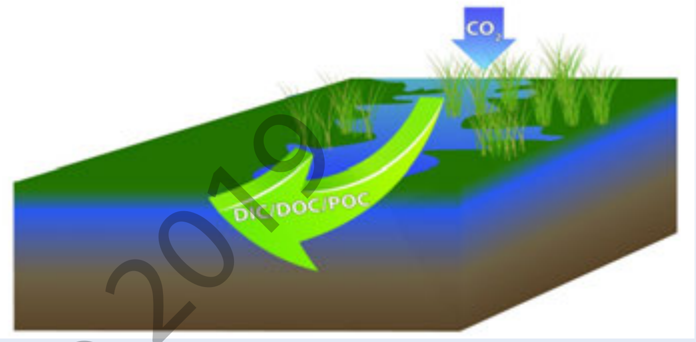
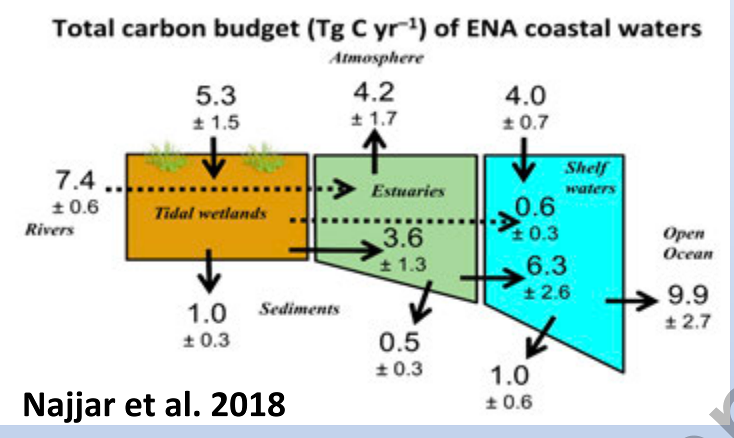
Update on an OCB-supported activity:

Lateral carbon flux in tidal wetlands: Filling a key knowledge gap through a methods intercomparison and data synthesis

https://www.us-ocb.org/lateral-c-flux-tidal-wetlands/



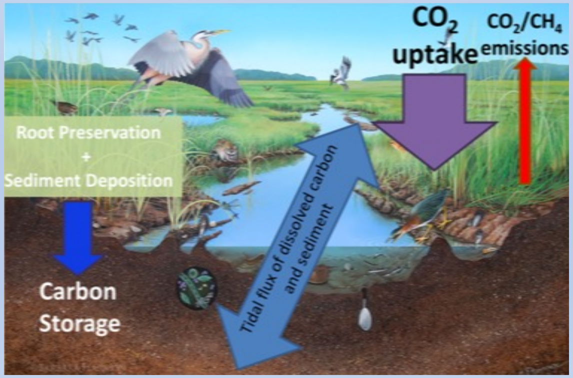
Kevin Kroeger, Maria Tzortziou, Meagan Gonneea, Chris Osburn, Aleck Wang, Neil Ganju, Brian Bergamaschi, Alana Menendez



Najjar et al. 2018

- The coastal zone is increasingly recognized as an important, but difficult to quantify component of the C cycle.
- Wetland lateral fluxes are poorly-known, but are estimated to be a primary feature of both wetland and estuarine budgets.

- Workshop held Aug 21-23, 2018, USGS, Woods Hole
- 29 participants with data & expertise related to wetlands C
- Objectives to:
    - Review & improve methods
    - Estimate annual rates of C exchange across contiguous U.S.



We began with the following two hypotheses:

1. Lateral flux is related to the rate of C cycling within the wetland (GPP, respiration).
2. Lateral flux is related to rate of aquatic exchange between wetland and estuary.

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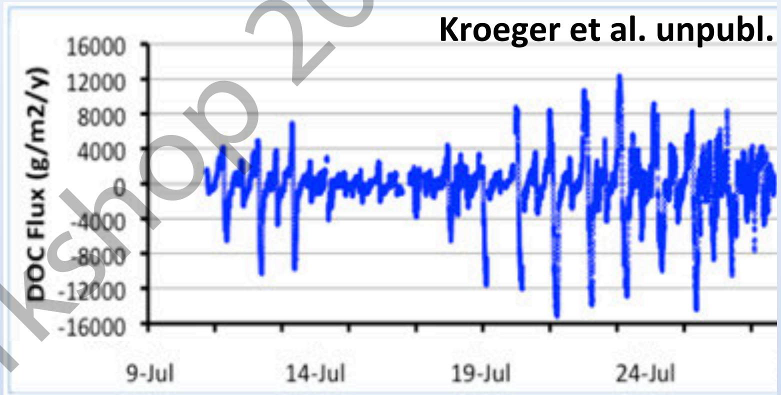
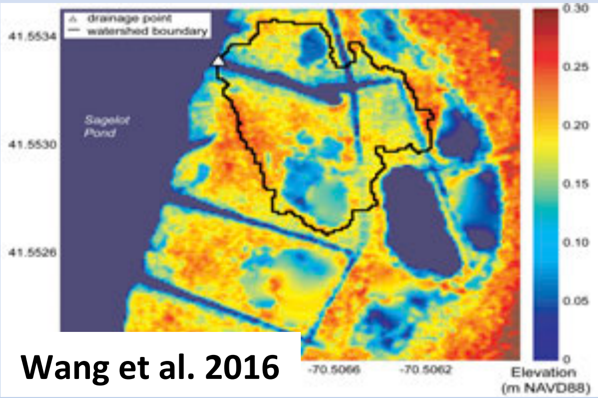
During the workshop we addressed and suggested approaches to the following complications that interfere with measurements of annual, net flux rates:

- Currently the Net Ecosystem Carbon Balance does not close. Measured rates of NEE are too small to support measured rates of lateral flux and net C storage.



- Classical methods attempt to measure a continuously-varying flux rate based on low frequency measurements: Suggested newer approaches to measure high frequency flux rates based on continuous sensor deployments.



- Commonly the contributing area for the lateral flux is not known: Suggested 1) mapping of drainage networks based on digital elevation model, or 2) calculation of area based on tidal volume and height.

Arrived at two approaches to estimate lateral flux at scale, following development of a set of higher confidence flux rate estimates:
1) Test relationships to measures of C supply or cycling rate and intensity of aquatic exchange. Based on those relationships, model and map lateral flux based mapped GPP, R, and tidal exchange.
2) Calculate NECB based on modeled GPP, modeled R, & estimated storage rates. Calculate lateral flux as the residual.

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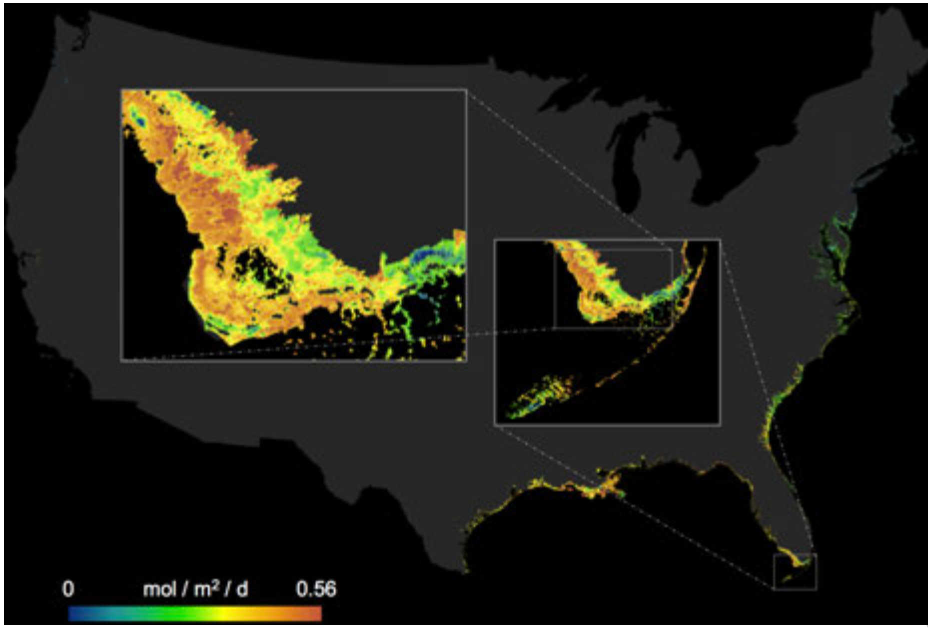
National model of GPP (Feagin, Forbrich, et al.)

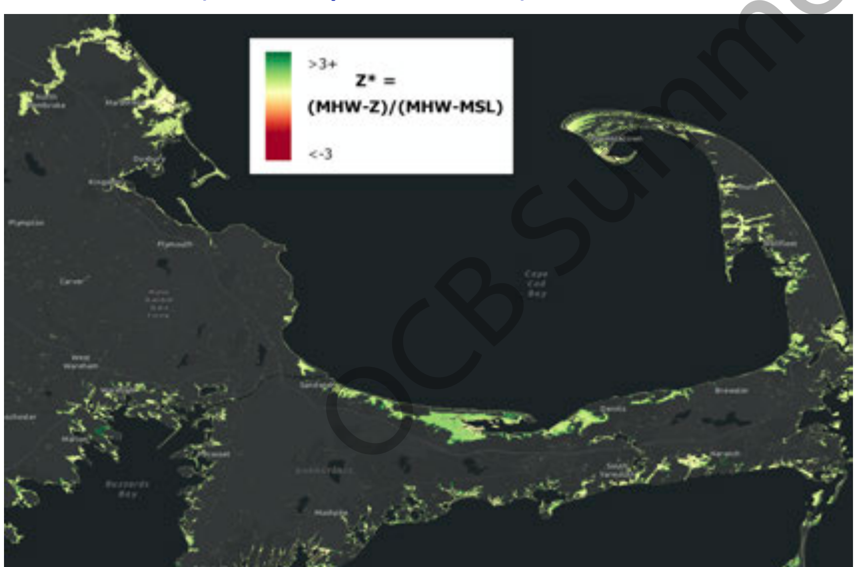


Progress along 3 main fronts:

1. New and compiled field data: Individual projects developing improved or new estimates of flux rate
2. Comprehensive information on marsh productivity, based on remote sensing model
3. Comprehensive data on intensity of tidal exchange

Pending: Development of approach to predict lateral flux based on drivers

National model of platform elevation within tide frame (Holmquist et al.)



National map of tidal wetland distribution, according to major estuaries (Hinson et al. 2018, Herrmann et al. 2015 & unpubl., NOAA)

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Particulate Matter Transport Following Marsh-Edge Erosion

Implications for Carbon Cycling

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Julia Moriarty

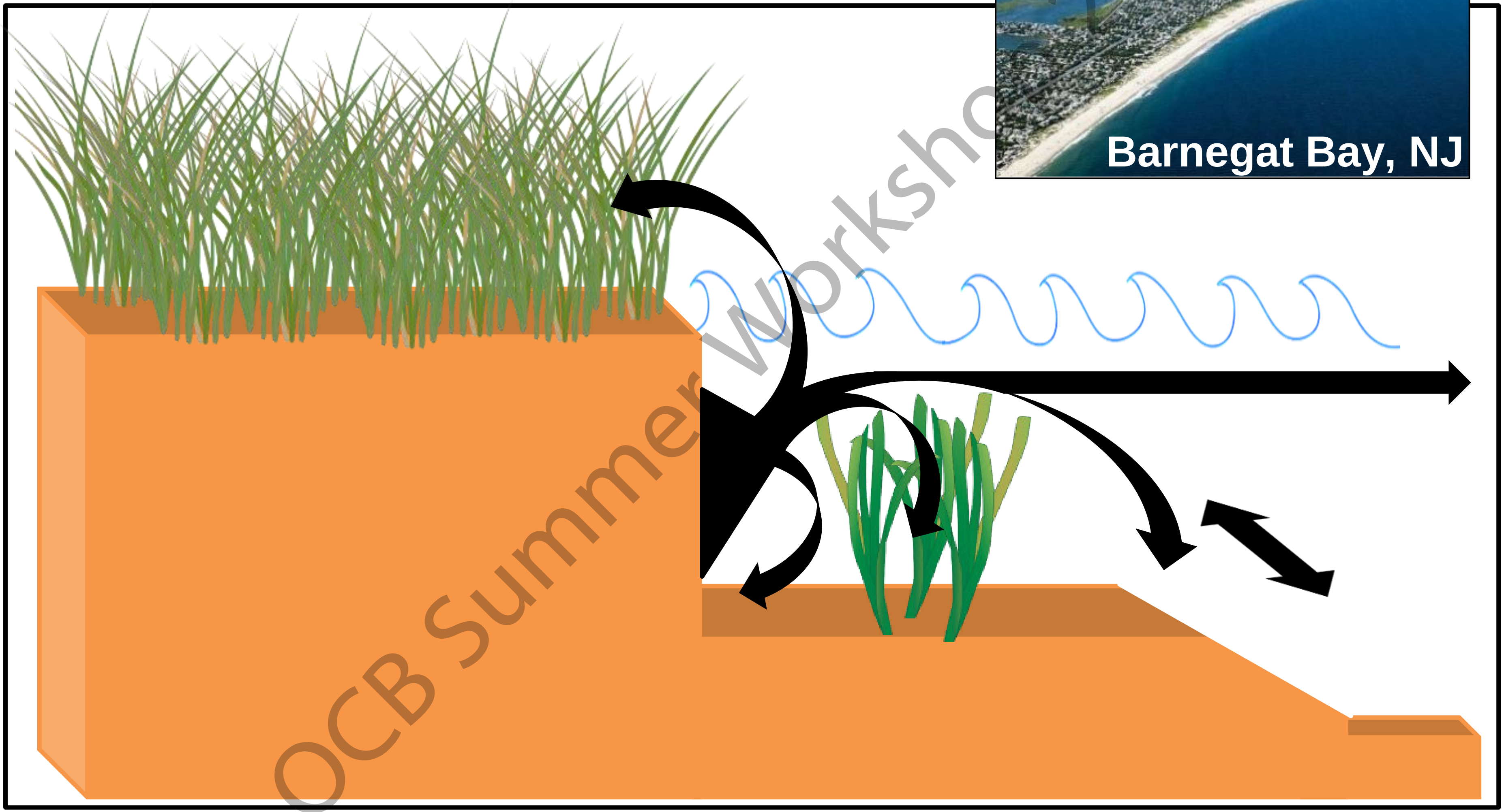
Collaborators: Neil Ganju, Taran Kalra, Zafer Defne

U.S. Department of the Interior
U.S. Geological Survey

GRC Coastal Ocean Dynamics
Manchester, NH
June 16, 2019

Marshes Erode!

Where does the POC and sediment go?



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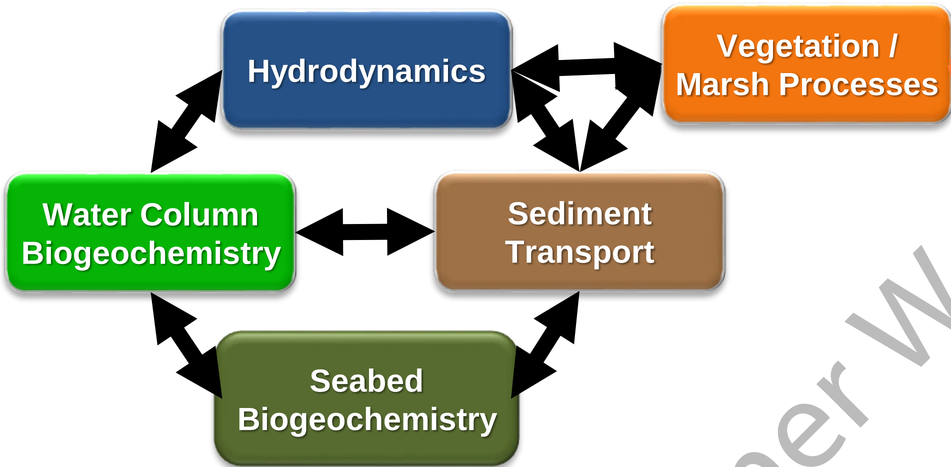
Modeling Marsh-Estuarine Fluxes of Particulate Matter in COAWST

COAWST (ROMS) Model Schematic



Wave-Induced Marsh-Edge Erosion

Photo by D. Nowacki

New Processes in COAWST:

- Vegetation-hydrodynamic interactions
- POM resuspension & transport
- Marsh-edge erosion

USGS

COAWST: Warner et al. (2010); **ROMS:** Haidvogel et al. (2000; 2008); Shchepetkin and McWilliams (2005; 2009); **SWAN:** Booij et al. (1999); **CSTMS:** Warner et al. (2008); Sherwood et al. (2018); **Veg/POM:** Beudin et al. (2017); Kalra et al. (2017); Moriarty et al. (2017); Fennel et al. (2006)

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Spatial Variability in Particulate Fluxes

Moriarty et al. (in prep); Image after FitzGerald et al. (2008)

- Erosion and export of particulate matter from the marsh is largest near barrier-island inlets.

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Spatial Variability in Particulate Fluxes

Moriarty et al. (in prep); Image after FitzGerald et al. (2008)

- Erosion and export of particulate matter from the marsh is largest near barrier-island inlets.
- Deposition on marsh platform is largest near estuarine channels

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Impacts of estuarine dynamics on CO_2 air-sea exchange

Jenny Thomas

Malcolm Scully

OCB 2019 Lightning Talk

Estuaries are proposed to play an important role in the global carbon budget, but there are considerable spatial and temporal uncertainties in their atmospheric fluxes of CO_2

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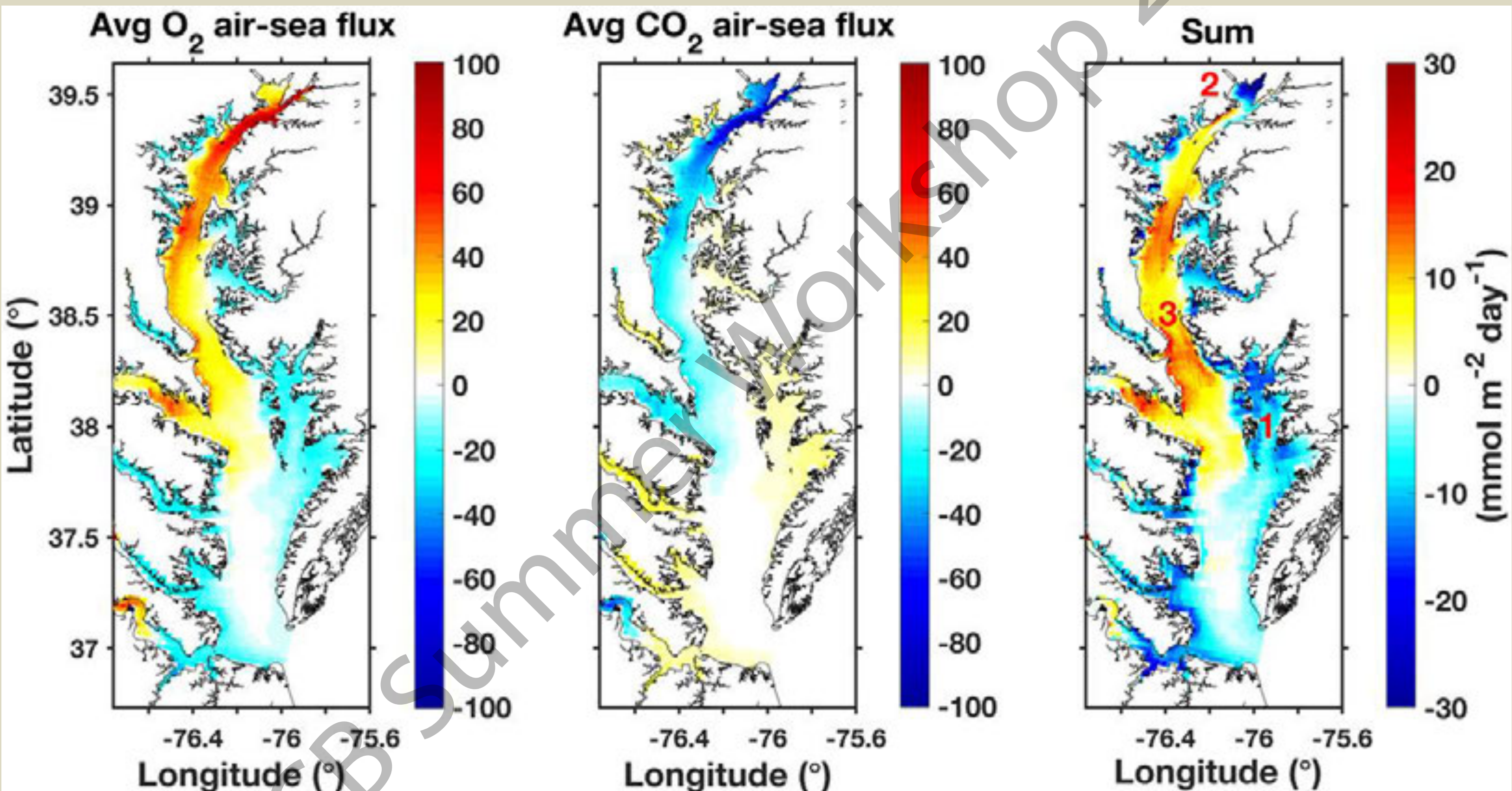
Woods Hole Oceanographic Institution

USGS science for a changing world

Air-sea fluxes are spatially variable

- Model reasonably accurately reproduces observed oxygen (*Scully JGR 2018*)



- Spatially variable
- Stratification limits CO_2 outgassing in lower bay
- Annually integrated CO_2 flux is outward

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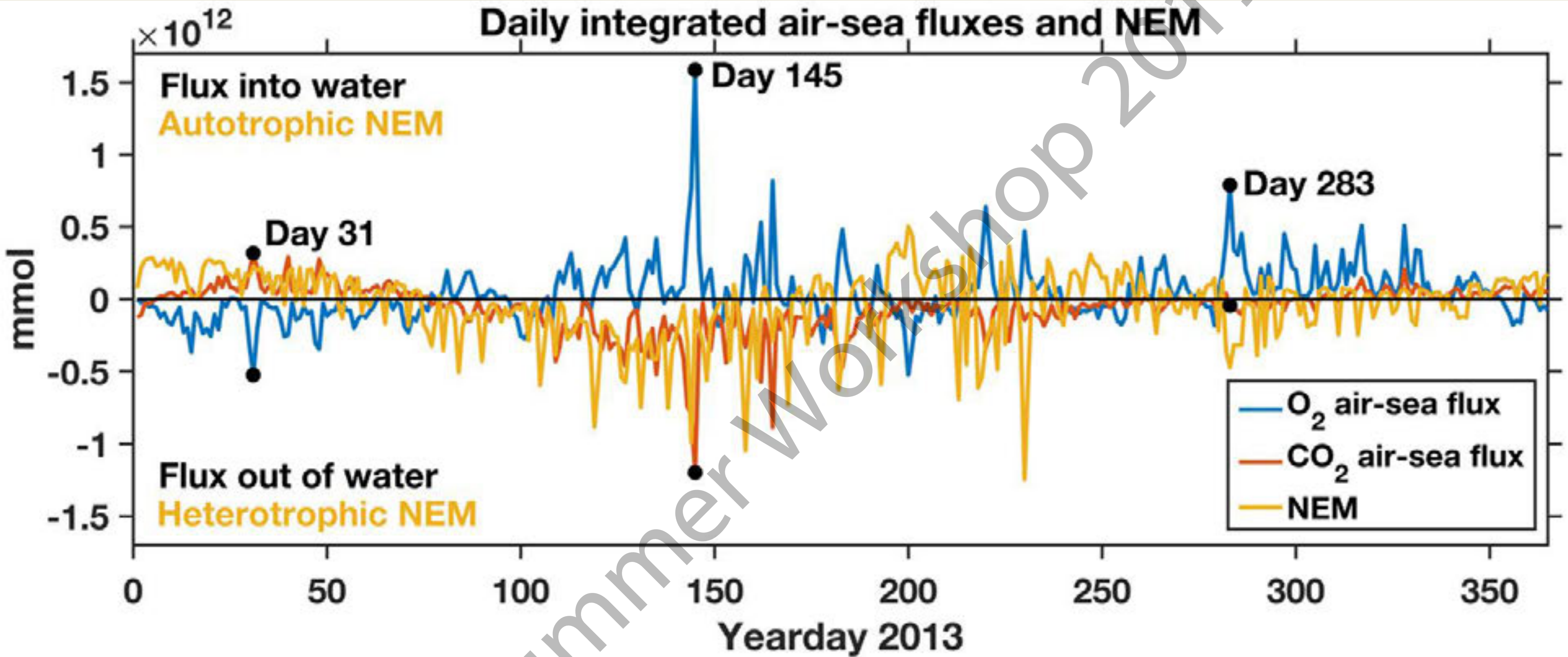
Air-sea fluxes are temporally variable



- Sometimes direction of flux in agreement with NEM (e.g. Days 31 and 145)
- Numerous times CO_2 fluxes smaller or in opposite direction than suggested by NEM (e.g. Day 283)

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I. Characterizing the spatiotemporal pCO_2 dynamics associated with water masses in the river-dominated East China Sea

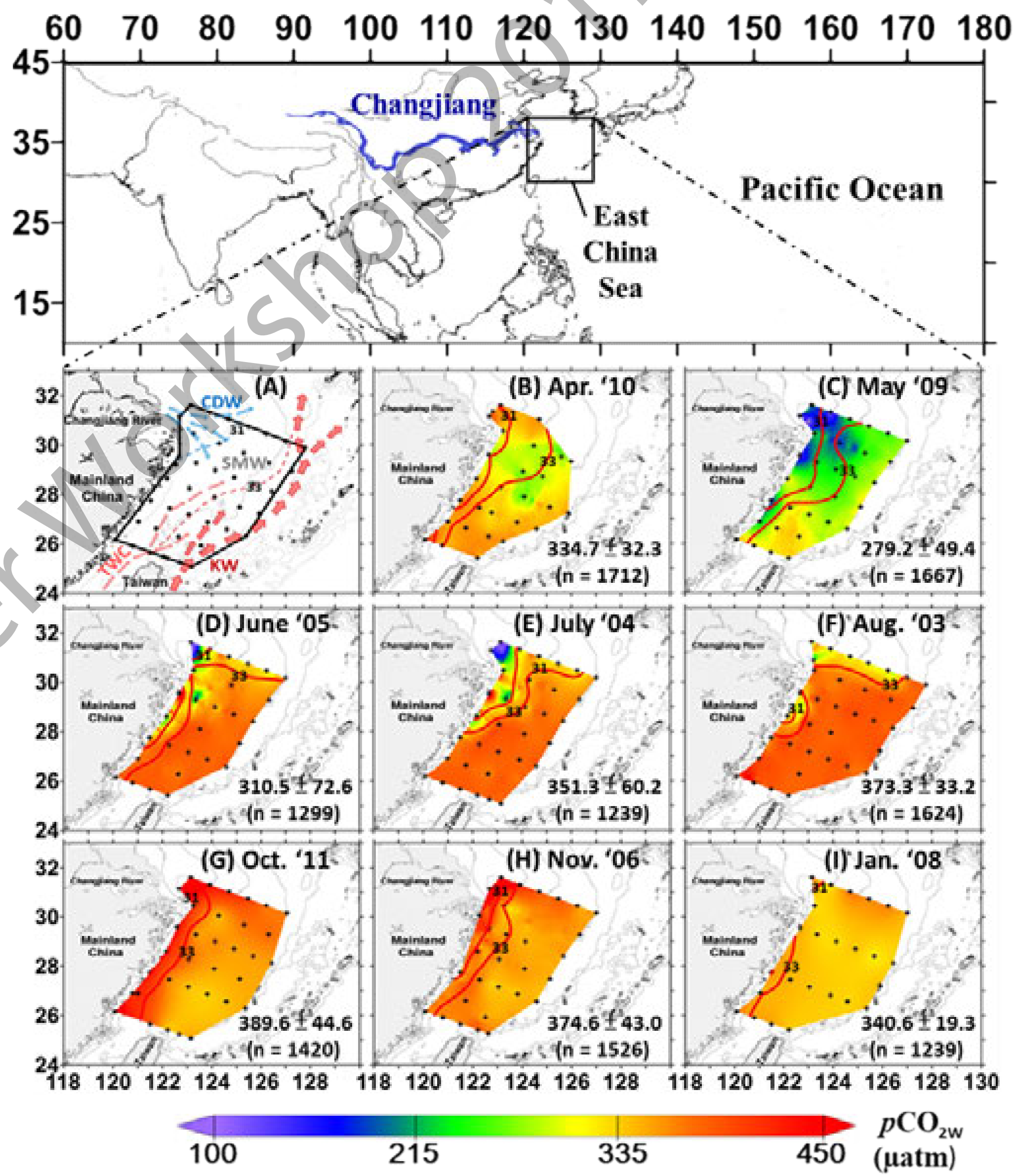
SHOU-EN TSAO

CO-AUTHORS:

PO-YUAN SHEN, YI-CHUN YANG, CHUN-MAO TSENG

Institute of Oceanography, National Taiwan University, Taipei, Taiwan <cmtseng99@ntu.edu.tw>

Monthly pCO_{2w} Distributions in the ECS



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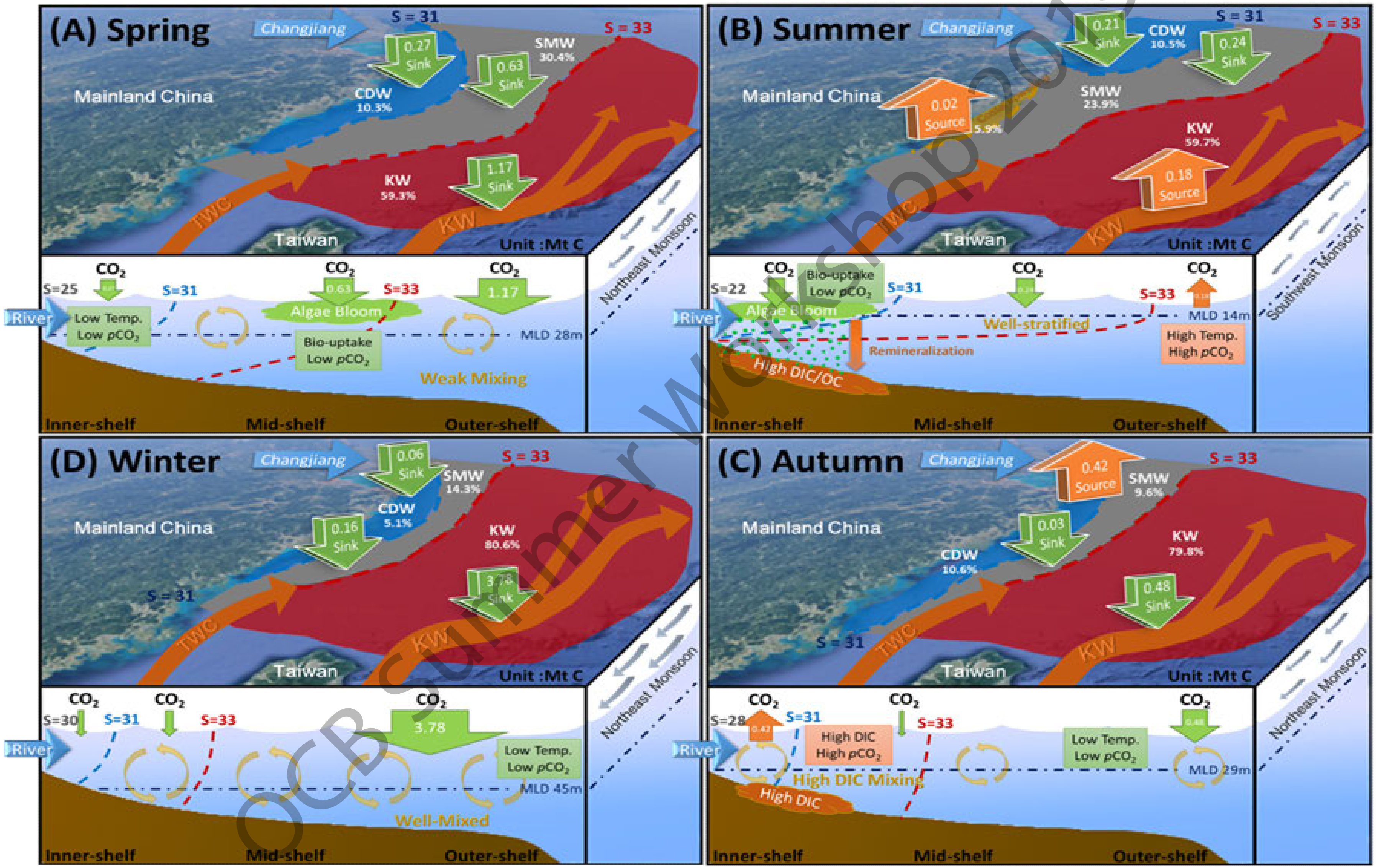
CO_2 Dynamics/Fluxes in the ECS



Upper panel:
CO_2 budgets associated with water masses which arrows represent CO_2 sink/source (unit: Mt C).

Lower panel :
processes corresponding to the water masse from inner-shelf to outer-shelf.

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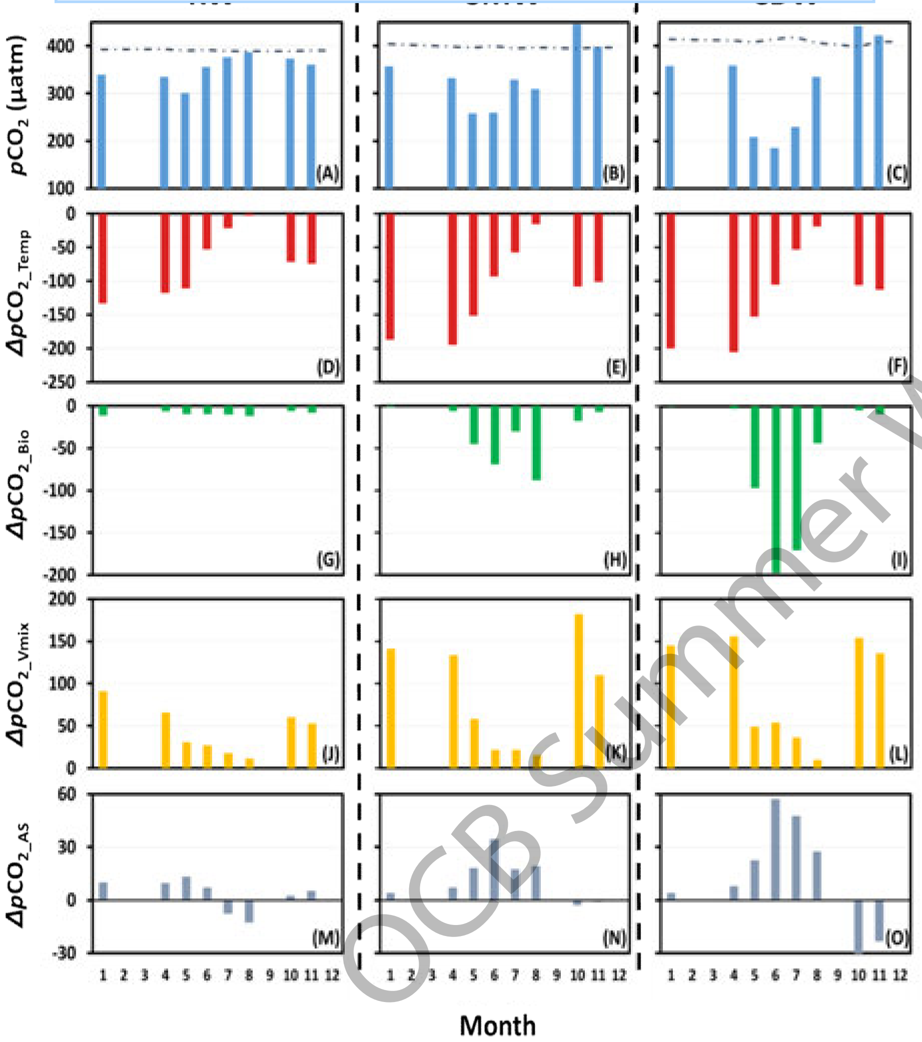
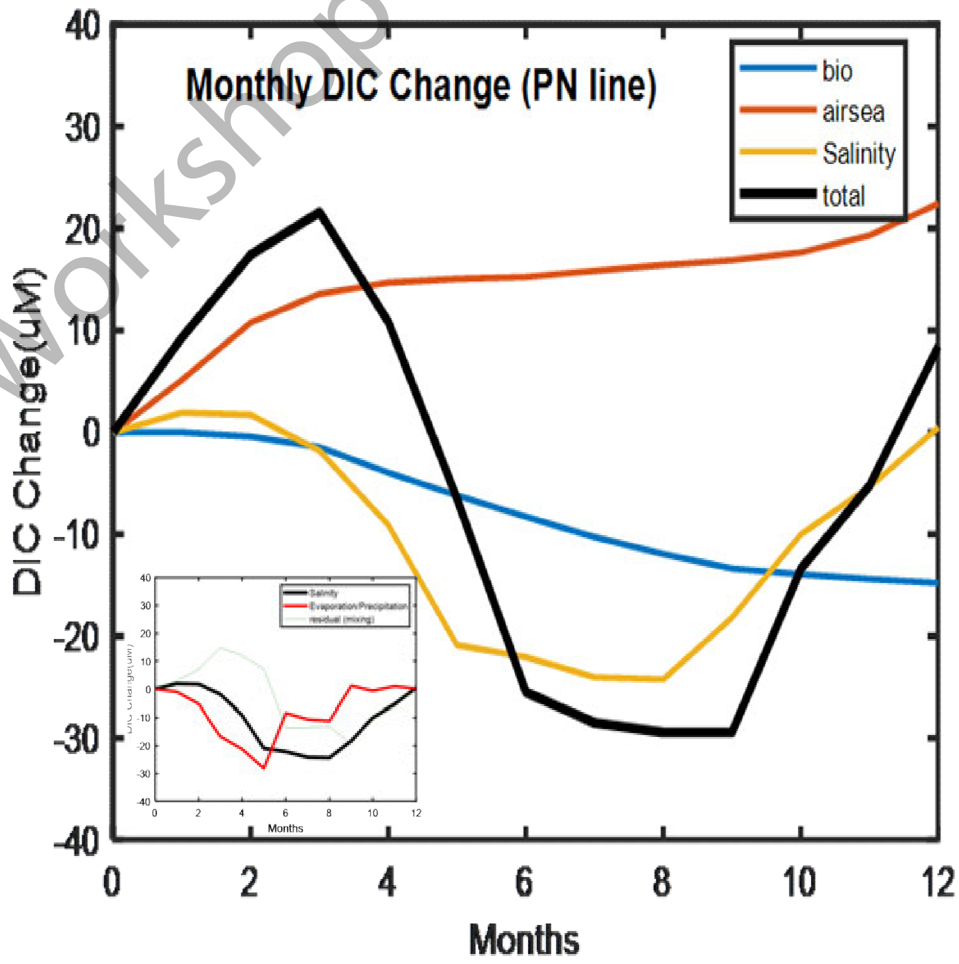
Quantifying Processes Controlling Surface pCO_2 in Varied Water Masses



$$pCO_{2\_Obs} = pCO_{2\_Ref} + \Delta pCO_{2\_Total}$$

$$\Delta pCO_{2\_Total} = \Delta pCO_{2\_Temp} + \Delta pCO_{2\_Bio} + \Delta pCO_{2\_Vmix} + \Delta pCO_{2\_AS}$$

II. Quantifying Processes Controlling the DIC Dynamics in Kuroshio surface waters at the PN Line



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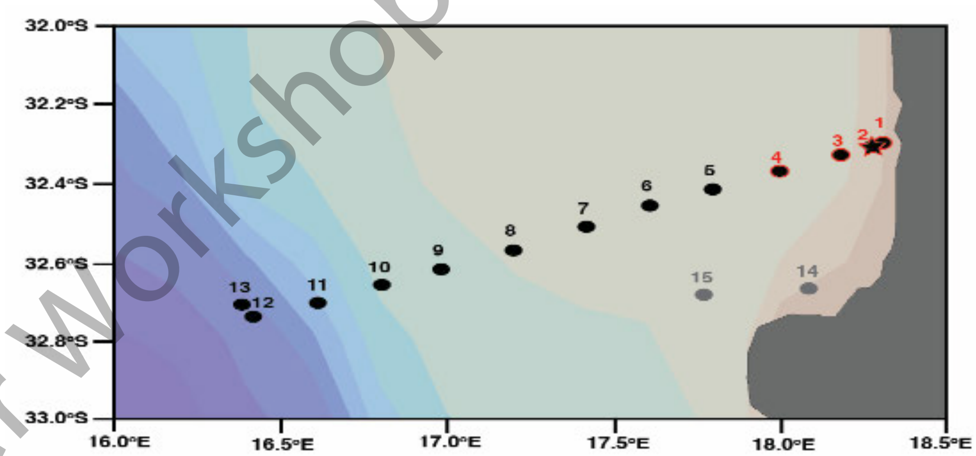
Temporal changes in nitrous oxide sources and sea-air fluxes in the Southern Benguela

Annie Bourbonnais (University of South Carolina)
Sarah Fawcett, Raquel Flynn, Jessica Burger (University of Cape Town, South Africa)
Mark Altabet (University of Massachusetts, Dartmouth)

N_2O is a potent **greenhouse gas** and stratospheric **ozone depleting** substance. The open ocean accounts for up to 30% of total N_2O emissions, but fluxes in highly productive or low-O_2 coastal regions are still poorly quantified.



Stations sampled:

a) 10 day experiment in Elands Bay, December 2016 (1 stn, star)
b) transect in the Southern Benguela in Feb 2017 (period of upwelling, black dots), and Aug 2017 (non upwelling period, red circles and numbers).

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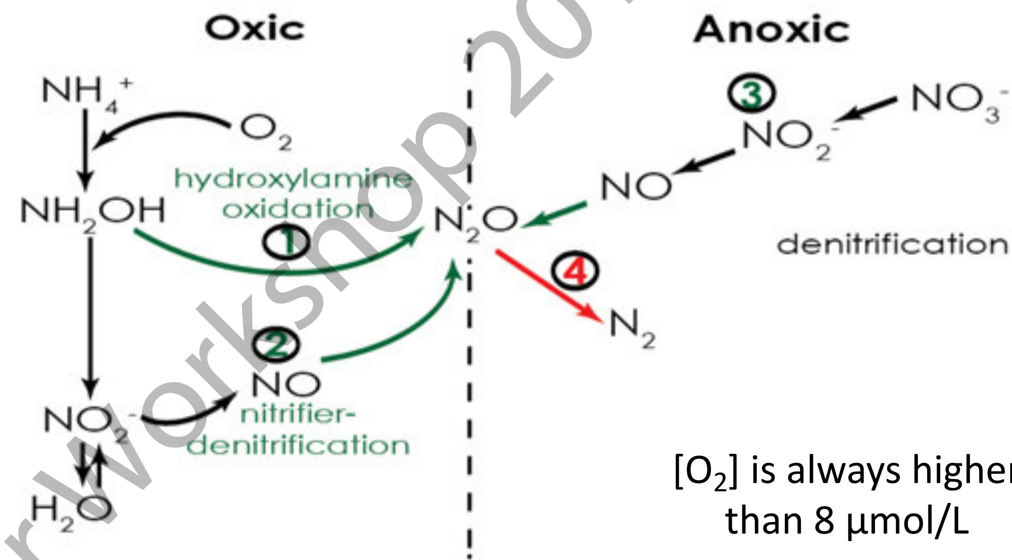
Temporal changes in nitrous oxide sources and sea-air fluxes in the Southern Benguela

1) What are the sources of water column N_2O?

2) What is the temporal variability of N_2O emissions?

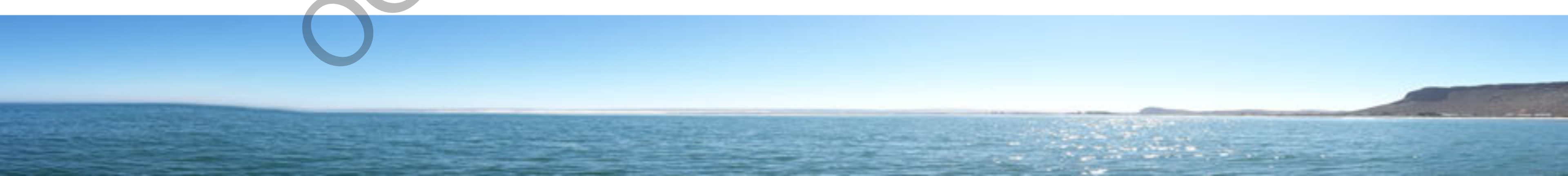
3) Is the sea-air flux of N_2O significant in this region?



$[O_2]$ is always higher than 8 µmol/L

Microbial N_2O production (green) and consumption (red).

We measured N_2O concentrations, isotopes and isotopomers to distinguish between these different processes.



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Temporal changes in nitrous oxide sources and sea-air fluxes in the Southern Benguela

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1) What are the sources of water column N_2O?

→ Temporal variations in N_2O sources: nitrification/denitrification in the sediments (Feb and Aug 2017) versus water-column nitrification (Dec 2016).

2) What is the temporal variability of N_2O emissions?

→ Highest in Feb and Aug 2017. Lowest in Dec 2016 after an upwelling event.

3) Is the sea-air flux of N_2O significant in this region?

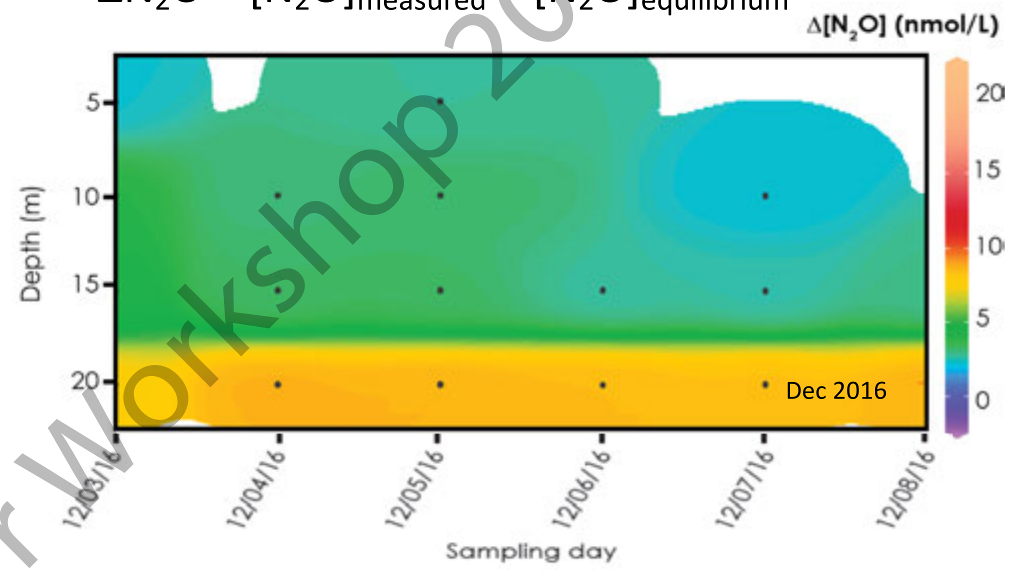
→ Fatm = 0 to 9 µmol m^{-2} d^{-1}

Peru coast: 459 to 1,825 µmol m^{-2} d^{-1}

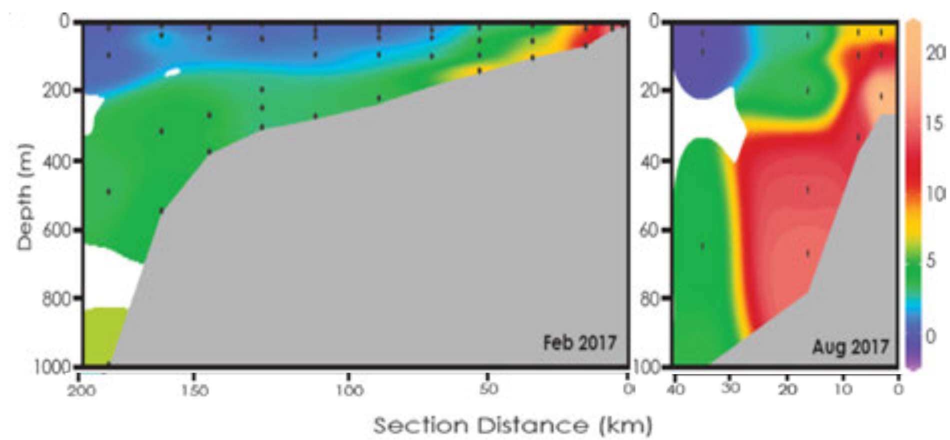
Northern Benguela:

-1.8 to 45.6 µmol m^{-2} d^{-1}

$\Delta N_2O = [N_2O]_{measured} - [N_2O]_{equilibrium}$

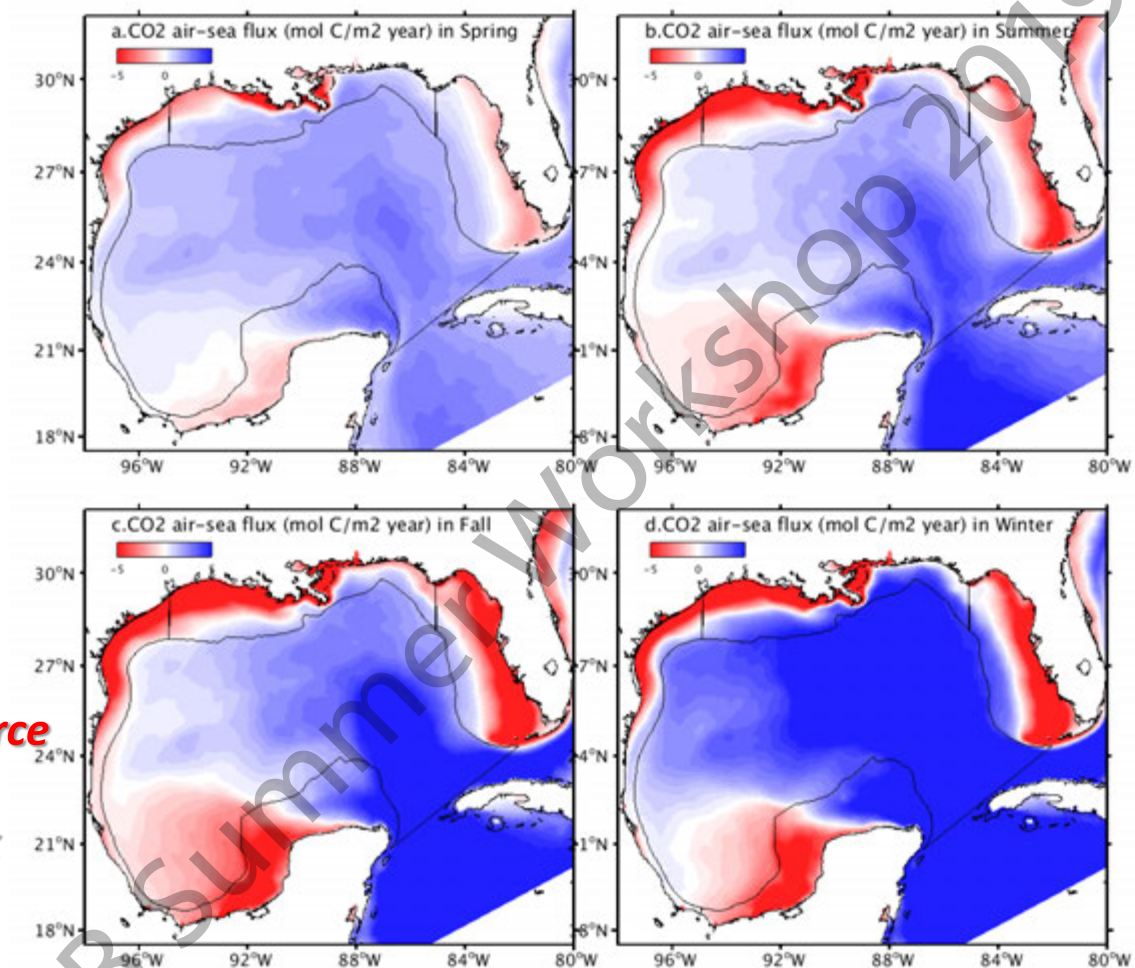


ΔN_2O = 8 nmol L^{-1}, 177% supersaturation)



ΔN_2O = 22 nmol L^{-1}, 305% supersaturation).

Air-Sea CO2 Flux Seasonality



Red:
ocean is carbon source
Blue:
ocean is carbon sink

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

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

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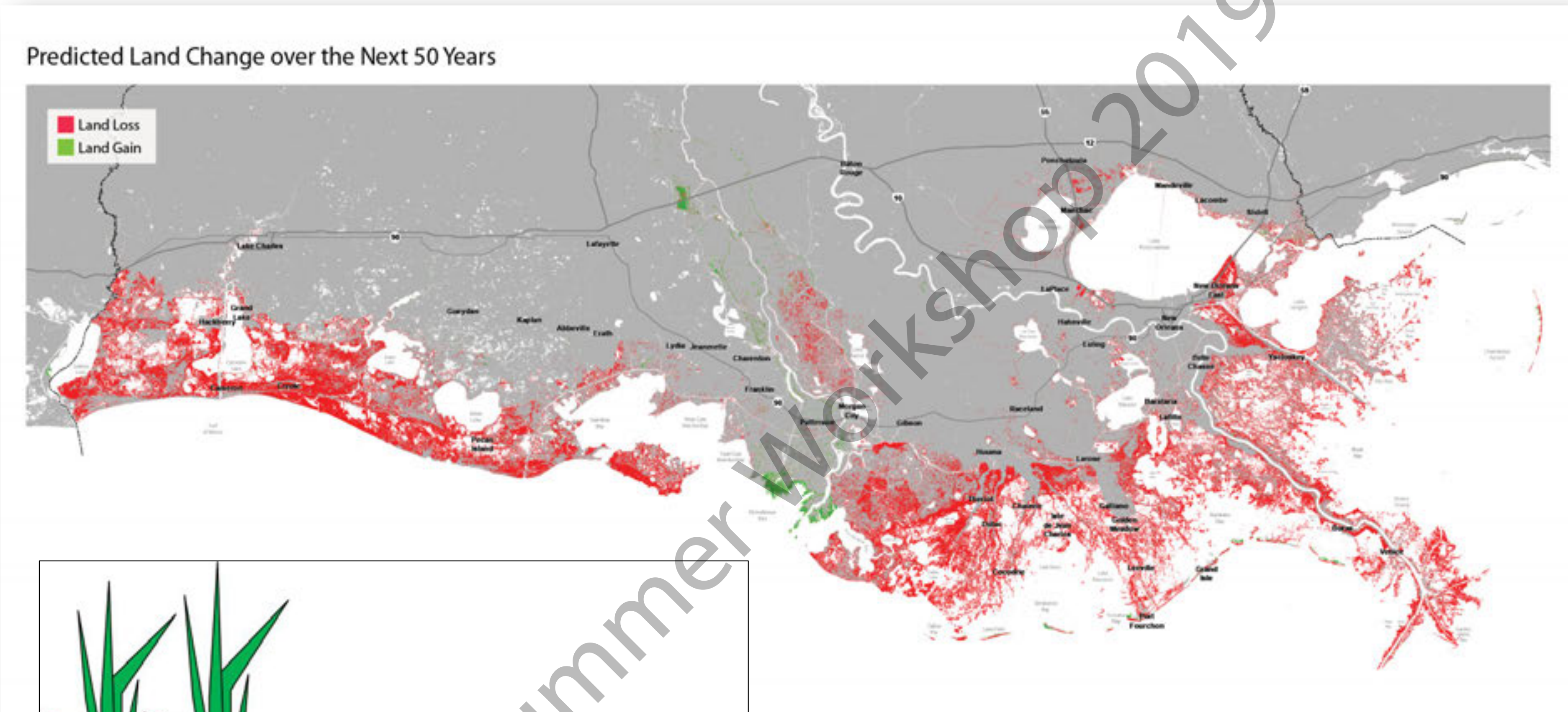
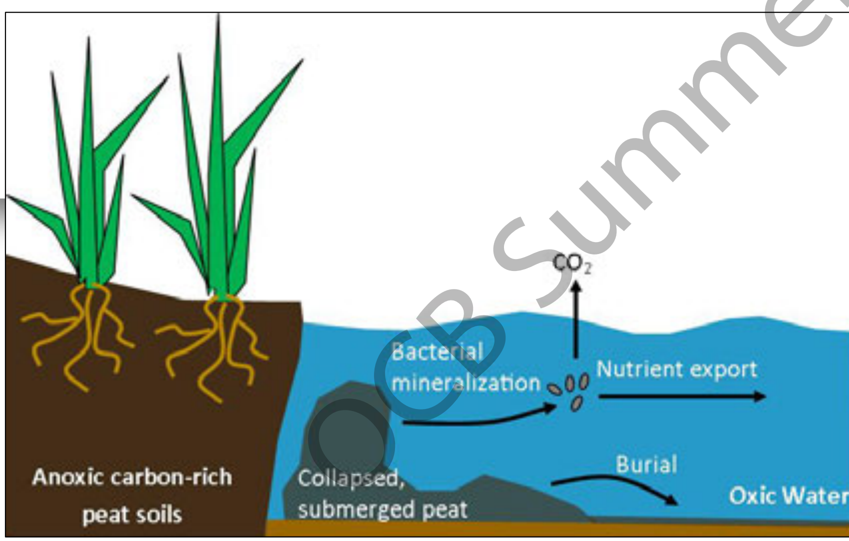
Carbon from Eroded Soil





Average Louisiana peat soil contains 0.09 g C cm^{-3}
Barataria Bay : 1,750 giga (10^9) gram of carbon
7% of riverine input!

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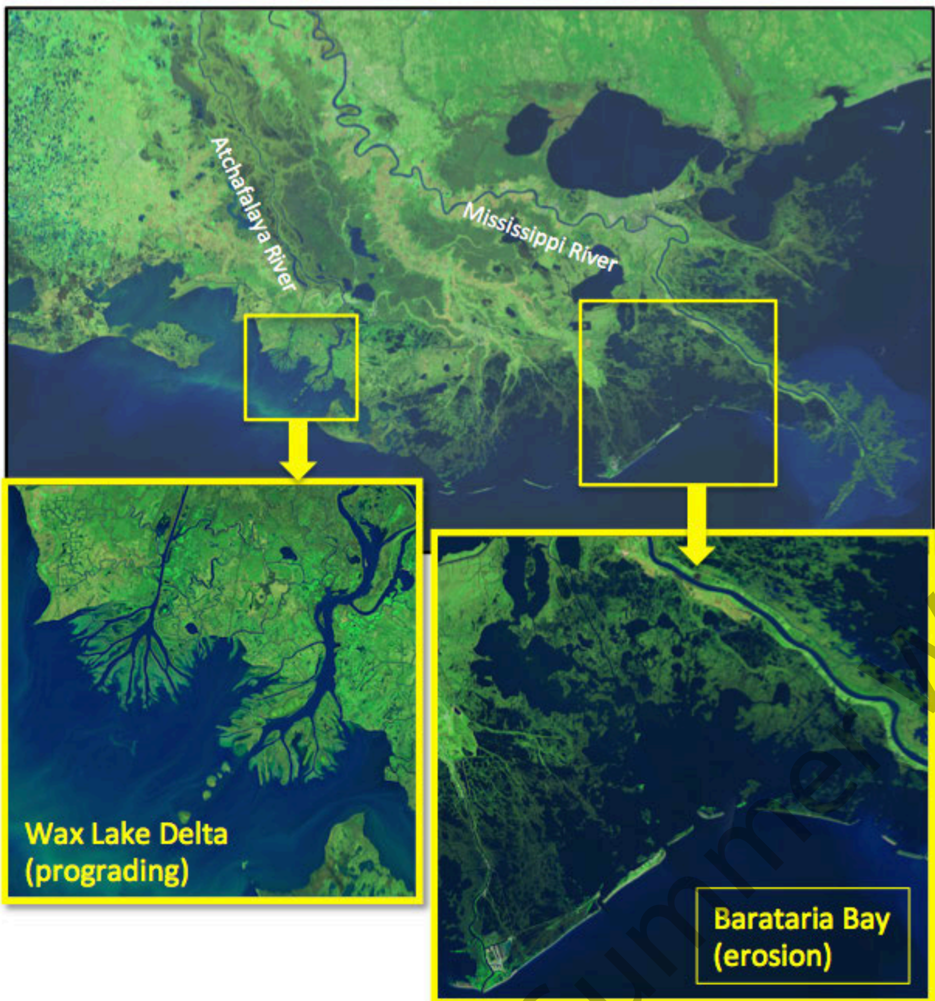

Emerging yet Struggling!

Understanding and Quantifying Carbon Export to Coastal Oceans through Deltaic Systems

Wetland survey + Coastal Survey + Remote Sensing + Numerical Modeling

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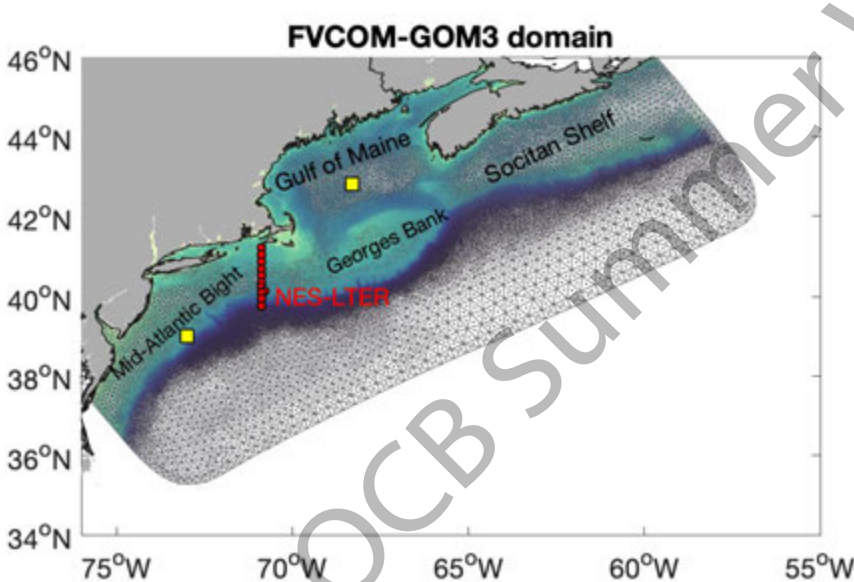
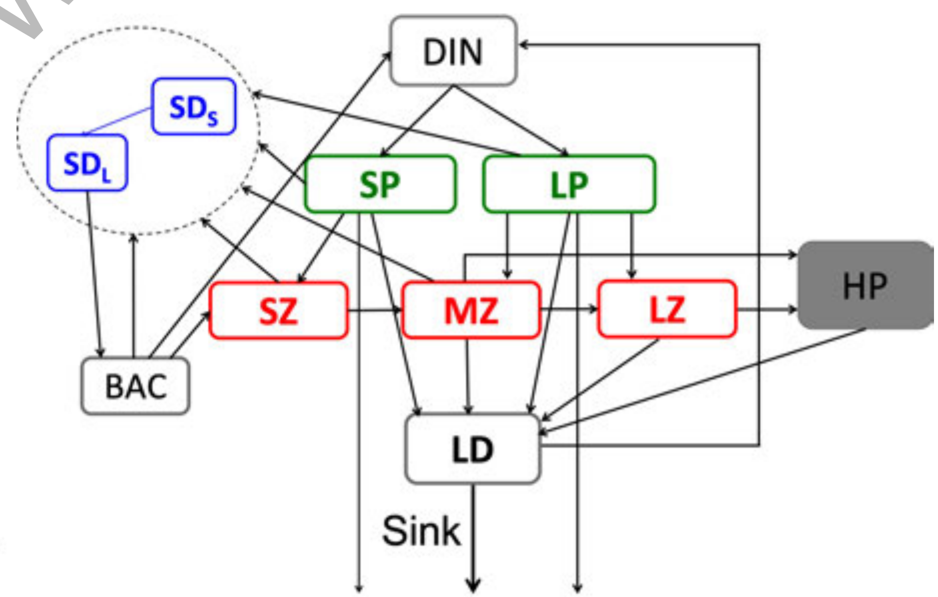
Modeling the Phytoplankton Bloom Dynamics on the Northwest Atlantic Shelf: Spatial Heterogeneity and Seasonal Variability

Zhixuan Feng, Rubao Ji, Cabell Davis, and Heidi Sosik
Woods Hole Oceanographic Institution
Changsheng Chen
University of Massachusetts Dartmouth



Northeast Coastal Ocean Forecast System (NECOFS; Chen et al. 2011)



Stock & Dunne 2010; Song et al. 2010&2011

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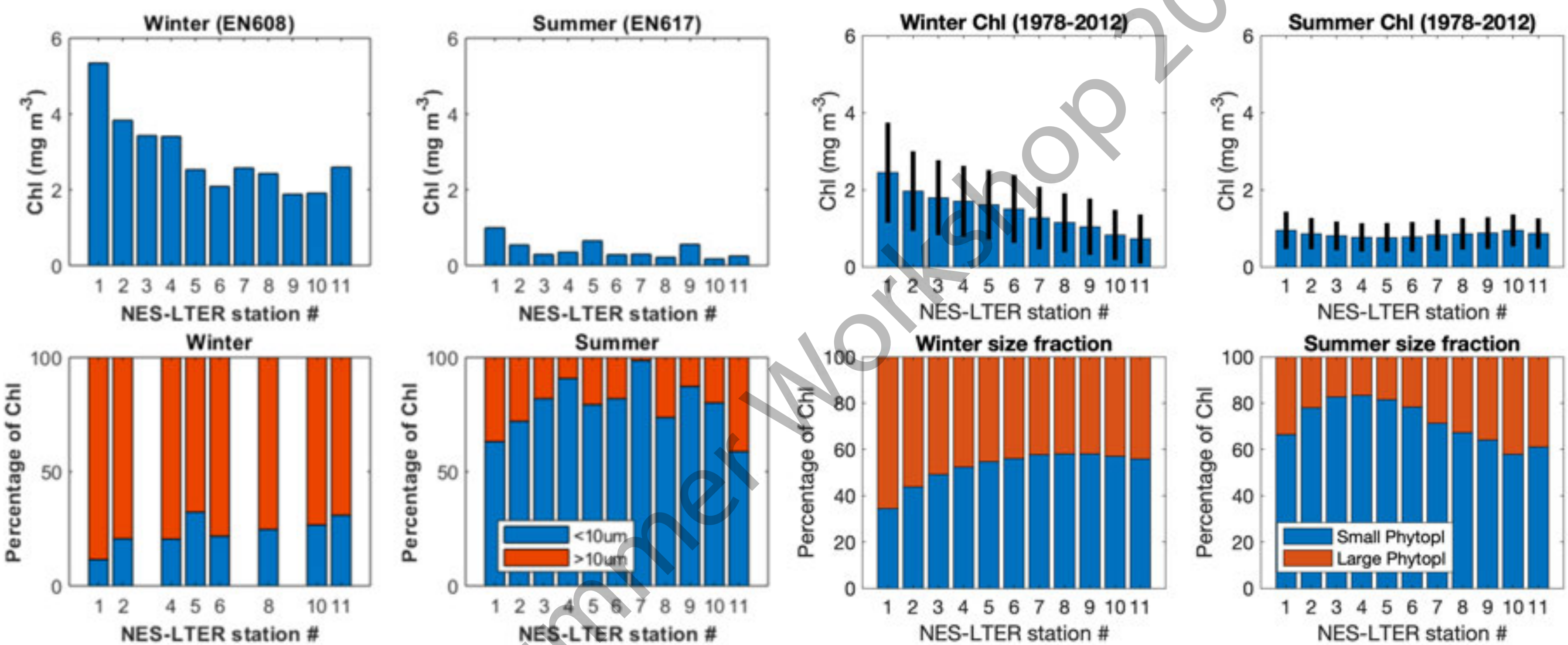
NES-LTER Observations Model Results



- ❑ Contrasting production and trophic-level energy transfer regimes:
- ➢ **Winter-spring:** nutrient rich, high productivity, large phytoplankton dominated, and high export efficiency.
- ➢ **Summer:** nutrient depleted, low productivity, small phytoplankton dominated, and low export efficiency.

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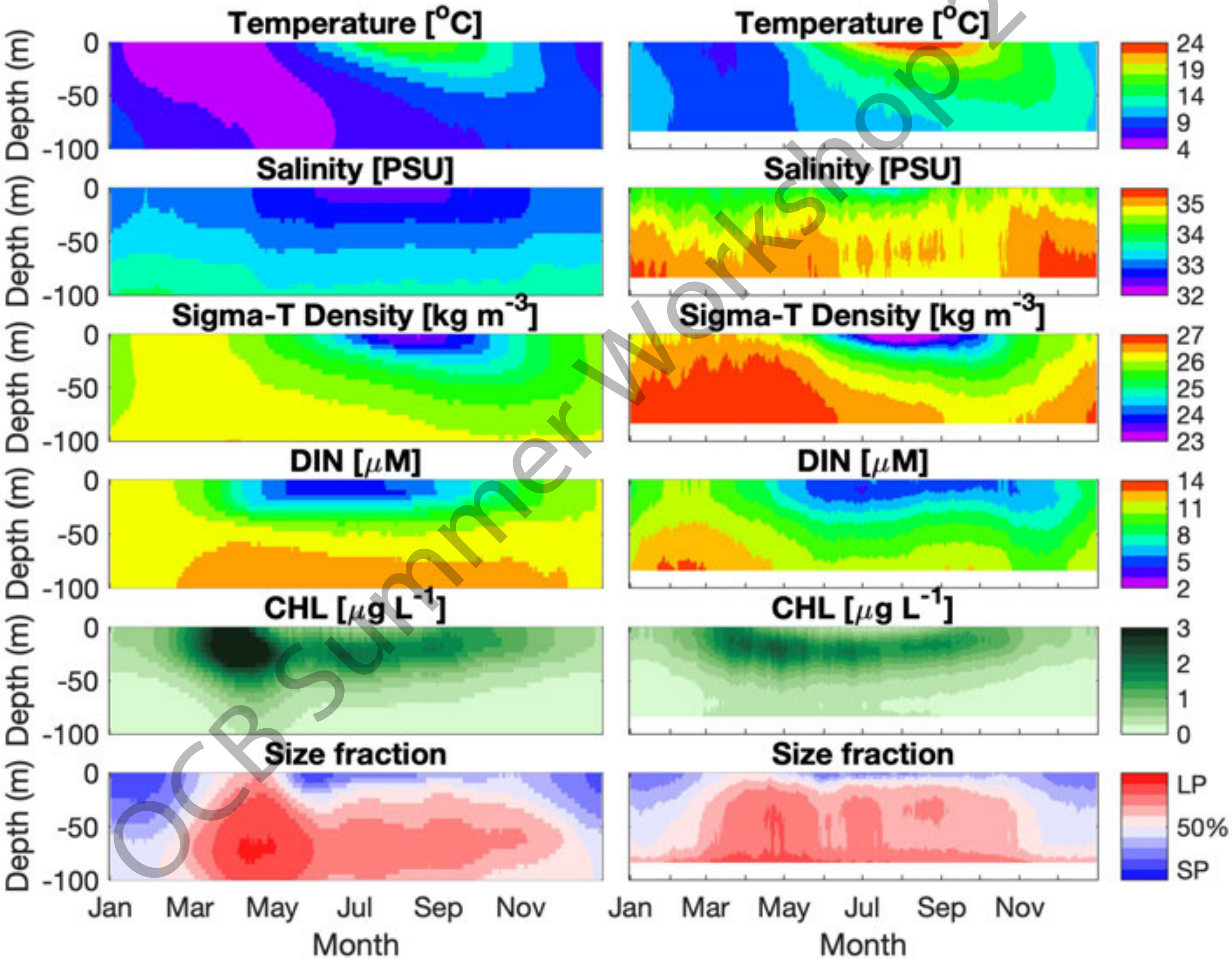
Gulf of Maine   Mid-Atlantic Bight



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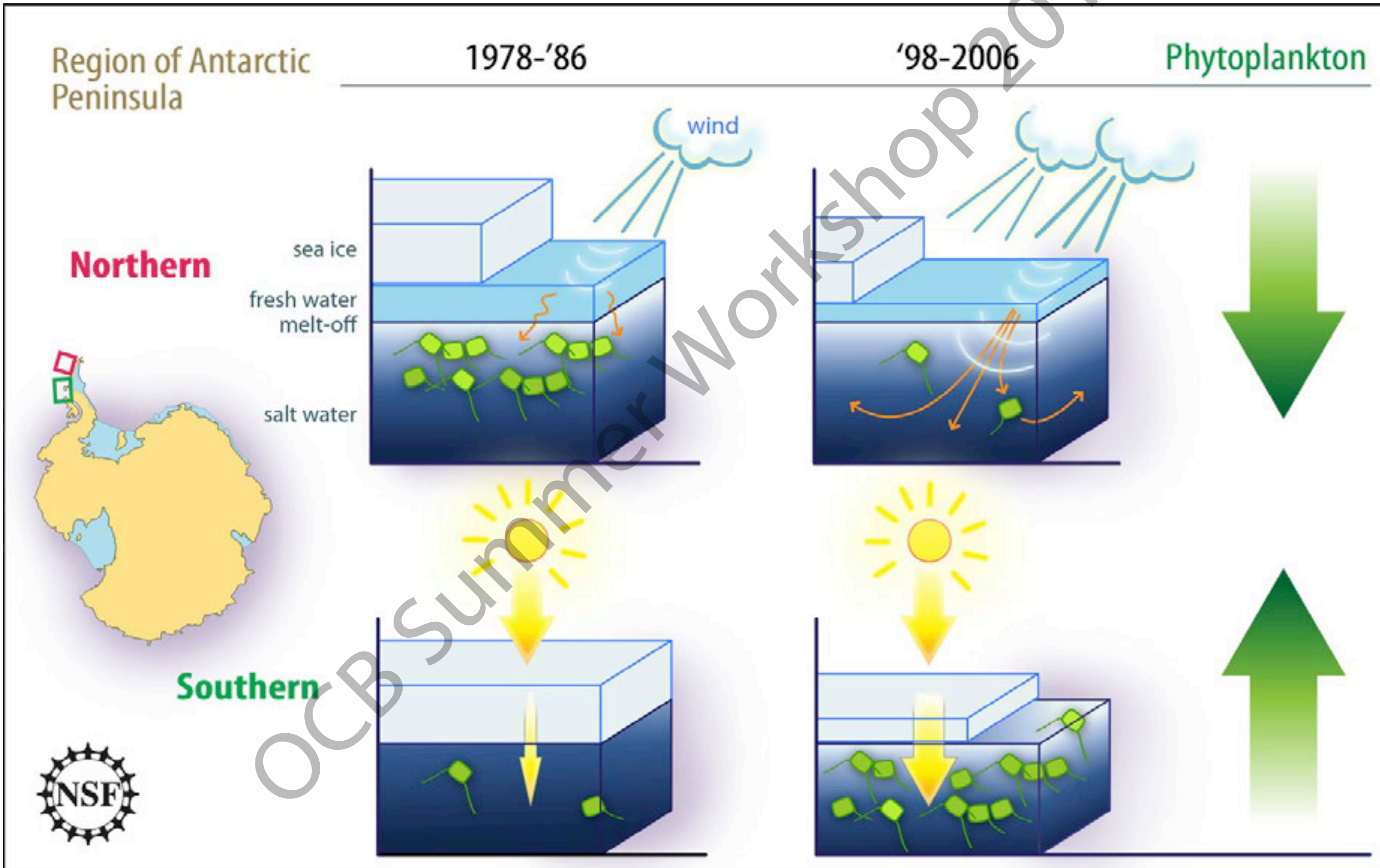
Modeling the Antarctic Peninsula biogeochemistry

Cristina Schultz



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Freshwater influence

- **Sources:**
  - Meteoric (glacial discharge and precipitation)
  - Icebergs
  - Sea ice
- **Influence:**
  - Stratification
  - Light
  - Nutrients (specially iron!)

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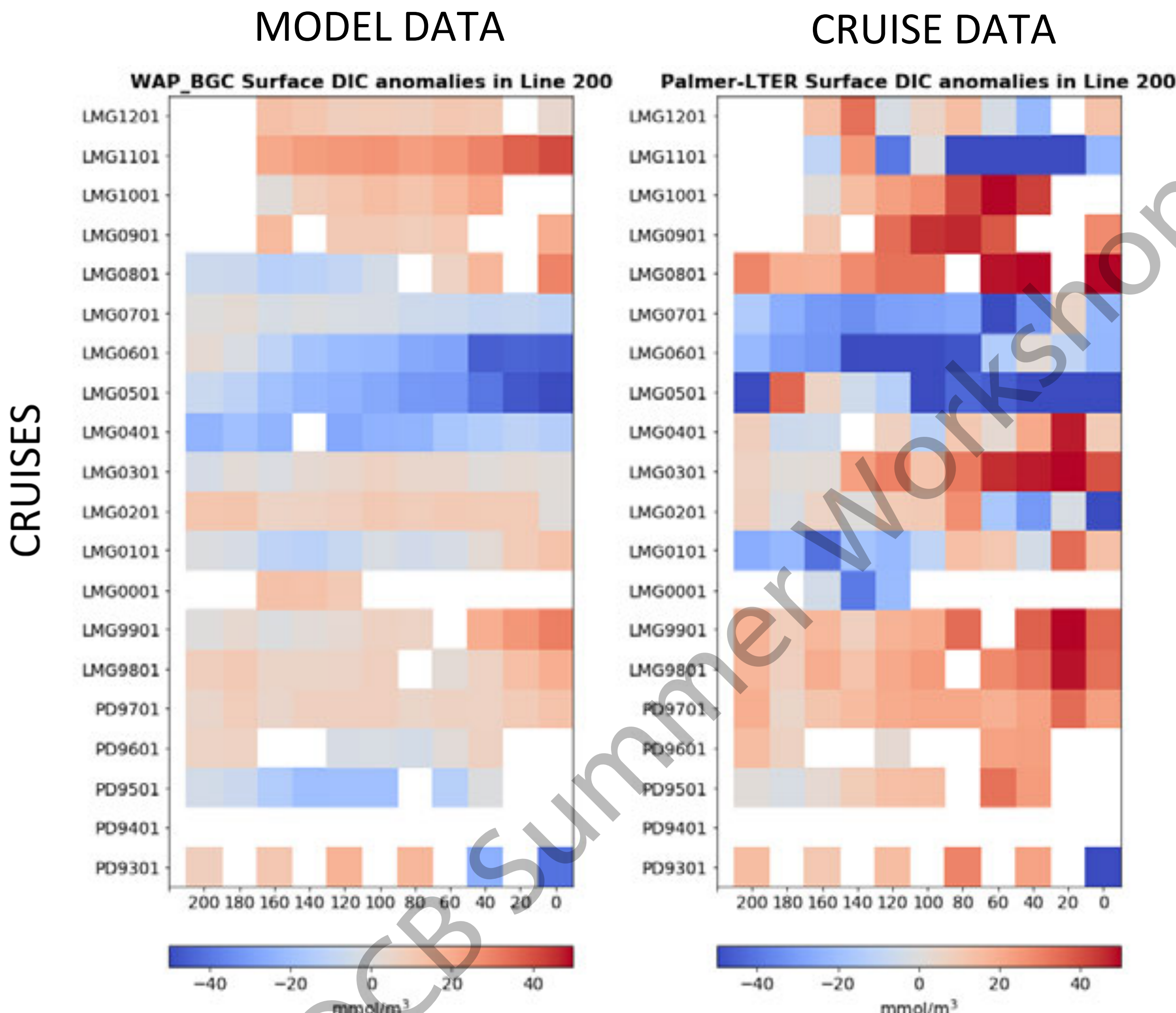
DIC anomalies



- Circulation, sea ice and biogeochemistry model (MITgcm, REcoMv2)
- Need for more iron and inorganic carbon data

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Springtime export of Arctic sea ice shapes the phytoplankton production in the Greenland Sea

Nicolas Mayot*, P. Matrai, A. Arjona, S. Bélanger, C. Marchese, T. Jaegler, M. Ardyna and M. Steele

*Bigelow Laboratory for Ocean Sciences, Maine, USA – nmayot@bigelow.org

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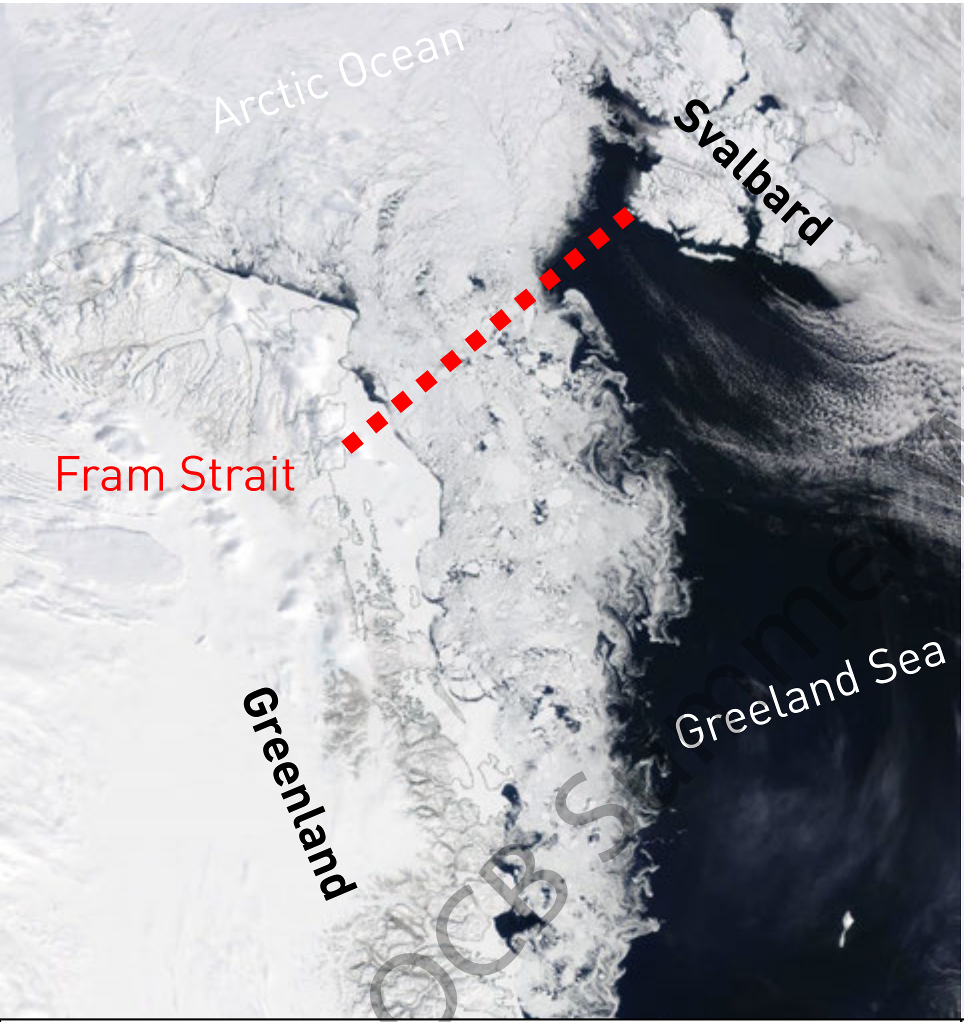
Bigelow | Laboratory for Ocean Sciences

Ocean Biology and Biogeochemistry program

NASA WORLDVIEW



May 04, 2011	April 28, 2016

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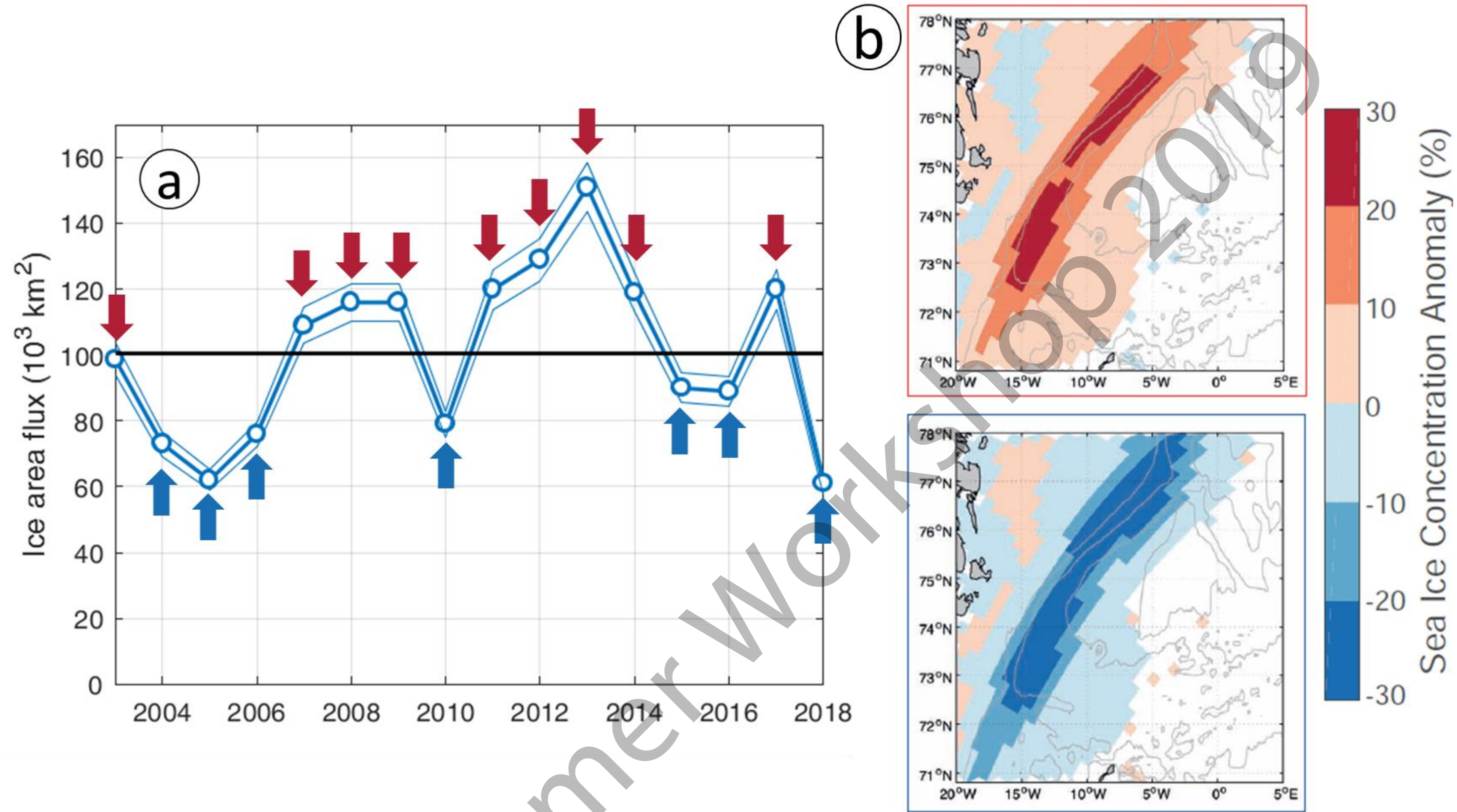
Relationship between the exported Arctic sea ice and the sea ice distribution in the Greenland Sea



Nicolas Mayot

Post-doctoral Researcher
Bigelow Laboratory for Ocean Sciences

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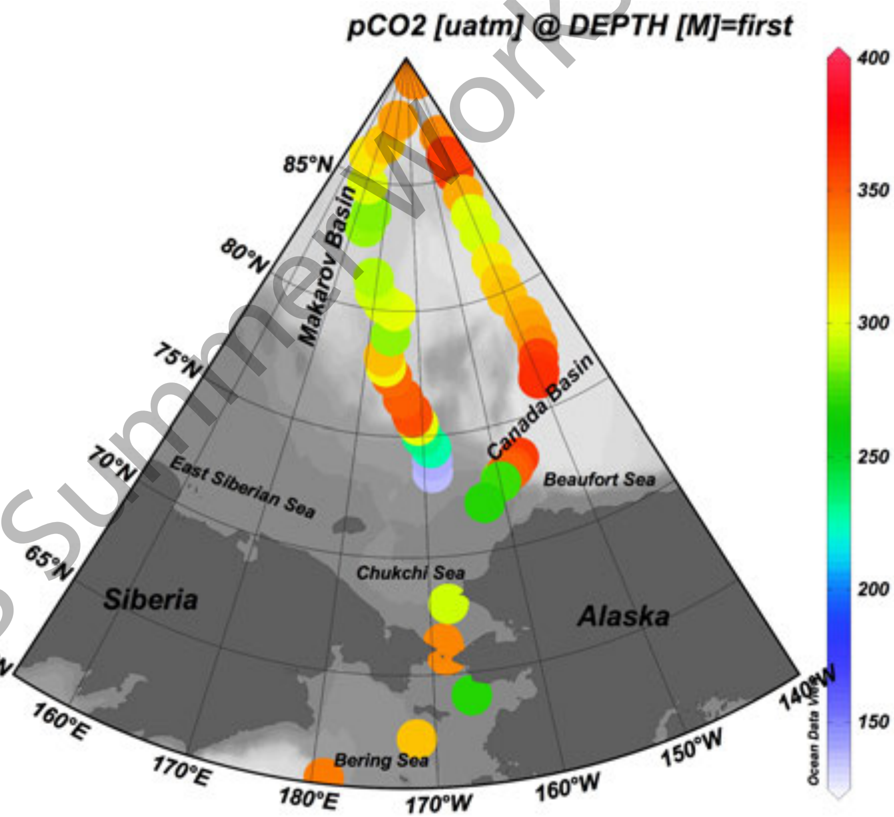
Freshening of the Western Arctic Negates Anthropogenic Carbon Uptake Potential

Ryan J. Woosley



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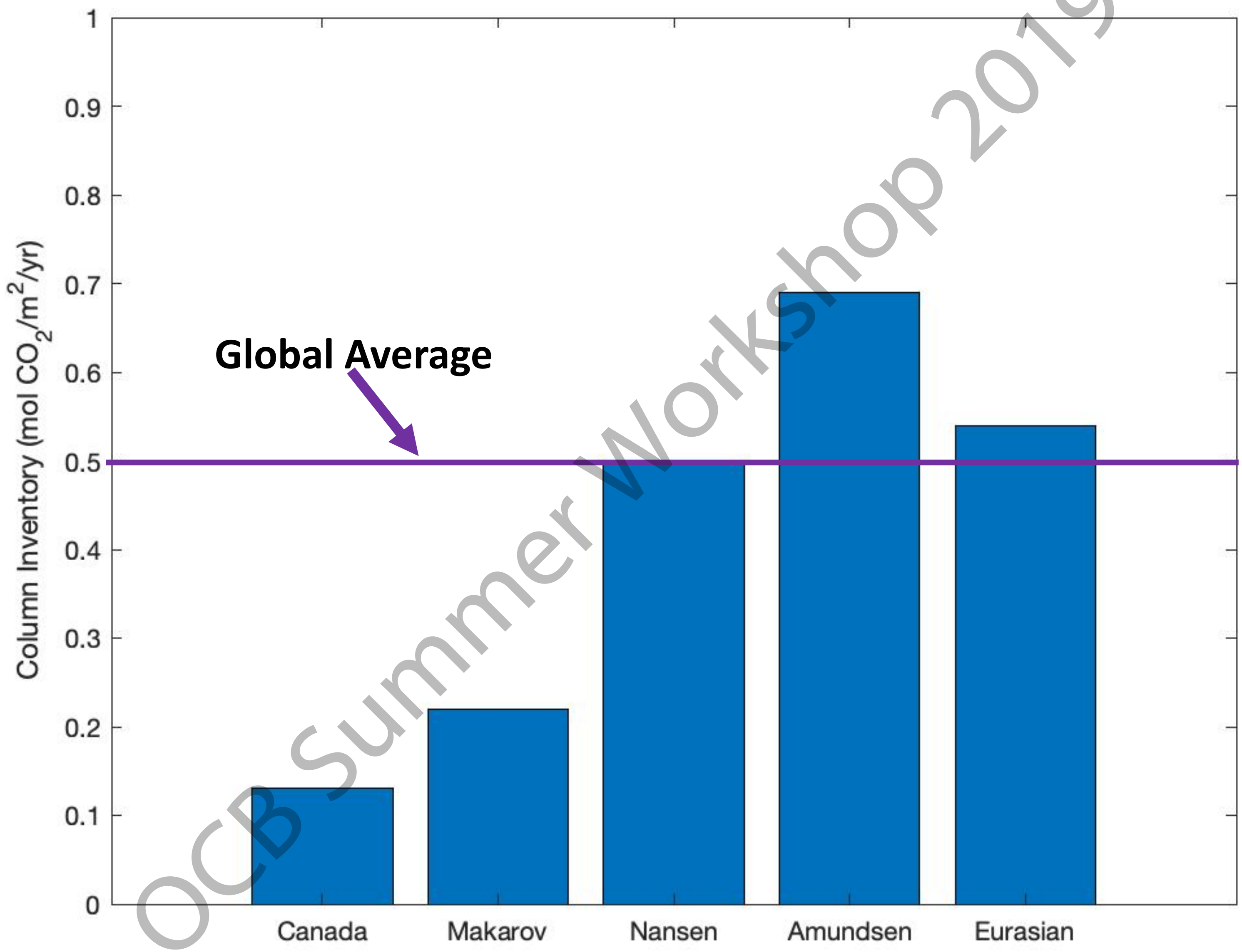
Massachusetts Institute of Technology

Anthropogenic Carbon Uptake Across the Arctic



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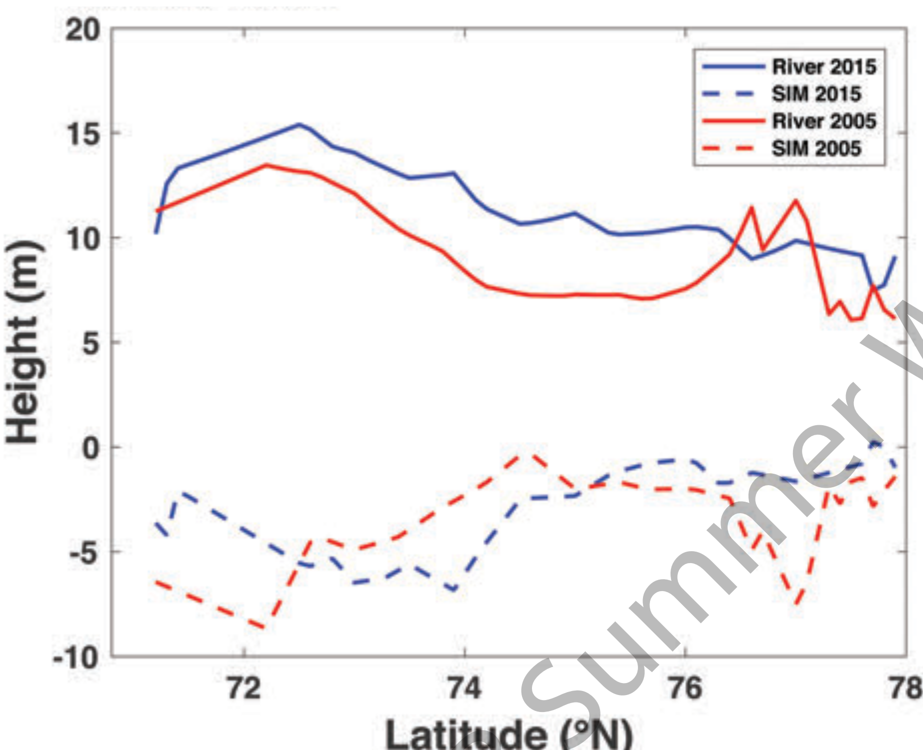
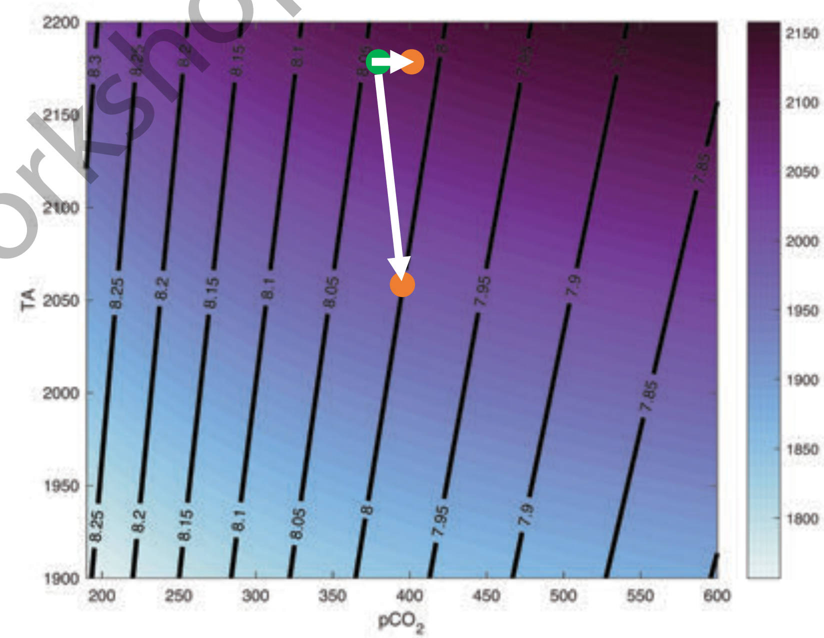
Canada Basin Freshwater



Two Degrees of Carbon



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