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
Ballasting


6/19
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

Twilight zone influence
Microbial gardening in the ocean's twilight zone?

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

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

\[ \text{Flux}(z) = F_0 \times \left( \frac{z_0}{z} \right)^b \quad \text{or} \quad \text{Flux}(z) = F_0 \exp\left(-\frac{z^*}{z_0}\right) \]

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
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]...
Lipid carbon flux

600–1,400 m,
Sinking flux: 2–8 g C m$^{-2}$ yr$^{-1}$
Lipid pump: 1–4 g C m$^{-2}$ yr$^{-1}$

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

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

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
Euphotic zone influence

Twilight zone influence

1000m

Phyto-detritus → Bacteria → Feces Carcasses

DOC POC → Aggregates

Micro Zoo → Macro Zoo

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

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