MEAP-TT Presentation

Biogeochemical (BGC) Argo data calibrate model parameters and model parameterizations for simulating the biological carbon pump

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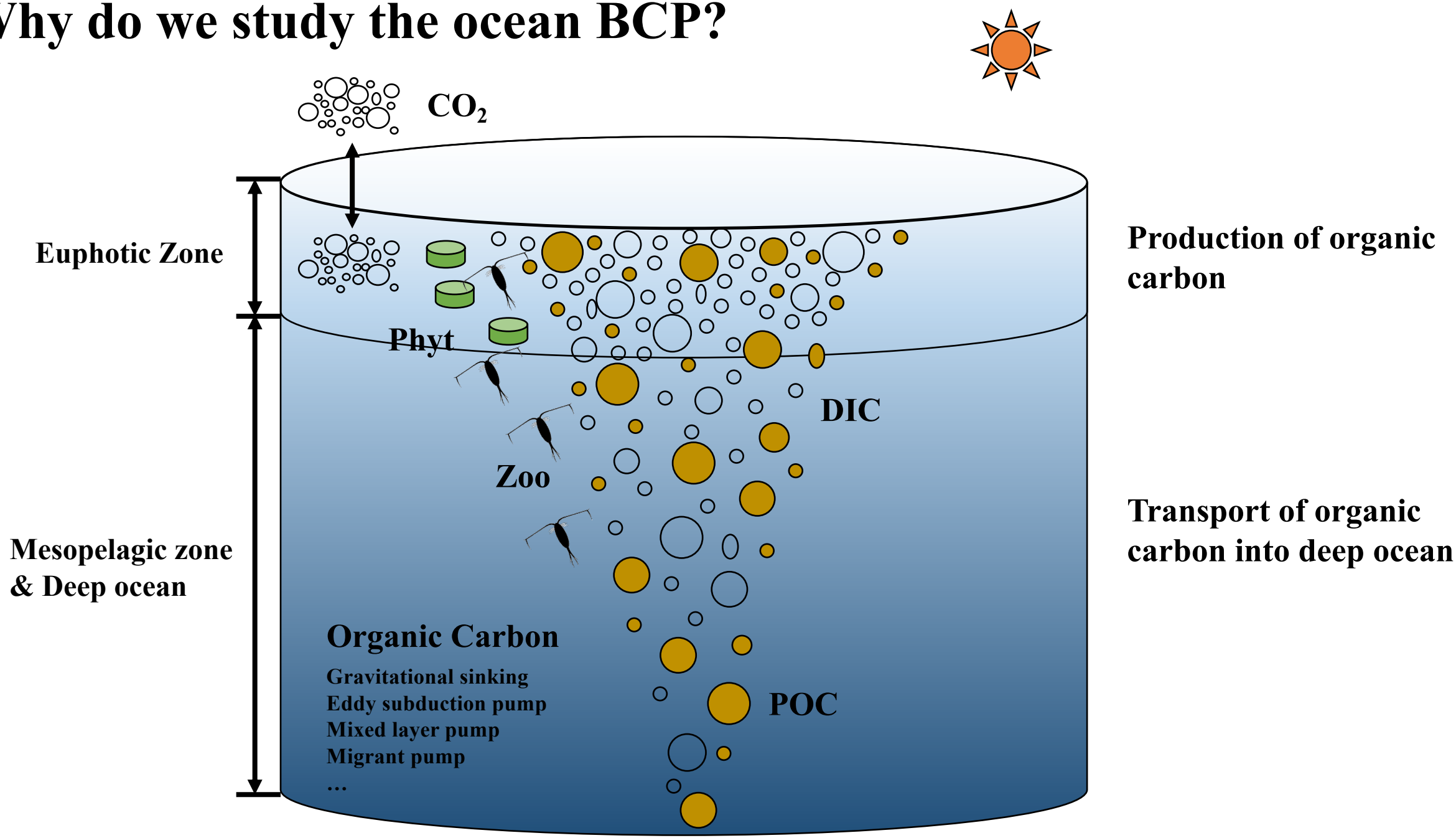
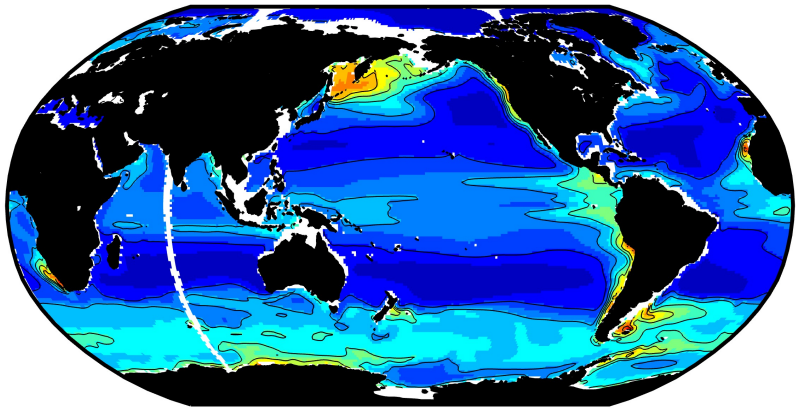
Why do we study the ocean BCP?



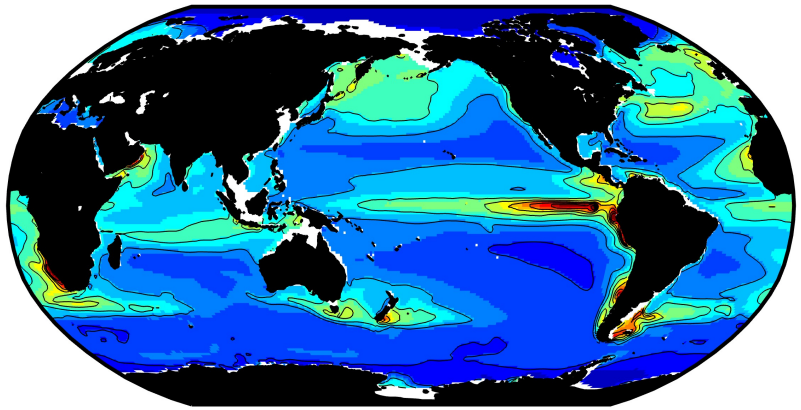
Large uncertainties exist in estimates of the BCP

At 100m

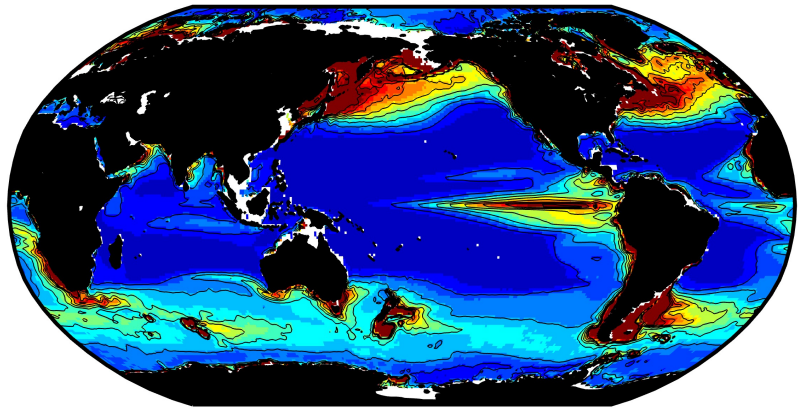
CMCC-ESM2 (5.43 Pg C yr^{-1})

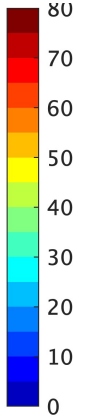


CESM (7.33 Pg C yr^{-1})



GFDL-CM4 (9.51 Pg C yr^{-1})





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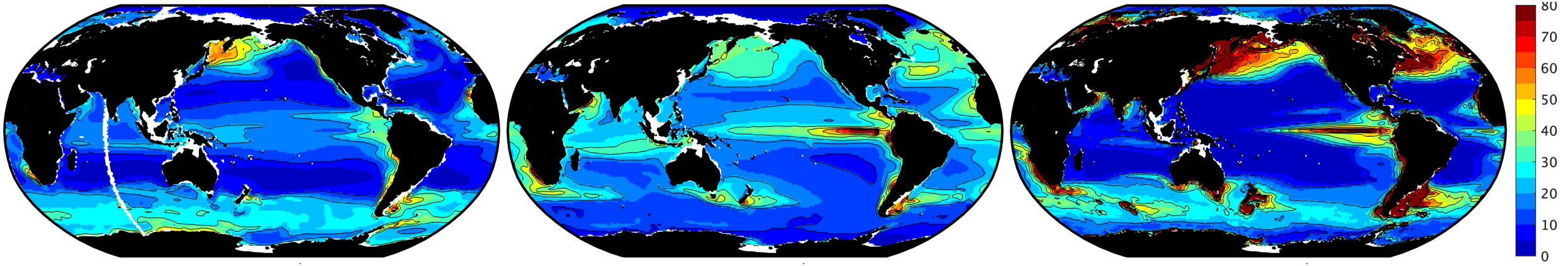
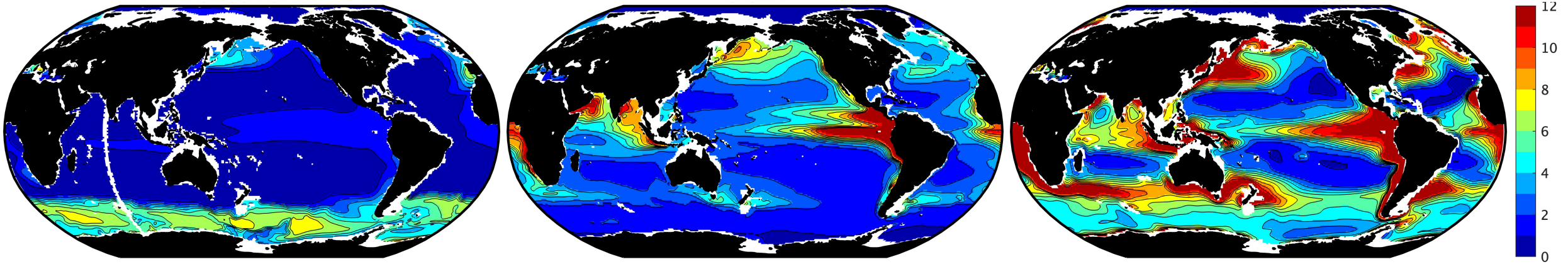


At 1000m

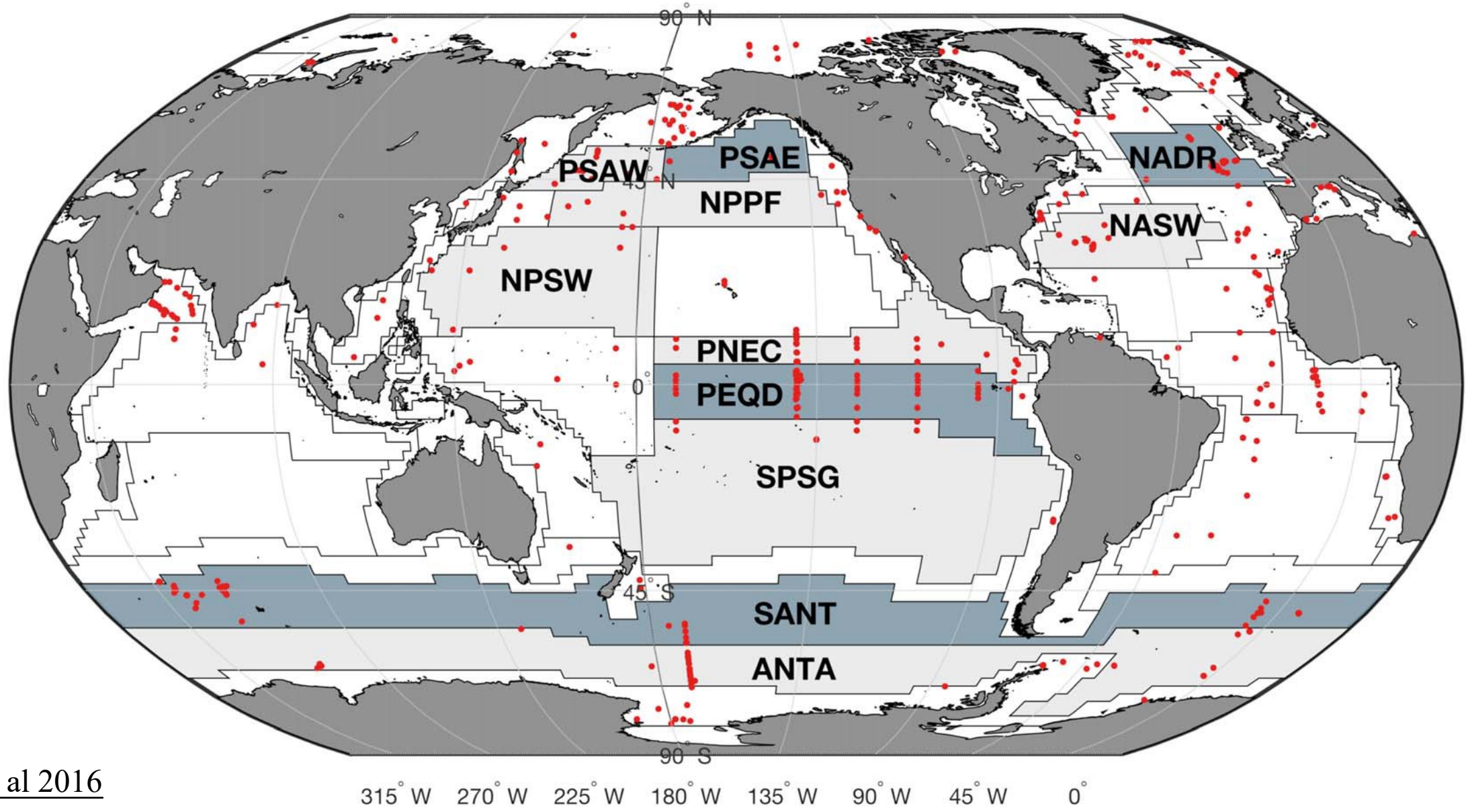
CMCC-ESM2 (0.48 Pg C yr^{-1})

CESM (1.11 Pg C yr^{-1})

IPSL-CM5A-INCA (1.81 Pg C yr^{-1})

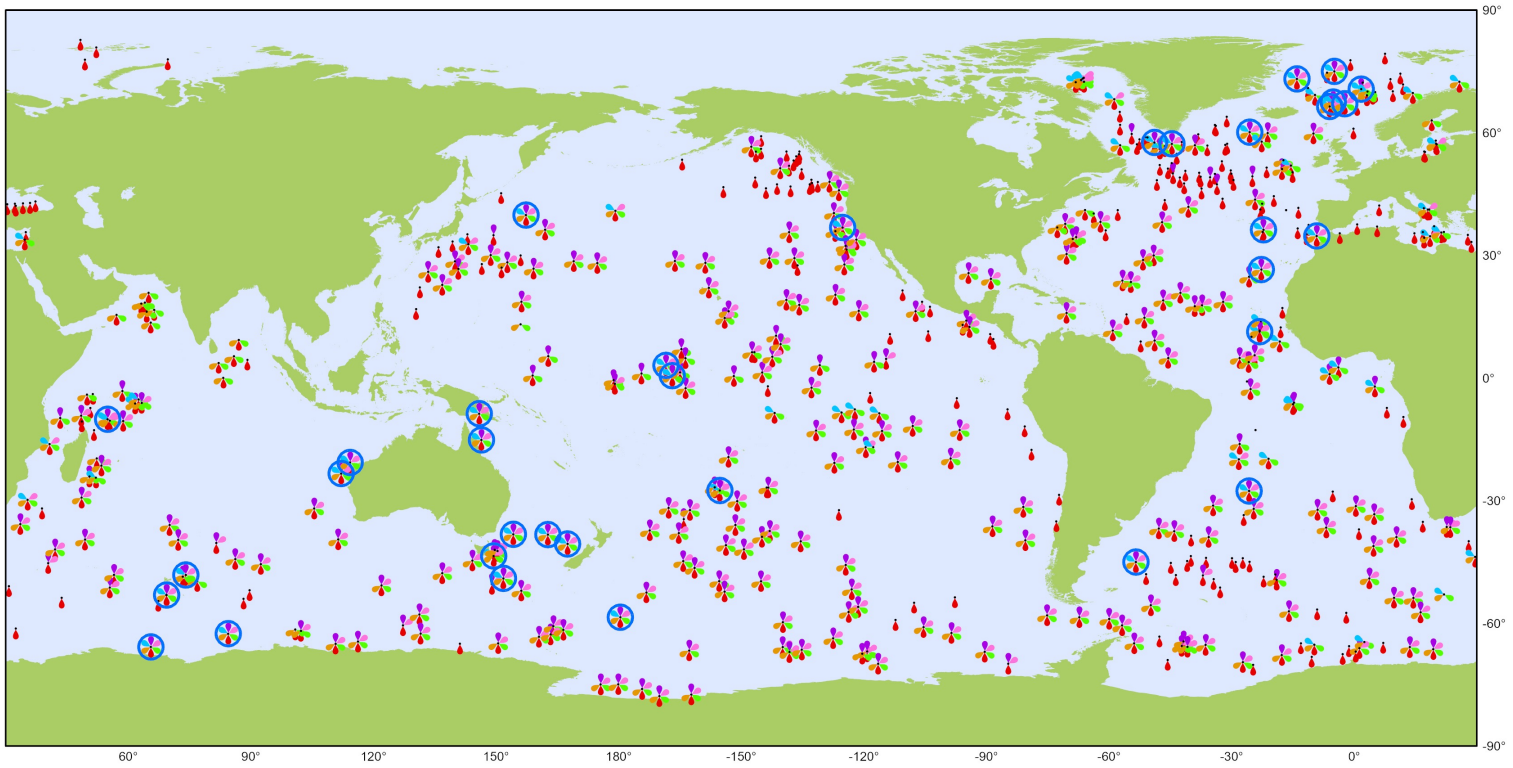


Sparse in-situ observations of POC flux



Gloege et al 2016

BGC-Argo data



Biogeochemical Argo — Sensor Types — April 2023

Latest location of operational floats (data distributed within the last 30 days)

271,492 O_2 profiles

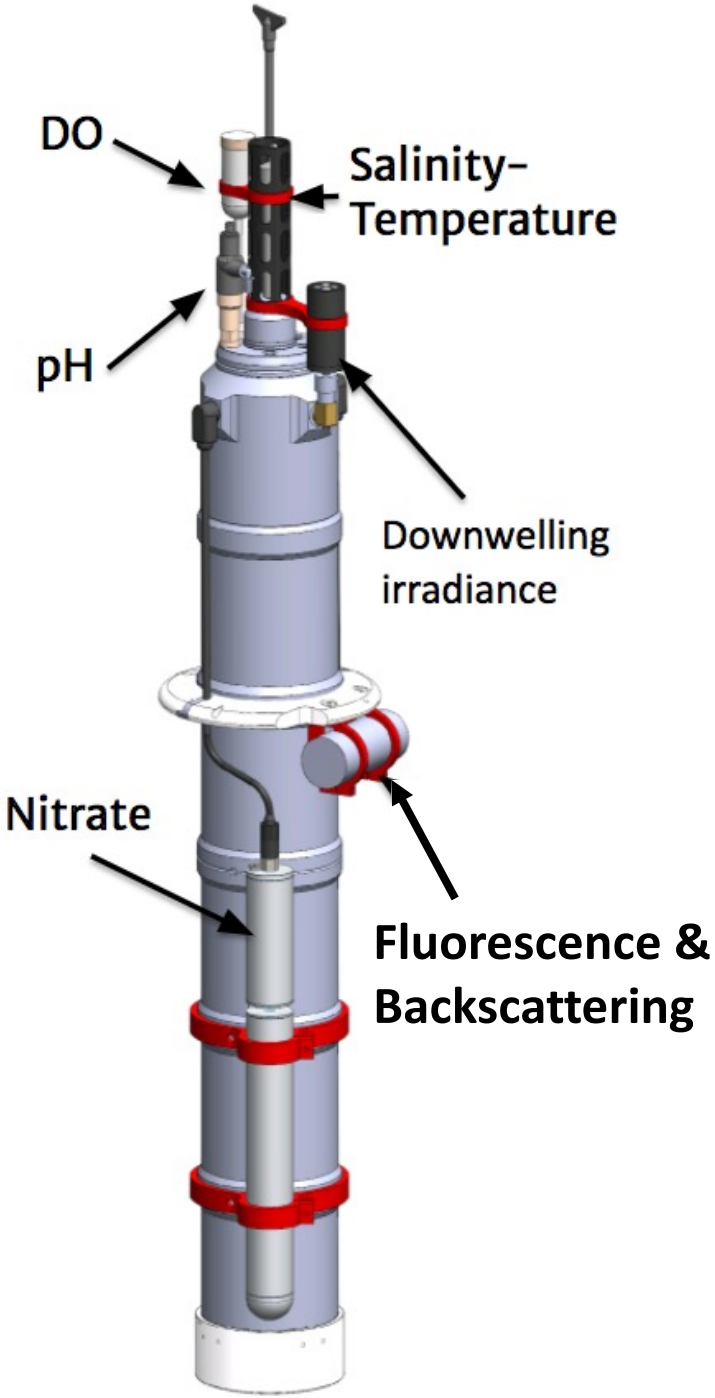
64,876 NO_3 profiles

43,957 pH profiles

116,666 CHLA profiles

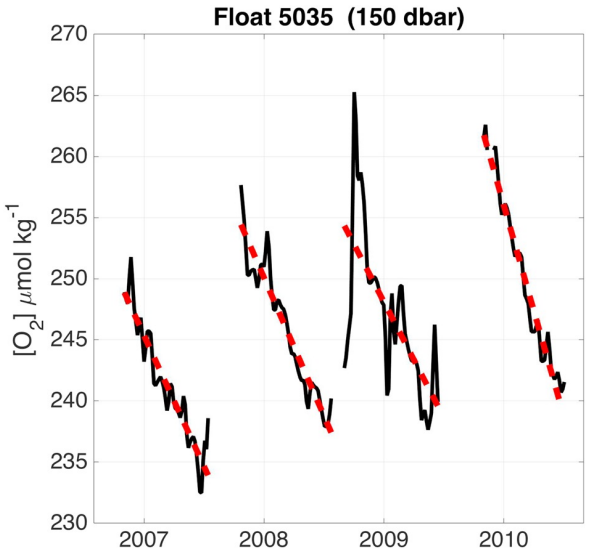
114,149 BBP profiles

49,858 Downwelling Irradiance



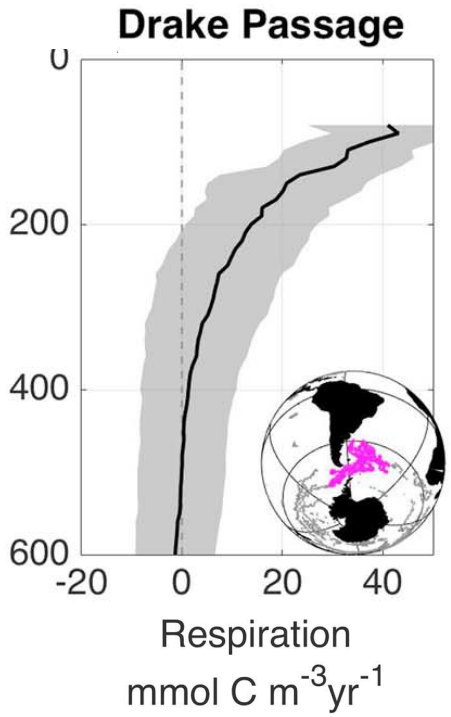
The BCP can be estimated from BGC-Argo data

1

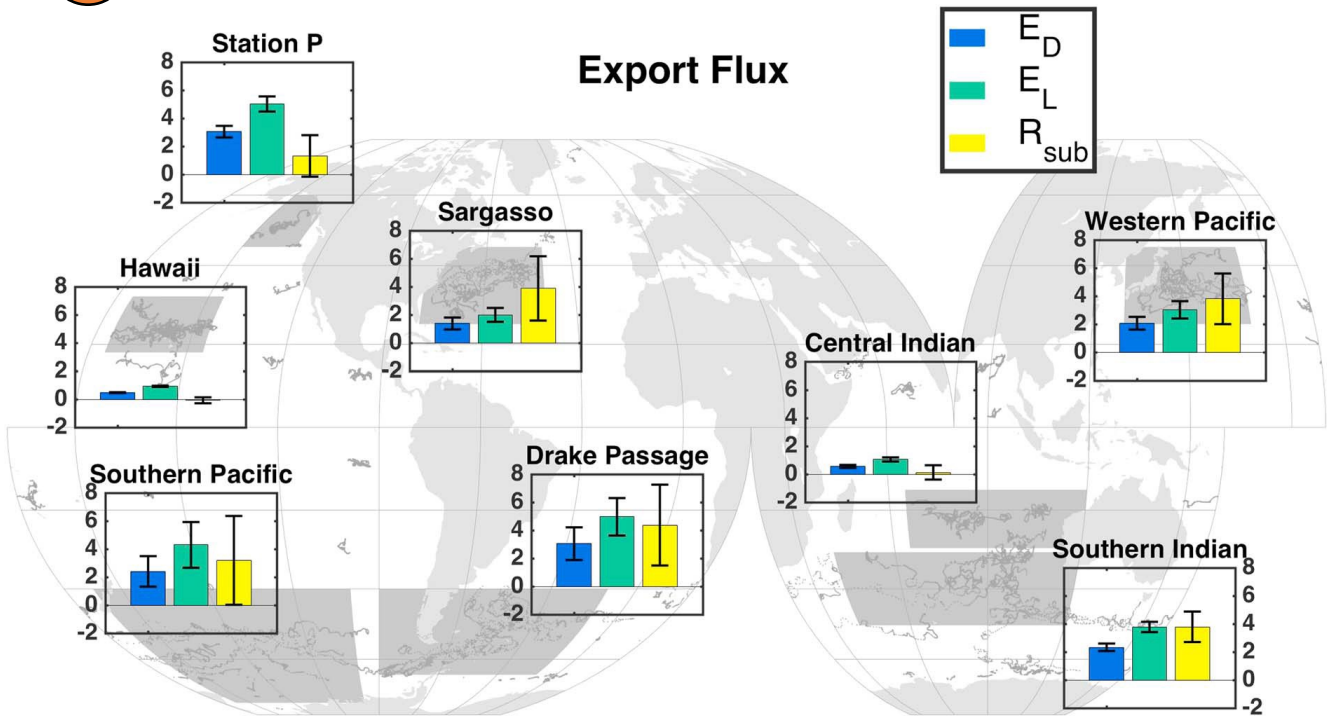


Fitting the oxygen concentration to calculate the net respiration rate.

2



3

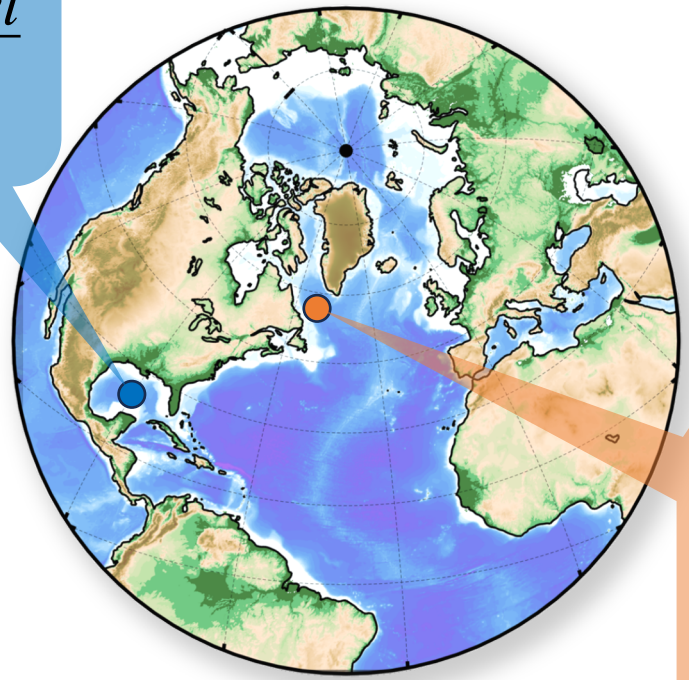


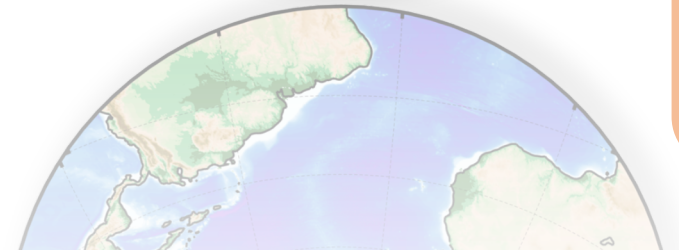
$$Export = \int respiration\, dz$$

Hennon et al. (2016)

Additional values of backscatter profiles for model calibration?

To optimize **parameters** controlling the carbon export out of euphotic zone (*Wang et al., 2020*)





To assess different model **parameterizations** describing the vertical attenuation of the BCP (*Wang and Fennel, 2023*)

Biogeosciences, 17, 4059–4074, 2020
https://doi.org/10.5194/bg-17-4059-2020

Biogeosciences
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Assessing the value of biogeochemical Argo profiles versus ocean color observations for biogeochemical model optimization in the Gulf of Mexico

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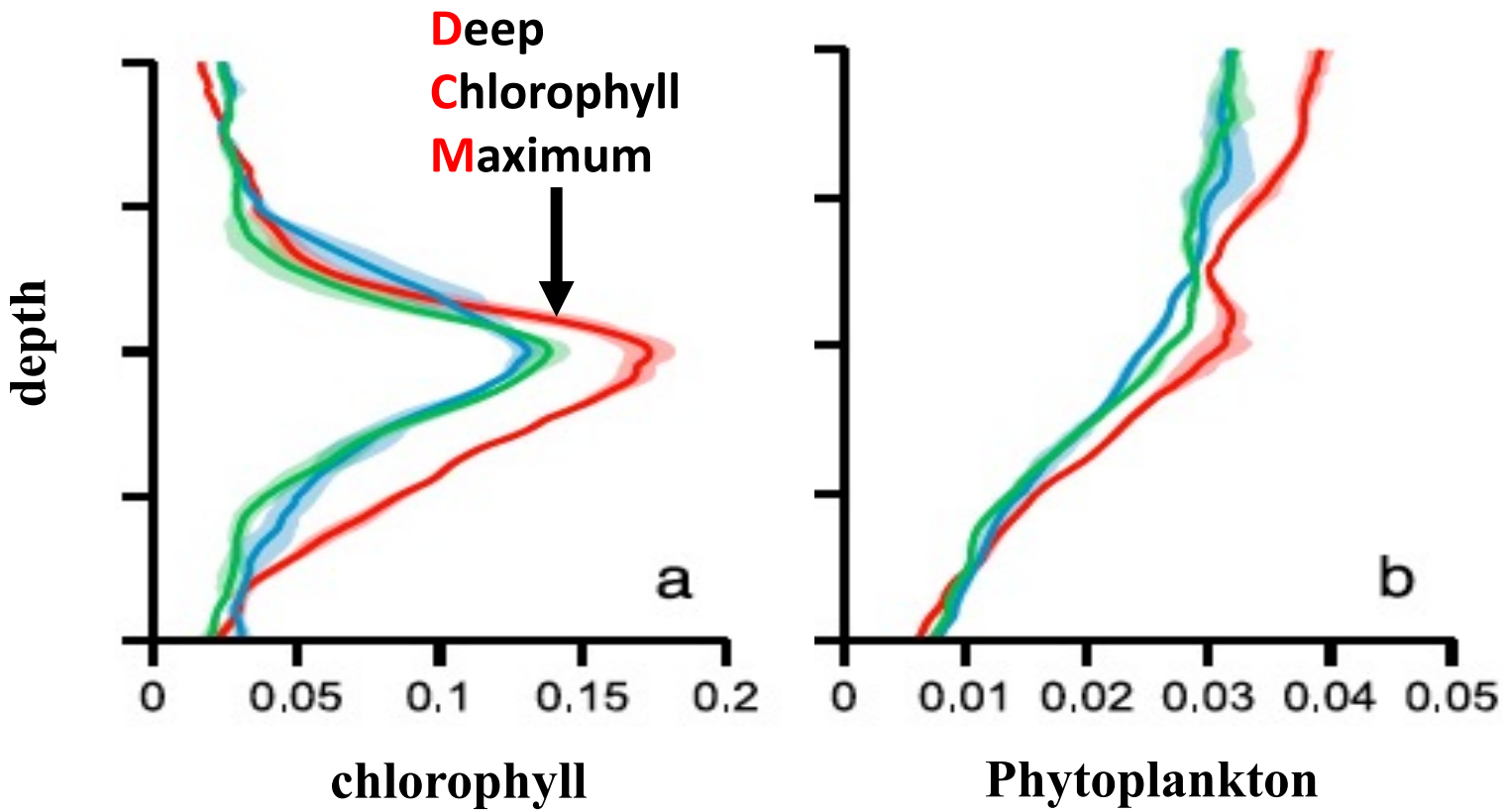
2Department of Mathematics, The Hong Kong University of Science and Technology, Kowloon, Hong Kong

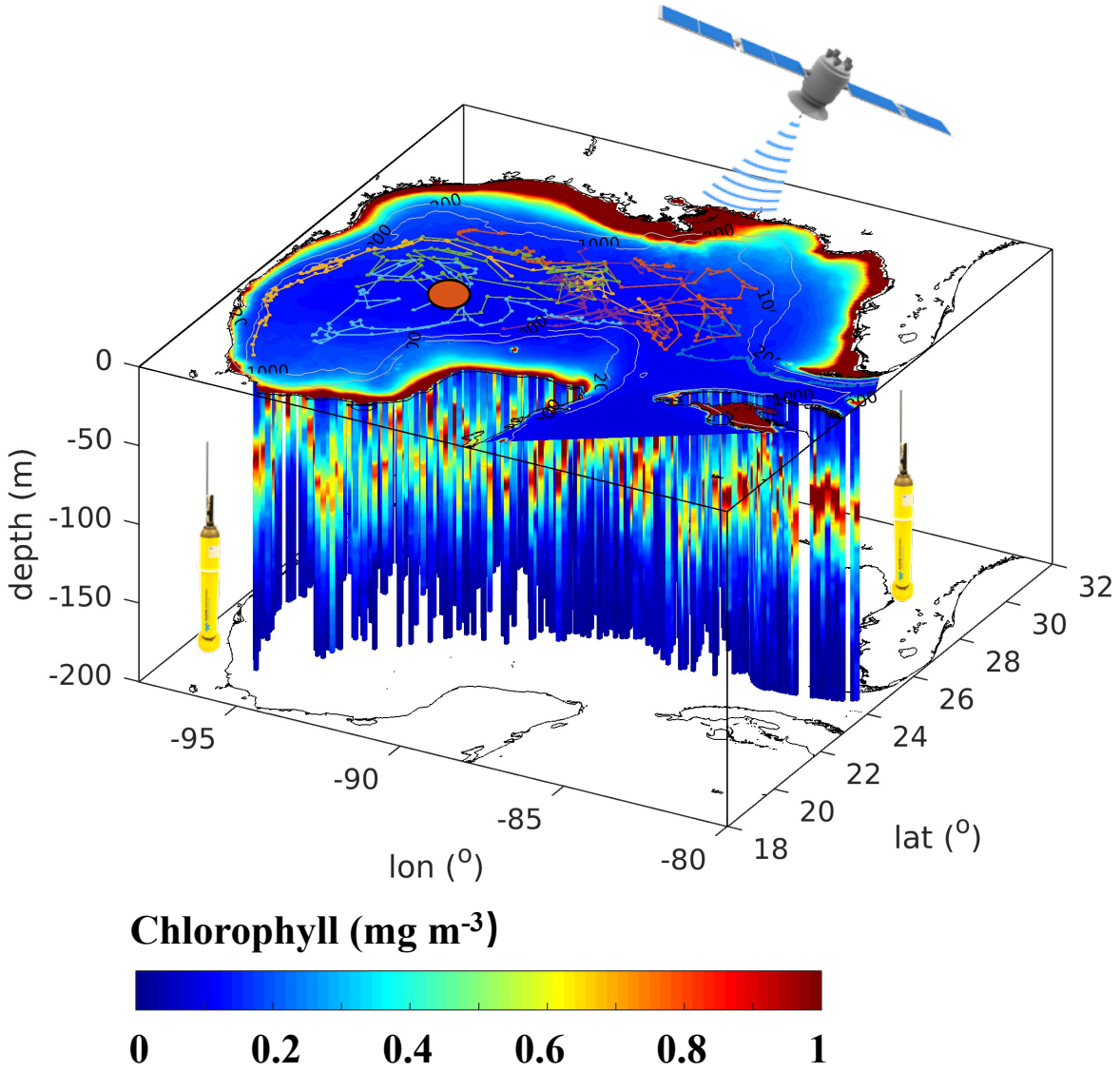
Chlorophyll is not a good proxy for carbon biomass



- Satellite data is limited to the surface
- Chlorophyll does not necessarily reflect changes in carbon biomass

Mignot et al 2014 (GBC)

Optimization Experiment settings



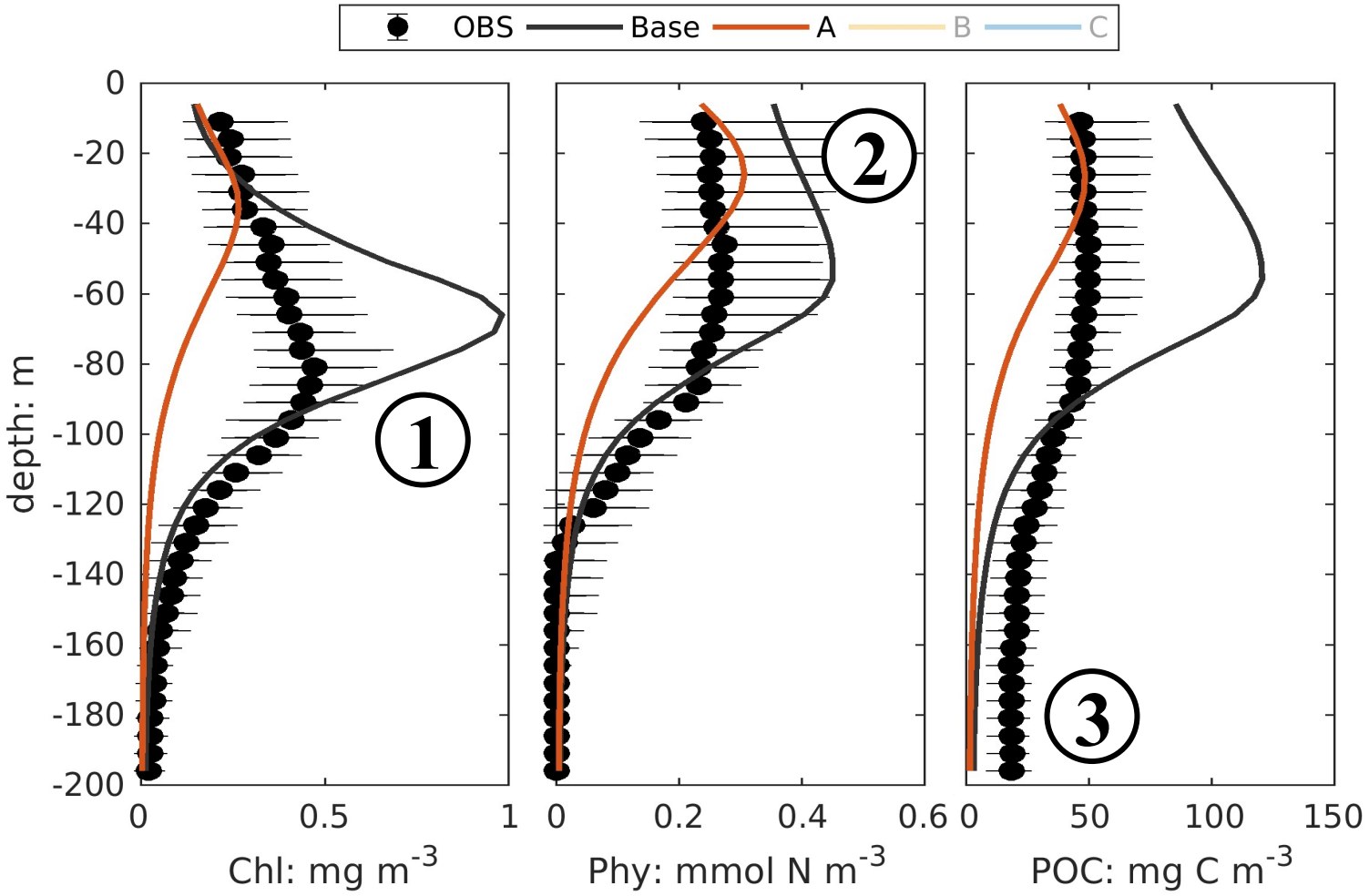
➢ Parameter Optimization experiments

	Satellite Surface CHL	Profiles of CHL	Profiles of backscatters
Base			
A	√		
B	√	√	
C	√	√	√

$$\mathrm{F}_v(P) = \frac{1}{N\sigma_v^2}\sum_{i=1}^{n}\left(\hat{y}_{i,v} - y_{i,v}(P)\right)^2$$

Optimize parameters of vertical carbon flux

	Satellite CHL	Profiles of CHL	Profiles of backscatter
Base			
A	√		
B	√	√	
C	√	√	√



1D model results

Wang et al., (2020)

Optimize parameters of vertical carbon flux

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Base			
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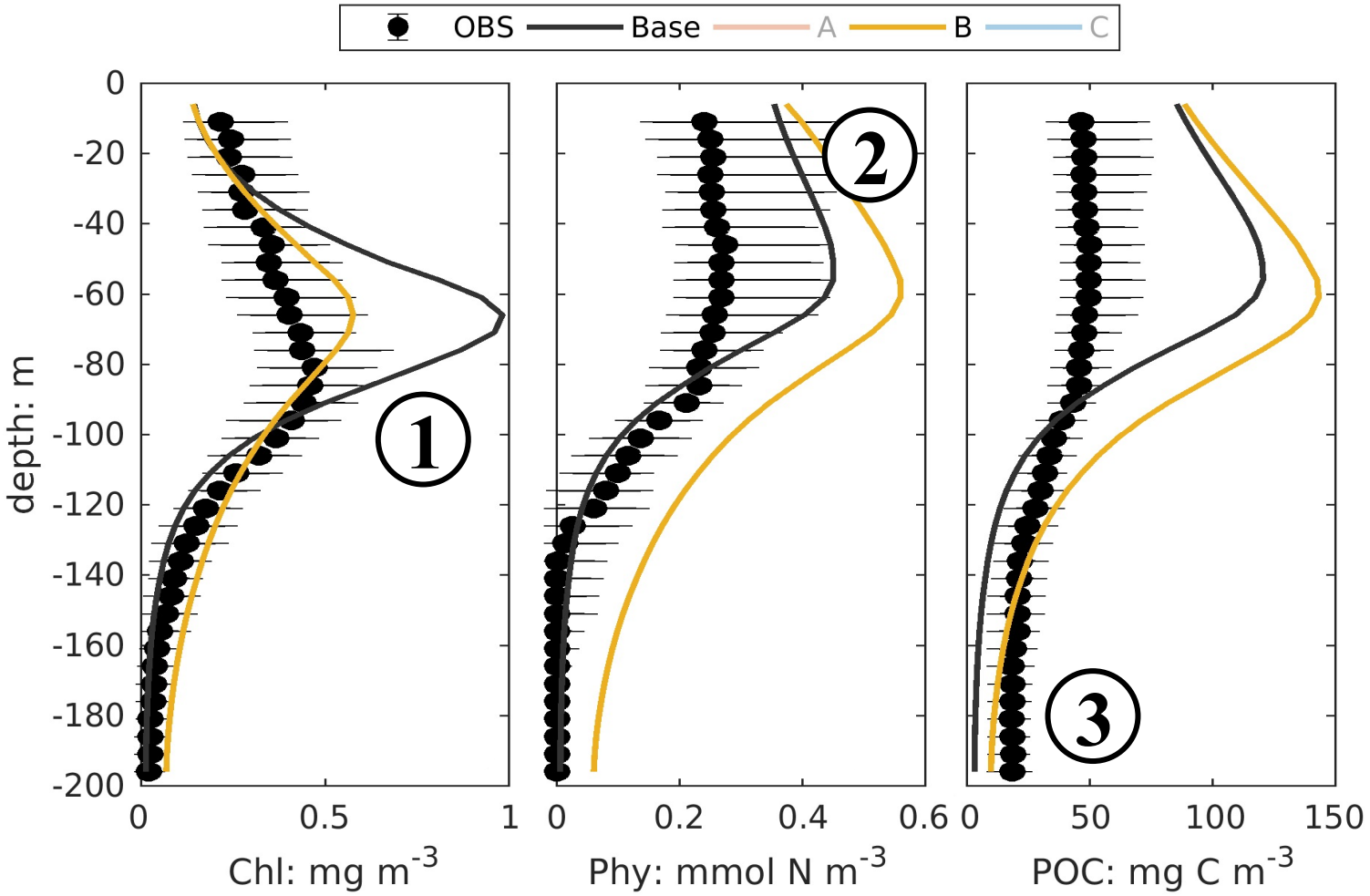

1D model results

Wang et al., (2020)

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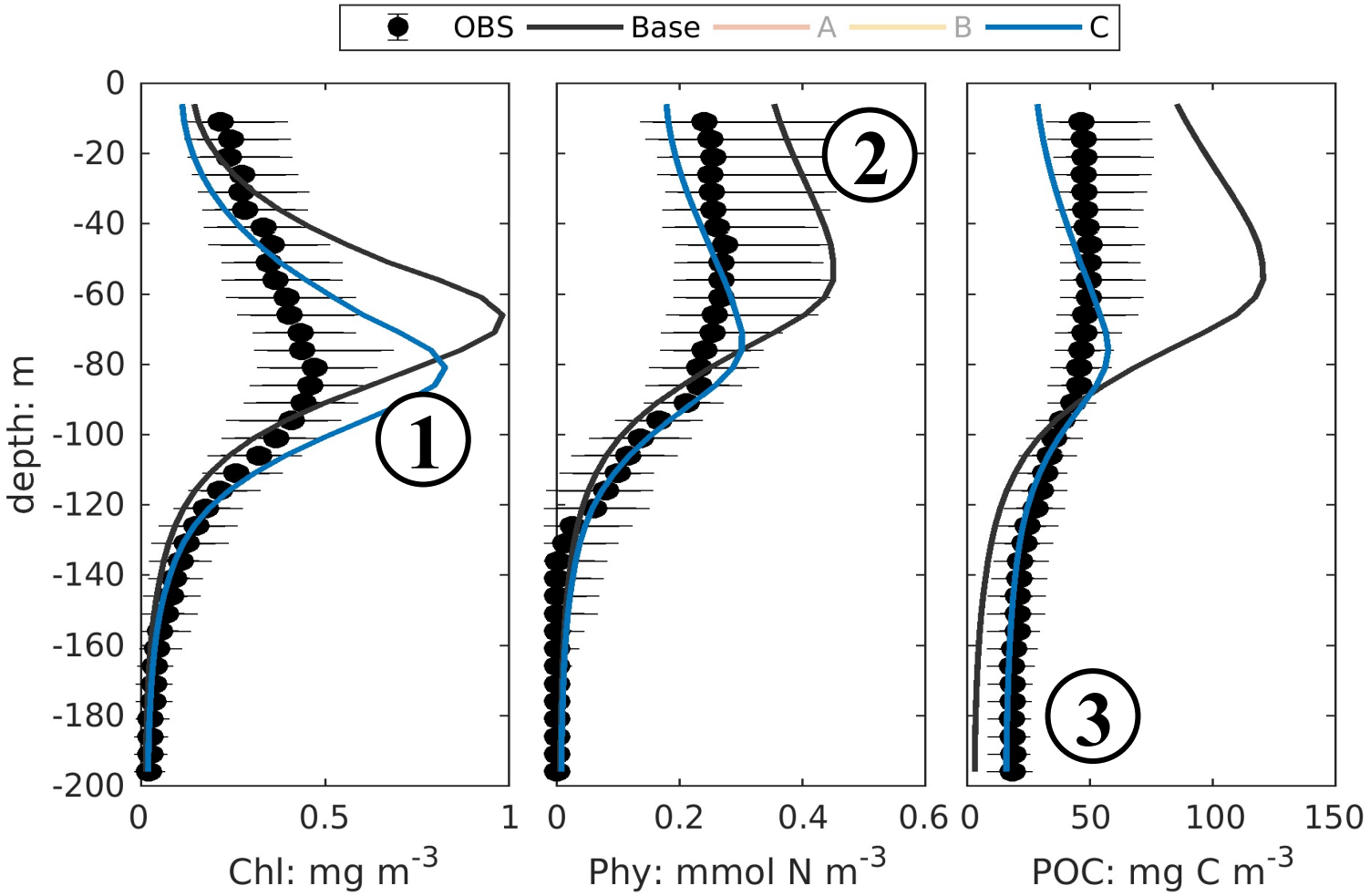
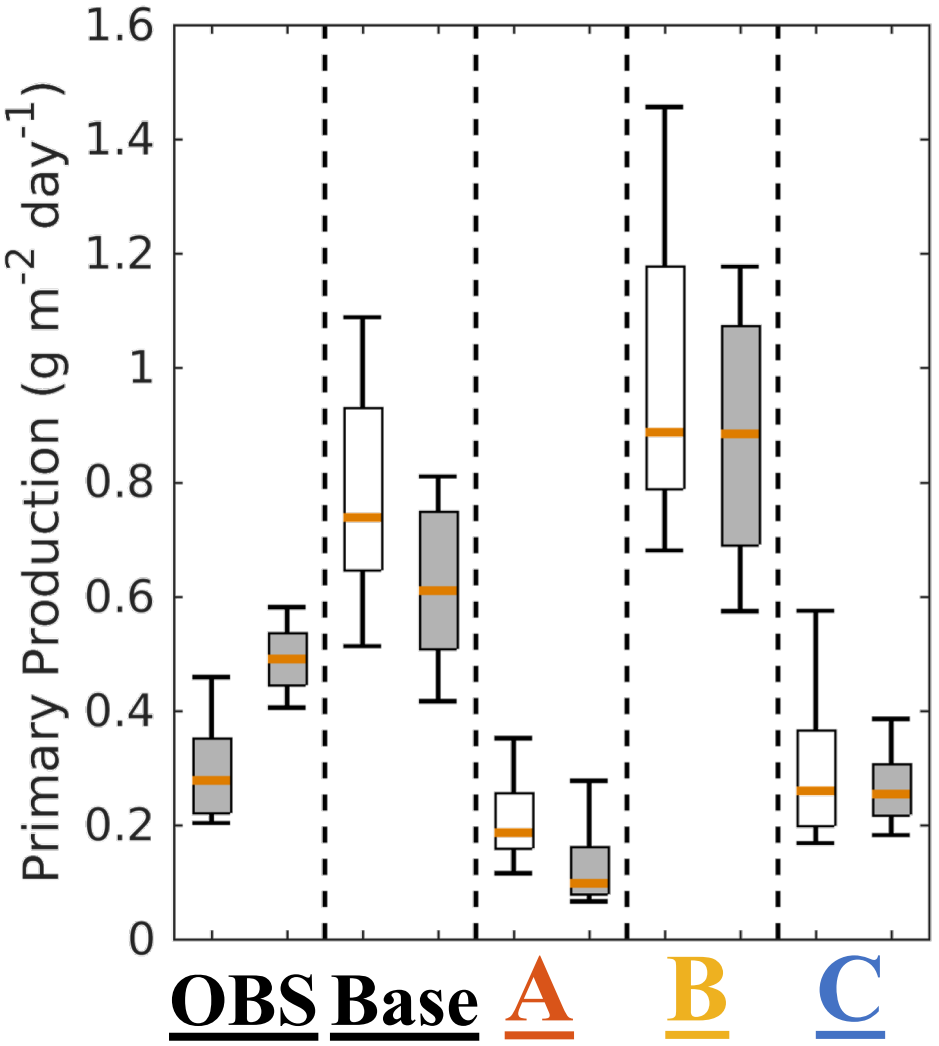
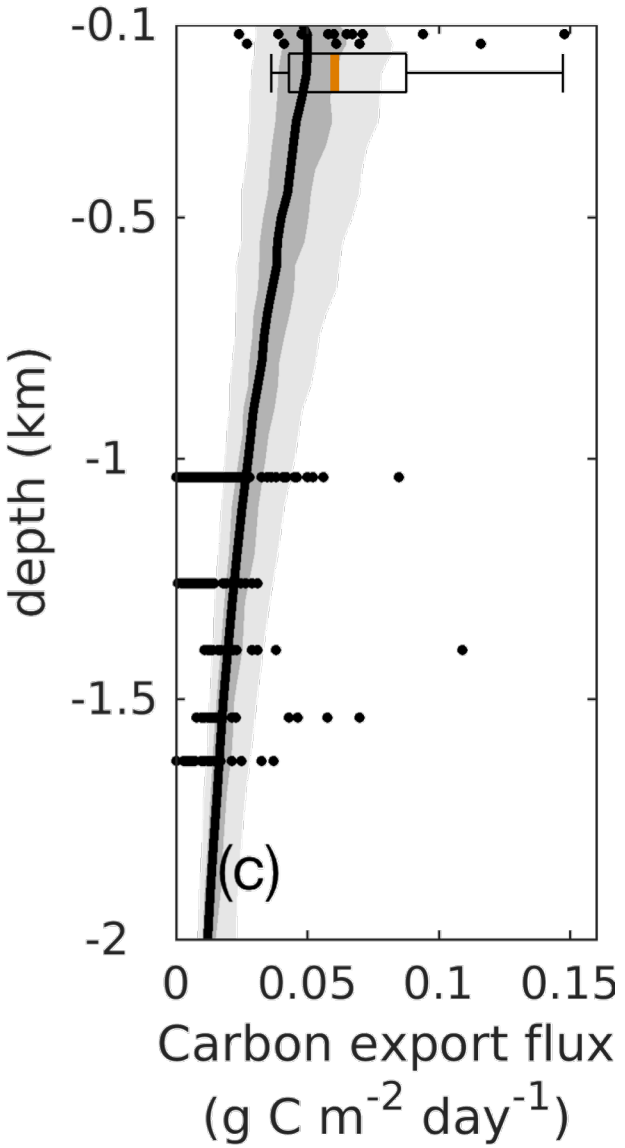


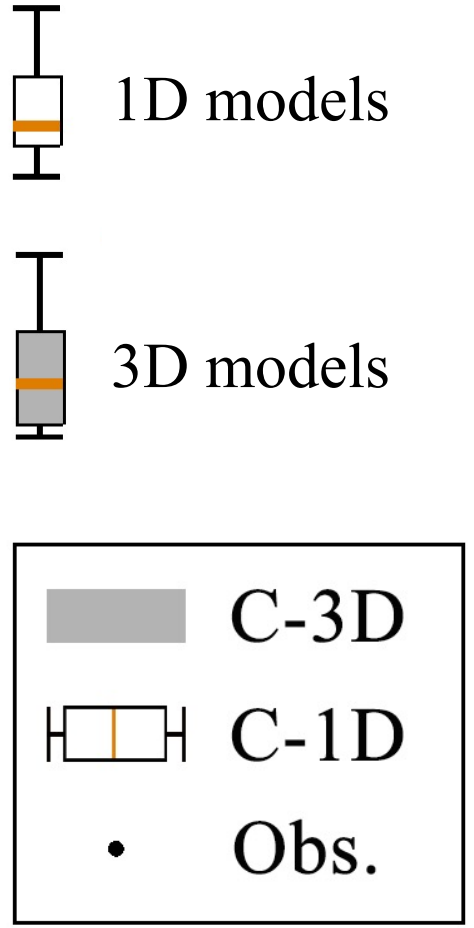
1D model results

Wang et al., (2020)

Optimize parameters of vertical carbon flux







Wang et al., (2020)

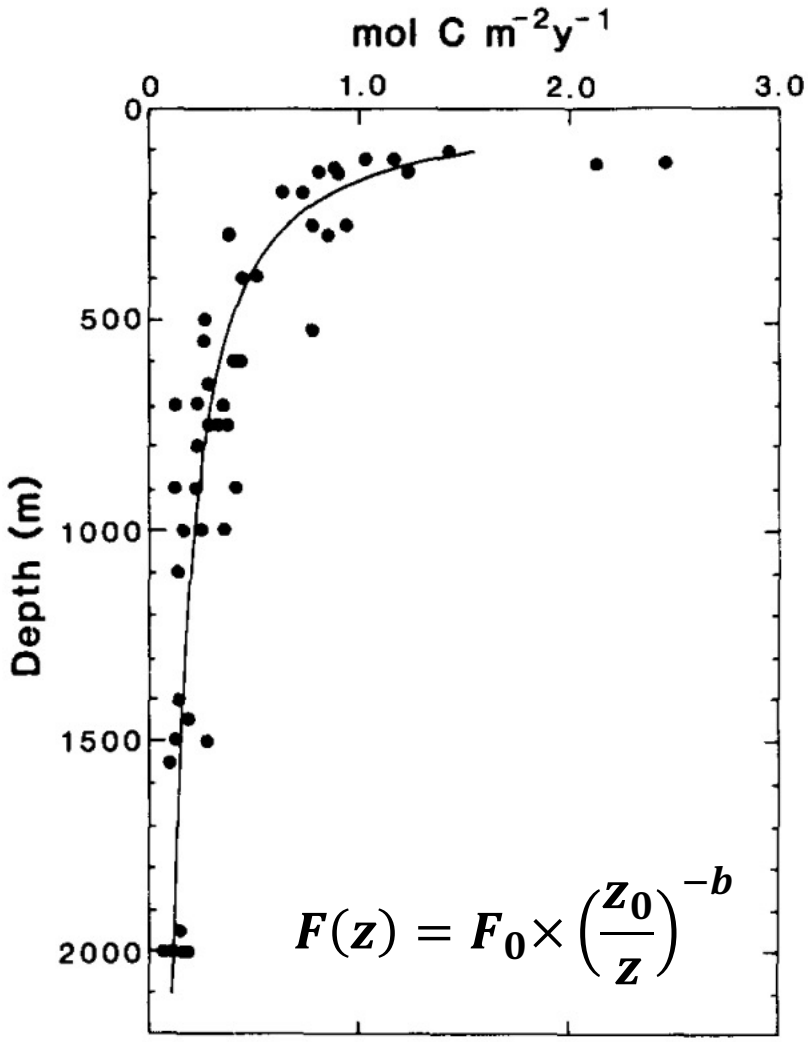
Geophysical Research Letters®

An Assessment of Vertical Carbon Flux Parameterizations Using Backscatter Data From BGC Argo

Bin Wang and Katja Fennel

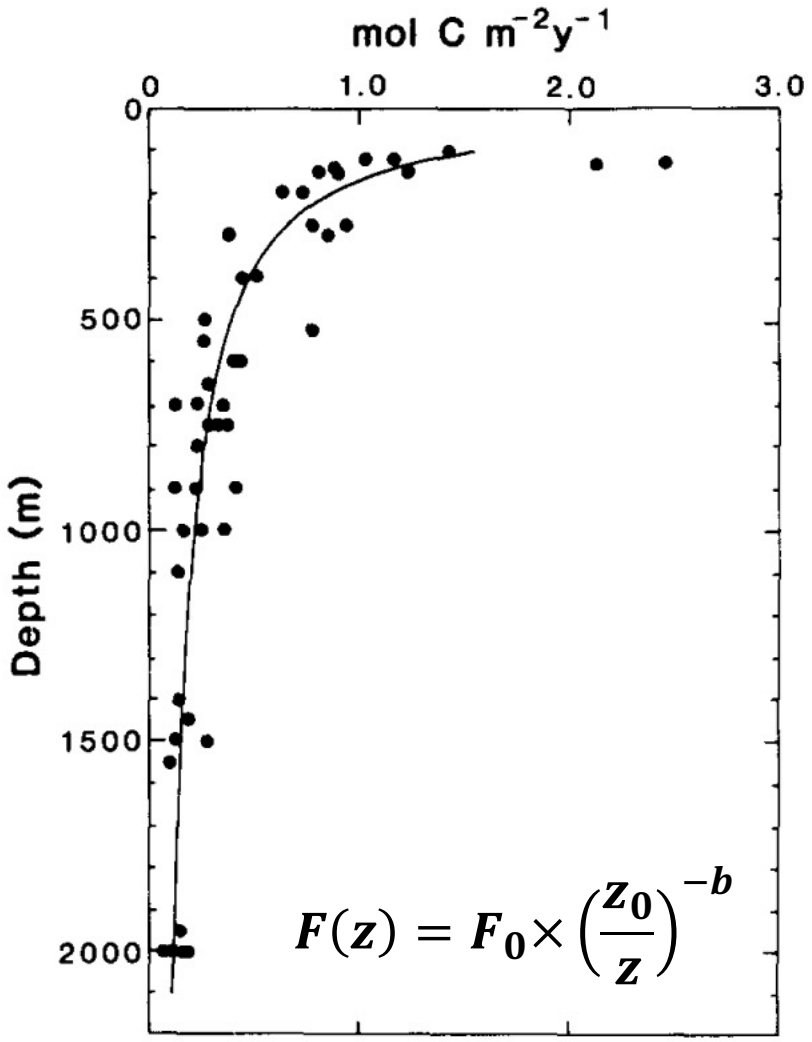
Department of Oceanography, Dalhousie University, Halifax, NS, Canada

Assessing model parameterizations of vertical carbon flux



Martin Curve

Assessing model parameterizations of vertical carbon flux



Martin Curve

Decreasing remineralization rate

Or

Increasing sinking velocity

Assessing model parameterizations of vertical carbon flux

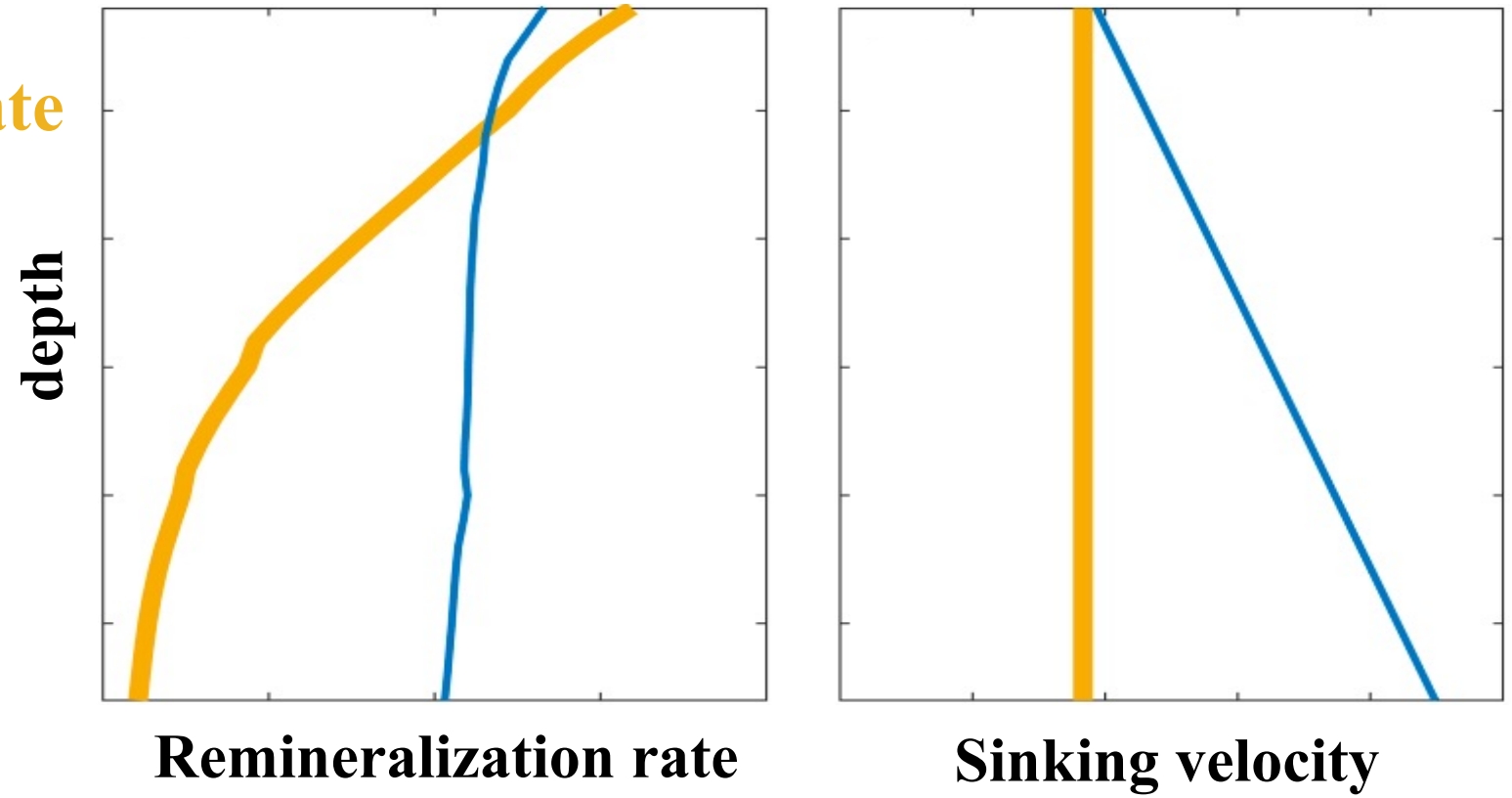
Two parameterizations:

- **Ballast scheme** (e.g., COBALTv2)
- **WLin scheme** (e.g., PISCES, HAMOOC)

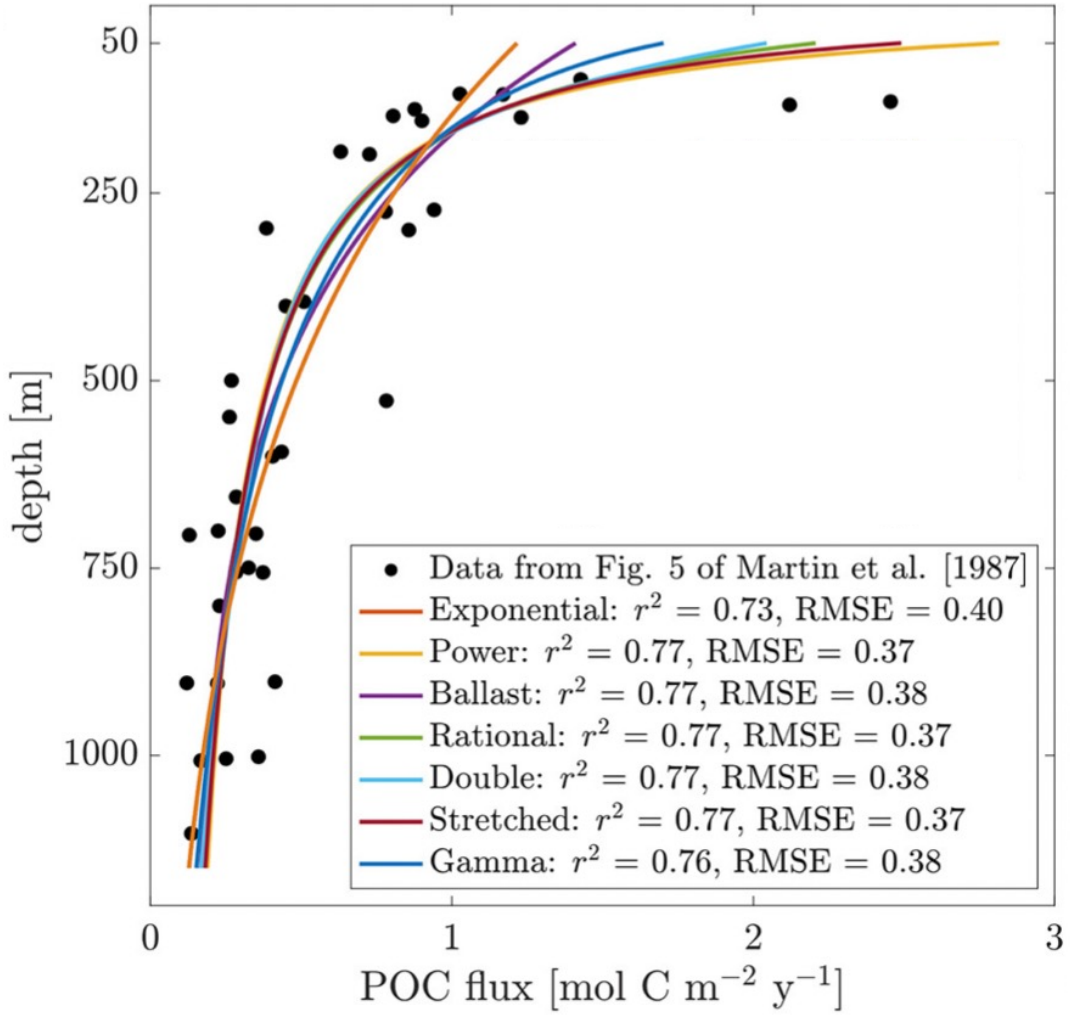
Decreasing remineralization rate

Or

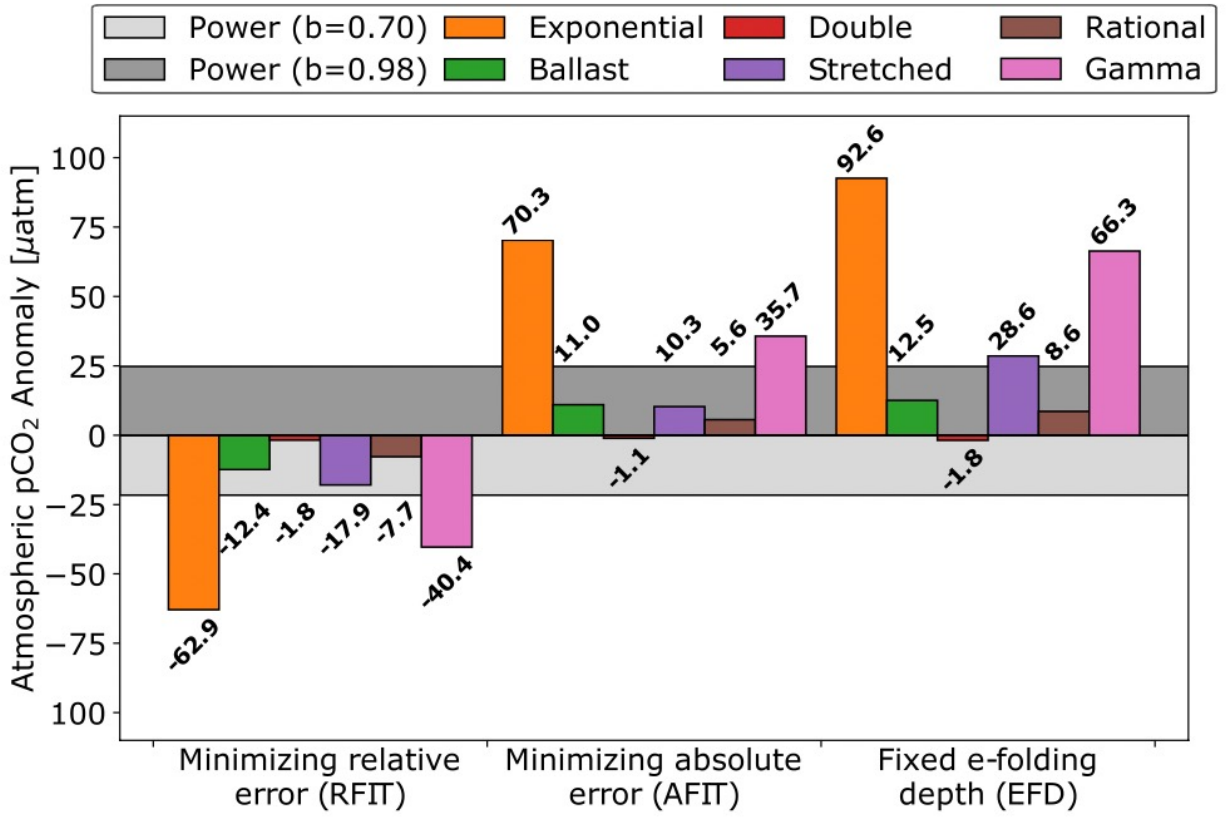
Increasing sinking velocity



Assessing model parameterizations of vertical carbon flux

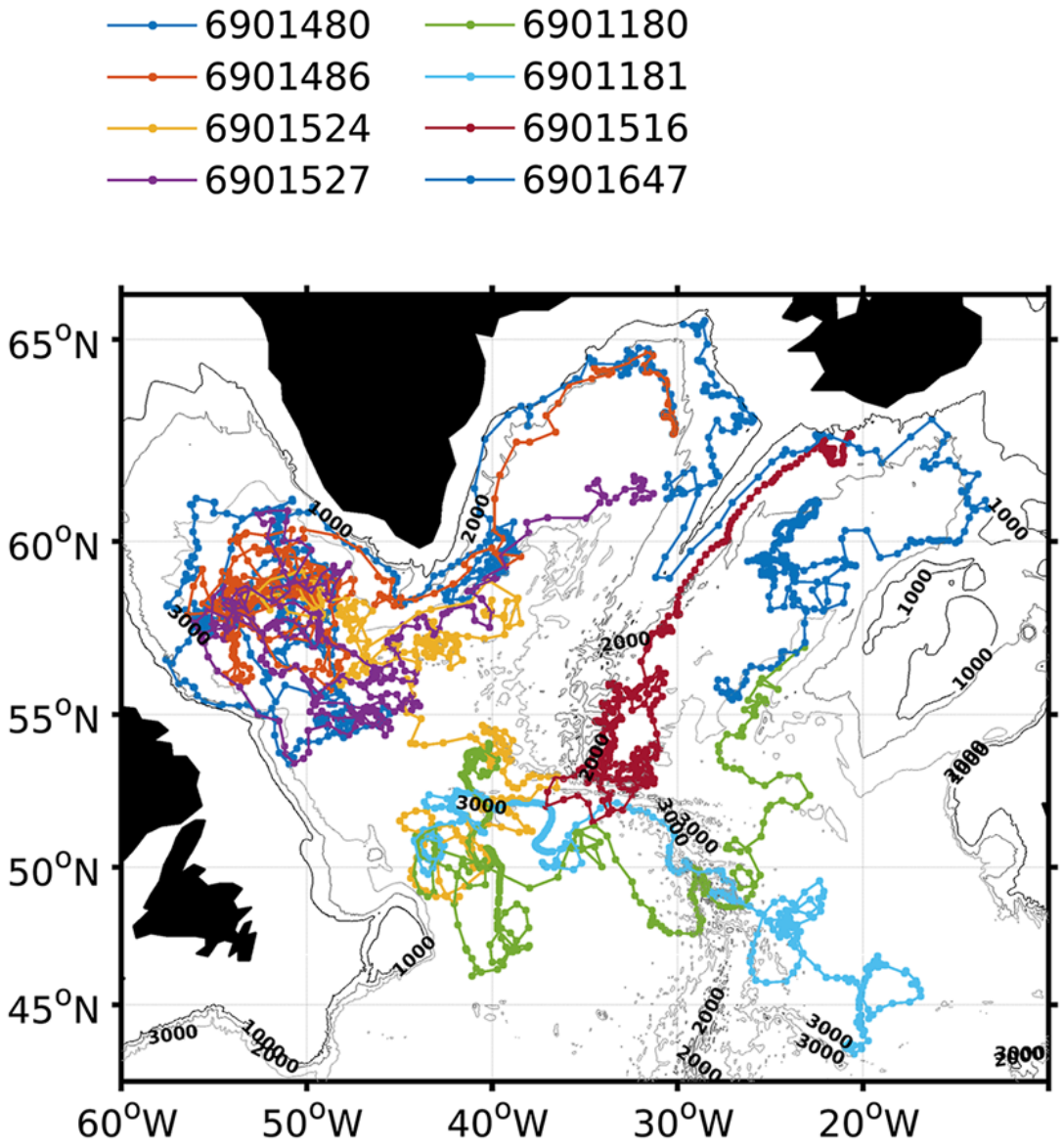


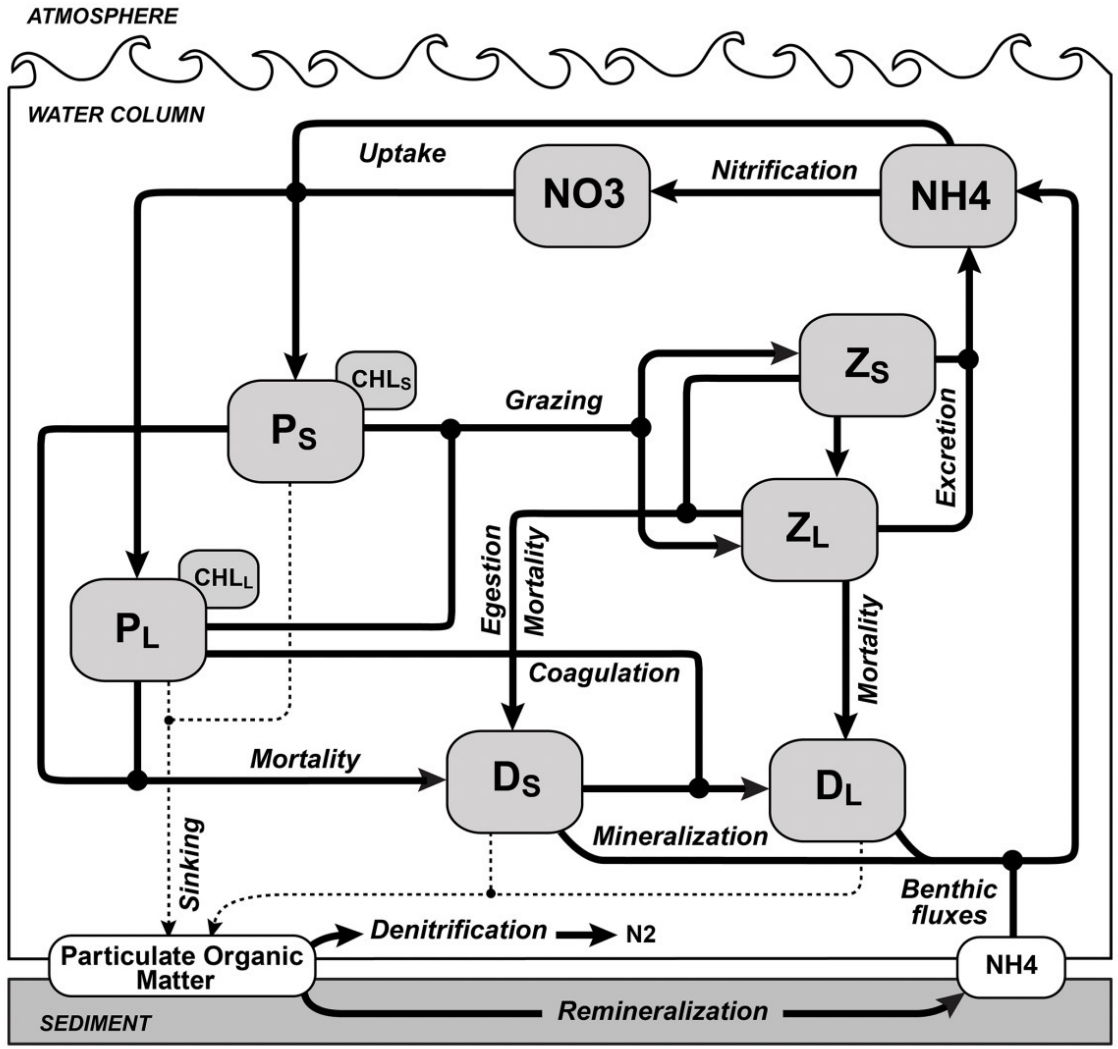
Cael and Bisson 2018



Lauderdale and Cael 2020

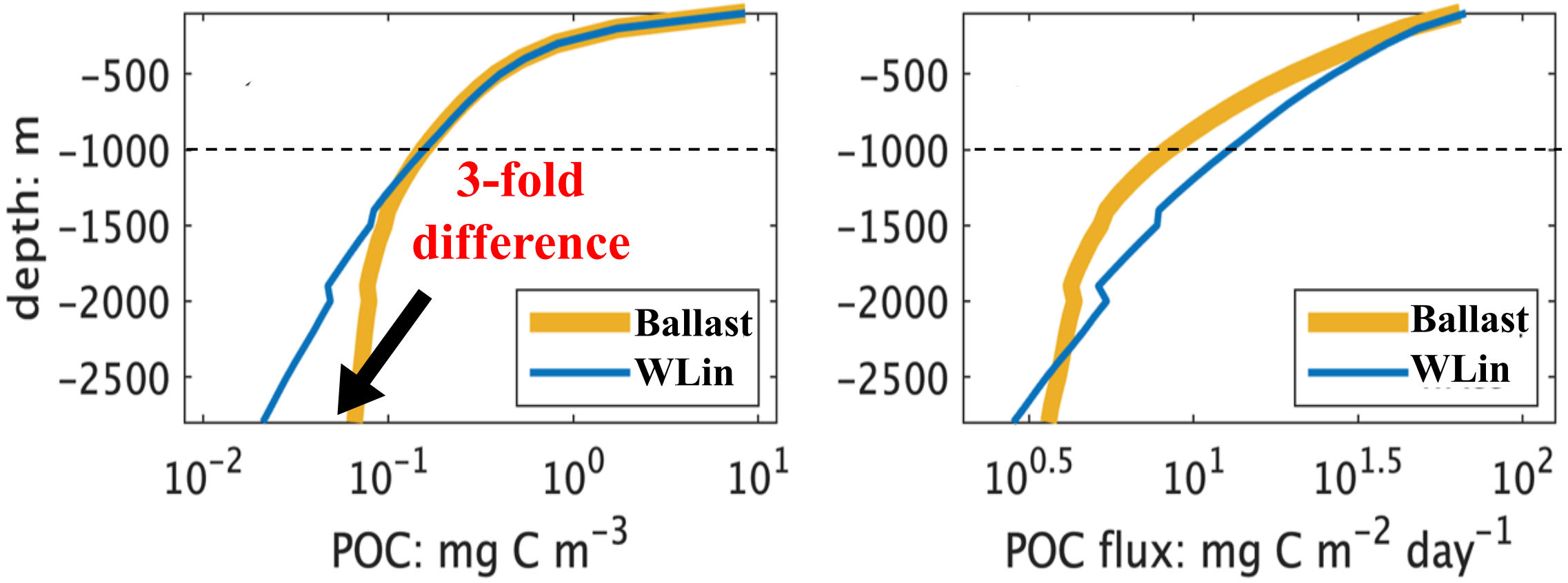
Assessing model parameterizations of vertical carbon flux





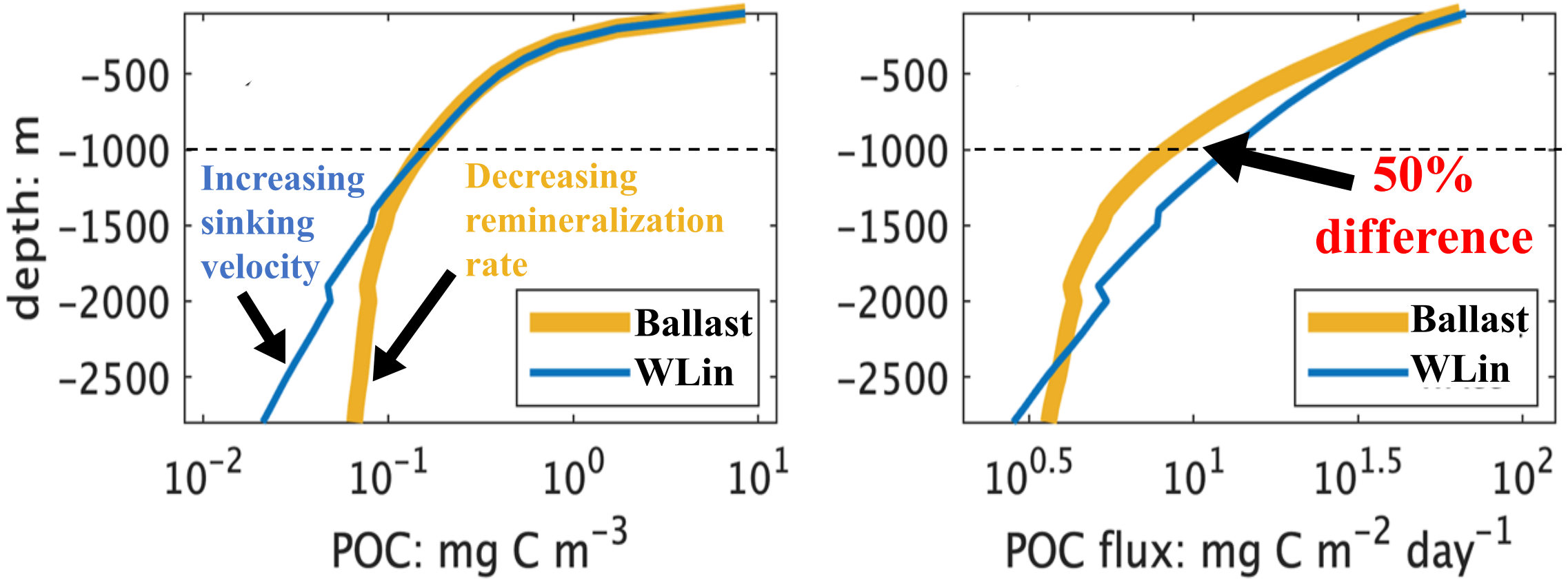
Laurent et al (2022)

Assessing model parameterizations of vertical carbon flux



Wang and Fennel (2023)

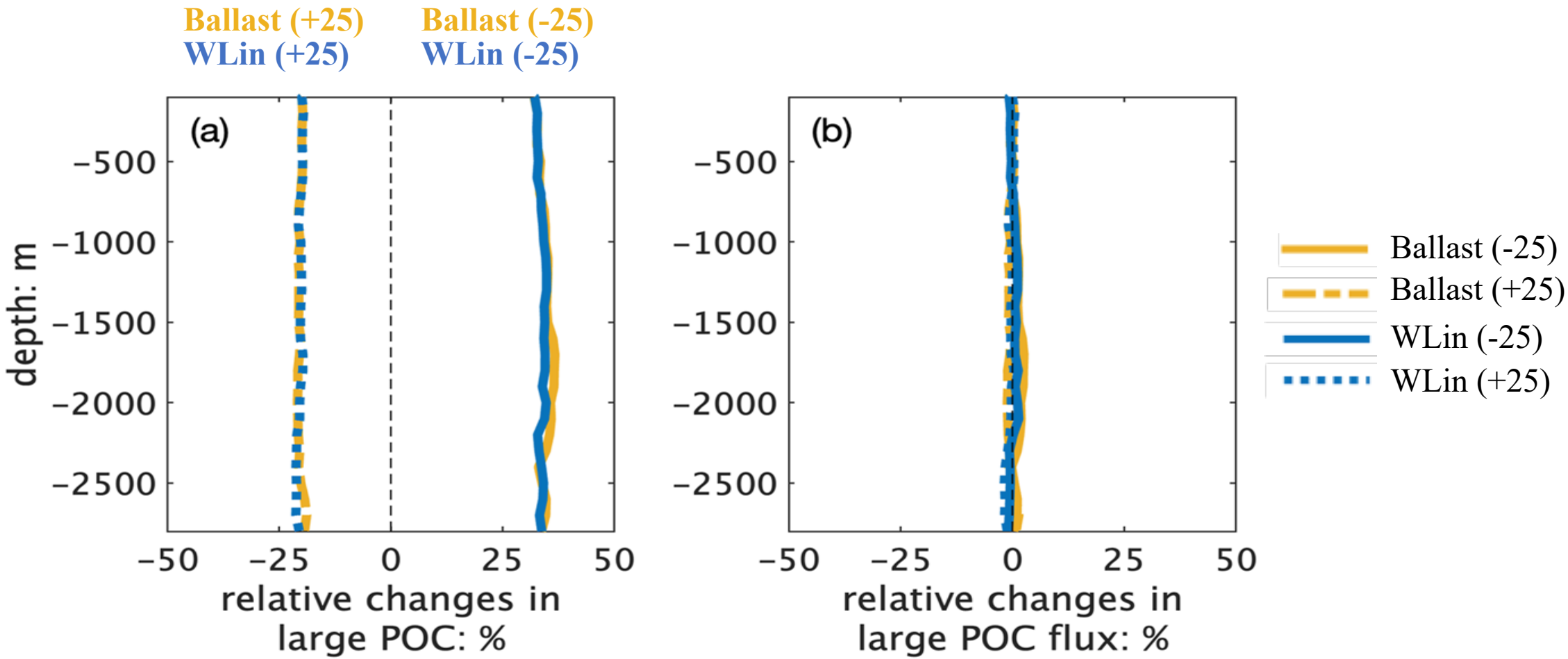
Assessing model parameterizations of vertical carbon flux



Wang and Fennel (2023)

Assessing model parameterizations of vertical carbon flux

- Increase/decrease remineralization rate and sinking velocity by 25%



Wang and Fennel (2023)

Summary

- The BGC-Argo float data are an important complement to current observations of POC flux to be used for

1) Optimizing key parameters (Wang et al., 2020 BC)
2) Informing parameterization schemes (Wang & Fennel. 2023 GRL)

- We would recommend the usage of BGC-Argo profiles of backscatters for model calibration

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