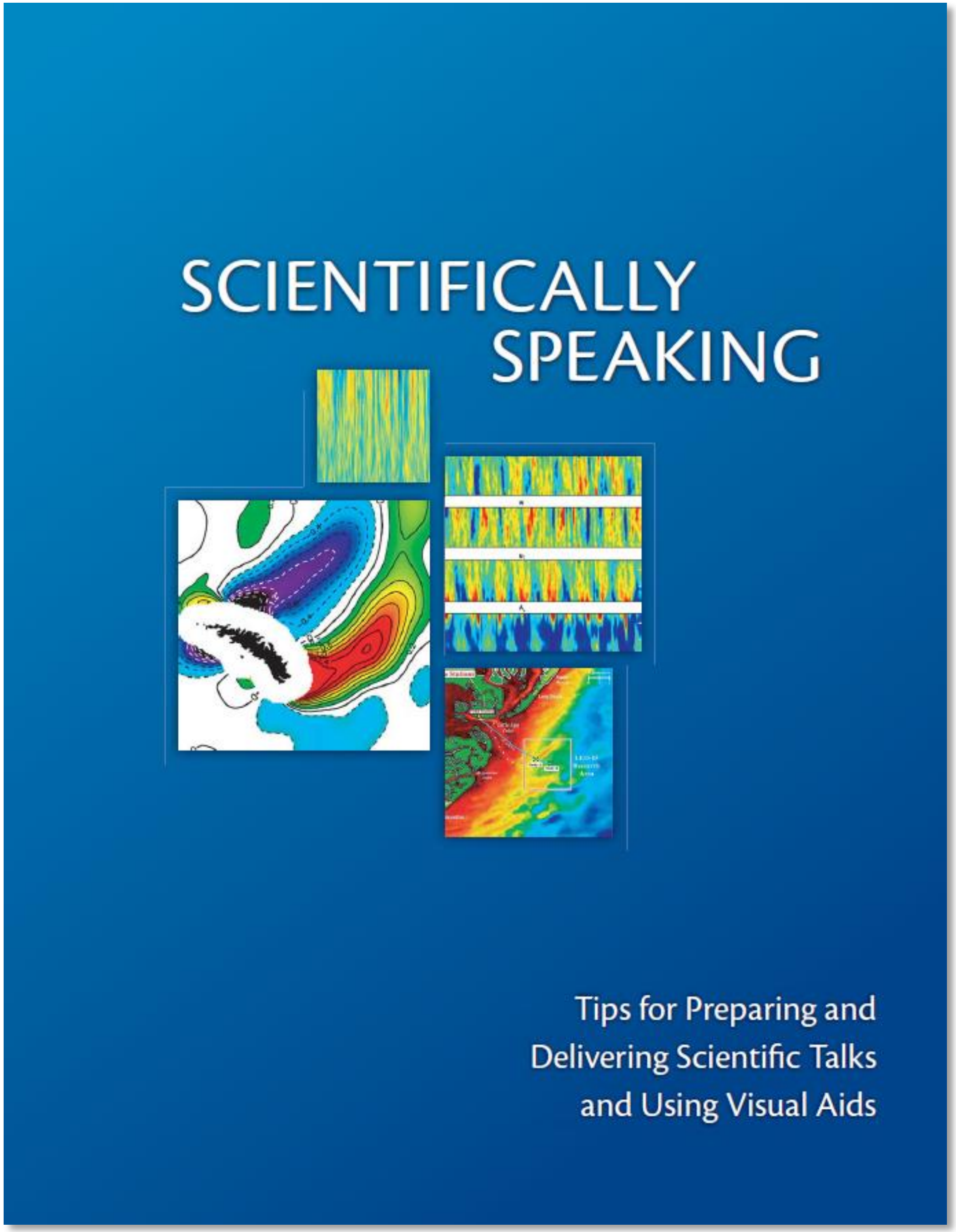
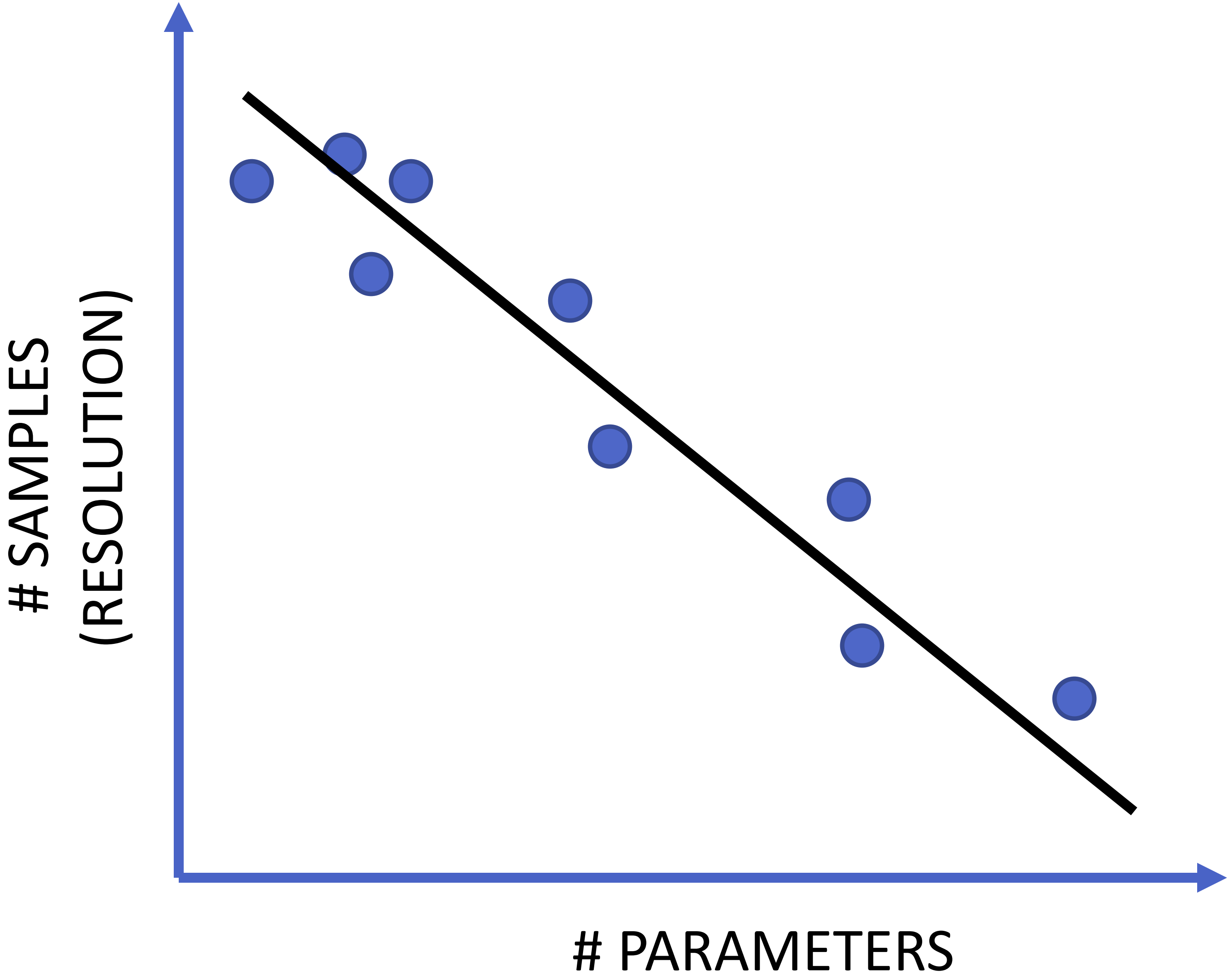
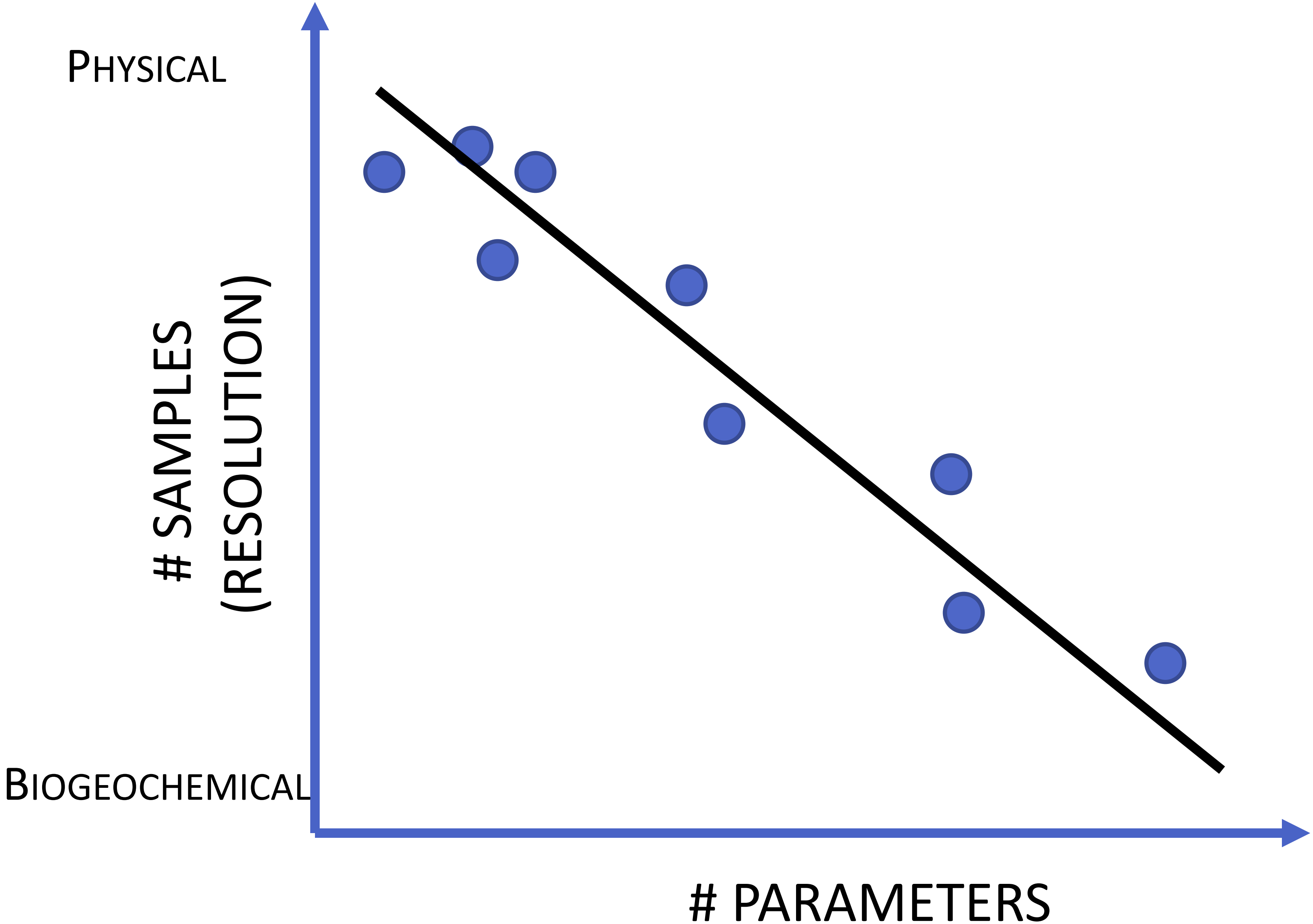
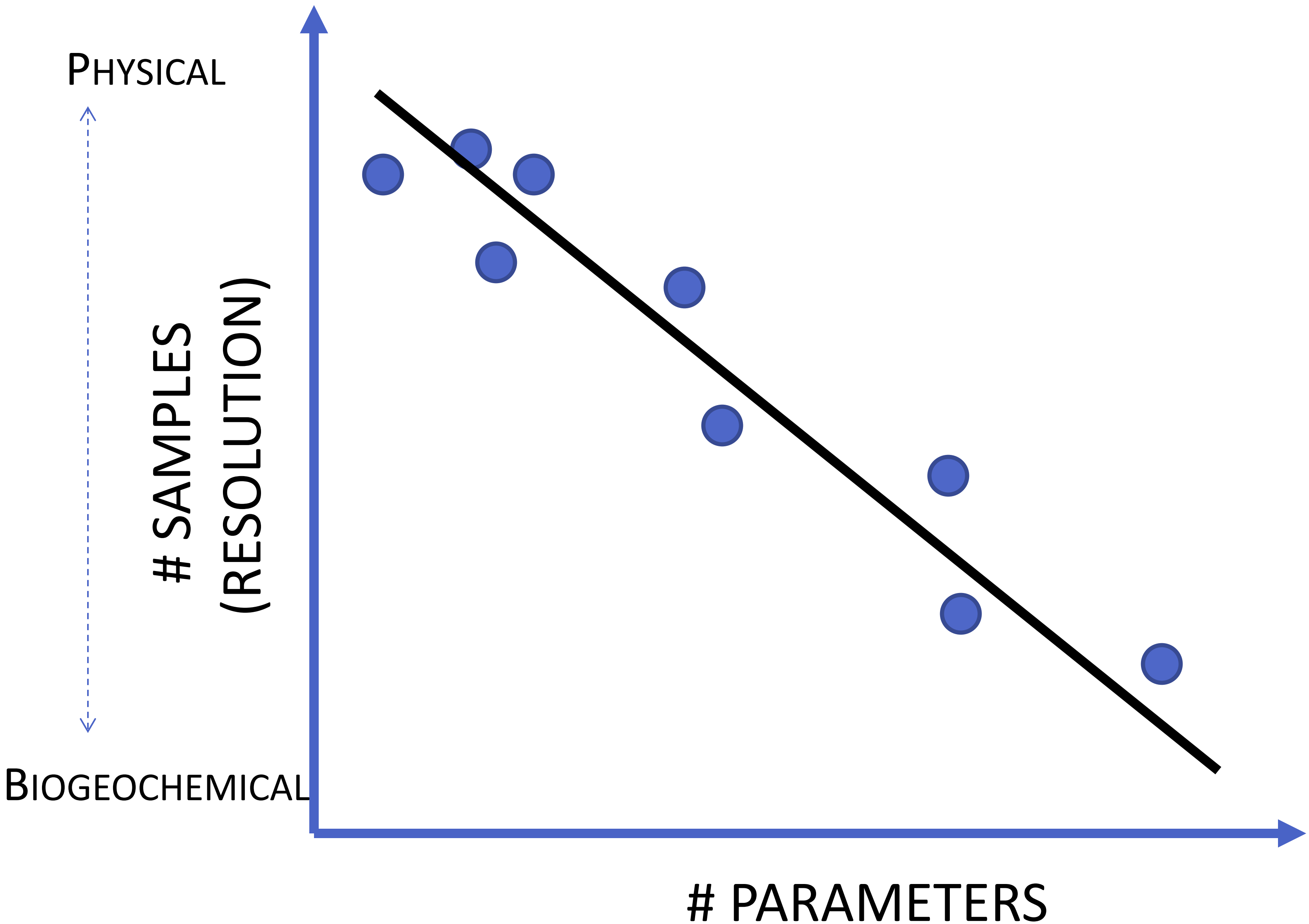


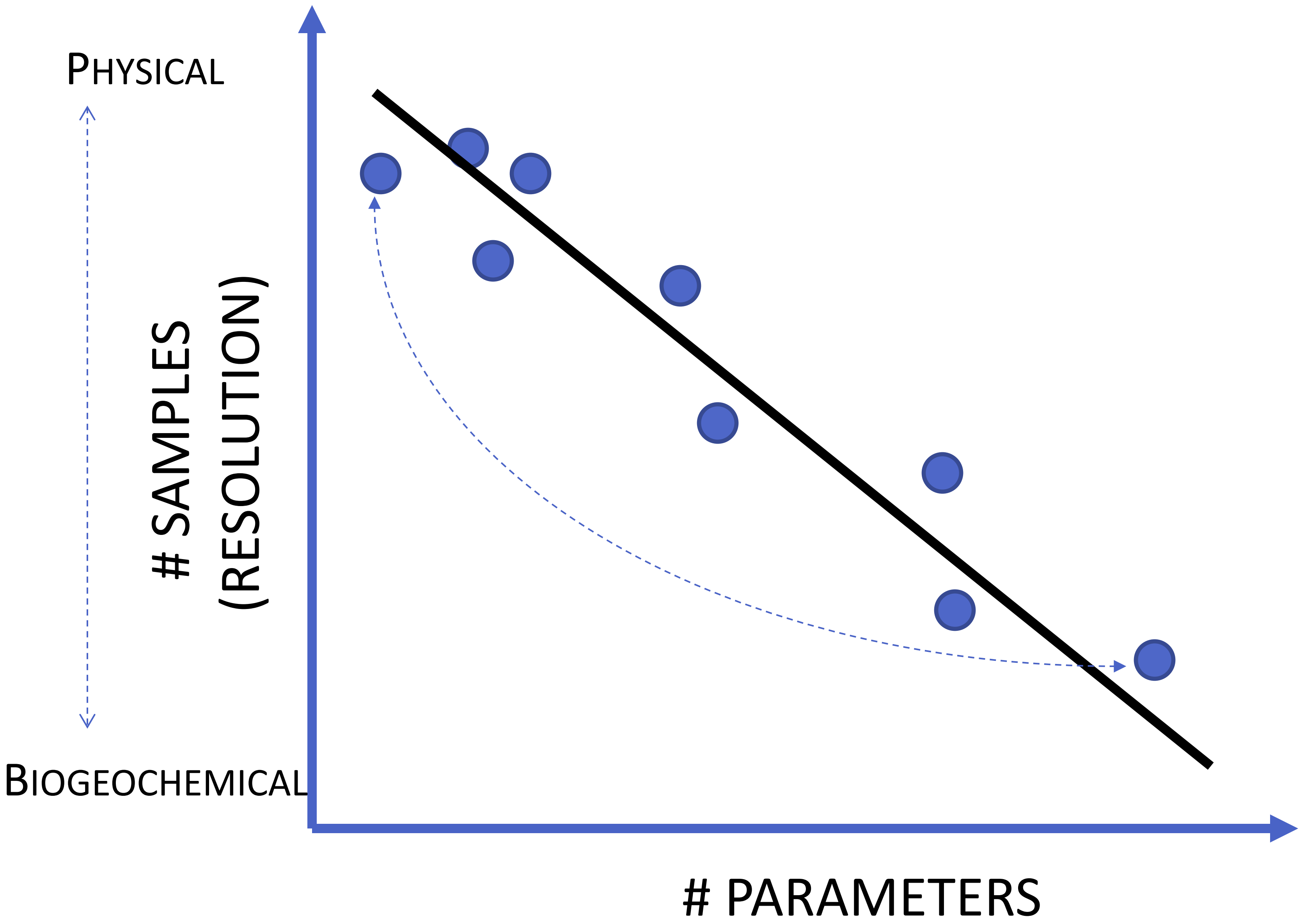
SCIENTIFICALLY SPEAKING
Tips for Preparing and Delivering Scientific Talks and Using Visual Aids

tos.org


SAMPLES
(RESOLUTION)
PARAMETERS


Physical
Biogeochemical
samples (resolution)
parameters


PHYSICAL
SAMPLES (RESOLUTION)
BIOGEOCHEMICAL
PARAMETERS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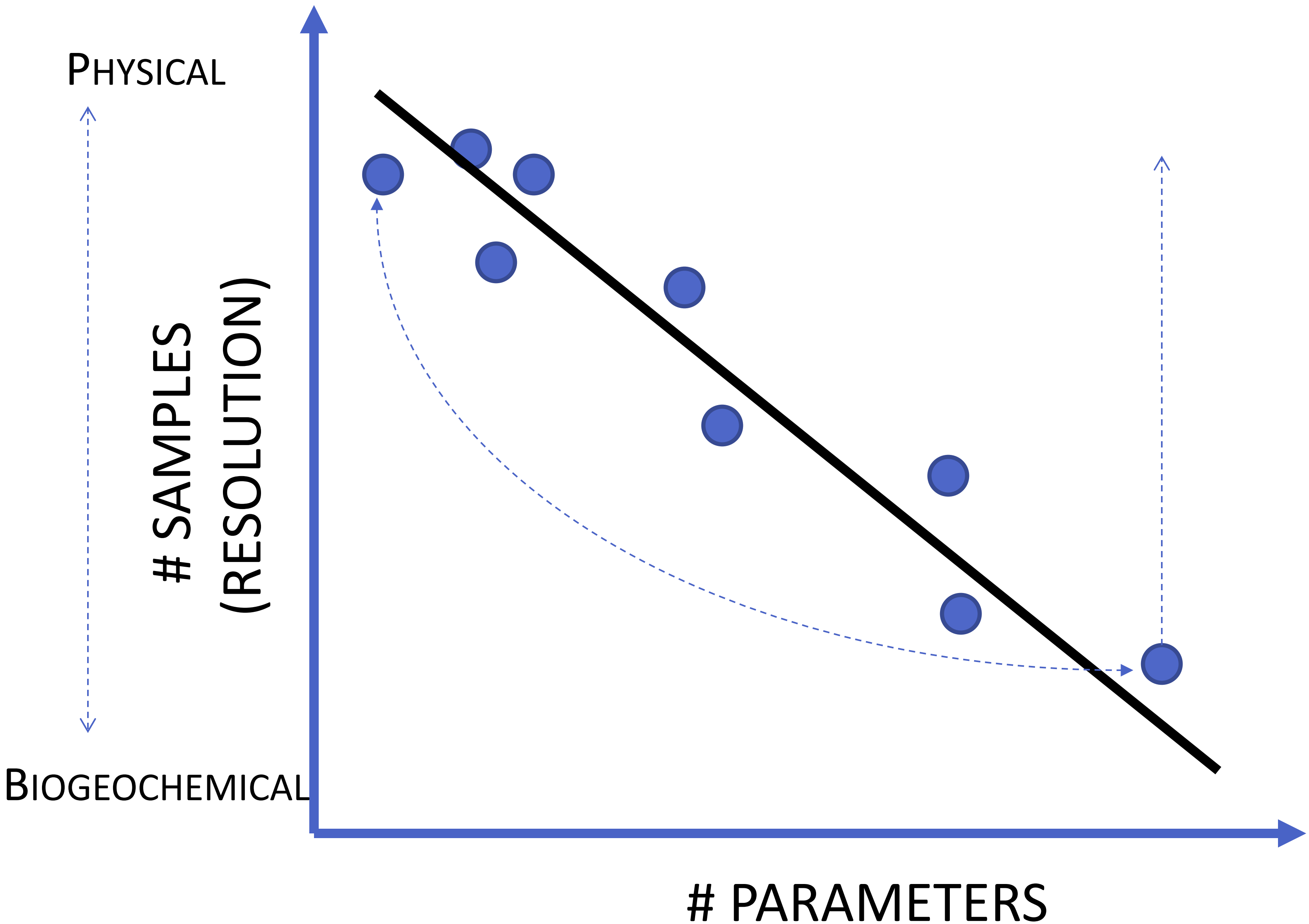
BIOGEOCHEMICAL
SAMPLES (RESOLUTION)
PARAMETERS


PHYSICAL
SAMPLES
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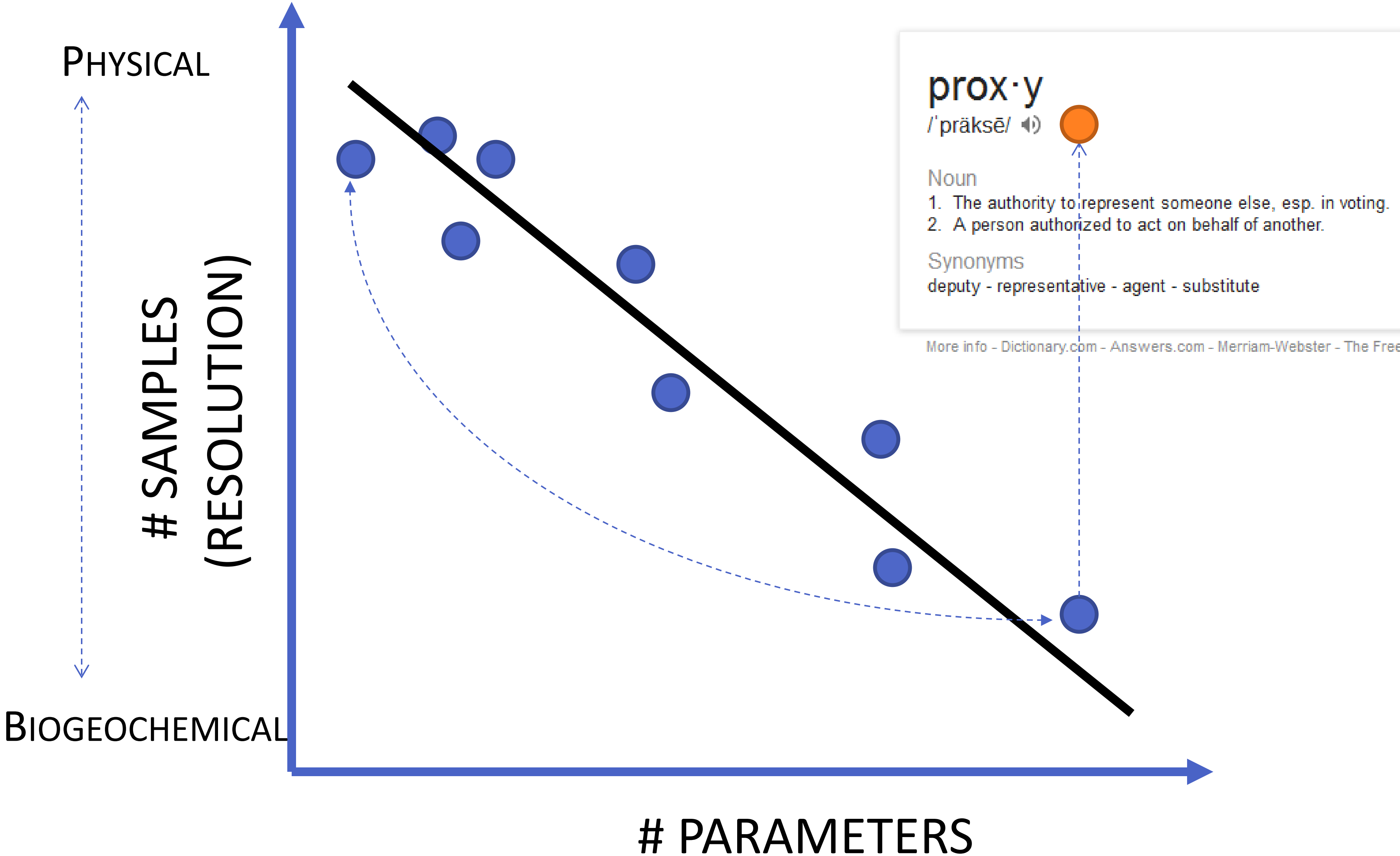
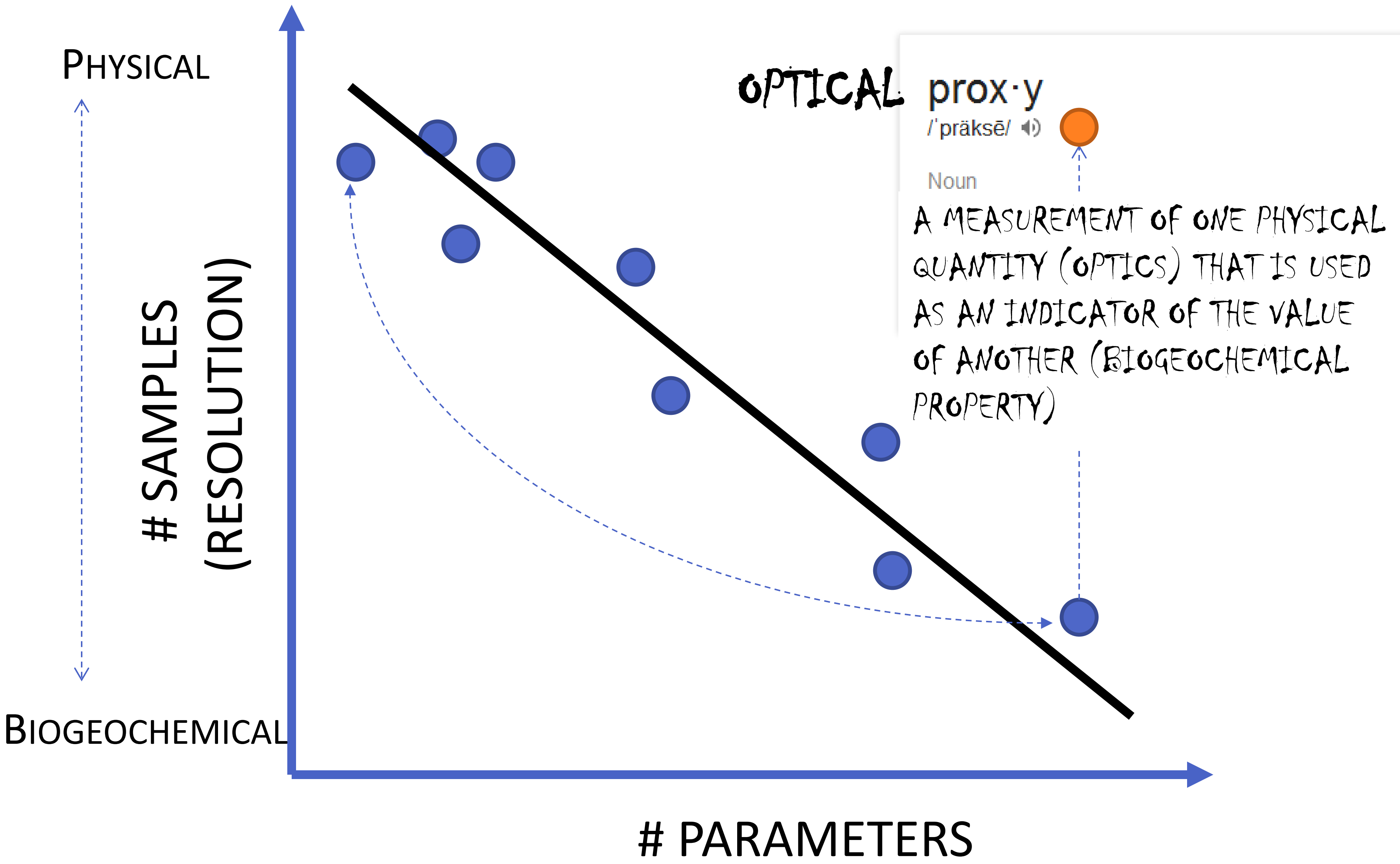
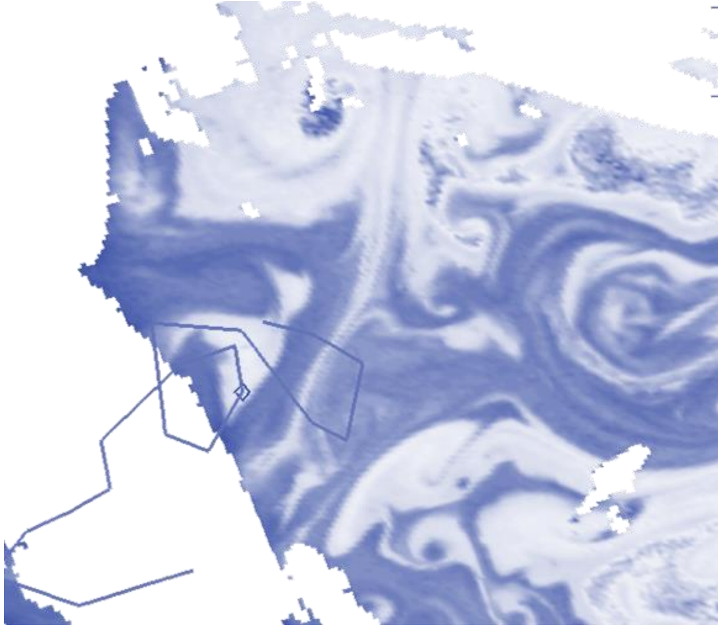
BIOGEOCHEMICAL
PARAMETERS


PHYSICAL
SAMPLES
(RESOLUTION)
BIOGEOCHEMICAL
PARAMETERS
prox·y
/ˈpräksē/
Noun
1. The authority to represent someone else, esp. in voting.
2. A person authorized to act on behalf of another.
Synonyms
deputy - representative - agent - substitute
More info - Dictionary.com - Answers.com - Merriam-Webster - The Free



PHYSICAL
BIOGEOCHEMICAL
SAMPLES (RESOLUTION)
PARAMETERS
OPTICAL prox·y
/ˈpräksē/
Noun
A MEASUREMENT OF ONE PHYSICAL QUANTITY (OPTICS) THAT IS USED AS AN INDICATOR OF THE VALUE OF ANOTHER (BIOGEOCHEMICAL PROPERTY)



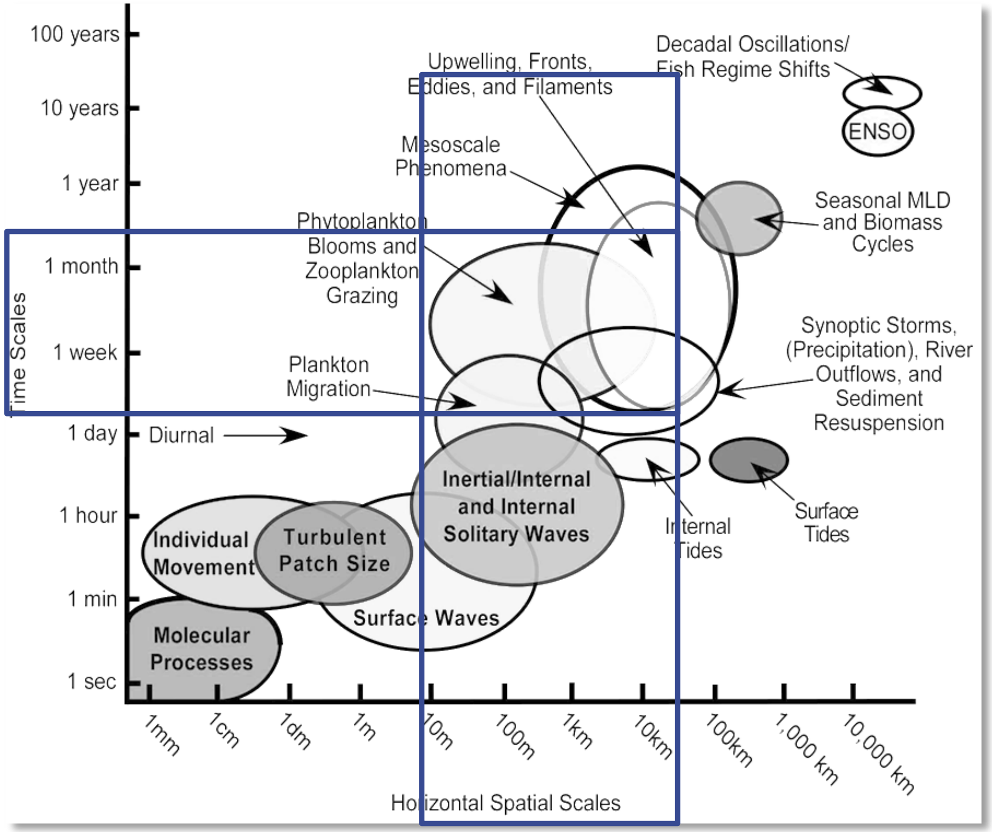
POC AND OTHER PROXIES

IVONA CETINIĆ

NASA GODDARD SPACE FLIGHT CENTER / USRA

Why?

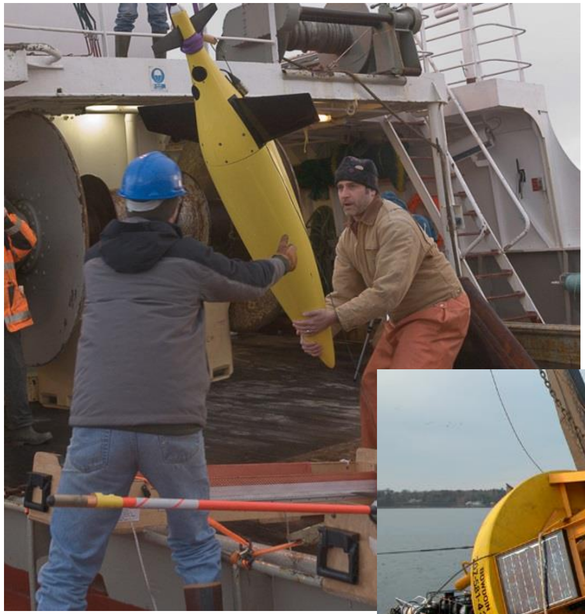
- Optics – in situ or remote sensed gives us higher resolution dataset
- Traditional methods (discrete) often expensive and time consuming
- Sampling the parameters on the scales of importance
- Validation for remote sensing and hi-res biogeochemical models



Chang, G. and T. Dickey (2008).

Why?

- Optical instruments are getting smaller, more robust and diverse
- They can be deployed over extended periods of time and in hard to reach areas



How?

Collin:

Anything that causes variability in the sample is an opportunity to extract additional information from that sample.

Few examples of real entities and associated optical proxies (in situ)

- Quantity
  - Chlorophyll -> Chlorophyll fluorescence, a(676)
  - Particulate organic carbon – c_p, b_{bp}
  - Phytoplankton carbon – $b_{bp,}$ Chl
  - Suspended particulate matter - c_p, b_{bp}
  - Particulate Inorganic Carbon – acid labile b_{bp} (Balch – week 4), cross - polarized attenuation
  - Dissolved organic carbon – CDOM absorption, fluorescence
  - Nitrate, sulfates – UV absorption
  - Primary productivity – Fv/Fm
- Quality (particulate composition)
  - Particulate composition – $b_{bp}/c_{p,}$ b_{bp}/b_p
  - Particle size - c_p, b_{bp} slopes and "fluctuation", multiple angle scattering, multiple angle c_p
  - Phytoplankton composition – Chl, a (λ), Chl/C, multiple channel fluorescence
  - DOC type – CDOM fluorescence and slope

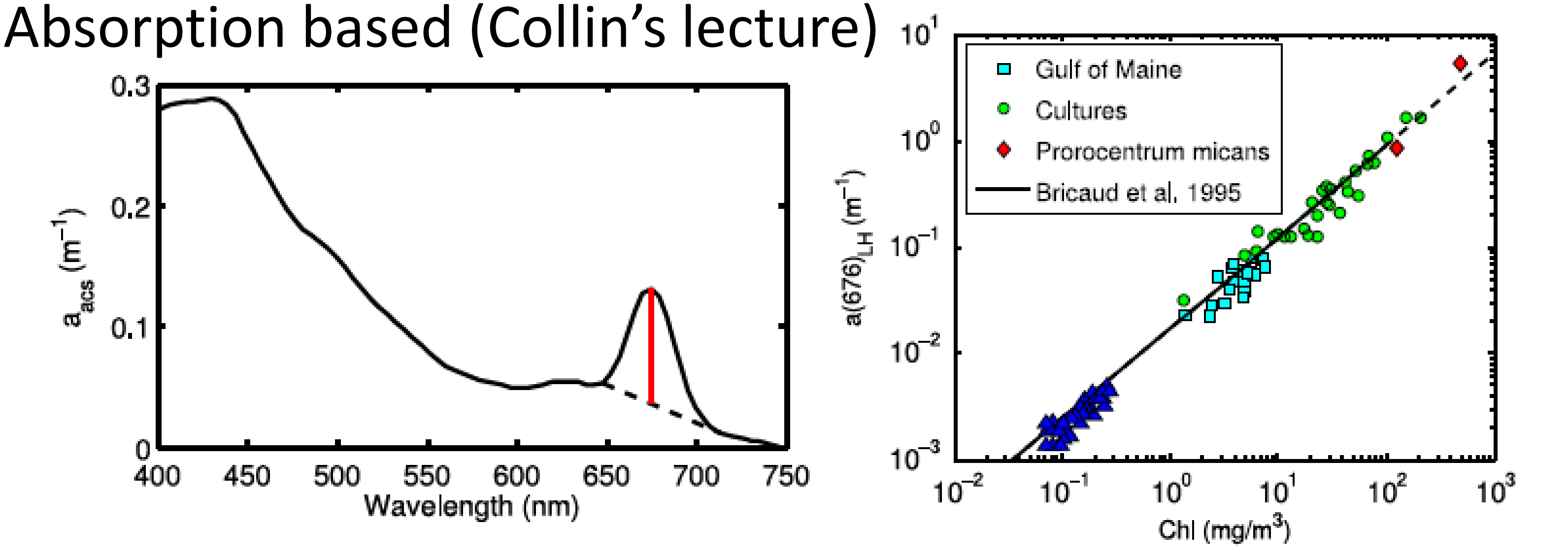
Check out - Boss et al (2014) and Babin, Roesler and Cullen (2008)

Few examples of real entities and associated optical proxies (in situ)

- Change in these quantities will tell us something about fluxes
  - Fluxes– movement of a quantity from one pool to another
    - Space - e.g. carbon export from mixed layer to deeper ocean
    - Time – productivity - e.g. primary production
    - Type – e.g. phytoplankton to detritus, POC to DOC

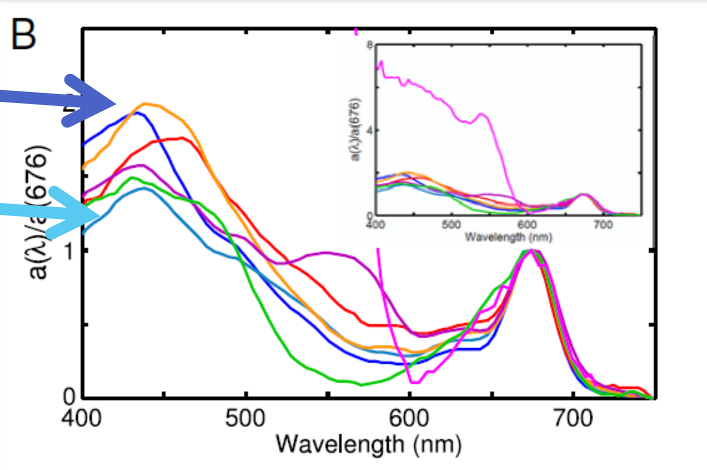
Chlorophyll biomass
(Chlorophyll is not a chlorophyll is not a chlorophyll)

- Absorption based (Collin's lecture)



High light

Low light

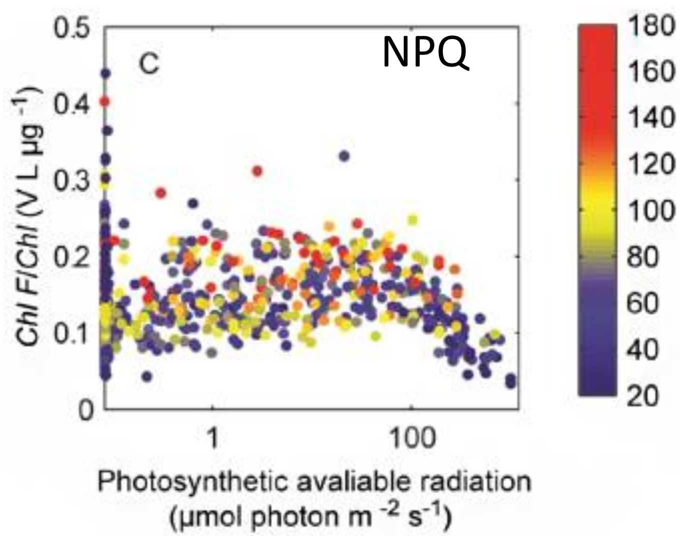


Roesler and Bernard, 2013

Chlorophyll biomass
(Chlorophyll is not a chlorophyll is not a chlorophyll)

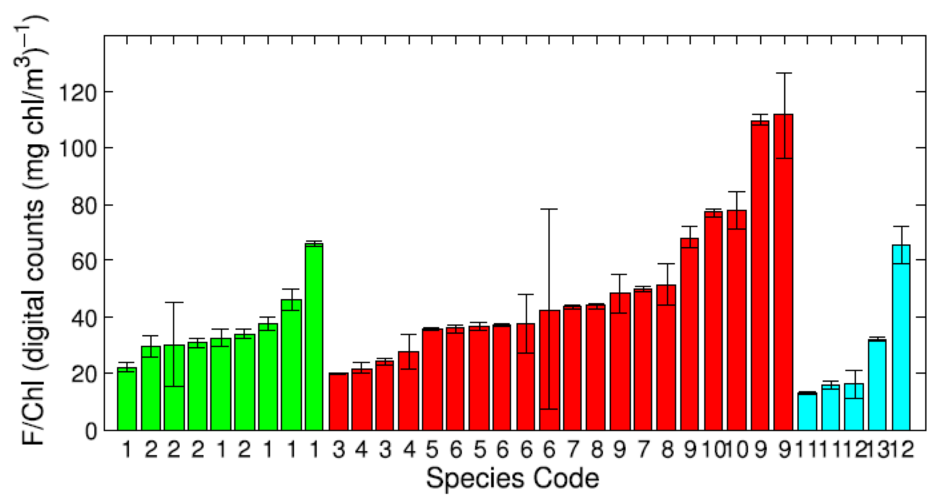
- Fluorescence based (Mary Jane's lecture on Friday)

1) Physiology - light, nutrients, life stages



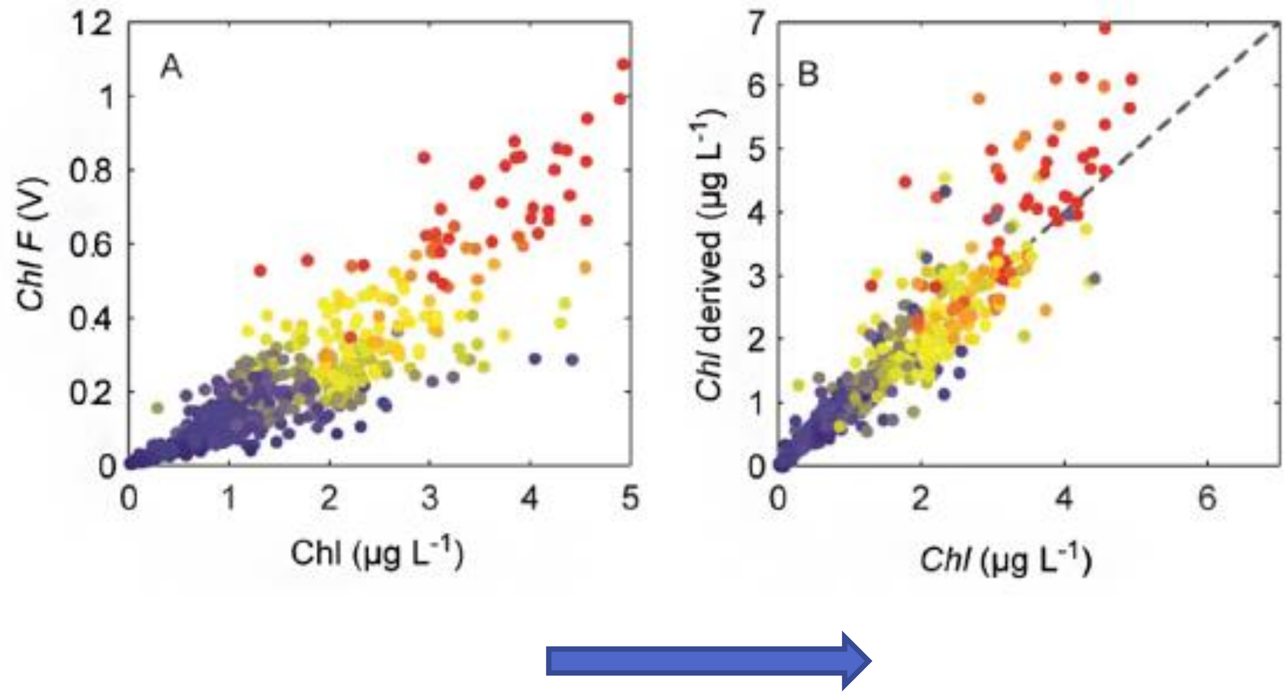
Cetinić et al., 2015

2) Species composition



Roesler and Bernard, 2013;
Proctor and Roesler, 2010

Chlorophyll biomass
(Chlorophyll is not a chlorophyll is not a chlorophyll)



Non – linear function of PAR, temperature, depth and time (details in D'Asaro (2011))

- Not a simple correction, depended on multiple factors
- should be interpolated within the time/space of your experiment, not extrapolated

Cetinić et al., 2015

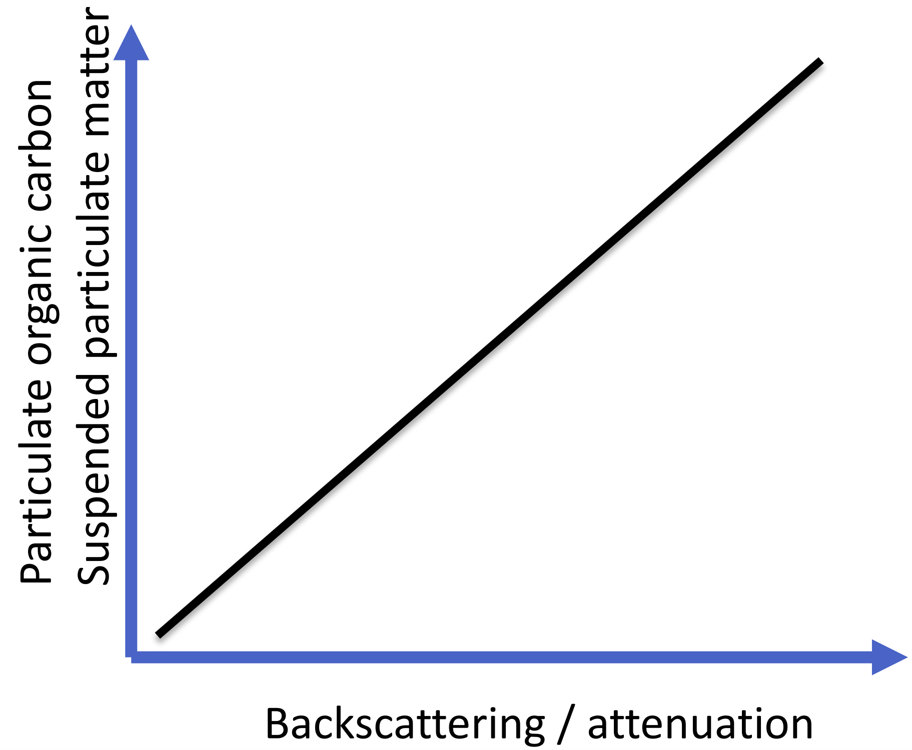
Particulate Organic Carbon & Suspended Particulate Material proxy

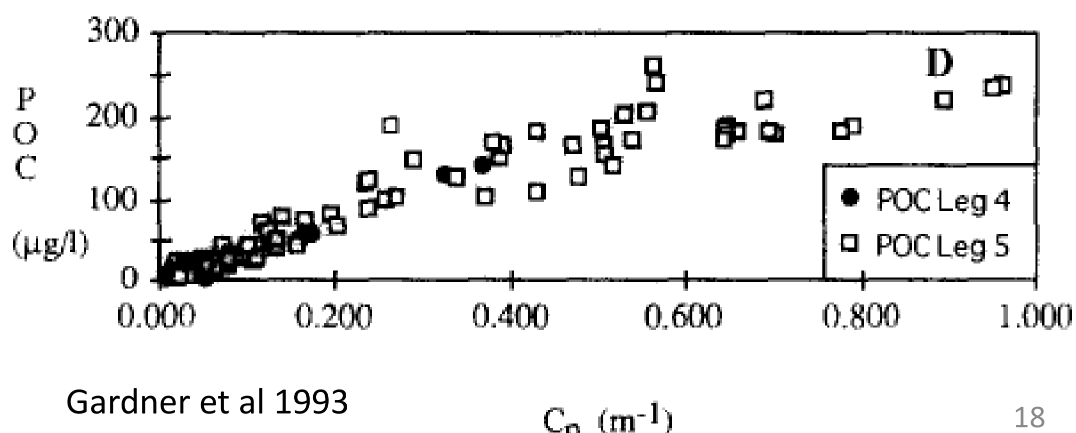
Backscattering and attenuation are associated with particle concentration / size.

However !!!

Backscattering is also highly dependent on morphology and type of the particle

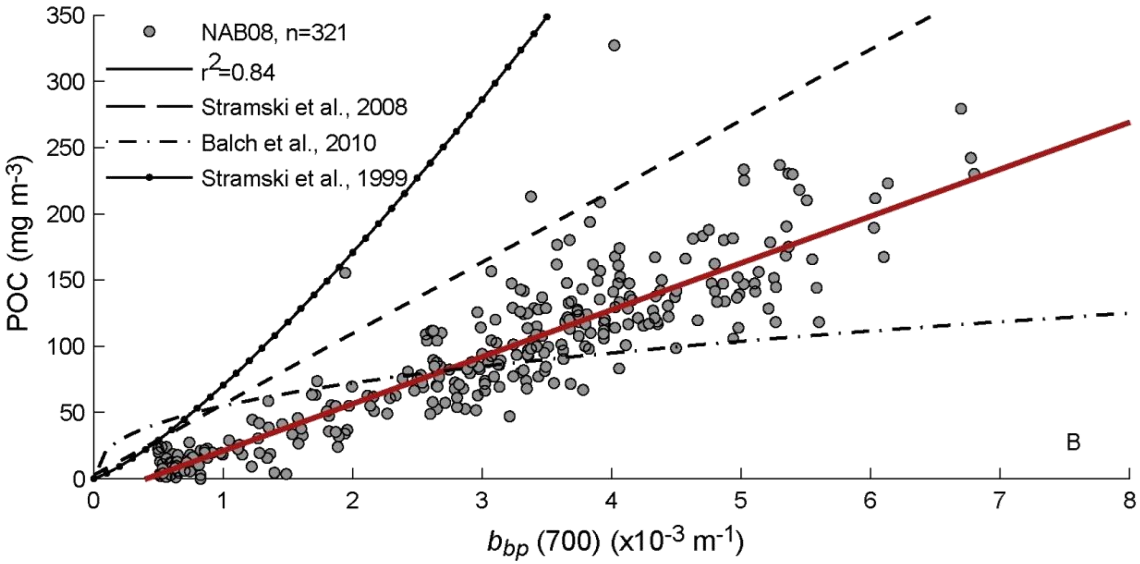
Carbon density in all oceanic particles /phytoplankton is not the same.





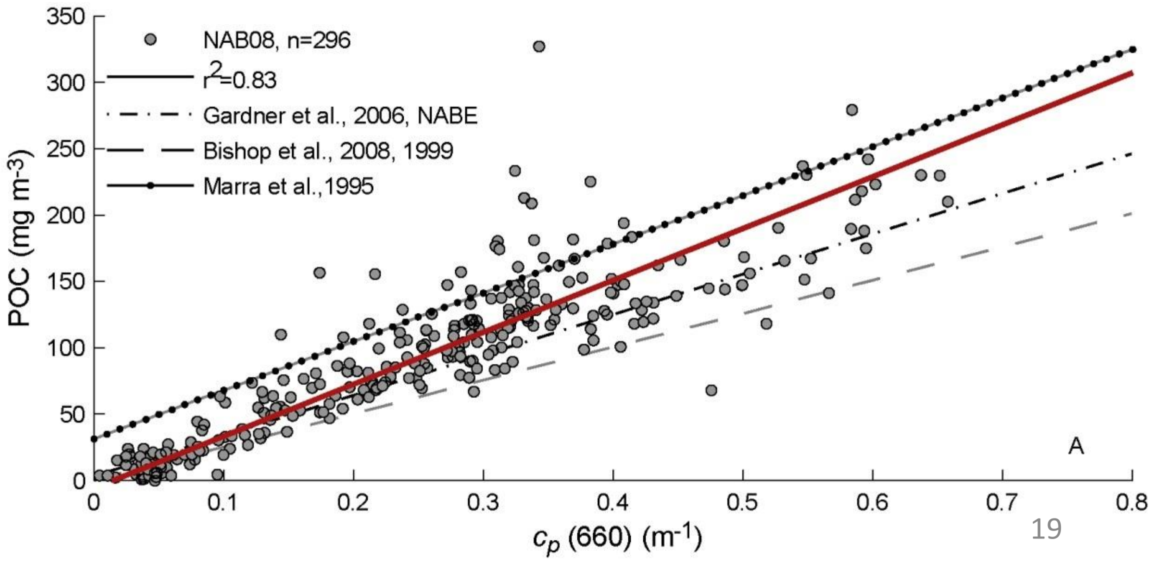
Gardner et al 1993

Particulate Organic Carbon



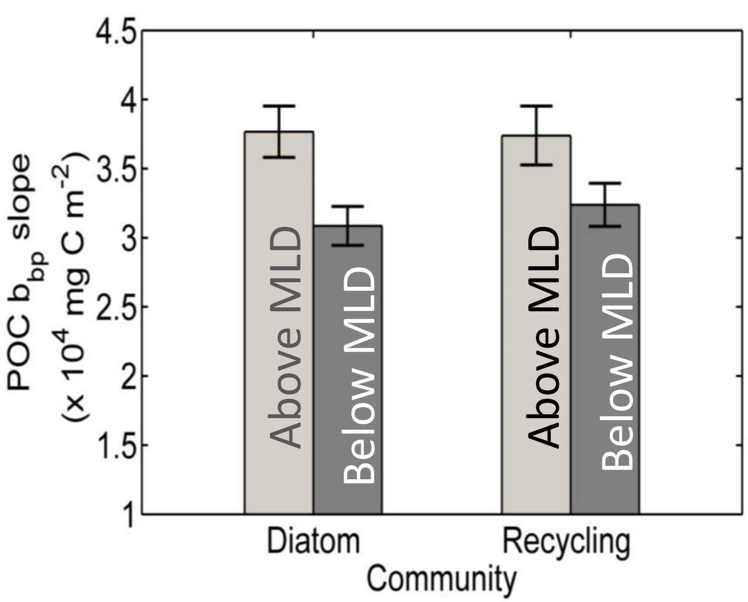
Particulate backscattering (b_{bp})

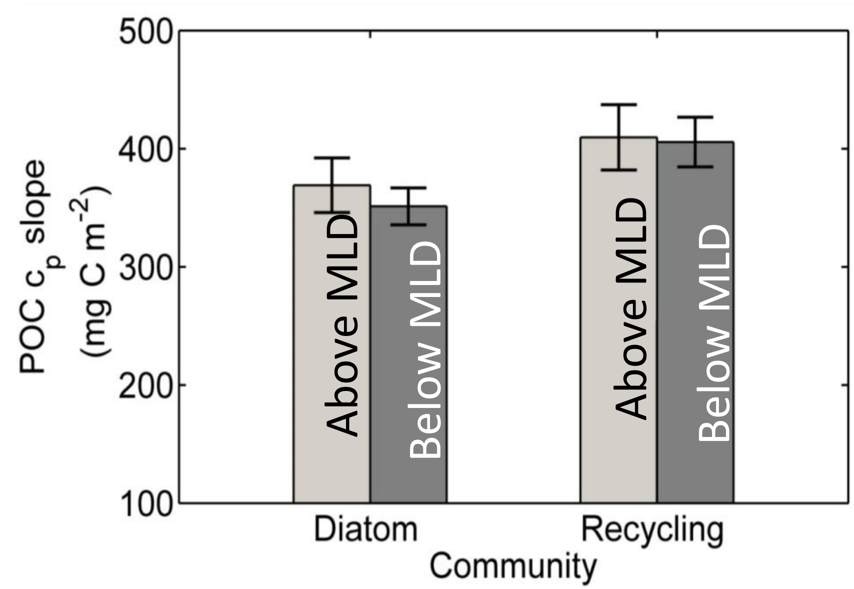
Beam attenuation (c_p)



Cetinić et al., 2012, JGR

Particle associated variability



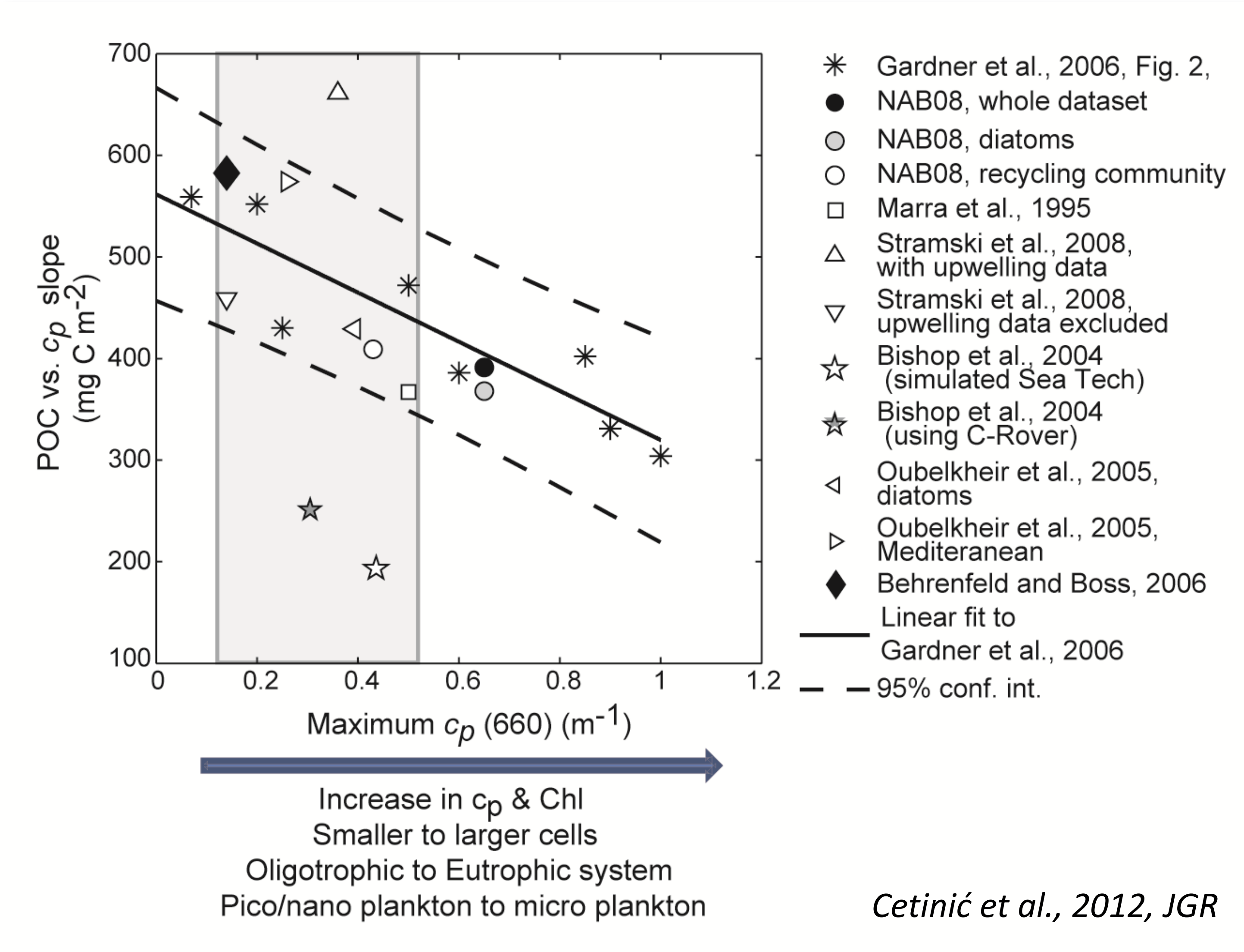


•POC_b_{bp} does not change with plankton community
•POC_b_{bp} decreases below mixed layer

•POC_ c_p changes with plankton community
•POC_ c_p below ML is same as overlying community

Cetinić et al., 2012, JGR

POC/c_p slope comparison (mg C m^{-2})

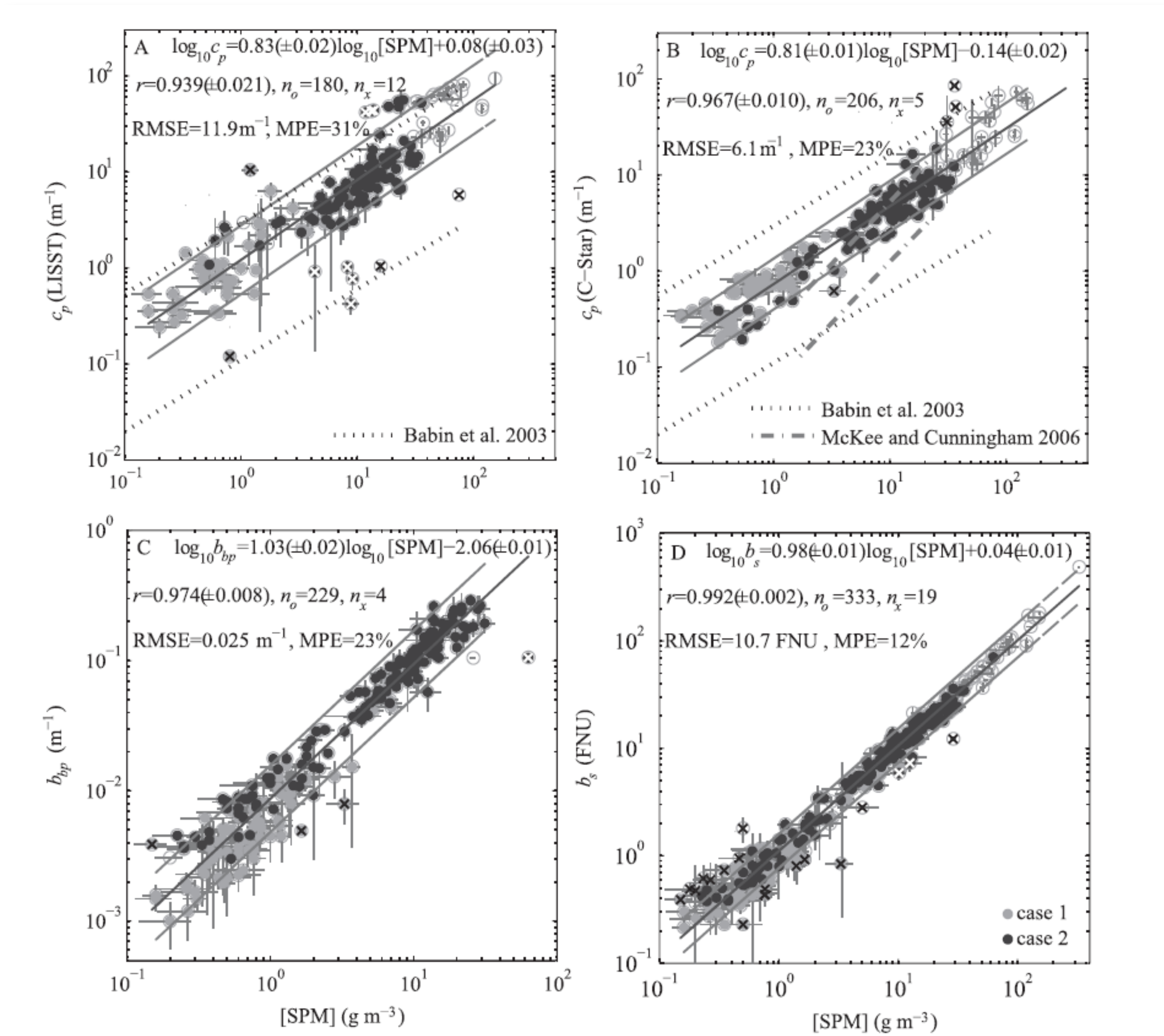


Cetinić et al., 2012, JGR

Suspended Particulate Matter

c_p

b_{bp}



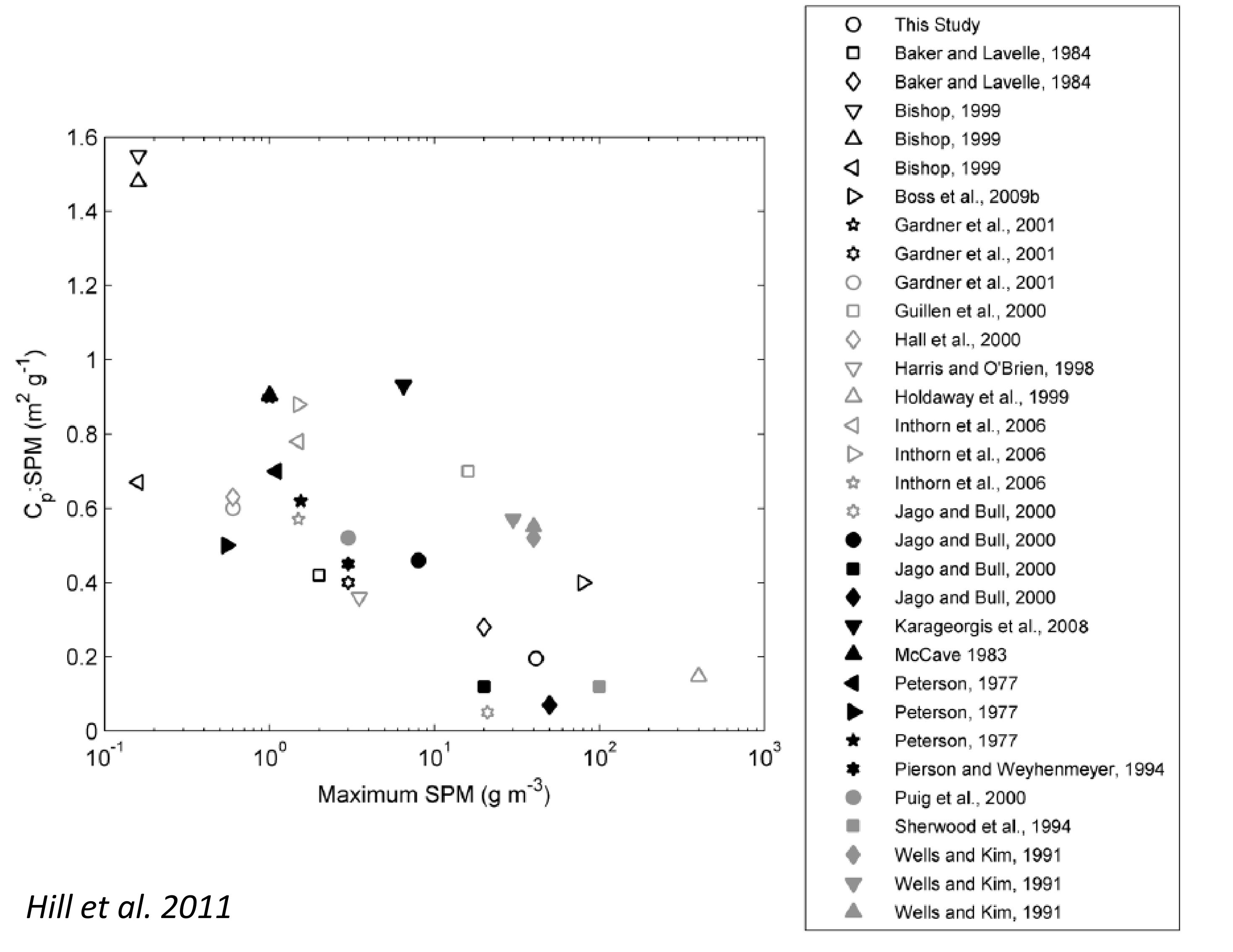
SPM

Particle apparent density

Particle composition

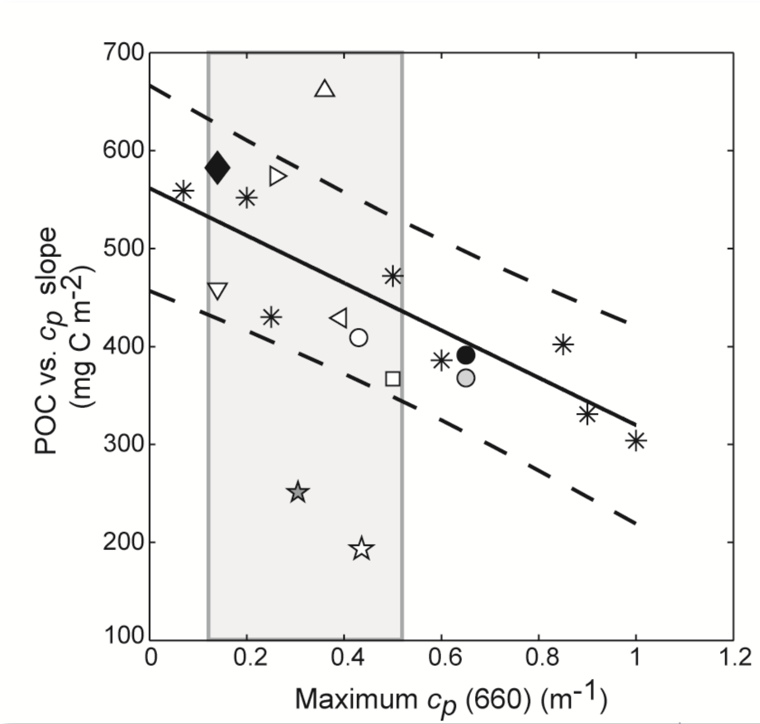
Nuekermans et al. 2012

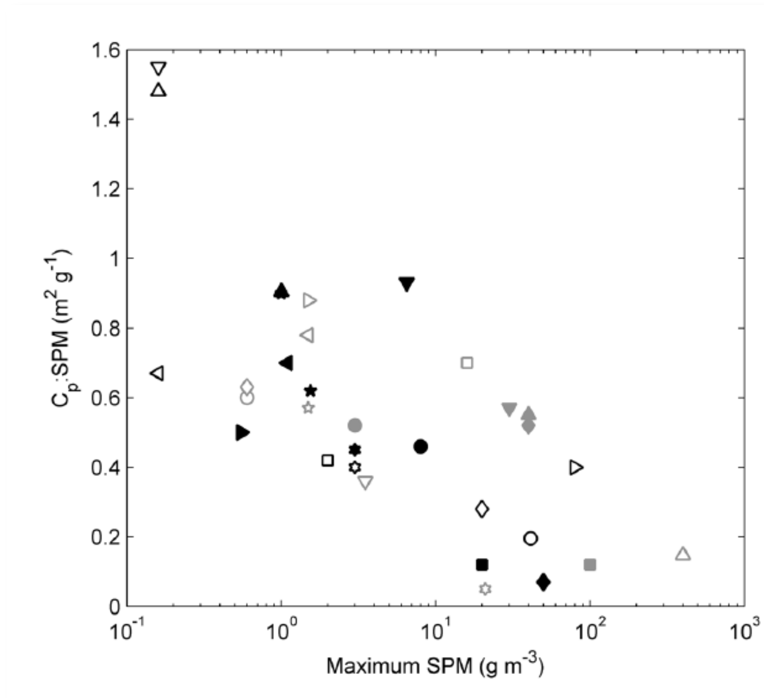
Suspended Particulate Matter



Hill et al. 2011

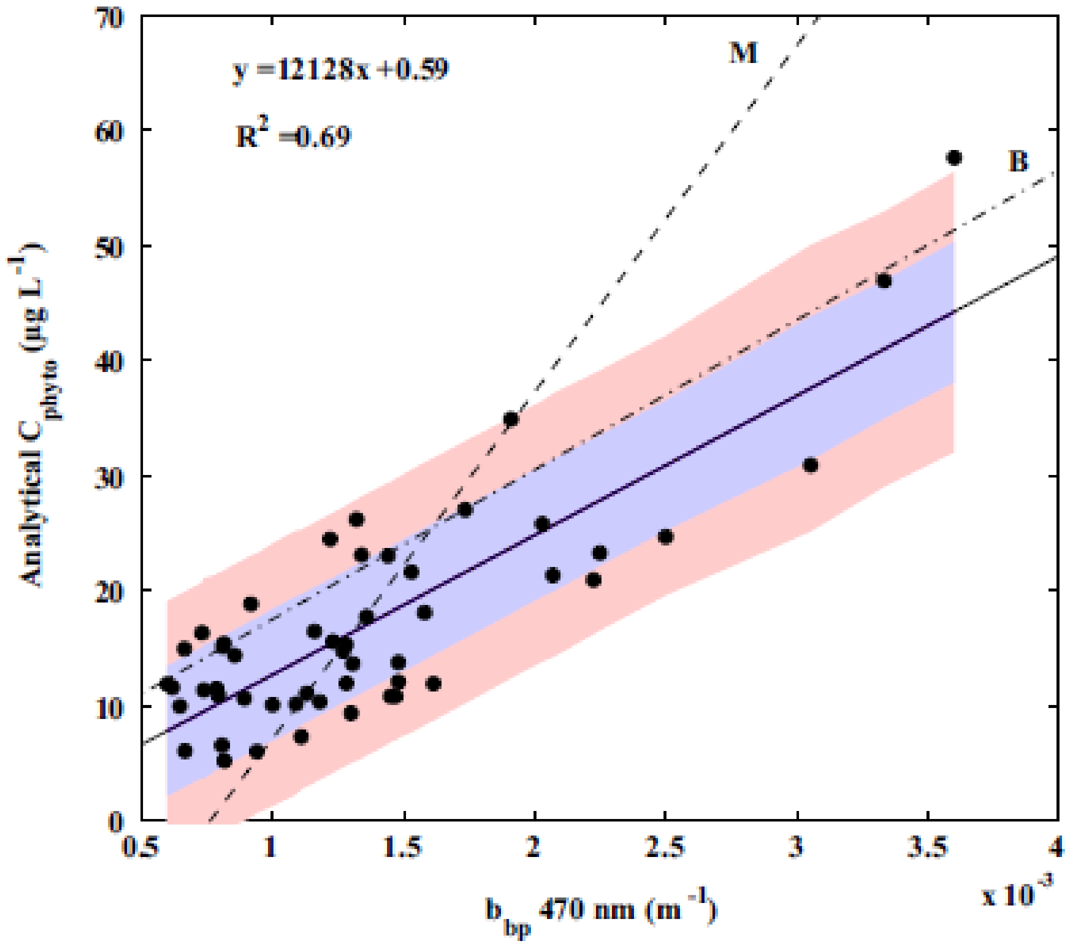
Why are we seeing opposite trends?





Phytoplankton carbon

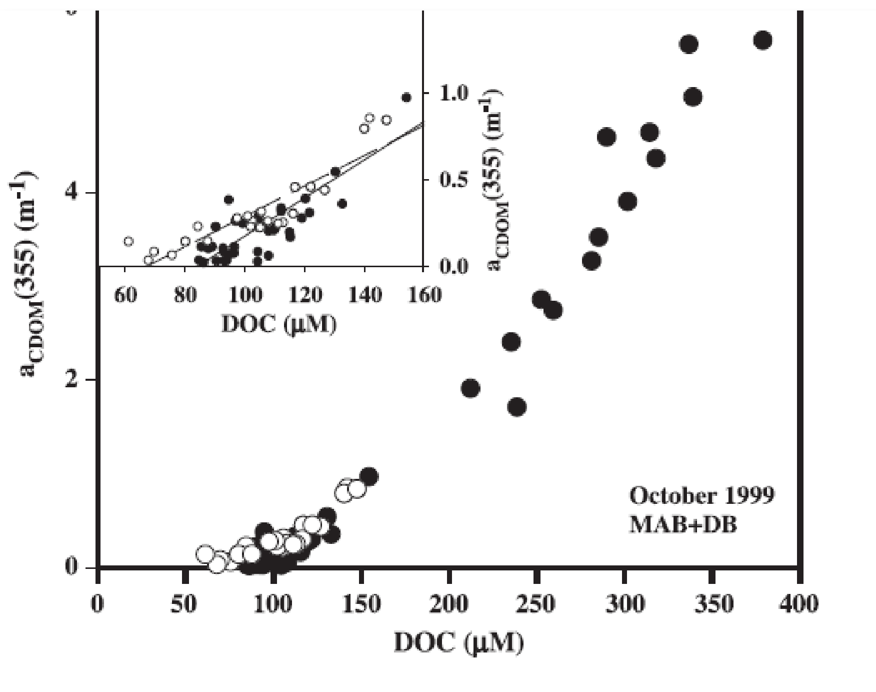
- Cell sorting technique in combination with optics
- Traditionally – calculation from of imaging/flow cytometry based biovolumes and cell/C values



Graff et al., 2015

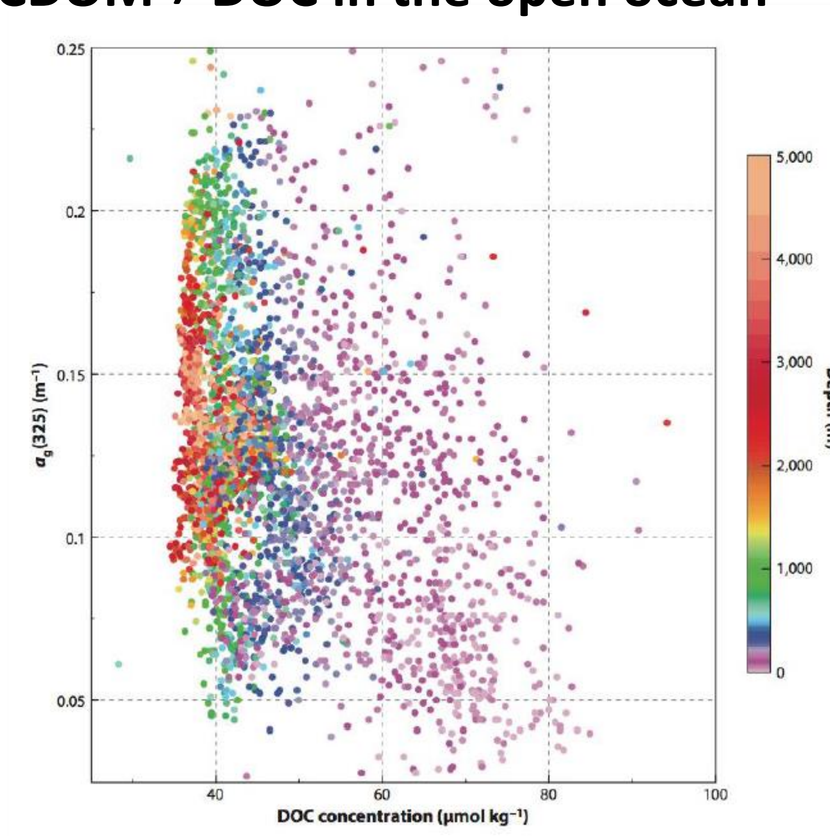
Dissolved Organic Carbon

CDOM = DOC in the coastal ocean



Vecchio and Blough, 2004

CDOM ≠ DOC in the open ocean

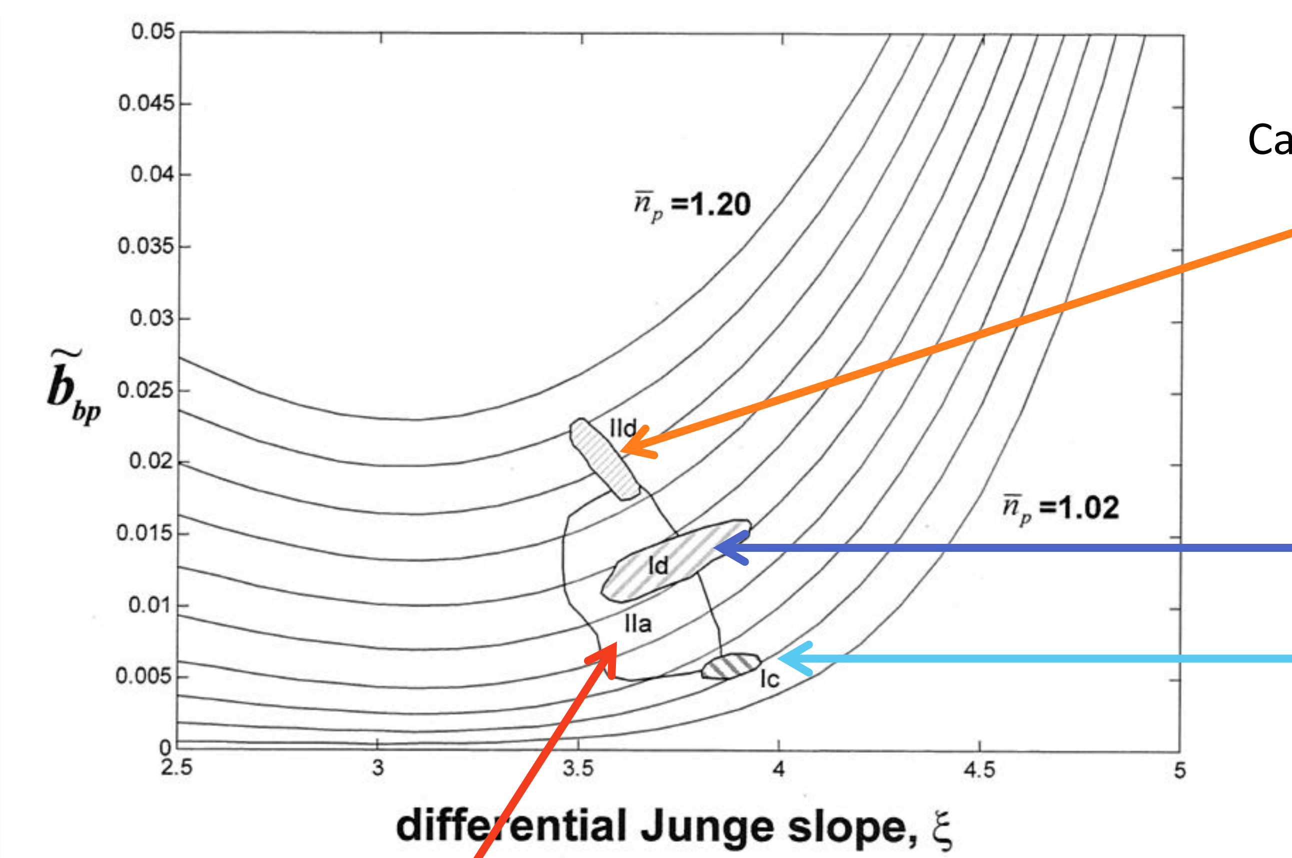


Nelson and Siegel 2013

As Rufus well knows, there's opportunity in chaos.

OPPORTUNITY IN CHAOS QUALITY (COMPOSITION)

Particulate composition – $b_{bp}/c_{p,}$ b_{bp}/b_p



Case II, bottom water

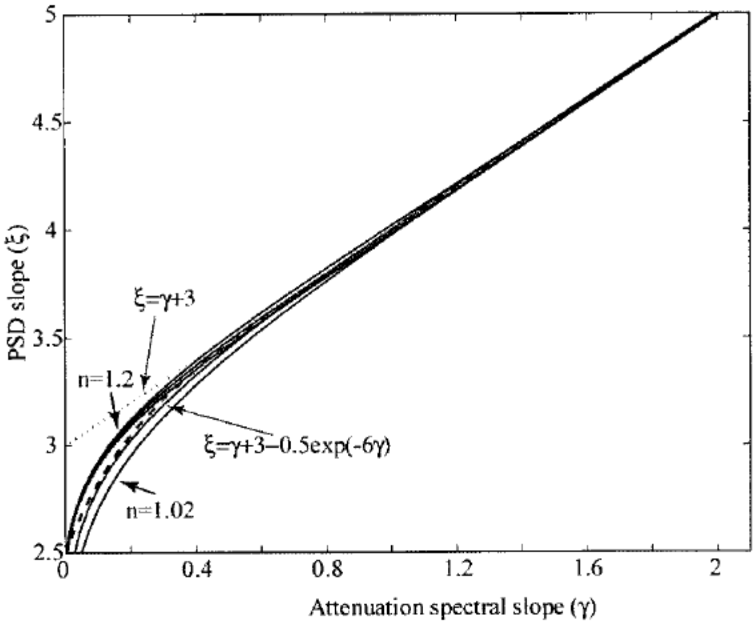
Case I, below 100 m

Case I, Chl maxima

Case II, coastal waters in complex enviroment

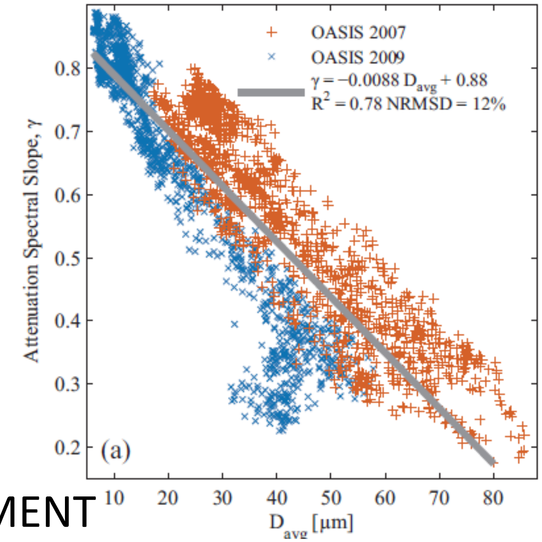
Twardowski et al, 2001

Particle size – slope based



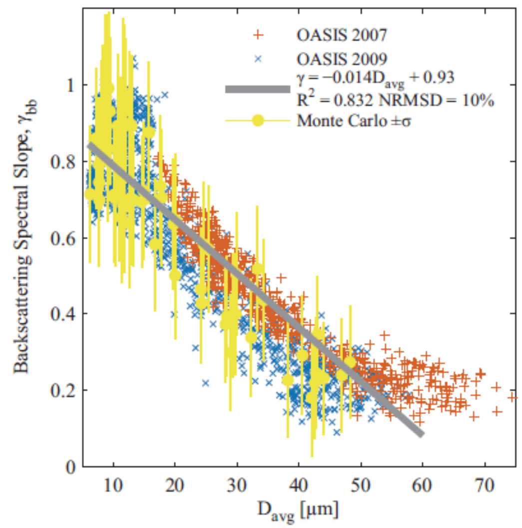
Boss et al, 2001

c_p



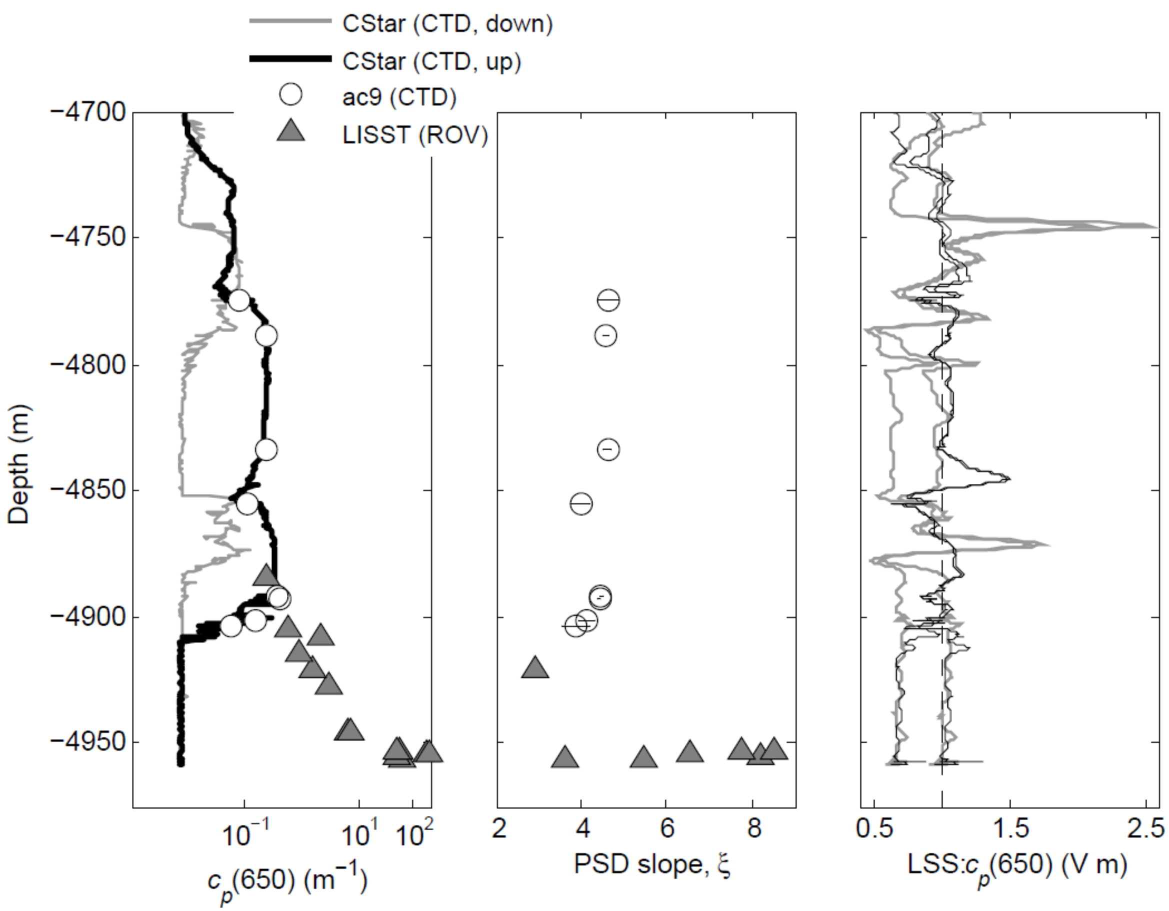
SEDIMENT

b_{bp}



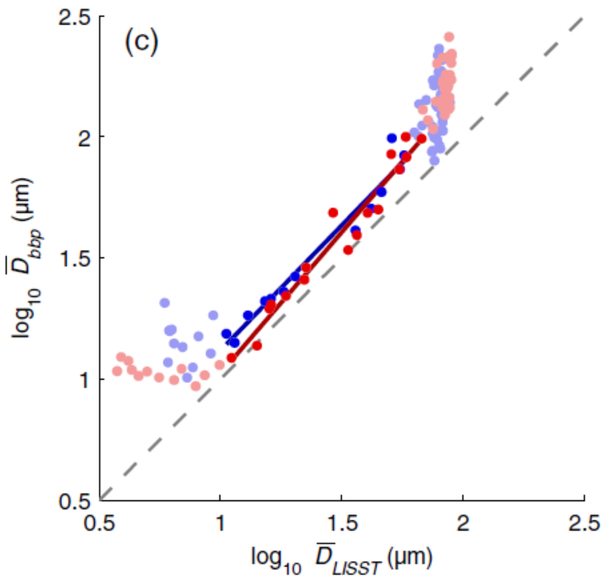
Slade & Boss, in review

Application - Particle composition in a hydrothermal plume



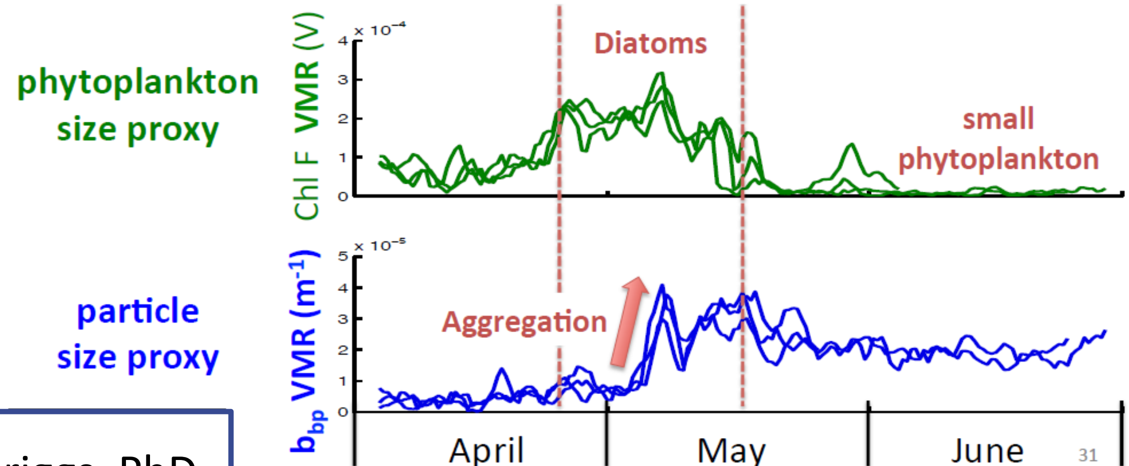
Estapa et al, accepted

Particle size – fluctuation based



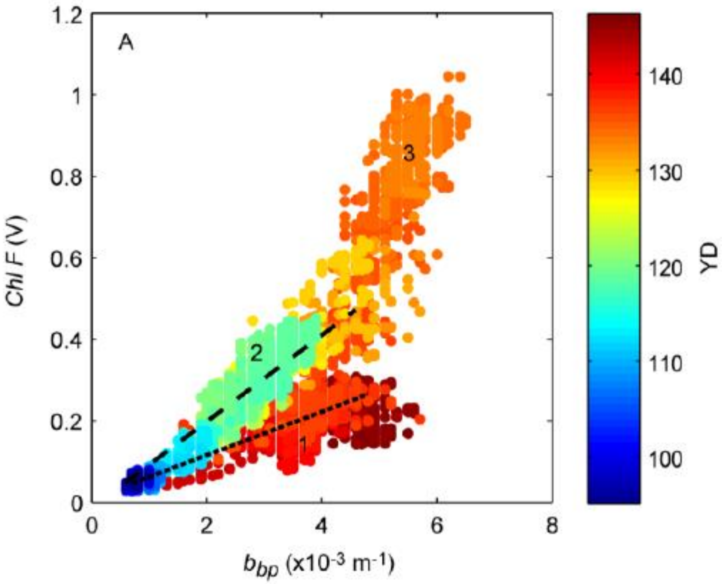
Briggs et al, 2013

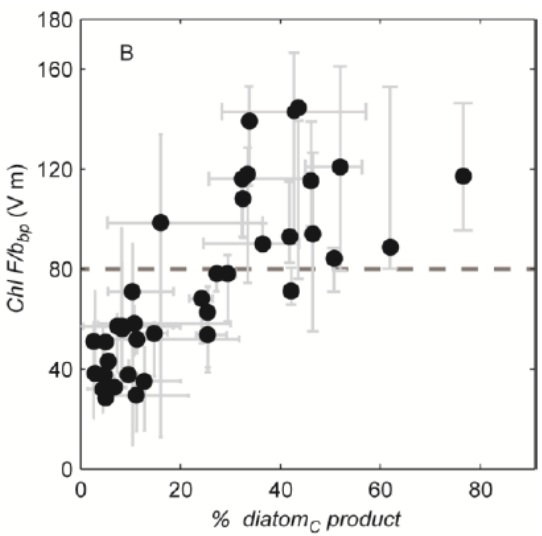
Application

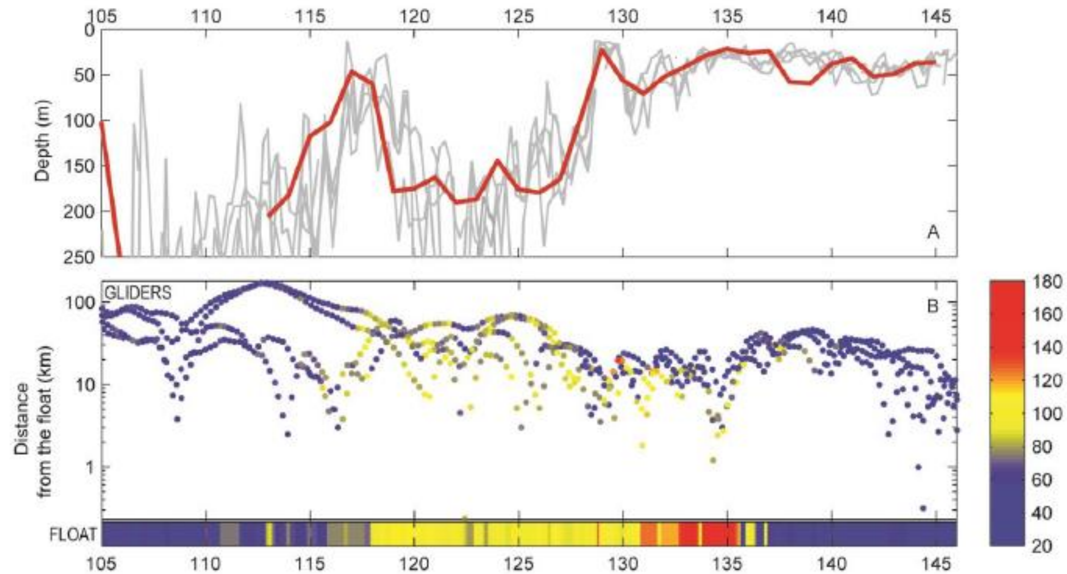


Briggs, PhD thesis

Phytoplankton Community composition

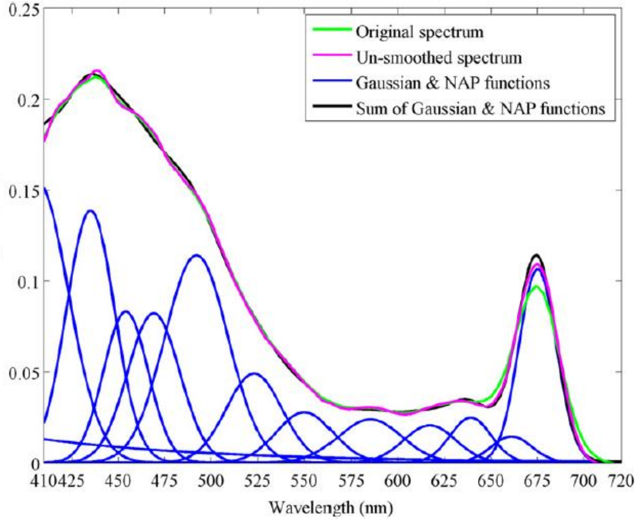






Cetinic et al, 2015

Phytoplakton community composition



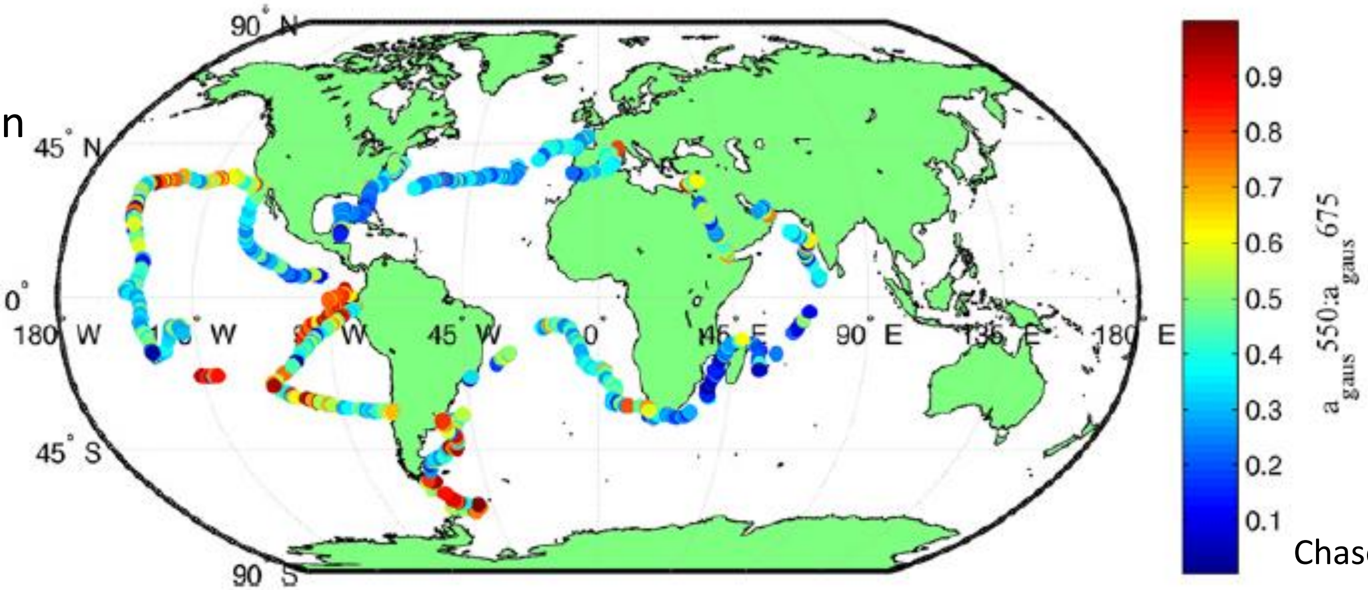
a_p

Wavelength (nm)

Table 2
Correlations between HPLC pigment concentrations and $a_{gaus}(\lambda_i)$ at ten different pigment absorption wavelengths. Correlation values are Spearman's rank correlation coefficient (non-parametric; denoted ρ). A and B are coefficients determined using Eq. (4) (Section 2.4).

Wavelength (nm)	Pigment(s)	ρ	A	B	e_{median} (%)
435	TChl *a*	0.868	0.031	0.578	35
617	TChl *a*	0.834	0.003	0.758	36
675	TChl *a*	0.899	0.014	0.798	30
454	0.03(TChl *b*) + 0.07(Chl *c*)	0.845	0.028	0.414	57
469	TChl *b*	0.783	0.066	0.533	52
661	TChl *b*	0.747	0.018	0.668	40
585	Chl *c*	0.846	0.014	0.582	53
639	Chl *c*	0.894	0.012	0.641	41
492	PPC	0.606	0.046	0.650	51
523	PSC	0.855	0.013	0.588	49

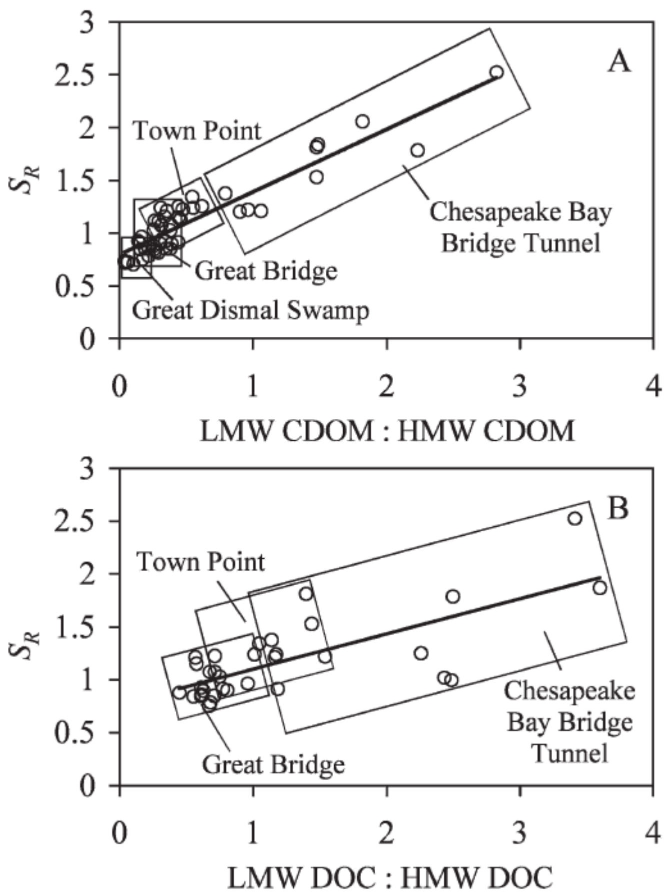
Phycoerithrin proxy distribution



Chase et al, 2013

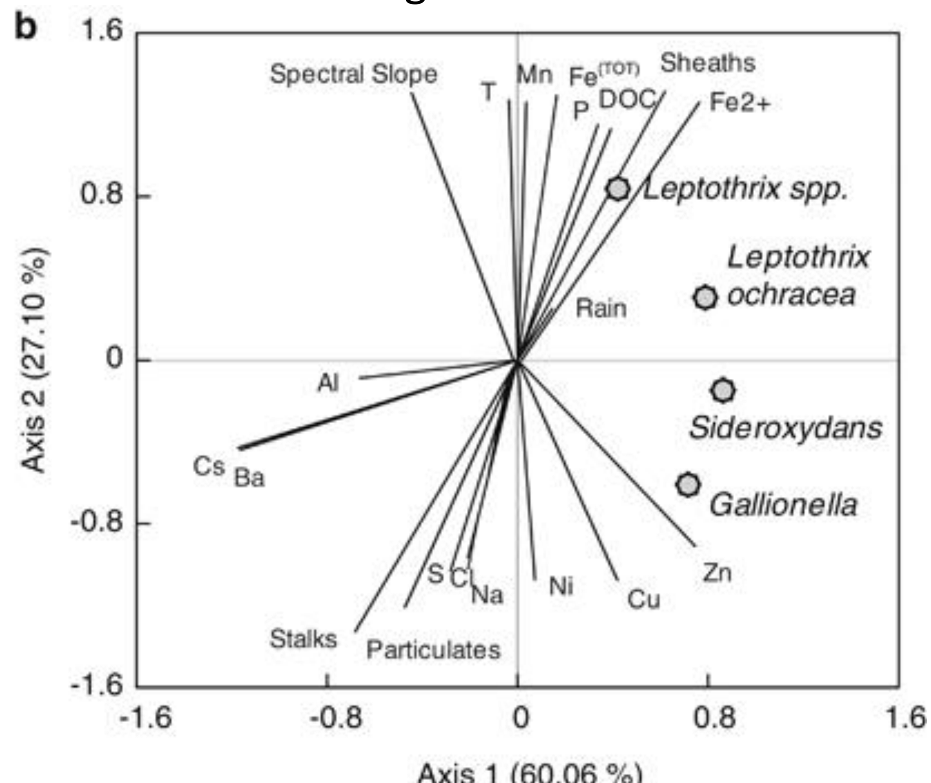
CDOM slope ~ DOC molecular mass

CDOM slope ratio



Helms et al., 2008

Ecological succession among iron-oxidizing bacteria
unexplored relationship between FeOB and organic carbon

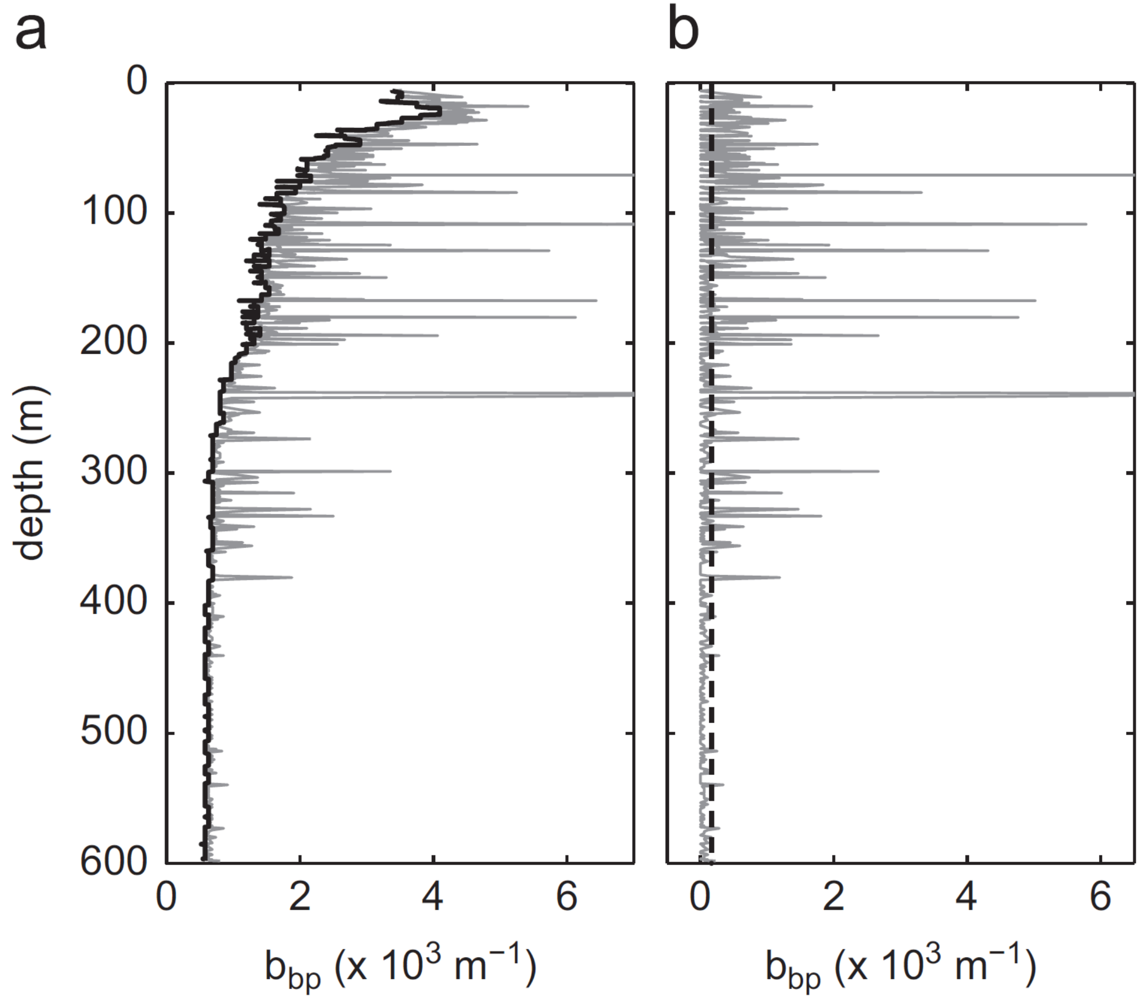


Fleming et al. 2014

As Rufus well knows, there's opportunity in chaos.

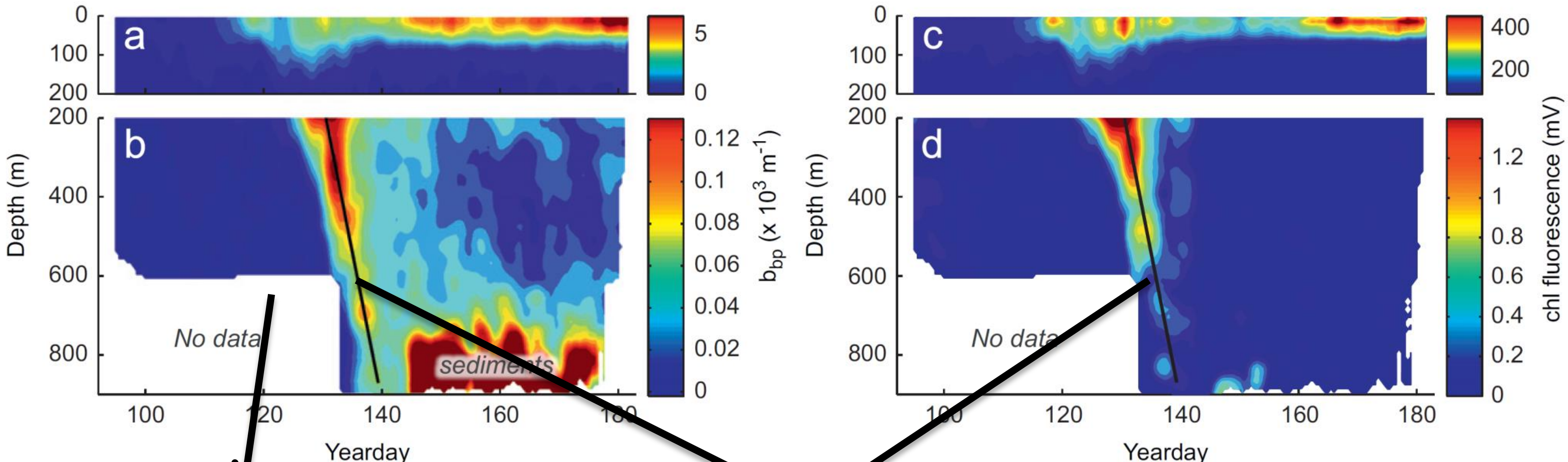
OPPORTUNITY IN CHAOS FLUXES

“noise” == aggregates

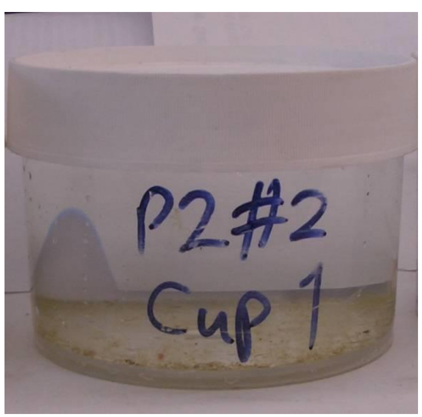


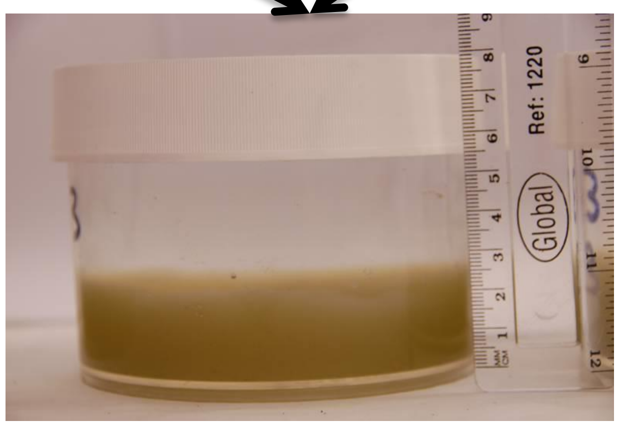
Briggs et al, 2011, DSR

Carbon flux



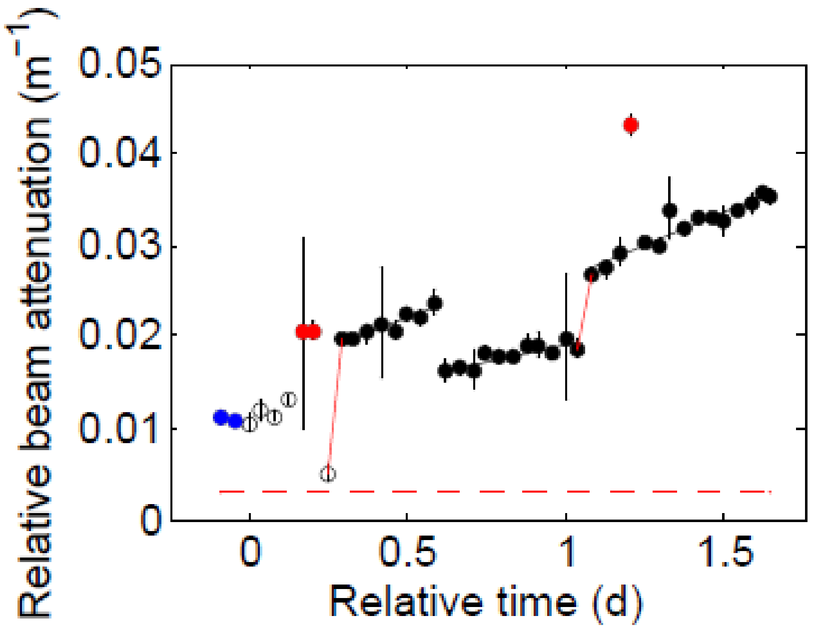
Briggs et al, 2011, DSR





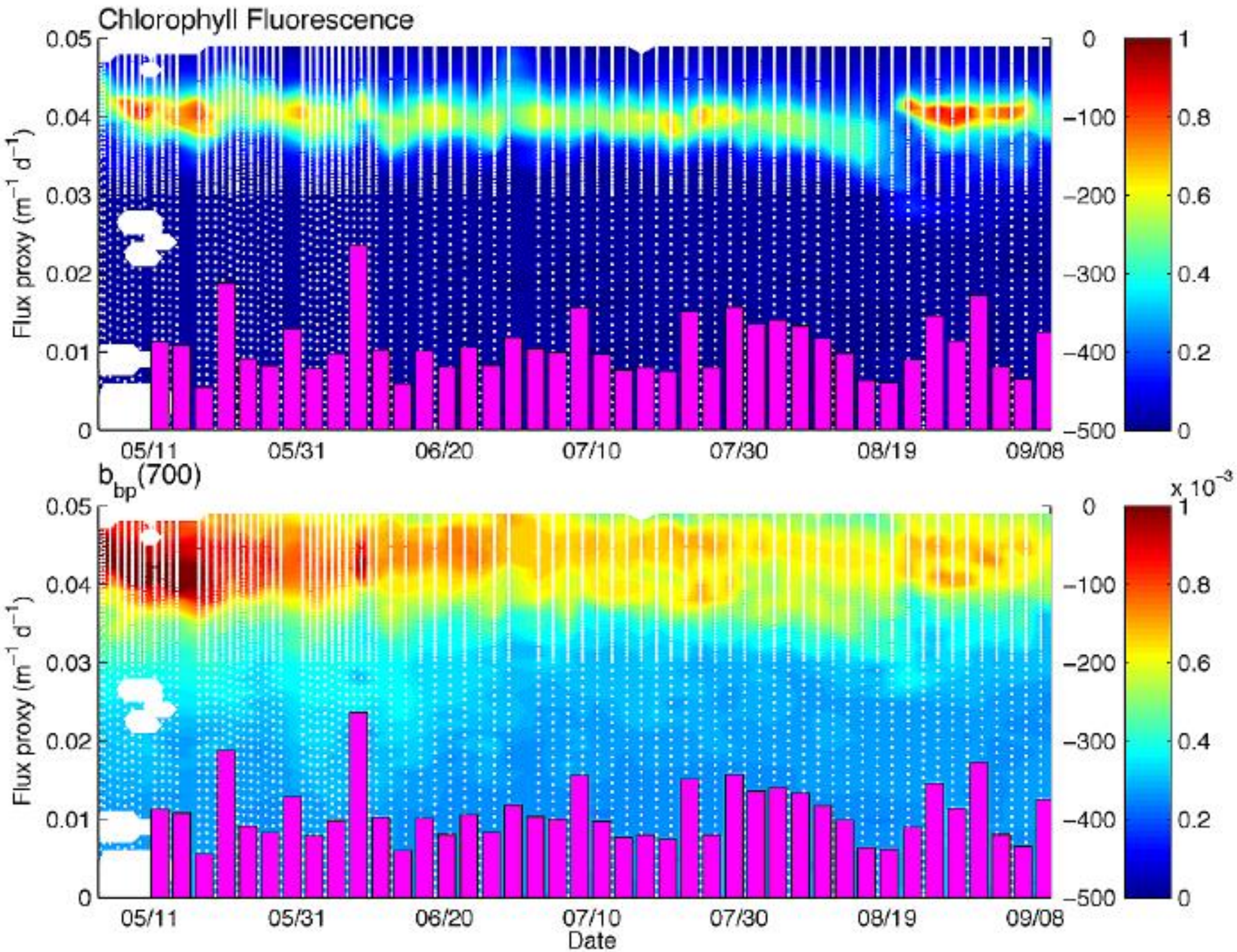
Rynearson *et al, 2013*

Optical sediment trap



Estapa et al 2013, Estapa et al, in review

Optical sediment trap



Estapa et al., 2013

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- Quality (particulate composition)
  - Particulate composition – $b_{bp}/c_{p,}$ b_{bp}/b_p
  - Particle size - c_p, b_{bp} slopes and "fluctuation", multiple angle scattering, multiple angle c_p
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- Change in these quantities will tell us something about fluxes
  - Fluxes– movement of a quantity from one pool to another
    - Space - e.g. carbon export from mixed layer to deeper ocean
    - Time – productivity - e.g. primary production
    - Type – e.g. phytoplankton to detritus, POC to DOC

PROXIES WORK UNTIL THEY DON'T (MJP)

1. Validate – make sure your proxies are based on strong and meaningful relationship with biogeochemical parameters
2. Interpolate rather than extrapolate – know the limits of your method, spatial, temporal and logical
3. Same as Rufus the dog, seize the variability and chaos (but remember 1 and 2)