An Overview of the Global and Regional Sea Level Projections: Means and Extremes

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Regional Water Management System in Florida: Future Concerns

**Stressors:**
- Sea Level Rise & Storm Surge
- Rising Water Table
- Possible increased extreme rainfall

**Forward Pumps**

**Urban Flooding**

**Saltwater Intrusion**

**King Tide Flooding**

**Peat Collapse**

**Natural System Impacts**

**Tidal/Storm Surge Impacts**

*Credit: Kevin Cunningham*
King Tide Flooding in South Florida (2015)

“Sunny Day Flooding”
Miami Beach

Credits: Rhonda Haag, Jennifer Jurado, Natalie Schneider
Sea Level Trends: Ocean side of Coastal Discharge Structures in south Florida

What happened after 2012?
• Florida Current?
• Ocean Warming?
• ENSO, NAO?
Sources of Global and Regional Sea Level Change

Global

Land Water Storage

Thermal Expansion

As water warms, it expands

Ice Melt

Land-Based Ice Melting
As glaciers, Greenland and Antarctica Ice Sheets melt, they add mass

Regional

Regional Sea Level
Factors that Affect Regional and Local Sea Level

Ocean Dynamics

Gravitational Effects

VLM
Vertical Land Movement
Surface and deep ocean circulation changes

Ice Melt Effects
Gravitational and other changes due to redistribution of land-based ice mass
Change in Relative Sea Level (RSL):  \( \Delta RSL = \Delta SL_G + \Delta SL_{RM} + \Delta SL_{RG} + \Delta SL_{VLM} \)

- Global Ocean Dynamics
- Gravitational Effects (Glaciers, Ice Sheets)
- Vertical Land Movement (Uplift/Subsidence, GIA)

*Suggested in Nicholls et al., 2011*
Global & Regional Mean SLR Projections

- **IPCC AR5 (2013, 2014)**
  The median projection for 2100 for the RCP 8.5 scenario is 0.73 with a range of 0.53 m to 0.97 m (Table AII 7.7) - "median confidence" (range has a probability of 66%). There is a 33% probability the range could be larger.

- **United States: Waves of SLR scenario development:**
  - Wave I: Discrete Scenarios with no likelihood assigned. VLM the only adjustment
  - Wave II: Contributing factors considered, their uncertainties, and geographic patterns
  - Wave III: Extended component-based approach. Also introduced probabilistic assessments of contributing factors conditioned on emission scenarios
  - Wave IV: Address deep uncertainty associated with high end scenarios and projections
Confidence (>90%) was assigned to the range as bounding possible futures, with no likelihoods assigned to individual scenarios.
DoD Project (Hall et al. 2016): GMSL Scenarios for installations world-wide

- Scenario approach, no probabilities
- Risk-based framing
- Upper limit still based on Pfeffer (2008)
- Regional Frequency Analysis for Extremes
NOAA (Sweet et al. 2017) for 4th National Climate Assessment

- Kopp et al. (2014)
- Conditional Probabilities
- Expert elicitation to get the tails
- DeConto & Pollard (2016)
  - Antarctica can contribute more, hence 2.5 m scenario
Regional Sea Level Projections

- Both Hall et al. (DoD 2016) and Sweet et al. (NOAA 2017) accounted for all components
Unified SLR Projections: South Florida

<table>
<thead>
<tr>
<th>Year</th>
<th>IPCC AR5 Median (inches)</th>
<th>USACE High (inches)</th>
<th>NOAA High (inches)</th>
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<tr>
<td>2100</td>
<td>31</td>
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Relative Sea Level Rise near Key West, FL (inches relative to mean sea level)

Four-County Climate Compact
Nuisance Flooding to Chronic Flooding

**PATTERNS AND PROJECTIONS OF HIGH TIDE FLOODING ALONG THE U.S. COASTLINE USING A COMMON IMPACT THRESHOLD**

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Sea Level Extremes

- General agreement that extremes vary primarily with the Mean Sea Level (MSL)
- SFWMD currently uses an Empirical Simulation Technique (Goring et al. 2011)
  - De-tiding & Non-tidal component
  - Wavelet Analysis
  - Extreme Value Distribution for extremes
  - Monte Carlo Simulations
Questions?
“Hot Spot in our region”

Ocean side of water control structure
On East Coast

What happened after 2012?
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• Ocean Warming?
• ENSO, NAO?
Decline in Florida Current Transport or NAO/ENSO Influence?

Spatial and temporal variability of sea level rise hot spots over the eastern United States

Arnoldo Valle-Levinson¹, Andrea Dutton², and Jonathan B. Martin²

¹, ²
“Coproduction of knowledge is believed to be an effective way to produce usable climate science knowledge through a process of collaboration between scientists and decision makers”
Global Average Sea Level Rise & Relative Sea Level Rise along US Coastline

1.7 mm/year

3.2 mm/year

La Nina
Improve Tidal Boundary Conditions for Regional Modeling

Existing Tidal boundary locations too sparse