Biodiversity and carbon sequestration in Arctic seas

ECOTIP

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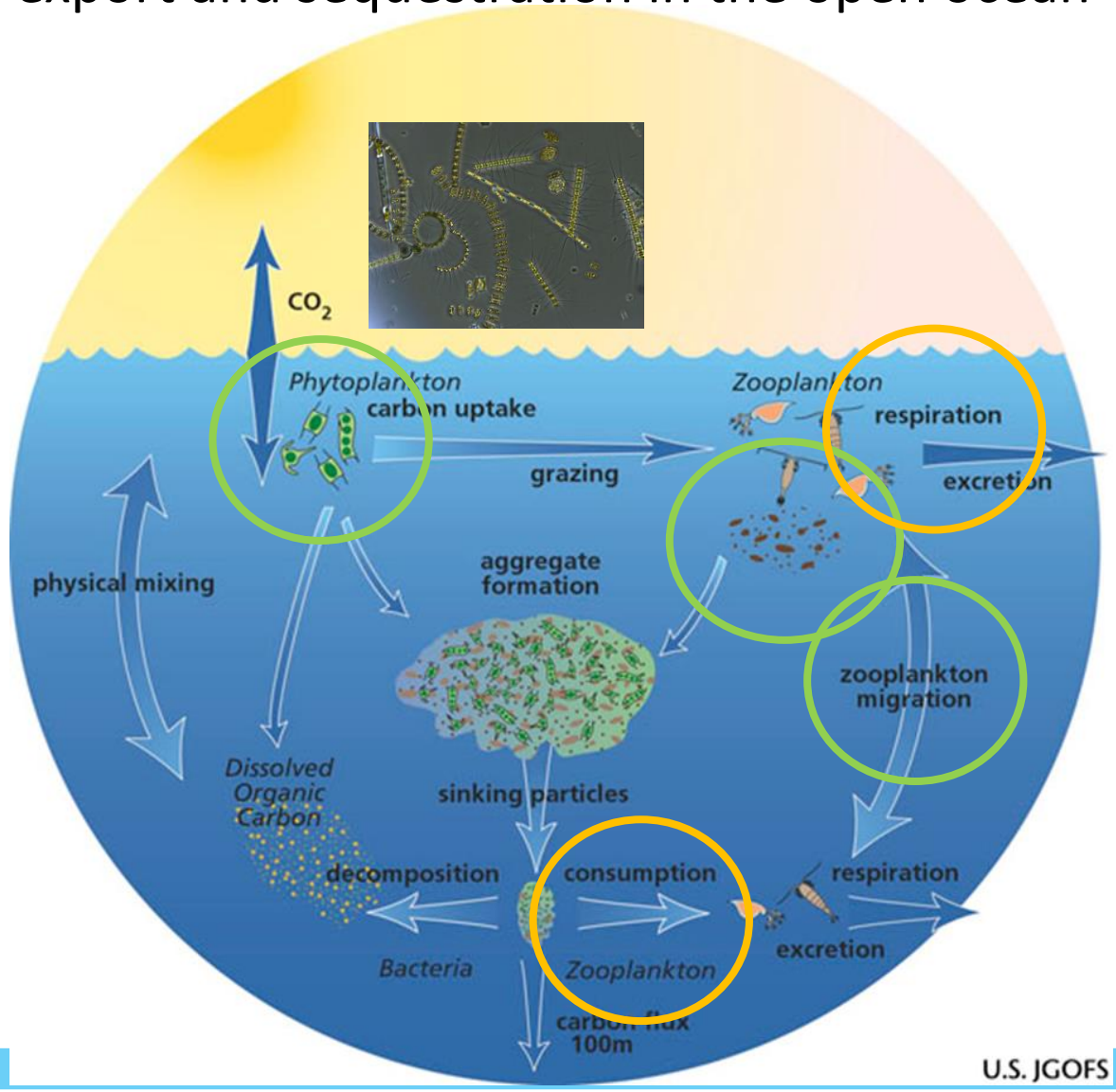
Importance of functional diversity of plankton to biologically-mediated carbon export and sequestration in the open ocean



Processes enhancing carbon export and sequestration:

- Fecal pellet production
- Active carbon transport
- Lipid pump
- Carcasses

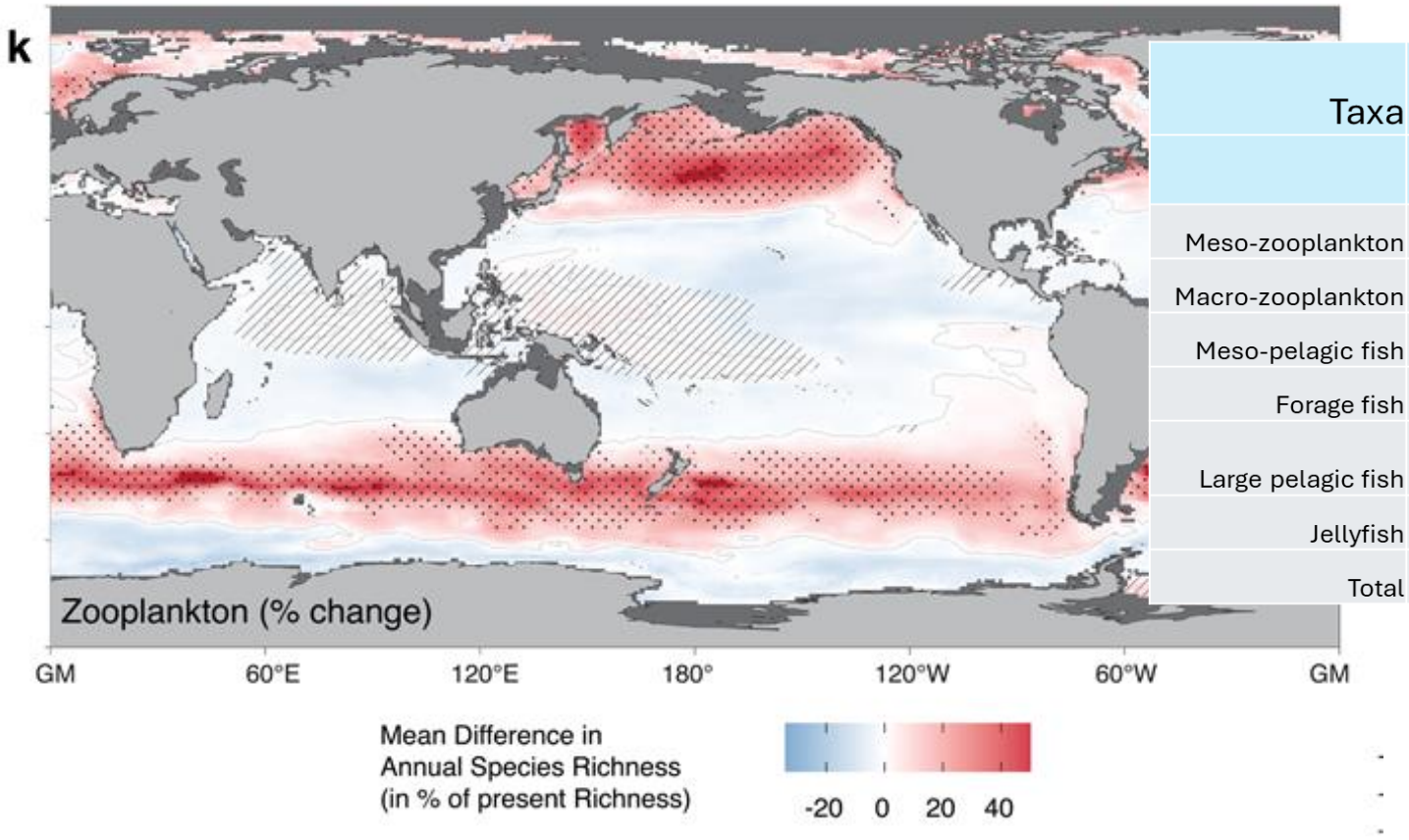
Photos: Sigrun Jónasdóttir

Processes decreasing carbon export / sequestration:

- Aggregate degradation
- Respiration at the surface layer

What if the functional diversity of plankton changes?

Benedetti et al. 2021: Major restructuring of marine plankton assemblages under global warming



Sequestration: biomass ratio of zpl is high

Taxa	DIC Injection rate	Sequestered carbon	Sequestration time scale	sequestered : biomass
	(PgC yr−1)	(PgC)	years	ratio
Meso-zooplankton	0.3-1.0	40-250	70-400	500 - 1000
Macro-zooplankton	0.4-2.0	100-400	100-400	1000-3000
Meso-pelagic fish	0.2-2.0	50-700	100-500	1000-2000
Forage fish	0.1-0.2	30-100	300-600	200-1000
Large pelagic fish	0.001-0,04	5-40	300-500	50-300
Jellyfish	0.04-0.2	30-120	500-900	1000-3000
Total	3	800	250	

Visser et al., in prep.

Could a regime shift become an ecosystem tipping point?

Or could changes in rates induce a tipping point?

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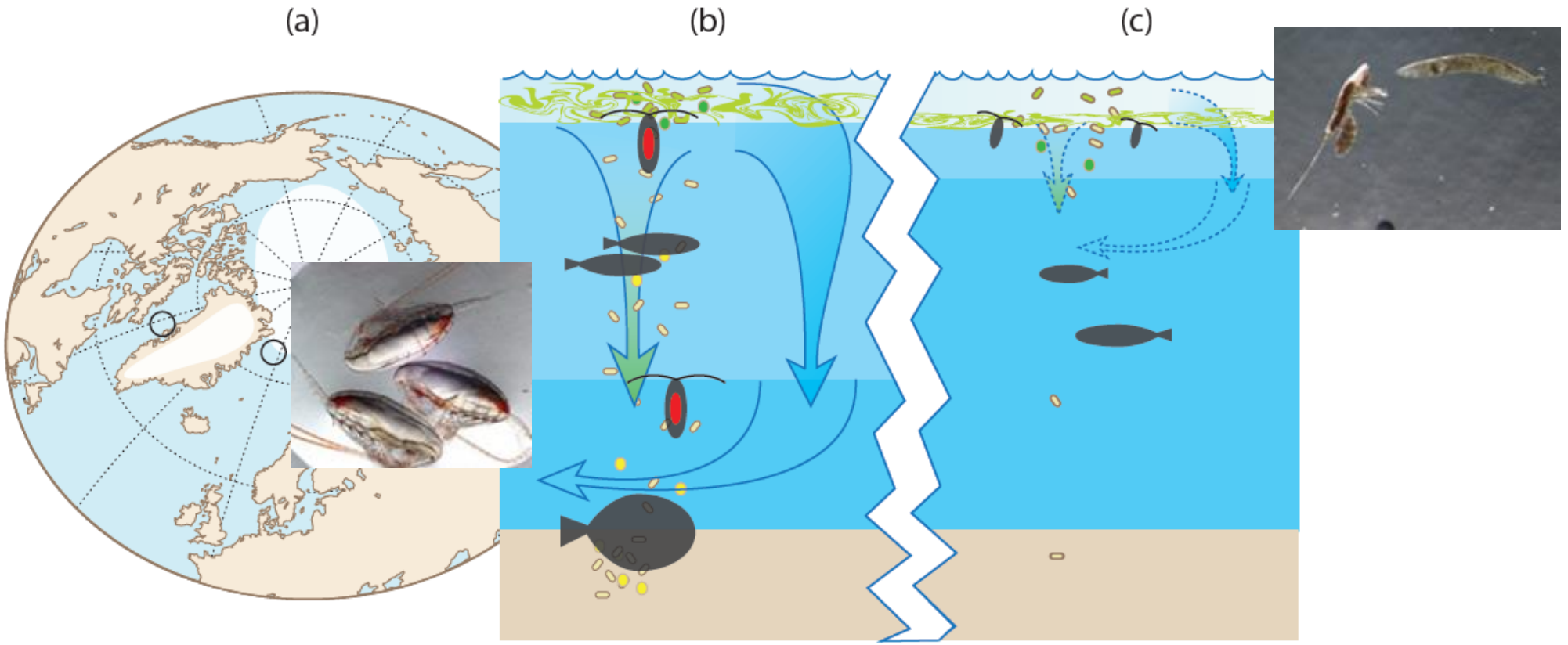
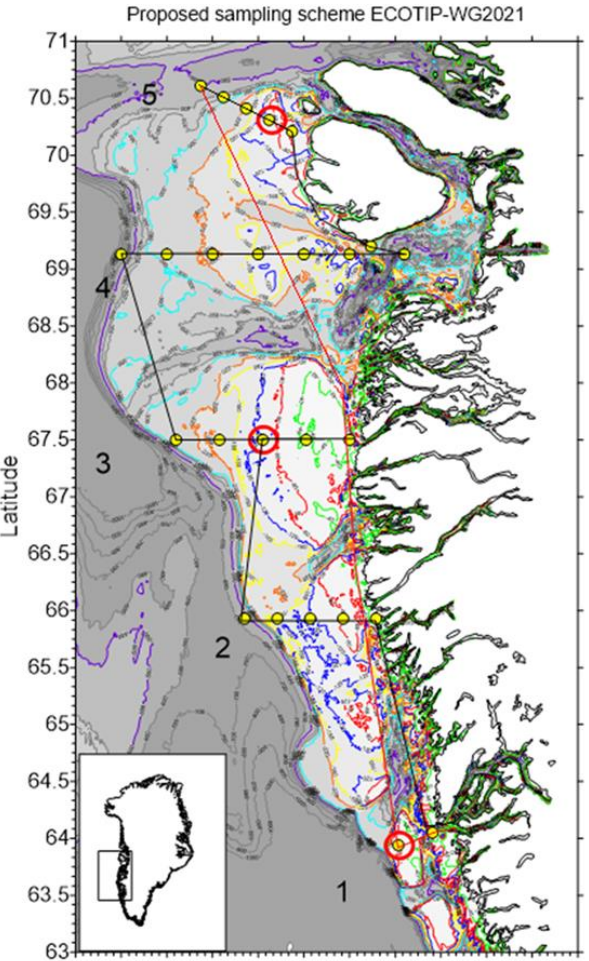
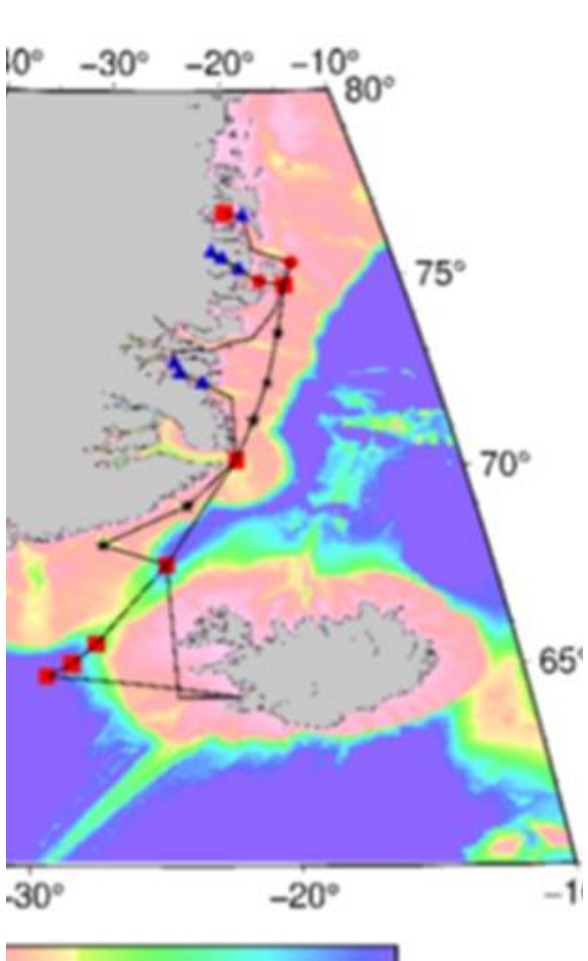


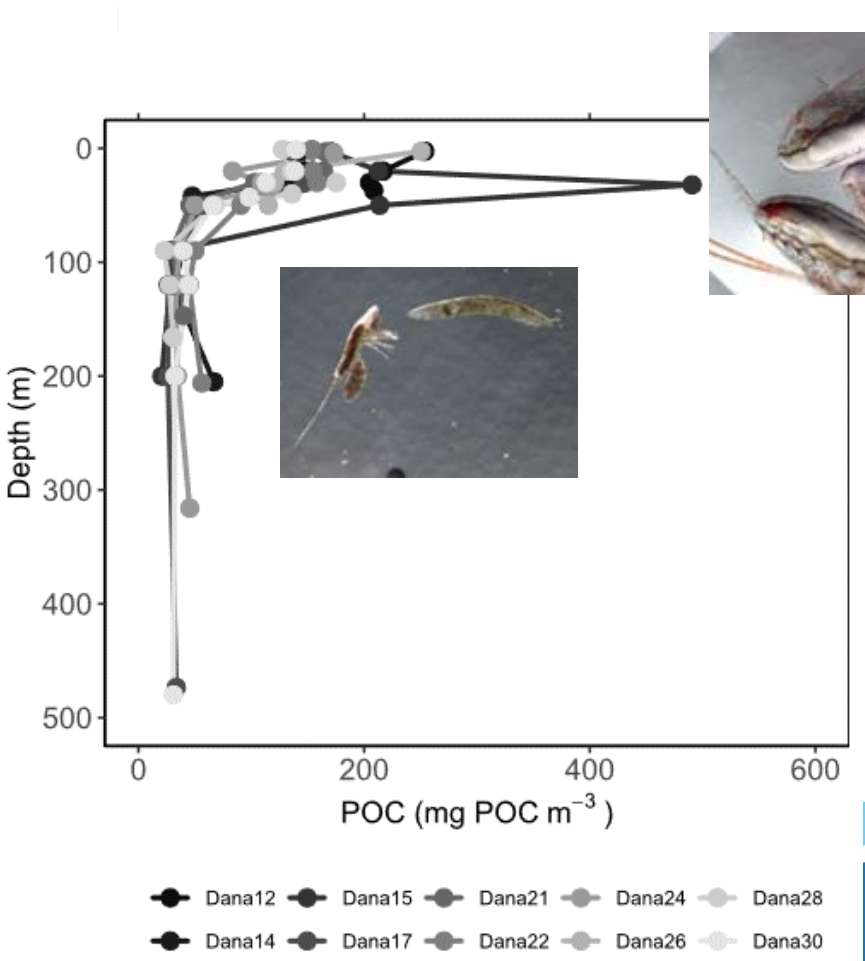
Jónasdóttir et al., in prep.

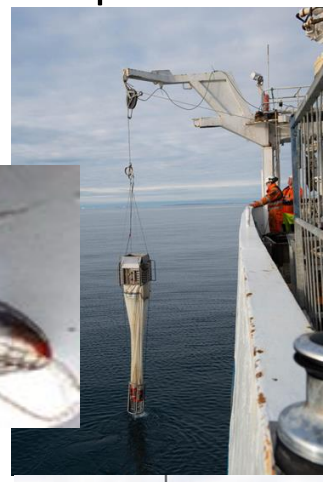
ECOTIP approaches

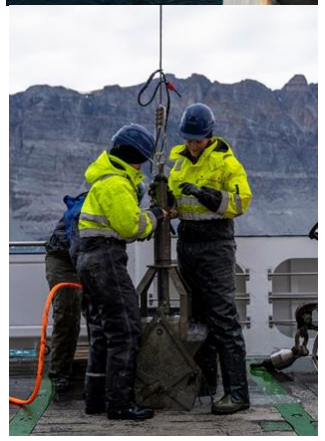
- **Interaction between functional diversity and carbon sequestration**: Process cruises in West and East Greenland - Vertical flux (sediment traps), community composition and rates
- **Effect of changing environment**: Laboratory experiments on lipid accumulation and t-specific respiration
- **Global importance**: Trait-based modelling



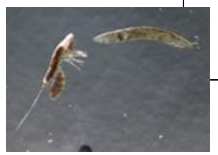








Large changes in functional diversity, best explained by temperature



Cal
Pse
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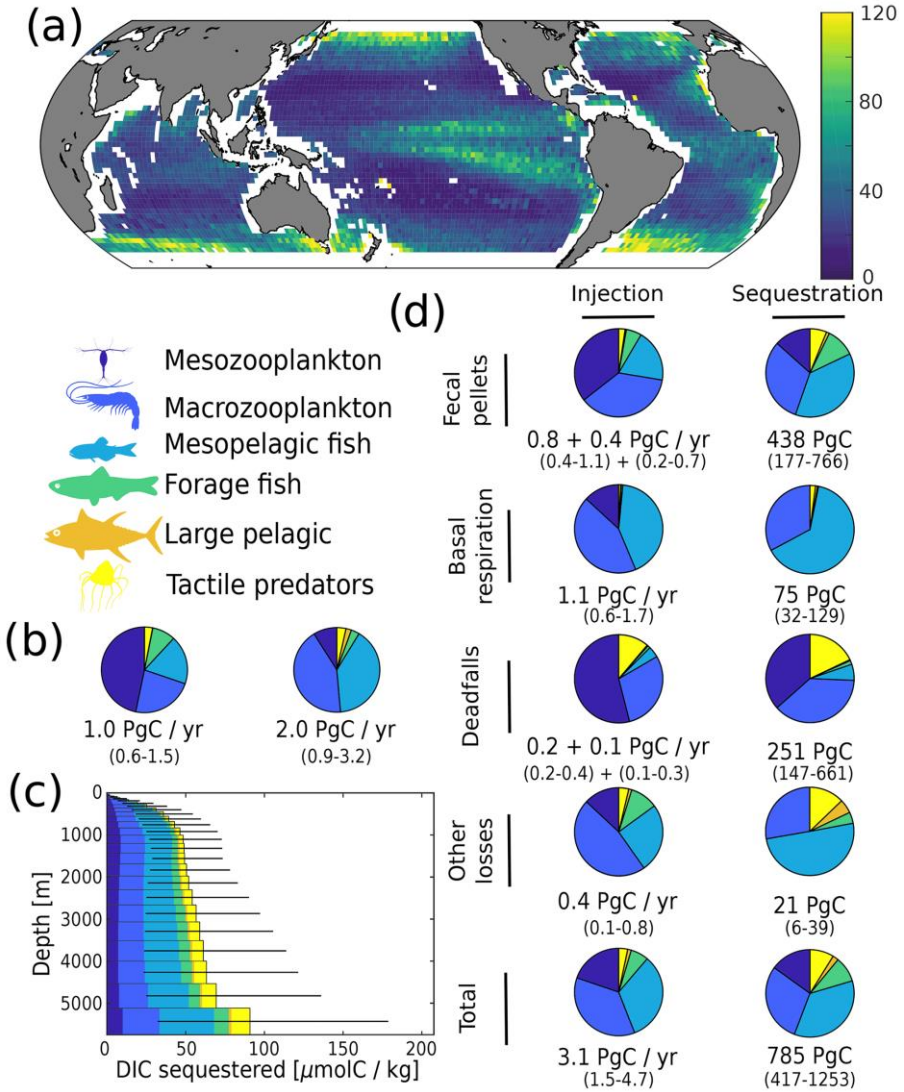
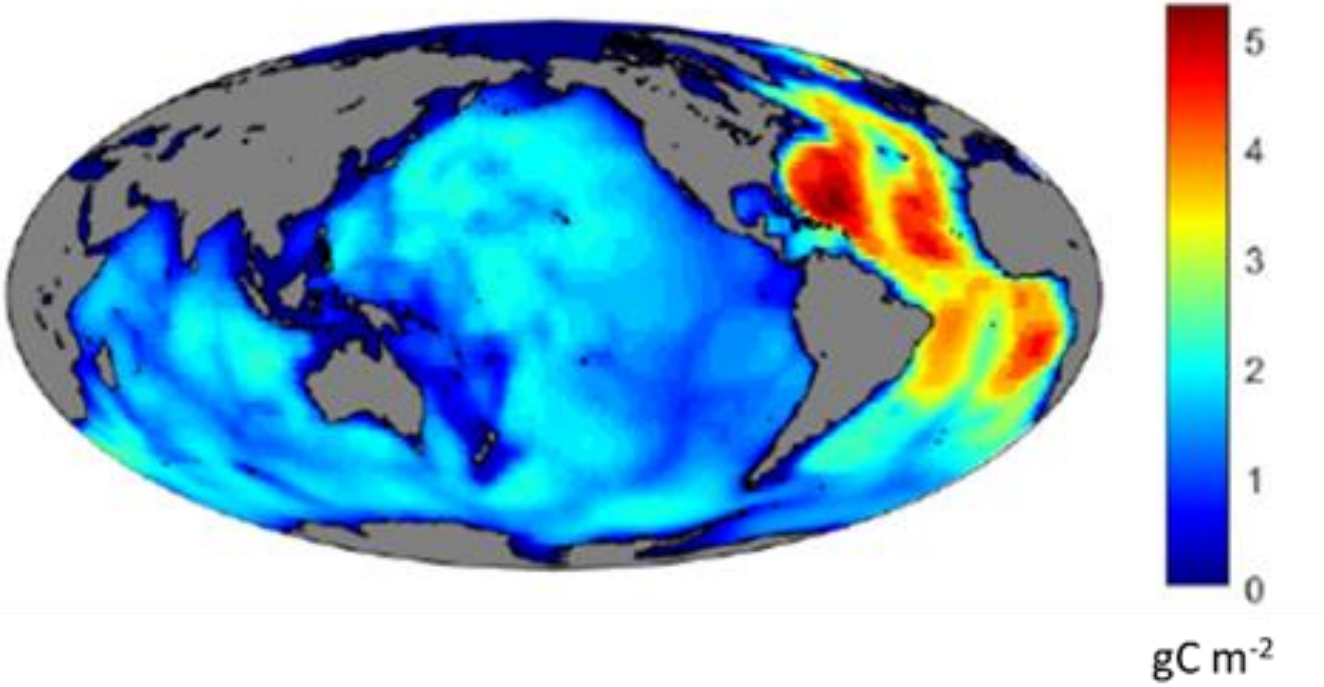
Other

1) Large calanoids – large sequestration potential?



Sequestration potential of different seasonally migrating copepod populations through lipid pump:



Pinti et al. 2023a and b

Potential changes in processes enhancing carbon sequestration

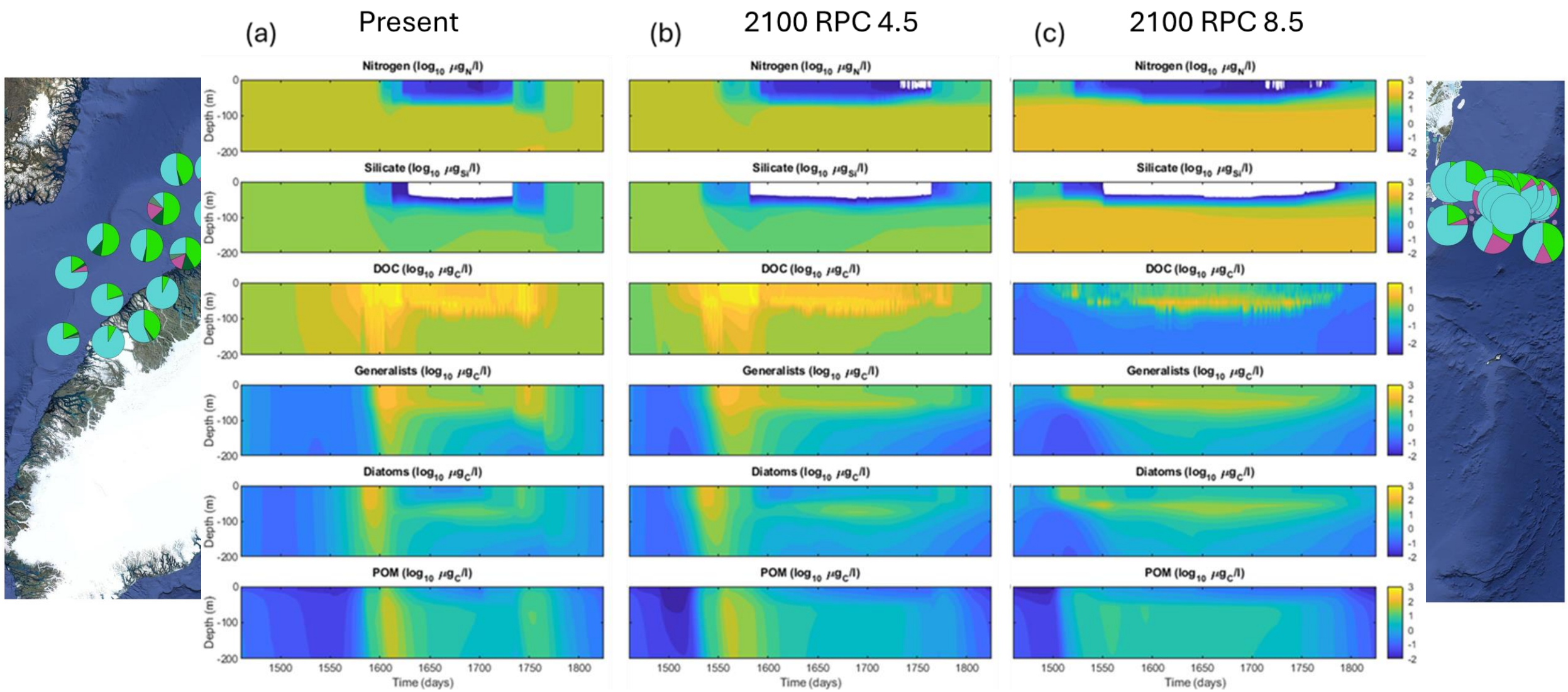
- Diatom-dominated diets result in highest production of fecal pellets and fast lipid accumulation

Jónasdóttir et al., in prep.

Are diatoms decreasing?

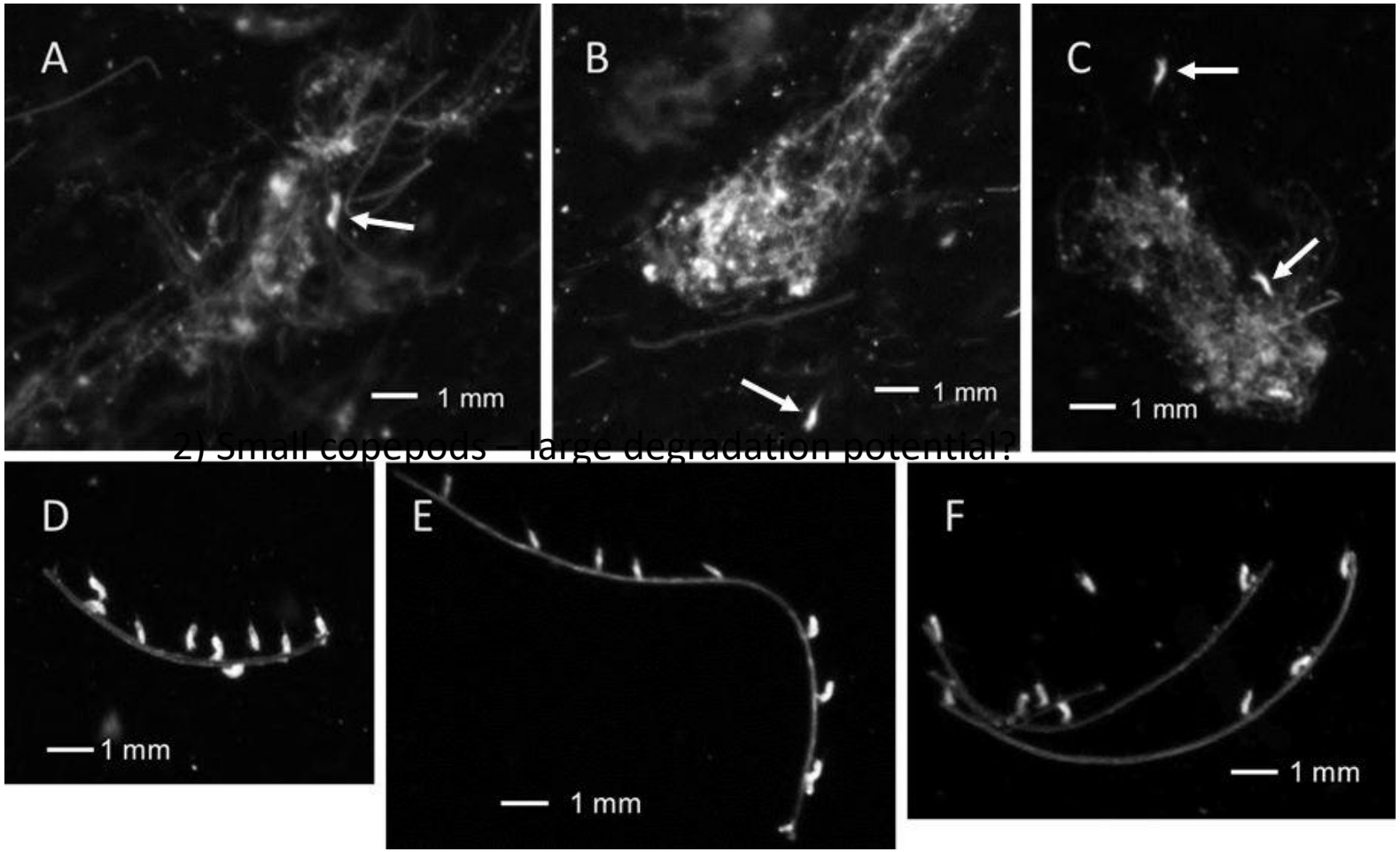
- NUM model and HPLC data from Greenland indicate that it is possible

Spatial distribution of Phytoplankton groups near Greenland shelf



Draganska et al.

2) Small copepods – large degradation potential?



2) Small copepods – large degradation potential?

VPR by Klas Ove Möller and Fredrikka Norrbin, in Svensen et al., 2024

Potential changes in processes decreasing carbon sequestration

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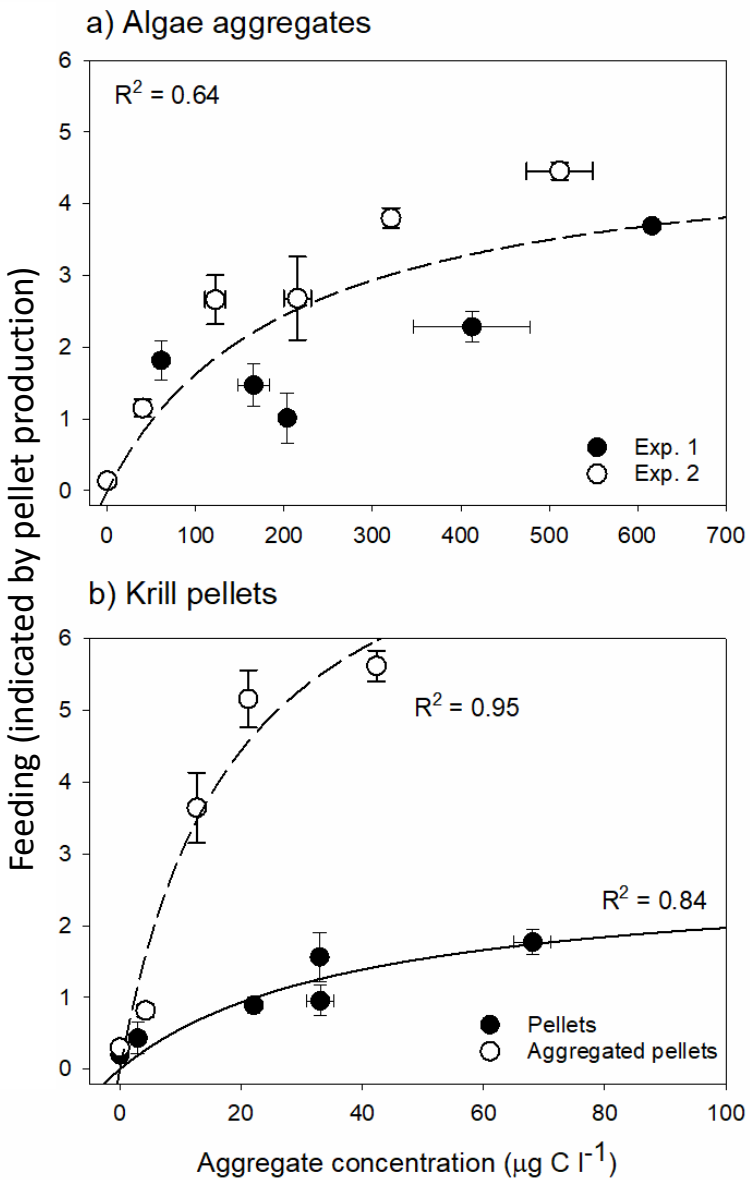
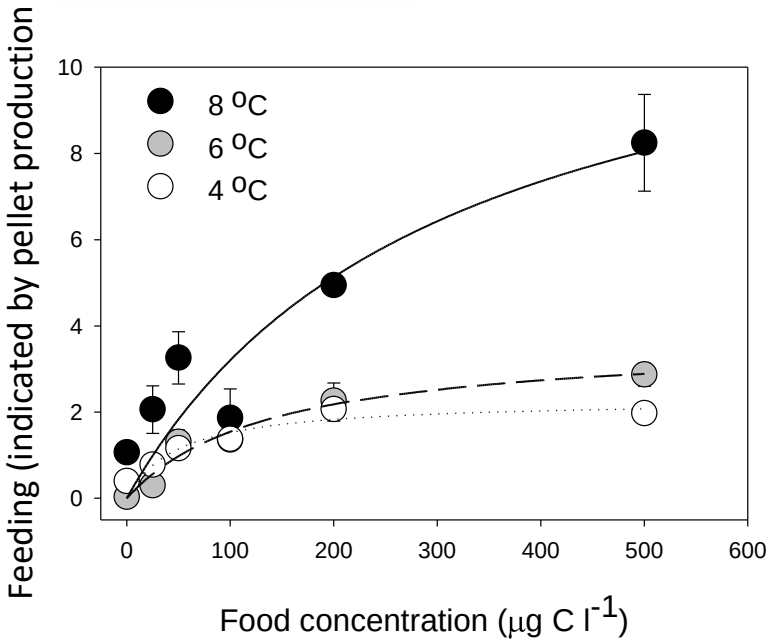
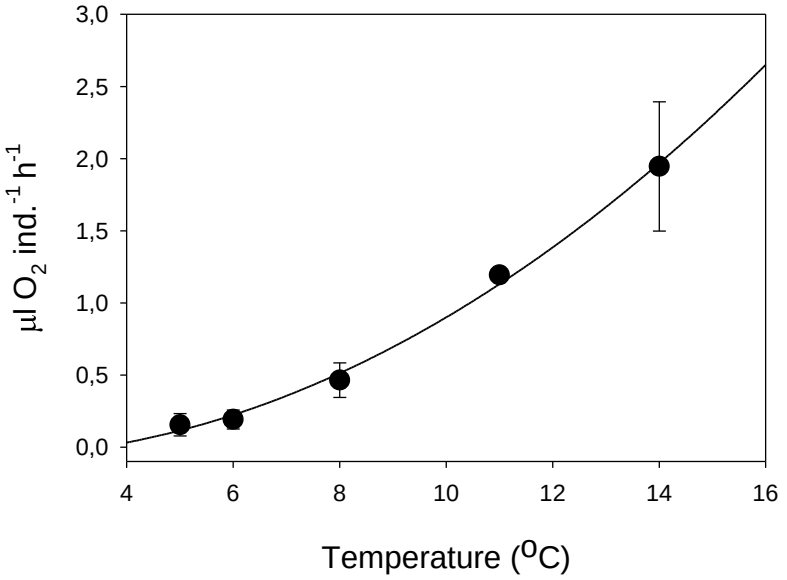
Effect of the aggregate type



Effect of temperature



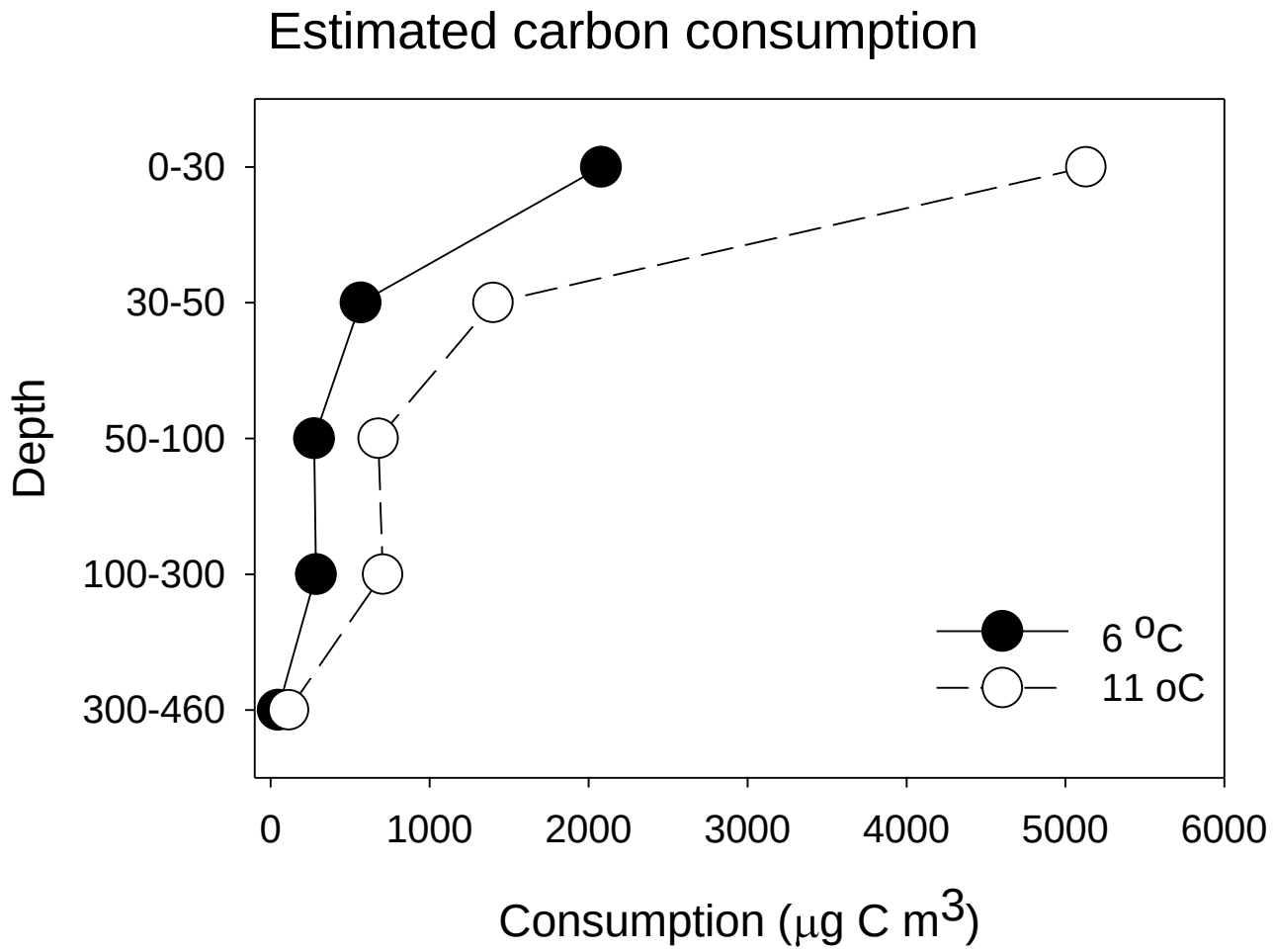


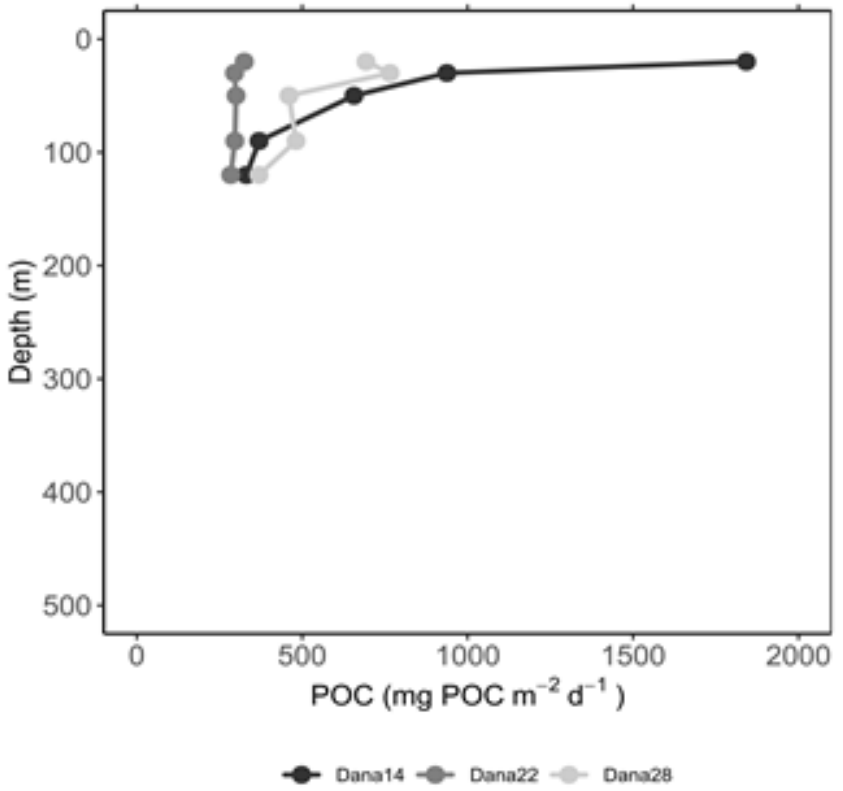
Svensen et al. 2024, Koski et al., in prep.

Potential consumption of vertical flux in West Greenland

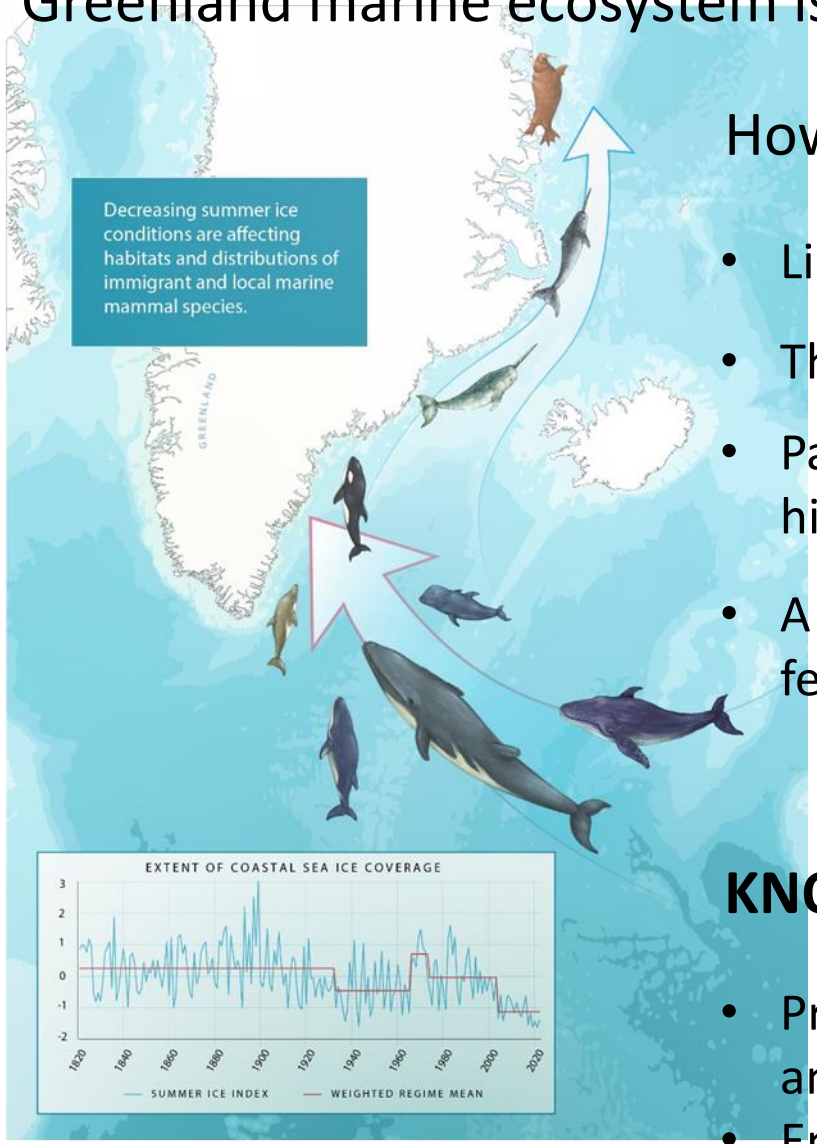
Station 30

Total in 6°C: 152 mg C m^{-2}
Total in 11°C: 374 mg C m^{-2}





Greenland marine ecosystem is experiencing a regime shift



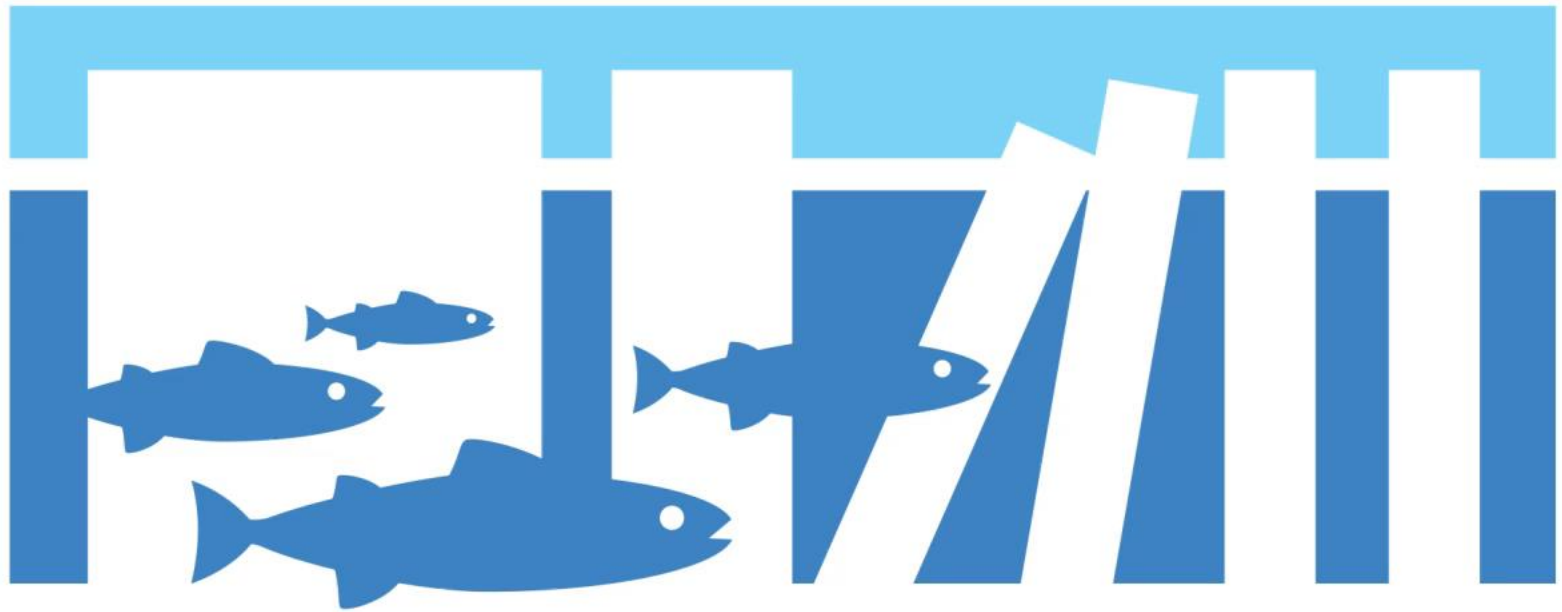
Heide-Jørgense et al. 2023, Glob. Change Biol. 29
Illustration by GRIDA

How would that affect carbon sequestration?

- Lipid pump and carbon sequestration by metazoans are of global importance
- These are sensitive to the changes in phytoplankton (FP, lipid accumulation..)
- Particle degradation rates are potentially high – and increase with a higher temperature
- A regime shift between the functional groups (*Calanus* vs. aggregate-feeders) would have large consequences for carbon sequestration
    - as would a change in eco-physiological rates

KNOWLEDGE GAPS

- Proportional importance of different processes – from regime shift and changing rates to ecosystem tipping?
- Emerging ecosystems – ice, temperature, new combinations of species…



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Thank you for your attention!

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