

# Development of a pre-operational forecast system for Mississippi Sound and Bight in the northern Gulf of Mexico

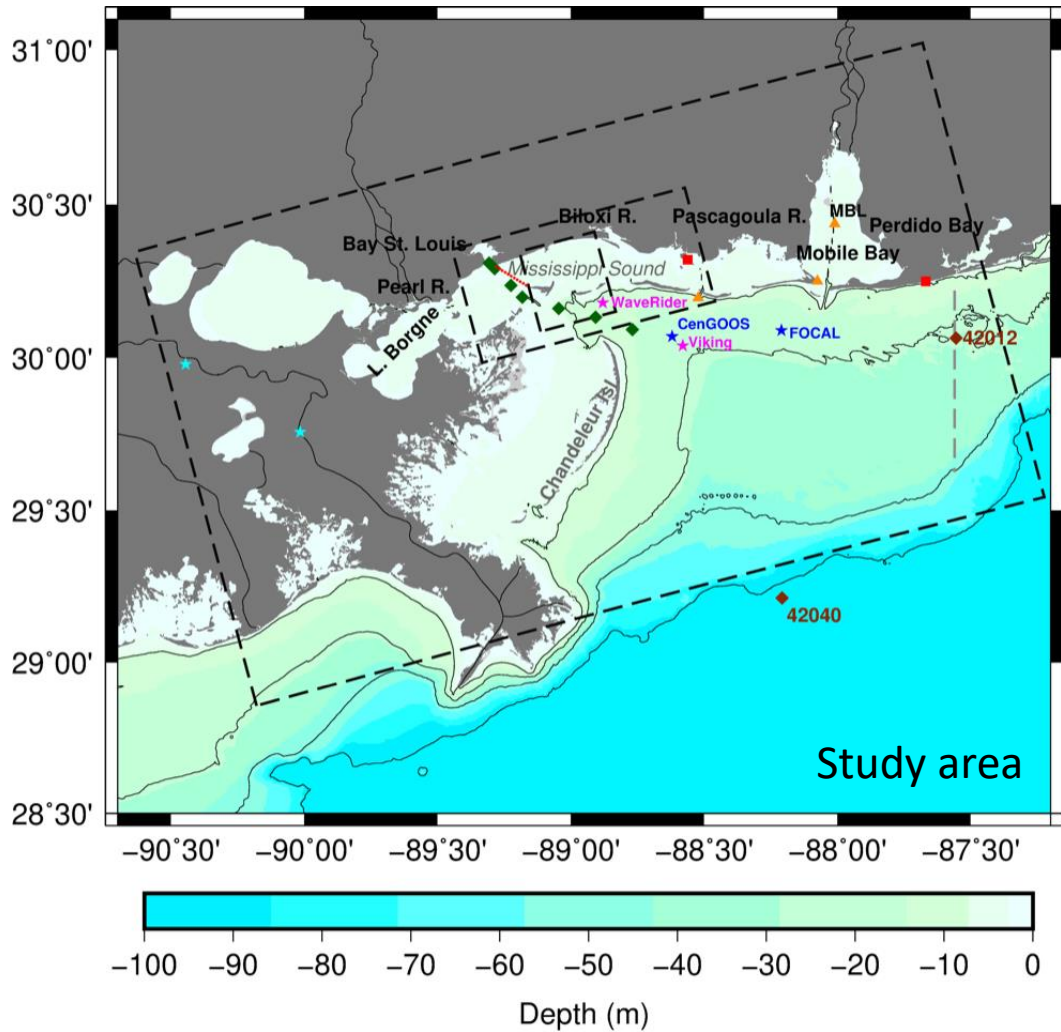
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*8th meeting of the COSS-TT: International Coordination Meeting  
Theme II: Coastal and Regional (pre-)operational ocean forecasting systems and applications  
April 12-13, 2022 - Online*

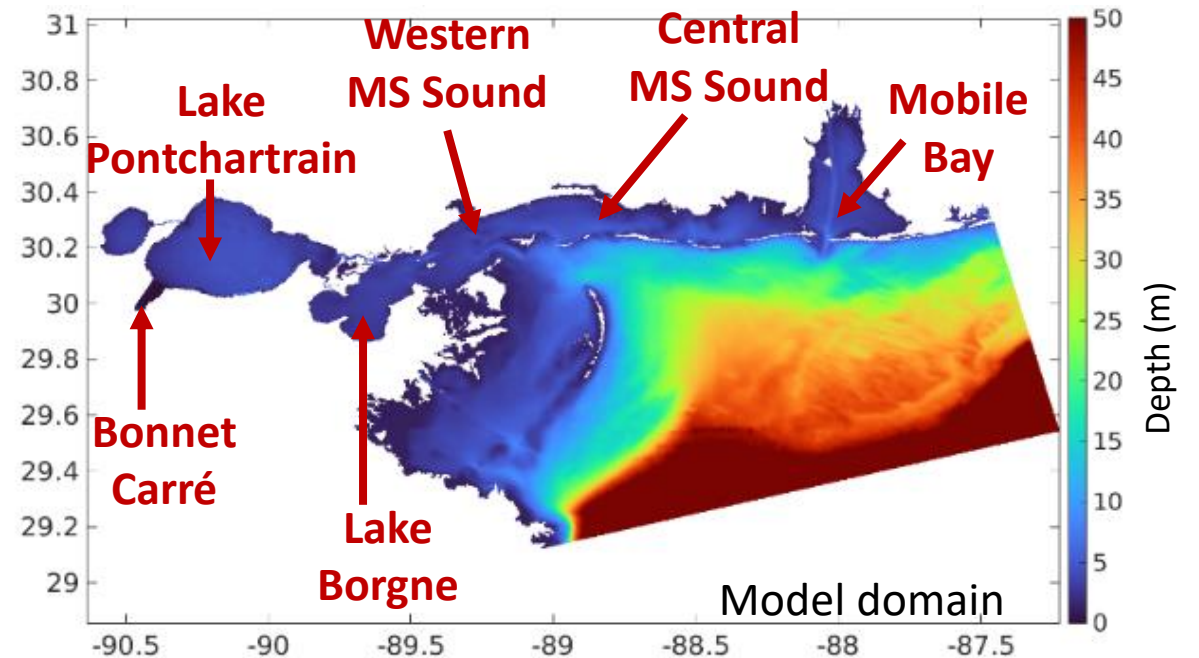


Model application developed during CONCORDE with a domain covering Louisiana, Mississippi and Alabama waters

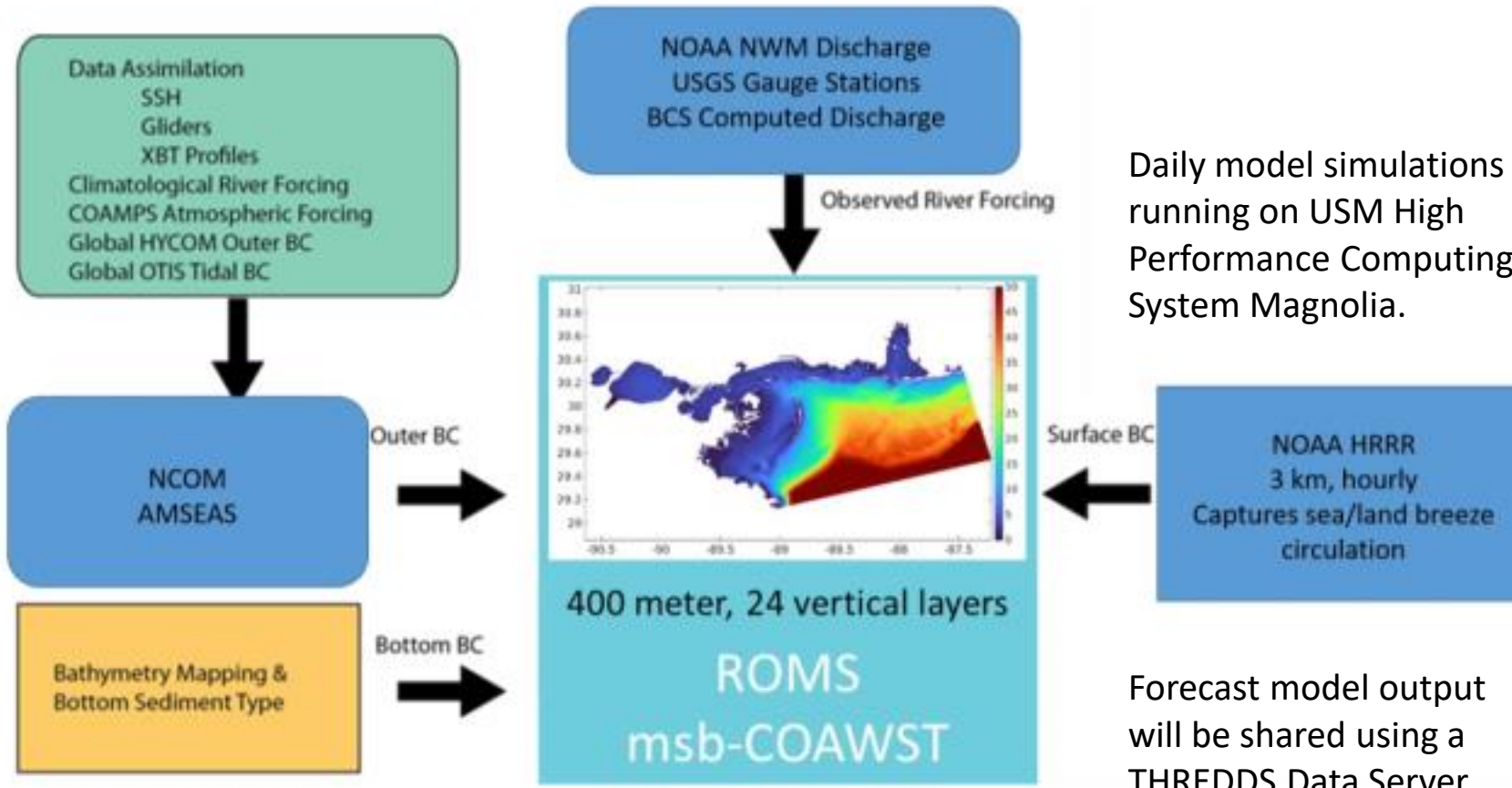
## Modeling + Field Measurements + Remote Sensing in Mississippi Bight:

- Ocean Color Data
- H/F Radar Measurements
- Autonomous Sampling
- Monitoring and Field Measurement Stations
- **Numerical Modeling**

Development of a COAWST application within Mississippi Bight using ROMS, WW3/SWAN, WRF, CSTM and BGC in a nested approach



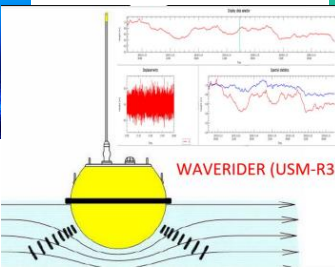
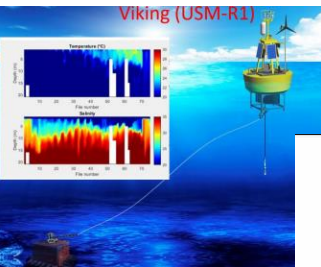
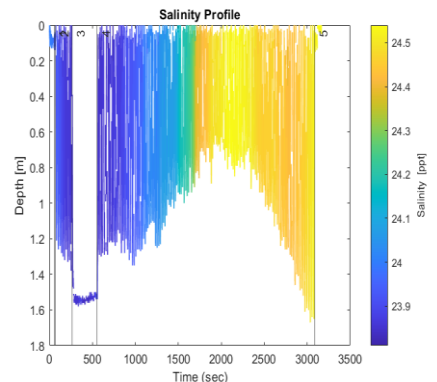
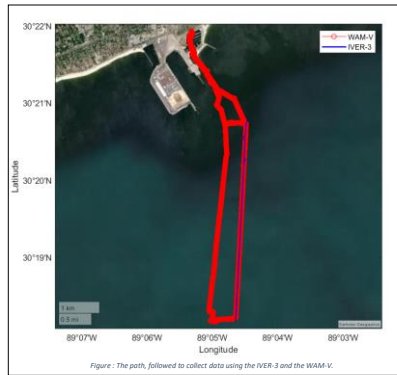
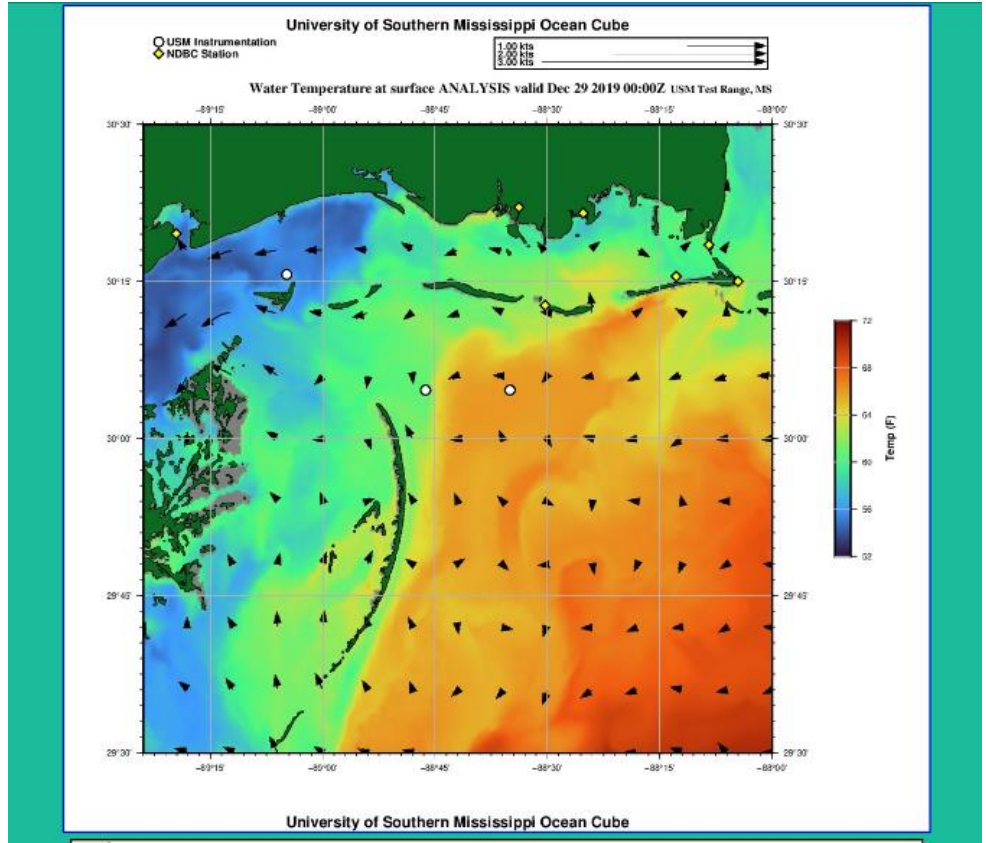
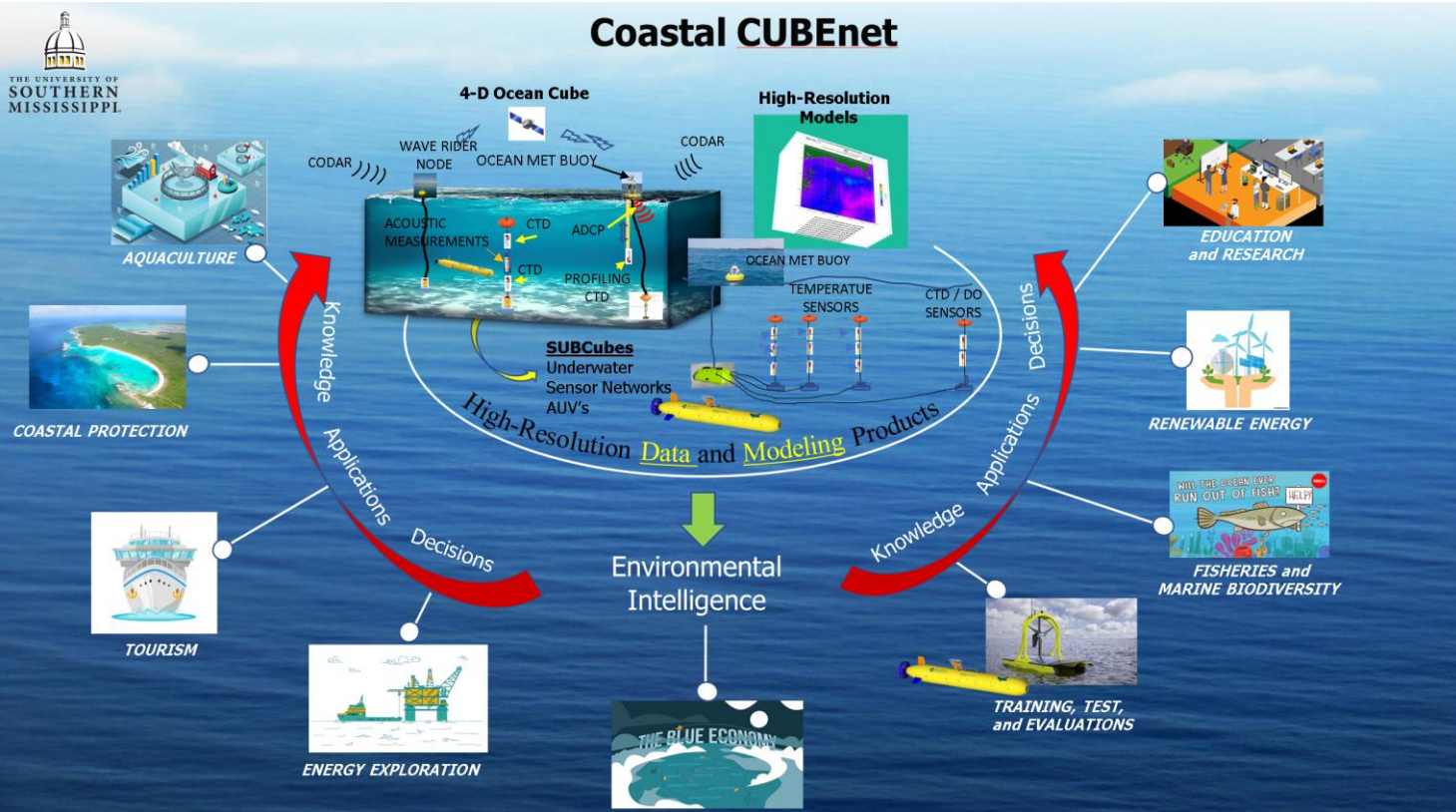
Model domain



- Daily river forcing from USGS-gages for near-real time hindcast (last 24 hrs)
- Hourly river forcing from National Water Model forecasts for pre-operational forecast model (24-hr forecast)
- Open Boundary Conditions from NCOM-AMSEAS (3-hrly, 1/30°) for temperature, salinity, velocities and sea surface height
- Surface atmospheric forcing from NOAA-HRRR (WRF) (hourly, 3-km resolution)
- Hourly model output

Our modeling system can be applied to study:

- Onset / Duration of coastal hypoxia and its impact on marine ecosystem / fisheries
- Impact of flooding / river diversions on oyster reef habitat
- Effects of coastal restoration projects on sediment budgets that have implications for shipping channel maintenance
- Coastal / estuarine transport pathways, and shoreline incursions, for particulate and dissolved material (e.g., pollutants)
- Adaptive sampling during scientific research cruises



Reference Point:	USMWR	HRSN	WYCM6	USMR1	PTBM6	FINLM6	GDXM6	CRTA1	DPIAL	KATA1
Speed(Knots):	0.07	0.46	nan	0.08	0.02	nan	nan	0.20	0.25	0.30
Temperature(F):	60.73	56.38	nan	66.04	62.50	nan	nan	60.53	61.11	59.87
Salinity(PSU):	30.58	26.09	nan	34.02	30.11	nan	nan	0.00	18.68	22.63
Surface Elevation(ft):	0.38	0.44	nan	0.39	0.51	nan	nan	0.45	0.39	0.48
Chlor a(mg/m <sup>-3</sup> ):	3.70	nan	nan	nan	nan	nan	nan	nan	nan	nan
Depth(ft):	44.5	17.2	2.6	63.7	-3.6	1.6	1.7	5.1	-2.0	9.7

Animation Settings		
Select	Controls	
Parameter: Temperature(F)	Depth (ft): 0	Speed: Slower / Faster
		Dwell First Frame: Shorter / Longer
		Dwell Last Frame: Shorter / Longer
Loop Mode: Once / Repeat / Step		

# Application example: Bonnet Carré Spillway



Bonnet Carré Spillway is the last flood defense structure on MS River diverting Mississippi River waters into Lake Pontchartrain at a capacity of 250000 cfs.

Spillway opened 3 years consecutively in 2018, 2019 and 2020. The 2019 double spillway opening was unprecedented in length and total discharge resulting in toxic algal blooms and 100% mortality of Mississippi Sound shellfisheries at many locations.

Figures adapted from usace.army.mil.

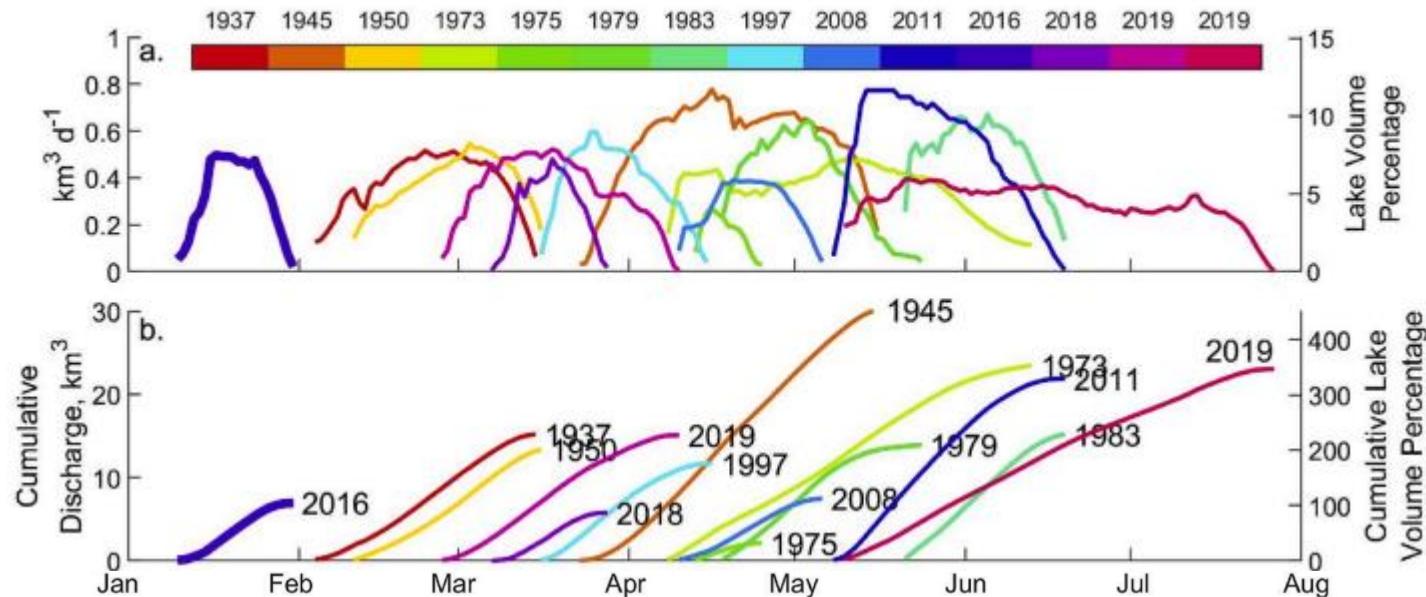


Figure adapted from Parra et al. (2020)

**2019 openings combined introduced the largest cumulative freshwater volume from the MS River.**

### Spillway opening impacts on:

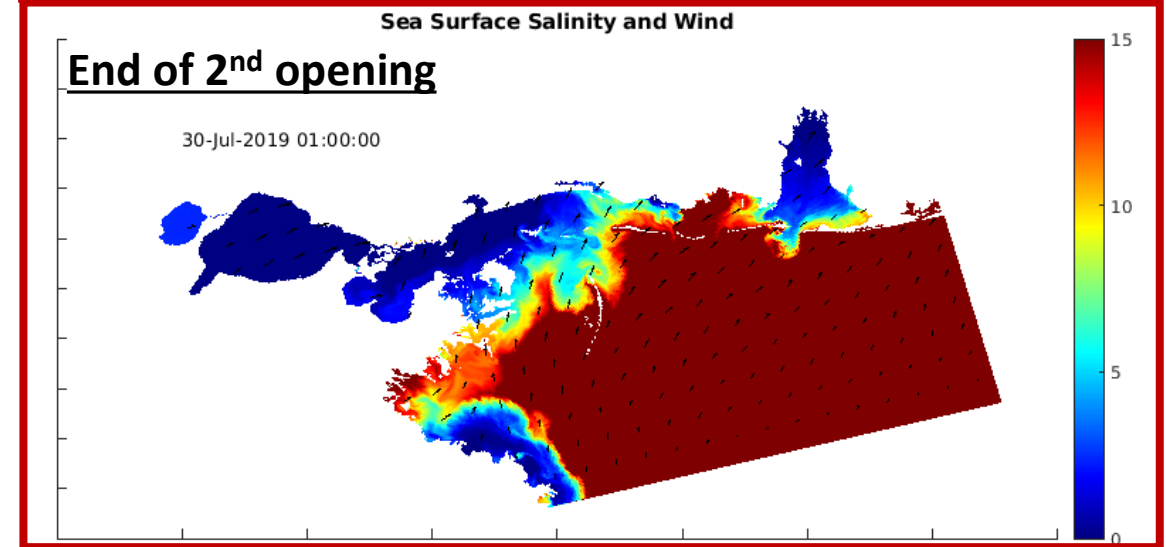
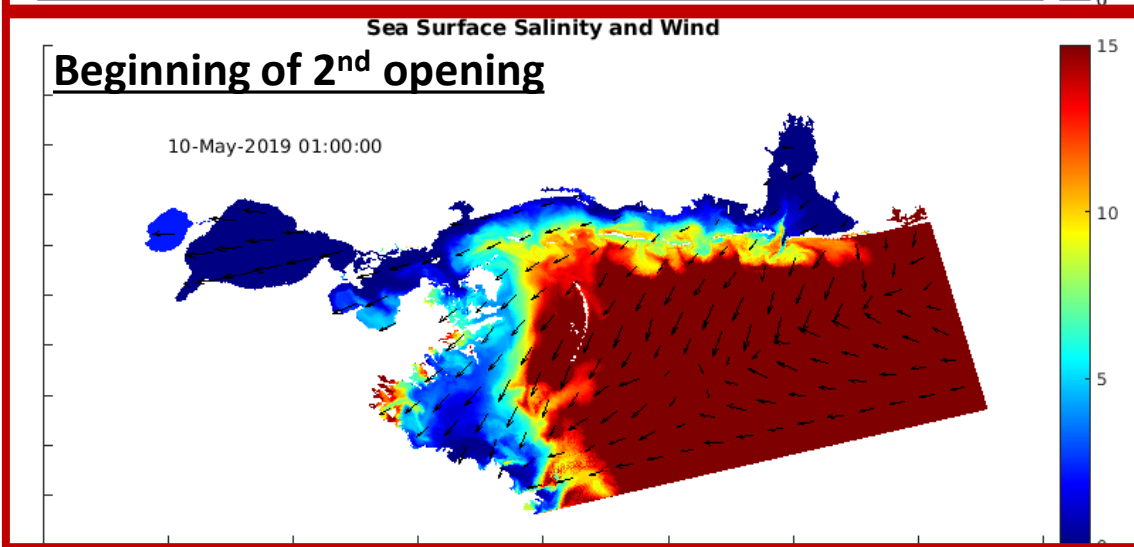
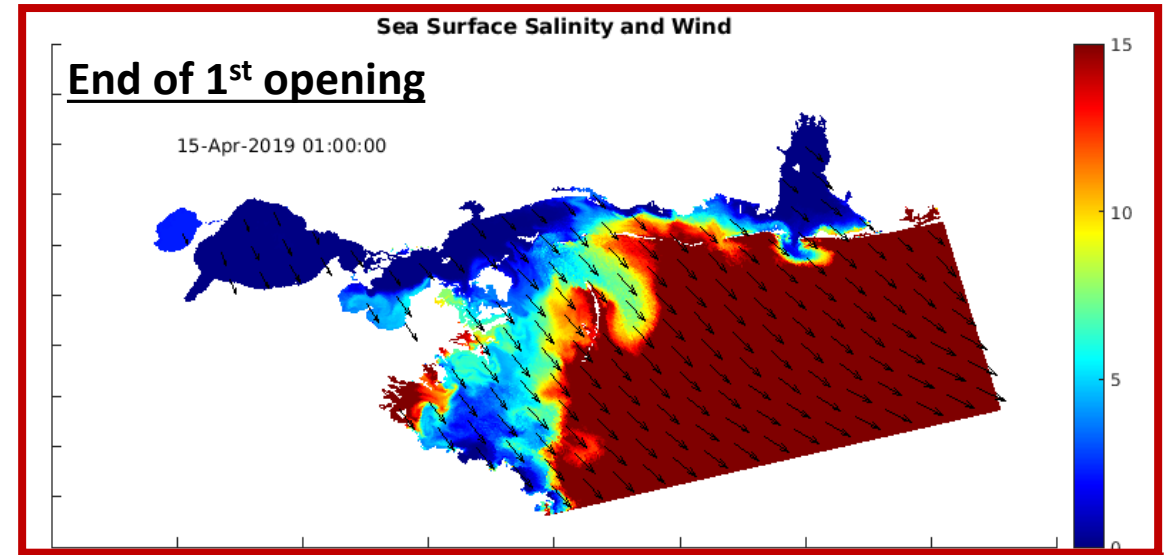
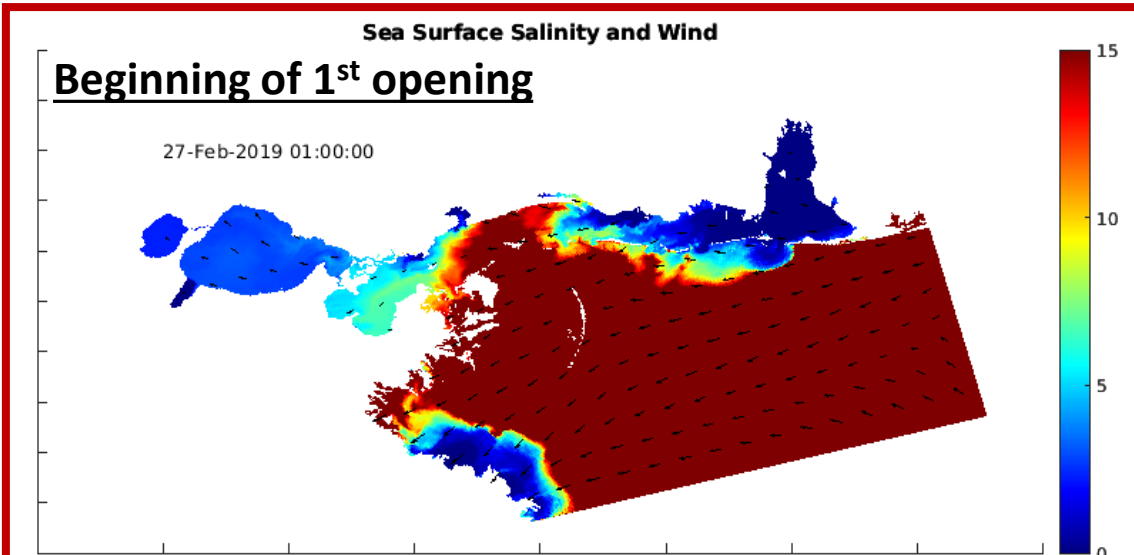
Water quality within the shallow estuarine systems; HAB formations; Onset of Hypoxia; Marine mammal mortalities; Beach closures; **Fisheries sustainability, specifically shellfisheries/oysters**

Understanding where diverted waters and rivers flow to and why is imperative for managing marine ecosystems.



## Forecasting impacts of Bonnet Carré Spillway

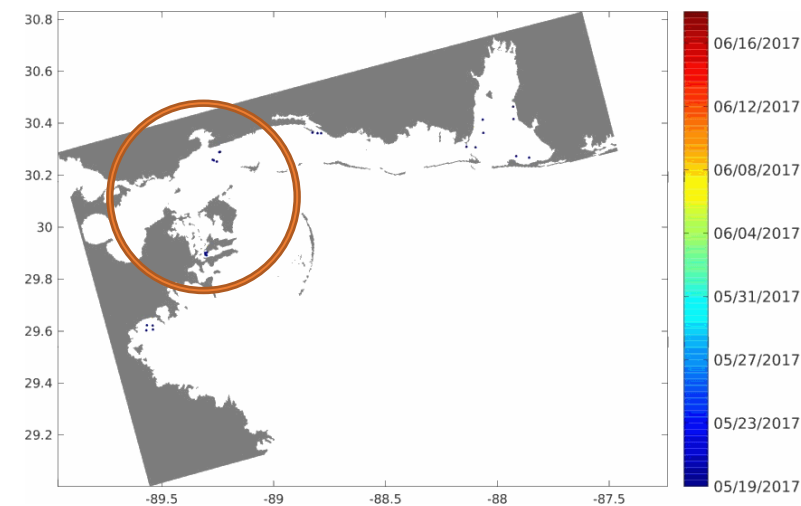
Back-to-Back Openings of Bonnet Carré Spillway in 2019 : 1<sup>st</sup> opening: February 27 to April 11 ; 2<sup>nd</sup> opening: May 10 to July 27  
Mississippi Sound did not have enough time to bounce back because of the limited time duration in between both openings.  
Overall, The estuarine system remained under low salinity pressure for about 5 months (March 2019 to August 2019).



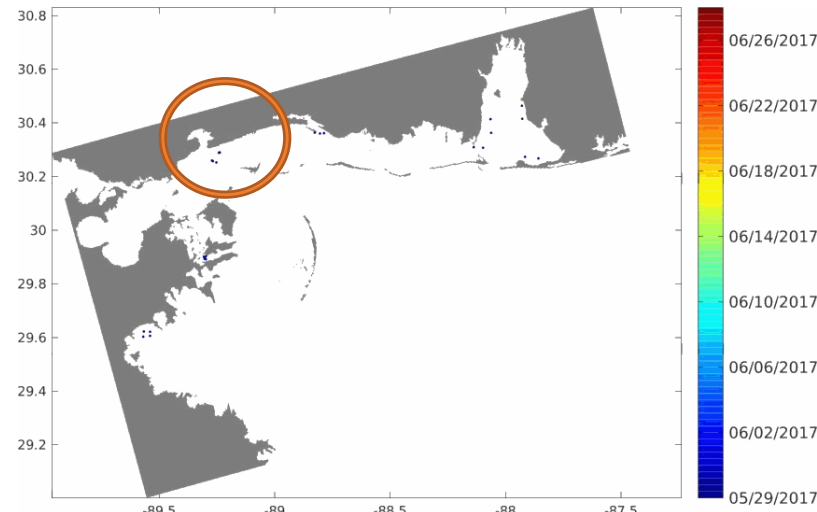
Oyster larvae are tracked as the model simulation is conducted. Drifters released from **known oyster spawning locations** (i.e. reefs in MS, AL, LA waters) and **tracked for 30-days, moving horizontally and vertically** at the model time step. We observe;

- interaction between reefs located in inter-state waters indicating the **connectivity of reefs**. (a & c)
- **self-seeding of reefs** in Western Mississippi Sound is also observed. (b)

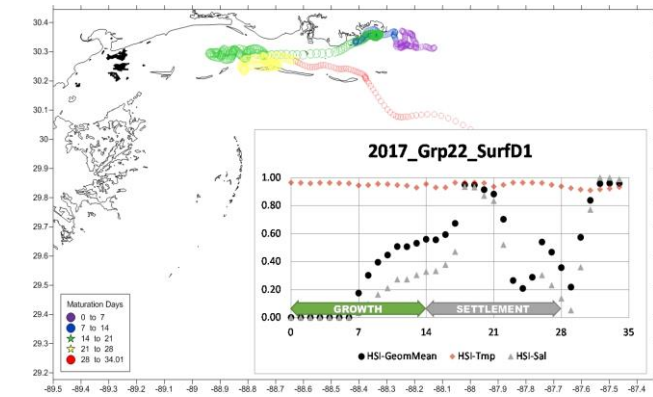
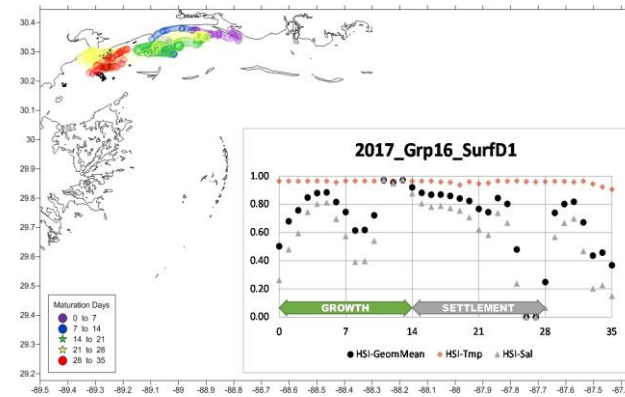
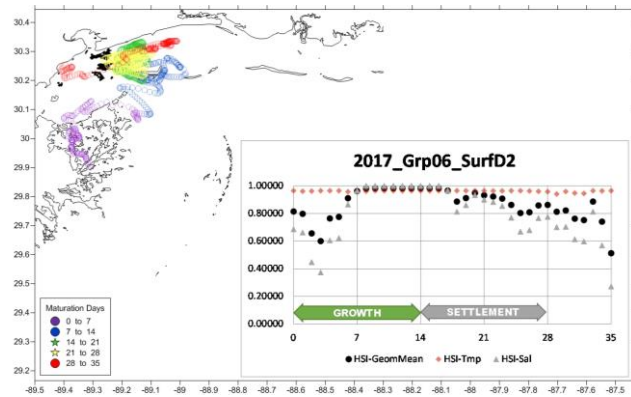
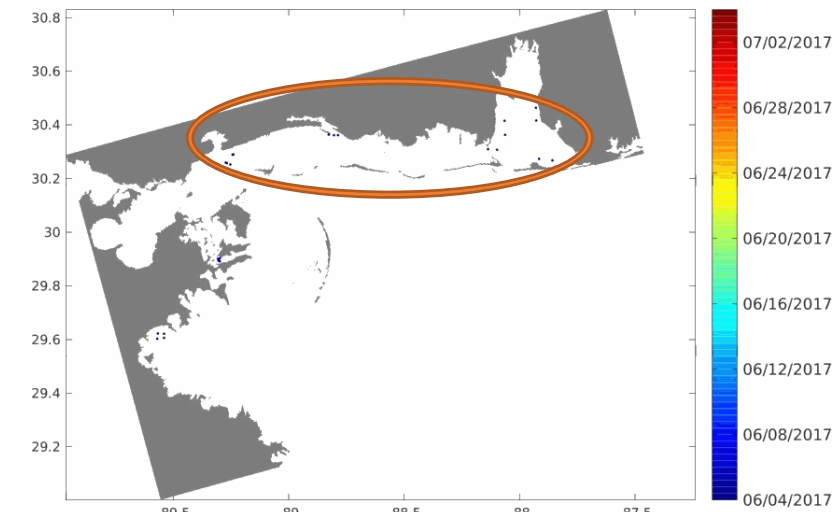
(a)



(b)



(c)



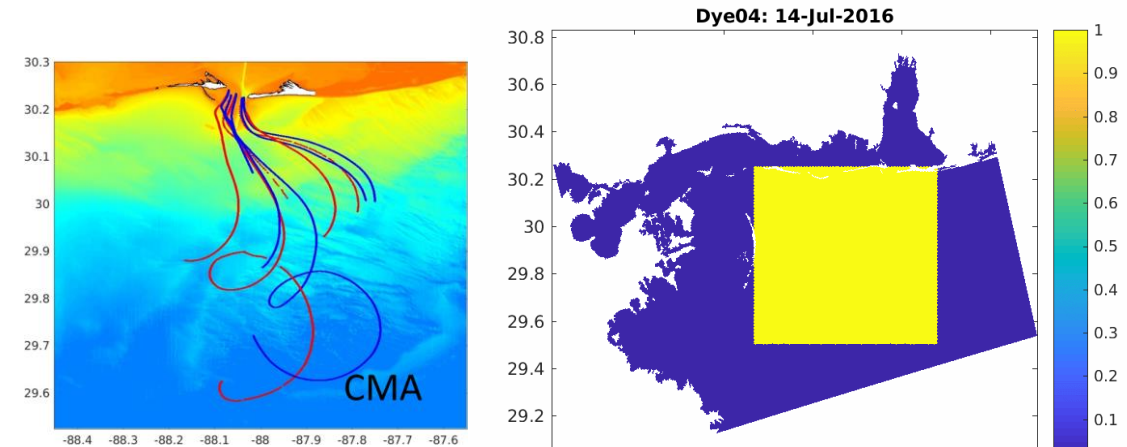
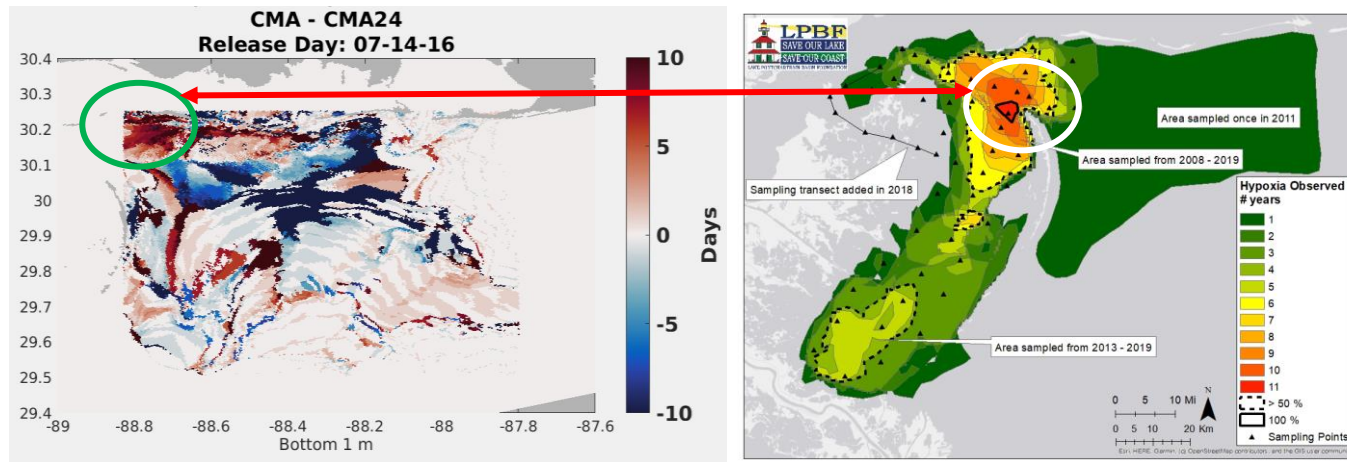
# Estuarine-shelf exchange and onset of hypoxia

**Diurnal Sea Breeze** Captured in atmospheric forcing has demonstrable impacts on:

- **Estuarine plume dynamics**
- **Estuarine - inner shelf planktonic exchange**
- Inner shelf flushing times

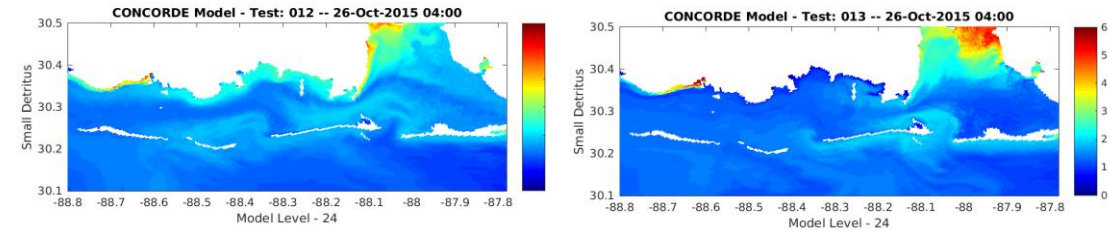
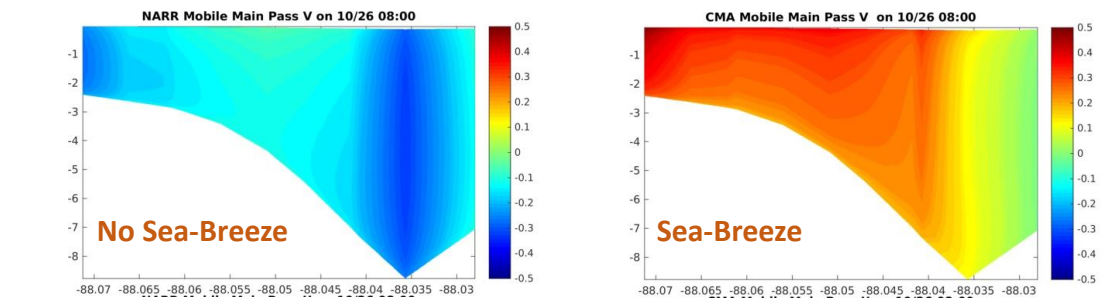
**Implications for hypoxia onset / evolution**

High resolution surface boundary conditions enable the model to better represent local circulation, connectivity, residence times and material exchange between the Mississippi Sound and Bight.



Modeling efforts are needed to further understand the biophysical interconnections that contribute to the development of hypoxia.

Circulation studies can reveal how flushing times could play a part in the onset / persistence of summertime hypoxia, DO distribution, and submarine groundwater discharge redistribution patterns and time scales.







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THANK YOU!

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