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

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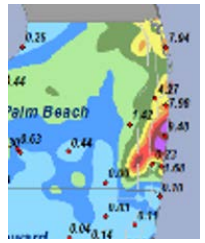
South Florida Water Management District

12th International Symposium on Biogeochemistry of Wetlands
April 25, 2018

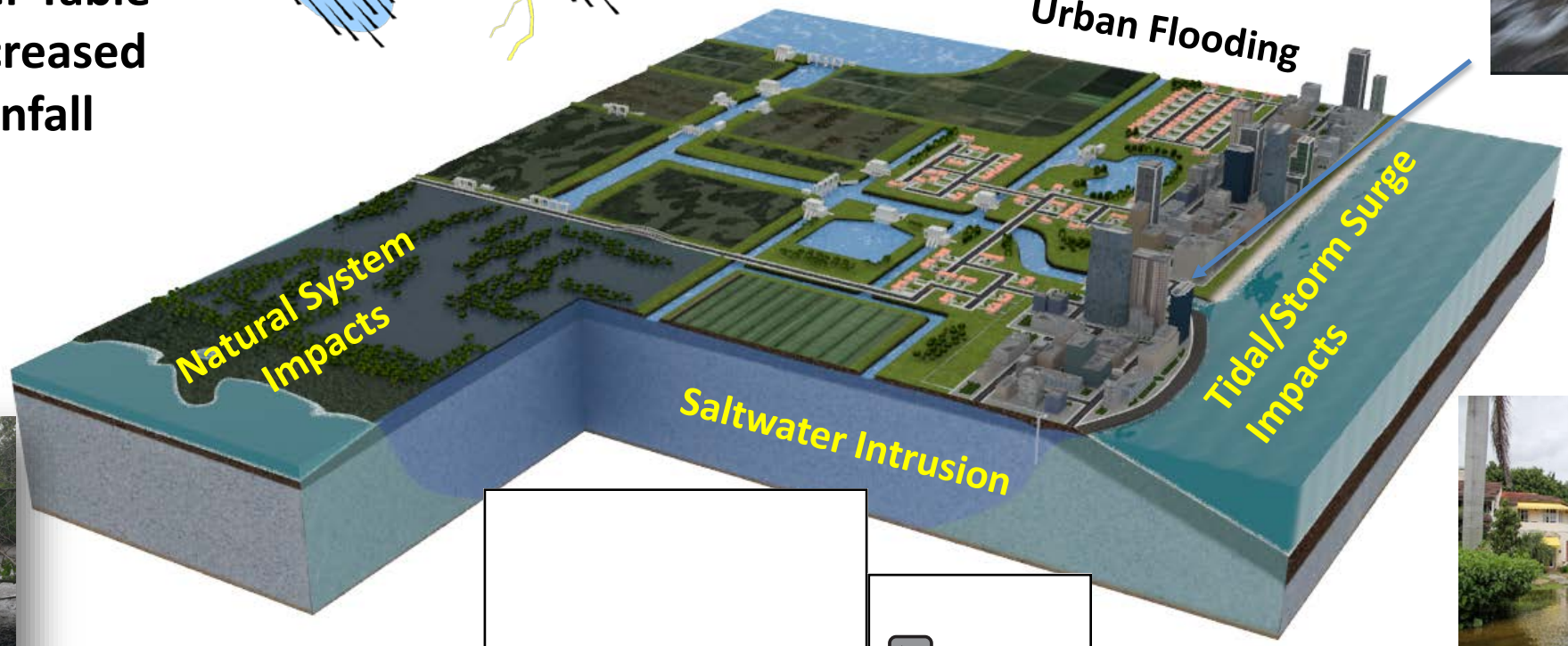
Regional Water Management System in Florida: Future Concerns

Stressors:

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



Forward Pumps

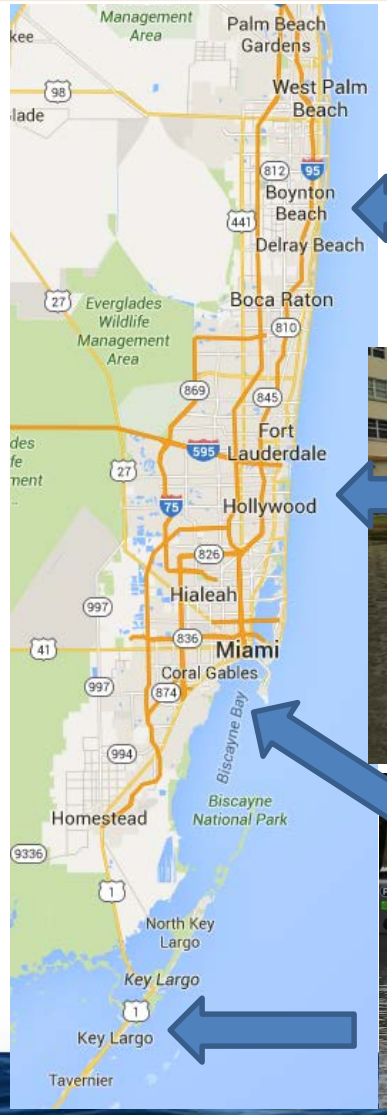


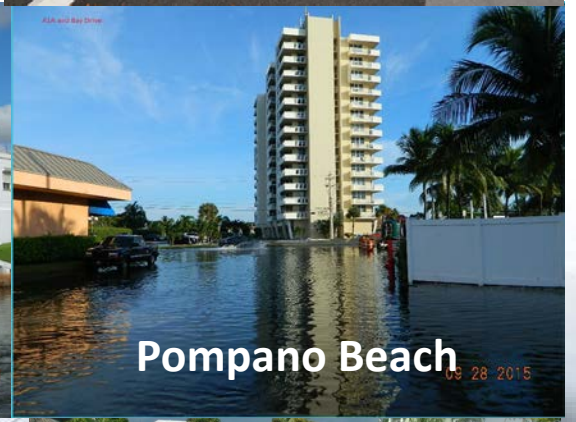
Peat Collapse

King Tide Flooding

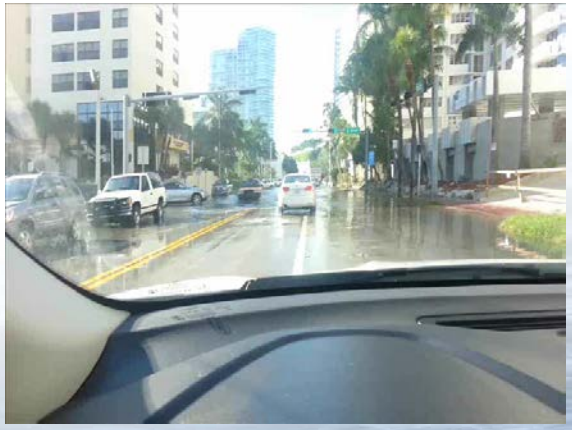
Kevin Cunningham

King Tide Flooding in South Florida (2015)



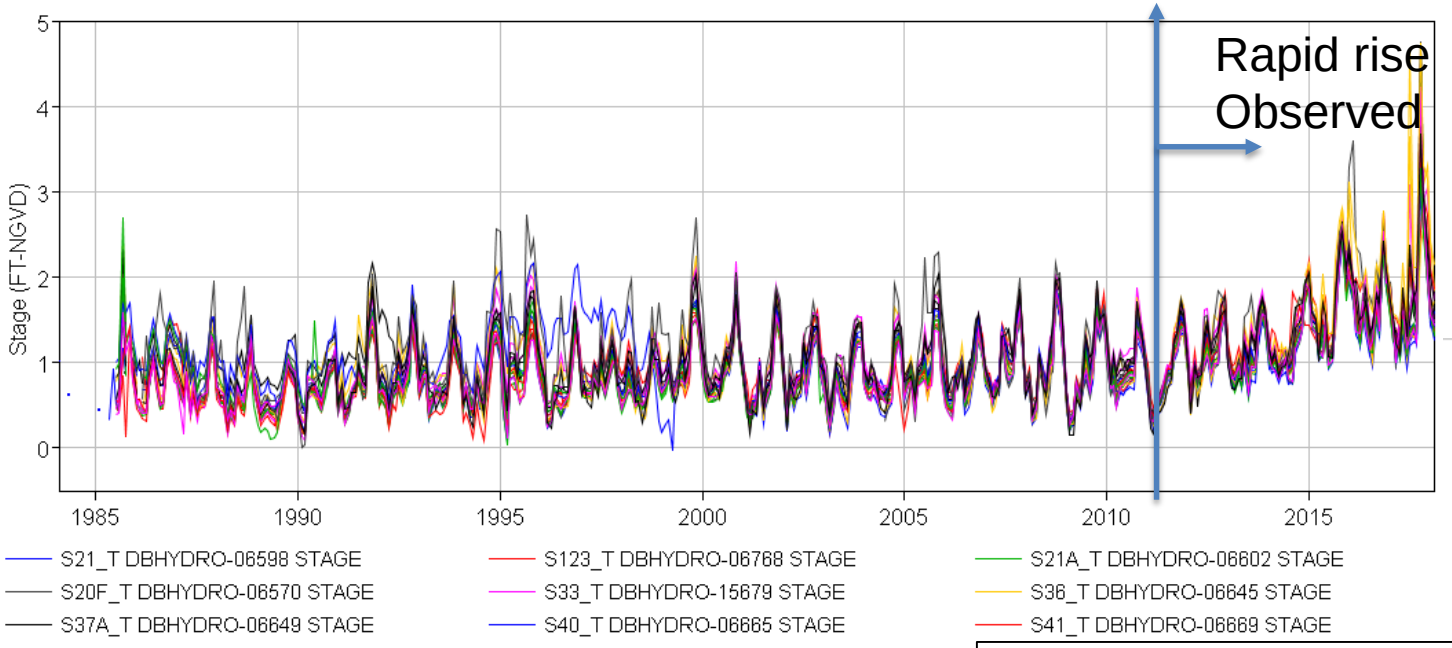


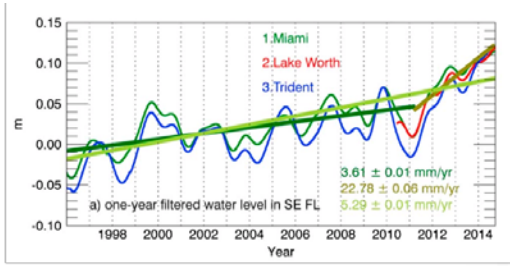
"Sunny Day Flooding"
Miami Beach



Credits: Rhonda Haag, Jennifer Jurado, Natalie Schneider

Sea Level Trends: Ocean side of Coastal Discharge Structures in south Florida





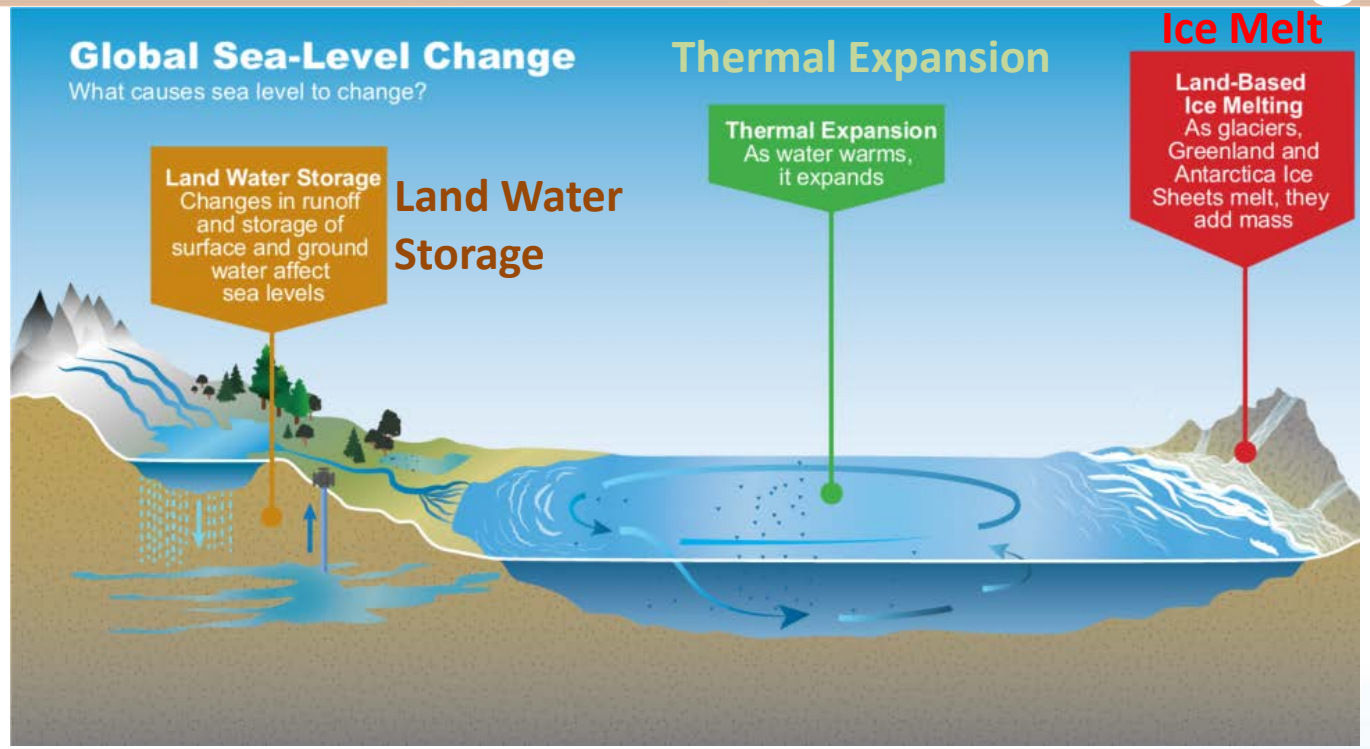
Spatial and temporal variability of sea level rise hot spots over the eastern United States

Arnoldo Valle-Levinson[1], Andrea Dutton[2], and Jonathan B. Martin[2]

What happened after 2012?

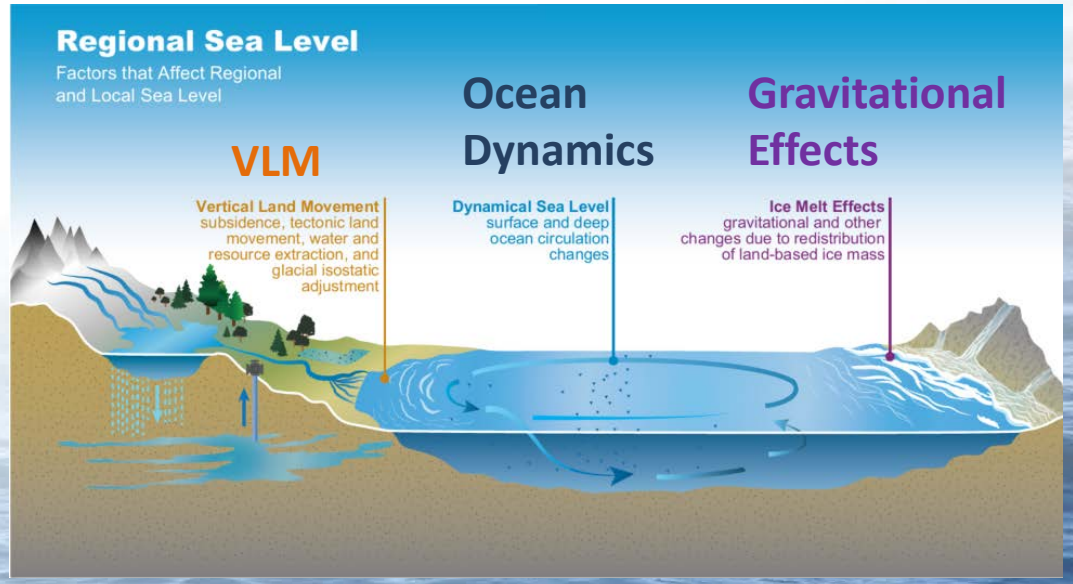
- **Florida Current?**
- **Ocean Warming?**
- **ENSO, NAO?**

Sources of Global and Regional Sea Level Change



Global

Regional



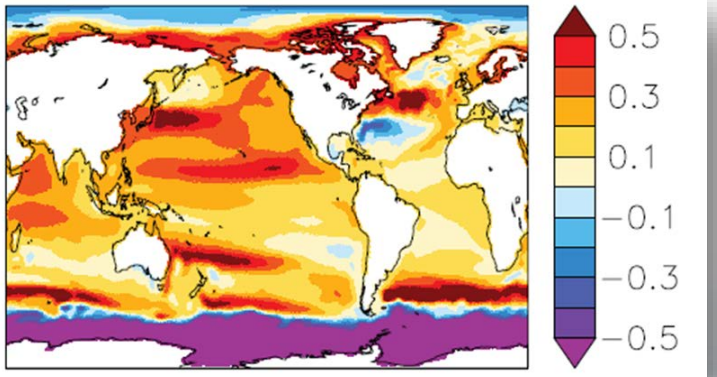
Regional/Local Sea Level Change

➢ Change in Relative Sea Level (RSL): *suggested in Nicholls et al., 2011

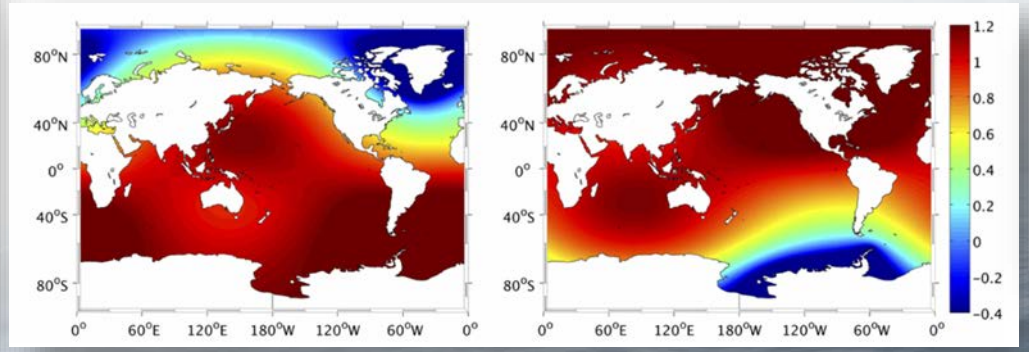
$$\Delta RSL = \Delta SL_G + \Delta SL_{RM} + \Delta SL_{RG} + \Delta SL_{VLM}$$

Global

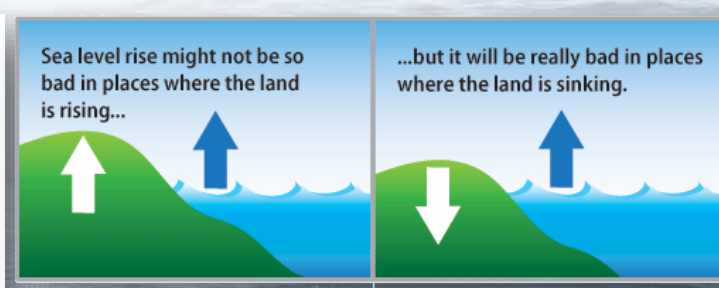
Ocean Dynamics



Gravitational Effects (Glaciers, Ice Sheets)



Vertical Land Movement (Uplift/Subsidence,GIA)



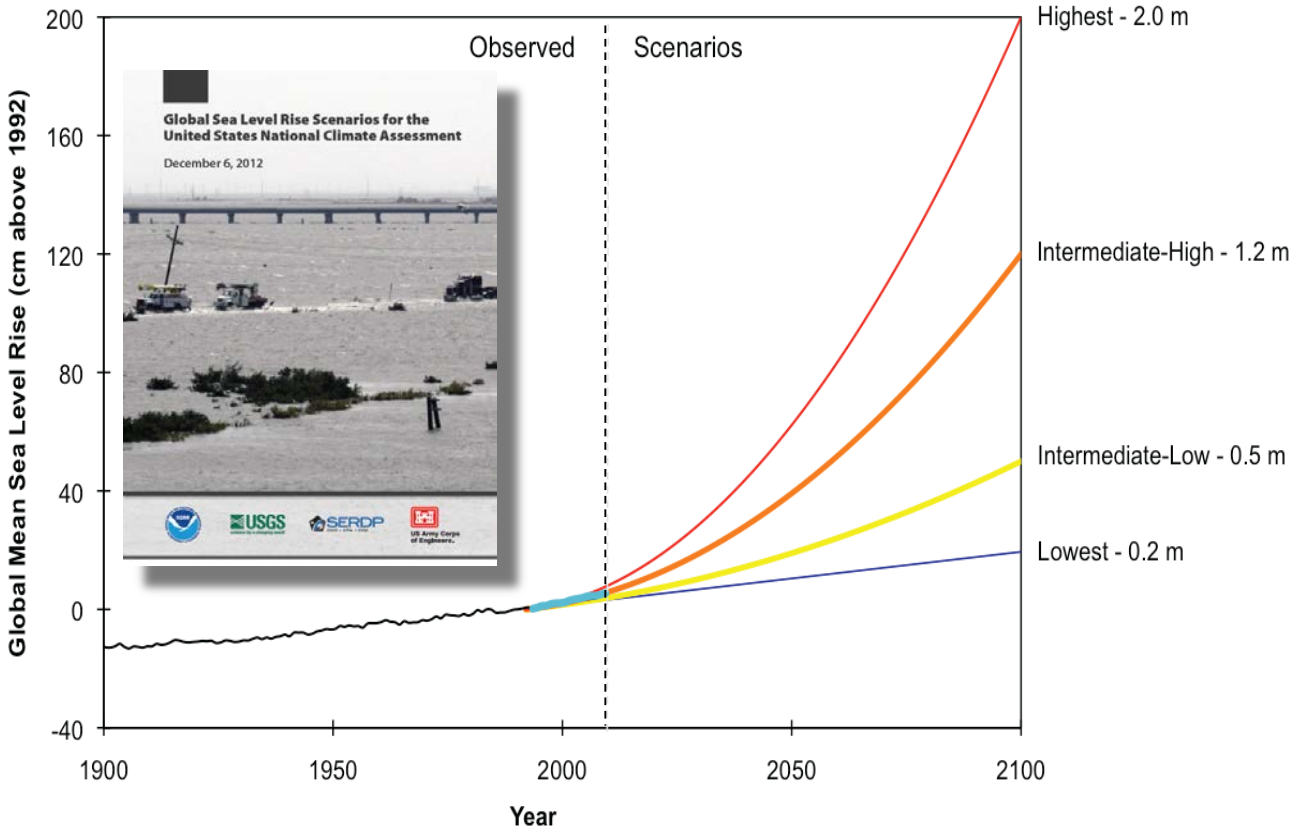
Global & Regional Mean SLR Projections

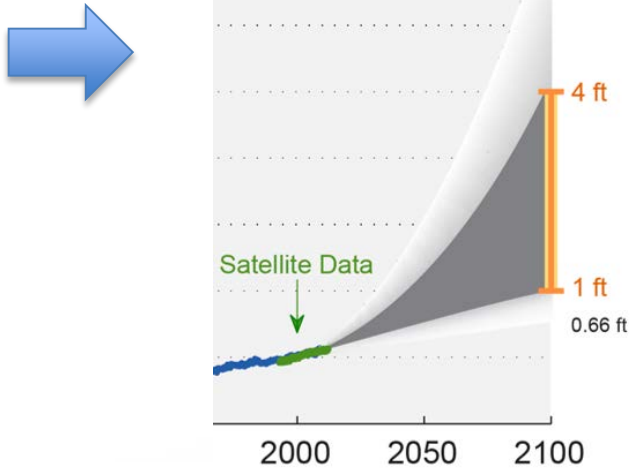
- **IPCC AR5 (2013, 2014)**

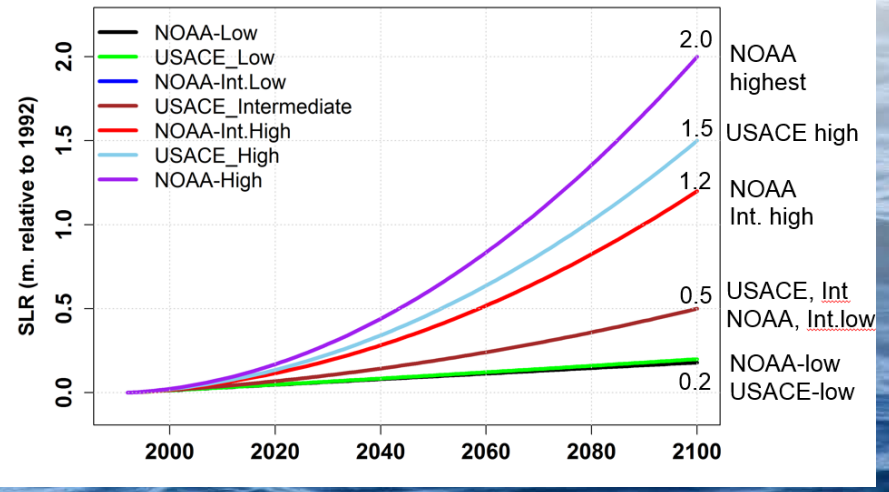
  The median projection for 2100 for the RCP 8.5 scenario is 0.73 with a range of 0.53 m to 0.97 m (Table AII 7.7)- **"median confidence"** (range has a probability of 66%.). **There is a 33% probability the range could be larger.**

- **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**

Scenario approach (NOAA, 2012) for 3rd National Climate Assessment

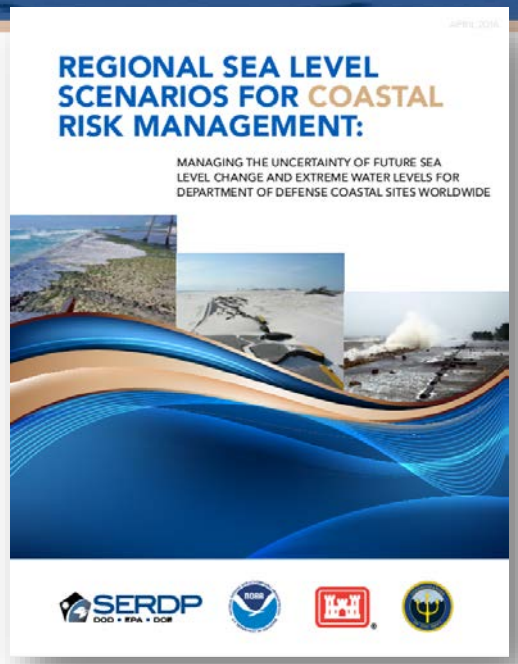


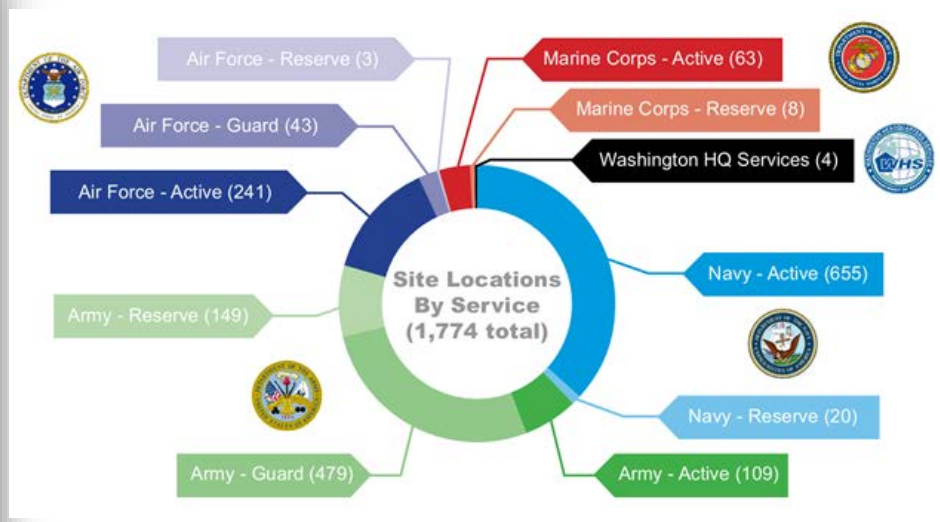


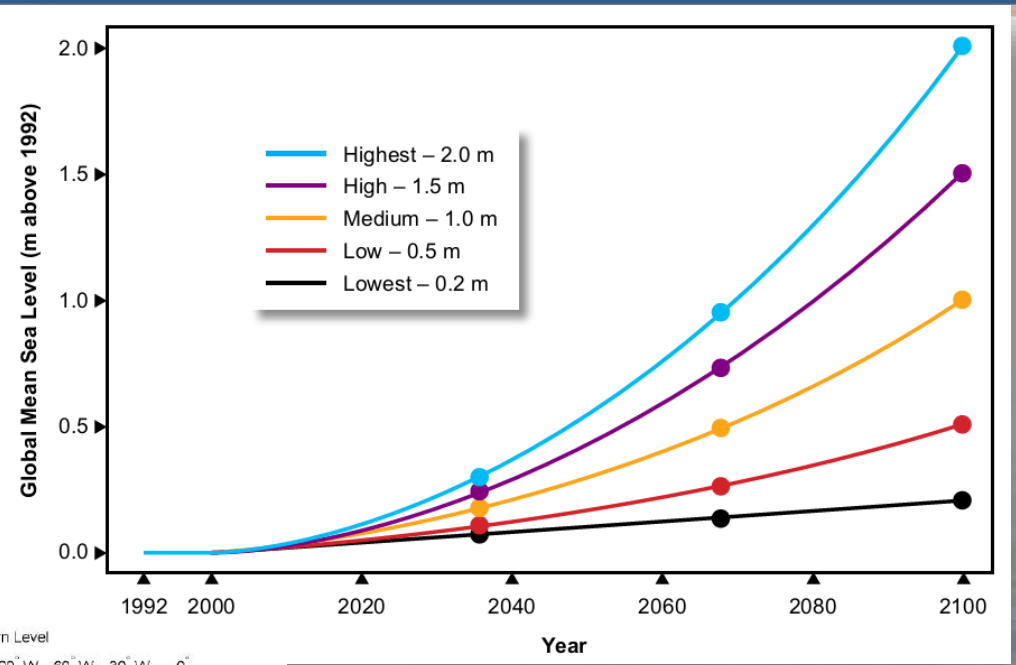


Confidence (>90%) was assigned to the range as bounding possible futures, with no likelihoods assigned to individual scenarios.

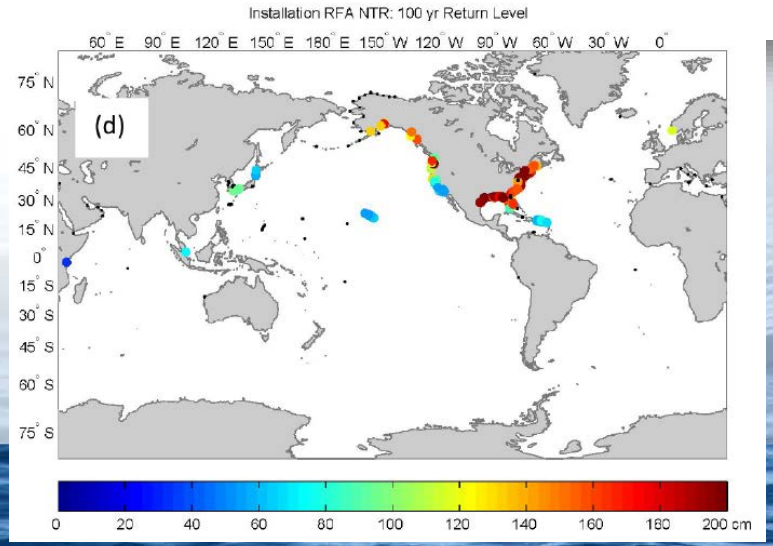
DoD Project (Hall et al. 2016): GMSL Scenarios for installations world-wide



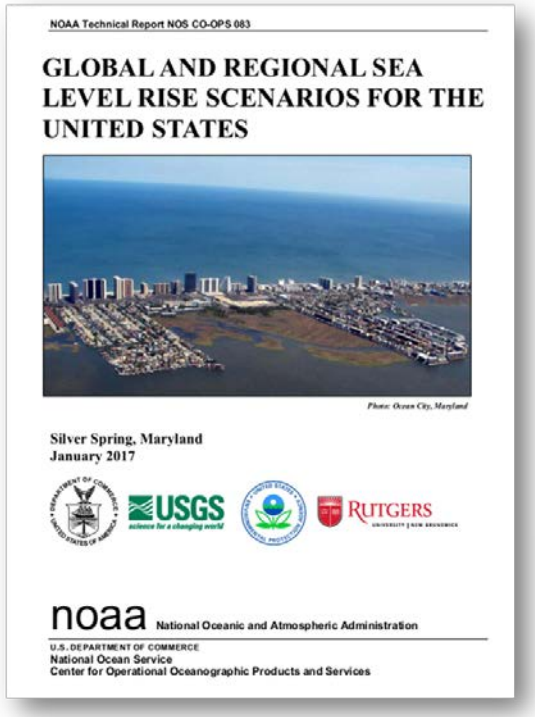




- Scenario approach, no probabilities
- Risk-based framing
- Upper limit still based on Pfeffer (2008)
- Regional Frequency Analysis for Extremes



NOAA (Sweet et al. 2017) for 4th National Climate Assessment

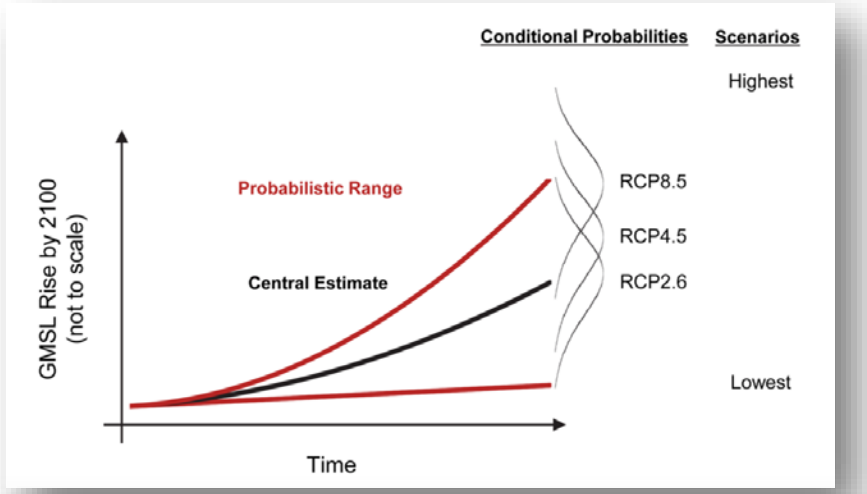

NOAA Technical Report NOS CO-OPS 083

GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES

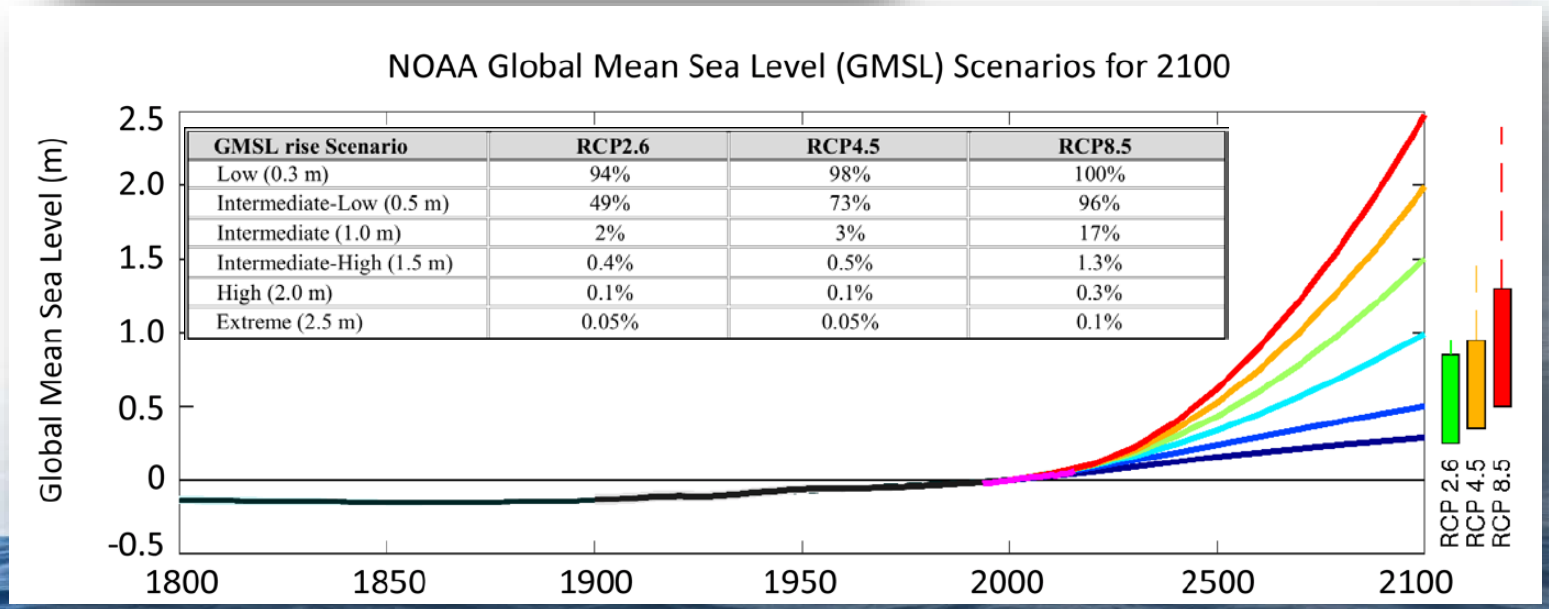
Silver Spring, Maryland
January 2017

USGS RUTGERS

noaa National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services



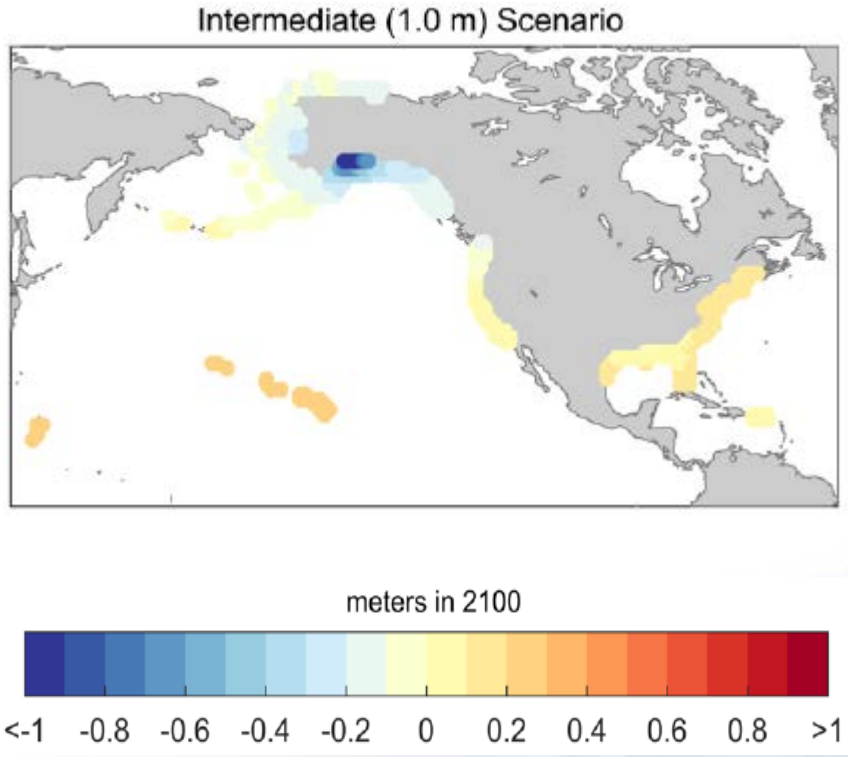
- Kopp et al. (2014)
- Conditional Probabilities
- Expert elicitation to get the tails
- **DeConto & Pollard (2016)**
  - Antarctica can contribute more, hence 2.5 m scenario



GMSL rise Scenario	RCP2.6	RCP4.5	RCP8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

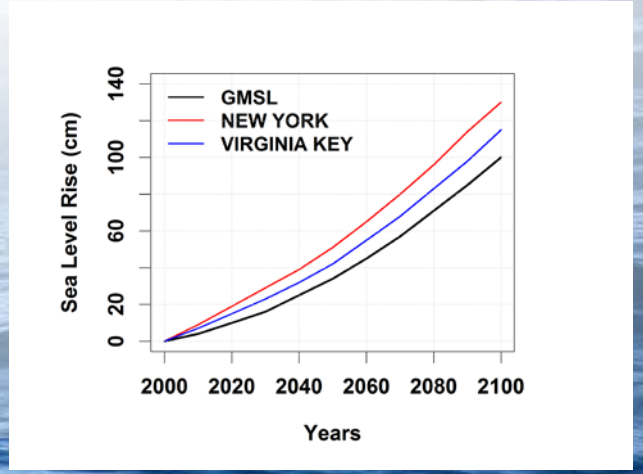
Regional Sea Level Projections

- Both Hall et al. (DoD 2016) and Sweet et al. (NOAA 2017) accounted for all components



Florida

Regional Sea Level Curves



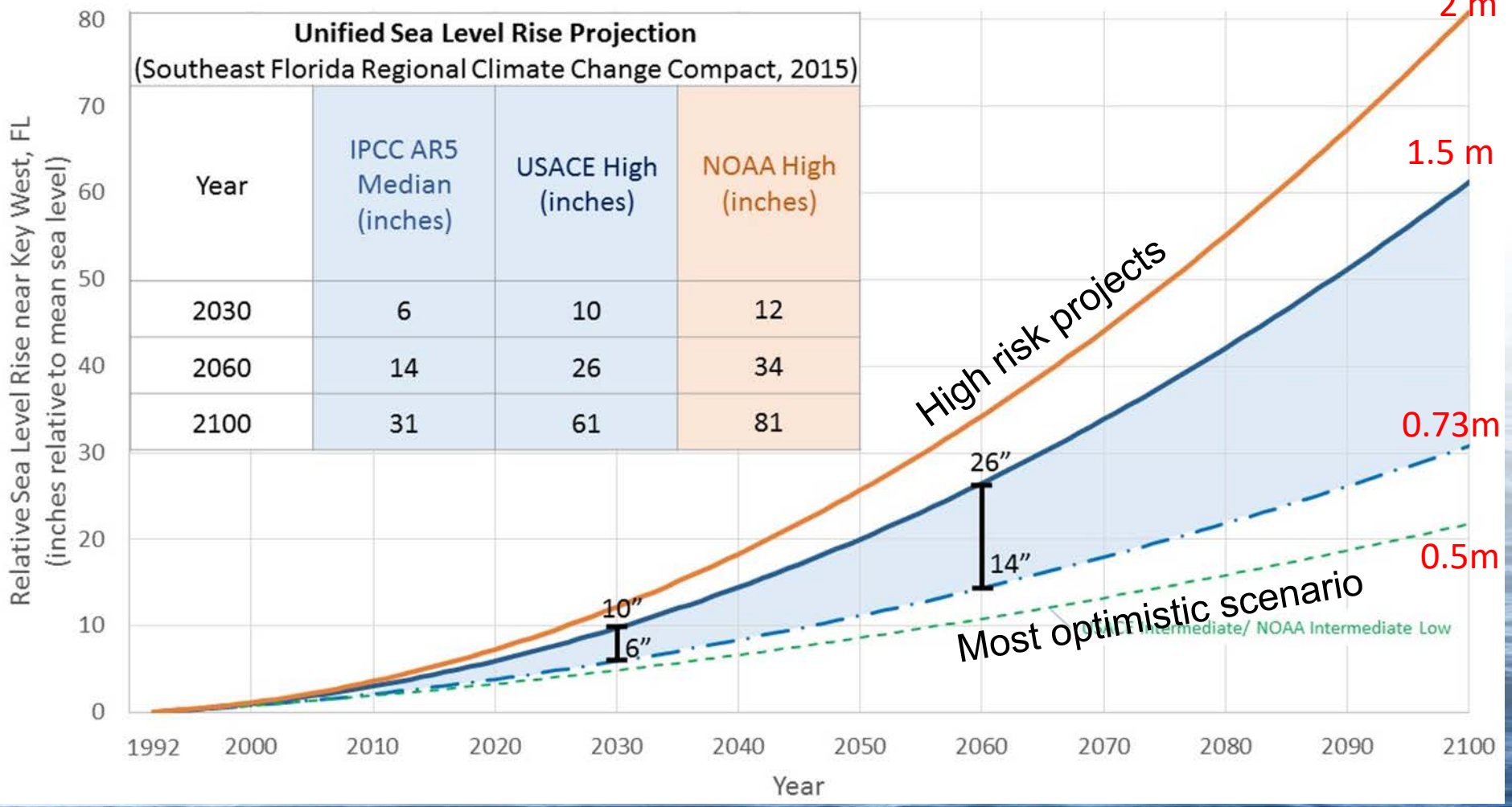
Unified SLR Projections: South Florida

SOUTHEAST FLORIDA REGIONAL COMPACT CLIMATE CHANGE

Four-County Climate Compact

Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81



Nuisance Flooding to Chronic Flooding

NOAA Technical Report NOS CO-OPS 086

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

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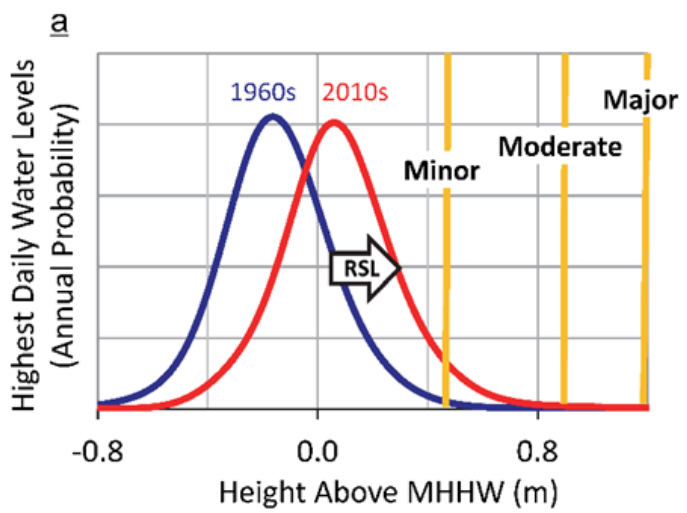
National Oceanic and Atmospheric Administration, National Ocean Service, Center for Operational Oceanographic Products and Services, Silver Spring, MD, USA

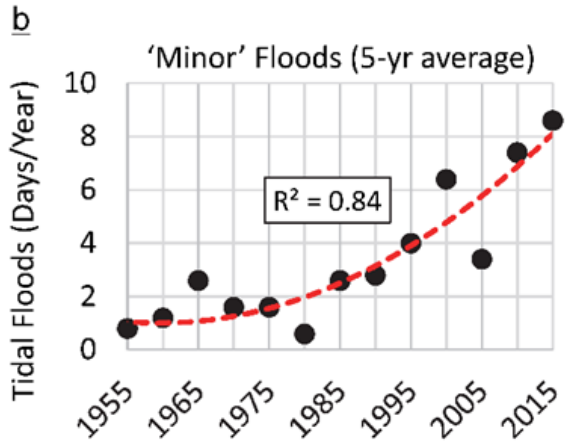
Greg Dusek
National Oceanic and Atmospheric Administration, National Ocean Service, Center for Operational Oceanographic Products and Services, Silver Spring, MD, USA

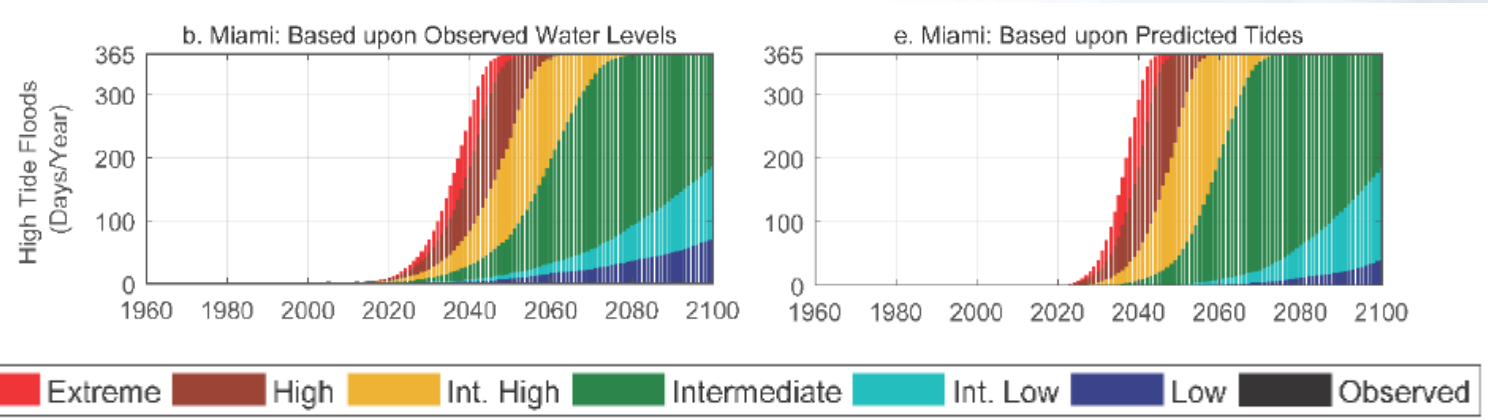
Jayantha Obeysekera
South Florida Water Management District, West Palm Beach, FL

John J. Marra
National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services, National Centers for Environmental Information, Honolulu, HI, USA

February 2018







Sea Level Extremes

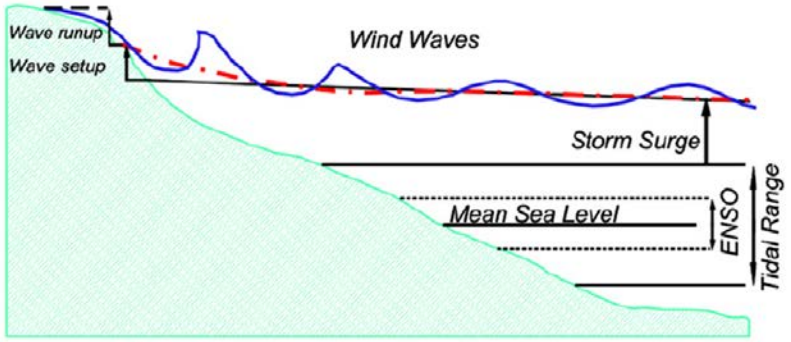
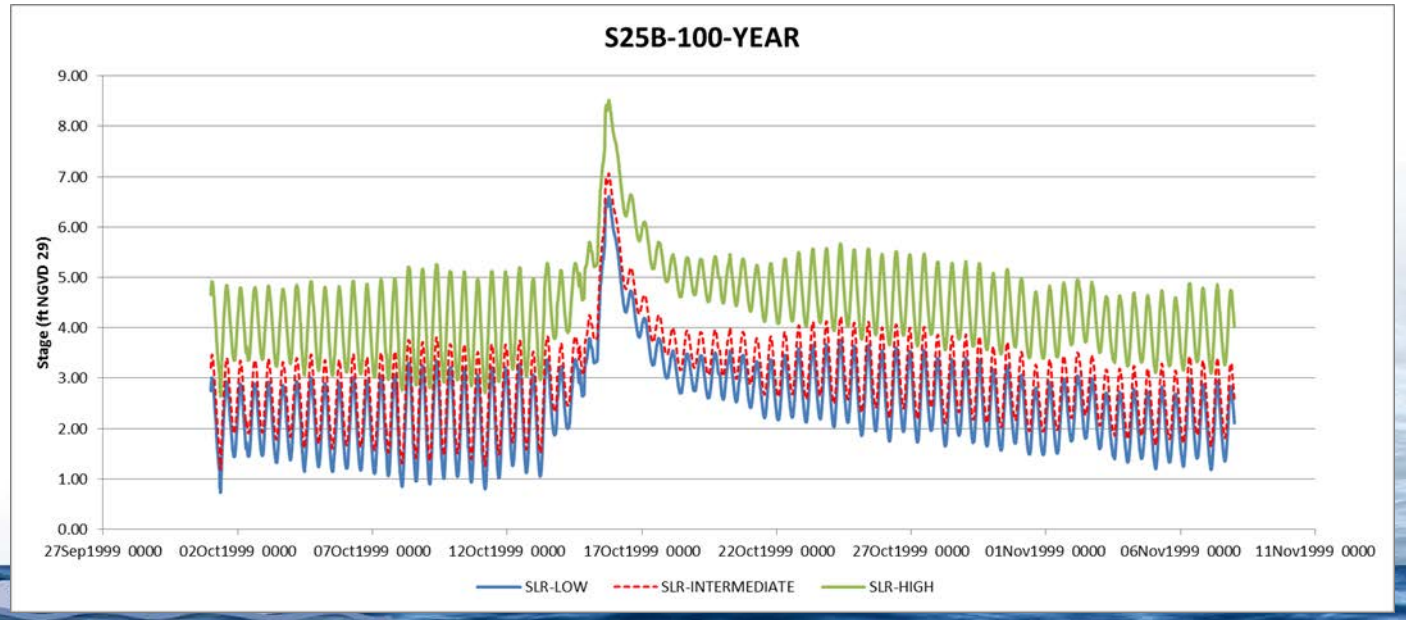


Fig. 2. Diagram illustrating the contributions to sea level due to tides, storm surge and wind-generated waves.

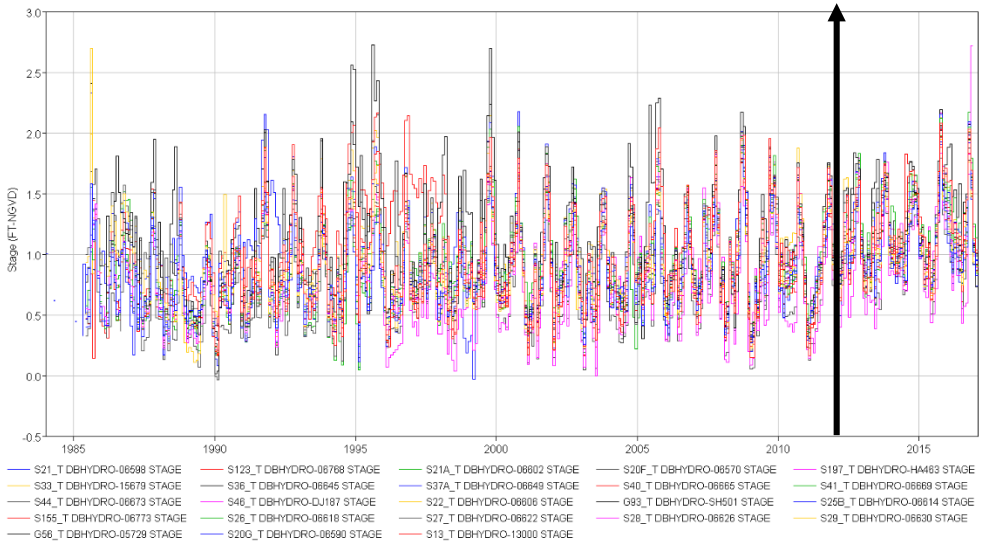


- General agreement that extremes vary primarily with the Mean Sea Level (MSL)
- SFWMD currently uses an **Empirical Simulation Technique** (Goring et al. 2011)
  - De-tiding & Non-tidal component
  - Wavelet Analysis
  - Extreme Value Distribution for extremes
  - Monte Carlo Simulations

Questions?

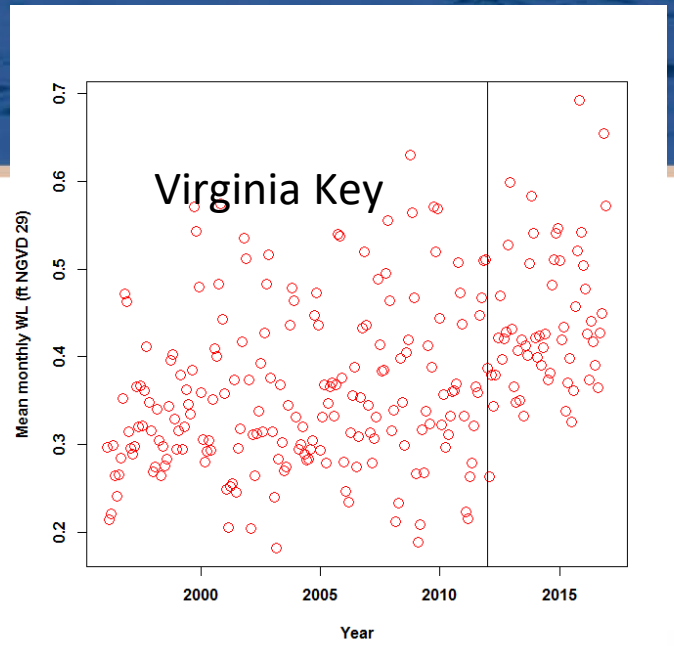
"Hot Spot in our region"

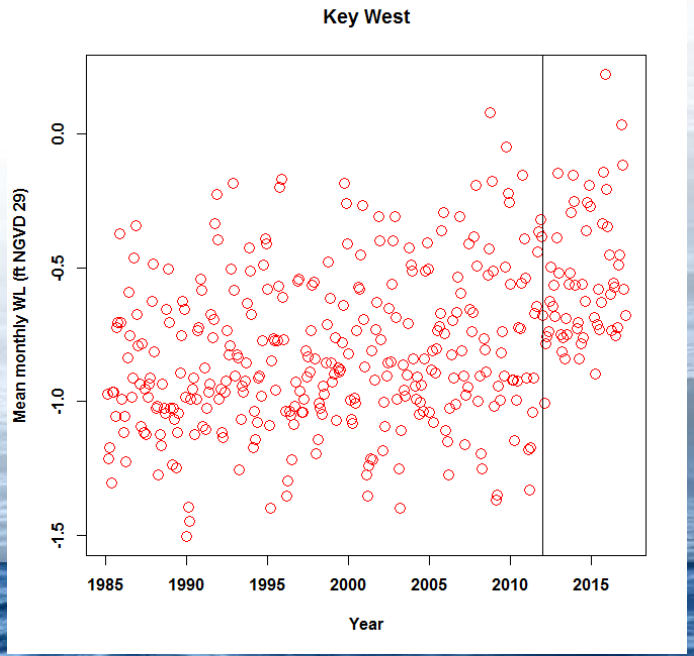
Ocean side of water control structure
On East Coast



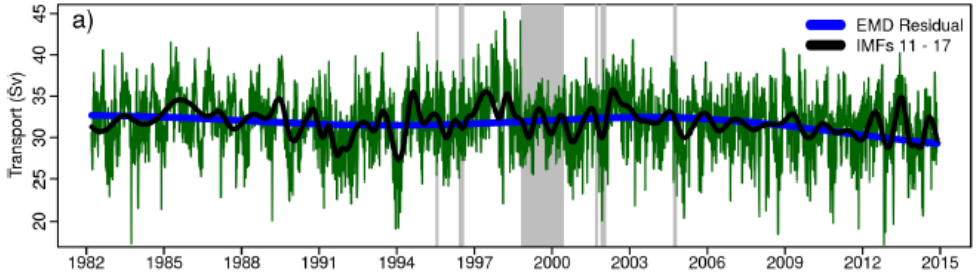
What happened after 2012?

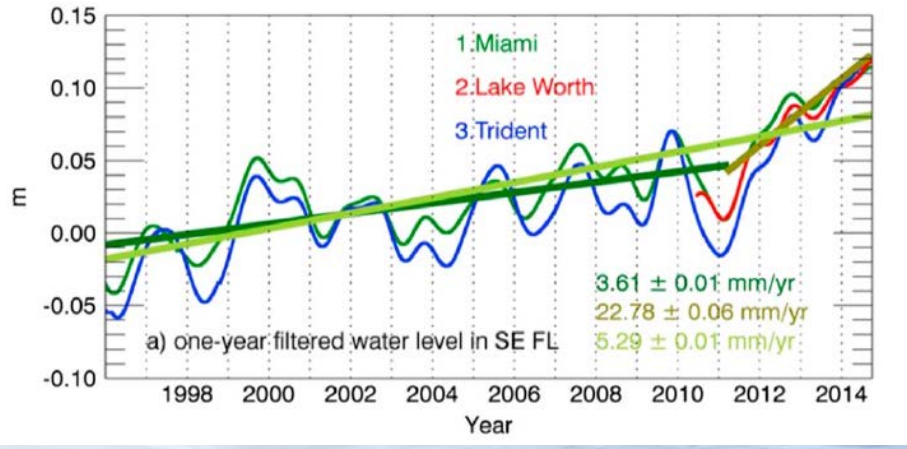
- **Florida Current?**
- **Ocean Warming?**
- **ENSO, NAO?**





Decline in Florida Current Transport or NAO/ENSO Influence?



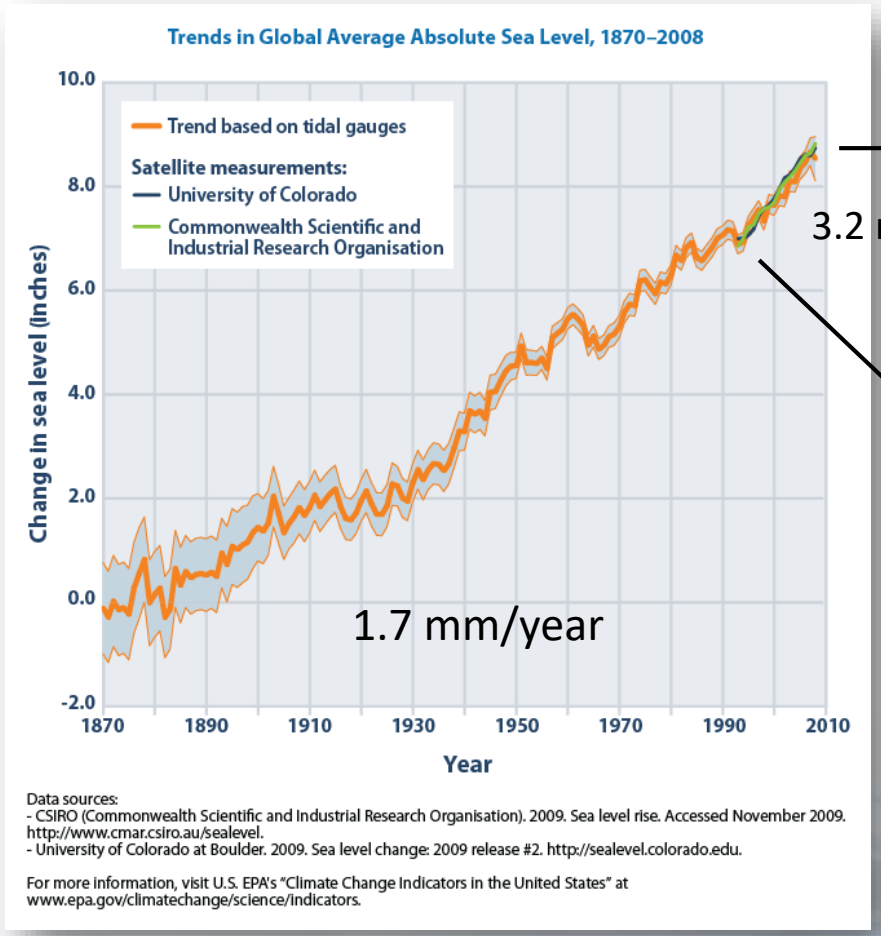


Spatial and temporal variability of sea level rise hot spots over the eastern United States

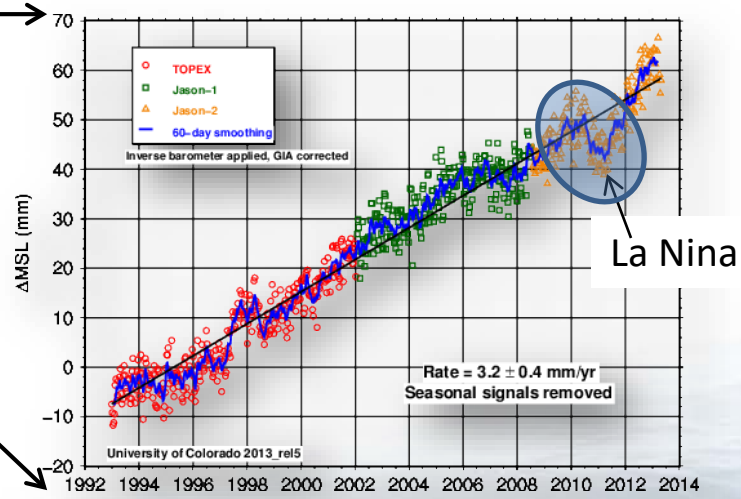
Arnoldo Valle-Levinson[1], Andrea Dutton[2], and Jonathan B. Martin[2]

"**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"

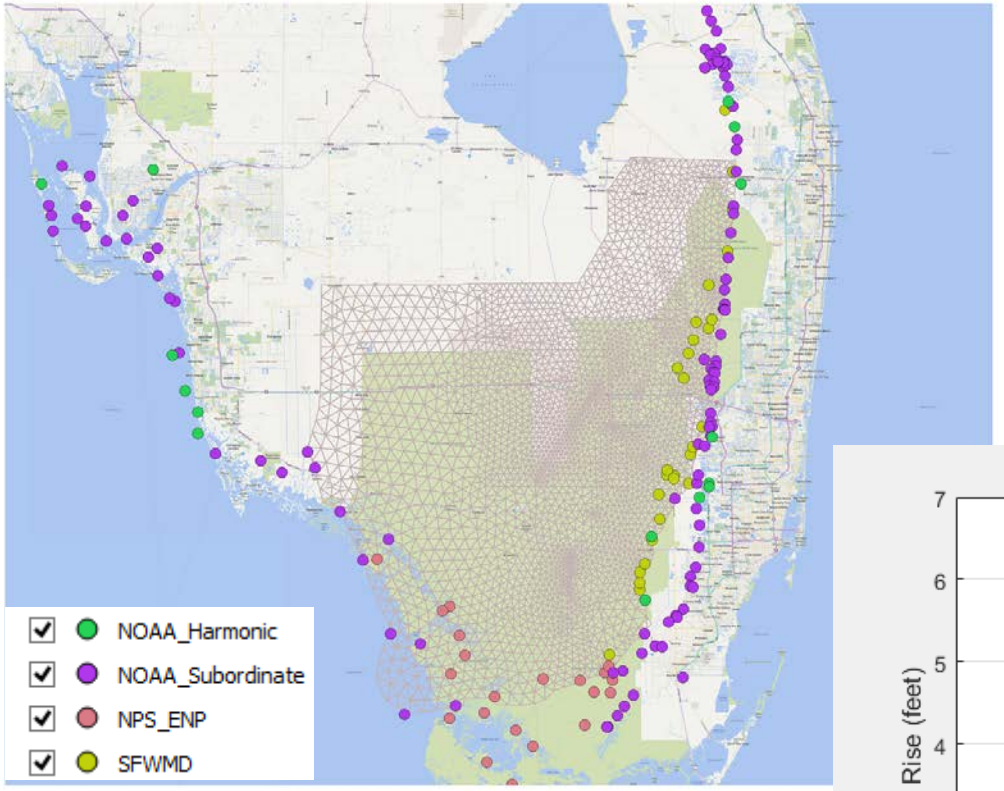
Global Average Sea Level Rise & Relative Sea Level Rise along US Coastline

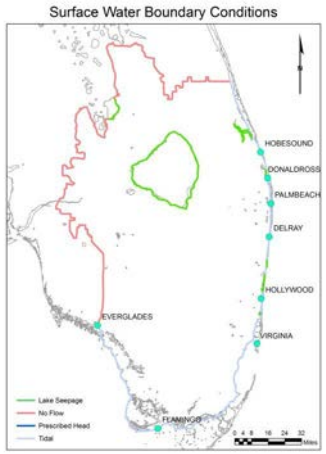


3.2 mm/year



Improvde Tidal Boundary Conditions for Regional Modeling





Existing Tidal boundary locations too sparse