NORTHROP GRUMMAN

Regional Climate Modeling and Decision Aids for Sea-Level Rise Stakeholders

Presentation to: Hampton Roads Planning District Commission

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Northrop Grumman

Who We Are

NORTHROP GRUMMAN

- Atmospheric Sciences and Engineering Dept within the Northrop Grumman Information Services (NGIS) Sector
  - Located in Chantilly VA
- Expertise is in the Atmospheric and Computational Sciences
- Our 24-member Department includes:
  - Seven Ph.D's in the atmospheric, climate and physical sciences
  - 75% have advanced degrees
  - Over 100 years of combined experience in the atmospheric sciences
- We have a thirty year history in Applied Meteorology supporting both Government and Industry

Our Interest in Climate Change

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- Northrop Grumman business is impacted by the impacts of climate change
  - Including sea-level rise!
- NG owns and operates several multi-billion dollar national assets
  - Newport News Ship Systems
  - Gulf Coast ship building (New Orleans LA & Pascagoula MS)
- We believe our exposure to risk in these areas is large but needs to be quantified
- It is critical to quantify risk in order to develop risk mitigation strategies
- NG has turned to our department to lead in quantifying these risks

Our Approach to Climate Change Adaptation

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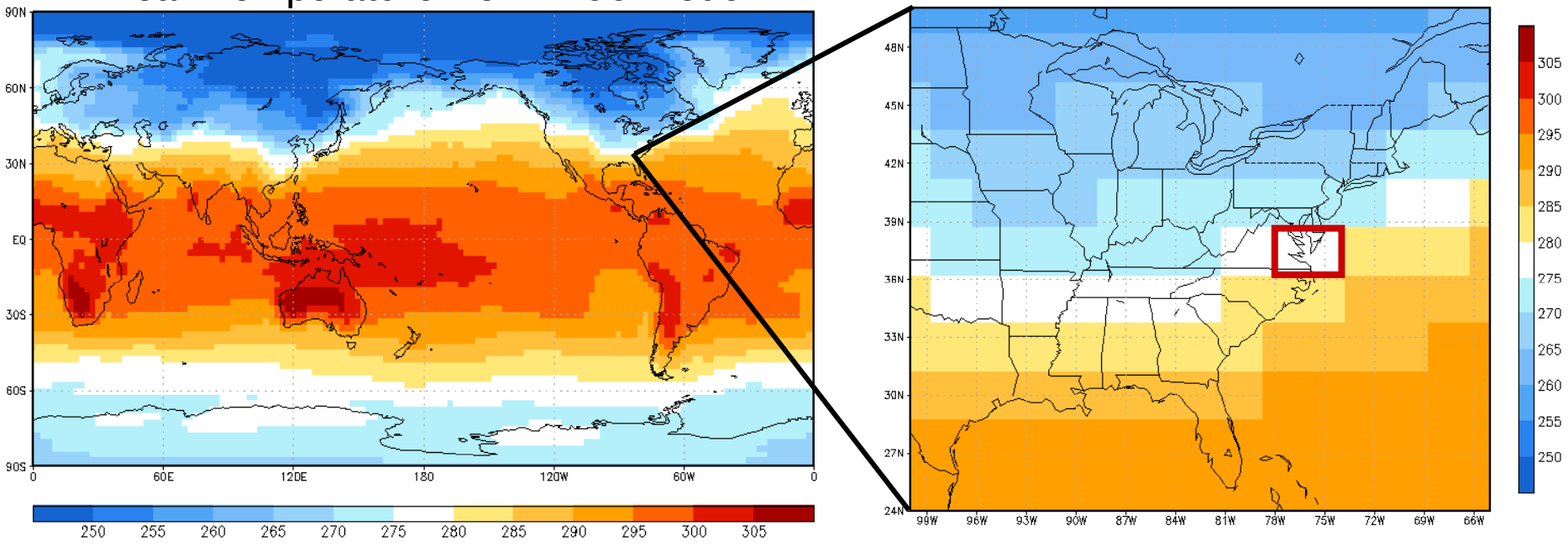
- Global models are used to produce the projections that are advertised by the Intergovernmental Panel on Climate Change (IPCC)
- These models are run at very coarse resolution (e.g., 250km) and therefore can not resolve regional & local climates
  - Precipitation processes are not well-modeled by the global models

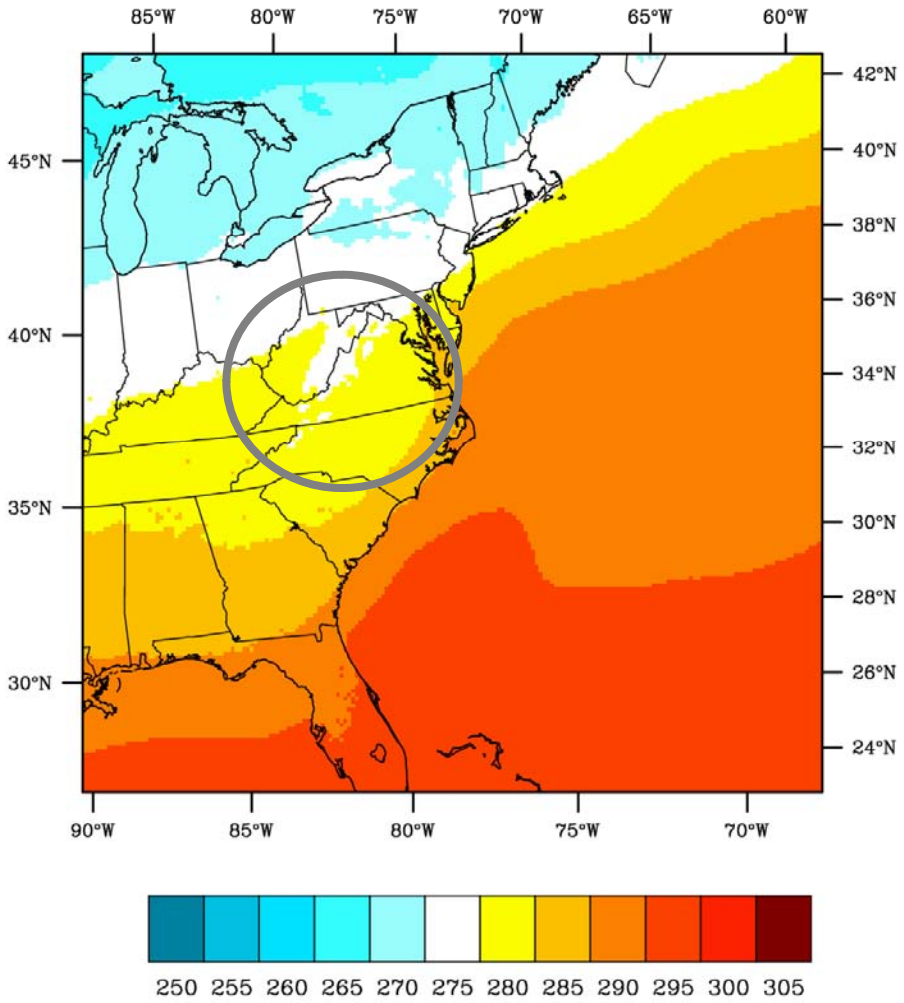
Mean Temperature from IPCC model



Appalachian mountains not resolvable

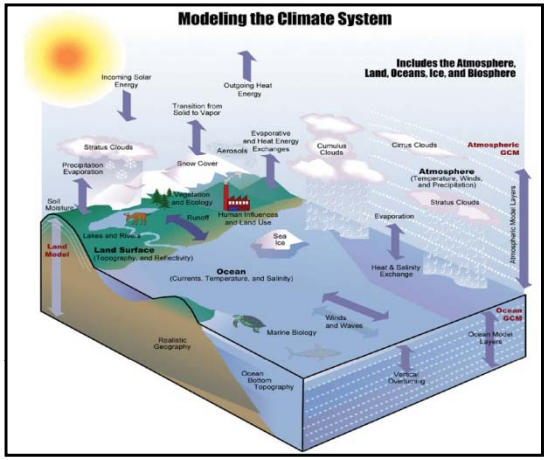
Our Approach to Climate Change Adaptation

Mean Temperature from a Weather Research and Forecasting (WRF) model 12 km simulation

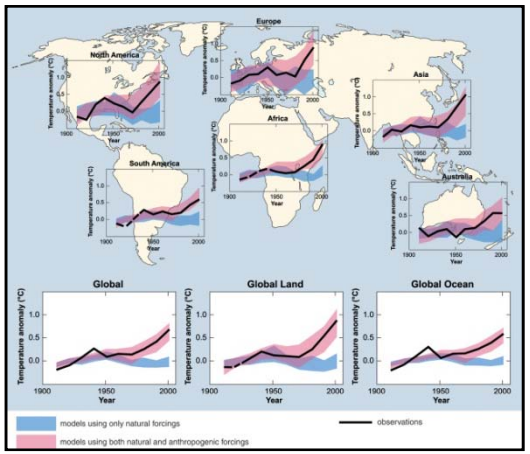


- We are using a regional model called WRF to downscale the IPCC models
- WRF provides climate projections at much finer resolution both in space and time
- Our approach is to quantify the uncertainty of climate projections by performing a number of simulations that represent different possible outcomes
- Translate high resolution regional climate projections to actionable information for risk assessors and planners

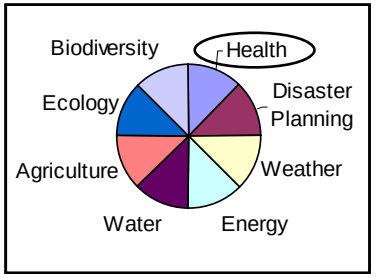
Decision Aid Development Process

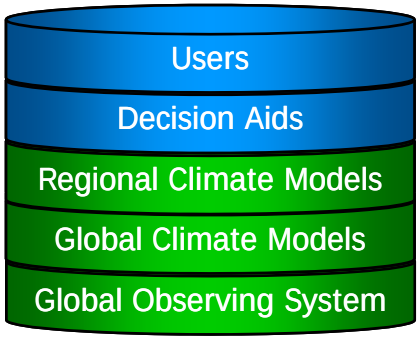


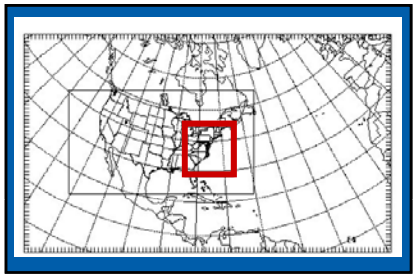
Observations, Best Science, and Physical Models



Raw Global-scale model results





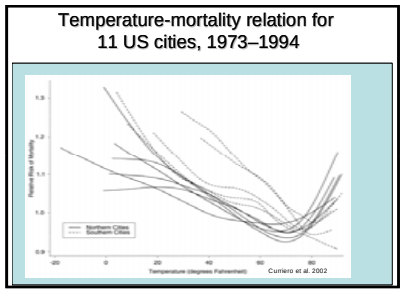


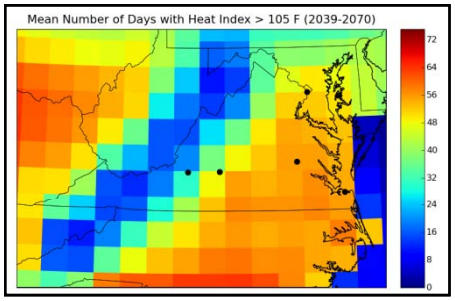
Regional Downscaling
Captures local effects and better physics

Actionable decision aid

City	Metro Pop	Mean "Oppressive" Days Per Year (Models have monthly biases with respect to GHCN removed) Current	Future	Change	Change in Deaths due to Change in Oppressive Days Deaths per Million	Additional Deaths for Metro
Richmond	1.2 M	17.47	47.22	29.8	26.78	32
Lynchburg	246 K	11.91	36.56	24.7	22.19	5
Roanoke	296 K	10.69	34.16	23.5	39.90	12
Wash. DC	5.3 M	16.31	35.56	19.3	17.33	92
Norfolk	1.8 M	13.28	38.31	25.0	22.53	40
'Change' is Future value - Current value						

Empirical and explicit decision domain modeling





High resolution regional model results

An Example Decision Aid
Impact of Heat Exposure on Mortality in Virginia

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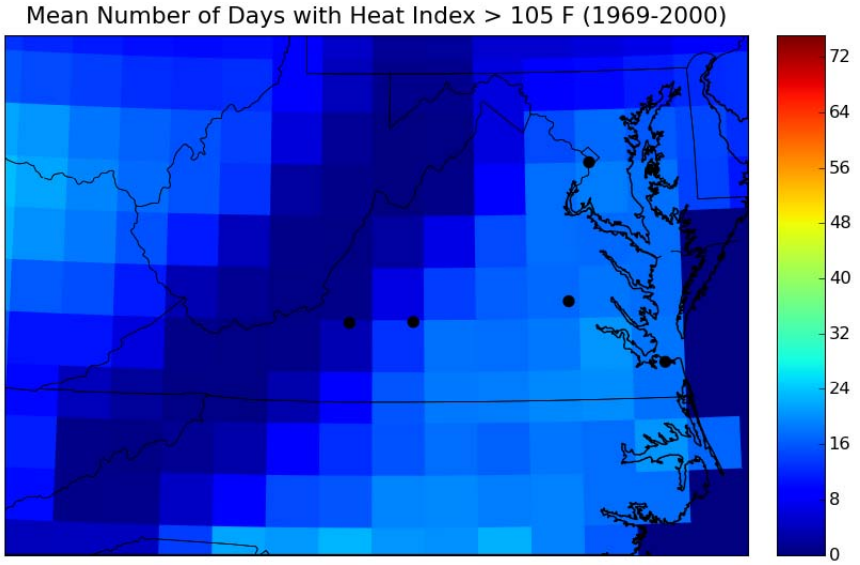

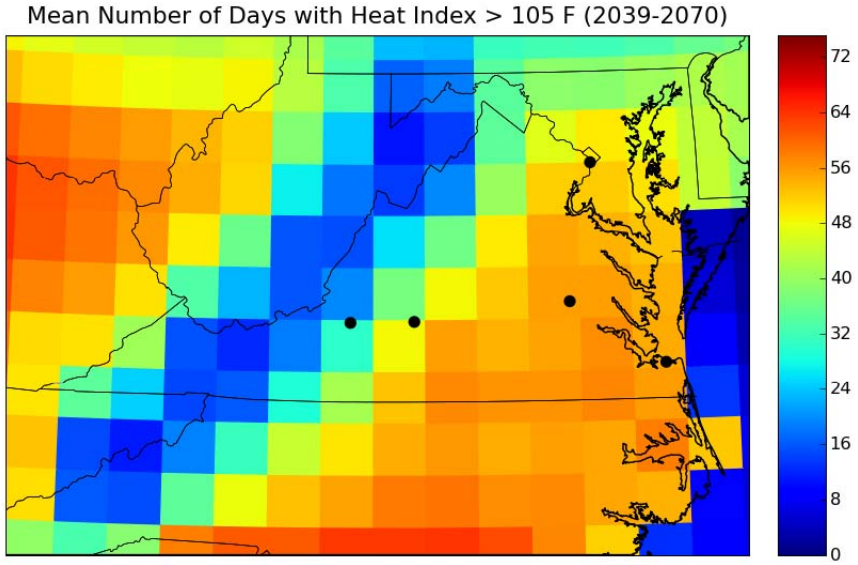

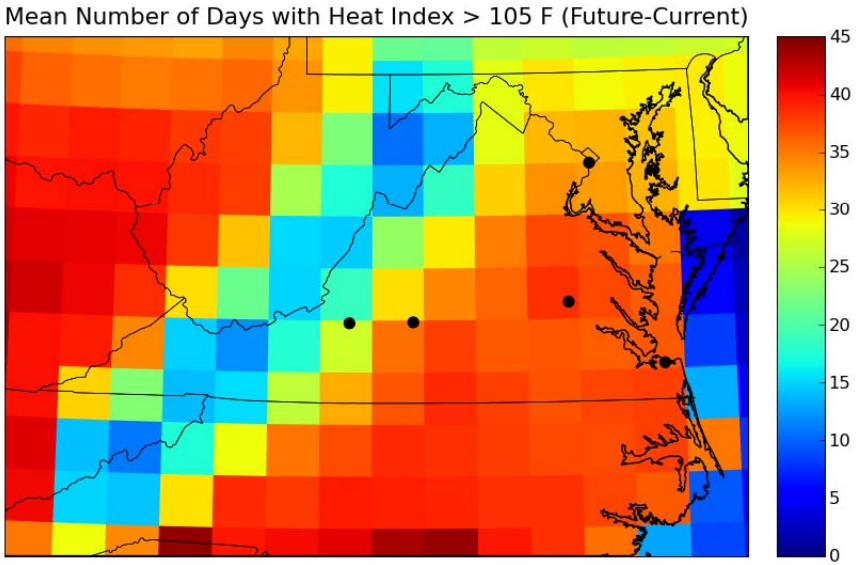

Bias corrected by month

		Mean "Oppressive" Days Per Year (Models have monthly biases with respect to GHCN removed)			Change in Deaths due to Change in Oppressive Days	
City	Metro Pop	Current	Future	Change	Deaths per Million	Additional Deaths for Metro
Richmond	1.2 M	17.47	47.22	29.8	26.78	32
Lynchburg	246 K	11.91	36.56	24.7	22.19	5
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'Change' is Future value - Current value						

Use: City planning, emergency planning, public facility planning, HVAC planning

Regional downscaling and its applications to sea-level rise impacts

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- We are interested in determining the joint risk of sea-level rise and coastal storm surge on the Newport News Shipyard
- A joint modeling effort between NG and VIMS will help to quantify these risks
- Our approach is to model a number of atmospheric scenarios in order to bound the uncertainty
- The atmospheric projections will be fed into VIMS' ELCIRC modeling system to provide us a risk assessment to the shipyard

Regional downscaling and its applications to sea-level rise impacts

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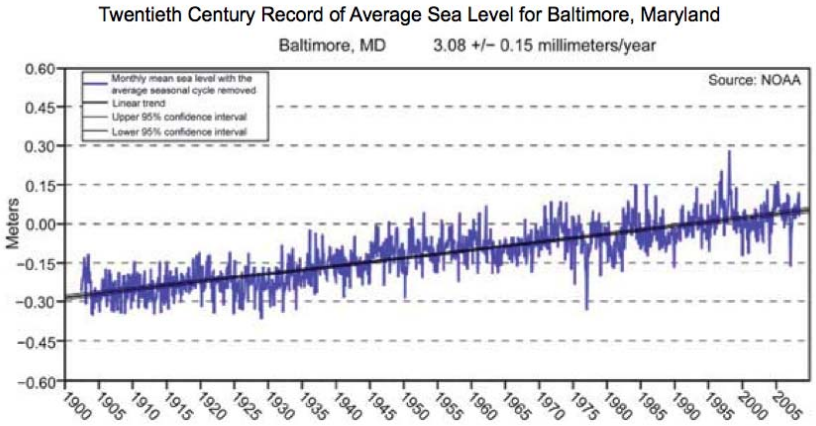
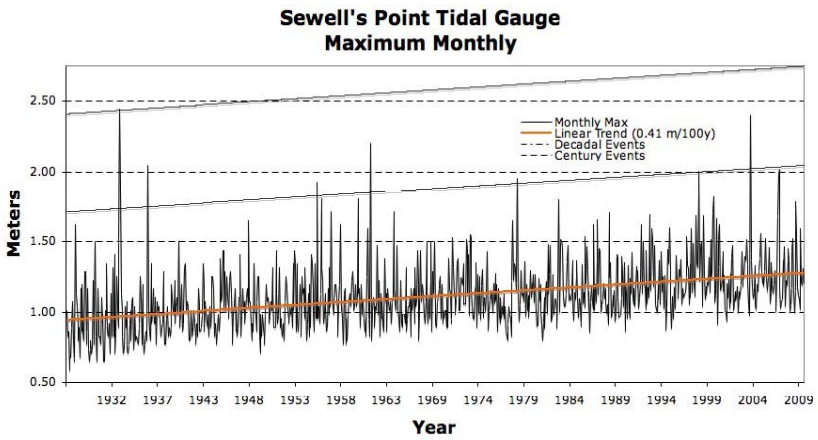
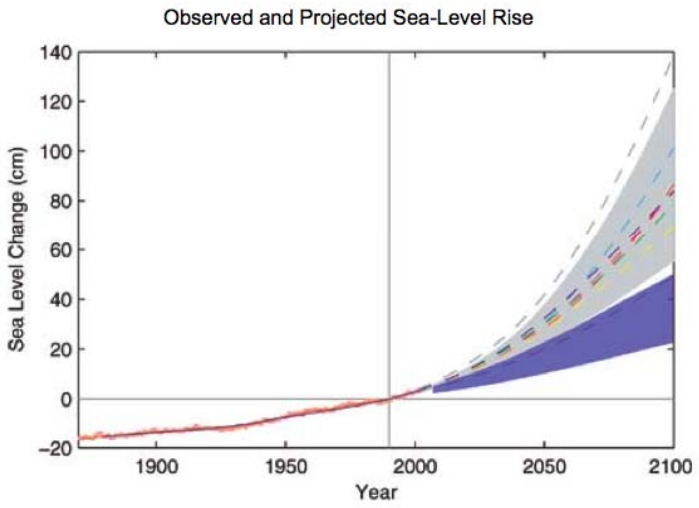
Sea Level Rise: Historical & Future





- Both Baltimore and Sewell's Point show recent sea level rise
- Rise in average sea level brings more severe decadal and century flooding events
- Future rise in sea level is uncertain only in magnitude



Regional downscaling and its applications to sea-level rise impacts

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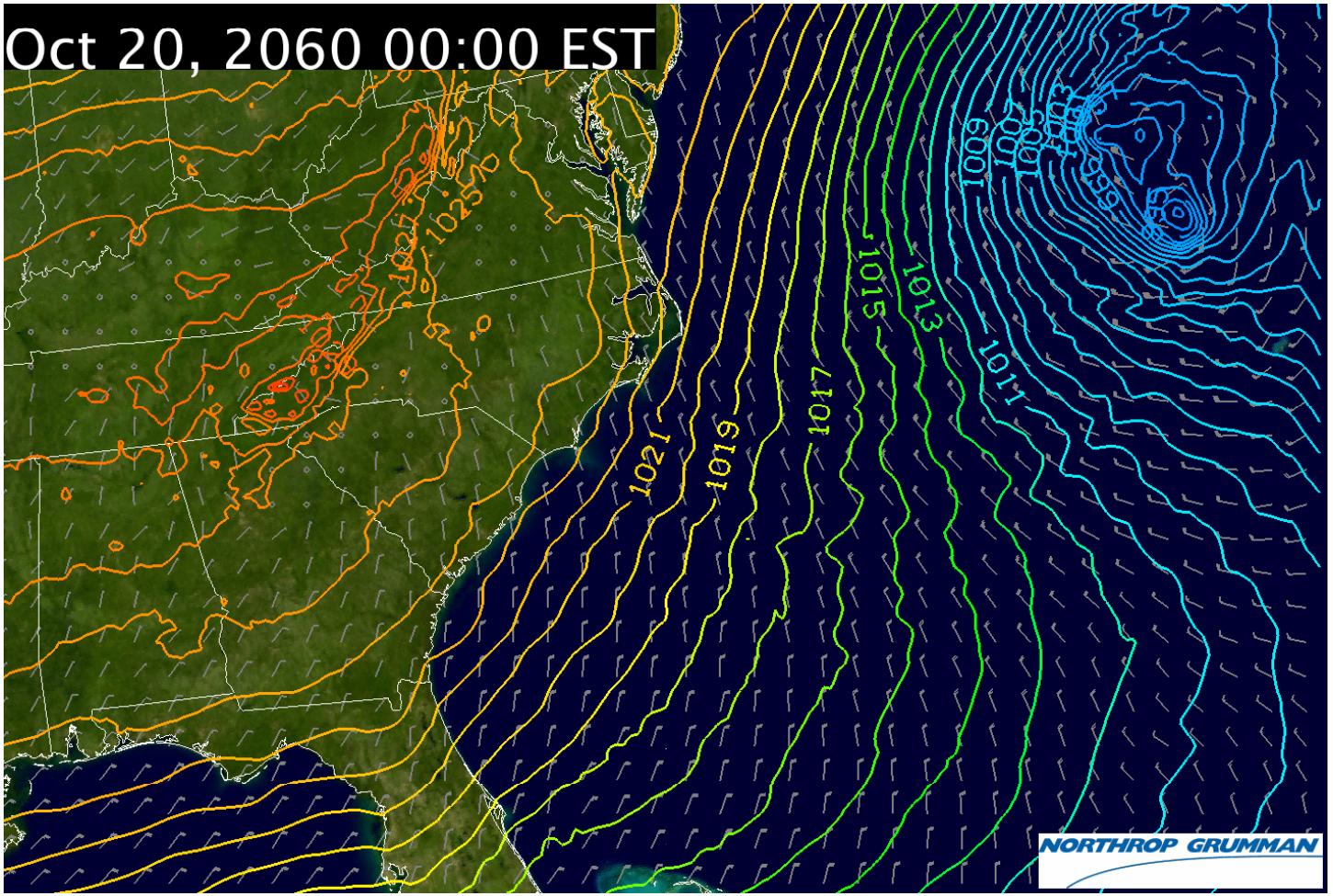
Impacts of Hurricane Isabel on the Northrop Grumman Ship Yard

James River spilling into dry dock #1

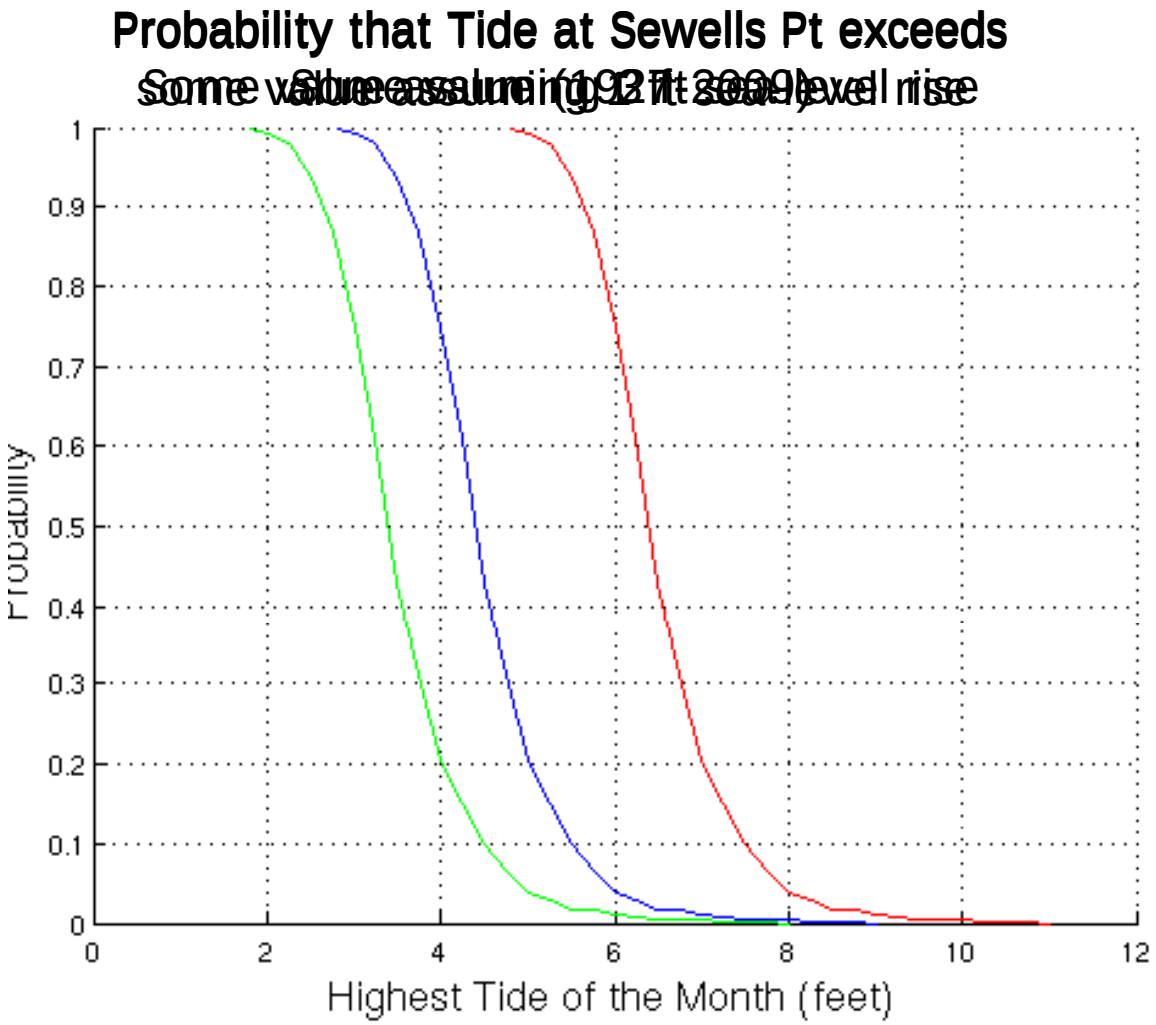
Record high water level at the Shipyard

Regional downscaling and its applications to sea-level rise impacts

NG regional climate modeling is quantifying the risk of future storm frequency in the Mid-Atlantic States



Regional downscaling and its applications to sea-level rise impacts – Notional Scenarios



Increasing Sea Level combined with storm surge frequencies alters the risk analysis

Modest levels of rise on the average increase the frequency of specific extreme events dramatically

Average Years Between Flooding Events					
Event Severity		Sea Level Rise (Ft)			
Flood Stage	Gauge Level	0	1	2	3
Action	4.50	0.70	0.15	0.09	0.08
Flood	5.00	1.71	0.33	0.10	0.08
Moderate	6.00	7.32	1.71	0.33	0.10
Major	7.00	26.83	7.32	1.71	0.33
Record	8.02	80.50	26.83	7.32	1.71
Disaster	9.00	~ 80.50	26.83	7.32	

Summary

- Northrop Grumman is reaching out to regional and local planners
  in order to understand user needs for climate information
- The combination of global and regional climate models and user-oriented decision aids can provide critical information to planners
- Using past climatic data as a surrogate for future planning is not consistent with IPCC projections
- Although climate models have weaknesses, they are improving and offer the best guidance for planning today
- Our collaboration with VIMS will help to quantify combined sea-level/storm frequencies and their impacts to the NG Shipyard