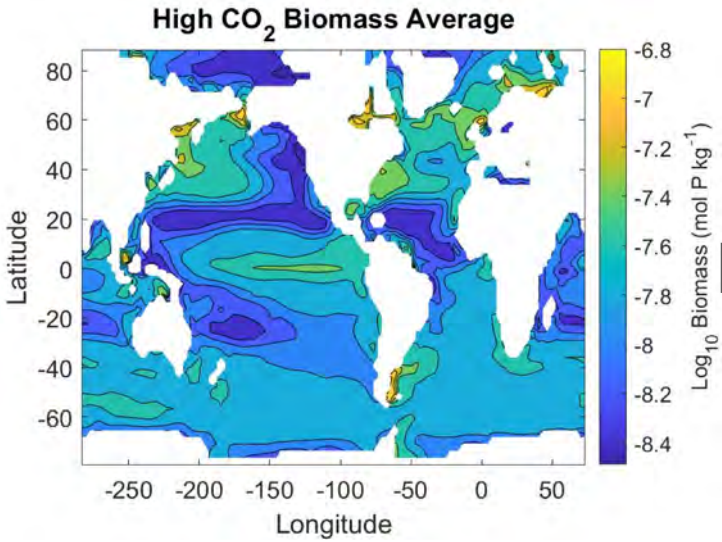
2019 OCB Workshop

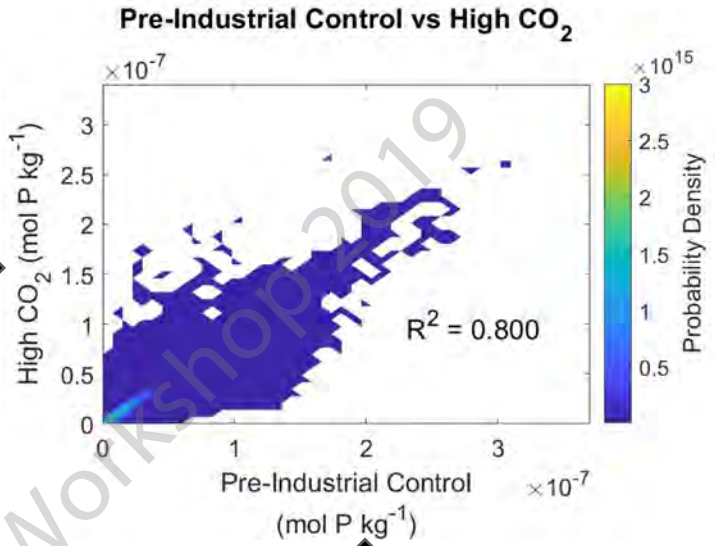
Graduate Student Lightning Session

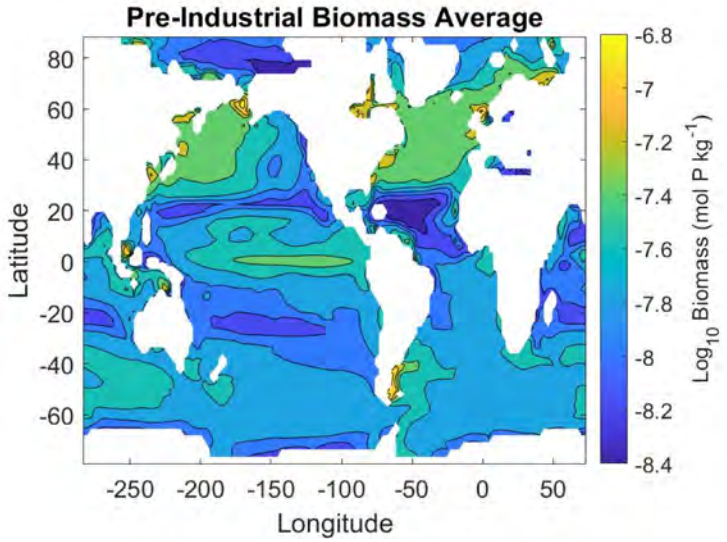
Woods Hole Oceanographic Institution
June 24, 2019

Comparing Biogeochemical Model Outputs using Neural Network Ensembles

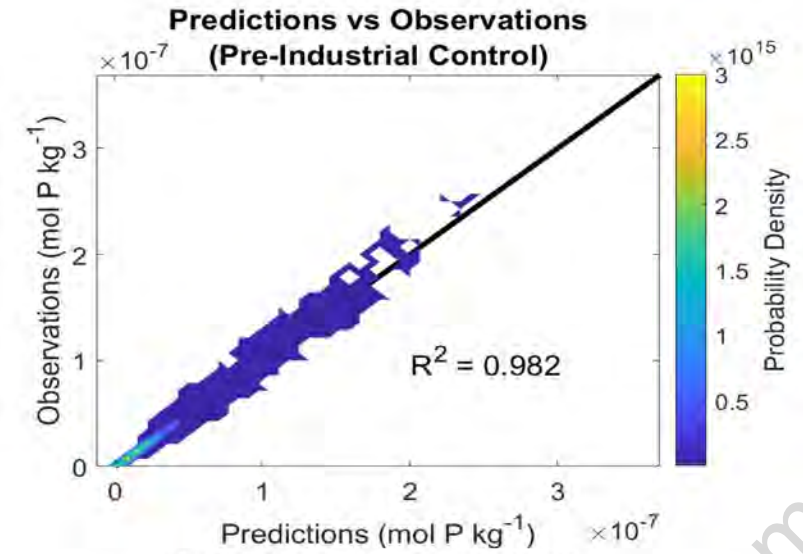
Christopher Holder and Anand Gnanadesikan
Johns Hopkins University

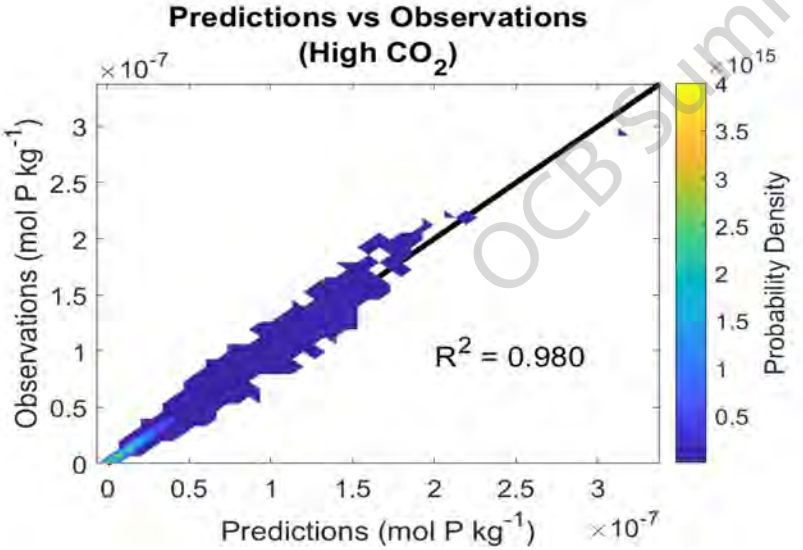




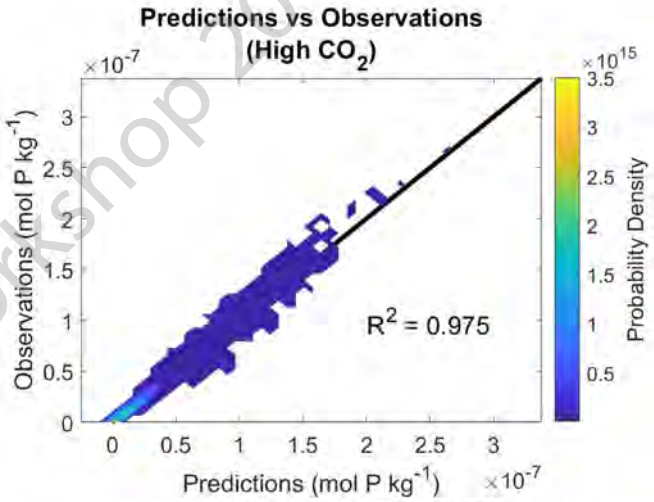


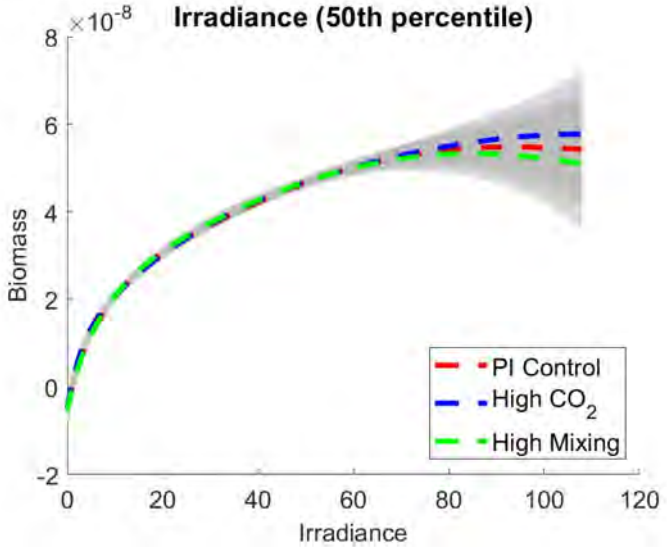
Can neural networks reproduce the results of a biogeochemical model?





Can neural networks be used to show the same apparent relationships between simulations?

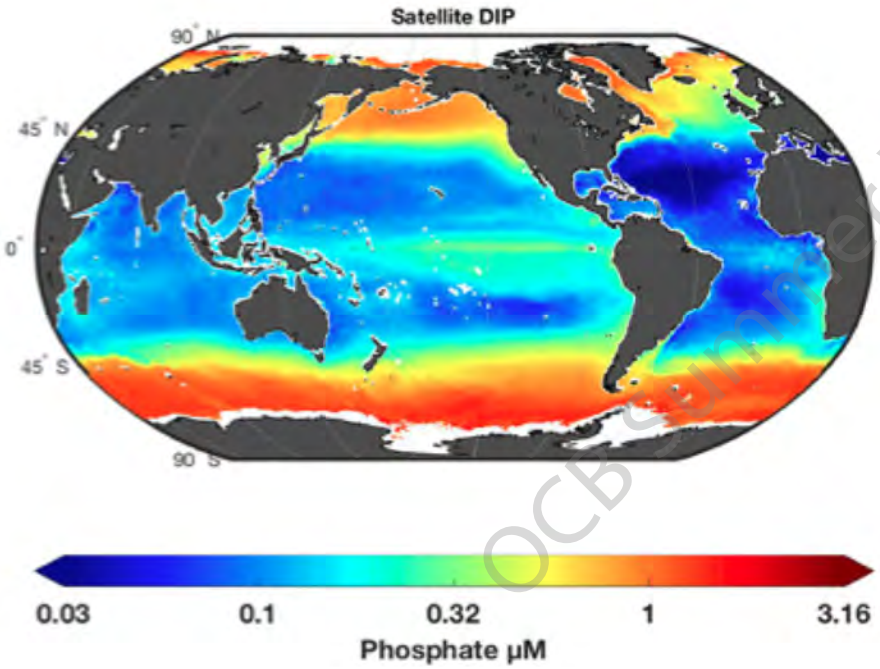




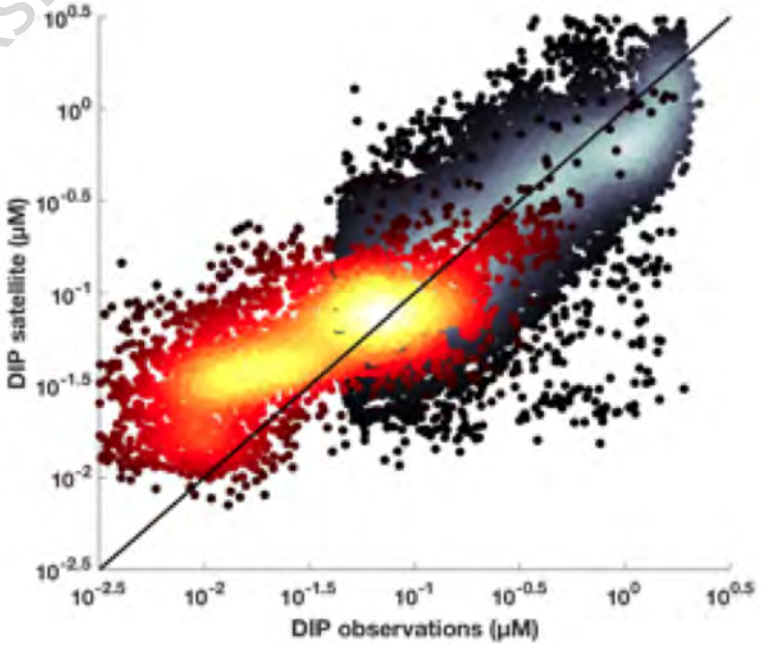
Remote Sensing of Surface Ocean Phosphate

Catherine A. Garcia[1], Toby K. Westberry[3], Michael J. Beherenfeld[3], and Adam C. Martiny[1,2]

We predict 73% of the variation in surface ocean phosphate concentration using remote sensing inputs to a neural network model.

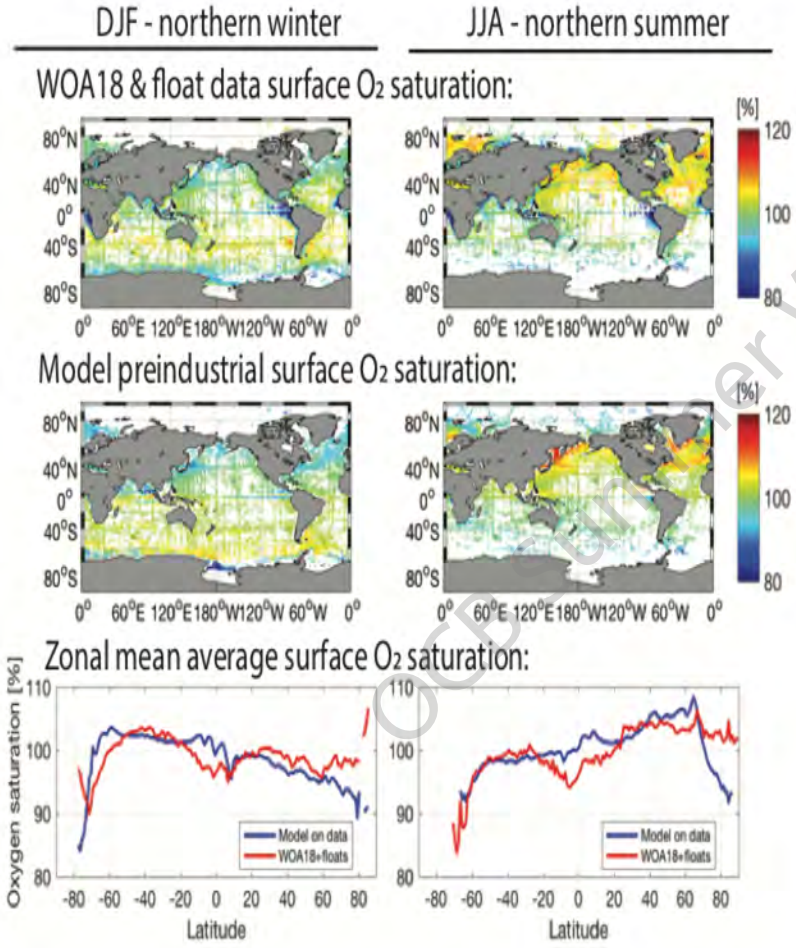


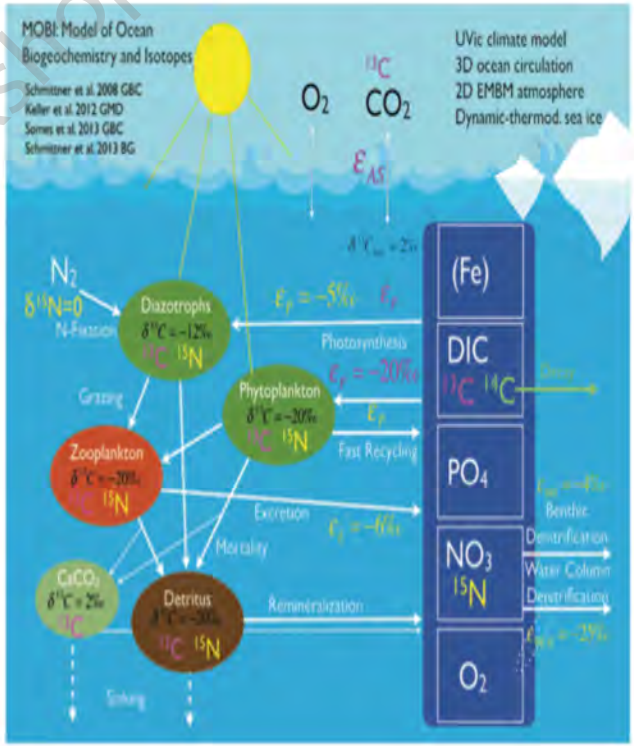
Including database of high sensitivity DIP measurements improves prediction at lowest concentrations.



Glacial Deep Ocean Deoxygenation Driven By Biologically Mediated Air-Sea Disequilibrium

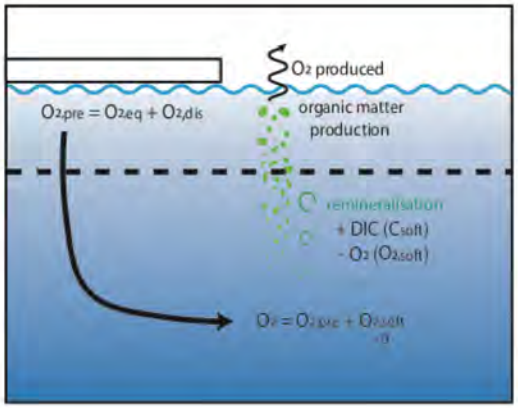
Ellen Cliff[1] (ellen.cliff@earth.ox.ac.uk), Samar Khatiwala[1], Andreas Schmittner[2], Juan Muglia[2]
1. Department of Earth Sciences, University of Oxford, United Kingdom 2. COAS, Oregon State University, USA

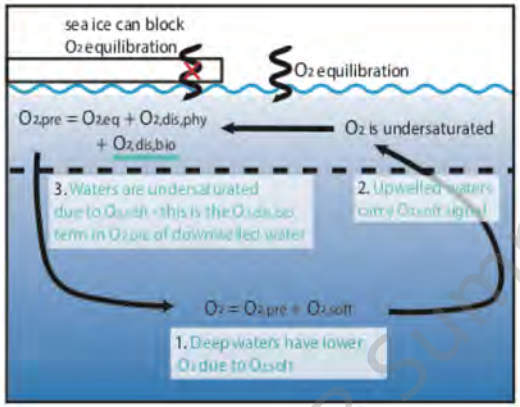


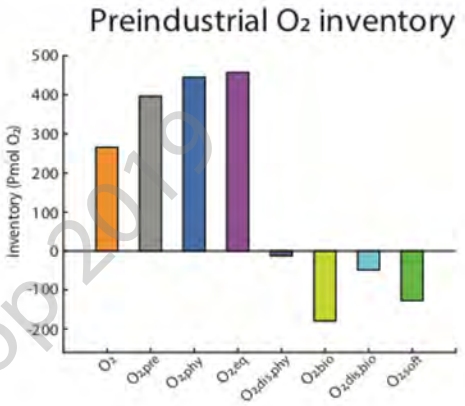


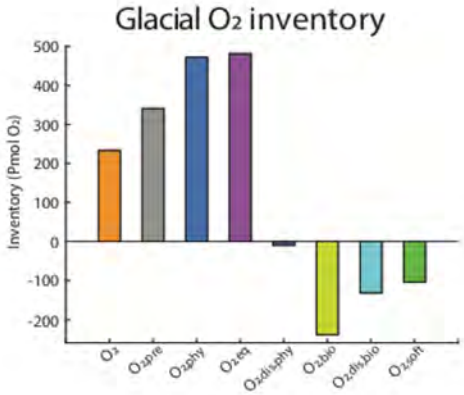
Biological contribution to O2 decomposition

Some results:





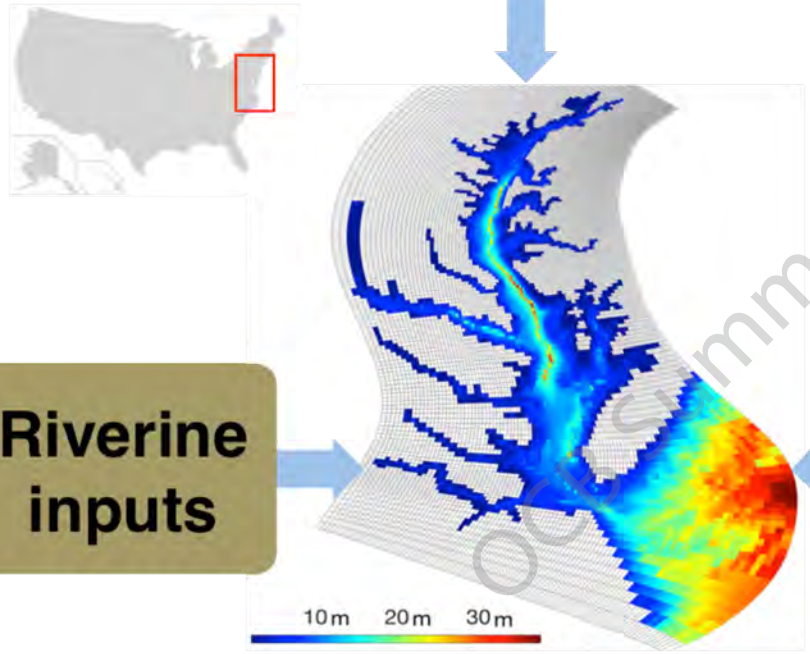




Impacts of atmospheric nitrogen deposition and coastal nitrogen fluxes on oxygen concentrations in Chesapeake Bay

Fei Da (fda@vims.edu), Marjorie Friedrichs, Pierre St-Laurent
Virginia Institute of Marine Science, William & Mary

Atmospheric inputs



Riverine inputs

Coastal fluxes

***Ches*ROMS-ECB**

Feng et al., 2015; Da et al., 2018

3-D Estuarine Carbon biogeochemistry model

River
Atmosphere
Coastal
(NO_3^- + NH_4^+)

Algal bloom

O_2

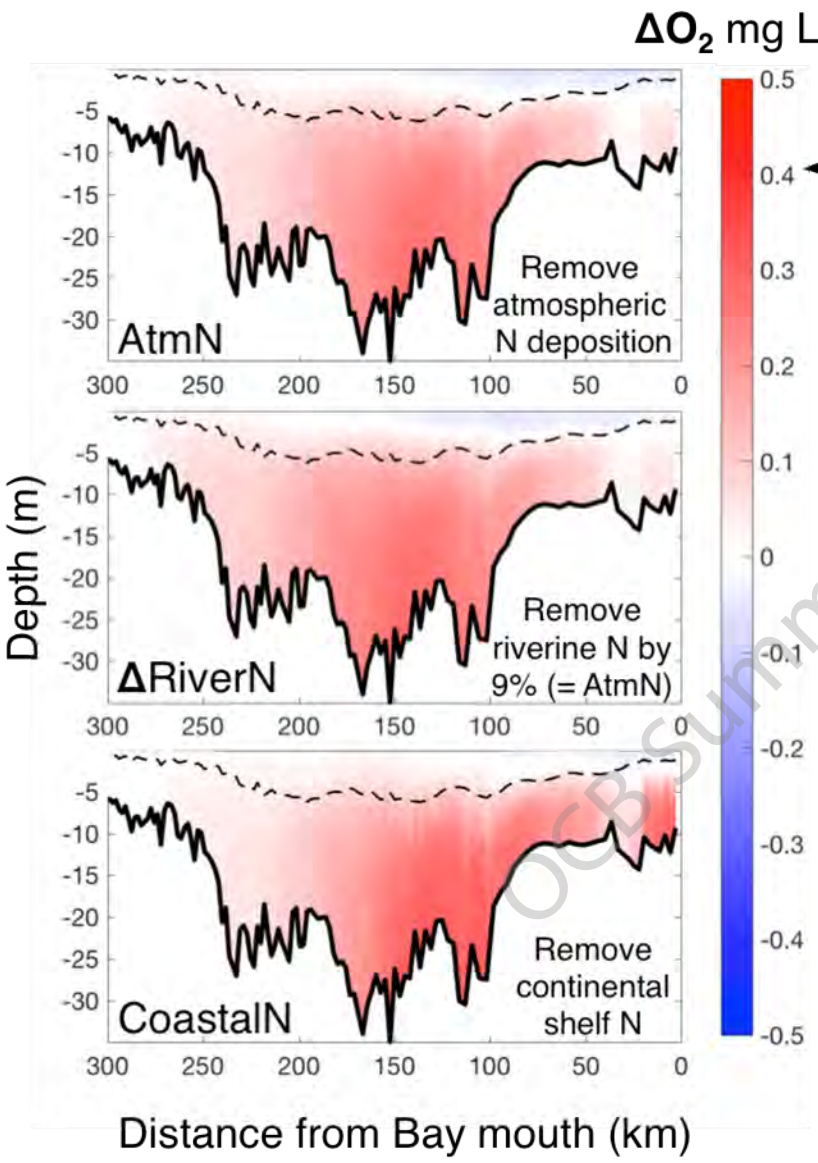
Decomposition

O_2

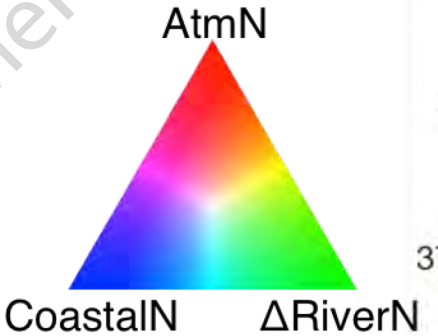
O_2

Hypoxia

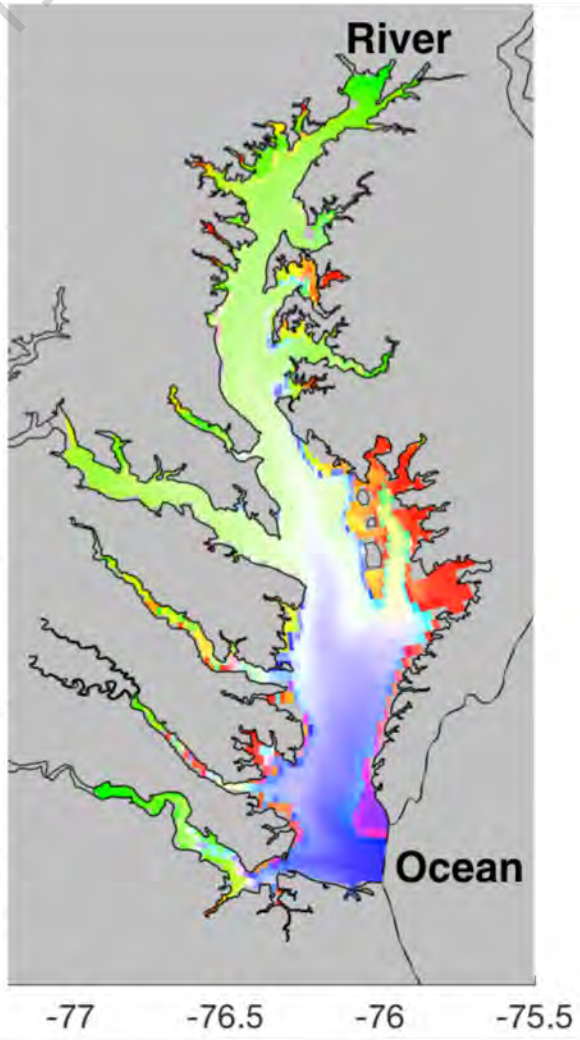
Impacts of atmospheric nitrogen deposition and coastal nitrogen fluxes on oxygen concentrations in Chesapeake Bay



Changes in O_2 due to reduced nitrogen inputs in the summer



Relative impacts on bottom O_2 in the summer



An organic source of alkalinity in the open ocean?

Michael Fong (mbfong@ucsd.edu) & Andrew Dickson,
Scripps Institution of Oceanography, UC San Diego

Poster Presenter:
Michael Fong

Observations of the widespread presence of excess alkalinity

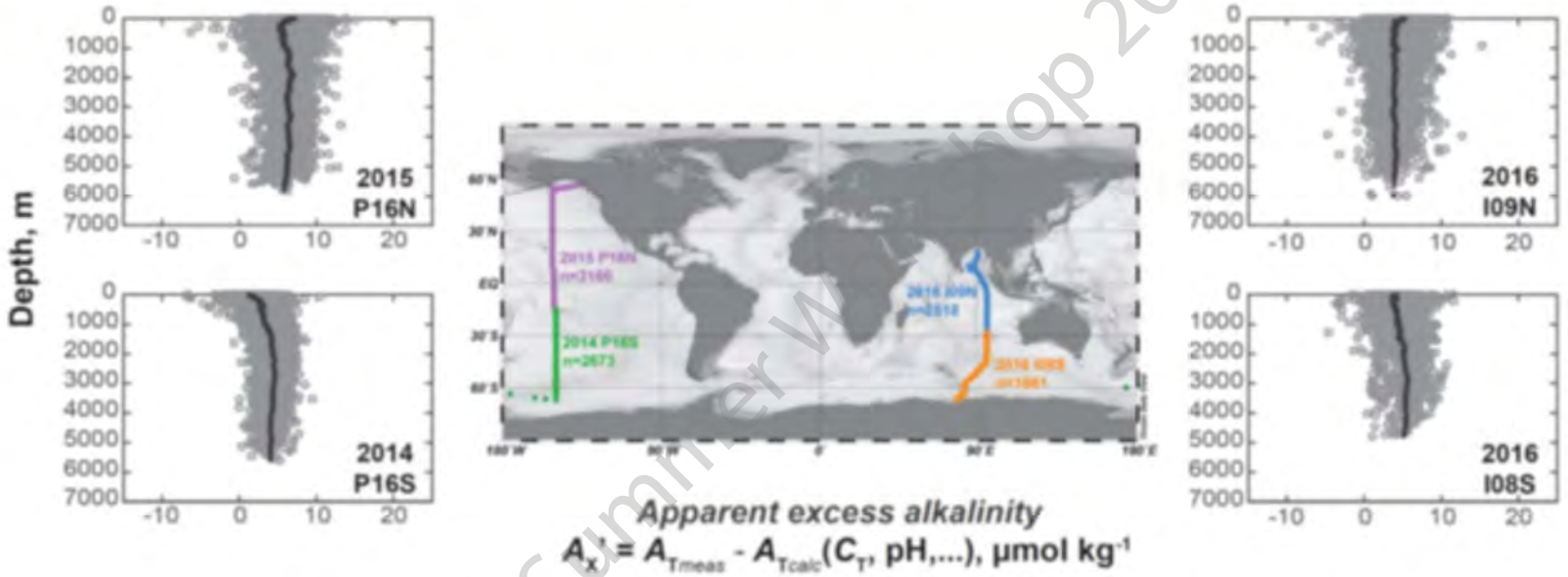
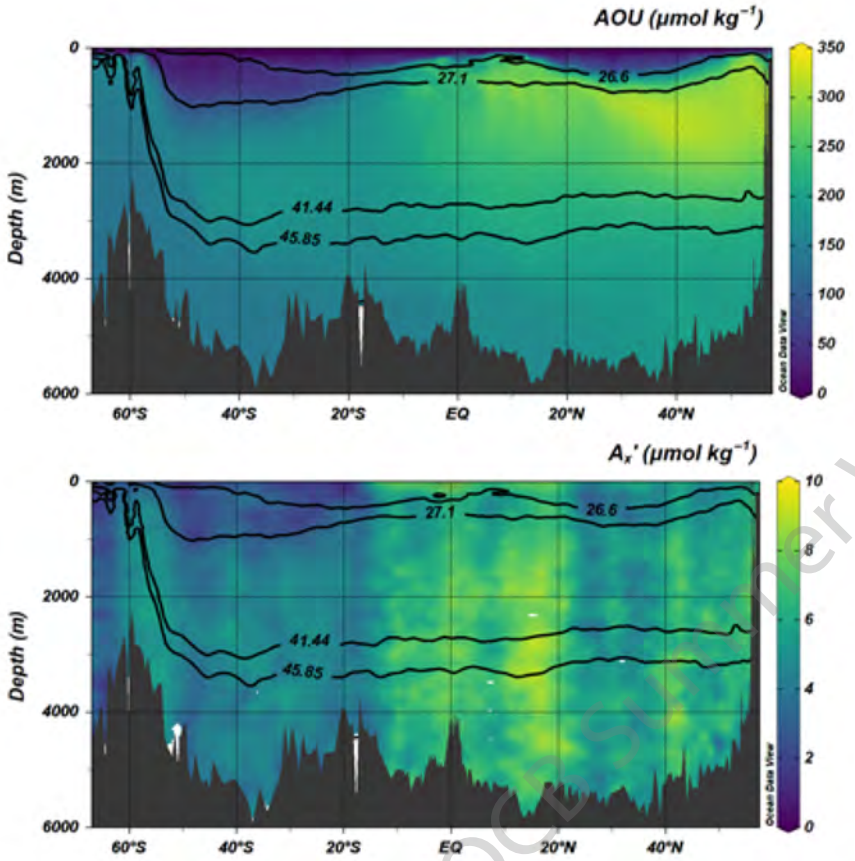
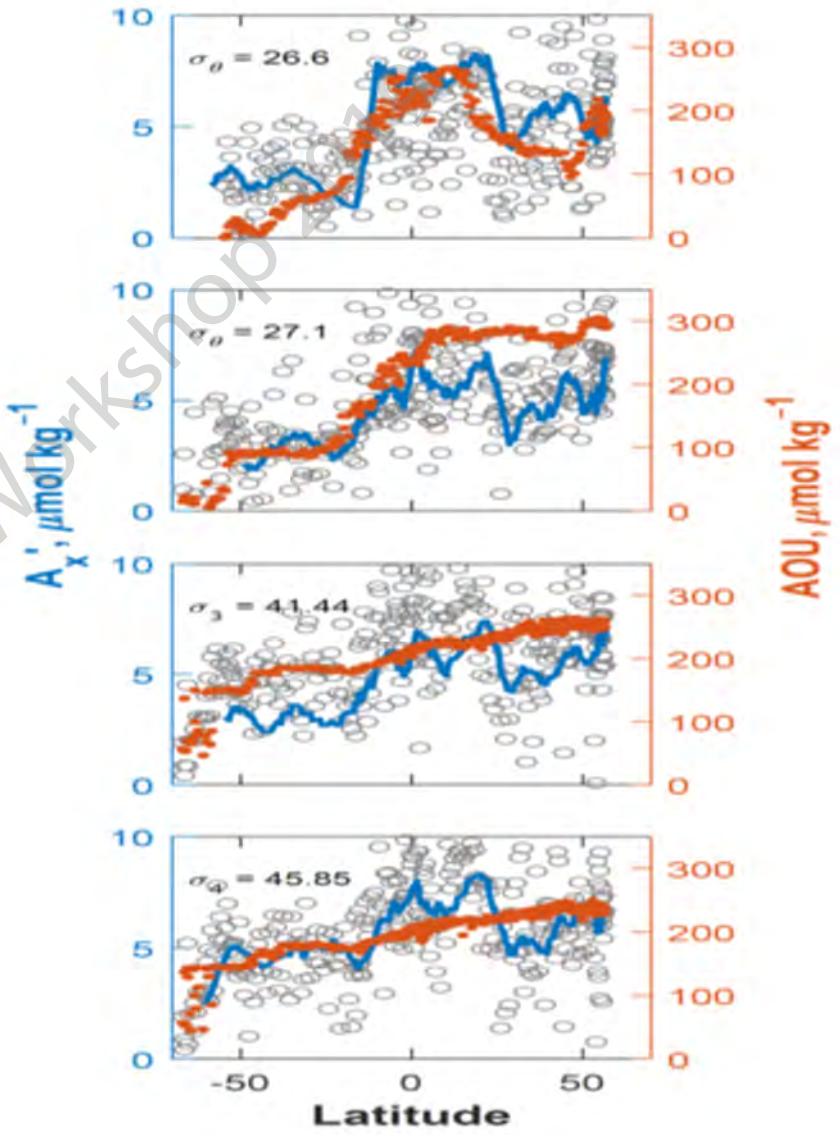


Fig. 3. Depth profiles of the difference between measured and calculated alkalinity on four GO-SHIP cruises and a 100 point running mean of the data (solid curve). These differences were calculated with the adjustments in pK_1, pK_2, and B_T/S as in **Fig. 2.** These values represent the apparent excess alkalinity (including potential systematic errors in A_T and C_T measurements).

Correlation of excess alkalinity with AOU



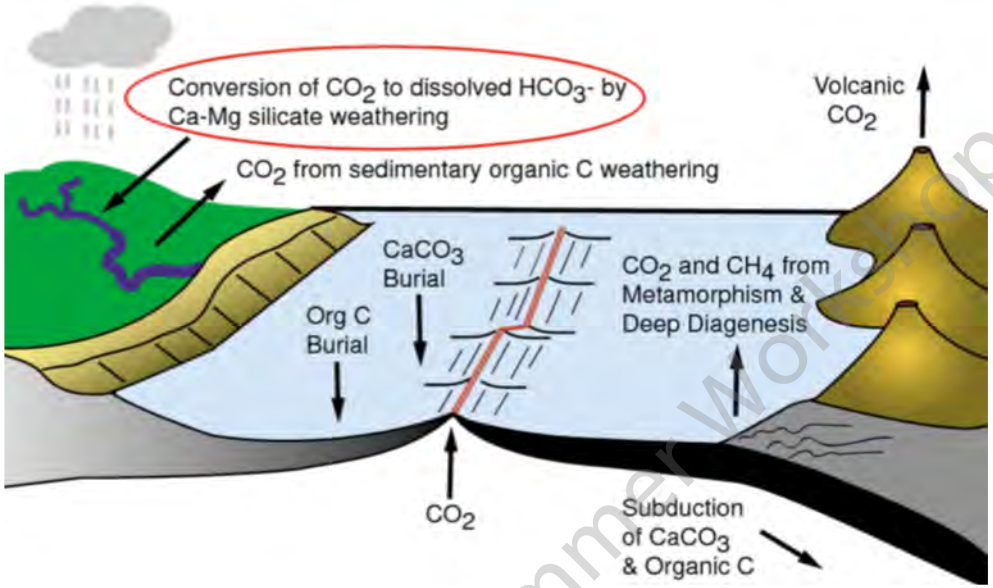
2014 P16S and 2015 P16N



The calcification response of coccolithophores to elevated ocean alkalinity

Sophie J. Gill[1] (sophie.gill@earth.ox.ac.uk), R. E. M. Rickaby[1] & G. M. Henderson[1]
[1]University of Oxford, Department of Earth Sciences, 3 South Parks Road, Oxford OX1 3AN

THE LONG TERM CARBON CYCLE



Can we enhance weathering to draw down carbon dioxide?

GREENHOUSE GAS REMOVAL RESEARCH PROGRAMME

Silicate weathering

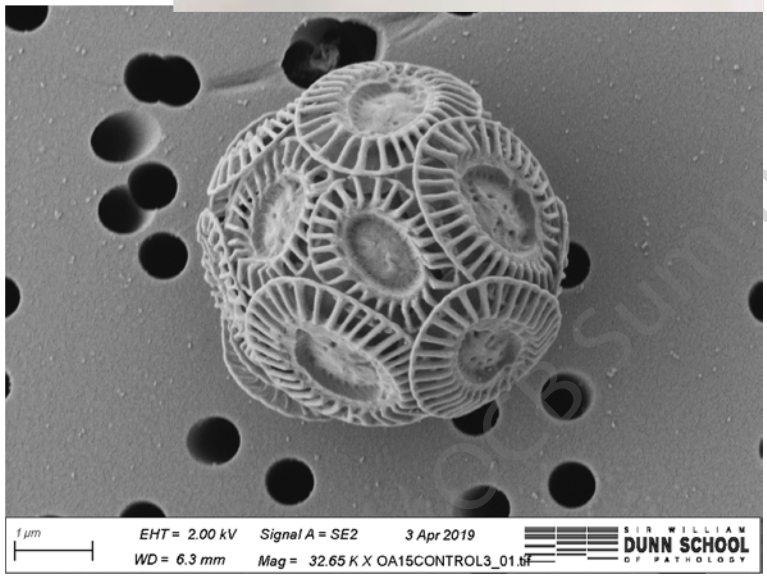
$$2CO_2 + 3H_2O + CaSiO_3 \rightarrow Ca^{2+} + 2HCO_3^- + H_4SiO_4 \rightarrow CaCO_3 + CO_2 + SiO_2 + 3H_2O$$

Weathering reaction → Dissolved products (ocean) → Calcification reaction?

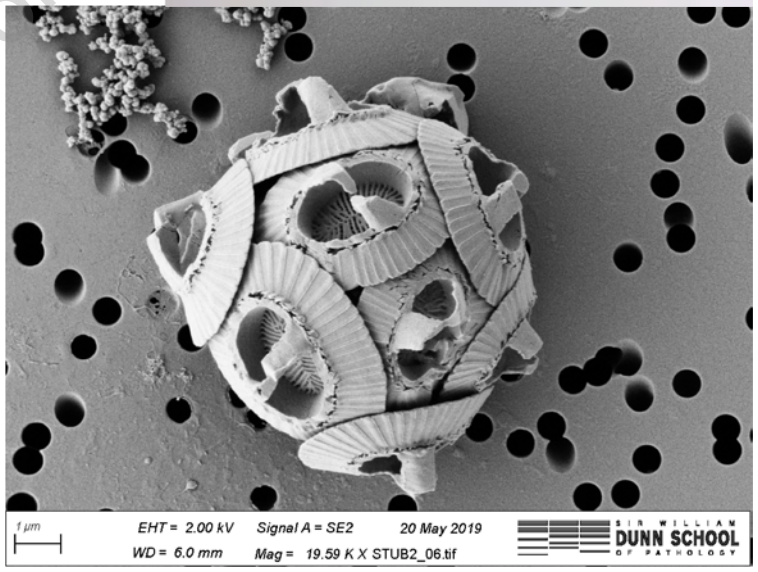
The calcification response of coccolithophores to elevated ocean alkalinity

Sophie J. Gill[1] (sophie.gill@earth.ox.ac.uk), R. E. M. Rickaby[1] & G. M. Henderson[1]
[1]University of Oxford, Department of Earth Sciences, 3 South Parks Road, Oxford OX1 3AN

E. huxleyi

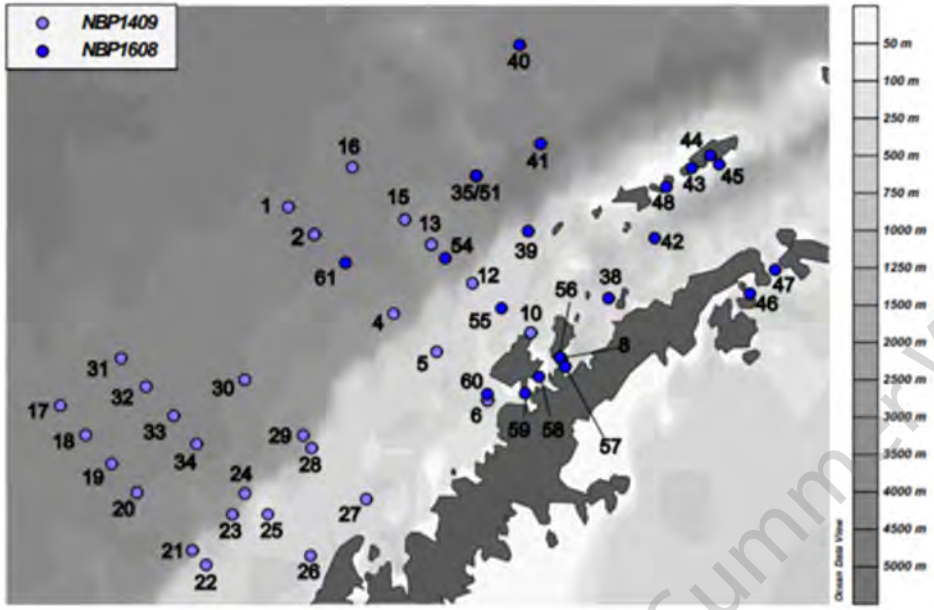


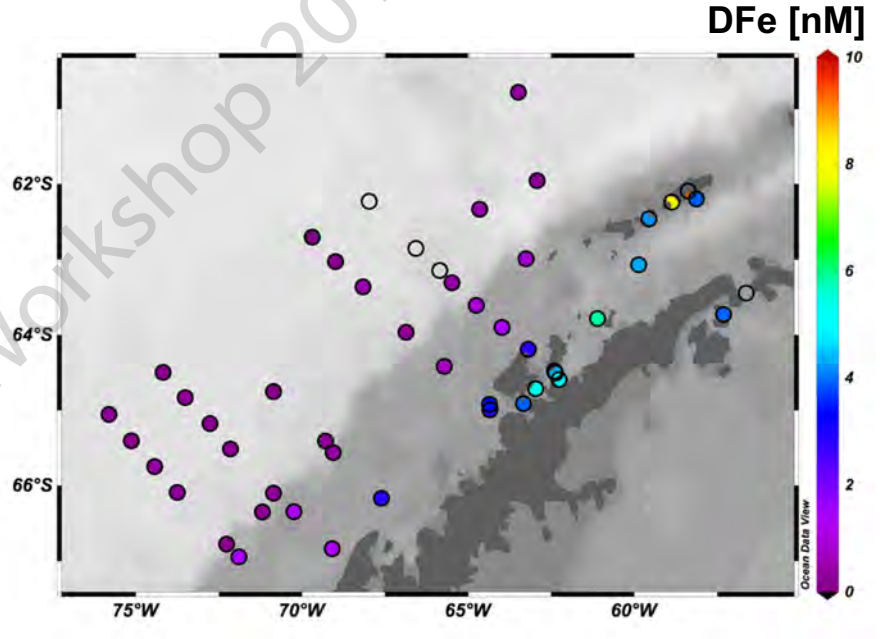
G. oceanica



Interannual comparison of diatom community composition in the Western Antarctic Peninsula

Laura Z. Holland, Alexa R. Sterling, Kristen N. Buck, Dreux P. Chappell, Kevin R. Arrigo, Anton F. Post, Bethany D. Jenkins





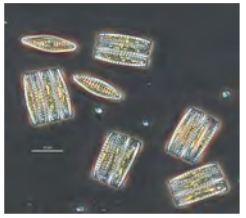
How do the diatom communities compare?

Which environmental factors correlate with them?

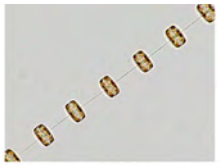
What are the implications for biogeochemical cycling?

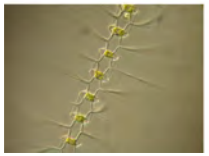
Co-occurrence analysis

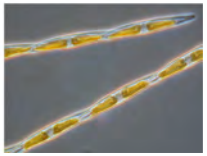
Module 1: *Fragilariopsis*

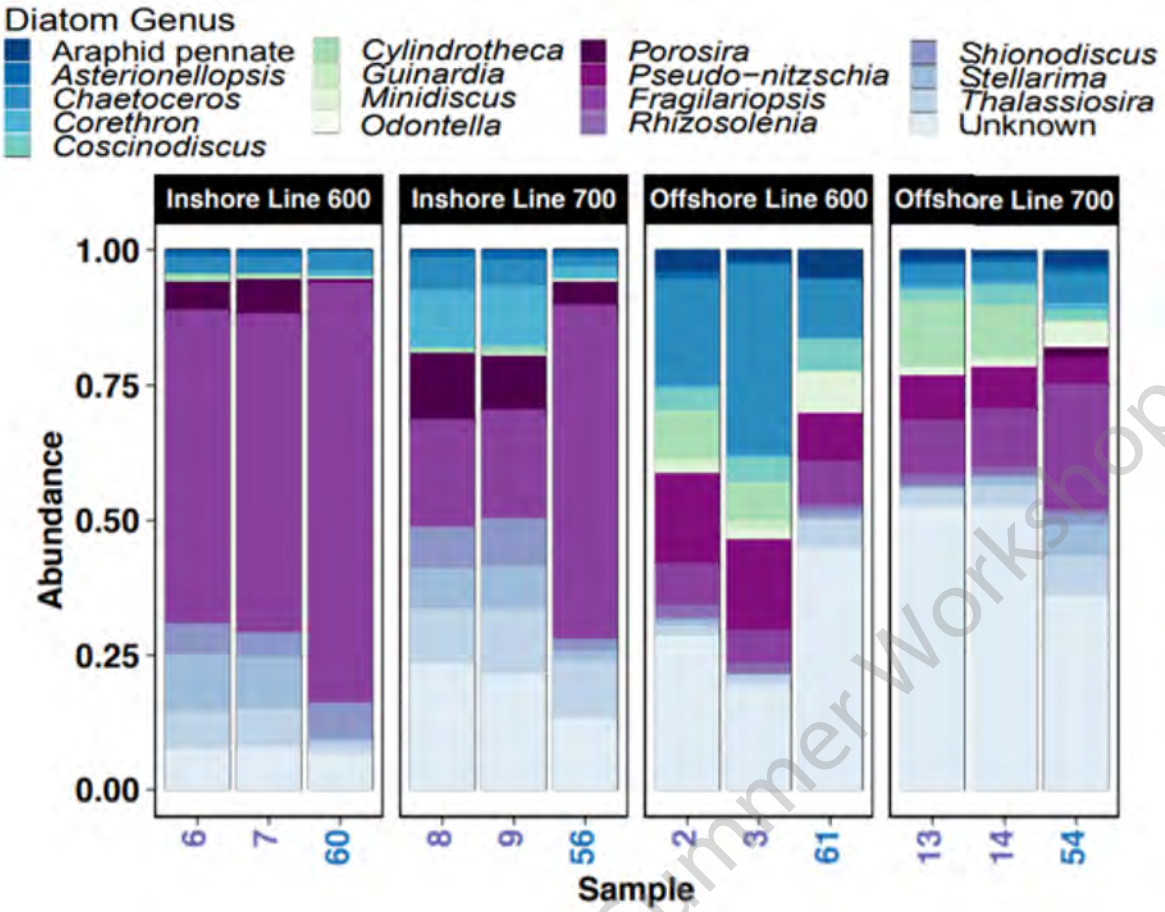


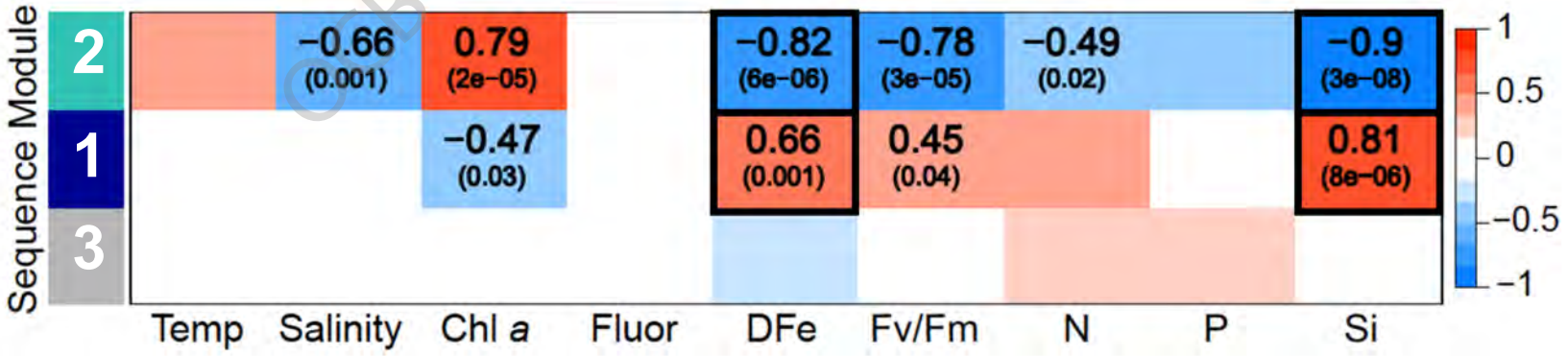
Module 2: *Pseudo-nitzschia* and small centrics







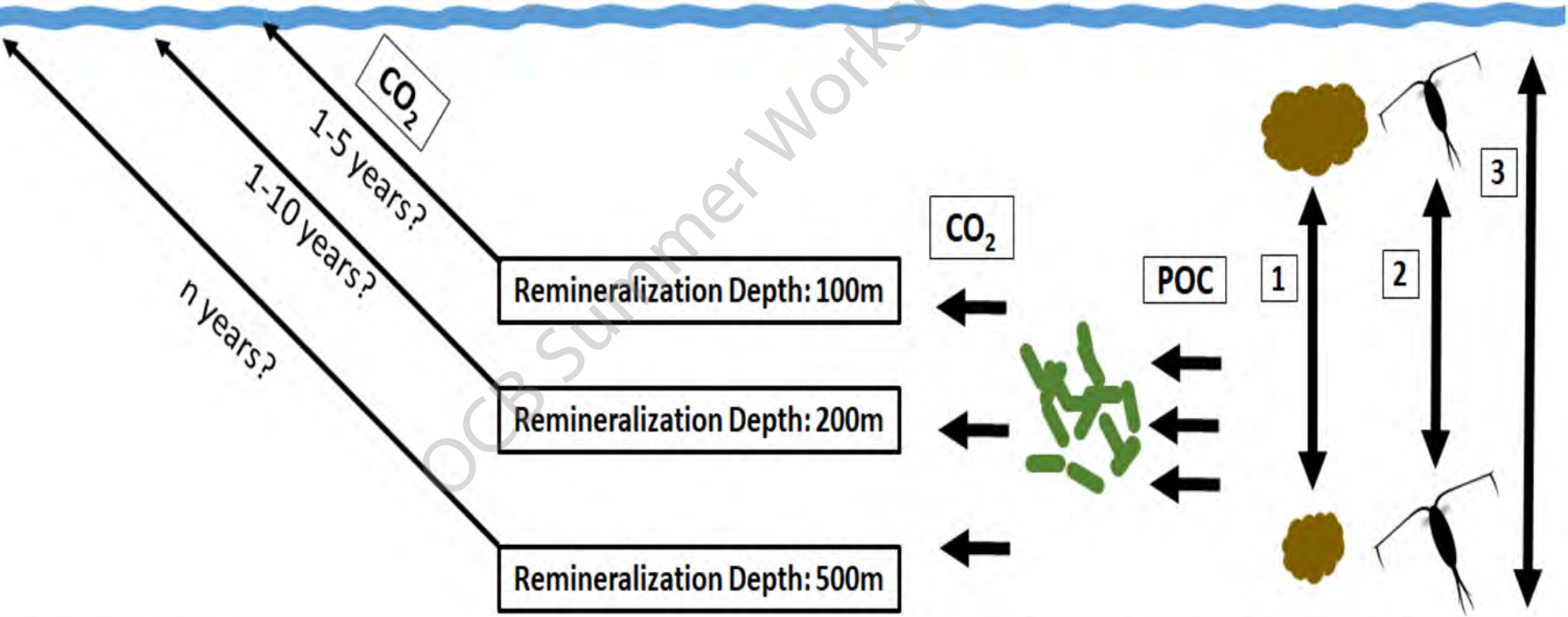




Quantifying the Sequestration Time of Remineralized CO_2 in the California Current Ecosystem

John P. Irving[1,2], Taylor A. Shropshire[1,2], Michael R. Stukel[1,2]

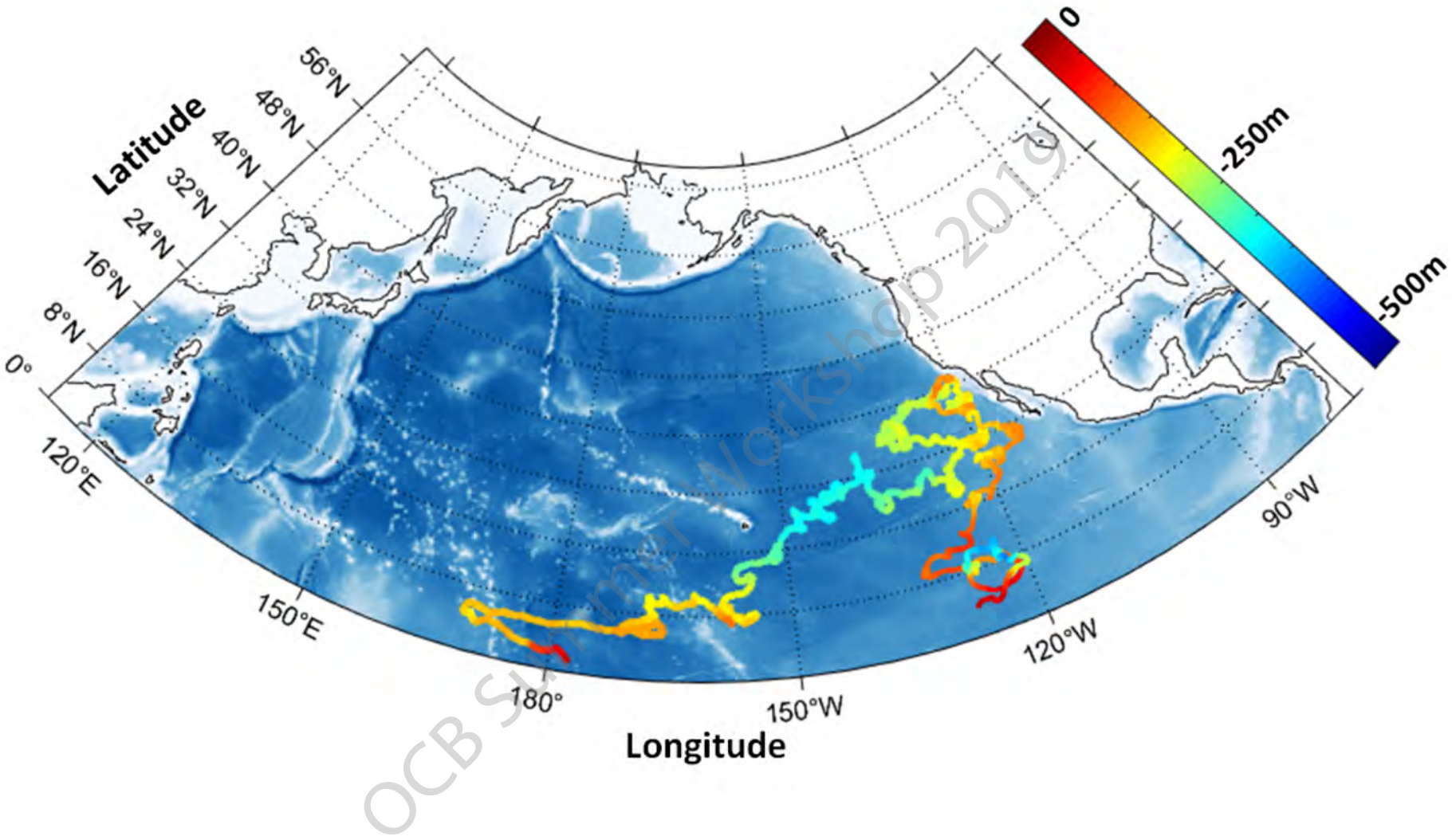
- POC is vertically transported through 3 mechanisms of the BCP; [1] sinking, [2] active transport, [3] subduction
- Each export pathway has a different remineralization length scale (RLS)
- **Goal**: Quantify the time scale of remineralized CO_2 as a function of remineralization depth



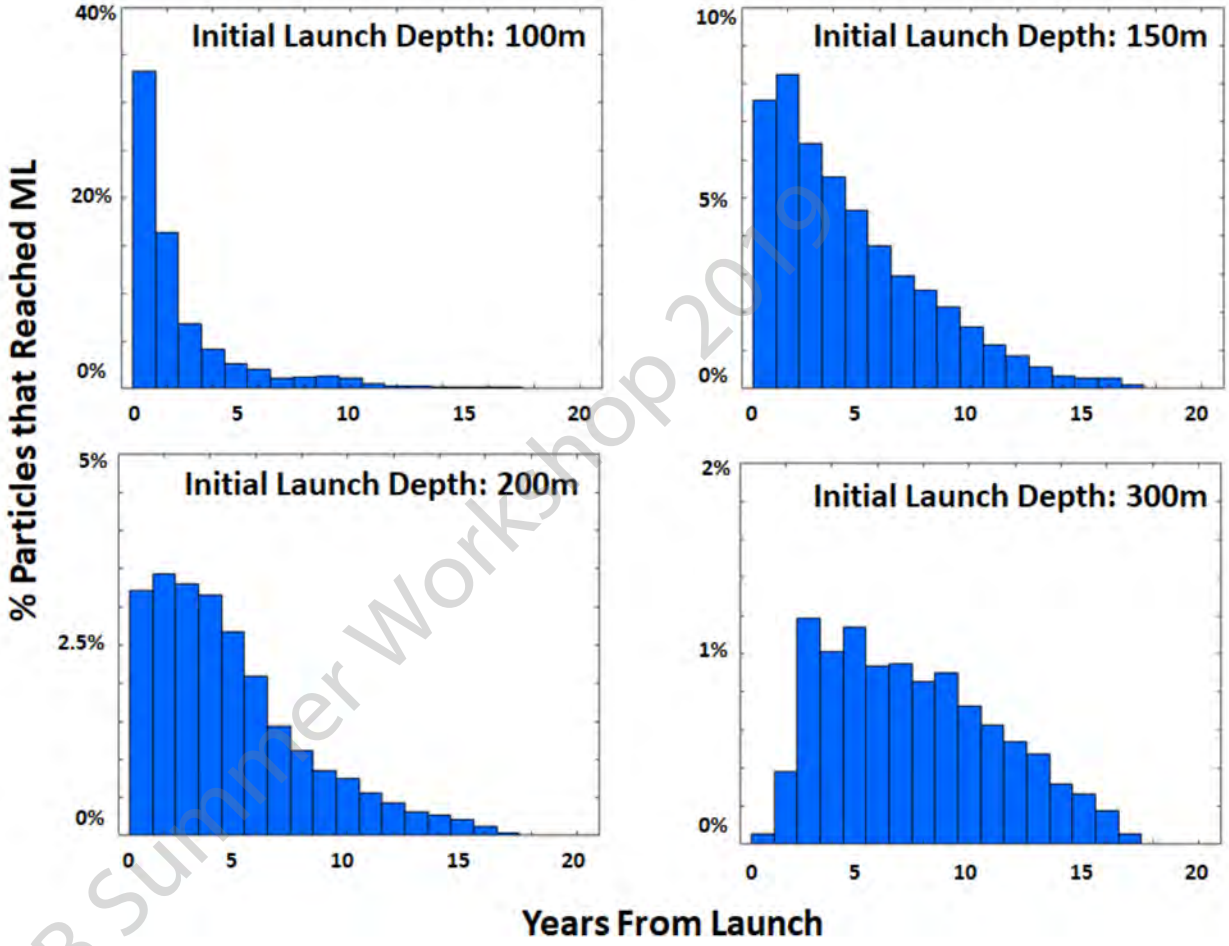
PI: Dr. Michael Stukel
Contact: John Irving - jpi18@my.fsu.edu

1:Dept. of Earth, Ocean, and Atmospheric Science, Florida State University,
2:Center for Ocean-Atmospheric Prediction Studies, Florida State University

Example Particle Trajectories



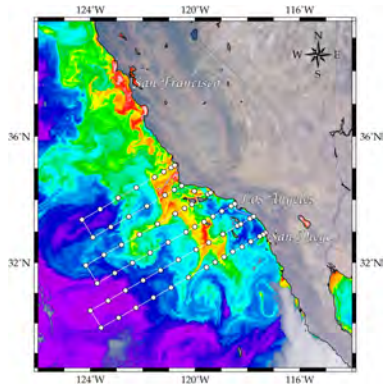
- Initial results indicate there are major differences in sequestration time as a function of remineralization depth. The more shallow launches had much higher total percentages of particles reaching the mixed layer and in much shorter time periods.



Production

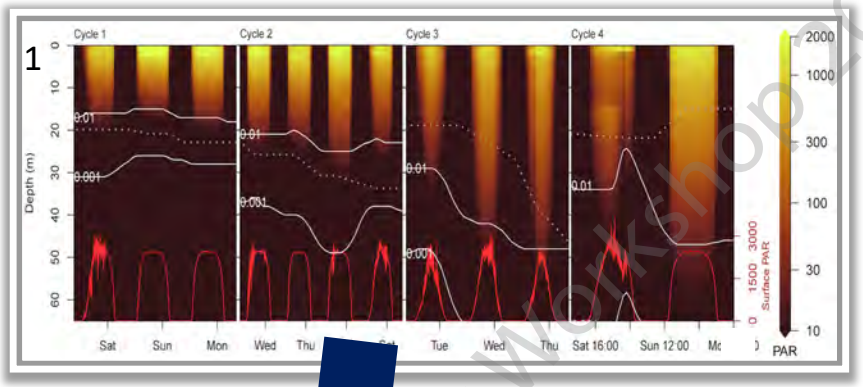
A comparison of estimates in the California current

Thomas B Kelly
Seaver Wang
Michael R Stukel
Ralf Goericke
Nicolas Cassar
Sven Kranz

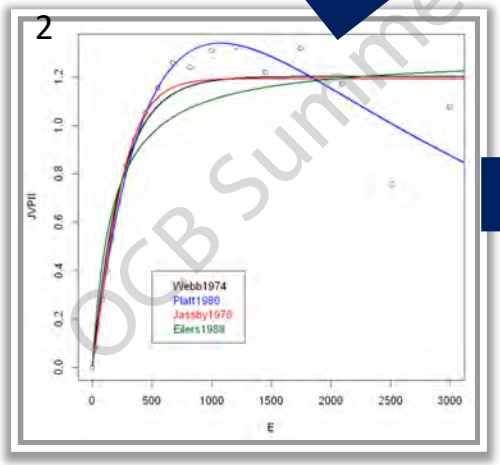


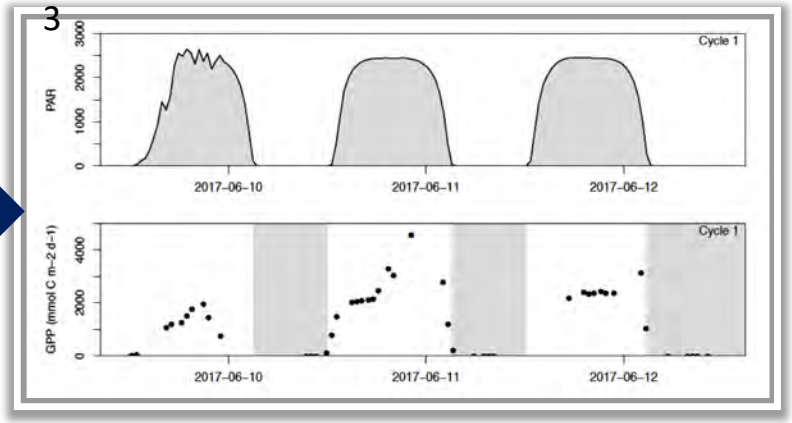
Many of us would consider primary production a key control on the rate of biogeochemical processes
Others may consider community production -- or even gross primary production

Autonomous measurement of GPP from Fast Repetition Rate fluorometry



1. In situ light field & Z_{ML}
2. Fit functional form to JVPII
3. Apply a photo-physiology model for GPP



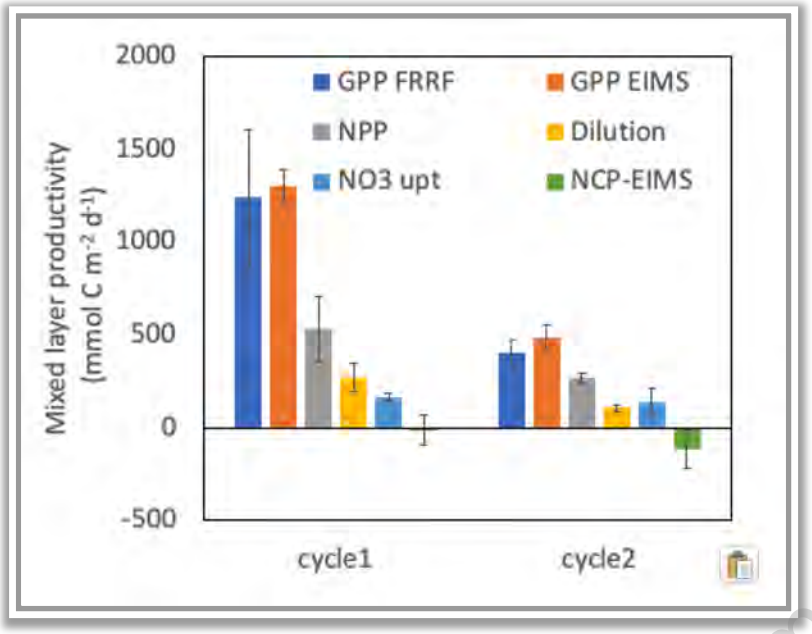


* tbk14@fsu.edu

But do we get a reasonable estimate?

Production

A comparison of estimates in the California current



Both GPP rate estimates look reasonable
Compares well with more traditional NPP, NCP and nitrate uptake estimates.

Also developed an O_2Ar-based GPP metric

$$NCP_{RT} = k \ (\Delta O_2/Ar)[O_2]_{sol}\rho + z\frac{d(\Delta O_2/Ar)}{dt}[O_2]_{sol}\rho$$

Change in O_2/Ar over due to air-sea gas exchange

correction for non-steady state effects

NCP_{RT} during the night equals the community respiration (NCR).
NCP_{RT} during the day equals GPP + NCR.

These independent productivity metrics compare surprisingly well!
Next we'll be attempting a closed budget by including respiration (e.g. ^{3}H-Leu, mesozooplankton, and protists) and export (e.g. sed trap & ^{234}Th).

Stop by my poster on across-shore flux estimates looking at a coastal filament!

Thomas B Kelly, Seaver Wang, Michael R Stukel, Ralf Goericke, Nicolas Cassar, Sven Kranz

Low-molecular-weight organic acids as important factors impacting on seawater acidification: A case study in the Jiaozhou Bay, China

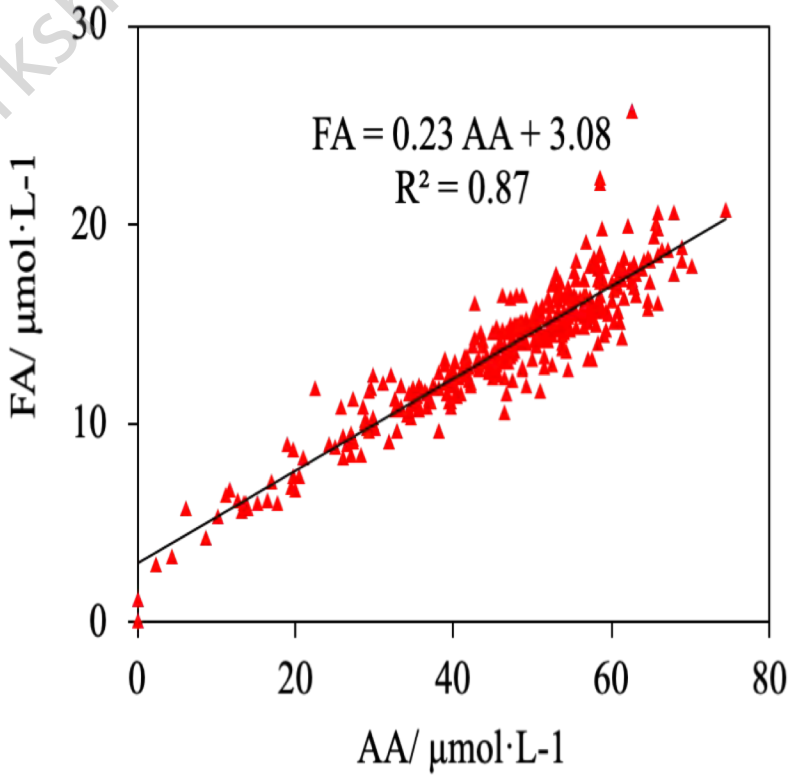
Haorui Liang (hliang@whoi.edu) [a,b], Haibing Ding [a,*], Eyal Wurgaft [b], Guipeng Yang [a,*], Xuchen Wang [a]
a: Ocean University of China, Qingdao, China, 266100
b: Woods Hole Oceanographic Institution, MA, USA, 02543

LMWOAs:

- 1-6 carbons
- 1-3 carboxyl groups

- Formic Acid (FA): pKa = 3.75
- Acetic Acid (AA): pKa = 4.74
- Lactic Acid (LA): pKa = 3.86

H_2CO_3 $pKa_1 = 6.38$



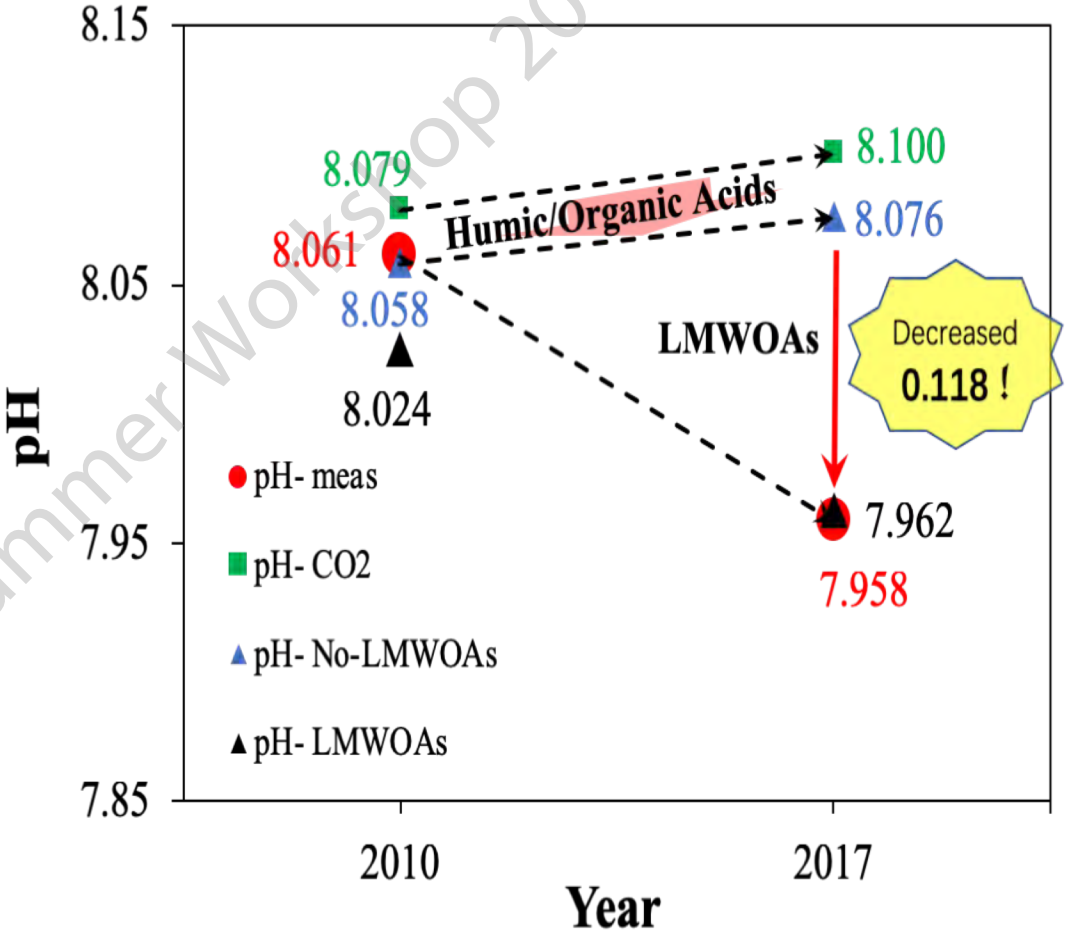
Correlation ship between FA and AA

Low-molecular-weight organic acids as important factors impacting on seawater acidification: A case study in the Jiaozhou Bay, China

Haorui Liang (hliang@whoi.edu) [a,b], Haibing Ding [a,*], Eyal Wurgaft [b], Guipeng Yang [a,*], Xuchen Wang [a]
a: Ocean University of China, Qingdao, China, 266100
b: Woods Hole Oceanographic Institution, MA, USA, 02543

	2010*	2017	△value (2017-2010)
pH	8.061	7.958	-0.103
LMWOAs (μmol·L^{-1})	18.5	61.5	43
TA (μmol·L^{-1})	2355	2332	-23
DIC (μmol·L^{-1})	2160	2101	-59
DOC (μmol·L^{-1})	178	377	199
DOC-revised (μmol·L^{-1})	142	265	123

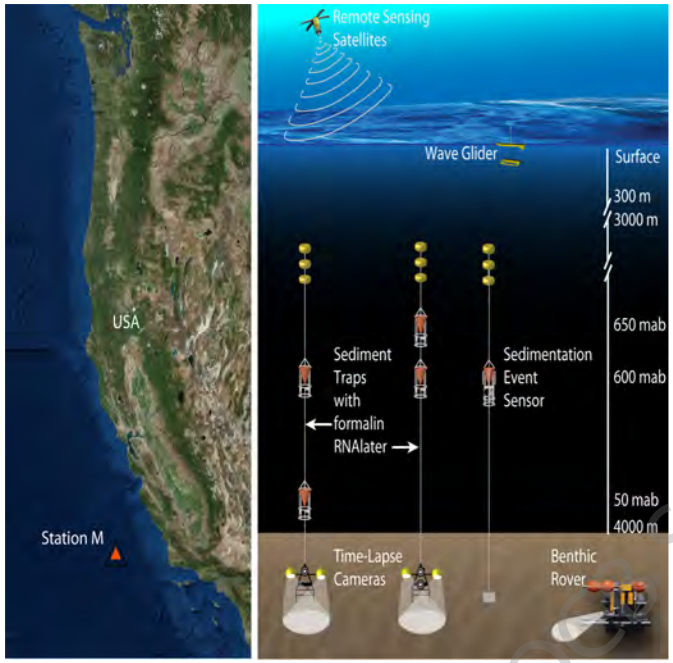
Data for 2010 from Deng et al. (2016) and Lyu et al (2017)

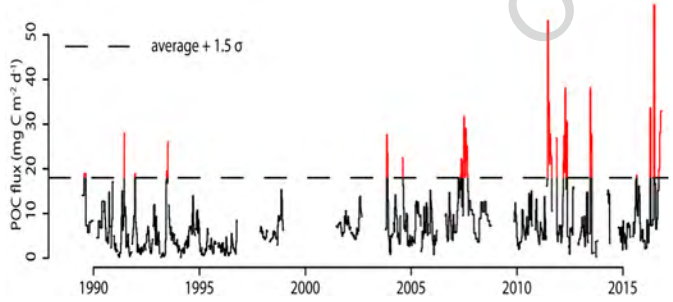


The difference of pH between 2010 and 2017

Effects of Phytoplankton Composition and Biominerals on the Episodic Pulses of Particulate Organic Carbon to Abyssal Depths

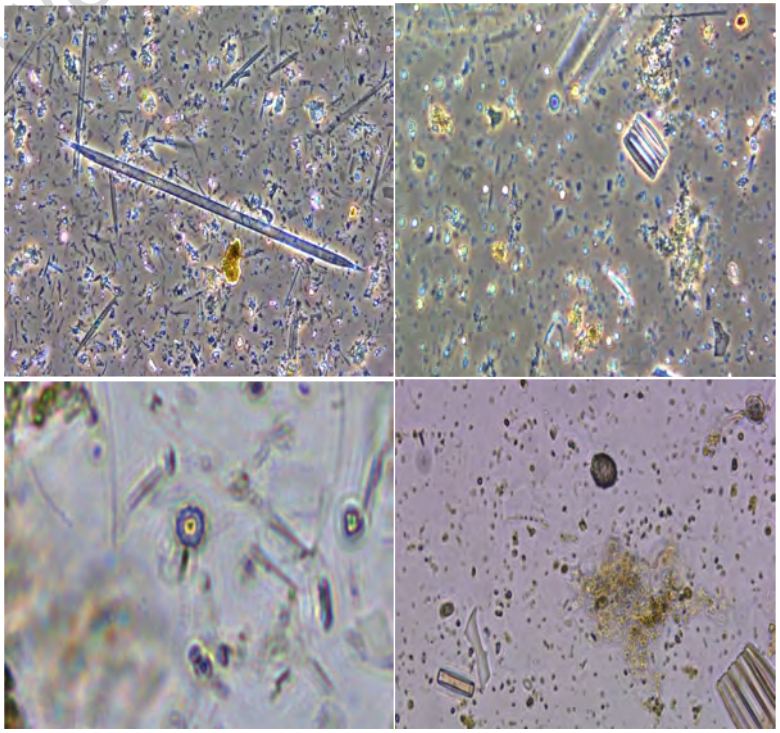
Cynthia A. Michaud[1], K. L. Smith, Jr.[2], C. L. Huffard[2], C. A. Durkin[1]
Moss Landing Marine Laboratories[1], Monterey Bay Aquarium Research Institute[2]





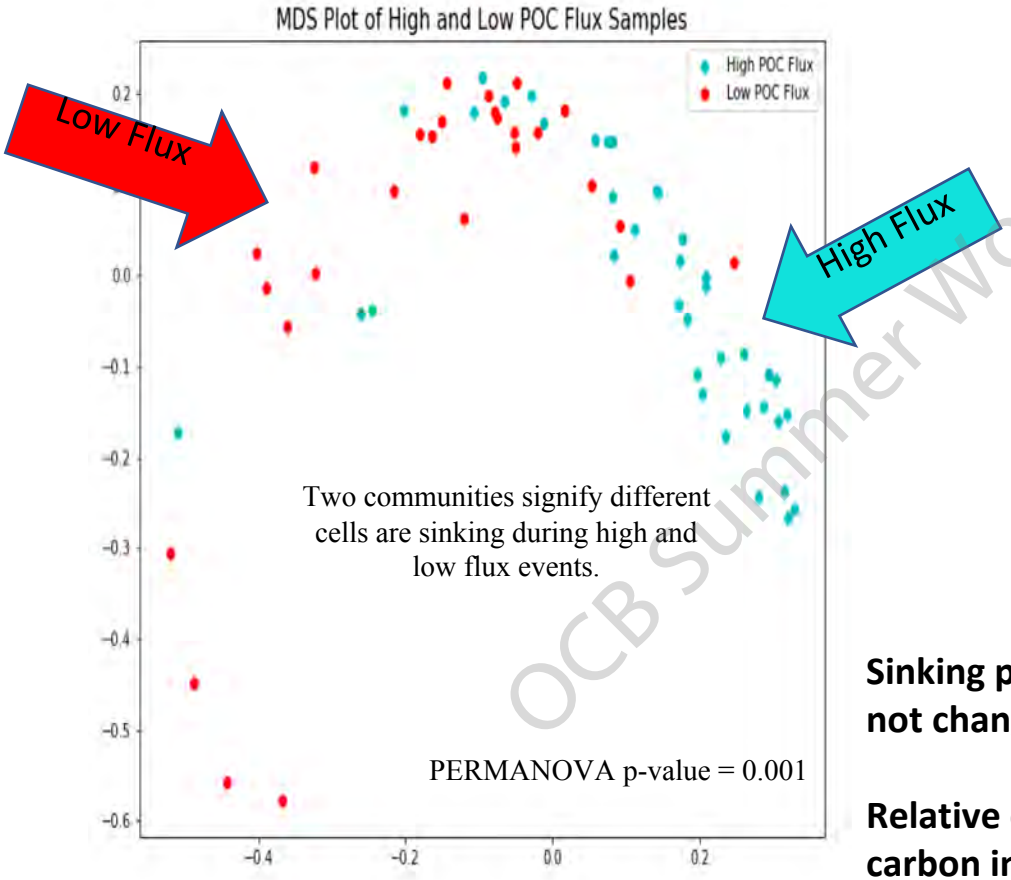
Hypotheses:

1. During the high flux events, more phytoplankton cells and different community compositions are collected in sediment traps.
2. Increased biogenic silica and calcium carbonate in phytoplankton aggregates, are correlated with episodic high POC flux events.

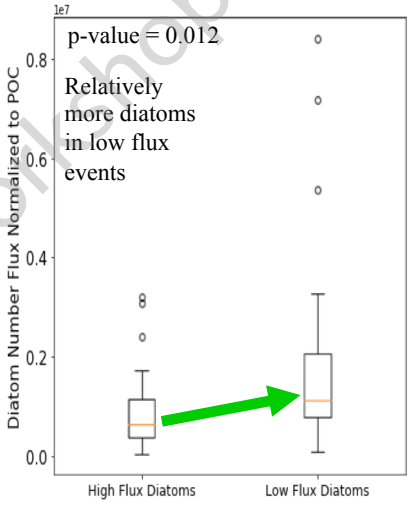


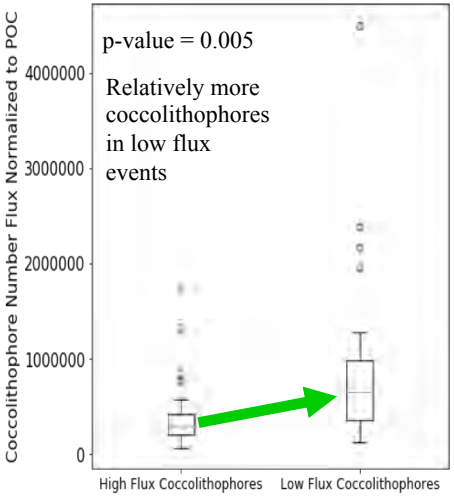
Effects of Phytoplankton Composition and Biominerals on the Episodic Pulses of Particulate Organic Carbon to Abyssal Depths

There are 2 distinct community compositions!



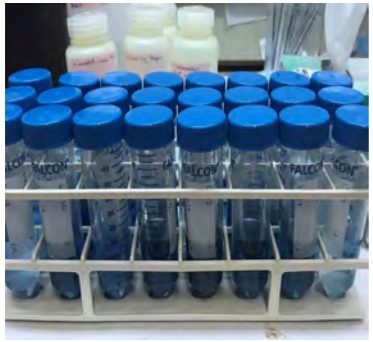
Low flux events are relatively more enriched in cells





Sinking particle silicification does not change

Relative calcification decreased as carbon increased



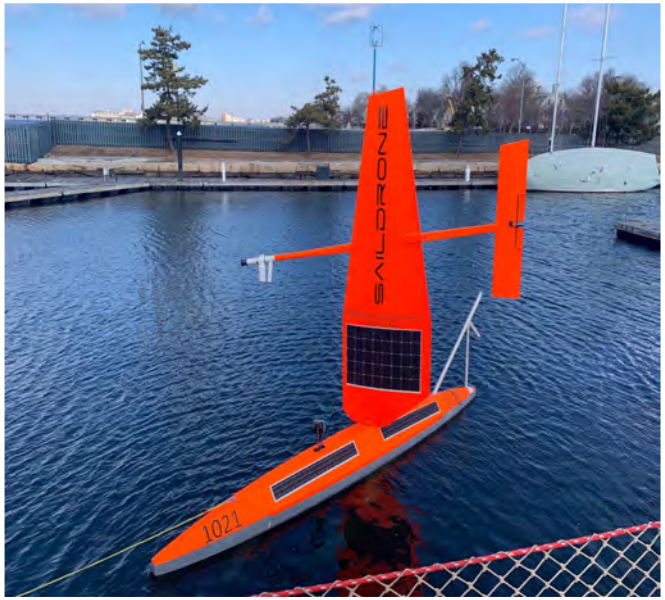
Direct wintertime pCO_2 observations from the Saildrone Gulf Stream Mission

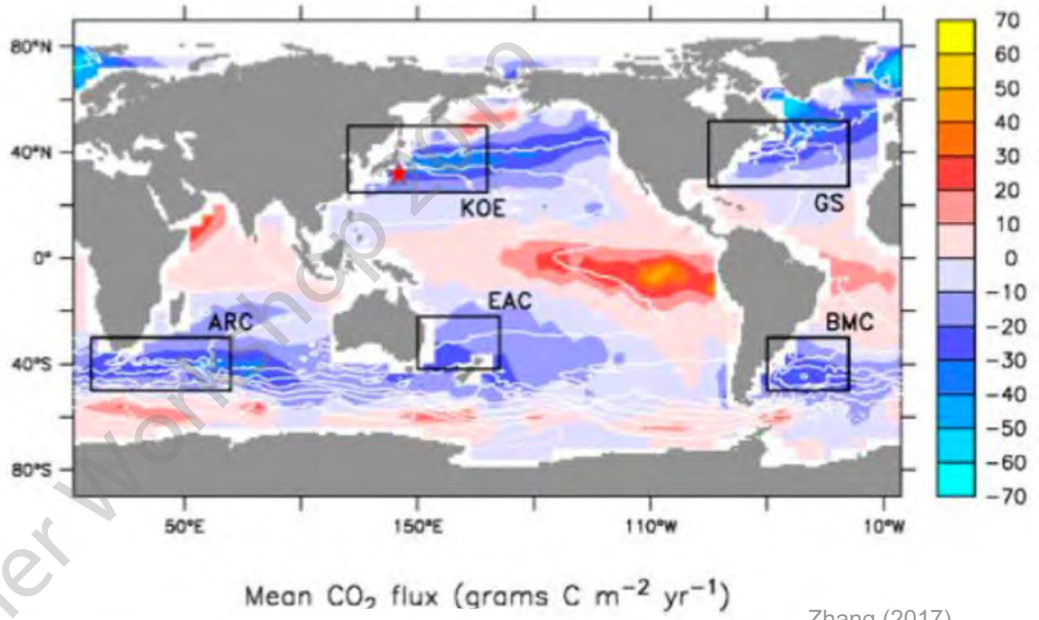
Sarah E. Nickford, Jaime B. Palter

University of Rhode Island – Graduate School of Oceanography

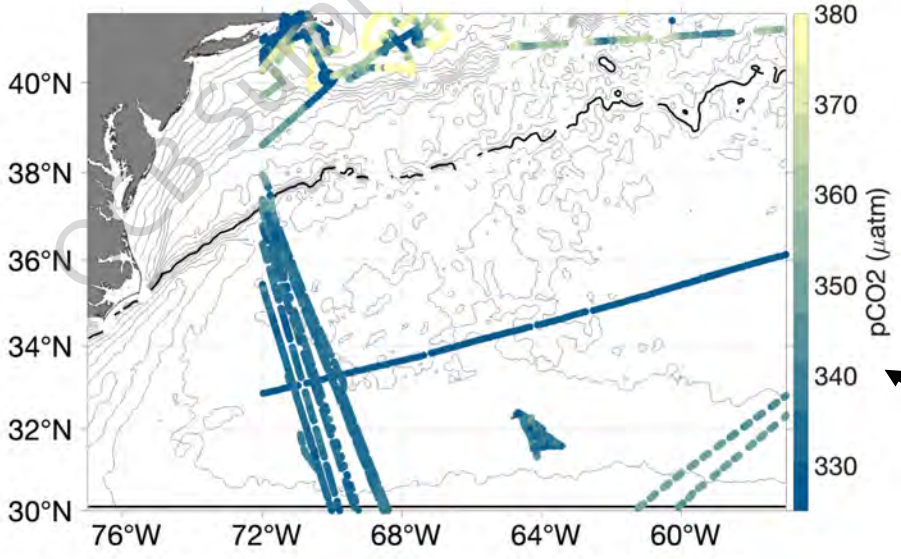
sarah_nickford@uri.edu
jpalter@uri.edu

THE UNIVERSITY OF RHODE ISLAND GRADUATE SCHOOL OF OCEANOGRAPHY





Zhang (2017)



February pCO2 observations from SOCAT & LDEO databases

Direct wintertime pCO_2 observations from the Saildrone Gulf Stream Mission

Sarah E. Nickford, Jaime B. Palter

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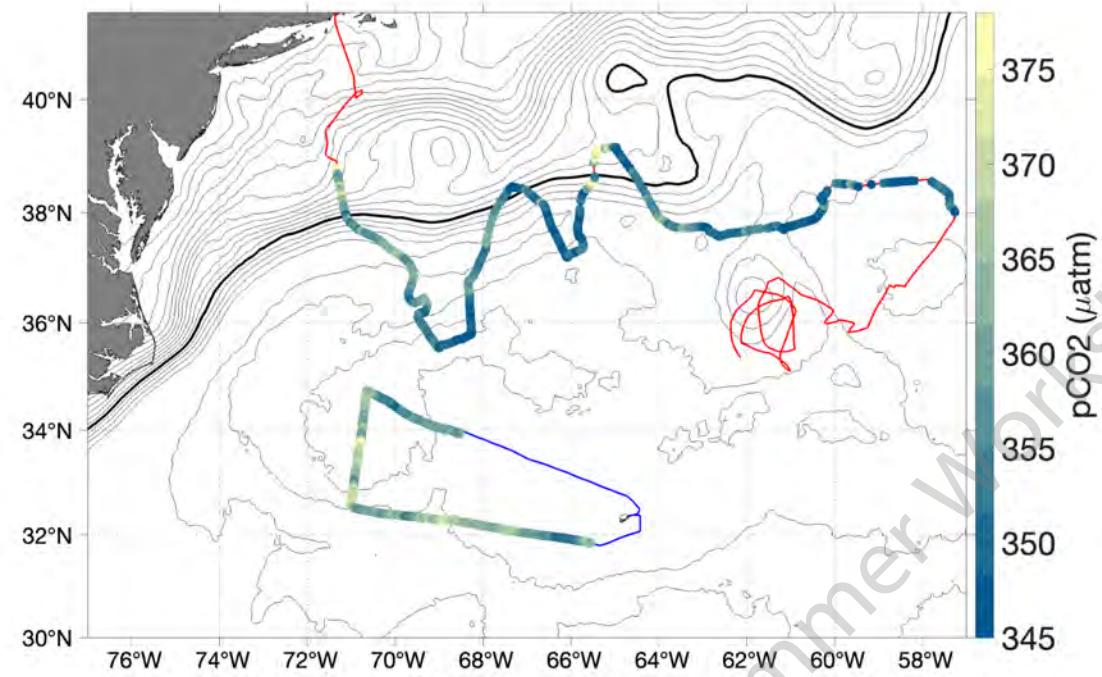
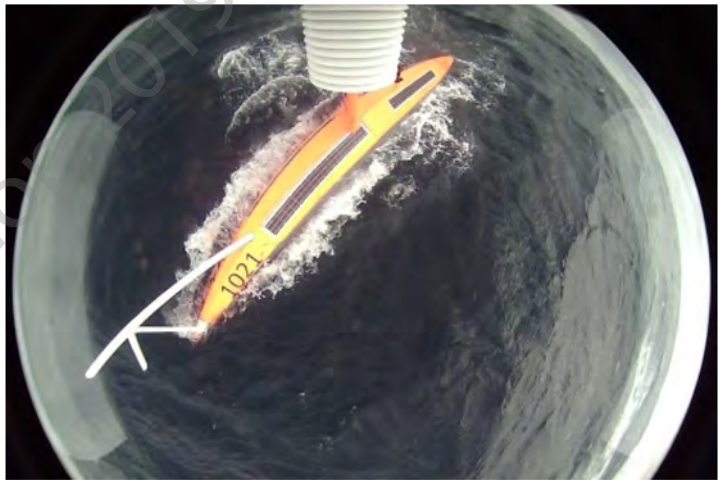
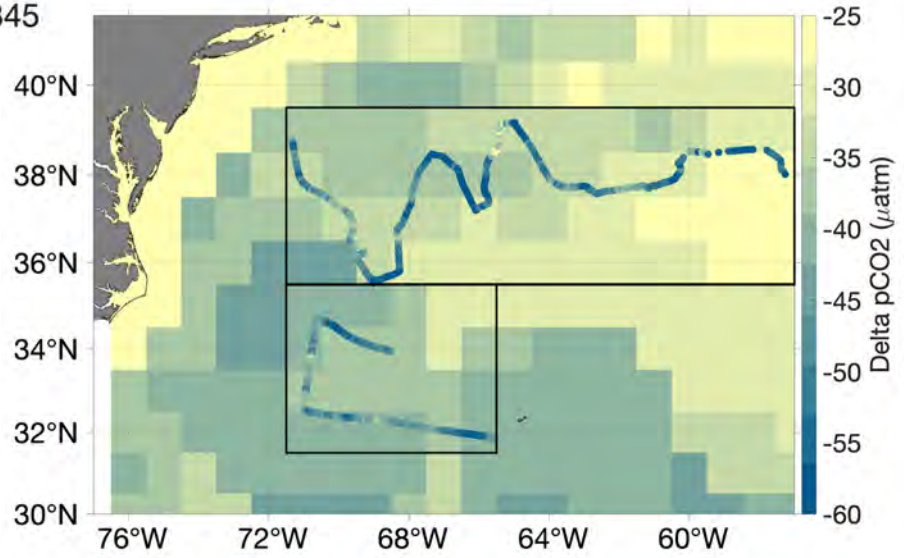






Saildrone-enabled observations of wintertime ΔpCO2 may lead to an upward revision of western boundary current CO2 uptake

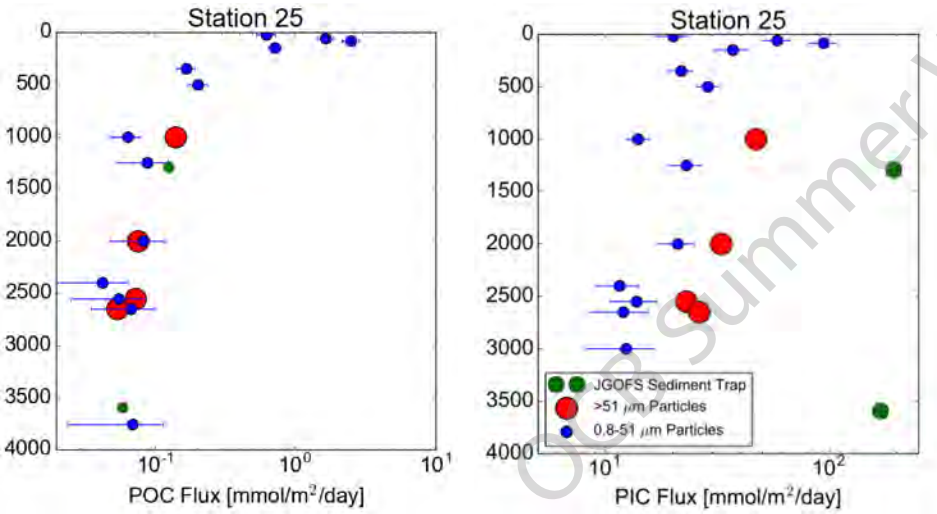
A global database of size fractionated POC and PIC concentrations compared to satellite-based estimates

Frank J. Pavia[1], Phoebe J. Lam[2], James K. Bishop[3], Lucas J. Gloege[1], Robert F. Anderson[1]

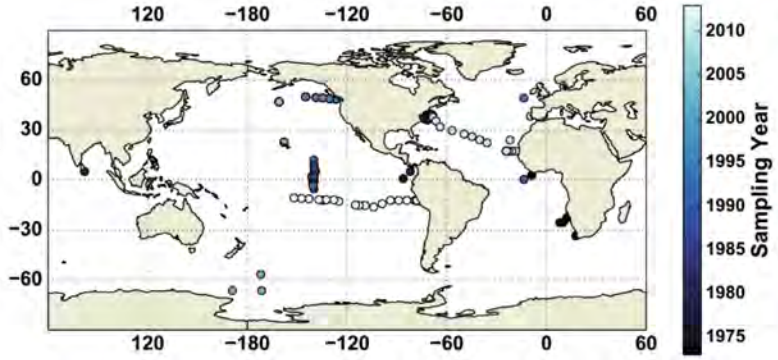
fpavia@ldeo.columbia.edu

[1]Lamont-Doherty Earth Observatory
[2]University of California Santa Cruz
[3]University of California Berkeley

How it began: Apparent size-fractionation in PIC:POC found when investigating POC regeneration and PIC dissolution from ^{230}Th-normalization



We assembled a database of all size-fractionated PIC and POC data from in-situ filtration



Pavia et al. 2019

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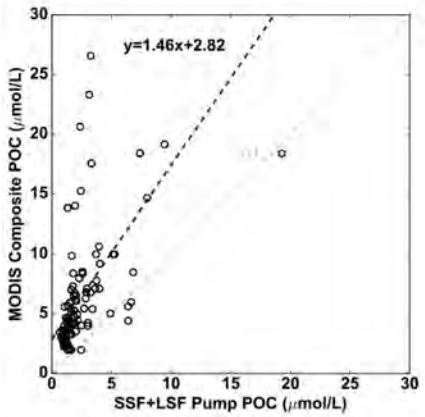
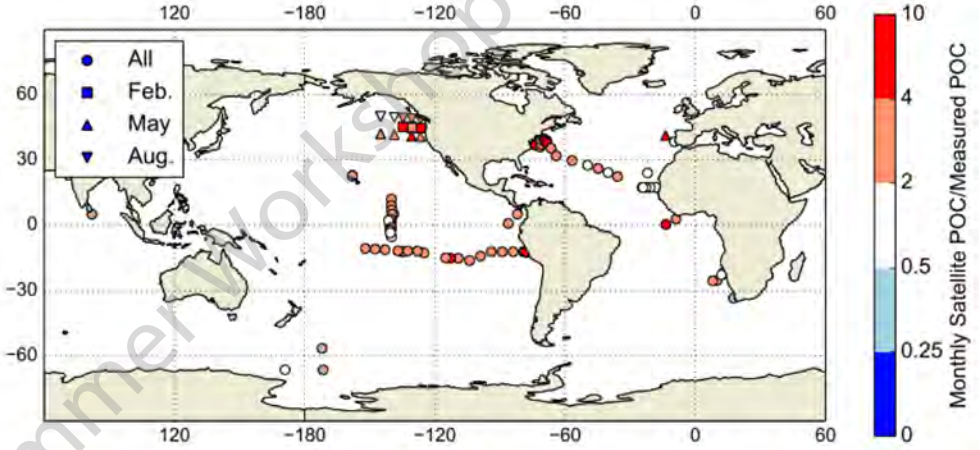
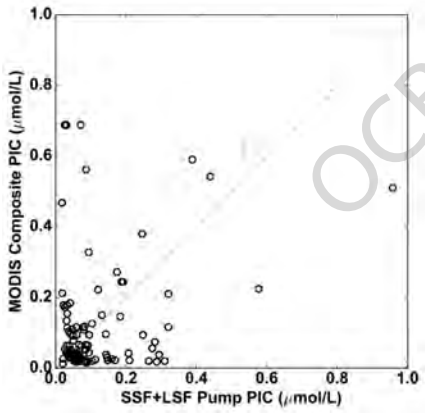
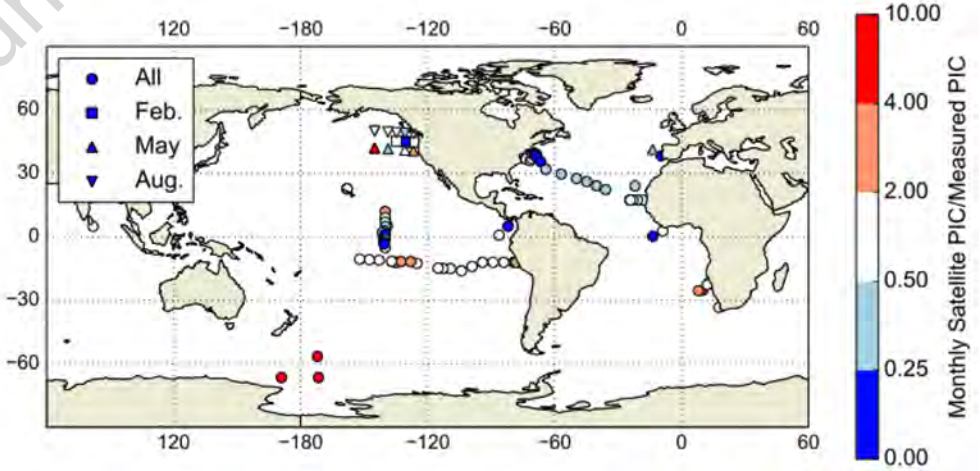
Monthly satellite climatologies overestimate surface in-situ pumped POC data



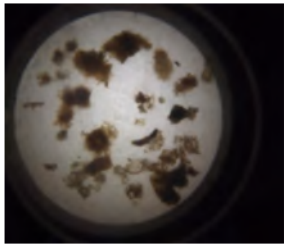


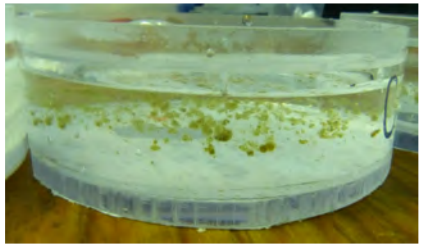


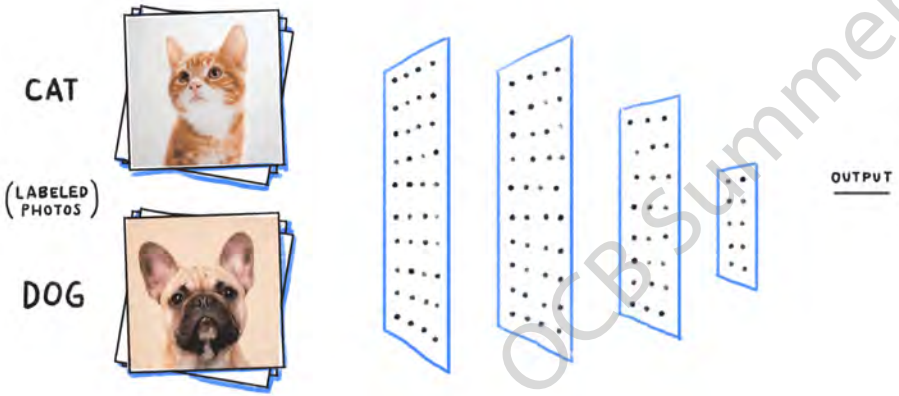


Automated identification of sinking marine particle images using transfer learning

Jessica Sheu[1]; Colleen A. Durkin, PhD[2]
[1]San José State University, [2]Moss Landing Marine Laboratories







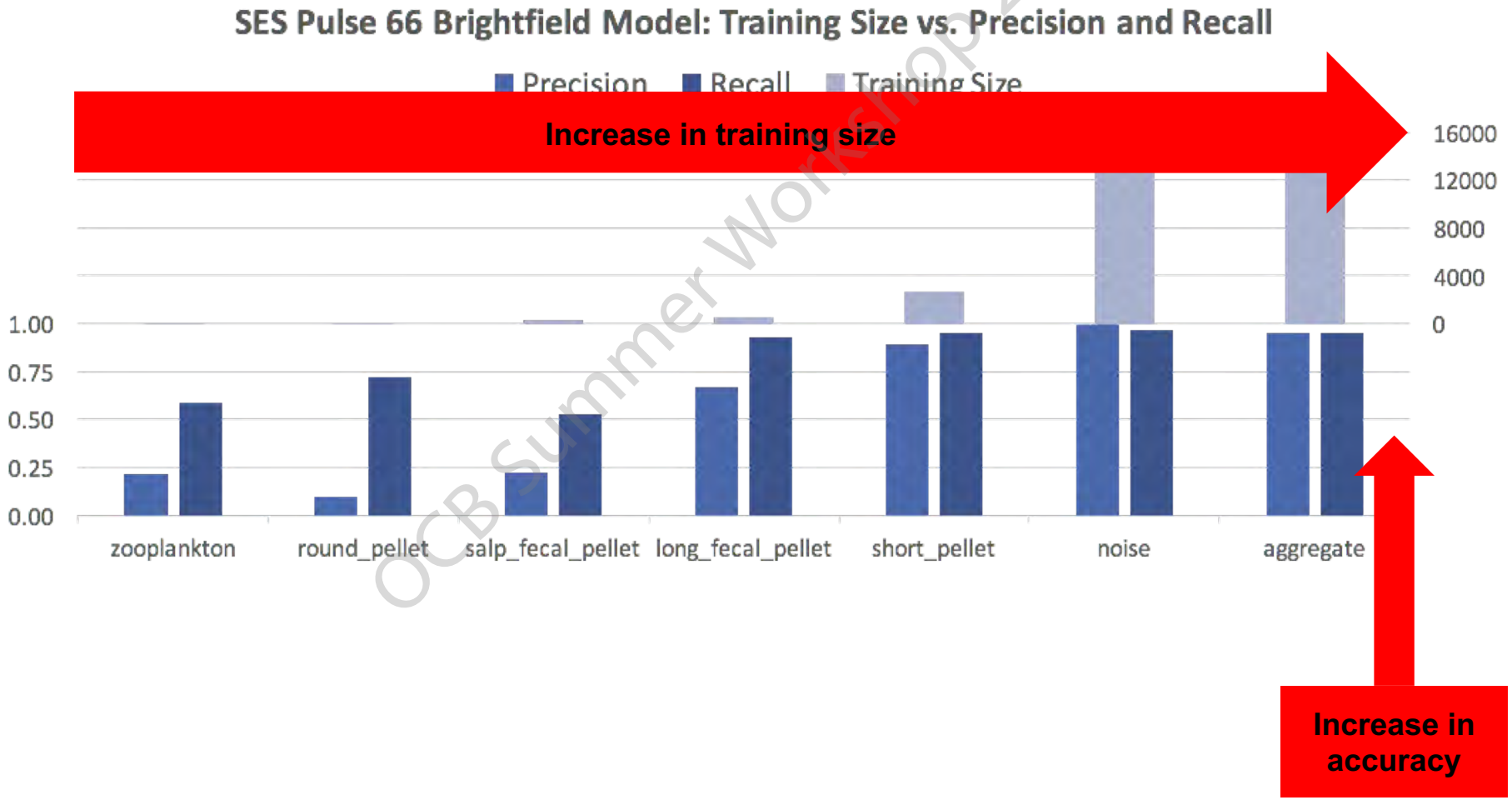
Category	Brightfield	Oblique
Aggregate		
Amphipod	N/A	
Copepod		
Dense Detritus		
Fiber		
Foraminifera		
Large loose pellet		
Long fecal pellet		
Mini pellet		

Category	Brightfield	Oblique
Phytoplankton		
Pteropod		
Rhizaria	N/A	
Salp pellet		
Short pellet		
Unidentifiable		
Zooplankton		
Zooplankton part		

Source: BecomingHuman

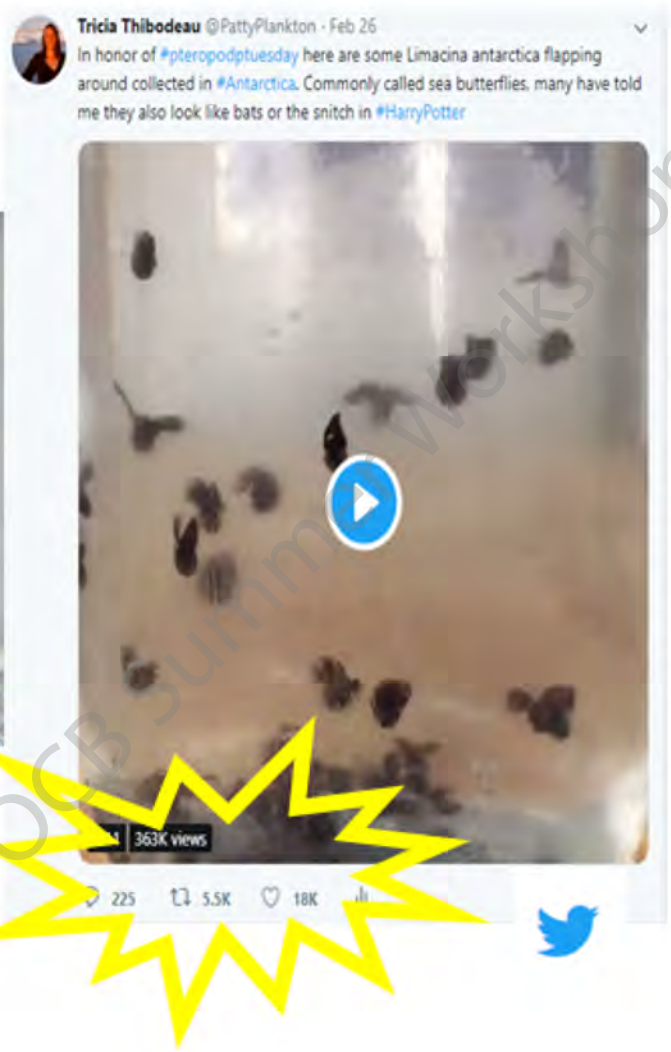
Automated identification of sinking marine particle images using transfer learning

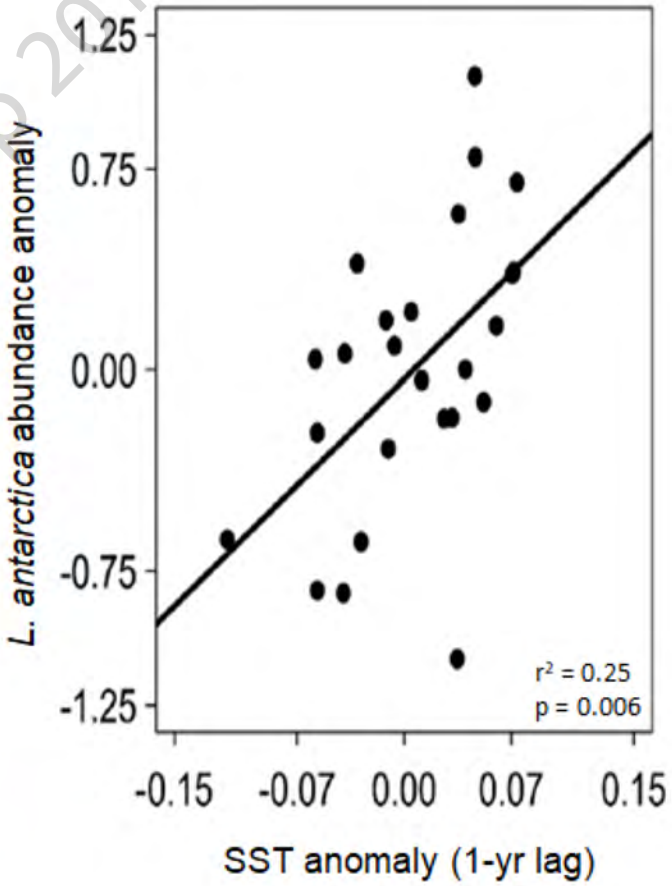
Jessica Sheu[1]; Colleen A. Durkin, PhD[2]
[1]San José State University, [2]Moss Landing Marine Laboratories



Environmental controls on pteropod ecology and physiology along the Western Antarctic Peninsula

Patricia (Tricia) Thibodeau, Deborah Steinberg & Amy Maas

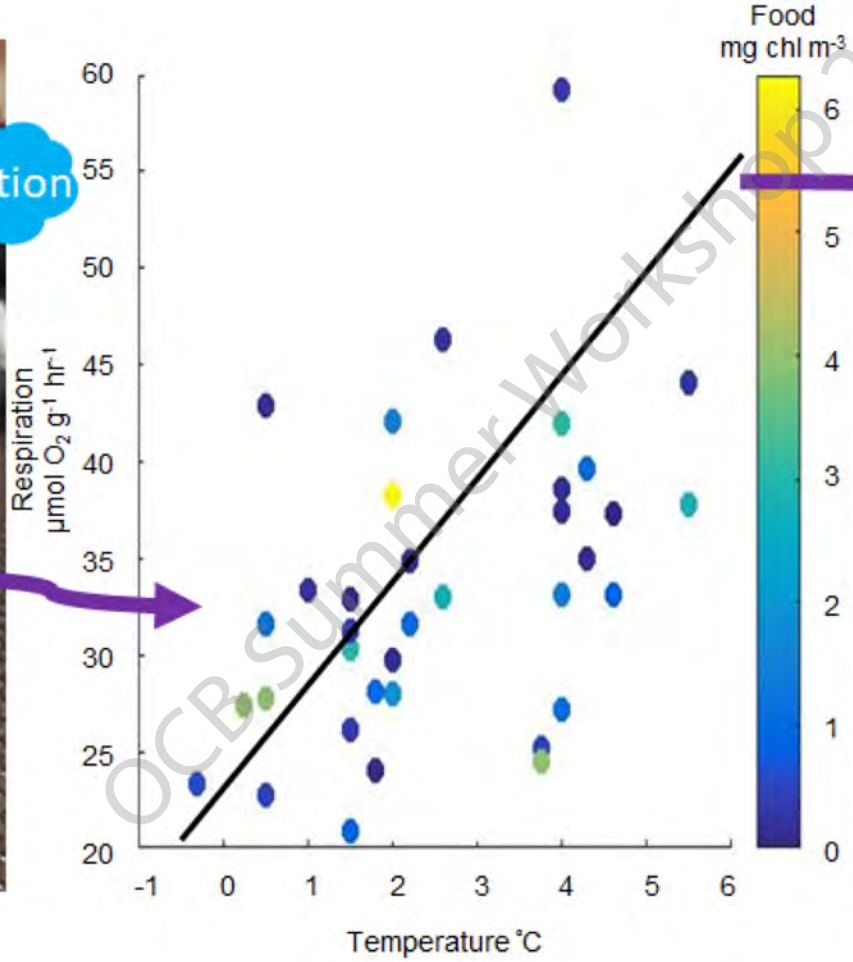




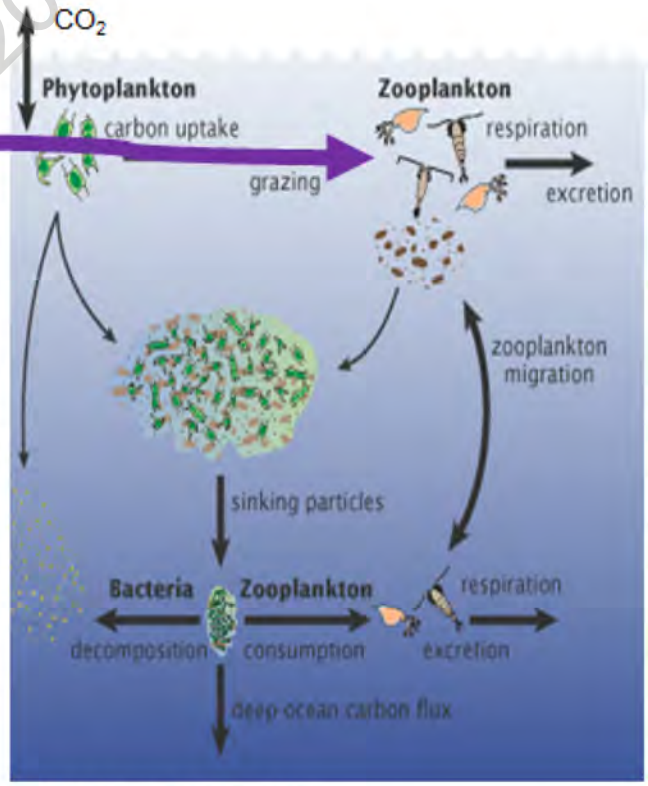
Thibodeau et al., *Limnology & Oceanography*, 2019

Environmental controls on pteropod ecology and physiology along the Western Antarctic Peninsula

Patricia Thibodeau, Deborah Steinberg & Amy Maas



Linear Mixed Effects Model
Temp: (F_{df} = 4.33, $p<0.05$, Food: (F_{df} = 0.24, $p>0.05$



NASA Earth Observatory
https://earthobservatory.nasa.gov/features/Phytoplankton/page2.php

Freshwater in the Arctic Ocean:
does gallium offer a solution to deconvolving sources?

Laura M. Whitmore, Angelica Pasqualini,

Bob Newton, Alan Shiller

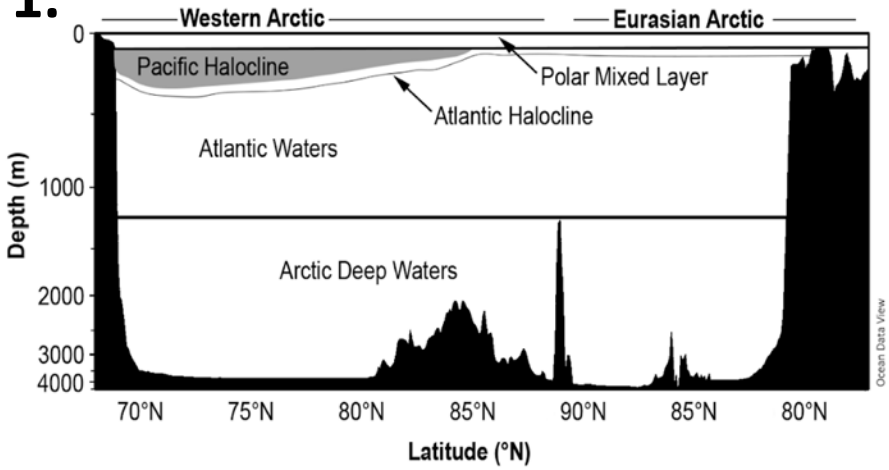
THE UNIVERSITY OF SOUTHERN MISSISSIPPI

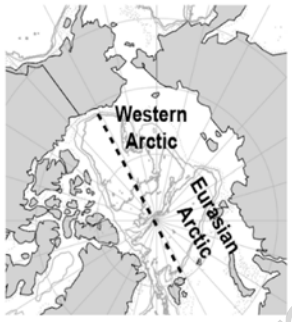
Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

GEOTRACES

NSF

1.





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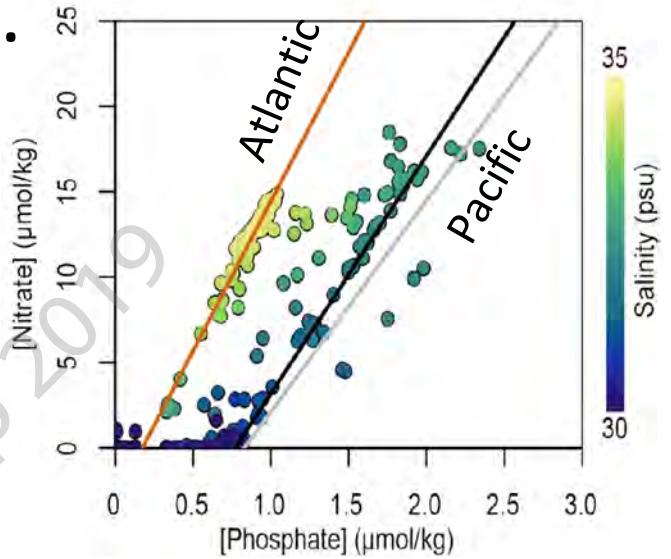

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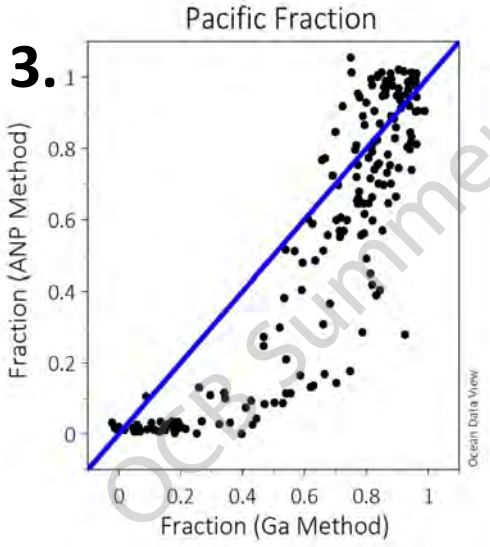

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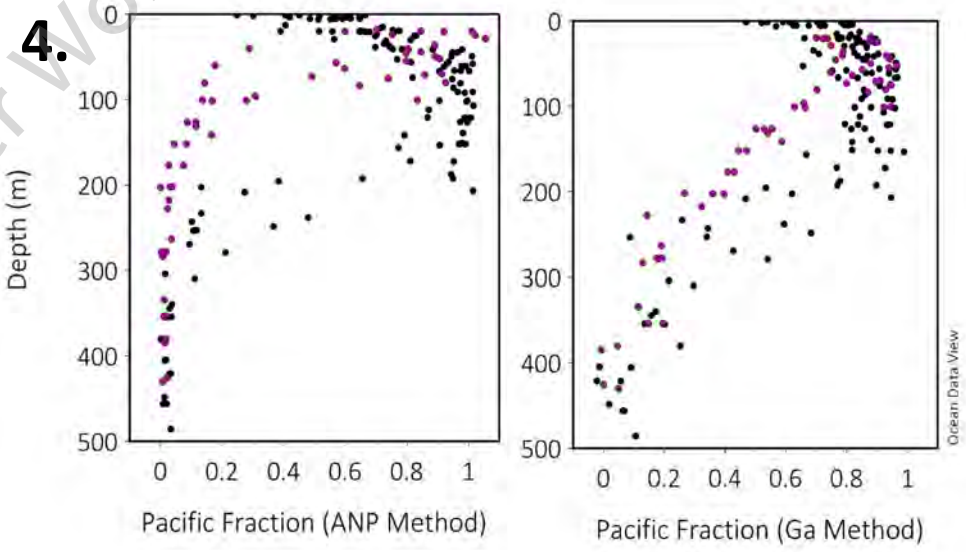
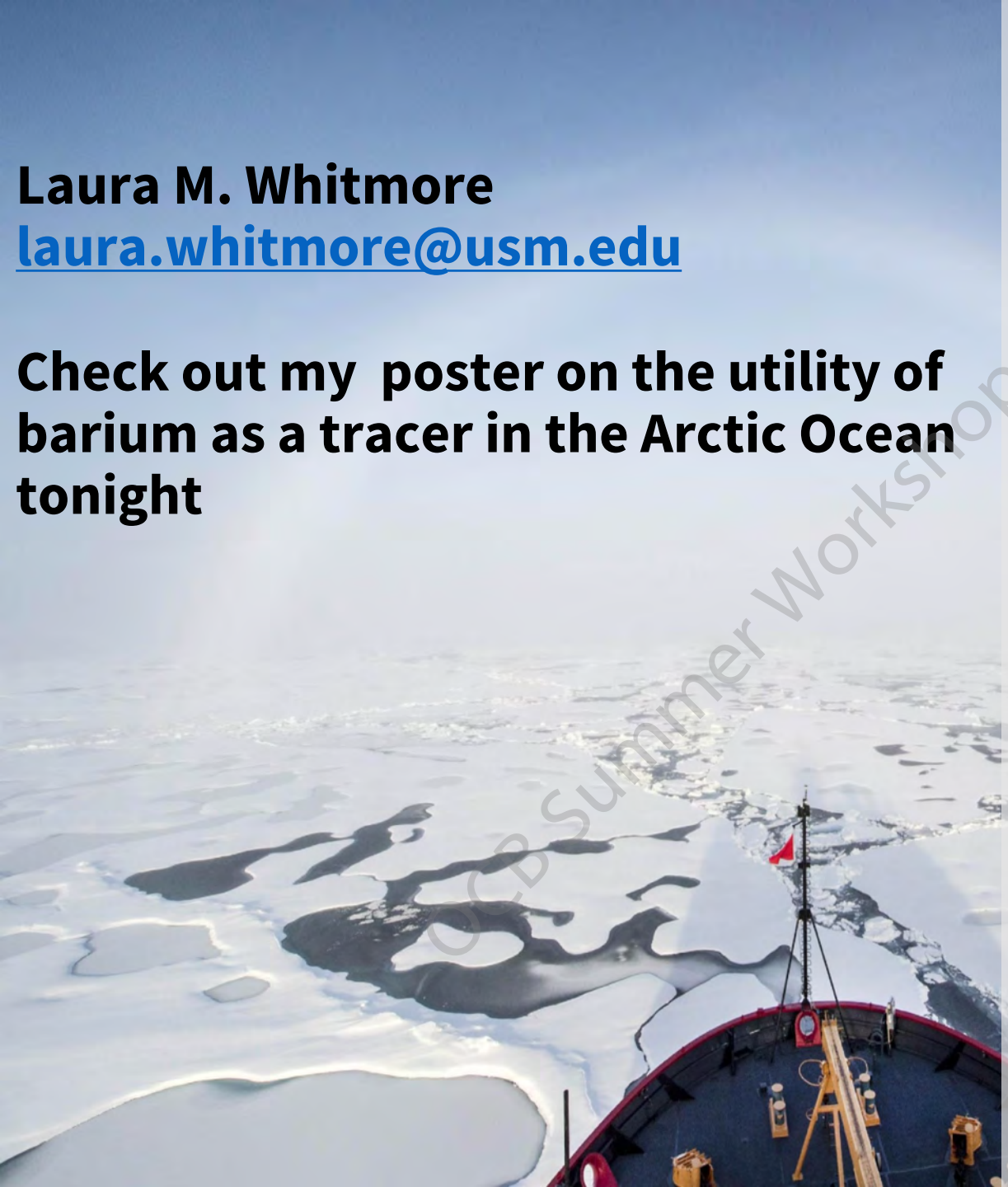


1. Water masses
2. Nutrient tracer
3. Comparison to new Ga tracer
4. Pacific fraction vertical profiles

Does the nutrient or gallium method more accurately represent the water column?

Laura M. Whitmore
laura.whitmore@usm.edu

Check out my poster on the utility of barium as a tracer in the Arctic Ocean tonight



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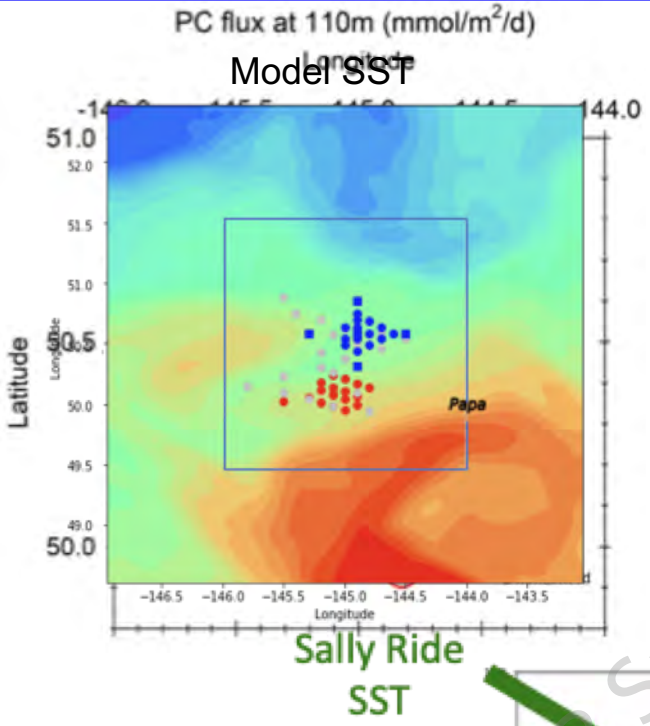
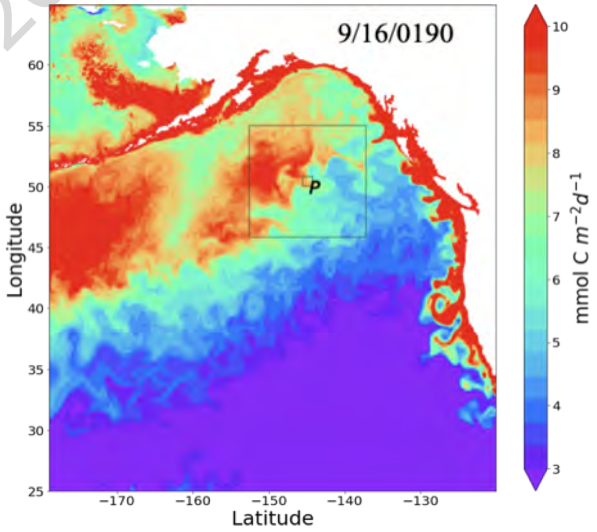
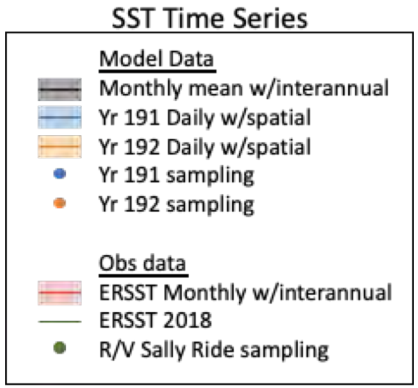
Particle Export and Plankton Spatio-Temporal Variability

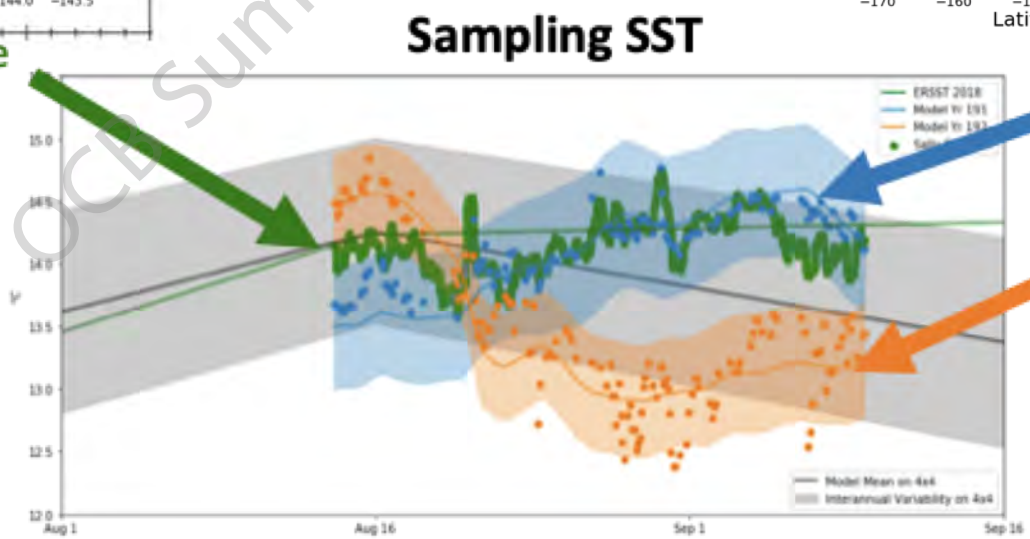
Exploring mesoscale and interannual variability during NASA EXPORTS cruise with a coupled biogeochemical Earth-system model.



Sampling the Model

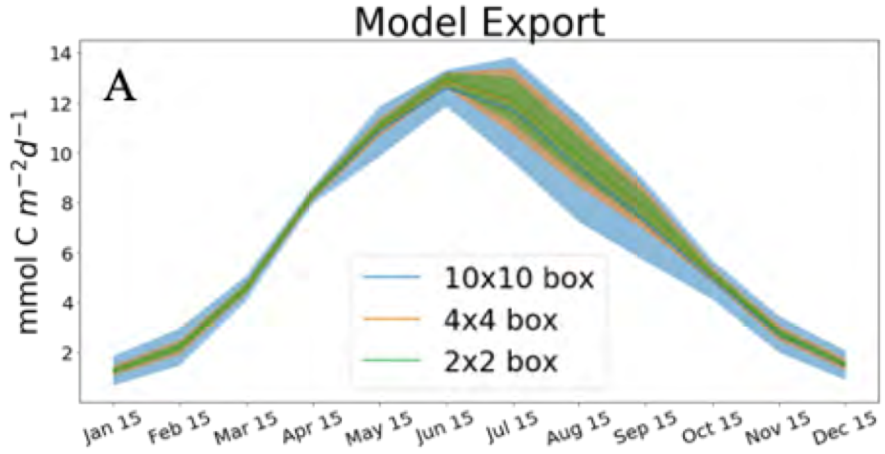


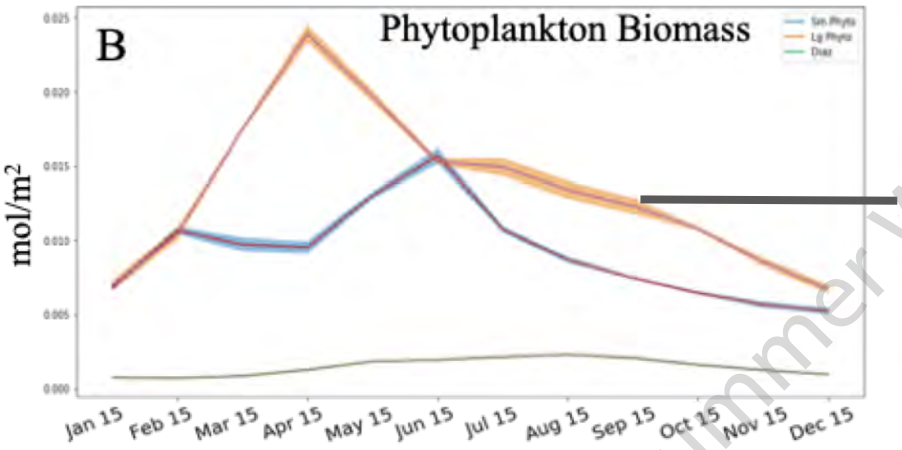


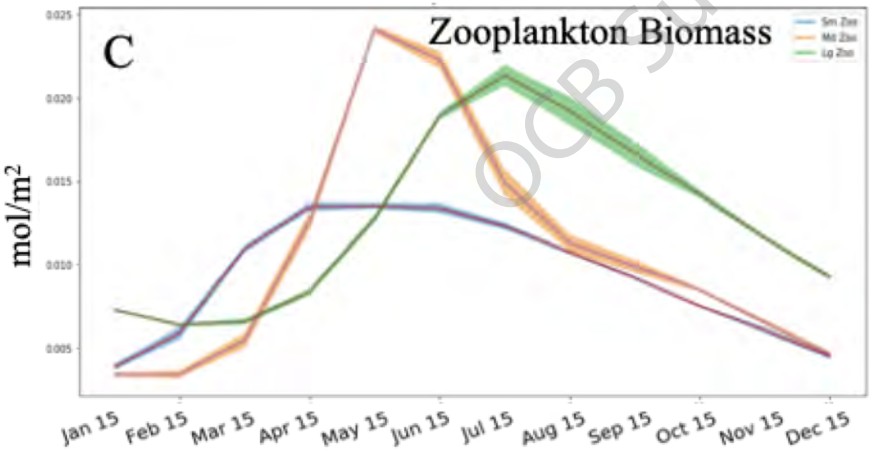


Preliminary Model Results

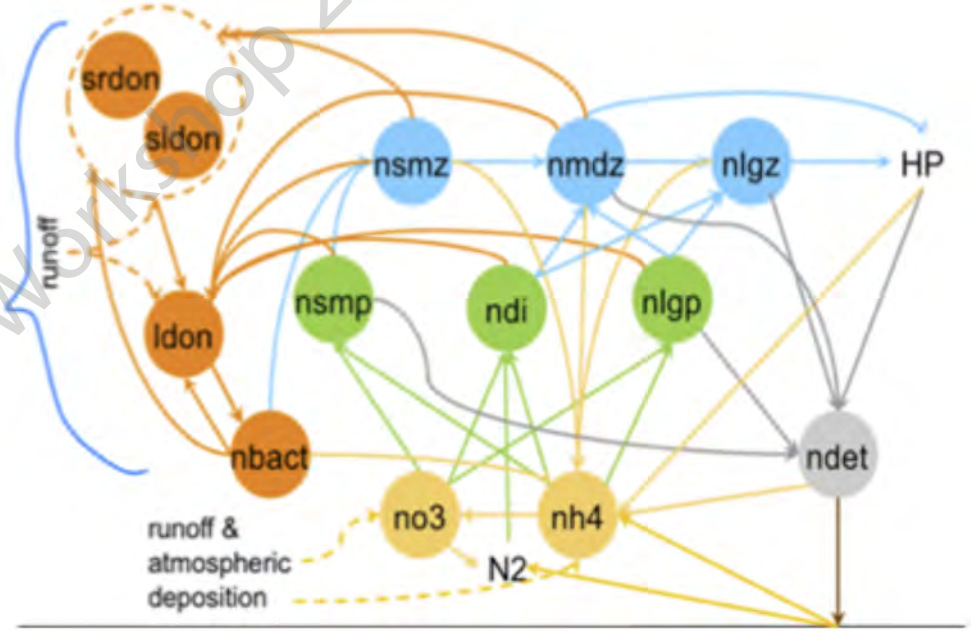
Interannual Variability







COBALT biogeochemical Model



Stock, et al., 2014

@AMWyatt