Planning for Sea Level Rise and Storm Surge Inundation: Climate Impacts in Hampton Roads

Regional Climate Change Meeting
Hampton Roads Planning District Commission

October 29, 2009

Barry Stamey

Director, Strategic Collaboration, Noblis

and Colleagues in the Chesapeake Bay Region

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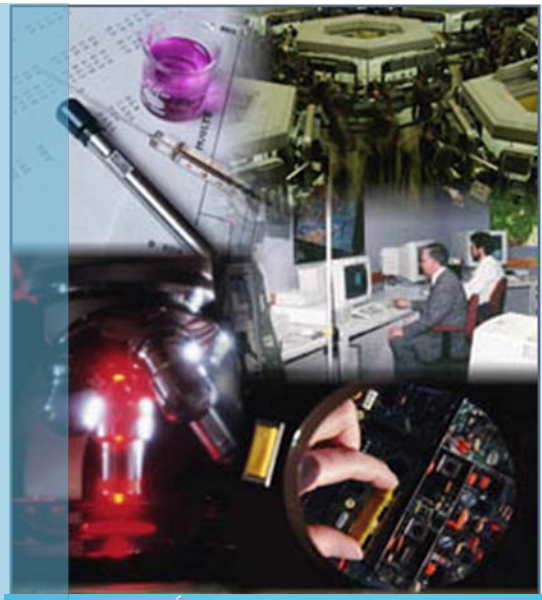
For the best of reasons

Noblis at a Glance

- Independent, non-profit, science, technology and strategy company
  - Work in the public interest
  - Headquarters in Falls Church, VA and offices nationwide; 750 employees
  - Over 40 years of successful support to the public sector – Mitretek Systems, Mitre Corporation
- Currently providing science and technology support to 32 federal agencies and 34 state governments
  - Impartial, conflict-free, independent counsel and support
- Transportation, Telecommunications, Healthcare, National and Homeland Security, Sustainable Energy, Oceans, Atmosphere & Space
- Climate Change



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The Role of Noblis

Project TEAL

- Greenhouse Gas Analytical Modeling
  - Noblis developed internal model to calculate and determine footprint
  - Significant interest from outside entities
  - Launched TEAL Spring 2009
- Significant work with the General Services Administration
  - GSA Integrated Technology Service requested assistance with baselining and greening their operations
  - Noblis expanded the green application to meet GSA's needs
- The future is green
  - Currently working with GSA to expand functionality of existing application
  - Fleet, building mechanical systems, emerging technologies
  - Ensure compliance with draft public sector protocol

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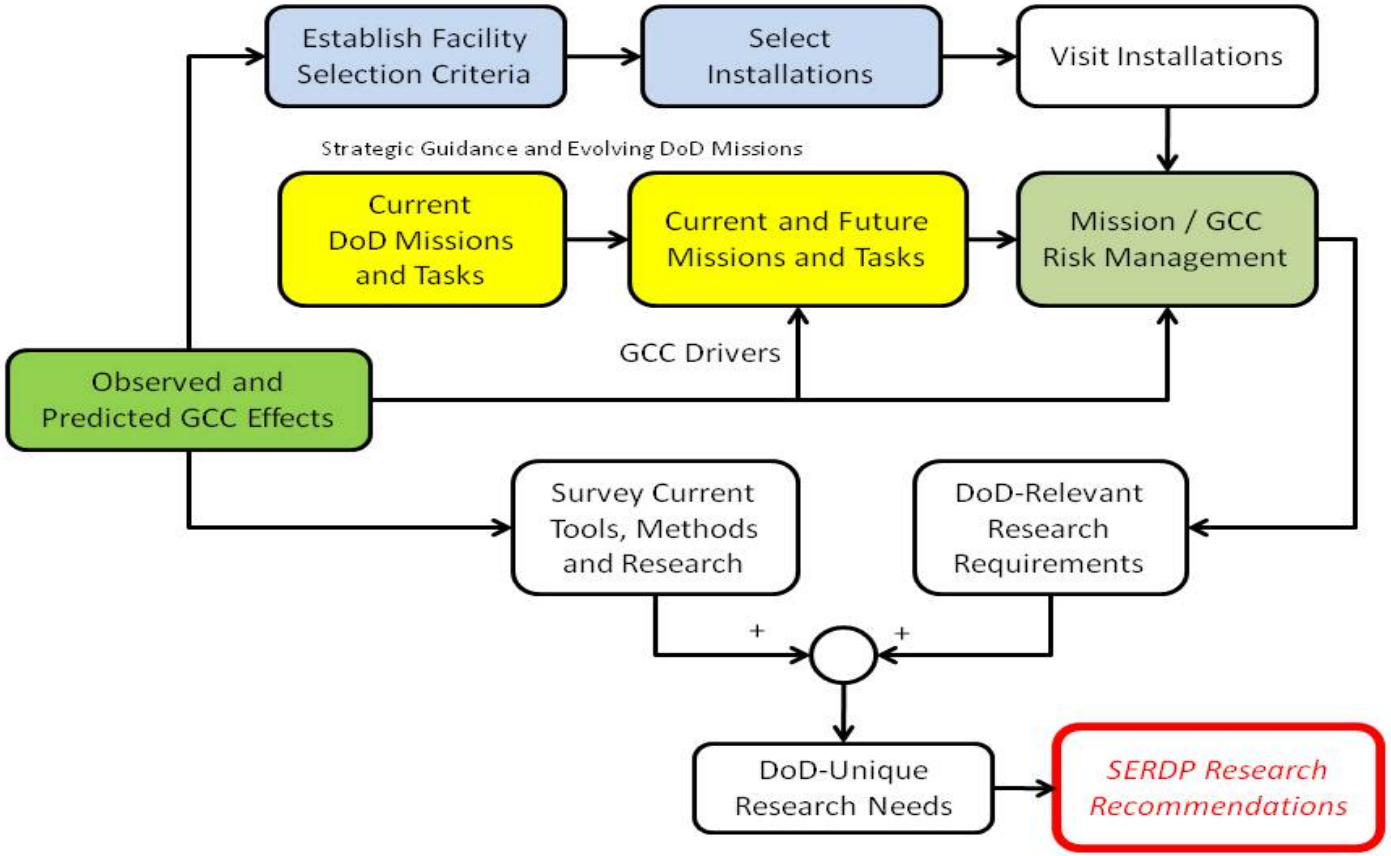
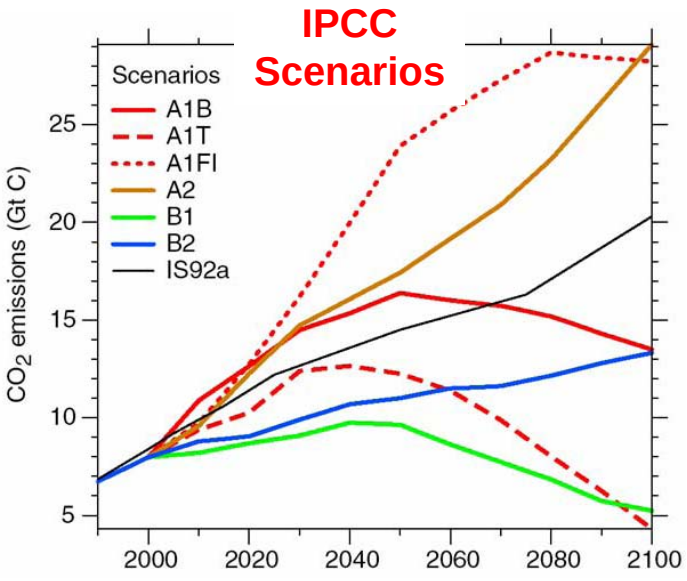
Assessment of the Impact of Sea Level Rise on Military Installations

Climate Change Planning for Military Installations

Climate Change Planning for Military Installations
Task Elements

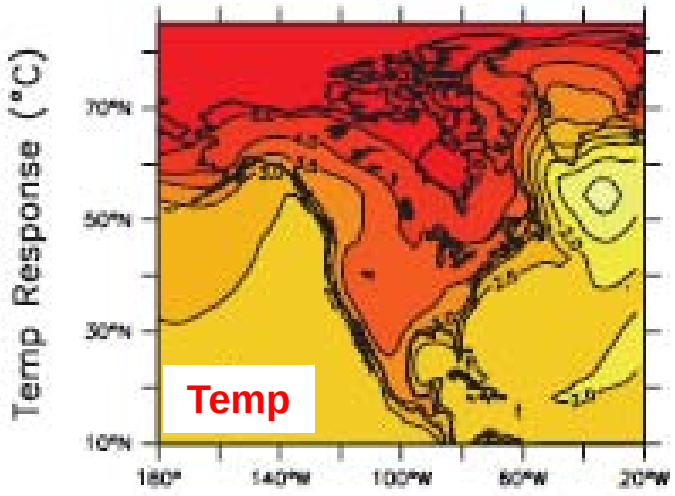


Coarse Resolution in Global-Scale Modeling

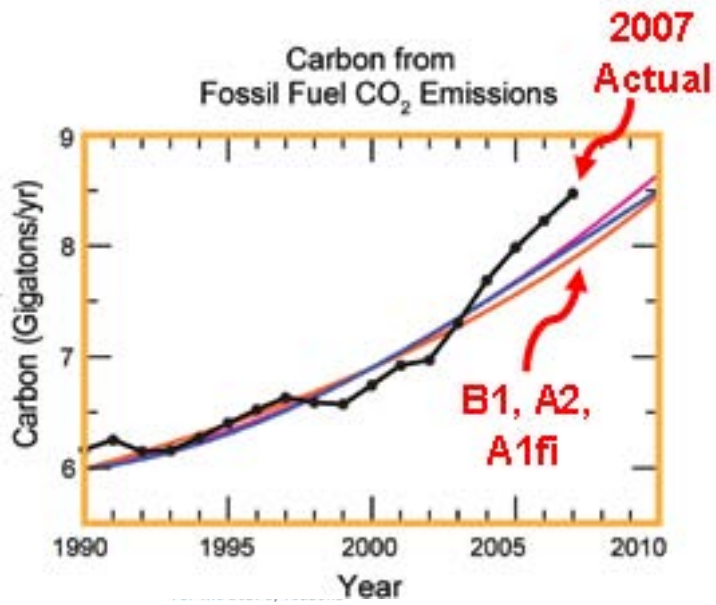


GCMs

(general circulation models)

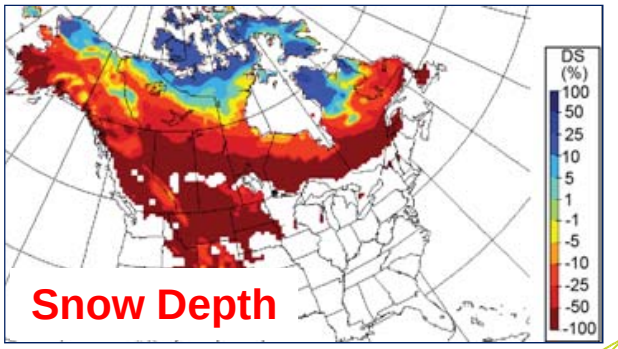


Hydrologic Modeling



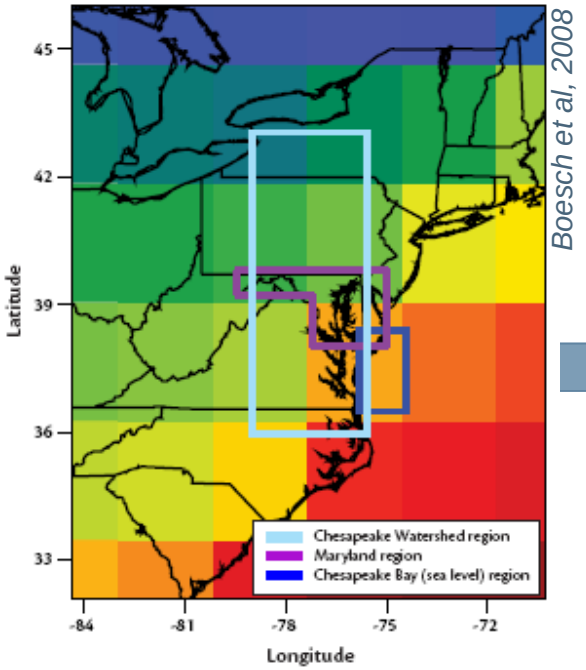
Timeframe for Results:

1961 – 1990
(2010 – 2030)
2035 - 2060
2070 - 2100



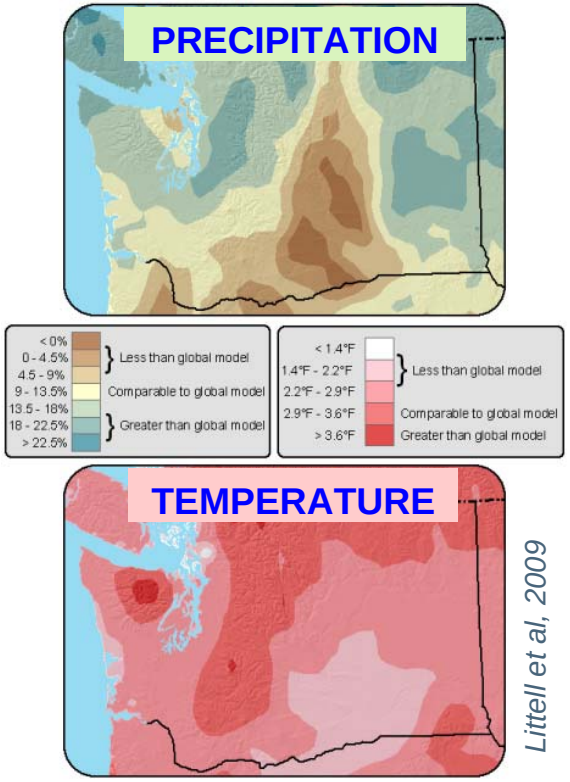
Graphics from IPCC, 2007 & USGCRP 2009

Higher Resolution Through Downscaling

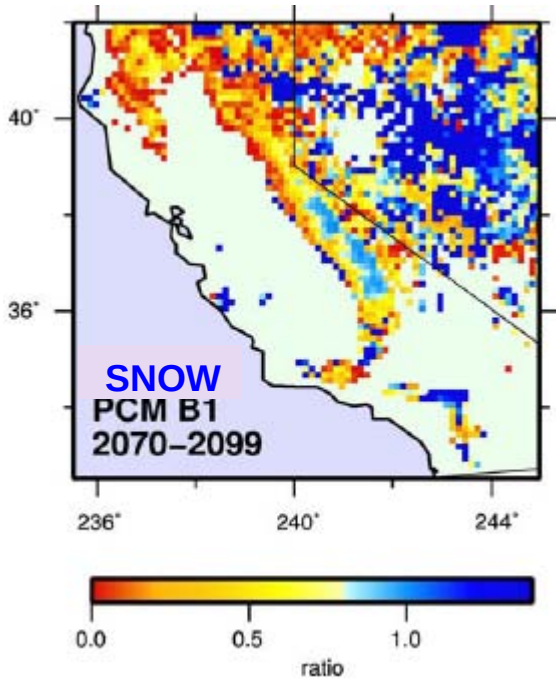


Boesch et al, 2008

GCM grids (pixels): ~150 miles



Littell et al, 2009



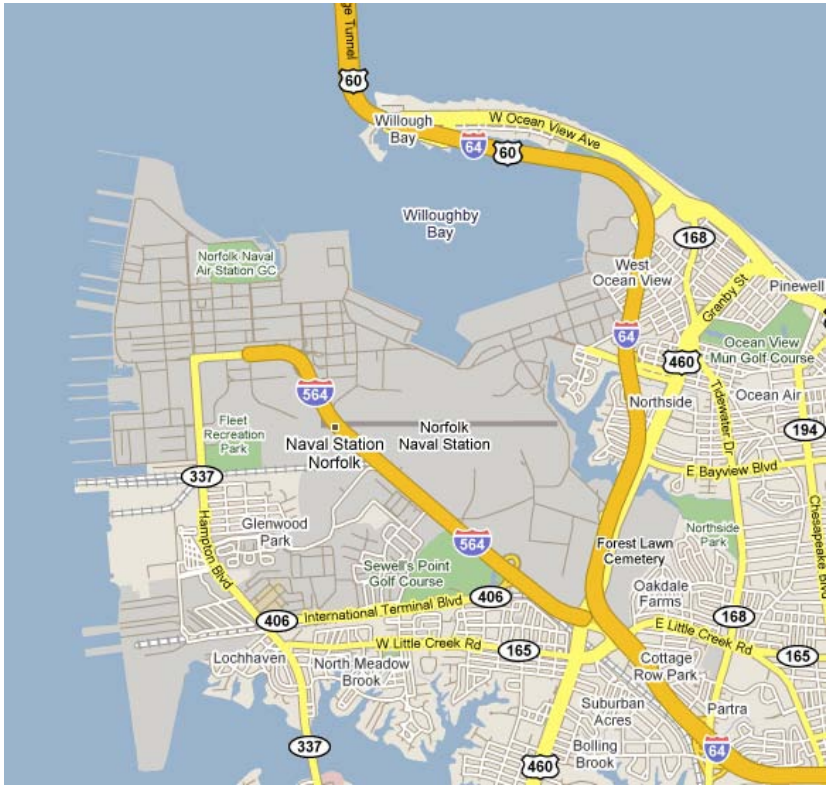
Cayan et al, 2008

Downscaling pixels: ~10 miles

Key Attributes for Military Installations

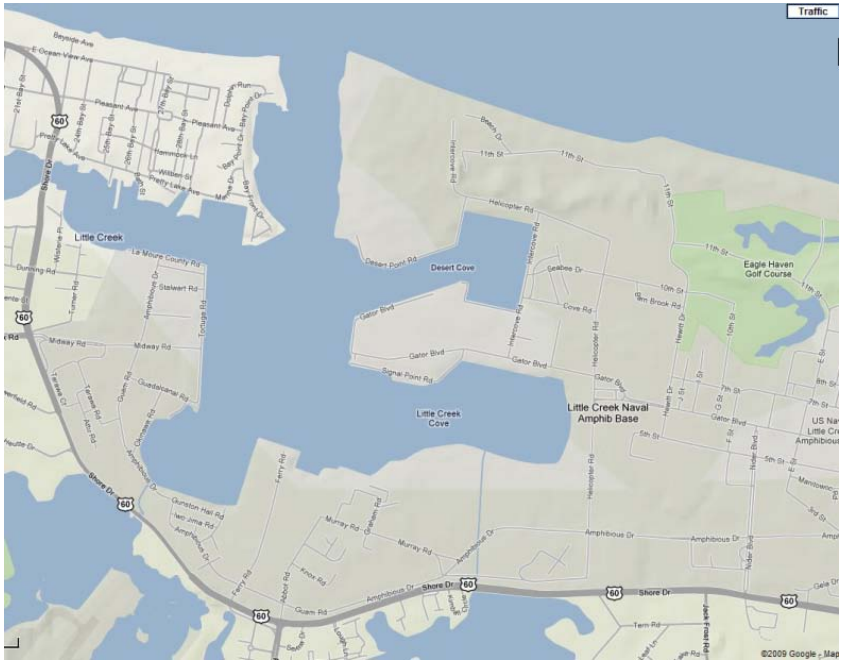
- **Good climate change data**
  - Downscaled data
  - Significant forecasted changes
  - Diverse geographic regions
- **Includes current and future missions**
  - Full range of land, sea, air missions
  - Disaster relief/humanitarian assistance
  - Power projection operations
- **Combines major military activities**
  - Most ground forces elements
  - Many air forces elements
  - Most sea force elements
- **Have extensive and diverse training areas**
  - Land
  - Water
- **Have major infrastructure and facilities**
  - Diverse types
  - High tempo air, land, and port operations
  - Training and range areas, ports, airstrips, training, command and control, buildings
- **Have important regional relationships and concerns**
  - Water
  - Endangered species
  - Off-post/base housing
  - Transportation
- **Vulnerable to potential climate change**
  - Infrastructure (power, transportation)
  - Sea level rise
  - Hurricanes, severe storms, storminess
  - Extreme heat and humidity

Naval Base Norfolk, VA



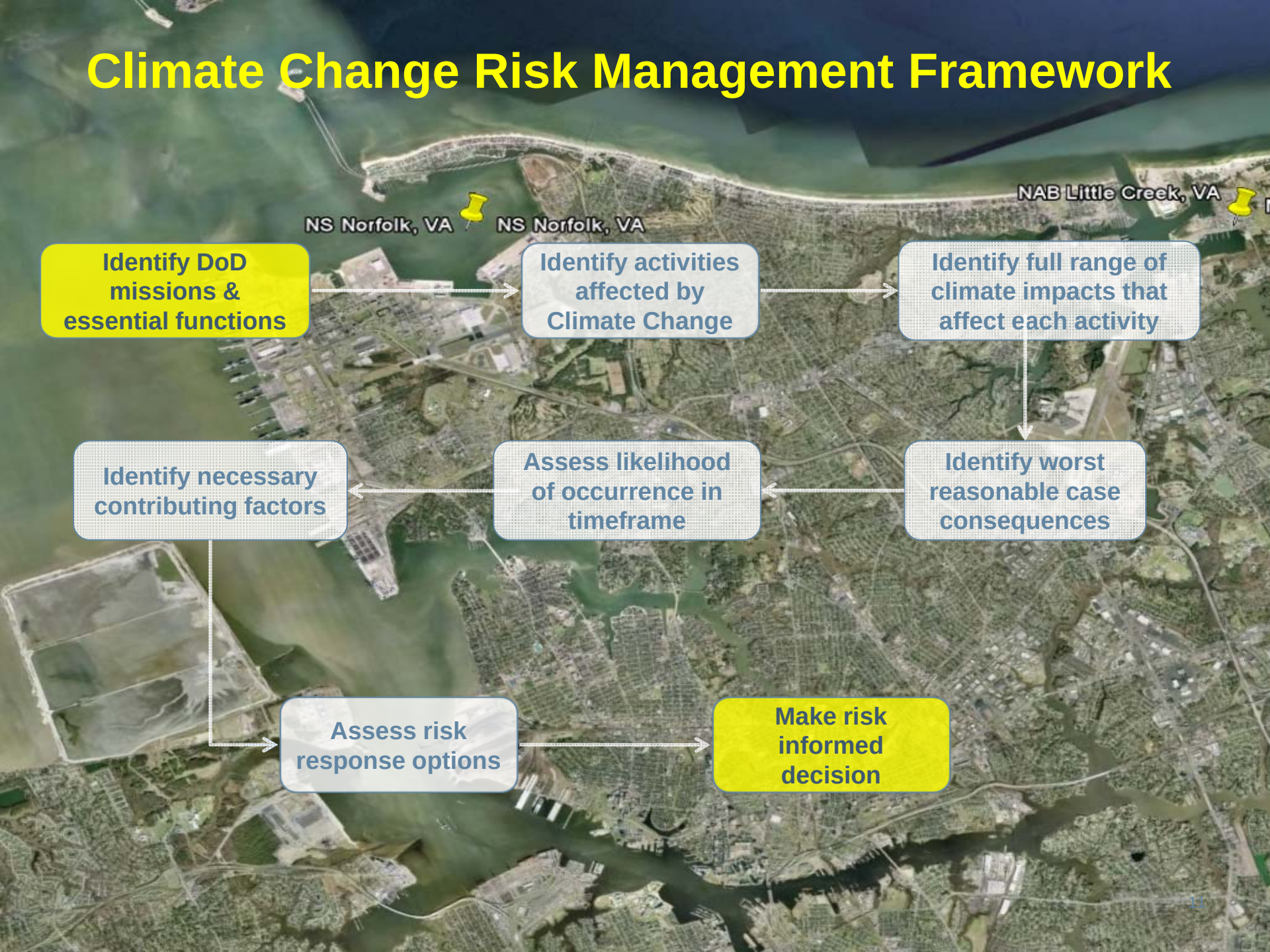
Summary – Largest US Navy base, vulnerable location, large and imbedded active duty and civilian workforce, regional dependencies

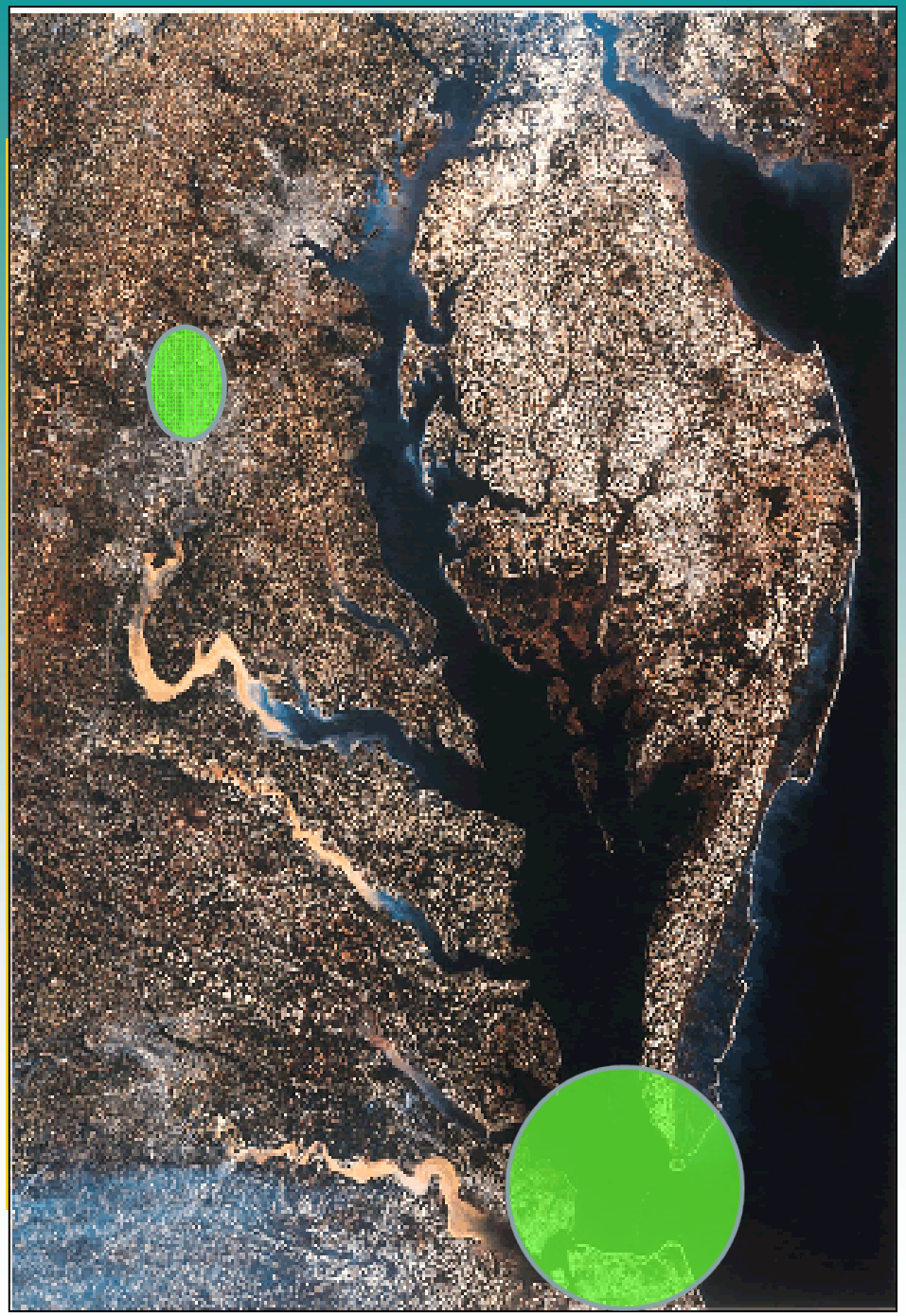
NAB Little Creek, VA



Summary – Critical, vulnerable, low elevation base with strong regional dependencies.

Climate Change Risk Management Framework





Chesapeake Inundation Prediction System (CIPS)

From Forecasting to Climate Planning

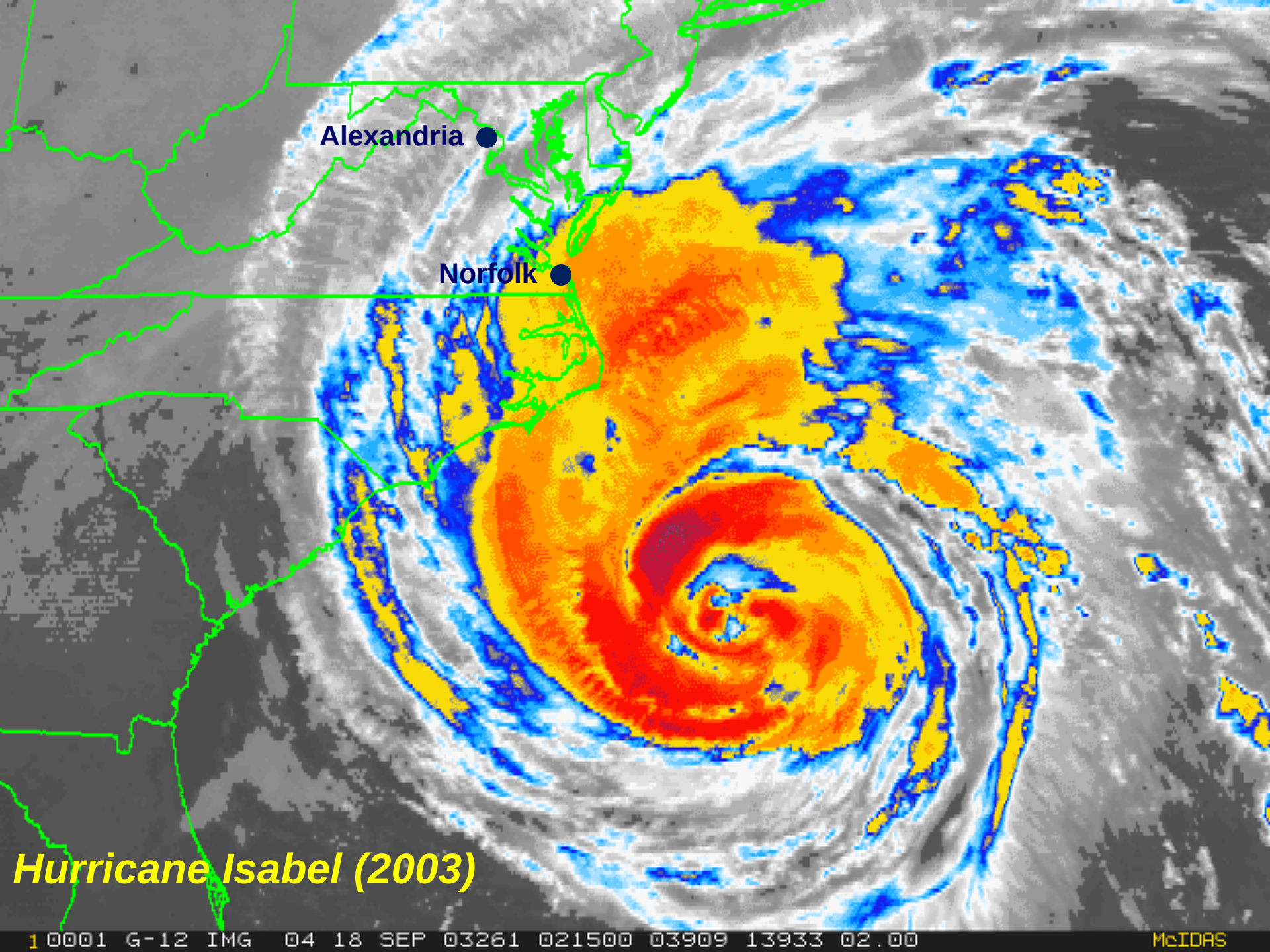
Colleagues

Chesapeake Bay Observing System (CBOS)

noblis

Chesapeake Bay CBOS Observing System

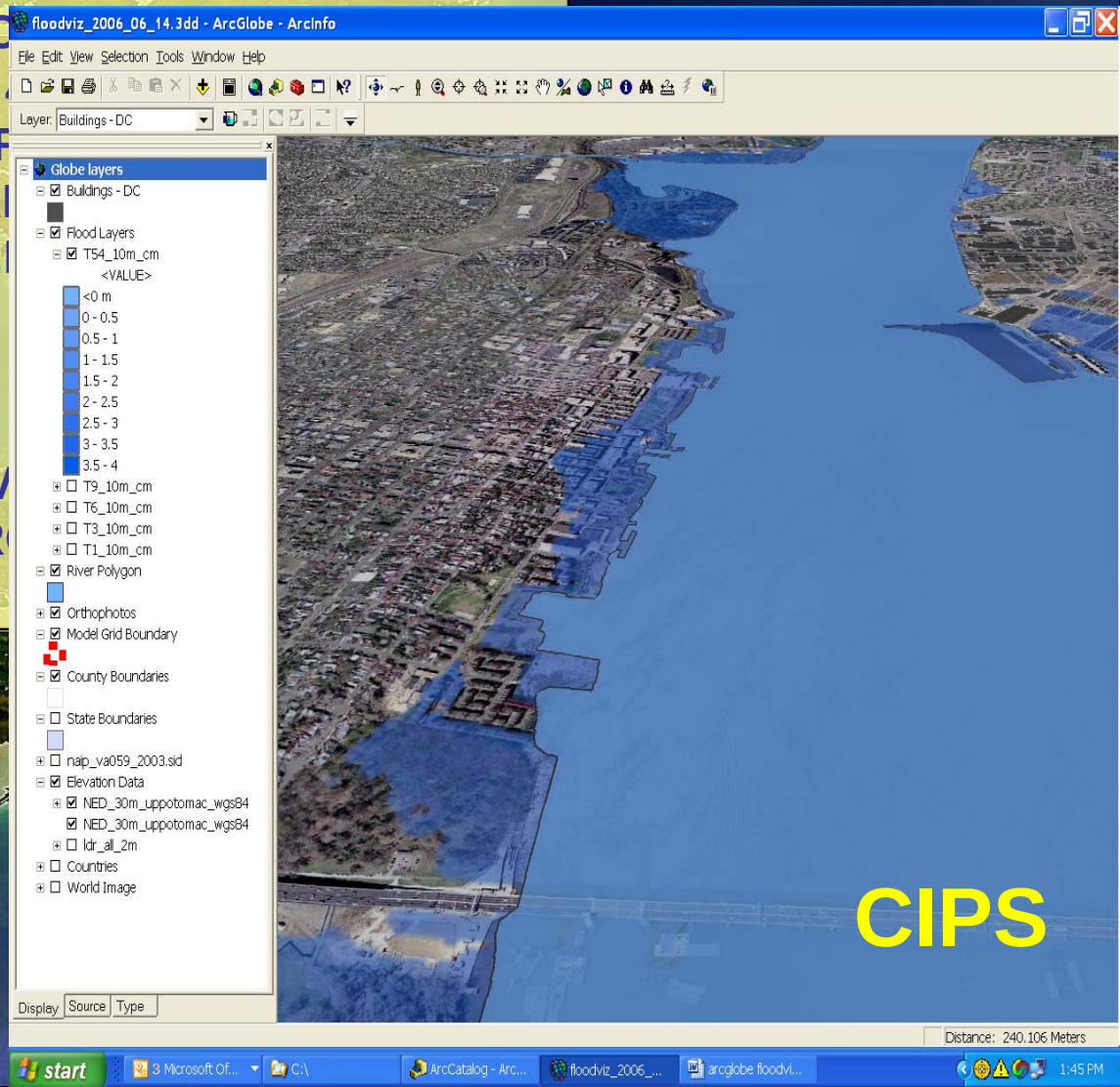
VIMS

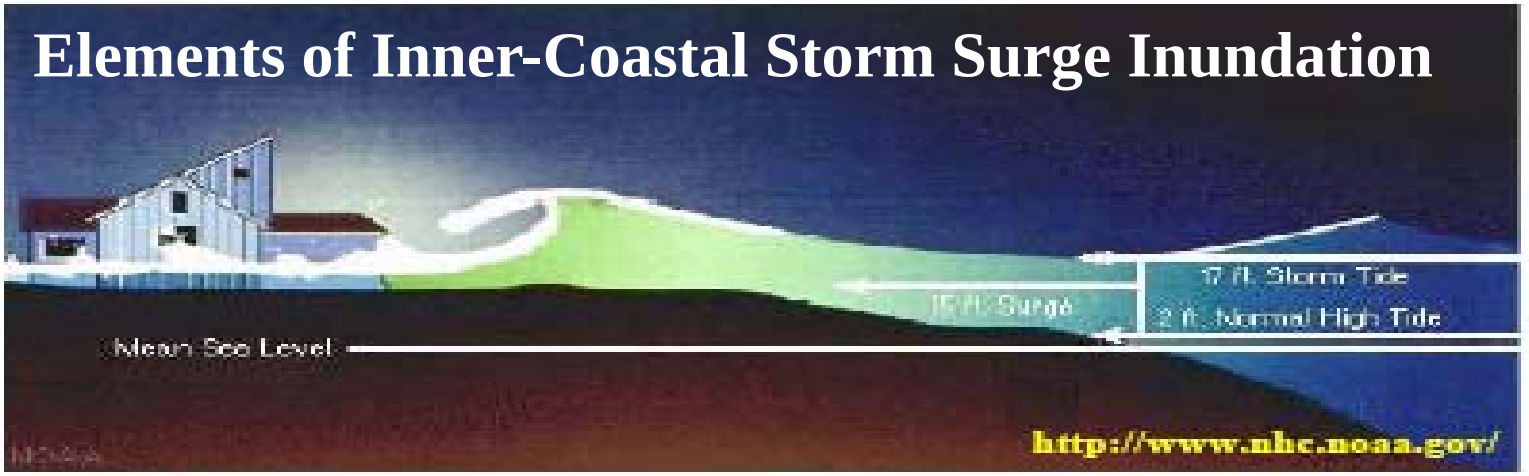

Alexandria
Norfolk
Hurricane Isabel (2003)
1 0001 G-12 IMG 04 18 SEP 03261 021500 03909 13933 02.00
McIDAS

THE POTENTIAL EXISTS FOR STORM SURGES OF 5 TO 10 FEET ALONG THE COAST FROM CURRITUCK BEACH TO CHINCOTEAGUE...4 TO 8 FEET OVER THE SOUTHERN BAY...AND 3 TO 5 FEET FOR THE CURRITUCK AND ALBEMARLE SOUND. PORTIONS OF THE WESTERN ALBEMARLE SO
STORM SURGE VALUES FROM
THE CHOWAN AND ROANOKE R
SURGES WILL CAUSE COASTA
LYING FLOOD PRONE AREAS...
TIMES OF HIGH TIDE.

EMERGING TECHNOLOGY

- Very high resolution hydrodynamic models with inundation (wetting & drying)
- Regional scale atmospheric wind forecast model
- Very high resolution elevation data (LIDAR)
- Emerging GIS and visualization capabilities for integrated, high-resolution impacts products





Storm Winds Prolonged intense winds with gusts of tropical strength

Storm Precipitation Direct rainfall (1-2 feet) on bay and estuaries

Storm Surge Ocean water (5-10 feet) pushed toward shore

Storm Tide Storm surge and normal tide (latter, up to ~ 3 ft)

Storm Waves Waves (3-6 feet in height) that accompany storm tide

Storm Flood Freshwater runoff toward shore from flash and subsequent river flooding (down-channel, out-of-bank, and overland)

Storm Surge Inundation The combination of all the above, and most severe in height if precipitation, surge, high tide, high precipitation, and flash flooding occur simultaneously, and in duration as they diverge in time

Modified, MTK, USGS

CIPS DEVELOPERS

Project Management:

- Chesapeake Bay Observing System (CBOS)/Old Dominion University
- Chesapeake Research Consortium

Atmospheric Modeling and Validation:

- NOAA National Weather Service (NWS) Weather Forecast Offices
  - Wakefield, VA; Sterling, VA; Mt. Holly, NJ
- WeatherFlow

Hydrodynamic and Hydrologic Modeling and Validation:

- Virginia Institute of Marine Science, College of William & Mary
- University of Maryland Center for Environmental Science (UMCES) Horn Point Laboratory
- NWS Middle Atlantic River Forecast Center

Overland Inundation Validation:

- USGS Water Science Center Baltimore
- USGS Office of Surface Water Reston

Visualization and Validation:

- Noblis

Economic Valuation and User Engagement:

- UMCES Chesapeake Bay Laboratory

Data Management and Communications:

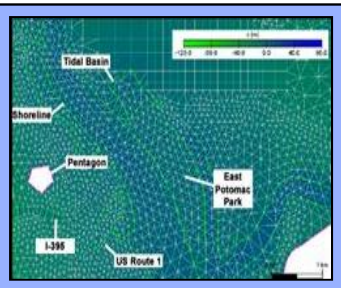
- NOAA Chesapeake Bay Office

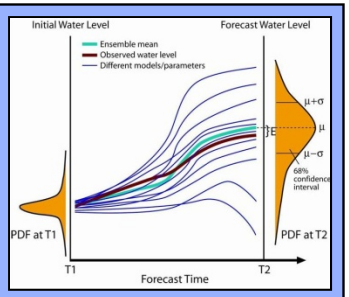
CIPS Storyboard: 2007-2010

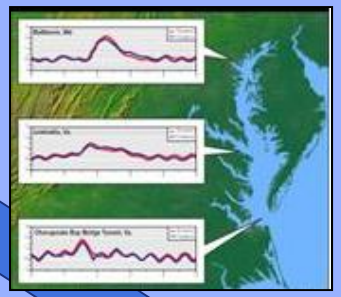
User Needs and Buy-In

OBSERVATIONS

VISUALIZATION





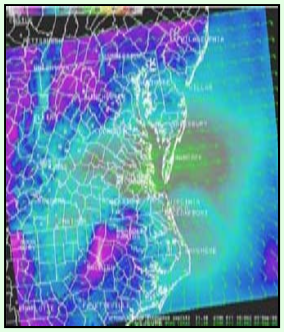


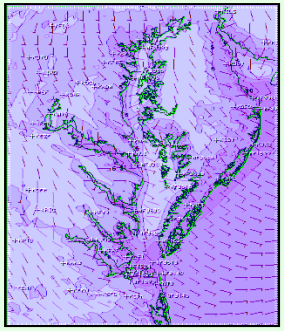
VALUATION

VALIDATION

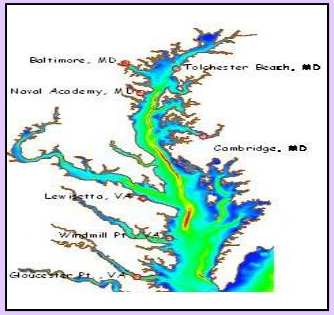
FORECAST

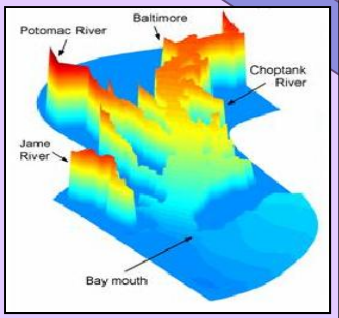
ATMOSPHERIC MODELING



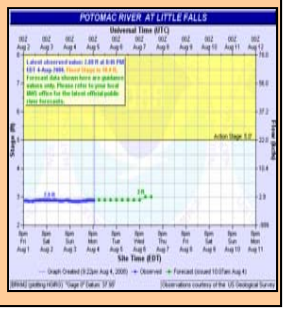


HYDRODYNAMIC MODELING

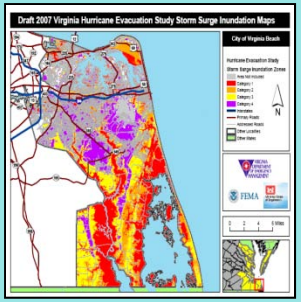




AHPS



LIDAR



OUTREACH

Emergency Management

Health

Sea Level Rise

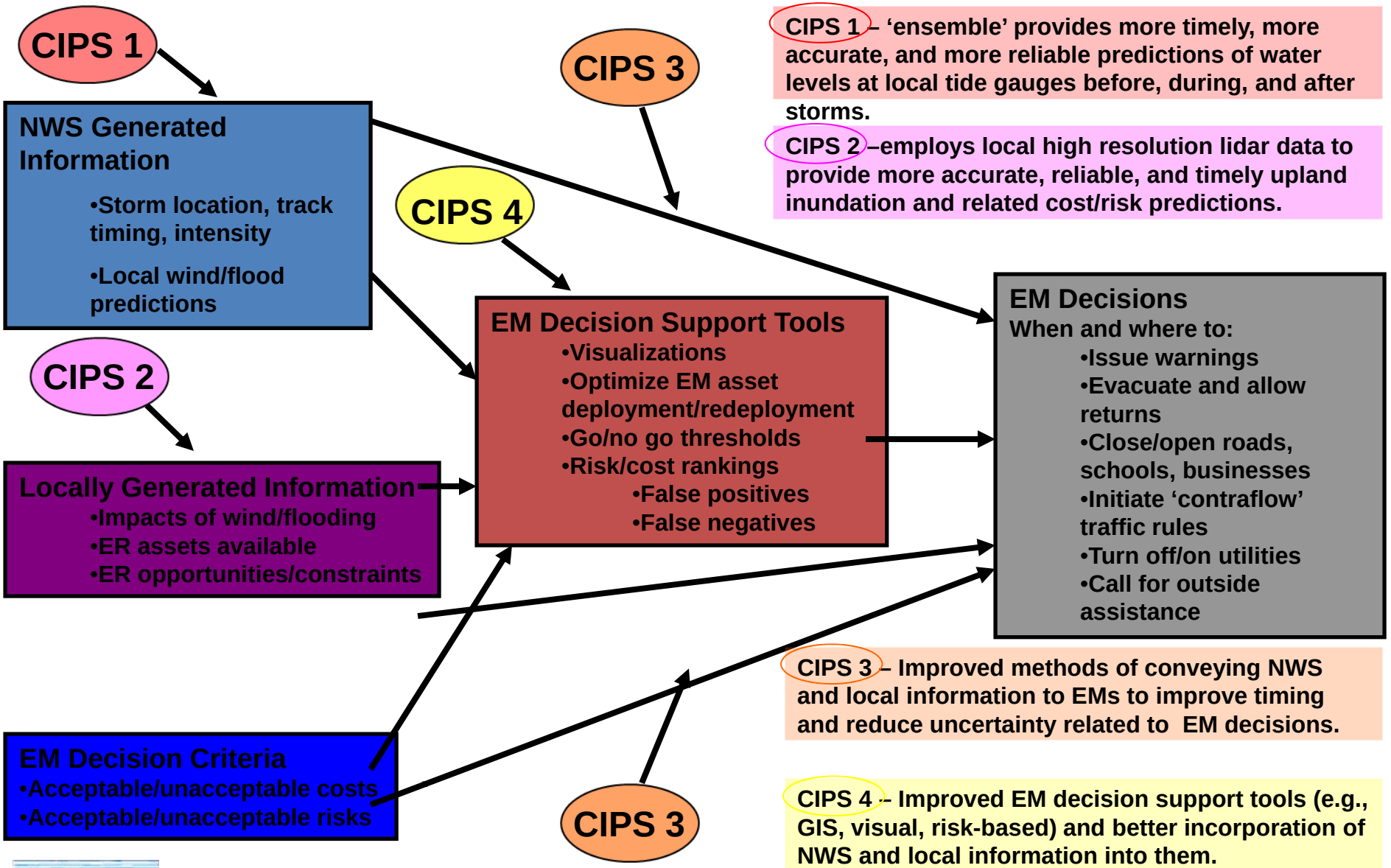
Structural Mitigation

Tsunami Planning?

Natural Resources

Environmental Quality

Potential CIPS Contributions to EM Decision-Making

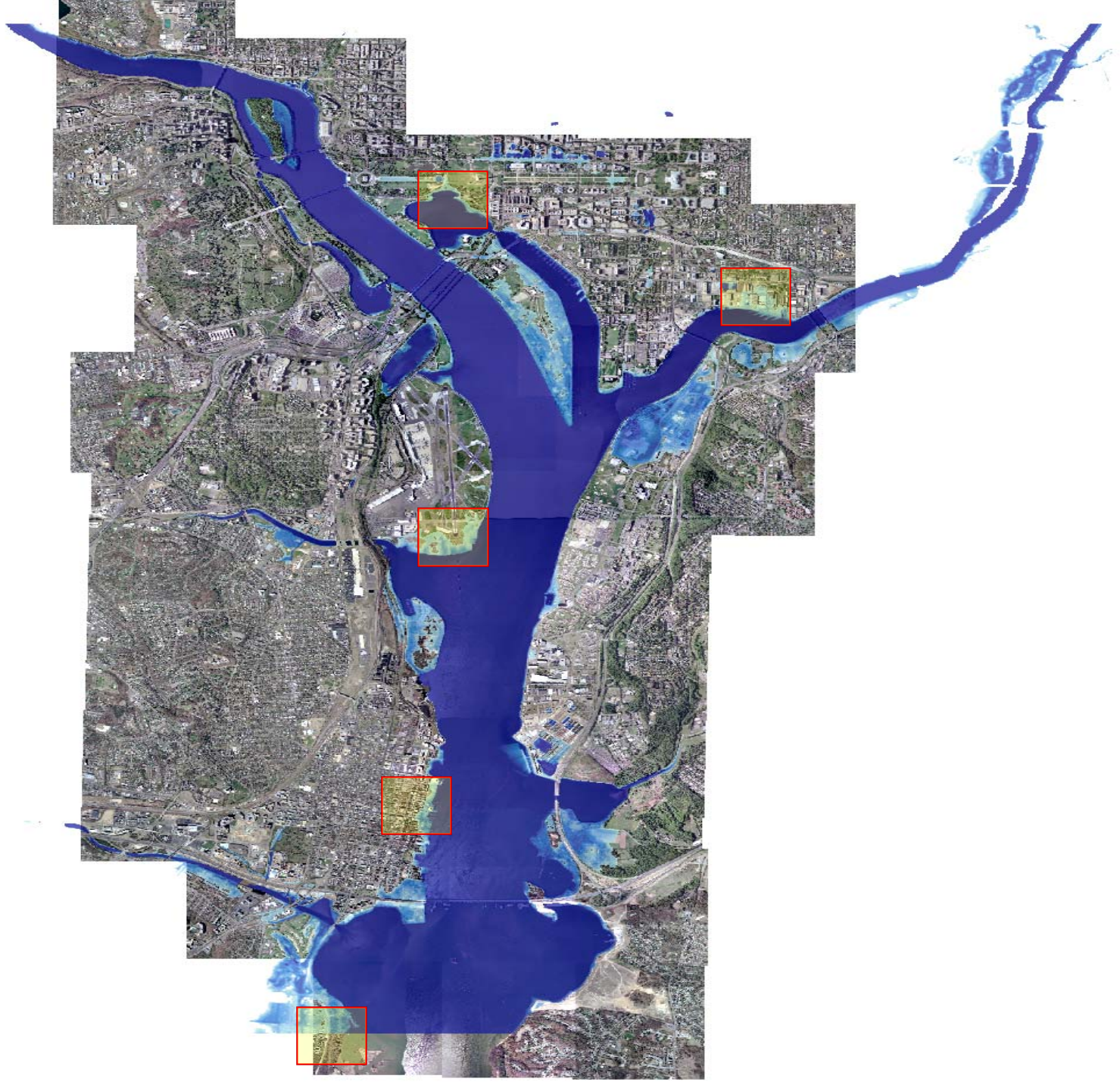


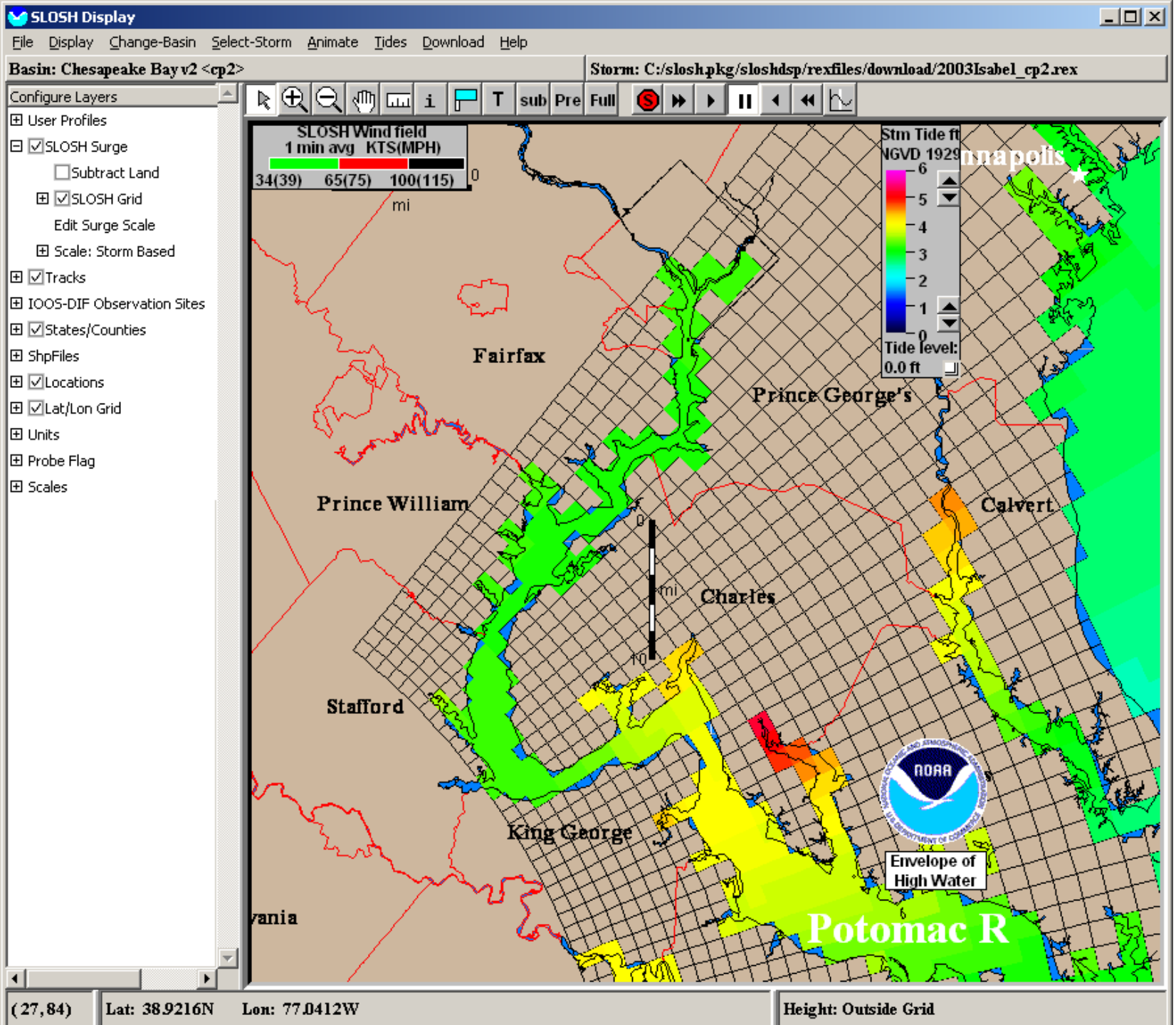
CIPS 1 – 'ensemble' provides more timely, more accurate, and more reliable predictions of water levels at local tide gauges before, during, and after storms.

CIPS 2 –employs local high resolution lidar data to provide more accurate, reliable, and timely upland inundation and related cost/risk predictions.

CIPS 3 – Improved methods of conveying NWS and local information to EMs to improve timing and reduce uncertainty related to EM decisions.

CIPS 4 – Improved EM decision support tools (e.g., GIS, visual, risk-based) and better incorporation of NWS and local information into them.




SLOSH Display
File Display Change-Basin Select-Storm Animate Tides Download Help
Basin: Chesapeake Bay v2 <cp2>
Storm: C:/slosh.pkg/sloshdsp/rexfiles/download/2003Isabel_cp2.rex
Configure Layers
User Profiles
SLOSH Surge
Subtract Land
SLOSH Grid
Edit Surge Scale
Scale: Storm Based
Tracks
IOOS-DIF Observation Sites
States/Counties
ShpFiles
Locations
Lat/Lon Grid
Units
Probe Flag
Scales
T sub Pre Full
SLOSH Wind field
1 min avg KTS(MPH)
34(39) 65(75) 100(115)
0
mi
Stm Tide ft
NGVD 1929
6
5
4
3
2
1
0
Tide level:
0.0 ft
Fairfax
Prince George's
Prince William
Calvert
Charles
Stafford
King George
Envelope of
High Water
Potomac R
(27,84)
Lat: 38.9216N
Lon: 77.0412W
Height: Outside Grid


Chesapeake Bay
CBOS
Observing System
noblis
VIMS

Chesapeake Inundation Prediction System (CIPS)

Hurricane Isabel

September 19, 2003 (4:00 AM)

0.0-0.5 (0-1.6)
0.5-1.0 (1.6-3.3)
1.0-1.5 (3.3-4.9)
1.5-2.0 (4.9-6.6)
2.0-2.5 (6.6-8.2)
2.5-3.0 (8.2-9.8)
Depth (m/ft)

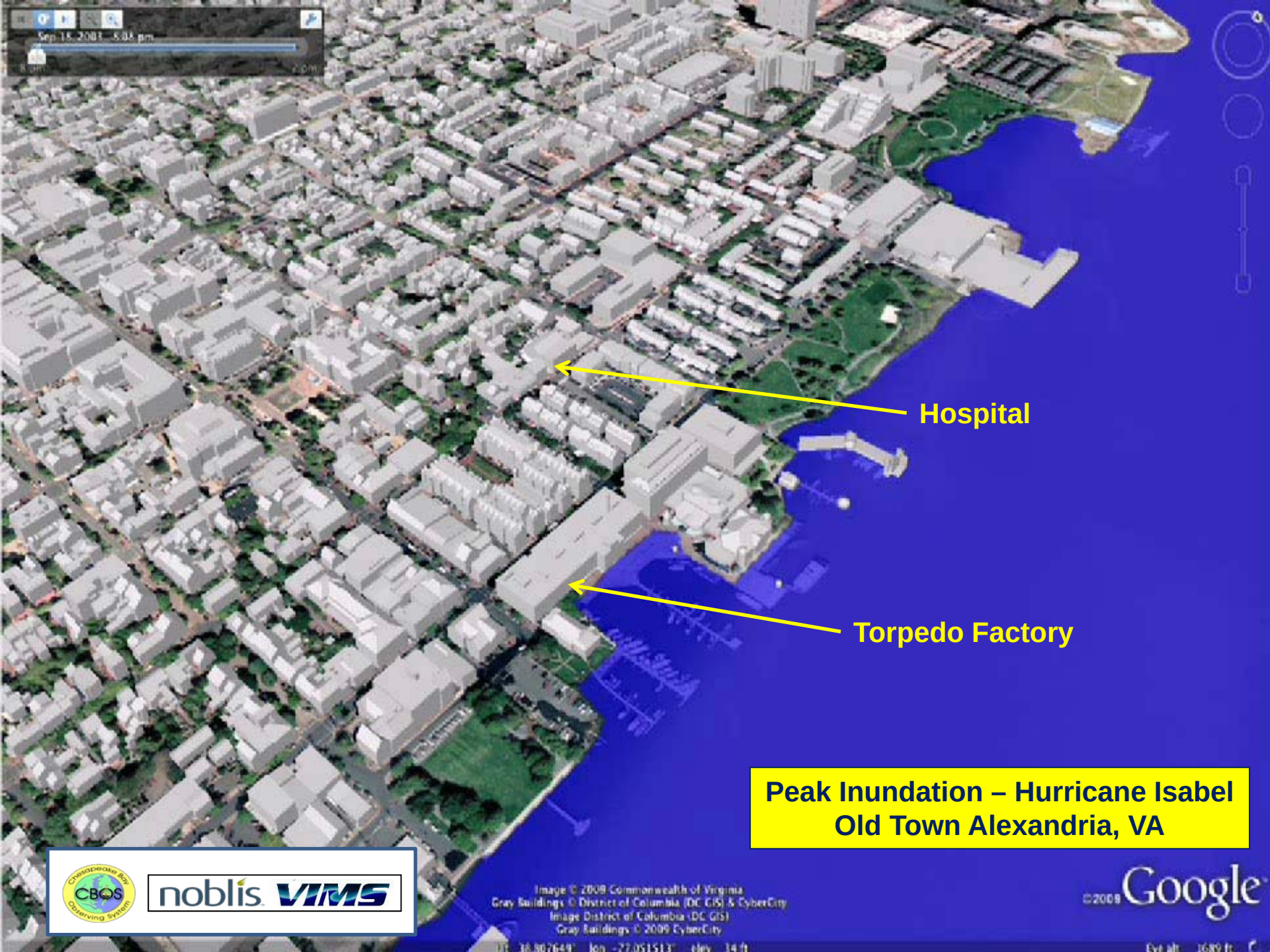
Lee St

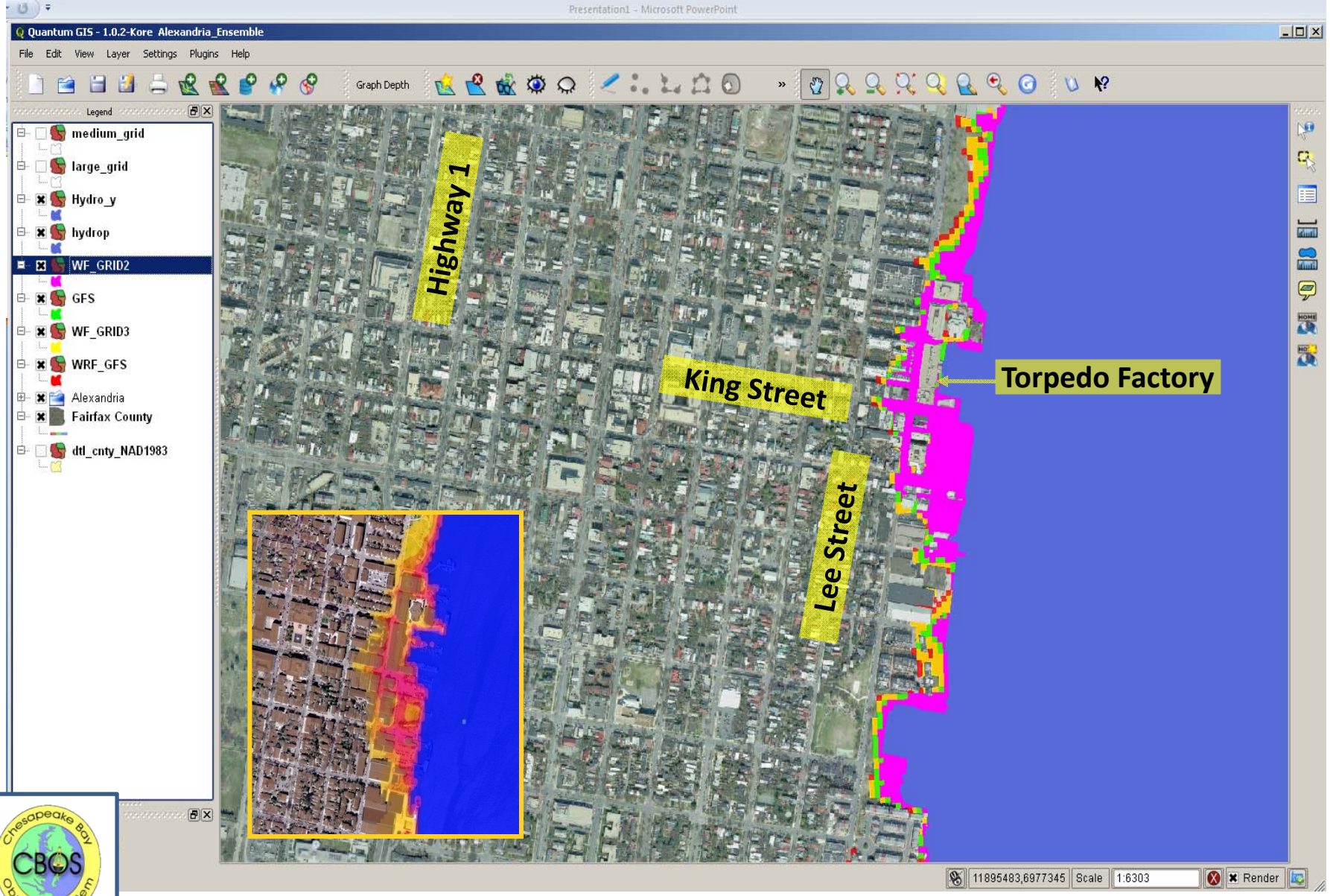
King St

Union St

Someone marked the high water point in Old Town Alexandria,VA

The intersection of Union and King Streets in Old Town Alexandria, VA

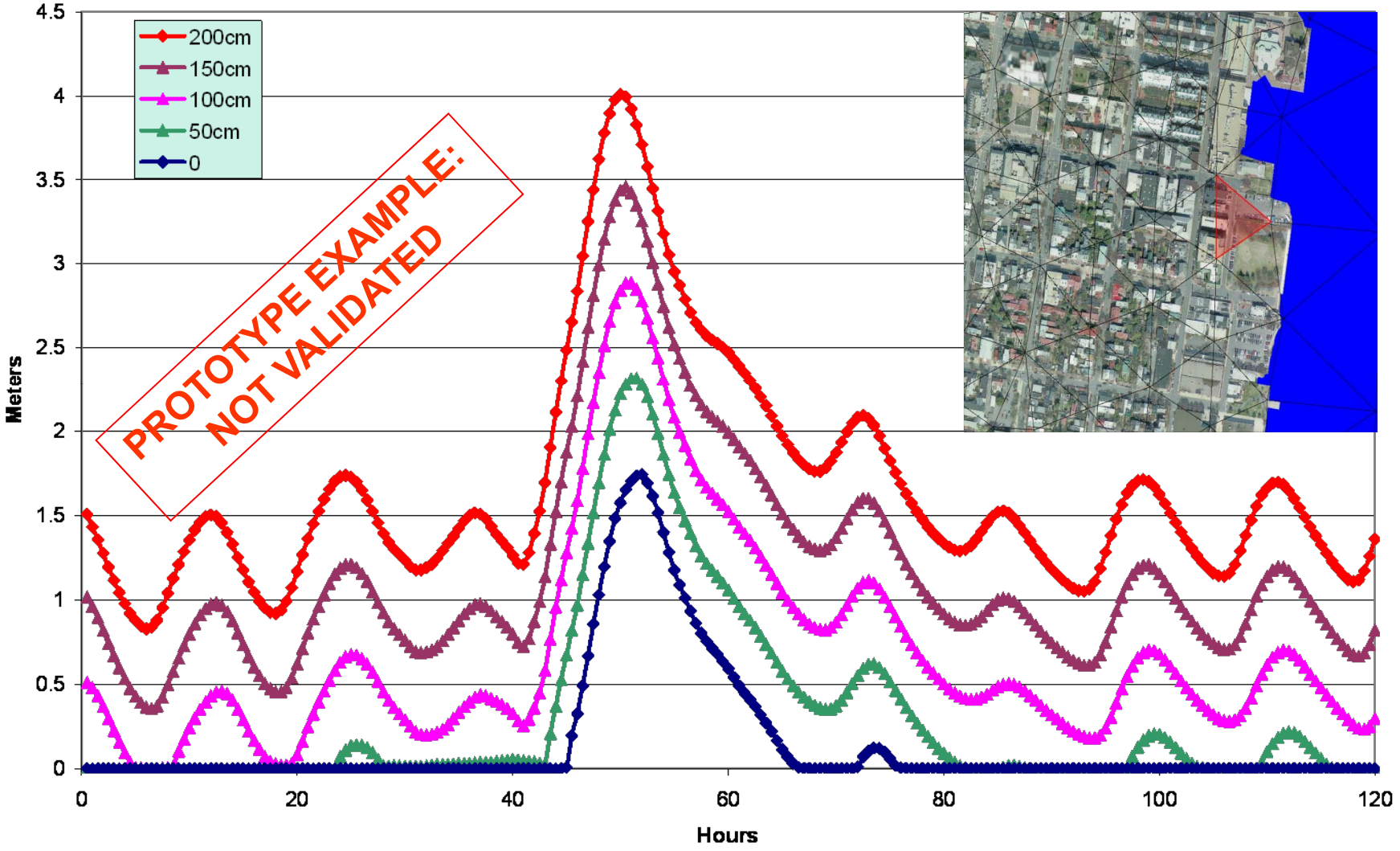

Hospital
Torpedo Factory
Peak Inundation – Hurricane Isabel
Old Town Alexandria, VA
Image © 2009 Commonwealth of Virginia
Gray Buildings © District of Columbia (DC GIS) & CyberCity
Image District of Columbia (DC GIS)
Gray Buildings © 2009 CyberCity
©2009 Google



Hurricane Isabel (2003): Alexandria, VA
Flood Depth (10 meter pixel horizontal resolution)
CIPS Forecast Models Ensemble

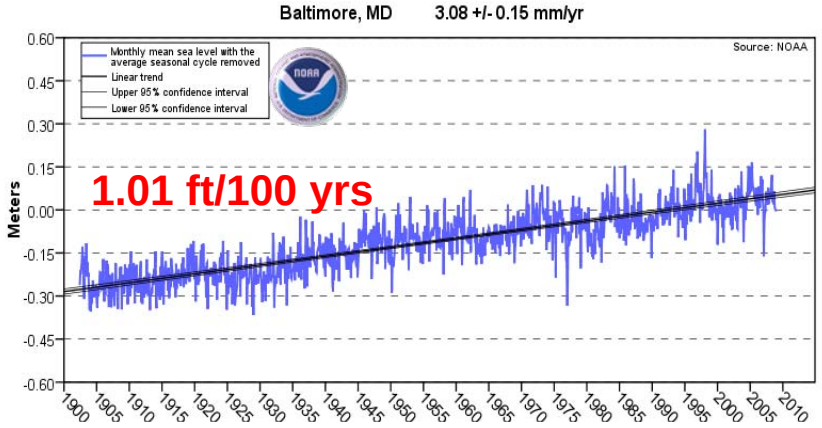
PROTOTYPE EXAMPLE: NOT FOR OFFICIAL USE - FOR DEMONSTRATION ONLY

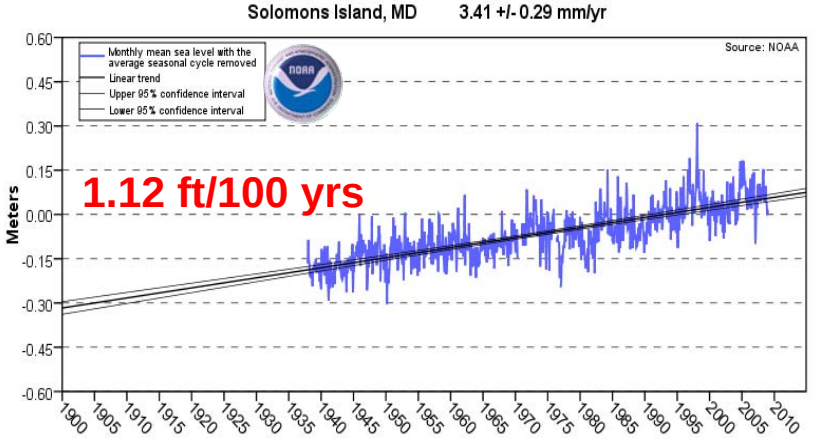
Flood Depth vs Sea Level Rise: Alexandria, VA Waterfront
Recreation of Hurricane Isabel (September 2003)

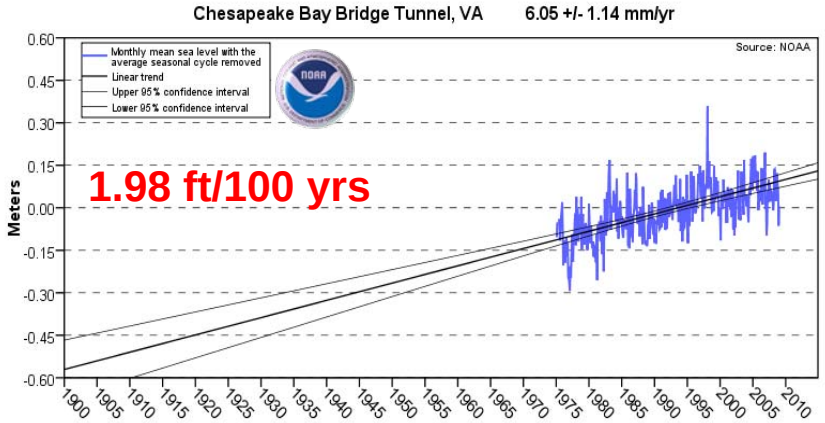


Chesapeake Bay CBOS Observing System

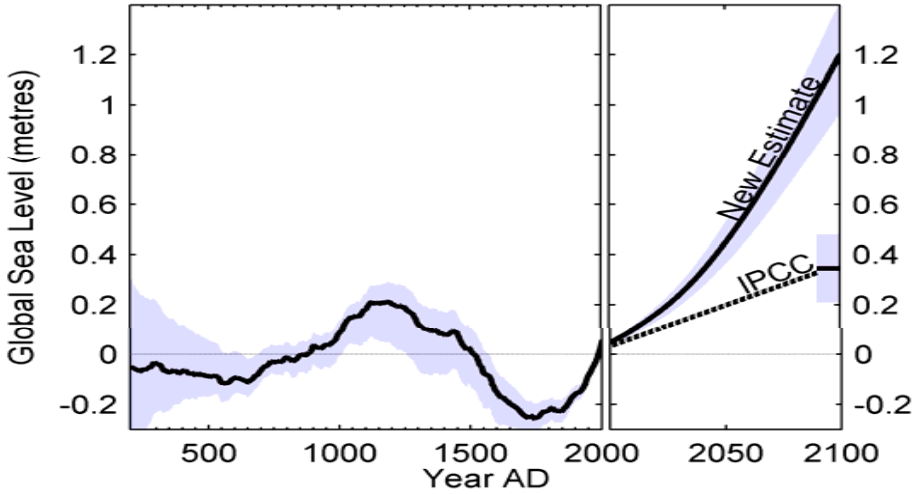
noblis VIMS



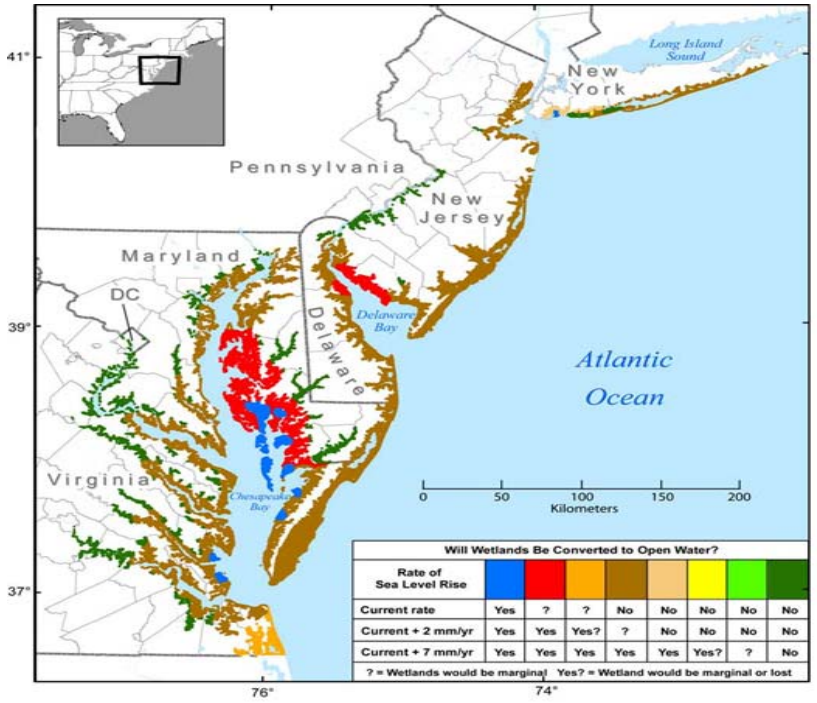




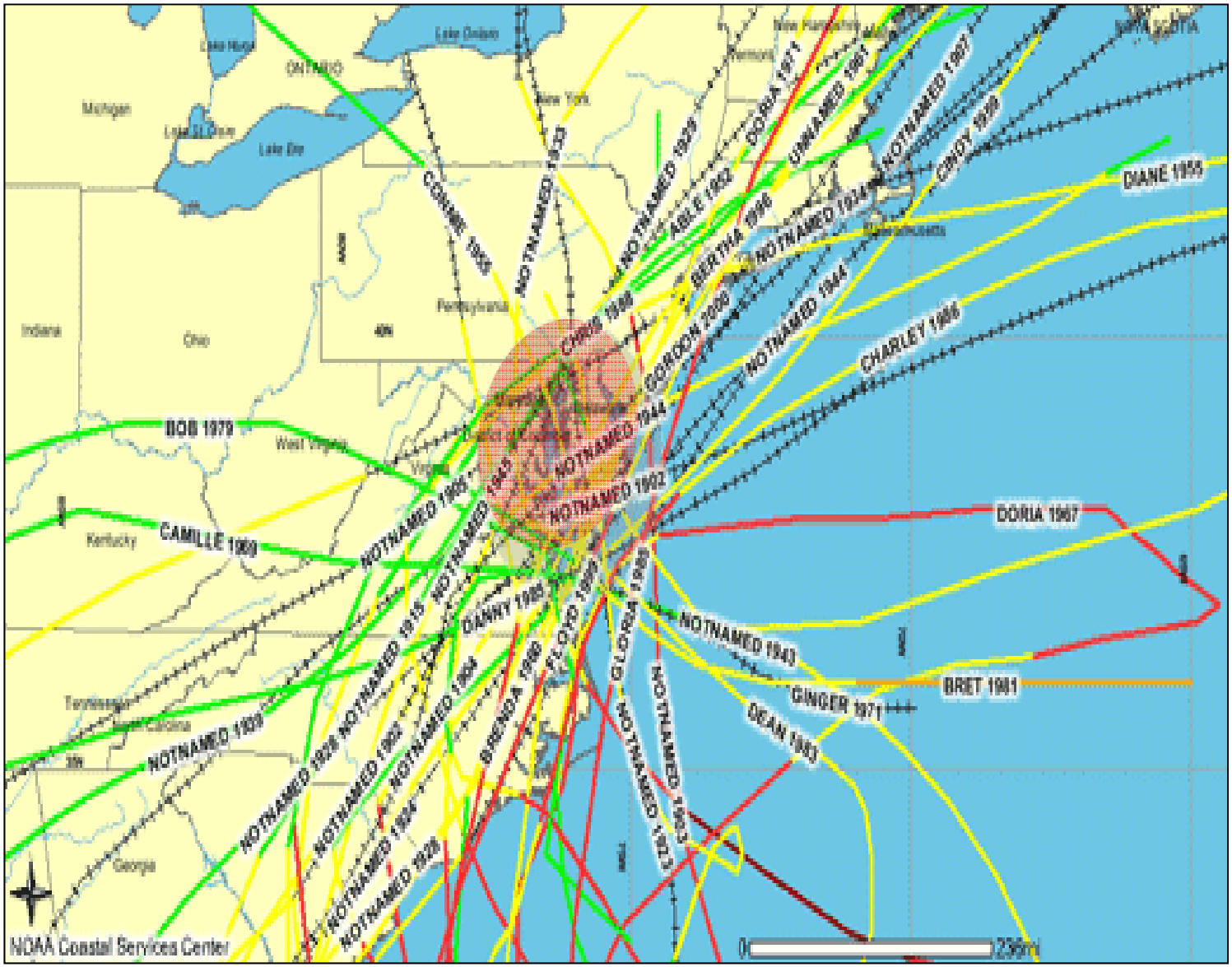
http://tidesandcurrents.noaa.gov/index.shtml



Aslak Grinsted, PhD, Centre for Ice and Climate
(Niels Bohr Institute, University of Copenhagen)



Coastal Sensitivity to Sea-level Rise Report/EPA (Jan. 15, 2009)

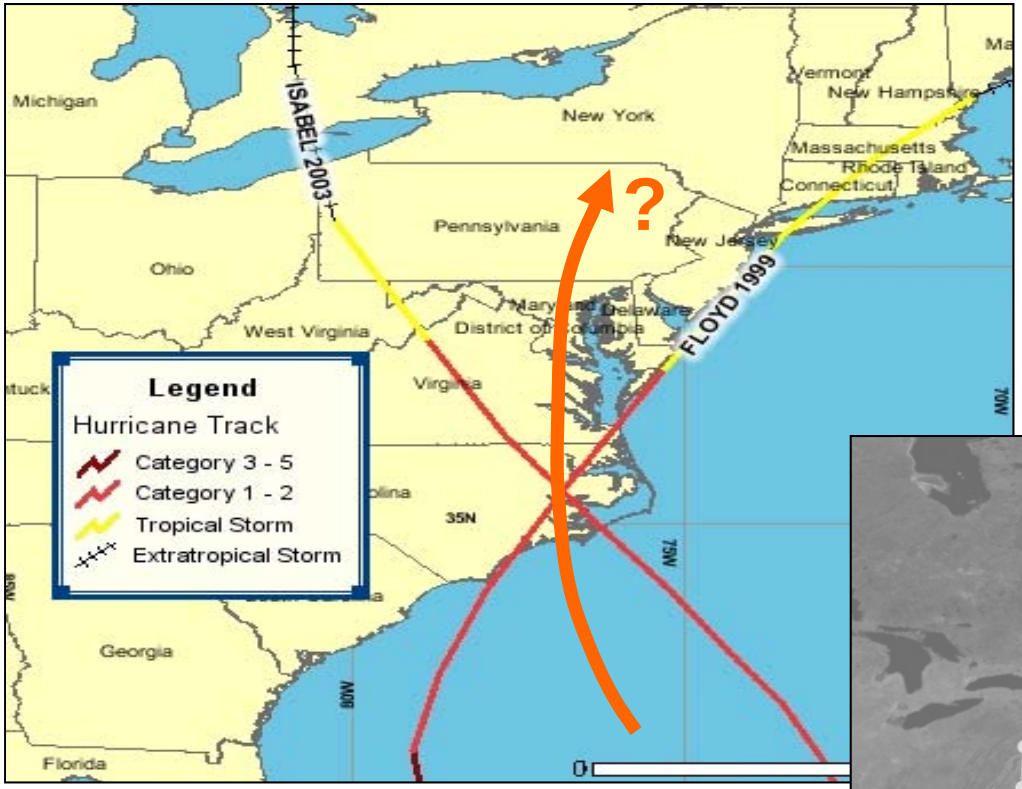


20th Century Hurricanes/Tropical Storms

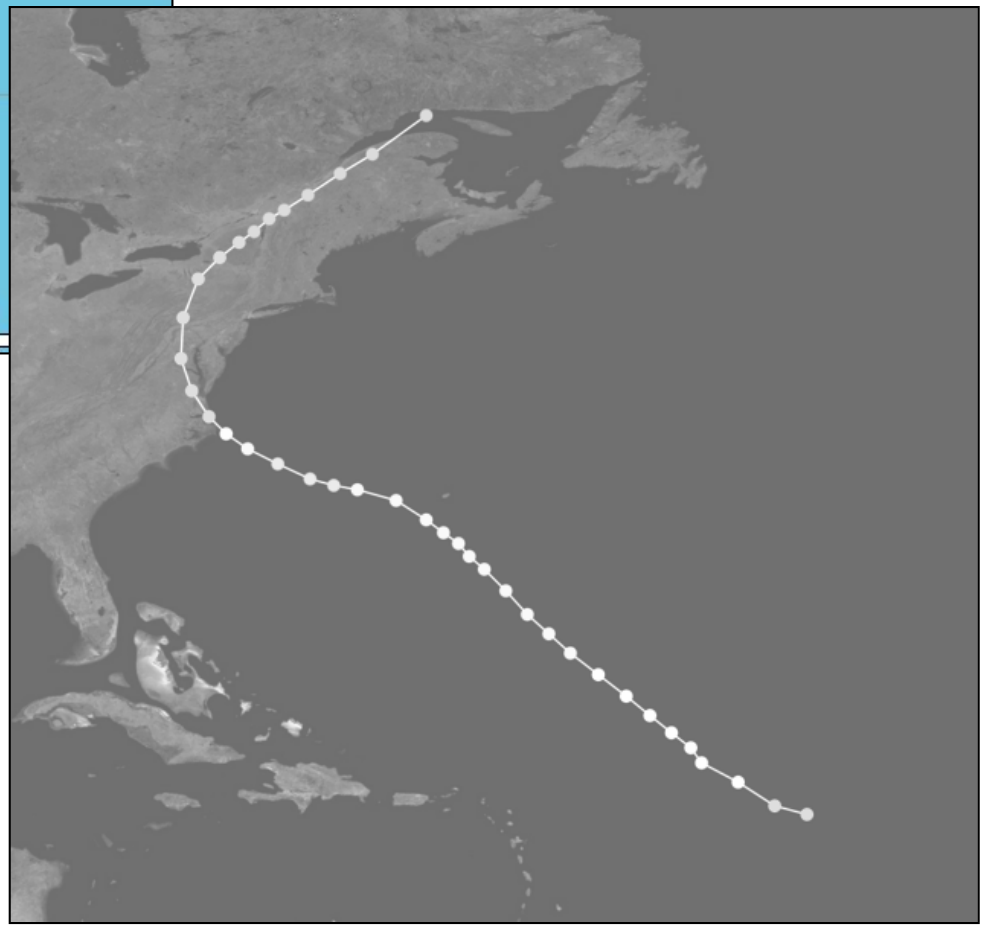
http://www.climate.org/topics/weather/isabel/21-storm-tracks.shtml

What if a Category 3+ went up the western side of the Bay?

http://www.climate.org/topics/weather/isabel/21-storm-tracks.shtml



1933 Atlantic hurricane 8



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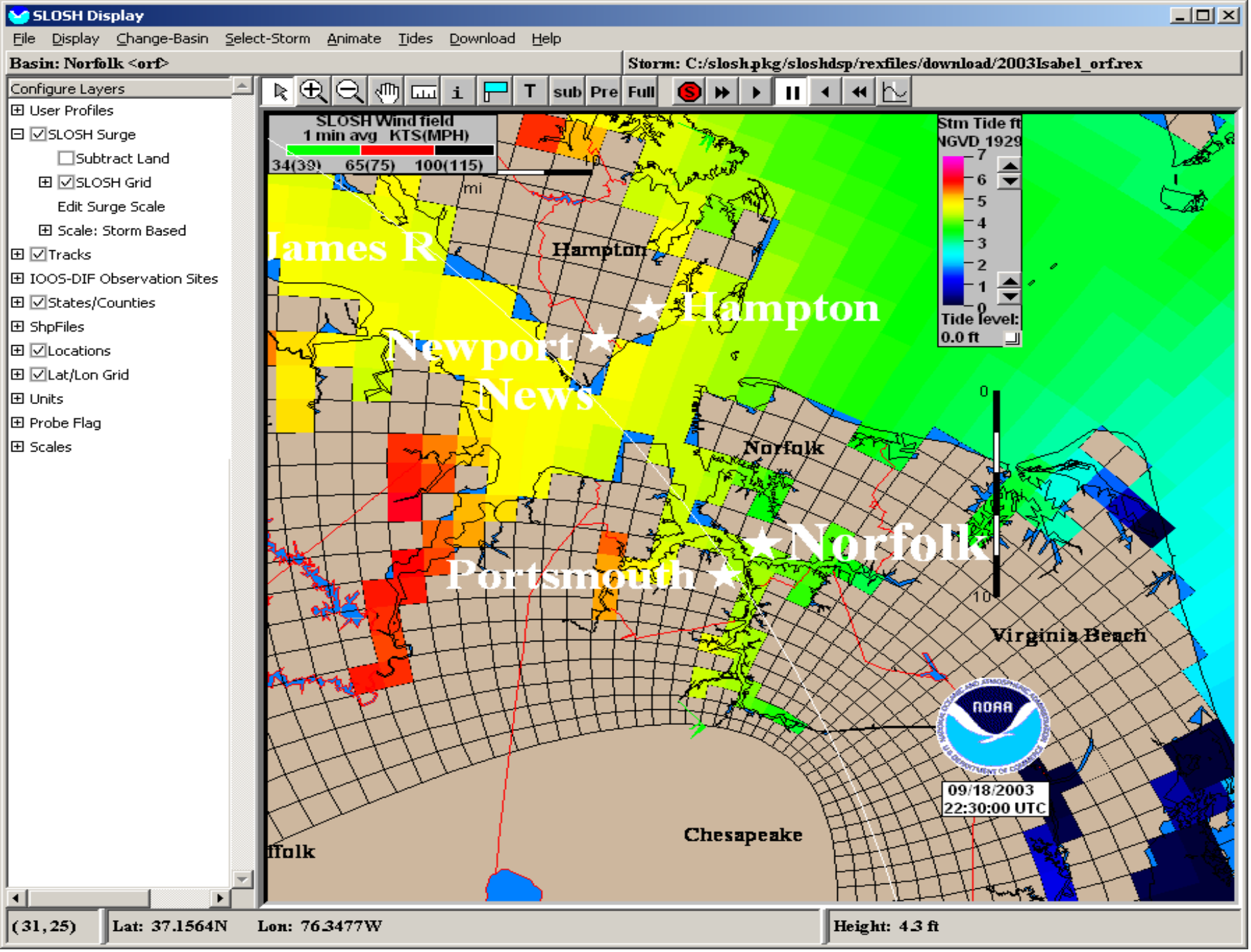
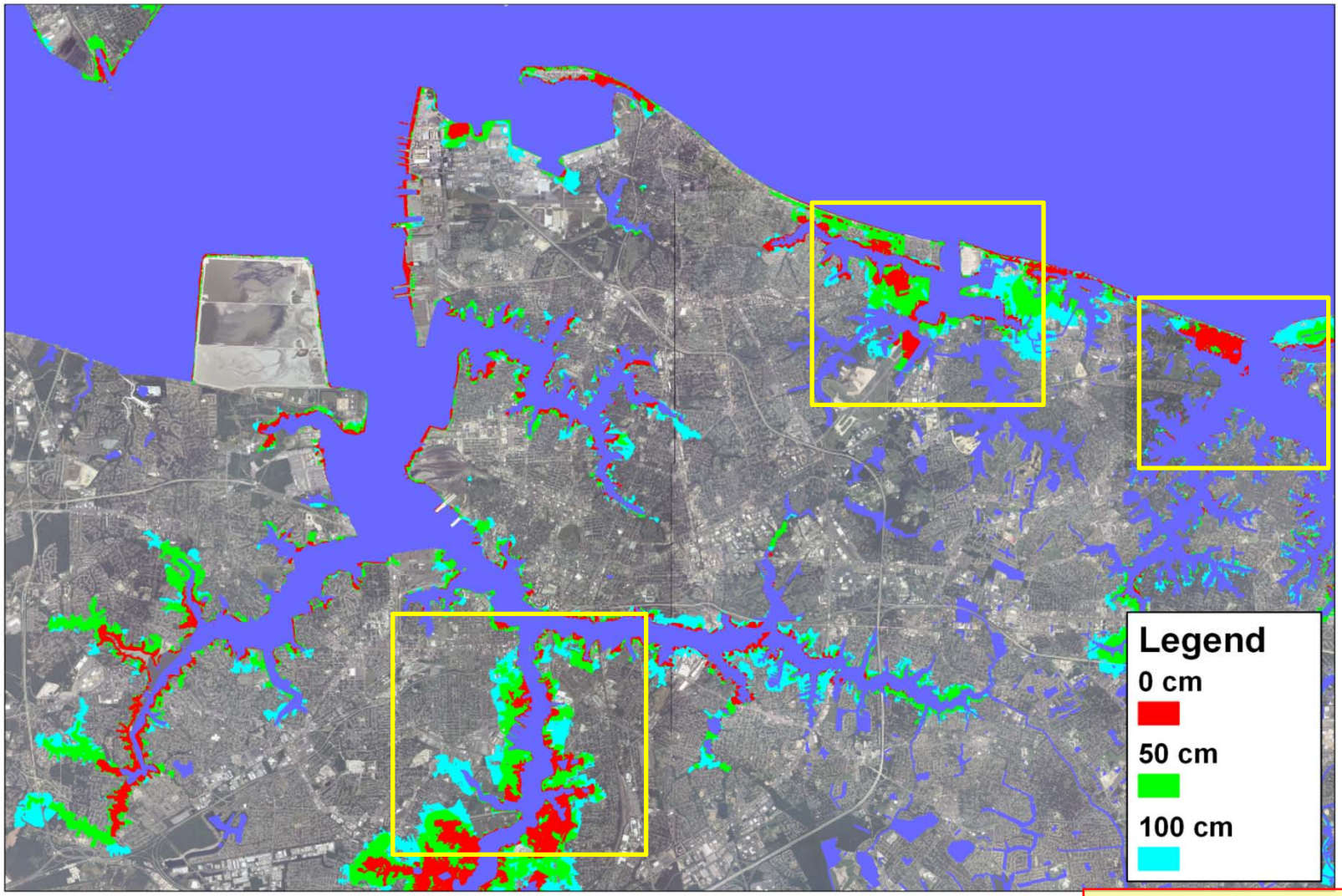
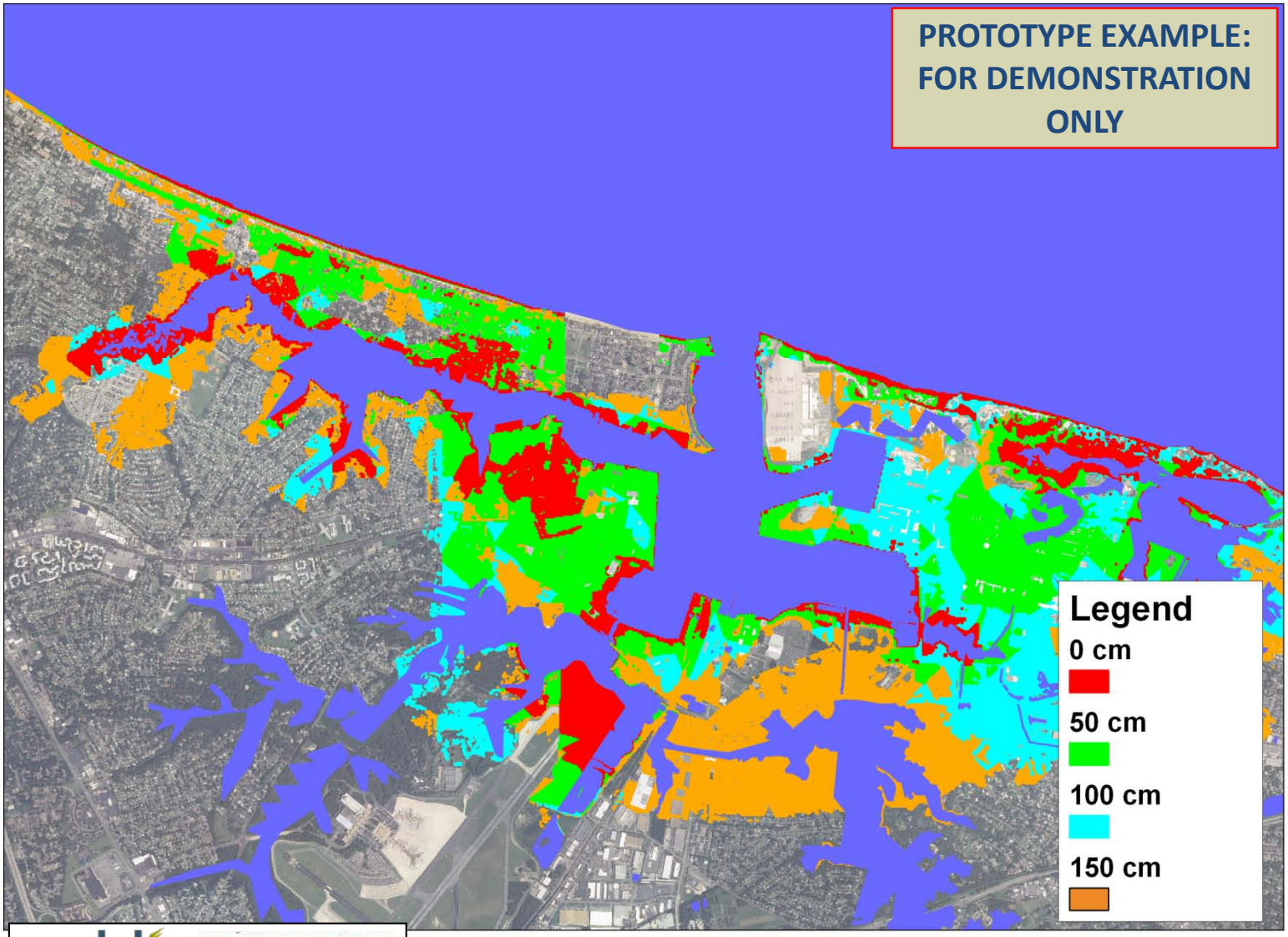

SLOSH Display
File Display Change-Basin Select-Storm Animate Tides Download Help
Basin: Norfolk <orf>
Storm: C:/slosh.pkg/sloshdsp/rexfiles/download/2003Isabel_orf.rex
Configure Layers
User Profiles
SLOSH Surge
Subtract Land
SLOSH Grid
Edit Surge Scale
Scale: Storm Based
Tracks
IOOS-DIF Observation Sites
States/Counties
ShpFiles
Locations
Lat/Lon Grid
Units
Probe Flag
Scales
sub
Pre
Full
SLOSH Wind field
1 min avg KTS(MPH)
34(39) 65(75) 100(115)
10
mi
Stm Tide ft
NGVD 1929
7
6
5
4
3
2
1
0
Tide level:
0.0 ft
James R
Hampton
Hampton
Newport News
Norfolk
Norfolk
Portsmouth
Virginia Beach
Chesapeake
folk
NOAA
09/18/2003
22:30:00 UTC
(31,25)
Lat: 37.1564N
Lon: 76.3477W
Height: 4.3 ft

Hurricane Isabel – Hampton Roads
Inundation versus Sea level Rise



PROTOTYPE EXAMPLE: FOR DEMONSTRATION ONLY

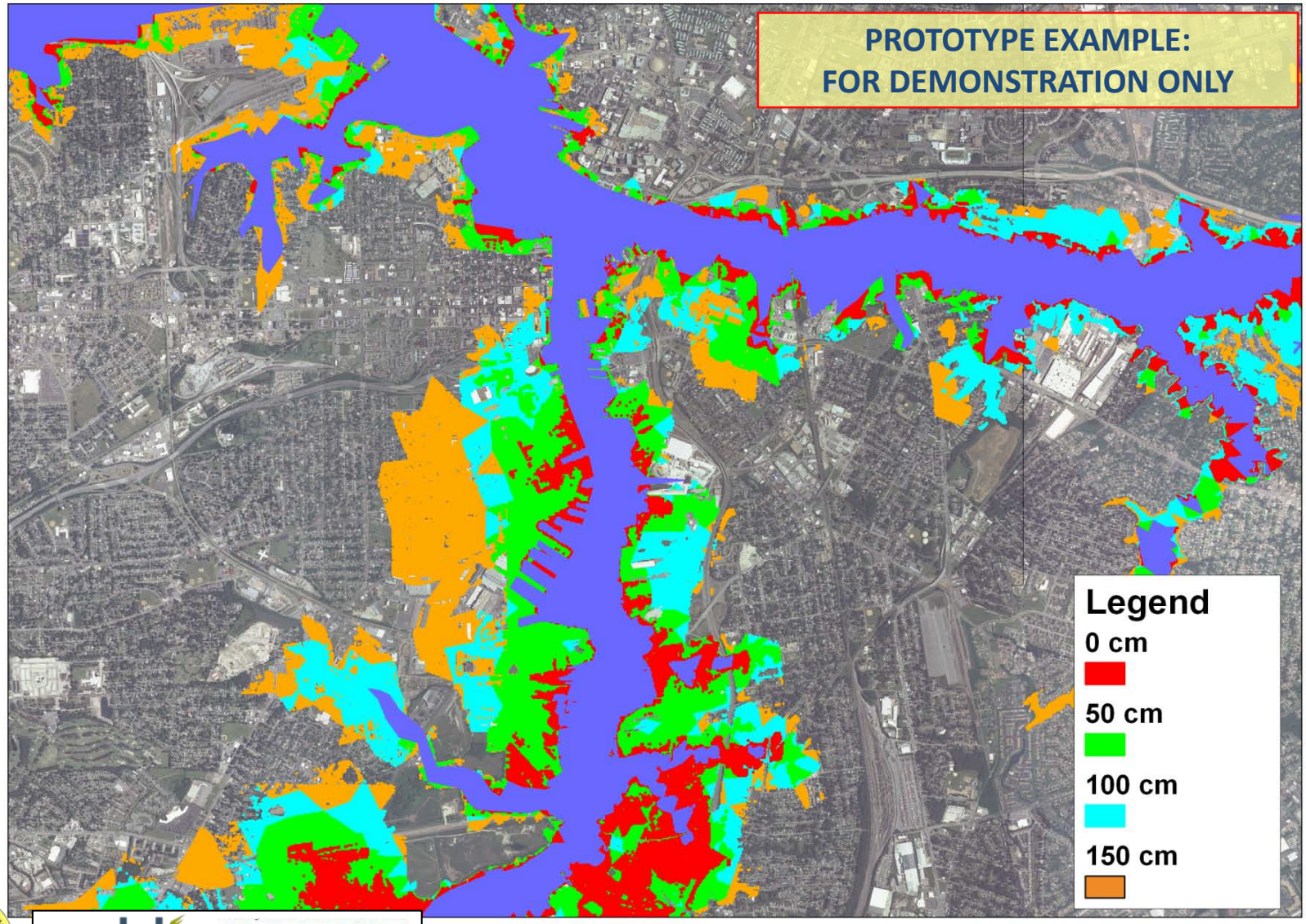
Hurricane Isabel - Naval Amphibious Base Little Creek
Inundation versus Sea Level Rise



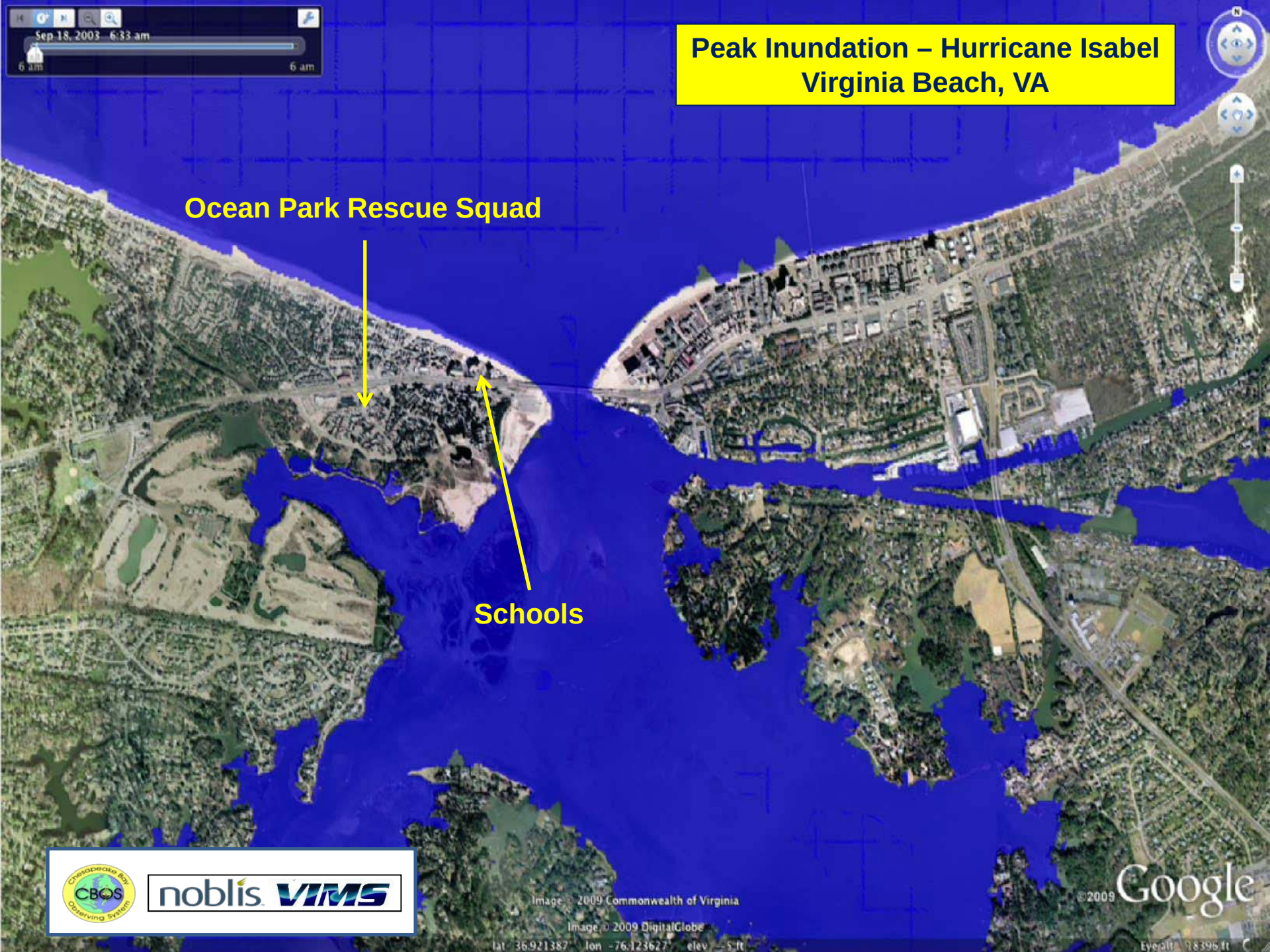
Chesapeake Bay CBOS Observing System

noblis VIMS

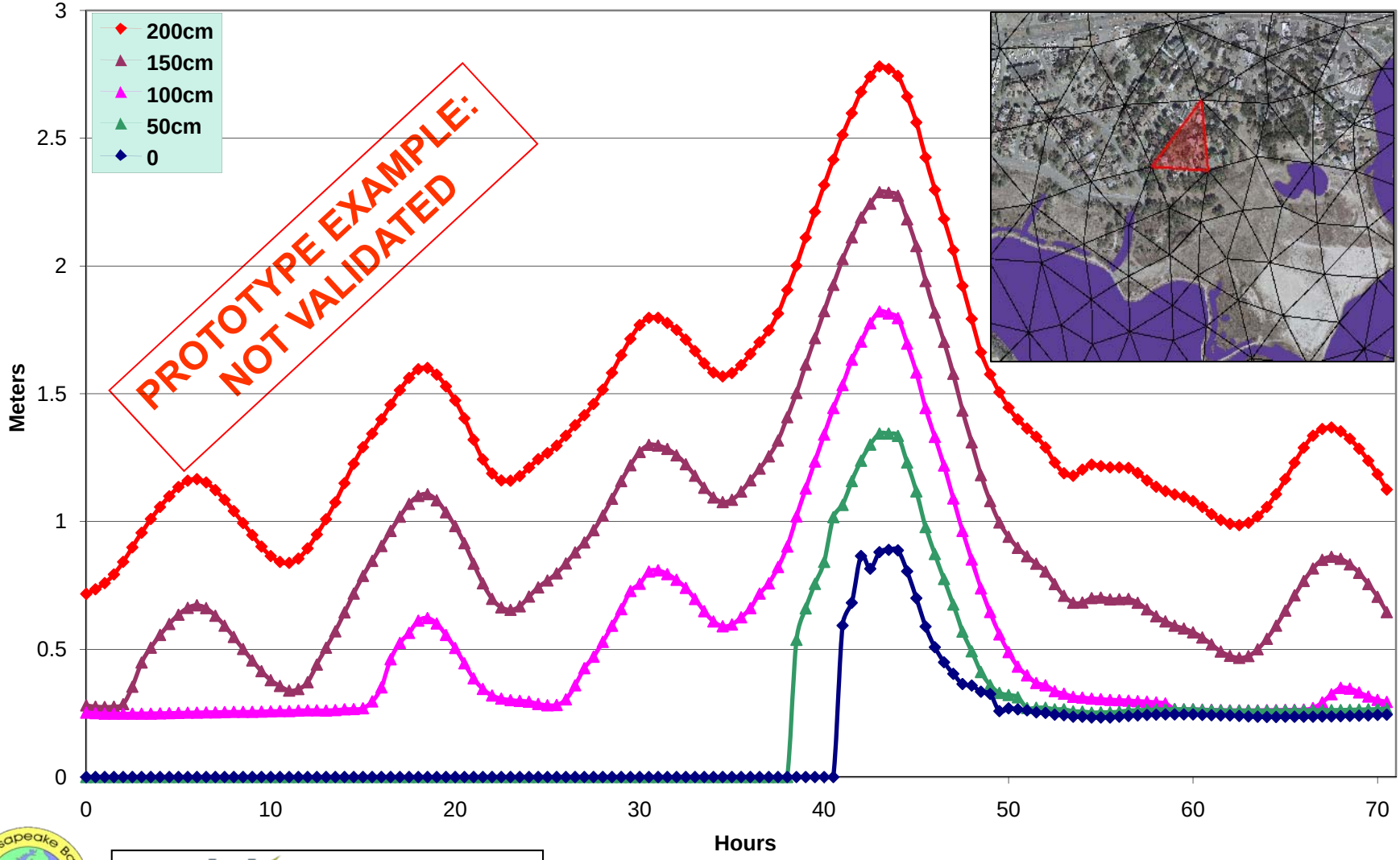
Hurricane Isabel - Norfolk Naval Shipyard
Inundation versus Sea Level Rise



Chesapeake Bay Observing System
CBOS
noblis
VIMS


Sep 18, 2003 6:33 am
6 am
6 am
Peak Inundation – Hurricane Isabel
Virginia Beach, VA
Ocean Park Rescue Squad
Schools
CBOS
noblis
VIMS
Image © 2009 Commonwealth of Virginia
Image © 2009 DigitalGlobe
©2009 Google

Flood Depth vs Sea Level Rise
Lynnhaven, VA Waterfront



Chesapeake Bay CBOS Observing System

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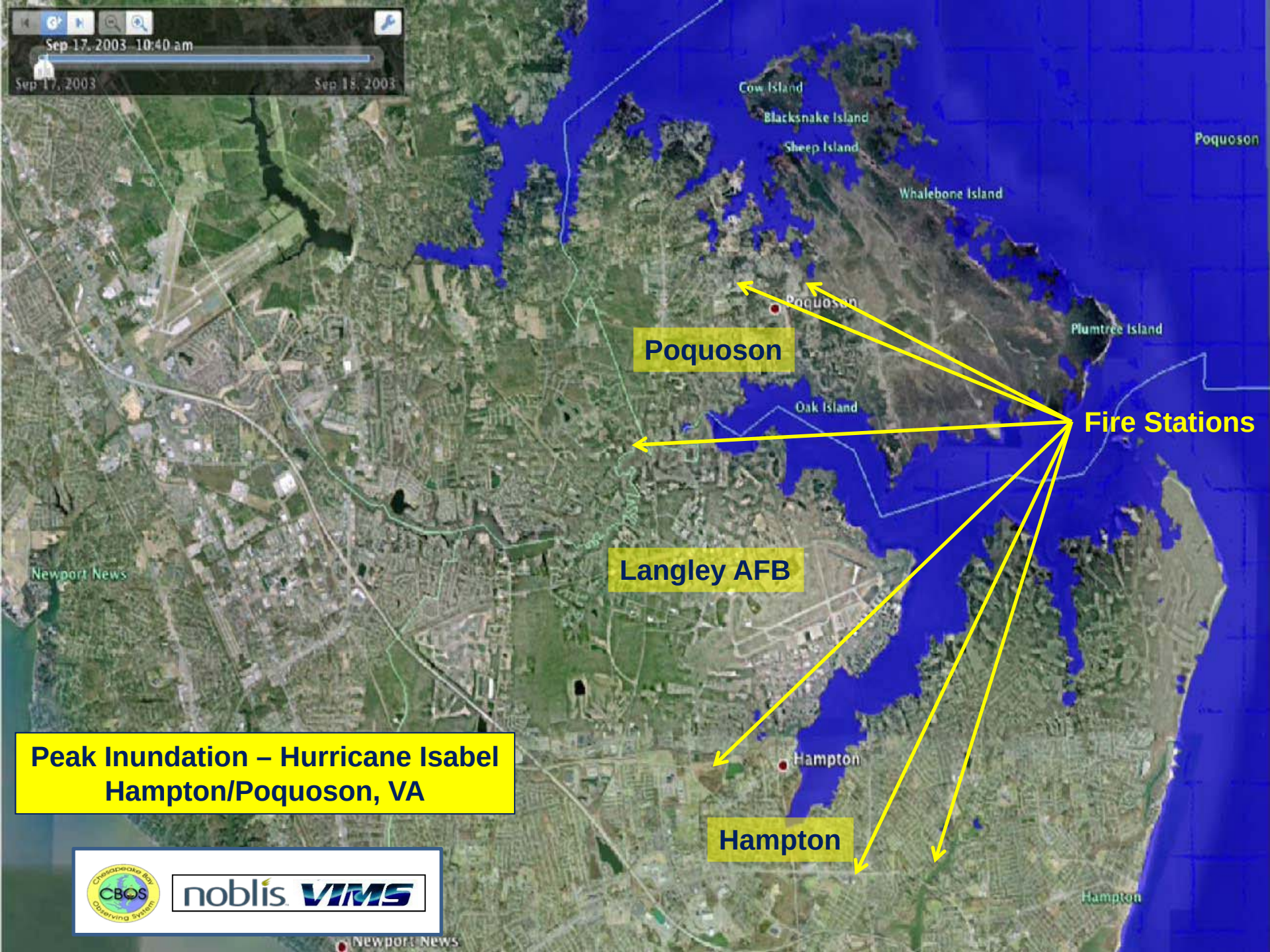
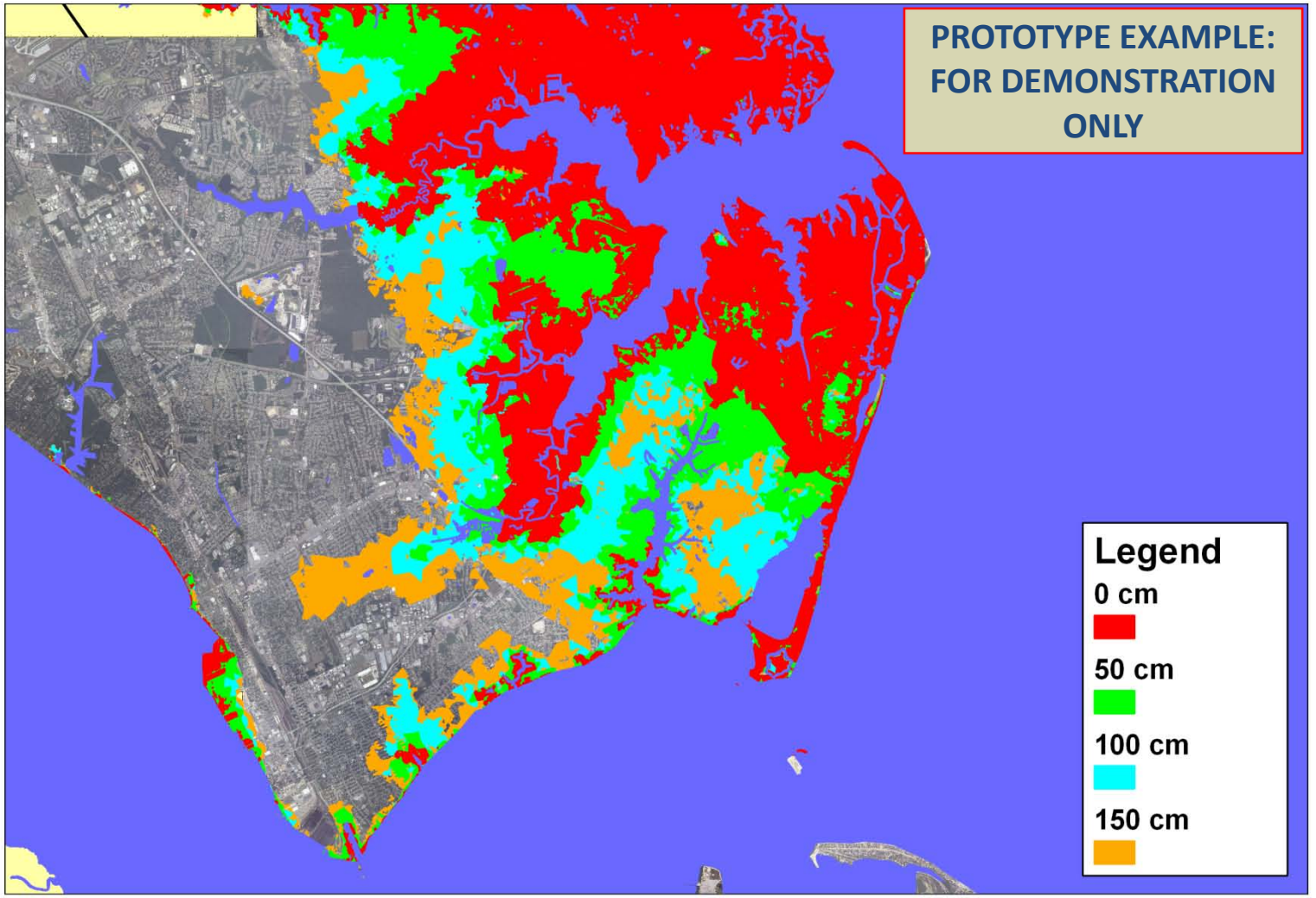

Sep 17, 2003 10:40 am
Sep 17, 2003
Sep 18, 2003
Cow Island
Blacksnake Island
Sheep Island
Whalebone Island
Poquoson
Poquoson
Plumtree Island
Oak Island
Fire Stations
Langley AFB
Newport News
Hampton
Hampton
Hampton
Newport News
Peak Inundation – Hurricane Isabel
Hampton/Poquoson, VA
CBOS
noblis
VIMS

Hurricane Isabel - Hampton/Poquoson
Inundation versus Sea Level Rise



Chesapeake Bay Observing System CBOS

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Thank You

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barry.stamey@noblis.org
703.610.1652

noblis™

Chesapeake Bay CBOS Observing System

Planning for Sea Level Rise and Storm Surge Inundation: Climate Impacts in Hampton Roads

Regional Climate Change Meeting
Hampton Roads Planning District Commission

October 29, 2009

Barry Stamey

Director, Strategic Collaboration, Noblis

and Colleagues in the Chesapeake Bay Region

noblis
For the best of reasons