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Impact of sea-ice decline on Arctic zooplankton vertical migration revealed by an autonomous observatory

Implications for ecosystem monitoring in the polar oceans

23.03.2024

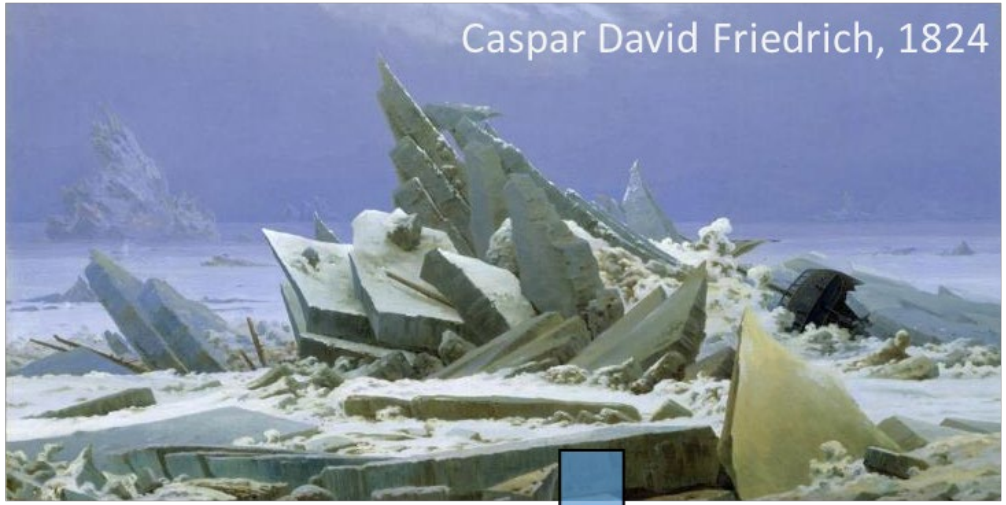
*Project PIs

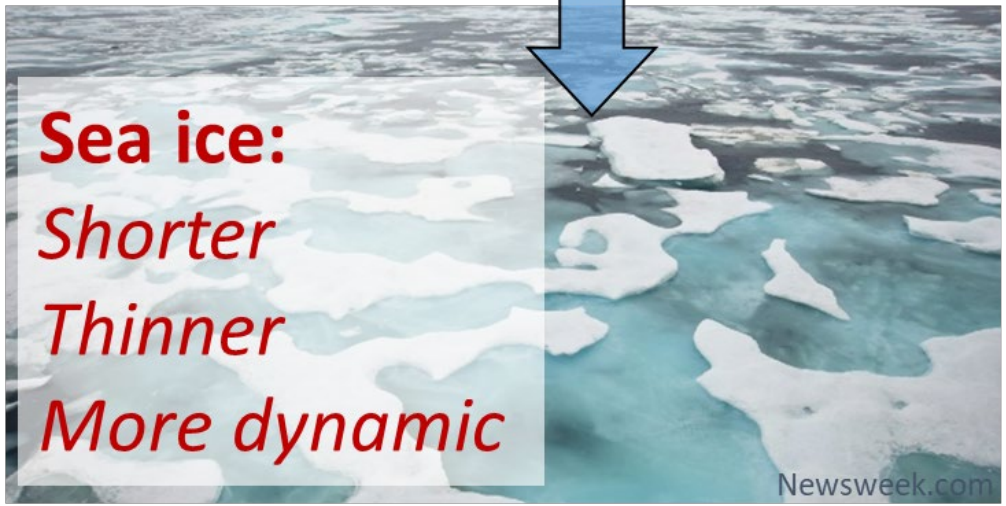
Very low changes in light intensity, even moonlight, can affect the vertical distribution of zooplankton

(Last et al. 2016, *Curr Biol*)

"Normal working-light from a ship may disrupt fish and zooplankton behaviour down to at least 200 m"

(Berge et al. 2020, *Comm Biol*)





Measuring zooplankton migration under ice

Very low changes in light intensity, even moonlight, can affect the vertical distribution of zooplankton

(Last et al. 2016, *Curr Biol*)

"Normal working-light from a ship may disrupt fish and zooplankton behaviour down to at least 200 m"

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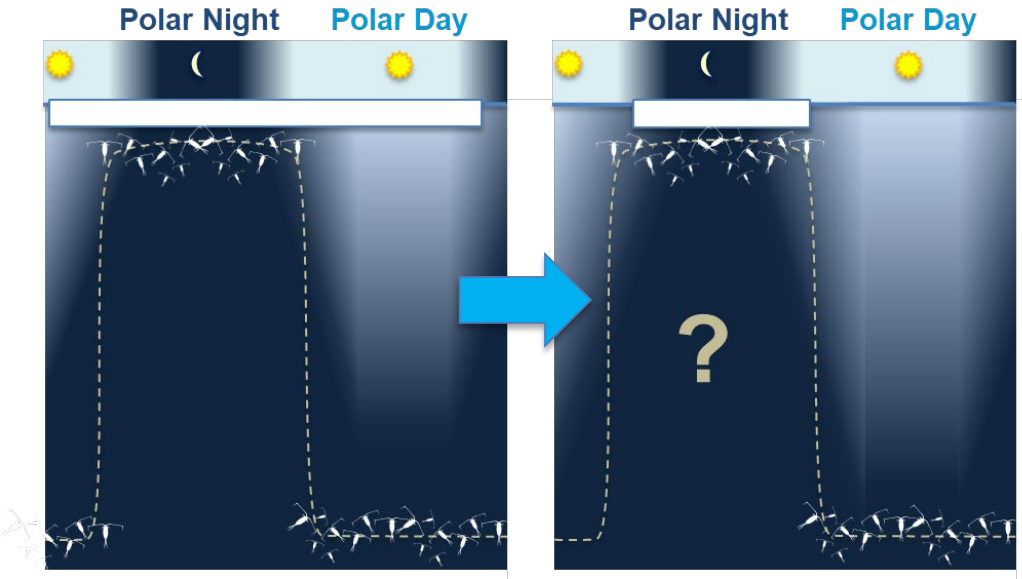
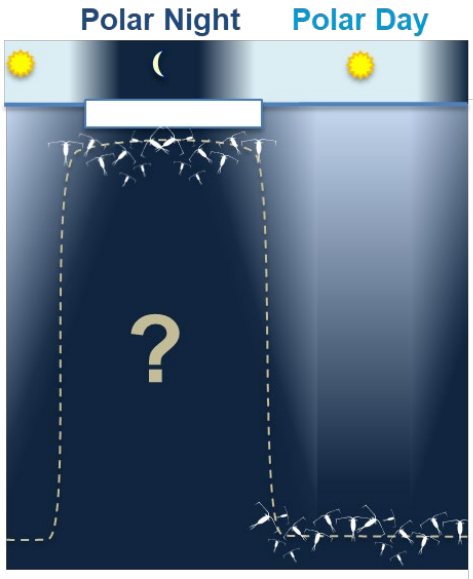
Will Vertical migration patterns change?



Measuring zooplankton migration under ice

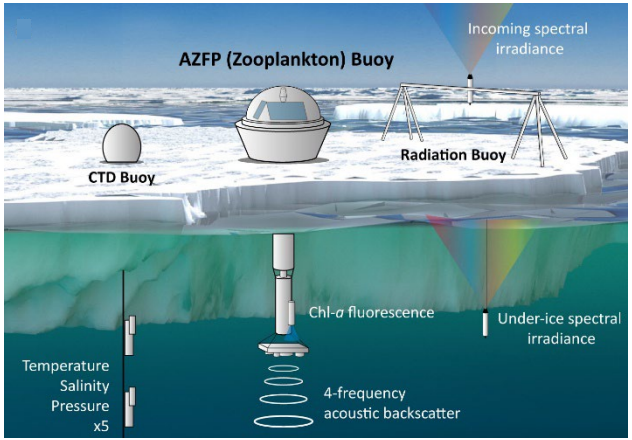
What do we need to measure zooplankton vertical migration under sea ice?

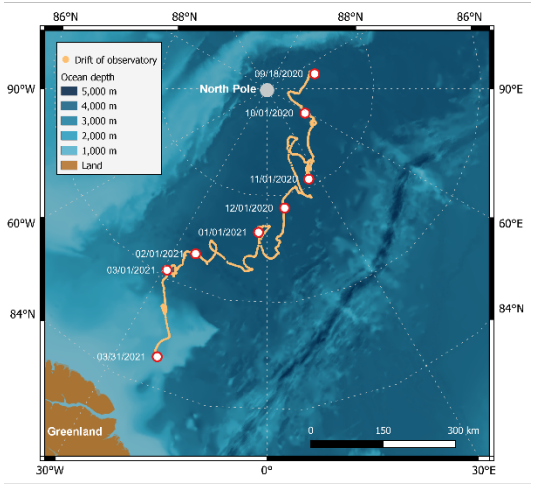
- Environment free of artificial light
- No other human disturbance (e.g. noise)
- Non-invasive sampling of under-ice habitat
  - Zooplankton
  - Light
  - Physical / BGC parameters
- Free drift



Measuring zooplankton migration under ice

Autonomous bio-physical observatory

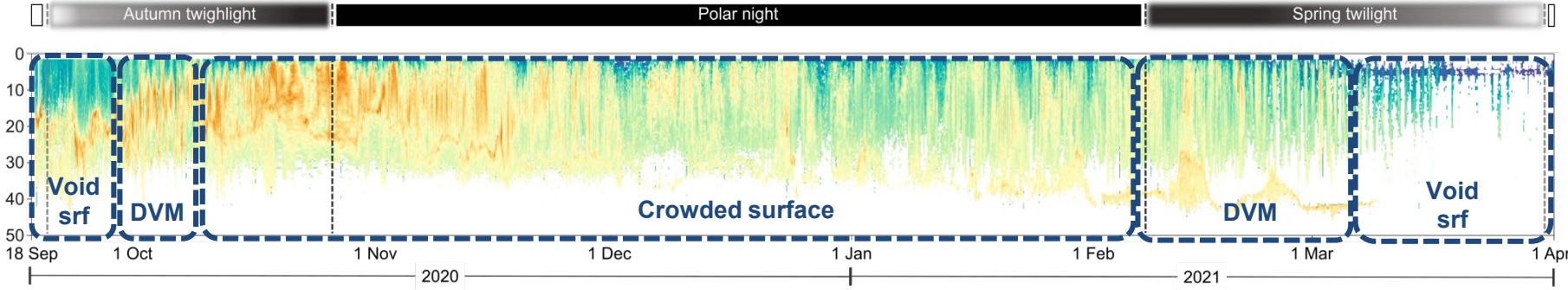


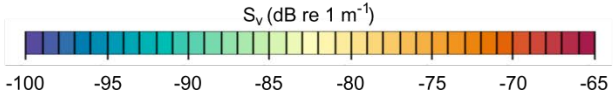


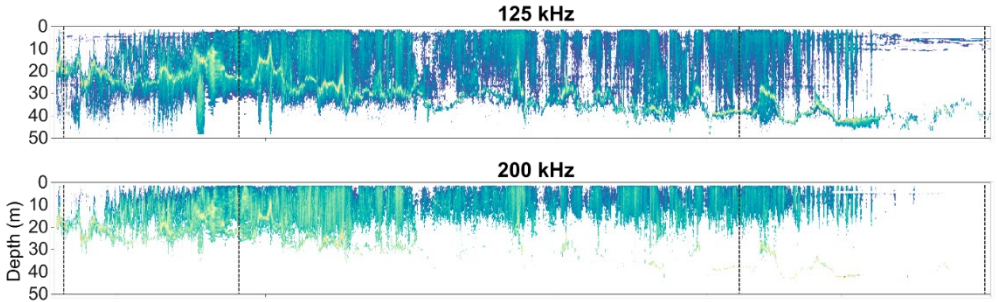
- 4-frequency echosounder
- Hyperspectral light
- Fluoresence
- Temperature, Salinity
- Near-realtime data transmission and remote programming
- Drift over 5,000 km Sep 2020 – May 2021

Measuring zooplankton migration under ice

Zooplankton backscatter @ 455 kHz







Who is behind the backscatter?

-> poster by A. Cornils **S10-P4**

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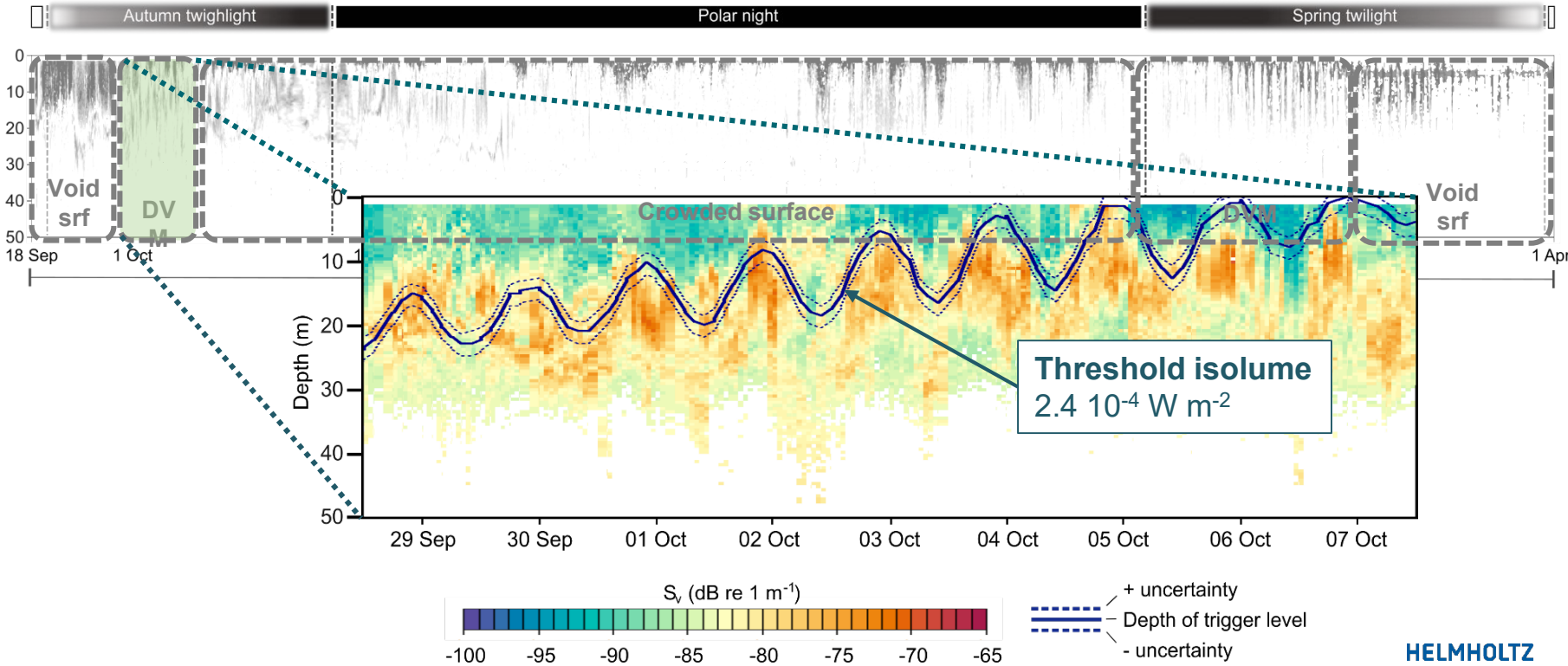
Measuring zooplankton migration under ice

Light threshold of diel vertical migration in the autumn twilight period



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Gaelle
Veyssière

Future scenarios

Input parameters

Trigger level

Twilight Irradiance (*new*)

Standard irradiance

CMIP6 Models

ACCESS-CM2

MPI-ESM1-2-HR

MRI-ESM2-0

MPI-ESM1-2-LR

SIT
SIC
SnD
Clouds
sTemp

Scenarios

Present (2015-2024)

Future (2045-2054)

SSP126 SSP585

Under-ice light field

Ensembles

Autumn

Spring

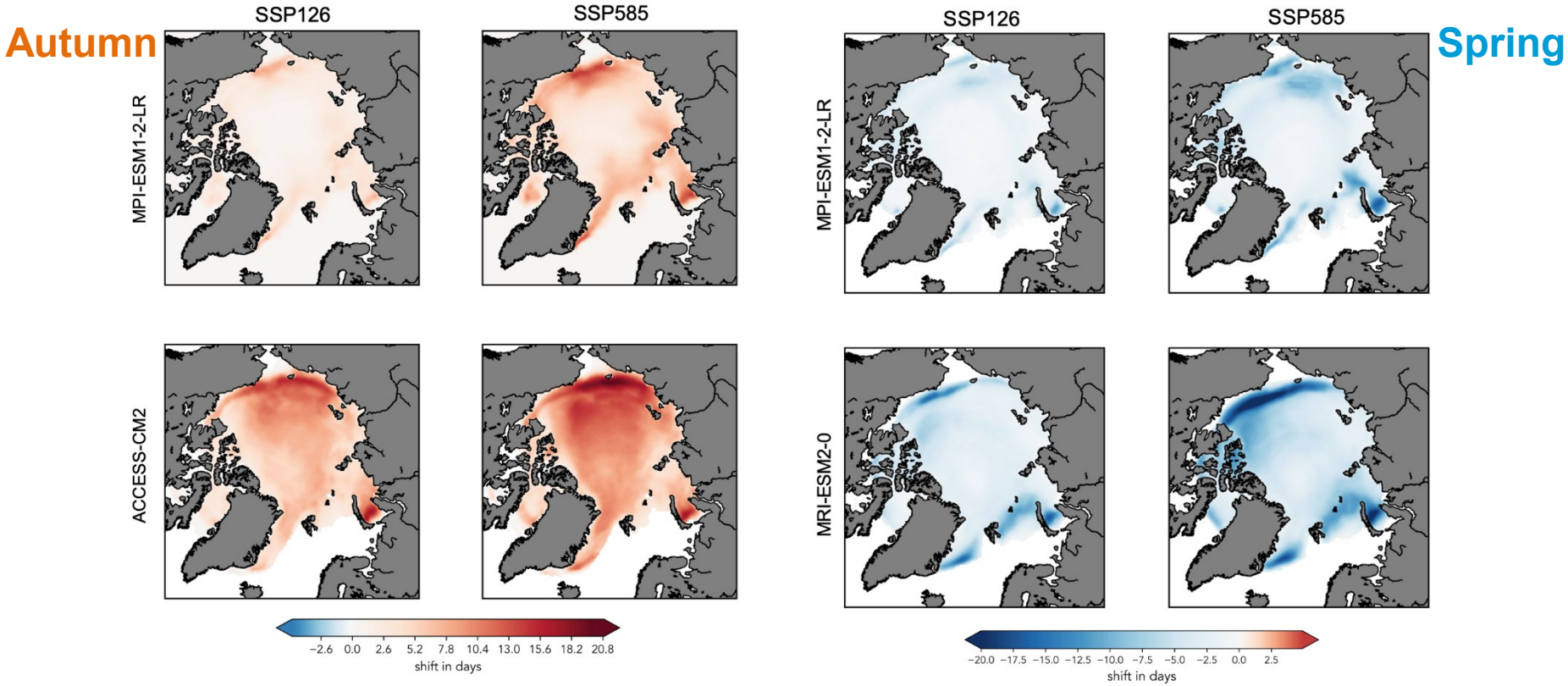
Autumn

Spring

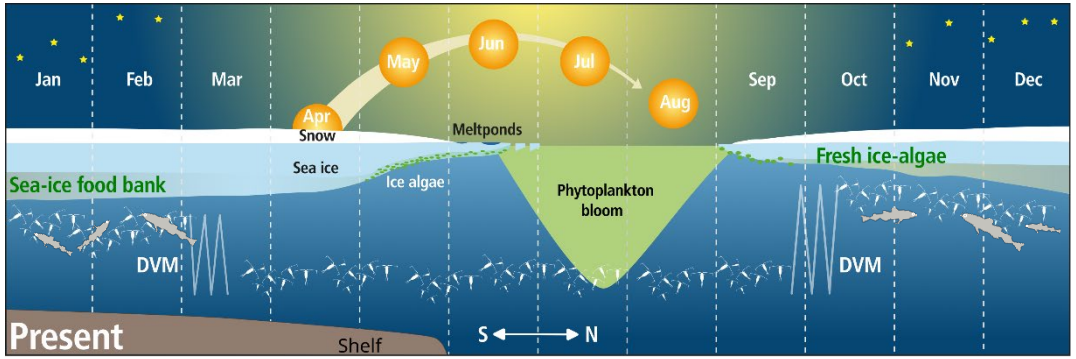
SSP126 SSP585

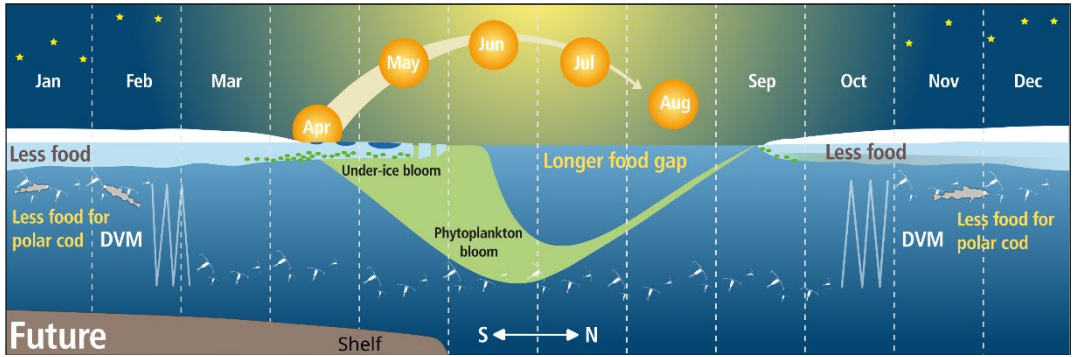
DoY when TL reaches 25 m

Potential future changes



Ecosystem implications





- Greater gap between algae blooms and arrival in the under-ice habitat
- Lower carbon stocks in the ‘sea-ice food bank’
- Reduced winter survival
- Reduced prey availability for polar cod
- Cascading effects on higher trophic levels

Conclusions

- A part of the zooplankton community permanently uses the **under-ice habitat during winter**
- Continuing sea-ice decline could mean **later autumn and earlier spring migration**
- Future changes of the under-ice light field can significantly impact on **ecological key species, ecosystem functions, and biodiversity**
- **Autonomous observatories** are key to understanding changes of the Arctic ecosystem and can be a powerful monitoring tool

Thank you!

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Paper at:
https://www.nature.com/articles/s41558-023-01779-1

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