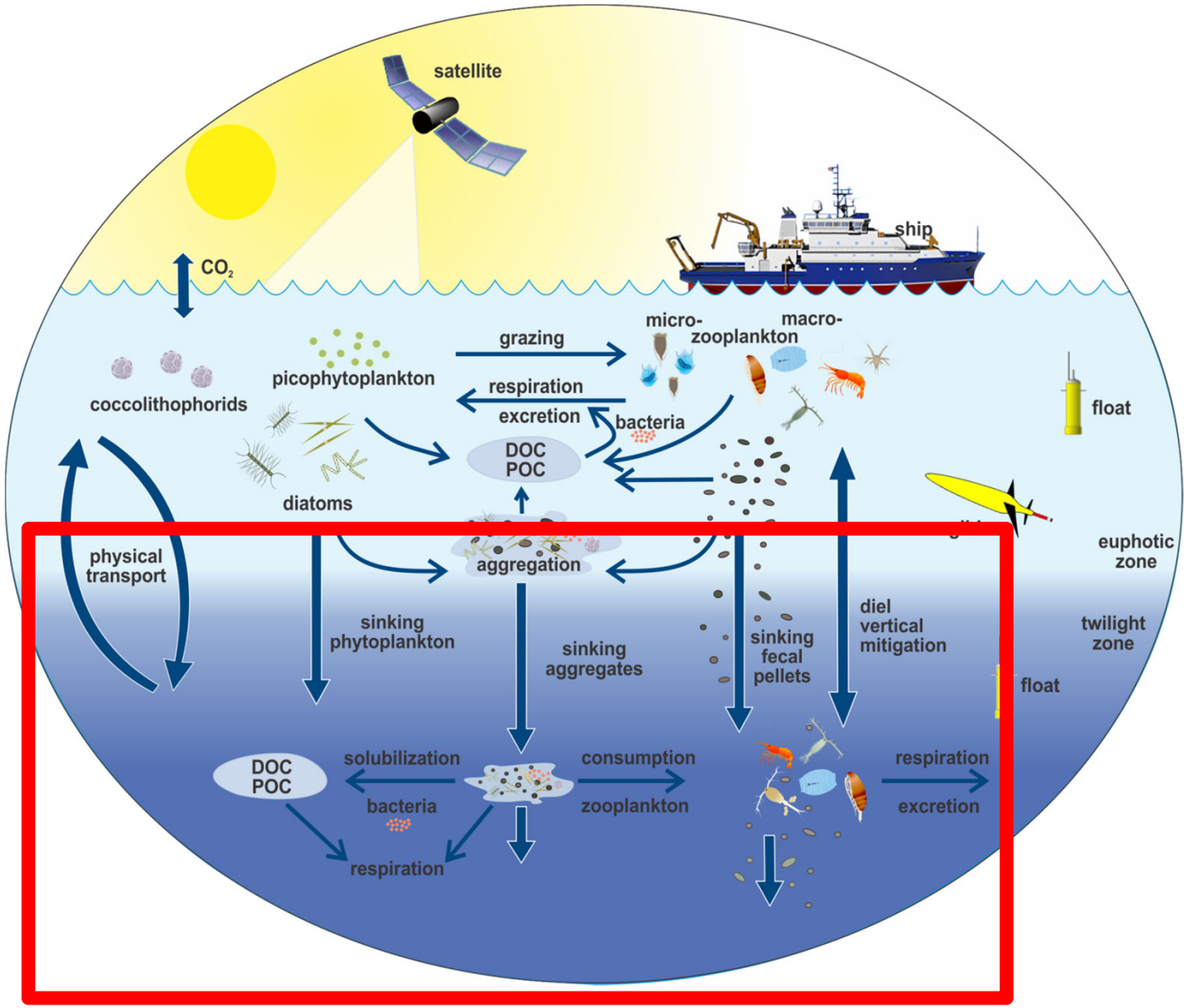
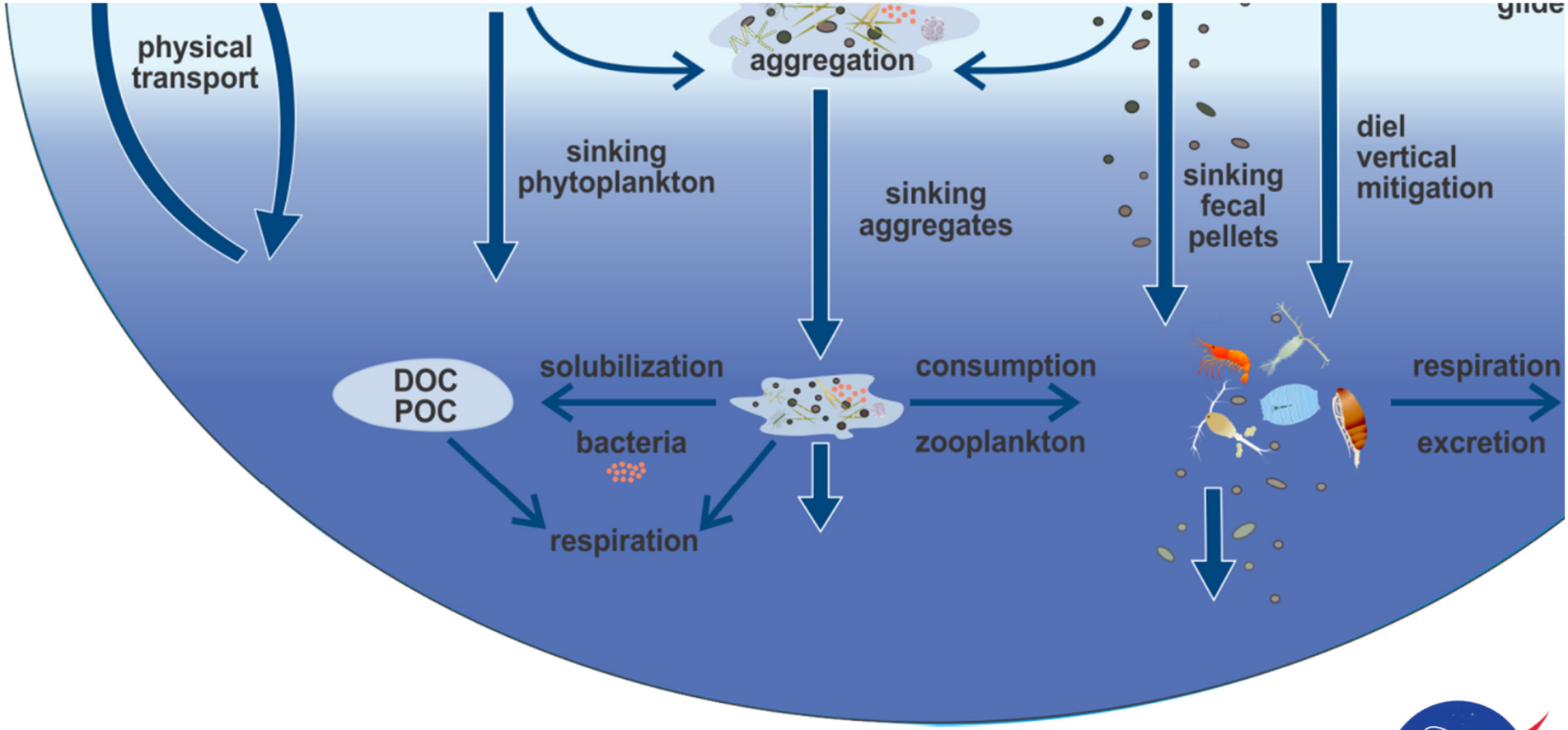
EXPORTS: Science question 2



What controls the efficiency of the vertical transfer of organic matter below the well-lit surface ocean?



Science Question 2
Subquestions

- *How does transfer efficiency of organic matter through the mesopelagic vary among the five primary pathways for export?*

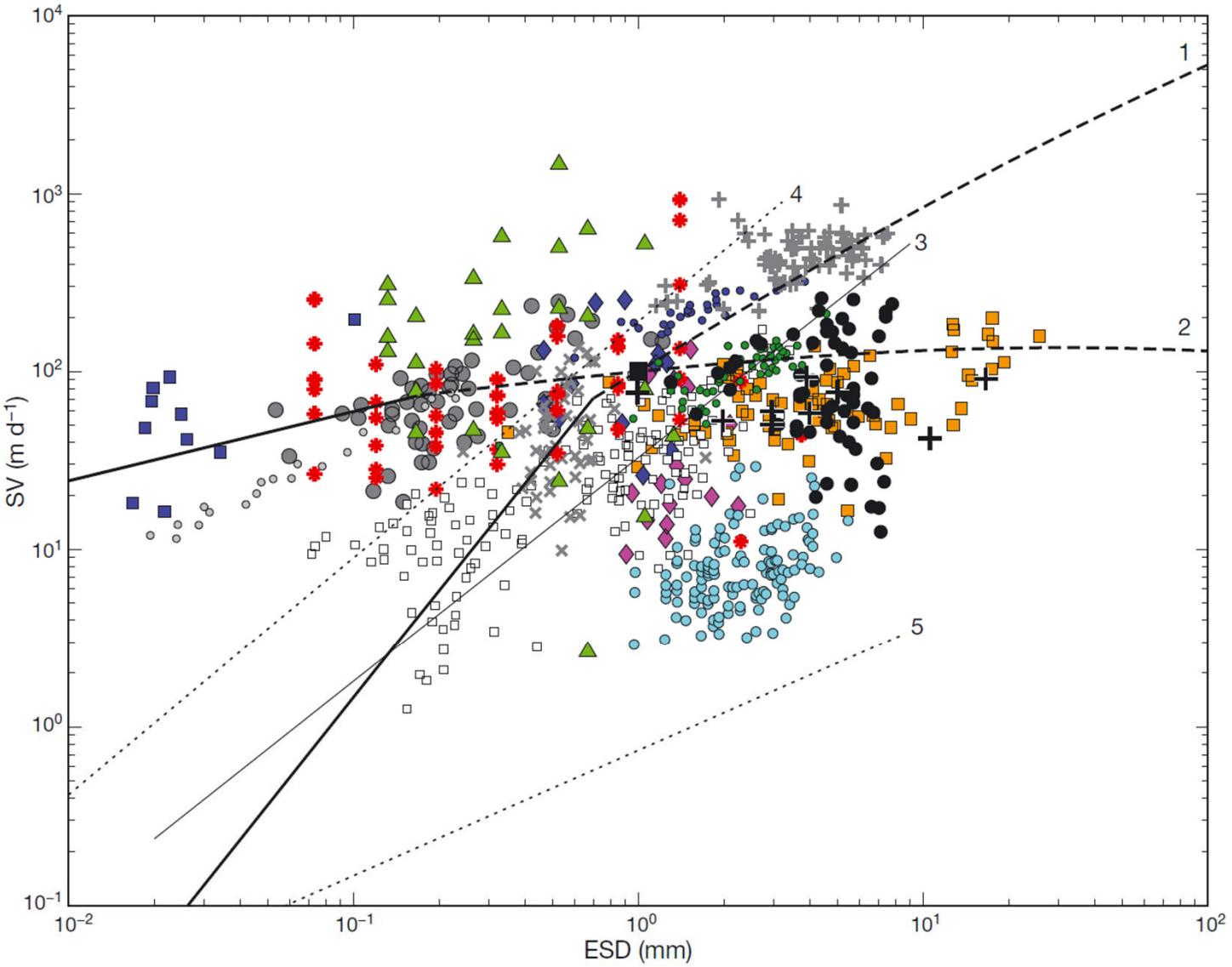
- *How is the transfer efficiency of organic matter to depth related to plankton community structure in the well-lit surface ocean?*

- *How do the abundance and composition of carrier materials in the surface ocean (cf., opal, dust, PIC) influence the transfer efficiency of organic matter to depth?*

- *How does variability in environmental and/or ecosystem features define the relative importance of processes that regulate the transfer efficiency of organic matter to depth?*

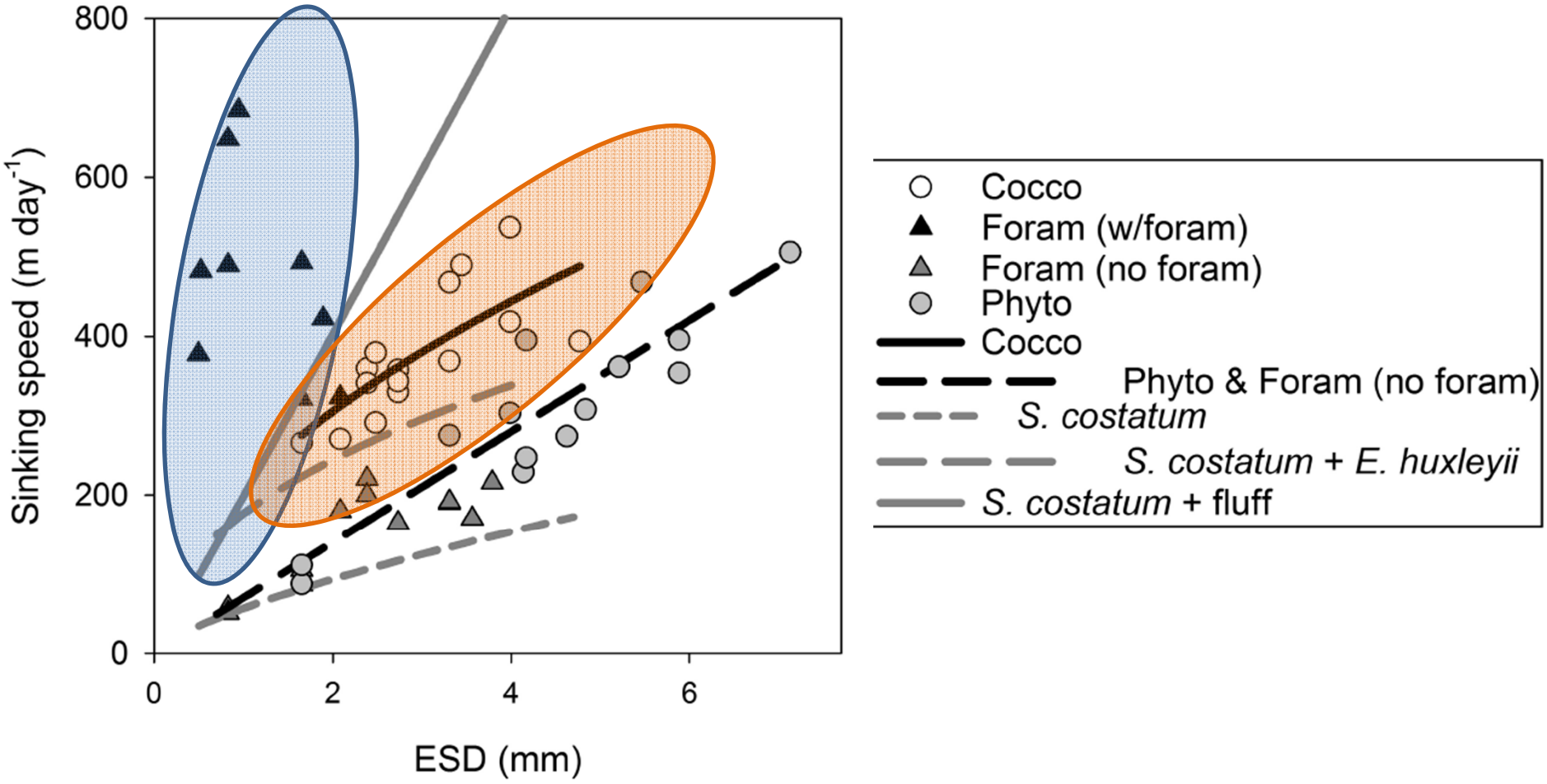
Surface influence

Sinking speed of marine snow



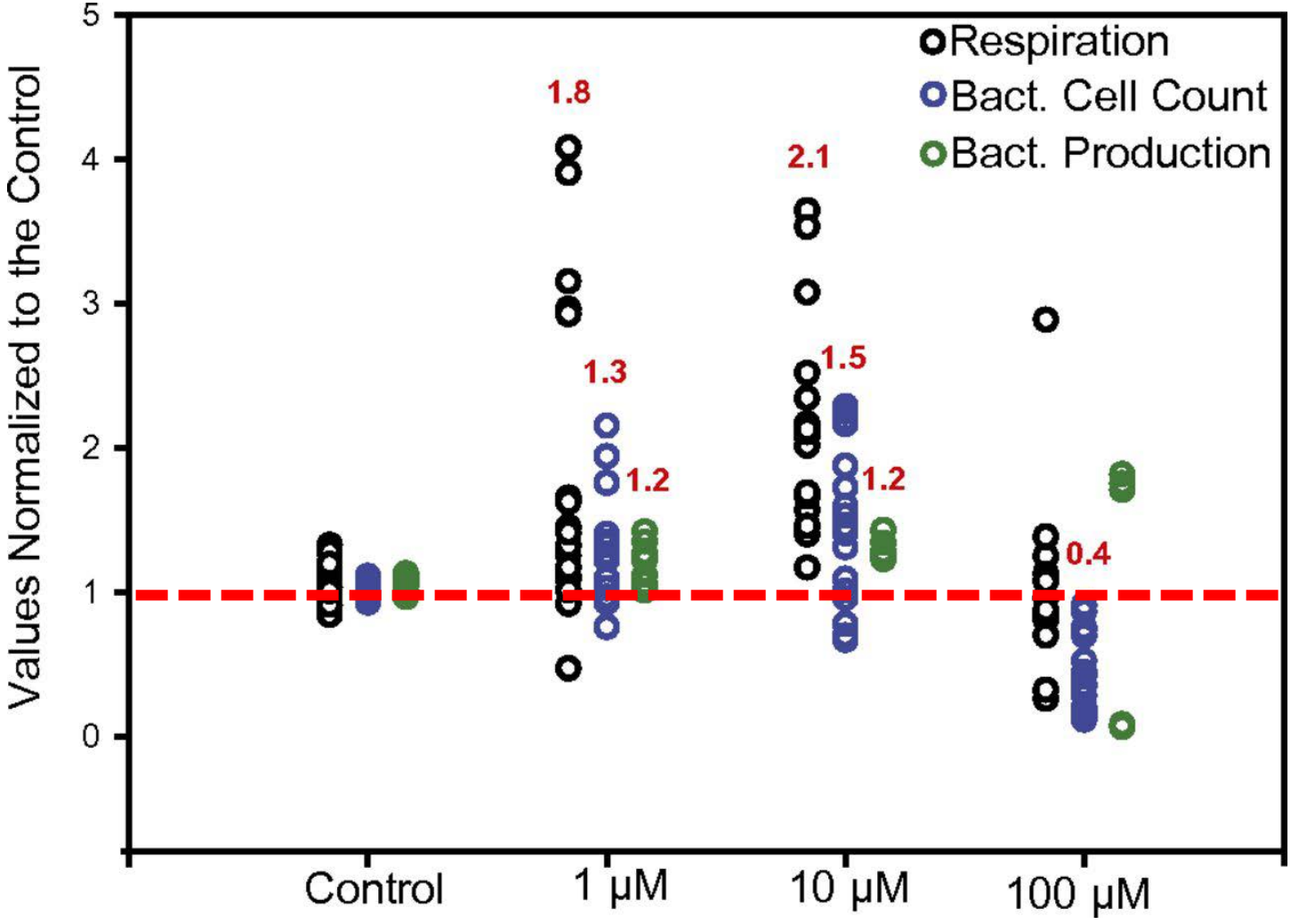
Laurenceau-Cornec et al. (2015) MEPS, 520: 35–56 doi: 10.3354/meps11116

Ballasting



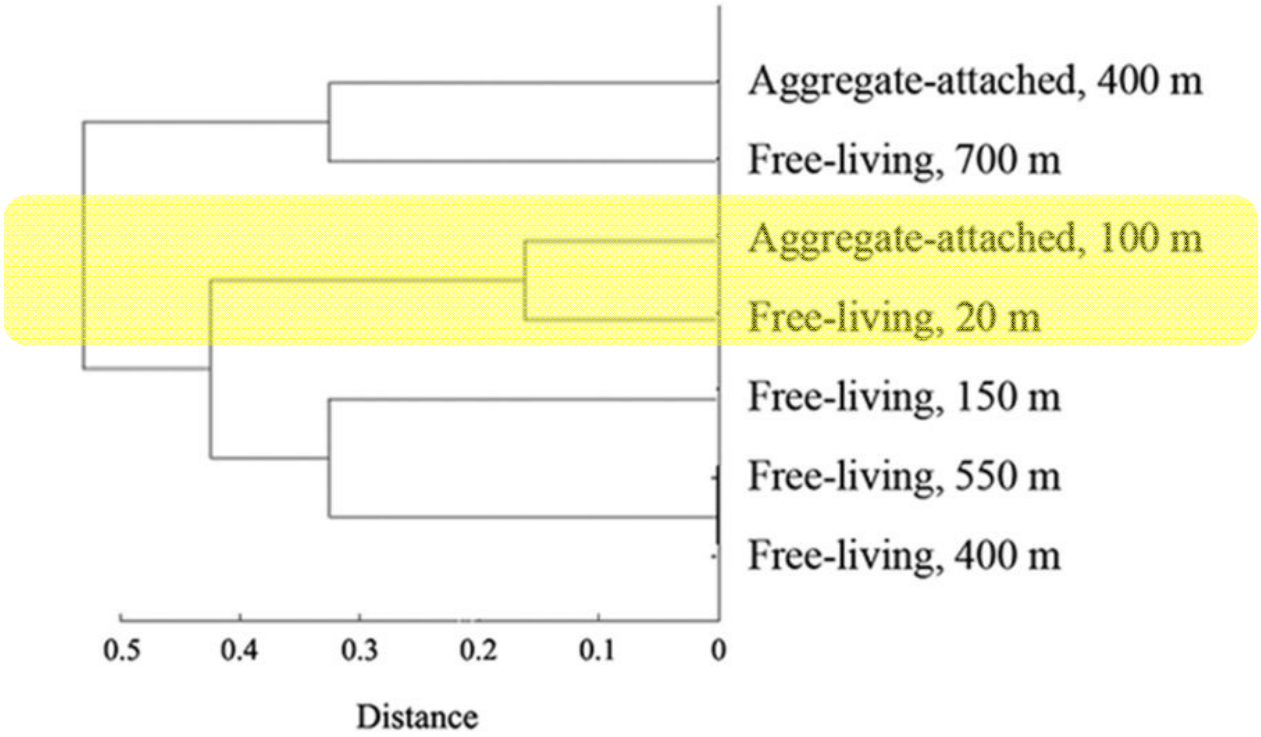
Schmidt et al. (2014) Biogeosciences, 11, doi:10.5194/bg-11-135-2014

Effects of polyunsaturated aldehydes



Edwards et al. (2015) PNAS,112:5909-5914

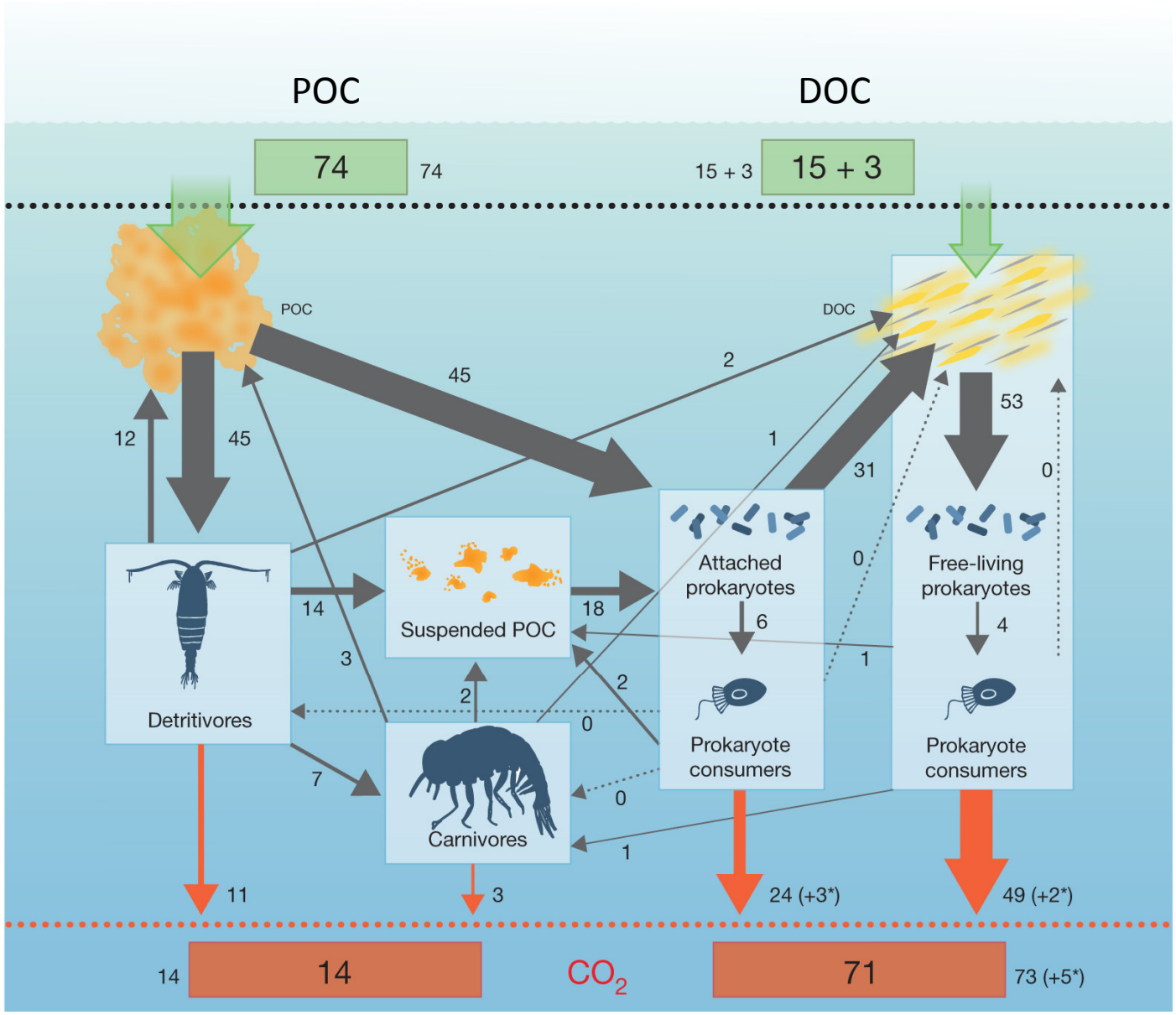
The source of particle attached bacteria



Microbial community in aggregate dominated by surface population and distinct from deeper free-living communities

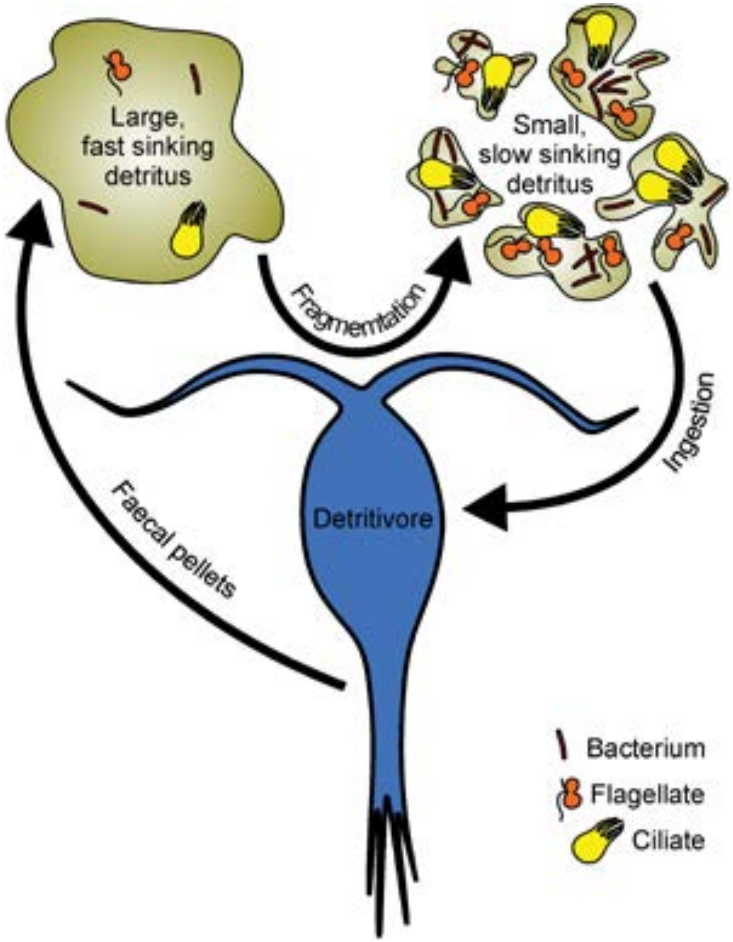
Thiele et al. (2015) Appl. Environ. Microbiol.,81:1463-1471

Twilight zone influence



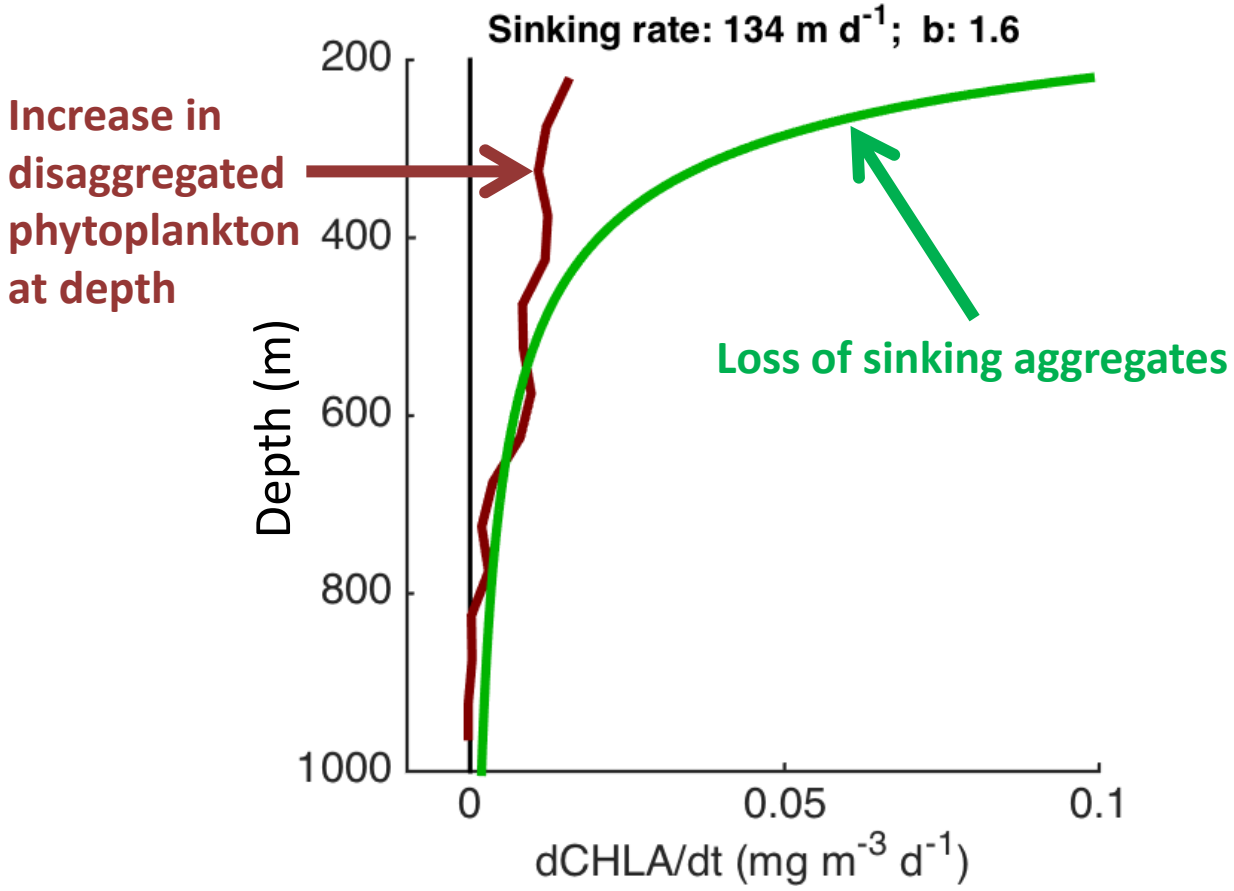
Giering *et al. (2014) Nature*, doi:10.1038/nature13123

Microbial gardening in the ocean's twilight zone?



Mayor et al. (2014) BioEssays, 36, 1132-1137 DOI: 10.1002/bies.201400100

Disaggregation

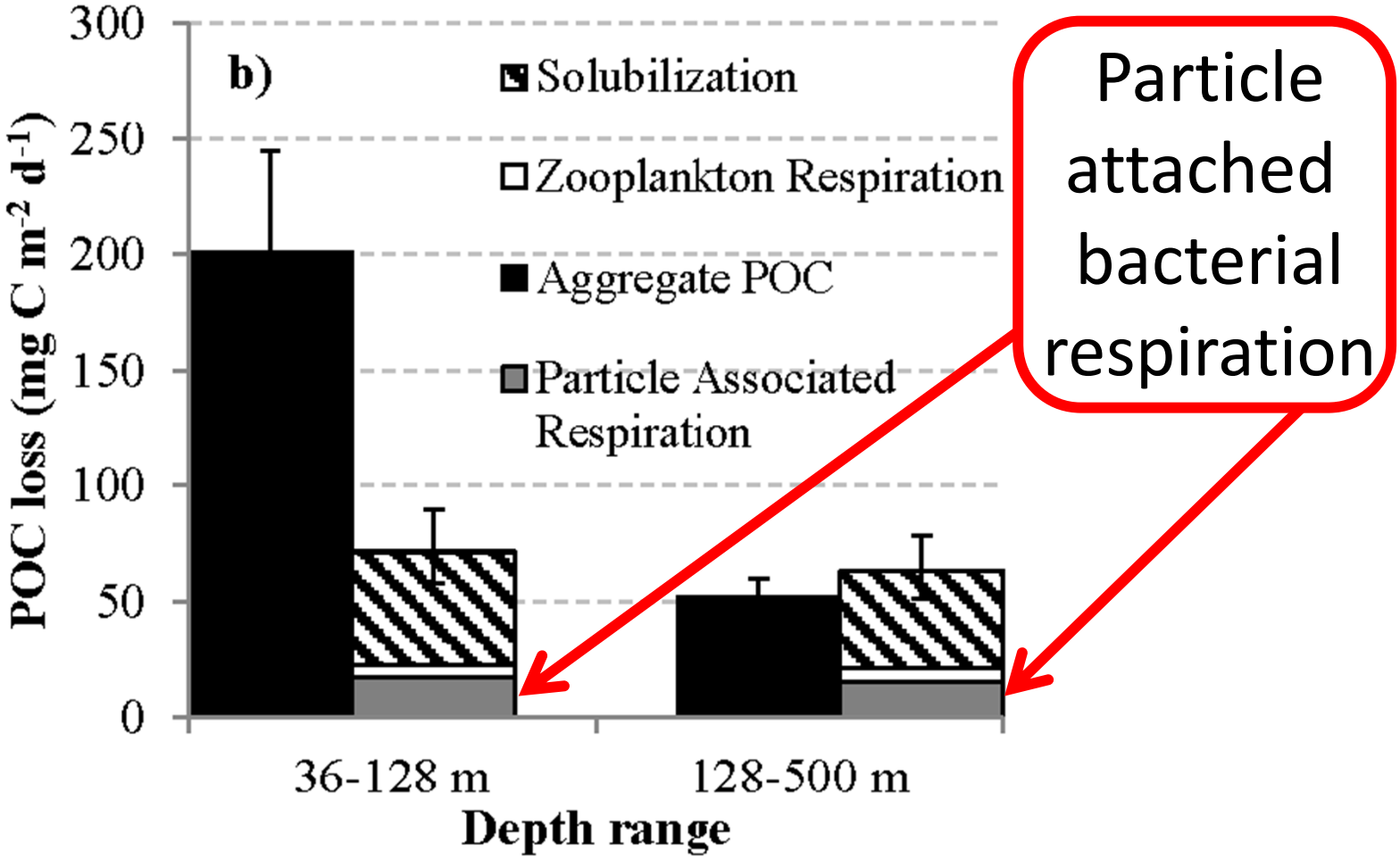


Using Bio-Argo to estimate disaggregation

Disaggregation may account for up to 37% of aggregate flux attenuation.

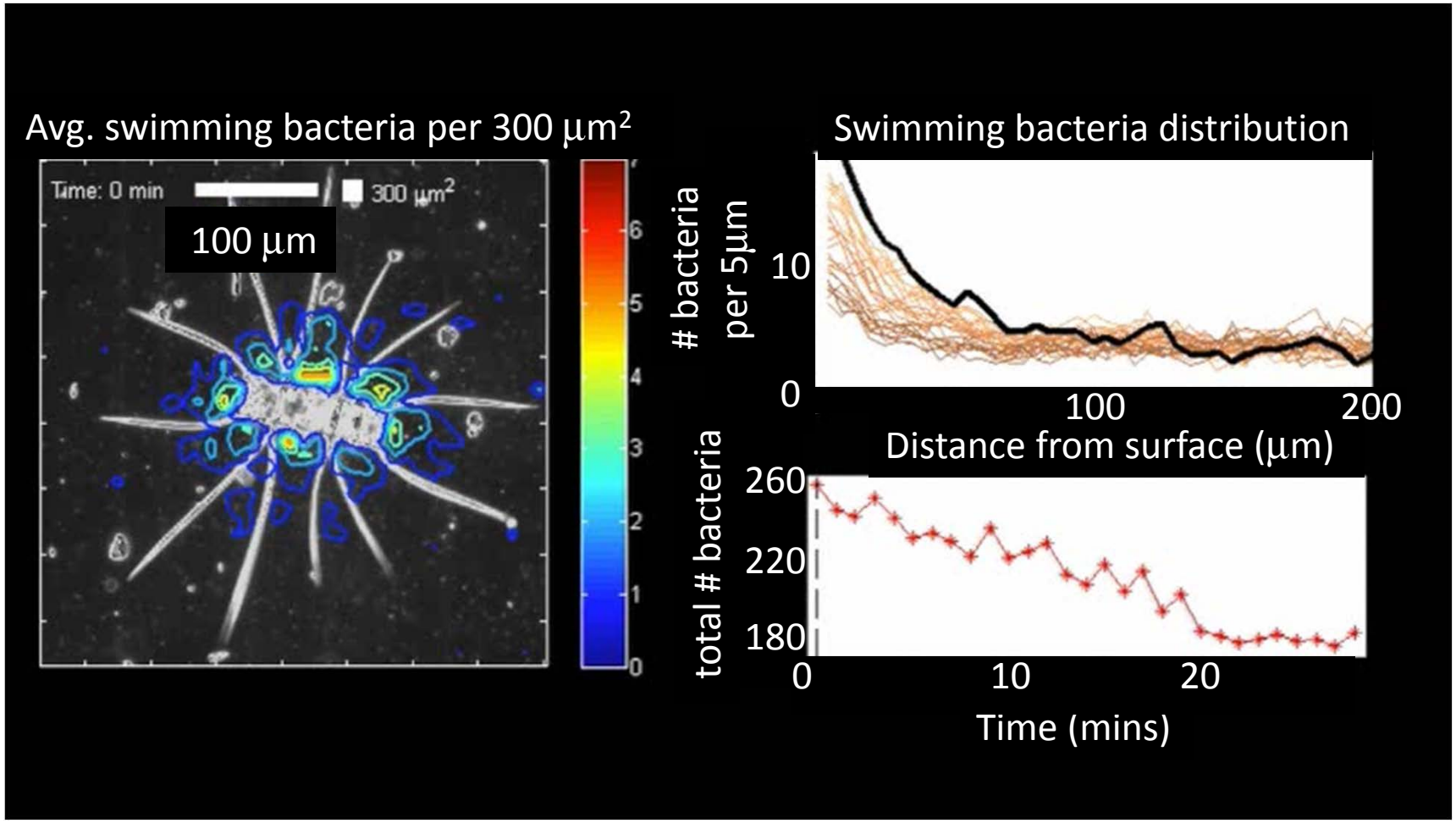
Briggs, Claustre and Dall'Olmo, in prep

The contribution of attached bacteria to remineralisation



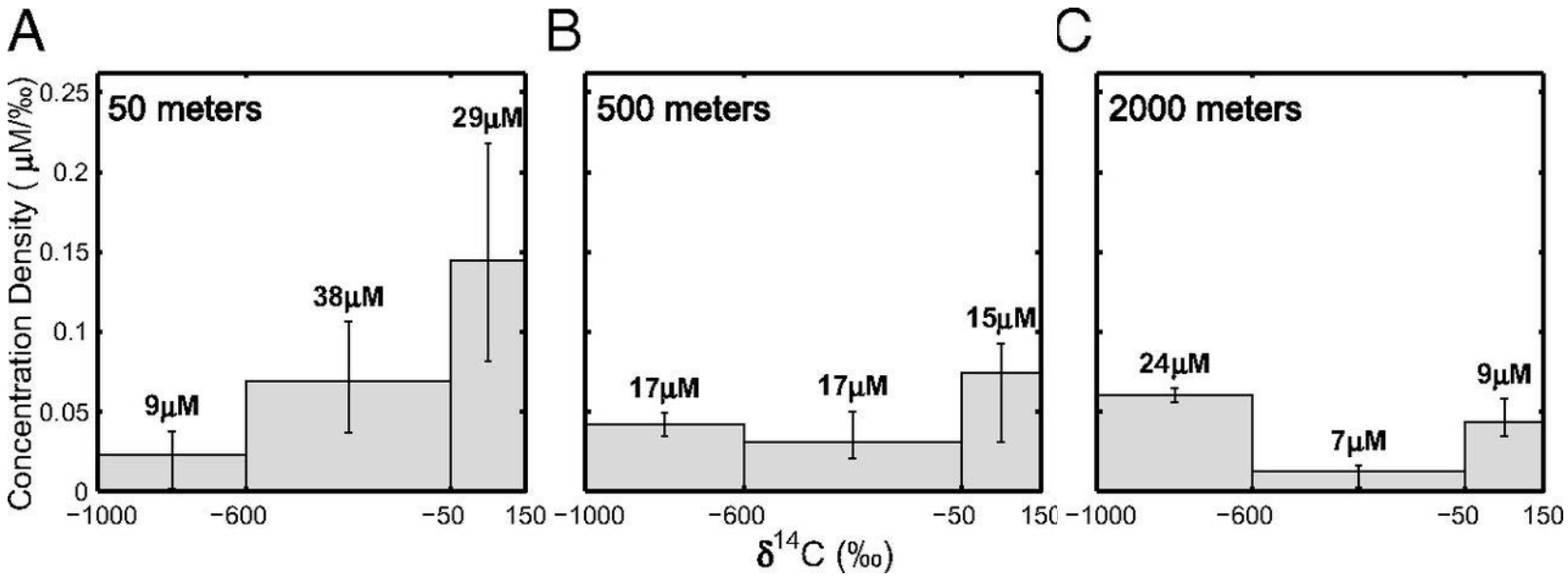
Belcher et al. (2016) Biogeosciences Discussions

Free living bacteria



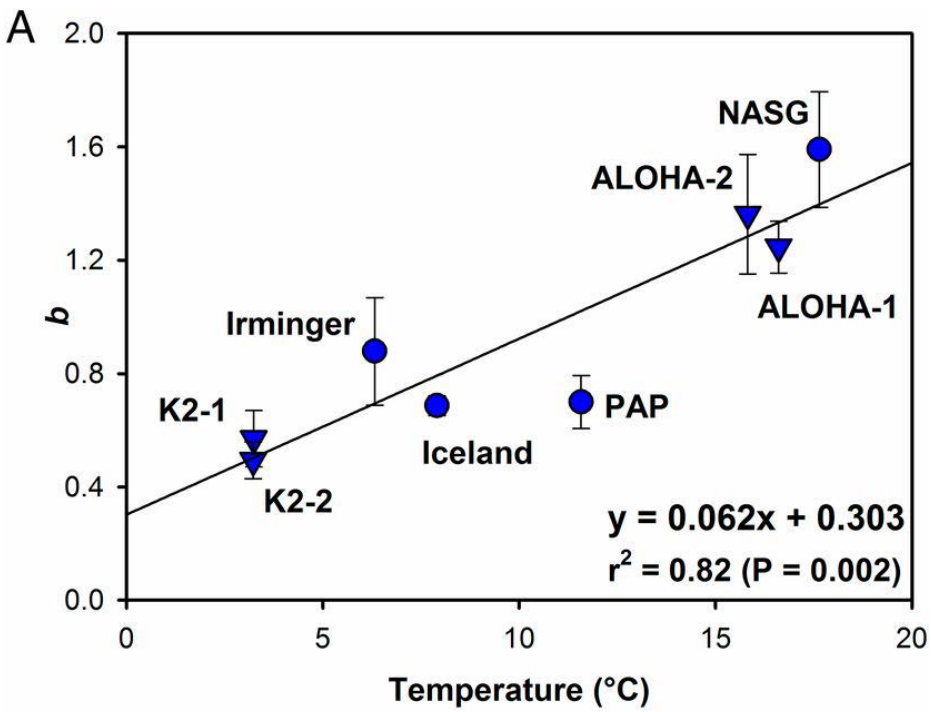
Smriga et al. (2016) PNAS, 113, doi: 10.1073/pnas.1512307113

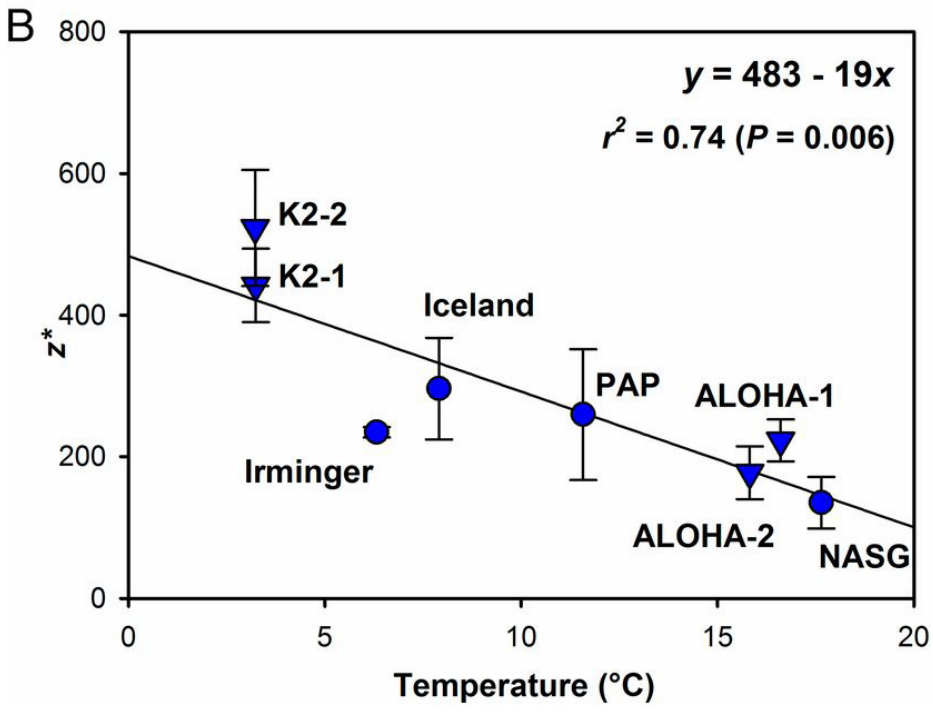
DOC dynamics



Follett et al. PNAS 2014;111:16706-16711

Effect of temperature on remineralization length

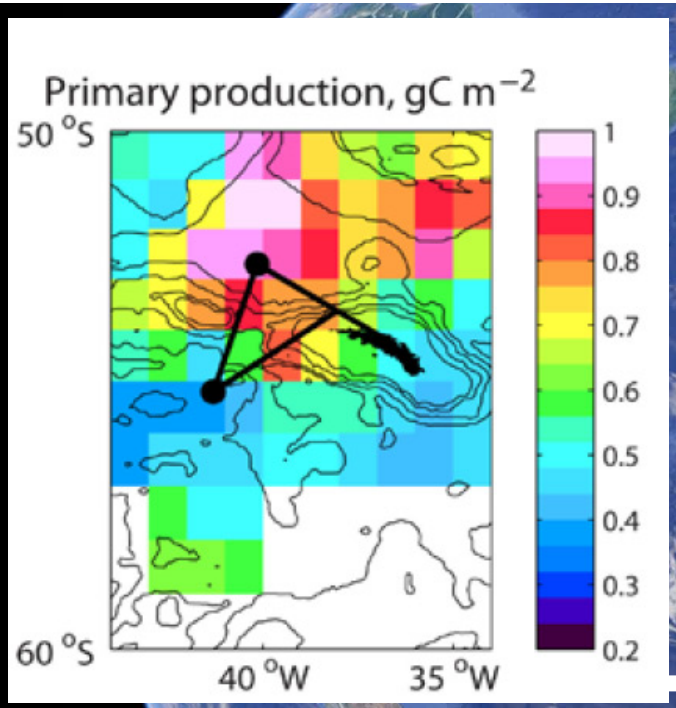


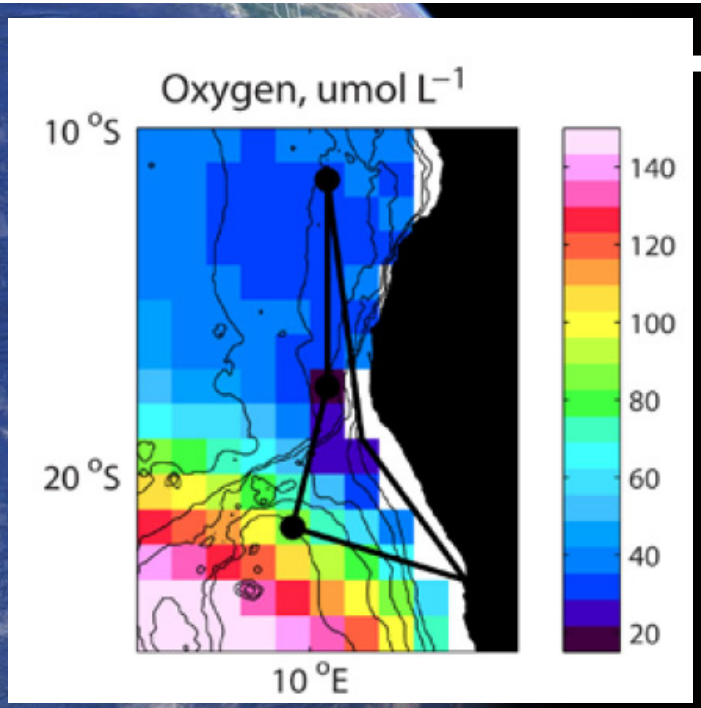


$$Flux(z) = F_0 \times (z_0/z)^b \quad \text{or} \quad Flux(z) = F_0 \exp(-z^*/z_0)$$

Marsay et al. (2015) PNAS,112:1089-1094

Controls over Ocean Mesopelagic Interior Carbon Storage (COMICS)



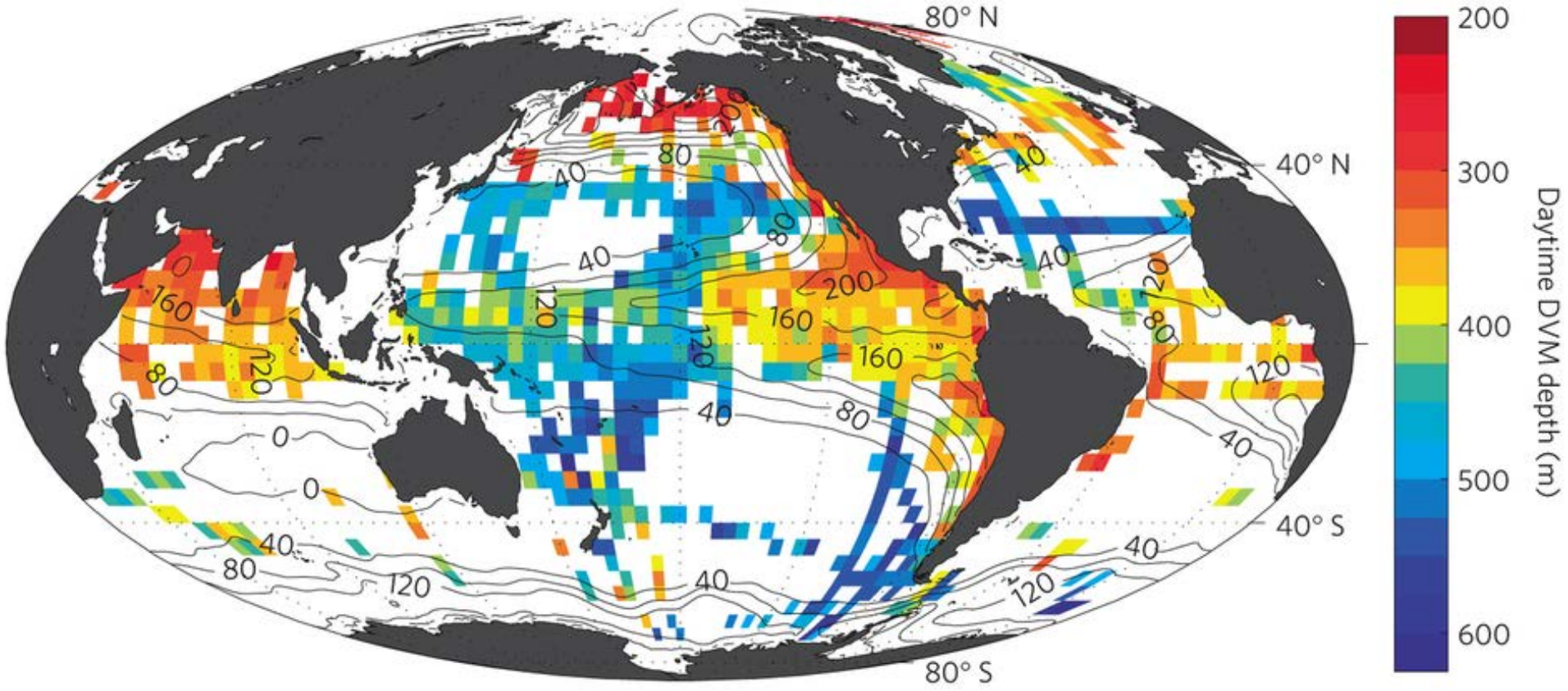


- South Georgia: strong gradient in Production at constant T, O_2
- Benguela: warm, strong gradient in O_2 at constant T, Production
- Large T contrast between sites
- Fieldwork 2018-2019

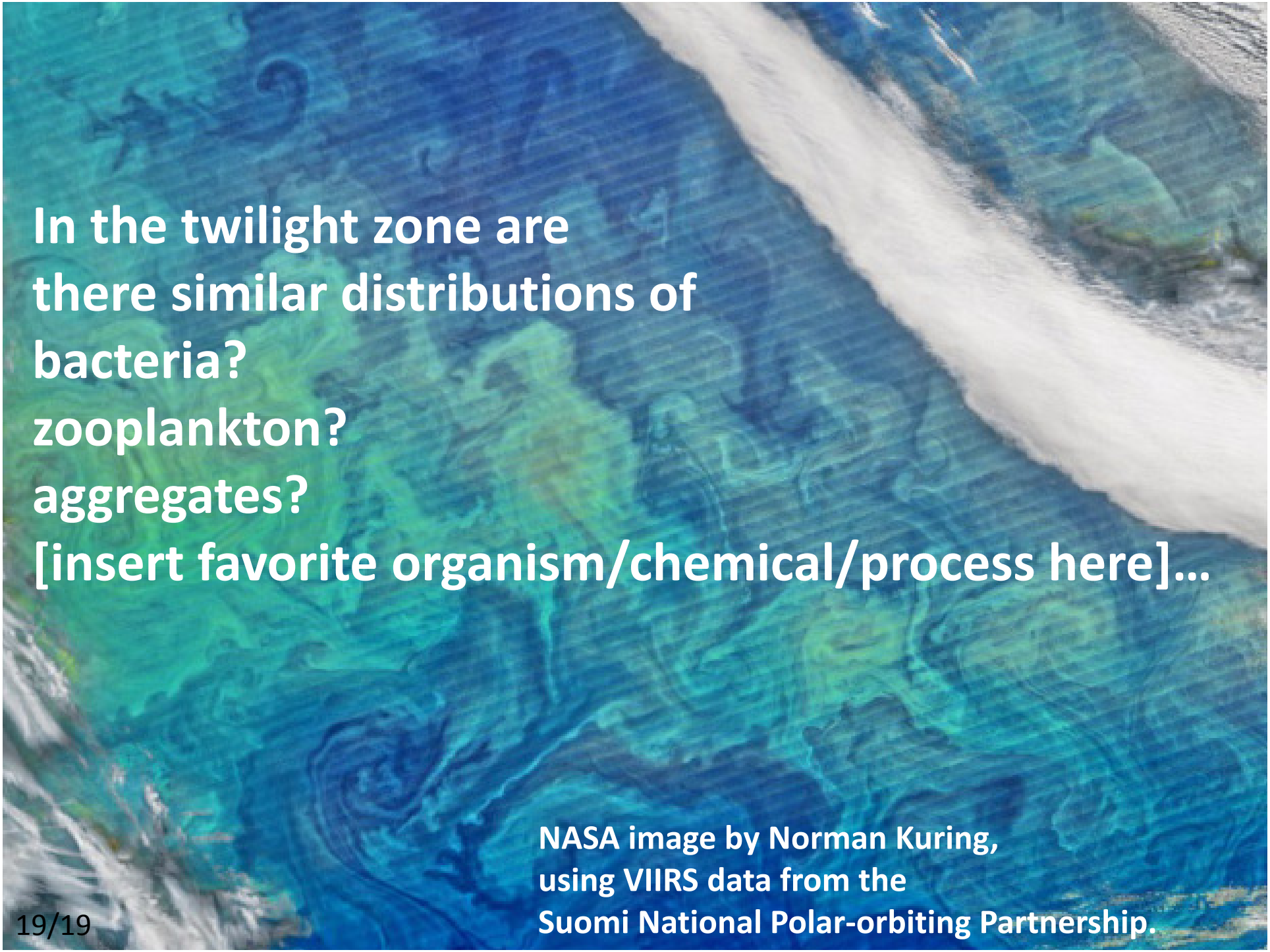
Google

NERC SCIENCE OF THE ENVIRONMENT

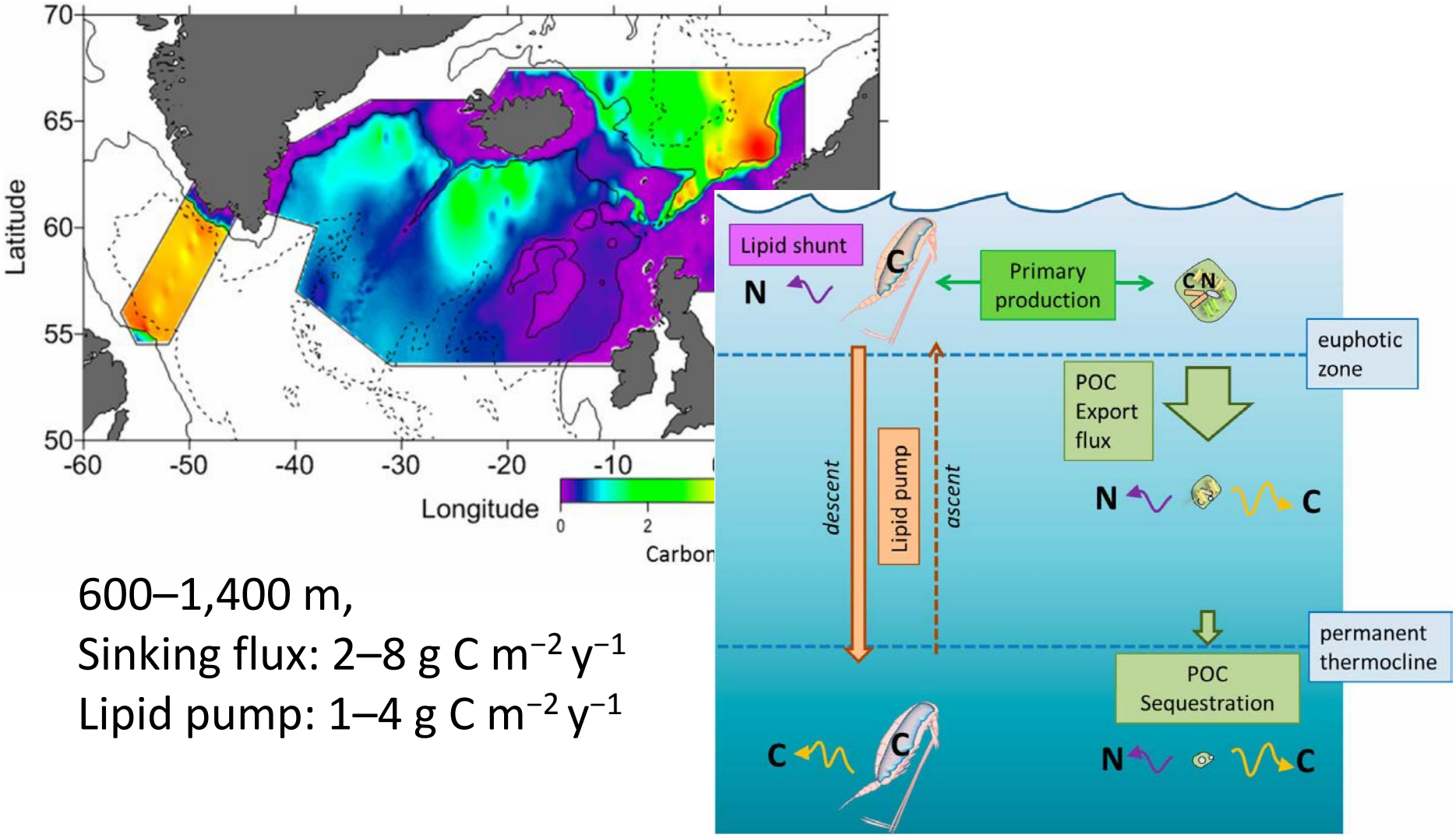
Effect of oxygen on active transport



Bianchi et al., (2013) Nature Geoscience, 6, DOI: 10.1038/NGEO1837


In the twilight zone are
there similar distributions of
bacteria?
zooplankton?
aggregates?
[insert favorite organism/chemical/process here]…
NASA image by Norman Kuring,
using VIIRS data from the
Suomi National Polar-orbiting Partnership.

Lipid carbon flux



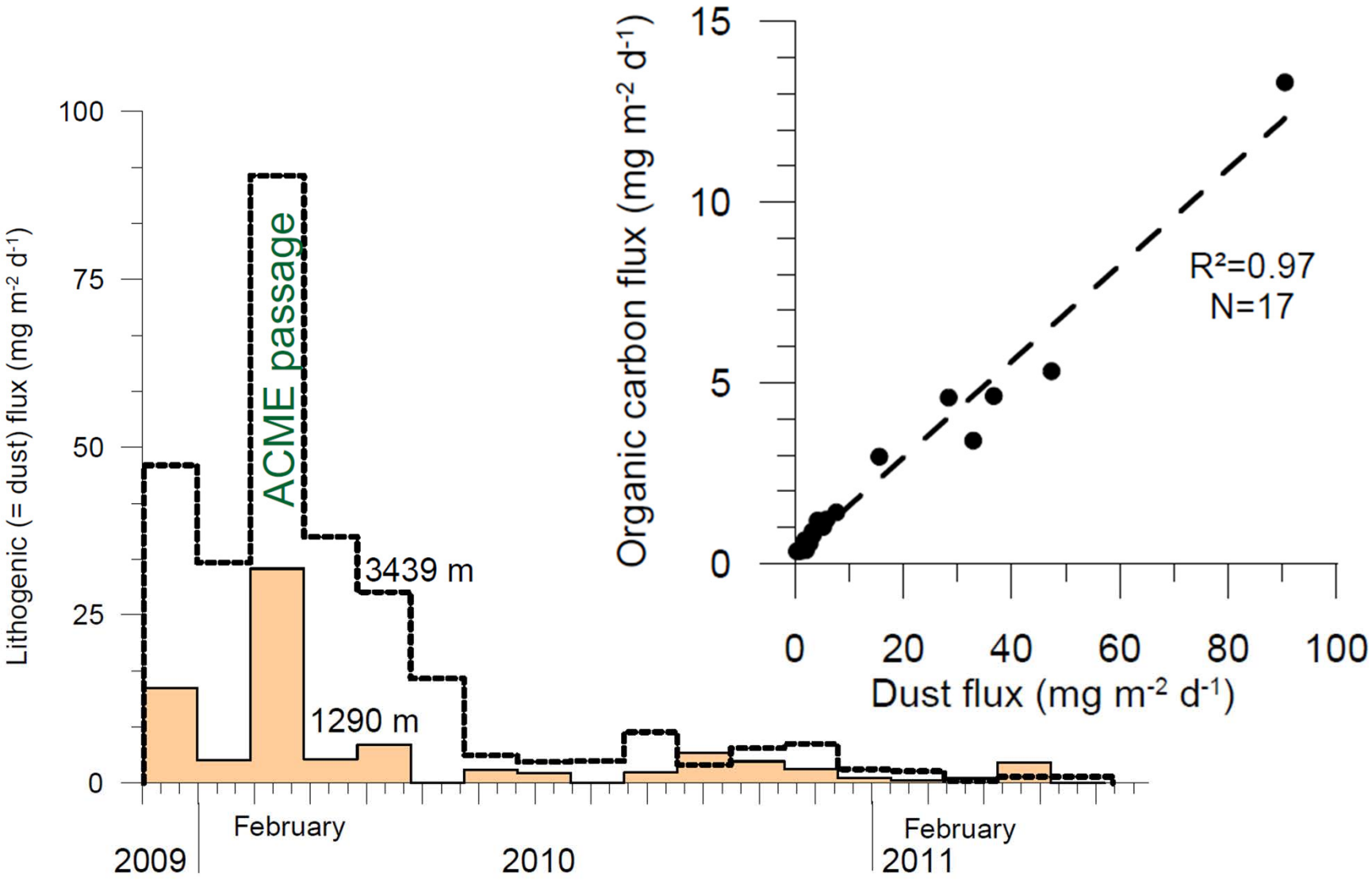
600–1,400 m,

Sinking flux: 2–8 g C m^{-2} y^{-1}

Lipid pump: 1–4 g C m^{-2} y^{-1}

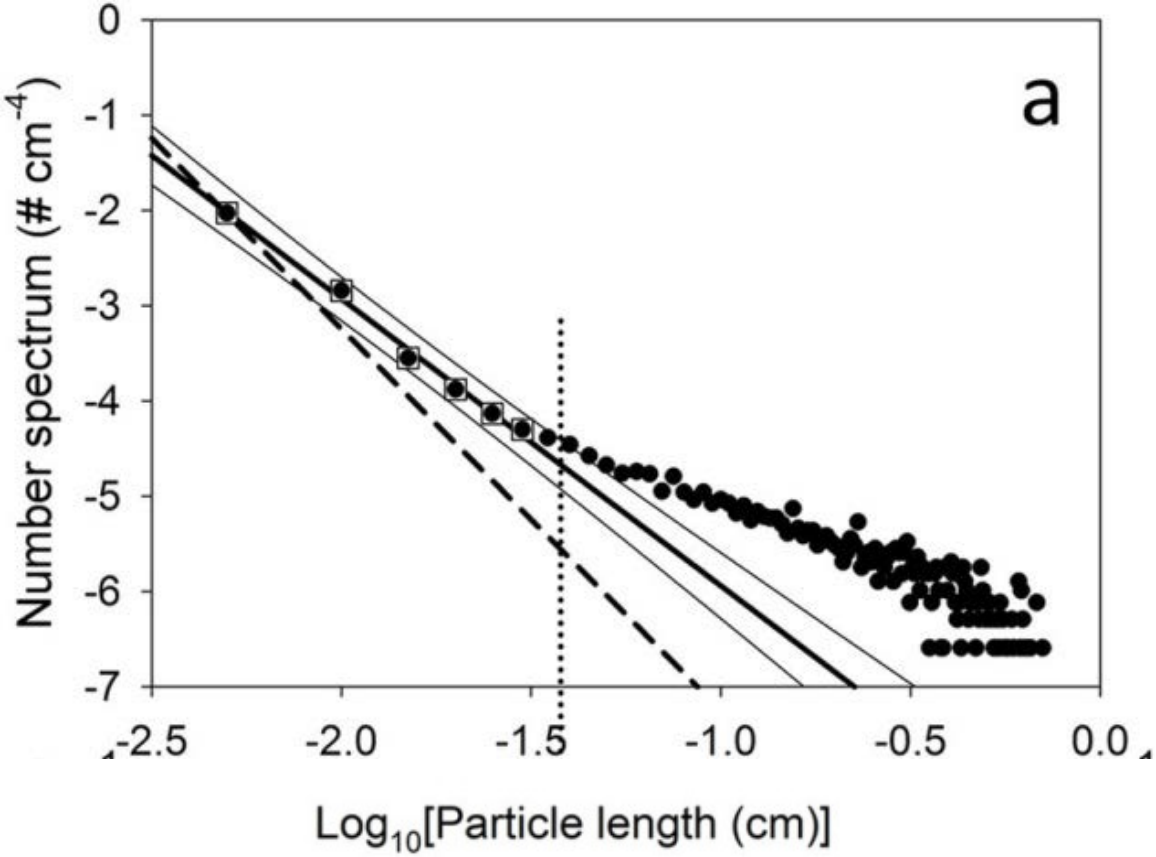
Jónasdóttir et al. (2015) PNAS,112,12122-12126

Eddy influence



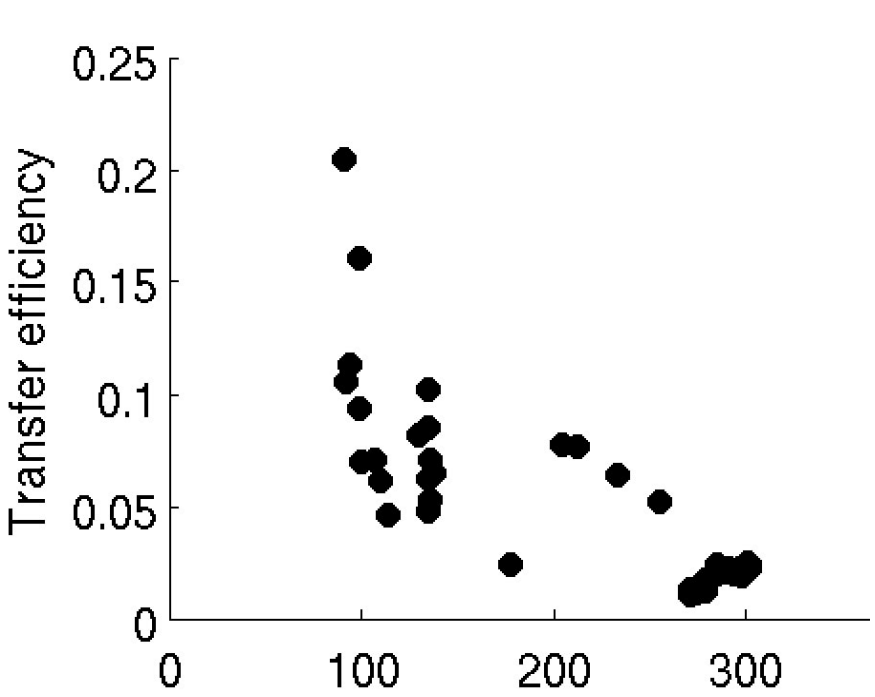
Fischer et al. (2016) Biogeosciences, 13, doi:10.5194/bg-13-3203-2016

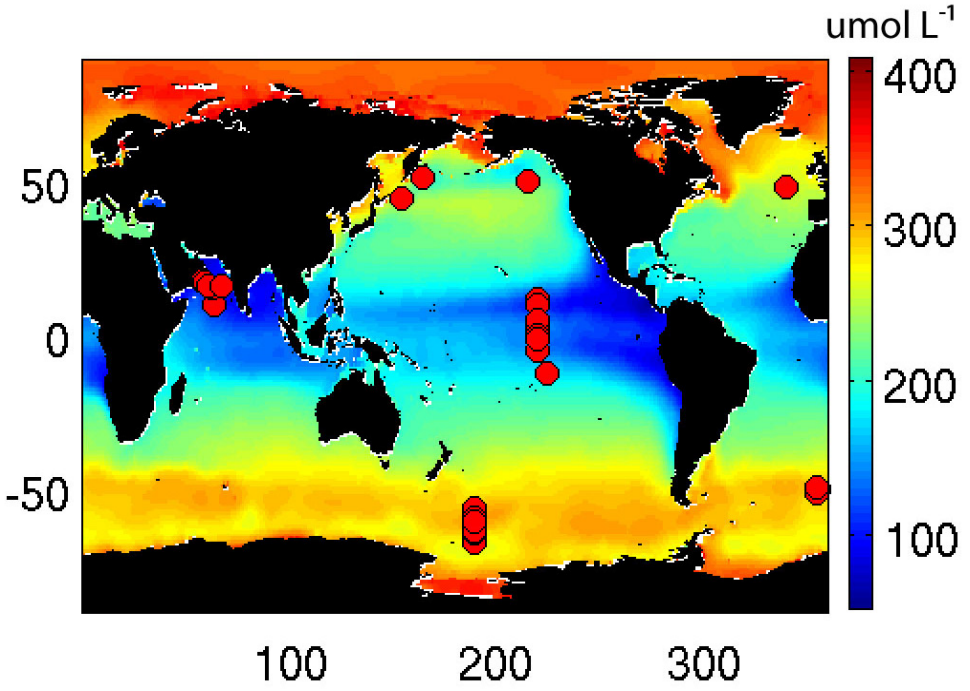
Particle number spectrum of deep sea (>1897 m) particles



Bochdansky, A. B., et al. (2016) Scientific Reports **6**: 22633.

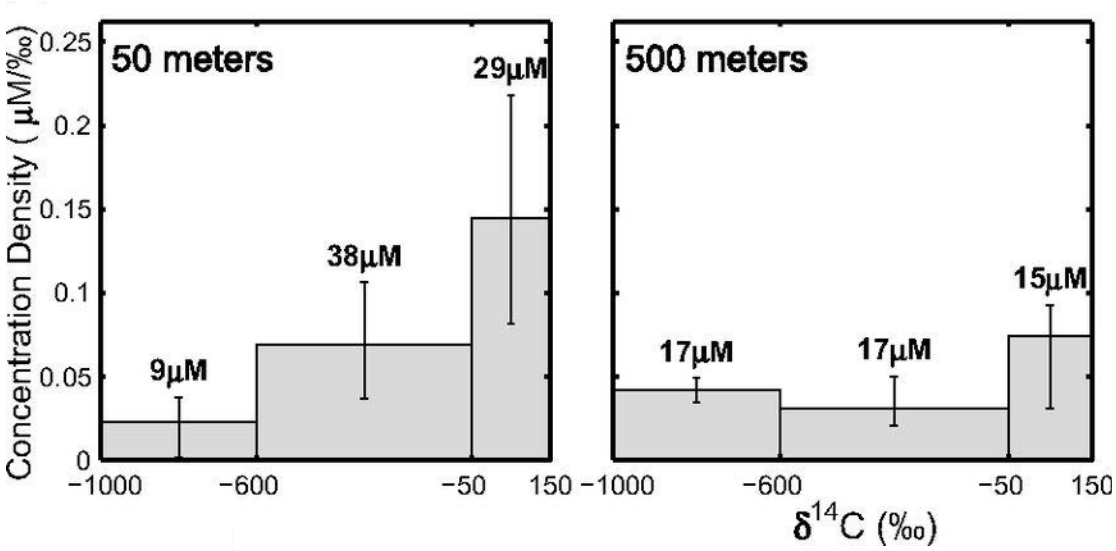
Effect of oxygen on remineralization length

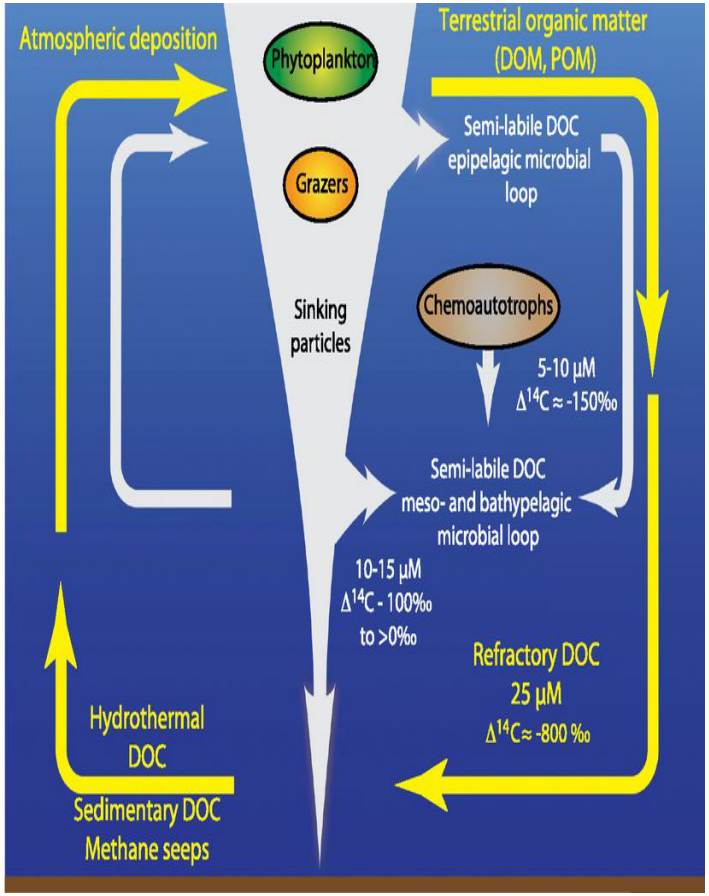




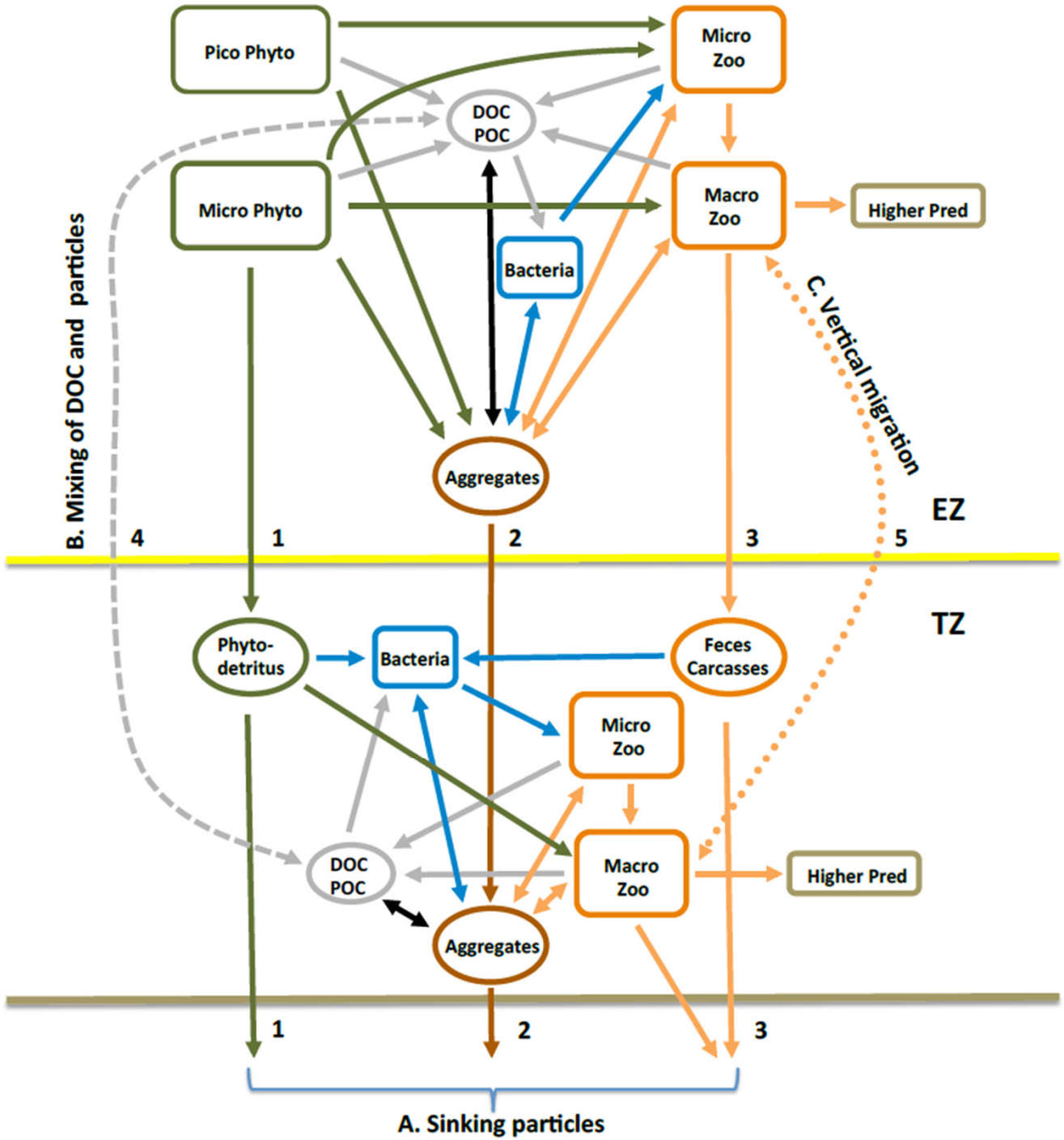
Henson et al., submitted to Frontiers in Marine Science

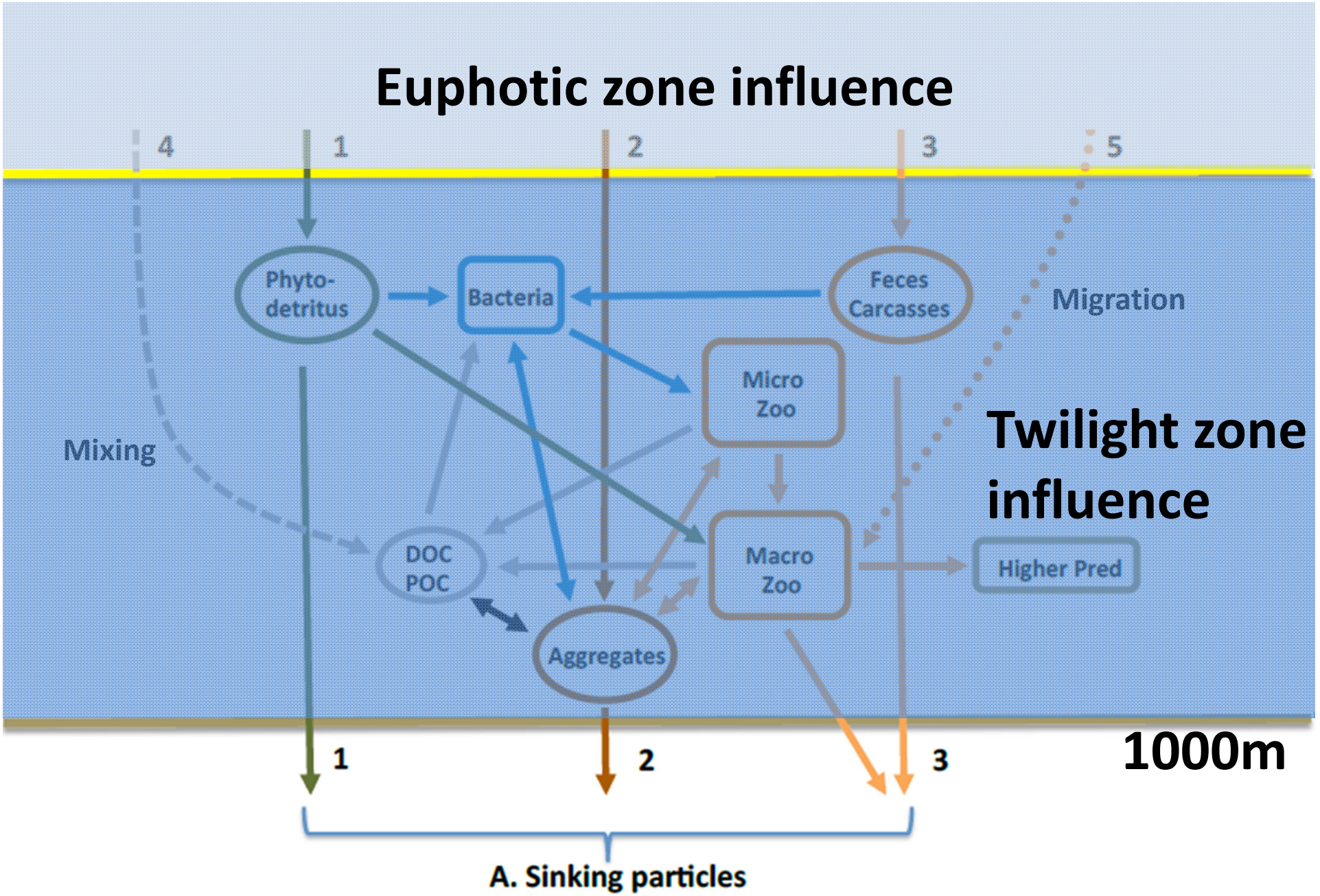
DOC dynamics



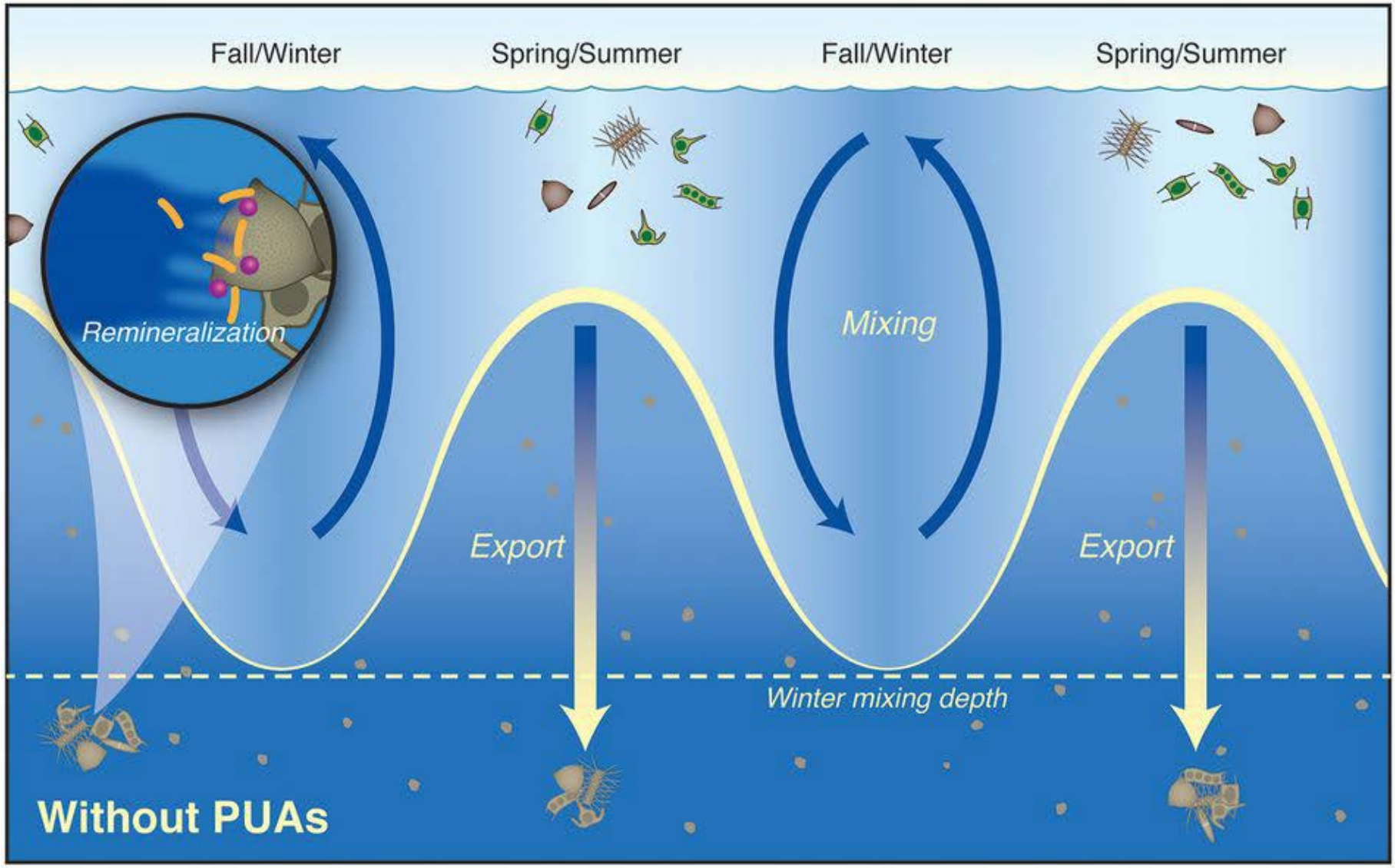


Follett et al. PNAS 2014;111:16706-16711


Pico Phyto
Micro Zoo
DOC POC
Micro Phyto
Macro Zoo
Higher Pred
Bacteria
B. Mixing of DOC and particles
C. Vertical migration
Aggregates
EZ
4
1
2
3
5
TZ
Phyto-detritus
Bacteria
Feces Carcasses
Micro Zoo
DOC POC
Macro Zoo
Higher Pred
Aggregates
1
2
3
A. Sinking particles

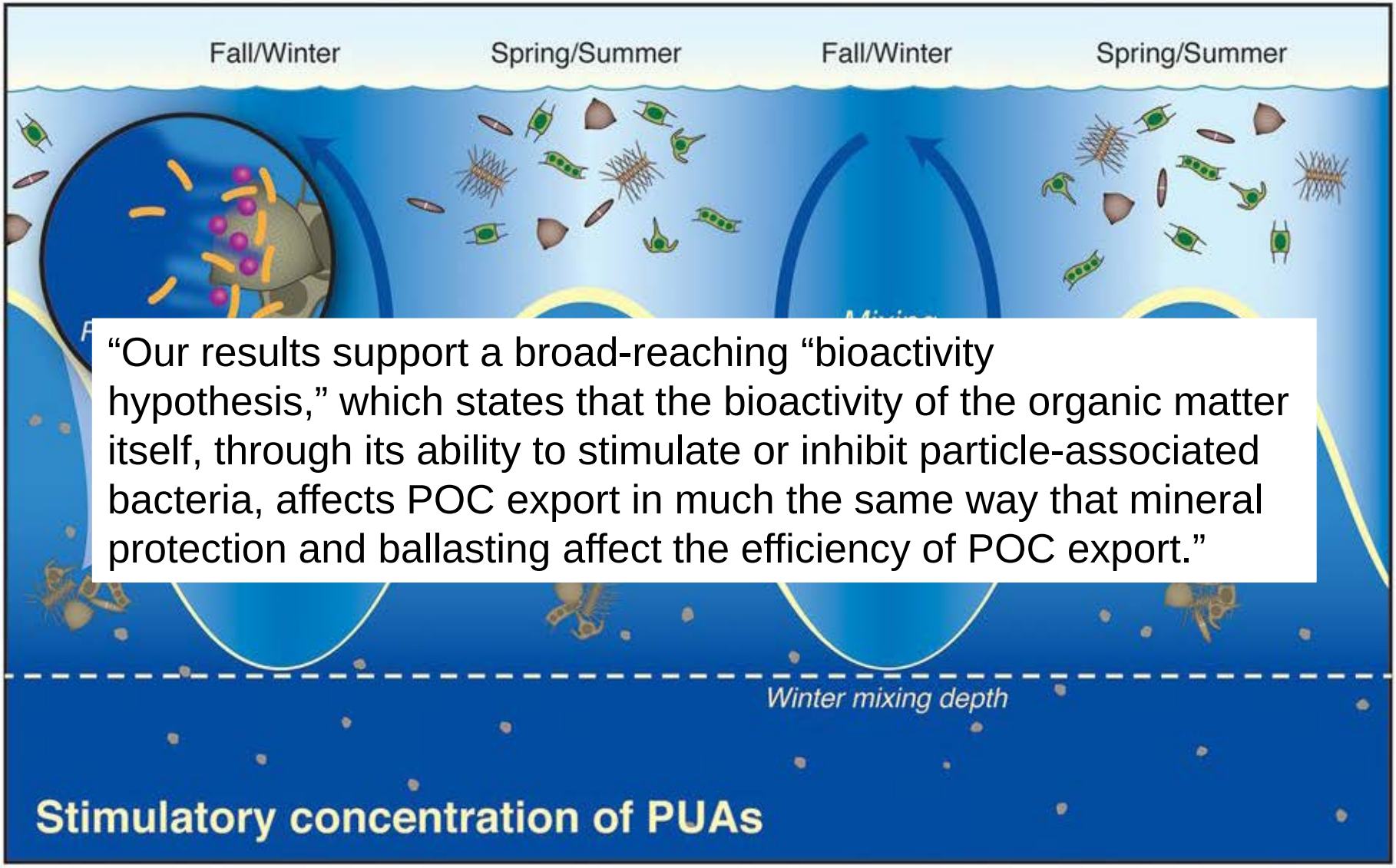

Euphotic zone influence
4
1
2
3
5
Phyto-
detritus
Bacteria
Feces
Carcasses
Migration
Micro
Zoo
Mixing
Twilight zone
influence
DOC
POC
Macro
Zoo
Higher Pred
Aggregates
1000m
1
2
3
A. Sinking particles

Impact of polyunsaturated aldehydes (PUAs) on seasonal export and remineralization



Edwards et al. (2015) PNAS,112:5909-5914

Impact of polyunsaturated aldehydes (PUAs) on seasonal export and remineralization



"Our results support a broad-reaching "bioactivity hypothesis," which states that the bioactivity of the organic matter itself, through its ability to stimulate or inhibit particle-associated bacteria, affects POC export in much the same way that mineral protection and ballasting affect the efficiency of POC export."

Edwards et al. (2015) PNAS,112:5909-5914