

Adaptation of Coastal Communities and Natural Ecosystems in a Changing Climate

“Adaptation of Coastal Urban and Natural Ecosystems”

Sponsor: NOAA Restore Science Program and ESLR Program

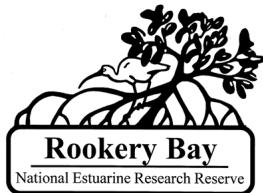
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Stakeholder Coordination Lead: Mike Savarese, Florida Gulf Coast University

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UF WI SYMPOSIUM 2-22-22

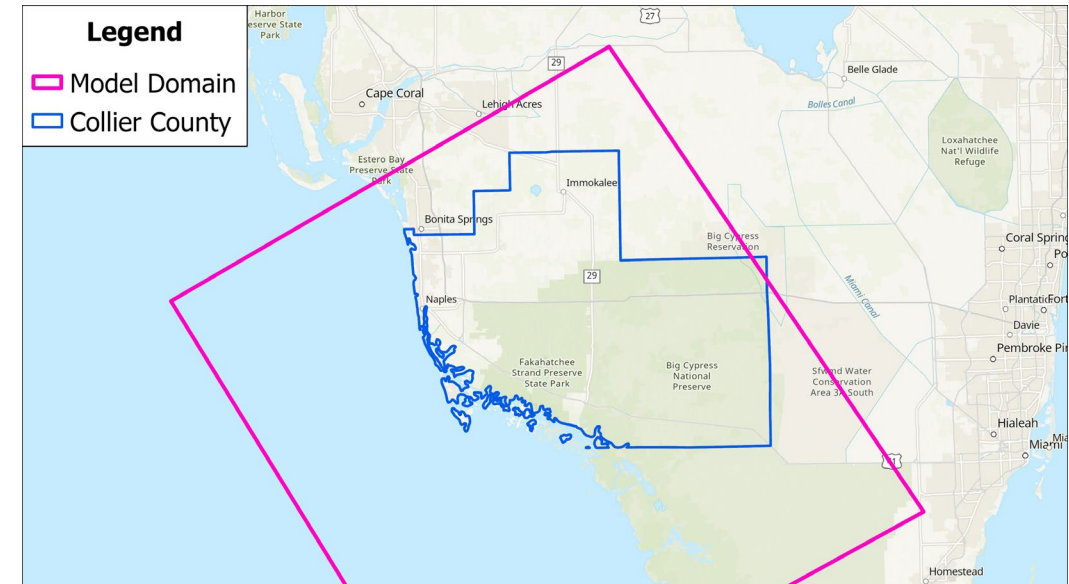
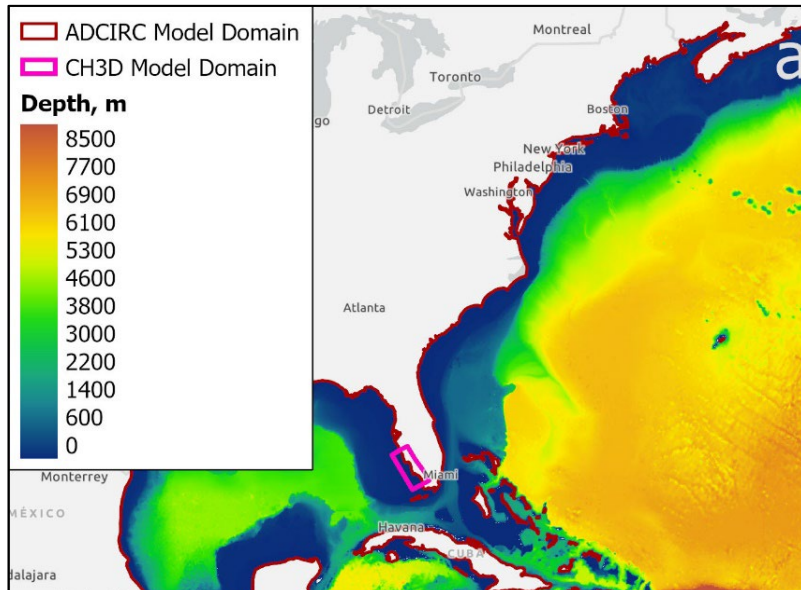


A Sustainable and Economically Healthy SW Florida in a Changing Climate



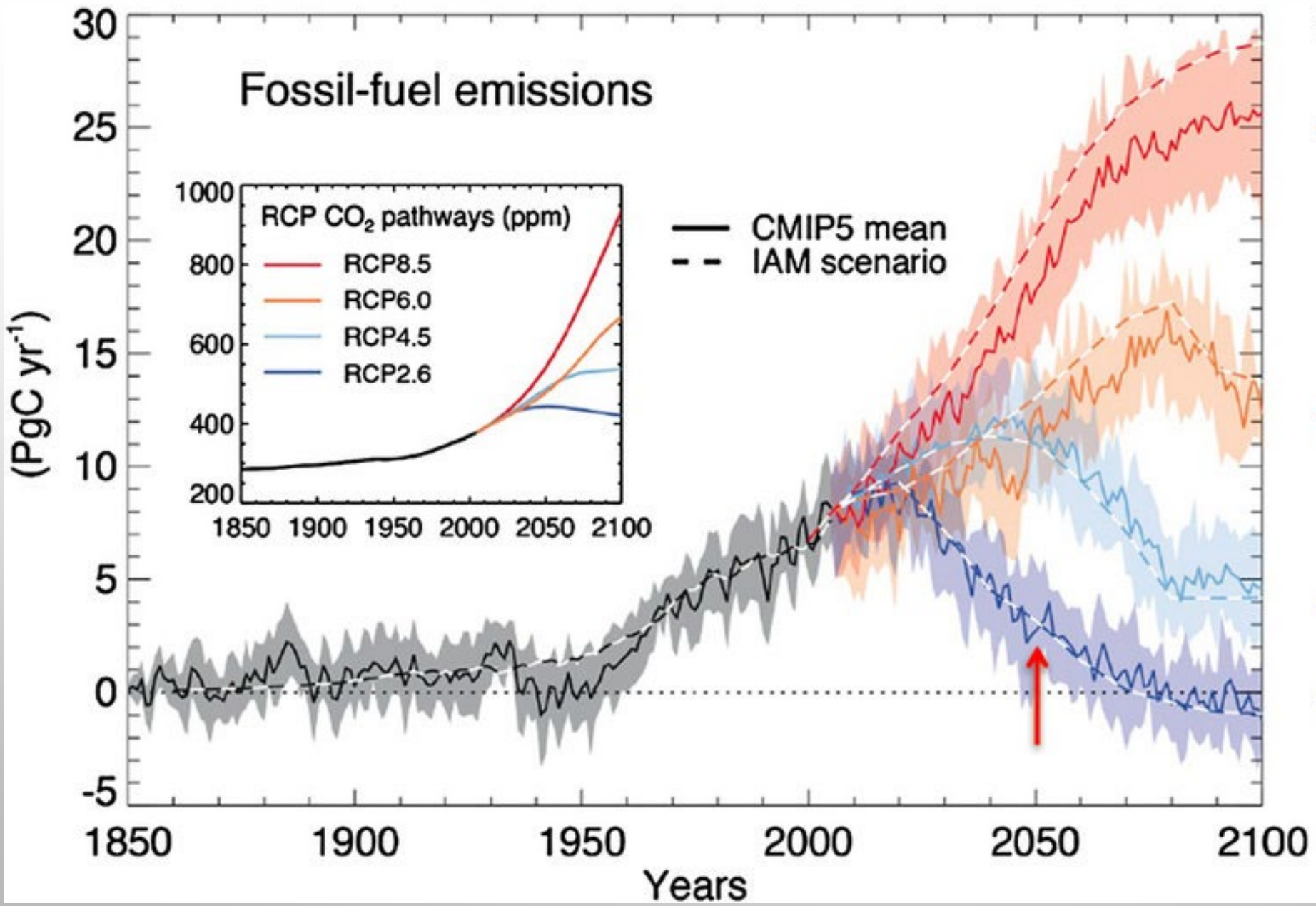
Coastal Flood Hazard and Vulnerability in the 21st Century

- TCs & SLR → Future Compound Coastal Flooding Hazard
- Evolution of Flood Hazard in 2020, 2030, 2060, 2100
- RCP4.5 and RCP8.5 Scenarios
- NOAA (2017) SLR Scenarios
- IPCC AR6 (2021) SSP Scenarios
- NOAA (2022) SLR Scenarios
- 1% Annual Chance Flood Maps
- Economic Impact Maps on Residential Structures
- Value of Mangroves for Flood Damage Reduction



A Three-Dimensional Vegetation-Resolving Hydrodynamic-Wave Modeling System CH3D-SWAN





T in 2100

IPCC

+ 4,5° C

RCP

+ 3° C

REPRESENTATIVE CONCENTRATION PATHWAY

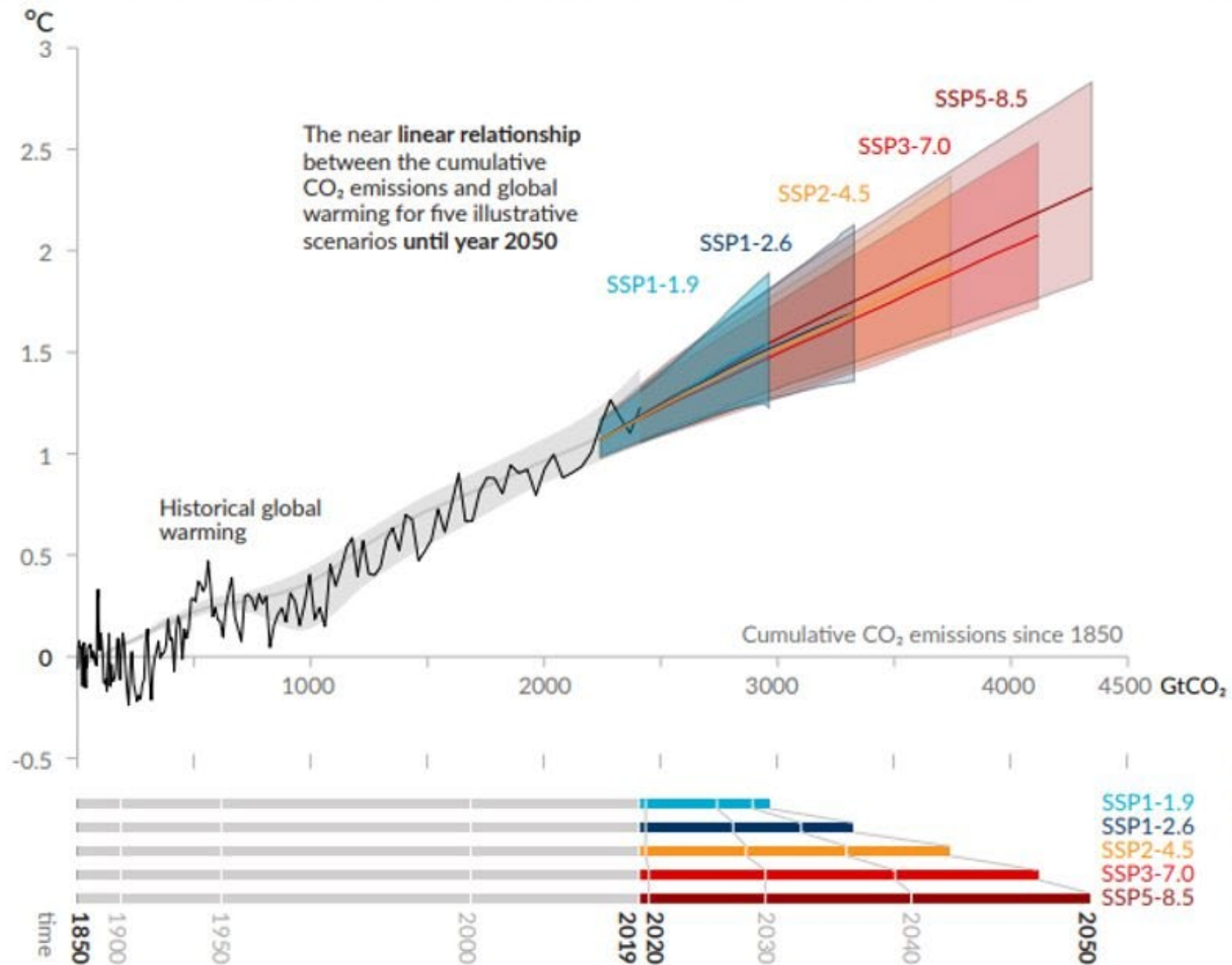
+ 2,5° C

+ 1,8° C

SCENARIOS



Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO₂ emissions (GtCO₂)



IPCC AR6 (2021)

SSP

SHARED SOCIAL- ECONOMIC PATHWAY

SCENARIOS



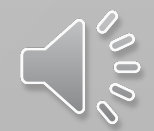
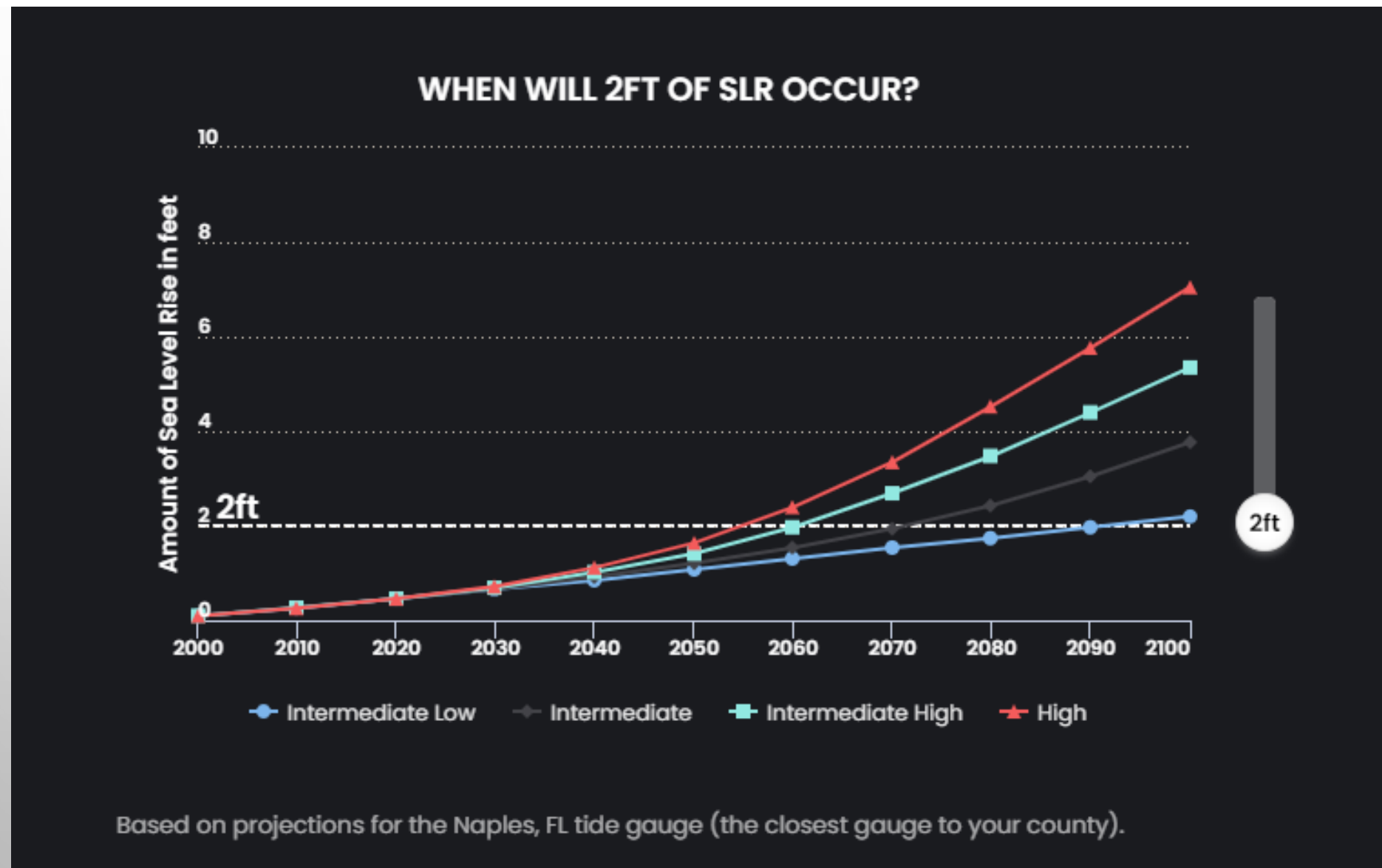
HISTORICAL
Cumulative CO₂ emissions between 1850 and 2019

PROJECTIONS
Cumulative CO₂ emissions between 2020 and 2050

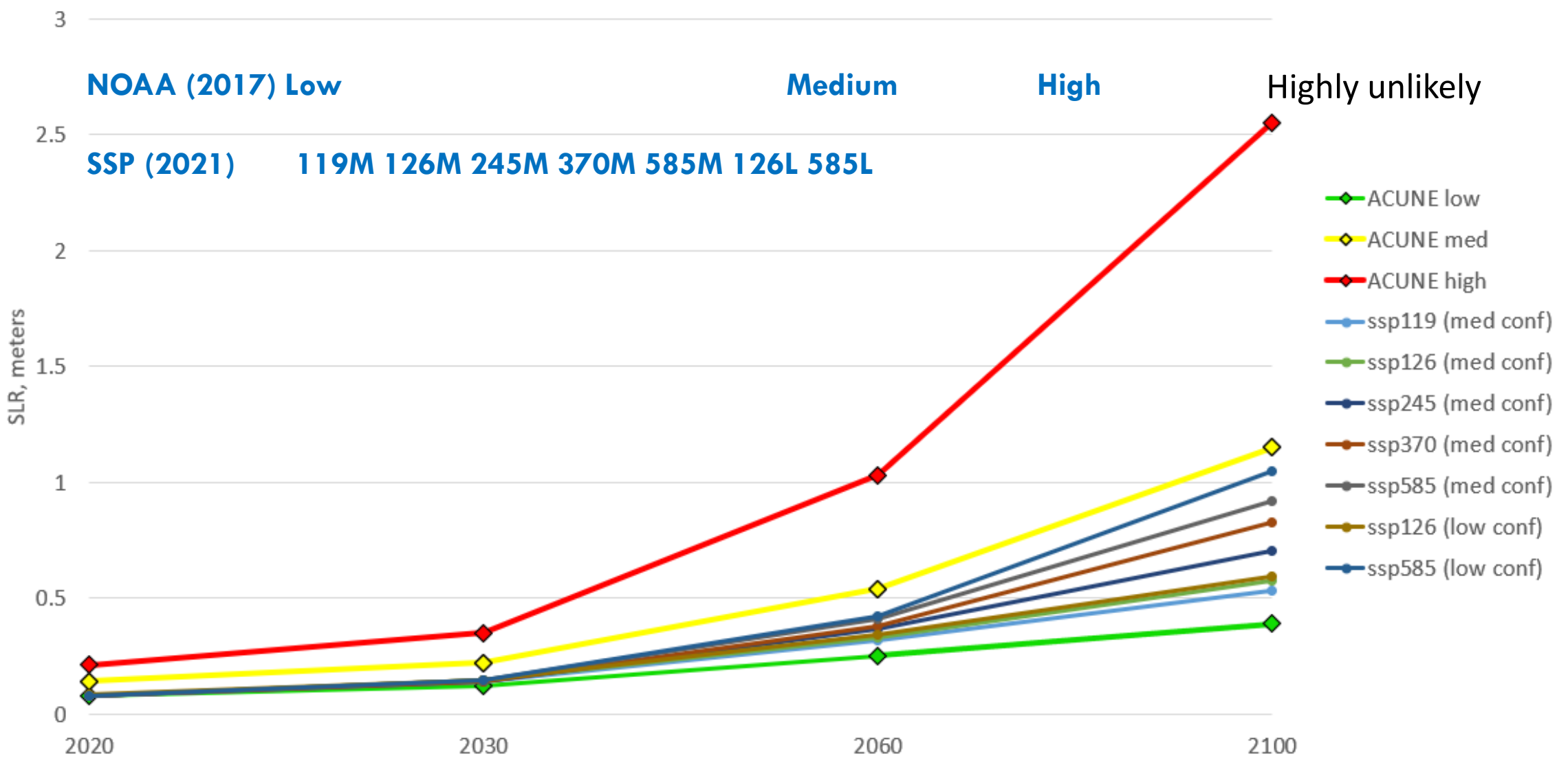
2022 US SLR REPORT



FEMA



Sea Level Rise Estimates

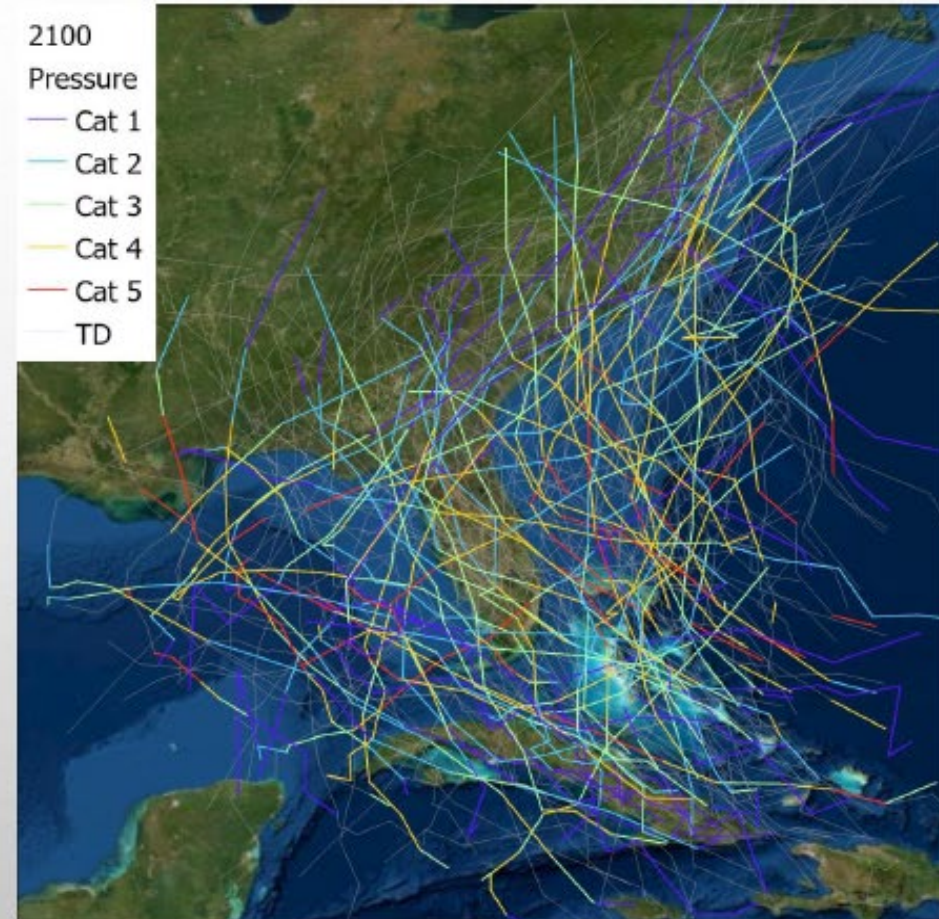
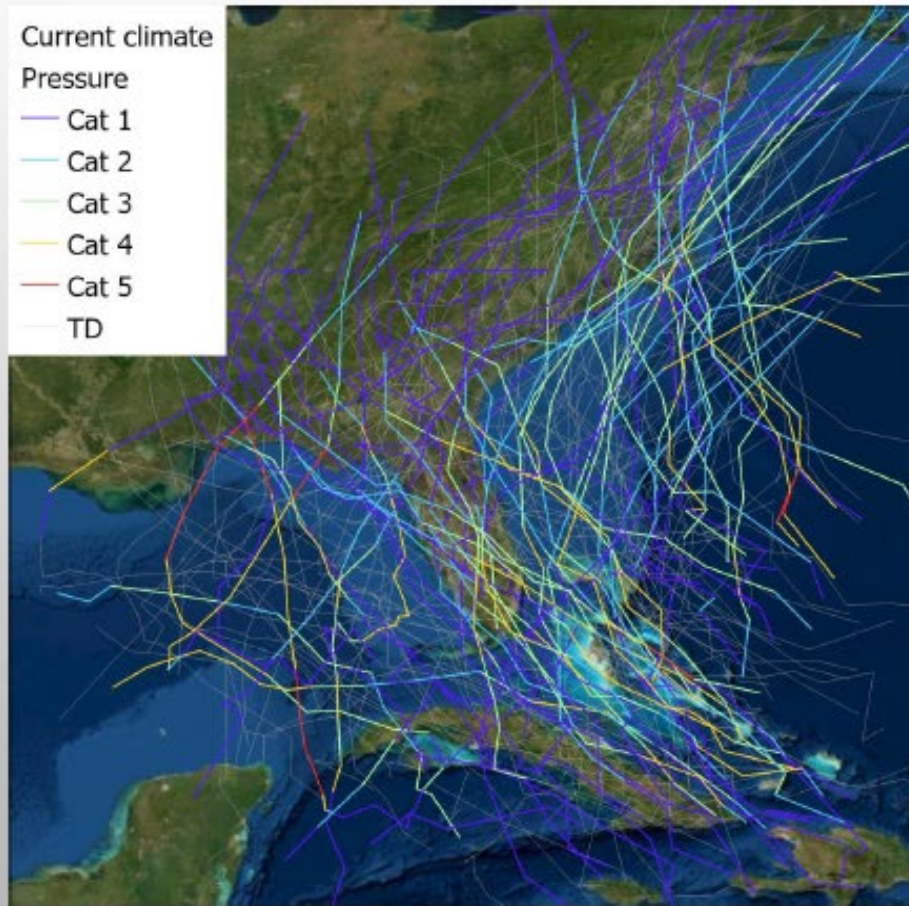


Many Climate Models! Many Future Predictions! Many TC tracks!

CURRENT CLIMATE (CC) STORMS

FUTURE STORMS (2100)

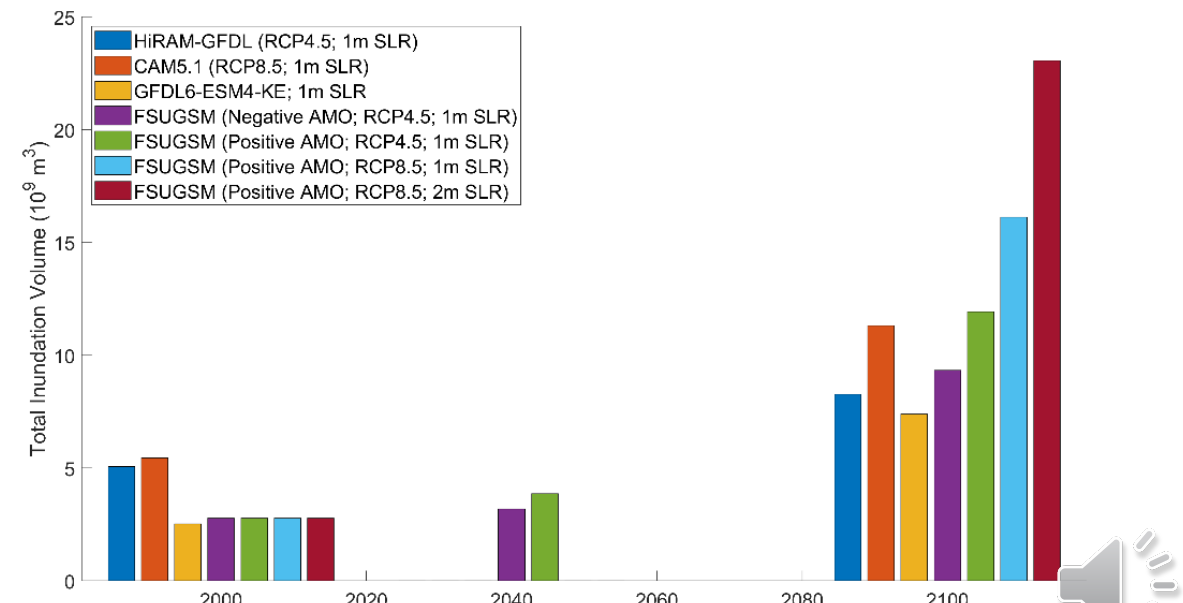
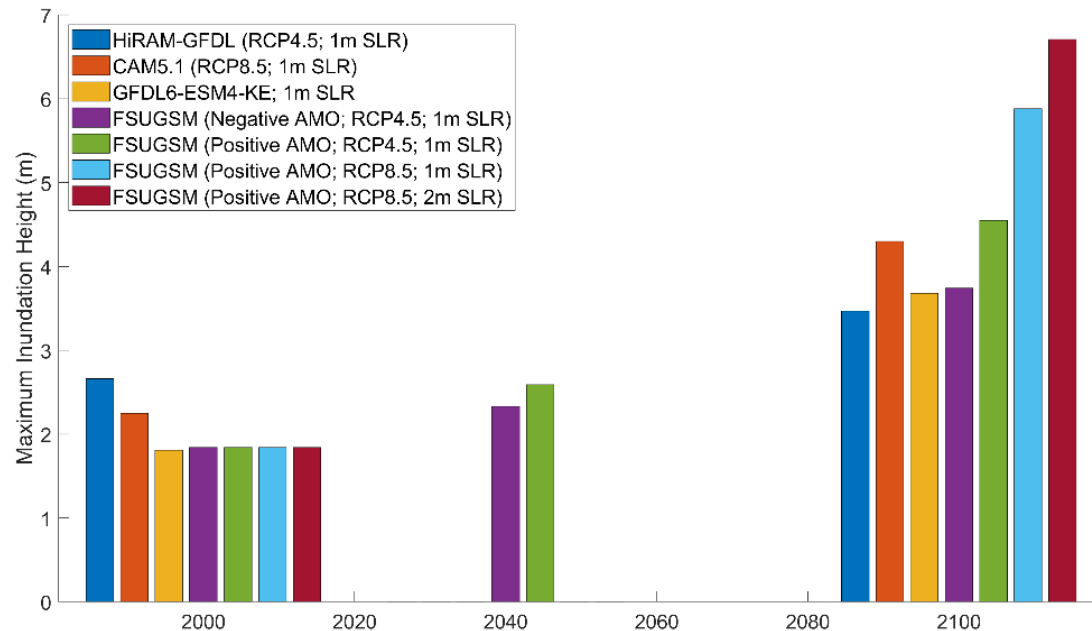
- CMIP5 and CMIP6 climate models and downscaling models: future TCs will likely become more INTENSE.
- The TCs are sensitive to the physics and resolution of climate and downscaling models.



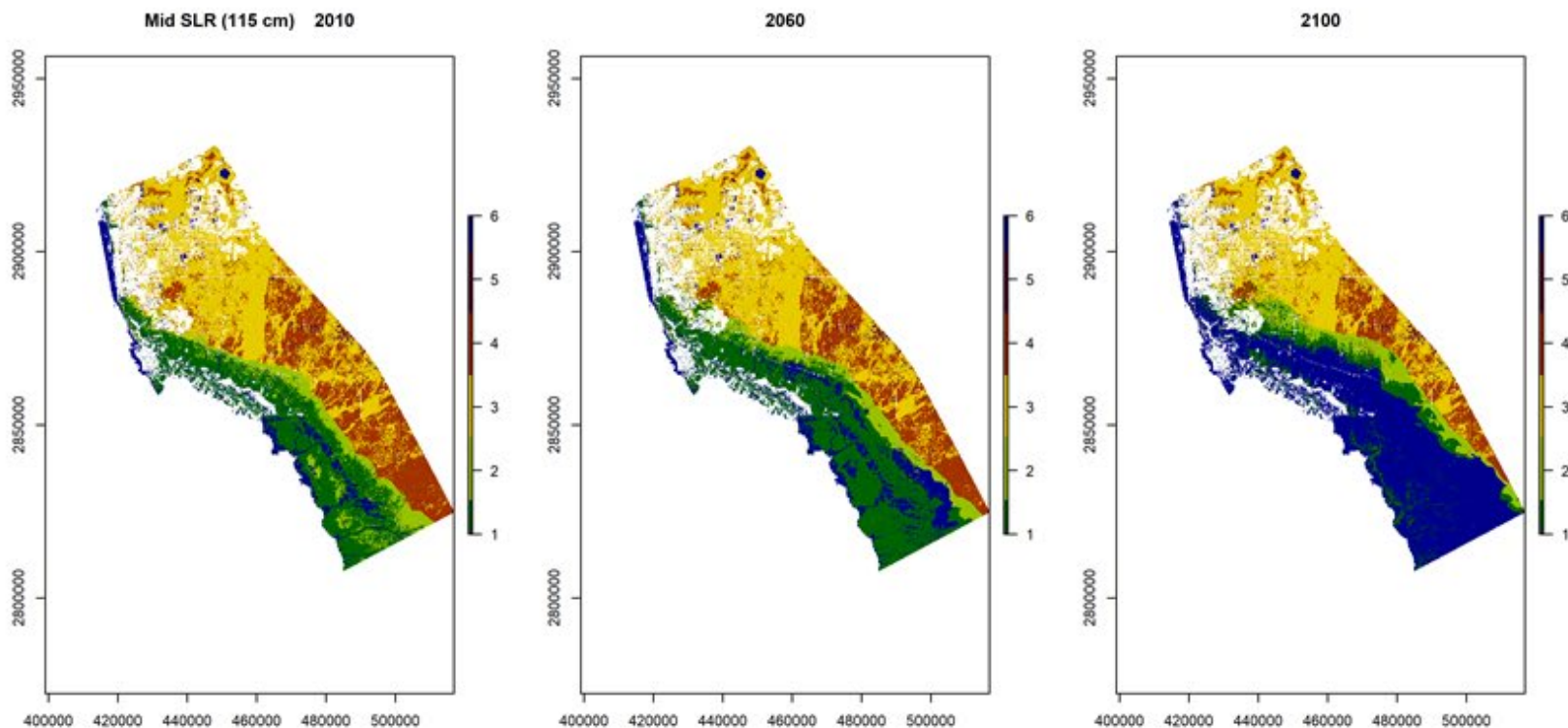
MAXIMUM INUNDATION HT (2000→2100)

TOTAL INUNDATION VOLUME (2000→2100)

- Sheng, YP, Paramygin, VA, Yang, K, Rivera-Nieves, A. **2022**. A Sensitivity Study of Compound Coastal Inundation due to Sea Level Rise and Tropical Cyclones over a Large Coastal Floodplain in a Changing Climate. *NPG Scientific Reports*. In Press.



Evolution of wetland response to medium sea-level rise (115cm 2100)

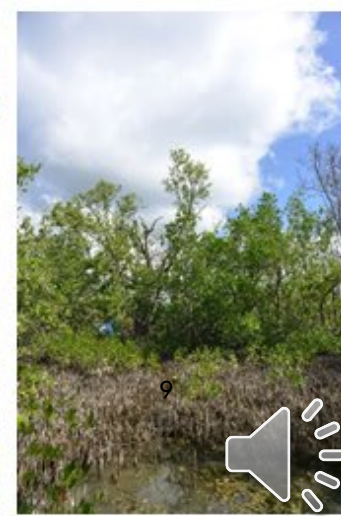


- 1: Mangrove
- 2: Salt marsh
- 3: Cypress

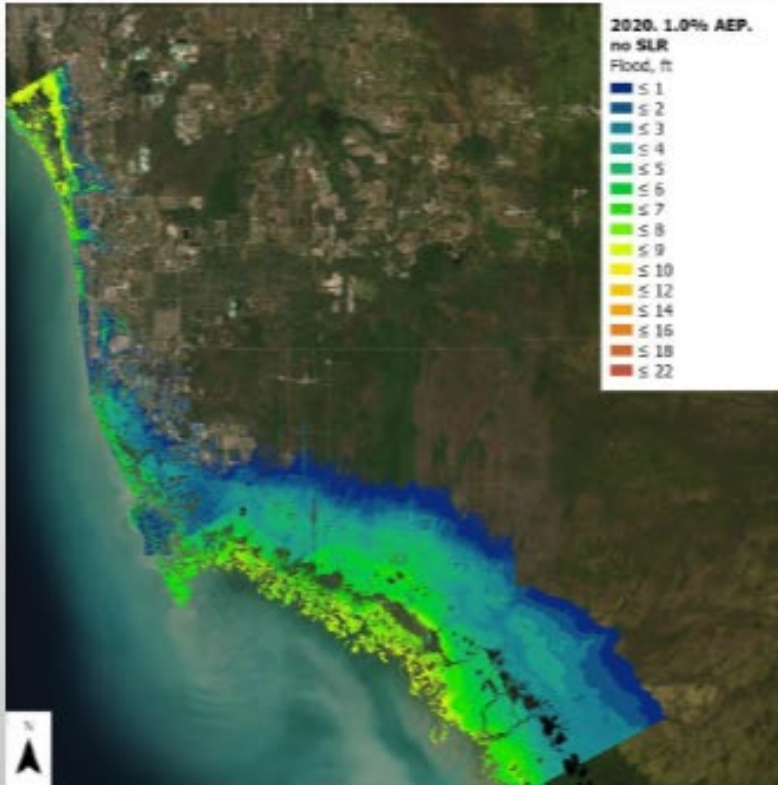
- 4: Fresh marsh
- 5: Upland forest
- 6: Open water



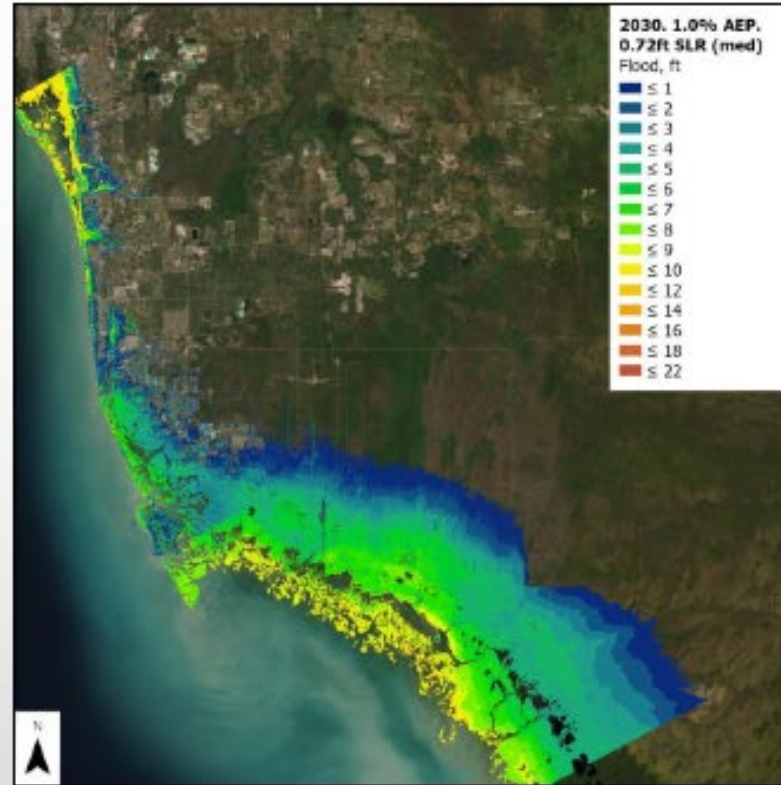
UF UNIVERSITY of FLORIDA



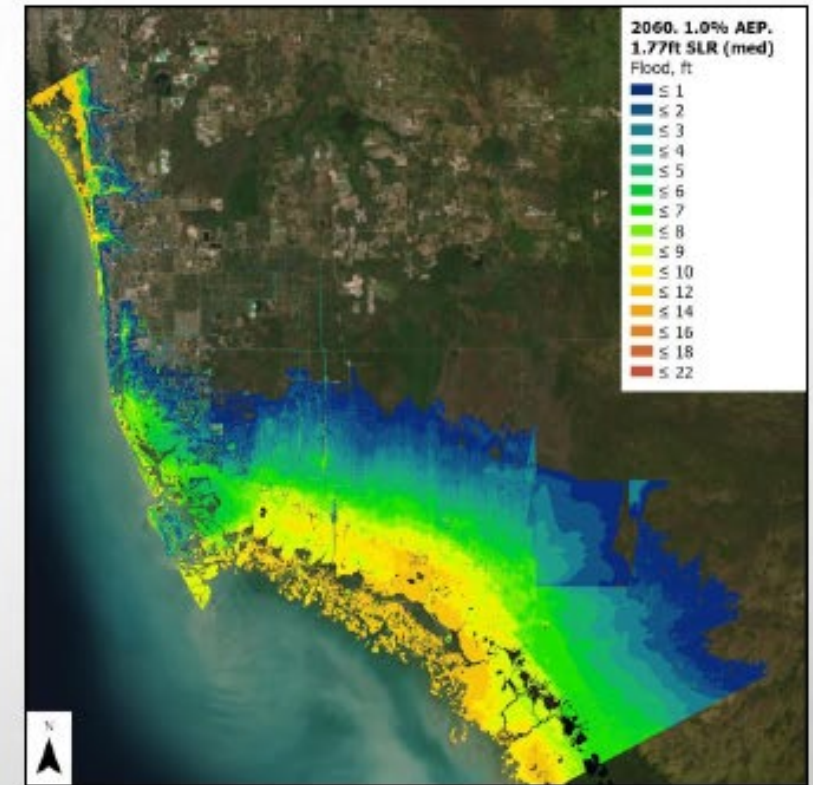
1% ANNUAL CHANCE (100-YEAR) FLOOD MAPS



2020



2030

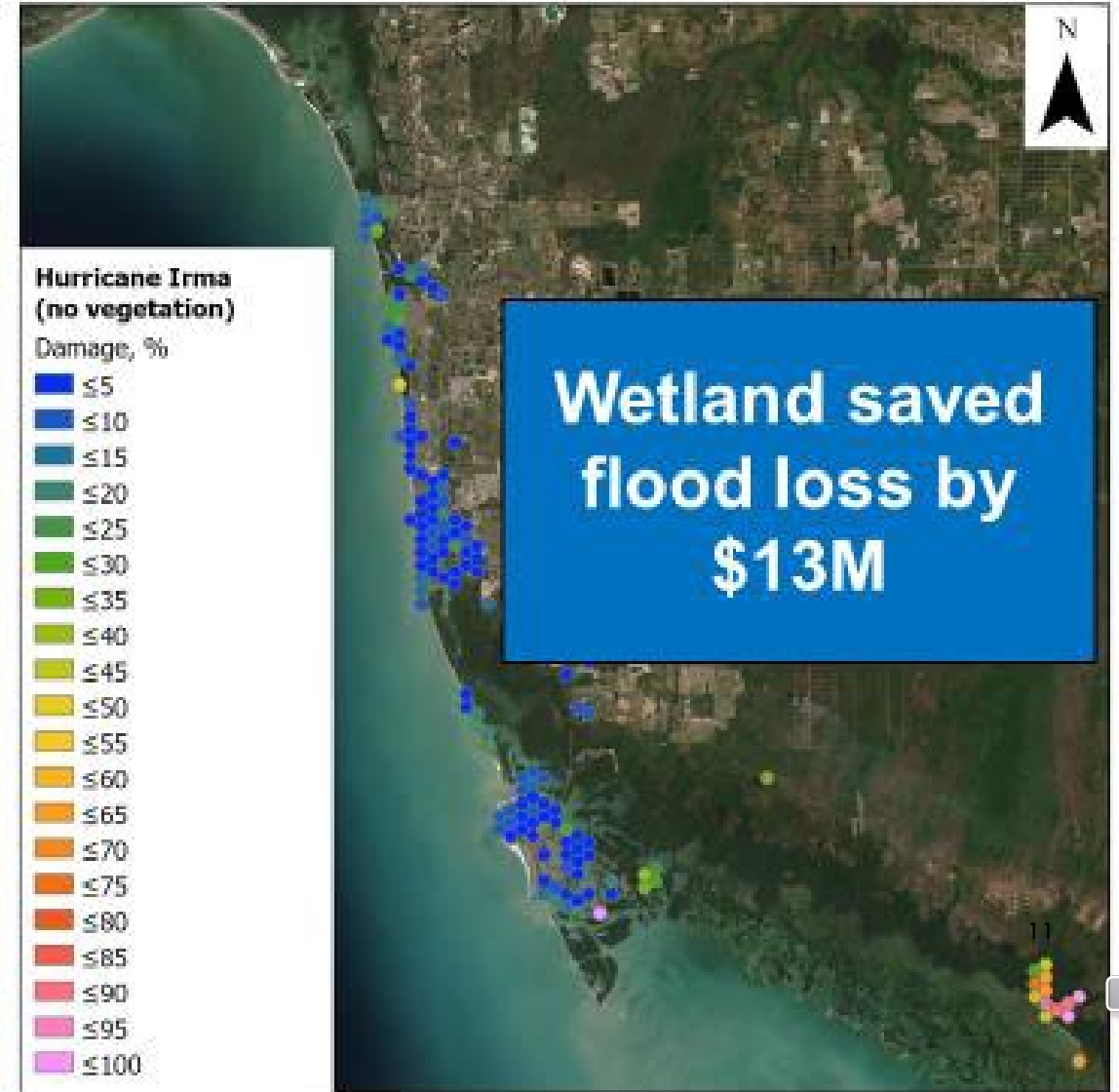
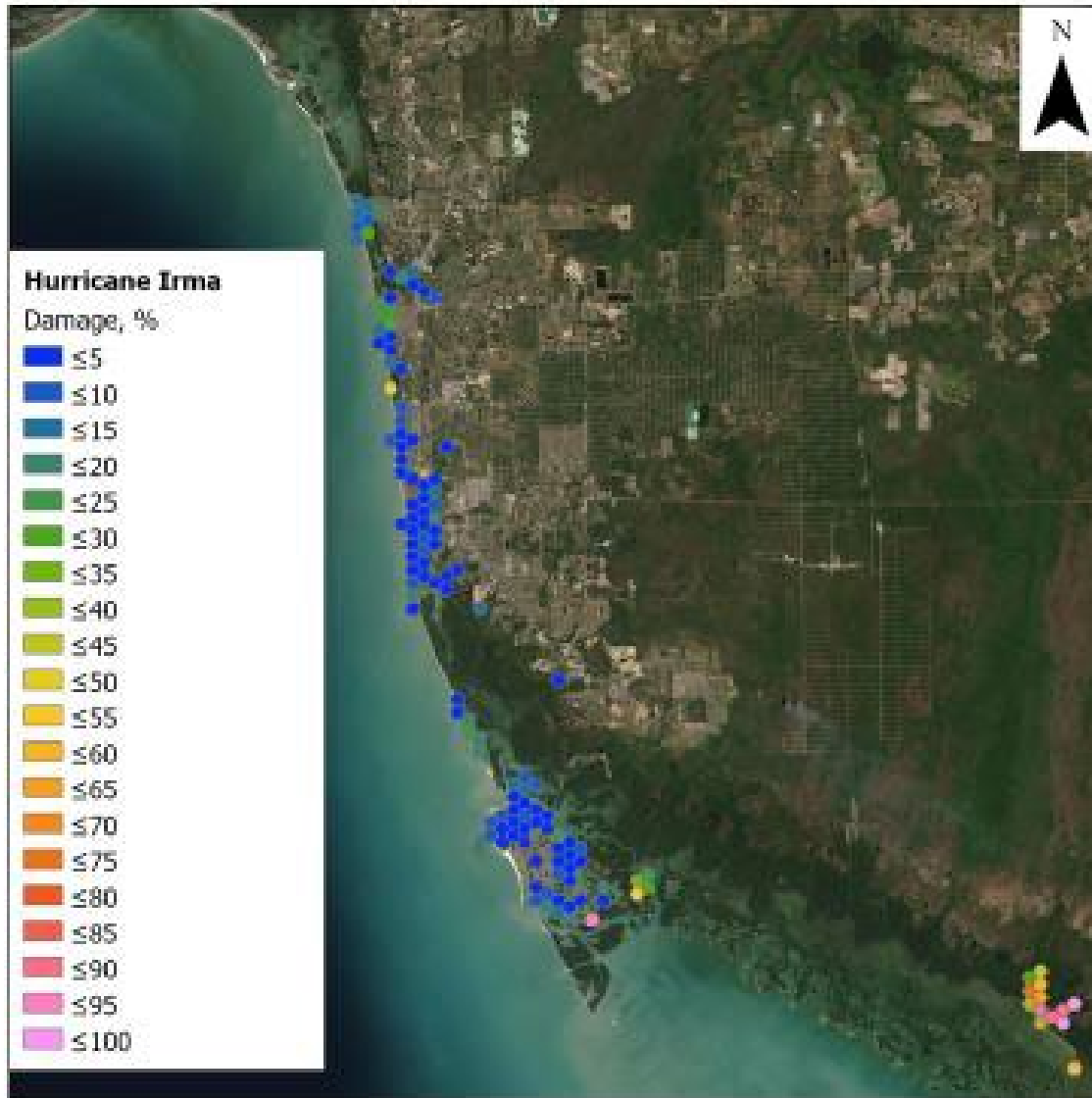


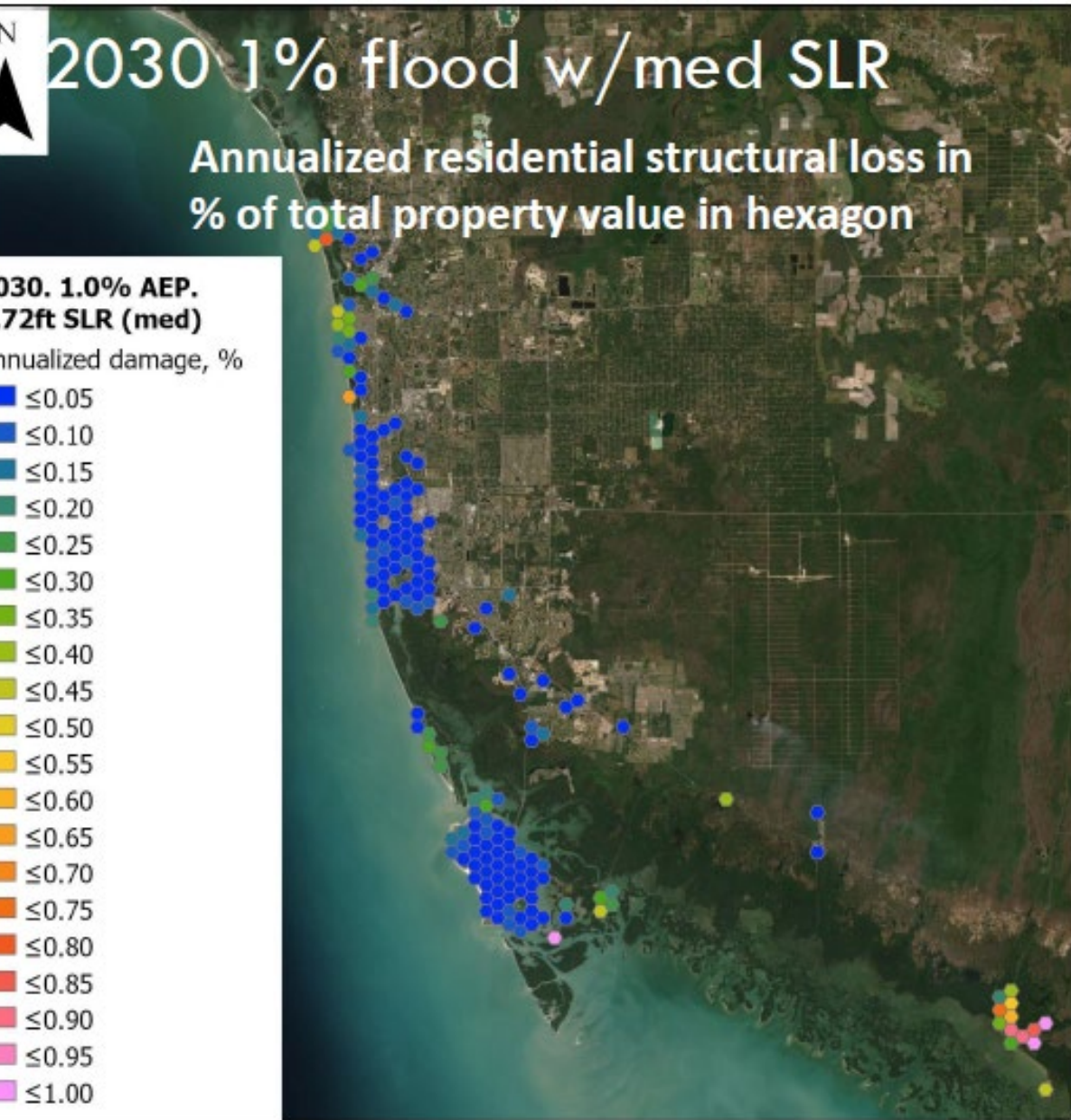
2060



With wetland: ~\$68M NFIP payout ~\$50M
IRMA LOSS (with wetland)

Without wetland: \$81M
IRMA LOSS (without wetland)





ACUNE Geo Tool

Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) is being used by stakeholders for adaptation planning and growth management

- 1% flood maps (w/ future TCs/SLR)
- Asset (infrastructure) maps
 - buildings, highways, hospitals, stormwater, etc
- Annualized damage maps
- Nuisance tide flood maps
- Bathtub flood maps
- Current climate (2020)
- Future climate (2030, 2060, 2100)



ACUNE+ (NOAA ESLR) is Integrating Programs, Projects and Products

Coupling four models:

Coastal – CH3D-SWAN

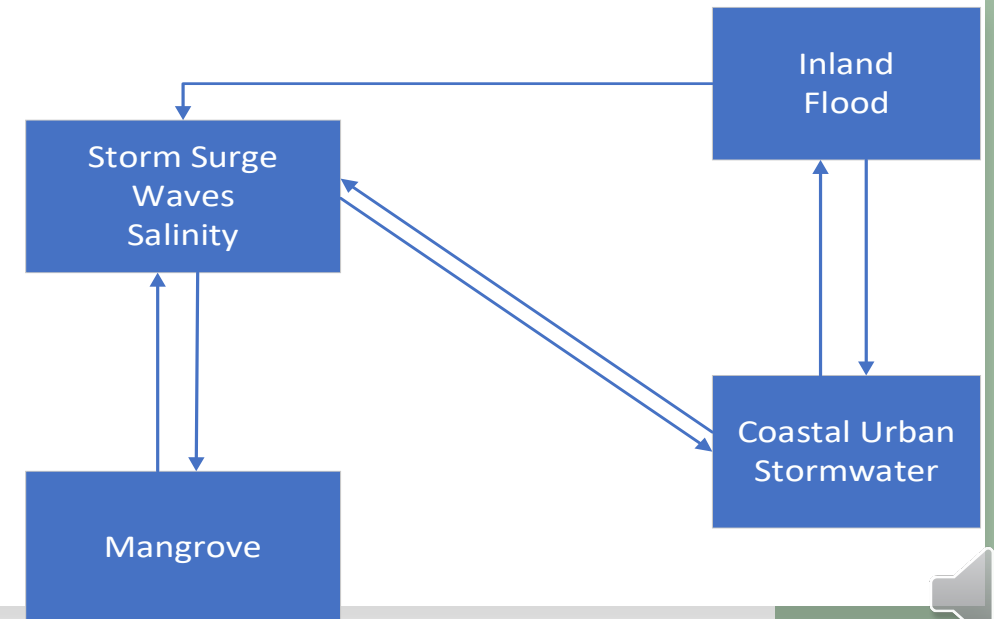
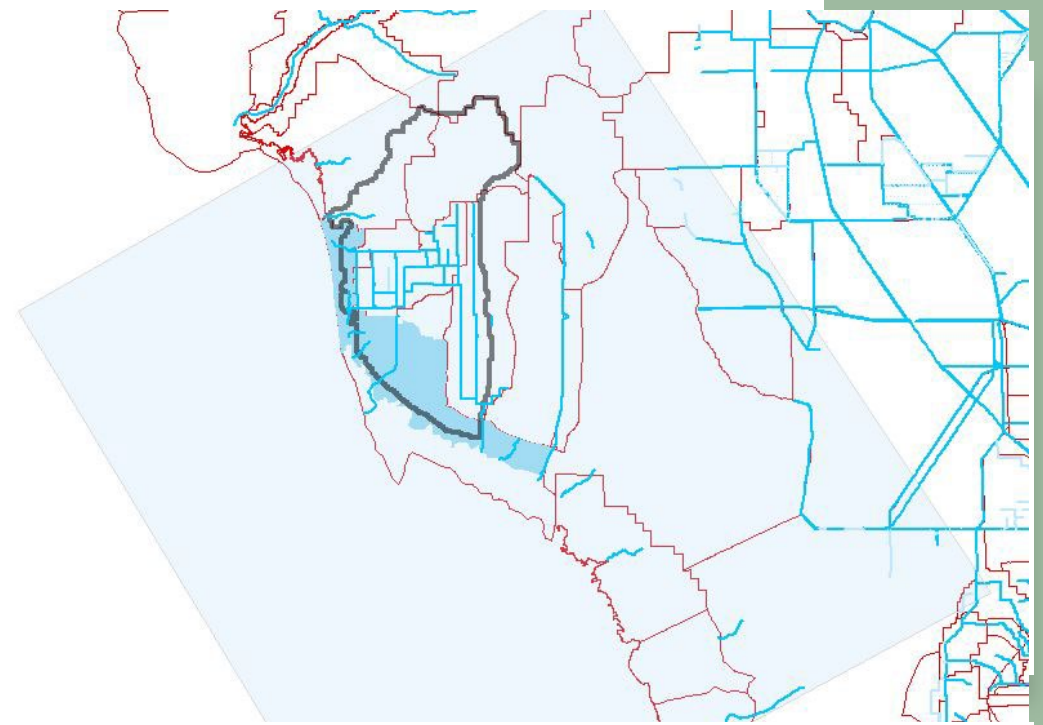
Watershed – BCB-FLOOD

Urban Stormwater – FLO-2D (SWMM5)

Mangrove – WARMER-MANGROVE

Improve coastal inundation maps

Develop mangrove restoration plans



Acknowledgement

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- *NOAA Restore Science Program under award NA17NOS4510094.*

“Development of a Web-Based Decision Support System for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE).”

- *NOAA Effects of Sea-Level Rise (ESLR) under award NA19NOS4780178.*

“Assessing the Role of Natural and Nature-Based Features for Buffering Coastal Communities from Storm-Induced Losses in a Changing Climate.”

- *NOAA Climate Program Office (CPO) under award NA11OAR43100105.*

“Incorporating Climate Change Effects into Next-Generation Coastal Inundation Decision Support Systems: An Integrated and Community-Based Approach.”

- *Collier County, Florida.*



Selected publications on Florida (Black) and NJ/NY (Blue)

- Sheng, YP, Yang, K, Paramygin, VA, 2022. Predicting compound coastal inundation in 2100 by considering the joint probabilities of landfalling tropical cyclones and sea level rise. *Environmental Research Letters*. In Press. <https://iopscience.iop.org/article/10.1088/1748-9326/ac50d1>
- Sheng, YP, Paramygin, VA, Yang, K, Rivera-Nieves, A. 2022. A Sensitivity Study of Compound Coastal Inundation due to Sea Level Rise and Tropical Cyclones over a Large Coastal Floodplain in a Changing Climate. *Scientific Reports*. In Press.
- Yang, K, Paramygin, VA, Sheng, YP, 2020. A Rapid Forecasting and Mapping System of Storm Surge and Coastal Flooding. *Weather and Forecasting*. <https://doi.org/10.1175/WAF-D-19-0150.1>
- Sheng, YP, and Paramygin VA. 2022. ACUNE Overview. ArcGIS StoryMaps. <https://storymaps.arcgis.com/stories/63ffeb76f8dc4430a23e02cdb3bb1f50>
- Sheng, YP, Rivera-Nieves, A, Zou, R., Paramygin, VA, 2021. Role of wetlands in reducing structural loss is highly dependent on characteristics of storms and local wetland and structure conditions. *Scientific Reports*. <https://rdcu.be/cgcuk/>
- Sheng, YP, Rivera-Nieves, A., Zou, R., Paramygin, VA, Angelini, C., Sharp, S. 2021. Invasive Phragmites provides superior wave and surge damage protection relative to native plants during storms. *Environmental Research Letters*. <https://hrnerr.org/wp-content/uploads/2021/08/Sheng-et-al.-2021-Phragmites.pdf>
- Sheng, YP, Paramygin, VA, Rivera-Nieves, A., Zou, R., Fernald, S., Hall, T., Jacob, K. 2022. Coastal Marshes Provide Valuable Protection for Coastal Communities from Storm-Induced Wave, Flood, and Structural Loss in a Changing Climate. *Scientific Reports*. www.nature.com/articles/s41598-022-06850-z



Sustainability

Special Issue:

Sea Level Rising: Coastal Vulnerability & Adaptation Management

Guest Editors:

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Trevor Meckley
Karen Thorne

Starting soon until November 30, 2022

