

Storm Surge Forecasting in the Middle Atlantic Bight: Review And Prospects

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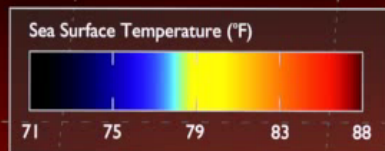
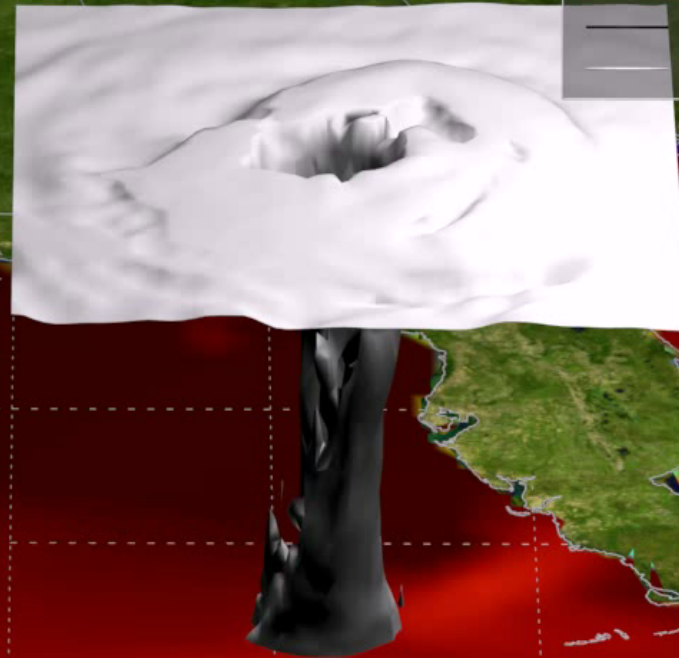
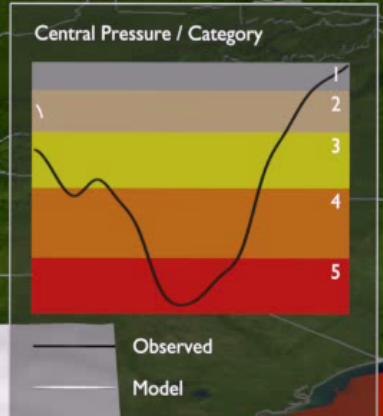
CINAR-TEMPESTS



Hurricane Katrina 2005

Hurricane Katrina Coupled Model Forecast

Aug 27 02:30 UTC

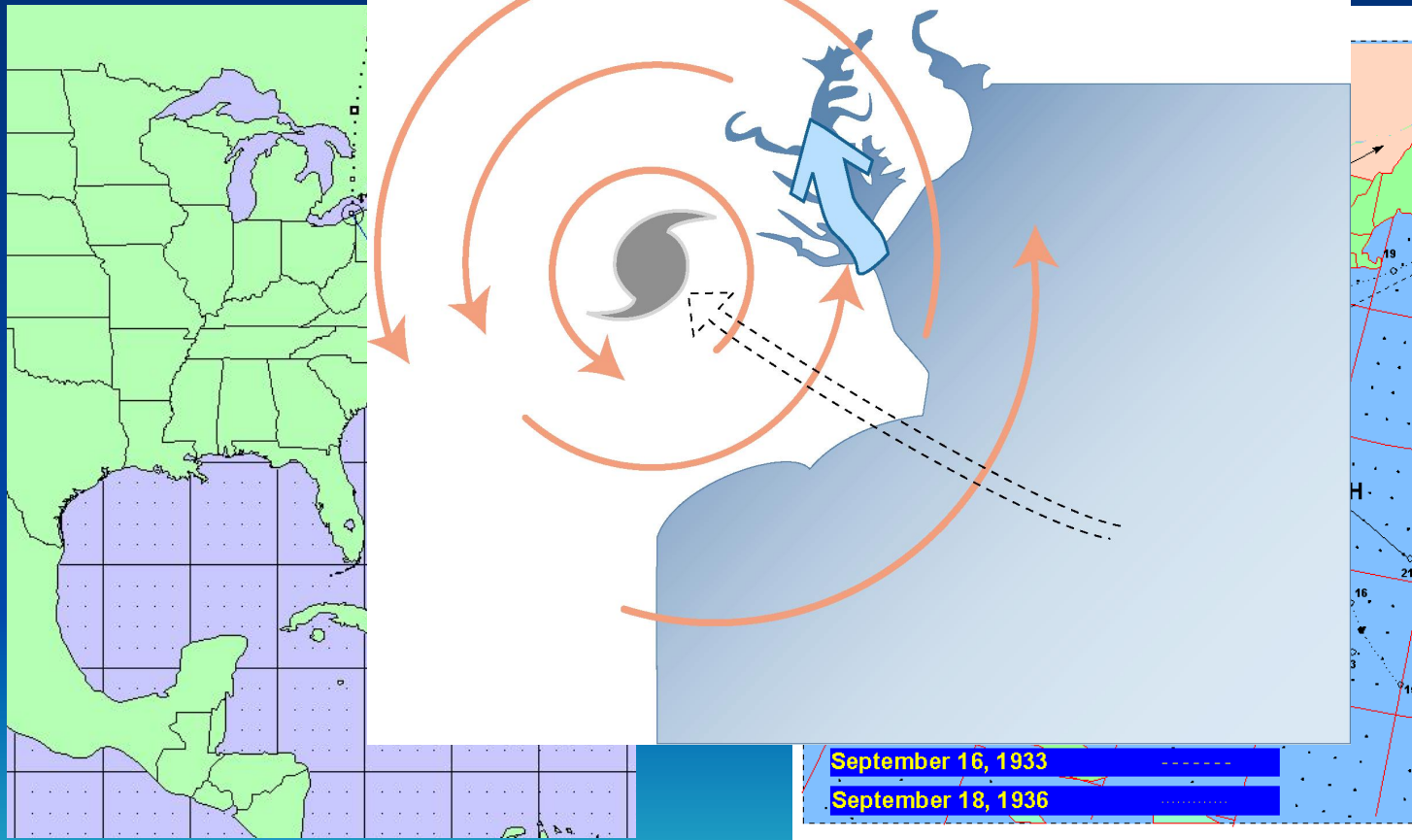




1933, 2003; Dark Side Forcing

Isabel

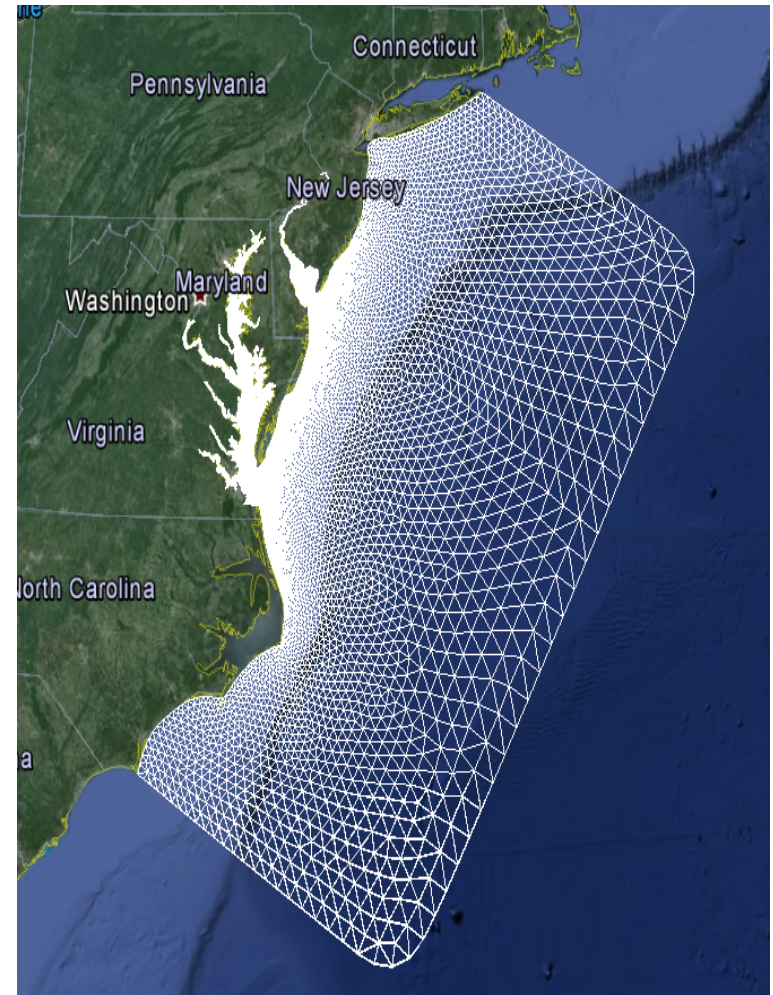
August 1933



Triply-nested WRF (12km-4km-1.3km)

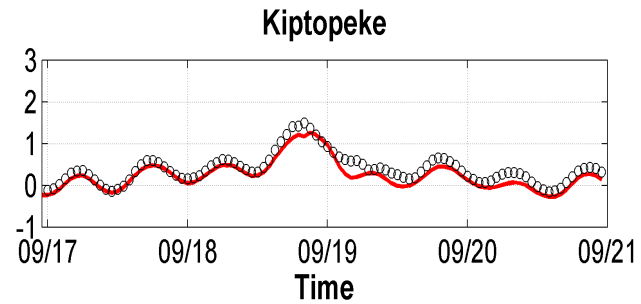
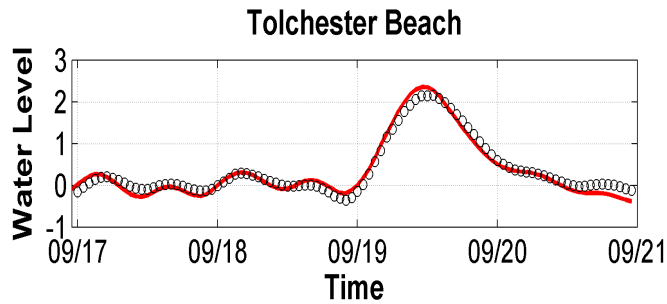
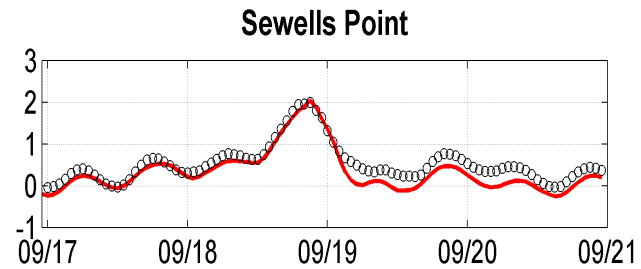
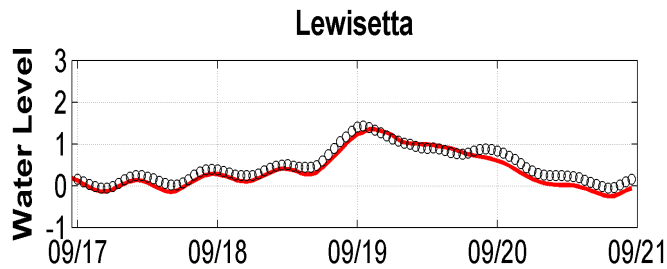
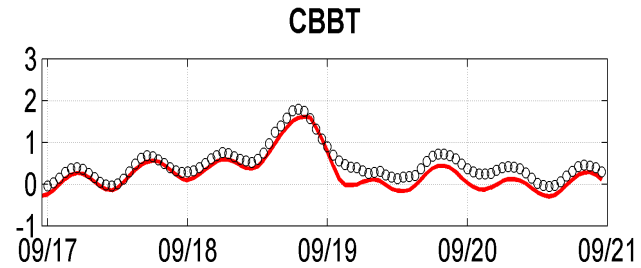
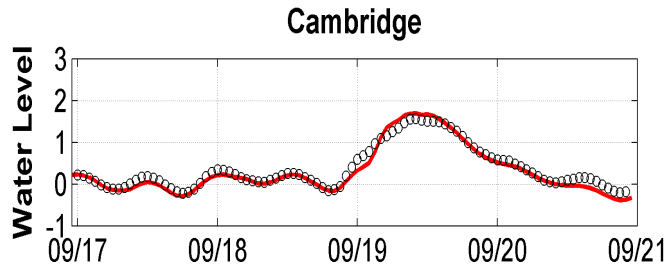
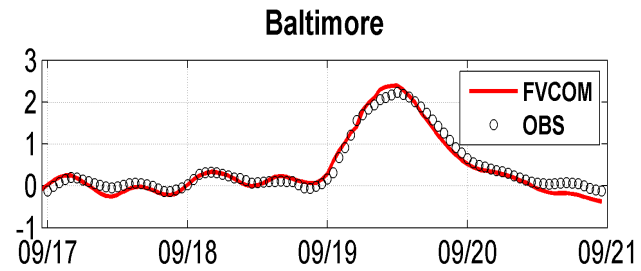
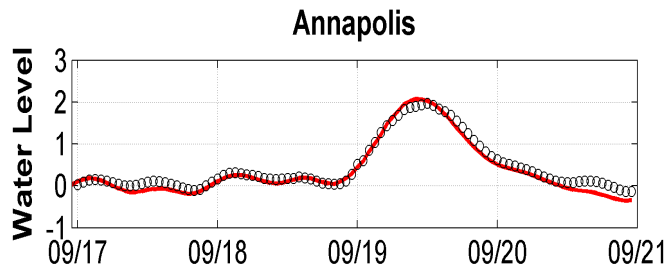


Unstructured FVCOM (50 m to 20 km)



CINAR-TEMPESTS

FVCOM Hindcasts for Isabel Storm Surges (2003)



TIMING

Urban Ocean Observatory at the Center for Maritime Systems



Present Conditions

NYHOPS Forecast

NJ Coast (CMN)

Storm Surge

Mobile Stations

CMS Partners

Data & Time Series



Storm Surge Warning System

Plot Series or Download Data

Station:
 Stations are listed from North to South

Start Date:

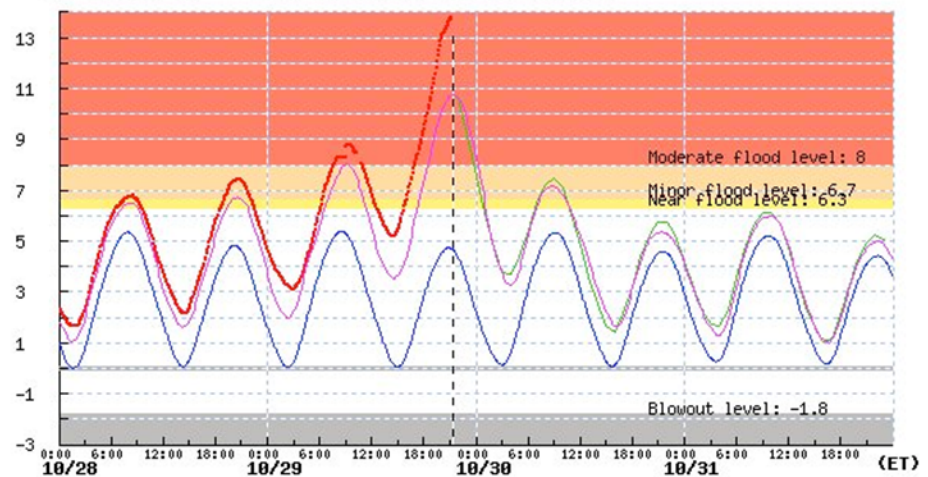
End Date:

Datum:

Units:

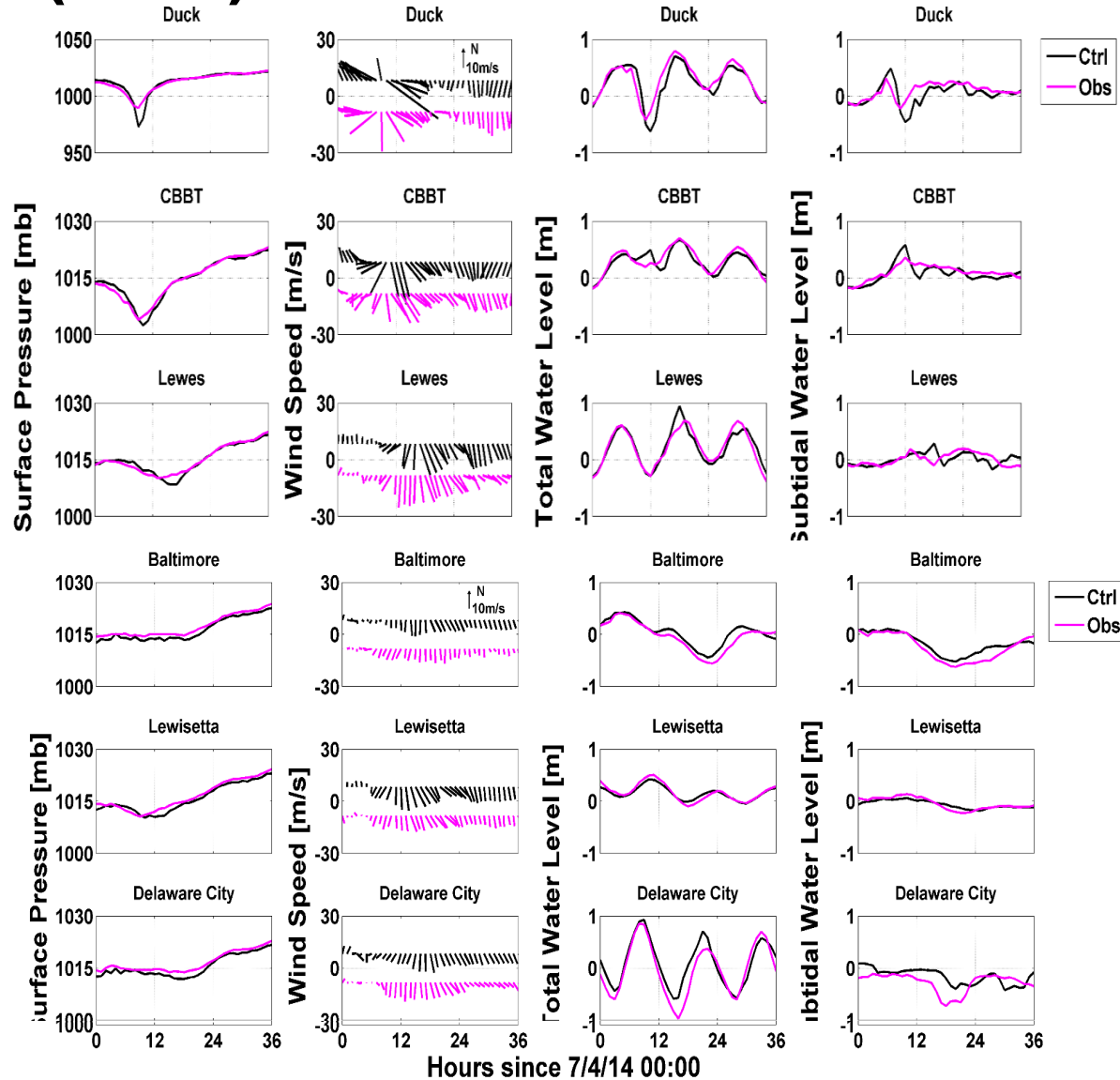
Time Zone:

The Battery NY - Water level relative to MLLW (ft)



- Astron. predictions
- Observations (where available)
- NYHOPS Forecast model
- NOAA Forecast model (where available)

Predictions for air pressure, wind speed, total and subtidal water levels during Hurricane Arthur (2014)



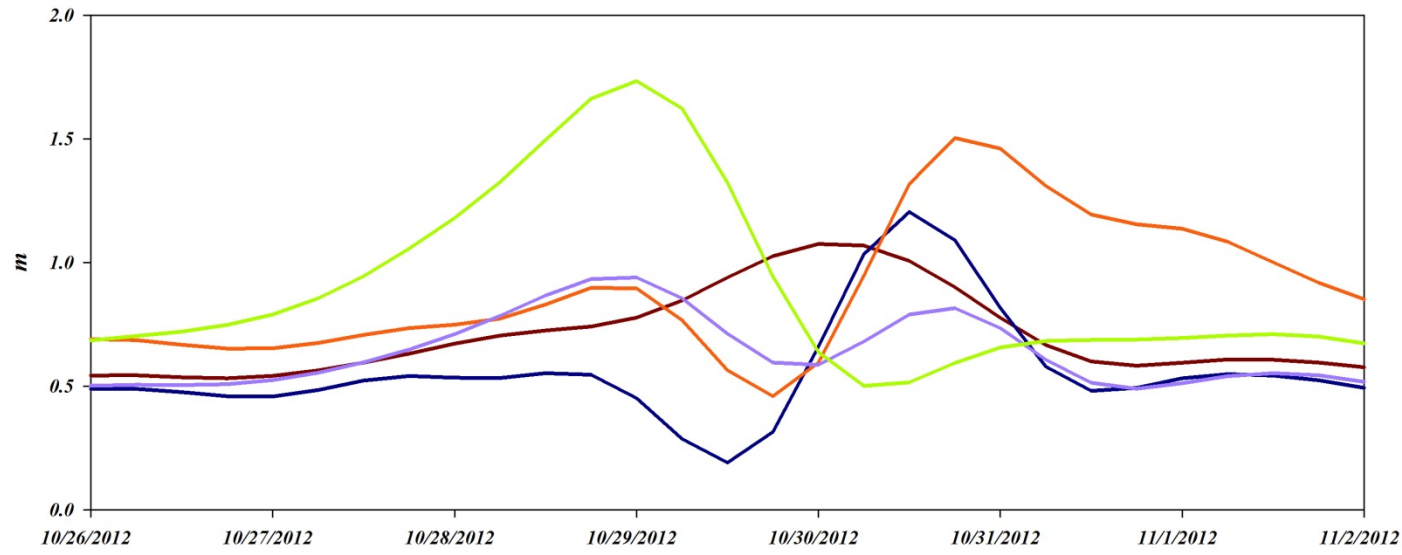
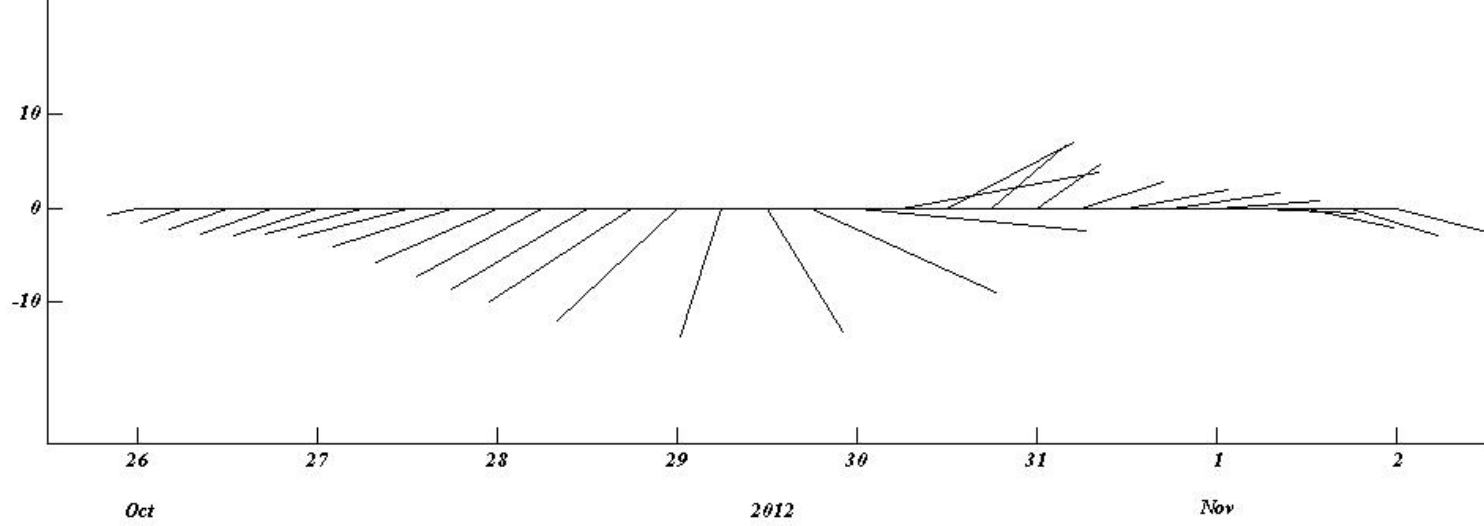


SANDY: CHESAPEAKE BAY

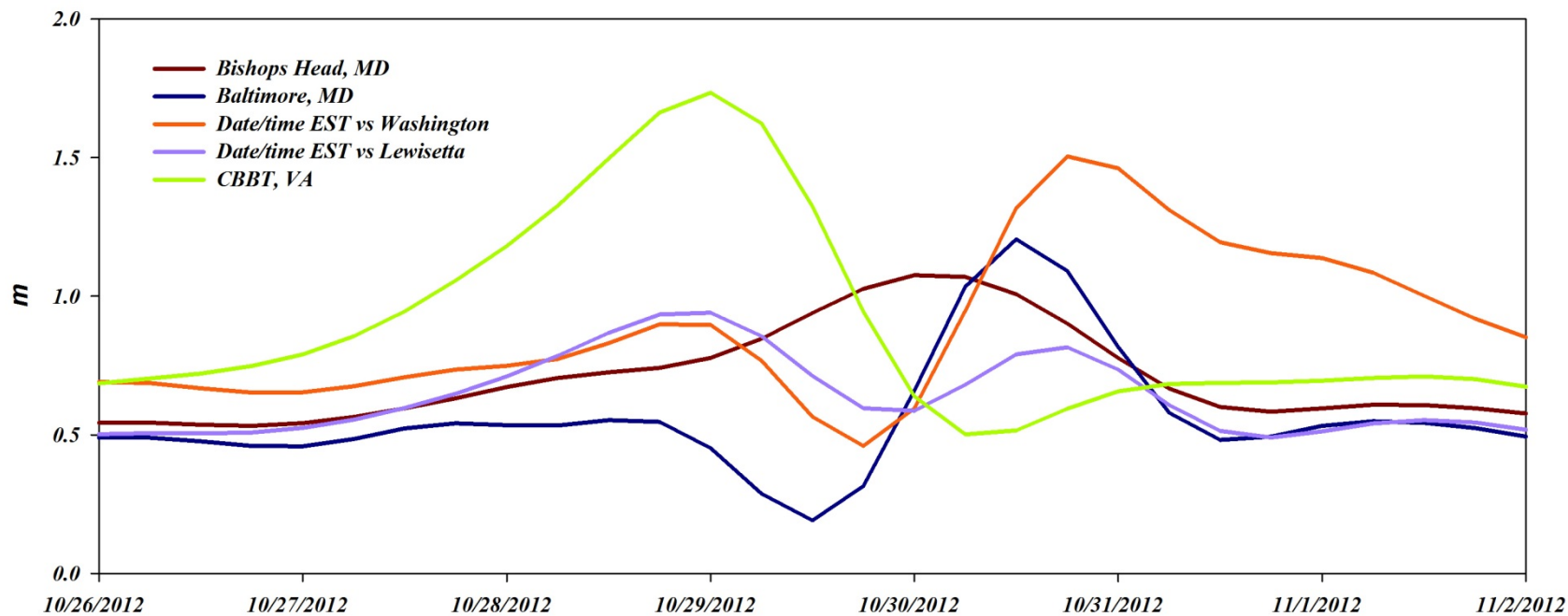
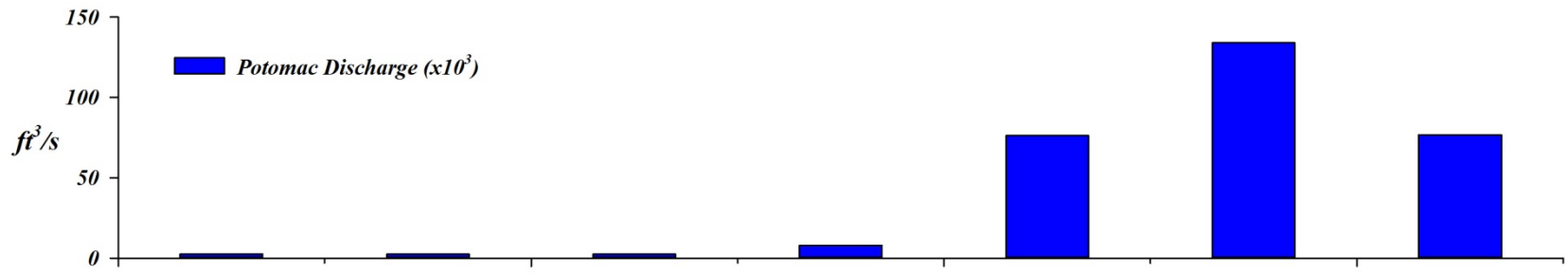
Tangier, 10:32am, Monday 29 October 2012



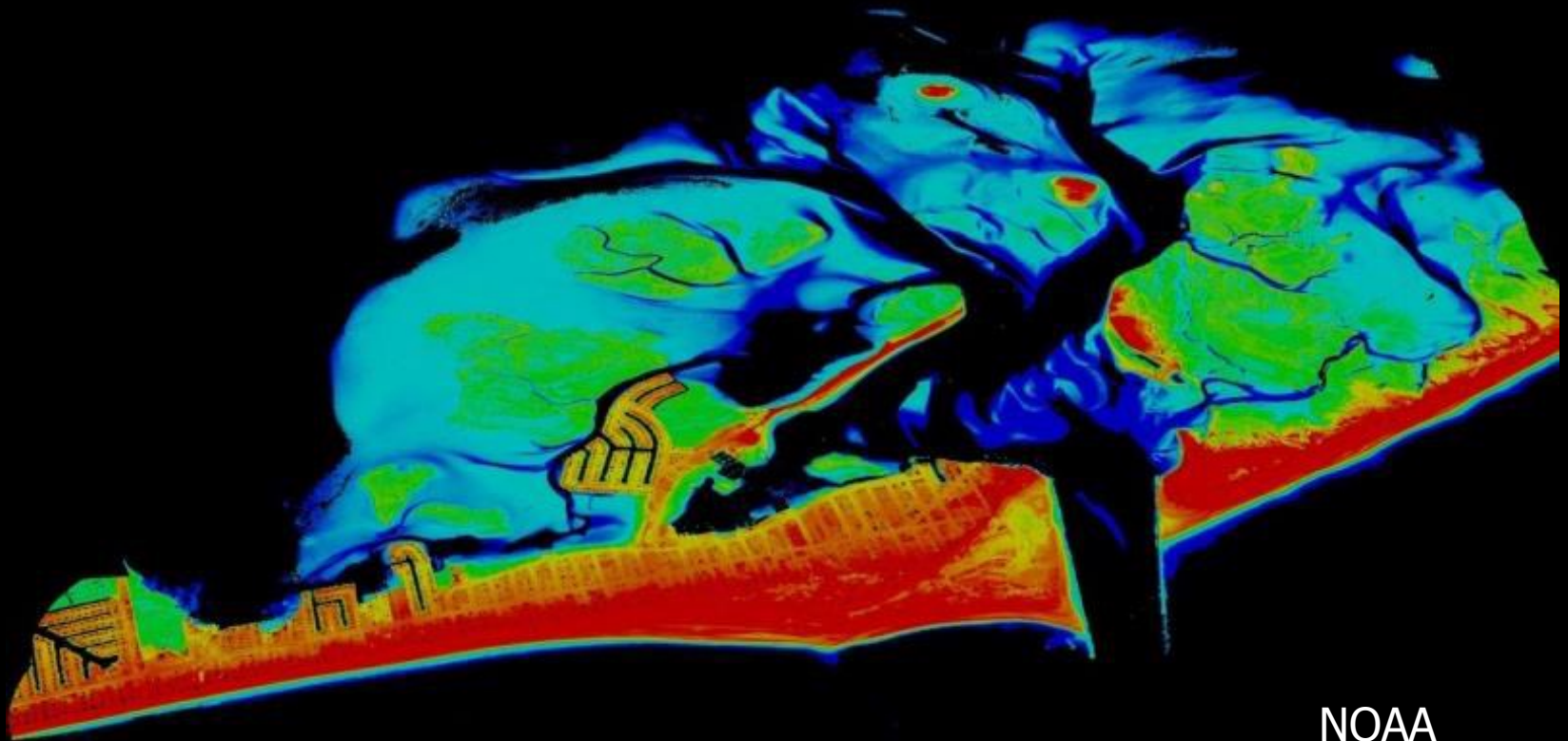
“Tide on Tangier streets, coming up fast, highest in Lonnie's life. Jessie at Bishops Head reports little rise and no problems. Very interesting storm. Thanks again for heads up. Don”



- *Bishops Head, MD*
- *Baltimore, MD*
- *Date/time EST vs Washington*
- *Date/time EST vs Lewisetta*
- *CBBT, VA*







NOAA

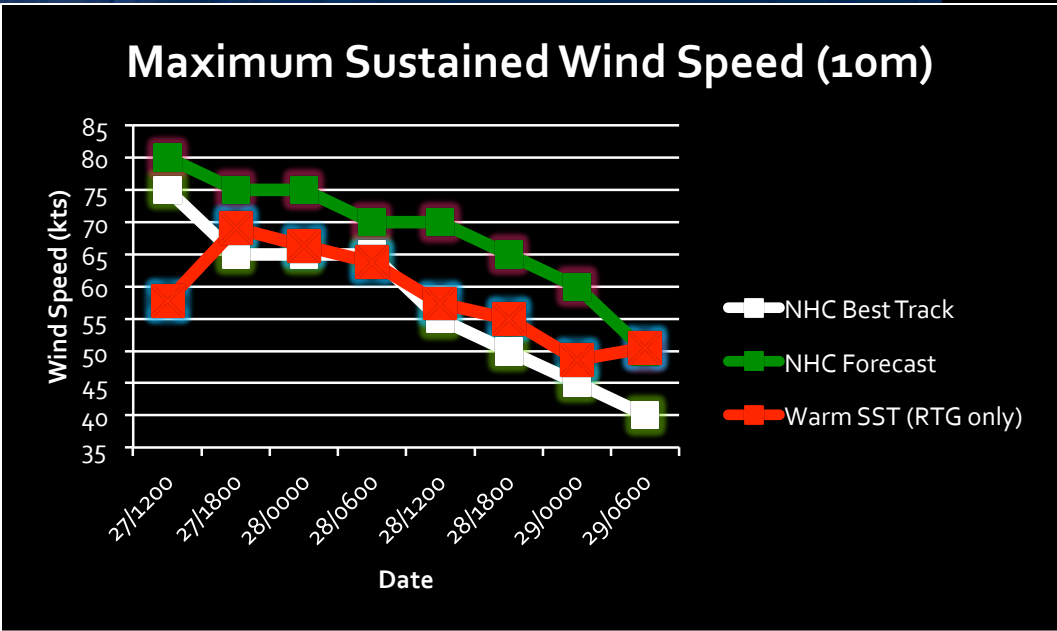
LIDAR BARNEGAT BAY

HURRICANE IRENE 2011

RU-WRF
Atmospheric
Forecast Model

Key

- NHC Best Track
- GFS 0.5 deg 06Z
- WRF 6km (Warm SST, 06Z, 06hr)

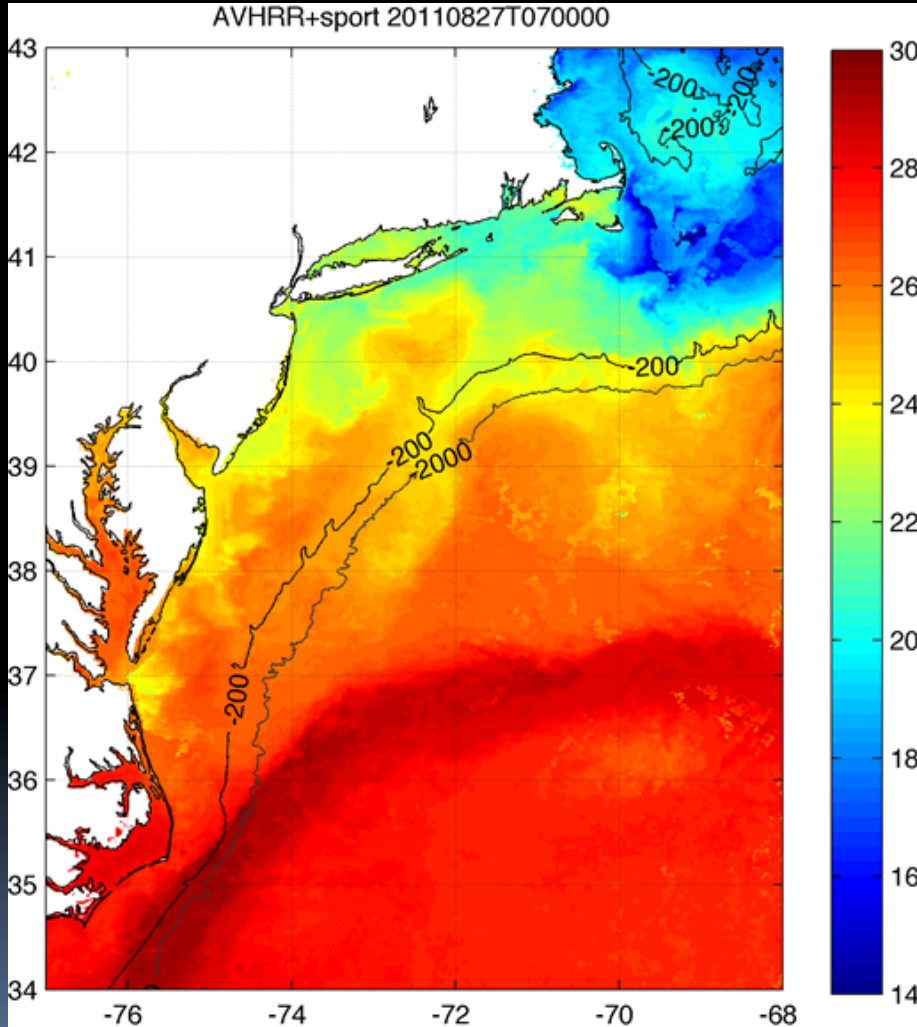


Data SIO, NC
© 20

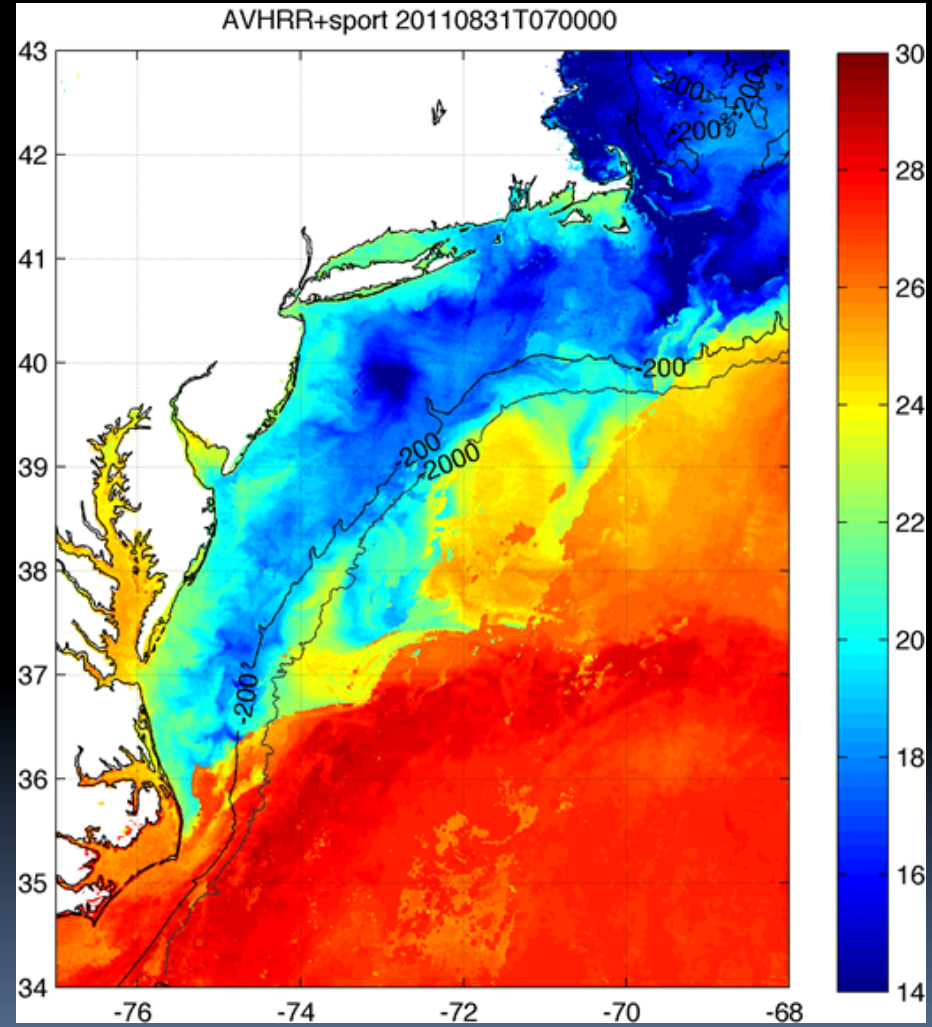
38°07'08.13"

2011: IRENE

BEFORE



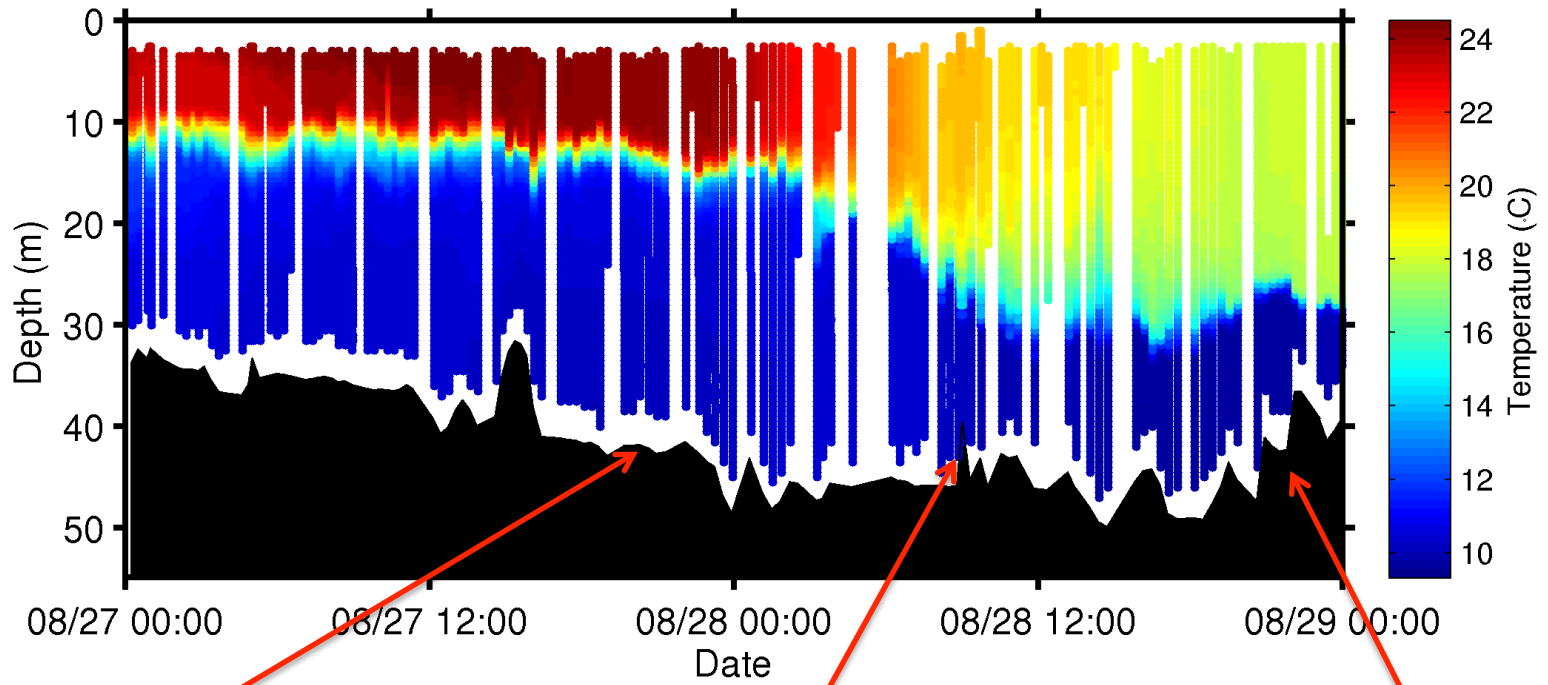
AFTER



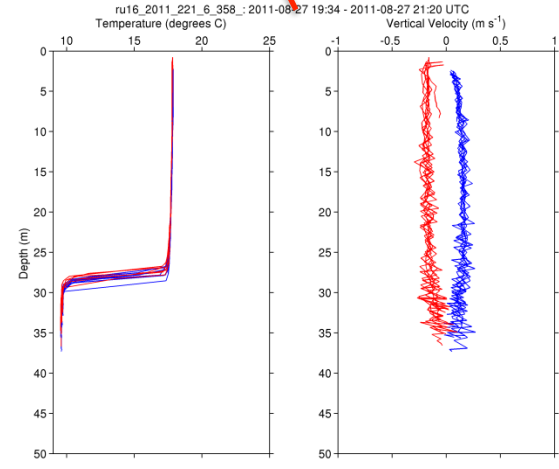
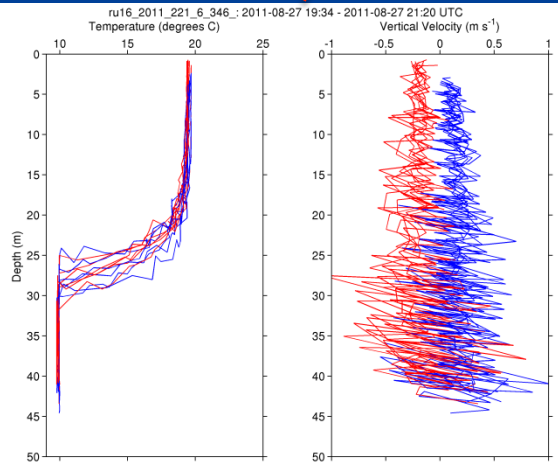
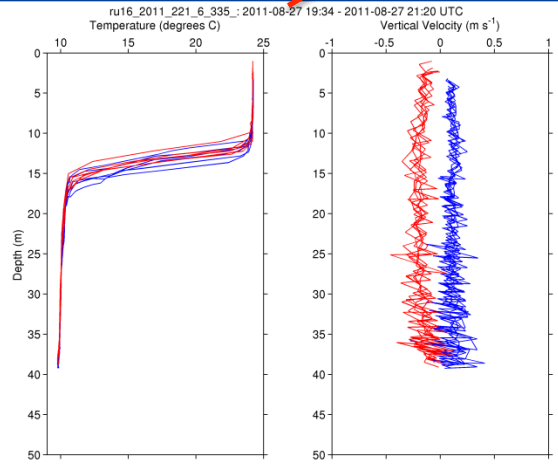


RU16
Temp.
Section

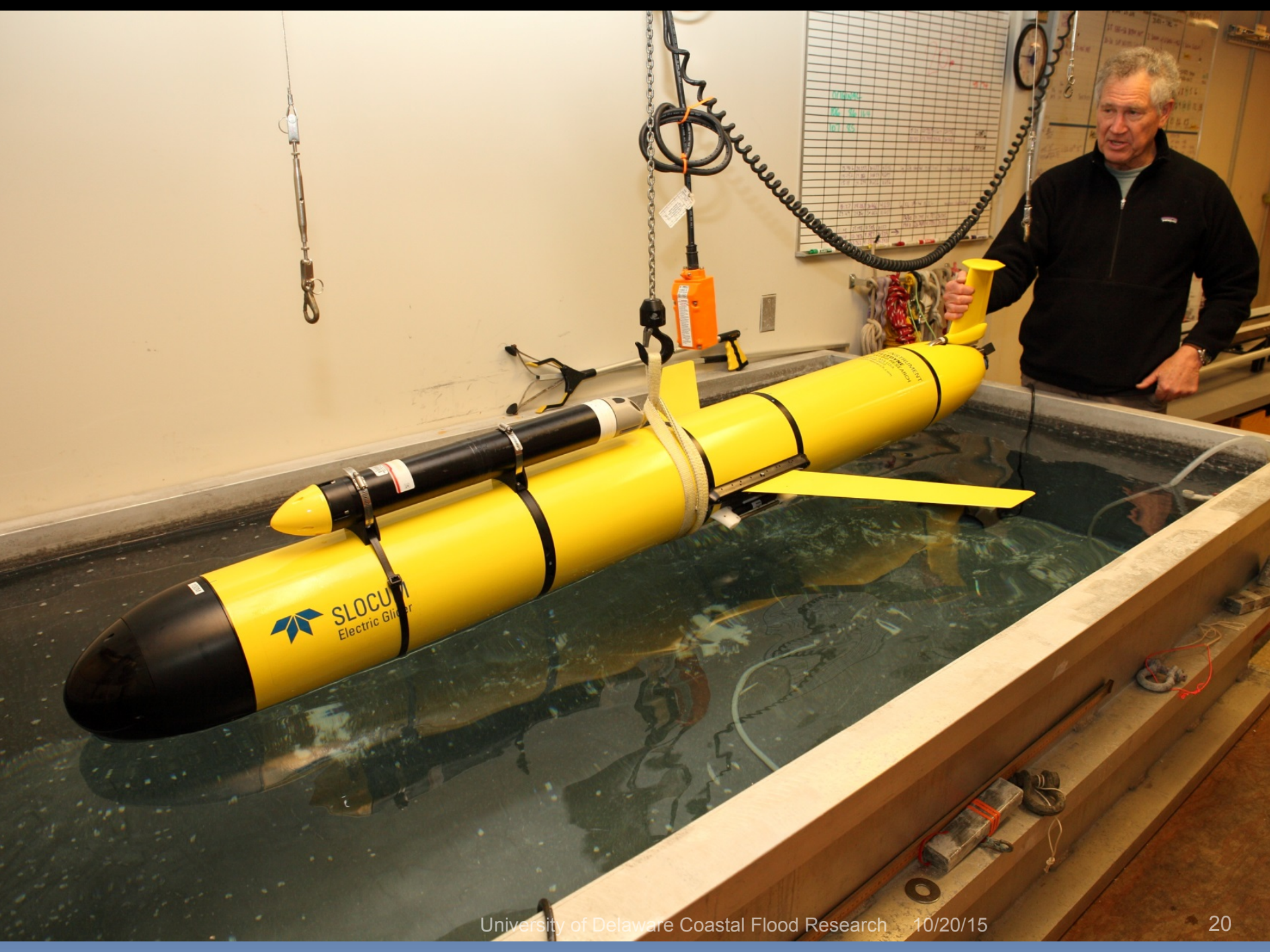
ru16: 2011-08-27 00:00 - 2011-08-29 00:00 UTC



Upcast
Downcast







Graphic Visualizations for Street-Level flooding in Cambridge, MD Using GIS and Google Earth





David Harp

Prospects

- Intensity
- Phasing
- Wetting and Drying
- Transition to Operations
- Partnerships

Global Rise: 1.8mm/yr

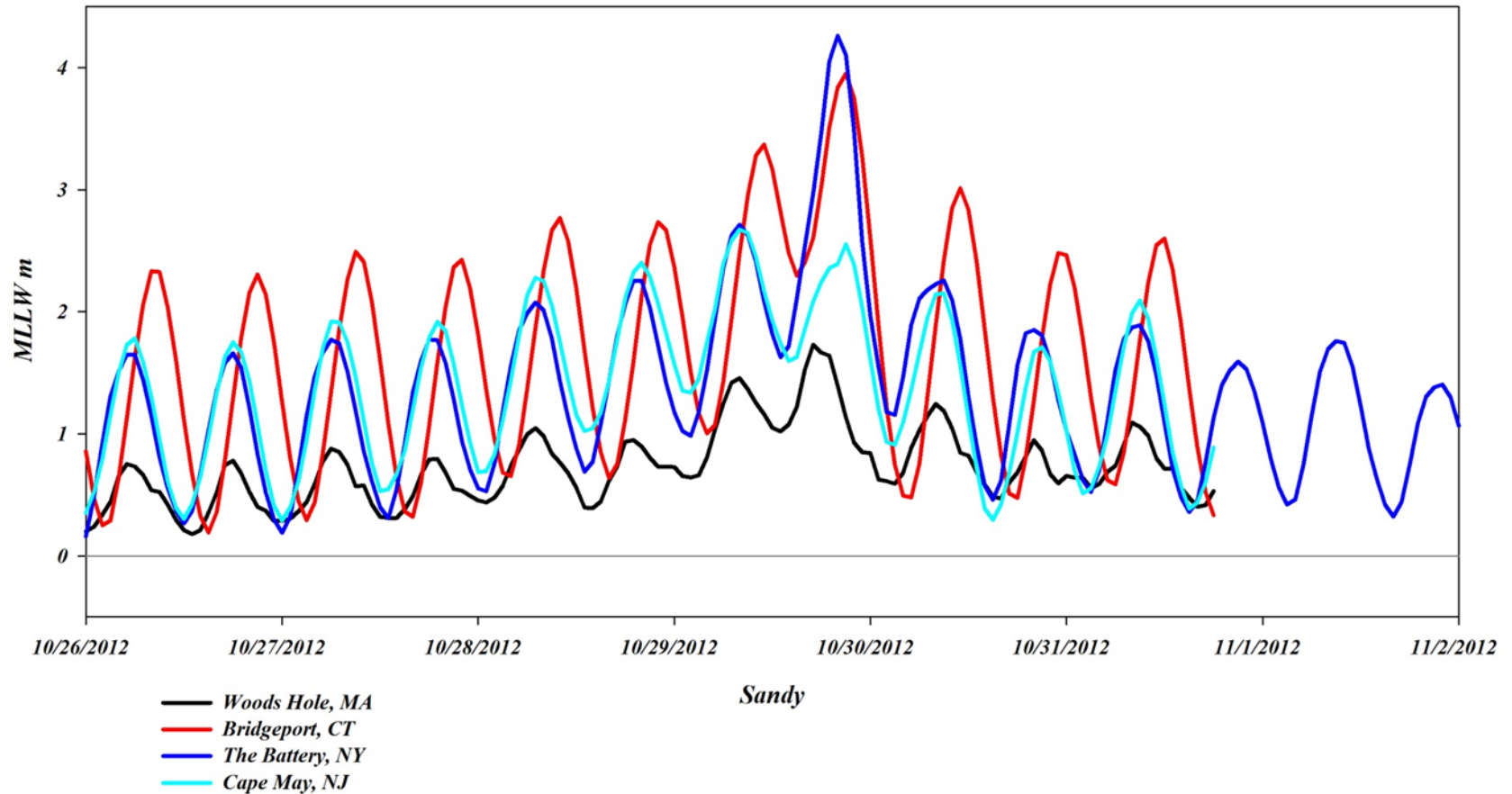
Subsidence: 1.7mm/yr

3.5mm/yr

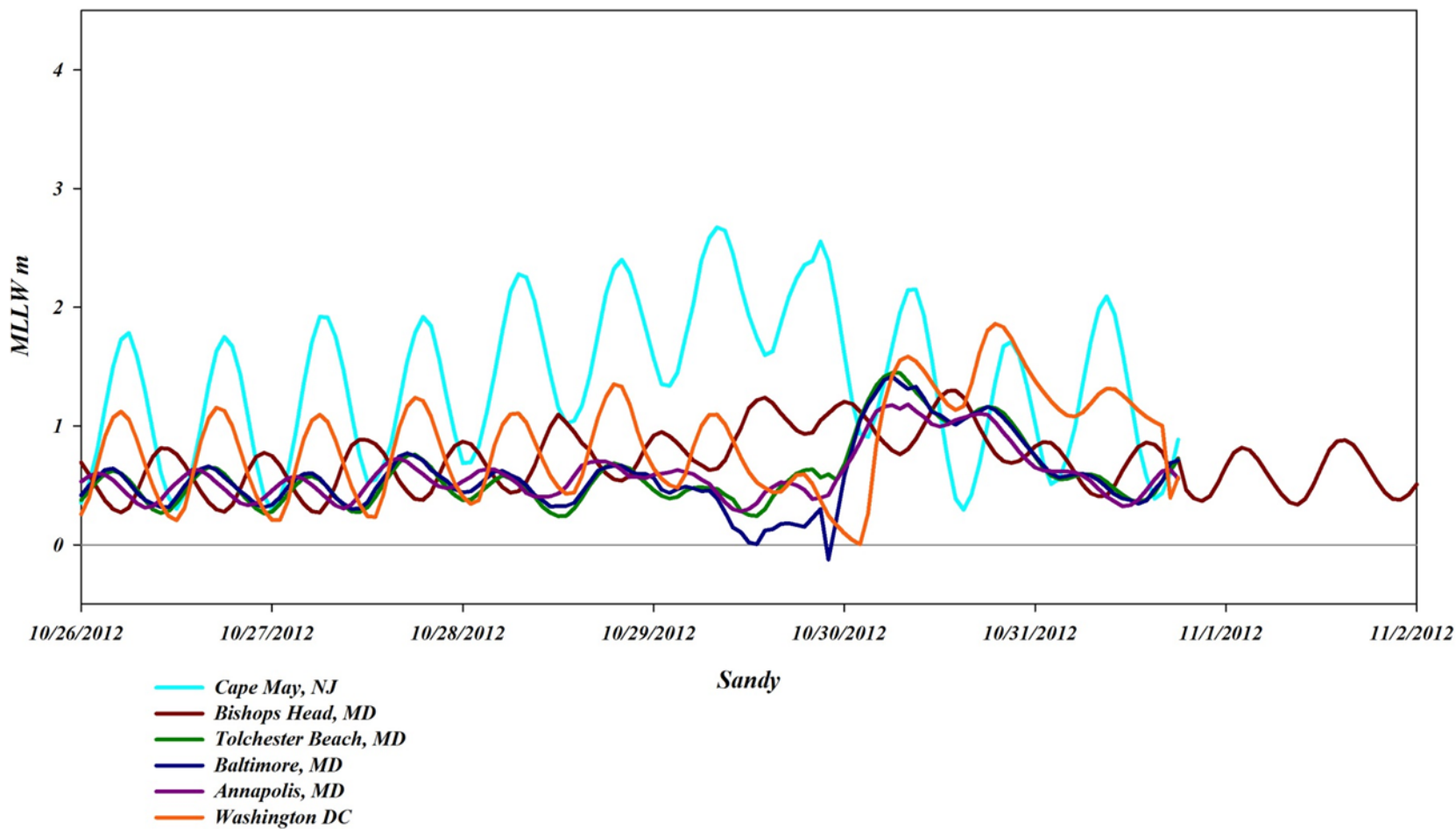
RISE FOR BAY SINCE 1961

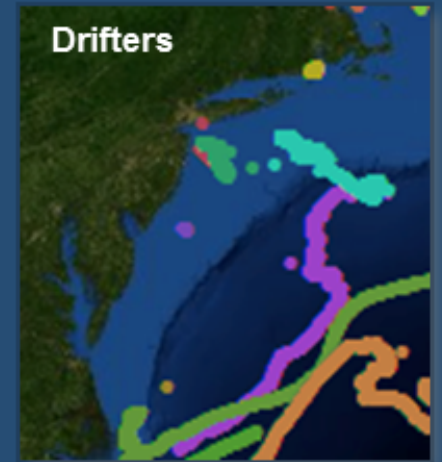
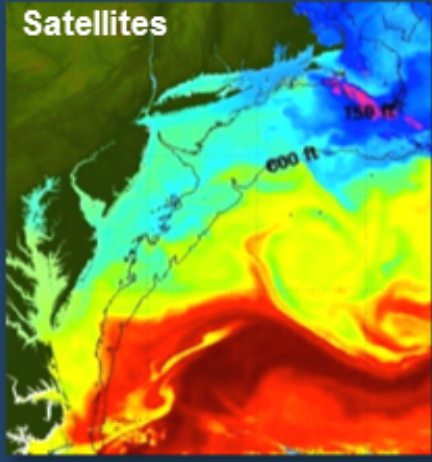
...and accelerating

Large Scale—Mid Atlantic Bight

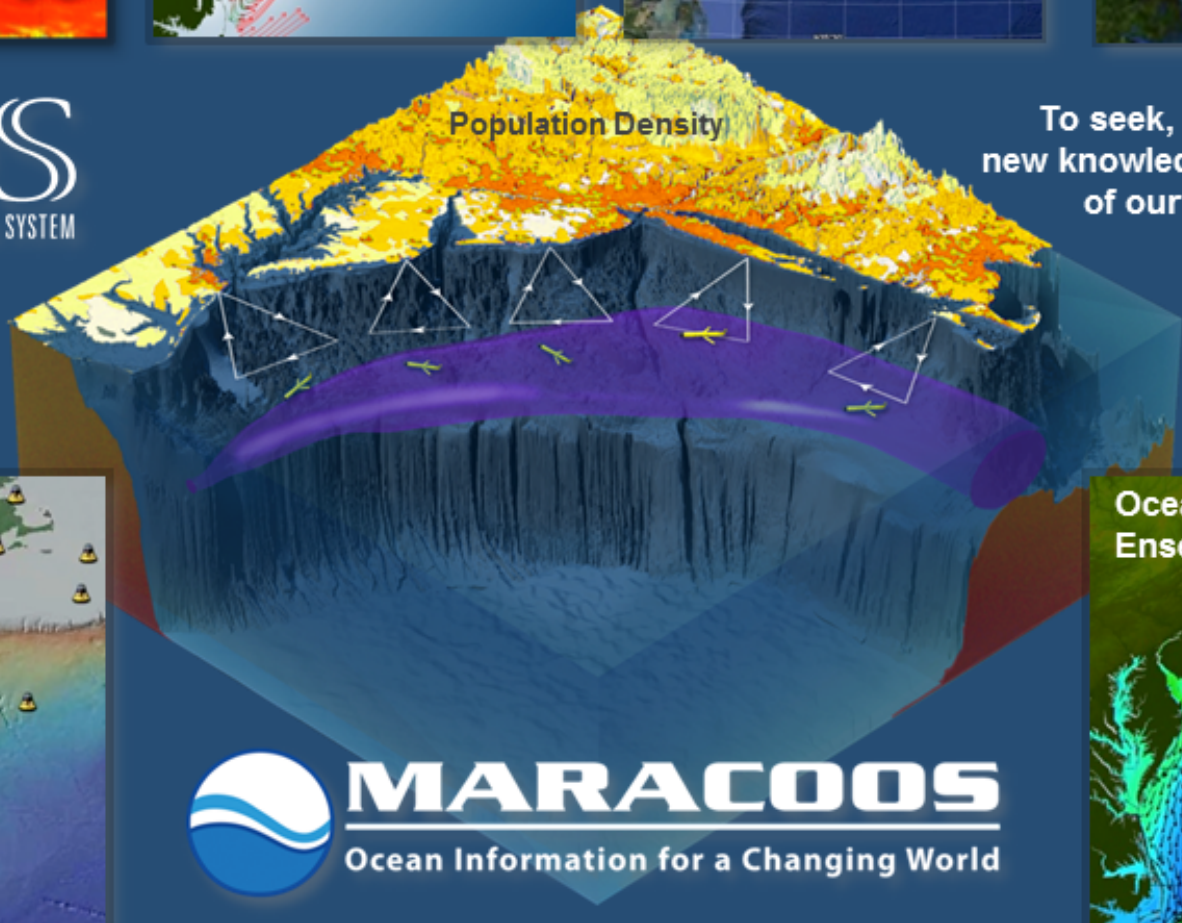


SANDY: CHESAPEAKE BAY

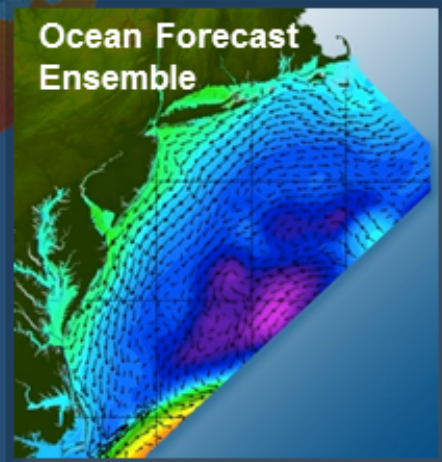
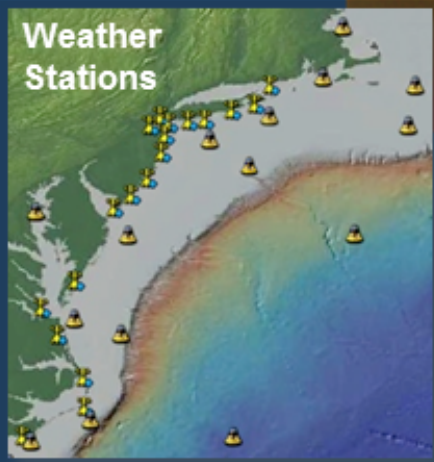




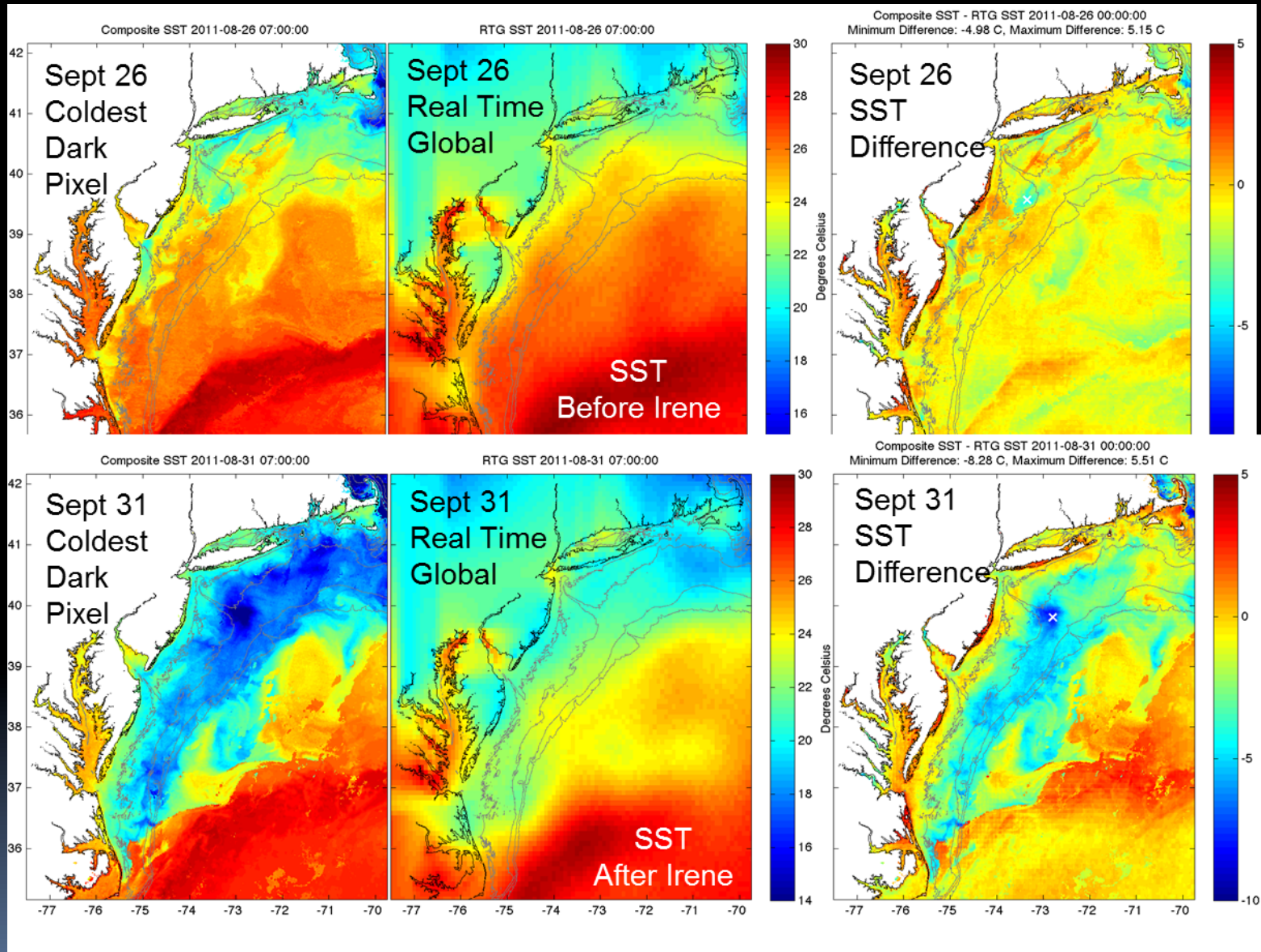
IOOS
INTEGRATED OCEAN OBSERVING SYSTEM



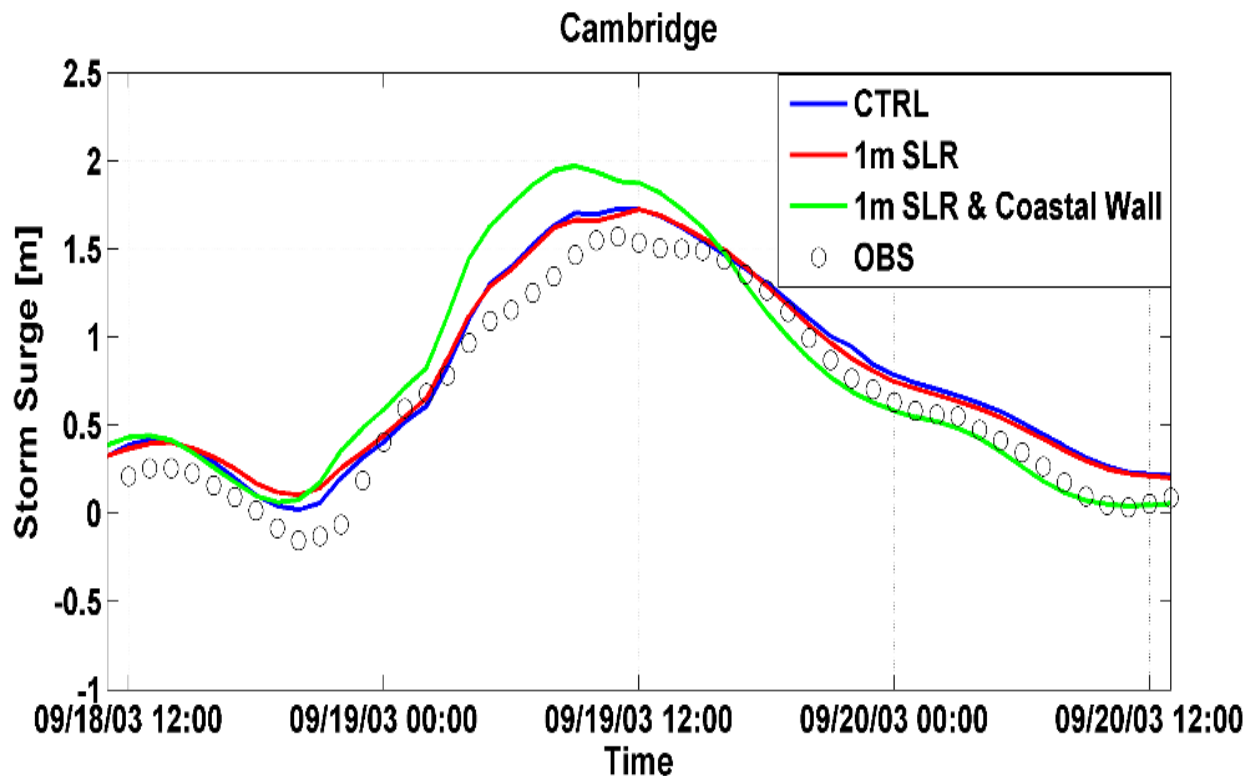
To seek, discover & apply
new knowledge & understanding
of our coastal ocean



MARACOOS
Ocean Information for a Changing World



Impacts of Sea Level Rise and Coastline Management on Storm Surge



Isabel in 2100

Surge levels will be the same at the higher mean sea level if low-lying lands are allowed to be flooded.

Surge levels will be 20-30% higher if sea walls are built along the coastlines.

A potential mitigation strategy: Flood parts of rural Eastern Shore of Maryland to protect

Last House Standing



Approximate area lost
2006-2014



Photo taken 9/26/2006
© 2006 Gordon Campbell

Gordon Campbell 914-772-6242

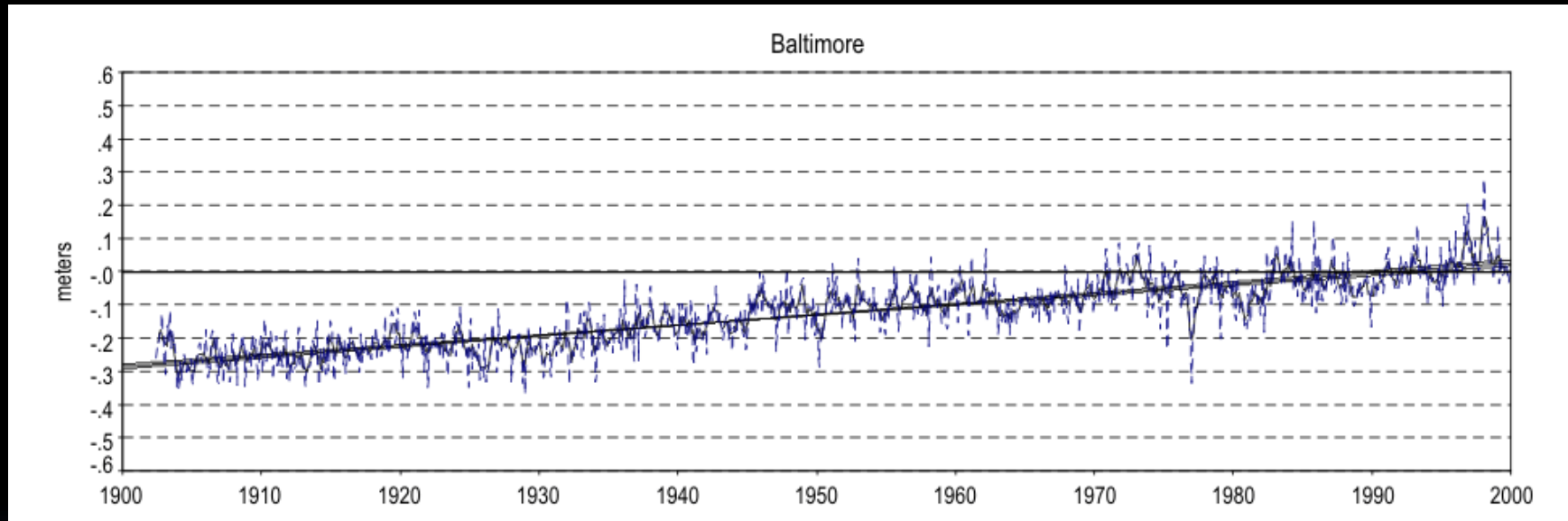


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SEA-LEVEL RISE CHESAPEAKE BAY



Now, Twice the Global Rate

Sea-Level Rise

A satellite-style map of the Chesapeake Bay region, showing the bay and surrounding land. The water is a light greenish-blue, and the land is brown and green. The map is overlaid with a white outline that represents the projected sea-level rise. The outline follows the coastlines and extends inland into the bay, indicating the areas that would be submerged. The text 'Sea-Level Rise' is written in white at the top left. On the right side, there is a list of factors: 'Ice', 'Water', 'Ocean Circulation', 'Storms', and 'Ice'. At the bottom right, there is text identifying the speaker: 'W.C. Boicourt', 'University of Maryland', 'Center for', and 'Environmental Science'. At the bottom left, there is a date: '10/20/15'. At the bottom center, there is text: 'University of Delaware Coastal Flood Research'. At the bottom right, there is a page number: '35'.

Ice
Water
Ocean Circulation
Storms
Ice

W.C. Boicourt
University of Maryland
Center for
Environmental Science

THWAITES GLACIER





Updating Maryland's Sea-level Rise Projections



*Scientific and Technical Working Group
Maryland Climate Change Commission*

June 26, 2013

2050:

Low 0.9ft
High 2.1ft
Best 1.4ft

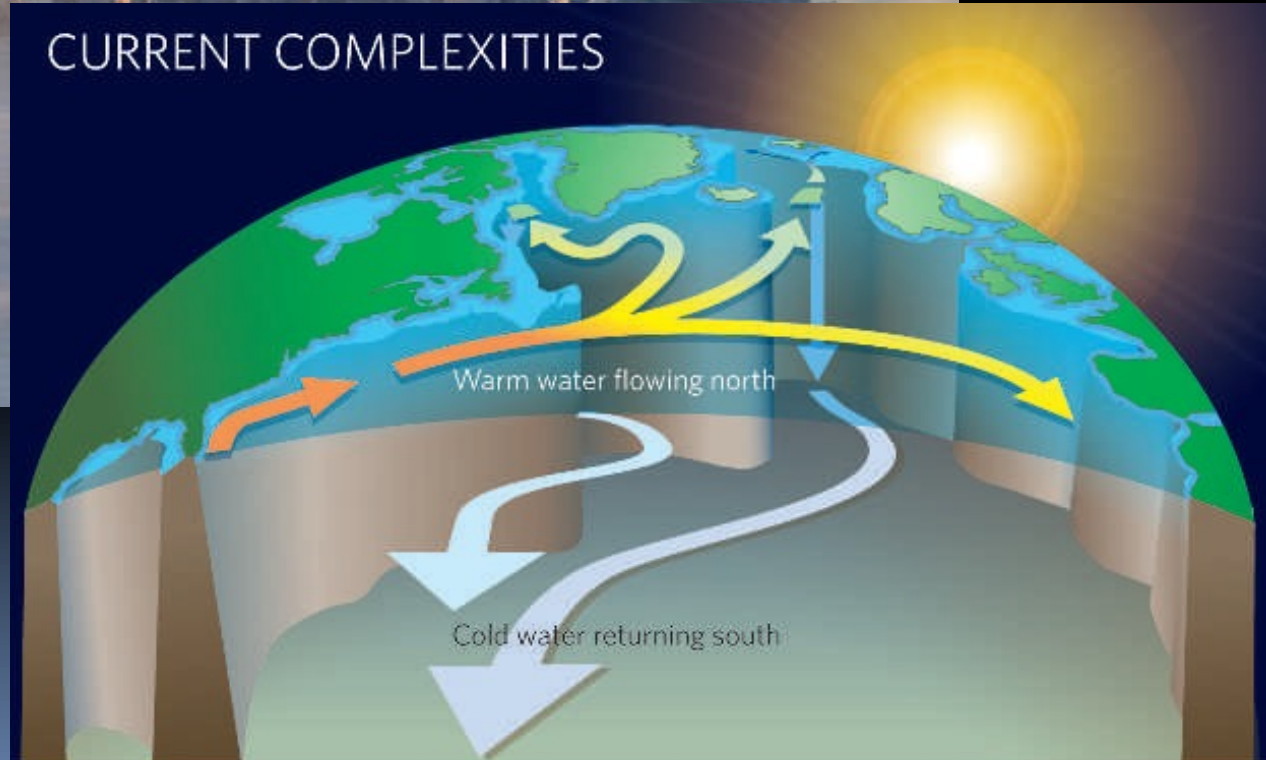
2100:

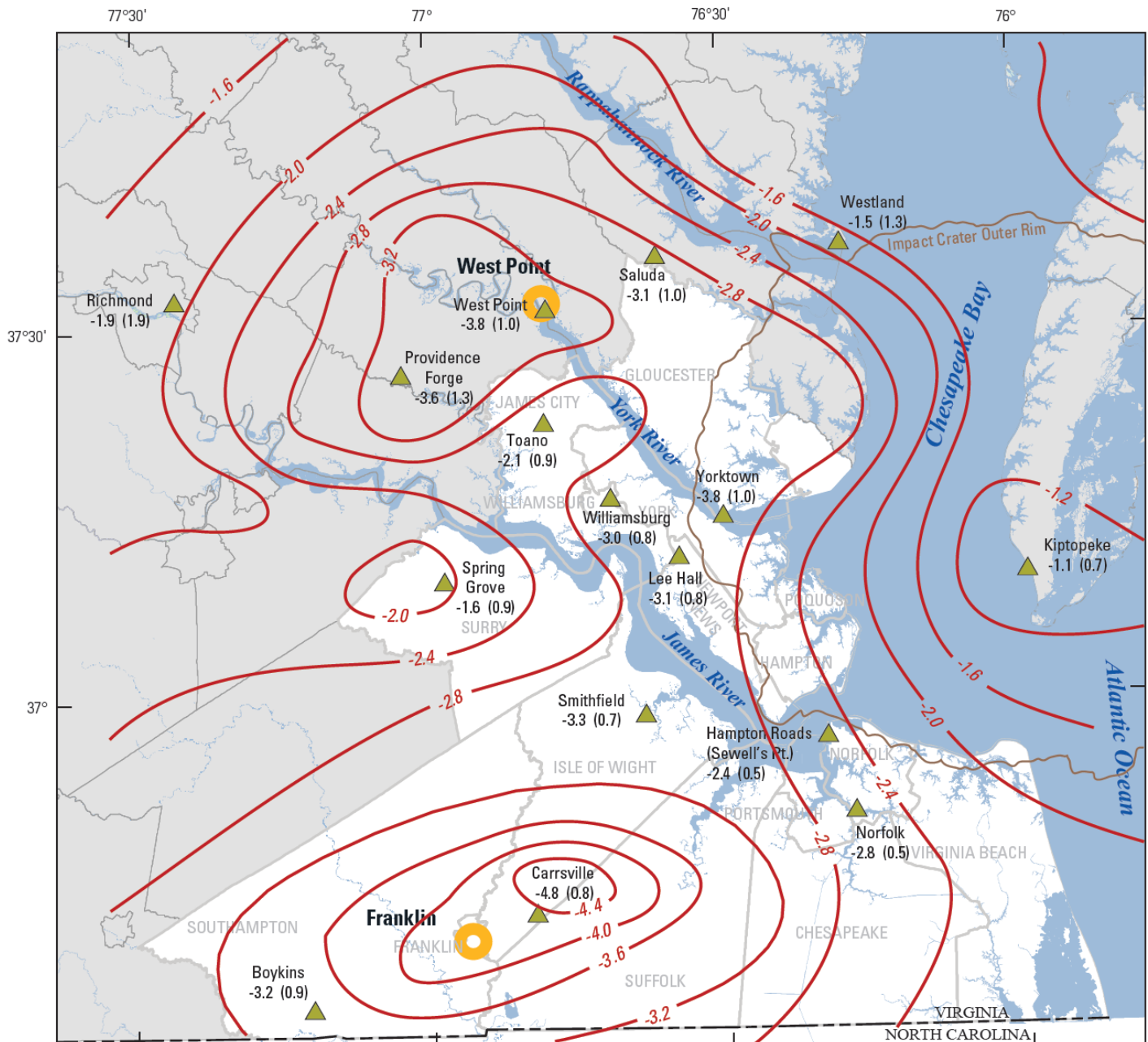
Low 2.1ft
High 5.7ft
Best 3.7ft.

The Day After Tomorrow



CURRENT COMPLEXITIES





Map made from U.S. Geological Survey and Virginia Department of Game and Inland Fisheries data

Virginia State plane projection

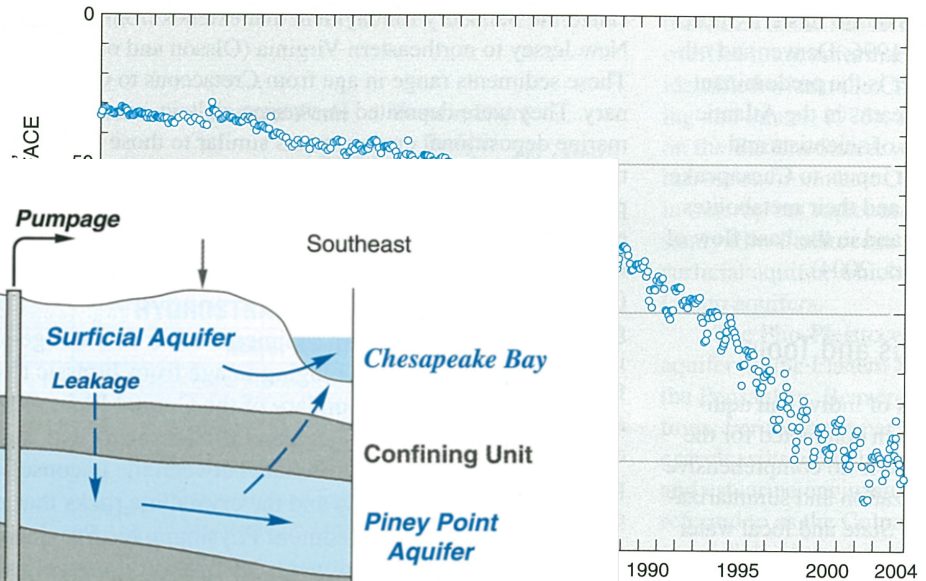
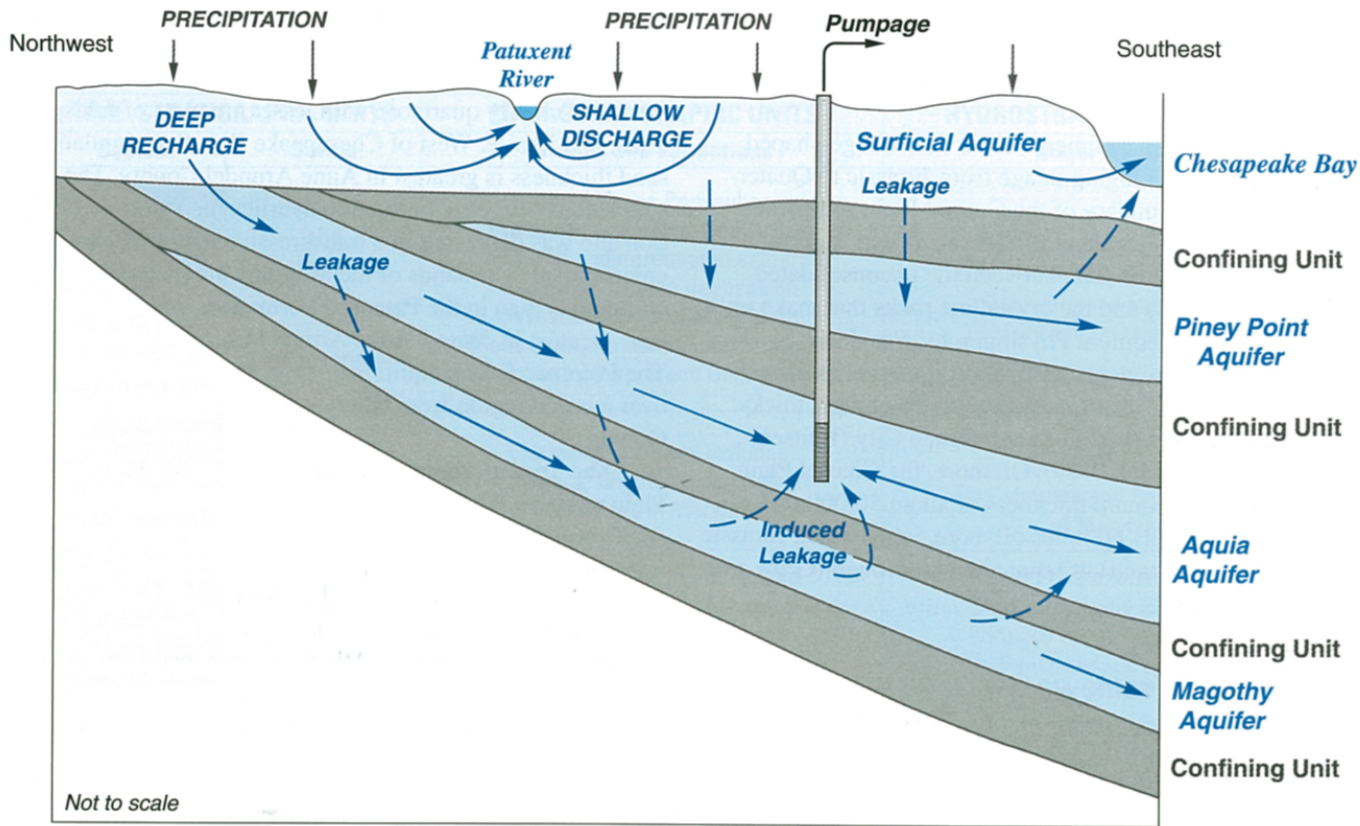
Virginia south Federal Information Processing Standard (FIPS) 4502

North American Datum 1983 (NAD83)

0 5 10 15 20 MILES

0 10 20 KILOMETERS

Geodetic leveling from Holdahl and Morrison (1974)



the Aquia aquifer near

Figure 3. Schematic diagram of part of the Atlantic Coastal Plain aquifer system showing generalized ground-water-flow directions (length of arrows not proportional to flow rates).

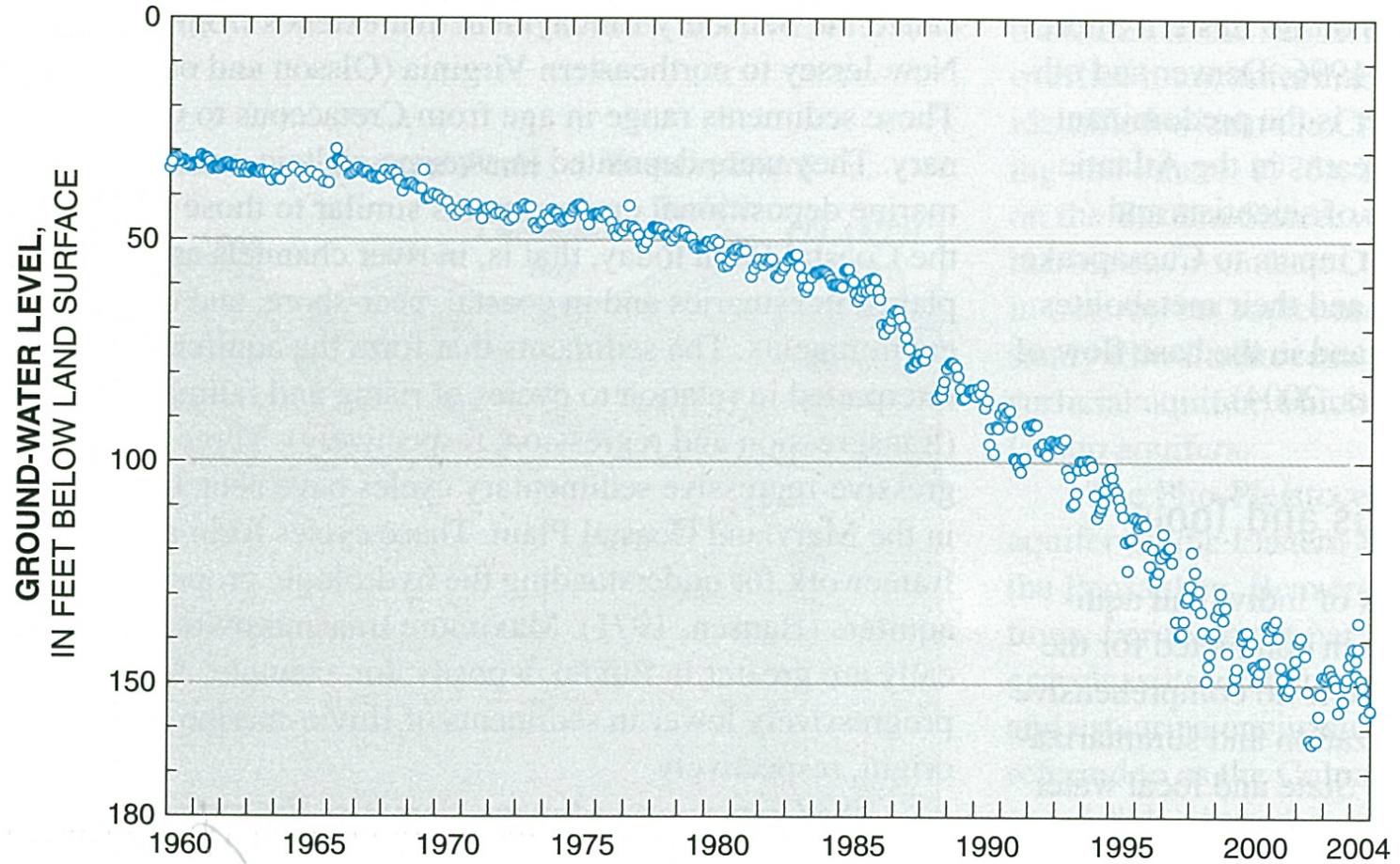
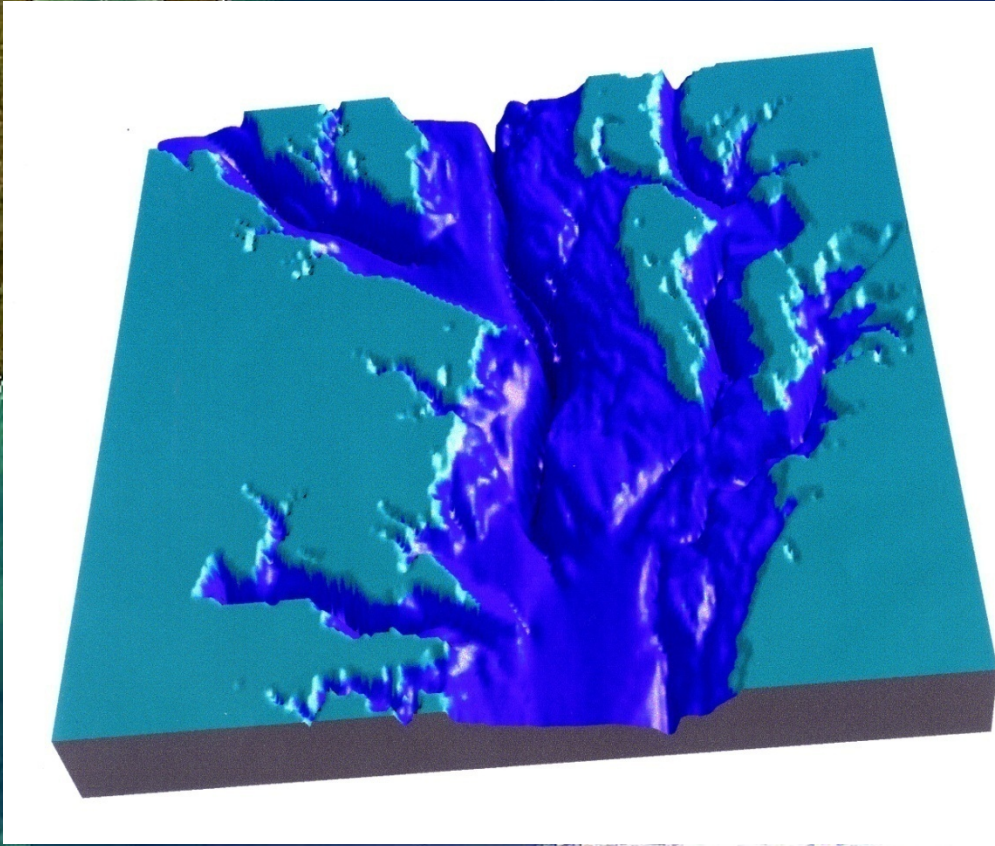
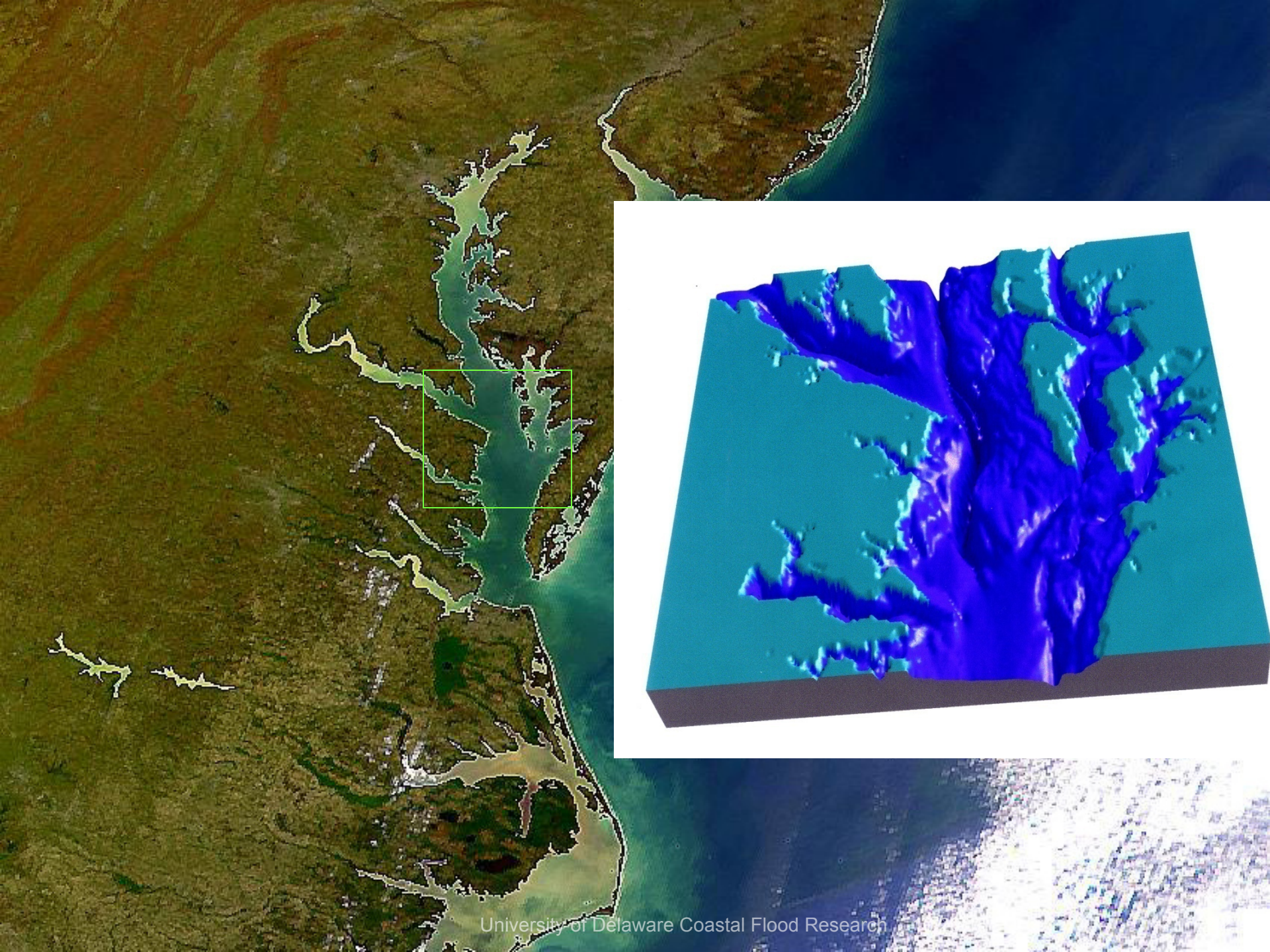
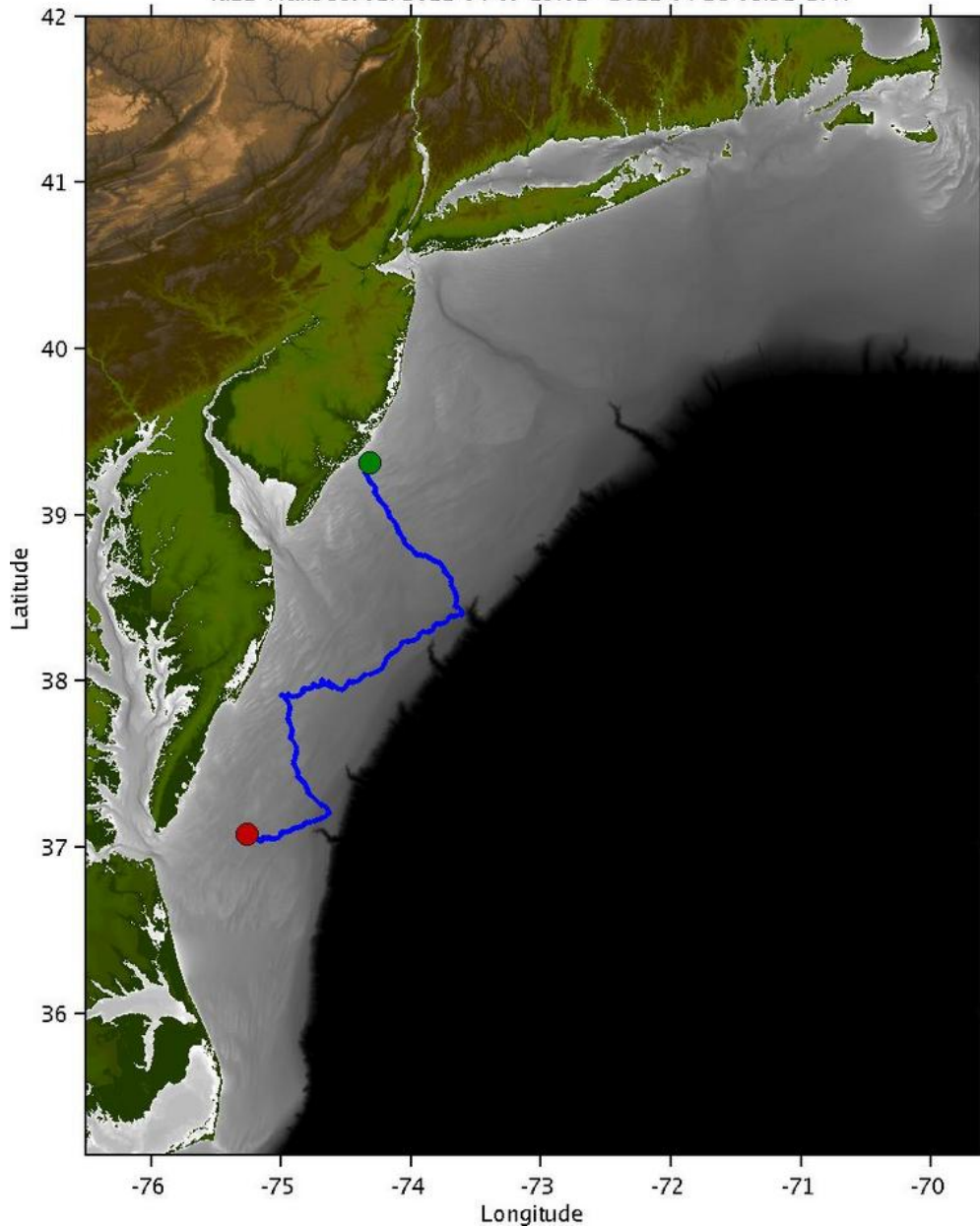


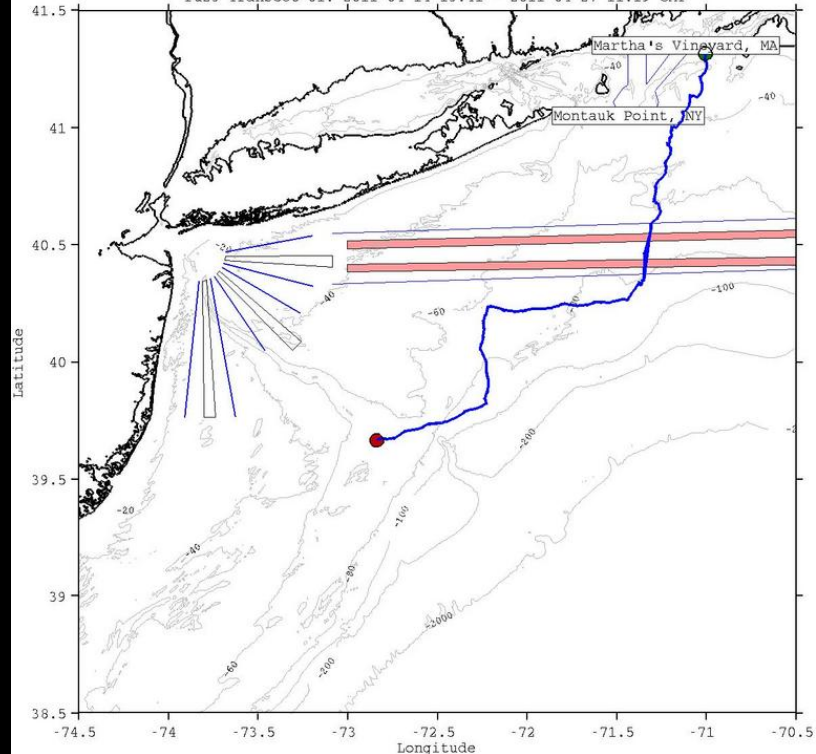
Figure 2. Hydrograph showing water-level decline in a well in the Aquia aquifer near Solomons, Calvert County, Maryland, 1960–2004.



ru22 Transect 01: 2011-04-07 19:01 - 2011-04-28 08:31 GMT



ru23 Transect 01: 2011-04-14 13:41 - 2011-04-27 11:19 GMT



Operational Glider Surveys



Groundwater extraction vs. Subsidence

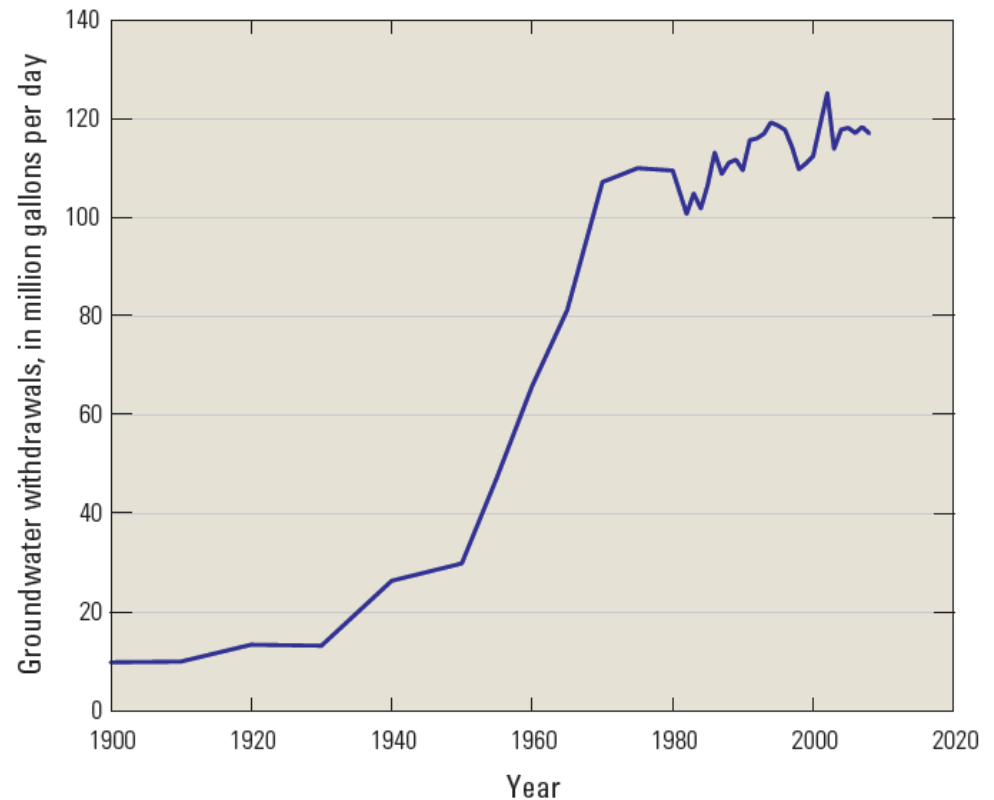
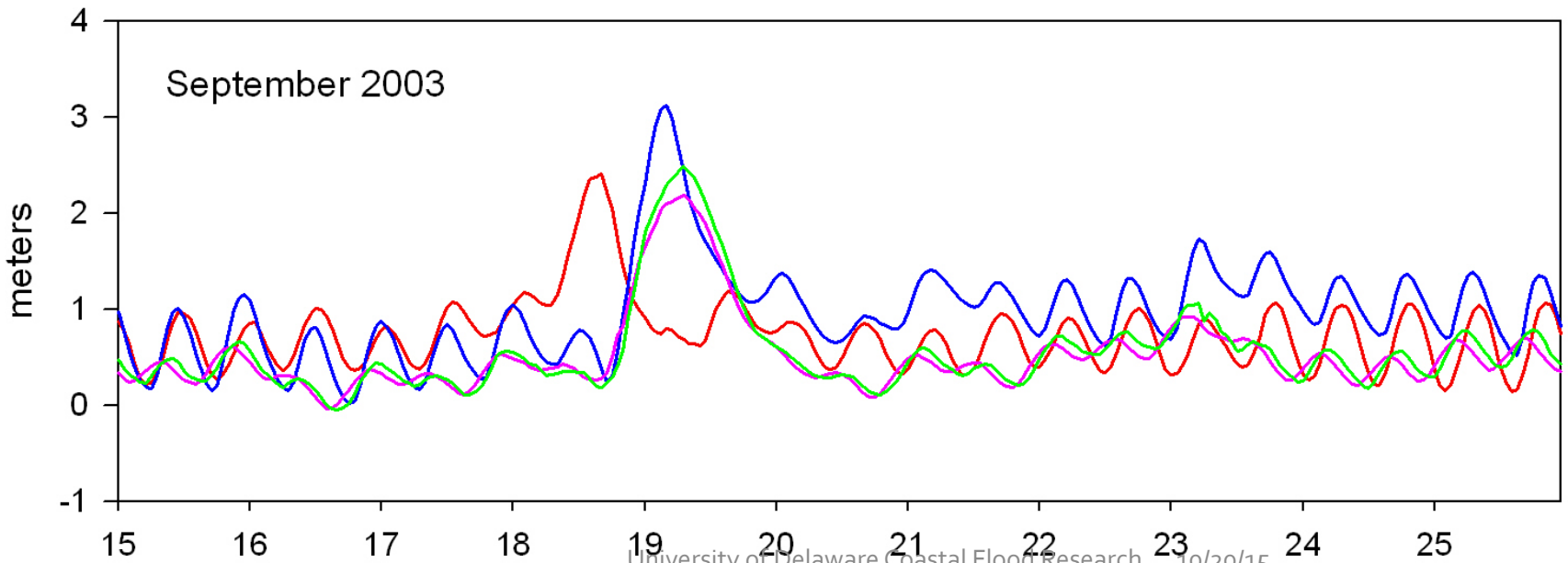
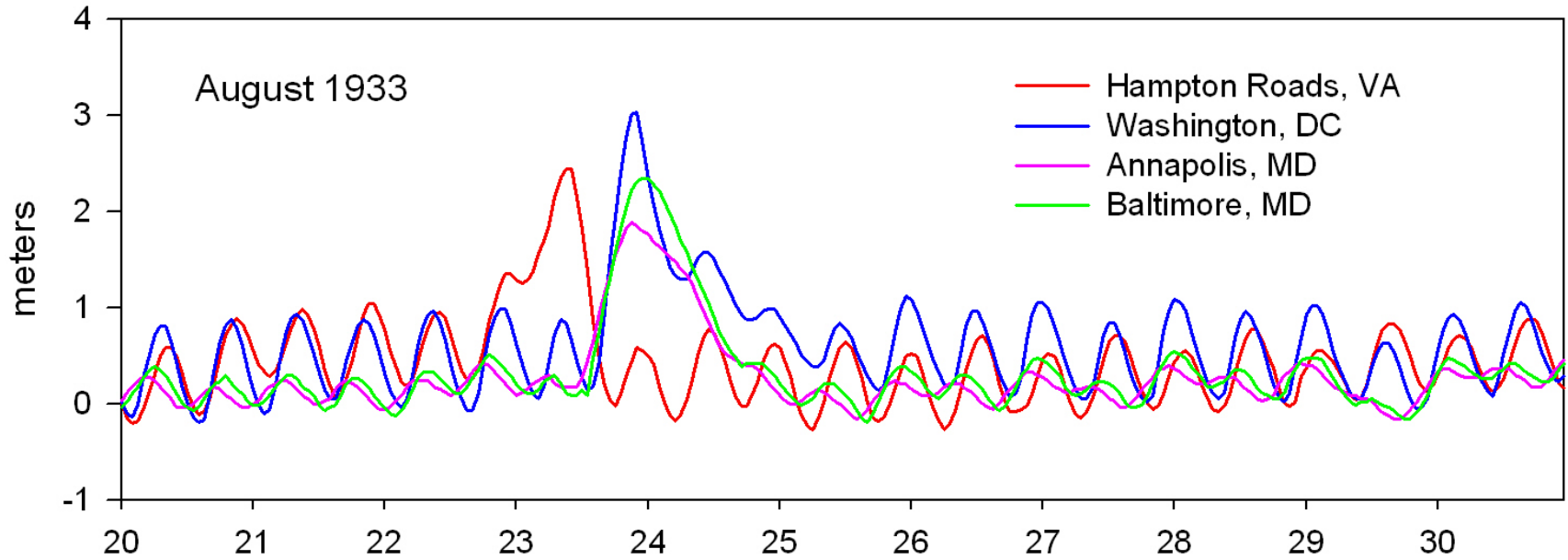


Figure 15. Groundwater withdrawal rates from Virginia Coastal Plain aquifers from 1900 to 2008. Modified from Heywood and Pope (2009).

Tidal Heights (relative to MLLW)



SANDY: CHESAPEAKE BAY

Wakefield, VA
08:57am, Wednesday
31 October 2012

Subject: Tidal Flooding Delmarva From Sandy
From: John Billet <john.billet@noaa.gov>
Date: 10/31/2012 8:57 AM
To: Ming Li <mingli@umces.edu>, William Boicourt <boicourt@hpl.umces.edu>

Hi MIng and Bill,

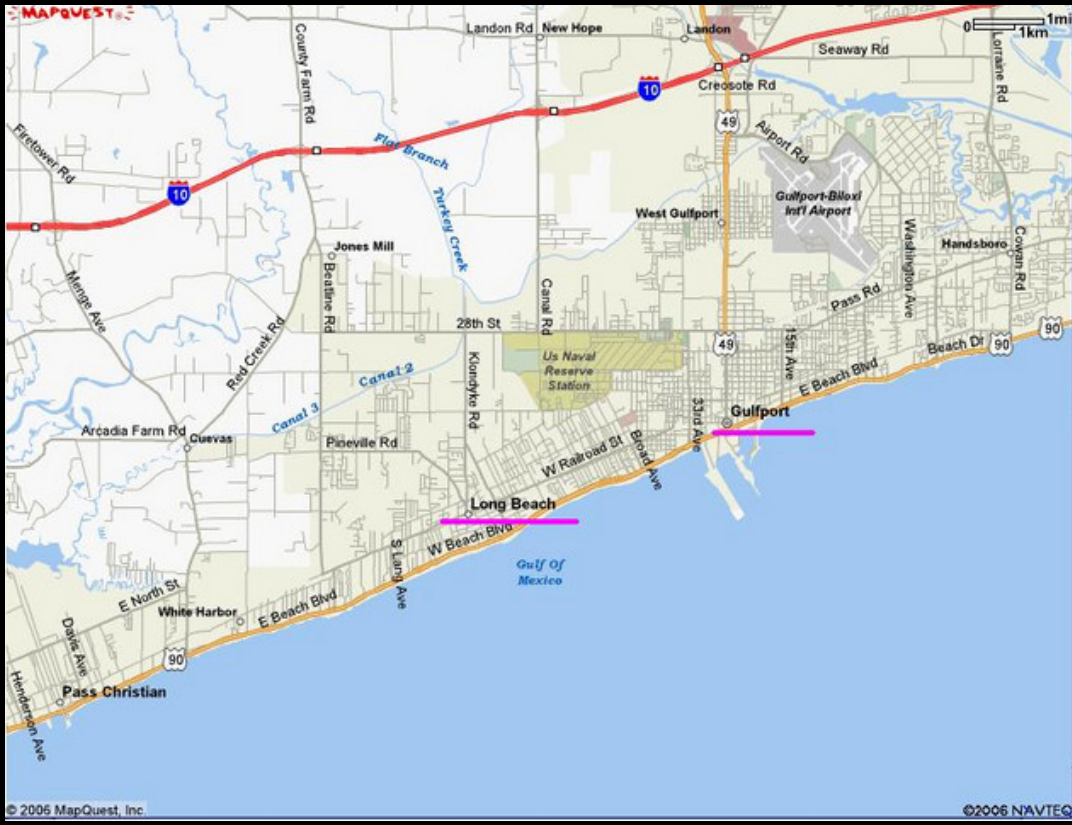
The flooding on the Maryland part of the Delmarva was very confusing from Sandy. We constantly seemed to be under forecasting and had significant trouble relating our gages at Cambridge and Bishop Head to what was actually happening. It seemed that when the wind switched to northwest Monday we got much higher flooding then anticipated on northwest facing areas. Using the two models we get for Cambridge neither model showed the magnitude of the flooding at other Dorchester county locations. The two models were the extra tropical storm surge from NWS and ESTOFS developed by NOAA coastal services. As the event continued models showed the tides coming down but they still remained high or went higher in many areas. These seemed to be topographic related. The coast line is quite complicated up there and I am sure this is causing some of the problems.

I would appreciate any thoughts you might have about this. I would be happy to share any information I have with you. We need to develop methods to improve our forecasts so we can serve our customers better.

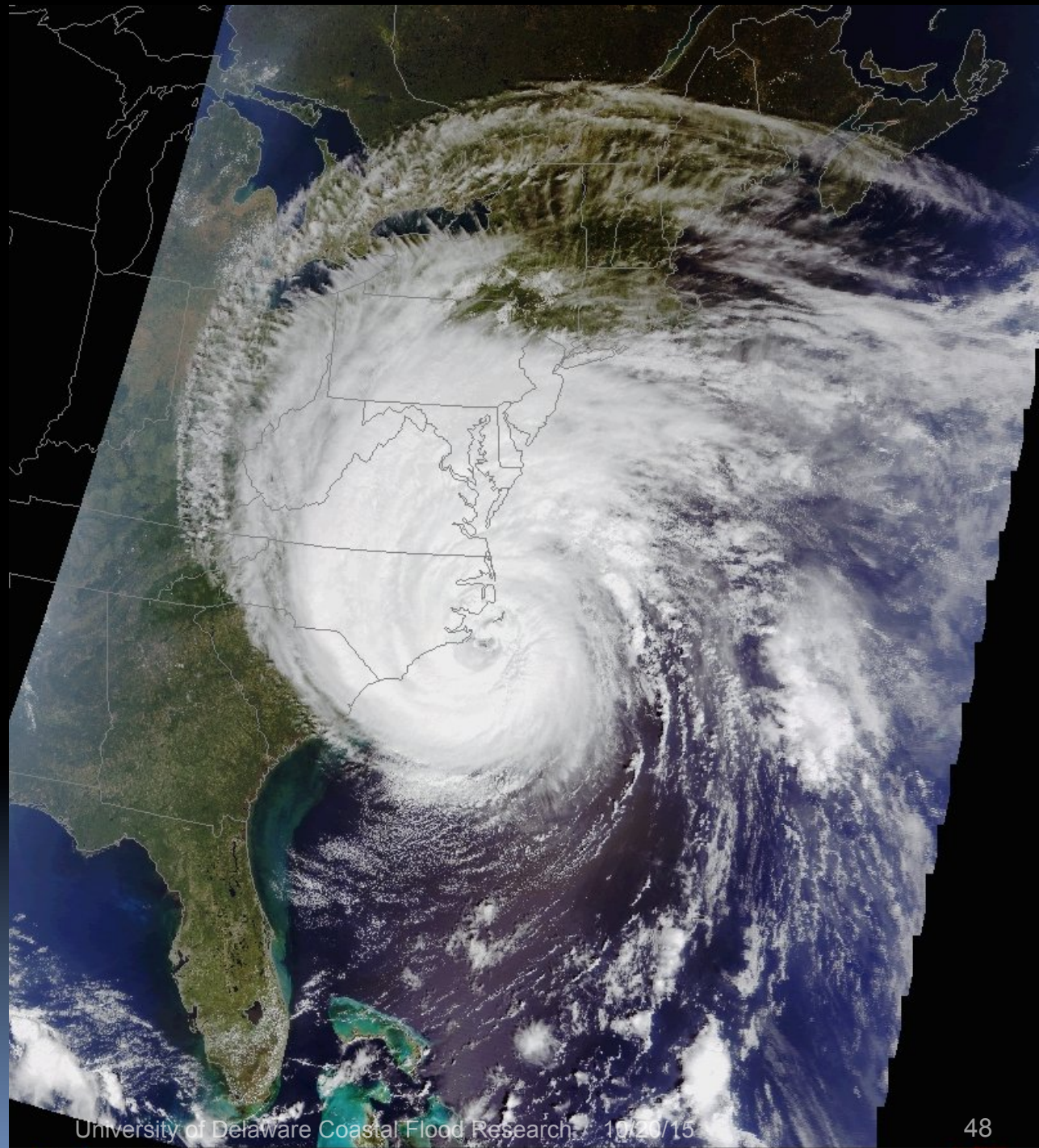
I hope the storm was not to be on you. I know we had reports of 65 mph winds and many places with 10 inches of rain. Thanks for your input.

John
--
John Billet
Science Operations Officer

NWS Wakefield VA
10009 General Mahone Hwy
Wakefield, VA 23888
phone 757-899-4200 ext 224



HURRICANE ISABEL 2003



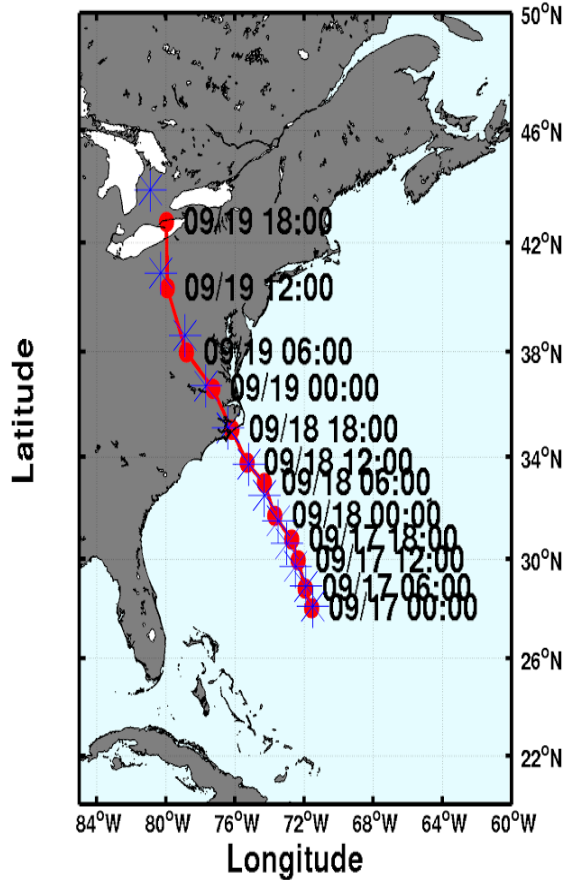
Coupled WRF-FVCOM Predictions for Hurricane Isabel (2003)

Red: WRF

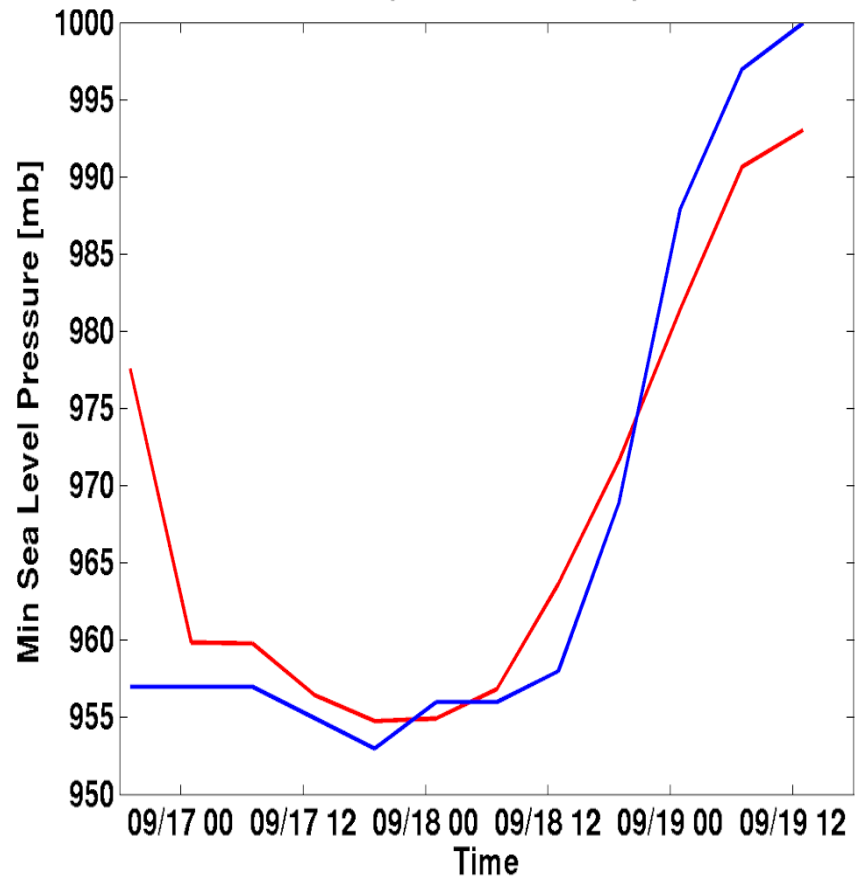
Blue: Best

Track

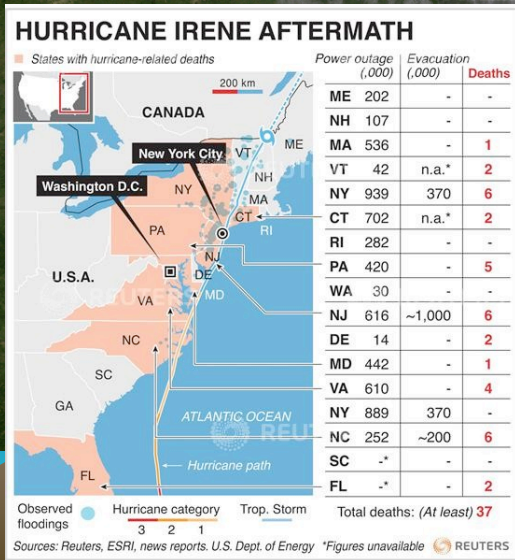
Comparison of Track for Isabel



Comparison of intensity



Hurricane Irene



- First tropical storm to threaten NYC since Hurricane Gloria in 1985
- Flooding records broken in 26 rivers
 - Caused at least 56 deaths
 - Damage nearly \$8 billion



CINAR-TEMPESTS