nws.noaa.gov/os/hurricane/resources/surge_intro.pdf)



# Chesapeake Bay Interpretive Buoys

## Where the buoys are

Click on map to learn specific buoy information:

<b>S</b> SUSQUEHANNA [RSS] [Y] [G] GET DATA GET INFO	<b>SN</b> PATAPSCO [RSS] [Y] [G] GET DATA GET INFO	<b>AN</b> ANNAPOLIS [RSS] [Y] [G] GET DATA GET INFO
<b>UP</b> UPPER POTOMAC [RSS] [Y] [G] GET DATA GET INFO	<b>GR</b> GOOSSES REEF [RSS] [Y] [G] GET DATA GET INFO	<b>PL</b> POTOMAC [RSS] [Y] [G] GET DATA GET INFO
<b>SR</b> STINGRAY POINT [RSS] [Y] [G] GET DATA GET INFO	<b>J</b> JAMESTOWN [RSS] [Y] [G] GET DATA GET INFO	<b>N</b> NORFOLK [RSS] [Y] [G] GET DATA GET INFO
<b>FL</b> FIRST LANDING [RSS] [Y] [G] GET DATA GET INFO	<b>RC</b> RICE RIVERS CTR. [RSS] [Y] [G] GET DATA GET INFO	



# Chesapeake Bay Interpretive Buoys

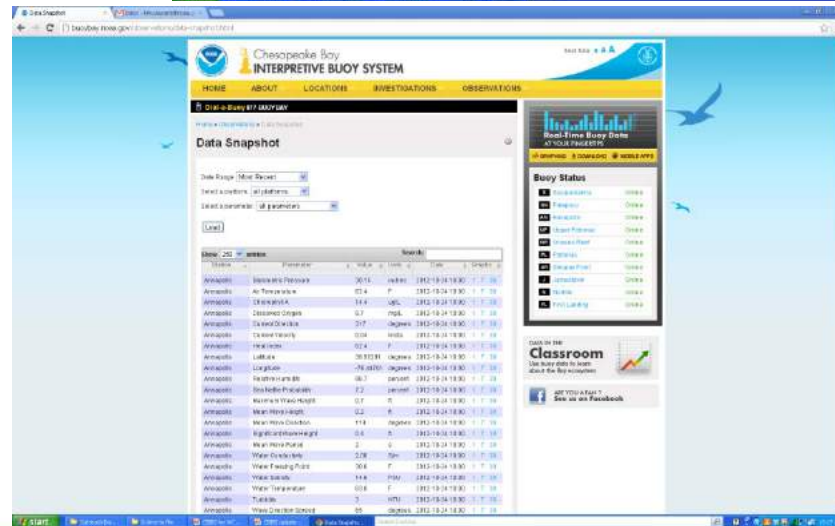
## Where can I get buoy information?

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



Annapolis (2010-06-09 02:40)  
Meteorological/Wind

Air pressure	30.0 in
Air temperature	69.9 F
Relative humidity	62.2%
Wind direction	SW
Wind speed	16.5 kt
Wind gust	20.4 kt
Water Quality	
Chlorophyll	5 ug/L





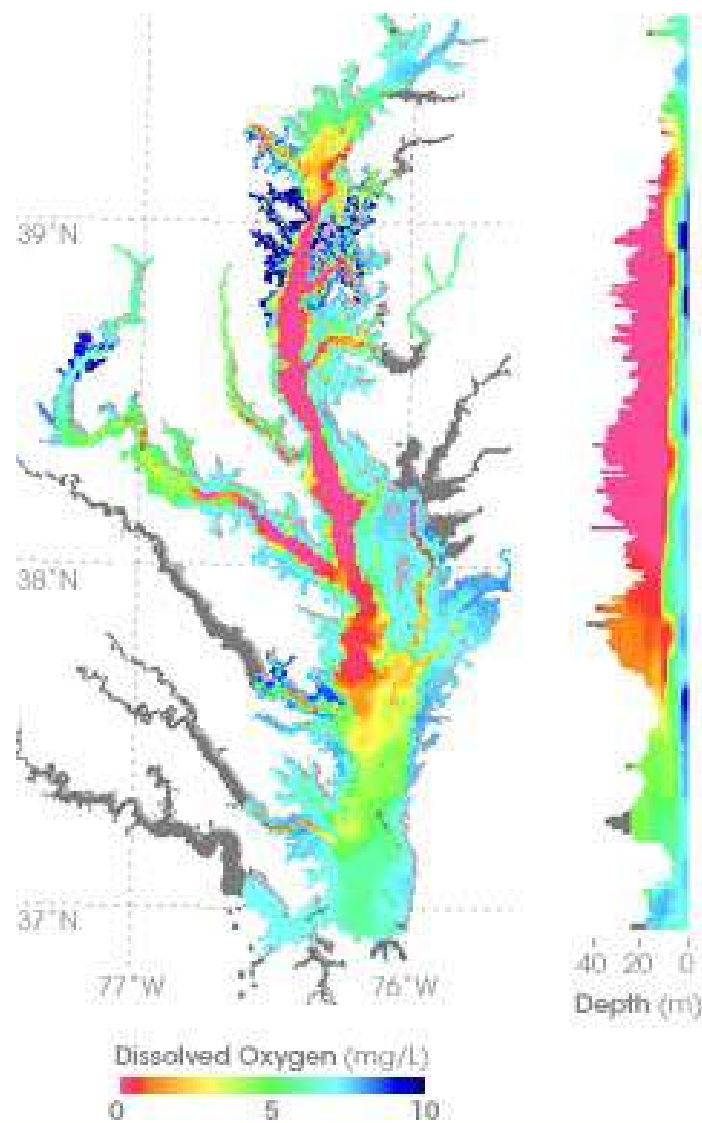
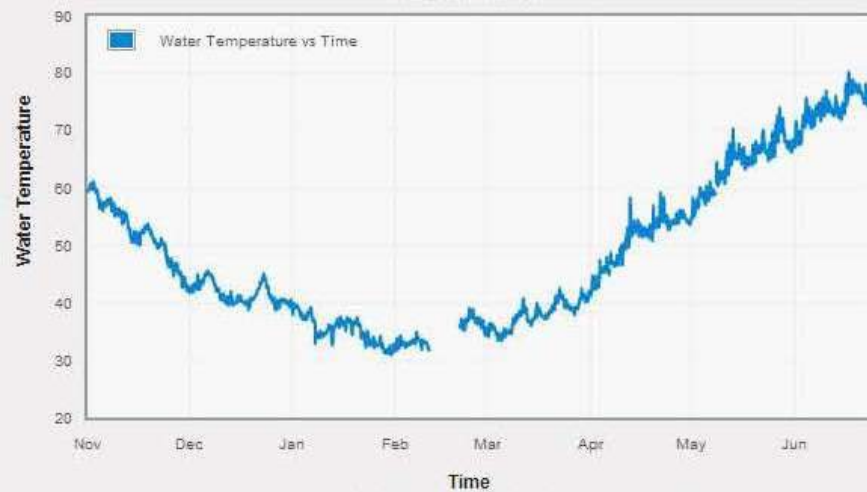


# CBIBS Data

### Annapolis



### Annapolis





# Thank You!

**NOAA** CHESAPEAKE BAY OFFICE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



<http://chesapeakebay.noaa.gov/>

*Peyton Robertson*