NTNU | SFI HARVEST

ZPS 2024, Tasmania, Australia
March 19 2024

Optical and acoustic based sampling of zooplankton with autonomous vehicles

Challenges and future perspectives

Karoline Hokstad Barstein
PhD candidate
Department of Marine Technology, NTNU
karoline.barstein@ntnu.no

[1]Norwegian University of Science and Technology
[2]UiT Arctic Univeristy of Norway
[3]Akvaplan-niva
[4]SINTEF Ocean

Contributors:
Emlyn Davies[4]
Sanna Majaneva[1,3]
Emily Venables[2]
Sünnje Basedow[2]

Main supervisor:
Prof. Martin Ludvigsen[1]

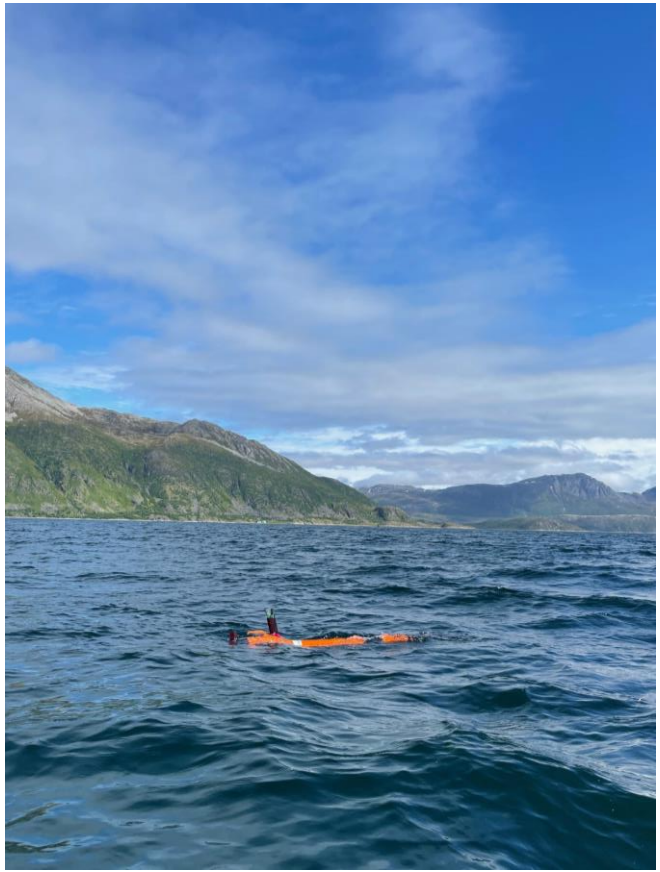
Karoline Barstein

- PhD student, NTNU
- Underwater robotics – adaptive sampling of zooplankton
- Marine engineering, computer science, computer vision
- Affiliations:
  - NTNU Department of Marine Technology
  - AUR-Lab
  - SFI Harvest

Email: karoline.barstein@ntnu.no

Zooplankton sampling

- **Autonomous systems with acoustics and optics**
  - Cover large areas in short time
  - Real-time information
  - High space-time resolution
  - Less human labour
  - Less/no ship time

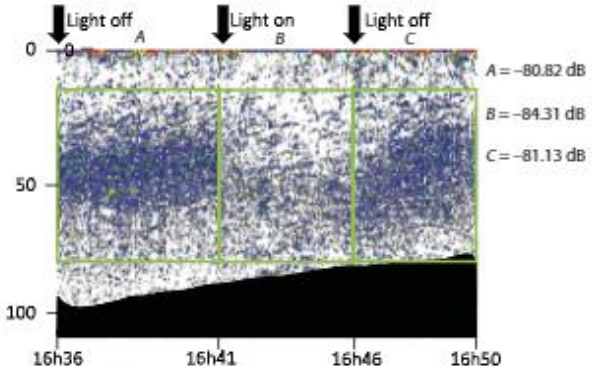


Tools

- Autonomous underwater vehicle (AUV)
  - EK80 scientific echo sounder
  - In-situ particle imager (SilCam)

- Unmanned surface vehicle (USV)
  - EK80 scientific echo sounder

Zooplankton response to artificial light



Ludvigsen et al., 2018

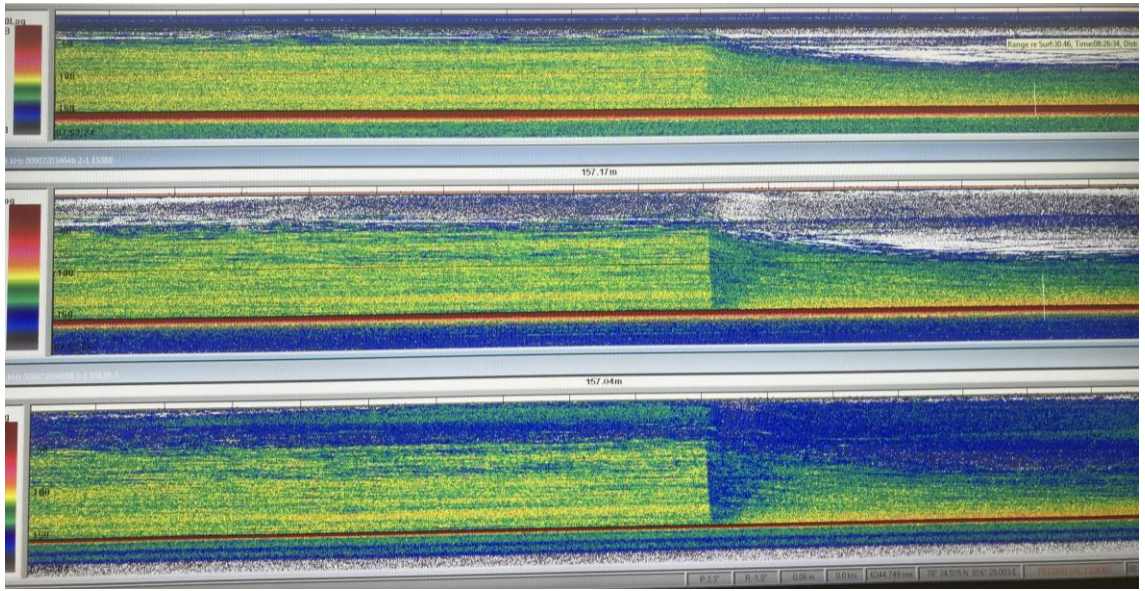


Image: NTNU/AUR-Lab

Profiling frame experiments

- Optical and acoustic instruments
- Profiling net samples
- Season: summer (June)

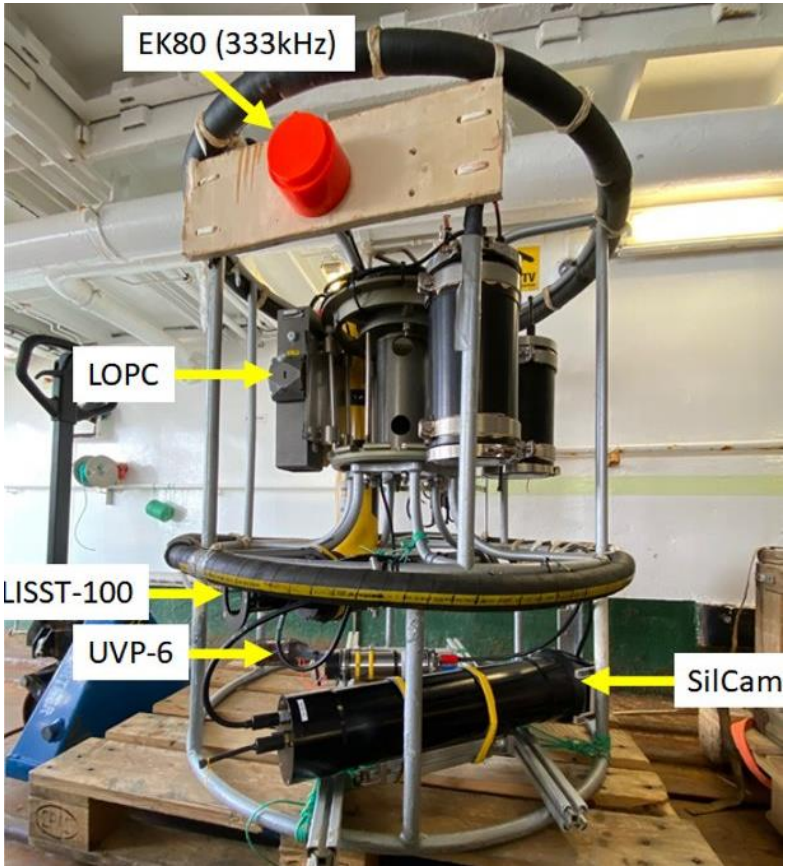
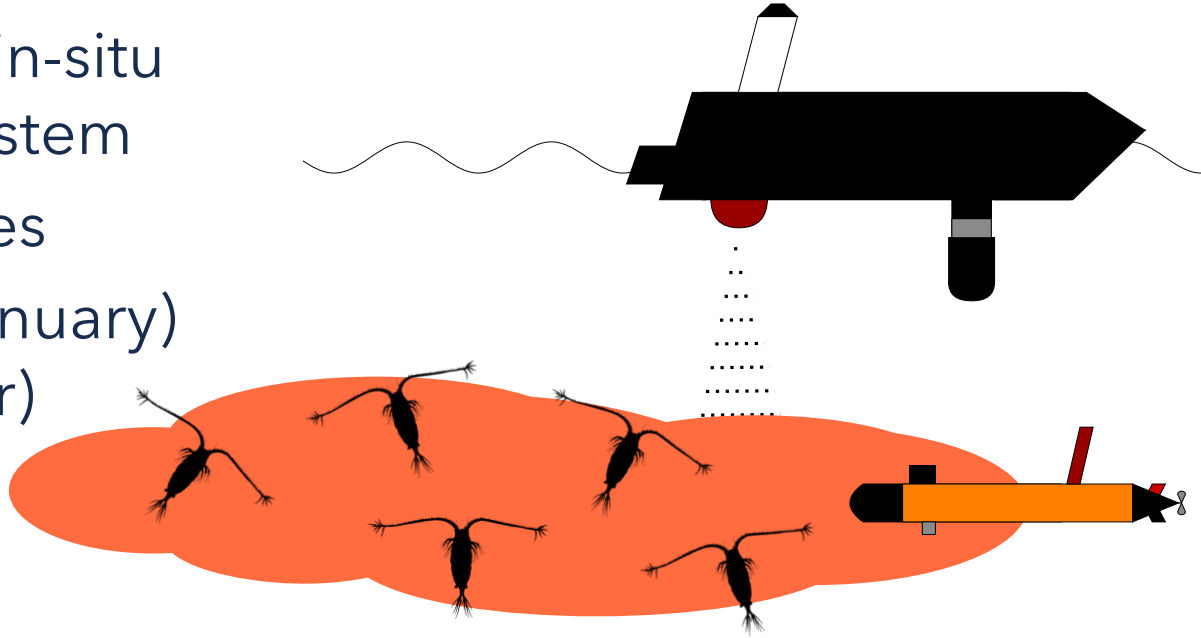


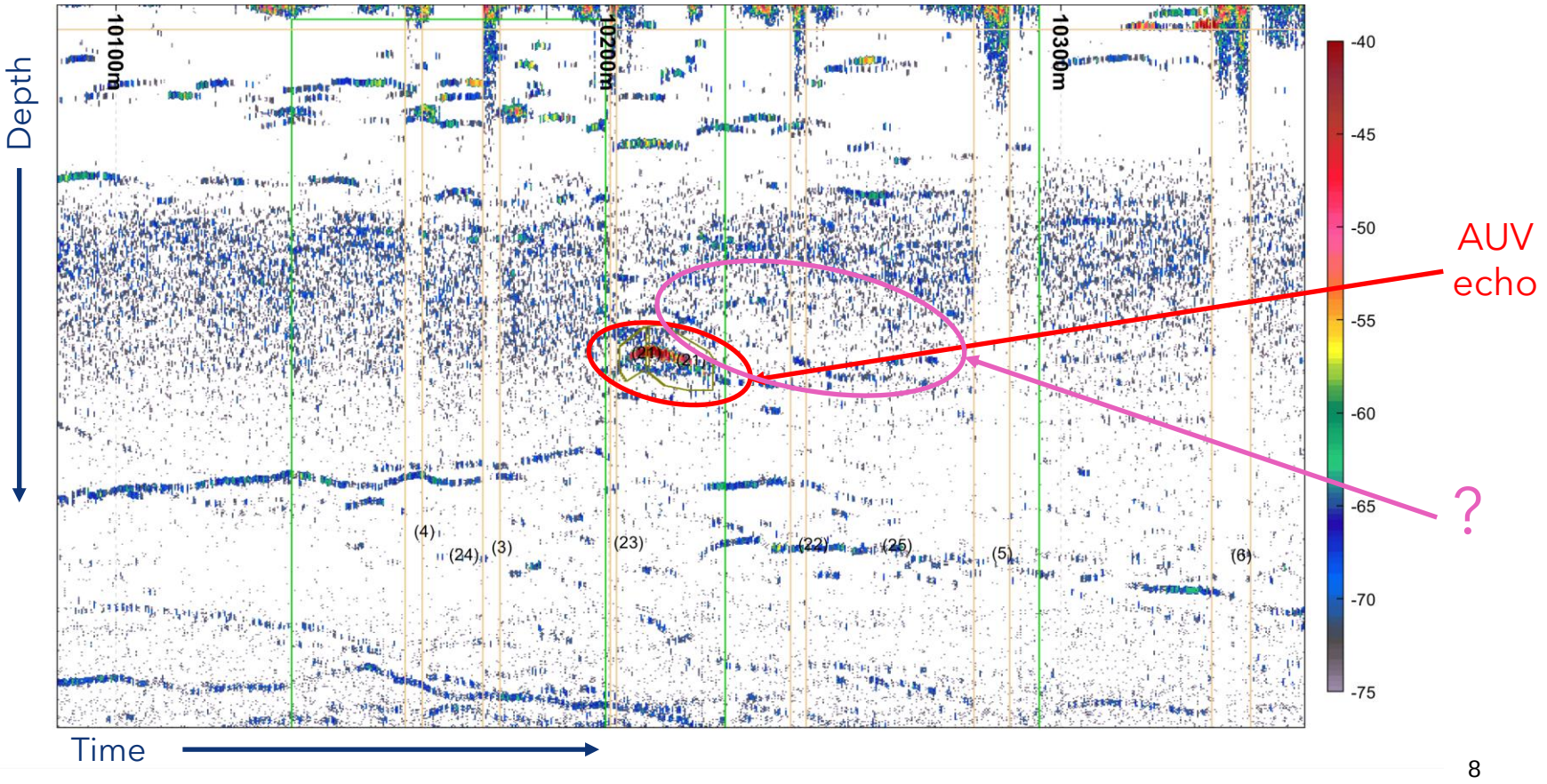
Image: Emlyn Davies/SINTEF

AUV and USV collaborative experiments

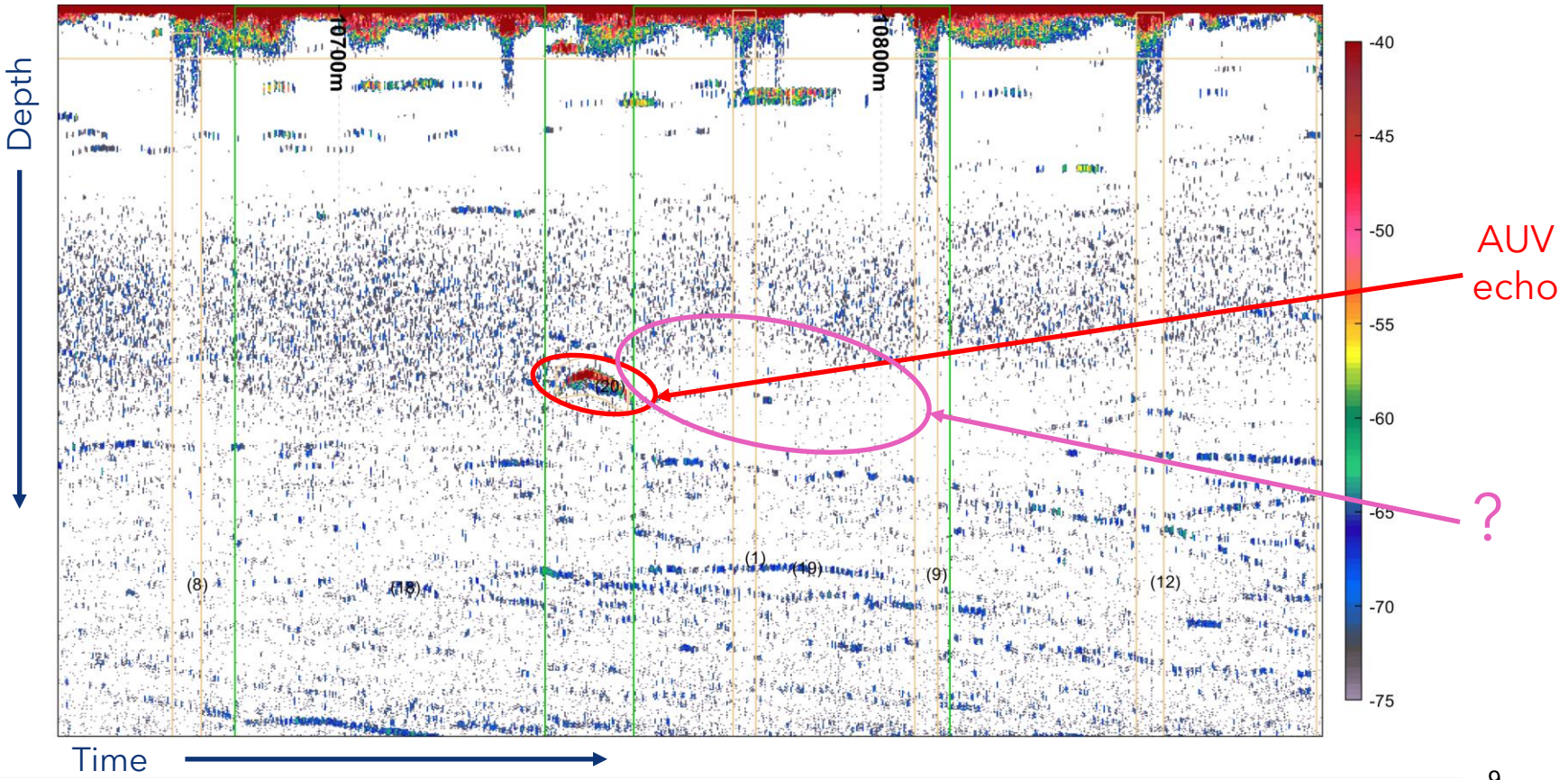
- Echo sounder and in-situ particle imaging system
- Profiling net samples
- Seasons: winter (January) and fall (September)



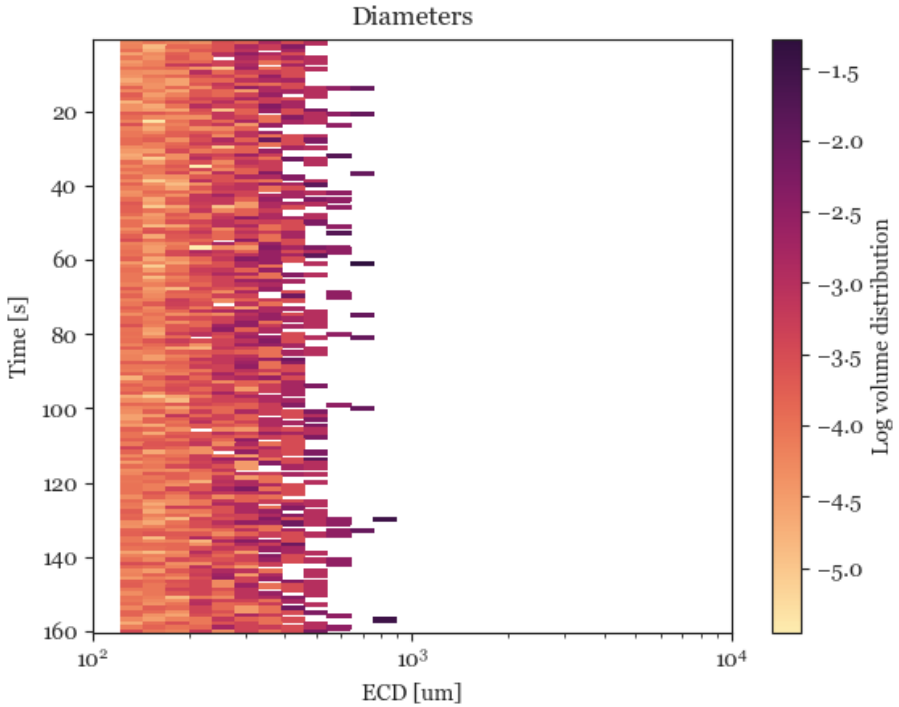
January – echogram 1



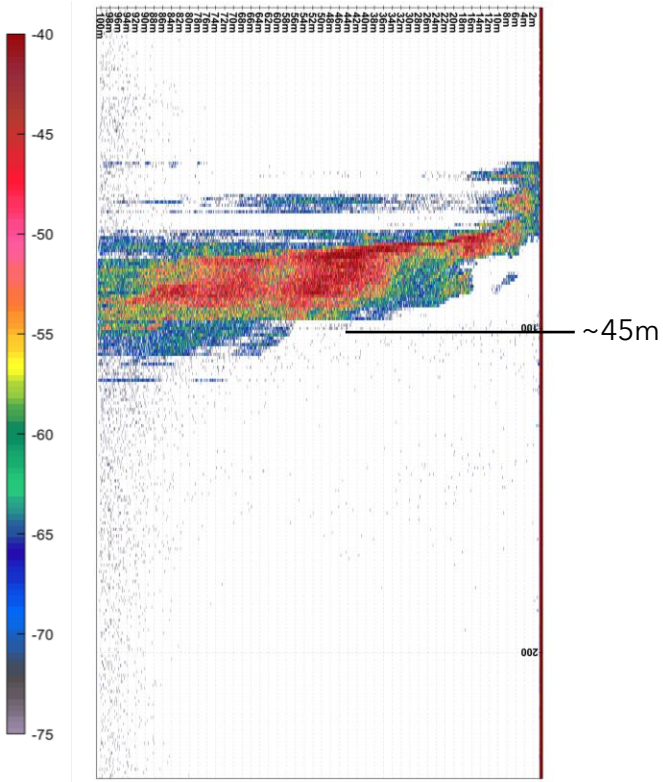
January – echogram 2

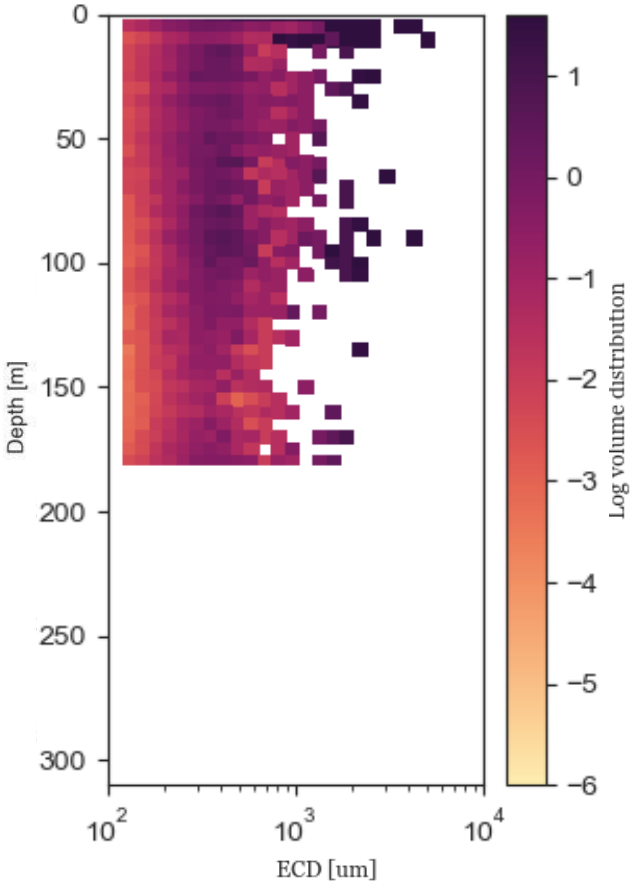


January – particle size distribution

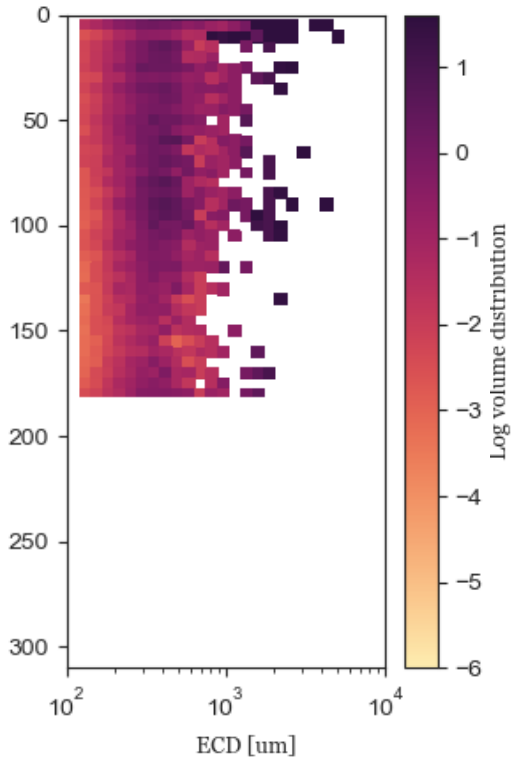


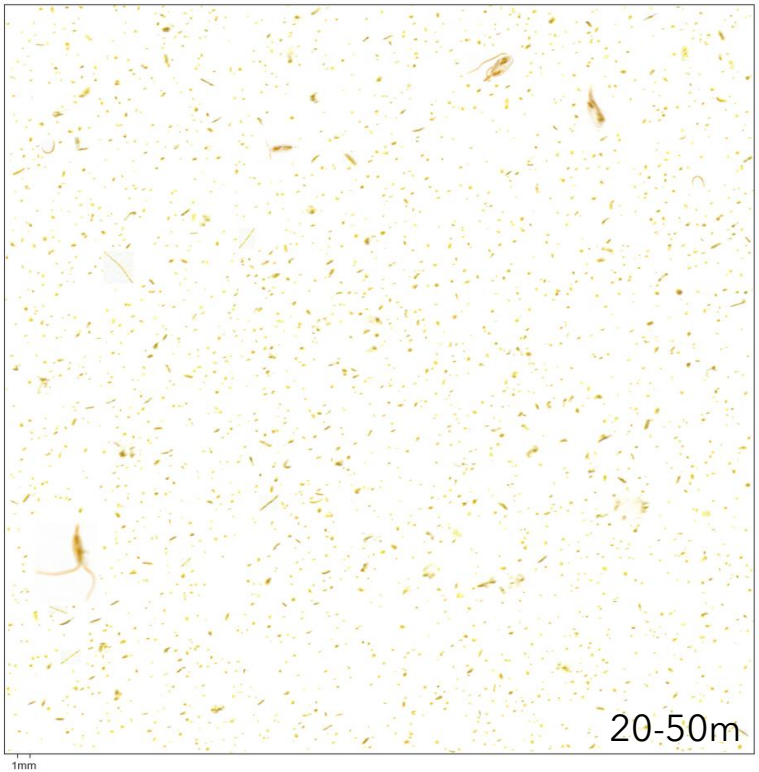
June


-40
-45
-50
-55
-60
-65
-70
-75
~45m

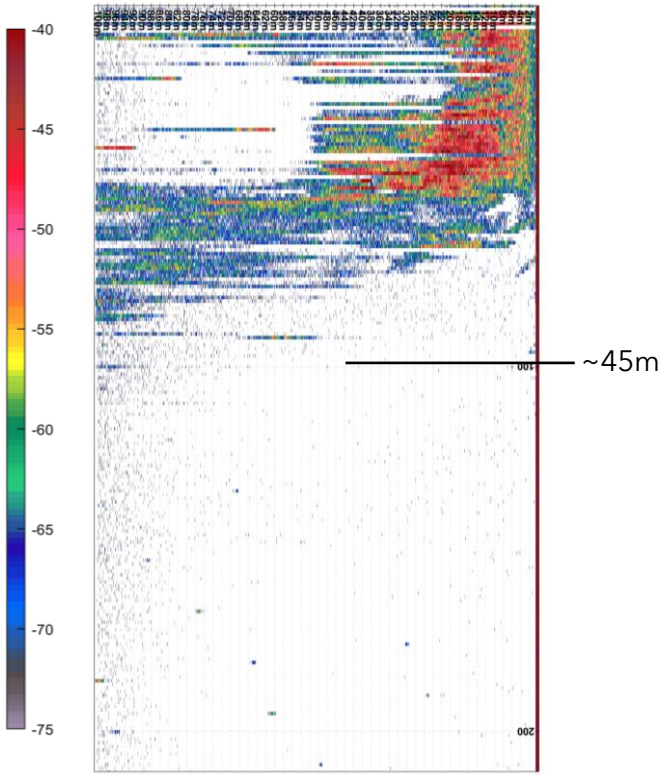

0
50
100
150
200
250
300
Depth [m]
10^2
10^3
10^4
ECD [um]
1
0
−1
−2
−3
−4
−5
−6
Log volume distribution

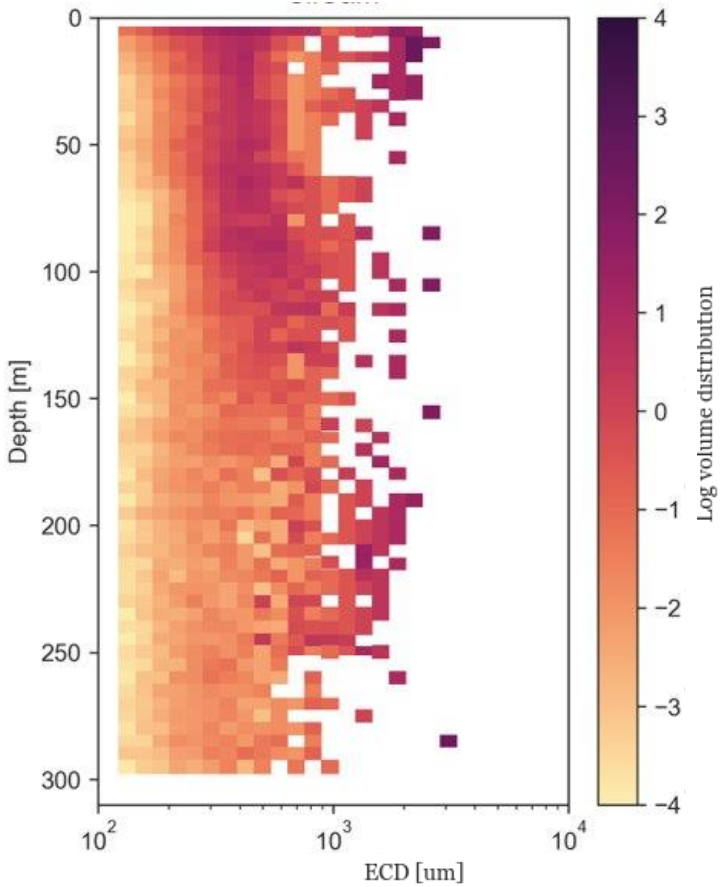
June – particle size distribution



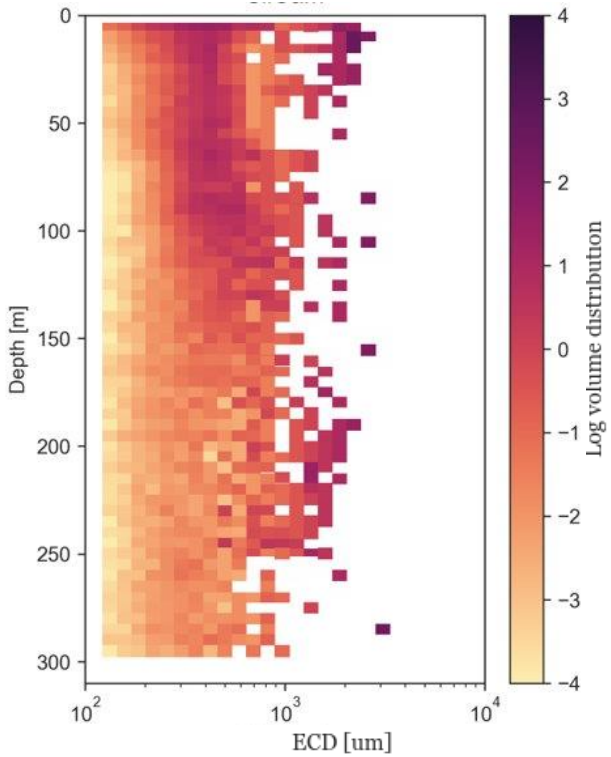


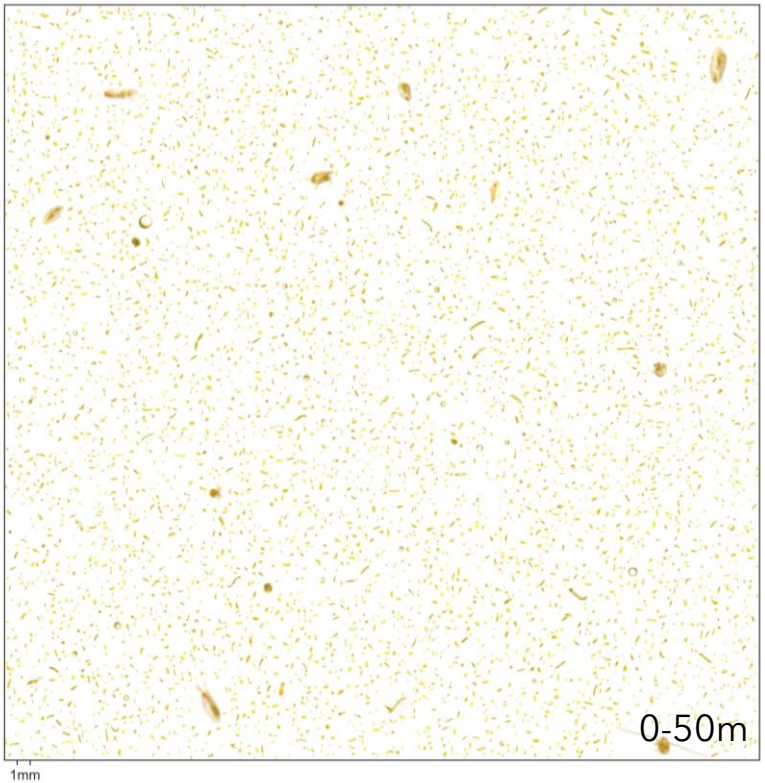
June


-40
-45
-50
-55
-60
-65
-70
-75
~45m

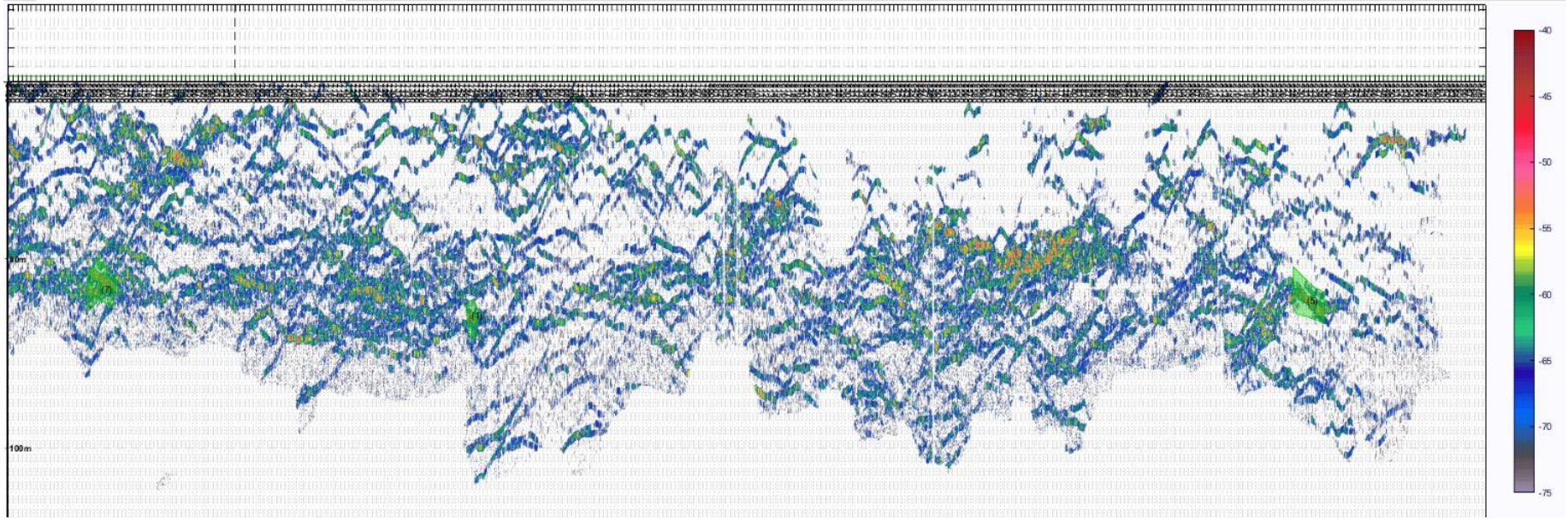

0
50
100
150
200
250
300
Depth [m]
10^2
10^3
10^4
ECD [um]
4
3
2
1
0
−1
−2
−3
−4
Log volume distribution

June – particle size distribution

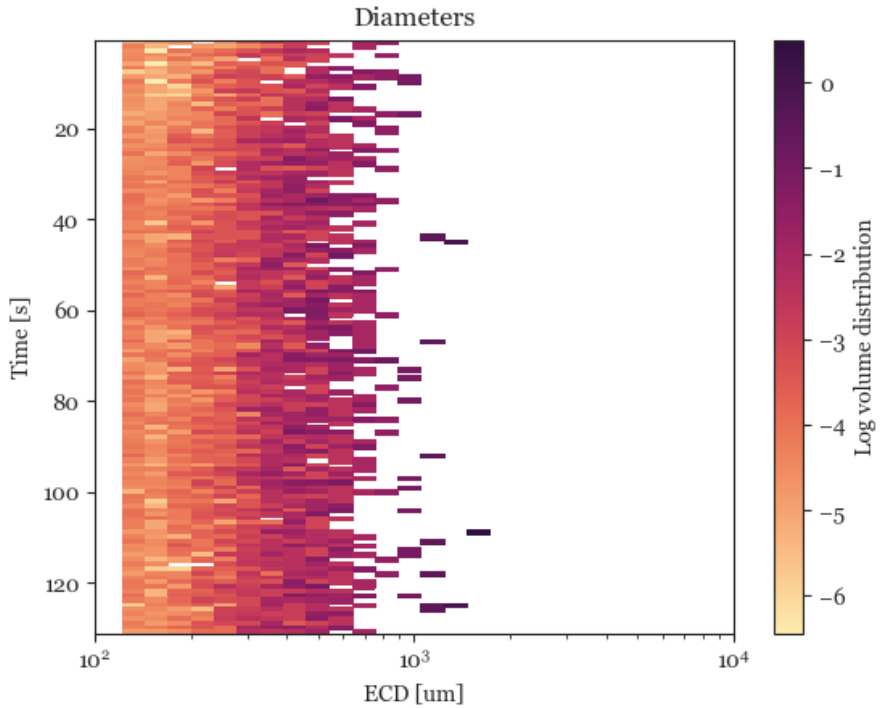


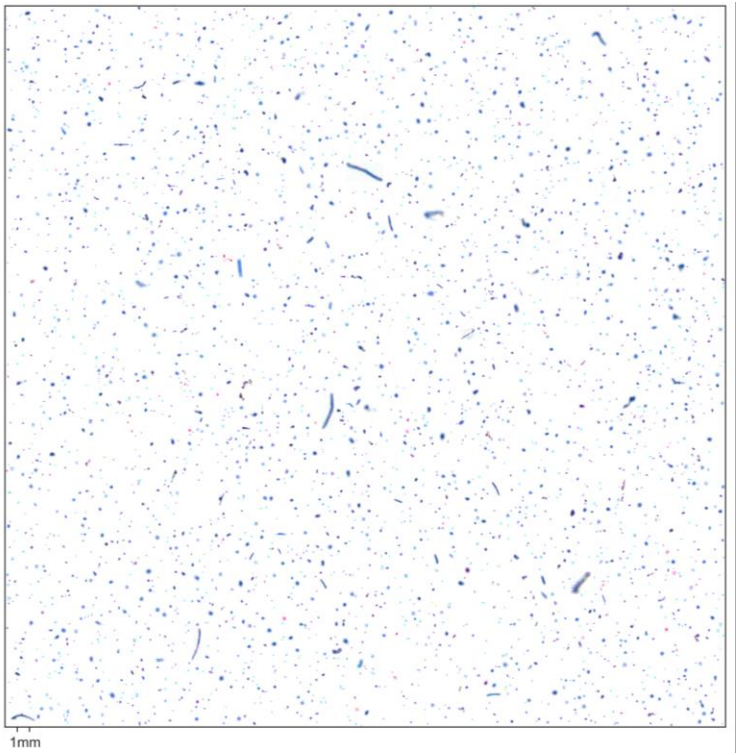


September - echogram



September – particle size distribution



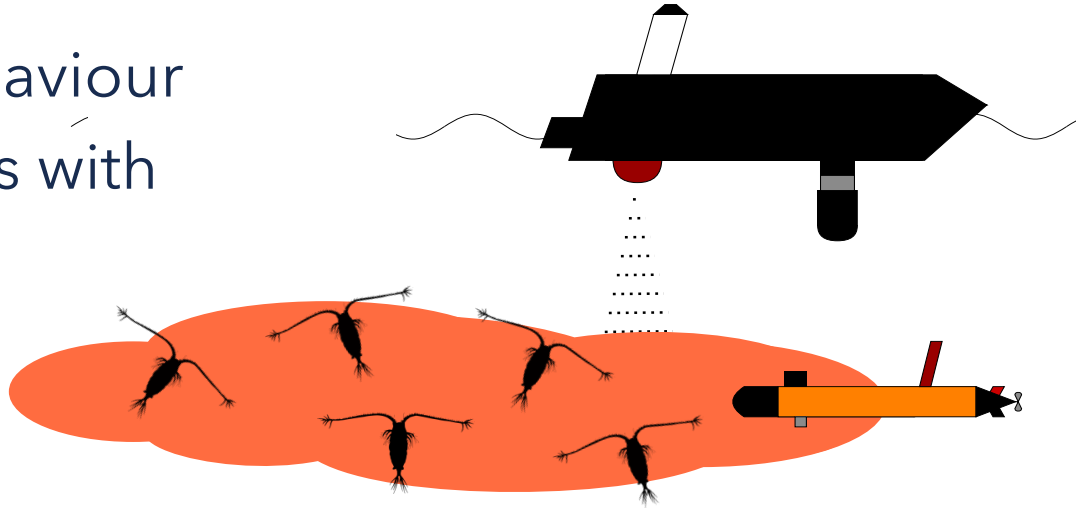


To sum up:

- As expected, more  in June, less in Jan and Sept
- Relationship between optical and acoustic data
- Challenging to quantify correlation between optical and acoustic data
- Avoidance behaviour is only observed qualitatively
- Great potential in robotic quantification of zooplankton!

Future work

- Improve sources of information
  - Camera improvement, camera placement on vehicle
- Address avoidance behaviour
- Fully robotized methods with reliable estimates!



References

- Ludvigsen, Martin & Berge, Jørgen & Geoffroy, Maxime & Cohen, Jonathan & Torre, Pedro & Nornes, Stein & Singh, Hanumant & Sørensen, Asgeir & Daase, Malin & Johnsen, Geir. (2018). Use of an Autonomous Surface Vehicle reveals small-scale diel vertical migrations of zooplankton and susceptibility to light pollution under low solar irradiance. Science Advances. 4. eaap9887. 10.1126/sciadv.aap9887.
- Bandara, Kanchana. & Varpe, Øystein. & Wijewardene, Lishani & Tverberg, Vigdis & Eiane, Ketil. (2021). Two hundred years of zooplankton vertical migration research. Biol Rev, 96: 1547-1589. 10.1111/brv.12715

This work was supported by

- The Research Council of Norway through the Centre for Research-based Innovation funding scheme, SFI Harvest, project number 309661
- The Research Council of Norway through the Centre of Excellence funding scheme, NTNU AMOS, project number 223254
- The Research Council of Norway, The Nansen Legacy, project number 276730

NTNU | Norwegian University of Science and Technology

SFI HARVEST

AURLab

Thank you for your attention!

Questions? Please contact me at karoline.barstein@ntnu.no

ZPS 2024, Tasmania, Australia
Karoline Hokstad Barstein
karoline.barstein@ntnu.no
March 19 2024