

Smart Sea Level Sensors for Coastal Resilience



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Nick Deffley

Director, Office of Sustainability, City of Savannah

Randall Mathews

Assistant Director, Chatham County Emergency
Management Agency



Photo: Sean Compton, FOX5 Atlanta

King Tides



Saturday Morning

Sunday Morning



Project Overview

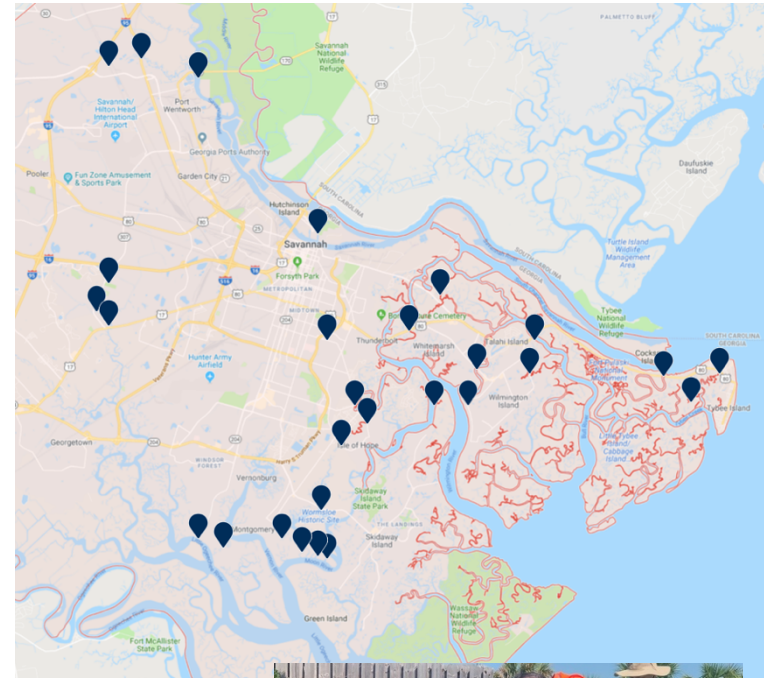


A high-density deployment of smart sea level sensors to provide hyper-local, real-time water level data across the community.

Goals:

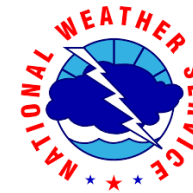
- ***emergency planning & response***
real-time data portal & toolkits
- ***short- and long-term risk assessment and resilience planning***
- ***develop & test educational resources***
middle & high school curricula
- ***communication and awareness***
public events, installations, website

See more details at <http://sealevelsensors.org>





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of Oceanography
UNIVERSITY OF GEORGIA



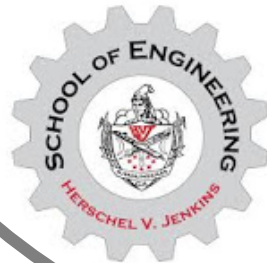
SAVANNAH
savannahga.gov



Georgia
Tech



UNIVERSITY OF HAWAII
MĀNOA



Georgia Tech
GEORGIA SMART
COMMUNITIES CHALLENGE



Project Team



Nick Deffley
Office of Sustainability
Tom McDonald
David Donnelly

Dr. Kim Cobb
Dr. Russ Clark*
Dr. David Frost
Dr. Emanuele Di Lorenzo
Dr. Alex Robel
Dr. Sally Ng
Dr. Iris Tien
Lalith Polepeddi
Matt Sanders
Jayma Koval
Tim Cone*
Selena Perrin
Peter Presti
Scott Gilliland

Randall Mathews
Leon Davenport
Dennis Jones
David Anderson

Harambee House
Dr. Mildred McClain
Dawud Shabaka

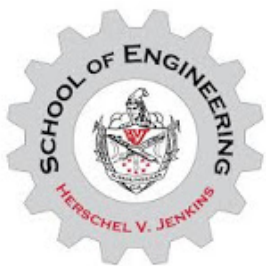


Lara Hall

*GT-Savannah



**Skidaway Institute
of Oceanography**
UNIVERSITY OF GEORGIA
Dr. Clark Alexander



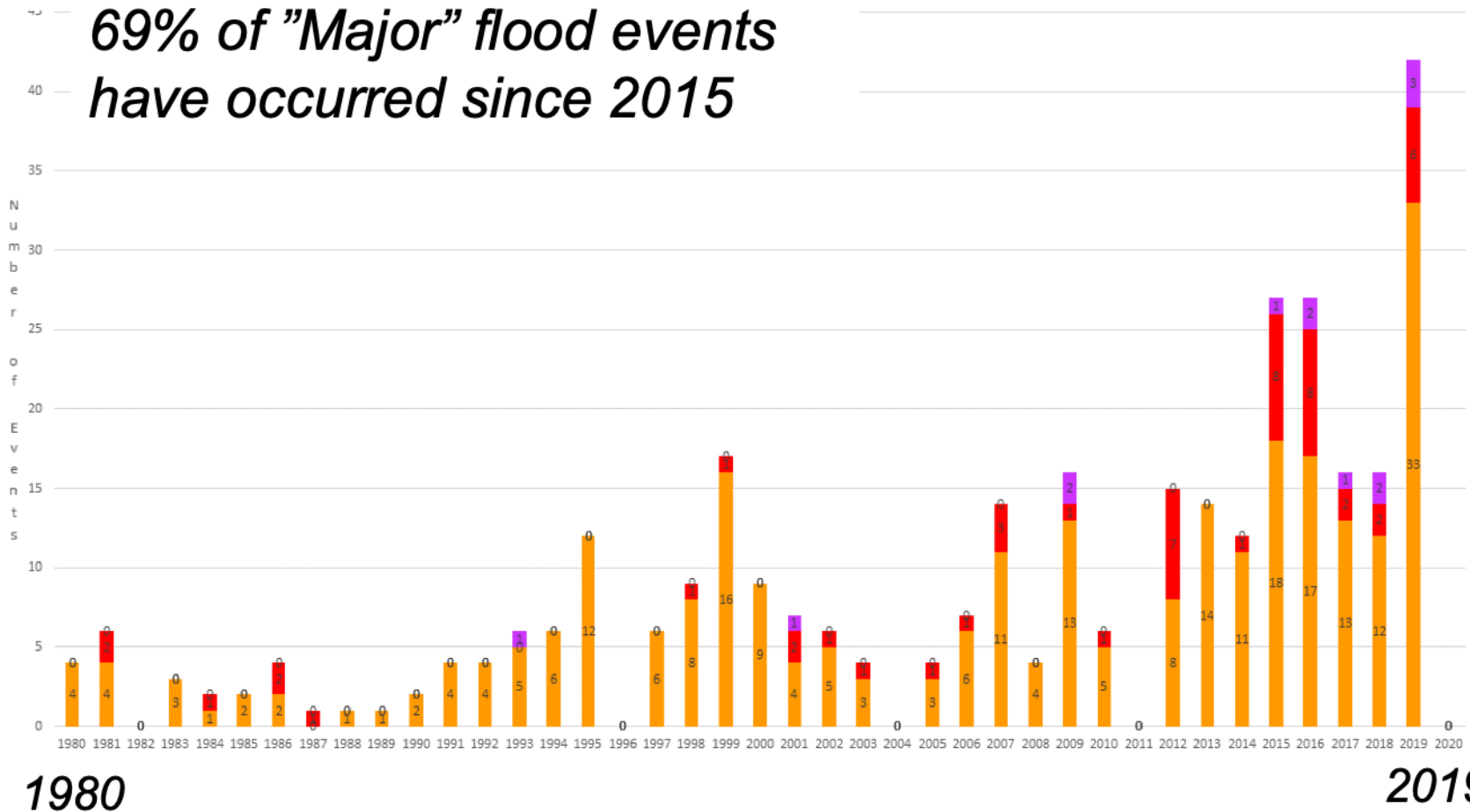
Tom Maty
Grace
Herrington



Rebecca
Greenbush

Sea level rise on the Georgia coast

69% of "Major" flood events have occurred since 2015



1980

2019

flooding frequency and intensity rising

Source: NWS Charleston

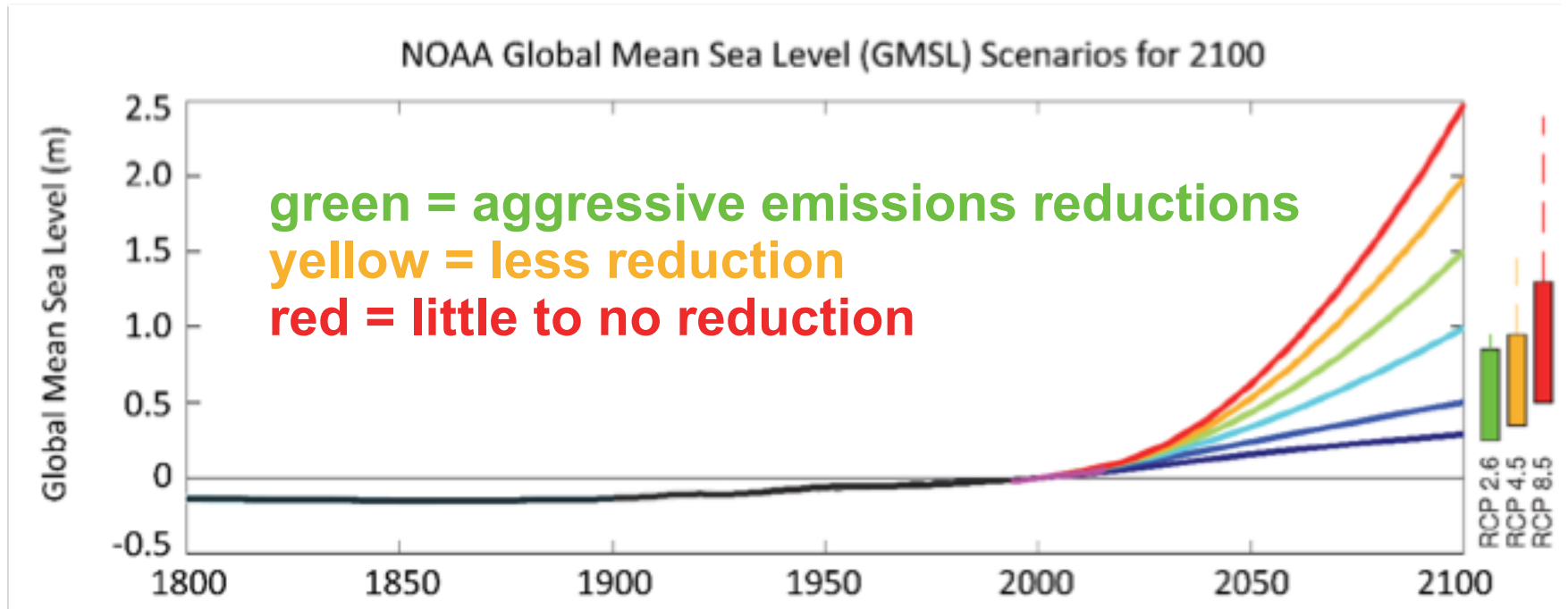
A photograph of a flooded residential area. In the background, a two-story house with a balcony is partially submerged in water. To the left, a palm tree trunk is visible. The foreground shows a grassy area and a gravelly path. The image is overlaid with a semi-transparent white box containing text.

+1-4ft likely

+10ft possible

**source: National Climate
Assessment, 2018**

Global sea level rise scenarios



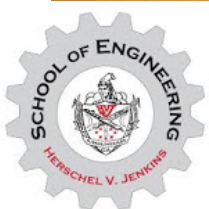
future sea level rise rates uncertain, depend on:

- 1) our emissions pathway
- 2) response of the ice sheets to warming



ultrasonic sensor:

- \$250 in parts
- powered by D-cell batteries or small solar cell
- LoRaWAN communications
- installed on bridges, docks
- low installation and maintenance costs





gateway device:

- roughly \$1,500
- 1 to 4 mile range
- can serve hundreds of sensors
- needs internet, power



opportunity:

- provides backbone for diverse IoT applications (temp, humidity, air quality, etc)
- Other student projects!



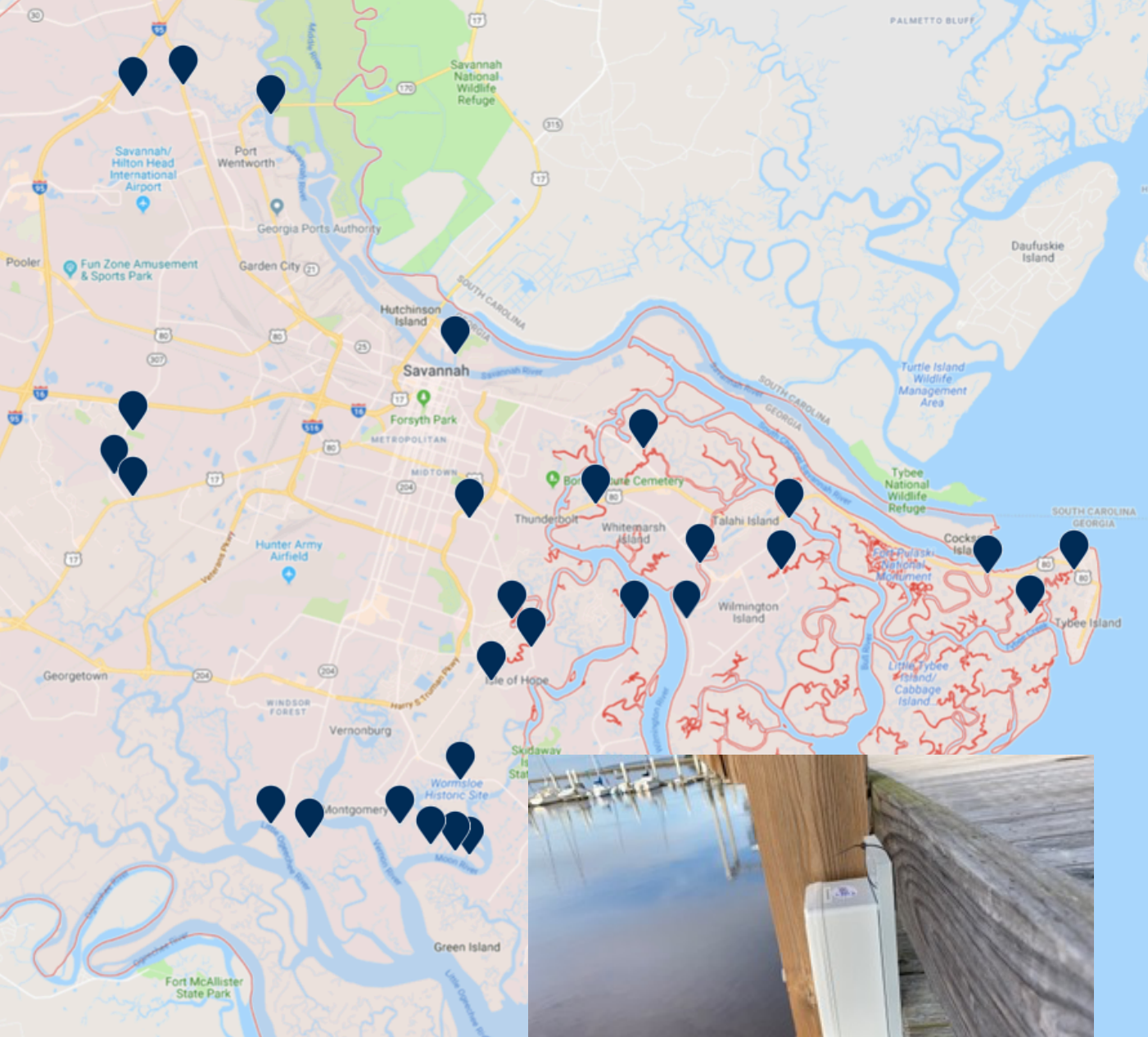
Tell your students about this!

- Great option for low powered, real-time monitoring projects
- Our goal is to provide this coverage across the Georgia Coast
- I love to help students work on these types of projects
- Have them email me:
Russ.Clark@gatech.edu

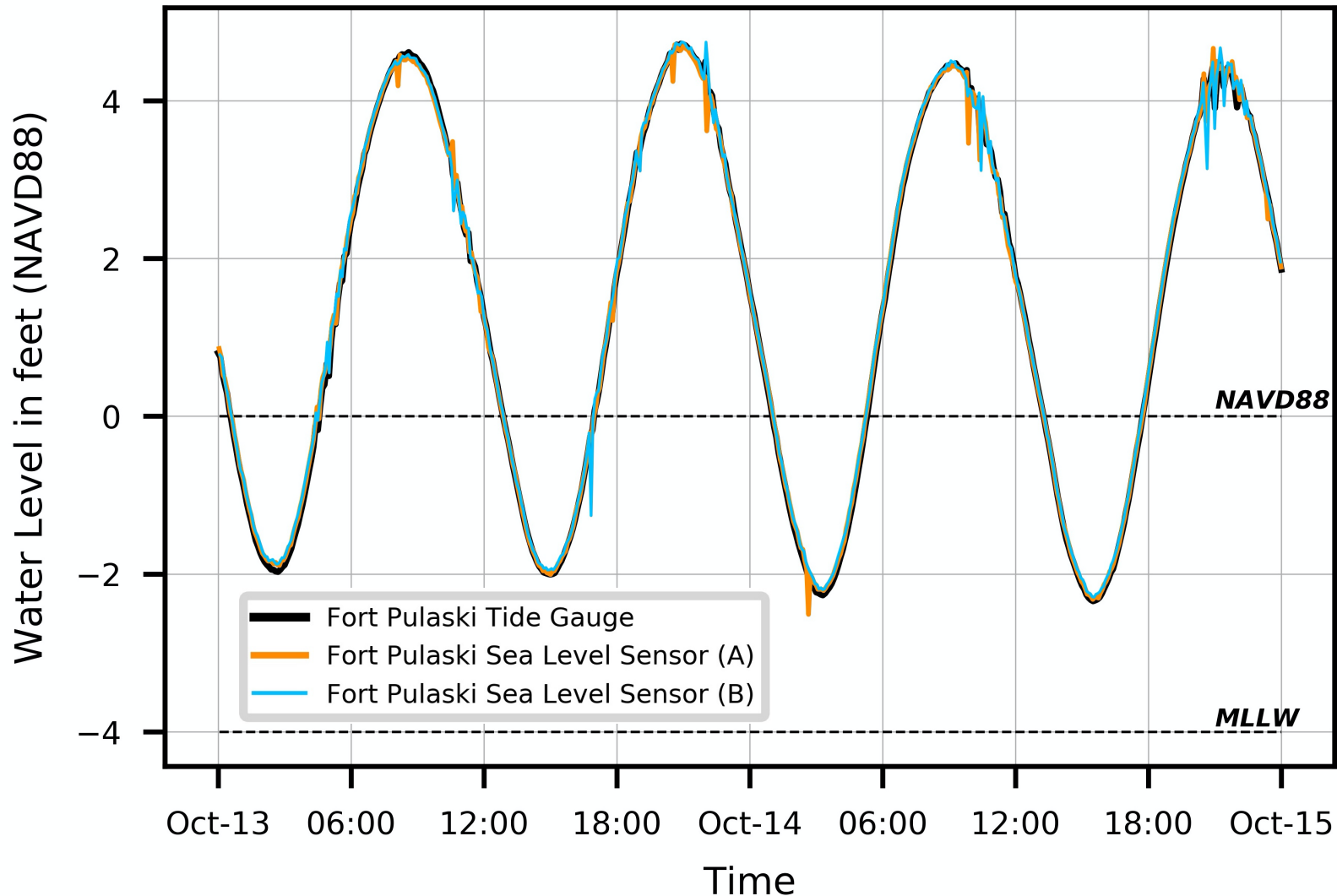




To date:
50+ sensors
15 gateways



Comparing two GT sensors with Ft. Pulaski NOAA gauge



average residuals between GT sensors and Ft. Pulaski = less than 1", maximum 6"

Decision Support Tools



public data portal (dashboard.sealevelsensors.org)

- browse sensor data past and present
- slider for visualizing flooding from past flood events, future flood events

emergency planning portal

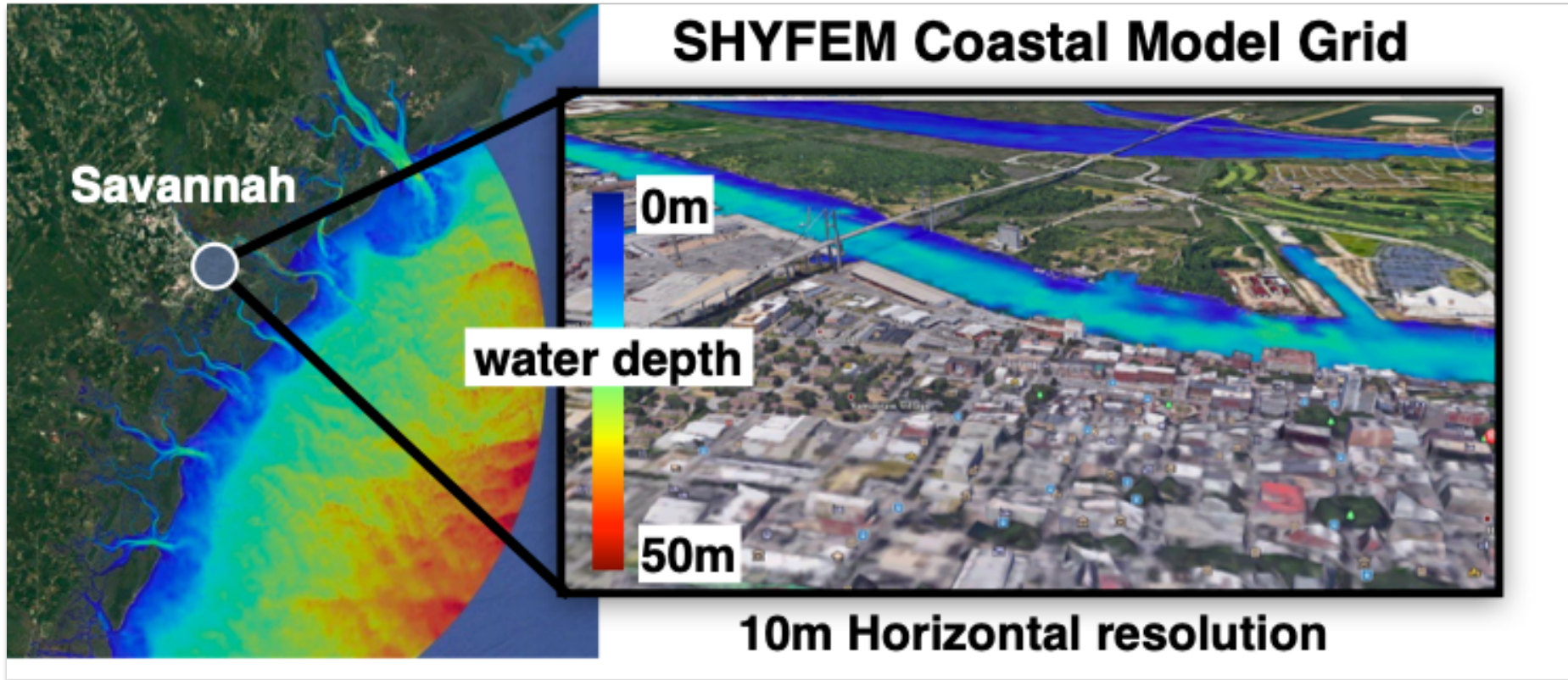
- access real-time water level data, flag bridges, critical infrastructure for flood risk

3-day flood forecasts (in development)

- validation with sensor data streams underway

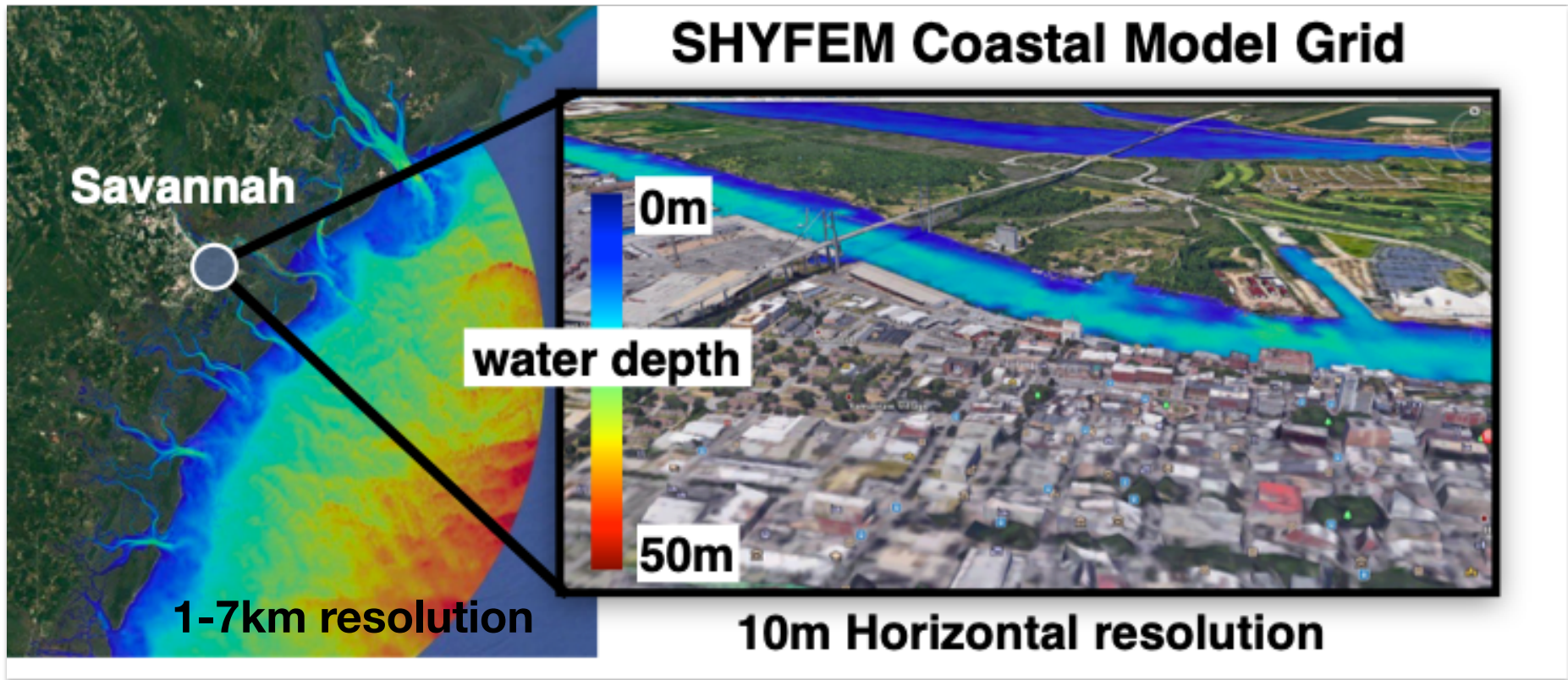
Modeling Research Team

Led by Dr Emanuele Di Lorenzo

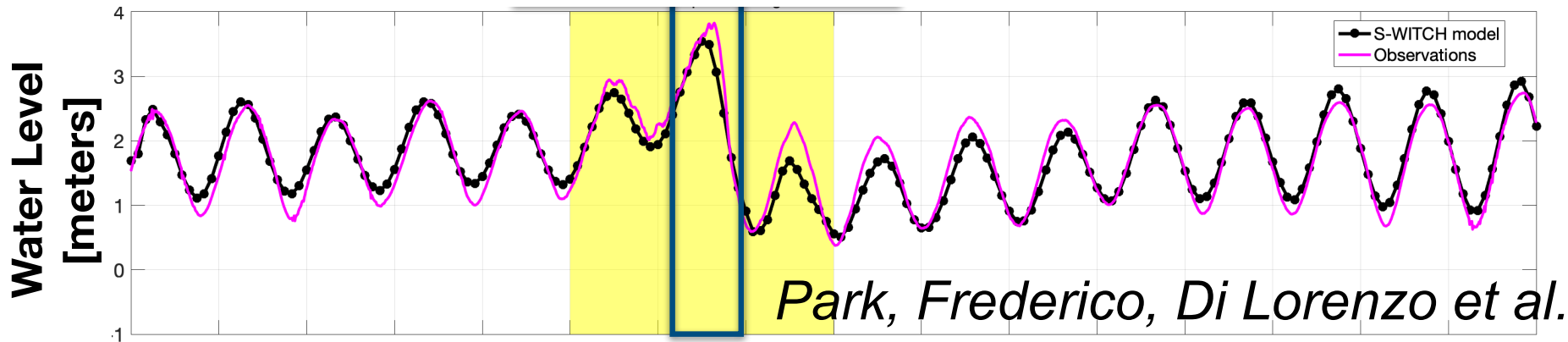


Di Lorenzo, Frederico, Pinardi et al.

SHYFEM Coastal Model Grid



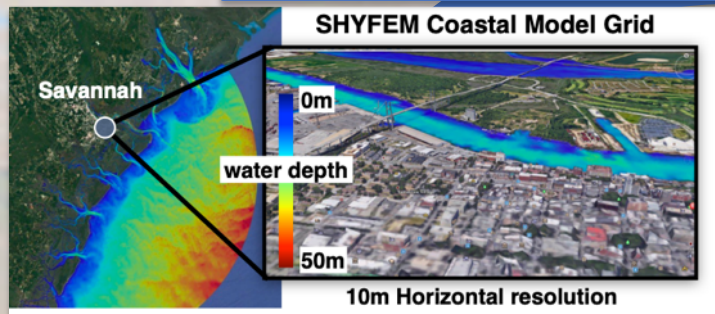
Hurricane Matthew – data/model comparison



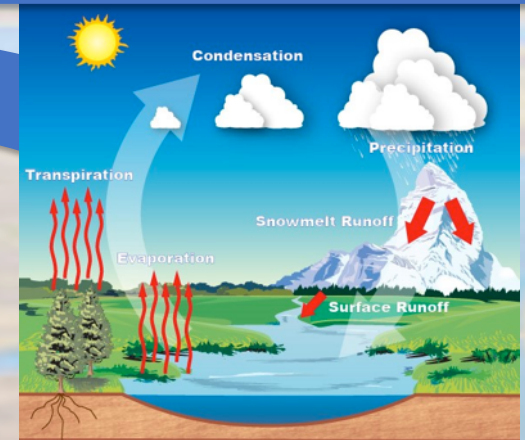
Future goals

integrated forecasts of
compound risk

Coastal Water and
Ocean Model



Regional Atmosphere &
Land Hydrology Model



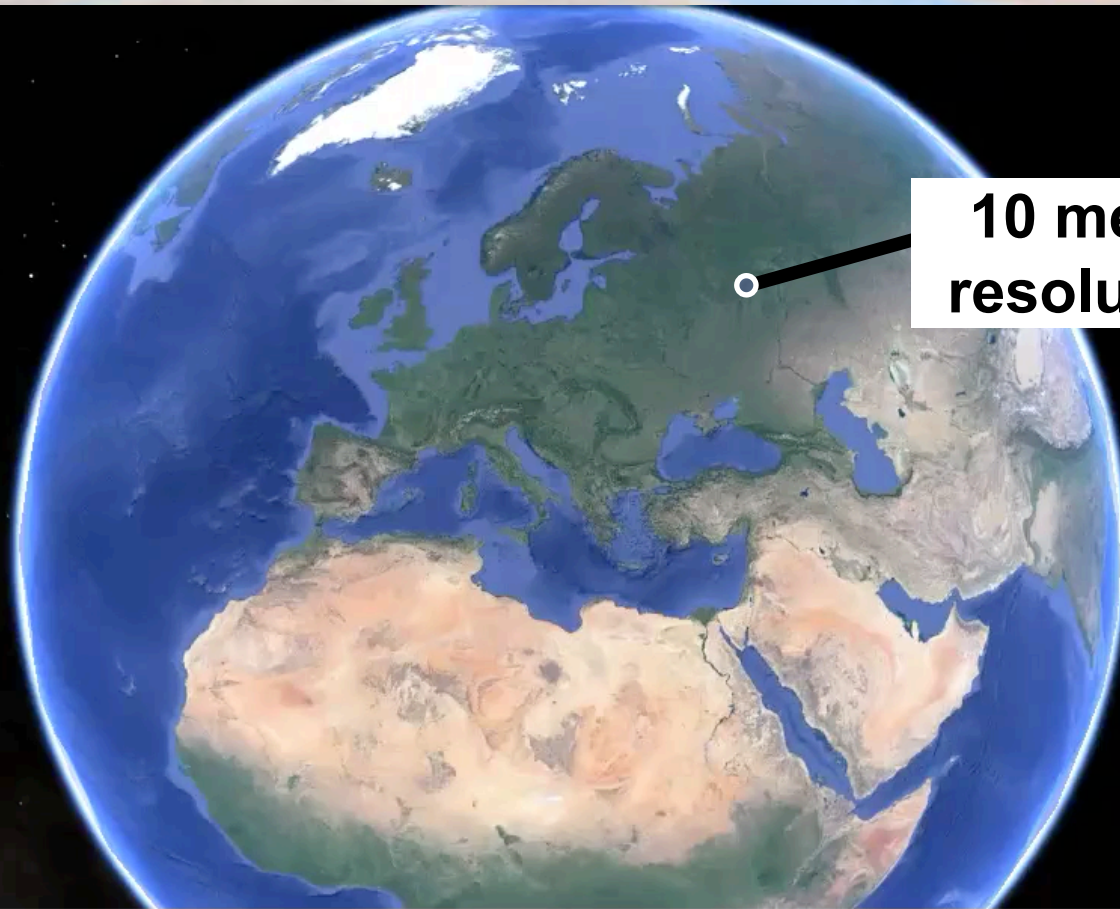
Urban Flooding Models
with Infrastructure



Di Lorenzo, Pinardi et al.

Lozano, Tien et al.

GOAL: To model and forecast water level changes
at the scale where people live



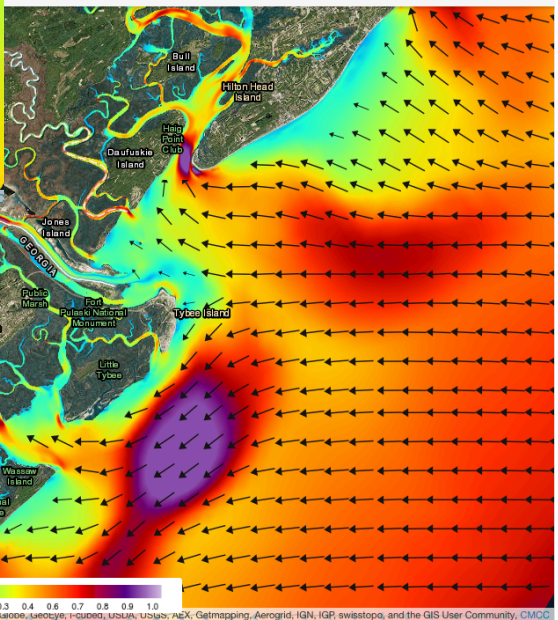
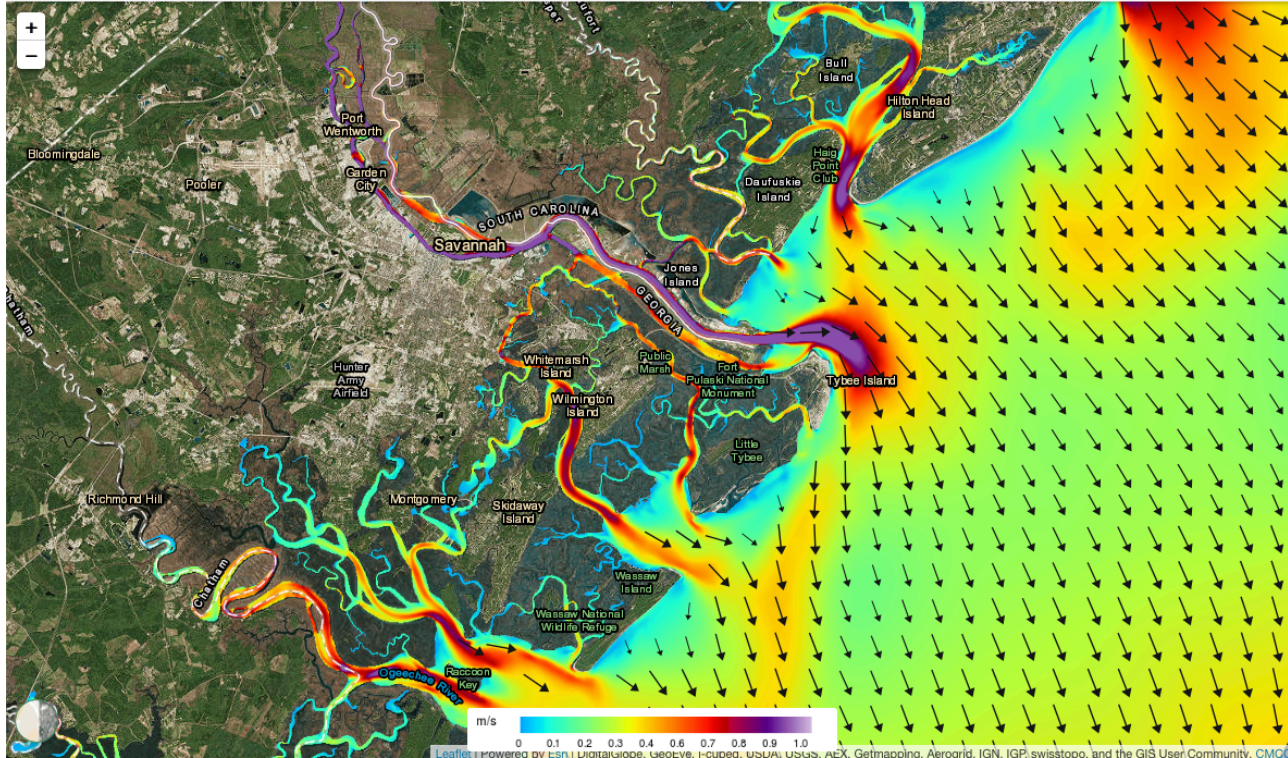
**10 meter
resolution**



New Simulation and Forecast Models



SAVANNAH Currents 20190402 0100 0m (Prod 20190401)

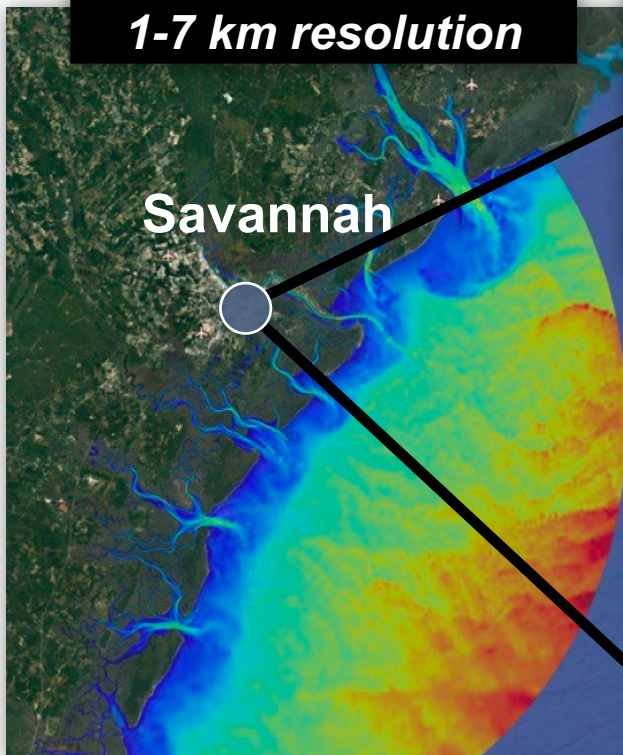


<http://savannah.cmcc-opa.eu>

Simulations of Water Levels at City-scale

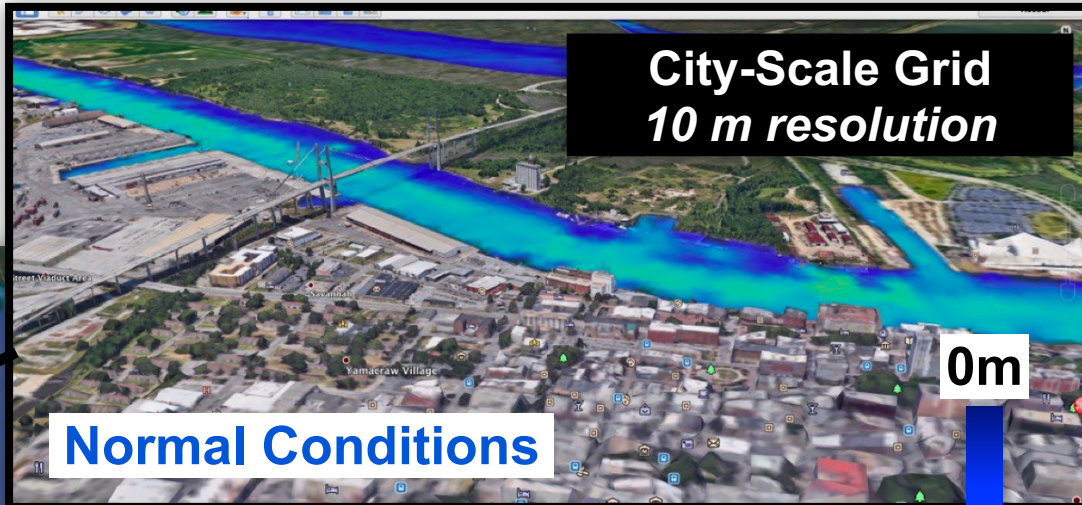
Multi-scale water modeling

State-Level Grid
1-7 km resolution



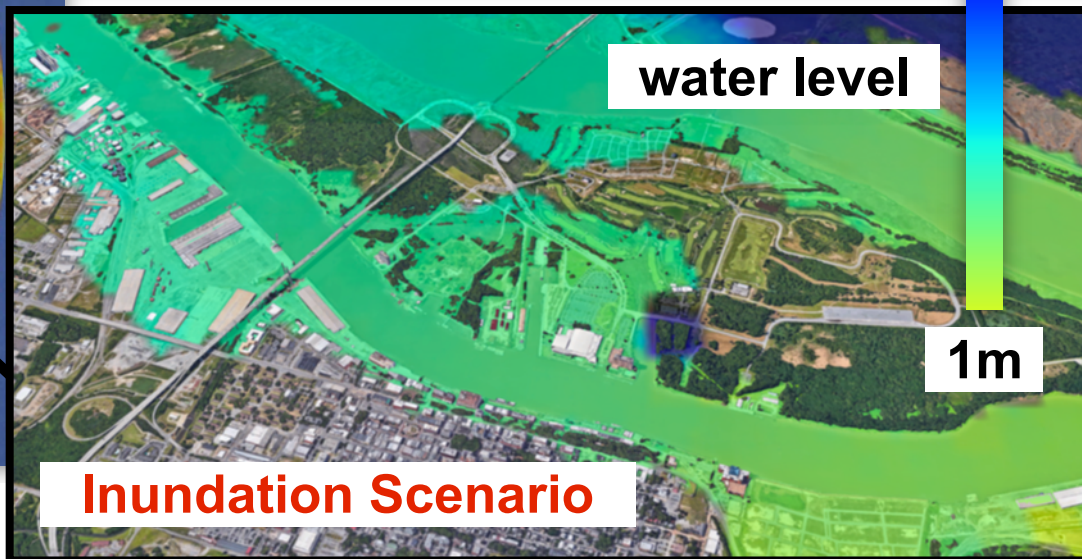
0m -50m
Topography

City-Scale Grid
10 m resolution



Normal Conditions

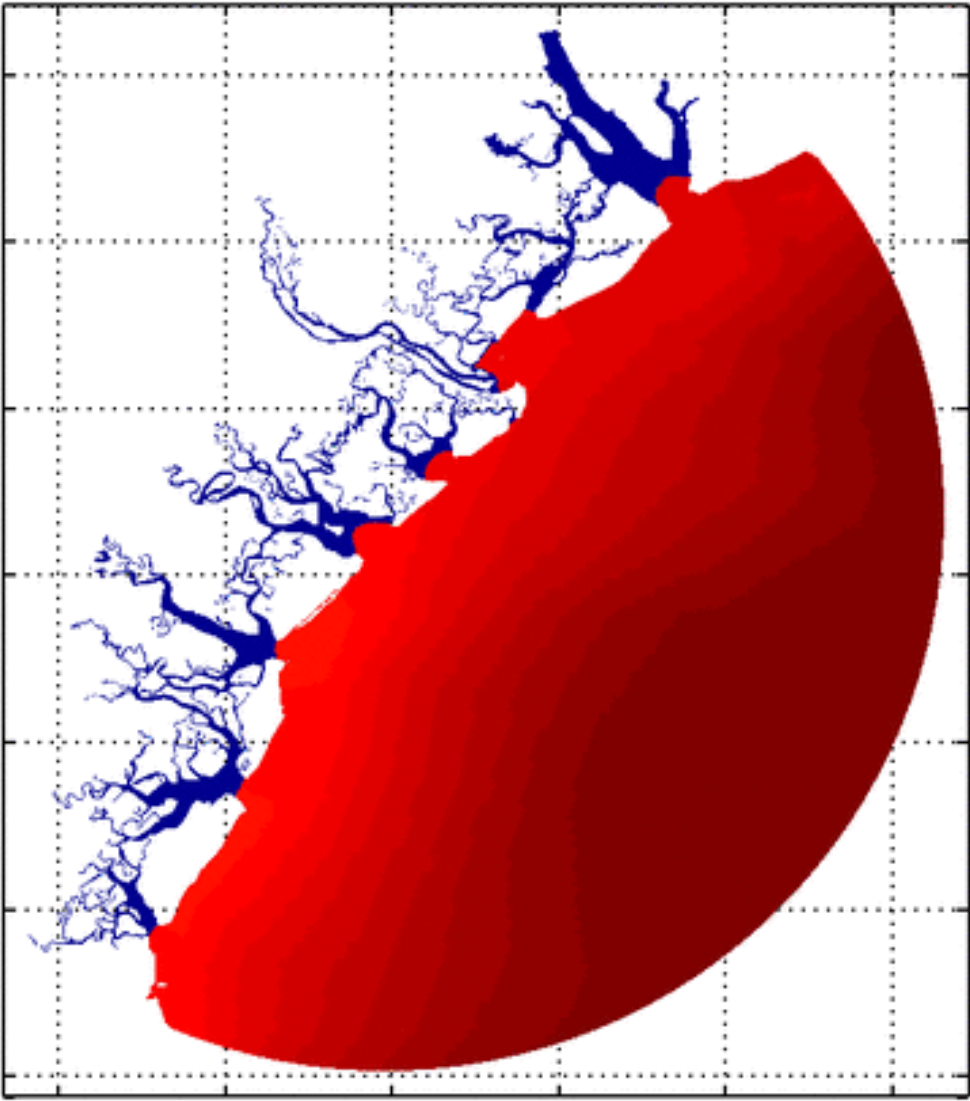
water level



Inundation Scenario

water depth

Models accounts for Rivers

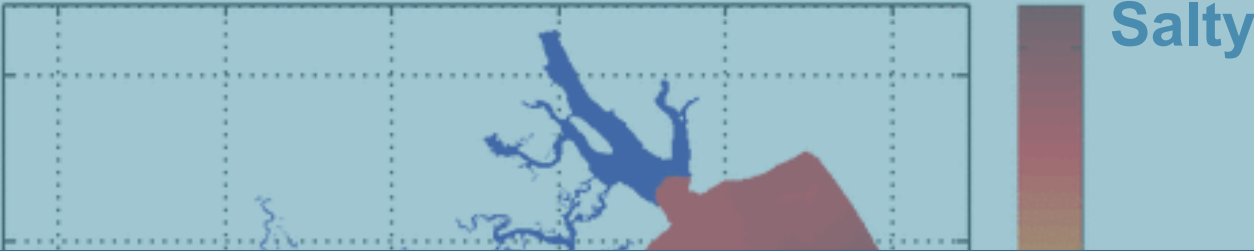


Salty

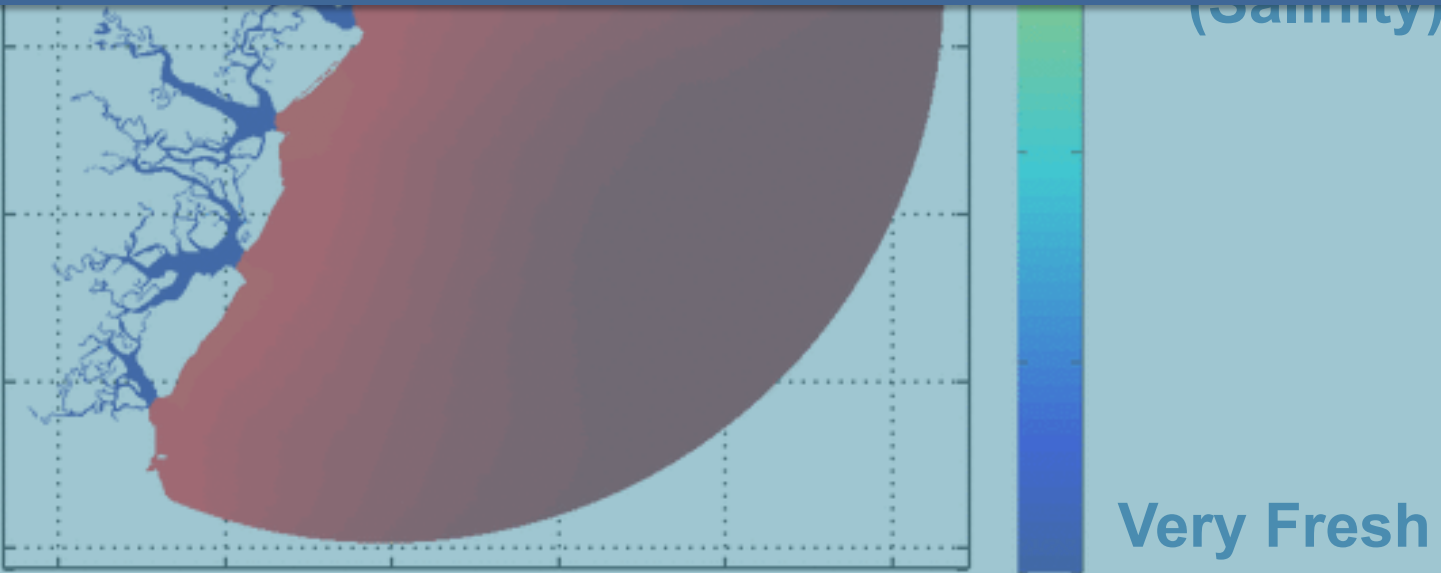
**Fresh Water
(Salinity)**

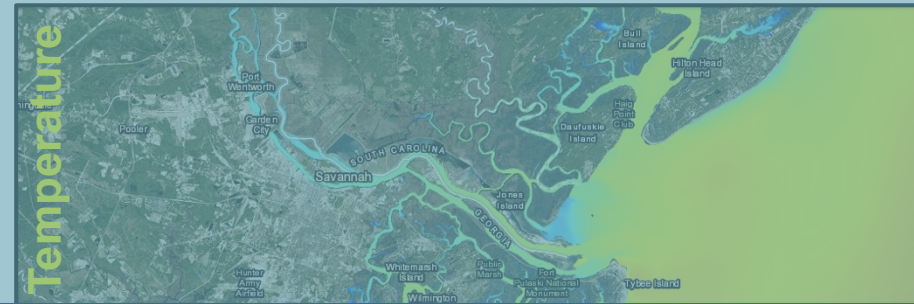
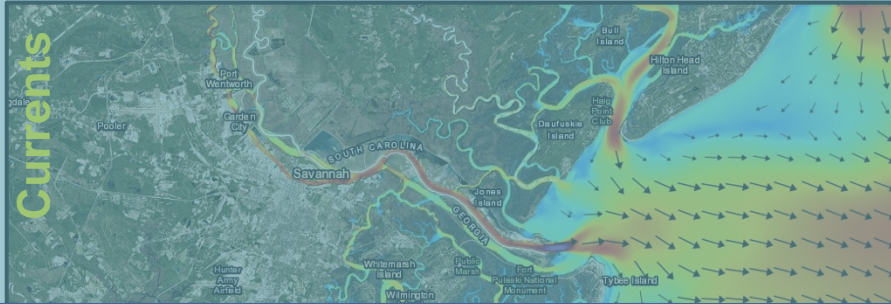
Very Fresh

Models accounts for Rivers

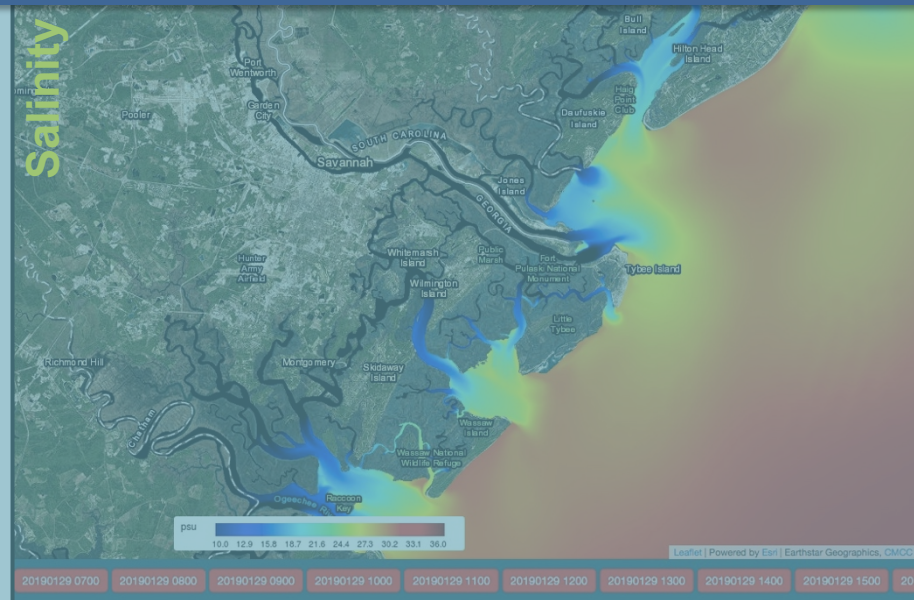
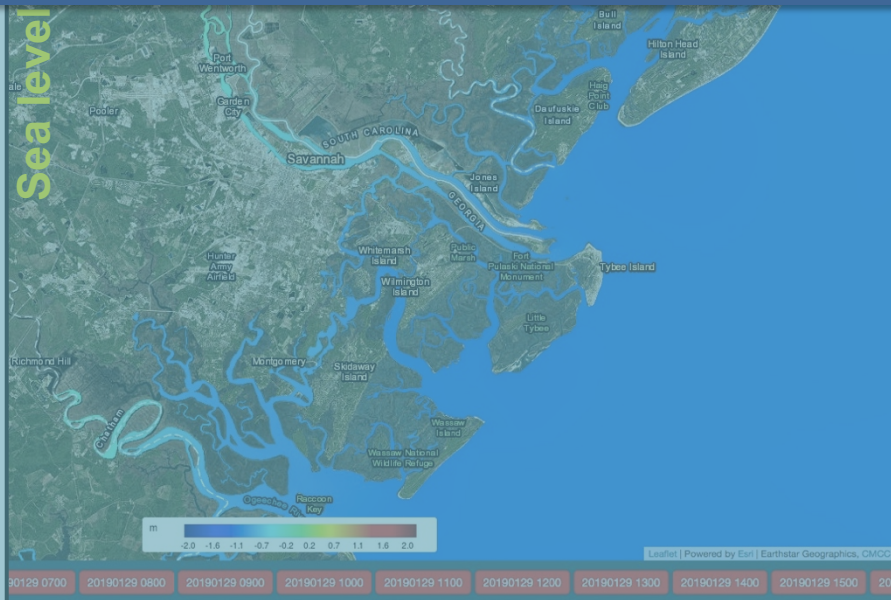


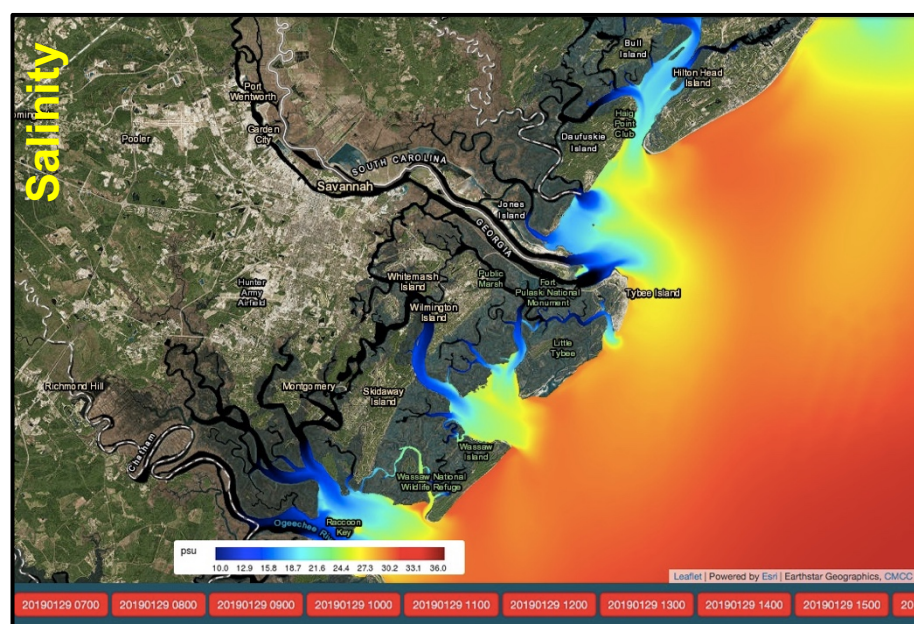
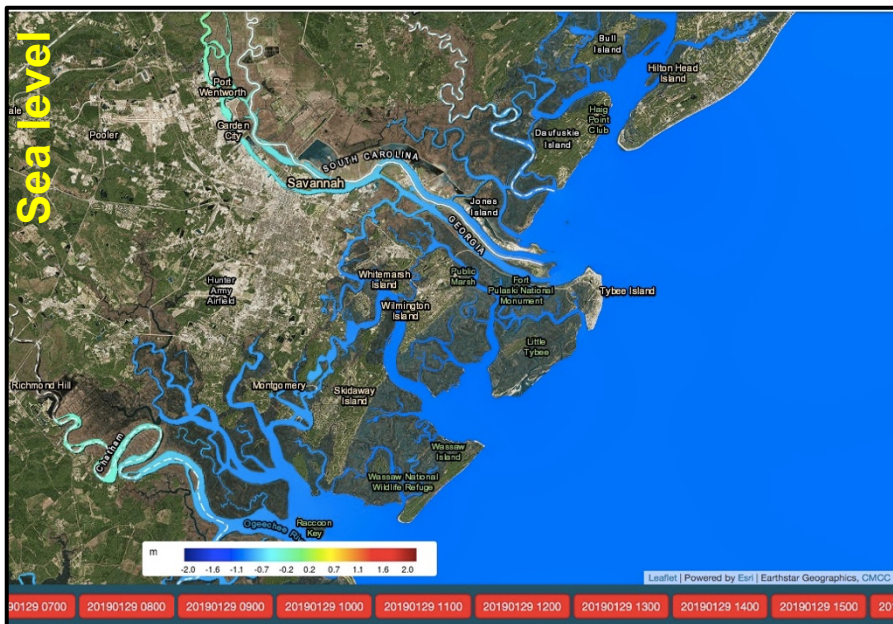
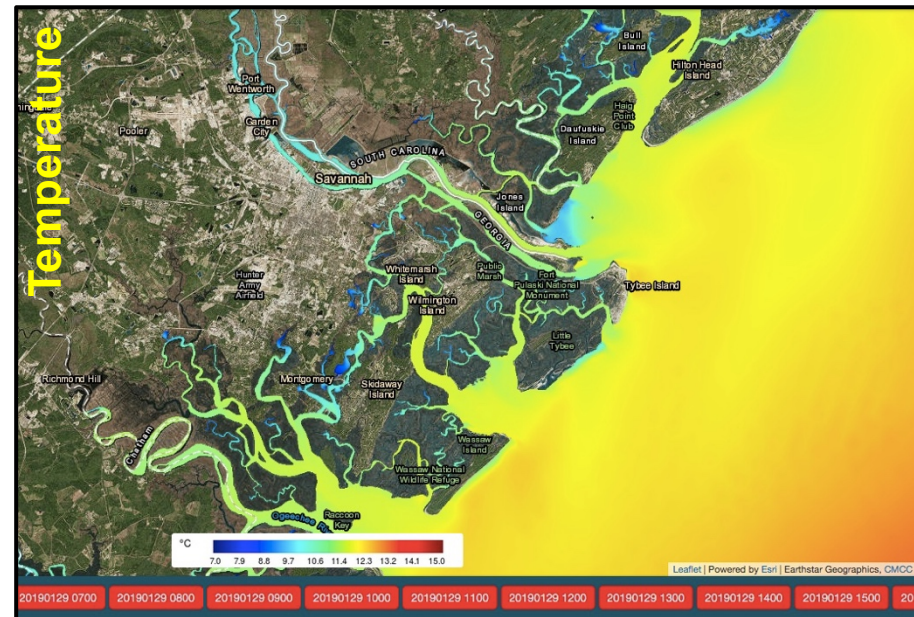
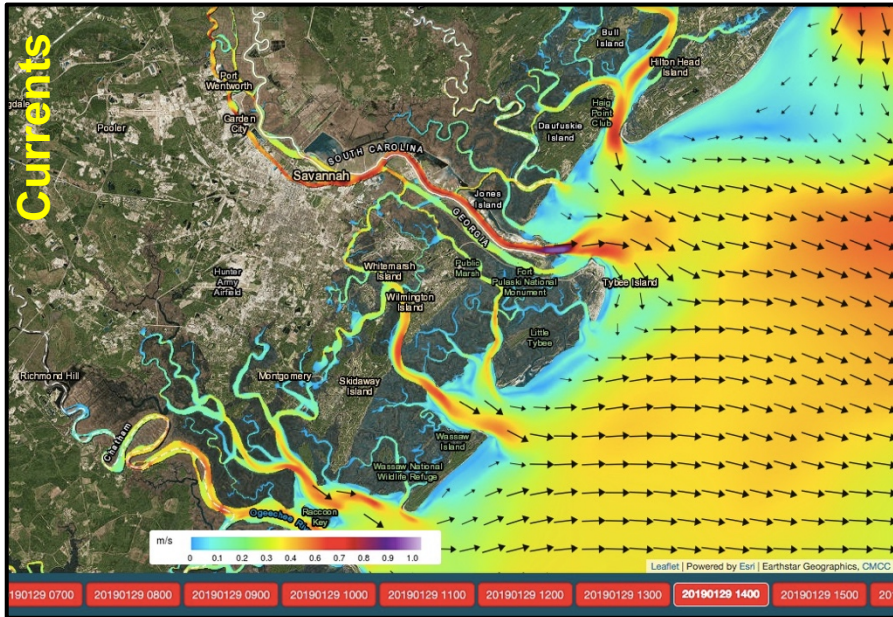
Real Time 3-day Forecasts





Internet Portal to access Water Level Forecasts





Water Level Predictions

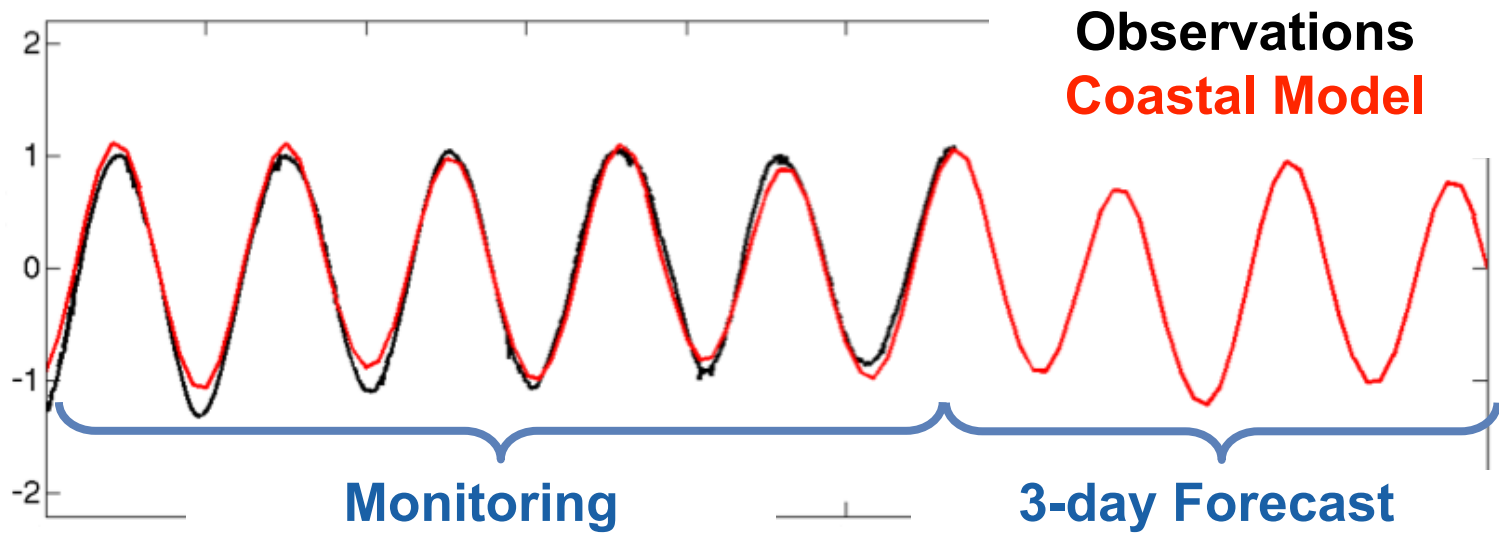
Tybee



Water Level Predictions

Tybee

Fort Pulaski, City of Savannah



Flooding Predictions

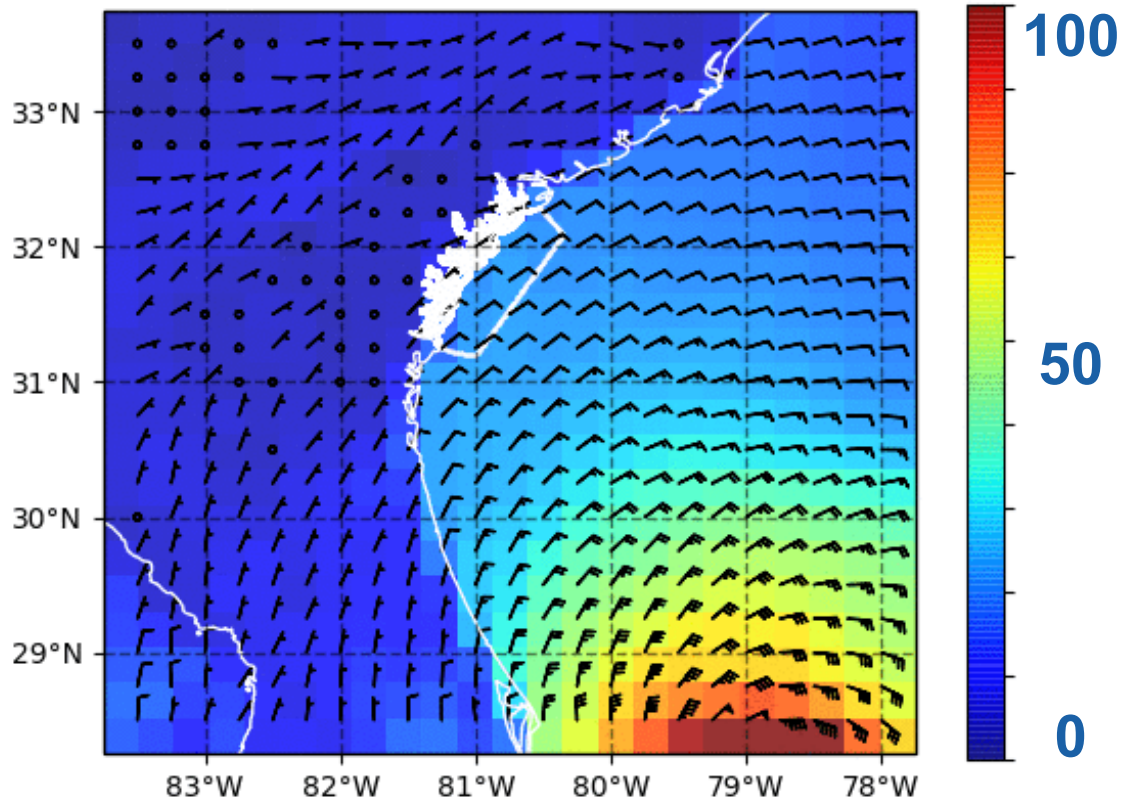
Tybee

Hurricane Dorian

Winds Speed

2019-09-04 00:00:00

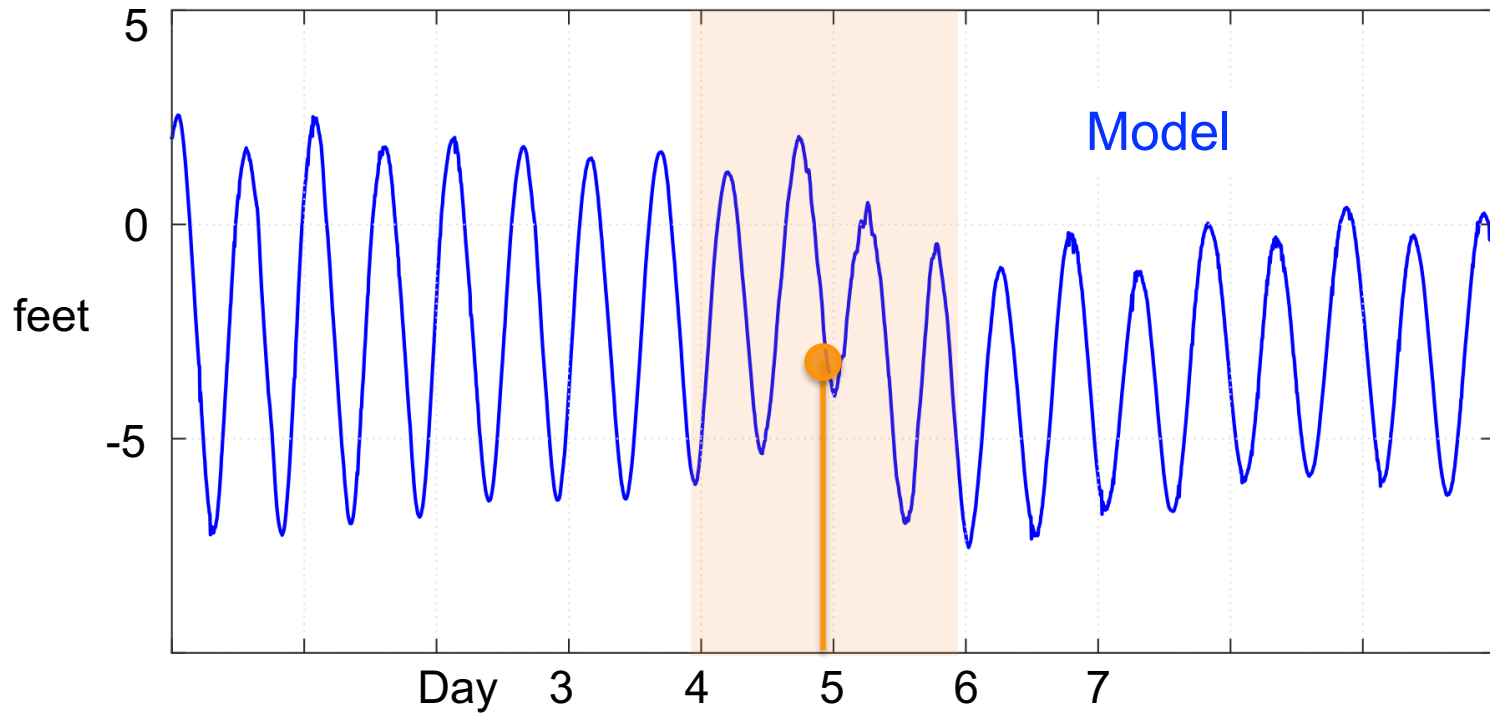
mph



Flooding Predictions

Hurricane Dorian

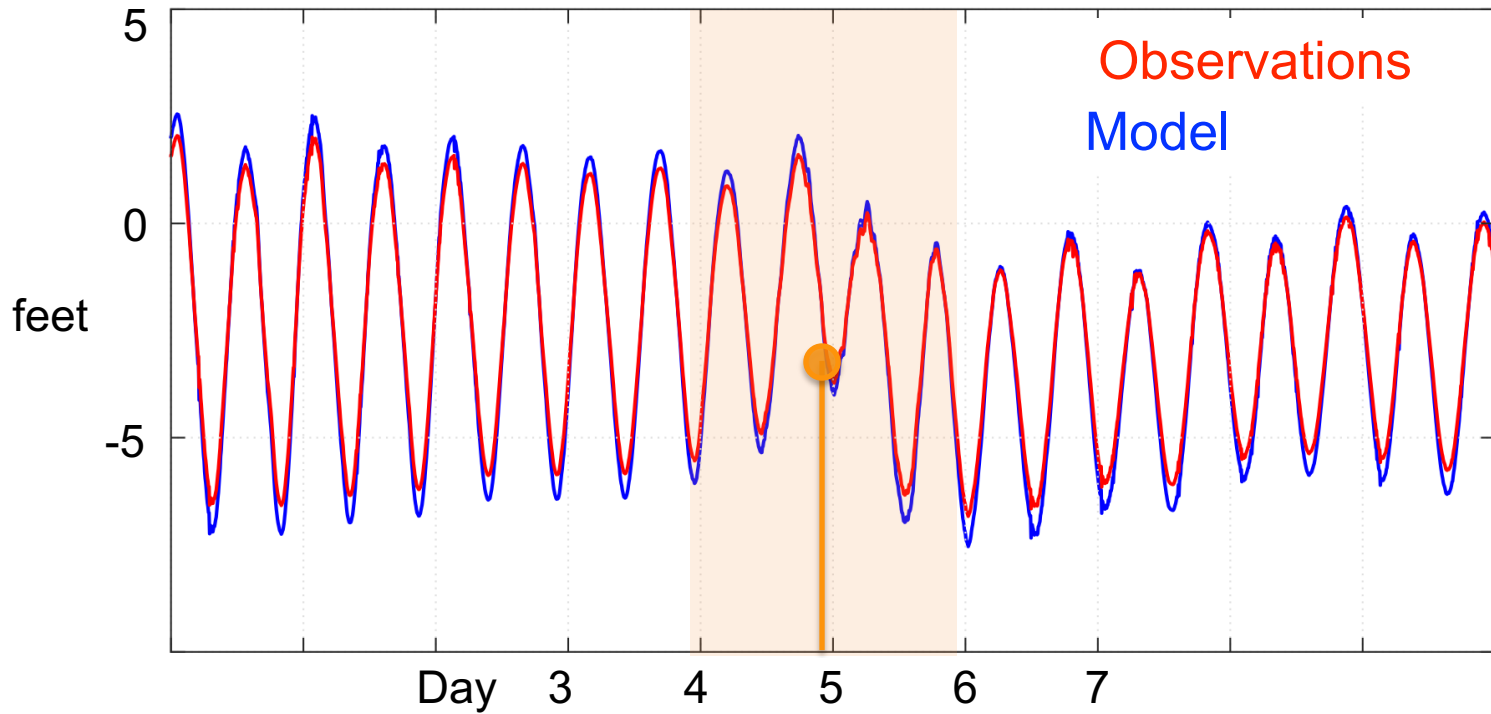
September 4, 2019 9PM



Flooding Predictions

Hurricane Dorian

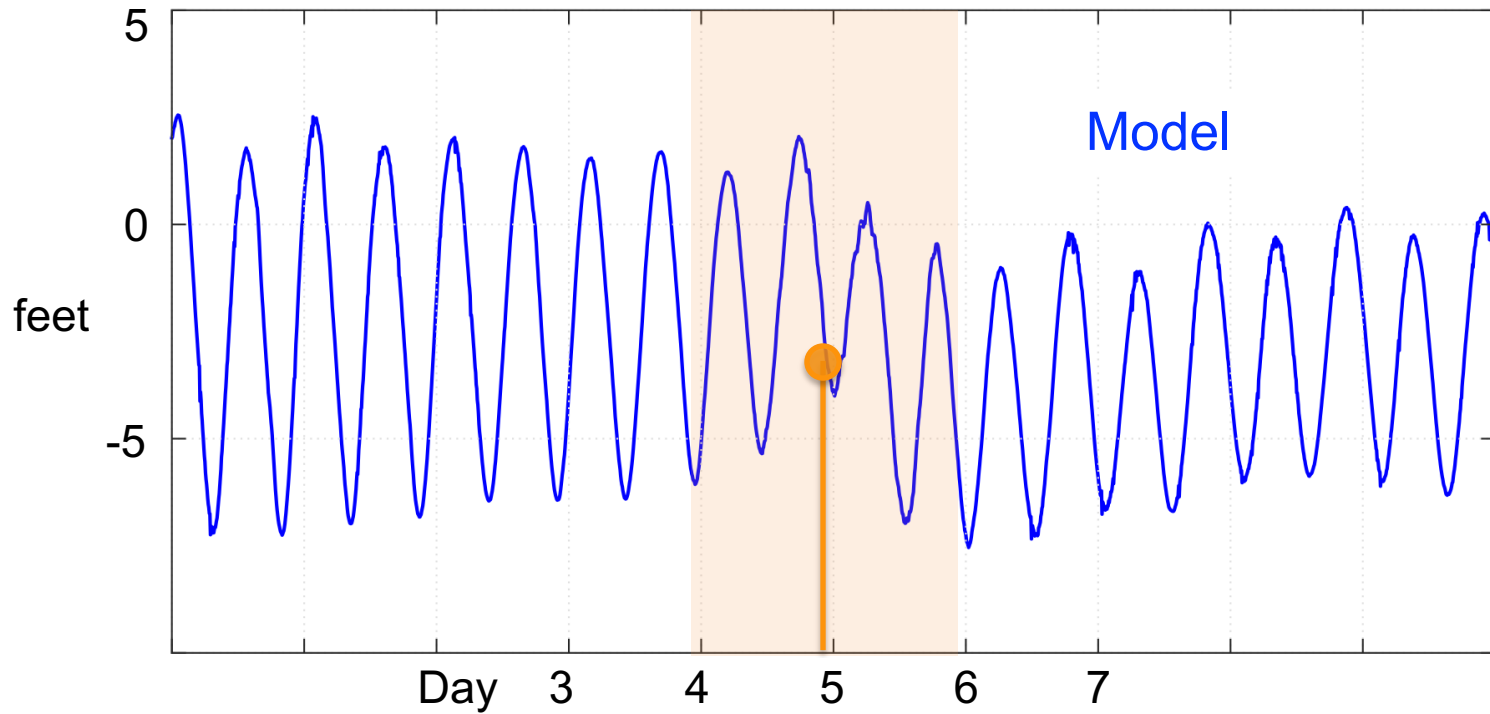
September 4, 2019 9PM



What if Dorian arrived 6 hours earlier?

Hurricane Dorian

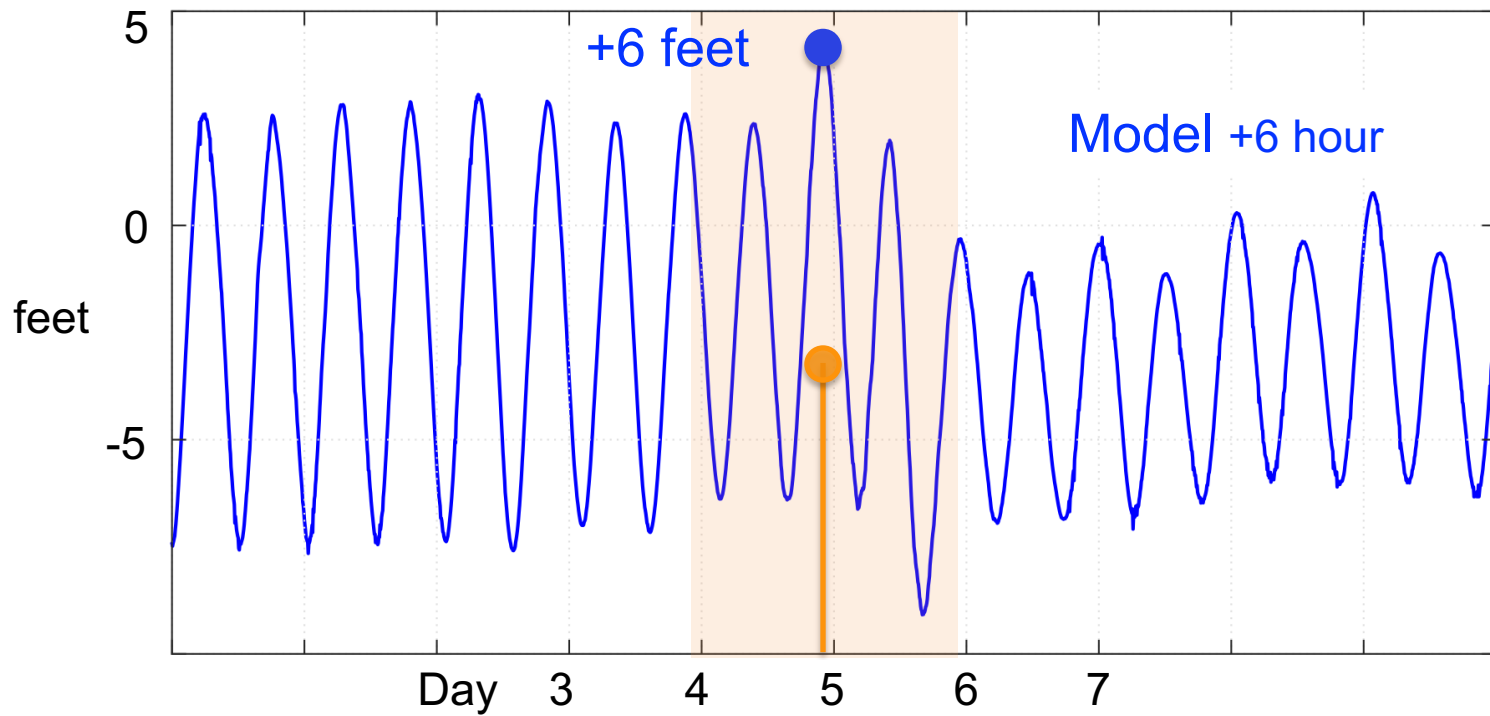
September 4, 2019 9PM



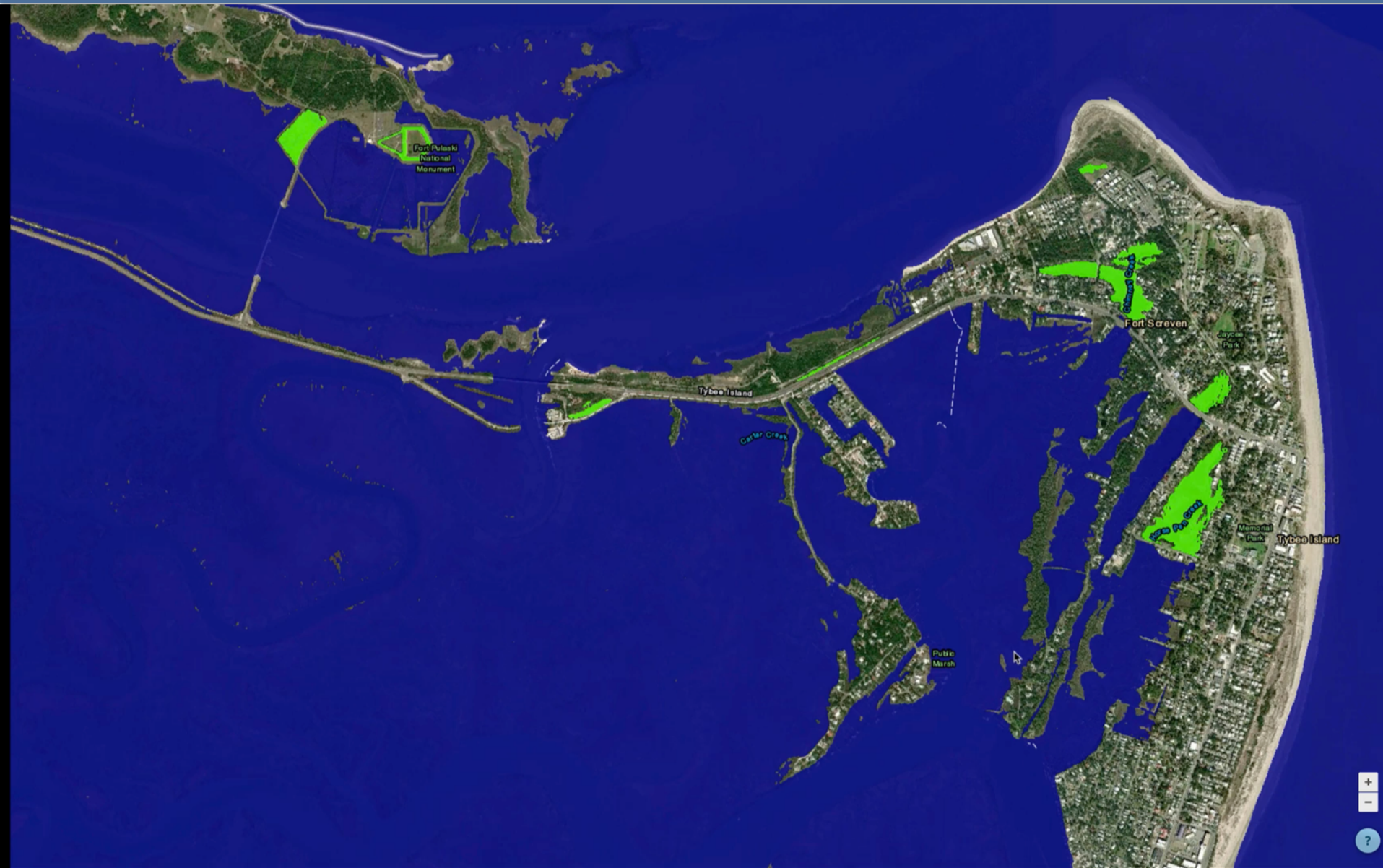
What if Dorian arrived 6 hours earlier?

Hurricane Dorian

September 4, 2019 9PM



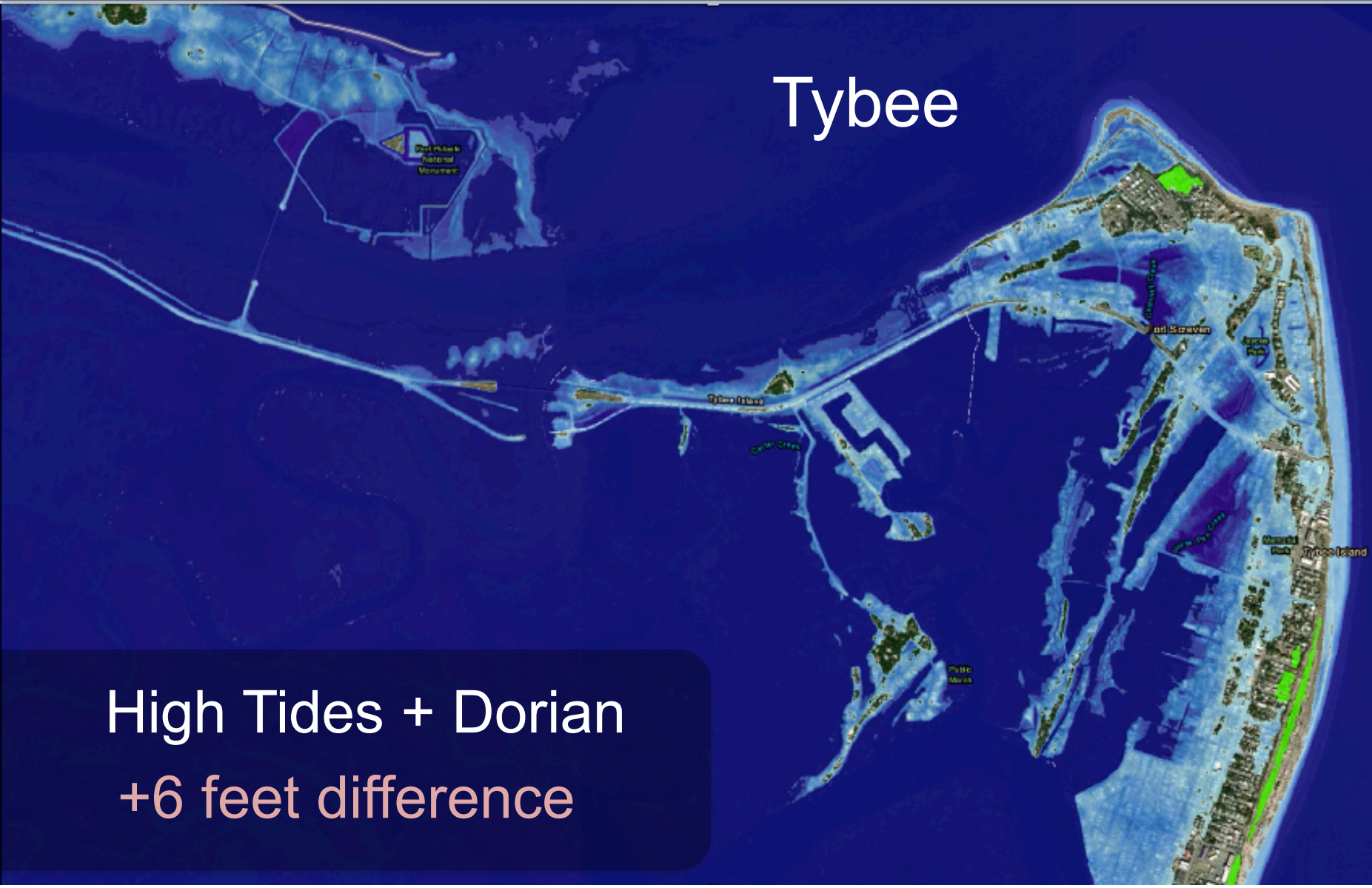
What if Dorian arrived 6 hours earlier?



What if Dorian arrived 6 hours earlier?

Tybee

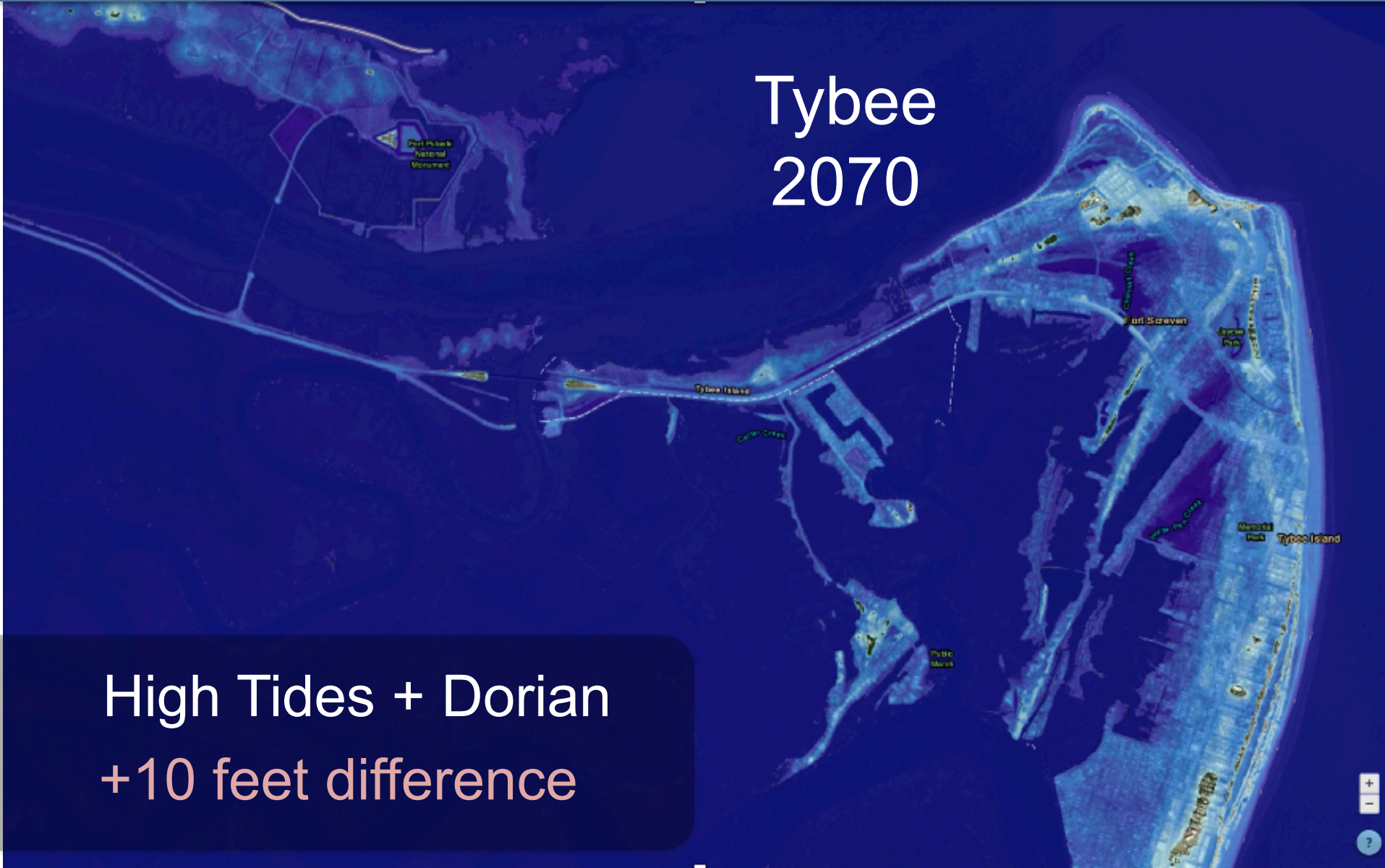
High Tides + Dorian
+6 feet difference



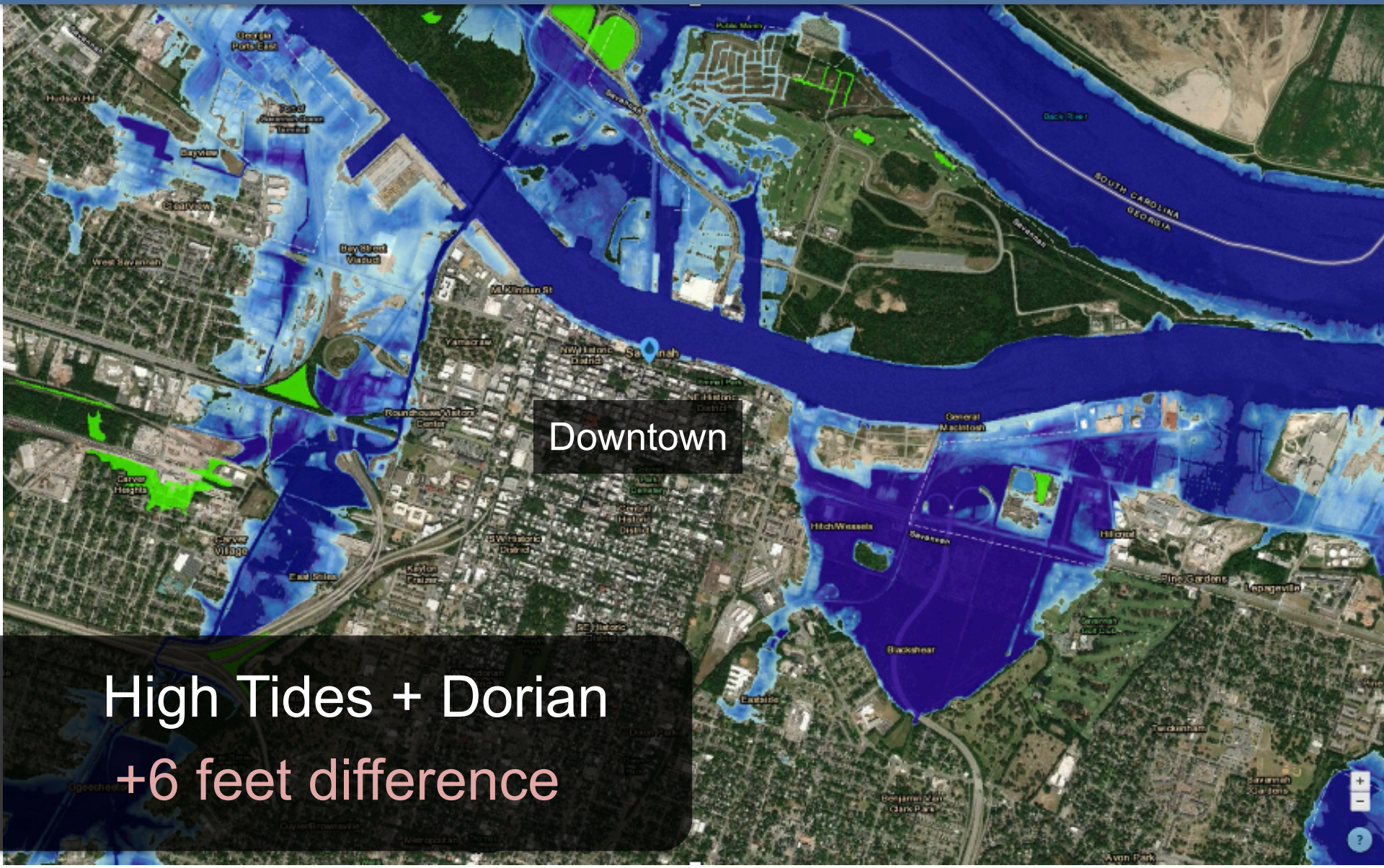
What if Dorian arrived 6 hours earlier?

Tybee 2070

High Tides + Dorian
+10 feet difference



What if Dorian arrived 6 hours earlier?



Downtown

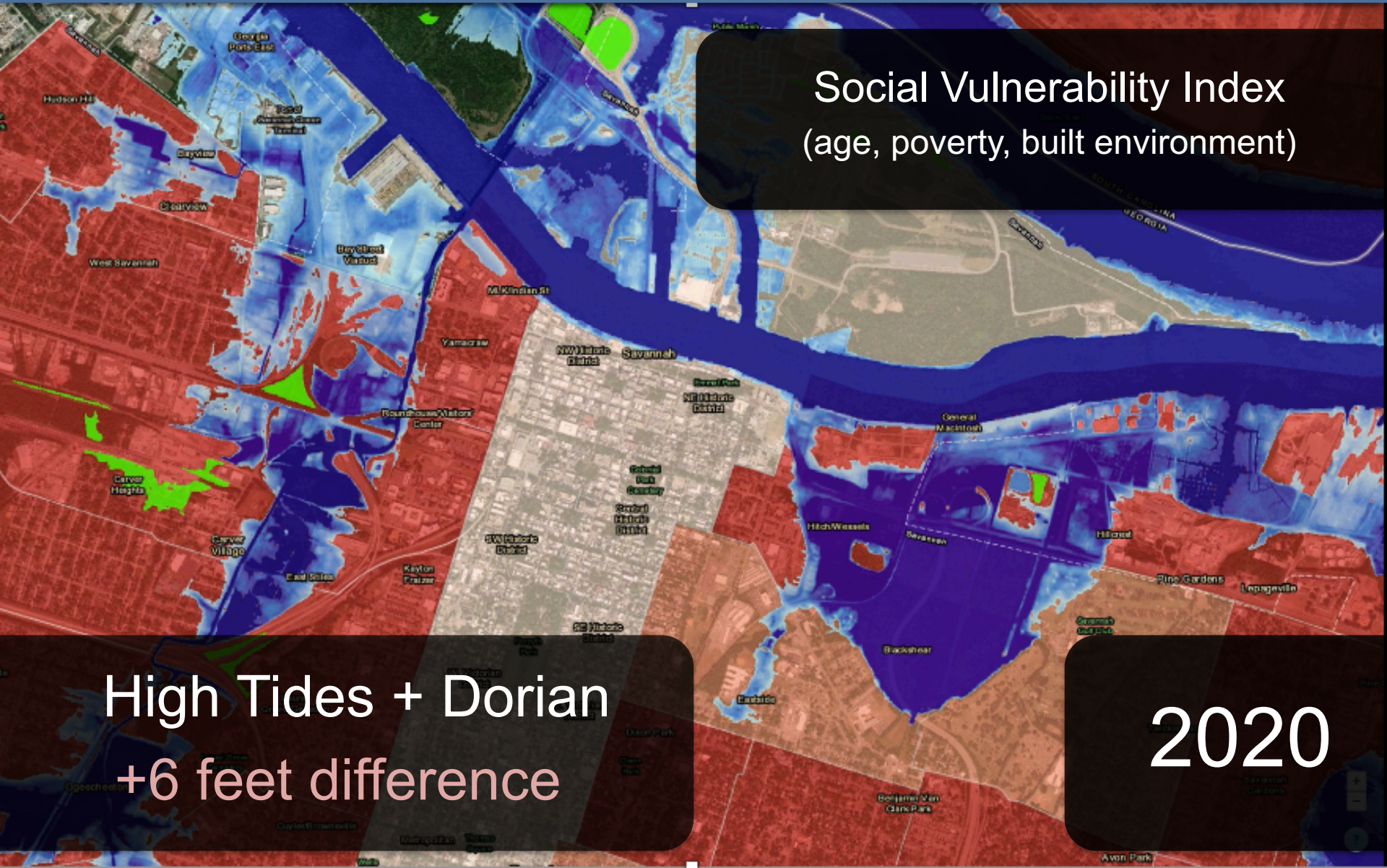
High Tides + Dorian
+6 feet difference

What if Dorian arrived 6 hours earlier?

Social Vulnerability Index
(age, poverty, built environment)

High Tides + Dorian
+6 feet difference

2020

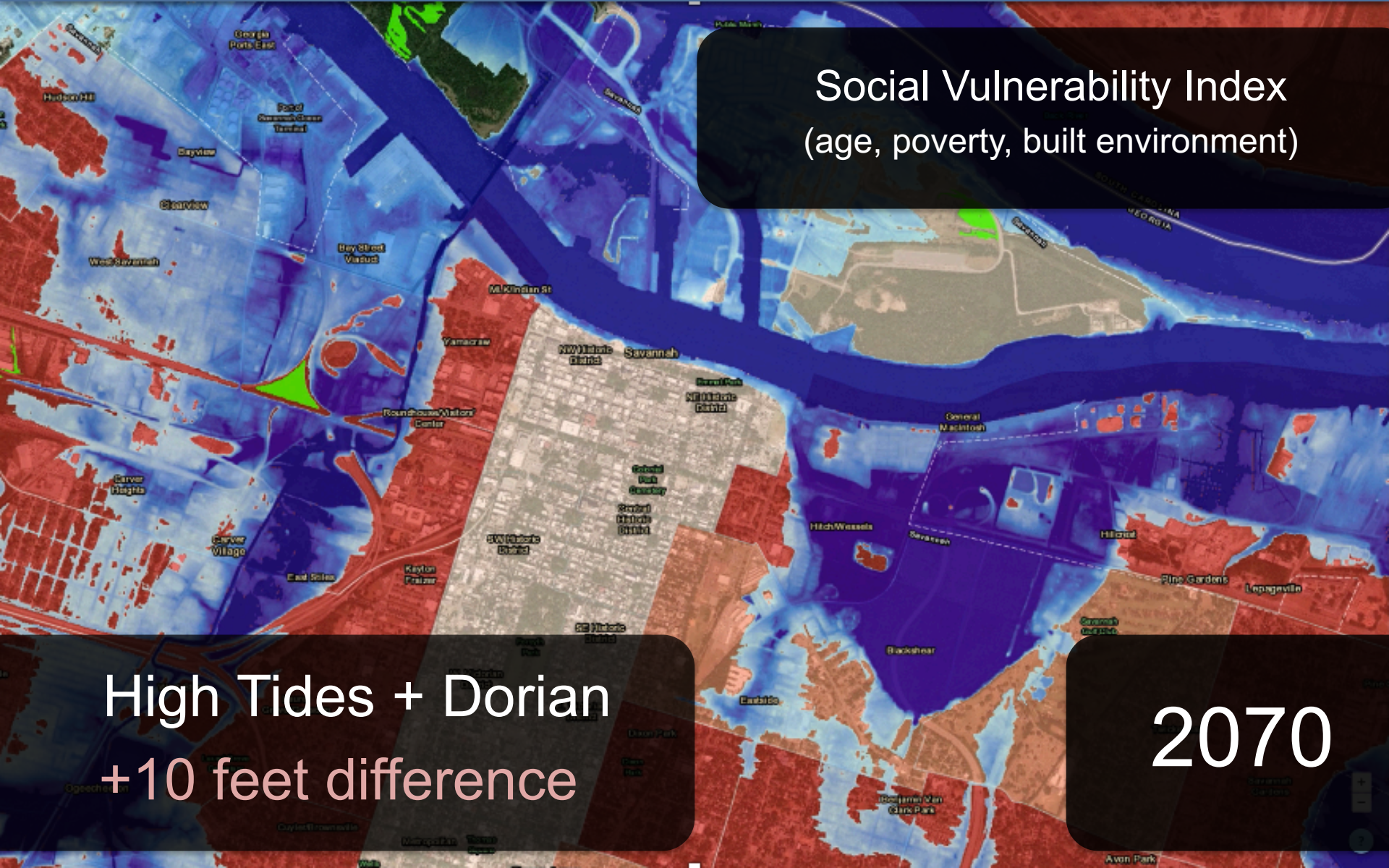


What if Dorian arrived 6 hours earlier?

Social Vulnerability Index
(age, poverty, built environment)

High Tides + Dorian
+10 feet difference

2070



“Without allies and friends and partnerships beyond our own backyard, we’re not gonna make it.”

-- Dr. Mildred McClain
Director, [The Harambee House](#)
Savannah, GA

Savannah, GA Poverty Rates

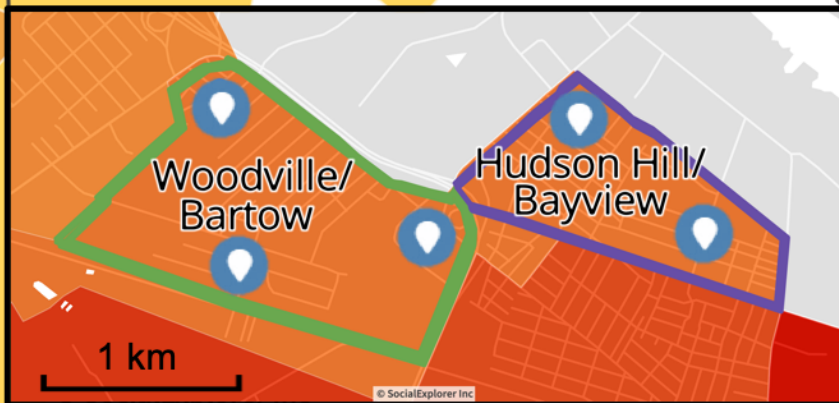
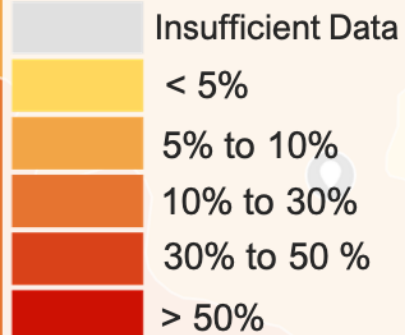
Savannah

Tybee Island

Legend

- Proposed Sensors
- Active Sensors
- Woodville/Bartow
- Hudson Hill/Bayview

Income Below Poverty Level



partnering
towards
a resilience
hub for
historically
marginalized
communities

targets
flooding,
air quality,
temperature,
starting with
K-12 schools

Chatham Emergency Management Agency (CEMA) Portal Team

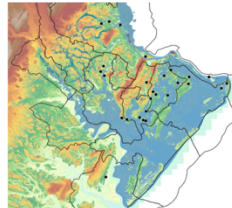


Developing tools for emergency management users

Inundation Methodology

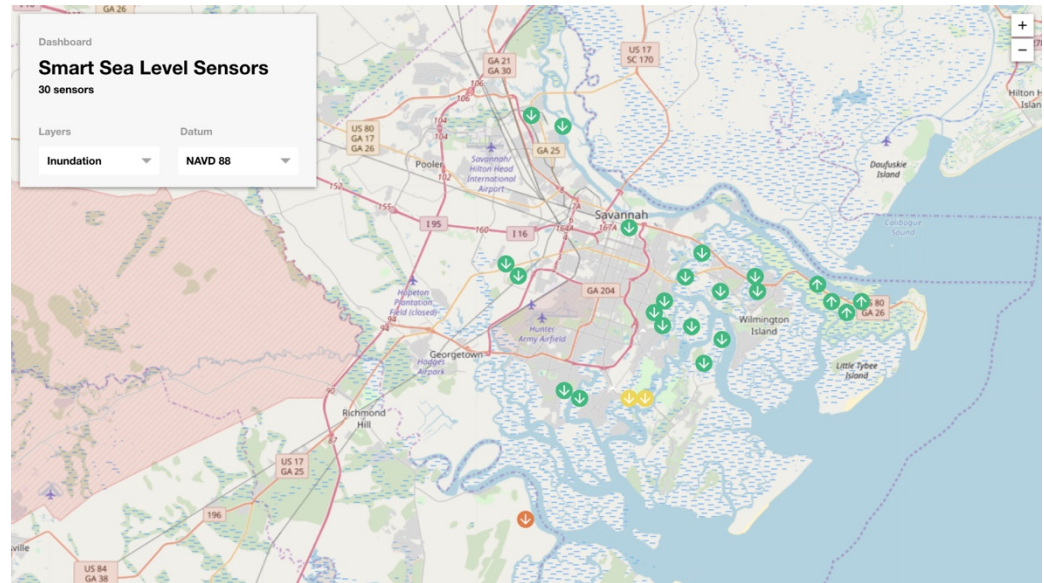
Data

- 1 ft (m) lidar-derived DEM (SAGIS)
 - possibly DSM to do bridge inundation?
- Hydrologic features (SAGIS)
- Sensor readings (API)
- HUC 12 boundaries? (USGS)



Methods

- Modified bathtub model vs. interpolation



Randall Mathews



Akhil Chavan



Jude Mwenda



Kait Morano



Lalith Polepeddi

Educational Partnerships



Sea Level Rise Curriculum



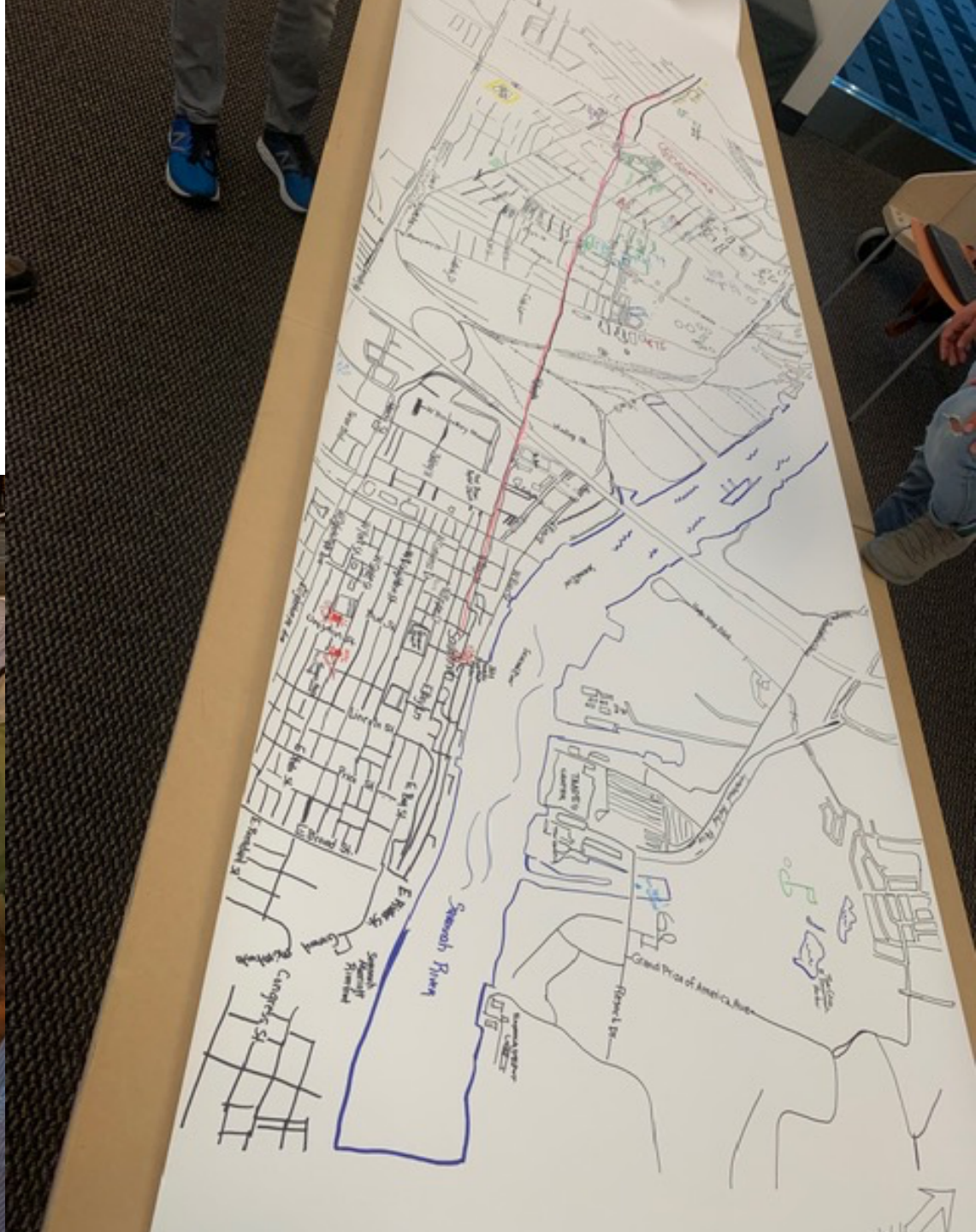
Coastal communities are experiencing an increase in coastal flooding due to storms, king tides, and sea level rise. Educating students on these issues is not only a great science and math exercise, it increases informed-decision making on adapting to climate change-related trends.

- developed by Dr. Alex Robel and Jayma Koval
- webinars for teachers available online at:
<https://secoora.org/education-outreach/sea-level-rise-curriculum/>

"Map Room"

Dr. Yanni Loukissas
Georgia Tech

Community engagement
& curriculum dev't





Keys to our success

- partnerships with city, county officials from Day 1
- frequent team calls, public workshops
- deep investments by entire research team
- incredible student researchers, interns

Continuing challenges

- funding, funding, funding
- hurricanes and pandemics