Mesozooplankton demands match carbon flux in the twilight zone

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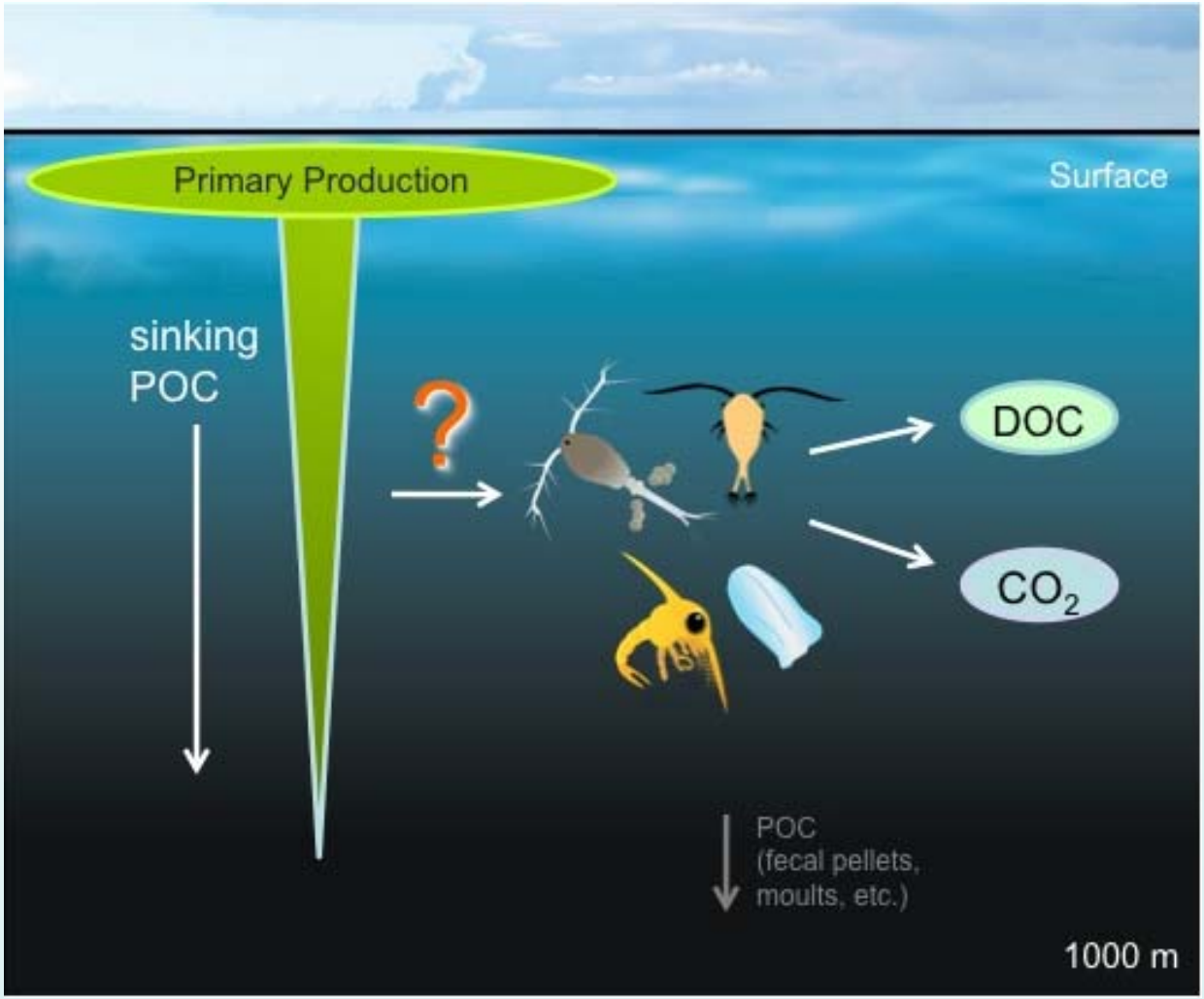
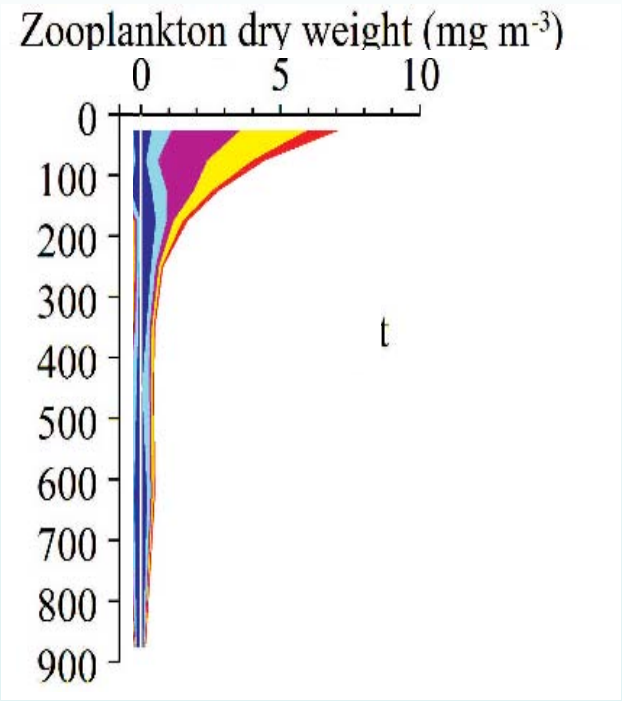
Carbon Export

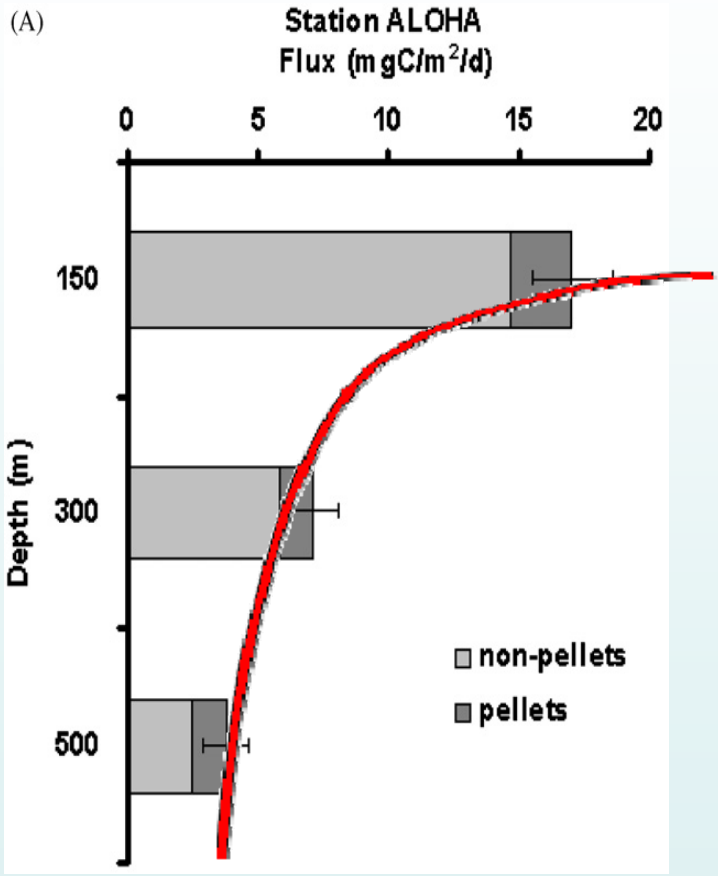


Particle flux



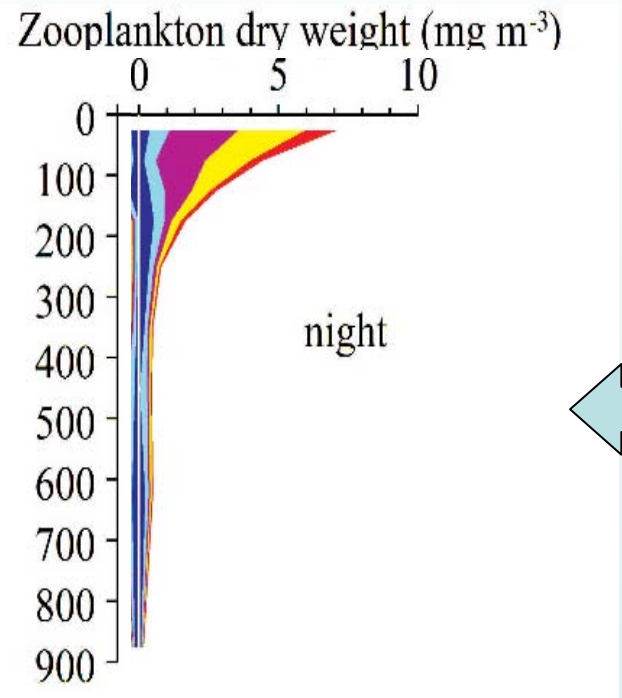
Mesozooplankton biomass profile
(Steinberg et al. 2008)

Particle flux



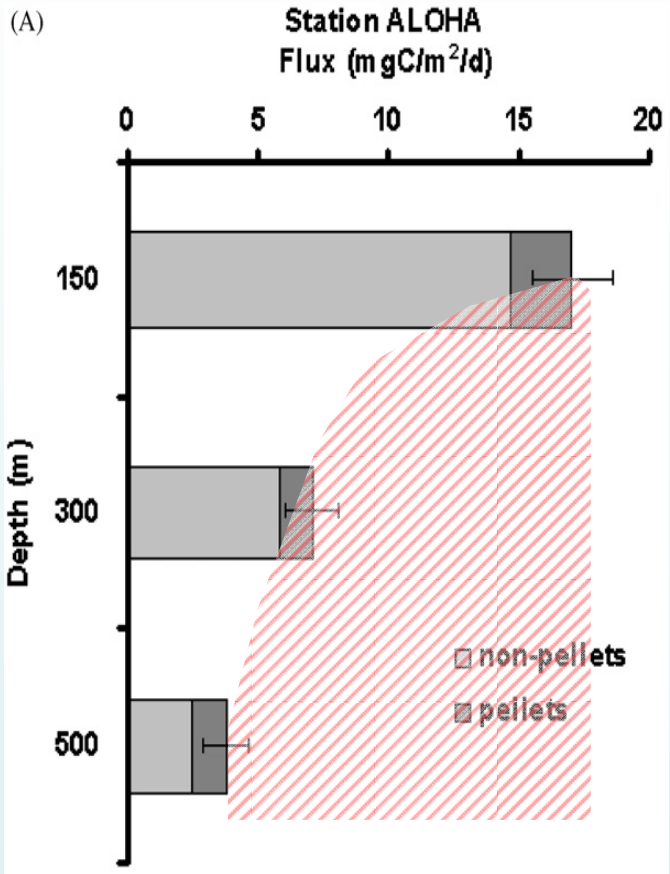
Wilson et al. 2008

Particle flux



Mesozooplankton biomass profile
(Steinberg et al. 2008)

?



Wilson et al. 2008

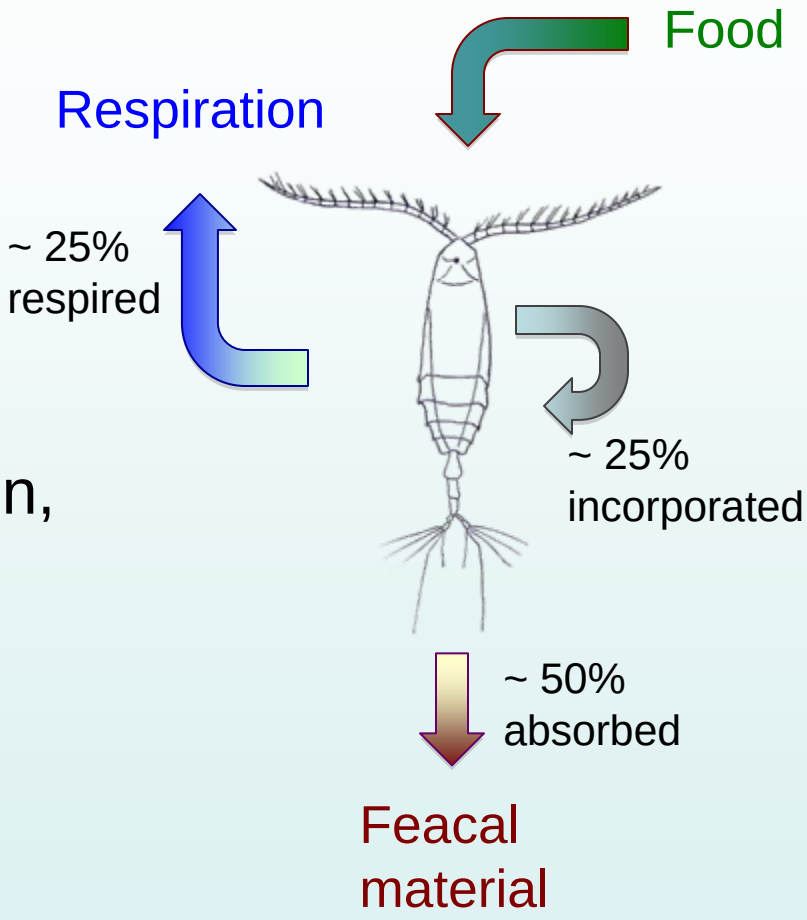
Carbon demand

- Carbon is essential

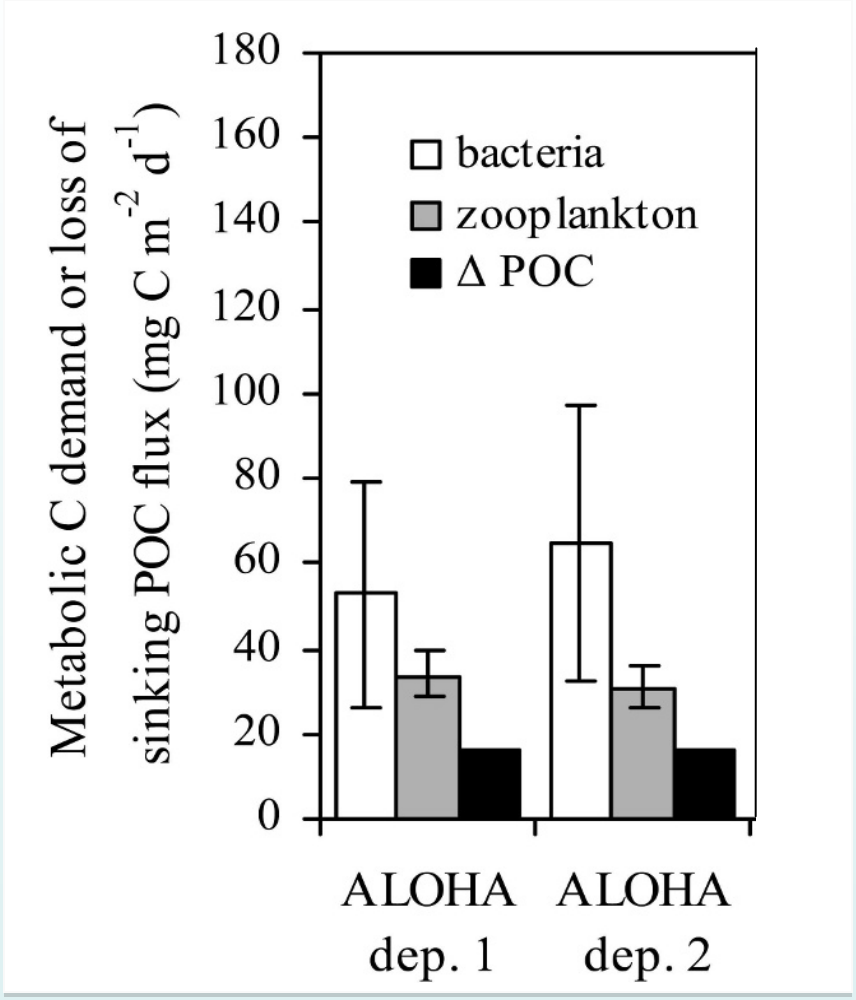
  Maintainance of all body functions including:

  respiration, growth, reproduction, locomotion, use of senses, etc.

- Acquired by feeding



Case study: Pacific

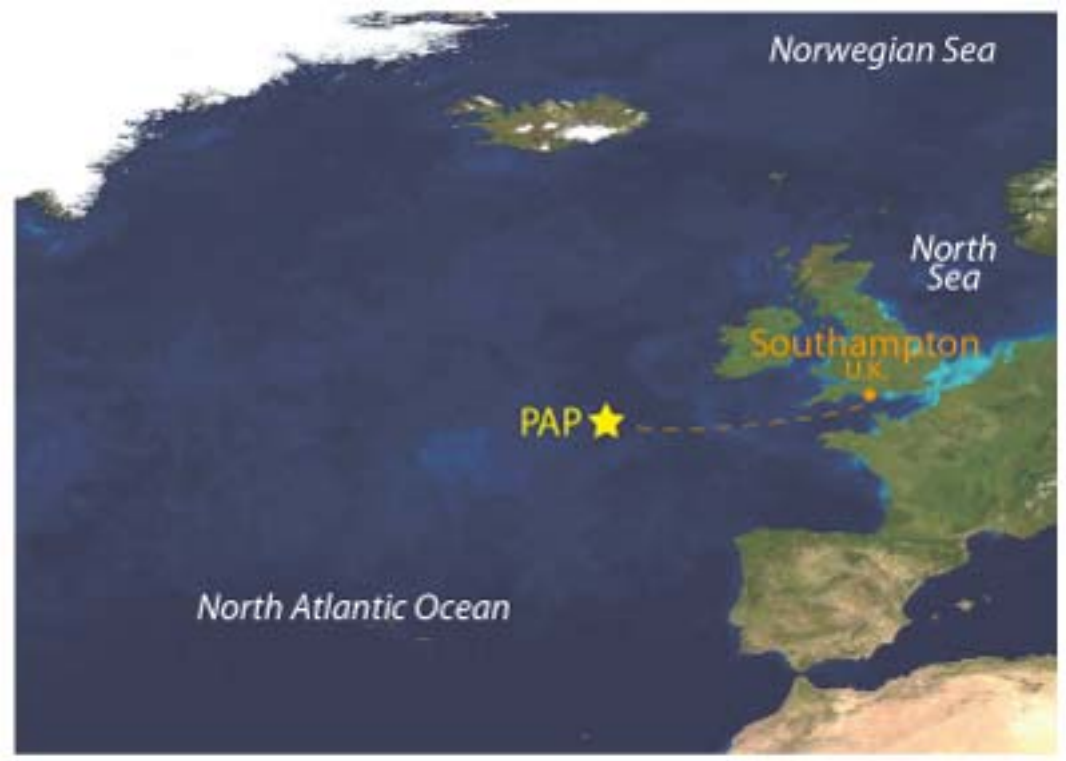


Bacterial & zooplankton carbon demands exceeded POC flux attenuation by far!

ALOHA: Station in subtropical Pacific
Steinberg et al. 2008

Aim of this study

Does POC flux attenuation satisfy mesozooplankton carbon demands in the North Atlantic?



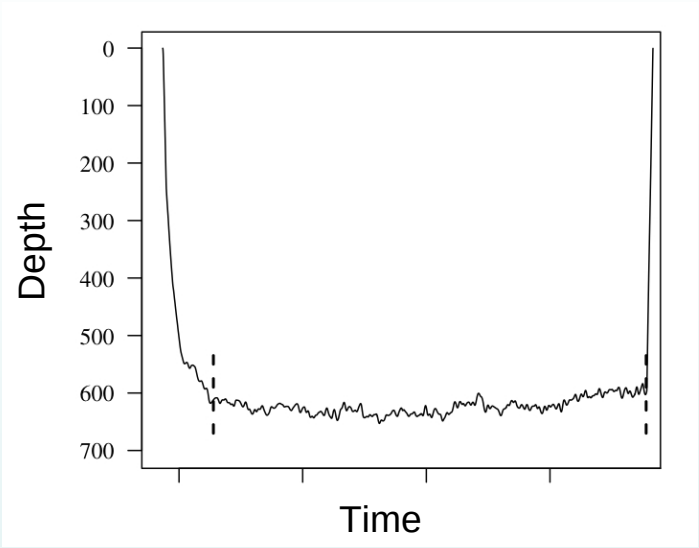
ARIES

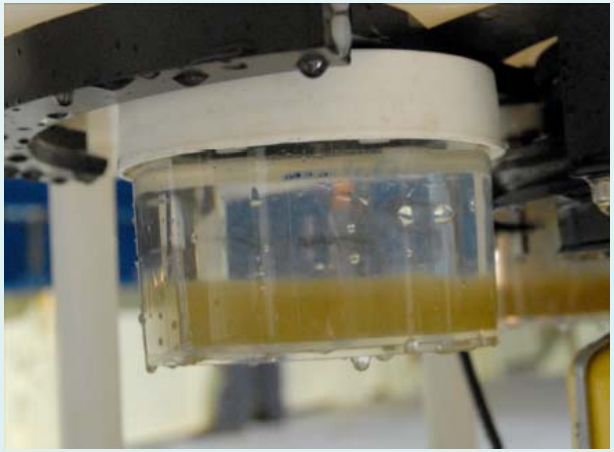
Autosampling & Recording Instrumented Environmental Sampling System

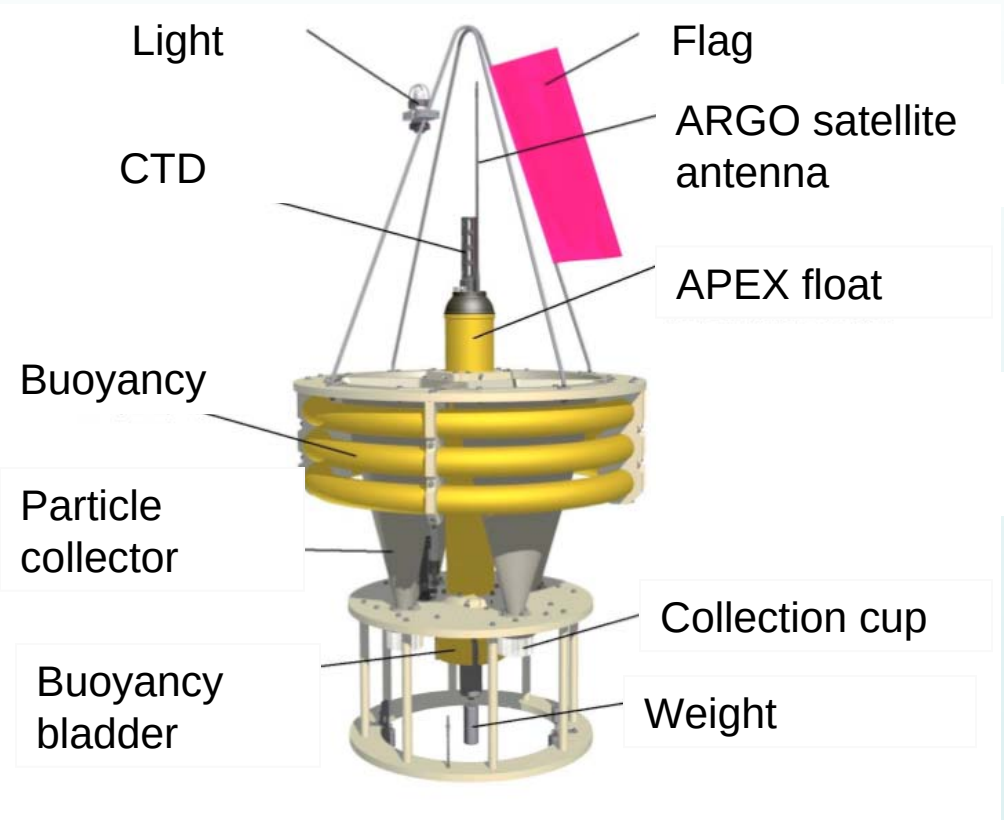
- towed behind the ship
- 110 samples
- 55 discrete depth intervals

PELAGRA

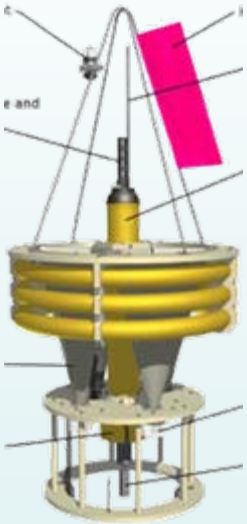
Neutrally buoyant sediment trap







Primary Production



50 m

150 m

300 m

450 m

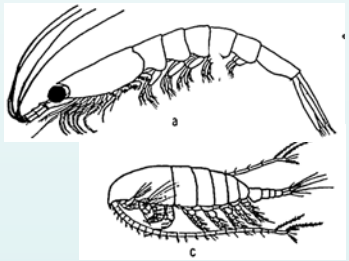
600 m

50 m

40 m intervals

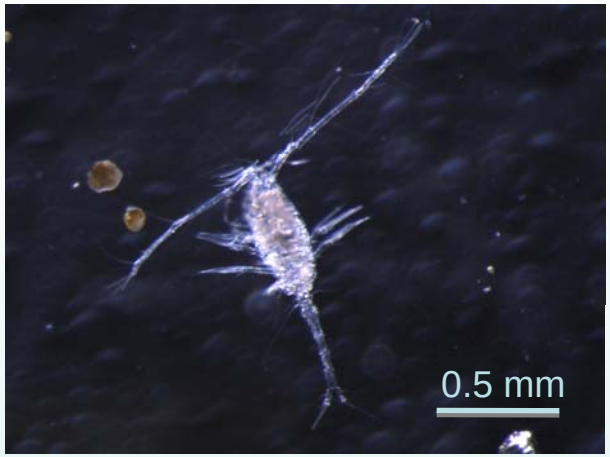
1000 m

ARIES



Mesozooplankton carbon demands

1. Samples were size-fractioned
2. Identified
3. Enumerated
4. Analysed for dry weight
5. Carbon demand calculated for different groups



Size class	Copepods	Group
>2000	Genus level	Large copepods
1000-2000		
500-1000	Oithona. Oncaea, Calanoid	Small copepods
350-500		
200-350		

Amphipods
Chaetognaths
Euphausids
Ostracods
Polychaetes
Pteropods

Carbon demand calculations

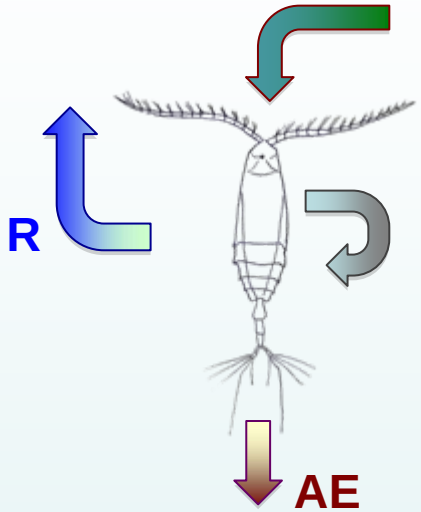
Temp (° C)

Body size (DW)

Oxygen consumption
(Ikeda 1985)
$\ln O_2 = a_1 + a_2 \ln DW + a_3 \text{ temp}$

Respiration rate
O_2 cons * RQ * (12/24.4)

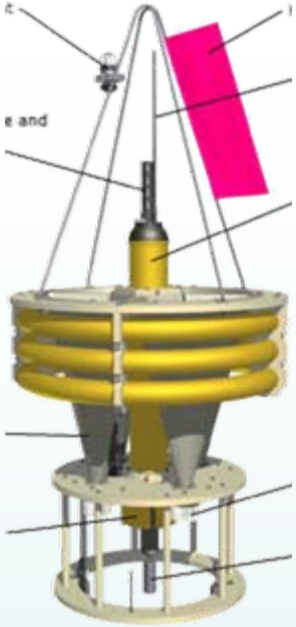
Carbon demand
Respiration / (AE * R)



Para-meter		Value used	Range
RQ	Respiratory Quotient	0.80	0.72 – 0.97 (Gnaiger 1983)
AE	Absorption Efficiency	0.60	0.47 – 0.85 (Mayor et al. 2010)
R	Respired C fraction	0.50	0.40 – 0.85 (Parson et al. 1984)
Ikeda conversion		$R^2 = 93.9$	(Ikeda 1985)

POC flux

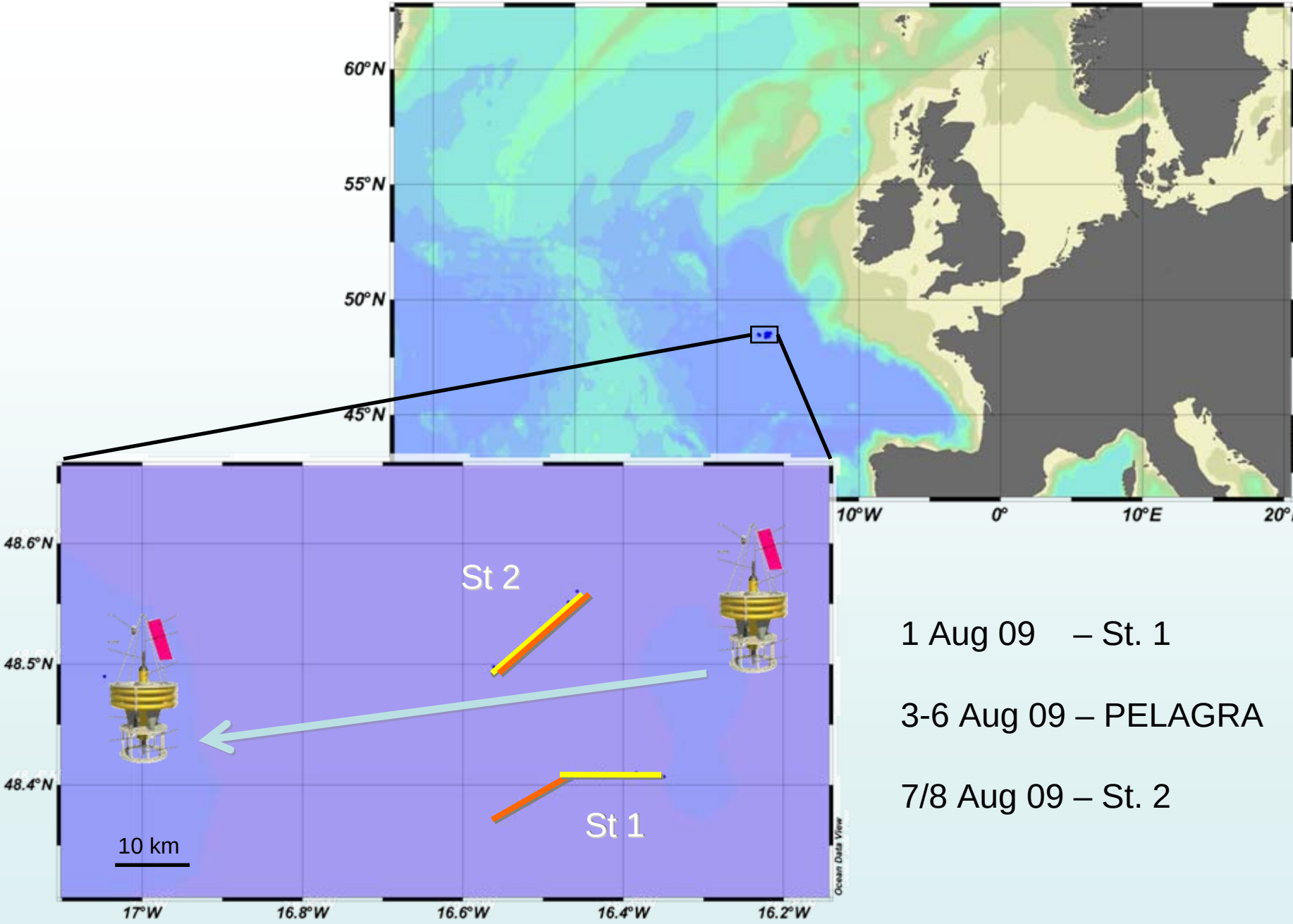
(Analysed by Chris M Marsay)



1. PELAGRA deployment: 48 h

2. Particles were caught in PELAGRA sample cups containing 4% formalin

3. Aliquots were filtered onto pre-combusted GF/F filters, dried, and POC measured using an elemental analyser

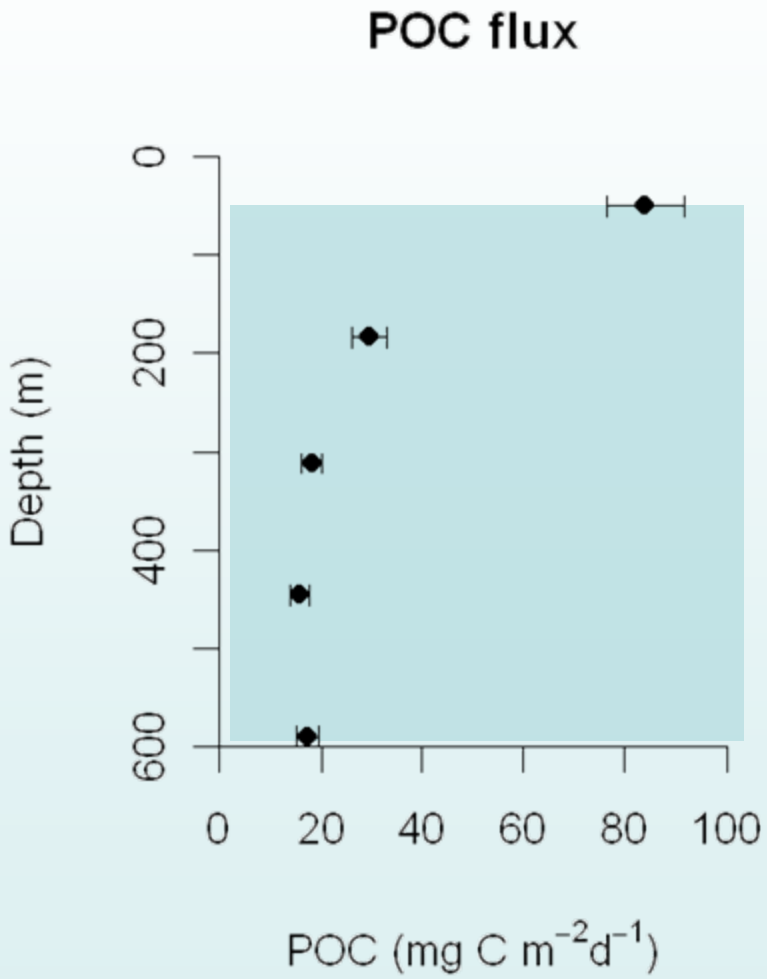


1 Aug 09 – St. 1

3-6 Aug 09 – PELAGRA

7/8 Aug 09 – St. 2

Flux attenuation



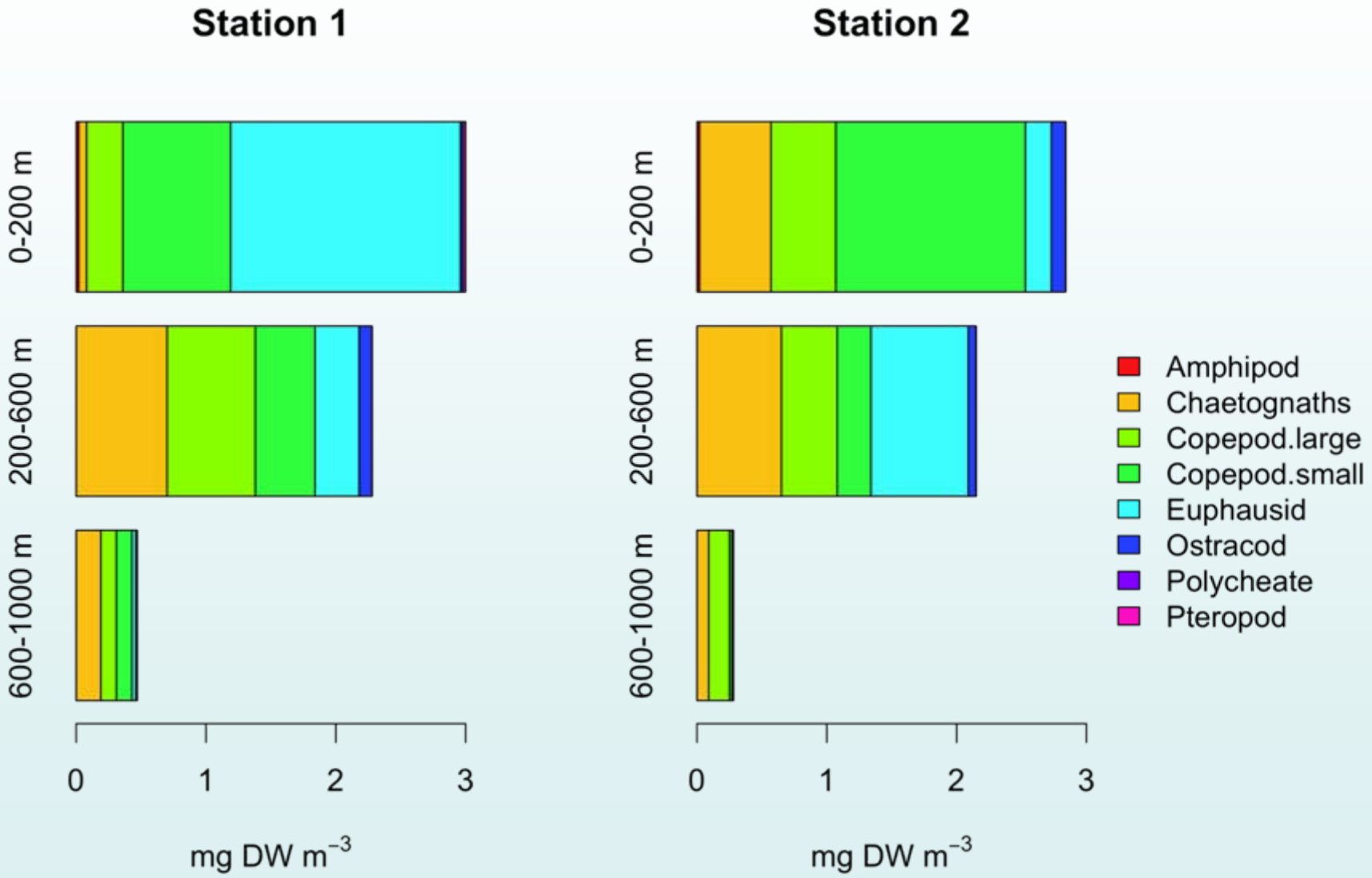
Attenuation between

50-600 m:
67 mg C m^{-2} d^{-1}

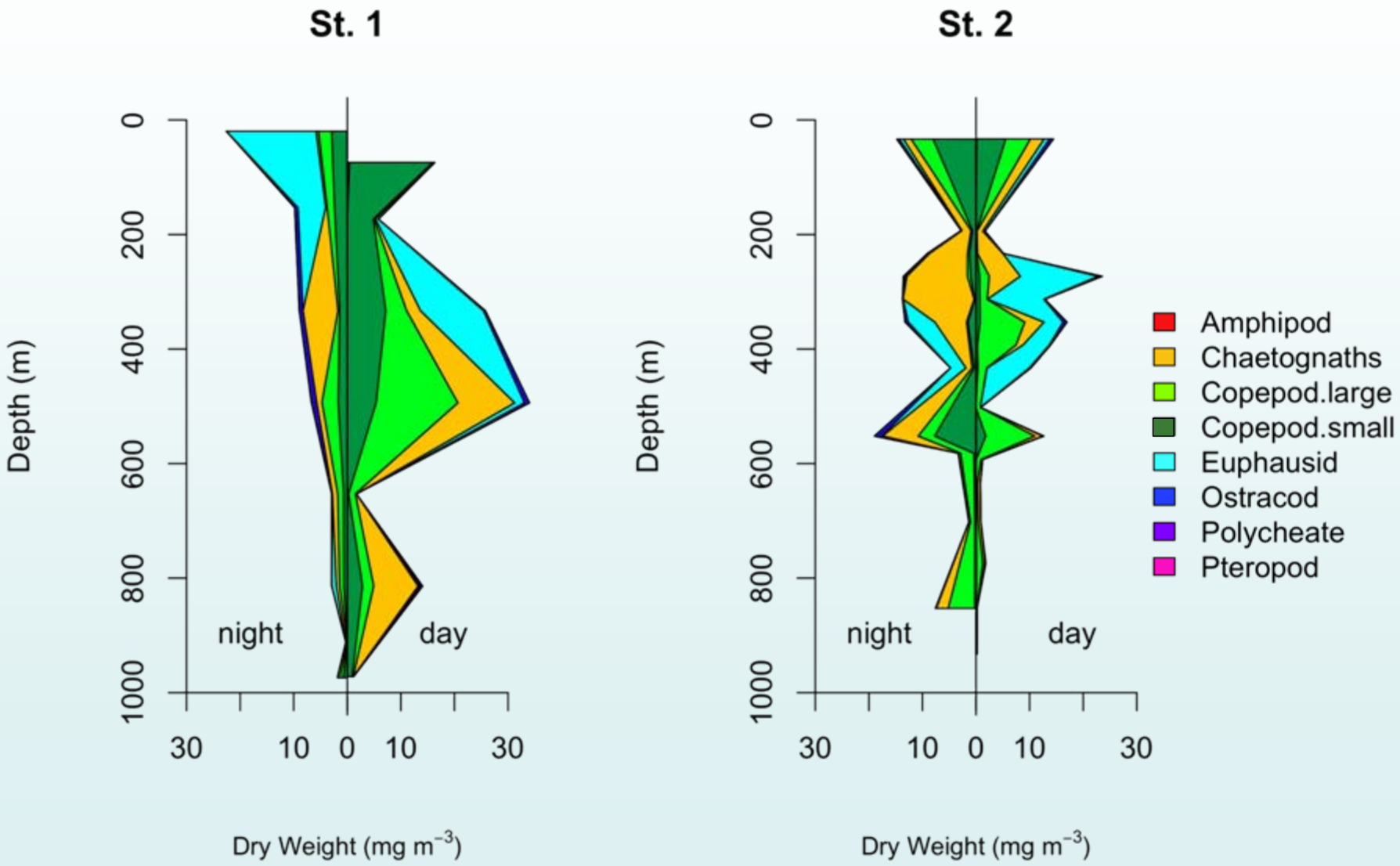
50-200 m:
55 mg C m^{-2} d^{-1}

200-600 m:
12 mg C m^{-2} d^{-1}

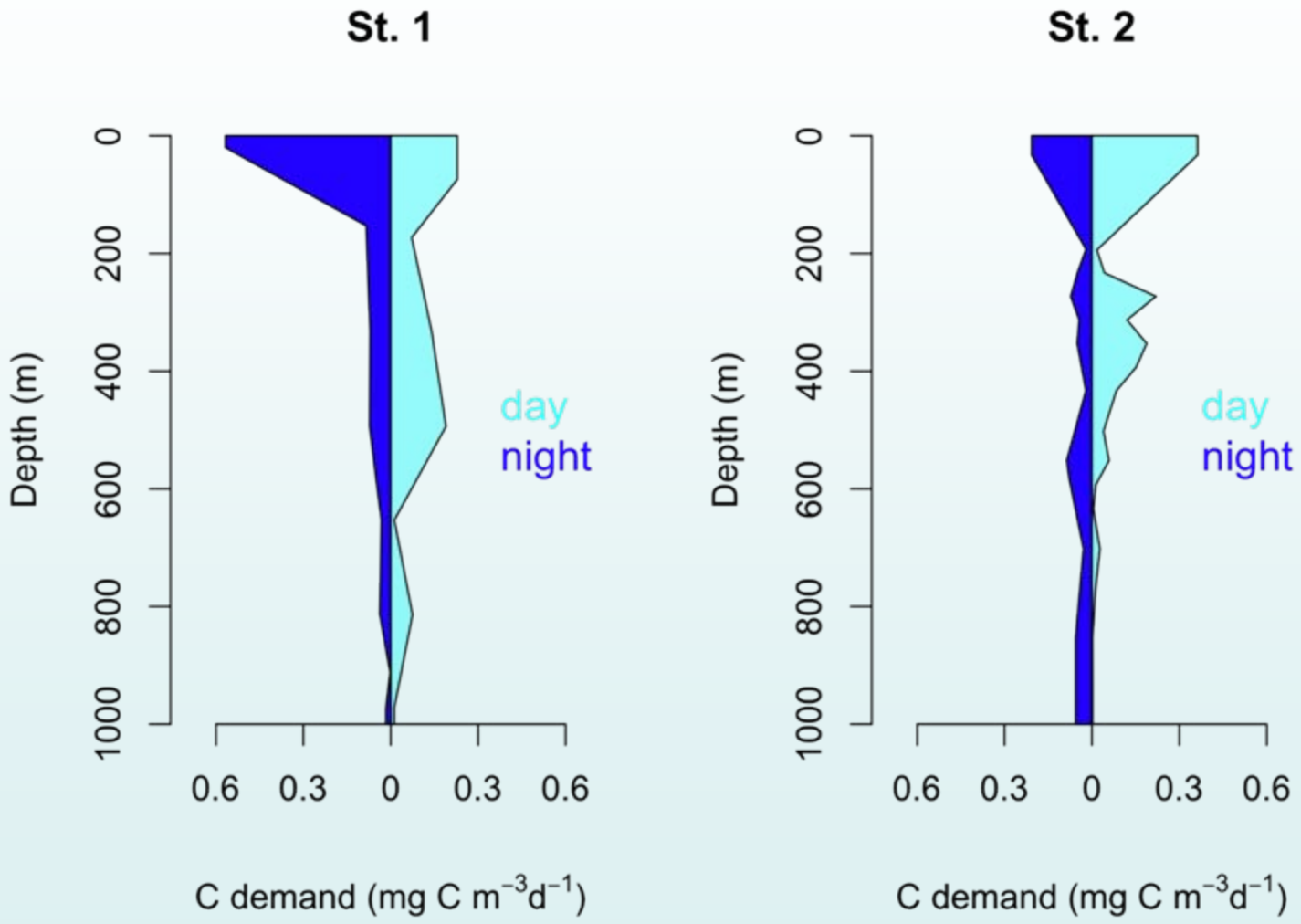
Community composition



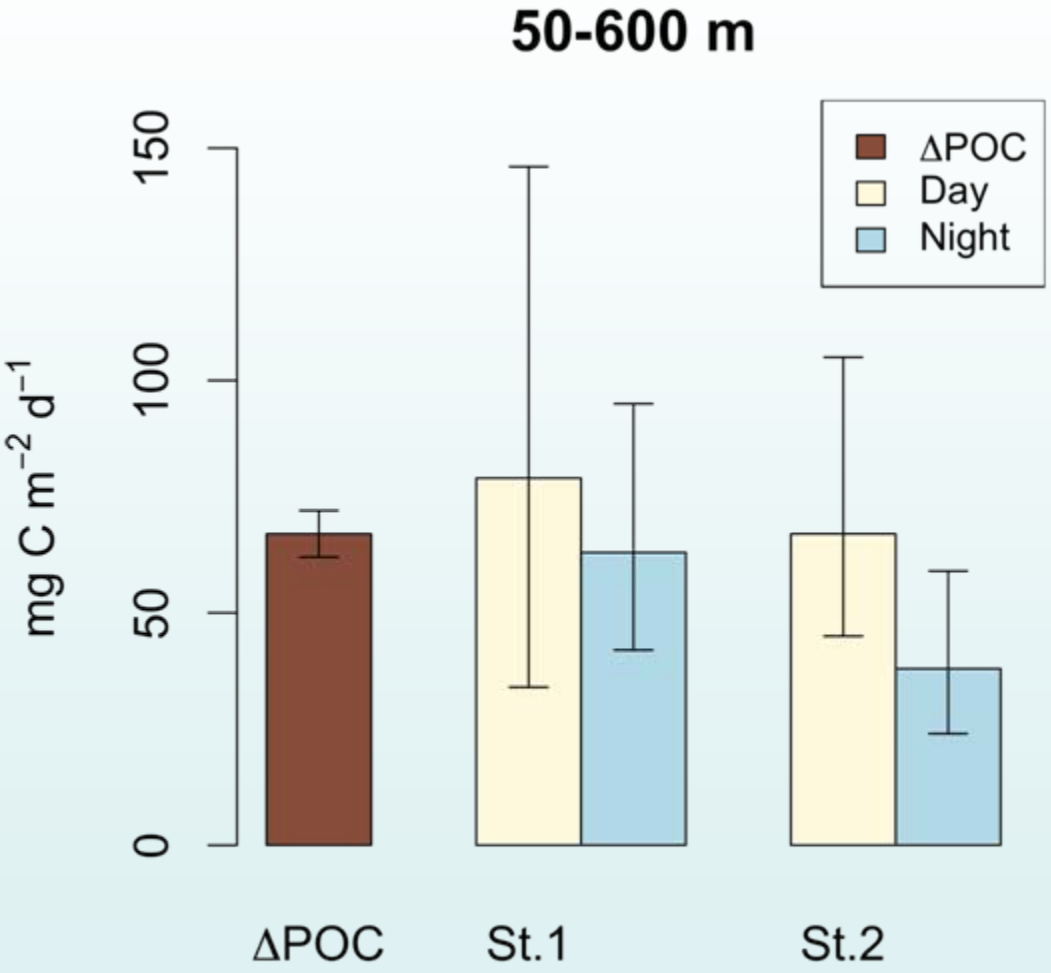
Mesozooplankton biomass



Carbon demand



Can C demands be satisfied?



Yes!

Mesozooplankton carbon demands between 50–600 m can be satisfied by the bulk POC flux.

- We estimated
  - Mesozooplankton C demand at 2 stations during day and night
  - POC flux attenuation using 5 PELAGRAs

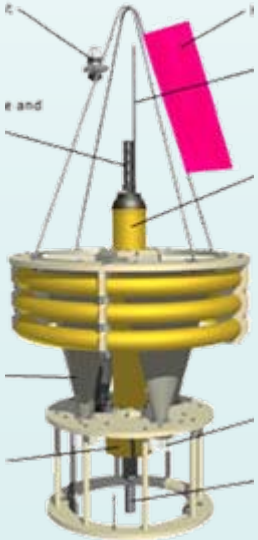
- We found
  - Mesozooplankton can live of bulk POC flux attenuation between 50 – 600 m !

How reliable are our estimates?

(1) PELAGRA

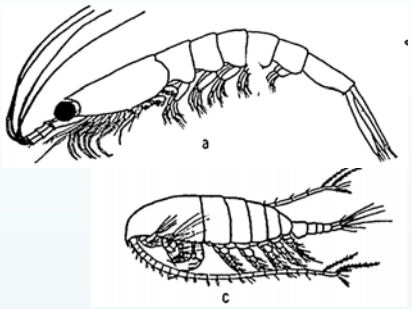
- All traps followed the same water mass
- Top trap estimates match 234Th and Marine Snow Catcher data

→ Fairly confident



How reliable are our estimates?

(2) Carbon Demands



1. Patchiness

2. Bacteria, microzooplankton, macrozooplankton, nekton???

   ↓ Under-estimation

3. Animals partly damaged or squeezed
   → Loss of biomass

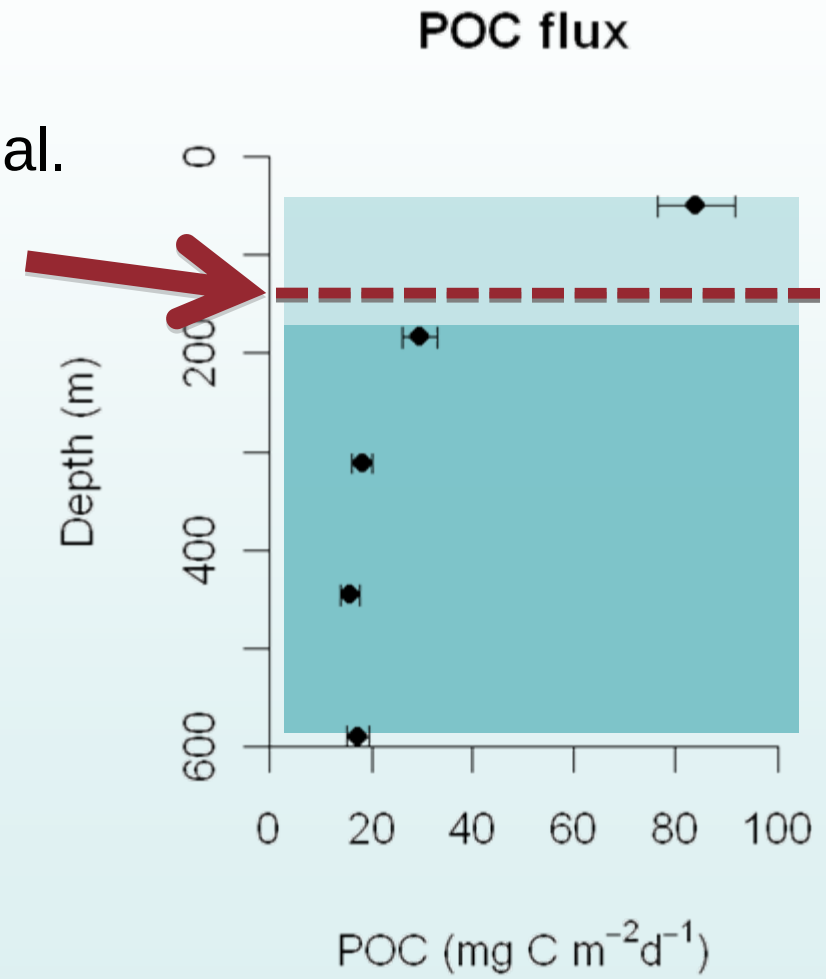
   ↓ Under-estimation

4. Conversion of biomass into CD: many uncertainties

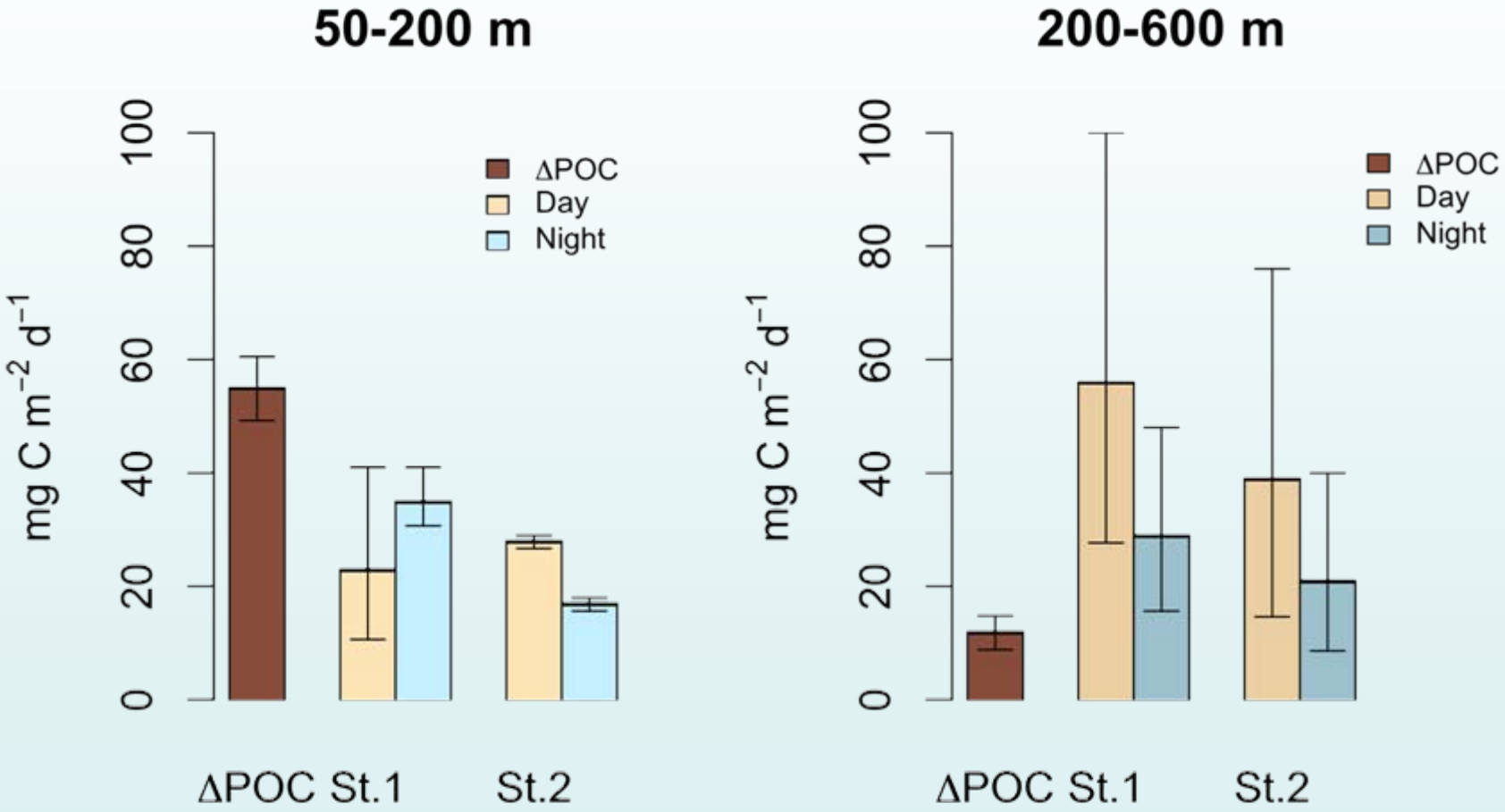
   ↓↑ Either way

Flux attenuation

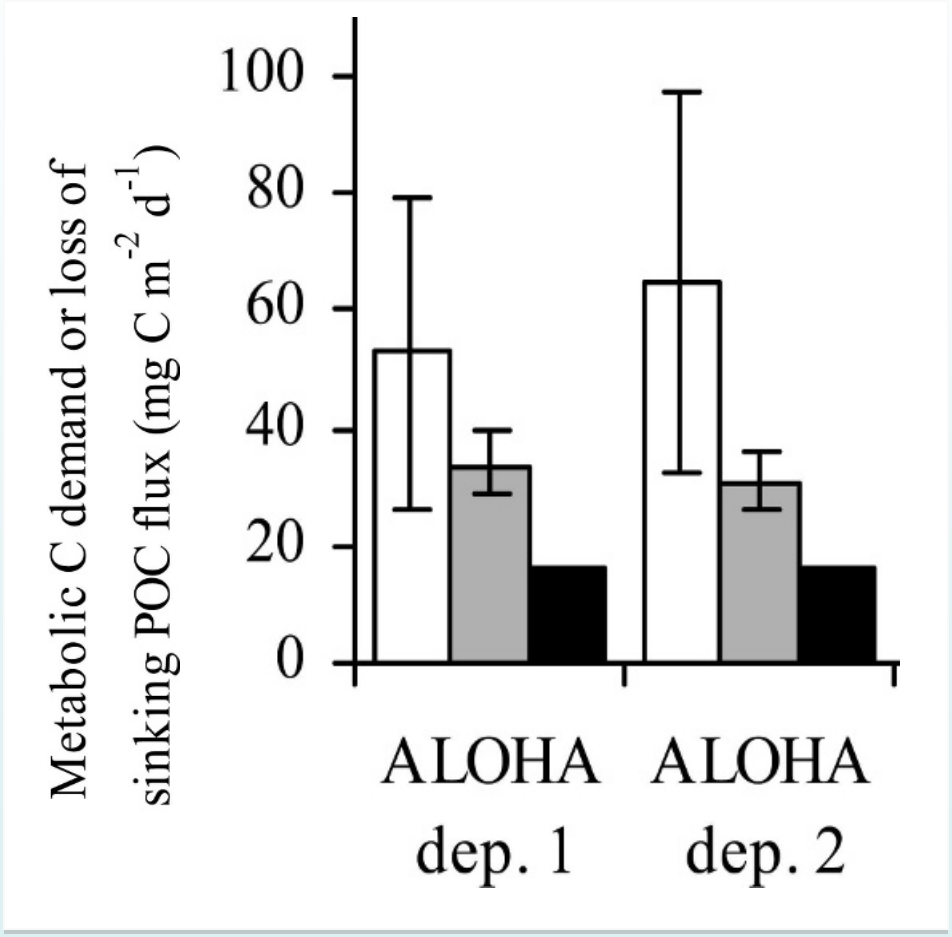
Steinberg et al. 2008



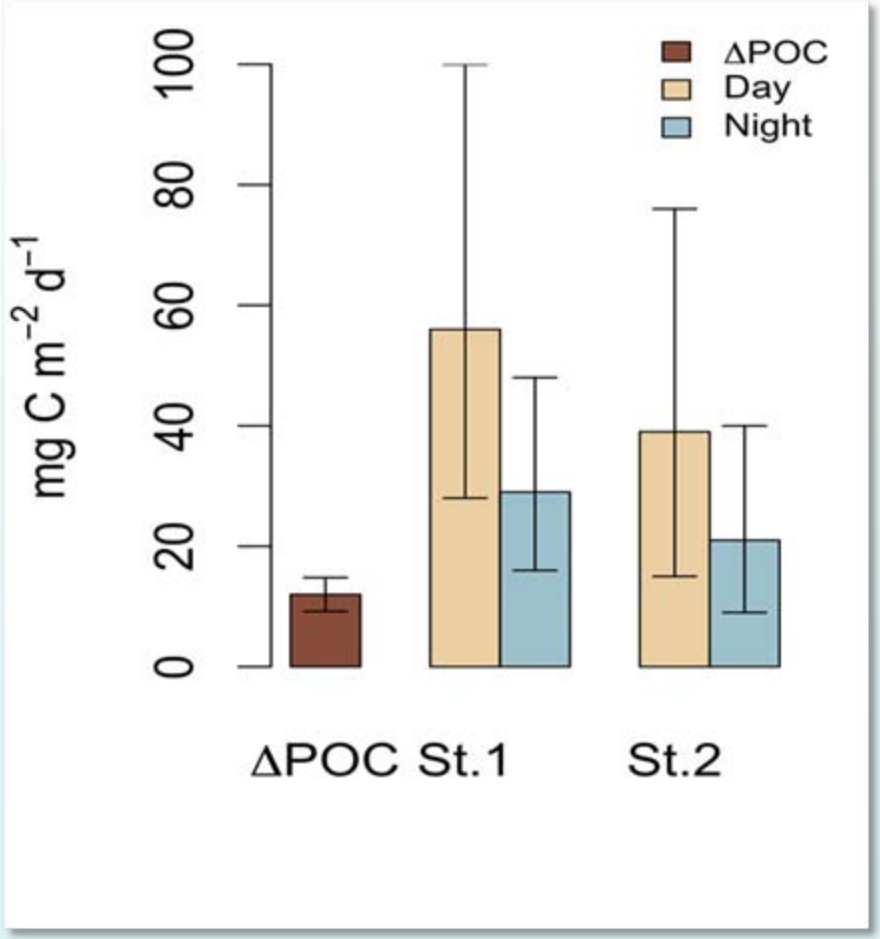
Does depth matter?

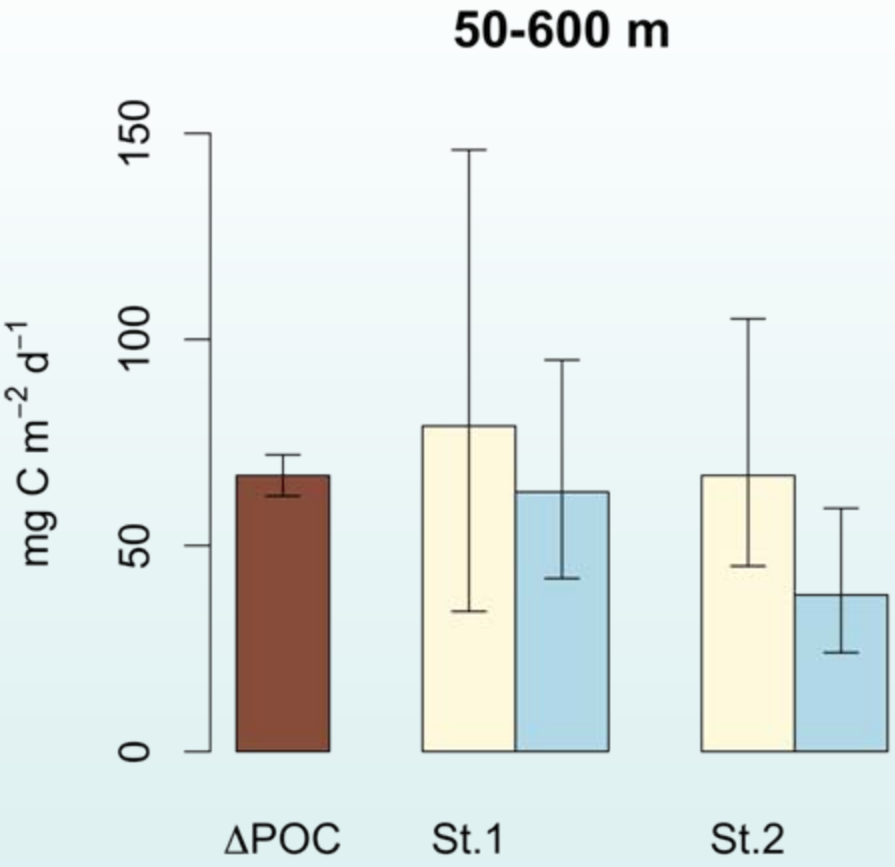


Steinberg et al. 2008



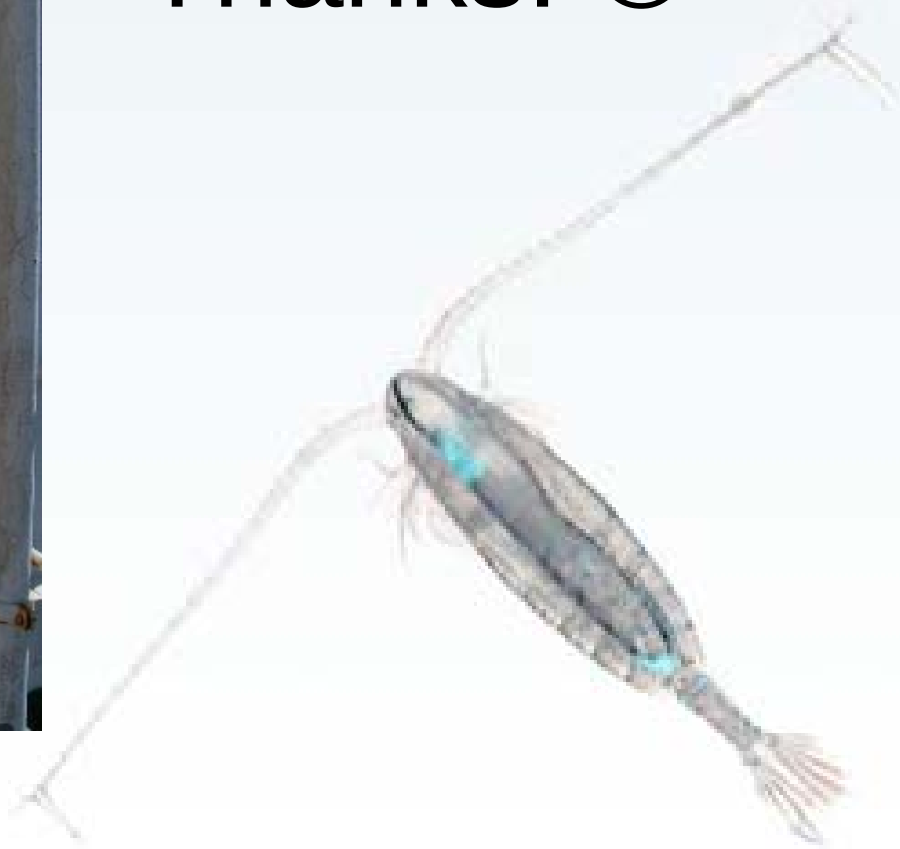
This study





- High biomass of resident mesozooplankton at depths
- Cannot satisfy metabolic requirements by feeding between 200-600 m alone.
- But: System is balanced between 50-600 m!

Thanks! ☺



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