Trait-based modeling of marine mesozooplankton feeding strategies at global scale

EGU meeting - Supplementary materials

Lisa Di Matteo[1], Sakina-Dorothée Ayata[1,2], Olivier Aumont[1,3]

[1] Sorbonne Université, UMR 7159 CNRS-IRD-MNHN, LOCEAN-IPSL, Paris, France
[2] Institut Universitaire de France (IUF), Paris, France
[3] Université Brest, CNRS, Ifremer, IRD, Laboratoire d'Océanographie Physique et Spatiale (LOPS), IUEM, Plouzané, France

✉ lisa.di-matteo@locean.ipsl.fr

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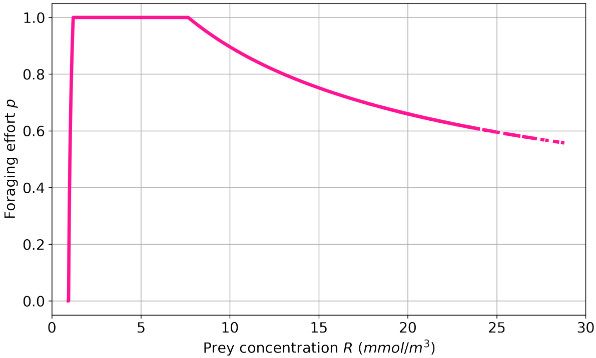
Methods - FORaging EFFort (FOREFF) configuration

- Based on Kiørboe et al. (2018)
- Optimal foraging effort p :

$$p = \frac{1}{\rho}\frac{f_c(m-\mu)-\sqrt{A}}{f_c(\mu-m)-\mu} \text{ ; with } A = \rho\mu - f_c(\rho-\mu)(\mu-m)$$

- Introduction of the parameter in the mortality equations



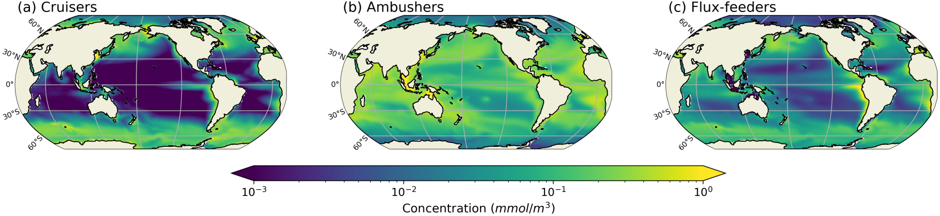
Methods - Parameters & experiments

Variable	Description	Unit	FOREFF	LGE
e^{M_X}	Maximum growth efficiency	/	CF = 0.4 AF = 0.4 FF = 0.4	CF = 0.34 AF = 0.4 FF = 0.4
K_M	Half saturation constant for mortality	$\mu molC.L^{-1}$	0.1	0.1
m^{M_X}	Quadratic mortality	$(\mu molC.L^{-1})^{-1}d^{-1}$	CF = 0.015 AF = 0.005 FF = 0.005	CF = 0.02 AF = 0.005 FF = 0.005
K_g	Half saturation constant for grazing	$\mu molC.L^{-1}$	CF = 20 AF = 20 FF = 20	CF = 10 AF = 30 FF = 20
r^{M_X}	Metabolic loss	d^{-1}	CF = 0.03 AF = 0.005 FF = 0.005	CF = 0.005 AF = 0.005 FF = 0.005
g_{FF}	Flux-feeding rate	$(molC.L^{-1})^{-1}$	CF = 0 AF = 0 FF = $3 * 10^3$	CF = 0 AF = 0 FF = $3 * 10^3$
g_m	Maximum grazing rate	d^{-1}	CF = 0.8 AF = 0.2 FF = 0	CF = 0.5 AF = 0.5 FF = 0

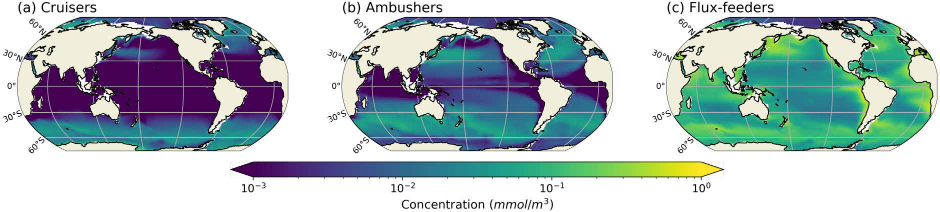
- All other experiments (NO_FOREFF, KILL_AF, KILL_CF & KILL_FF) have the same parameters as FOREFF.
- For NO_FOREFF, we set the foraging effort to 1.
- For KILL_XX experiments, we set grazing/flux-feeding rates to 0.

Biogeography of mesozooplankton

Averaged over the top 150 m:

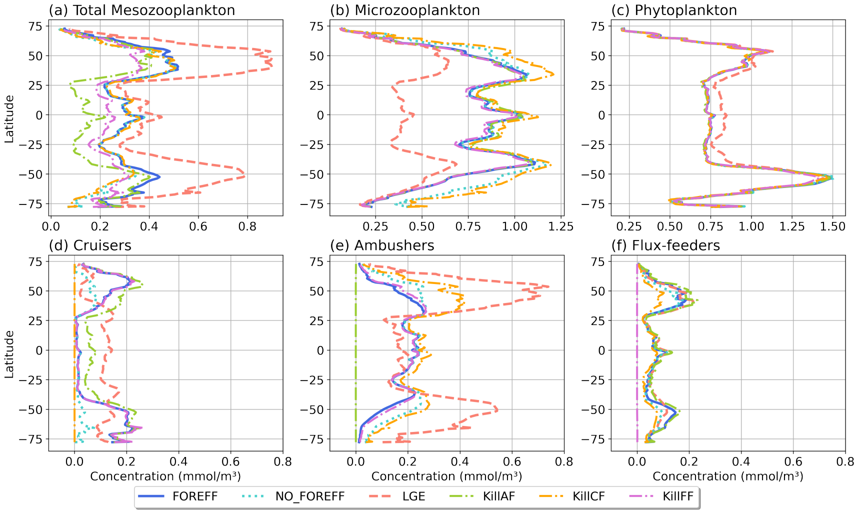


Averaged between 150-1000 m:



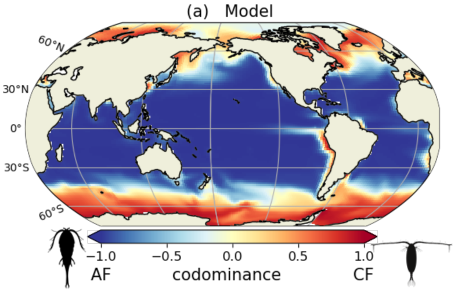
- Cruisers present only at high latitudes & in productive regions
- Ambushers: dominant feeding strategy at global scale
- Flux-feeders: dominant at depth, in coastal areas

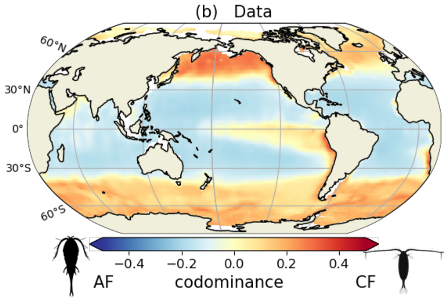
Results - Impact on ecosystem biomass



- LGE (different set of parameters) has the most impact → increase in ambushers (thus mesozooplankton) leads to decreases in microzoo-, phyto-plankton

Results - Comparison with in situ studies

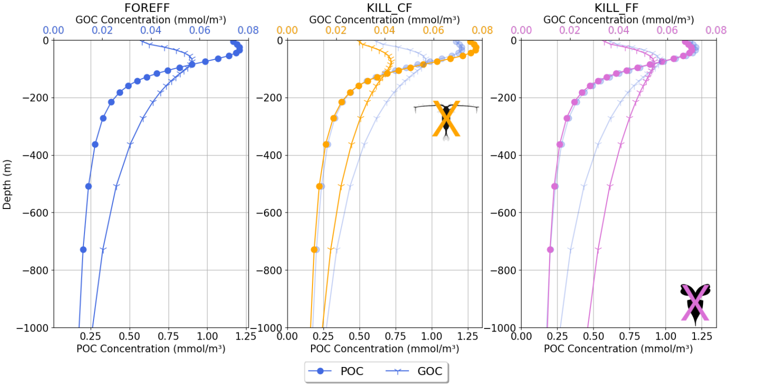




- Data from the study of Benedetti et al. (2023)
- More codominance in data than in model outputs (⚠different scales)
- Similar biogeographies
- Their study is based on **presence data** and **habitat suitability indices**estimated from **niche models** → does not consider biomass

2 factors control C export variations:

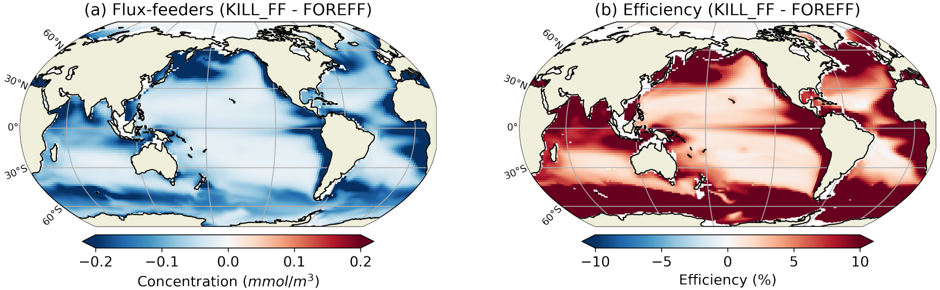
- production of organic particles in upper ocean (contribution of suspension feeders, especially **cruisers**)
- fate of sinking particles, so transfer efficiency, affected by **flux-feeders**



- KILL_CF: **no more CF = less GOC**, especially in surface layers
- KILL_FF: **no more FF = larger GOC** concentration at depth

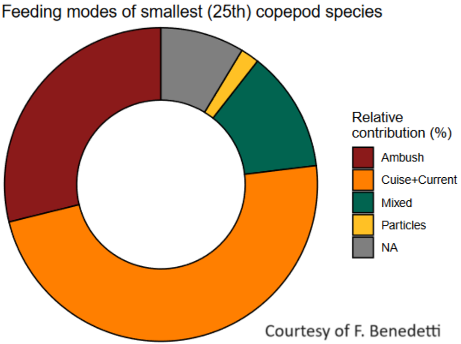
Results - Impact on carbon export

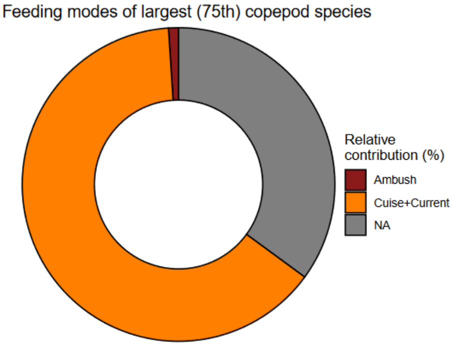
Averaged between 150-1000 m:



- Removal of flux-feeders = increase of carbon transfer efficiency (especially in coastal/productive regions)

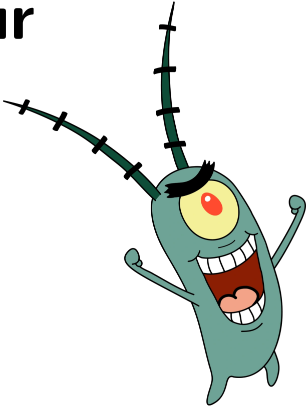
Perspectives - Motivation for the addition of size classes



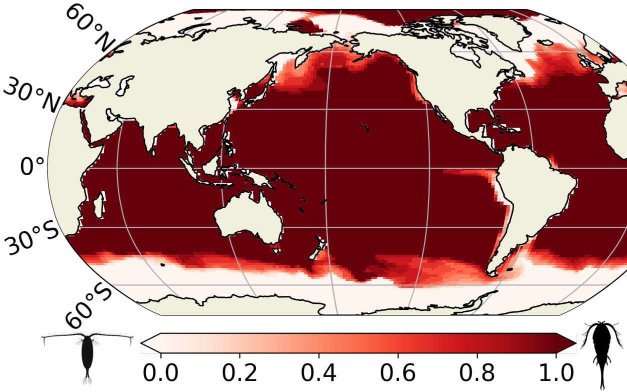


Courtesy of F. Benedetti
Based on the Benedetti et al. (2023) dataset

Thank you for your attention!

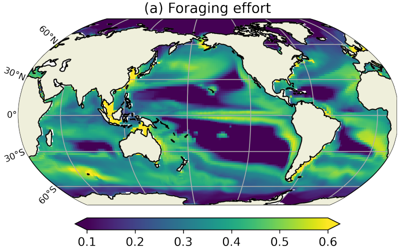


APPENDIX



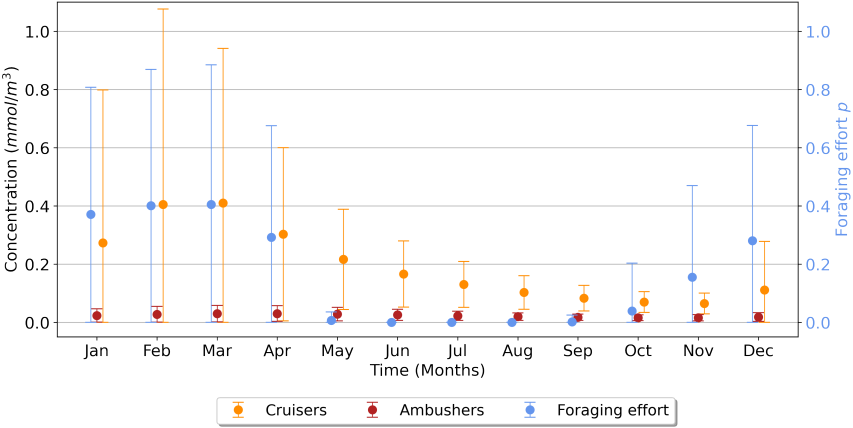
- Dominance of ambushers all year long (values close to one, red shading)
- Very few regions with intermediate values (between 0.3 and 0.7) → few regions where there is a seasonal succession of the dominance between the suspension feeders

Appendix - Seasonal variation



- Focus on the Southern hemisphere $\rightarrow$ largest variations of the foraging effort

Appendix - Seasonal variation (south of 60°S)



- Similar seasonal pattern for cruisers and their foraging effort
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