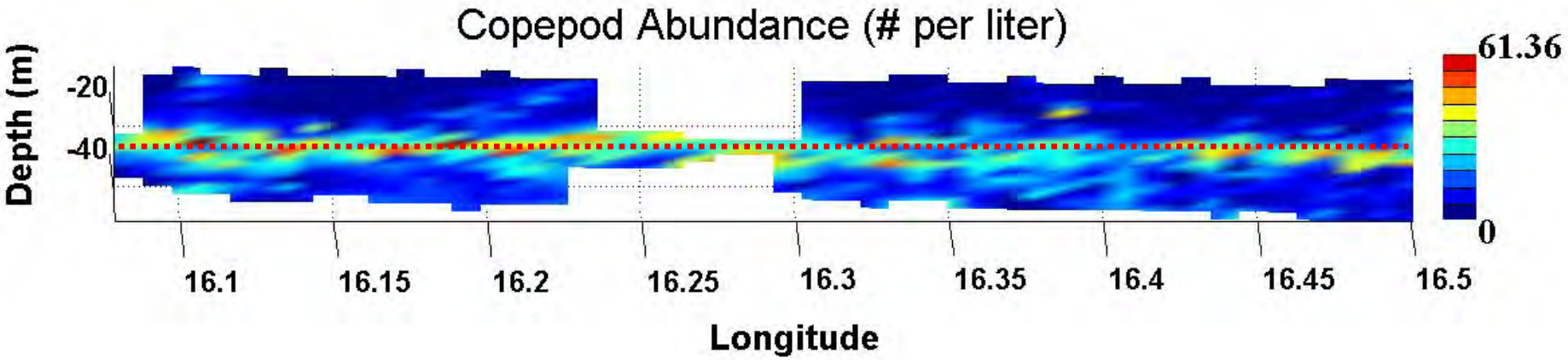
Resolving the small-scale distribution of plankton and marine snow: Unravelling the role of thin layers using optical techniques

Klas Ove Möller, Christian Möllmann, Axel Temming and Michael St. John

Introduction: Thin Layers and their ecological role

- **„Thin Layers“ - vertically thin patches of organisms occurring on scales from tens/cm to m.**

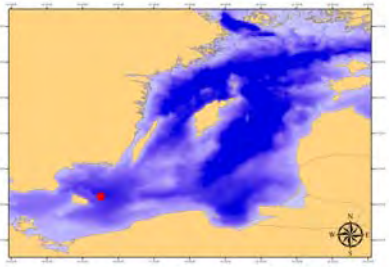


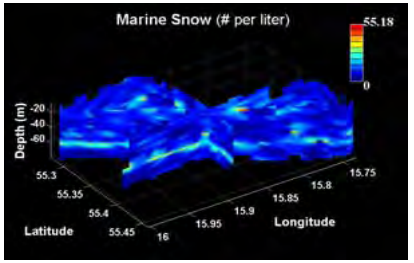
- **Patchiness and spatial overlap are a key for predator prey interactions in stratified marine systems.**

- **Marine snow: aggregates of detritus, inorganic matter and microorganisms = potential food source for zooplankton (e.g. Dilling et al., 1998 / Wilson & Steinberg, 2010) - undersampled & underrated?**

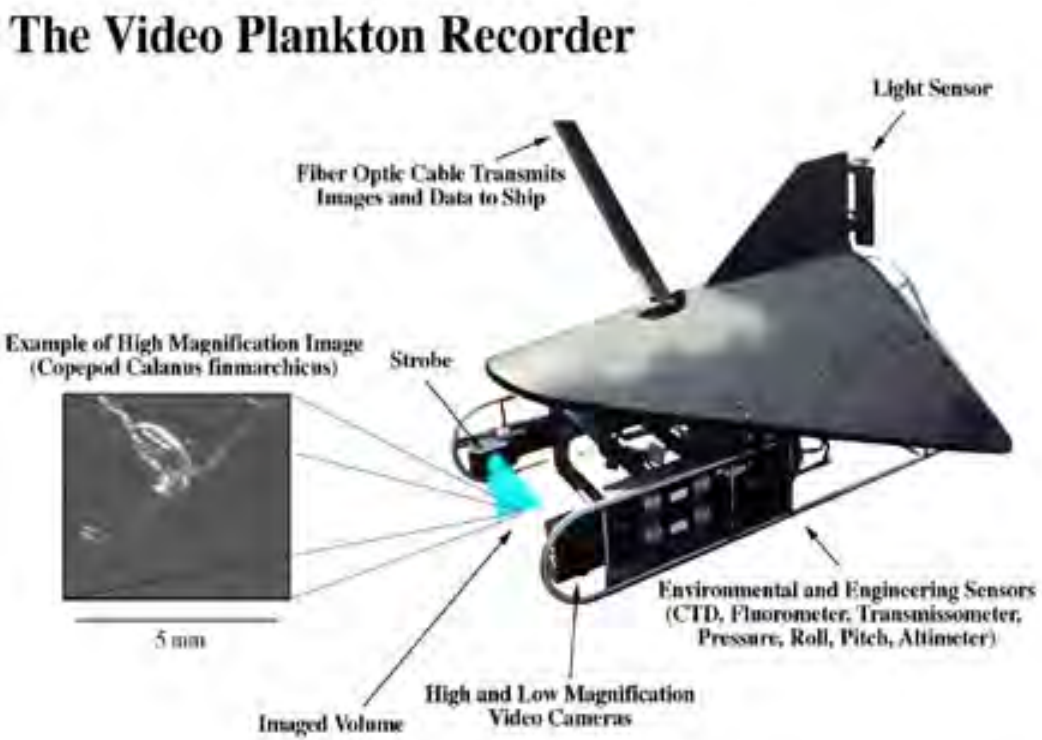
Aims of this study

- ***to resolve*** **the vertical small-scale distribution of zooplankton and marine snow in a highly stratified marine ecosystem.**
- ***to identify*** **the zooplankton species utilizing thin layers and aggregations of marine snow.**
- ***to elucidate*** **trophic interactions relative to thin layers and patchiness.**





Methods: The Video Plankton Recorder (VPR) Seascan Inc.



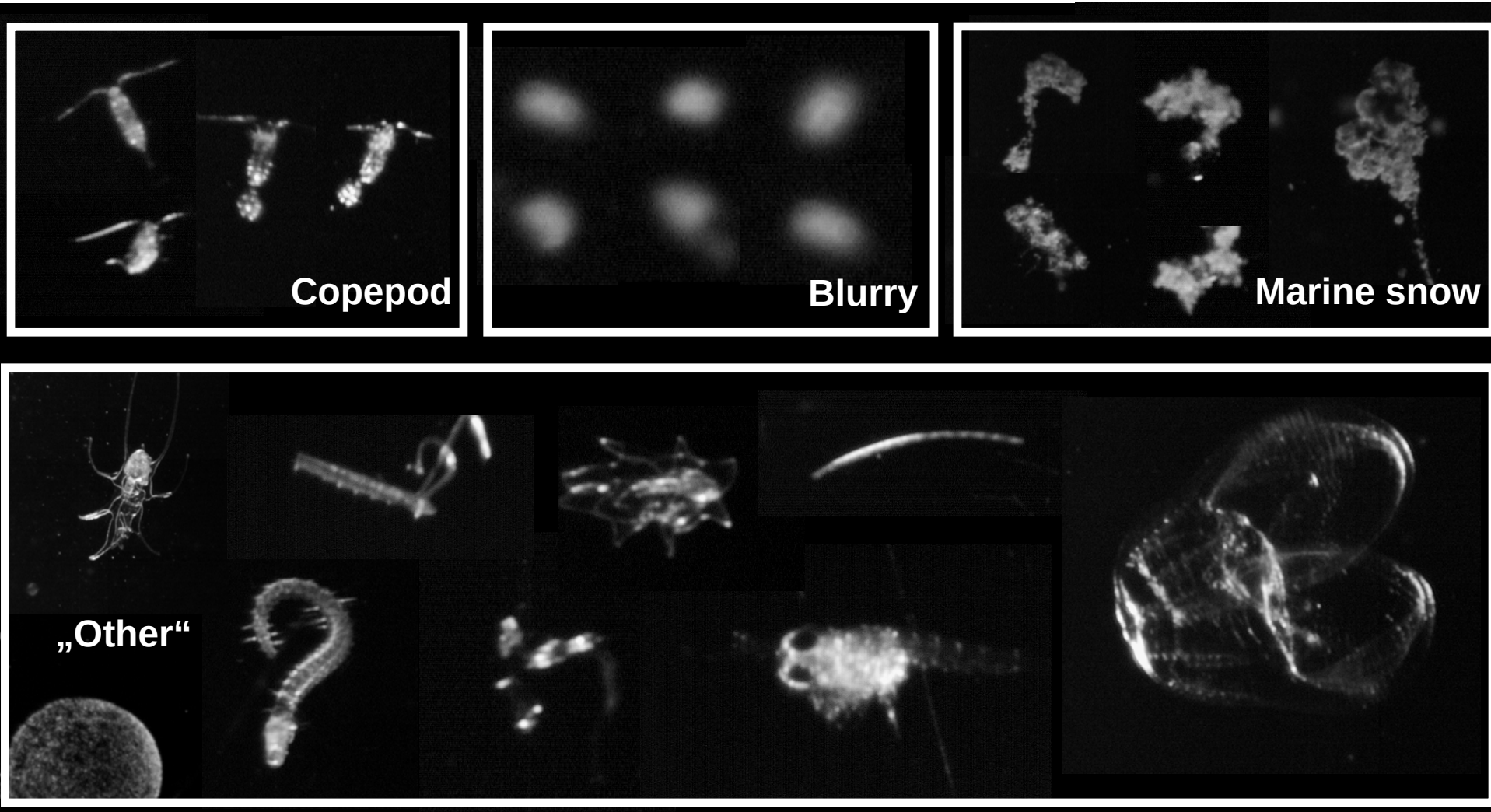
- **Towed „underwater microscope“**
- **Equipped with CTD, Turbidity-, Fluorescence-, PAR-, and Flight-control sensors**
- **Images (25fps) are combined with sensor data from log file (1s)**
- **Image volume = 1.45ml (DoF 7x7mm)**
- **Real-time sampling via fibre-optics**
- **Non-destructive sampling of delicate organisms on small-scales**

Methods: Data processing & classification

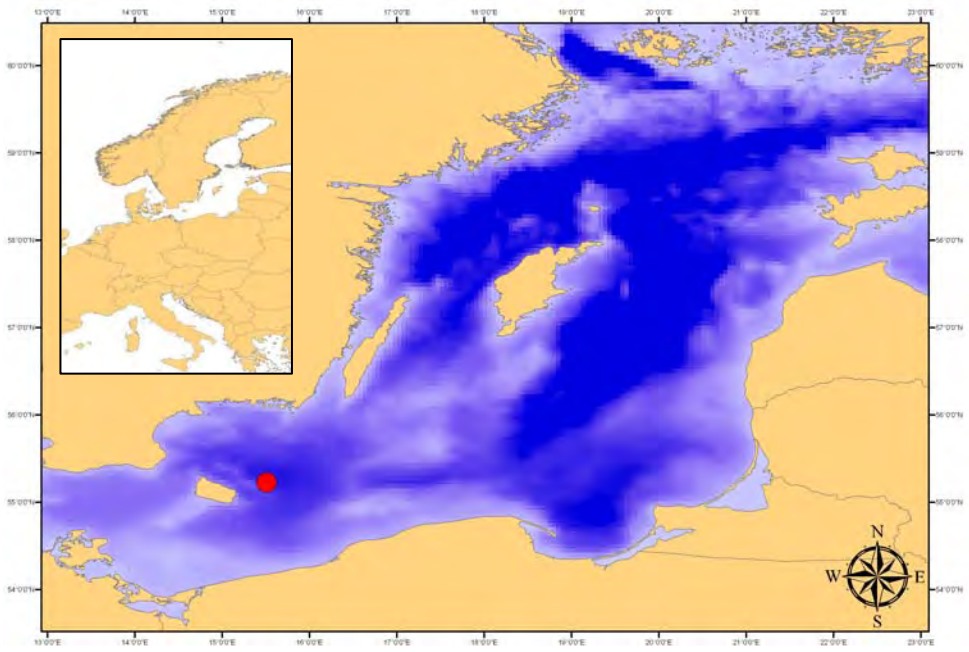
- **„ROIs“ are extracted from each image**

- **Classifier categories: Copepoda, Marine snow, Blurry and „Other“**
- **Automatic classification of high abundant categories with dual classification (Support vector machine & Neural network) and automatic correction (Hu & Davis, 2006)**
- **Results were checked manually**
- **Groundtruthing was performed with a Multinet (300µm)**

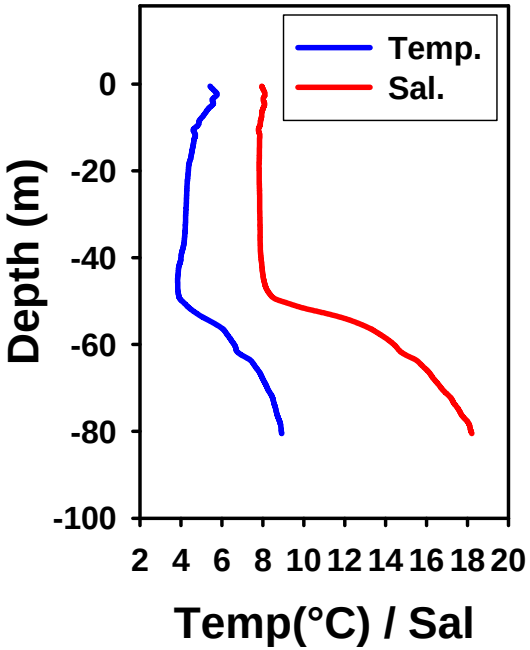
Images of taxonomic categories



The Baltic Sea

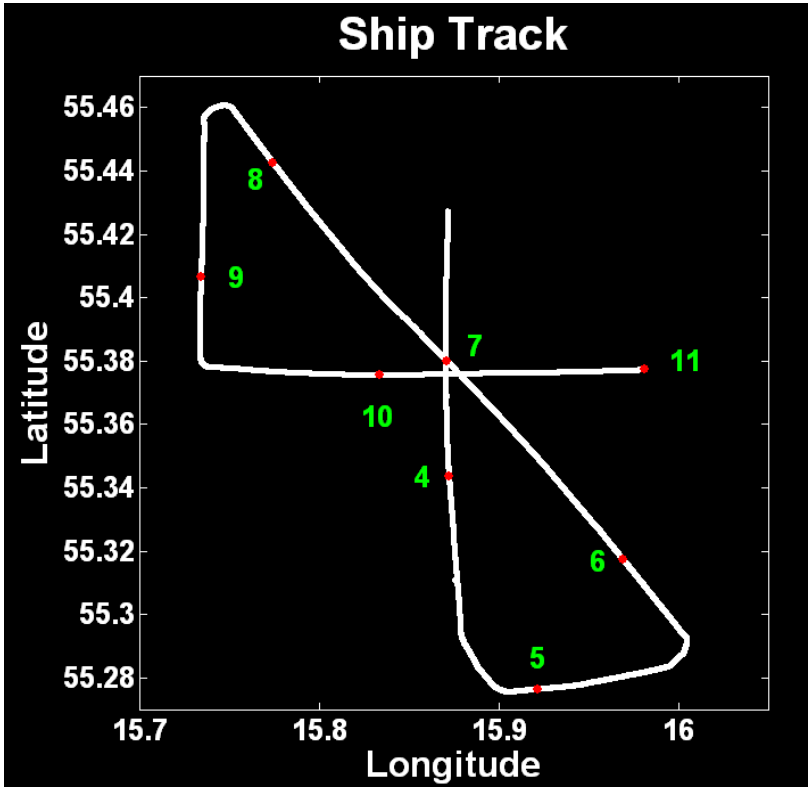


Vertical hydrographic Profile



- **Largest brackish water system in the world.**
- **Characterised by strong thermal & saline gradients.**
- **Low oxygen concentrations below the halocline.**
- **Ventilation of deep basins depends on inflows from the North Sea.**

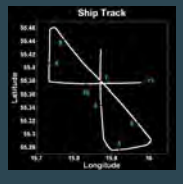
Sampling Design

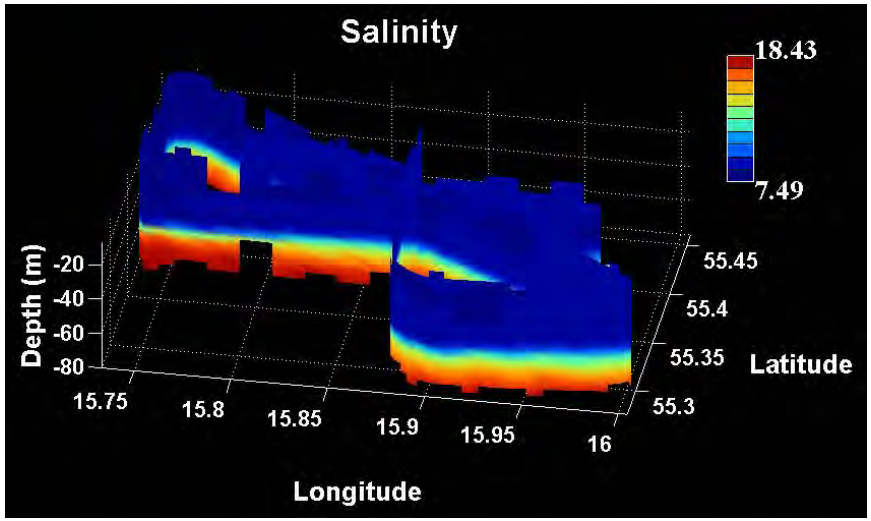


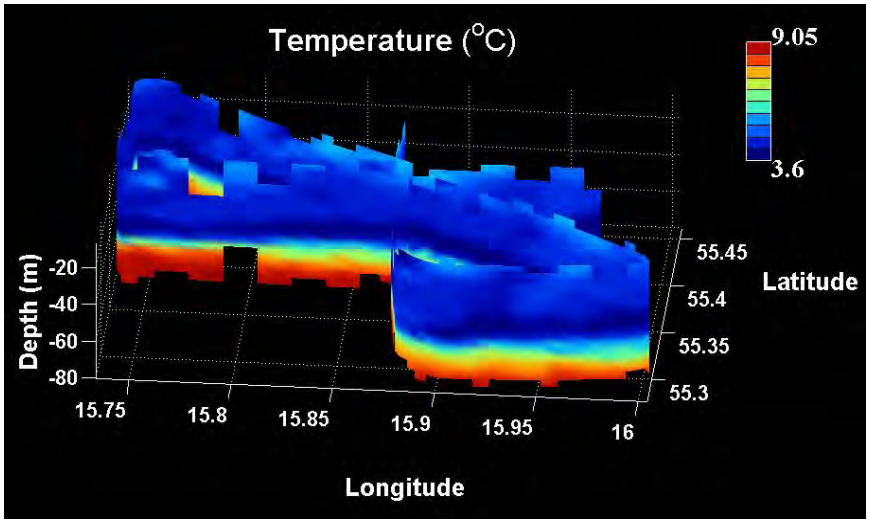
- Data was obtained during spring bloom conditions on a cruise on April 26th 2002 between 3am and 11am.
- The VPR was undulated from 8m above the bottom to 8m below the surface in relation to a permanent station in order to resolve vertical gradients.

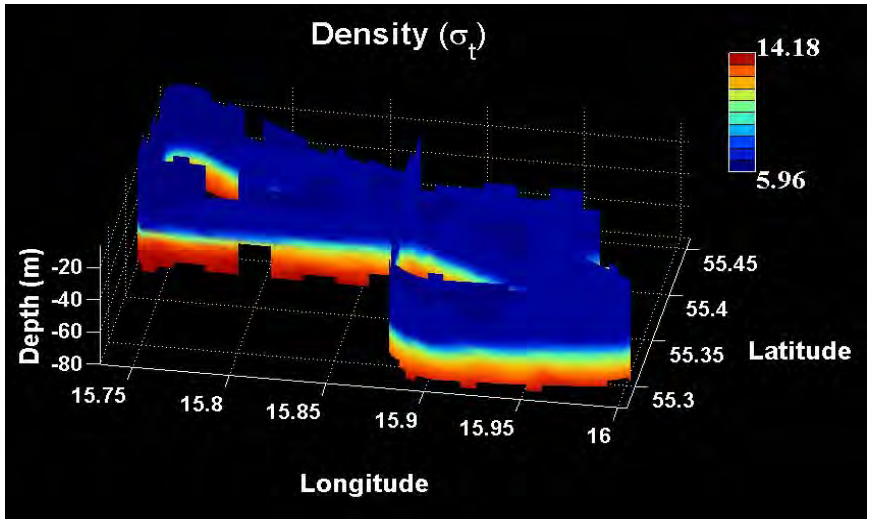
Tow #	Time	Total ROI #	Sampling Vol. (l)	Sampling depth (m)
3	08h	40366	1691.7	75,1m

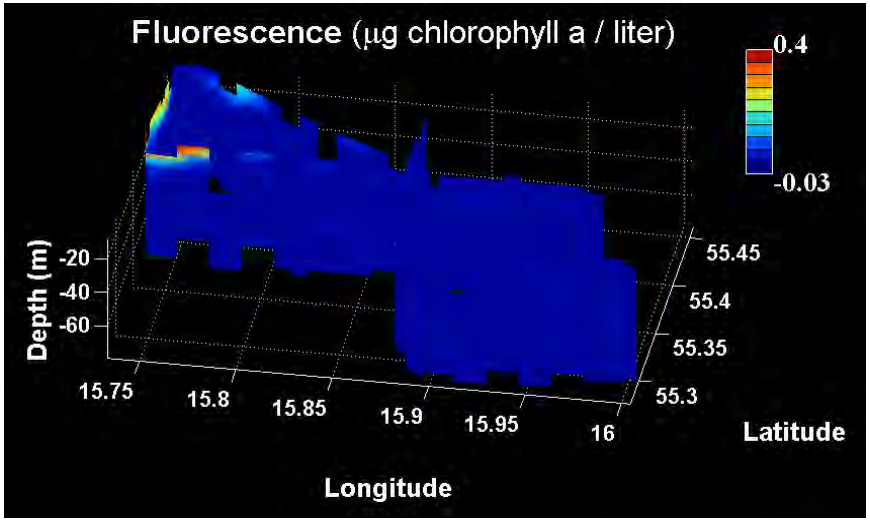
Results: Hydrography - Strong vertical gradients



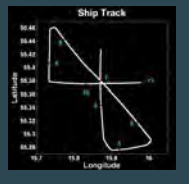


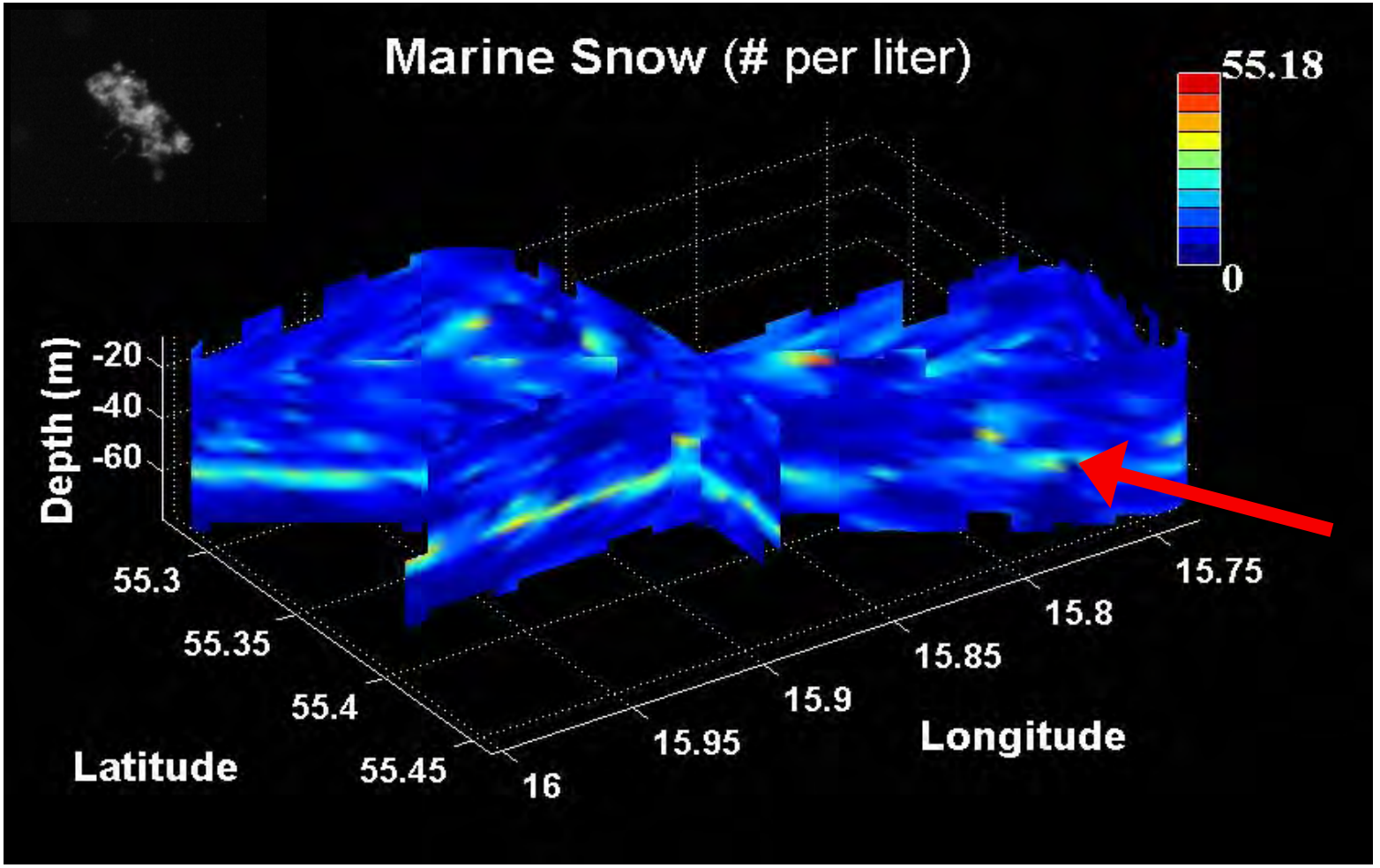




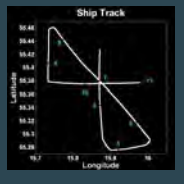


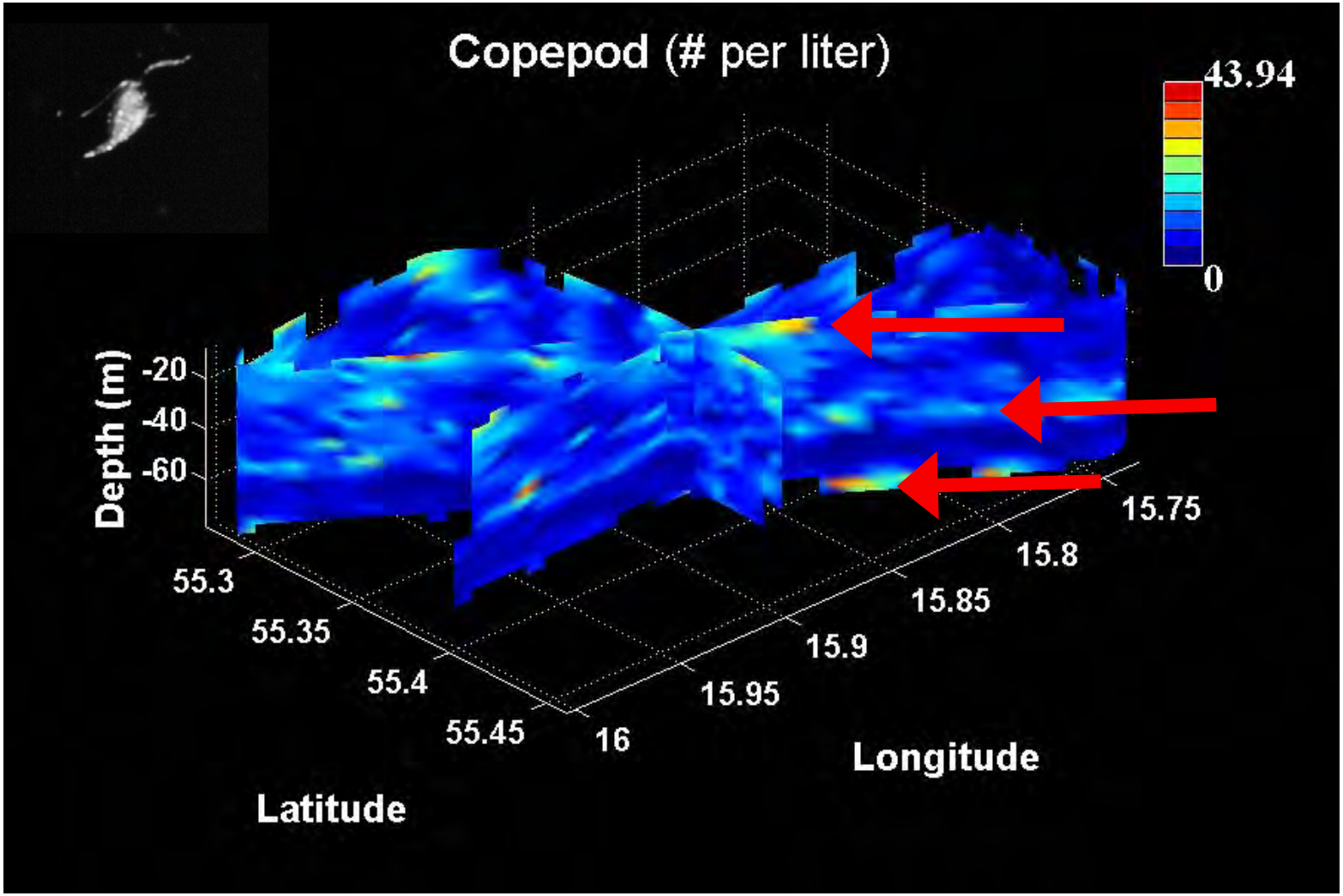
Results: Marine Snow Distribution





Results: Copepod Distribution





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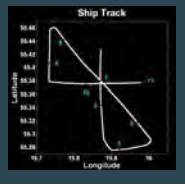

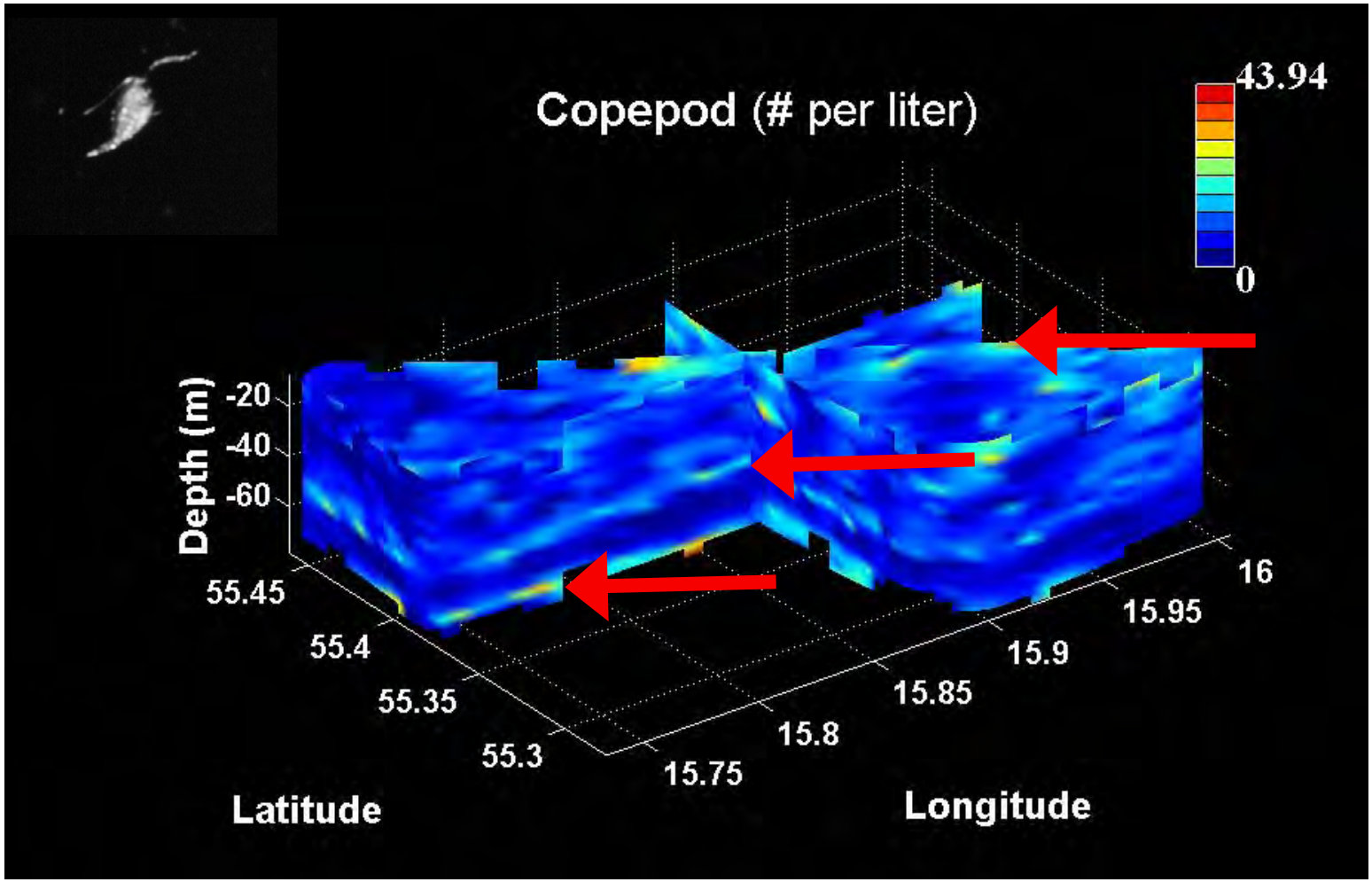

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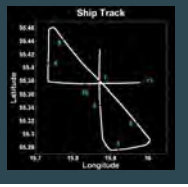
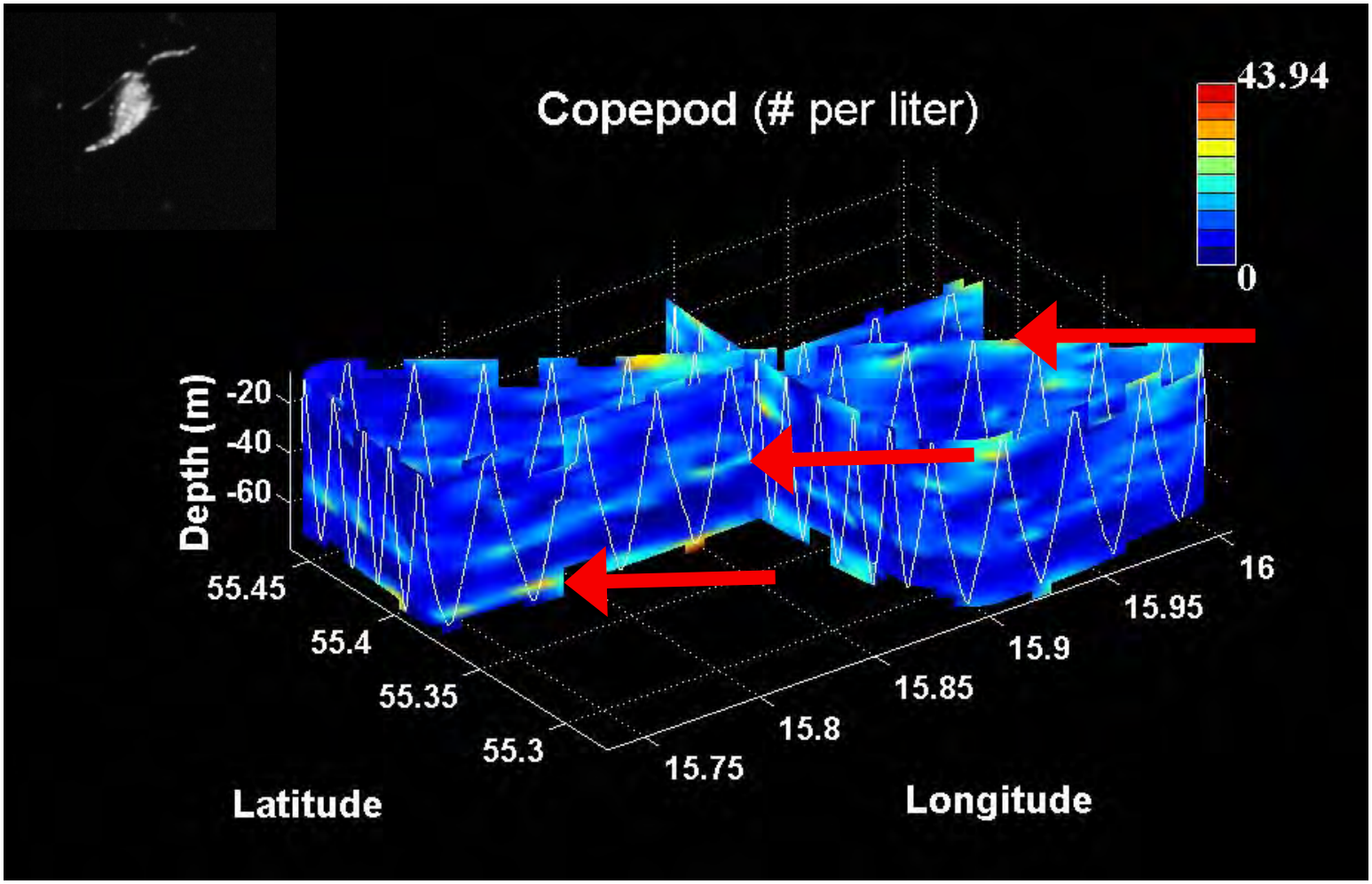
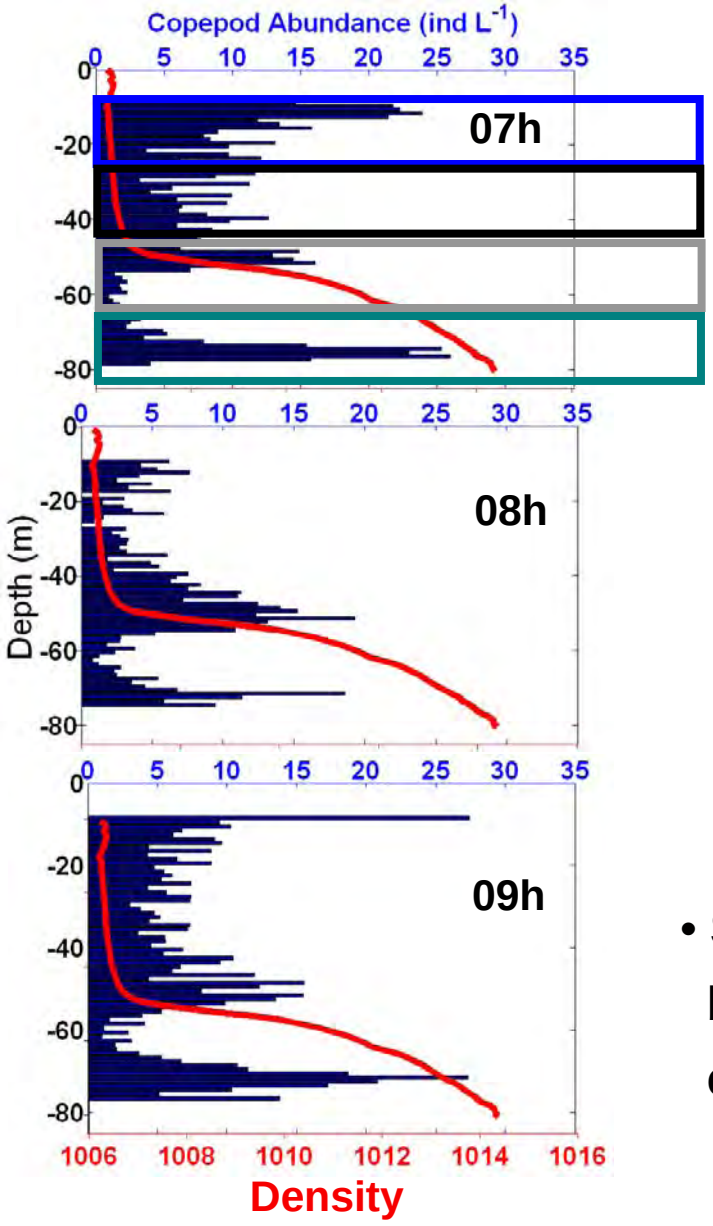
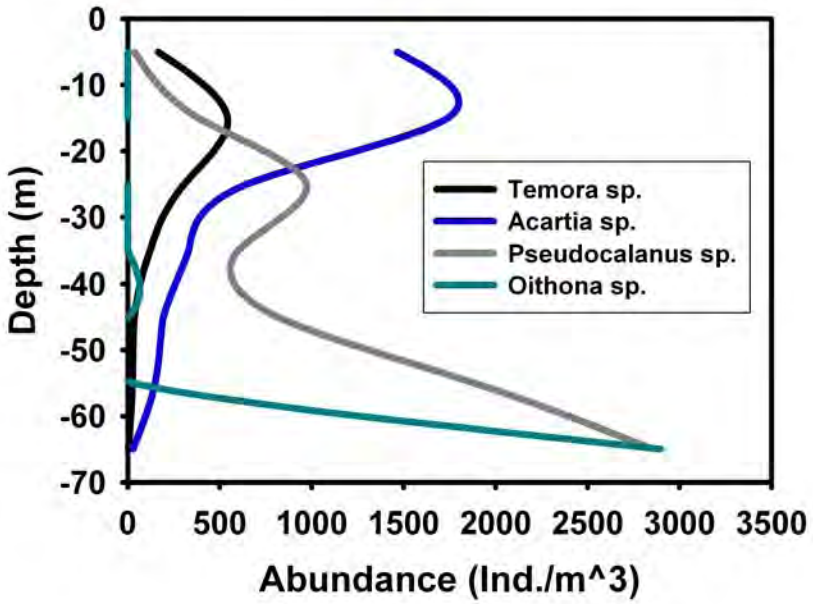




Results: Vertical distribution / species resolution

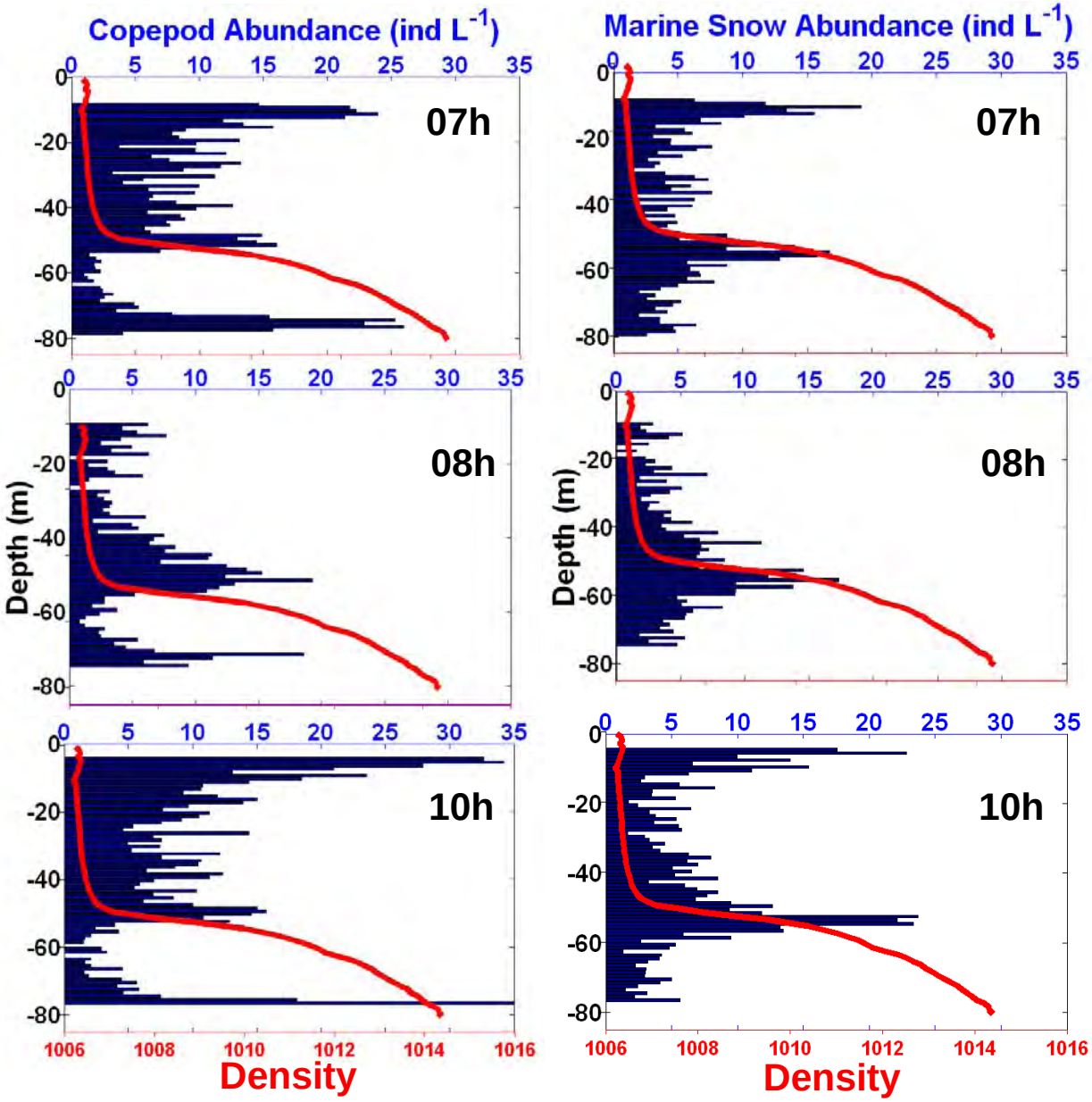


Copepod species distribution from Multinet

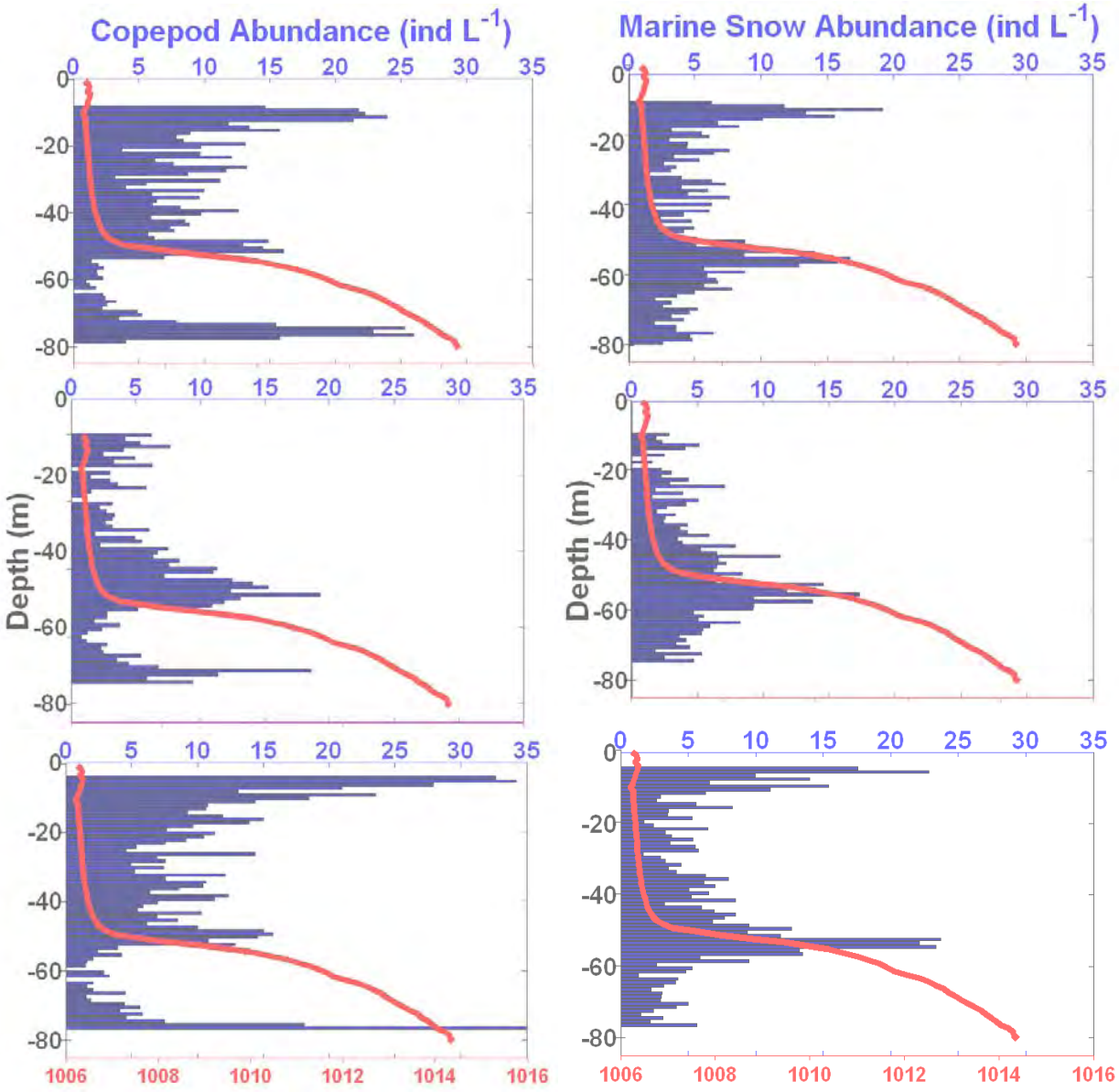


- **Species specific abundance patterns can be related to thin layers and water column characteristics.**

Results: Vertical distribution



Results: Vertical distribution



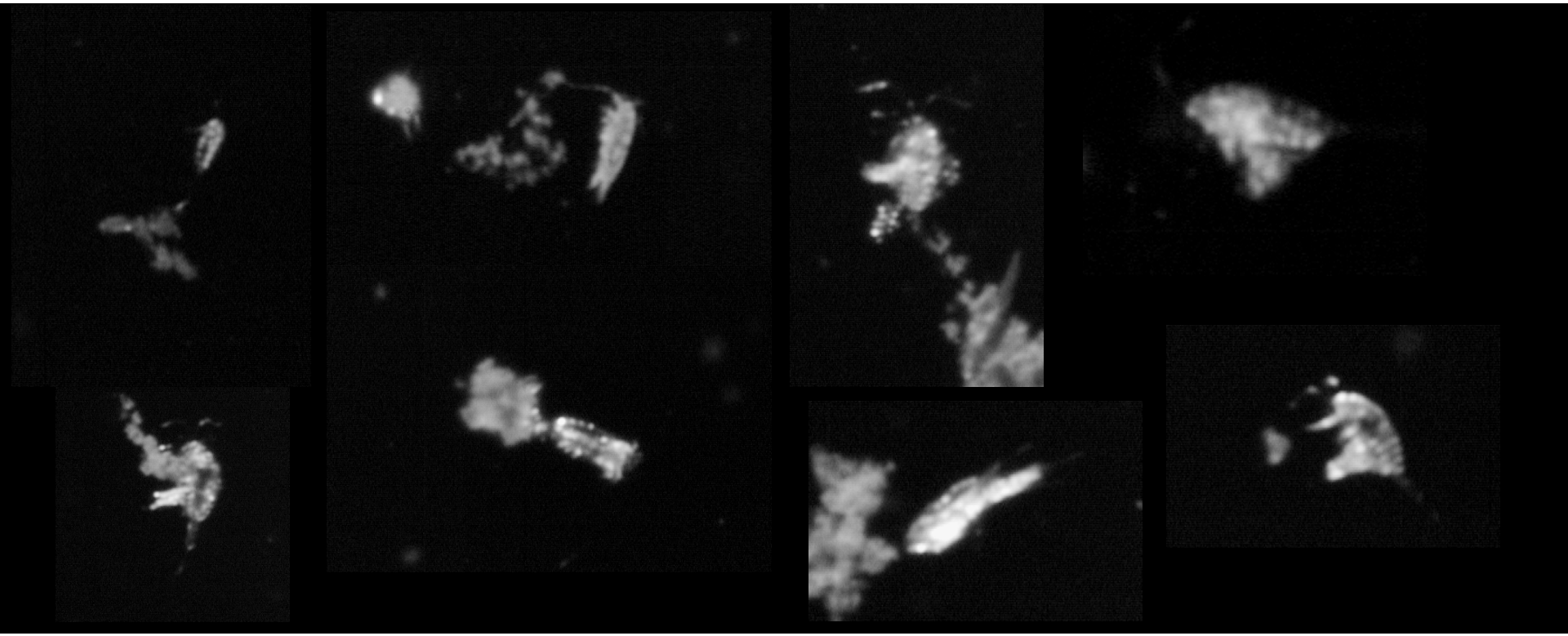
Correlation Coefficients

Hour 07	Copepod
Marine snow	0,22
Density	-0,18
Temperature	-0,07
Salinity	-0,17

Hour 08	Copepod
Marine snow	0,25
Density	-0,02
Temperature	-0,11
Salinity	-0,03

Hour 10	Copepod
Marine snow	0,35
Density	-0,28
Temperature	-0,12
Salinity	-0,26

Results: Ecological Interactions



- **Feeding on/in marine snow**
- **Spatial overlap & interaction**
- **Non-disturbed behaviour i.e. feeding position of antenna**

Summary

…to resolve the vertical small-scale distribution of zooplankton and marine snow in a highly stratified marine ecosystem:

- **First observations showing pronounced thin layers of zooplankton and organic particles in the Baltic Sea.**

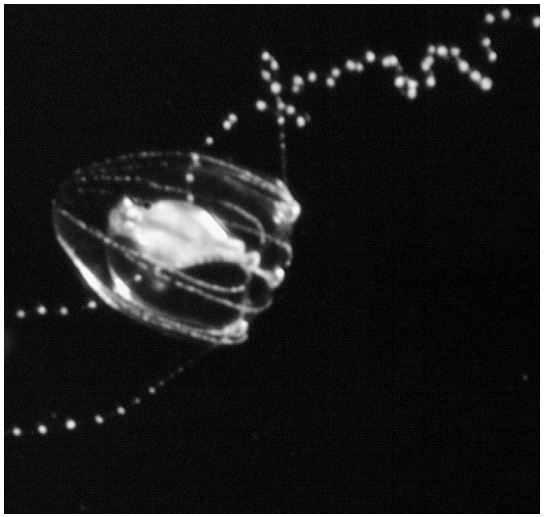
…to identify the zooplankton species utilizing thin layers and aggregations of marine snow:

- **Species specific overlap with thin layers of marine snow were identified.**

…to elucidate trophic interactions relative to thin layers and patchiness:

- **Indications of marine snow as a potential food source for *Pseudocalanus sp.* in thin layers in the Baltic Sea.**

Thank You!



References:

- Dilling, L., Wilson, J., Steinberg, D.K., Alldredge, A.L. (1998) Feeding by the euphausiid *Euphausia pacifica* and the copepod *Calanus pacificus* on marine snow. Mar Ecol Prog Ser 170: 189-201.

- Hu, Q. and Davis, C. (2006) Accurate automatic quantification of taxa-specific plankton abundance using dual classification with correction. Mar. Ecol. Prog. Ser., 306, 51-61.

- Wilson, S.E., Steinberg, D.K. (2010) Autotrophic picoplankton in mesozooplankton guts: evidence of aggregate feeding in the mesopelagic zone and export of small phytoplankton. Mar Ecol Prog Ser 412:11-27