# The Office of Infrastructure Protection

National Protection and Programs Directorate
Department of Homeland Security

Climate Change Adaptation Planning in the Casco Bay Region of Maine

Regional Resiliency Assessment Program Out-Brief

December 20, 2016

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# ME CCA RRAP Project Summary

- Project supported the following national climate change plans, policies and directives:
  - The President's Climate Action Plan
  - Executive Order 13653: "*Preparing the United States for Impacts of Climate Change*."
  - The DHS Climate Change Adaptation Road Map

# ME CCA RRAP Objectives

- Assess climate change related impacts and vulnerabilities to lifeline sector infrastructure systems
- Identify dependencies, interdependencies, and cascading effects of the loss of regional infrastructure systems
- Identify gaps in our understanding of regional or sector specific issues related to climate change impacts to critical infrastructure resilience
- Provide data and develop methodologies to help the region's communities and businesses better understand and manage the risks associated with extreme weather and other impacts of climate change

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# MAINE CLIMATE CHANGE ADAPTATION RRAP

## Phase 1
### Initial Engagement

- Identify and Engage with State and Local Stakeholders
- Assess Utility of USG Climate Data Initiative (CDI) and Climate Resilience Toolkit (CRT) to Support State and Local Adaptation Planning

1. Assessment of State and Local Adaptation Planning Initiatives

JAN 14 — MAR 14

## Phase 2
### Climate Change Adaptation Assessment

- Conduct CI Life-line Workshops:
  - Energy (Electric & Fuel) Life-line Sector
  - Transportation Life-line Sector
  - Telecommunications Life-line Sector
  - Water/Waste-water Life-line Sector
- Conduct Capstone Facilitated Discussion to Determine Stakeholder Adaptation Planning Resource Requirements
- Identify Federal Resources to Support State and Local Adaptation Planning

1. Results from Adaptation Workshops
2. Results from Capstone Facilitated Discussion
3. Interim Resiliency Assessment

APR 14 — OCT 14

## Phase 3
### Climate Change Adaptation Implementation

- Conduct Adaptation Planning TTX employing USG Climate Resilience Toolkit Five-Step Planning Process
- Provide Data, Tools and Expertise to Support State and Local Adaptation Planning Initiatives

1. Assessment of Life-line Sector Dependencies/Interdependencies in the Casco Bay Region
2. Final Resiliency Assessment

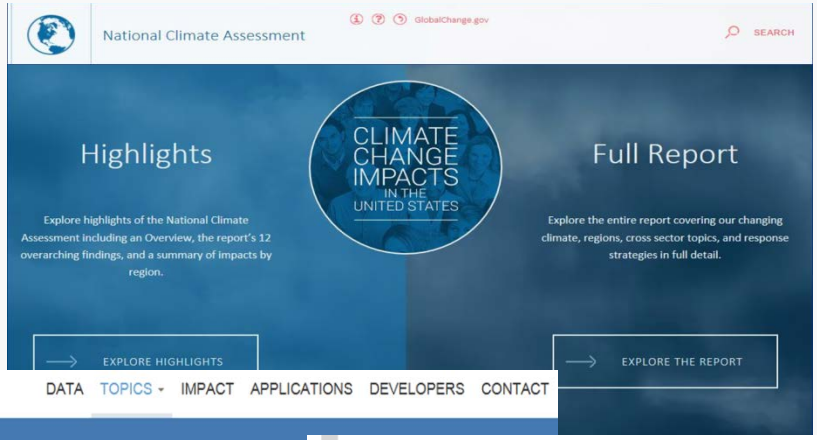
NOV 14 — DEC 16

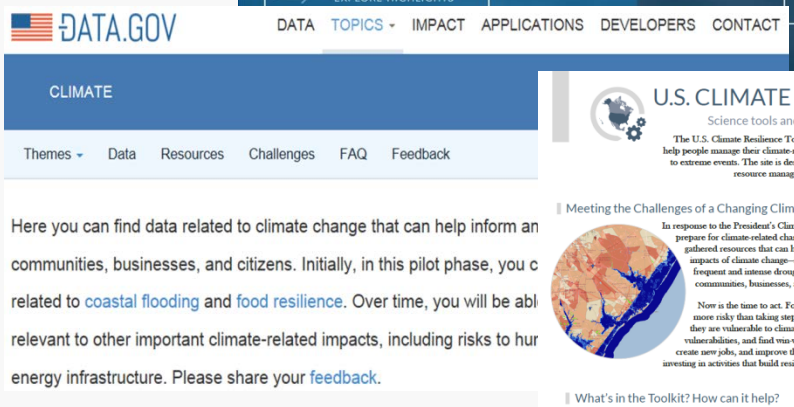
# Workshop Focus Questions

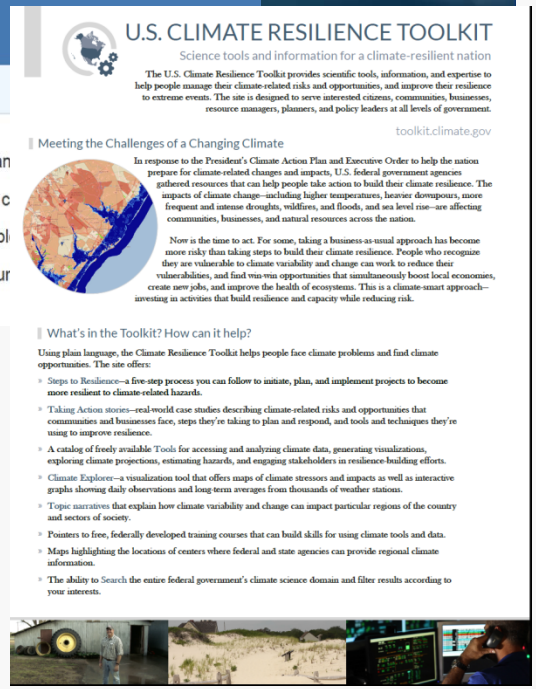
- Are there critical nodes in the lifeline functions that could be impacted by climate change?
- Are there critical dependencies or interdependencies that could be affected by the projected impacts?
- Does your organization have existing adaptation plans or strategies?
- What are the barriers that prevent active and effective adaptation planning?
- What does your organization need to move forward with its adaptation planning efforts?

# Federal Resources Employed

- USGCRP Third National Climate Assessment
- Climate Data Initiative (data.gov/climate)
- Climate Resilience Toolkit (http://toolkit.climate.gov)

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# Climate Change Adaptation Challenge

- The vast majority of infrastructure is still being designed for a static climate
  - Design standards and tools use historical records (e.g., rainfall, temperature)
  - Standards drive design to avoid liability in the event of failure
  - Unless design reflects a changing climate, failure is more likely
- Barriers to climate change adaptation
  - Lack of local-level modeling of temperature and precipitation changes
  - Lack of high-resolution climate scenario data to justify starting adaptation projects
  - Lack of a local framework for adaptation planning

*"Two issues are lack of routinely available data that's useful at the local scale and experts who can translate science-based findings into policy objectives. We simply don't have that cadre built yet of knowledgeable people who can consult and offer the advice."*

*—Alice Hill, National Security Council, White House, June 2015 speech on mainstreaming climate risks into U.S. Government Planning*

# Outcomes

- Casco Bay Estuary Partnership is serving as RRAP implementation host organization
  - Will convene workshops with local municipalities on the use of RRAP products
  - Using radar and climate data to inform ongoing projects
- Gulf of Maine Research Institute Community Resilience Informed by Science Experience (C-RISE) program to use all RRAP products
- City of Portland is requesting immediate assistance using storm surge modeling and rainfall analysis to inform large-scale waterfront redevelopment planning
- City of South Portland is interested in using storm surge modeling tool to assess impacts to industry and infrastructure along Fore River
- Maine DOT Hydrology and Environmental Divisions will use IDF curve report and data to inform NEPA and hydraulic design
- Local universities (UMaine, Bowdoin, USouthern Maine) are utilizing climate modeling data and manual, references to RRAP in their programs
- NOAA's Northeast Regional Climate Center (NRCC) at Cornell is hosting and utilizing climate, radar, and IDF products

# Outcomes

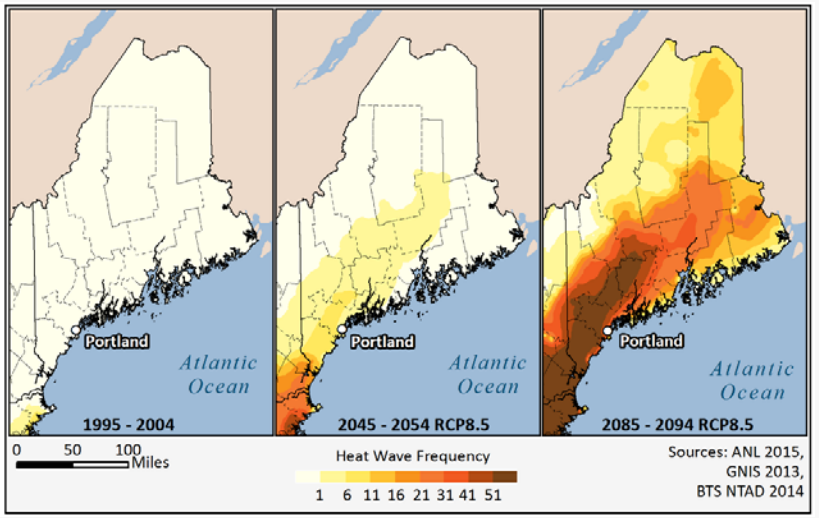
- Through our network of stakeholders and mission partners, we will continue to share the latest climate change information; participate in State, local, and regional climate-change-related planning and information exchange events:
  - Maine Prepares (the annual preparedness conference for the entire State)
  - New England Federal Partners
  - NOAA's Northeast Regional Climate Center, etc.
- Assist other IP Regions to further their understanding of the impacts of climate-change-related severe weather on critical infrastructure
  - Climate Data User Guide under consideration for use in TX and CA RRAPs
  - Electric power heat wave analysis is informing Region 1 RRAP
  - Hydrological analysis methodology being used for NJ RRAP
  - Radar and hydrological analysis being considered for NYC RRAP, etc…
- Support IP/IDR by advising on critical infrastructure development and recovery issues related to climate-change-driven severe weather events in affected communities and facilitating coordination with critical infrastructure owners and operators

# Implementation Activities

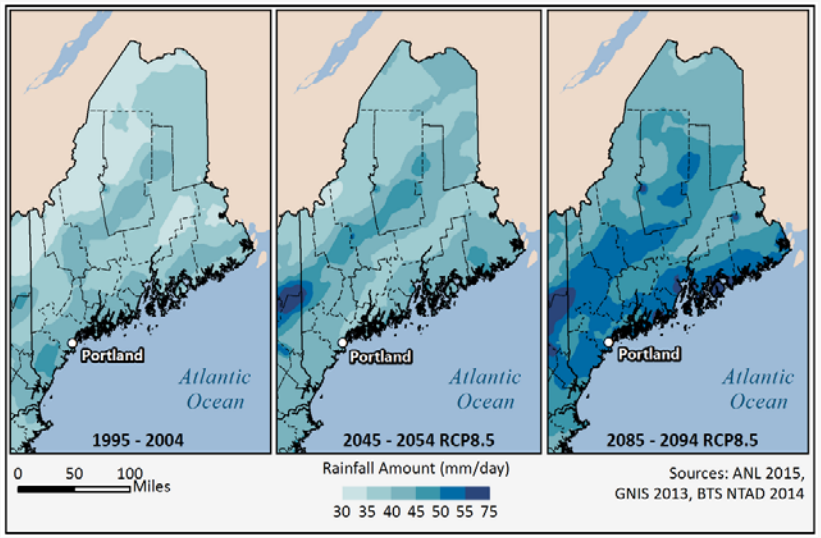
1. Regional Climate Modeling (RCM)
2. Radar-Based Rainfall Data
3. Intensity Duration Frequency (IDF) Curve Development
4. Storm Surge Modeling

# Regional Climate Modeling

- Increases spatial resolution of climate model output: 1- to 2-degree grids (global scale) to 1/8-degree grids (regional scale)
- Downscaling involves using Argonne's supercomputing facility to perform multiple runs of a regional climate model
- Produces projections of the following:
  - Average and maximum annual precipitation
  - Average and maximum annual temperature
  - Other climate stressors identified by stakeholders
  - Multiple time slices: mid-century, end of century




Projected Trend in the Average Number of Heat Waves per Decade




Projected Average Annual Maximum Precipitation (Greater than 99%)
*Source: Argonne National Laboratory EVS Division (2015)*

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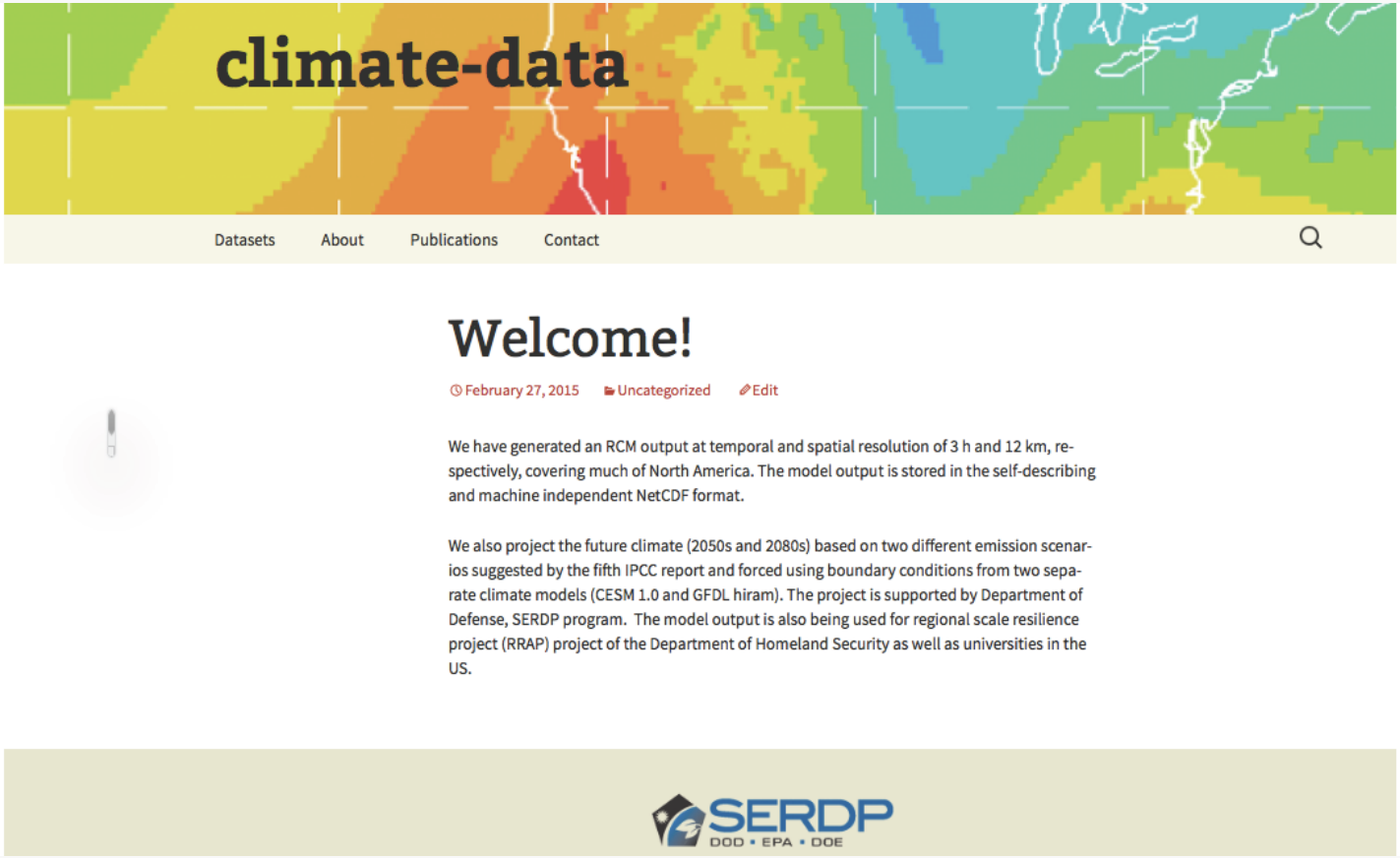
# Dissemination of Model Results (Data Portal) Using a Globus-based Data Distribution Model

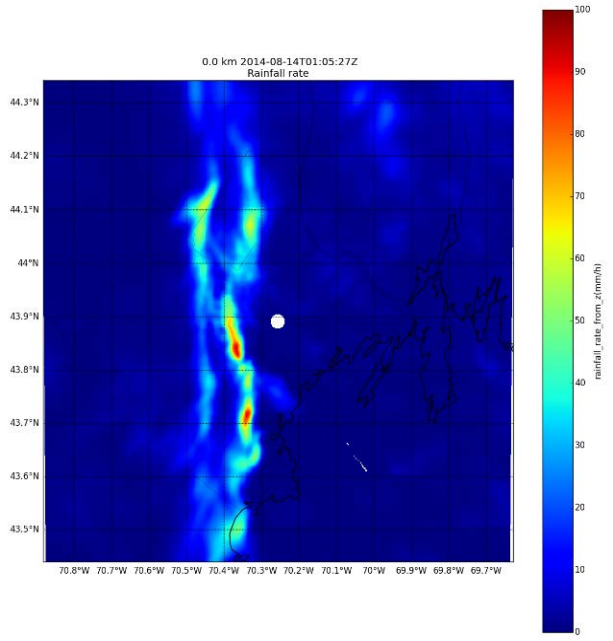


# Using Downscaled Climate Data to Drive Infrastructure Impact Models

- Infrastructure models (e.g., electric, natural gas, petroleum, water, transportation systems) can be coupled to climate models to assess climate hazards
- For example, Argonne is using the EPfast (electric) model as part of an analysis of the impacts of mid-century increased temperature on Maine's electric grid to
  - Determine impacts on the capacity of power plants, transmission lines, and transformers, as well as growth in demand
  - Identify implications on overall grid performance via load flow simulation
- Results show that increasing temperatures affect seasonal electricity demands (e.g., increased cooling demand in the summer), power plant output, and transmission line capacity, which could cause rolling brown-outs if electric infrastructure does not adapt

*Regional climate models, coupled with infrastructure modeling and analysis, can inform planning decisions that will result in design and construction of more resilient infrastructure in the future.*

# Radar Climatology of Rainfall over Portland, Maine




*Source: Argonne National Laboratory EVS Division (2016)*

- Key science question: Is the RCM output (12-km resolution) refined enough to resolve high-intensity localized precipitation events?
- To answer this question, we used National Oceanic and Atmospheric Administration (NOAA) Weather Surveillance Radars to create high-resolution (200-m) rain maps to feed into hydrological models to analyze the impact on stream and culvert flow
- More than 10 years of 10-minute-resolution retrievals were performed, generating a 1-Tb database of rainfall maps and a “look-up table” to identify extreme events
- Provides full spatial coverage of an area, as opposed to extrapolating area rainfall information from point-measurements (e.g., rain gauge stations)
- A report and data from this task are available on the Northeastern RRAP web site

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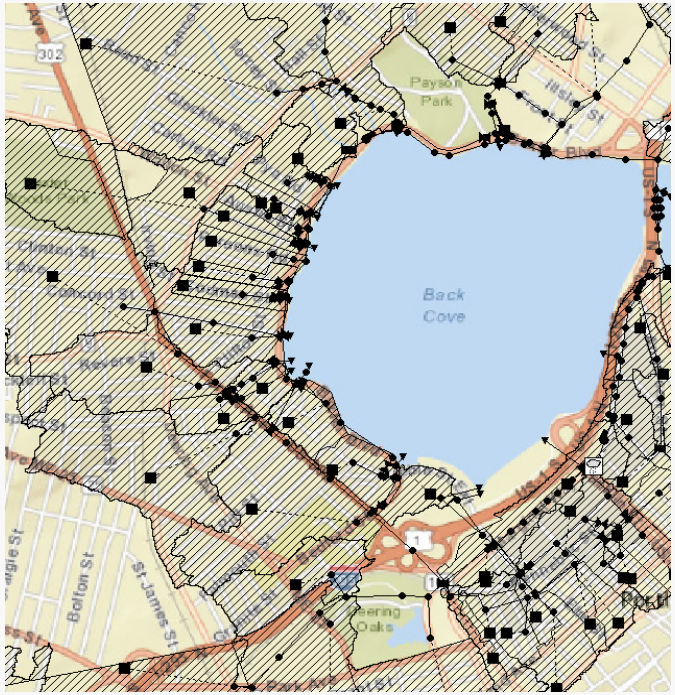
# IDF Curves for Portland, Maine




SWMM data showing drainage network

*Source: City of Portland, Maine*

- The City of Portland recommended the Back Cove area as a test site and provided storm water management model (SWMM) data
- A two-dimensional (2-D) hydraulic model was constructed to simulate flow on streets, roof tops, and subsurface drainage system
- Incorporated outputs from radar analysis
- Radar data at 250-m resolution captured spatial variation that cannot be identified based on very limited hourly rain gage stations
- Used the radar data for input to the 2-D hydrological/hydraulic model
- A report and data from this task will be available on the Northeastern RRAP web site

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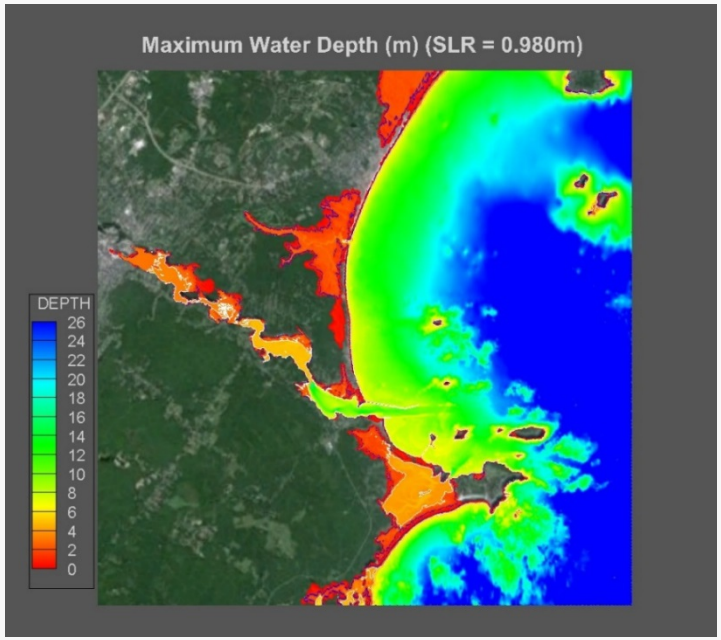
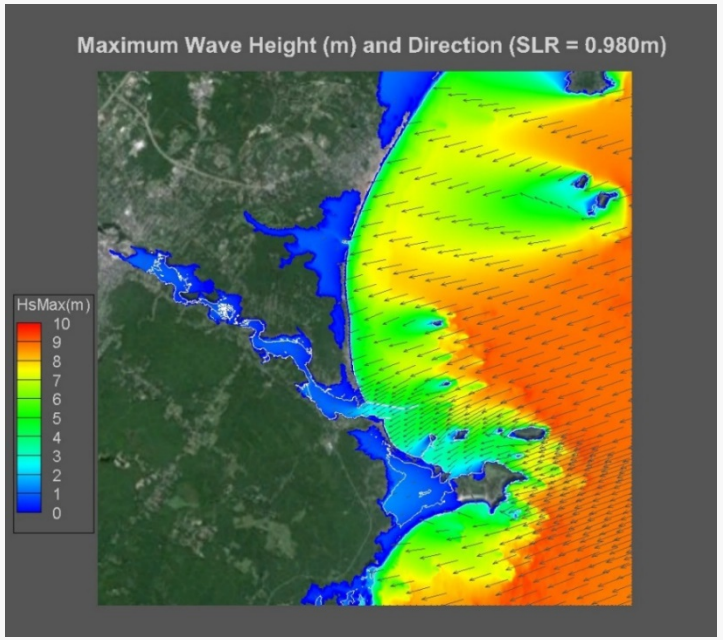
# Storm Surge Modeling

- Projected sea level rise in the region will amplify the effects of storm surge
  - Increasing storm inundation areas
  - Increasing wave action impacts
- Coastal infrastructure that is vulnerable to inundation and marine infrastructure will experience increased loading associated with storm surge waves




*Source: National Center for Computational Hydroscience and Engineering*

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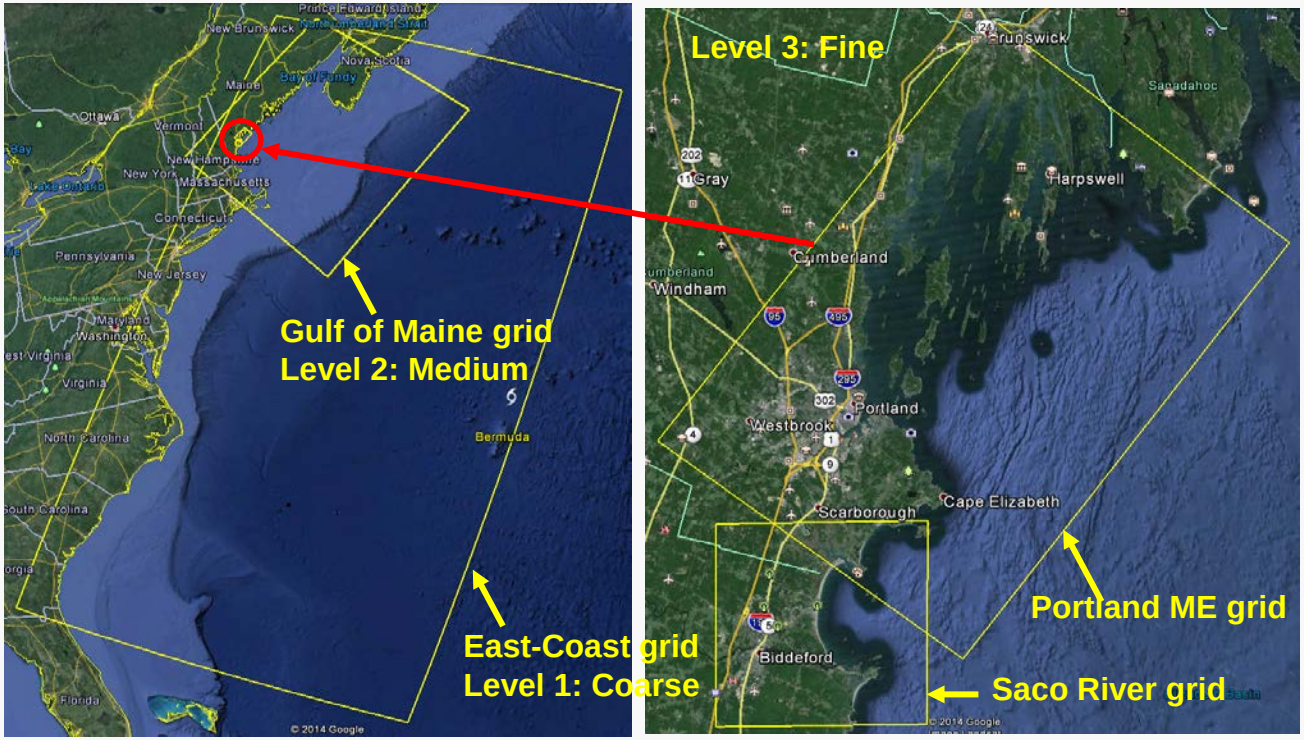
# Storm Surge Modeling (Cont.)

- The National Center for Computational Hydroscience and Engineering (NCCHE) developed three nested model resolutions for preliminary storm surge analysis of an extreme, Sandy-like hurricane
- These models produced data on hydrodynamics (e.g., wave height and direction), sediment transport (e.g., erosion), and wind field (e.g., speed and direction)

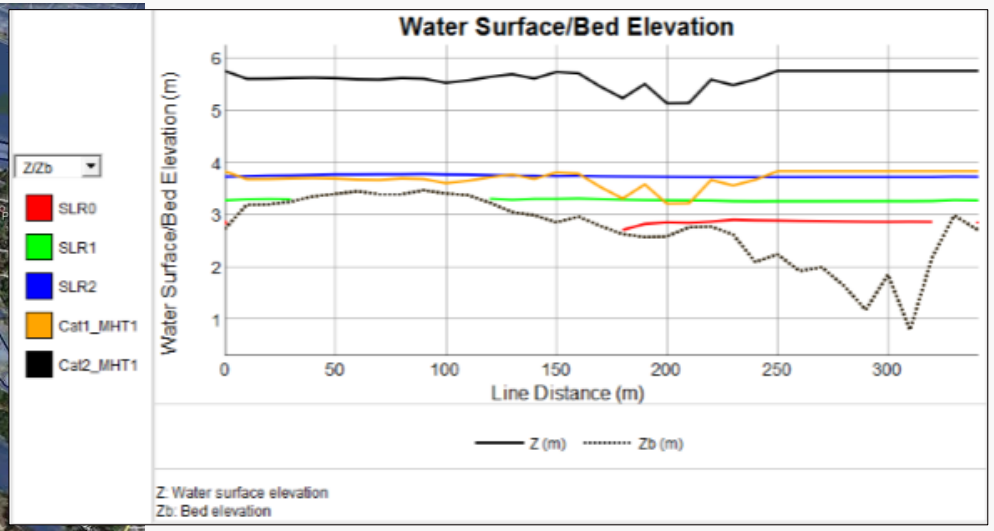



*Source: National Center for Computational Hydroscience and Engineering*

# Storm Surge Modeling (Cont.)

- Develop risk analysis for selected critical infrastructure utilizing simulation results
  - Risk-based prioritization of assets based on the probability and consequence of flooding
  - Data on water surface elevation and flow depth at critical locations to inform future resilience and adaptation design activities


Source: National Center for Computational Hydroscience and Engineering




Source: National Center for Computational Hydroscience and Engineering

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# Regional Climate System Assessment Framework



Source: Argonne National Laboratory

# Data and Report Repositories

- Northeastern University: Center for Resilience Studies: http://www.northeastern.edu/resilience/rrap/
- NOAA's Northeast Regional Climate Center (NRCC) at Cornell: http://precip.eas.cornell.edu/
- State of Maine Climate Change Adaptation Toolbox: http://www.maine.gov/dep/sustainability/climate/adaptation-toolkit/index.html
- University of Maine Climate Change Institute: http://climatechange.umaine.edu/
- Gulf Maine Research Institute's Community Resilience Informed by Science Experience (C-RISE): http://gmri.org/
- Senator Angus King Podcase: http://www.king.senate.gov/inside-maine-podcast

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