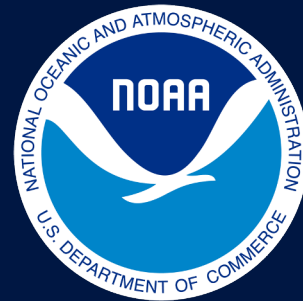


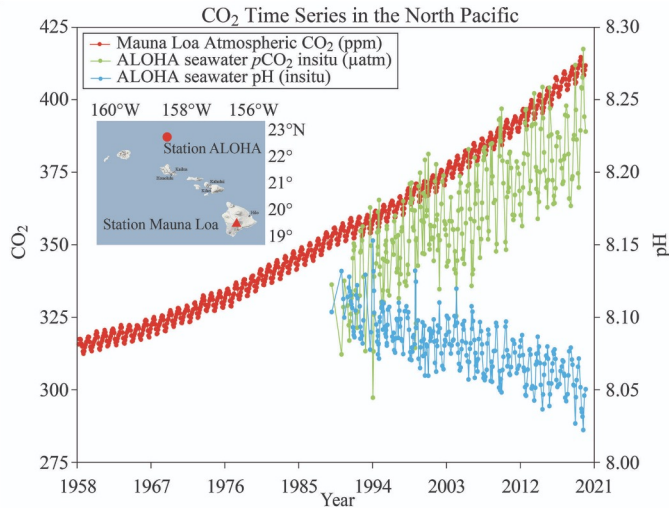
# Discovering the role of the ocean in long-term marine ecosystem changes

Marine carbon and ecosystem modeling  
Fabian Gomez, Ph.D.

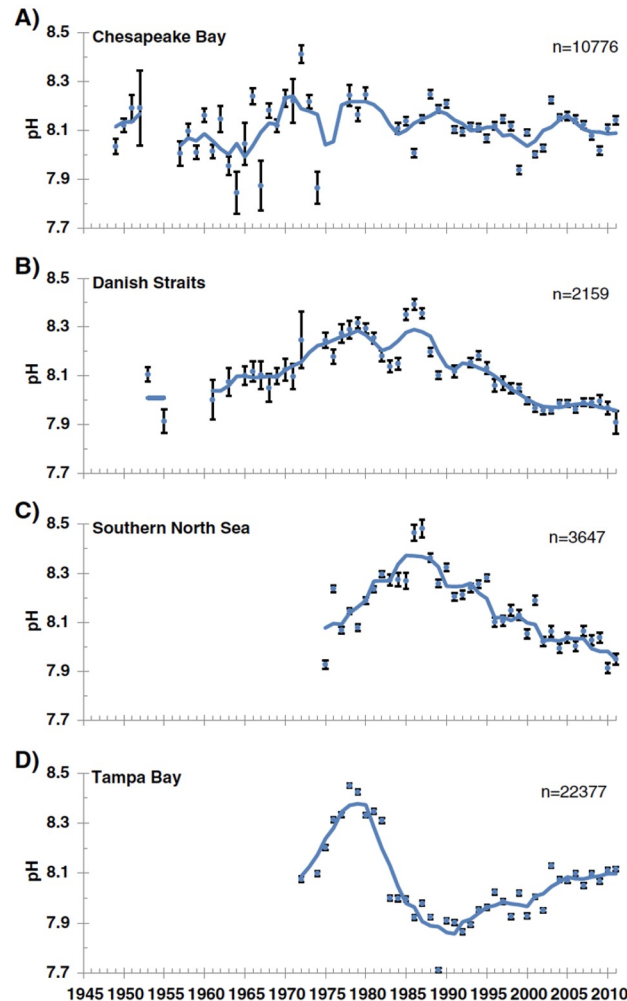


Atlantic Oceanographic & Meteorological Laboratory  
National Oceanic and Atmospheric Administration  
U.S. Department of Commerce

# Ocean acidification progression



NOAA OAP / Modified after R.A. Feely



pH series at four coastal sites

(Duarte et al., 2013)

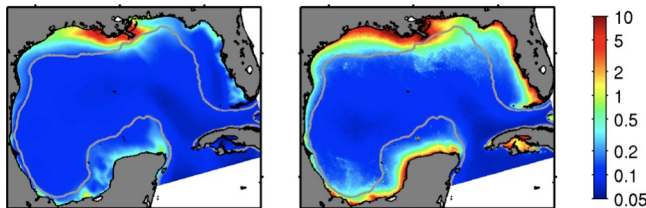
# Our Goals

- Simulate spatiotemporal variability in the marine carbonate system
- Understand the underlying drivers of that variability
- Provide valuable information to support marine resource management



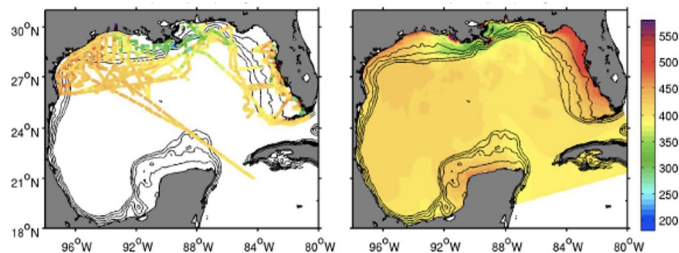
# Ocean-biogeochemical patterns in the Gulf of America

## Chlorophyll ( $\text{mg m}^{-3}$ )



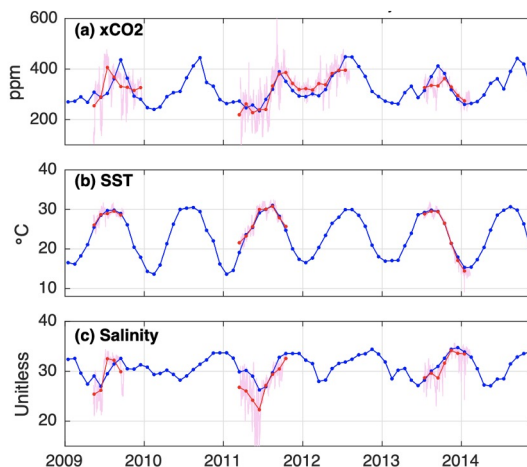
Model outputs & satellite data

## Partial pressure of $\text{CO}_2$ ( $\mu\text{atm}$ )



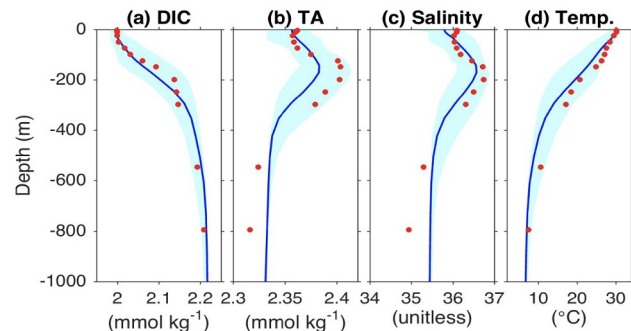
Model outputs & ship of opportunity records

## $\text{CO}_2$ , SST, SSS



Model outputs & coastal buoy series

## Vertical distribution of DIC, alkalinity, salinity & temperature



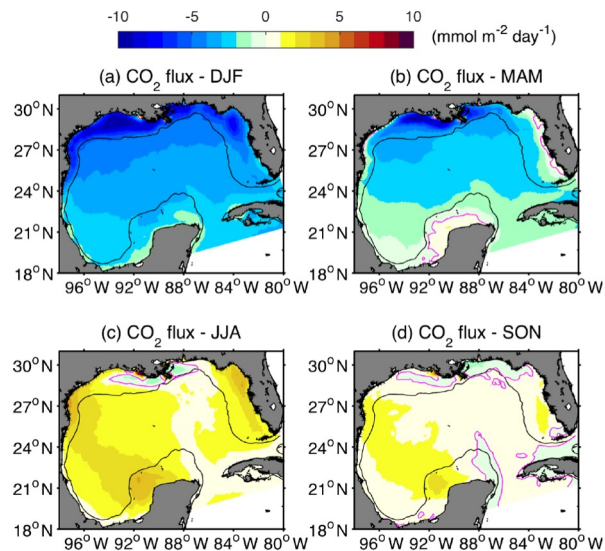
Model outputs & GOMECC cruises

Gomez et al. (2018, 2020)

# Model development and validation

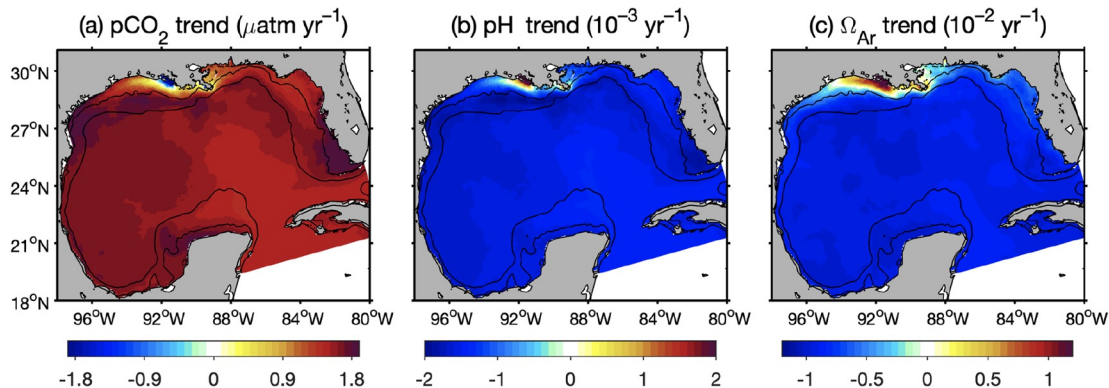
# Ocean-biogeochemical patterns in the Gulf of America

Seasonal variability (Gomez et al., 2020)



Surface CO<sub>2</sub> flux

Ocean acidification progression (Gomez et al., 2021)

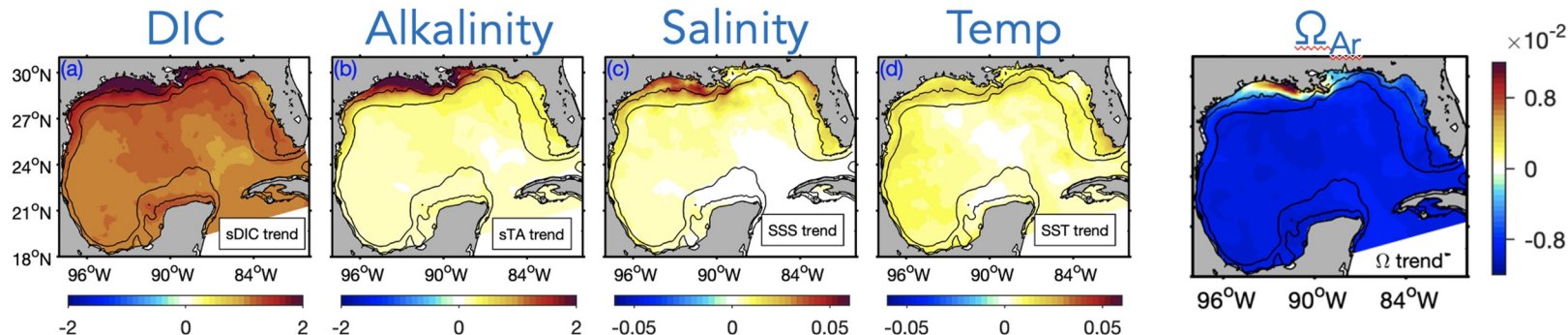


Long-term trends in surface pCO<sub>2</sub> (μatm yr<sup>-1</sup>), pH (yr<sup>-1</sup>), and aragonite saturation state (yr<sup>-1</sup>)

## Describing carbonate system patterns



# Ocean-biogeochemical patterns in the Gulf of America



Changes in Mississippi River chemistry from the 1970s to 2010s:

|                         |      |
|-------------------------|------|
| Alkalinity              | +15% |
| Alkalinity to DIC ratio | +5%  |

- The Mississippi River runoff is a key driver of the coastal ecosystem variability in the northern Gulf of America
- Changes in the carbon chemistry of the MS river waters determined a slower OA progression near the MS delta region

## Mississippi River impacts in the northern Gulf

# River chemistry for ocean-biogeochemical models

## RC4USCoast: a river chemistry dataset for regional ocean model applications in the US East Coast, Gulf of Mexico, and US West Coast

Fabian A. Gomez<sup>1,2</sup>, Sang-Ki Lee<sup>2</sup>, Charles A. Stock<sup>3</sup>, Andrew C. Ross<sup>3</sup>, Laure Resplandy<sup>4</sup>, Samantha A. Siedlecki<sup>5</sup>, Filippos Tagklis<sup>2,6</sup>, and Joseph E. Salisbury<sup>7</sup>

<sup>1</sup>Northern Gulf Institute, Mississippi State University, Starkville, Mississippi, USA

<sup>2</sup>NOAA Atlantic Oceanographic and Meteorological Laboratory, Miami, Florida, USA

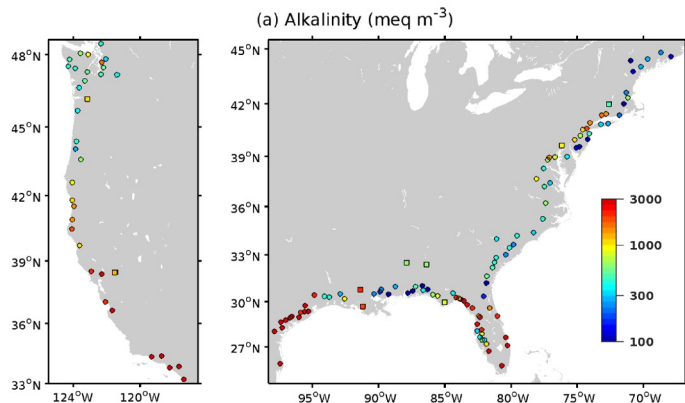
<sup>3</sup>NOAA Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey, USA

<sup>4</sup>Department of Geosciences, High Meadows Environmental Institute, Princeton University, Princeton, New Jersey, USA

<sup>5</sup>Department of Marine Sciences, University of Connecticut, Groton, Connecticut, USA

<sup>6</sup>Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Miami, Florida, USA

<sup>7</sup>Ocean Process Analysis Laboratory, University of New Hampshire, Durham, New Hampshire, USA

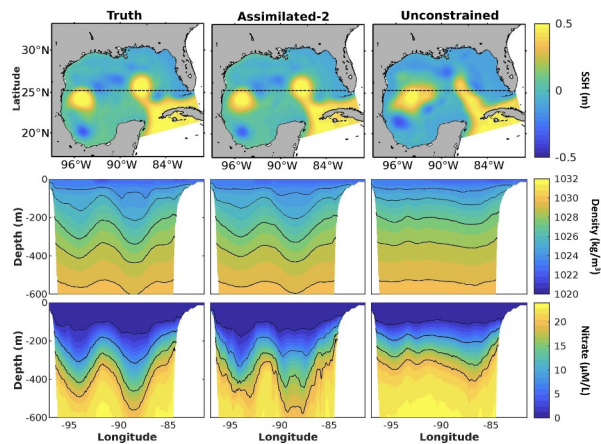


(Gomez et al., 2023)

- Ocean BGC models need realistic inputs of river-water properties to properly simulate coastal ecosystem responses to river runoff, but the availability of these inputs is usually limited
- We developed the RC4USCoast dataset, which contains relevant variables to characterize biogeochemical and water fluxes (land-to-ocean) along the US West Coast, US East Coast, and Gulf of America
- RC4USCoast has been used in two NOAA CEFI modeling efforts: Northwest Atlantic (Ross et al., 2023; Northeast Pacific (Drenkard et al., 2024)

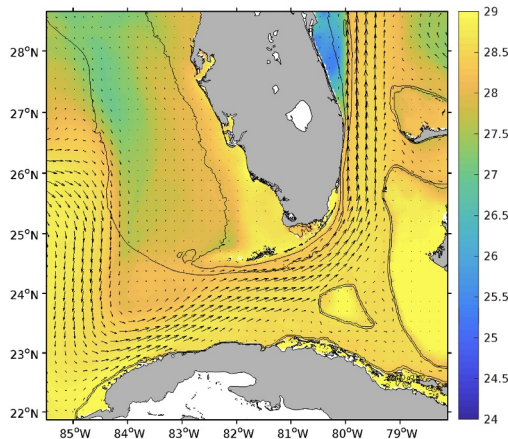
# Ongoing ocean-biogeochemical research

**Red tide:** Toward building a subseasonal to seasonal red tide and hypoxia warning system for the West Florida Shelf.



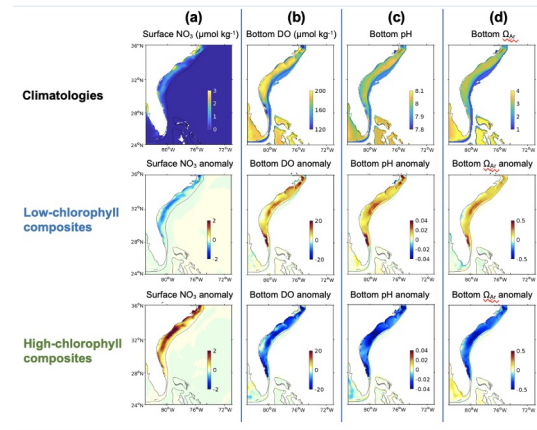
(Bordin et al., in prep)

**FRESCA:** Ocean-BGC modeling in support of multistressor characterization



MOM6-COBALT-SFL36

**CEFI:** Linking interannual coastal biogeochemical changes to Gulf Stream and wind-driven upwelling in the South Atlantic Bight



(Gomez et al., in prep)



# Concluding Remarks

High-resolution ocean-biogeochemical models can assist in filling observational gaps by describing and attributing ocean biogeochemistry variability over time.

AOML conducts relevant ocean-biogeochemical modeling studies in the Gulf of America and the US Southeast Coast, contributing to a better understanding of plankton dynamics and carbonate system patterns

This work represents a multidisciplinary research effort, which includes an active collaboration with the NGI, CIMAS, and other NOAA labs.



# Partners



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- Ross, A. C., C. A. Stock, A. Adcroft, E. Curchitser, R. Hallberg, M. J. Harrison *et al.*, 2023: A high-resolution physical-biogeochemical model for marine resource applications in the Northwest Atlantic (MOM6-COBALT-NWA12), *Geosci. Model Dev.*, 16, 6943–6985, <https://doi.org/10.5194/gmd-16-6943-2023>

