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

- 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

- 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

- 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

- 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**

### Actionable decision aid

<table>
<thead>
<tr>
<th>City</th>
<th>Metro Pop</th>
<th>Current</th>
<th>Future</th>
<th>Change</th>
<th>Deaths per Million</th>
<th>Additional Deaths for Metro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richmond</td>
<td>1.2 M</td>
<td>17.47</td>
<td>47.22</td>
<td>29.8</td>
<td>26.78</td>
<td>32</td>
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<tr>
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<td>38.31</td>
<td>25.0</td>
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'Change' is Future value - Current value

### Empirical and explicit decision domain modeling


#### Observations, Best Science, and Physical Models

- **Raw Global-scale model results**
  - Captures local effects and better physics

#### Decision Aids

- **Regional Climate Models**
- **Global Climate Models**
- **Global Observing System**

#### Users

- **Decision Aids**
- **Regional Climate Models**
- **Global Climate Models**
- **Global Observing System**

### Additional Mean “Oppressive” Days Per Year (Models have monthly biases with respect to GHCN removed)

- Change in Deaths due to Change in Oppressive Days

- **Mean Number of Days with Heat Index > 105°F (2039-2070)**

- **High resolution regional model results**
An Example Decision Aid
Impact of Heat Exposure on Mortality in Virginia

Bias corrected by month

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Use: City planning, emergency planning, public facility planning, HVAC planning
Regional downscaling and its applications to sea-level rise impacts

- 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

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

Impacts of Hurricane Isabel on the Northrop Grumman Ship Yard

Record high water level at the Shipyard

James River spilling into dry dock #1
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.
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

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<th>Event Severity</th>
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<tr>
<td>Flood Stage</td>
<td>0</td>
</tr>
<tr>
<td>Flood</td>
<td>5.00</td>
</tr>
<tr>
<td>Moderate</td>
<td>6.00</td>
</tr>
<tr>
<td>Major</td>
<td>7.00</td>
</tr>
<tr>
<td>Record</td>
<td>8.02</td>
</tr>
<tr>
<td>Disaster</td>
<td>9.00</td>
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**Average Years Between Flooding Events**

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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.