LSU College of the Coast & Environment

Understanding and Quantifying Carbon Export to Coastal Oceans through Deltaic Systems

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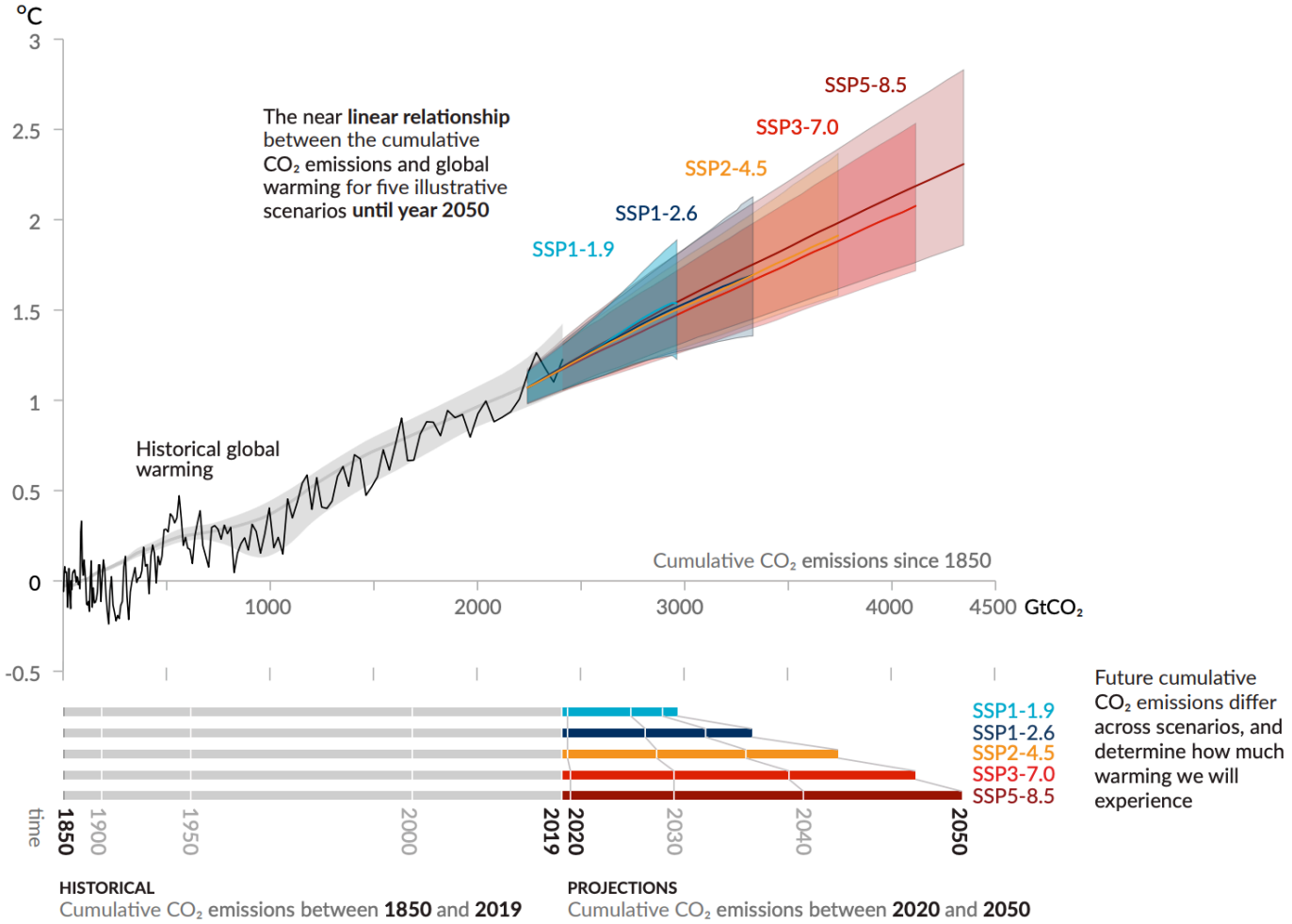
LSU CENTER FOR COMPUTATION & TECHNOLOGY

NASA REGENTS

EPSCoR FY18 - BoR

Every tonne of CO_2 emissions adds to global warming

Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)

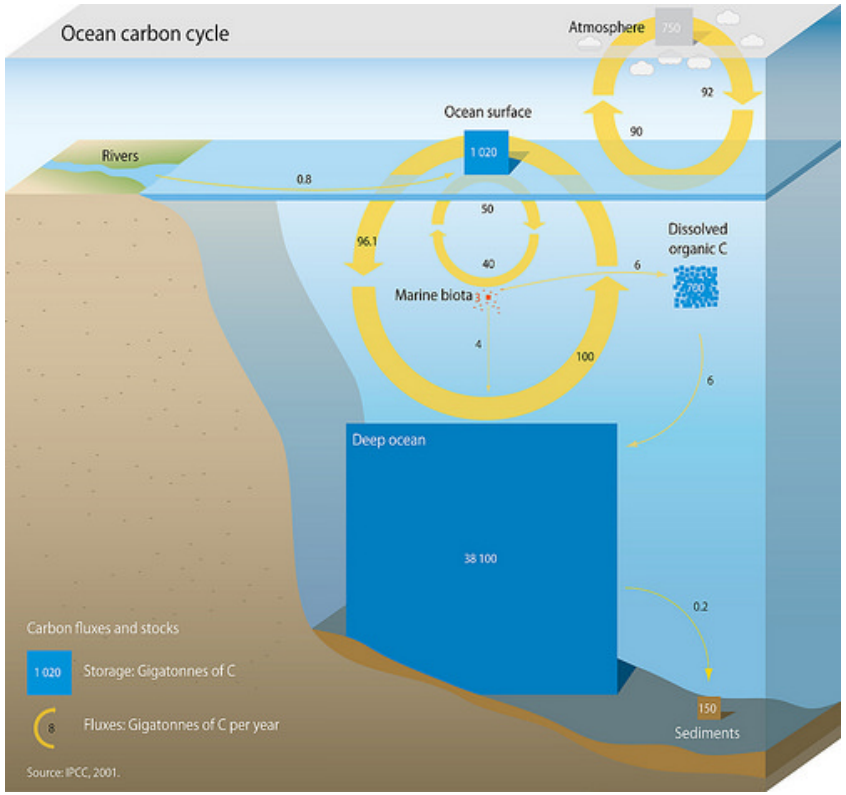


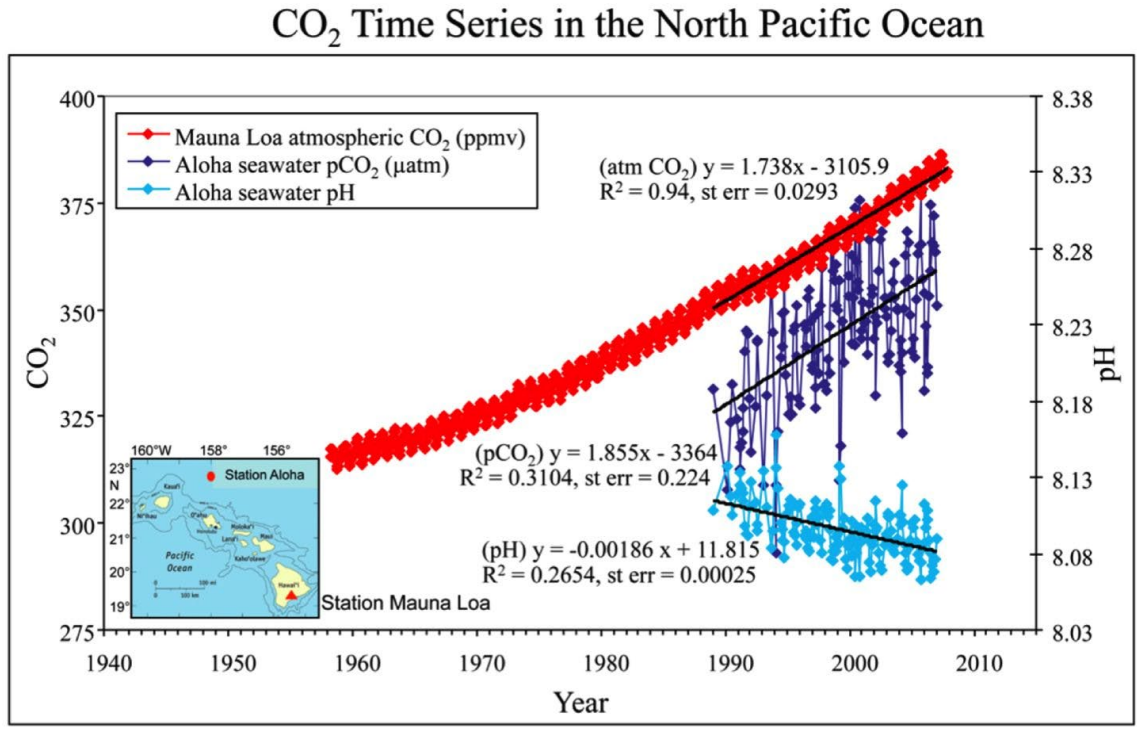
Future cumulative CO_2 emissions differ across scenarios, and determine how much warming we will experience

- IPCC AR6, 2021

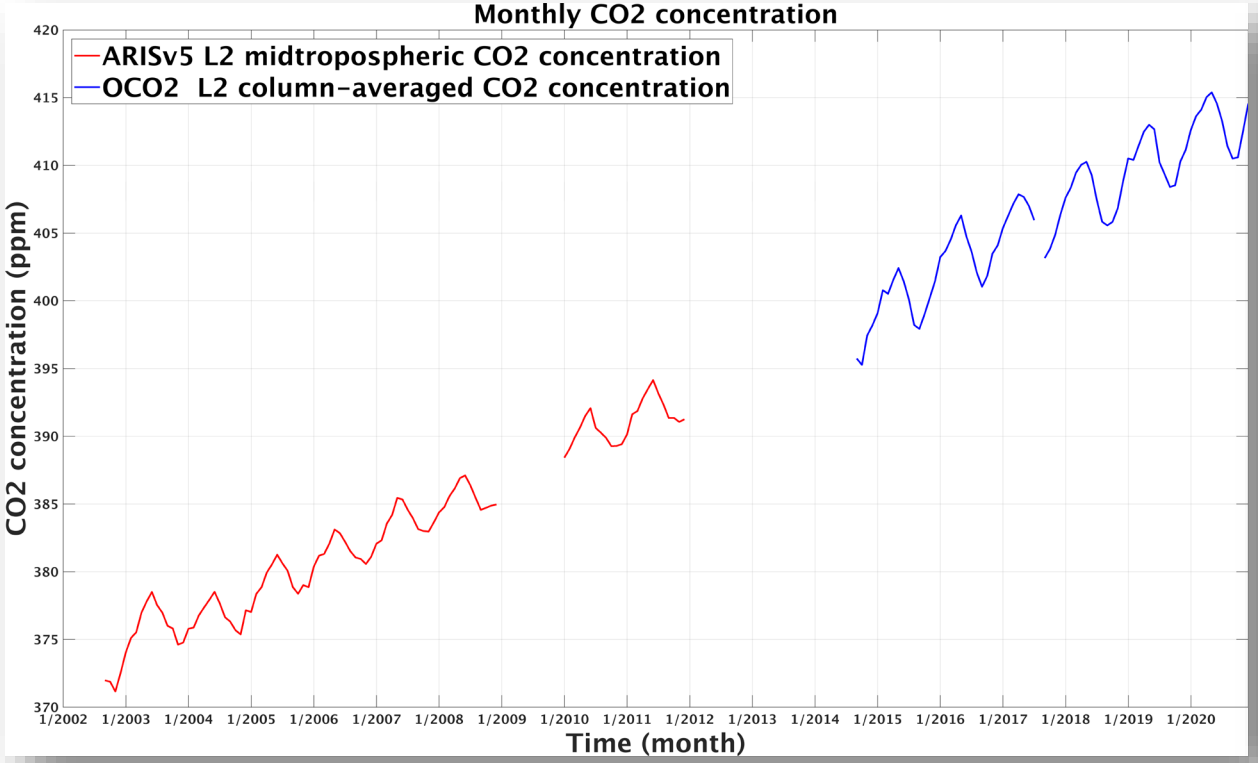
Ocean Acidification

- Ocean took up on average, **2.5 ± 0.6 Pg C yr^{-1}** or 23 ± 5% of the total anthropogenic CO_2 emissions over the decade 2009–2018

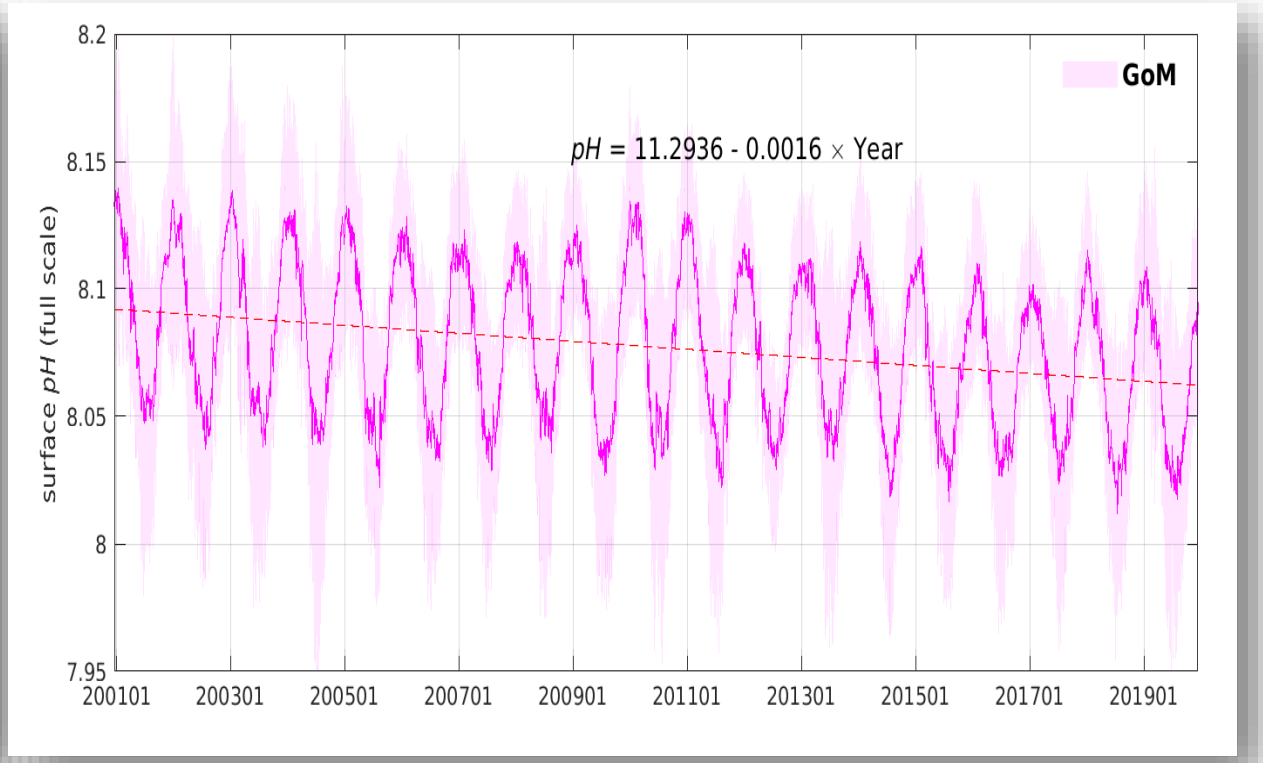




CO_2 in the Gulf of Mexico

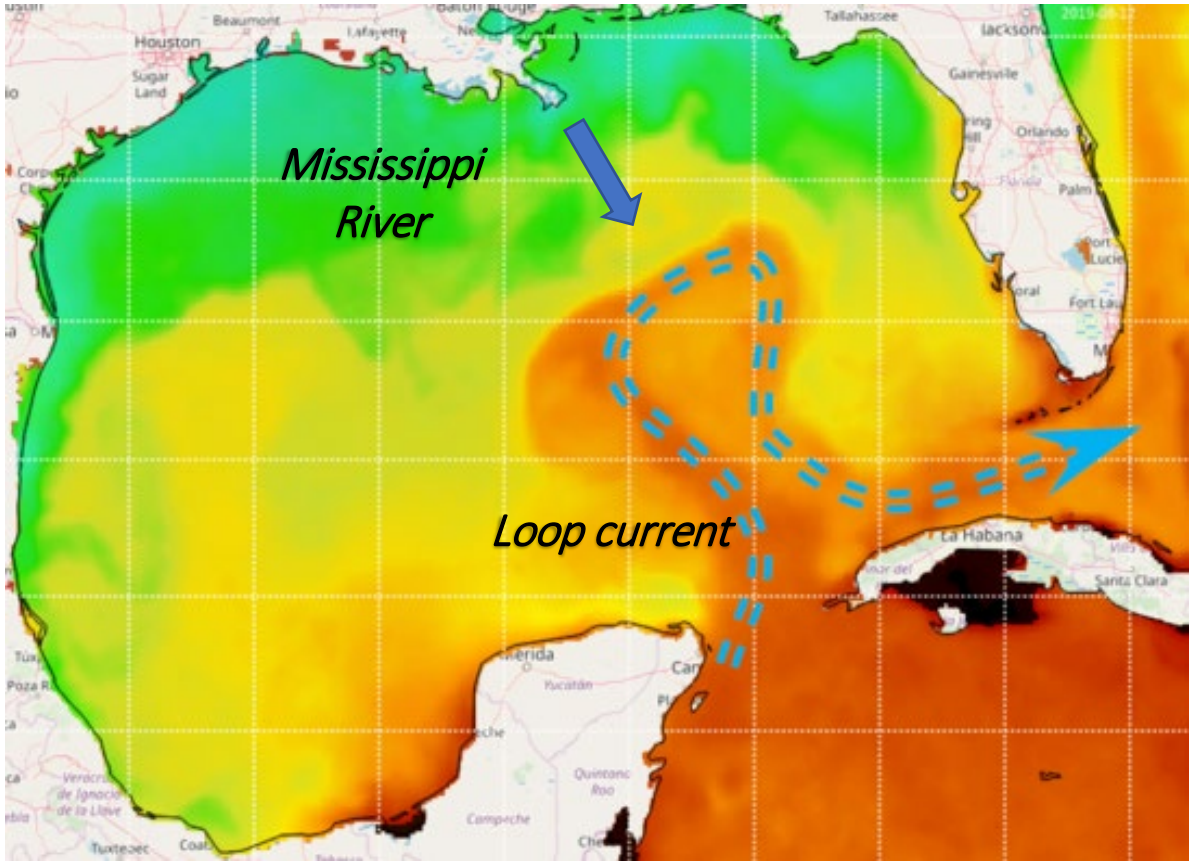


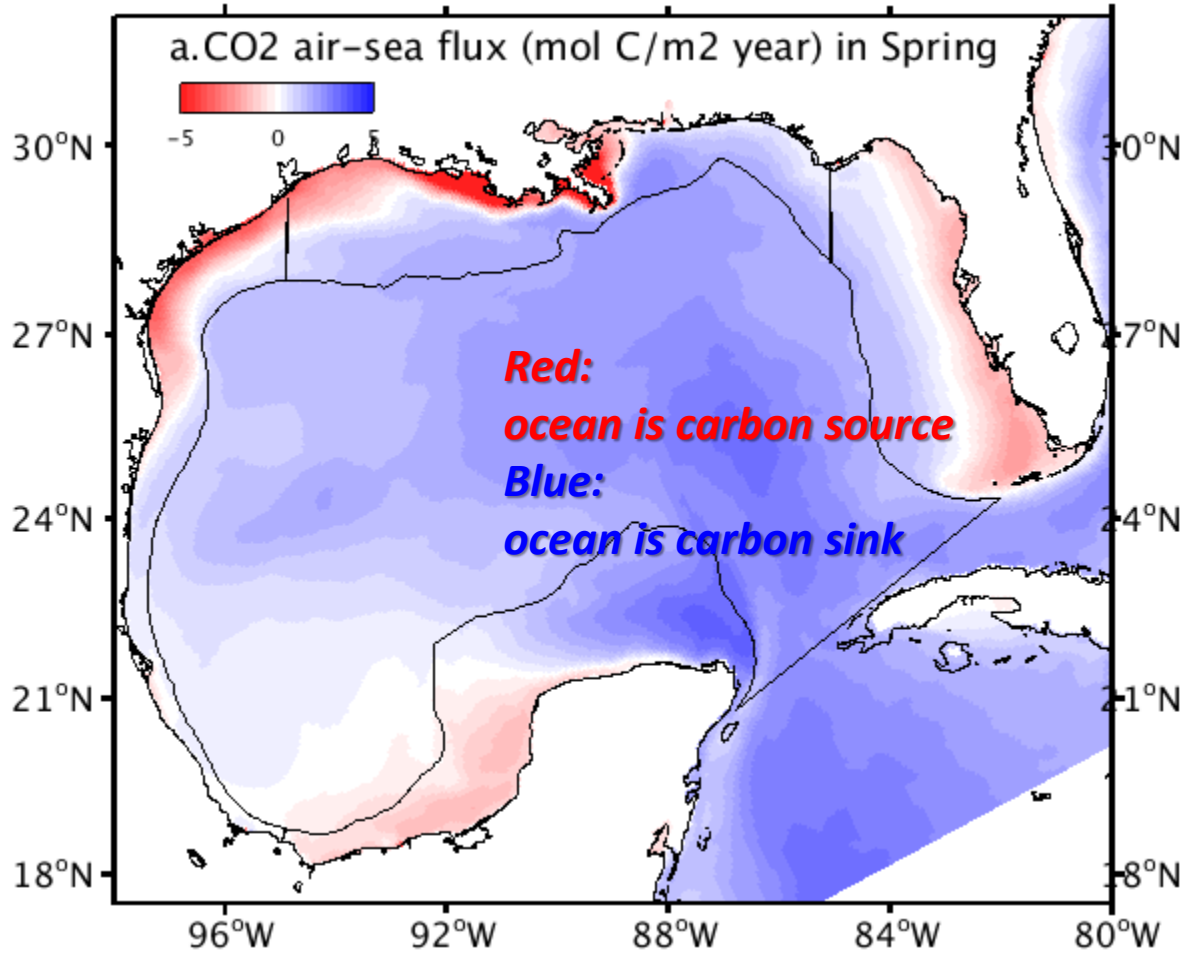
Satellite measured Air CO_2



Model simulated *pH* value in the Gulf of Mexico,
Zhang and Xue, in prep.

Gulf of Mexico Carbon Budget



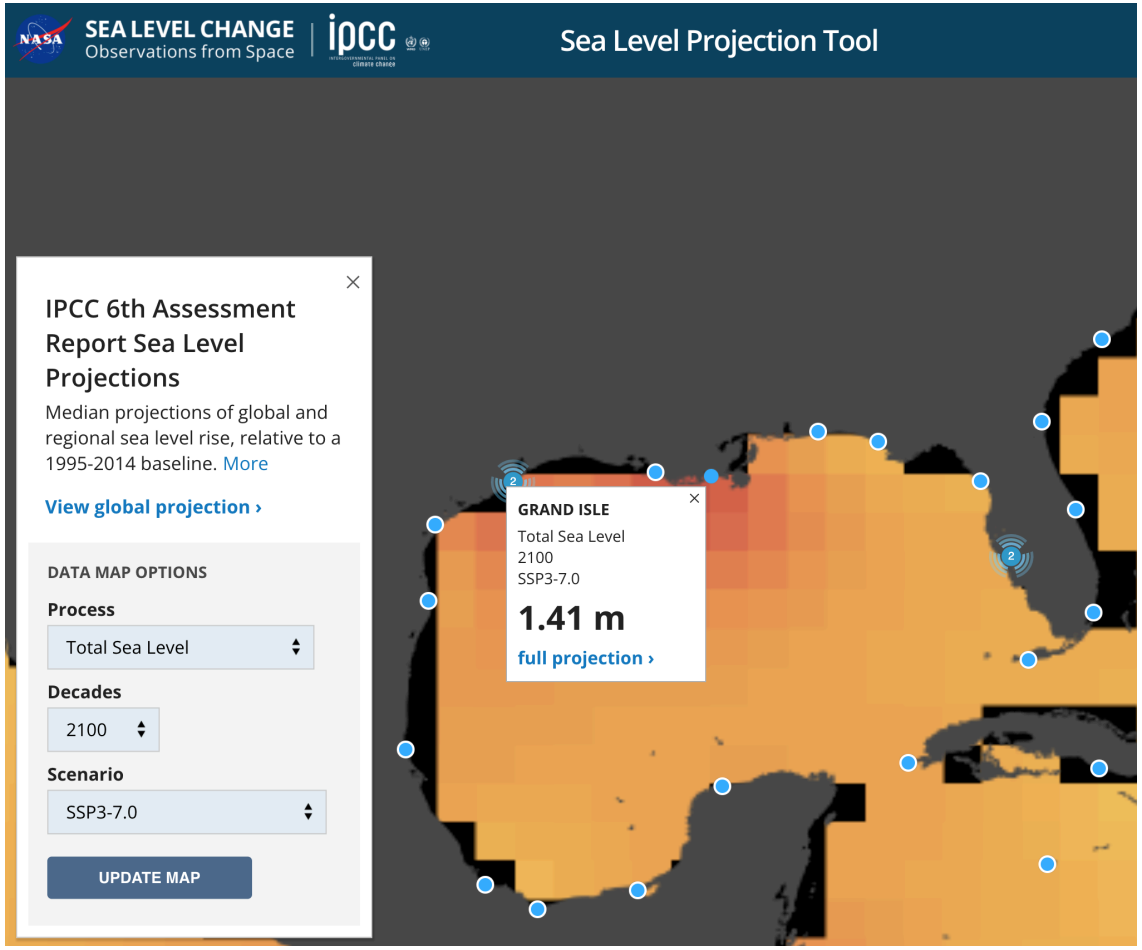


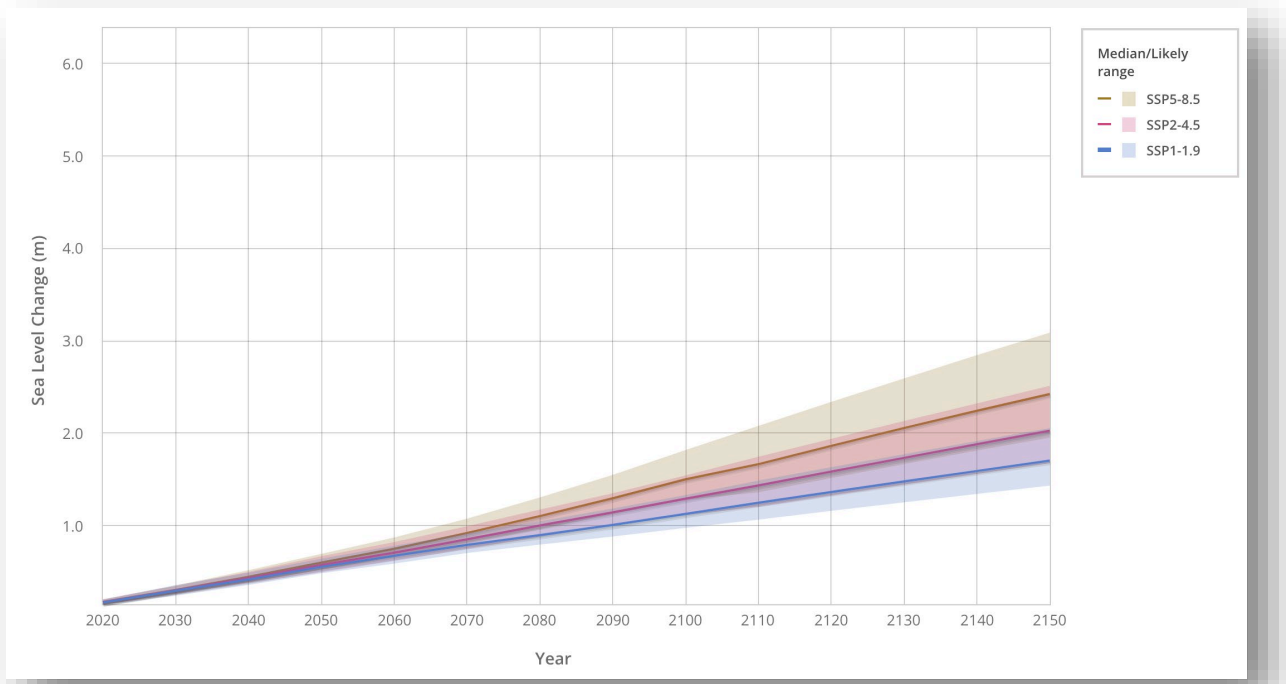
Carbon Budget: **Export (through Loop Current)** ≈ **CO2 influx** + **Riverine Input**

3.30×10^{12} mol C yr^{-1}, Wang et al., 2013 | 1.12×10^{12} mol C yr^{-1} | 2.18×10^{12} mol C yr^{-1}

Xue et al., 2016

• Sea Level Projection

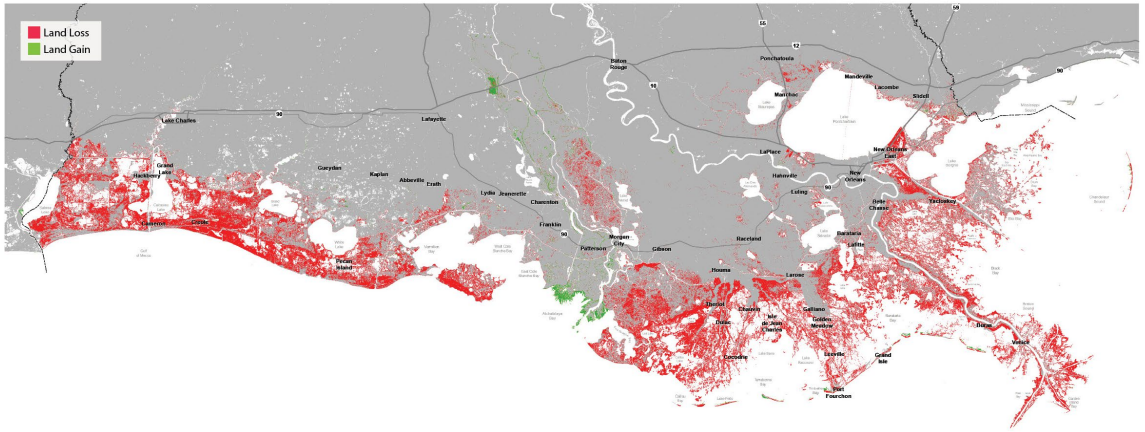


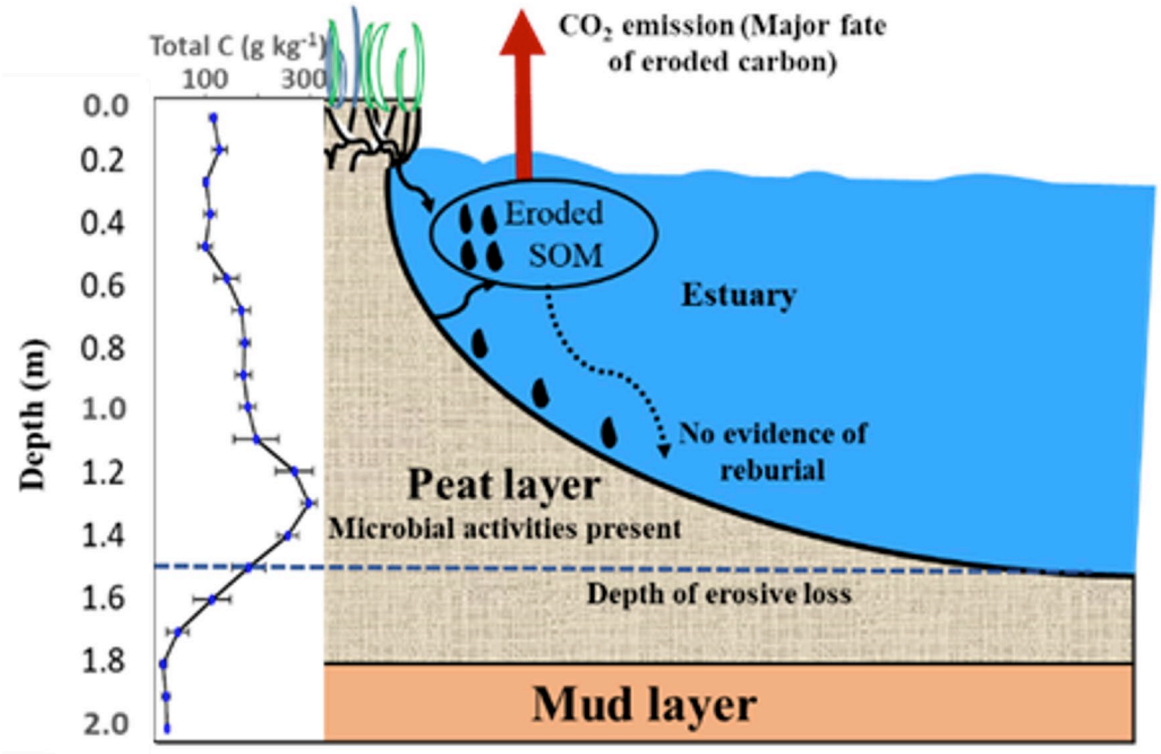


Louisiana land loss: one football field per hour

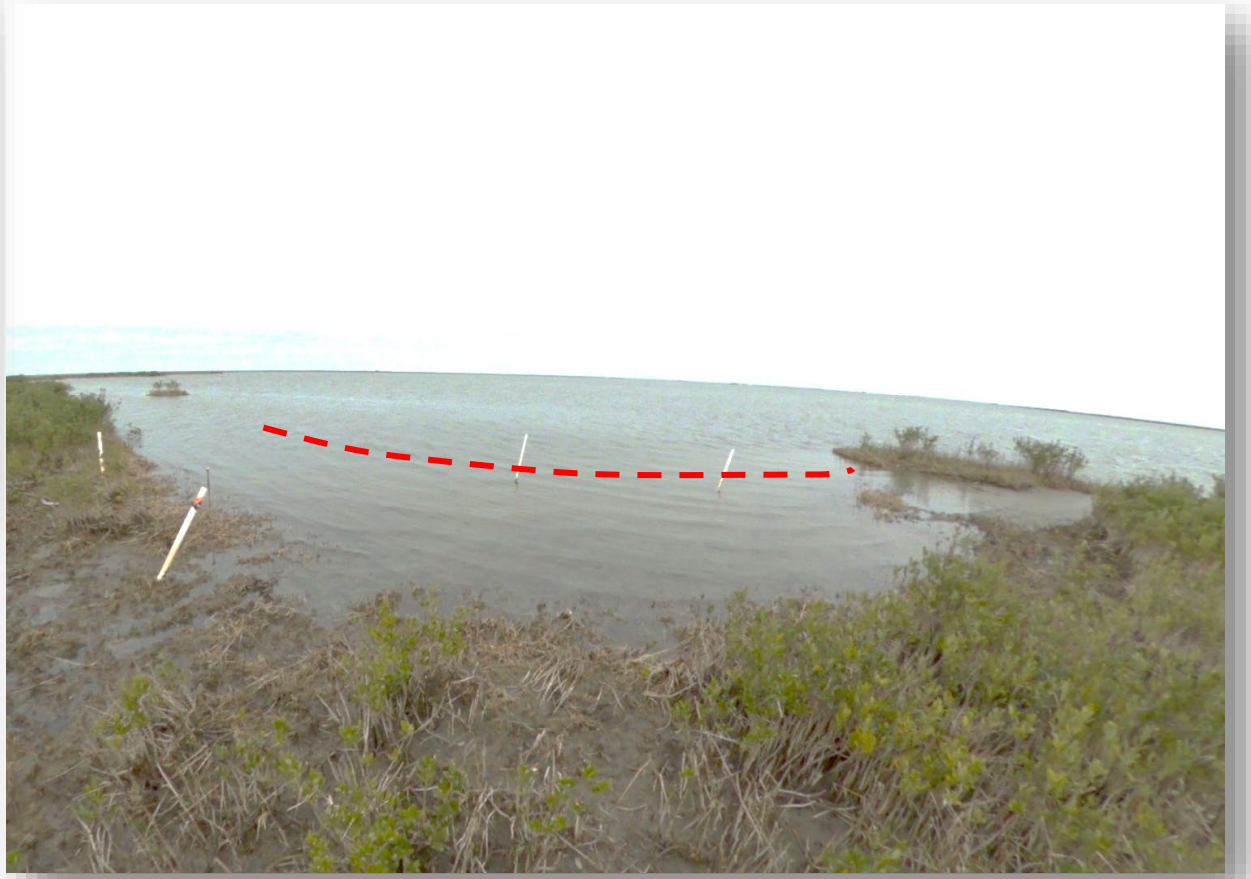
- **Average Louisiana peat soil contains 0.09 g C cm^{-3}**
- **Barataria Bay : 1.75 million ton of carbon to the ocean per year**

Predicted Land Change over the Next 50 Years





Struggling mangrove shrubs in the Barataria Bay



1.5 m retreat within four months after the cold snap in Feb 2020

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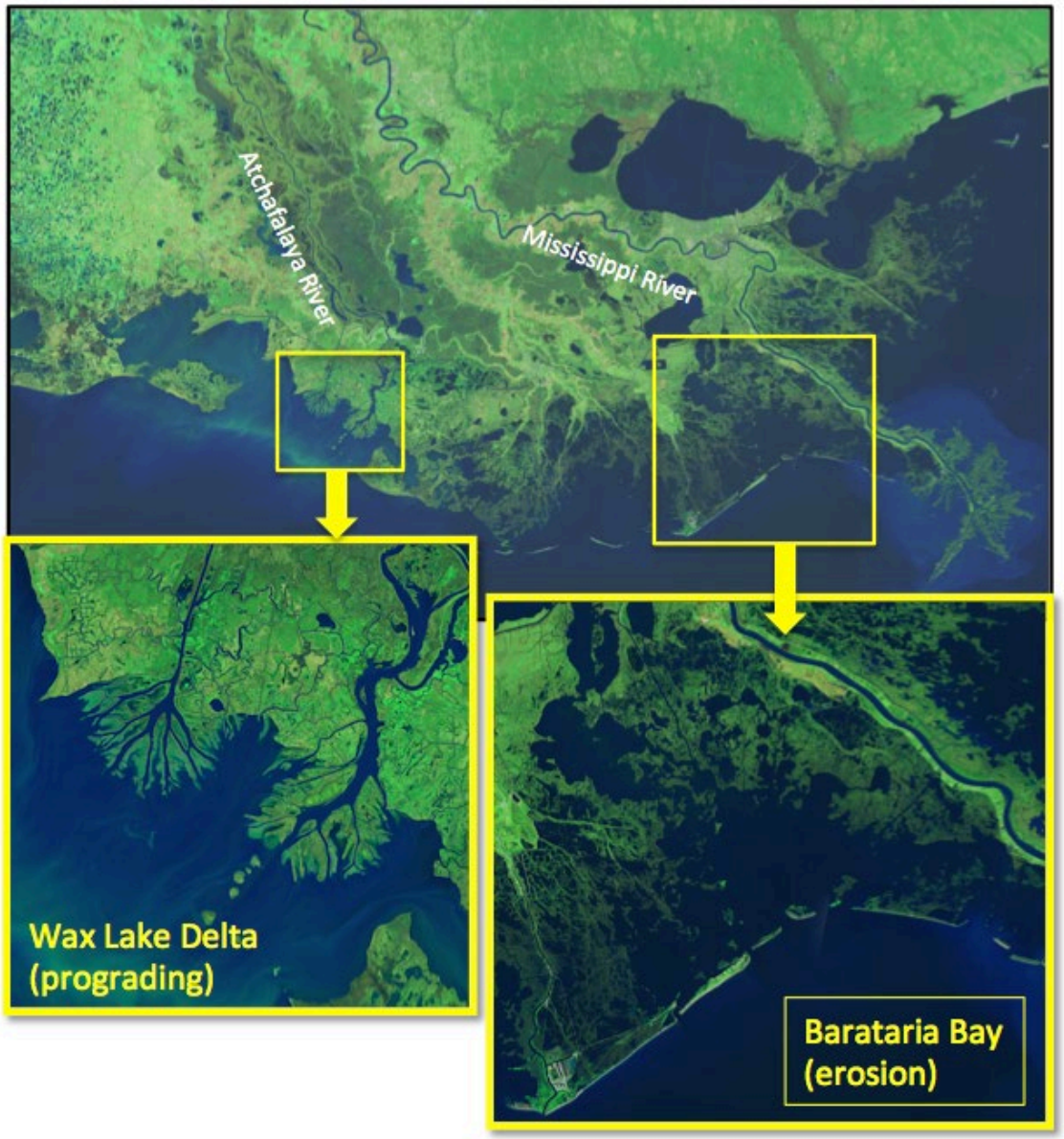
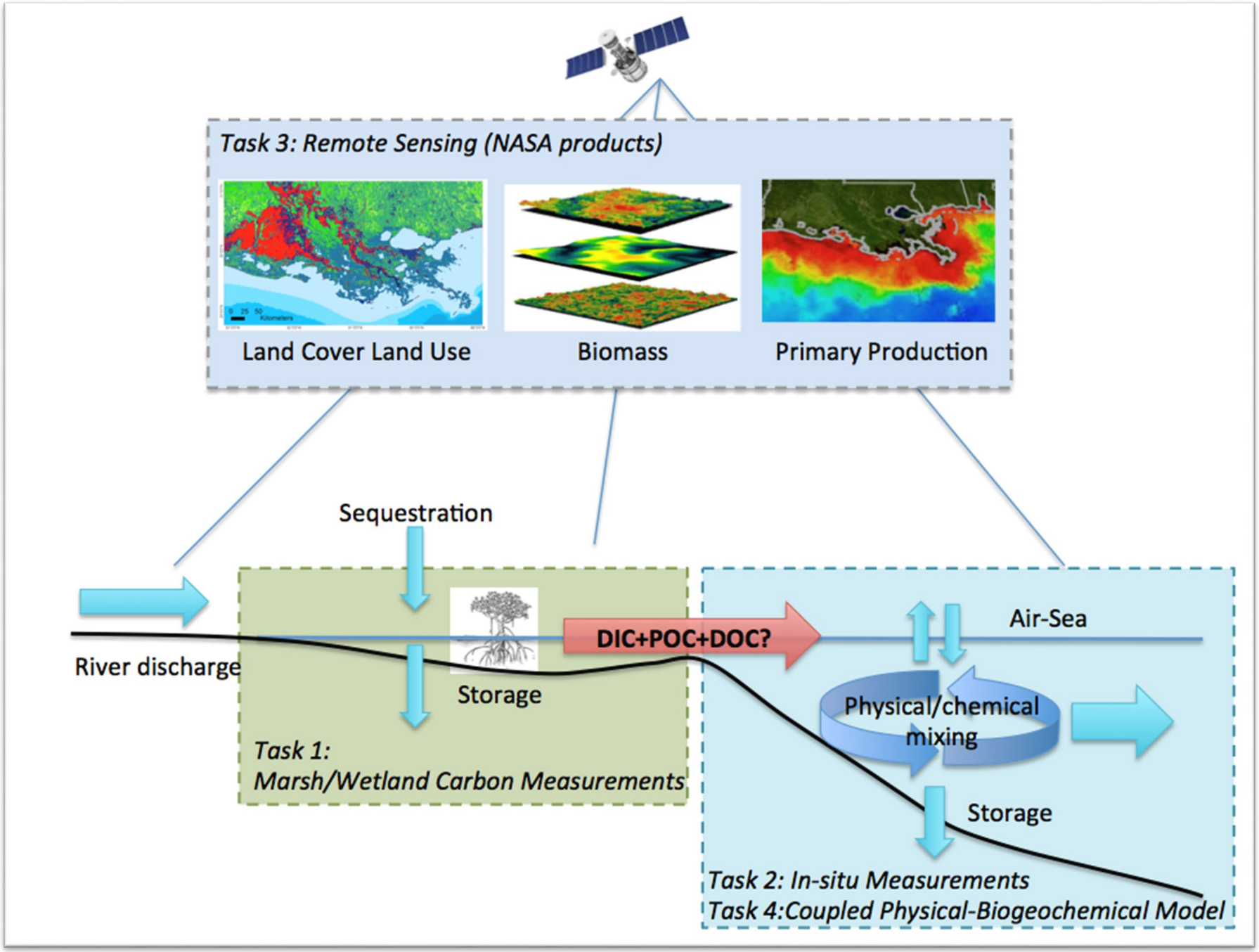
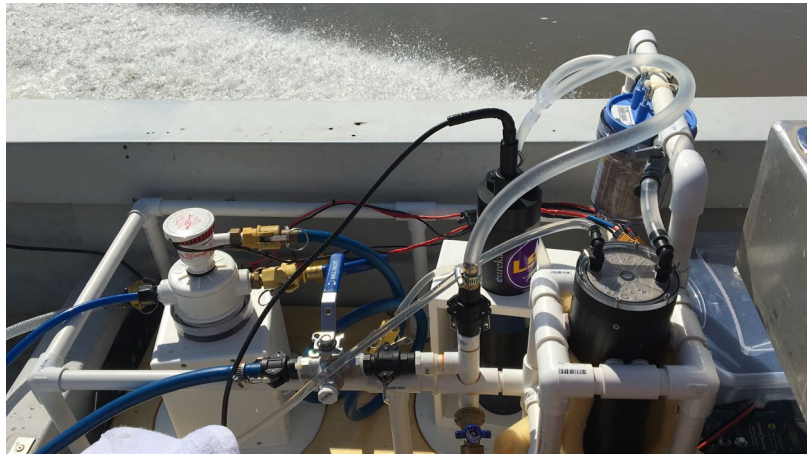
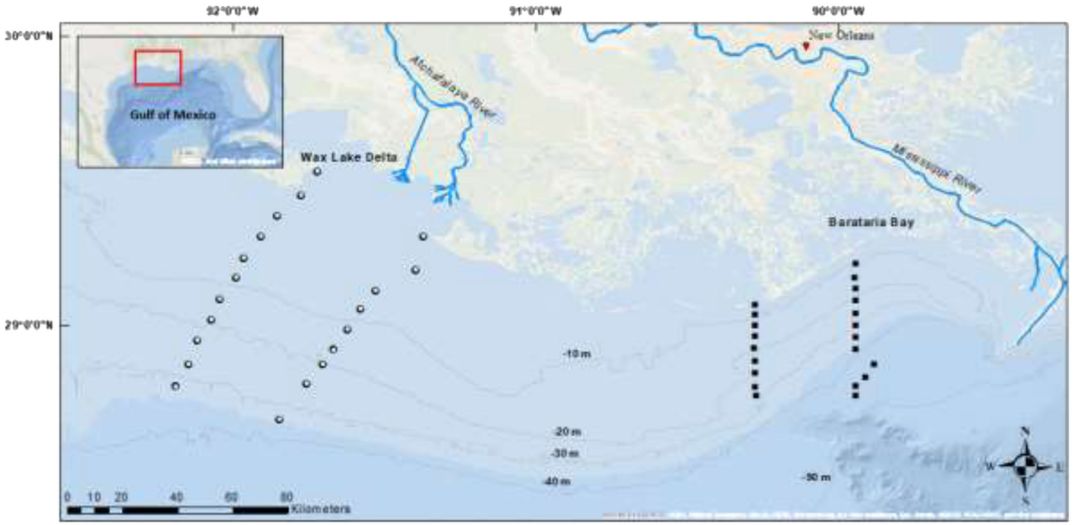


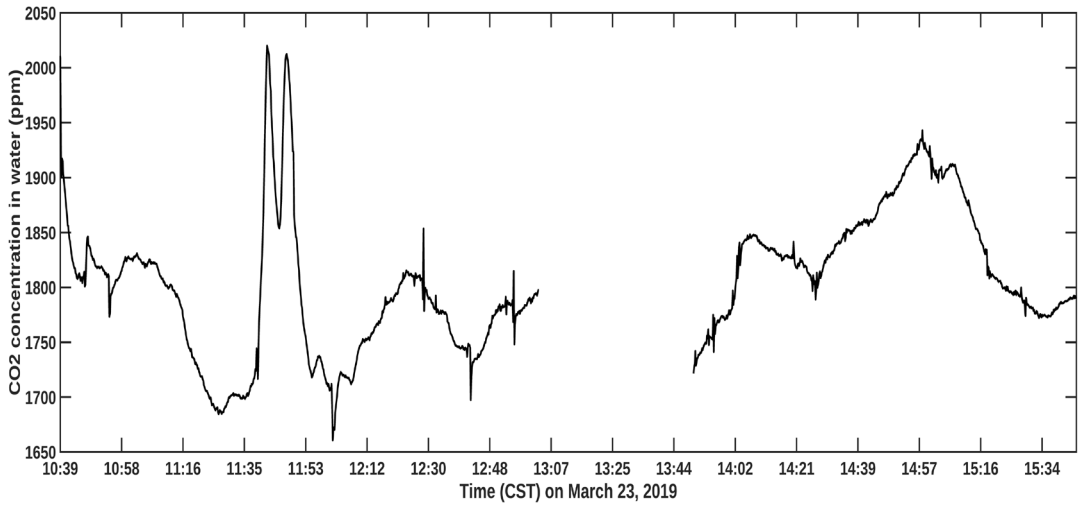

Task 3: Remote Sensing (NASA products)
Land Cover Land Use
Biomass
Primary Production
Sequestration
River discharge
Storage
DIC+POC+DOC?
Air-Sea
Physical/chemical mixing
Storage
Task 1:
Marsh/Wetland Carbon Measurements
Task 2: In-situ Measurements
Task 4:Coupled Physical-Biogeochemical Model



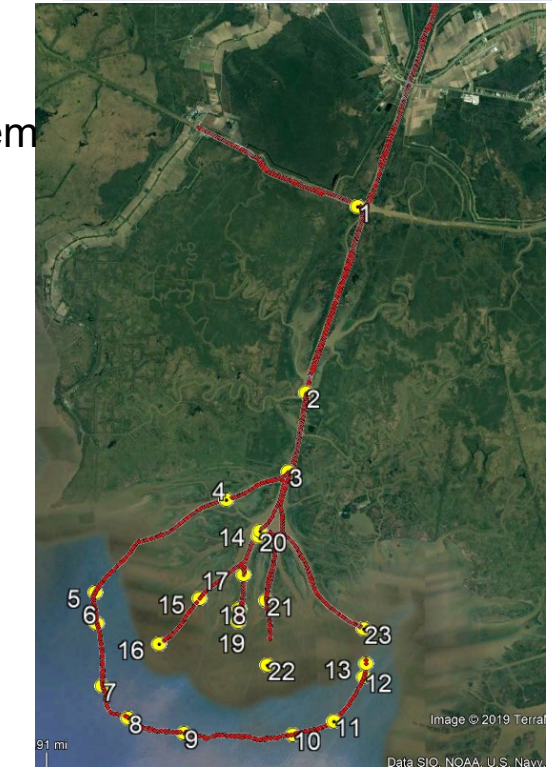
flow-through water sampling system

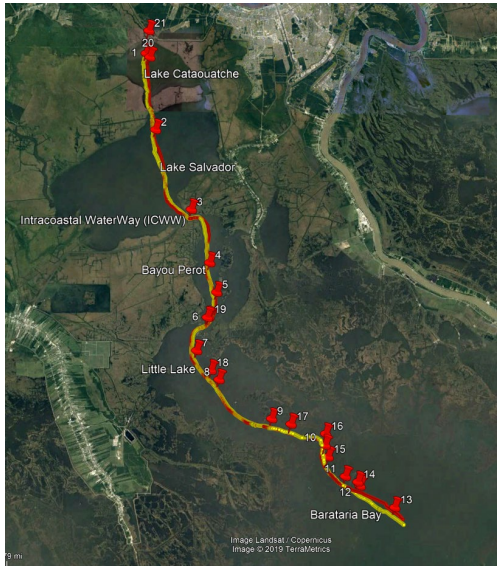
water CO_2 measurement system



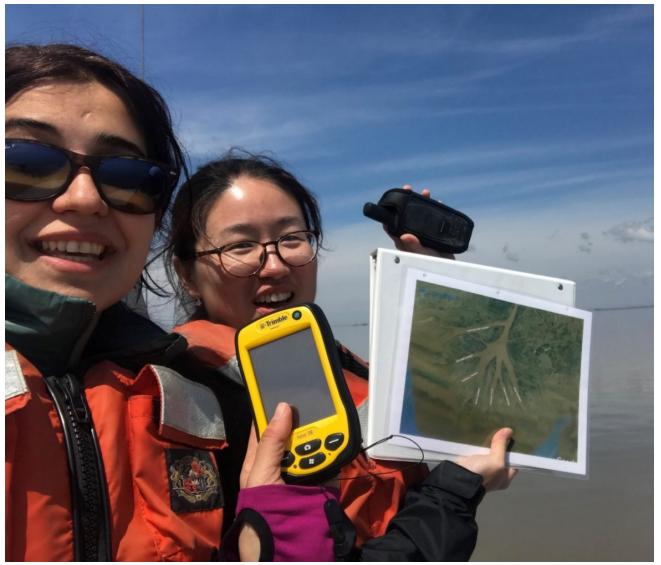


Bay water is super saturated with CO_2





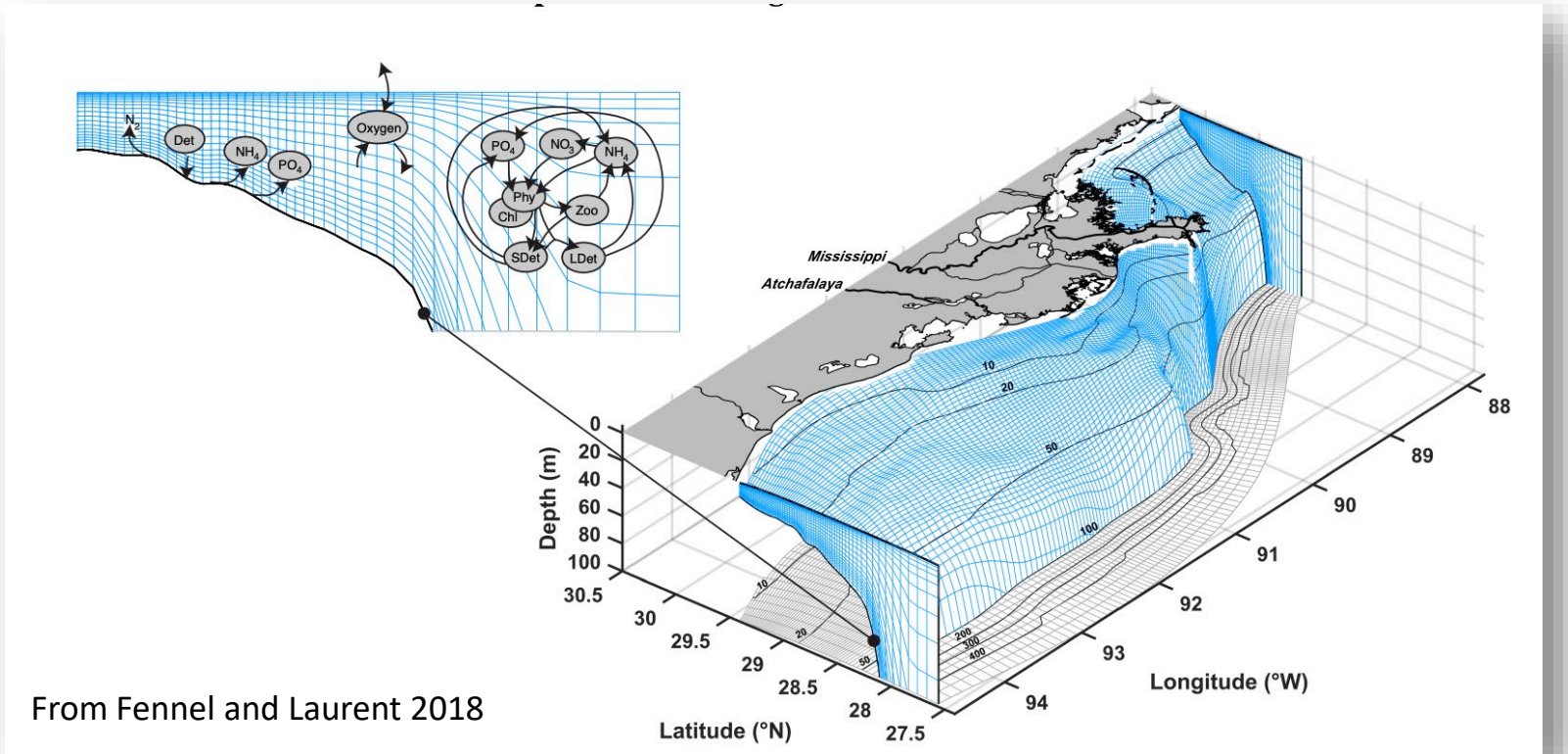
Sampling stations in Barataria Bay and Wax Lake Delta



- 6 Offshore Surveys (T/S, Water Quality, Carbon)
- 17 Wetland Surveys (Dataflow system)
- 12 Graduate students (7 Ph.D.+5 M.S.)
- 9 Peer-reviewed Journal Articles

Regional Ocean Modeling System

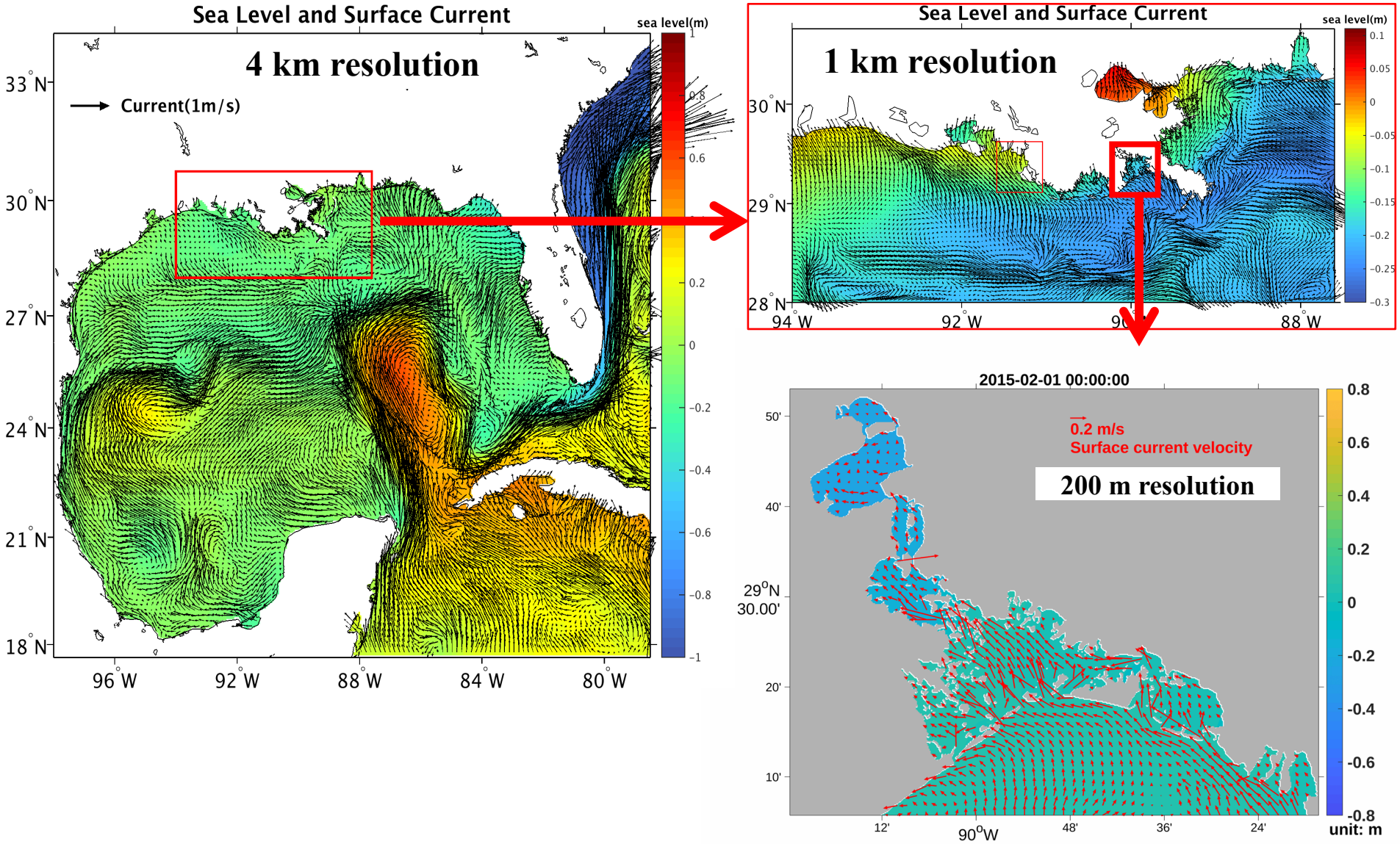
- Free surface, hydrostatic ocean model
- Finite-difference 3D Reynolds-averaged Navier-Stokes equations
- Horizontal orthogonal curvilinear Arakawa C grid
- Vertical stretched terrain-following Sigma coordinates
- Parallel code in MPI and OpenMP



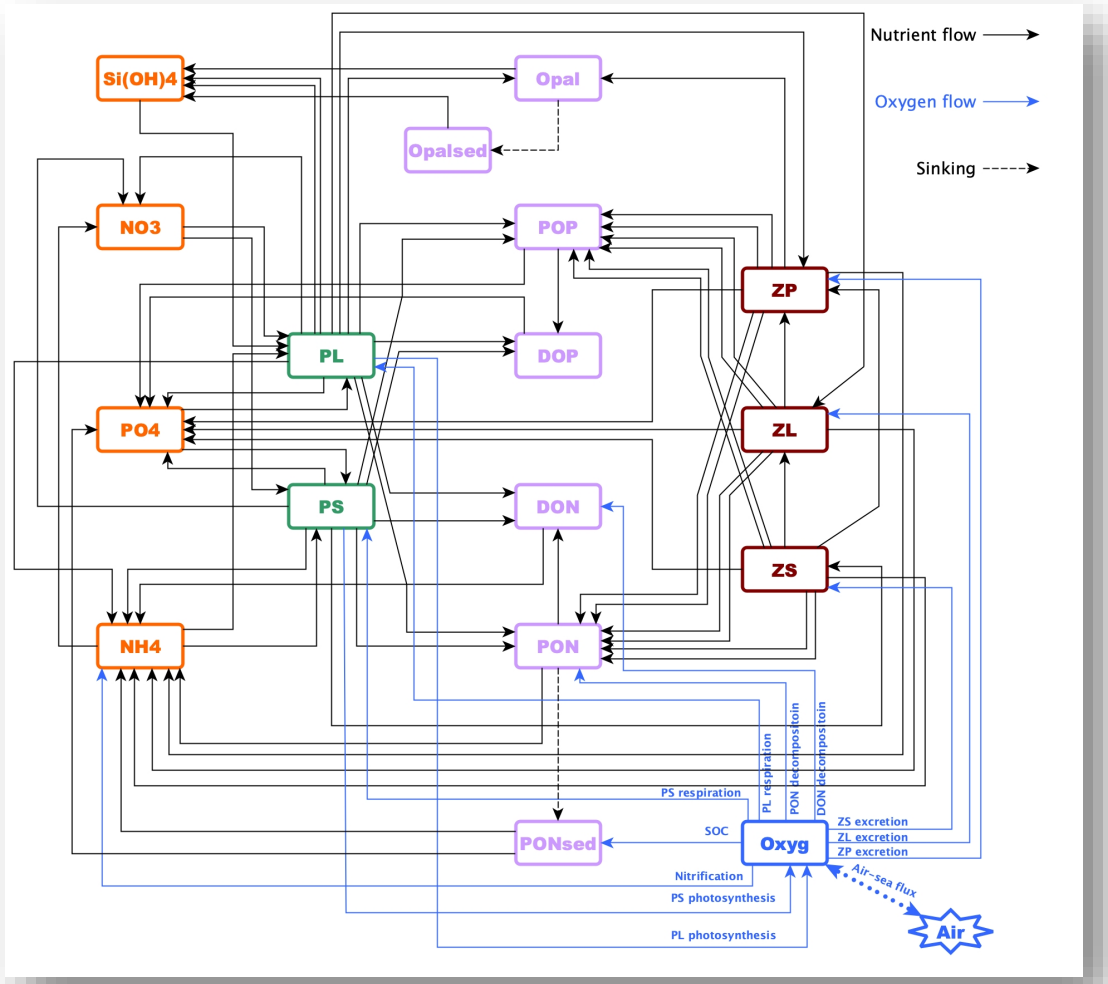
From Fennel and Laurent 2018

LSU supercomputer "QueenBee3"

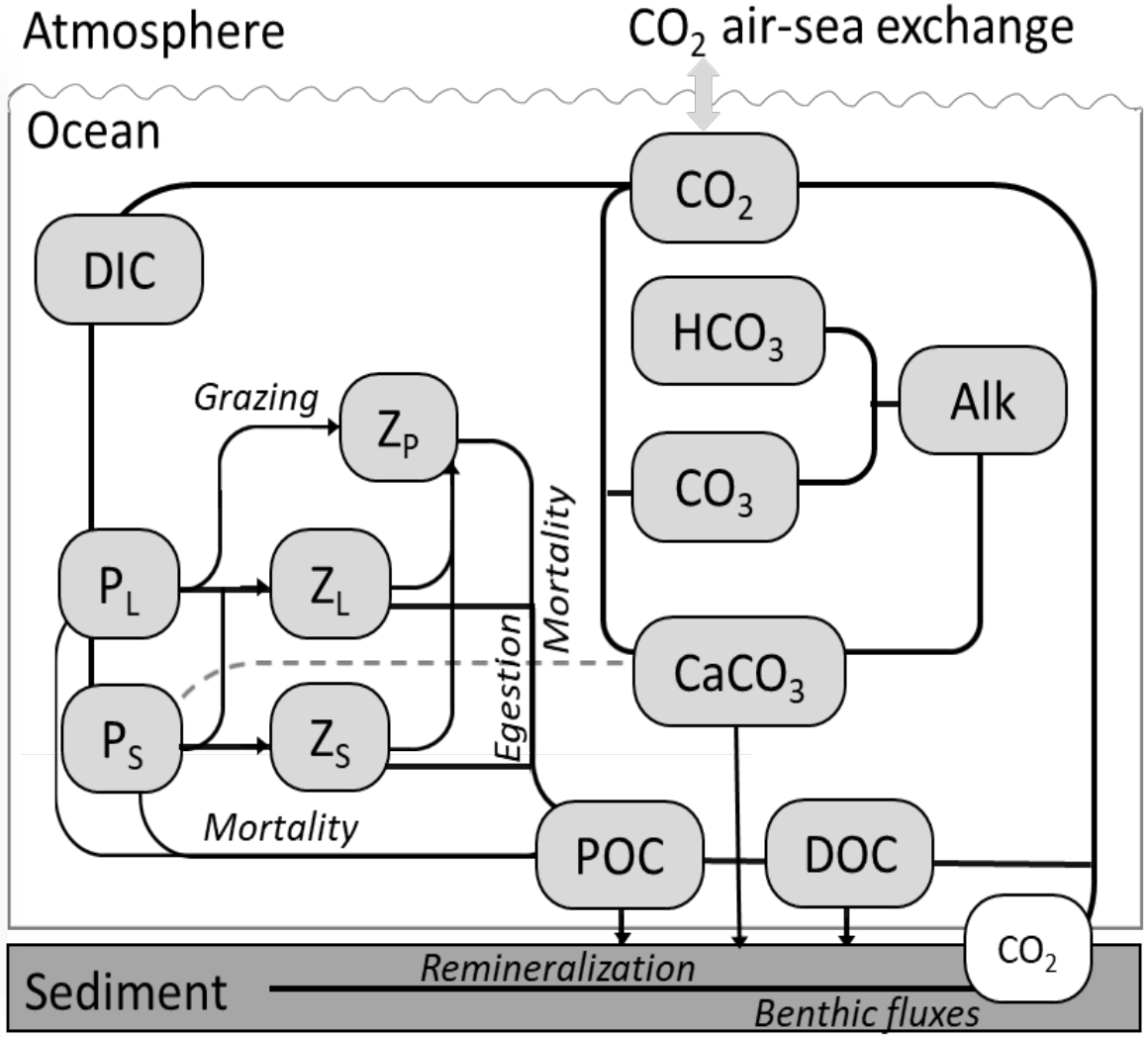
Multiple Model Nesting



Coupled Physical-Biogeochemical Model

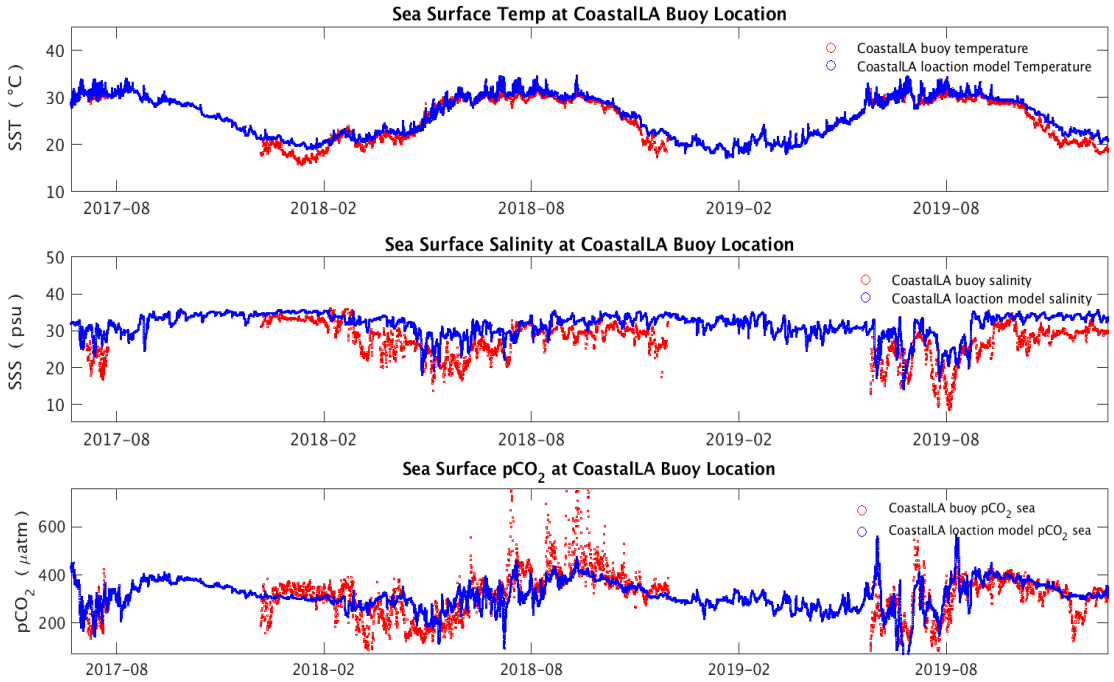


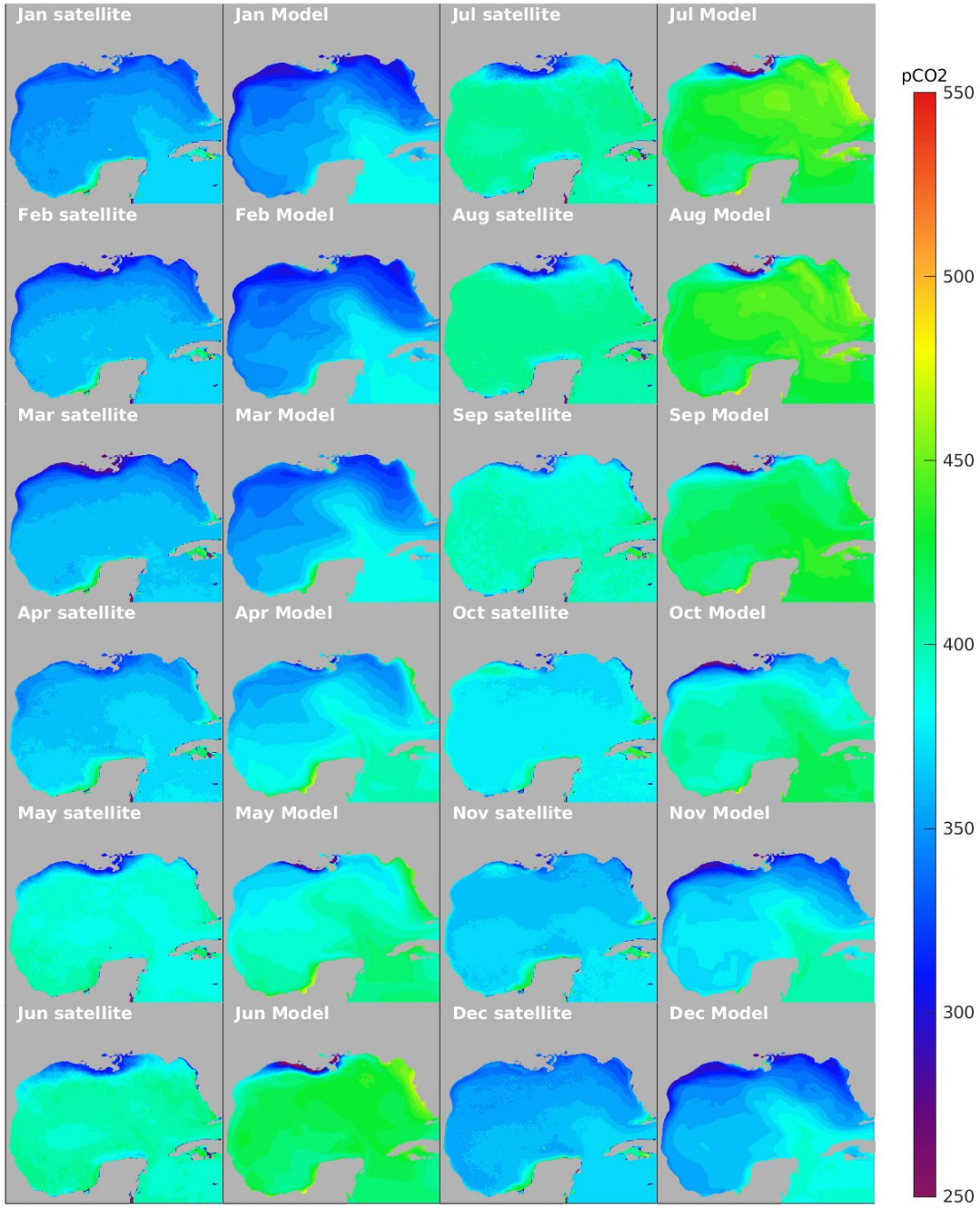
Nutrient cycle



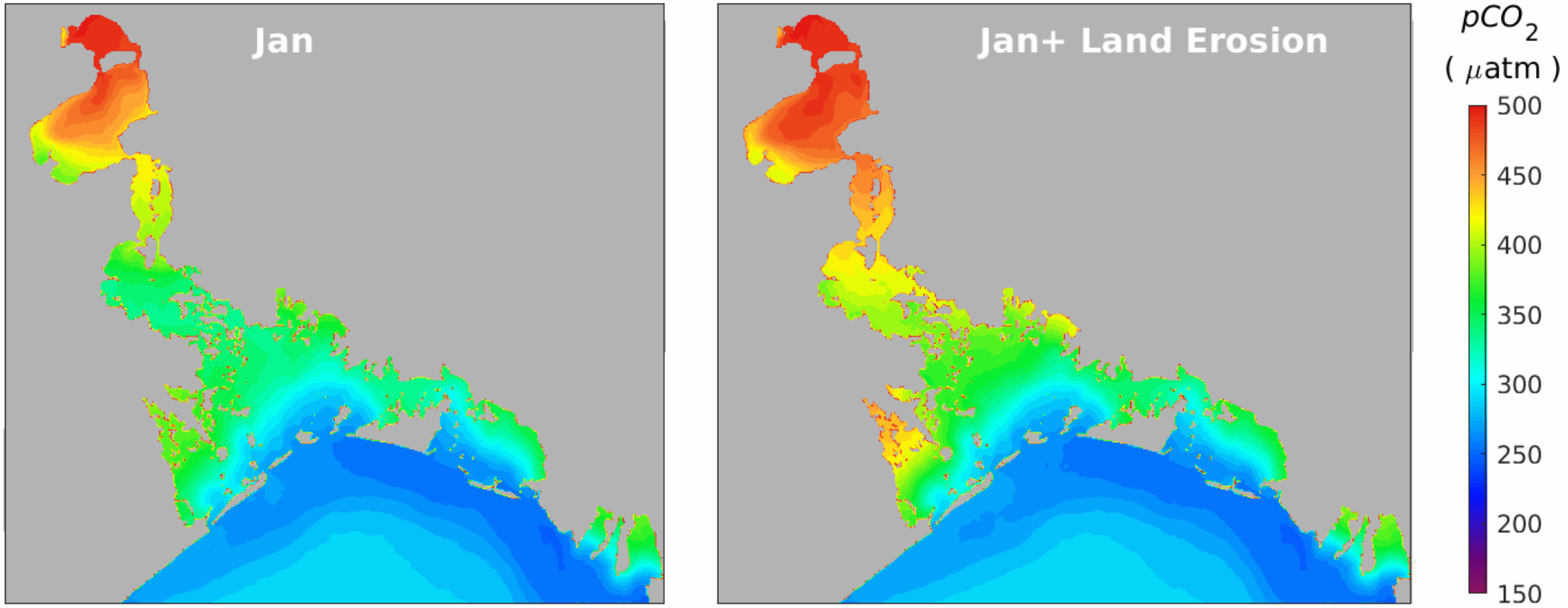
Carbon cycle

Model-Data Comparison





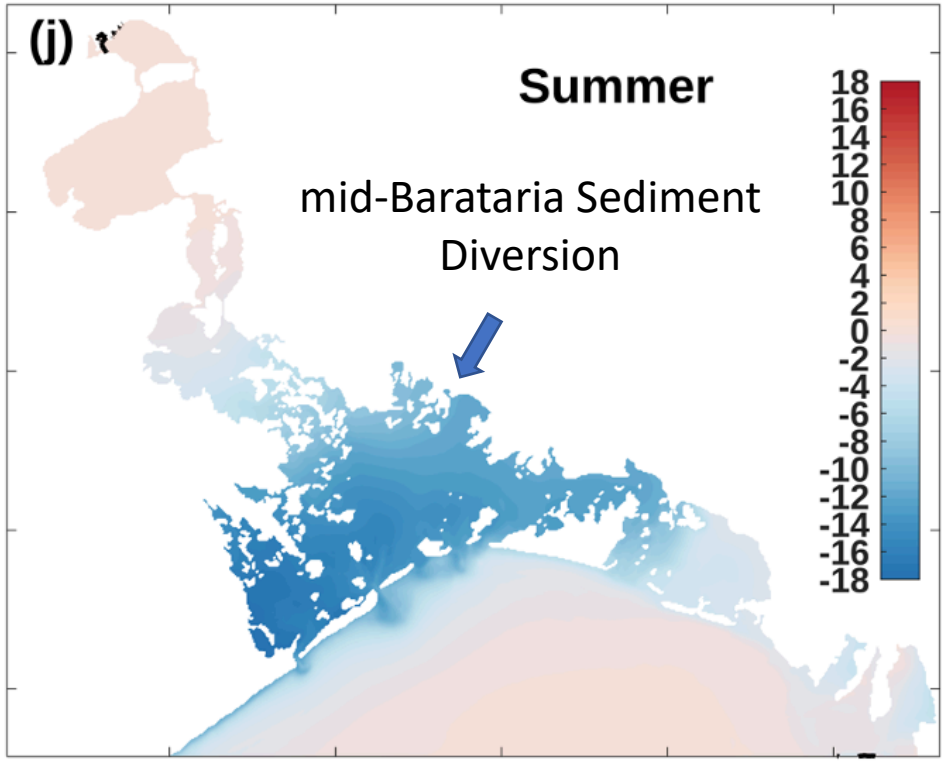
Landloss' impact on carbon export



- Bay water more saturated and serves as a much lower (35% decrease) sink from the above atmosphere.
- The majority (70%) of the carbon released from the eroded soil is exported to the open ocean as dissolved inorganic carbon (DIC) via the tidal inlet.

EPSCOR: Established Program to Stimulate Competitive Research

How about change due to mid-Barataria Sediment Diversion?

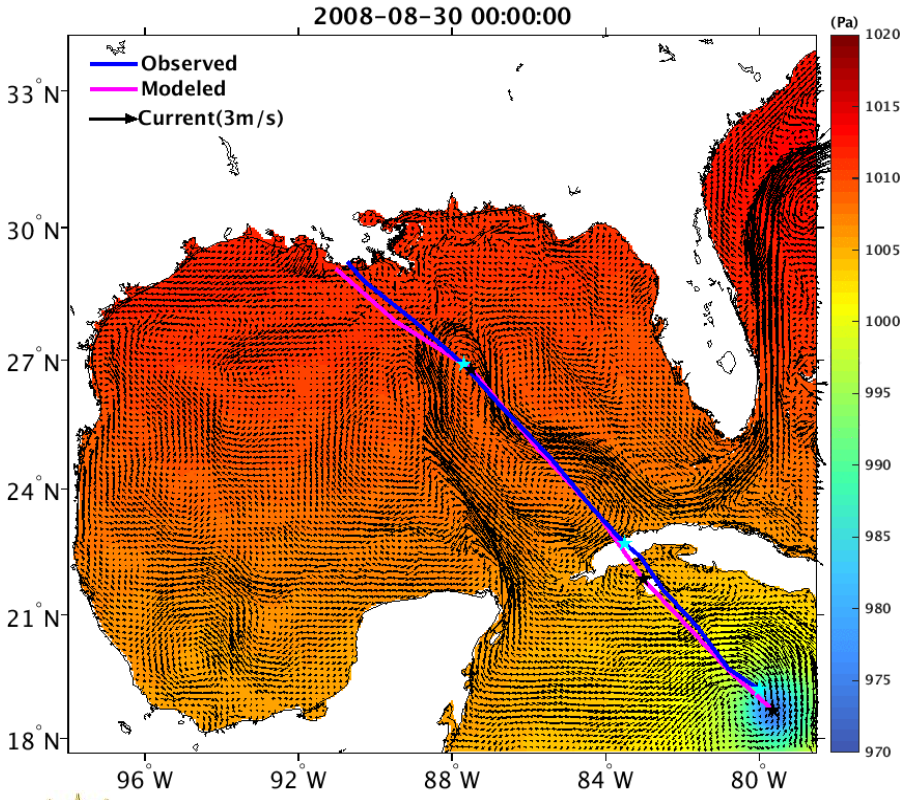


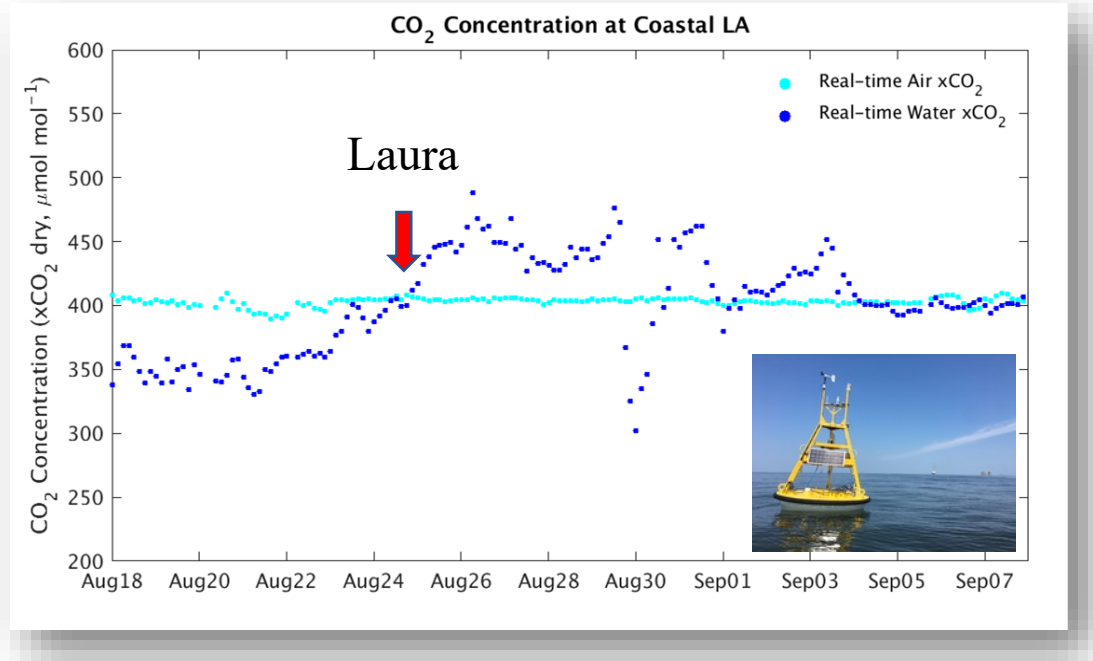
Ou, Xue, et al., 2020

Synergistic Effects of Petroleum Production and Ocean Environmental Changes on Oyster

OA Fellowship: Assess River Diversion and Air-Sea CO2 flux's impact on Louisiana Coastal Acidification

EPSCOR: Established Program to Stimulate Competitive Research



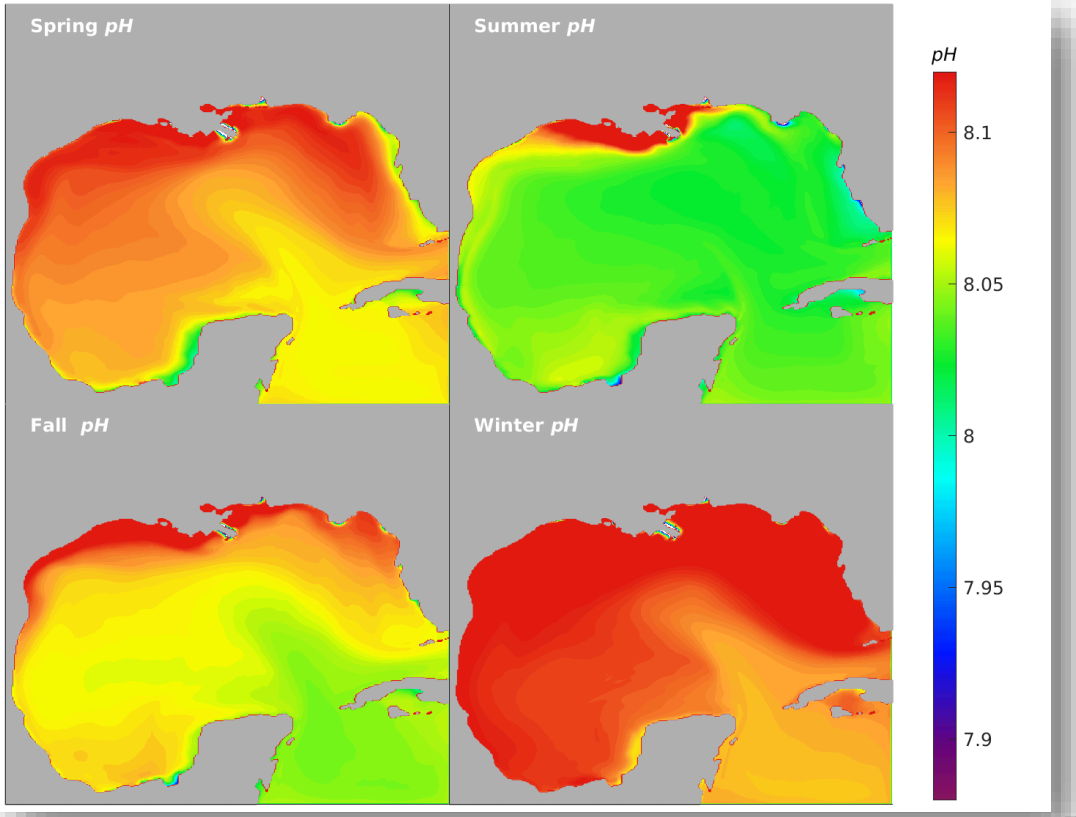


Ocean changed from carbon sink to source to the atmosphere

RAPID: Waiting to Exhale: Quantifying Tropical Storm-Induced Increased Flux of Coastal Wetland Carbon into the Atmosphere?

COAWST WSSSR Coupled Ocean Atmosphere Waves Sediment Transport Waves, Sediment, Surge and Structure Response Forecasting System

EPSCOR: Established Program to Stimulate Competitive Research



NSF AWARDS LSU COLLEGE OF THE COAST & ENVIRONMENT RESEARCHERS TO DETERMINE CLIMATE CHANGE IMPACTS ON FLORIDA STONE CRABS

September 08, 2021

– Phil Gravinese, Florida Southern College

BATON ROUGE — The LSU College of the Coast & Environment, or CC&E, is leading a team of researchers that has been awarded $922,033 from the National Science Foundation to conduct ground-breaking research to identify how climate change will impact one of Florida's most iconic fisheries, the Florida stone crab. The stone crab fishery is a $30 million commercial industry in Florida that supports more than 800 workers. Unfortunately, the annual stone crab harvest in Florida has declined by about 30 percent since the 2000-2001 season, an estimated loss of one million pounds of claws per year, suggesting that fishing pressure and possibly other environmental stressors may be having an impact on the fishery.

Assistant Professor Dan Holstein and Associate Professor Zuo "George" Xue, from the LSU Department of Oceanography & Coastal Sciences, within CC&E, and Assistant Professor Philip Gravinese from the Department of Biological Sciences at Florida Southern College, or FSC, are the principal investigators on this collaborative project. Furthermore, Xue is jointly appointed at the LSU Center for Computation and Technology, or CCT.

Larval orientation, dispersal and connectivity in a brachyuran crab under ocean acidification and elevated temperature