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Presentation to: Metropolitan Washington Council of Governments Climate Adaptation Workshop

23 July 2009

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Northrop Grumman

Introduction

- Climate modeling and decision aids
- Some examples of climate products and decision aids
- Summary and Discussion

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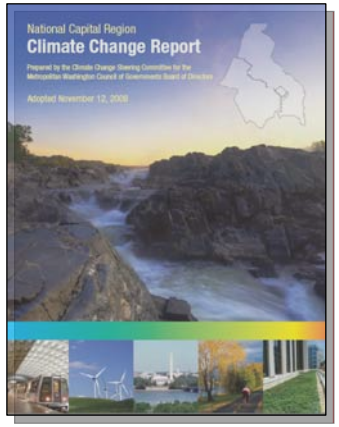
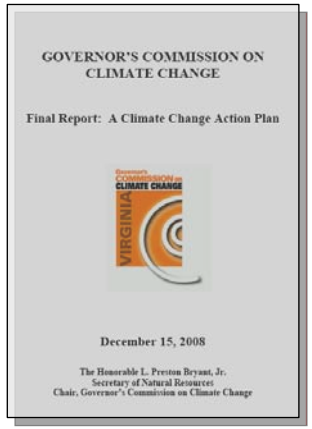
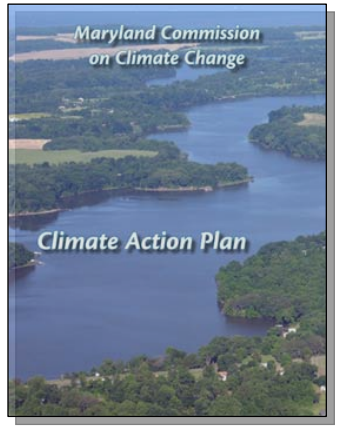
Climate Modeling and Decision Aids

Many Significant Potential Effects of Regional Climate Change

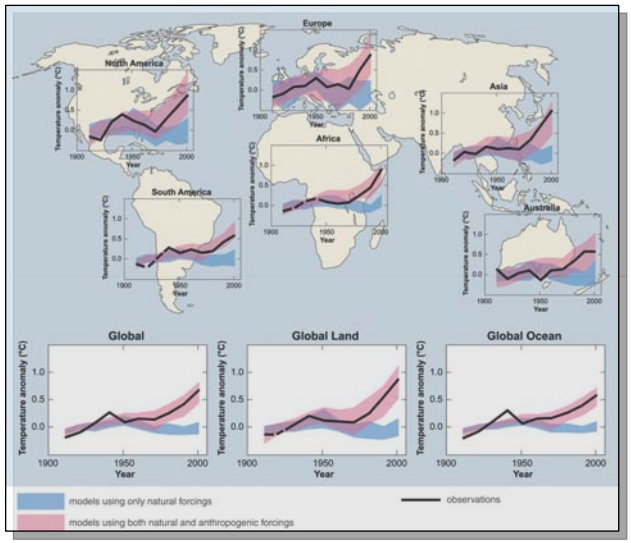






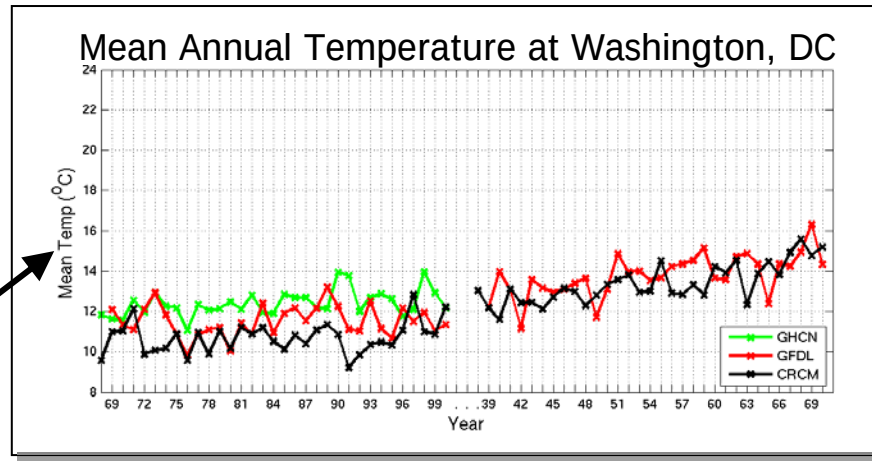
- "In addition to increases in air temperature, the metropolitan Washington region is experiencing the effects of climate change with rising sea levels and a warmer Chesapeake Bay ..."
- "Sea level rise is a major concern for coastal Virginia, particularly the highly populated Hampton Roads region."
- "The amount of warming later in the century is dependent on the degree of mitigation of GHG emissions, with summer temperatures projected to increase by as much 9°F and heat waves extending throughout most summers if GHG emissions continue to grow unchecked."
- "These increases could have significant economic impacts as well as devastating impacts on public health and the environment, ..."

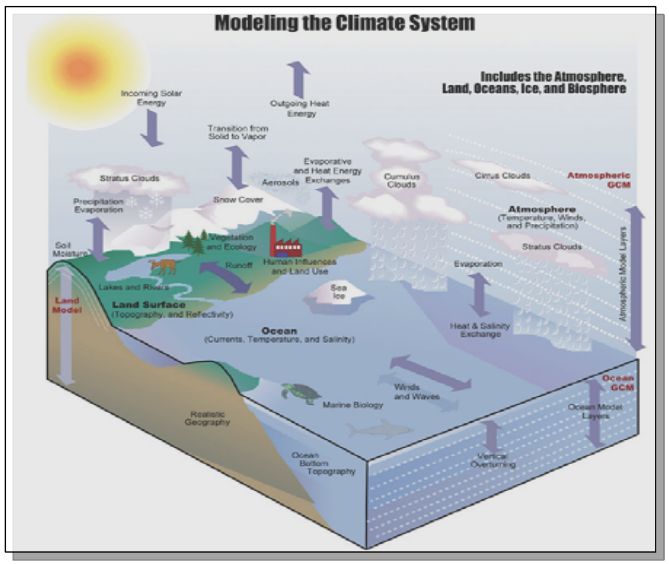
Climate Modeling and Decision Aids — Global and Regional Climate Models

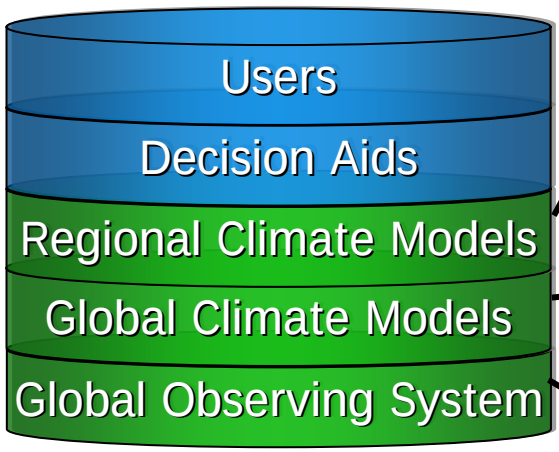


Global scale

Regional scale





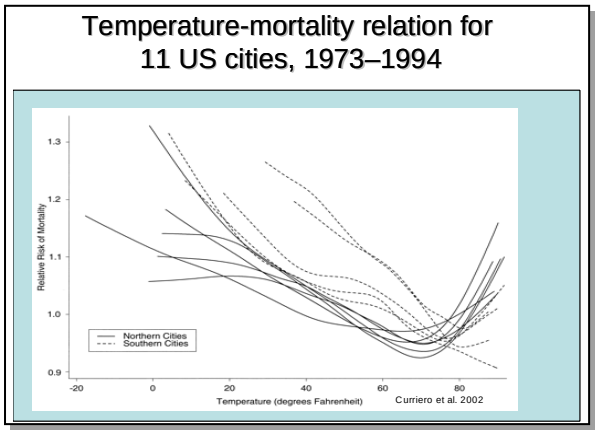


Provide consistent, higher resolution forecasts for regions

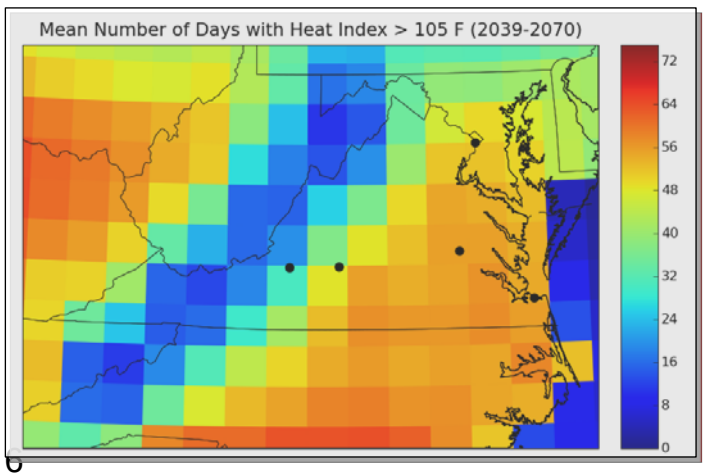
Provide coarse Resolution Climate Forecasts at Global Scales

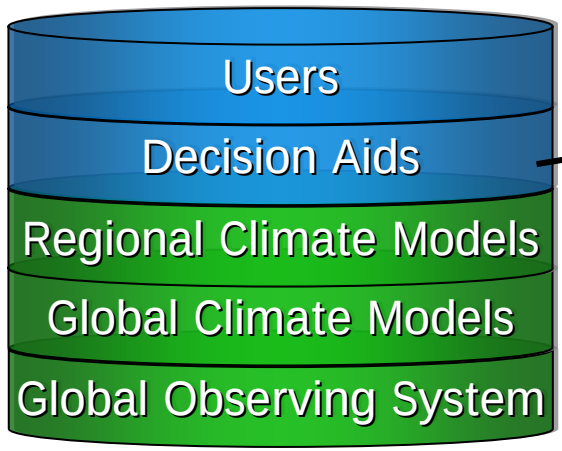
Provides Data Needed to Run and Validate Climate Models

Climate Modeling and Decision Aids — Regional Models to Decision Aids



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						



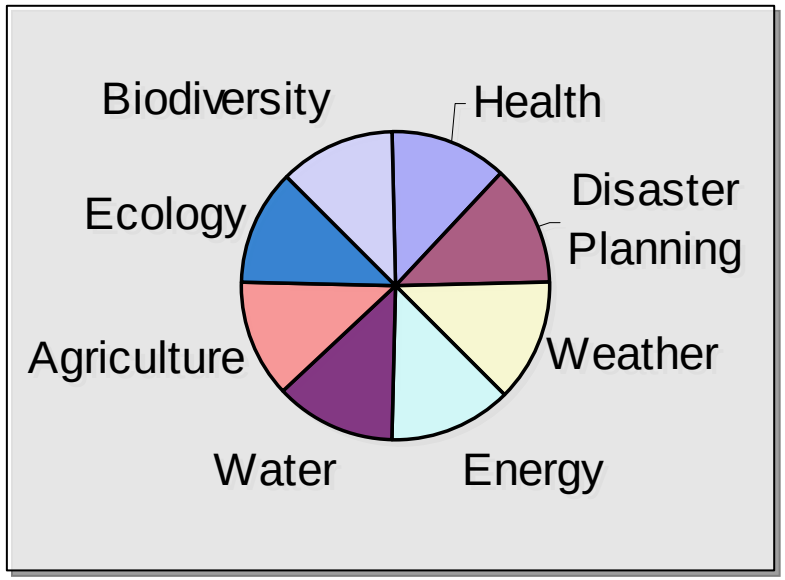


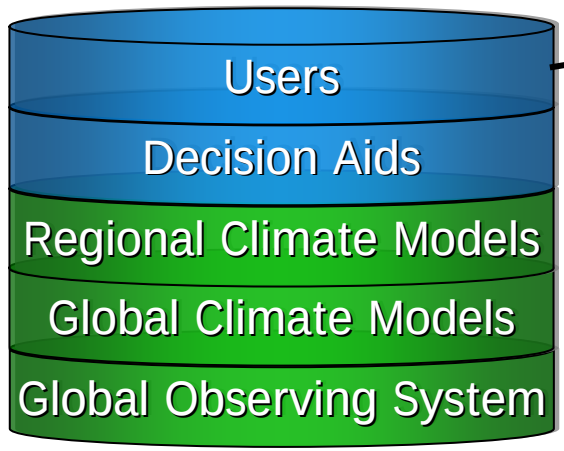
Translate Regional Climate Data into Actionable Information for Users

Temperature and Humidity from regional climate models

Climate Modeling and Decision Aids- Users

- Users in various sectors understand how the environment affects their industry
- Where climate or weather statistics are now used in planning, so will they likely be used in the future
- The IPCC is saying that the climate is changing, so past climatic data should be replaced with our best estimate of future climate data
- It is also possible that regions that did not need to consider certain issues in the past (impact of sea level rise) will need to consider those issues in the future

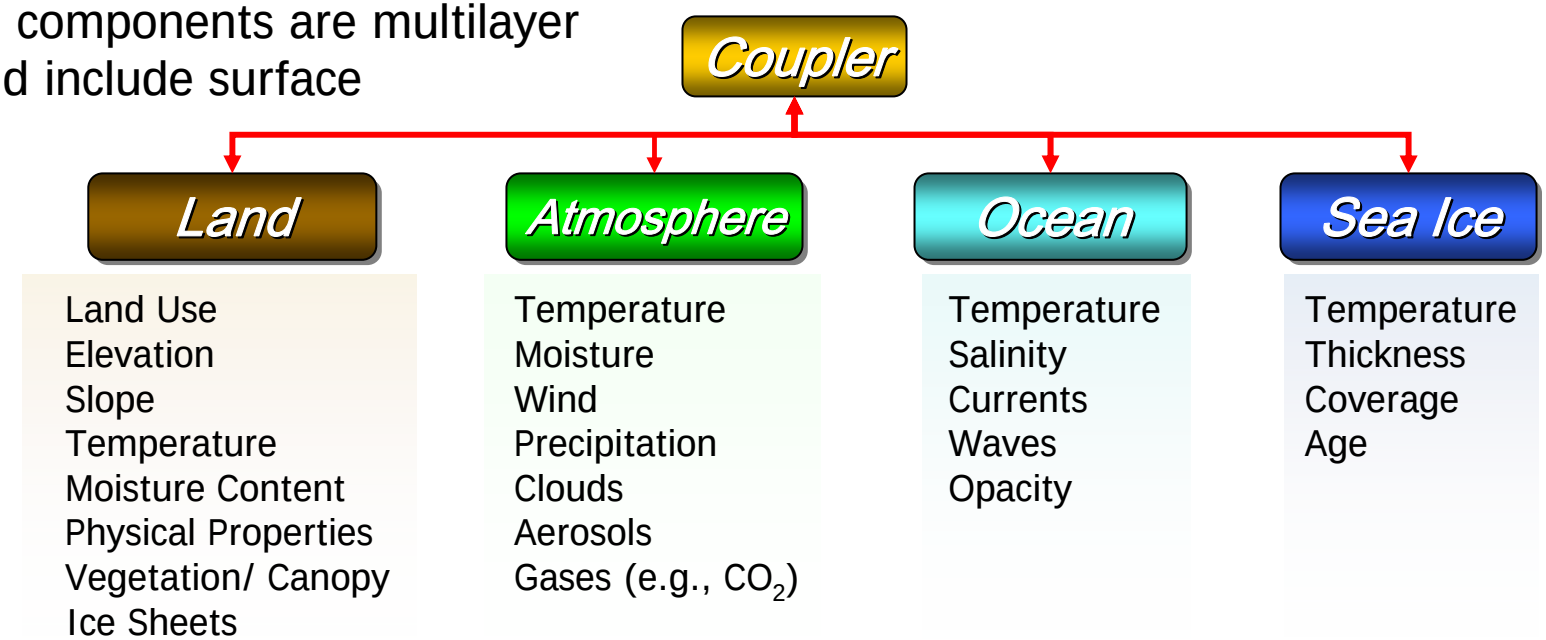




Need to make adaption and mitigation decisions based upon climate change

Climate Models and Decision Aids: Coupled Global Climate Model Components

All components are multilayer and include surface

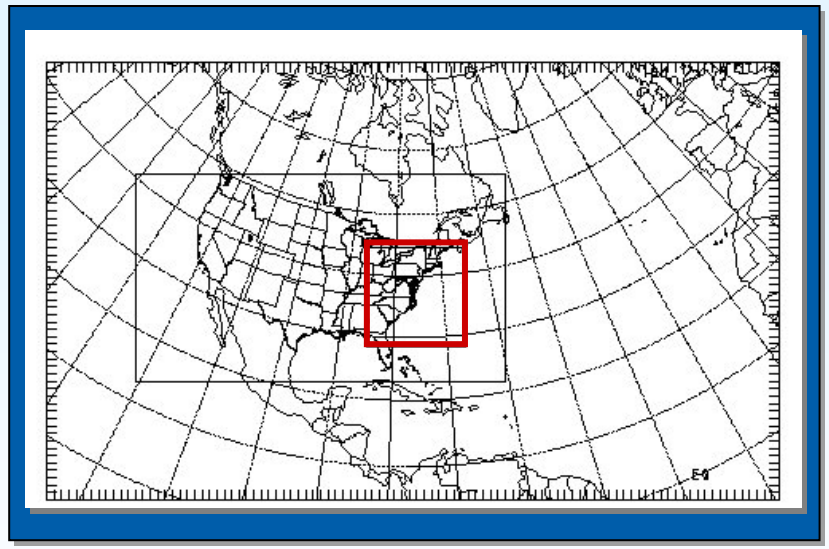


- Sophisticated modeling across four basic areas
- Component parameters (e.g., Temperature) change with time
- Resolution is coarse (~200km resolution) for global models because of the enormous computational requirements
- Physical modeling simplified at coarser resolutions

All products derived from the IPCC 4th Assessment Report are derived from these models

Climate Models and Decision Aids: Regional Climate Models

- Provide higher resolution modeling over a limited area
- Are able to model physical processes not resolved by the global climate models
  - e.g., precipitation processes are not well-modeled by the global models
- Regional models include physics to better resolve precipitation processes
- The weakness of current regional climate models is that they are not interactively coupled with the global climate models
- Current research is addressing this limitation



NG Regional Modeling Domain
Over the Mid-Atlantic States
10km Resolution

Climate Models and Decision Aids: Regional Down Scaling Approach

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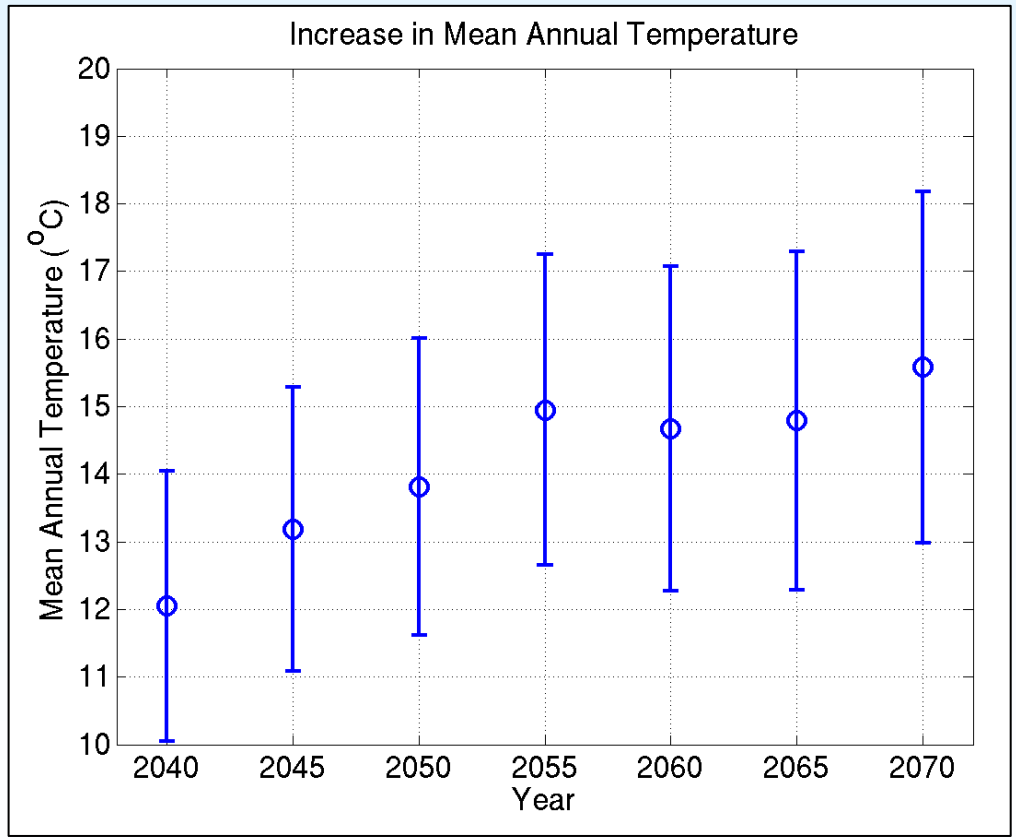
- A single run of an RCM will produce one prediction
- Due to uncertainties in climate modeling no single simulation is reliable
- Our approach is to quantify the uncertainty
- Thus the most likely outcome can be determined from the distribution of simulations
- This approach is embraced by the research community as the best method for quantifying the uncertainty



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Some Examples of Climate Products and Decision Aids

Some Examples Climate Products and Decision Aids

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- Temperature trends in a few cities from Regional Climate Models
- Decision Aids Examples for:
  - Agriculture
  - Health
  - Energy
  - Coastal Flooding

Some Examples Climate Products and Decision Aids Annual Temperatures for Several Cities

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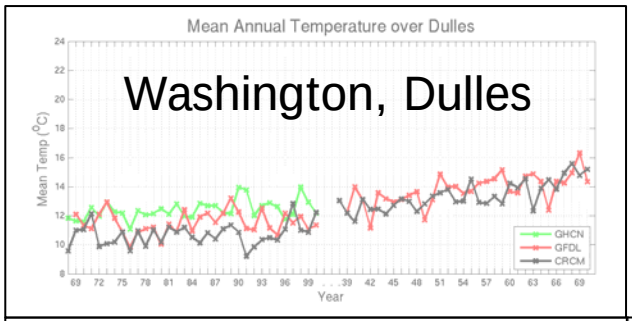
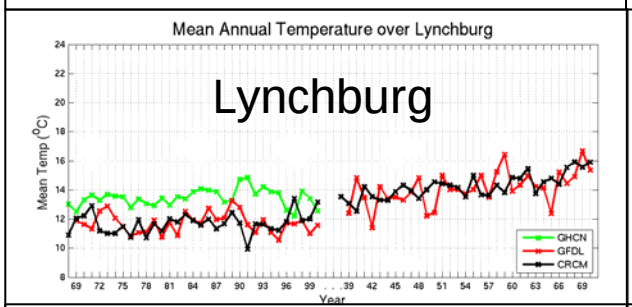
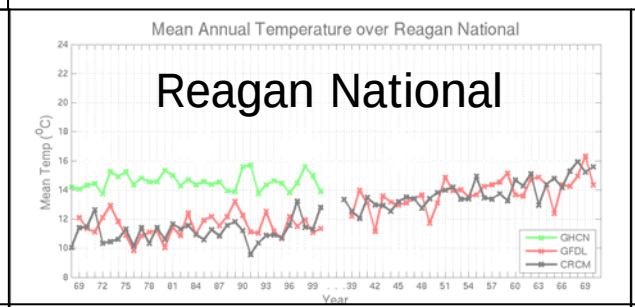
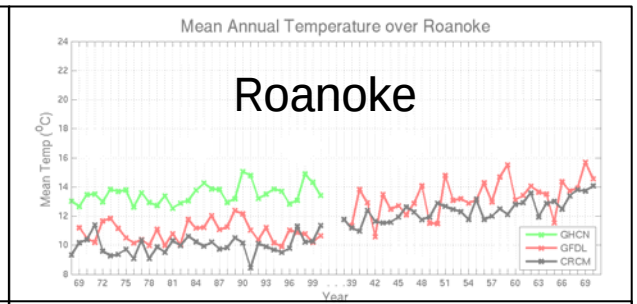
Plots below show the mean annual temperature over each site

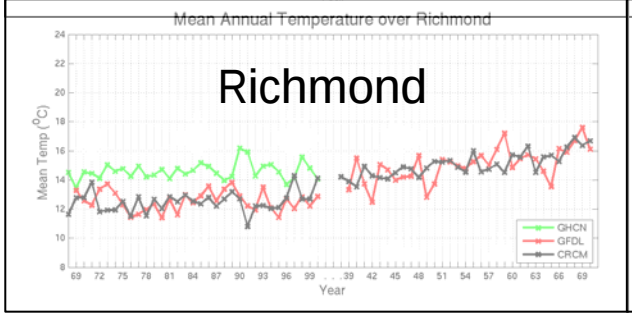


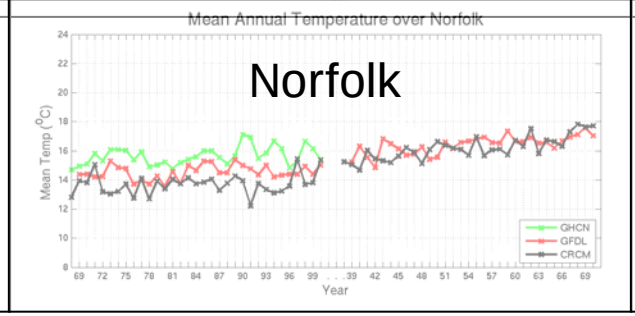
- At most sites, temp increases throughout the current and future periods, although the rate of increase is much higher in the future period
- Biases are evident at some sites and vary by season

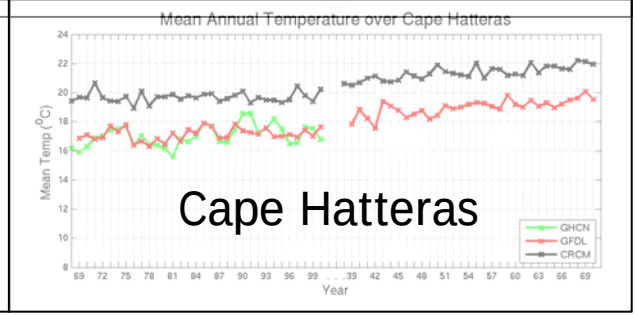












Some Examples Climate Products and Decision Aids Agriculture: VA Growing Season

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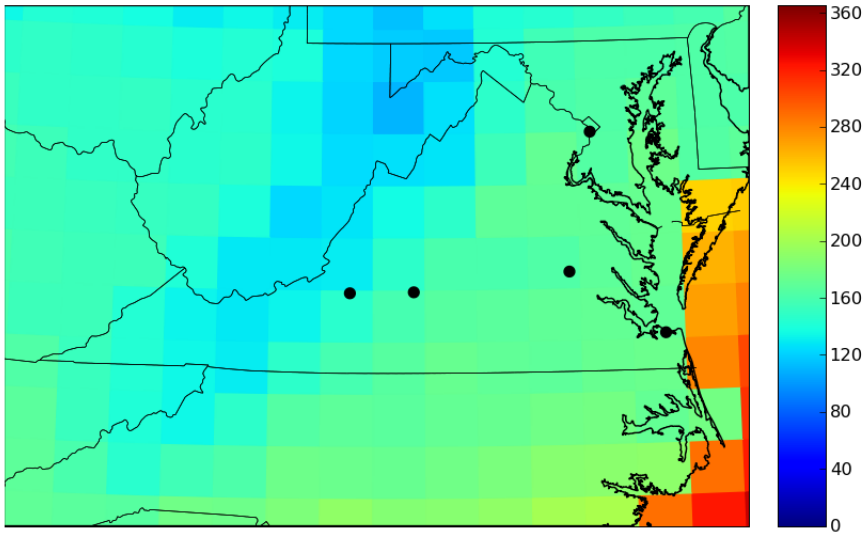
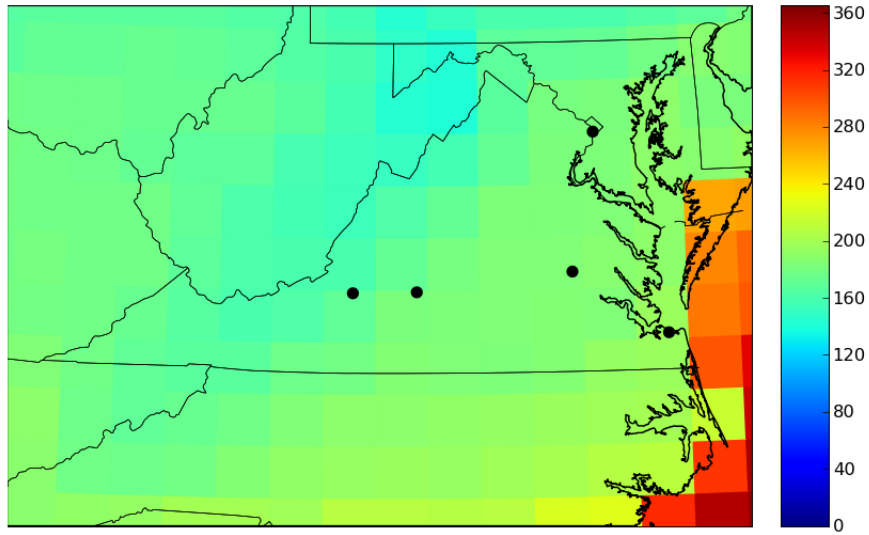
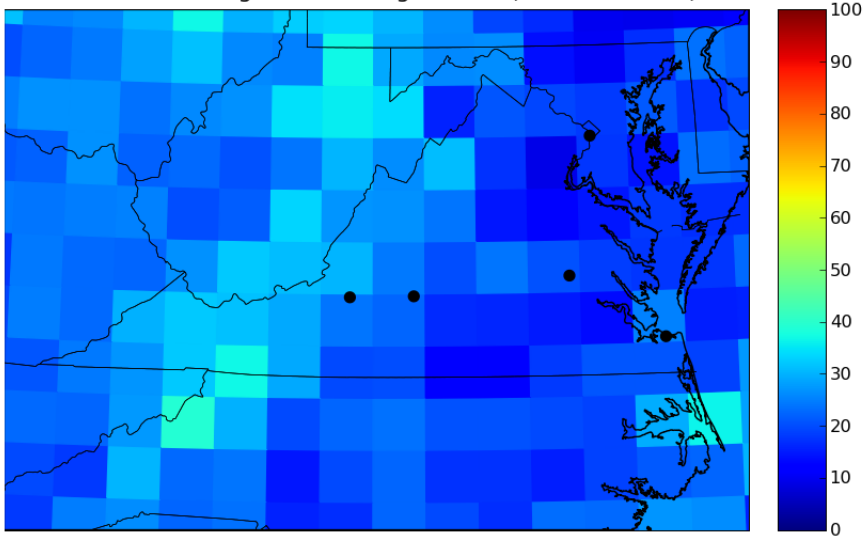
GFDL Mean Length of Growing Season 1969-2000



GFDL Mean Length of Growing Season 2039-2070



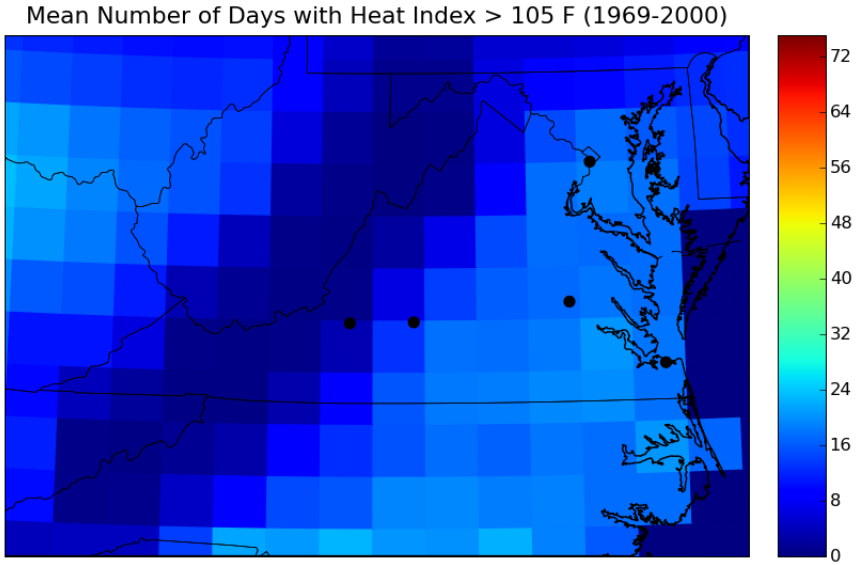
GFDL Mean Length of Growing Season (Future-Current)

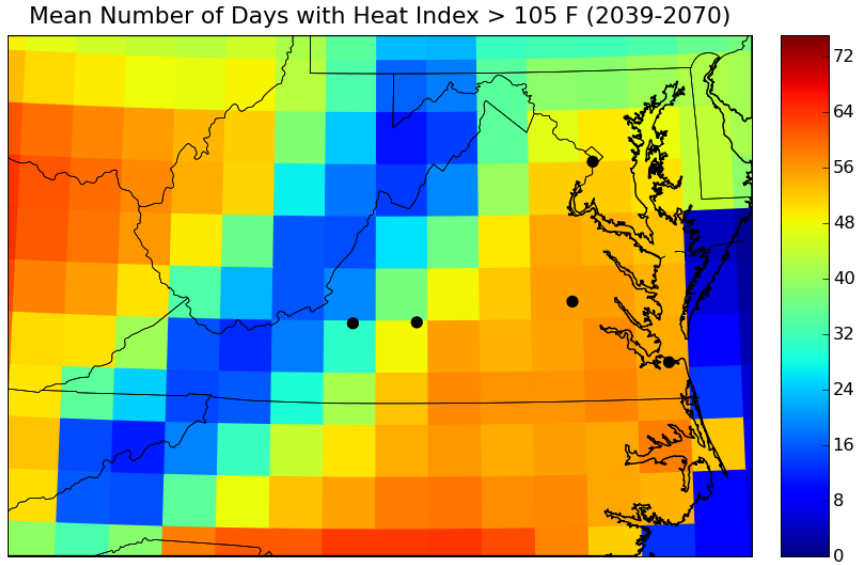


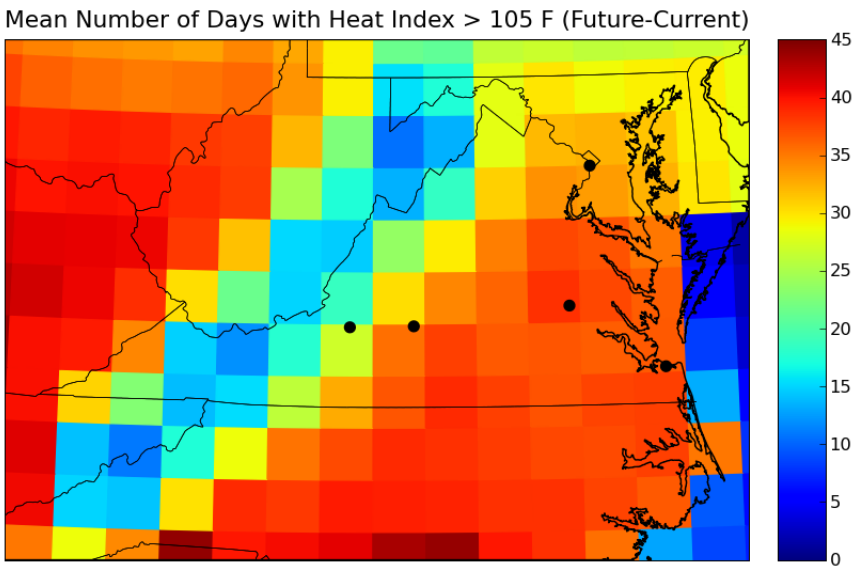
Bias corrected by month	Days in Growing Season	
	Current	Future
Richmond	179	196
Lynchburg	171	185
Roanoke	166	187
Washington DC	157	176
Norfolk	196	228

Use: Agricultural planning, crop selection and rotation, trends in food sources

Some Examples Climate Products and Decision Aids Health: VA Heat Index





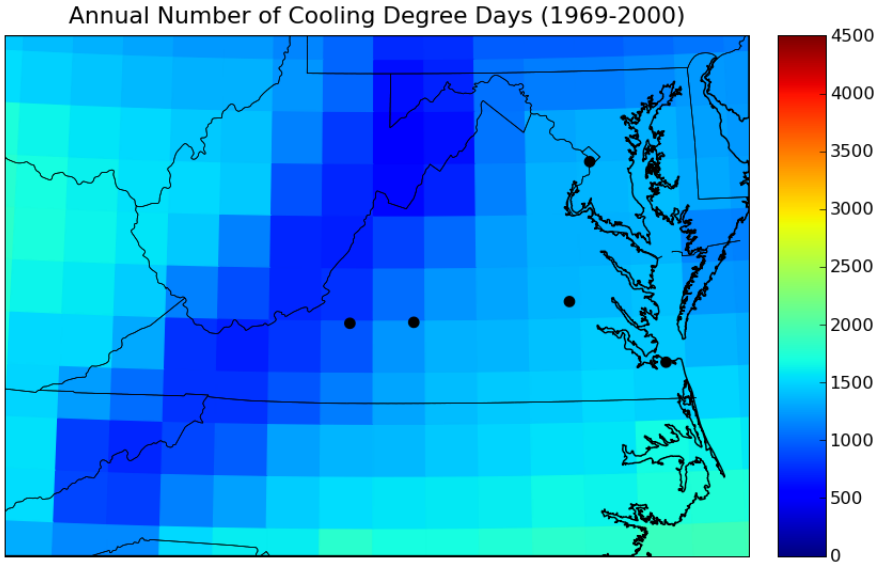


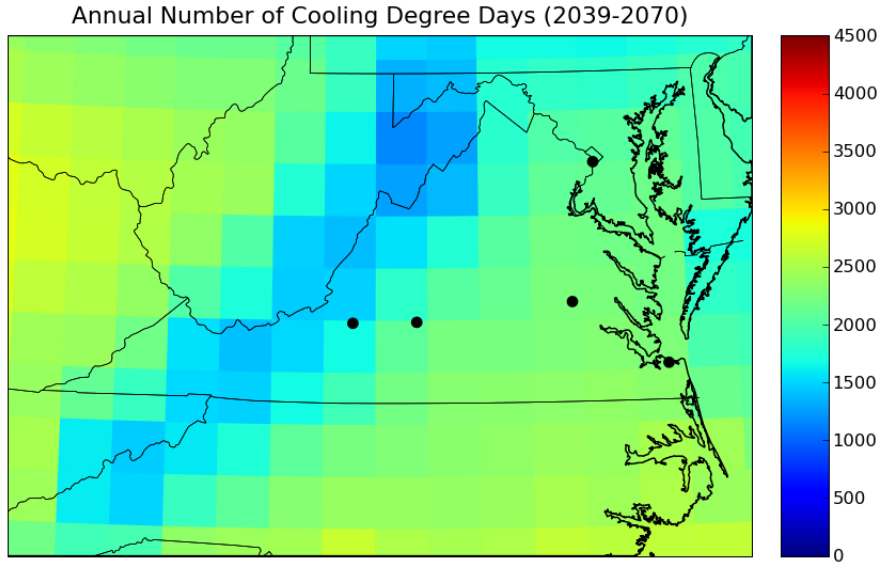
Bias corrected by month

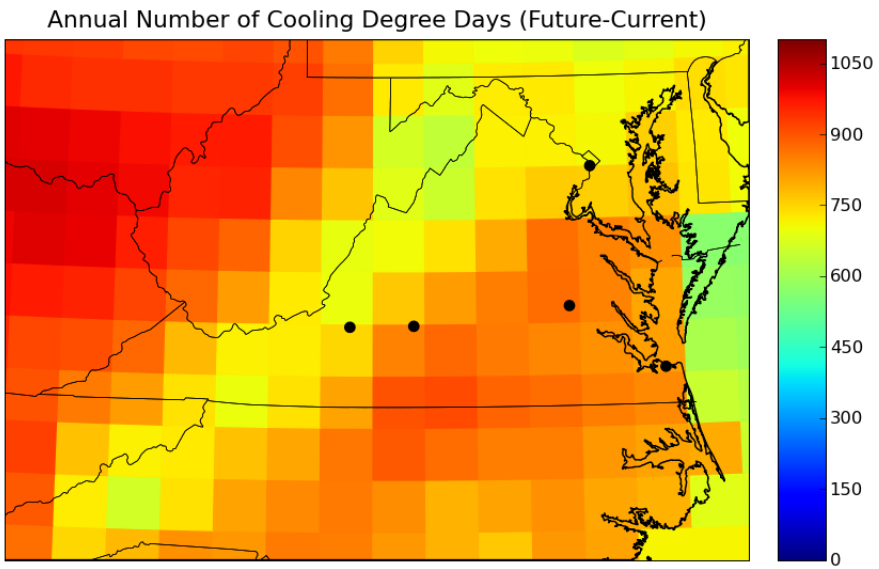
		Mean "Oppressive" Days Per Year (Models have monthly biases with respect to GHCN removed)			Change in Deaths due to Change in Oppressive Days	
City	Metro Pop	Current	Future	Change	Deaths per Million	Additional Deaths for Metro
Richmond	1.2 M	17.47	47.22	29.8	26.78	32
Lynchburg	246 K	11.91	36.56	24.7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

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

Some Examples Climate Products and Decision Aids Energy: VA Cooling Degree Days and Energy Demand







Bias corrected by month

City	Metro Pop	Mean CDD Per Year			Change in Residential Electricity Demand	
		Current	Future	Change	KWHr/ Capita	Metro MW-Hr
Richmond	1.2 M	1538	2480	942	452	548
Lynchburg	246 K	1206	2088	882	423	104
Roanoke	296 K	1202	2040	838	377	112
Wash. DC	5.3 M	1134	1850	716	286	1518
Norfolk	1.8 M	1708	2604	896	430	772

'Change' is Future value - Current value

Use: Strategic energy planning, future energy demand, power plant needs, alterative power sources

Some Examples Climate Products and Decision Aids Example of Coastal Inundation Modeling

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- Hurricane Isabelle in September 2003 caused extensive coastal flooding in the Chesapeake Bay
- IPCC projects more frequent and stronger coastal storms, including hurricanes
- IPCC also projects sea level rise due to ice melt and thermal expansion of ocean water
- The coupled effect of sea level rise and storm surge will be important issues for coastal area planning
- A combination of simulations of storm frequency and intensity from regional climate models coupled with coastal inundation models can provide planners with critical adaptation information

Some Examples Climate Products and Decision Aids Isabelle Imagery from NOAA/GOES-8

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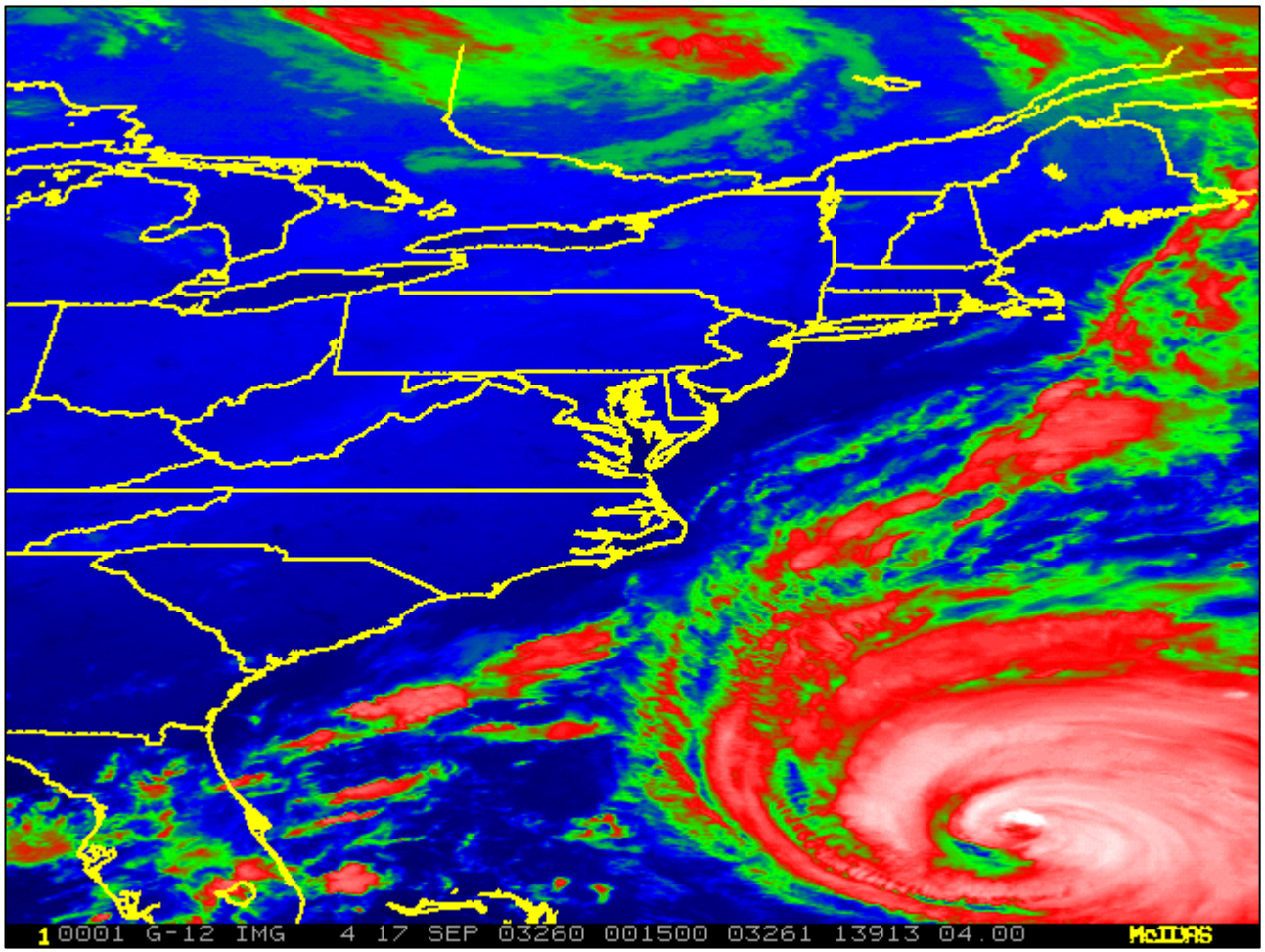
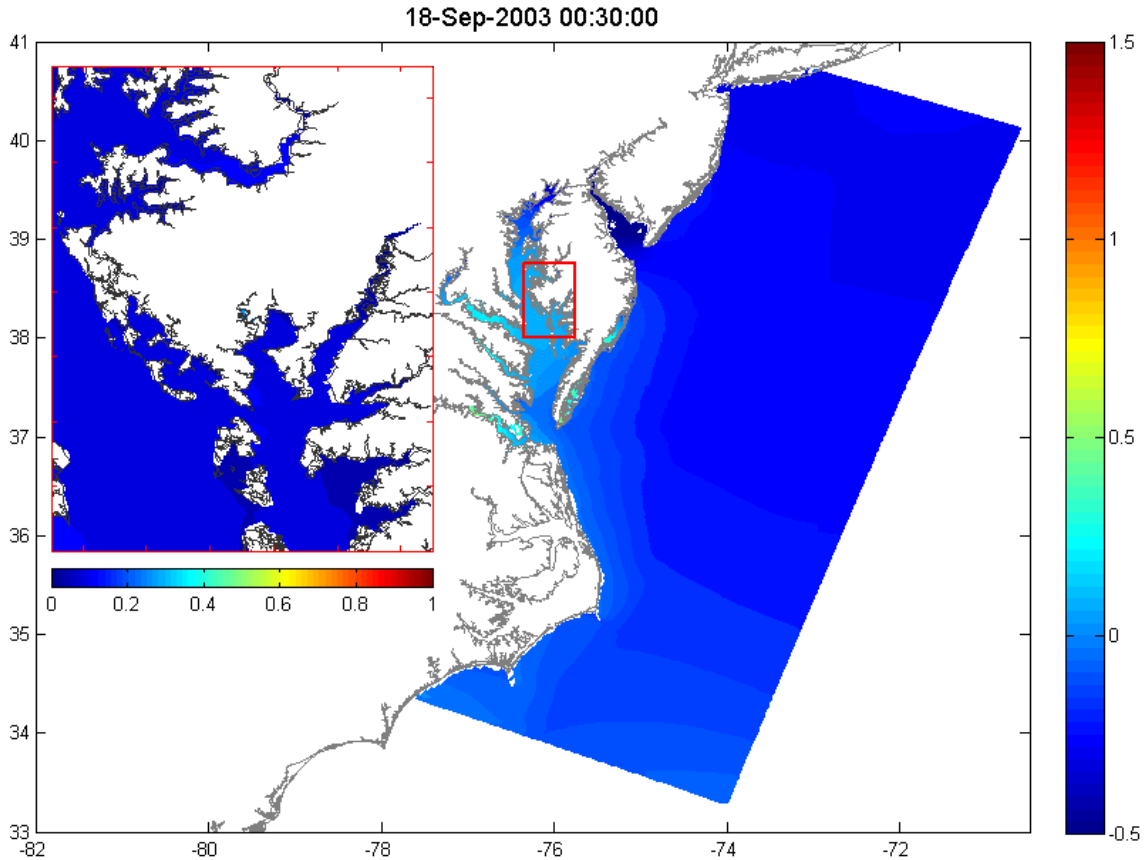


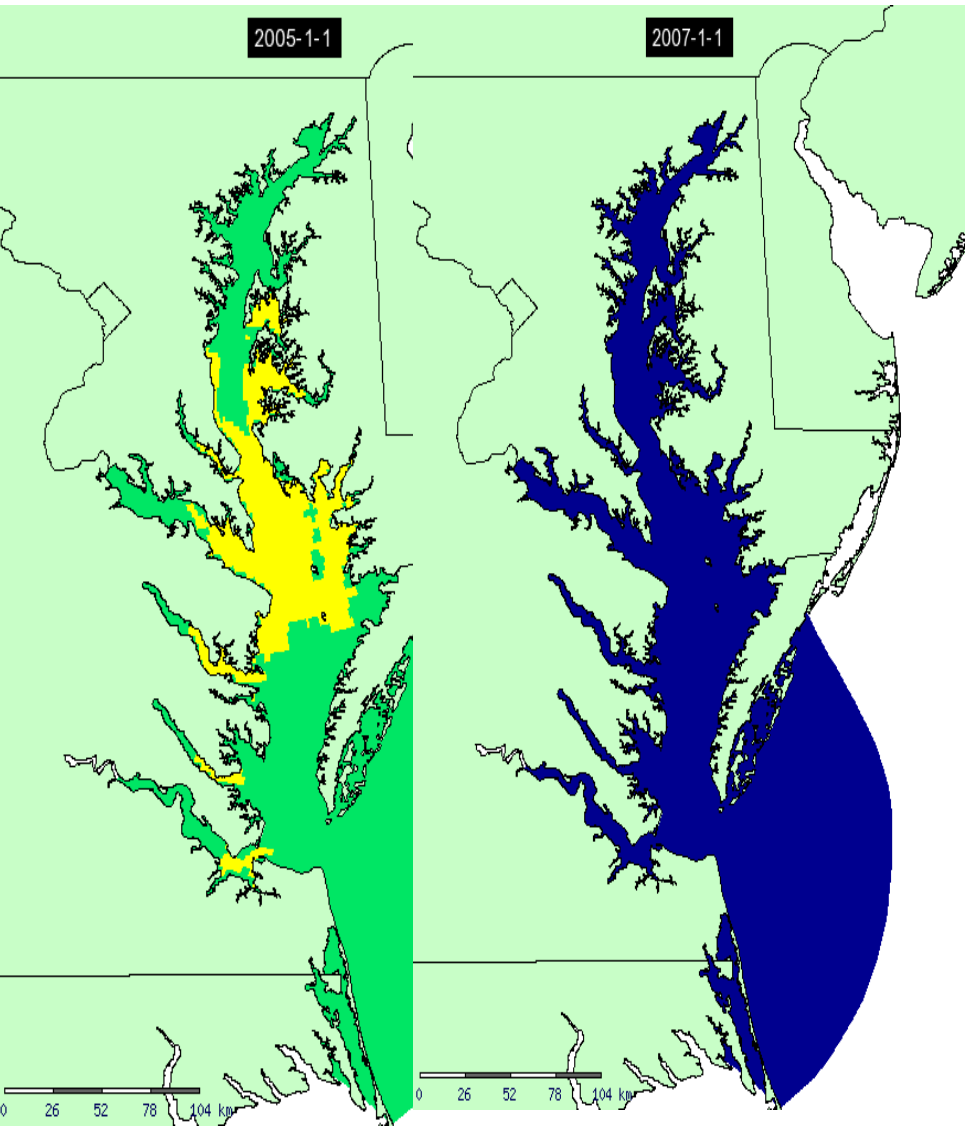
Increased Coastal inundation will impact many economies from transportation to Ship building

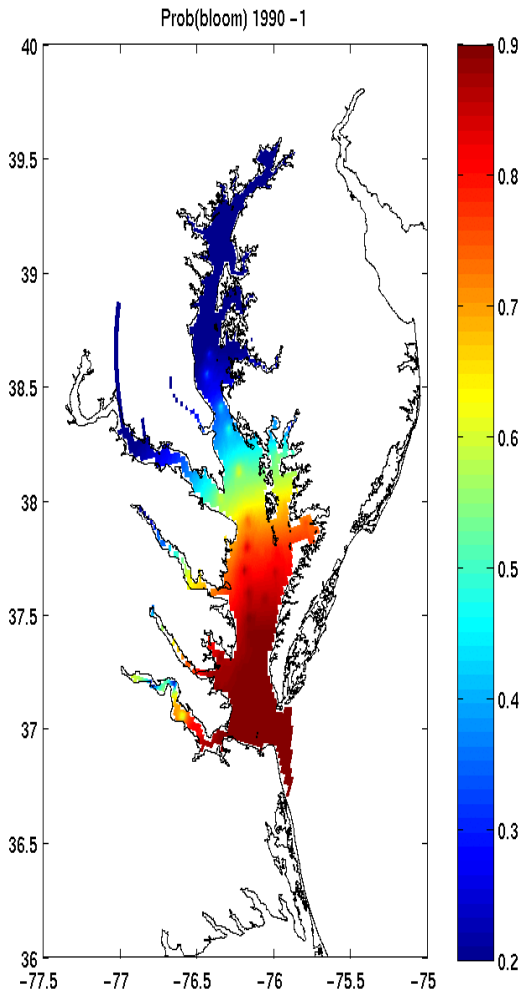
Some Examples Climate Products and Decision Aids Isabelle Storm Surge Modeling

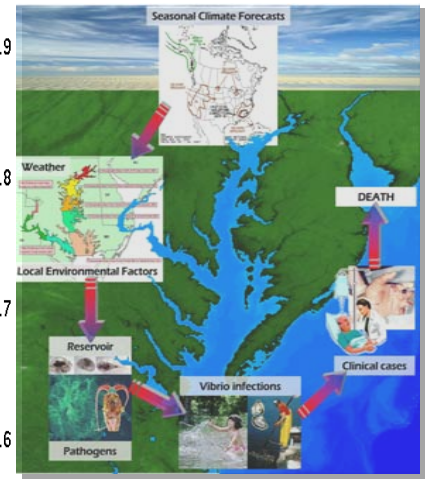


Modeling by the University of Maryland (UMD)

An End-to-End Early Warning System: Prototype to be based on Vibrio and toxic algal blooms. UMD







Summary

- Northrop Grumman is reaching out to groups like MWCOG 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
- Running multiple simulations with multiple climate models
- Interaction with users is critical to optimally tailoring decision aid development and making best use of climate data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