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Listen to the ocean

Challenges of and needs for monitoring the size of small particles by Argo-derived optical proxies

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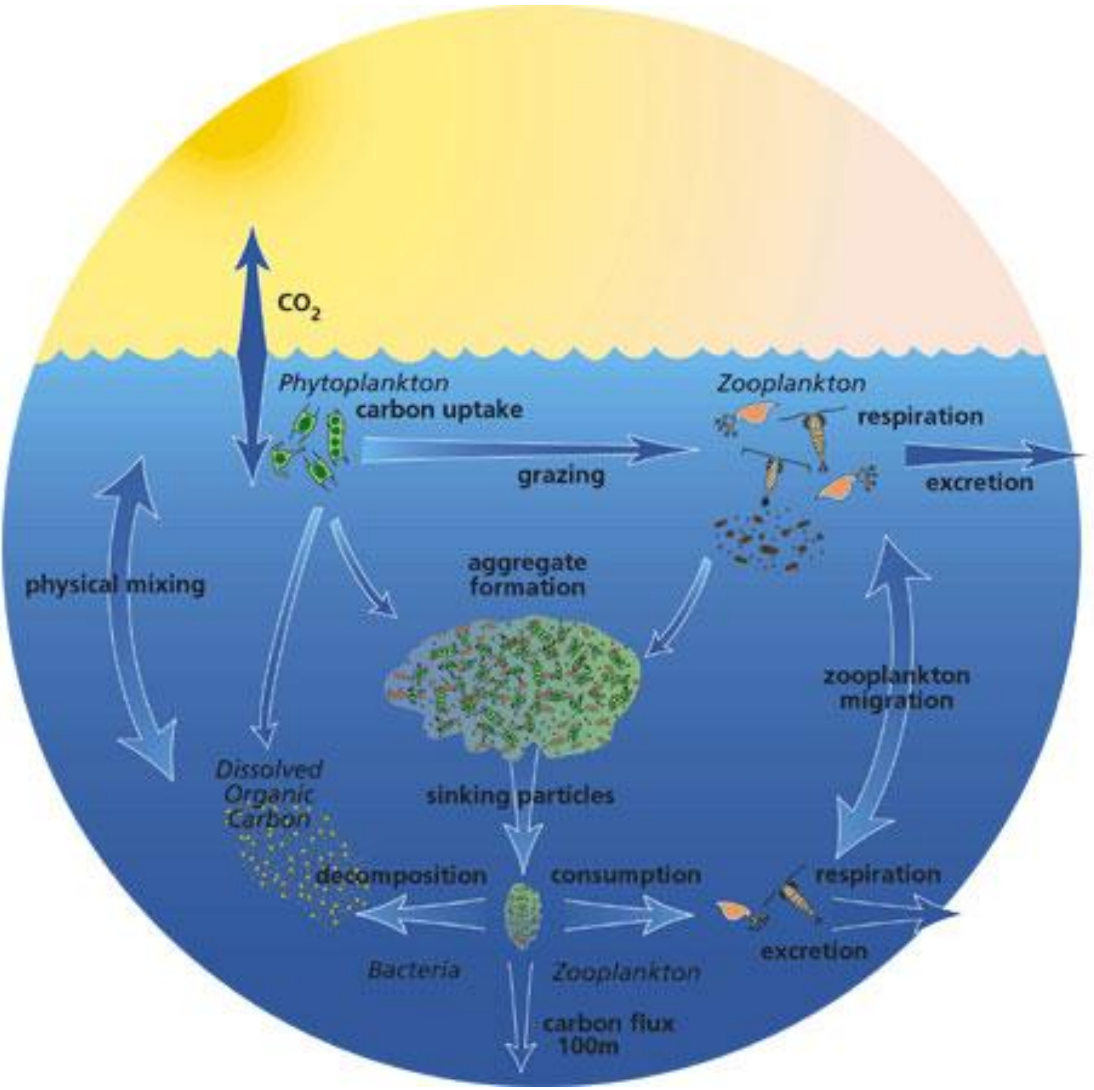
MARIE CURIE ACTIONS

Outlines

1. Introduction
2. Methods
3. Results
4. Implications for BGC-Argo floats
5. Take home messages

Introduction

The fate of marine organic particles in the biological carbon pump



Algal photosynthesis is the most important pathway of production of organic particles in the ocean. Thereafter, these particles can:

aggregate

be grazed

be fragmented

be remineralised to CO_2

sink to the abyss

The ***size*** of particles governs all these processes, and varies over the time and depth

U.S. JGOFS (2001)

The fate of marine organic particles in the biological carbon pump

Algal photosynthesis is the most important pathway of production of

"Observing particle and plankton size distributions (PSDs) in a synoptic manner could help to better understand the processes contributing to the biological pump"

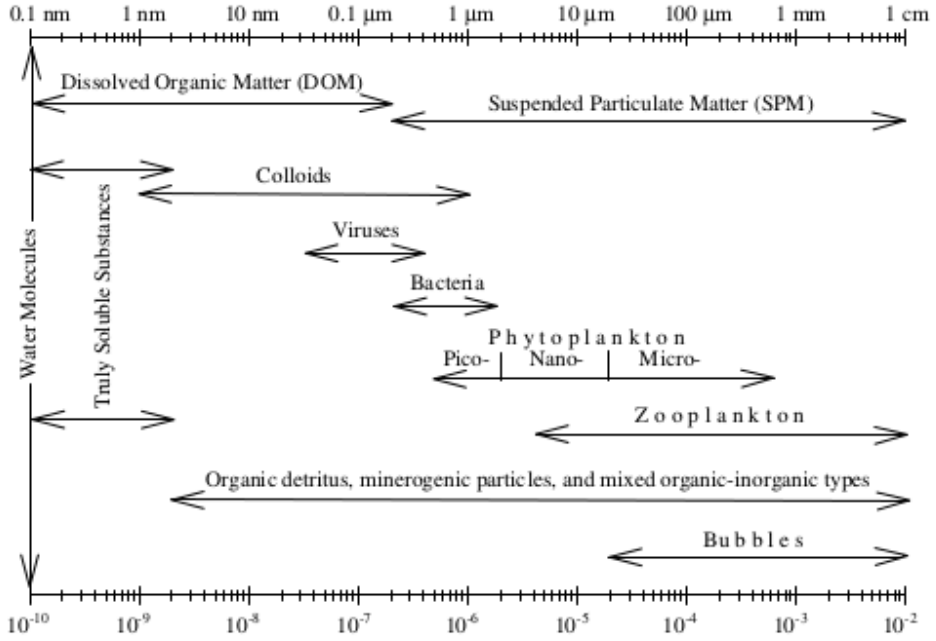
(Stemmann and Boss, Ann. Rev. Mar. Sci. 2011)

sink to the abyss

U.S. JGOFS (2001)

The ***size*** of particles governs all these processes, and varies over the time and depth

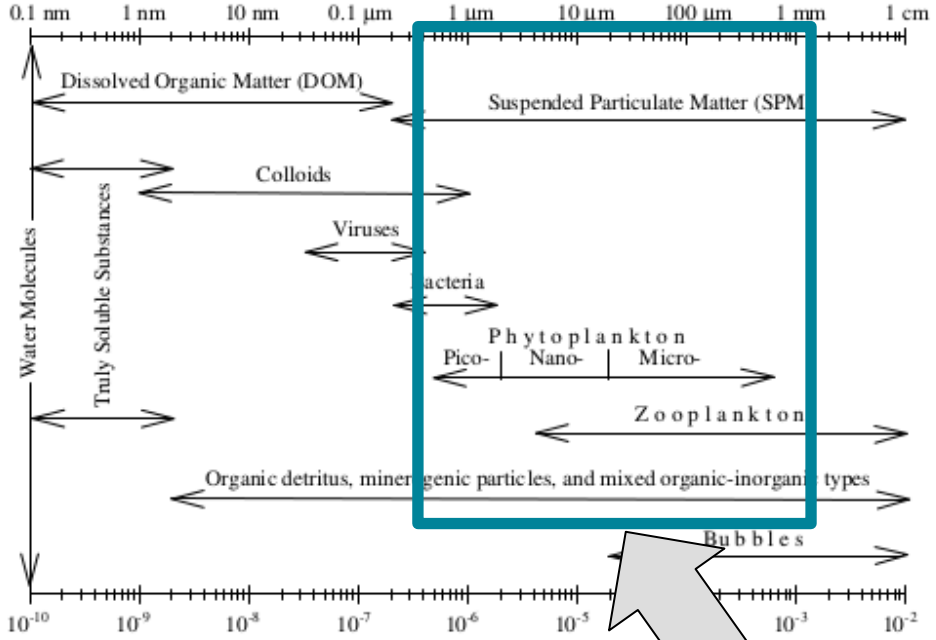
The size of marine particles and how to measure PSDs



Stramski et al. (2004)

Particle Size (m)

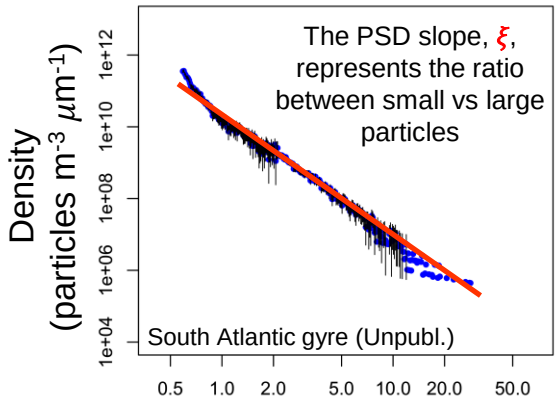
The size of marine particles and how to measure PSDs



Stramski et al. (2004)

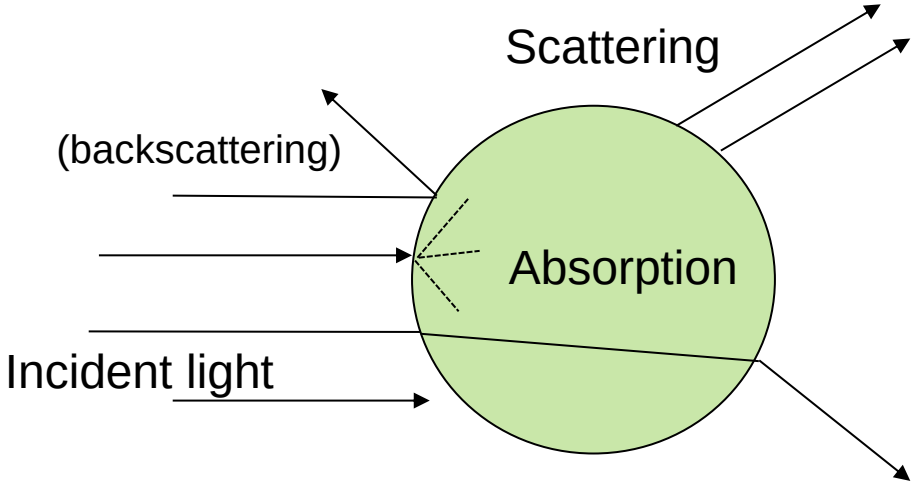
Particle Size (m)

0.4-1200 µm



Coulter Counter

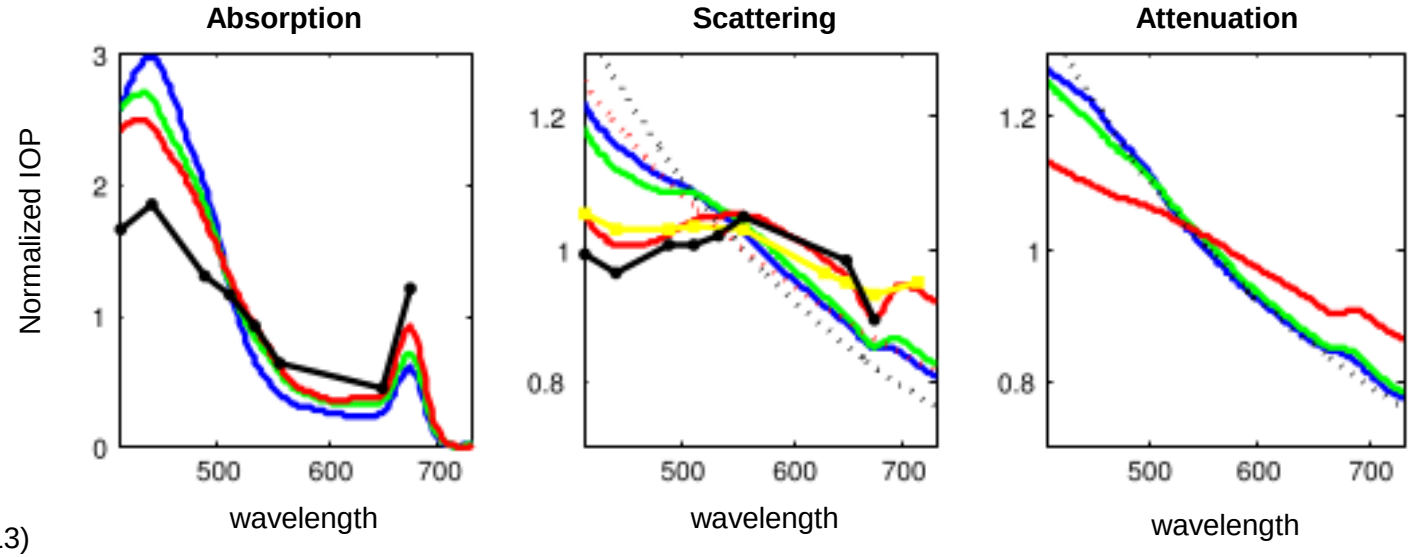
Particles (0.2-20 μm) interact with light



Attenuation= Absorption + Scattering

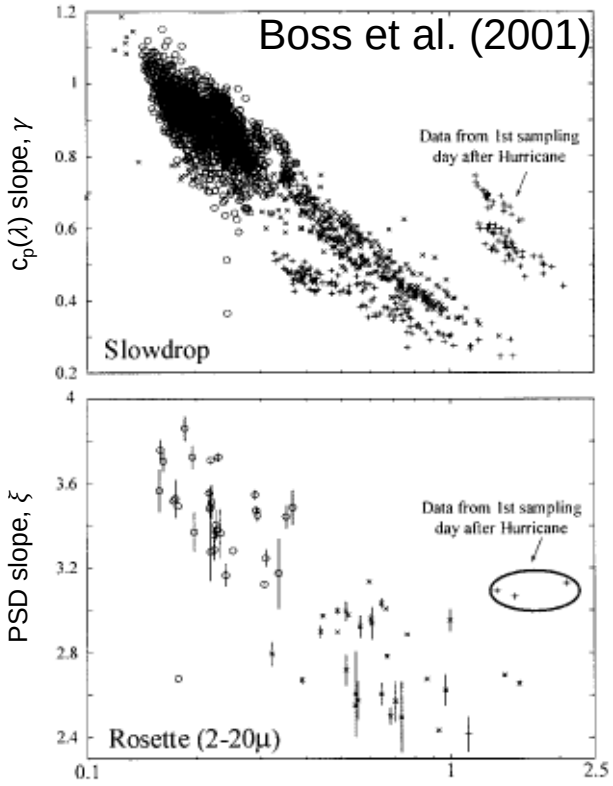
$c_p(\lambda) = a_p(\lambda) + b_p(\lambda)$

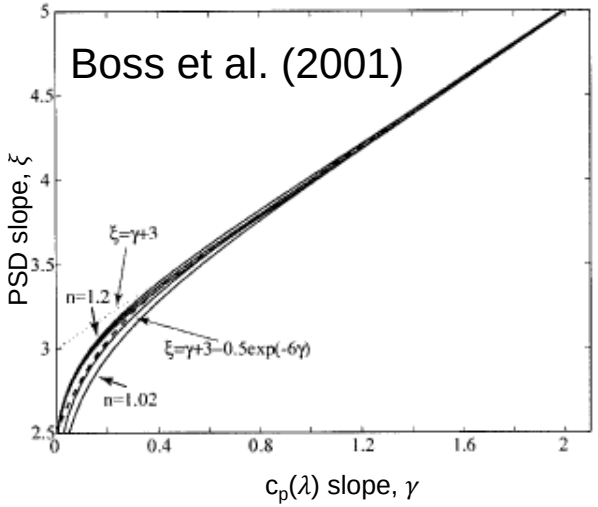
(called IOPs)



Boss et al. (2013)

Optical proxies of particle size

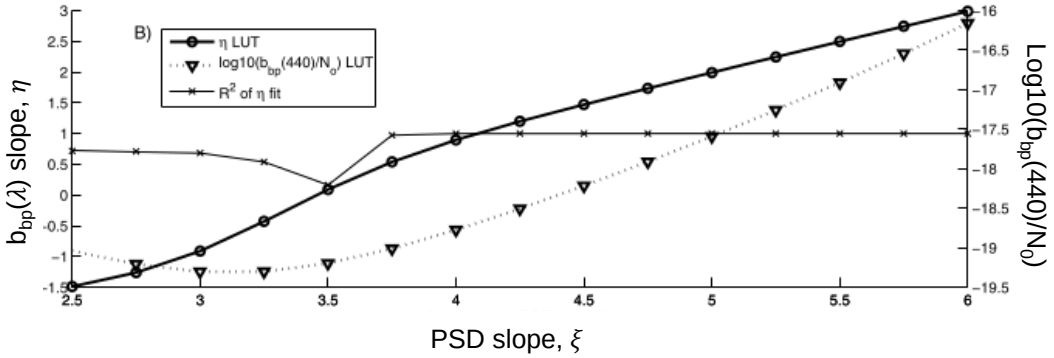




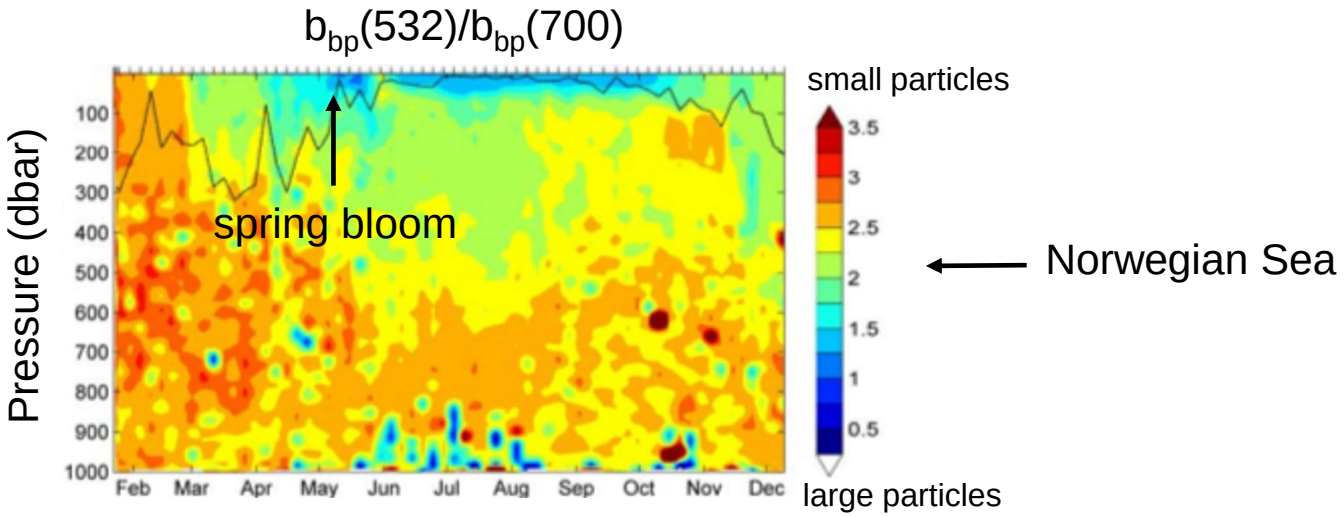
The slope, γ, of the beam attenuation coefficient ($c_p(\lambda)$) can be used as a proxy of the slope, ξ, of the Particle Size Distribution (PSD)

The slope, η, of the particle backscattering coefficient ($b_{bp}(\lambda)$) can be used as a proxy of the PSD slope, ξ

Kostadinov et al. (2009)



The potential of Biogeochemical Argo floats



Dall'Olmo & Mork (2015)

BGC-Argo floats for:

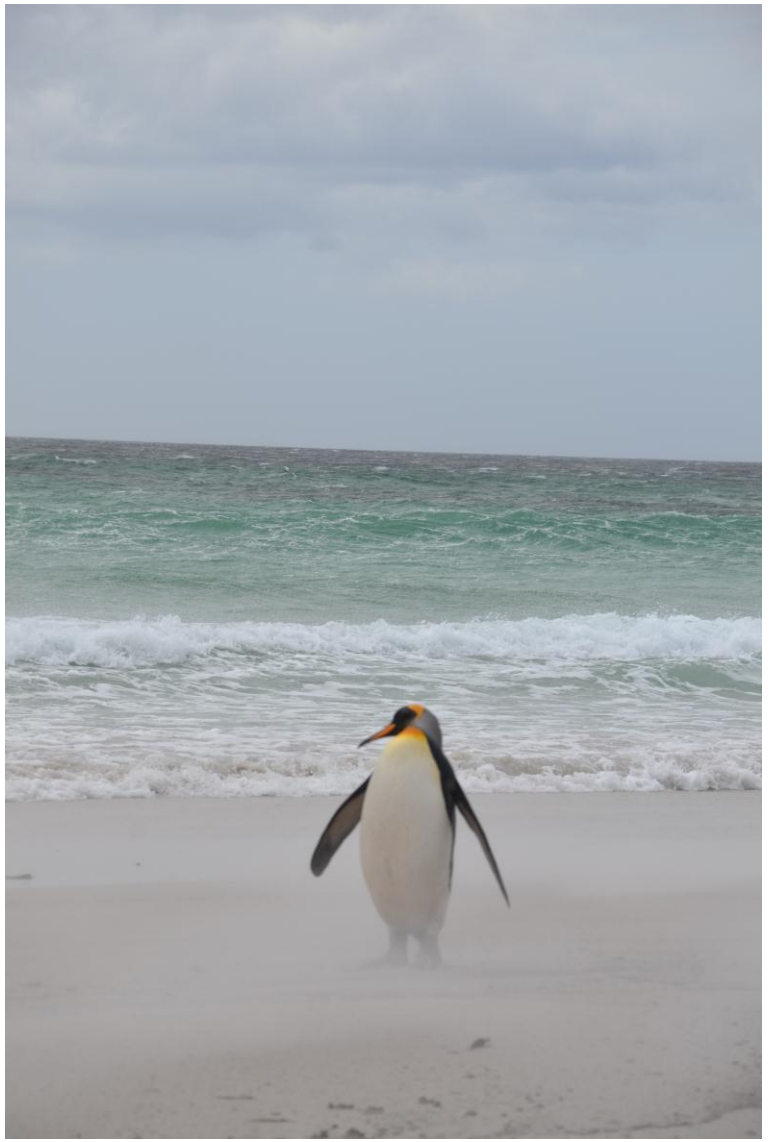
Monitoring changes in particle size and concentration using $b_{bp}(\lambda)$-derived optical proxies. This could help improving our understanding of the pathways of the biological pump processes, and of the magnitude and variability of carbon fluxes in the mesopelagic region.

Critical need (aim of the talk):

To understand how the relationships between PSDs and optical proxies vary spatially and temporally, from the surface to the ocean interior.

Organelli et al. (2016)

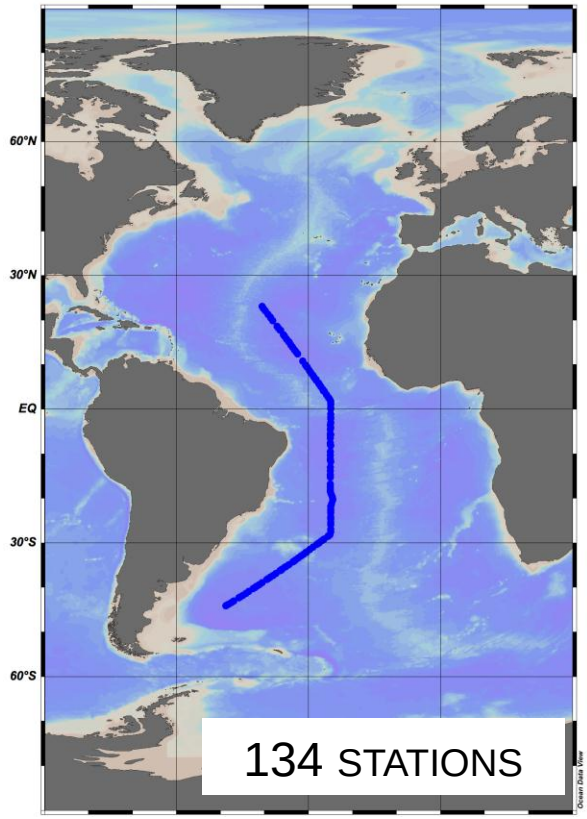
Methods



PSDs and optical proxies from the Atlantic Meridional Transect

AMT22

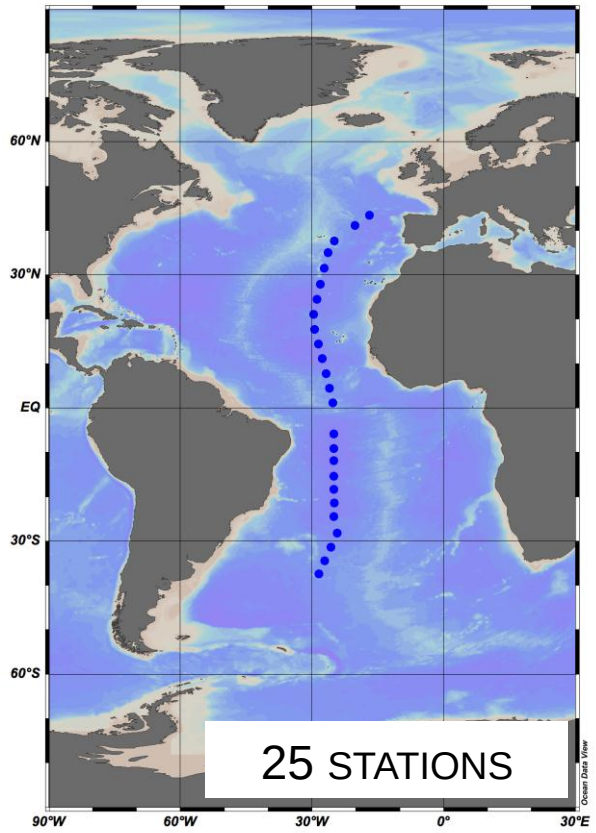
Oct.–Nov. 2012



PSD (coulter counter)**:** 1.4-42 μm
Optics: ac-s & bb3
1 depth: 5 m
(ship's underway samples)

AMT26

Sep.–Nov. 2016

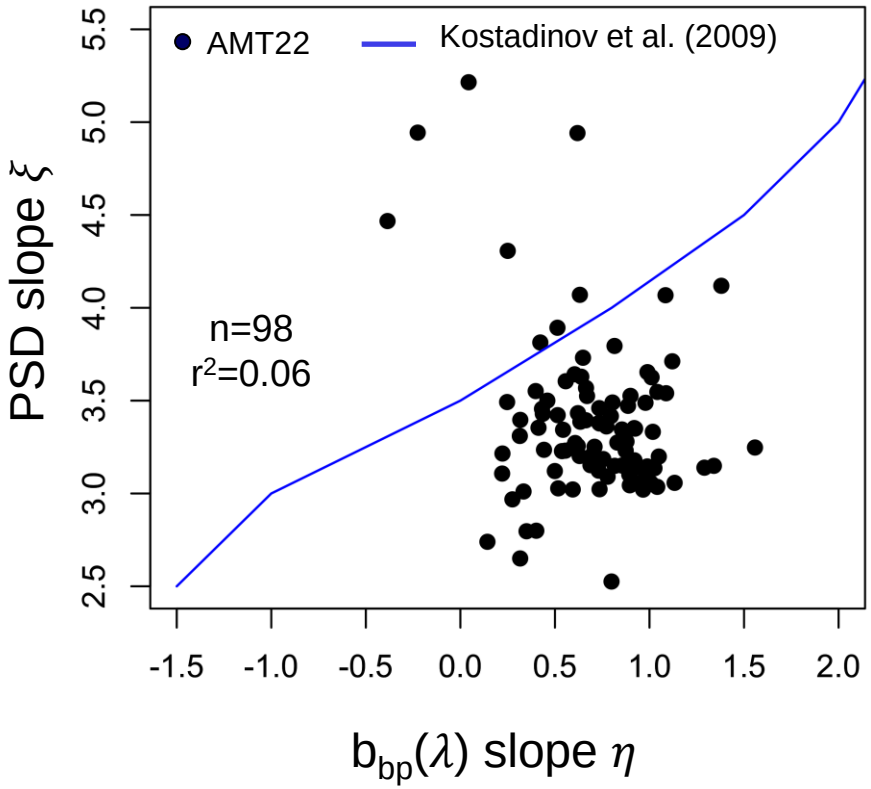


PSD (coulter counter)**:** 0.55-60 μm
Optics: ac-9 & Hydroscat-6
6 depths: 5 to 500 m
(cast samples)

Results

PSD and optical proxies (at 5 m)

backscattering

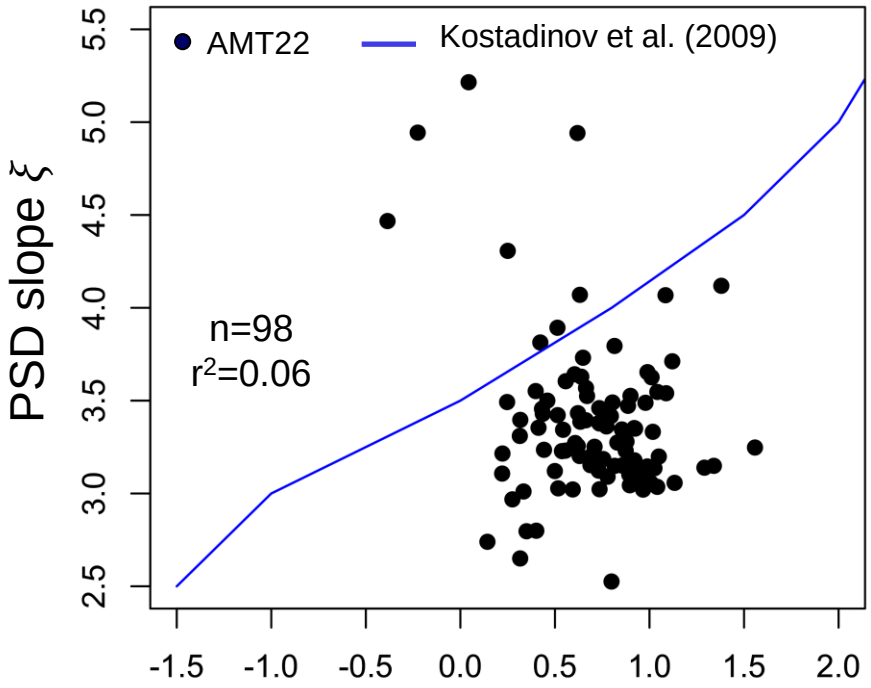


at 2 wavelengths 470 and 532 nm

Organelli et al. in prep.

PSD and optical proxies (at 5 m)

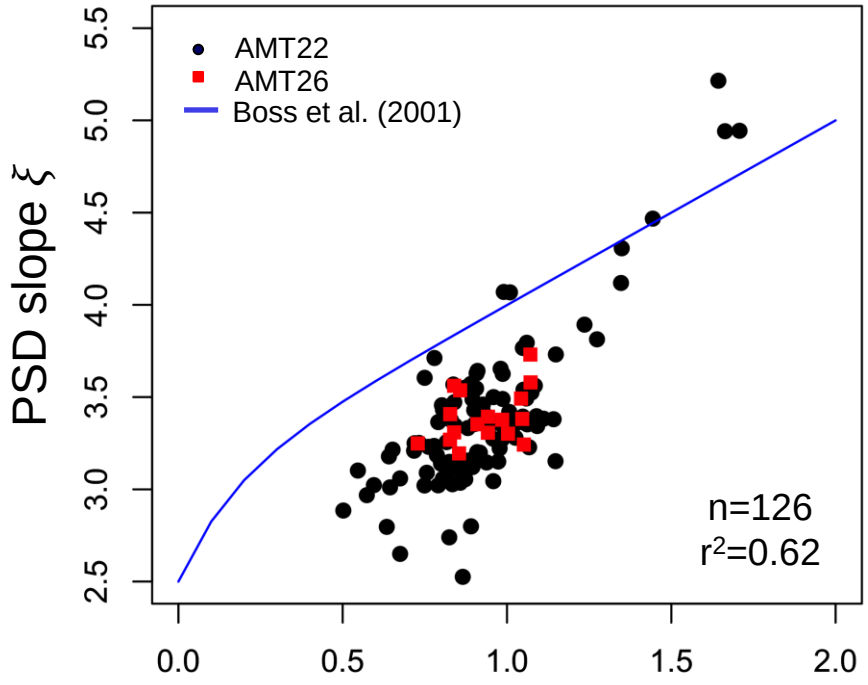
backscattering



$b_{bp}(\lambda)$ slope η

at 2 wavelengths 470 and 532 nm

attenuation



$c_p(\lambda)$ slope γ

spectral range: 400-700 nm

Organelli et al. in prep.

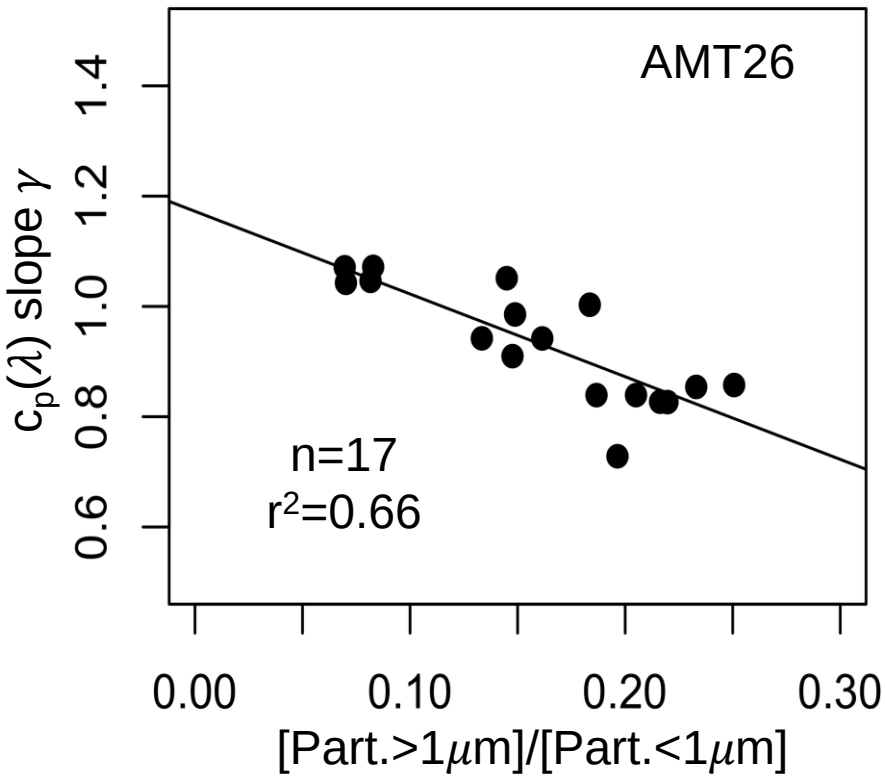
PSD and optical proxies (at 5 m)

γ
(based on more than 2 wavelengths)
is a proxy of the relative contribution of large and small (living and not) particles

as well as of the algal community structure…not shown

Useful measurement currently unavailable on BCG-floats

attenuation



Organelli et al. in prep.

Multispectral b_{bp}-derived optical proxies

AMT26

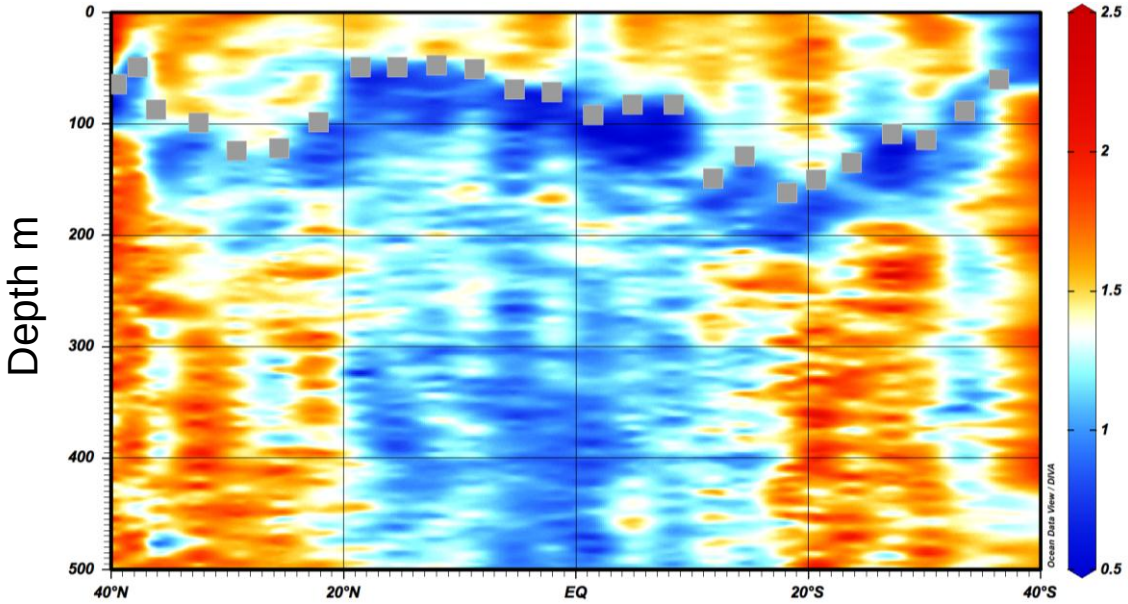
$b_{bp}(\lambda)$ slope η (5 wavelengths between 442-671 nm)

Multispectral b_{bp}-derived optical proxies

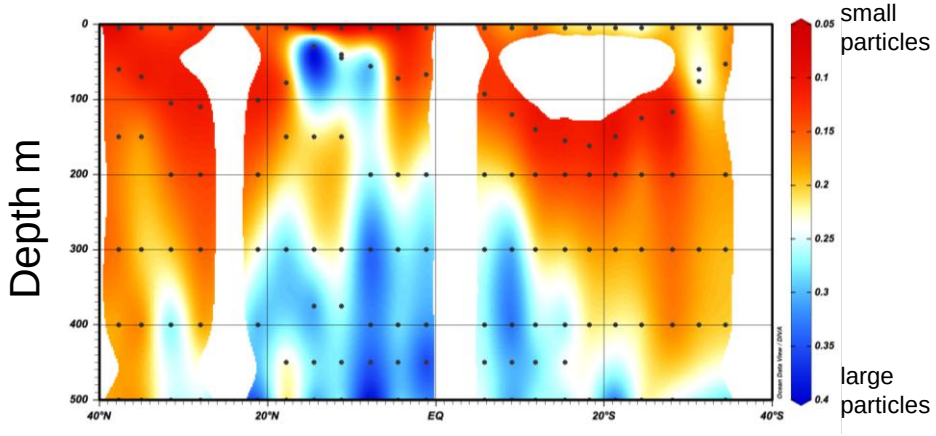
AMT26

DCM

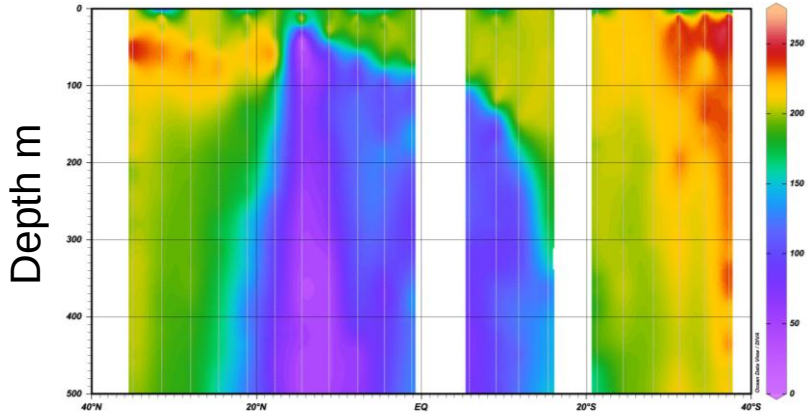
$b_{bp}(\lambda)$ slope η (5 wavelengths between 442-671 nm)



Large-to-Small particles (1μm) (from Coulter)



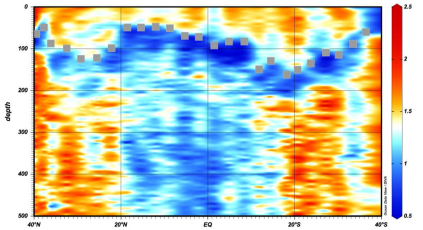
Oxygen μmol Kg^{-1}



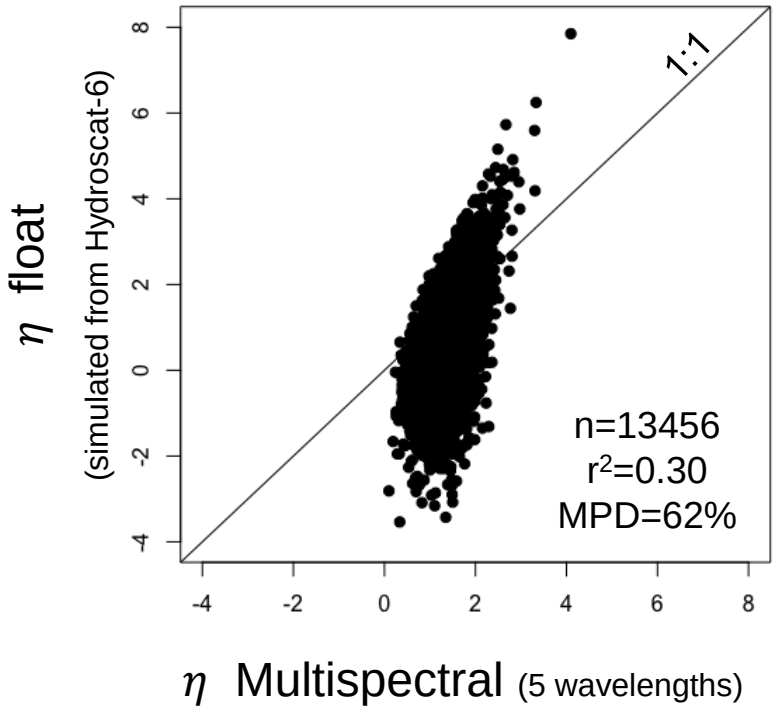
Organelli et al. in prep.

Implications for BGC-Argo floats

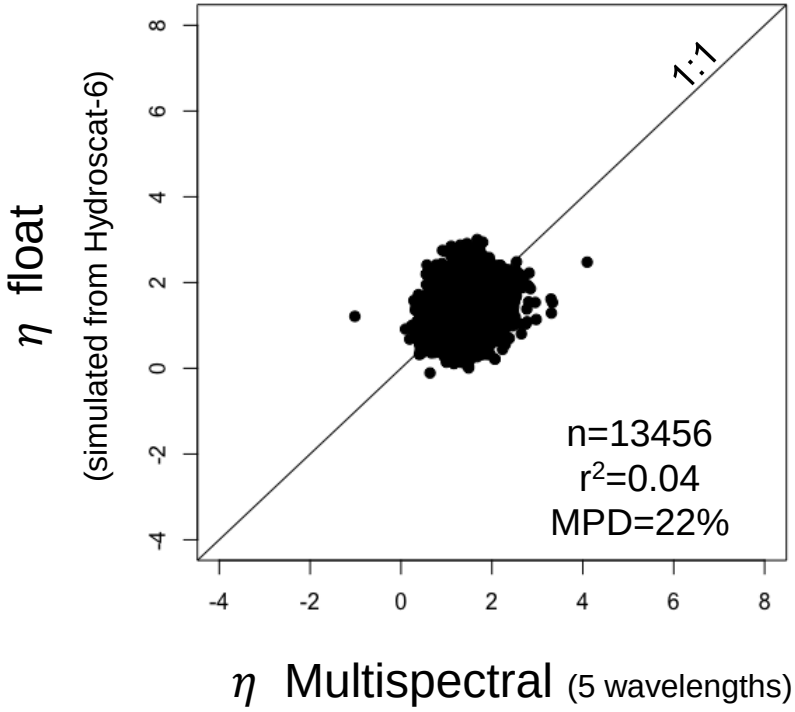
Can we infer PSDs from current BCG-Argo configuration (b_{bp} at 532 and 700 nm)?

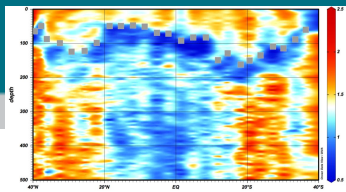


550-671 nm



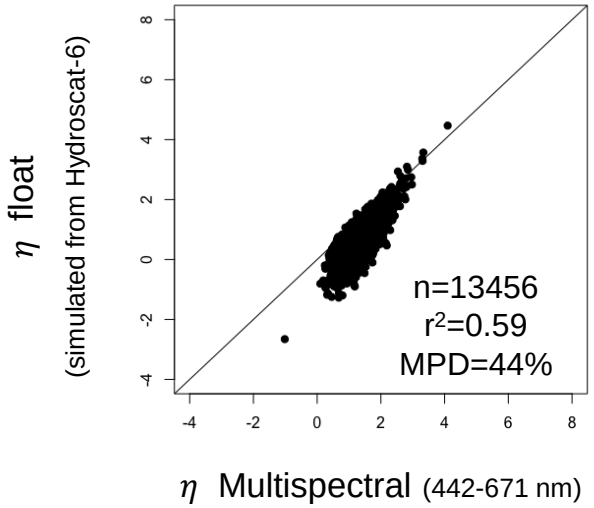
550-852 nm



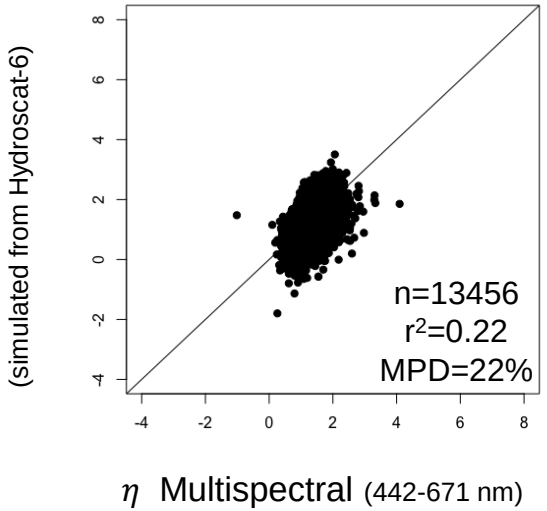


What can we do next?

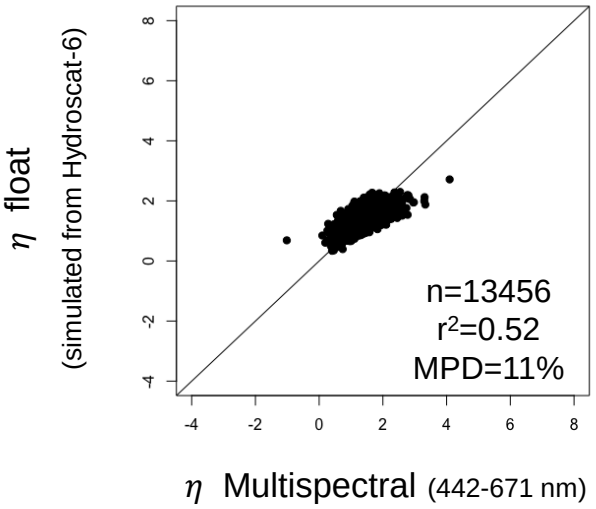
448/550/620/671 nm



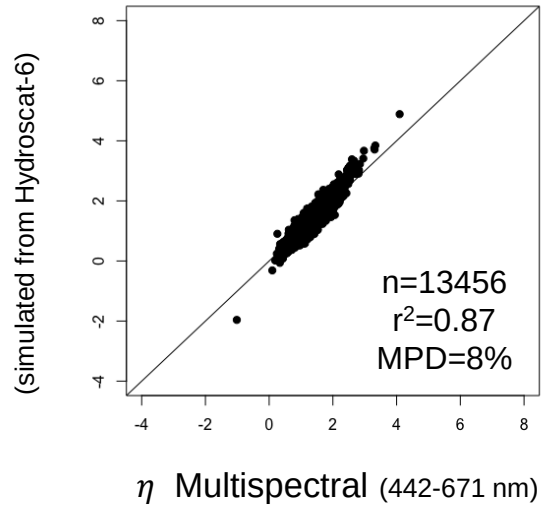
448/550/620 nm



6$\lambda\lambda$= 442 to 852 nm



2$\lambda\lambda$= 442 and 671 nm



Take home messages

- ***Optical proxies*** (backscattering and attenuation) measured ***over a broad spectral range help understanding changes in particle size*** along the Atlantic Meridional Transect

- ***Current*** backscattering measurements on ***BGC-Argo floats can mislead*** our ***interpretation about small particle size*** (at least in the oligotrophic Atlantic Ocean)

- ***Future BGC-Argo floats*** may be ***equipped with $b_{bp}(442)$ and $b_{bp}(671)$ or $b_{bp}(852)$,*** or at least 2 wavelengths covering a broad spectral range

- Measurements of the ***spectral beam attenuation*** coefficient ***could*** further ***help understanding changes in*** the contribution of ***large-to-small particles*** and of the ***algal community structure***

Thanks!

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