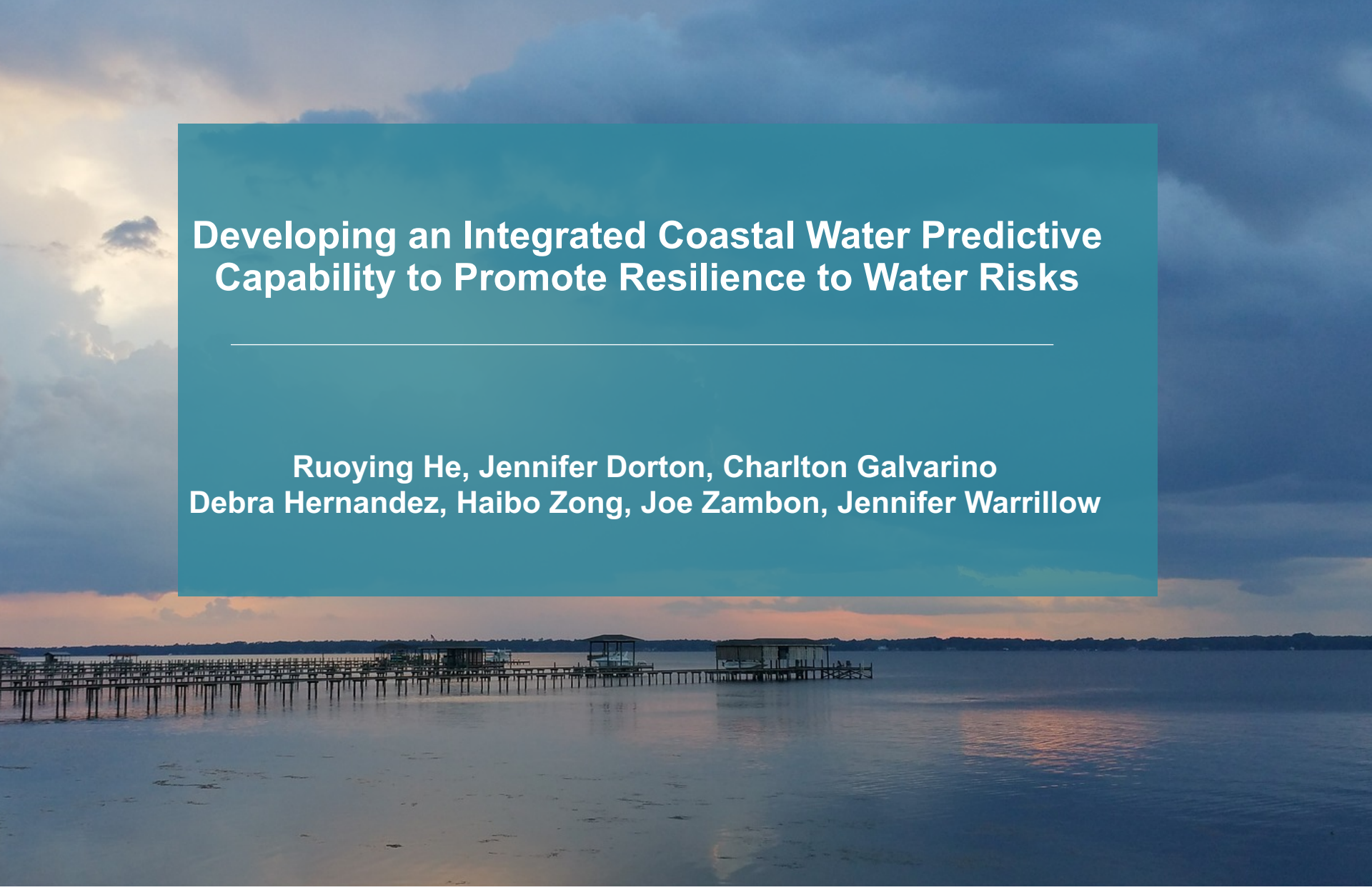

# Developing an Integrated Coastal Water Predictive Capability to Promote Resilience to Water Risks

Ruoying He, Jennifer Dorton, Charlton Galvarino
Debra Hernandez, Haibo Zong, Joe Zambon, Jennifer Warrillow

**Webinar December 15, 2020**

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IOOS
Integrated Ocean Observing System

# Project Goal

To develop an integrated coastal water predictive capability that will deliver new water intelligence products and information vital for decision making both during high-impact weather events, such as hurricanes, nor'easters, and storm surge, and for routine water management, including marine ecosystem health, transportation, and agriculture.

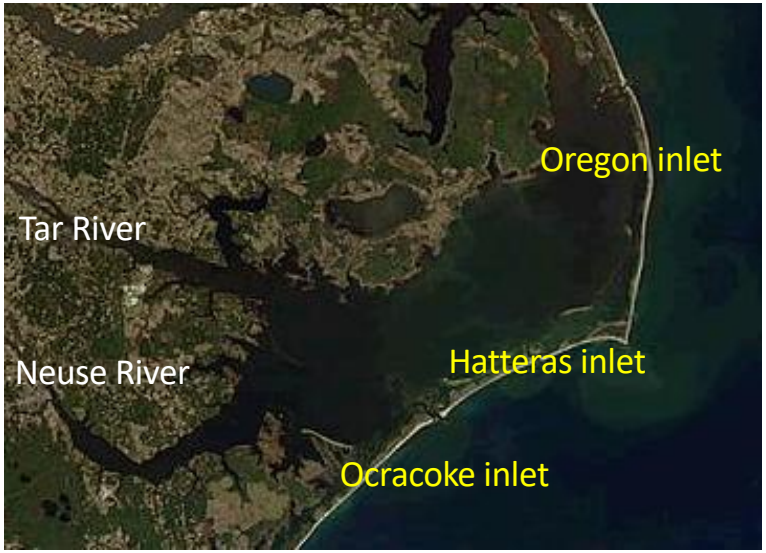
As coastal ocean prediction science is pushed to the land-sea boundary, a critical need arises for implementation of a robust, efficient, multi-scale coupling methodology to accurately describe the interactions between terrestrial hydrology and the coastal ocean at high resolution and fidelity.

We will address this need by developing a prototype baroclinic prediction system that couples three-dimensional coastal ocean predictions with NOAA's National Water Model (NWM) forecasts.

# Project sites

**Two river-ocean subsystems representing distinct end-members are considered**

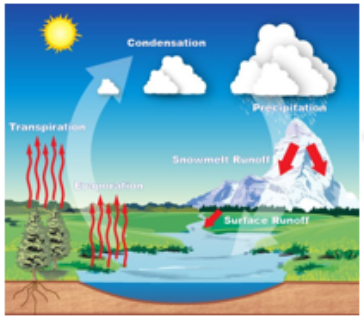
**1) Pamlico Sound in North Carolina:**
a classic lagoonal system, where river-ocean exchange is through inlets on the Outer Banks. Especially complex river-ocean interactions happen during high impact events when storms, flooding, shoreline breaching, and/or formation of new inlets occur.




**2) St. Johns in Florida**
a classic estuarine system, where river-ocean interactions are acting continually and affecting navigation, agriculture, and other important human activities and decisions on a daily basis.

# Project Approach

National Water Model (NWM) (WRF-Hydro)




NWM streamflow output points

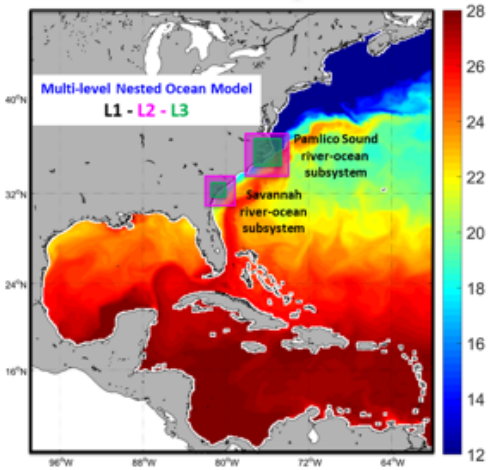

NWM streamflow nowcast and forecast

| Analysis & Assimilation | Short-Range | Medium-Range | Long-Range |
|---|---|---|---|
| Cycling Frequency | | | |
| Hourly | Hourly | 4 x Day at 00Z, 06Z, 12Z, 18Z | Daily Ens (16 mem) |
| Forecast Duration | | | |
| - 3 hrs | 0-18 hours | 0-10 days | 0-30 days |
| Forecast Latency (latency of external forcing data accounts for most of delay) | | | |
| 1 hour | 1 hour 45 mins | 6 hours | 19 hours |

Collaboration with operational agencies and R2O:
- NOS CO-OPS
- NWS NWC
- NOS CSDL

End users engagement and product development:
- flooding
- water quality management
- marine ecosystem
- navigation …

Prototype river-ocean coupled nowcast/forecast of:
**total water level (tides & surge), & currents**
**salinity,**
**water temperature,**
**residence time**
for Pamlico Sound and St. Johns River and their adjacent shelf seas

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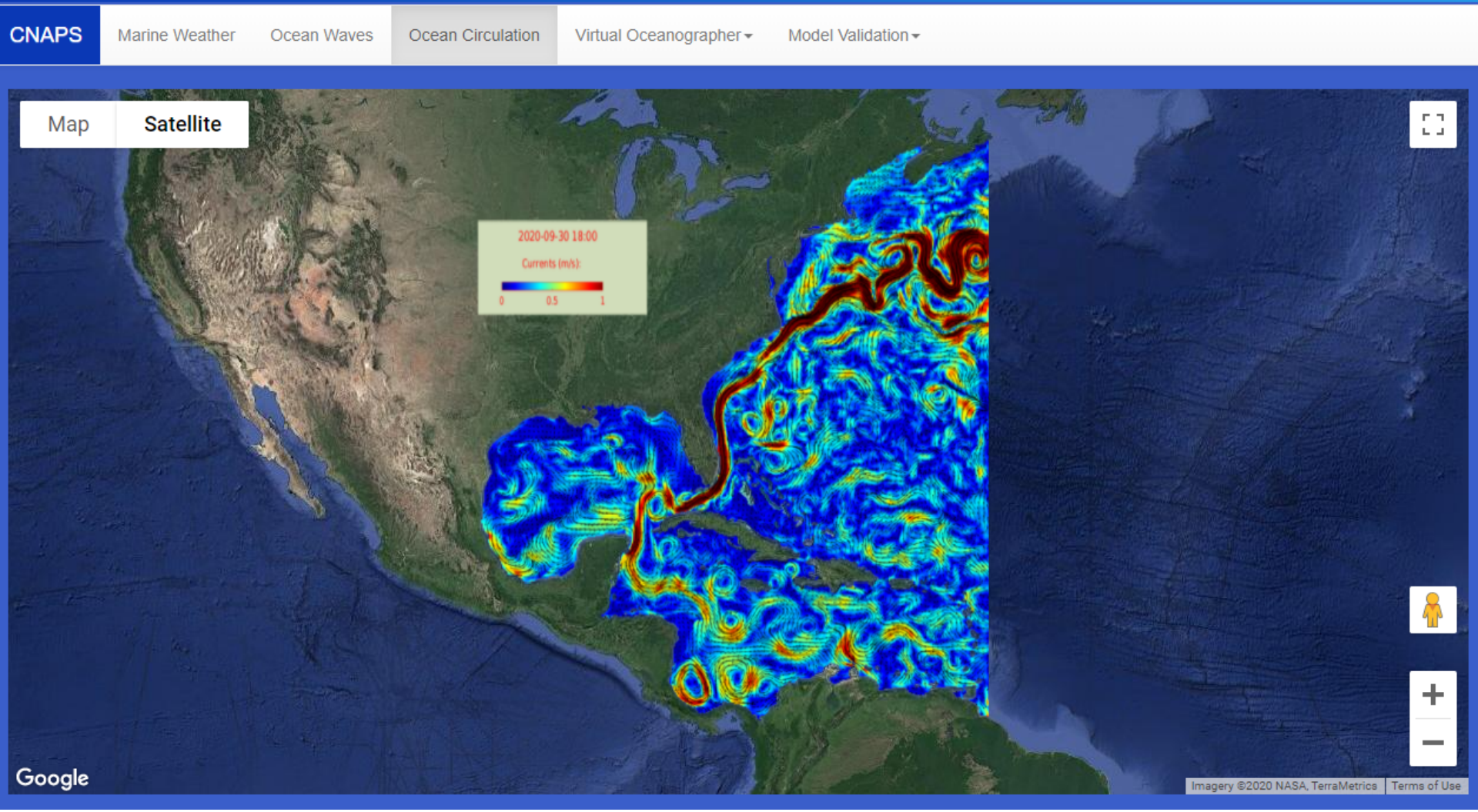
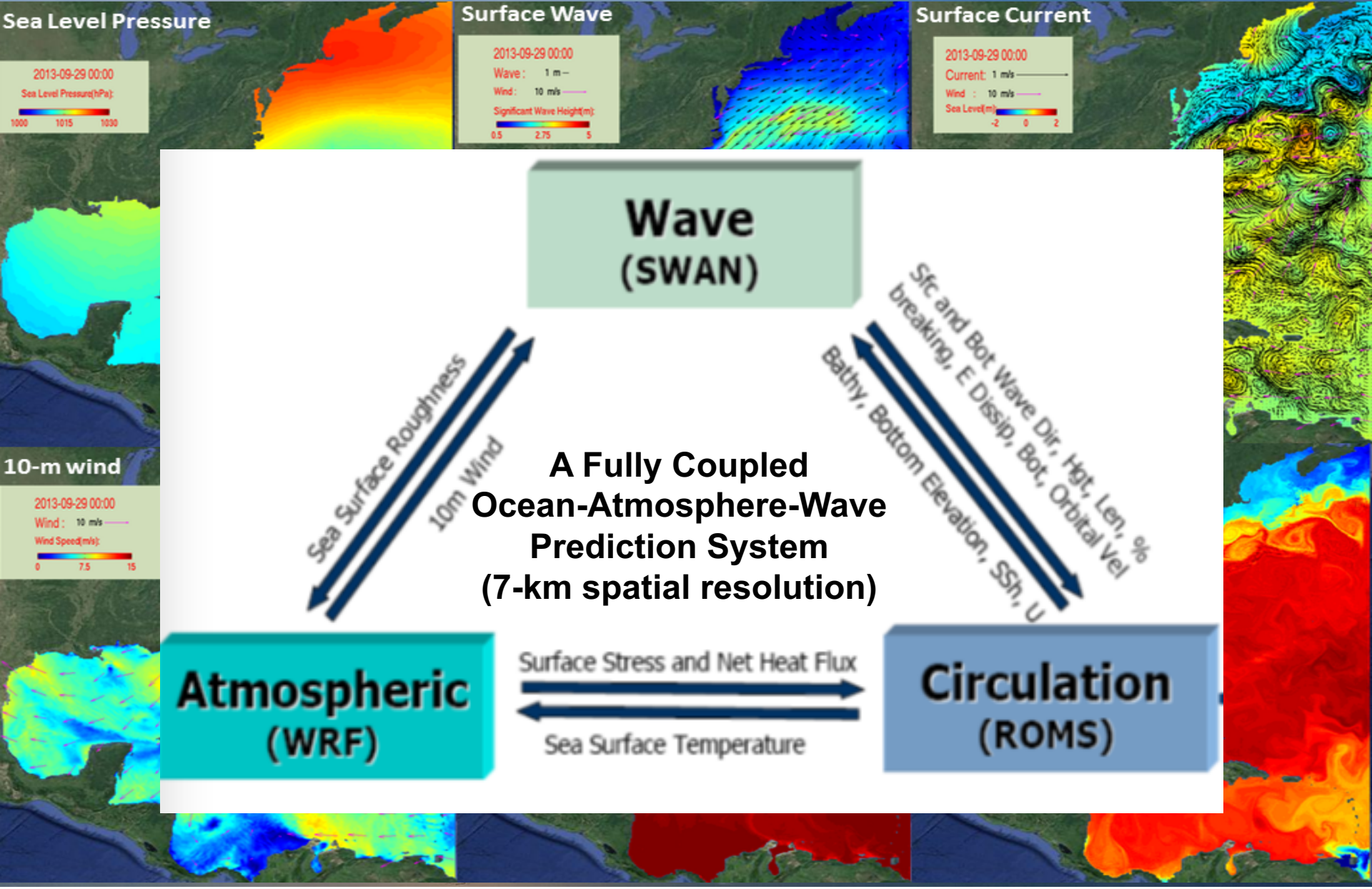
# CNAPS

Coupled Northwest Atlantic Prediction System

http://go.ncsu.edu/cnaps




Providing daily nowcast and 3-day forecast of regional marine environment

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# Project Approach (con't)

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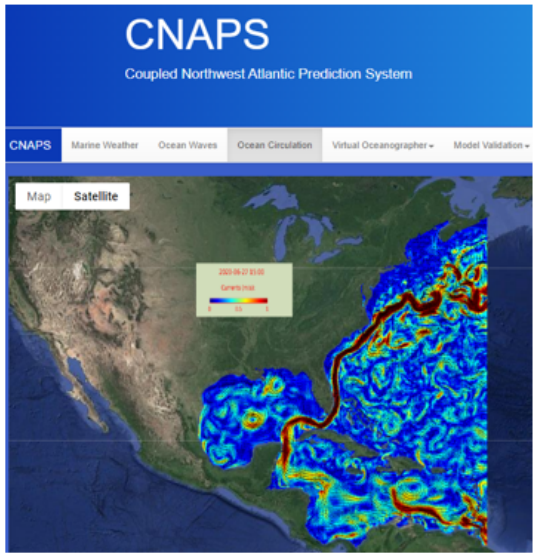
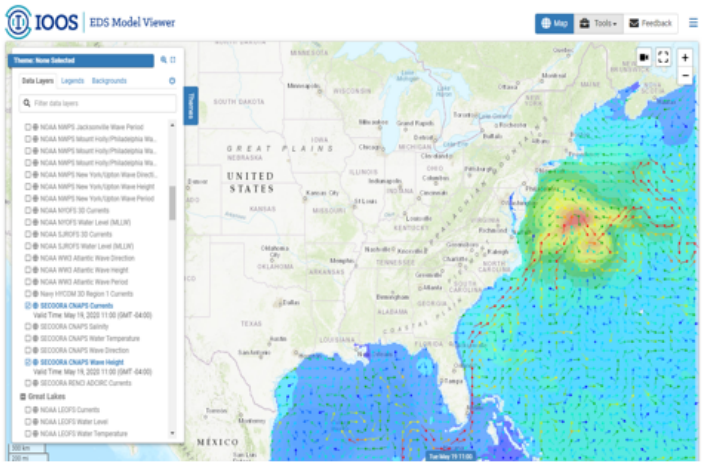
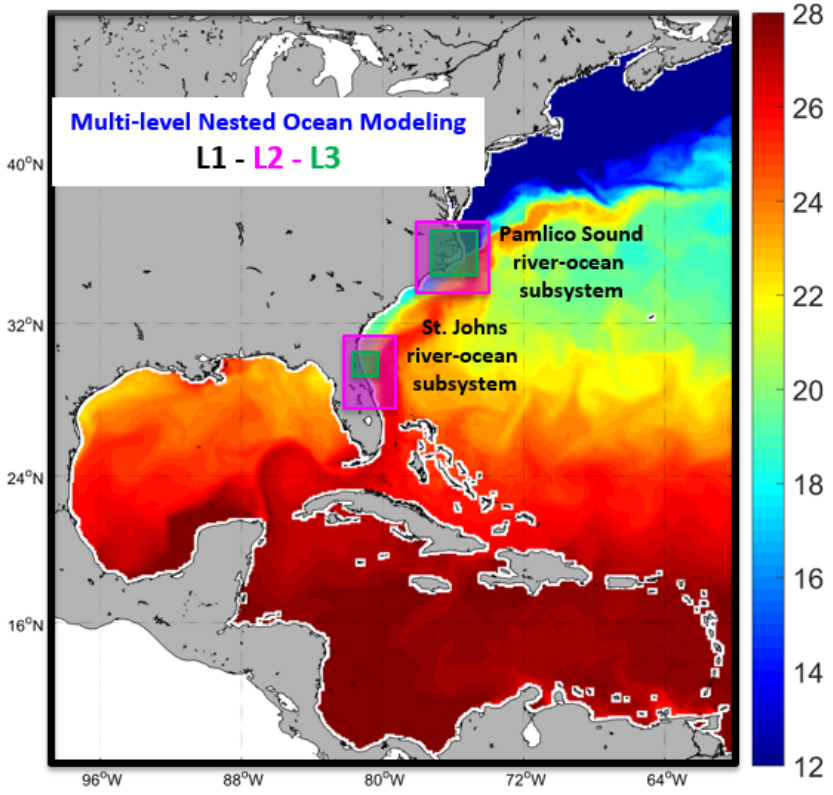
**Based on NOAA IOOS funded three-dimensional baroclinic NW Atlantic regional prediction system**




http://omgsrv1.meas.ncsu.edu:8080/CNAPS/

https://eds.ioos.us/

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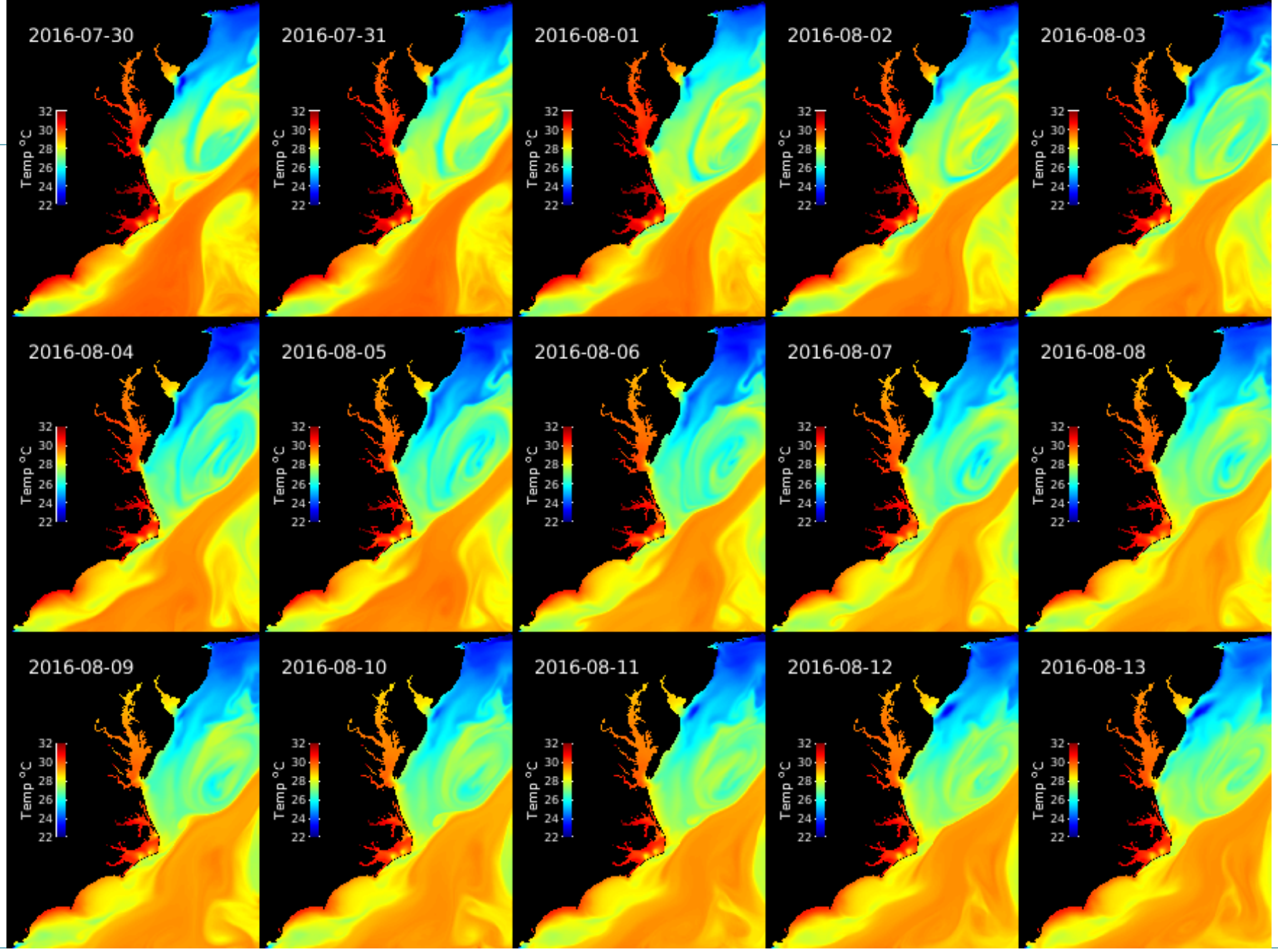


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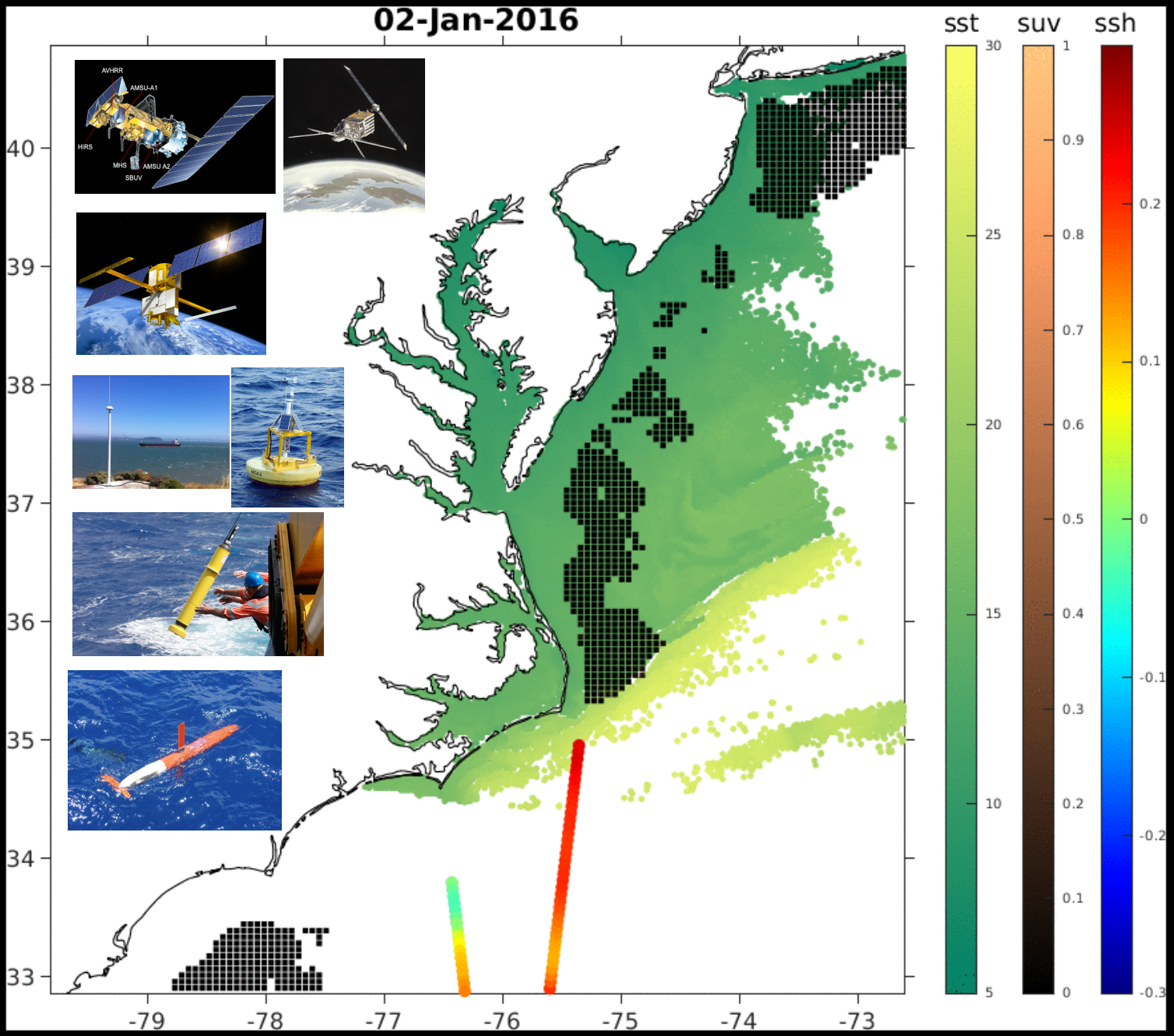
02-Jan-2016
AVHRR
AMSU-A1
HIRS
MHS
AMSU A2
SBUV
sst
suv
ssh
30
25
20
15
10
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0.6
0.5
0.4
0.3
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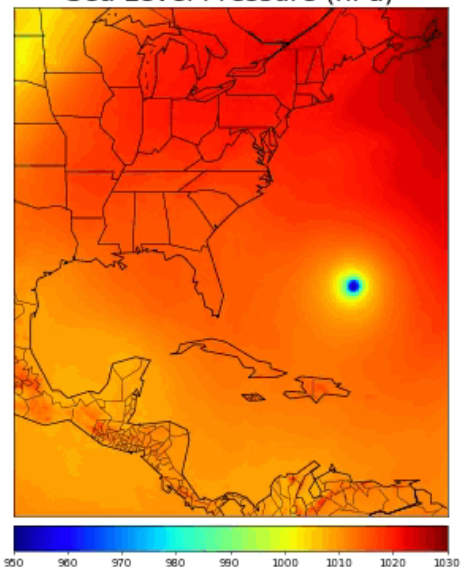
0.1
0.2
0.1
0
-0.1
-0.2
-0.3
40
39
38
37
36
35
34
33
-79
-78
-77
-76
-75
-74
-73

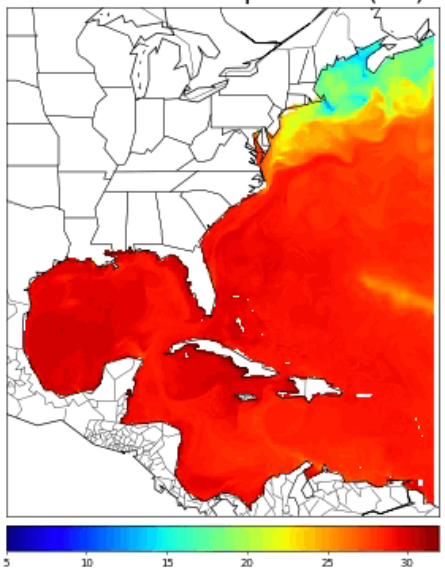
Forecast Valid: 12 Sep 2018 00Z UTC

# Hurricane Florence

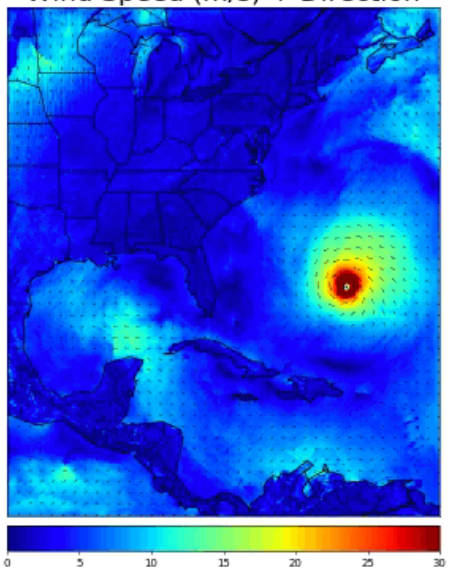
Sea Level Pressure (hPa)



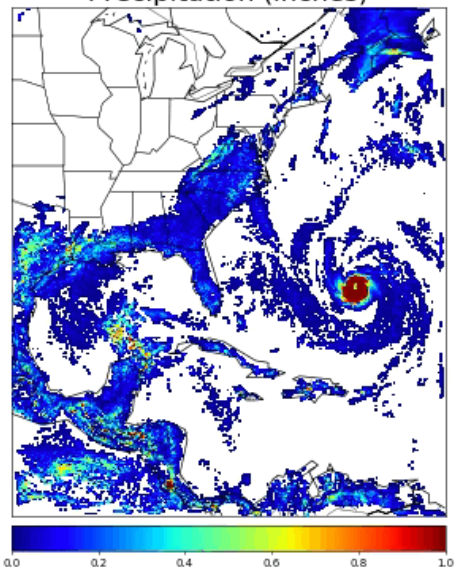

Sea Surface Temperature (˚C)



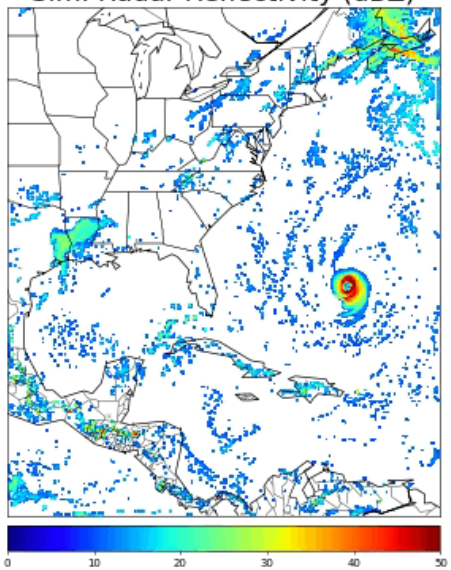

Wind Speed (m/s) + Direction



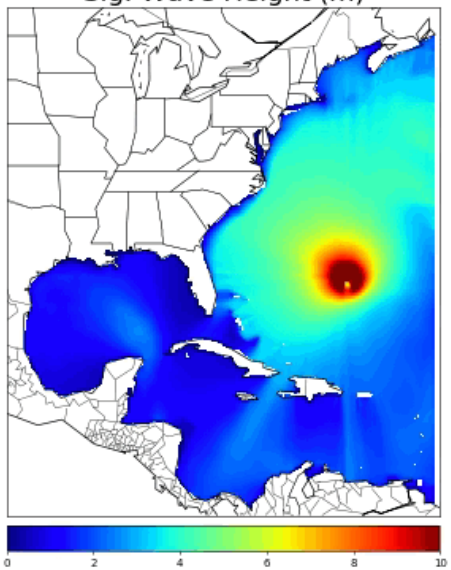

Precipitation (inches)



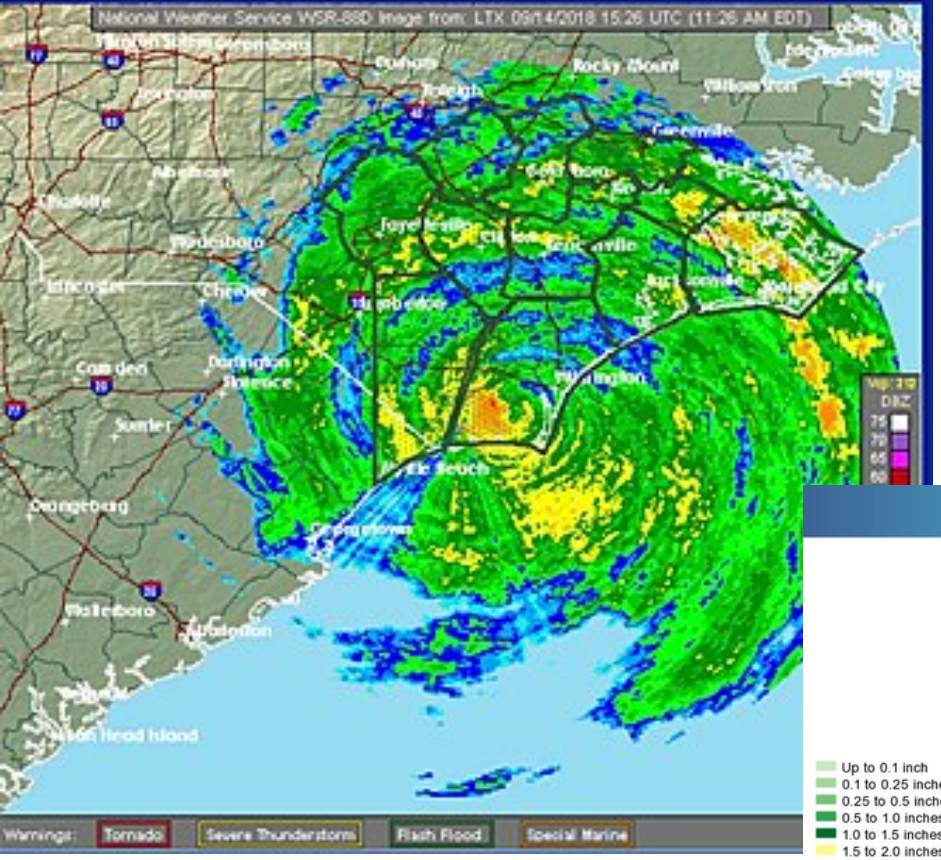

Sim. Radar Reflectivity (dBZ)

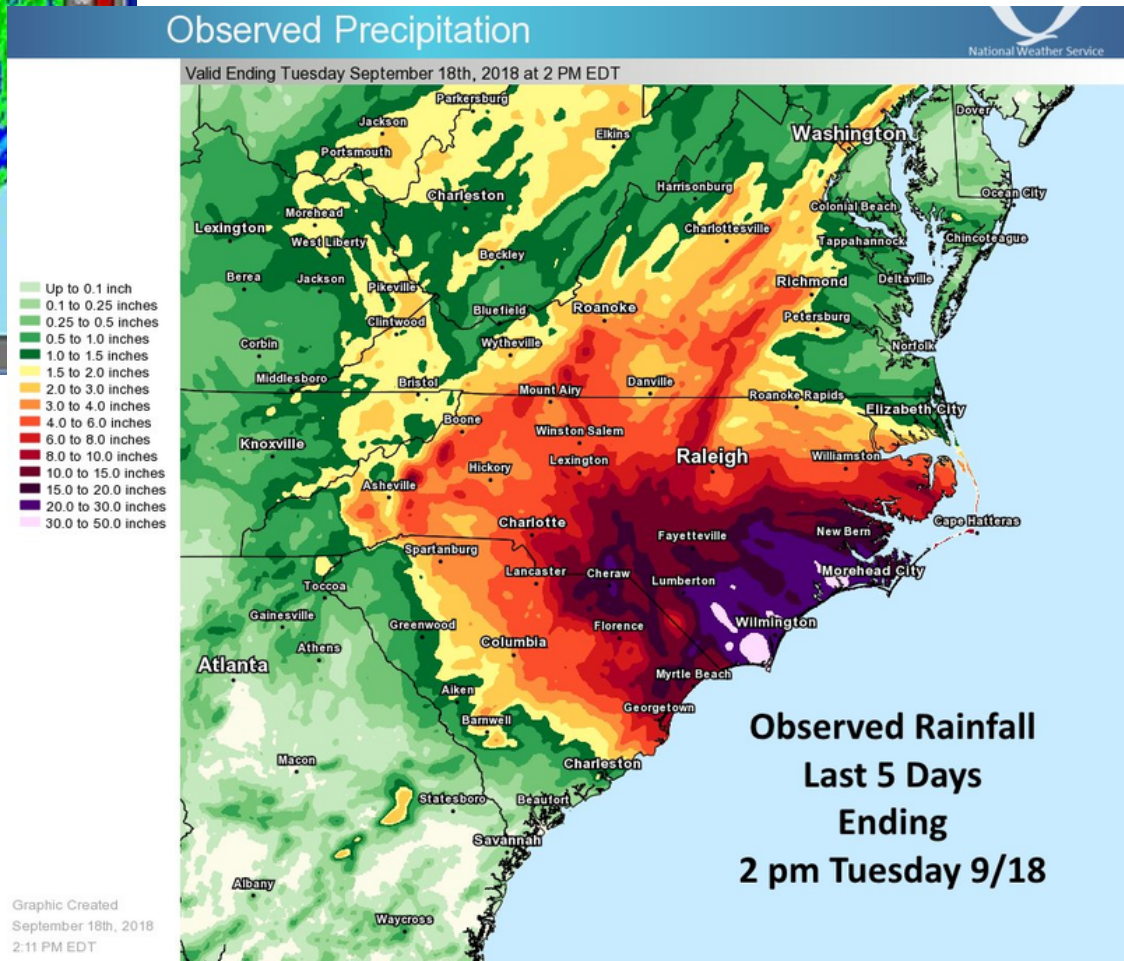



Sig. Wave Height (m)

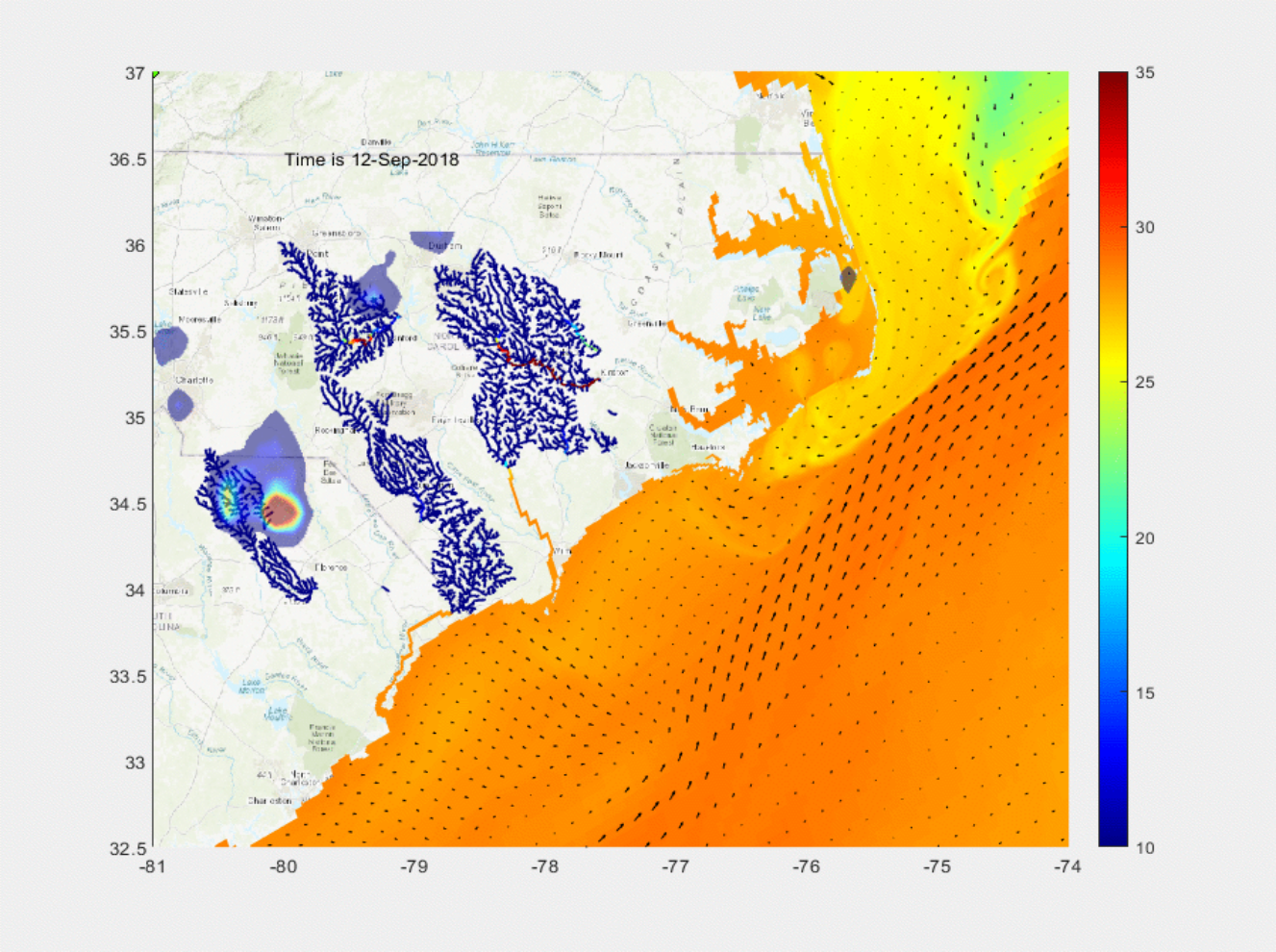


Florence dropped 35.93 in. (913 mm) of rain in Elizabethtown, NC, the wettest tropical cyclone in the Carolinas.



# Model coupling of ocean-atmosphere-river




In collaboration with John Warner (USGS) and George Xue (LSU)

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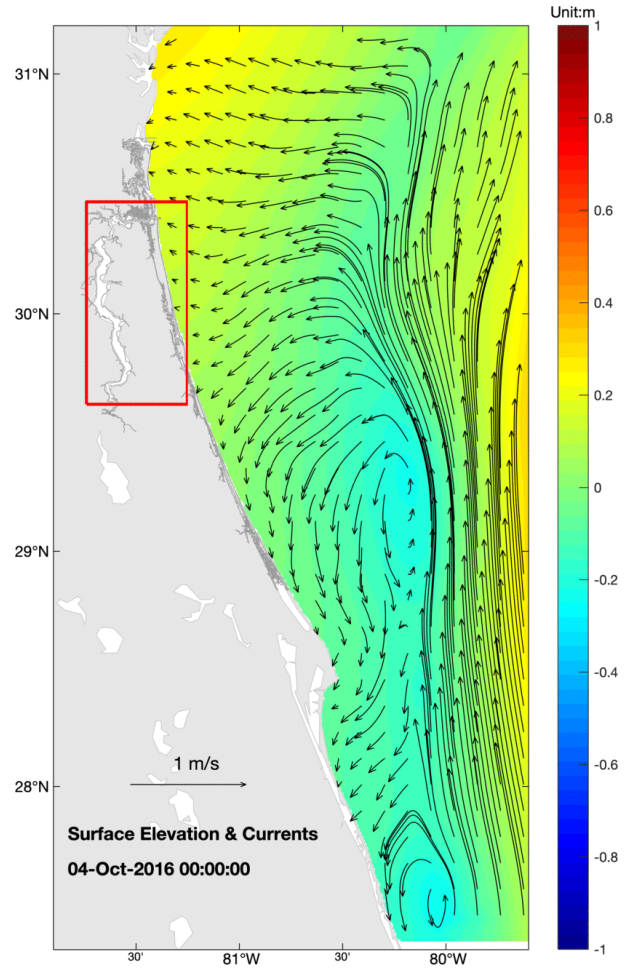
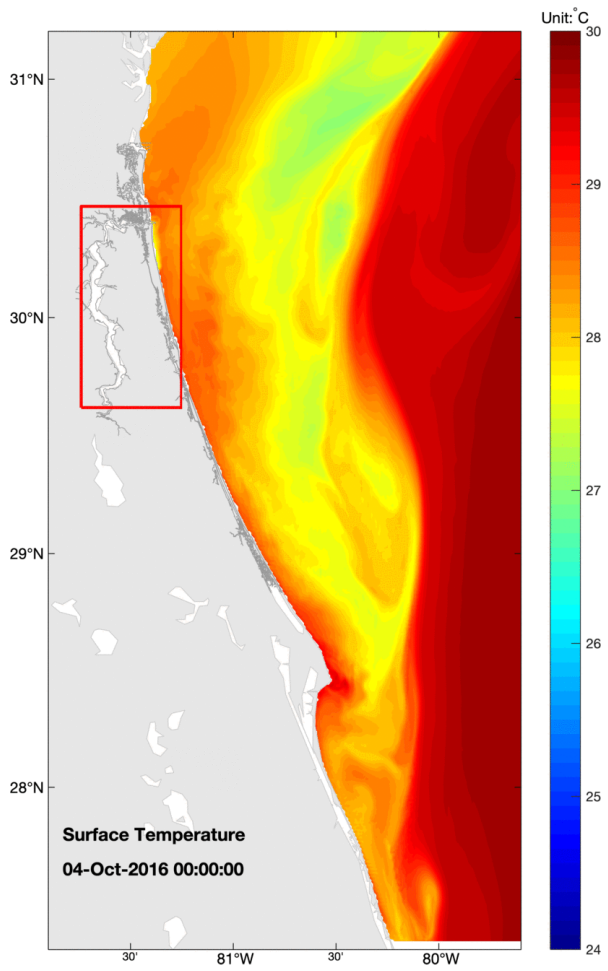
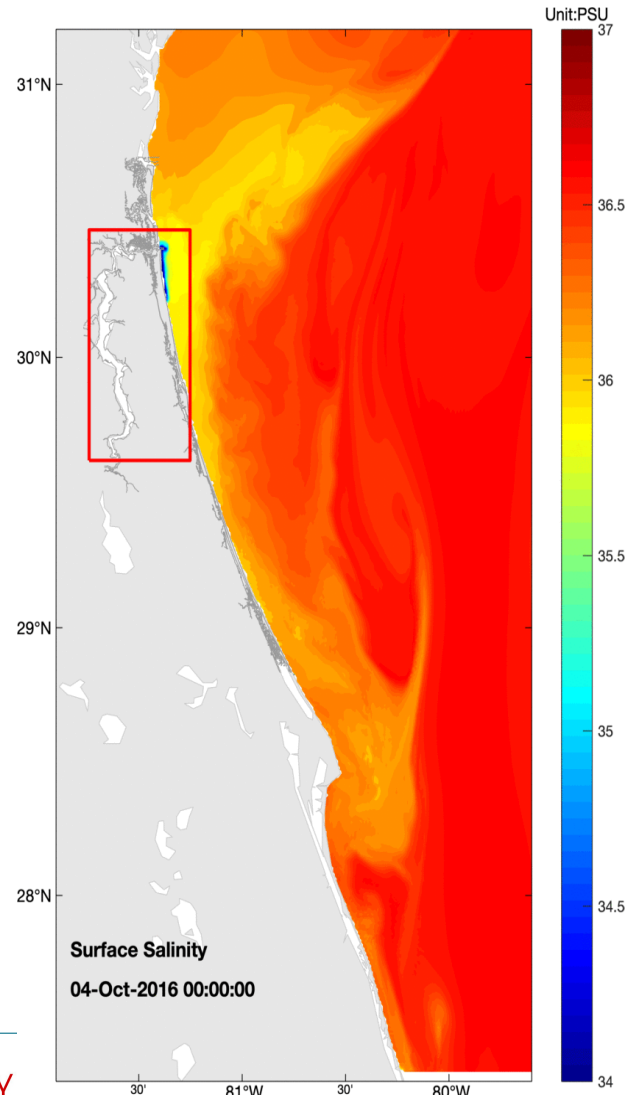
# St. Johns system (800 m resolution) : L2 model simulated

## L2 model simulated SSH, SST, SSS on Oct 4- Oct 13. 2016

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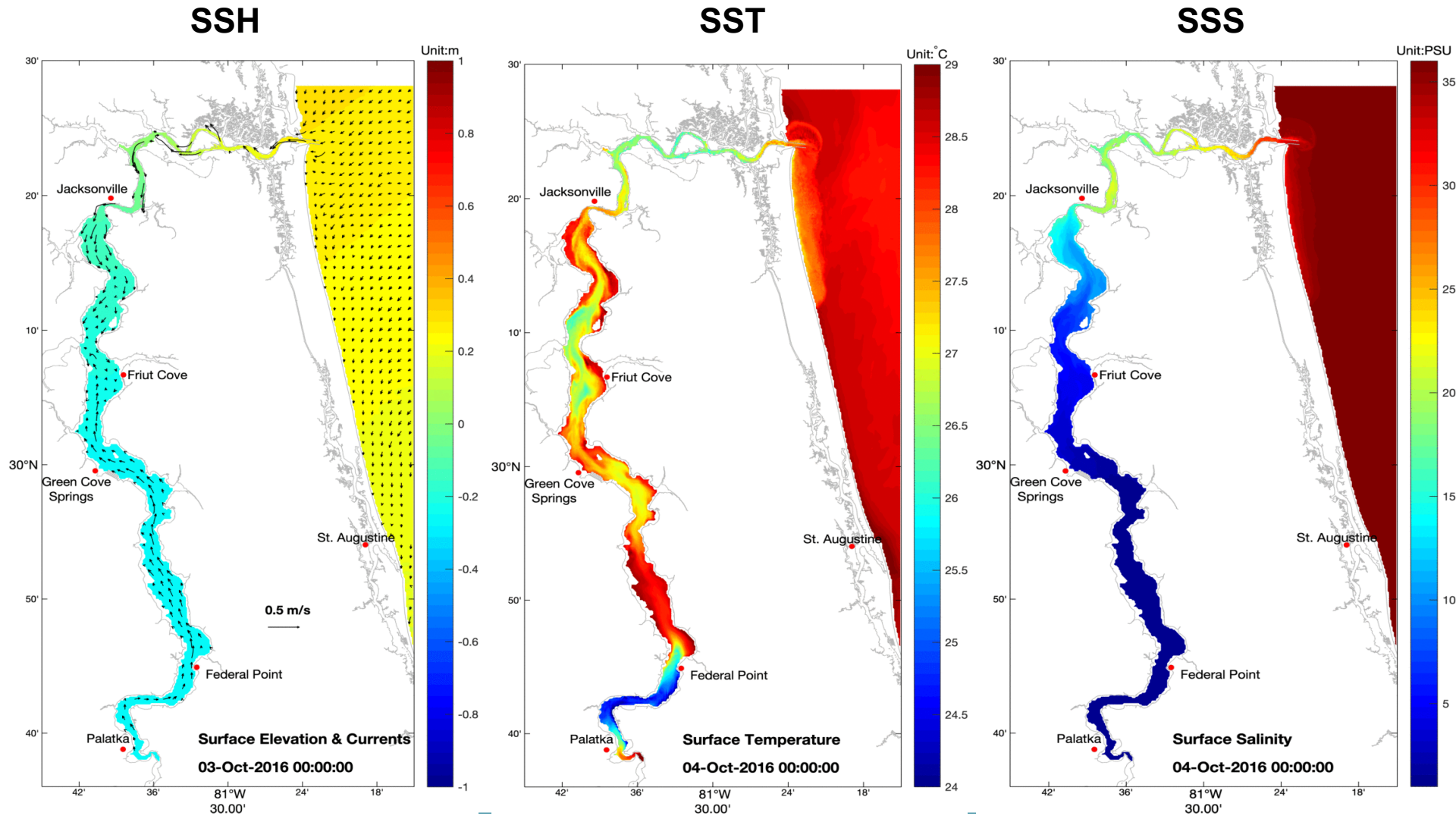
# St. Johns system (160 m resolution) : L3 model simulated

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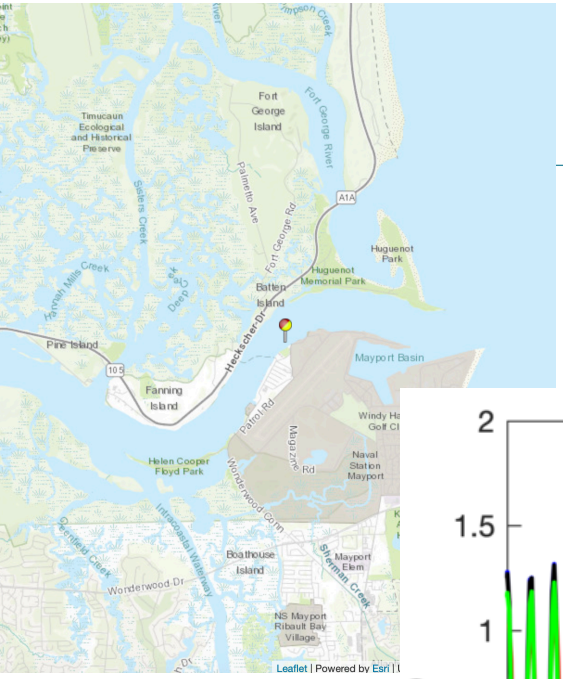
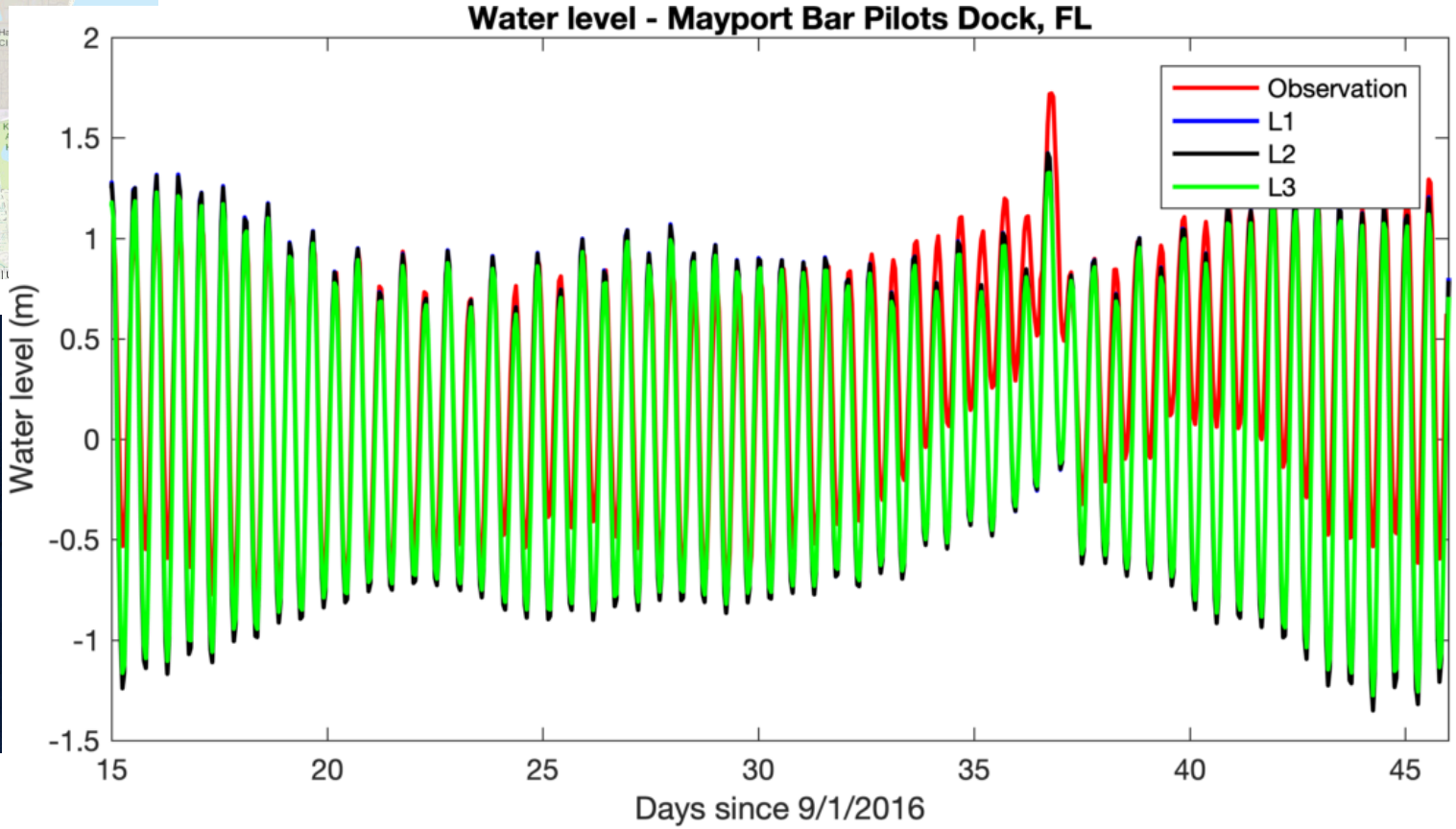
# SJR model validation

## Storm Surge verification





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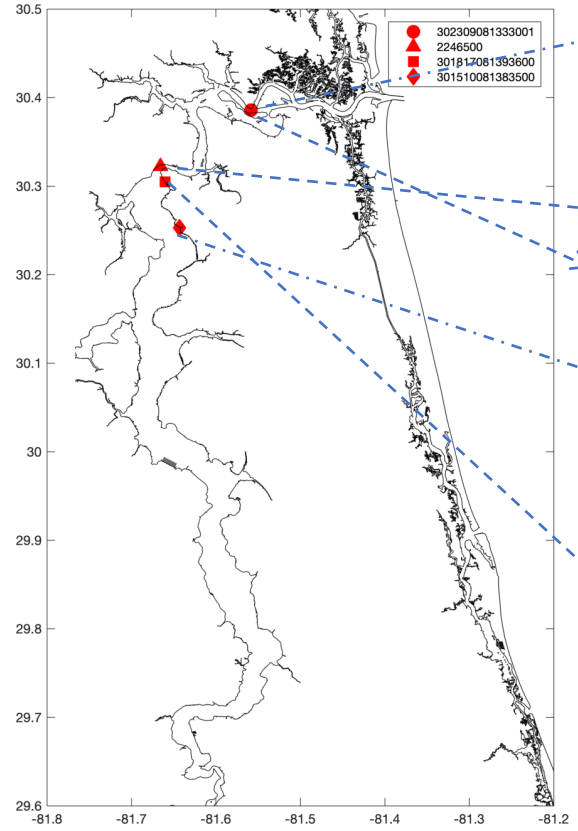
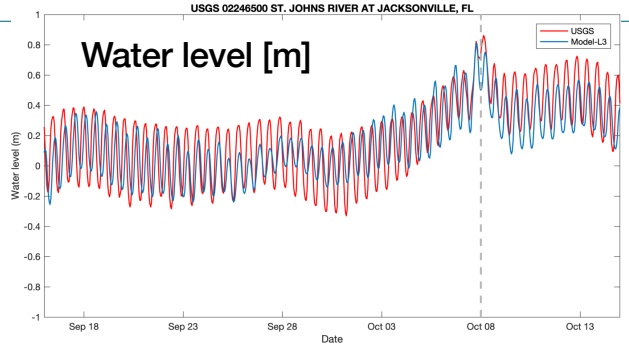
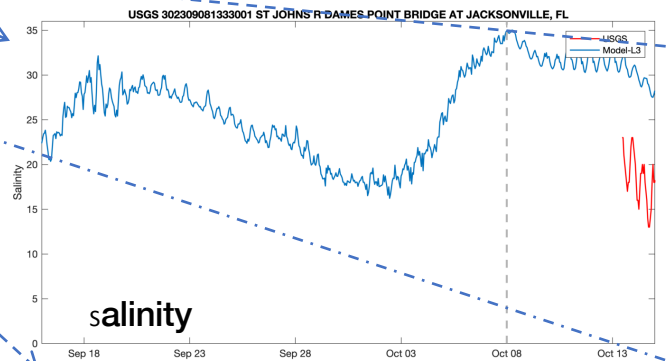
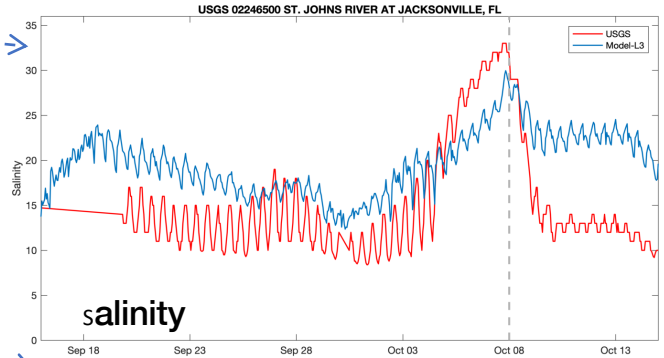
# SJR model validation (con't)

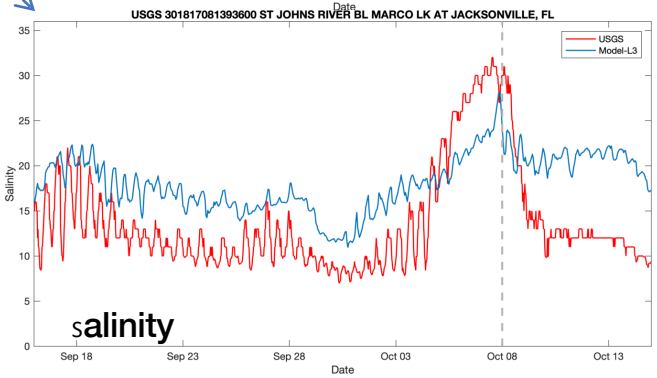
## Model(L3)-Data Comparisons

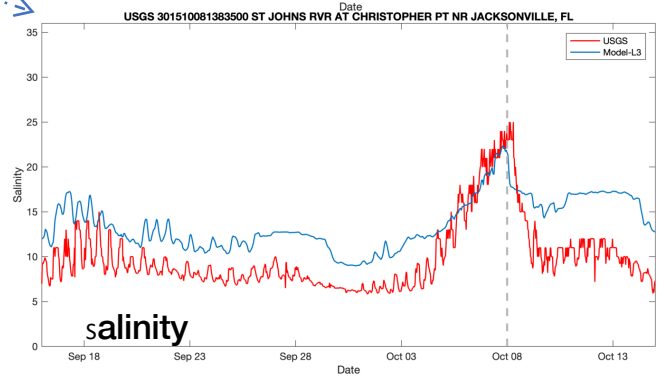
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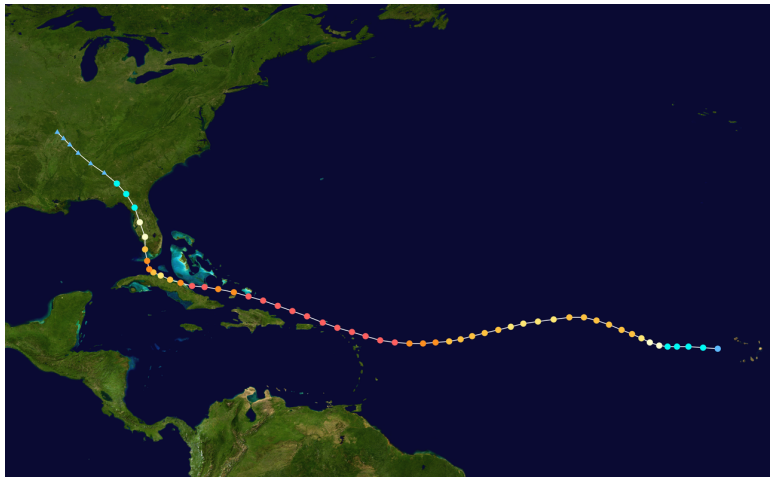
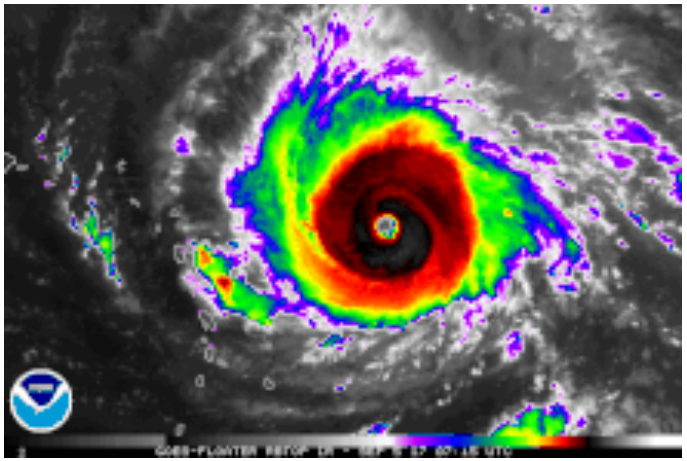
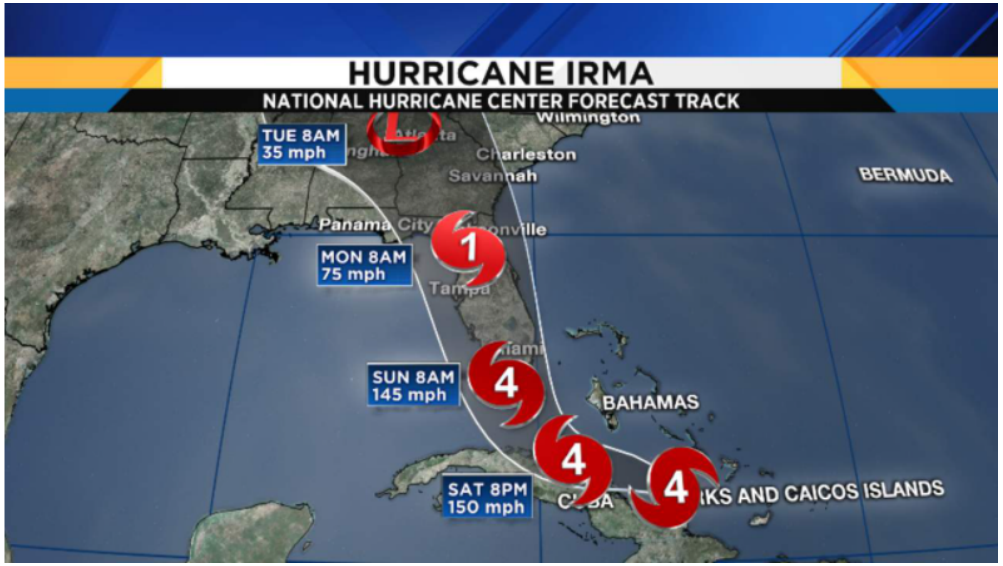
# Hurricane Irma (Aug 3 – Sept 14, 2017)







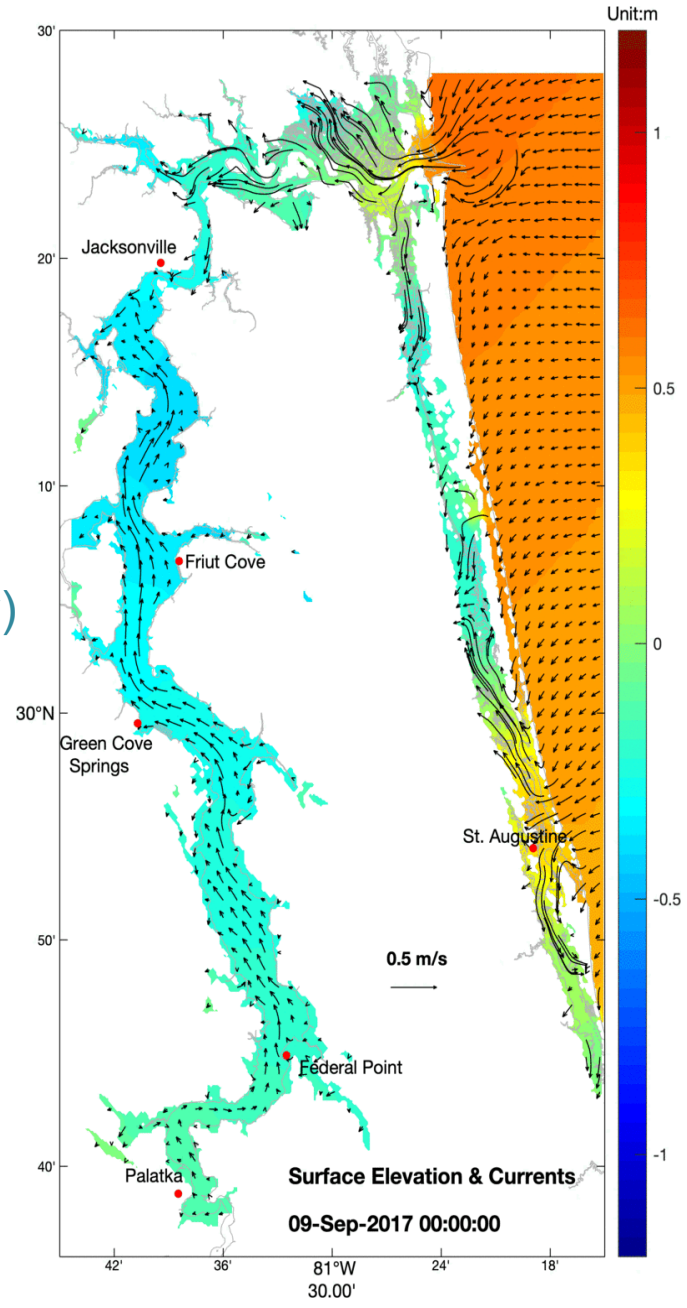
L3 (160 m res)

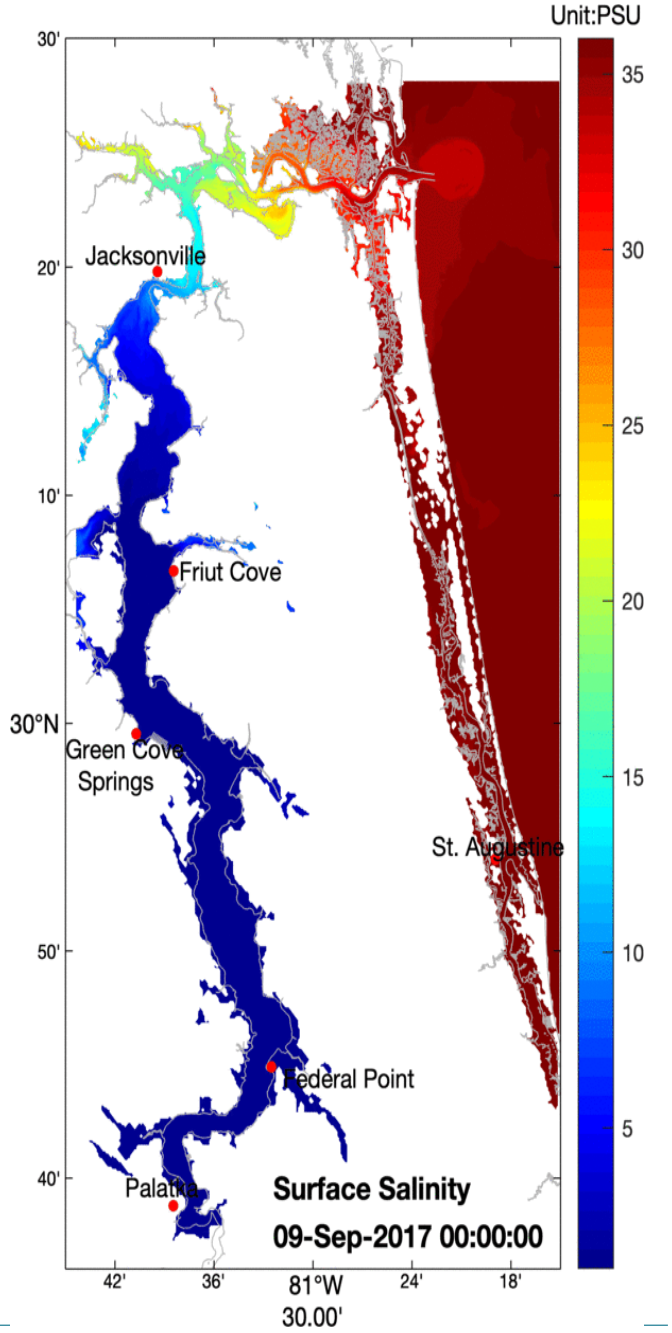
Hourly prediction:

LEFT:
SSH + Surface (u,v)

RIGHT:
Surface Salinity

With wetting/drying



## Goal

- Develop an integrated coastal water predictive capability that will deliver new water intelligence products and information vital for decision making

## Approach

- A prototype baroclinic prediction system that couples three-dimensional coastal ocean predictions with NOAA's National Water Model (NWM) forecasts

## Progress

- developed functional multi-level nested baroclinic ocean models for two sub regional study sites.
- continue working on extensive validation against observations from regional networks
- continue working on ocean-river coupling

## Stakeholder engagement

- Flooding and coastal inundation
- Water resource and water supply management
- Water quality risks to marine ecosystem and coastal communities
- Marine transportation and navigation