

Forecasting the Impacts of Lake Operations on the Estuarine Hydrodynamics and Pollutant Transport

Water Institute Symposium – February 20-21, 2024

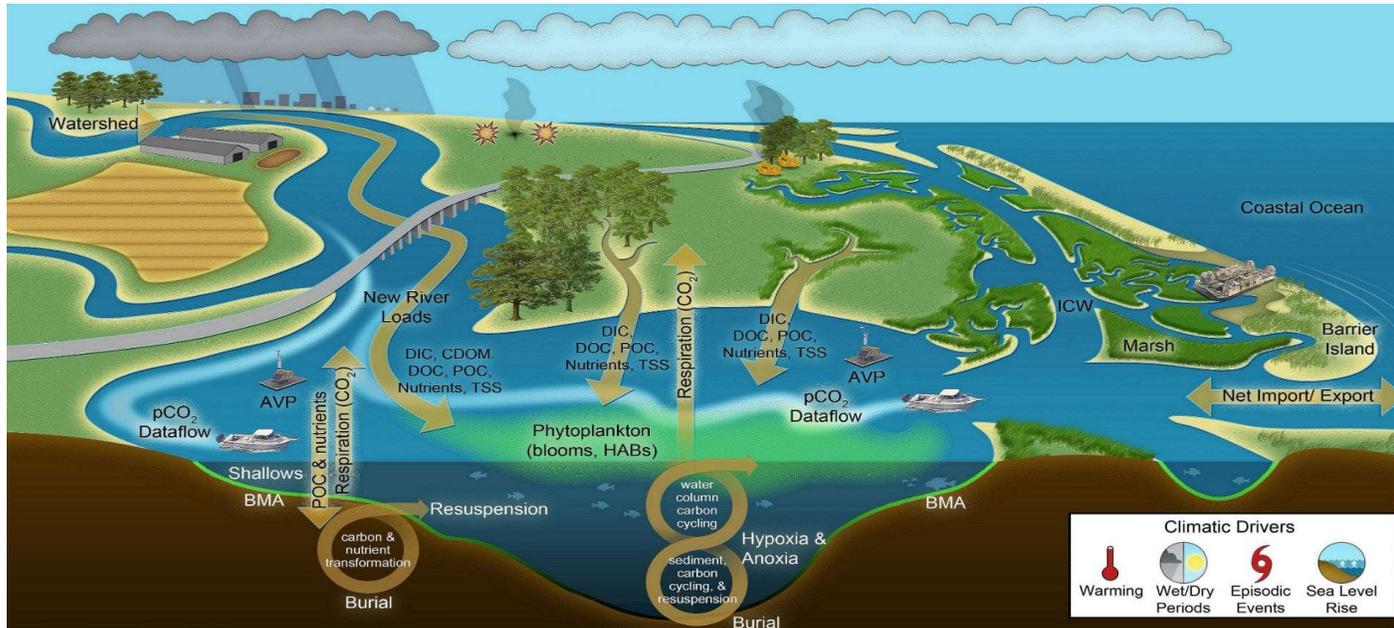
Maitane Olabarrieta (UF), David Kaplan (UF), Scoot Lee Young (UF), Jiahua Zhou (UF), Luming Shi (UF), Haithaishi Hewageegana (UF), Jose Maria Gonzalez (UF), Enrique Orozco (UF) and collaborators



Relevance of estuaries

- Estuaries are partially enclosed bodies of water formed by fresh water from rivers flowing into and mixing with ocean saltwater.
- Estuaries provide important ecosystem services:
 - **Clean water and abundant wildlife**
 - **Tourism and recreation**
 - **Protection** from the impacts of flooding and climate change
 - **Sustainable fisheries**
 - **Job generation and economy**
 -

Major processes driving estuarine ecosystems



Chilton et al., 2021. Front. Environ. Sci.

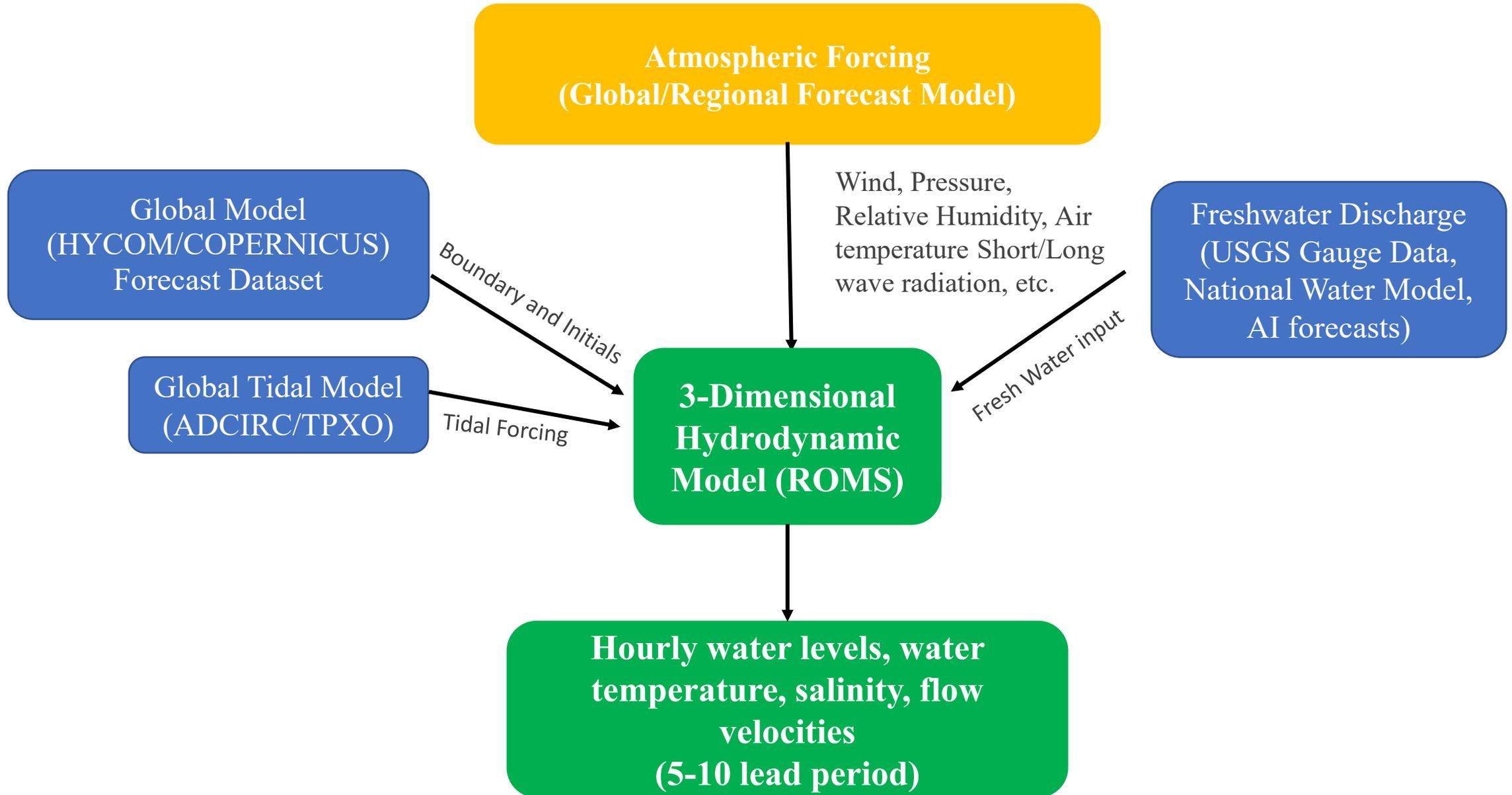
- Hydrodynamics (e.g., salinity, water circulation, mixing and flushing)
- Sediment dynamics
- Nutrient cycling and trophic transfer
- Hydrological connectivity

[Coastal Research | Estuaries & Mangroves \(osu.edu\)](https://coastalresearch.osu.edu/estuaries-mangroves)

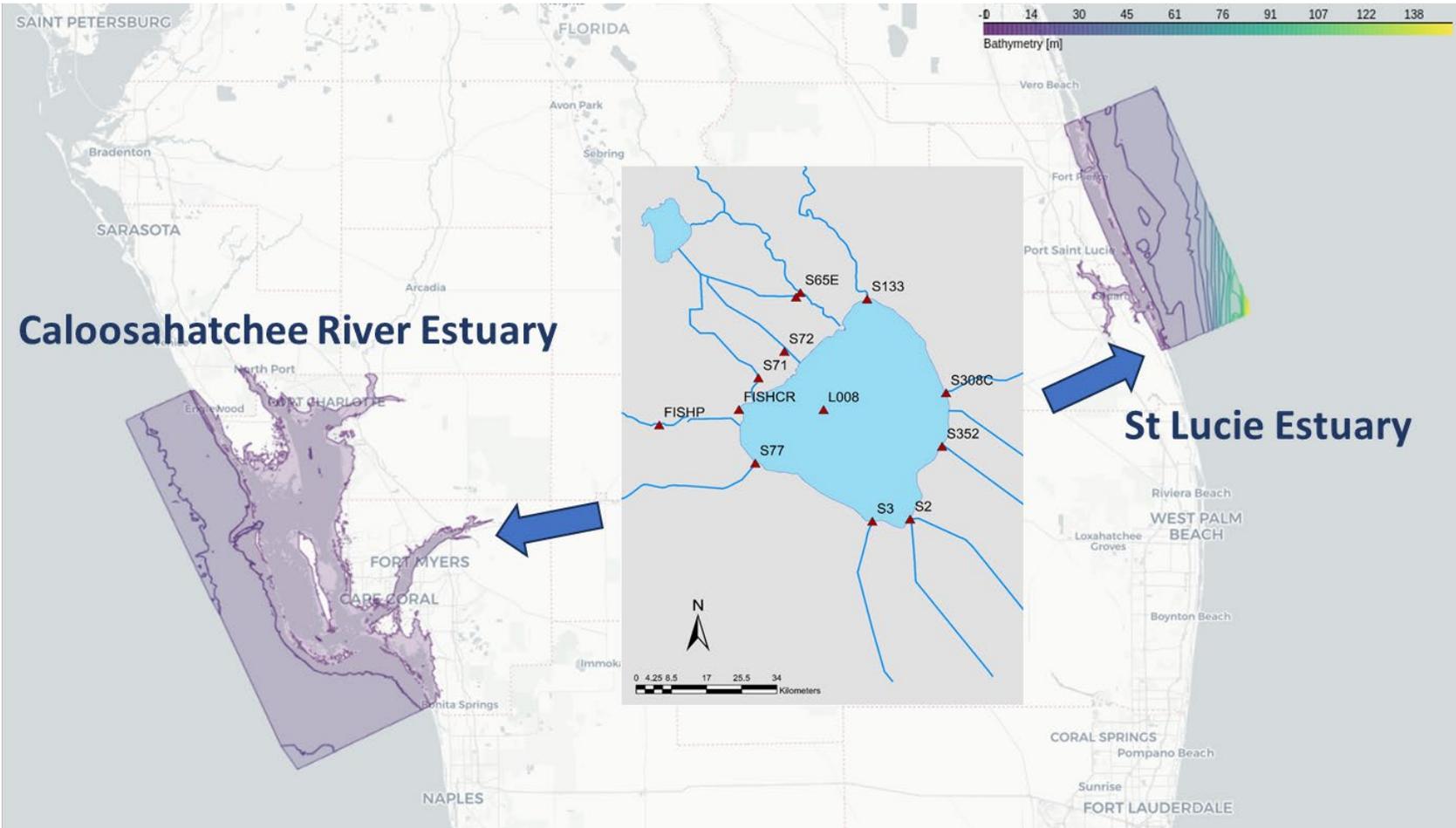
These processes are changing as result of climate change and direct anthropogenic stressors

We need short-term (week) and long-term (years) prediction systems

Nearshore and Estuarine Hazard prediction system



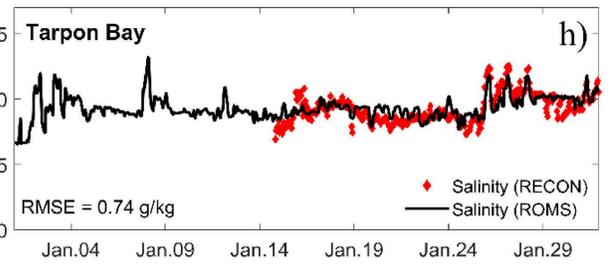
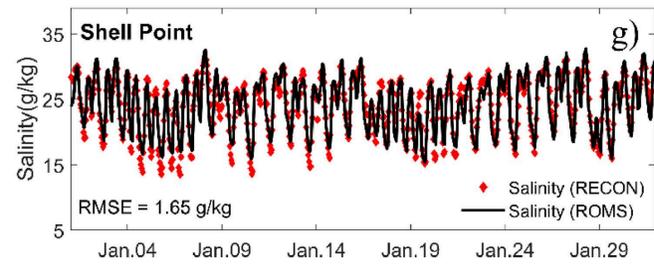
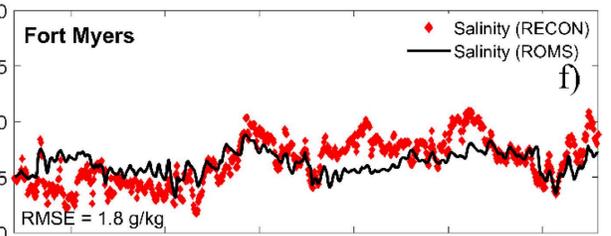
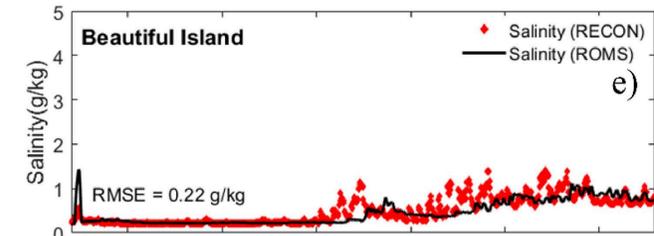
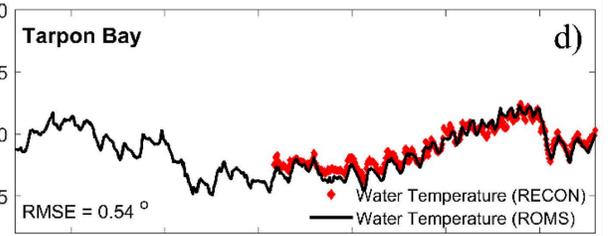
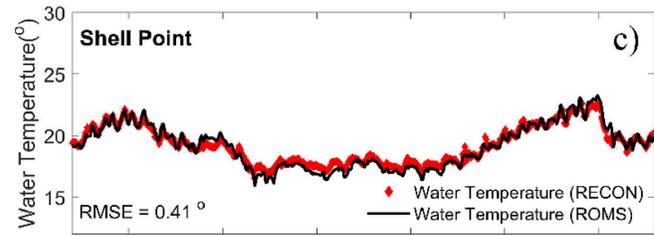
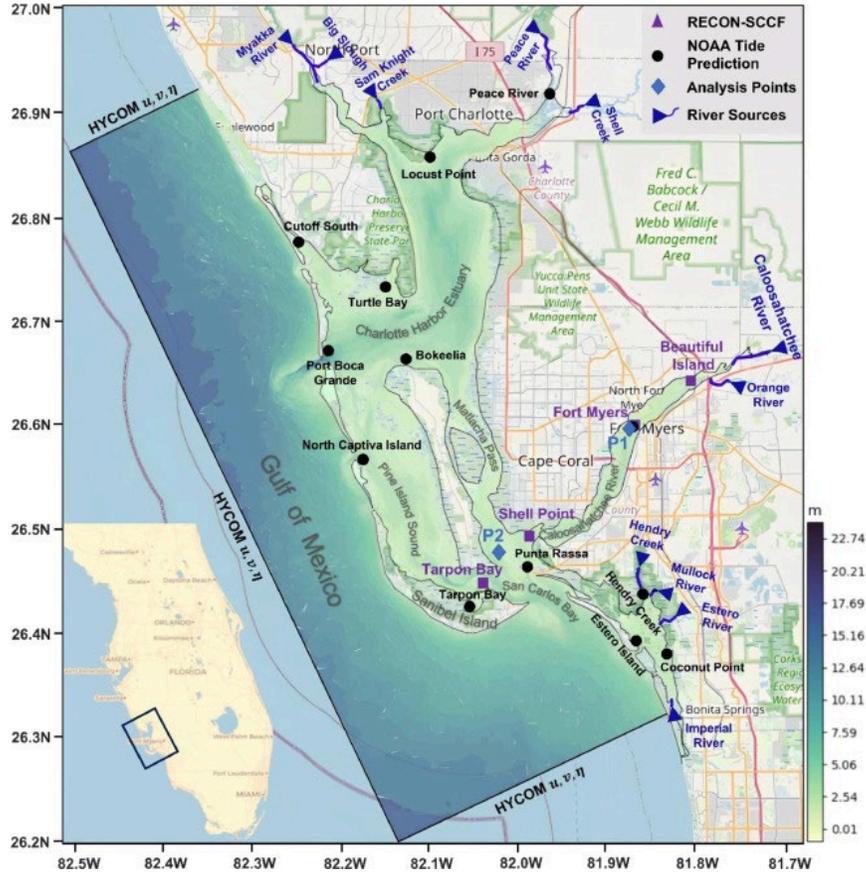
Application to the Caloosahatchee River Estuary and the St Lucie Estuary



CLEW: Coupling lake, watershed, and estuarine models to better understand the role of engineered freshwater discharges in driving the severity, location, and timing of harmful algal blooms.

SLEW: Integrating Modeling Tools and Observations for Prediction and Management of Harmful Algal Blooms in the St. Lucie Estuary and Watershed

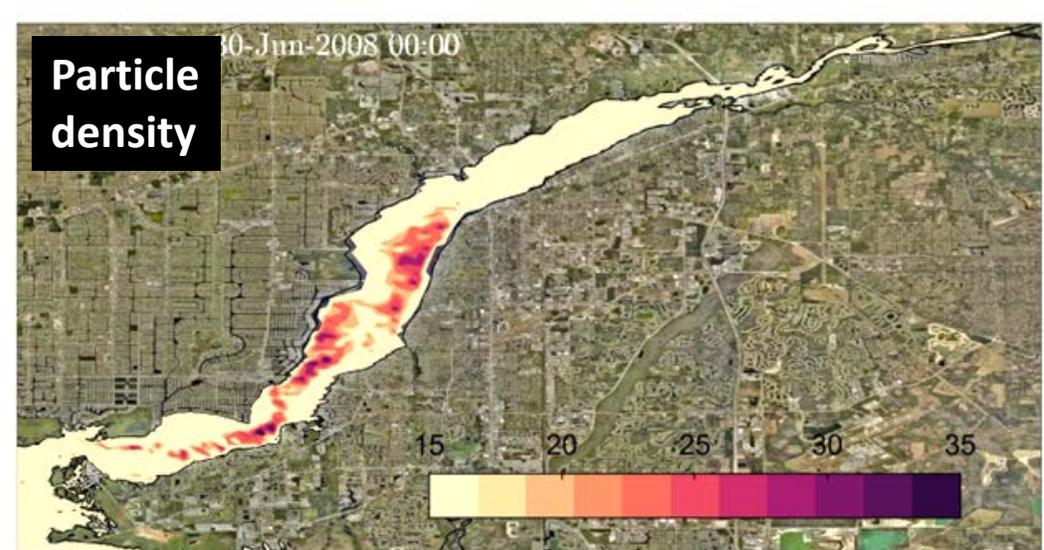
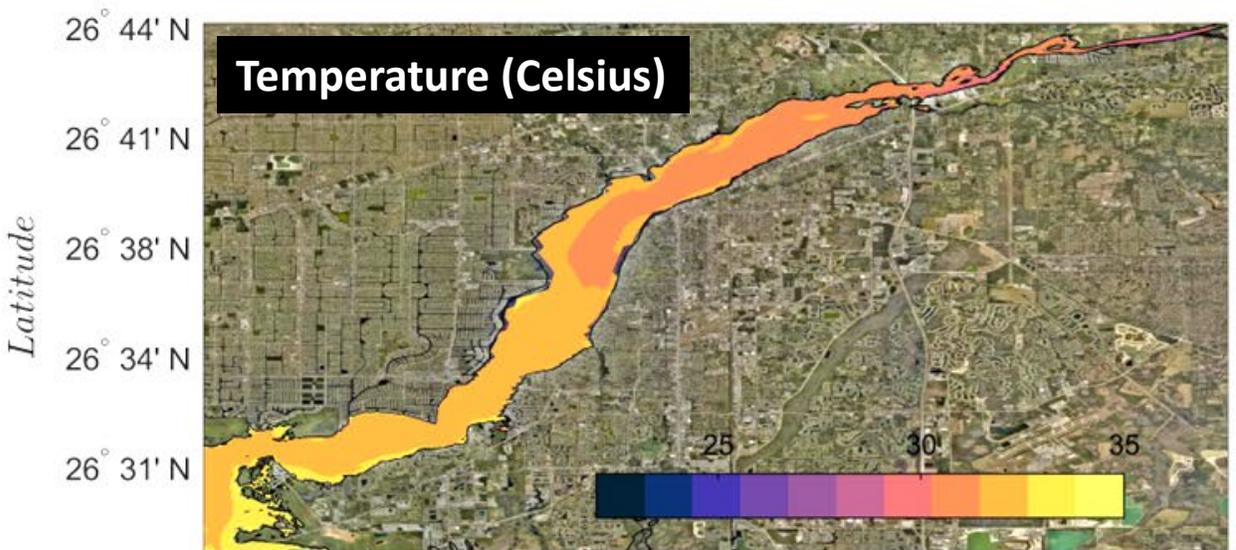
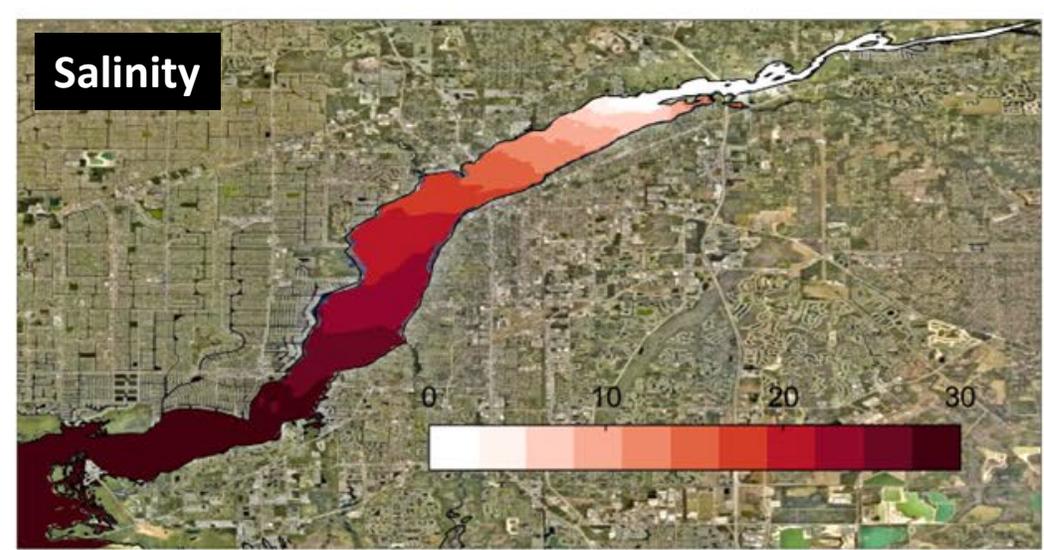
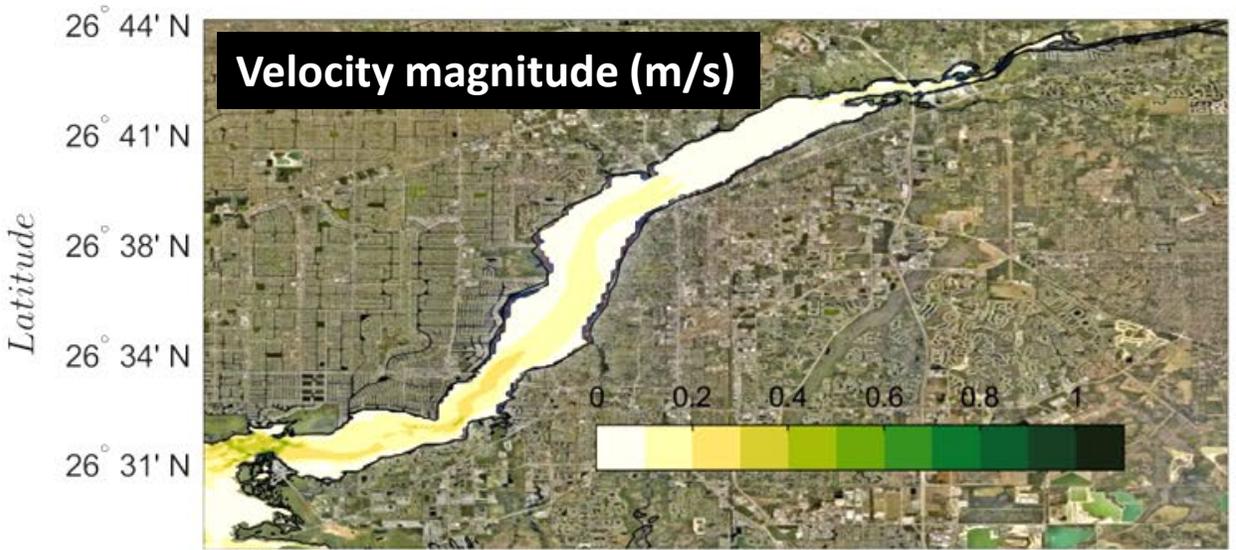
Caloosahatchee River Estuary Model



Water Level	Location	R^2	RMSE (cm)	RRE (%)
	Fort Myers (NOAA)	0.78	8.70	5.50
	Fort Myers	0.77	8.24	5.50
	Shell Point	0.80	8.28	6.27
	Tarpon Bay	0.89	7.21	5.97
	Gulf of Mexico	0.86	10.99	4.79
	Redfish pass	0.86	8.05	5.21

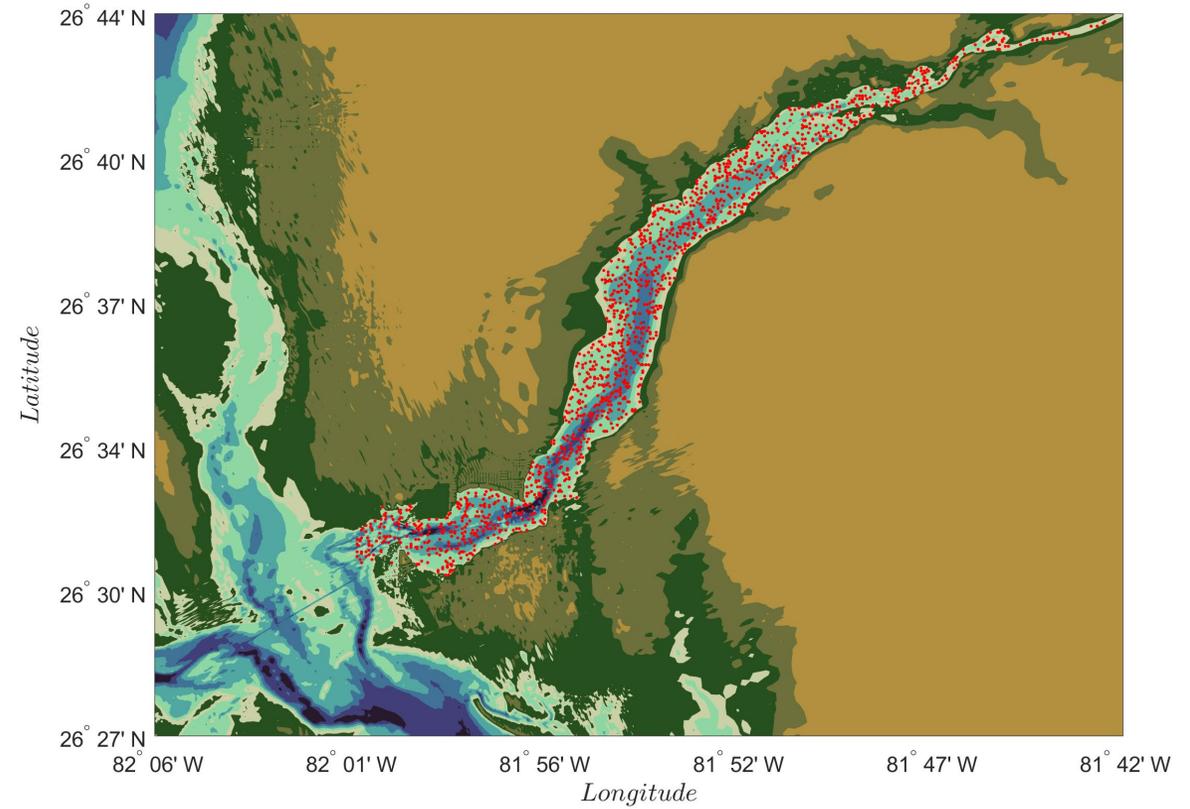
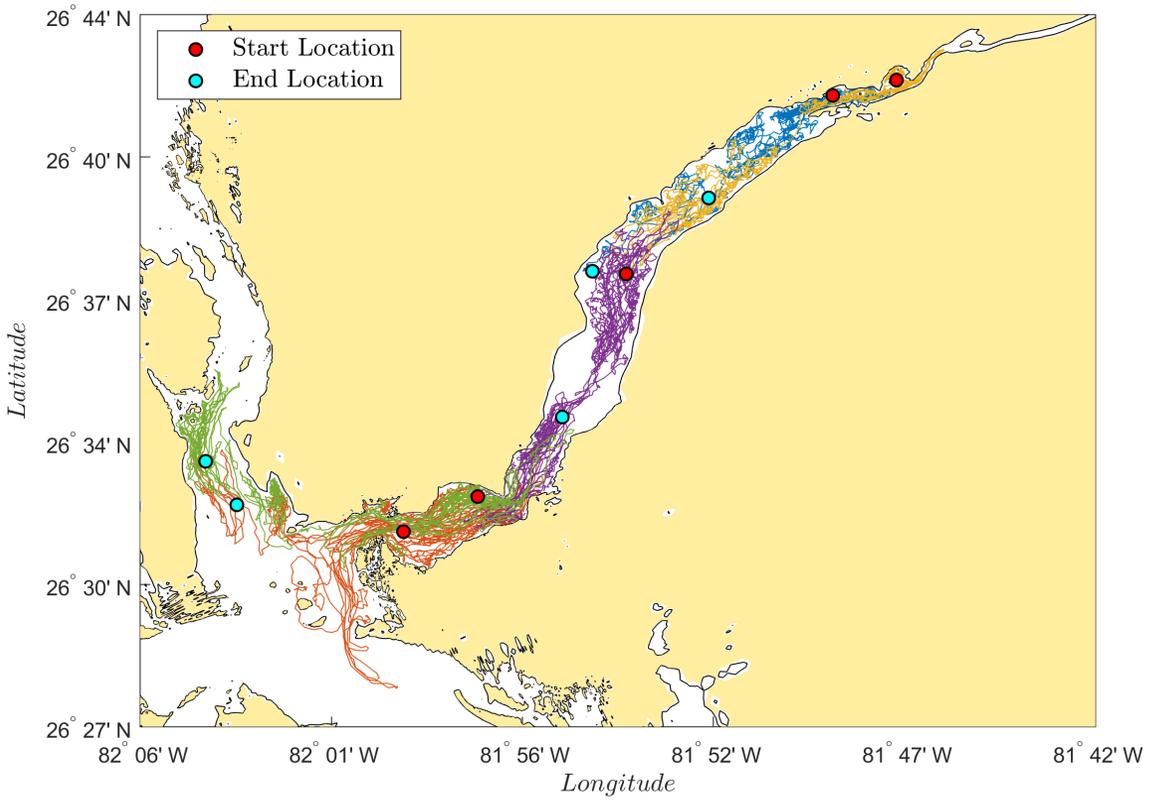
Salinity	Location	R^2	RMSE	RRE (%)
	Fort Myers	0.89	3.58	12.13
	Shell Point	0.87	3.75	9.78
	Tarpon Bay	0.92	2.00	10.33
	Redfish pass	0.63	1.3	7.52
Temperature	Location	R^2	RMSE (C)	RRE(%)
	Fort Myers	0.97	1.09	4.84
	Shell Point	0.98	0.79	3.16
	Tarpon Bay	0.96	0.83	5.32
	Gulf of Mexico	0.98	1.01	4.14

Shi et al. (2023) Advances in Water Resources

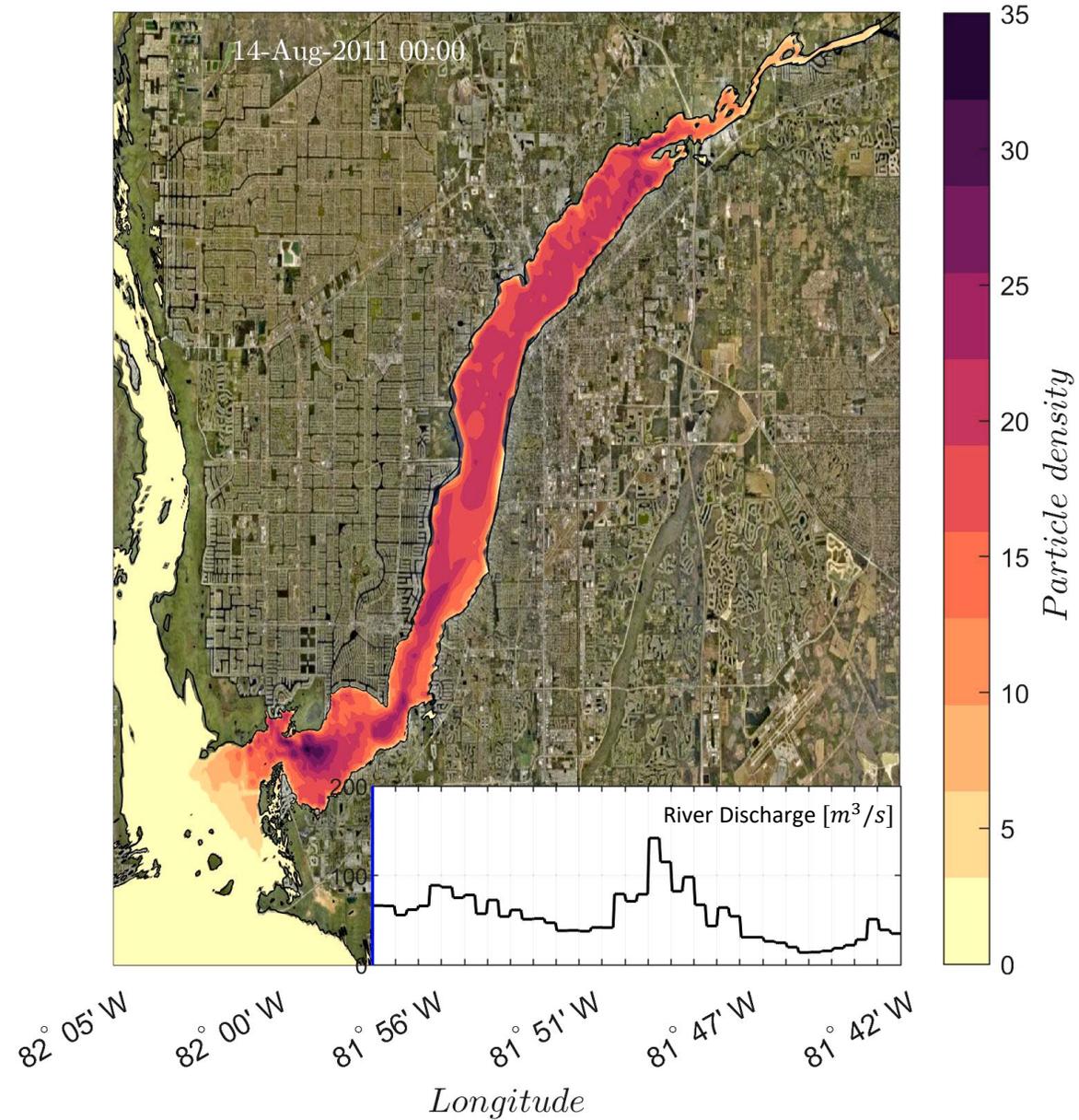
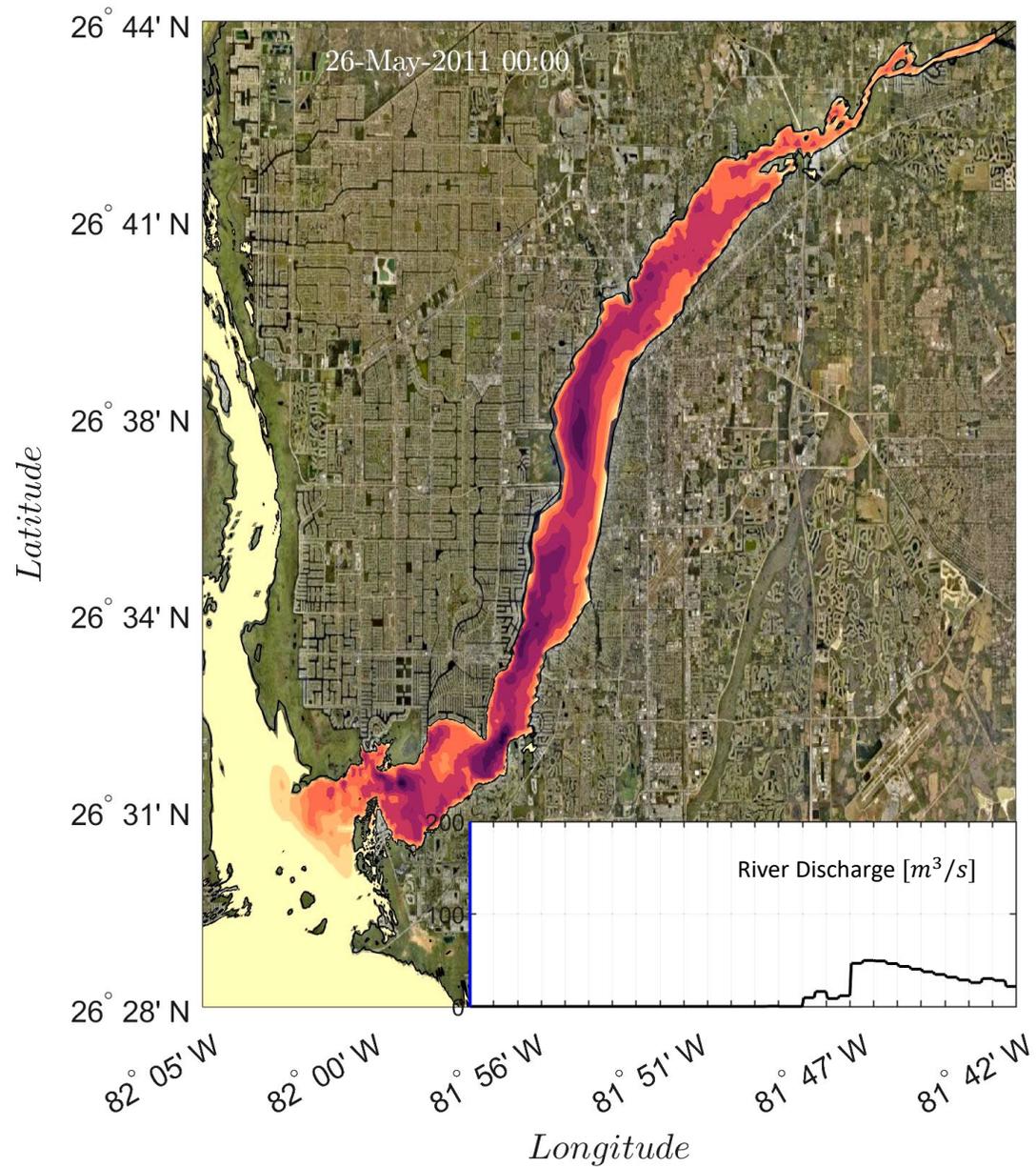


82° 00' W 81° 56' W 81° 53' W 81° 49' W 81° 46' W 81° 42' W 82° 00' W 81° 56' W 81° 53' W 81° 49' W 81° 46' W 81° 42' W

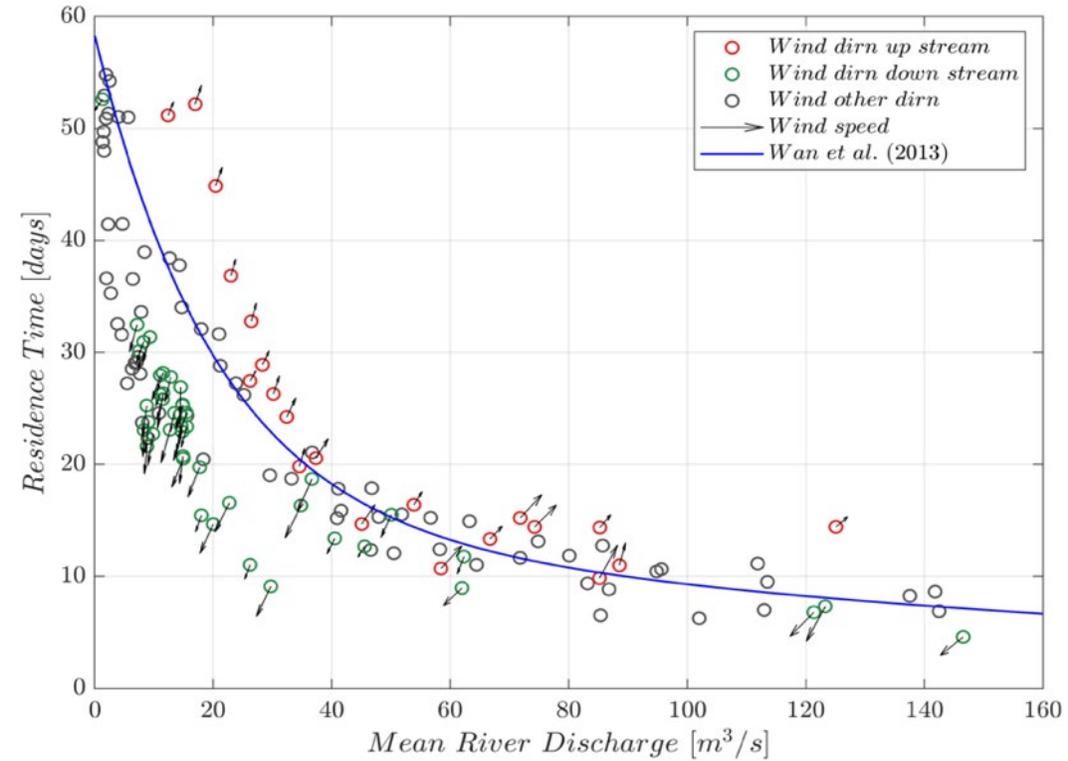
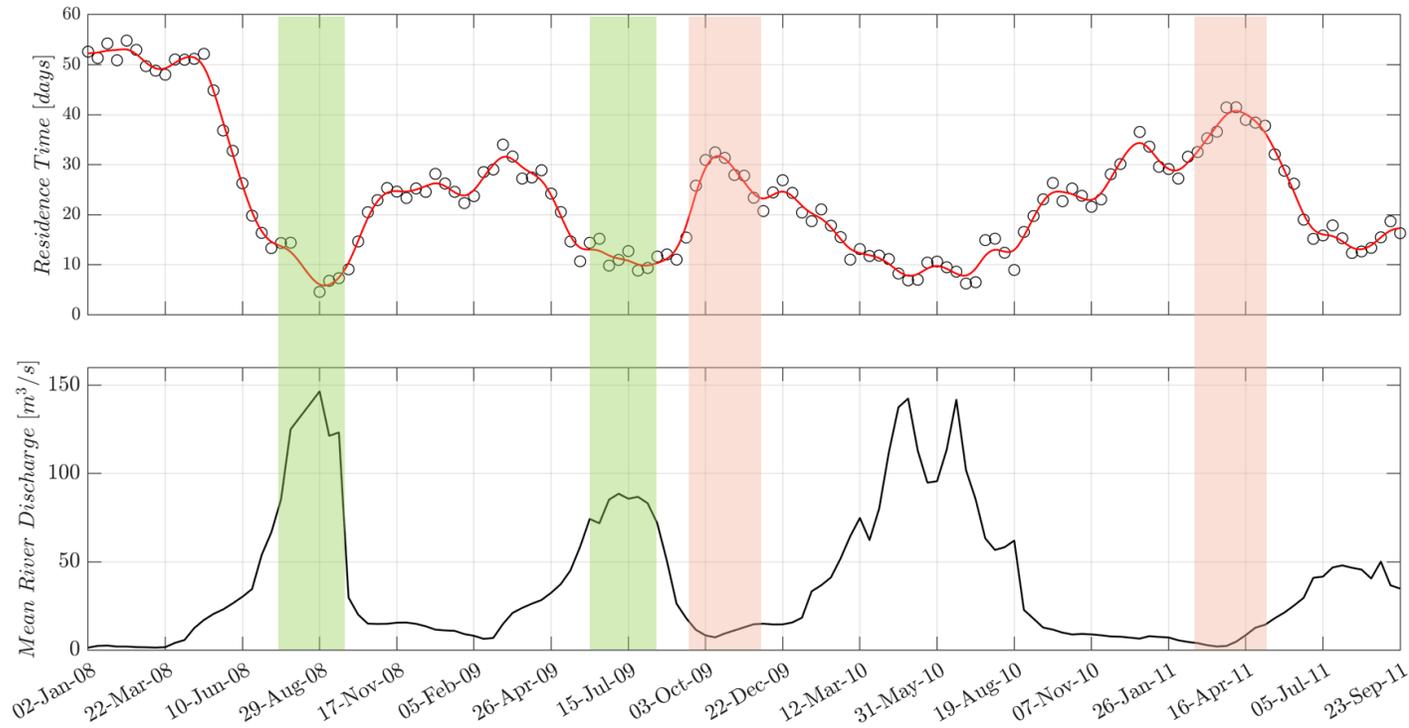
Longitude *Longitude*



33440 particles released over the estuary uniformly

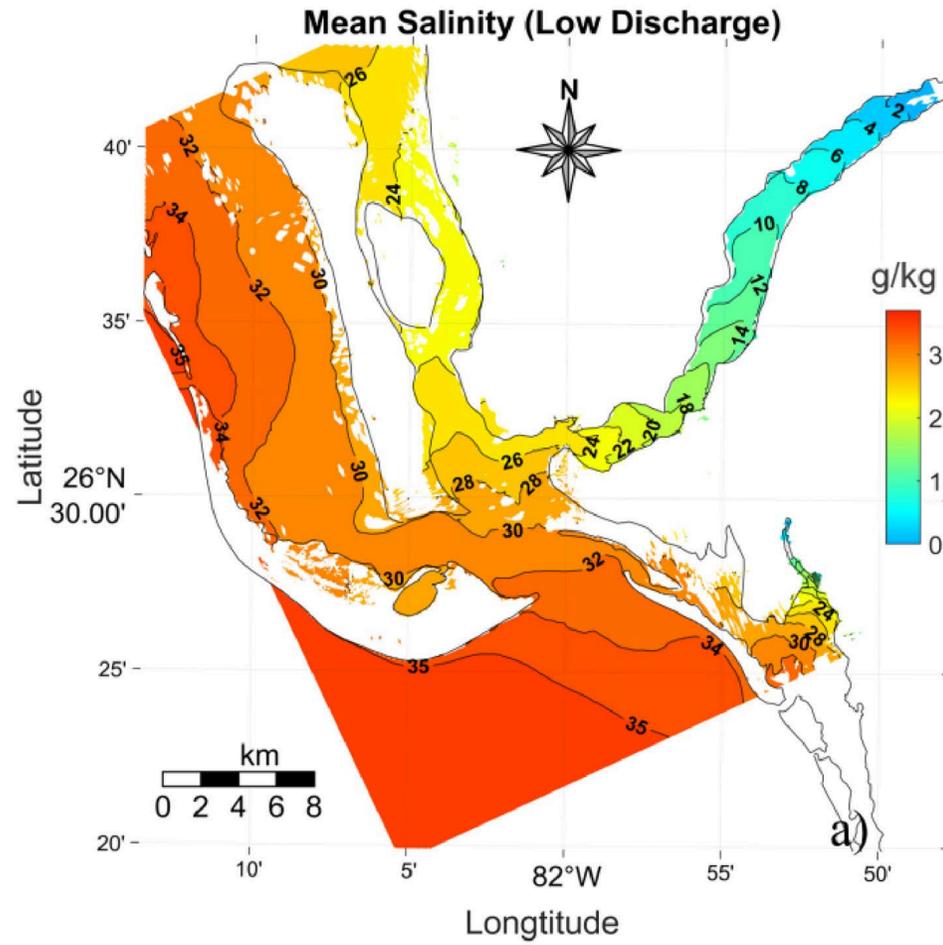


Hewageegana et al. (2023) JMSE

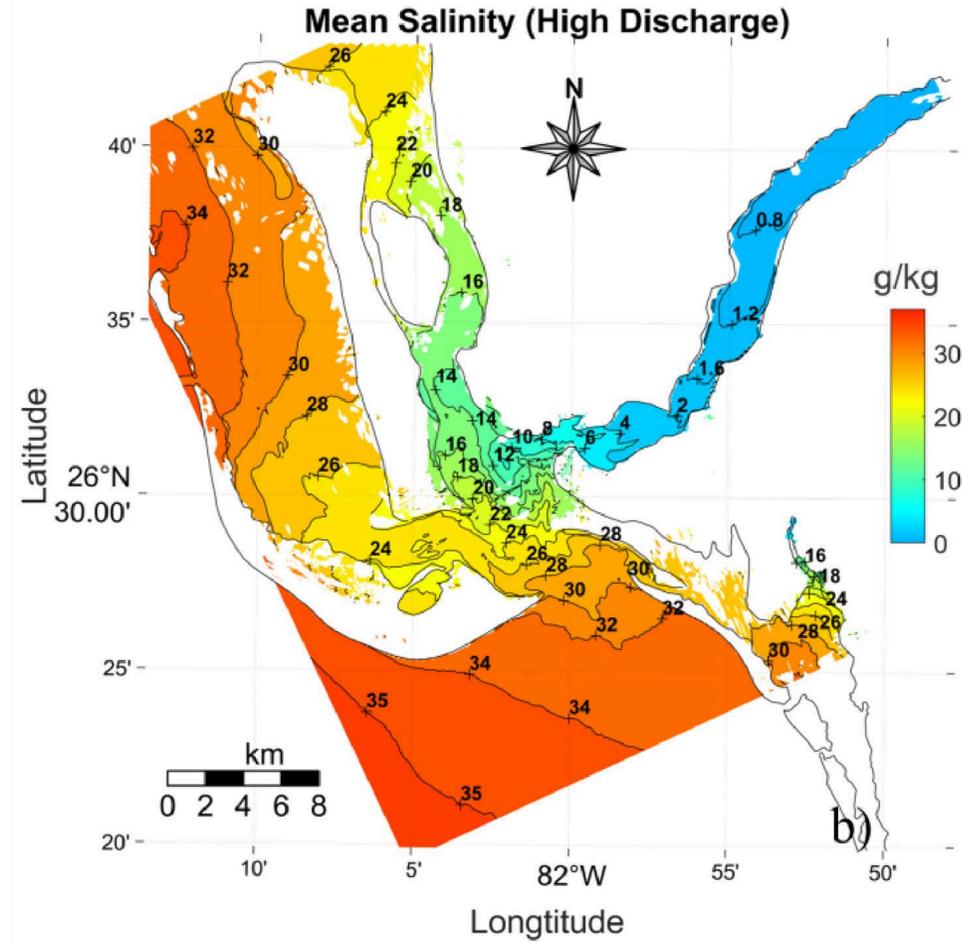


- Estuary model has high skill modeling CRE water levels, temperatures, and salinities.
- Freshwater flow dominates estuary residence time

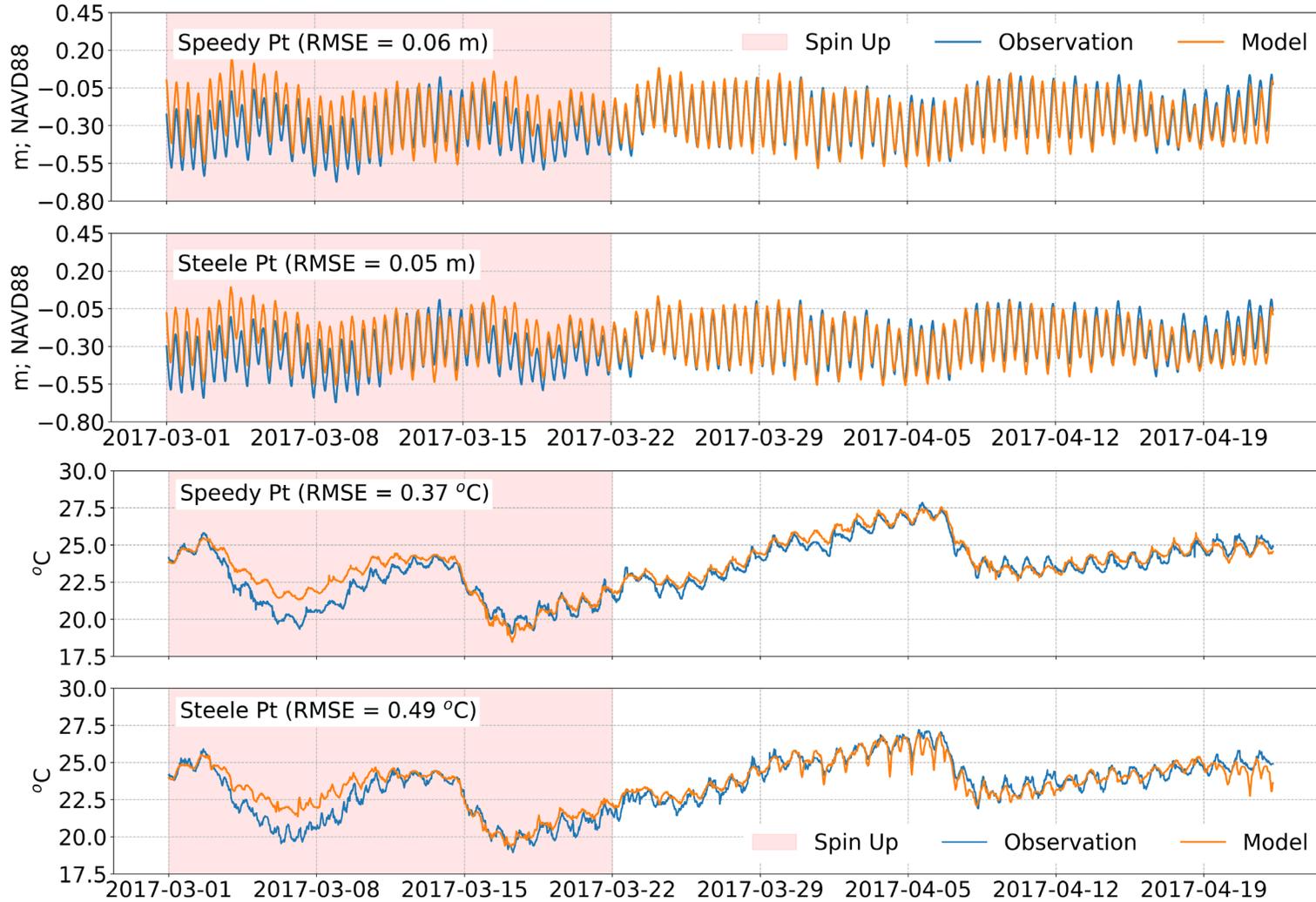
Q= 0.5 m³/s DRY SEASON



Q= 200 m³/s WET SEASON

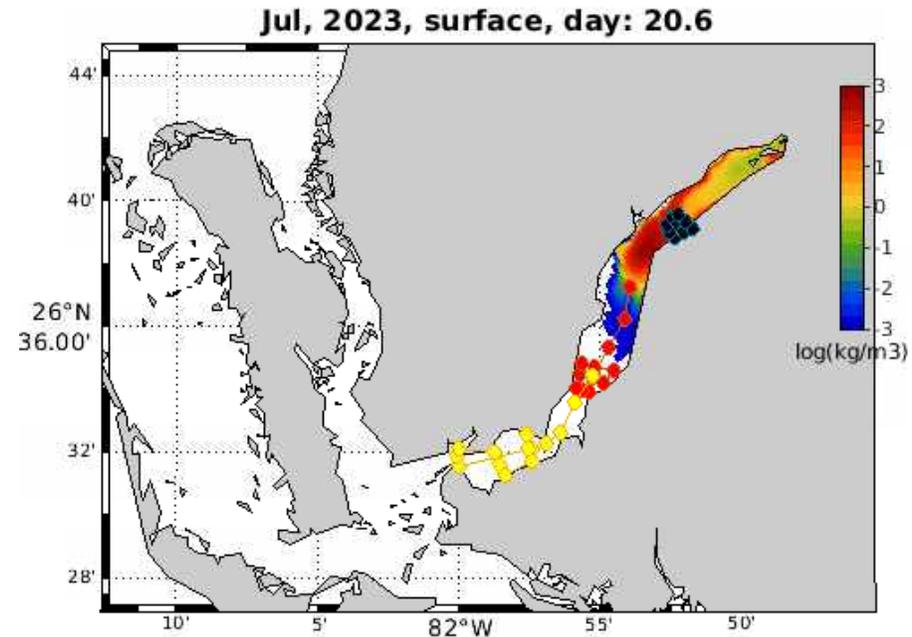
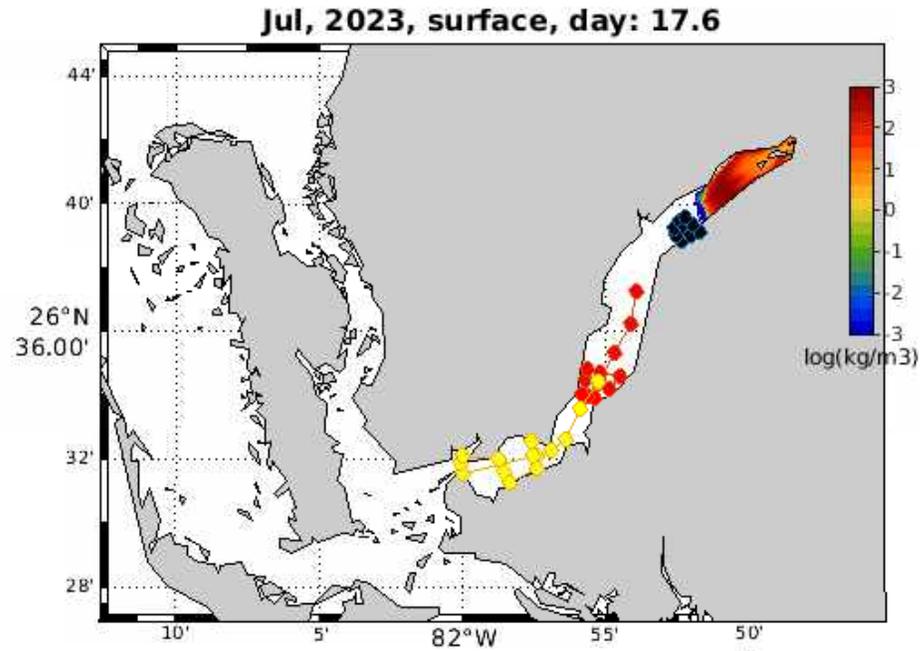


St Lucie Estuary Model



Applications

Algae Bloom Release During July, 2023



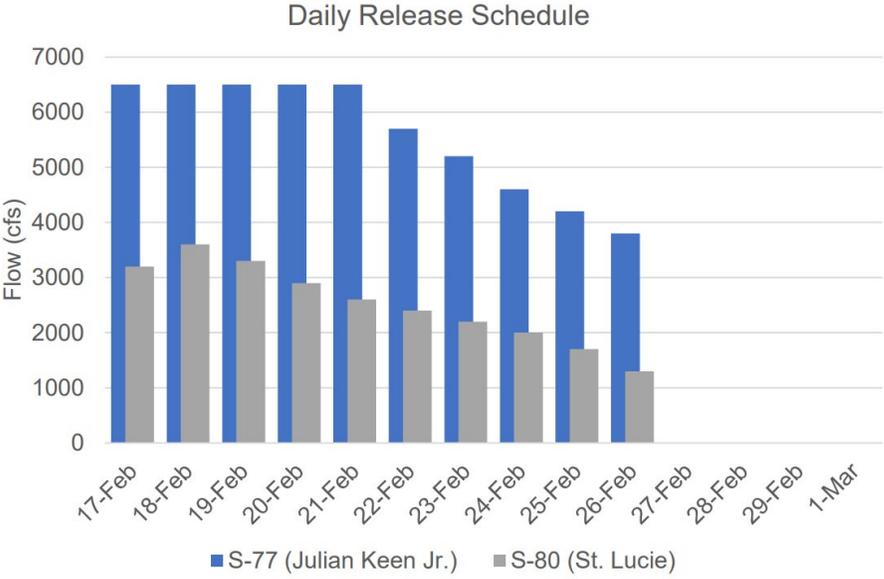
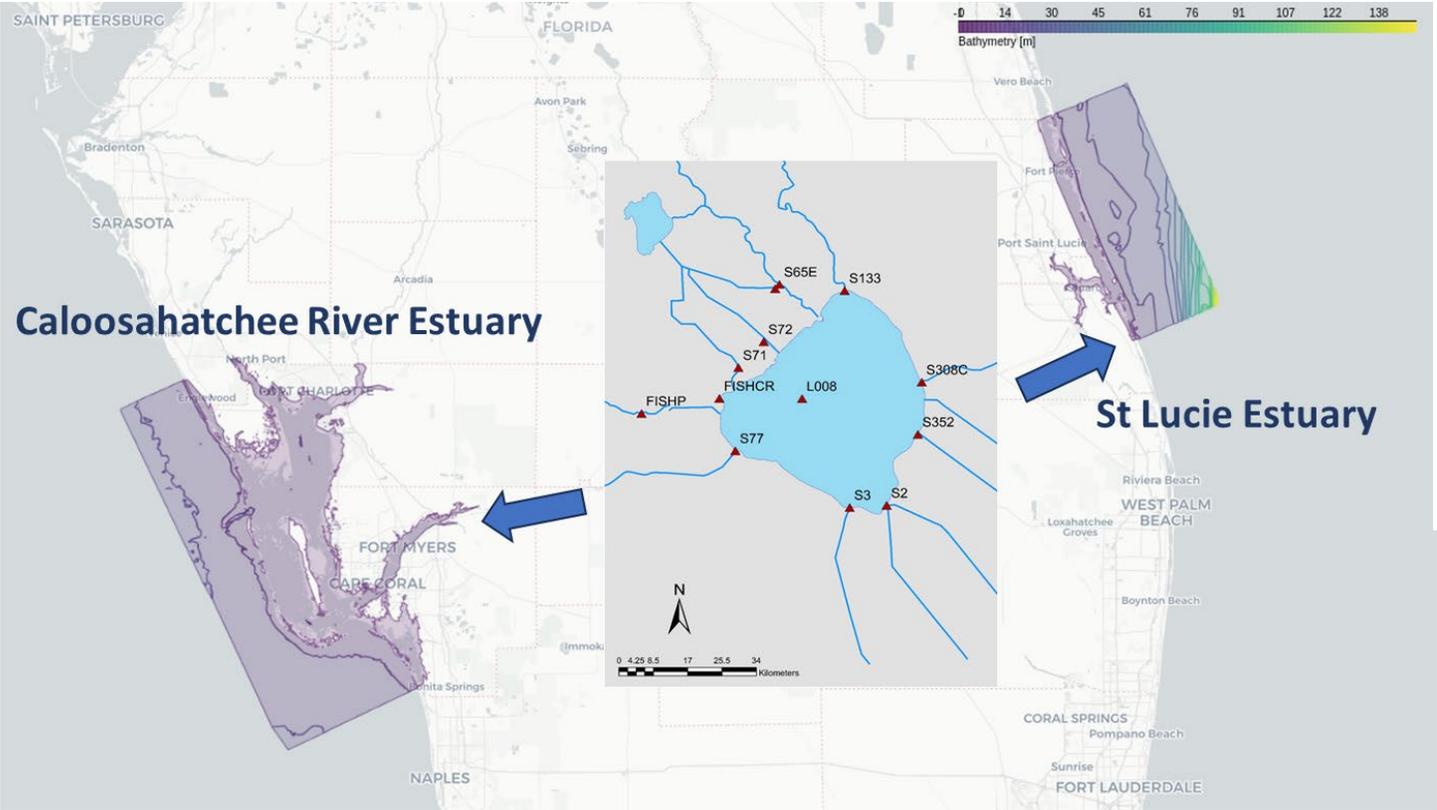
Black points: locations where blooms were observed around 10am (UTC-4) on Jul 17th

Red points: locations where blooms were observed around 10am (UTC-4) on Jul 20th

Yellow points: locations where blooms were observed around 10am (UTC-4) on Jul 24th

Applications

Freshwater release from Lake O to Caloosahatchee River Estuary and St Lucie Estuary



Caloosahatchee River at S-79, Nr.Olga, Fla -

02292900

February 12, 2024 - February 19, 2024

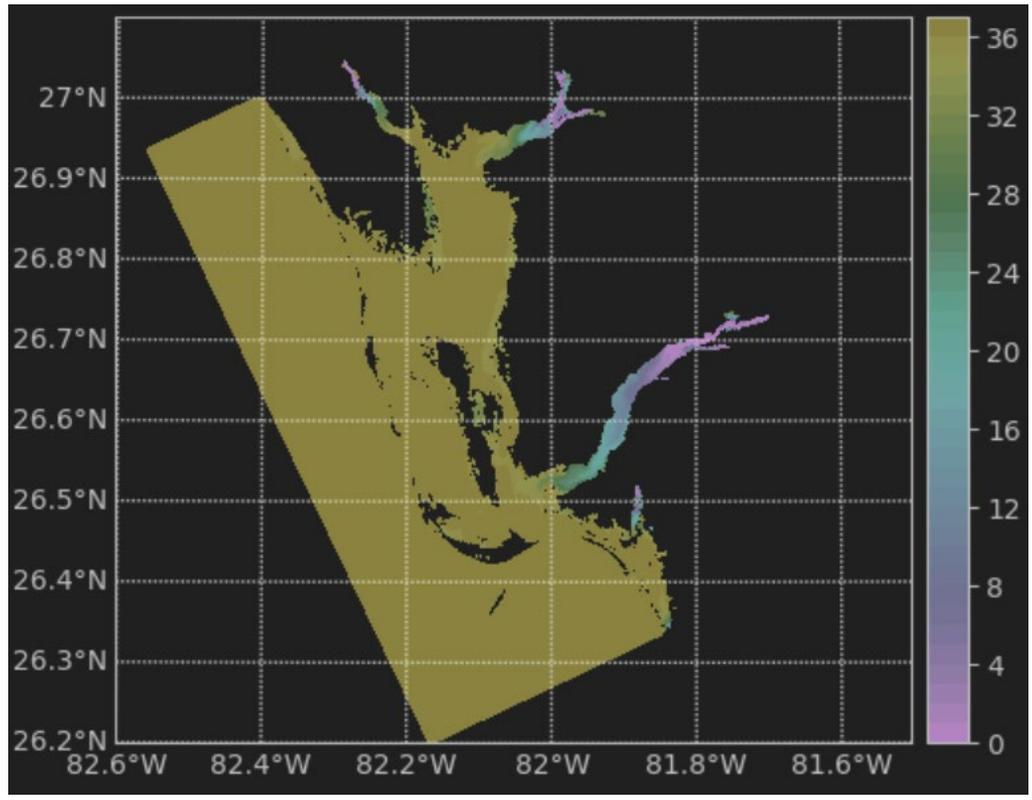
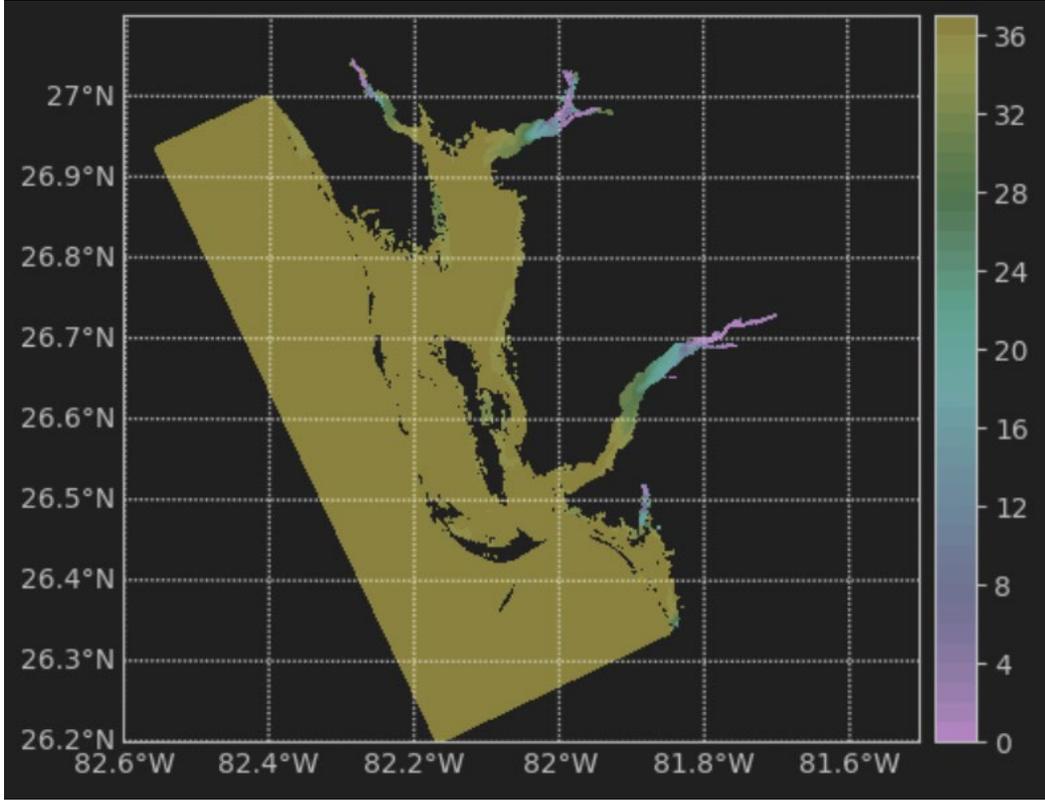
Discharge, cubic feet per second



RESULTS FROM THE 02-17-2024 Forecast

**SURFACE SALINITY NO RELEASE
02-22-2024 00:00 UTC**

**SURFACE SALINITY WITH RELEASE
02-22-2024 00:00 UTC**



Summary and conclusions

- **Estuarine models have been successfully verified for water levels, temperatures and salinities and provide with 5-day forecasts of water levels, water temperature, salinity and residence times.** We are in the process of verifying forecasts and extending the forecast period to 10 days.
- **Preliminary applications of the forecasting system show its potential** to identify beneficial conditions for Lake O discharge across scenarios for both estuaries
- **We are adapting and coupling existing models** spanning from Lake Okeechobee to the Caloosahatchee River Estuary and St Lucie Estuary → assist with freshwater release decision making.

Acknowledgements

- **Army Corps of Engineers**
- **Sanibel Captiva Conservation Foundation**, Eric Milbrandt
- **South Florida Water Management District**
- **Project collaborators** Mauricio E. Arias , Cassondra R. Armstrong , Natalie Nelson, Paloma Carton de Grammont , Thomas Frankovich , Wendy D. Graham, Lisa S. Krinsky , Elise Morrison , Robert Scharping , Shin-Ah Lee , Hung Q. Nguyen, Edward J. Philips, Sajad Soleymani Hasani¹, Osama M. Tarabih , Darlene Saindon Velez , Barbara Welch², Qiong Zhang ...
- **COAWST, ROMS and ROMSPath developers**
- **NOAA**

Thanks for your attention!