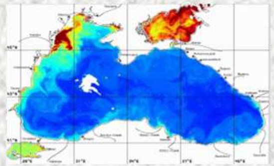

APPLICATION OF THE MOORED PROFILER *AQUALOG* FOR MEASUREMENT OF THE ACOUSTICAL BACKSCATTER BY MESOZOOPLANKTON IN THE NE BLACK SEA

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Background

- Heterogeneity in physical, chemical and biological patterns spans all spatial scales from millimeters to kilometers in both vertical and horizontal dimensions in the ocean
- Only recently the ubiquity of fine-scale structures and their full ecological importance has been recognized
- Fine-scale structures can be smeared or missed completely by traditional sampling techniques
- Effective methods require sensors with vertical resolution on the order of centimeters. Such resolution is achieved in acoustic and optical systems

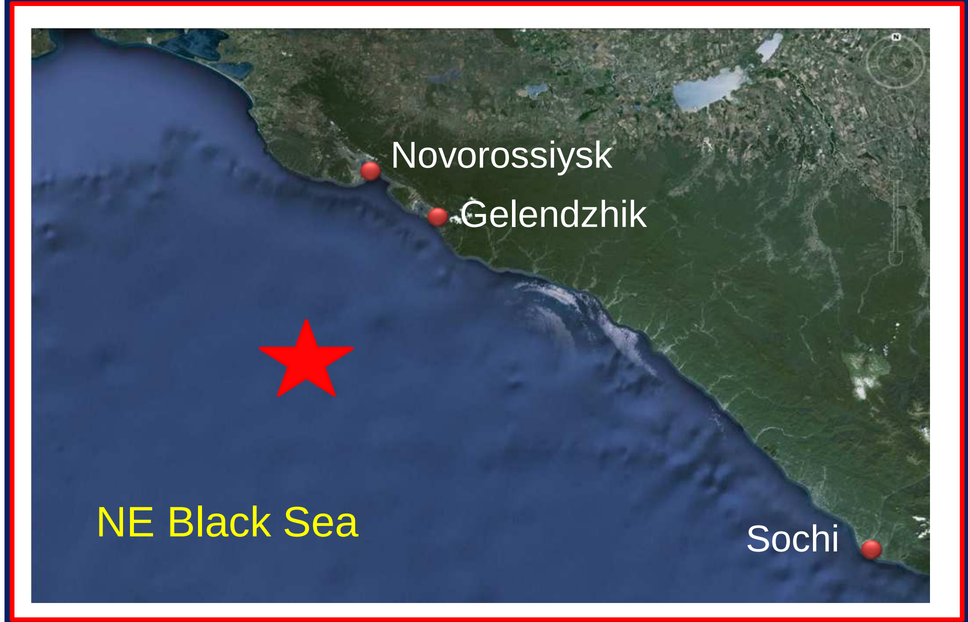
Objectives

- To investigate the spatial and temporal scales of fine-scale structures

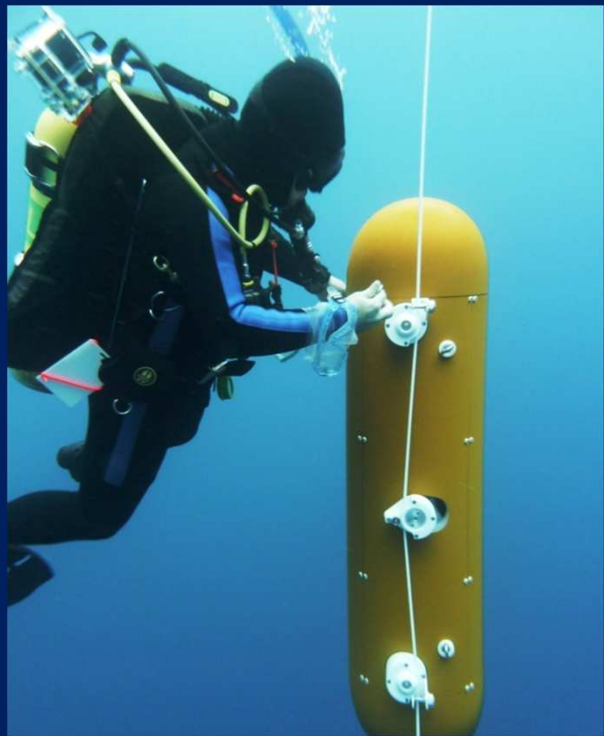
- To quantify the relationship between thin layers and biological phenomenon

- To consider the physical and chemical mechanisms influenced thin-layer development in the Black Sea

Material & Methods

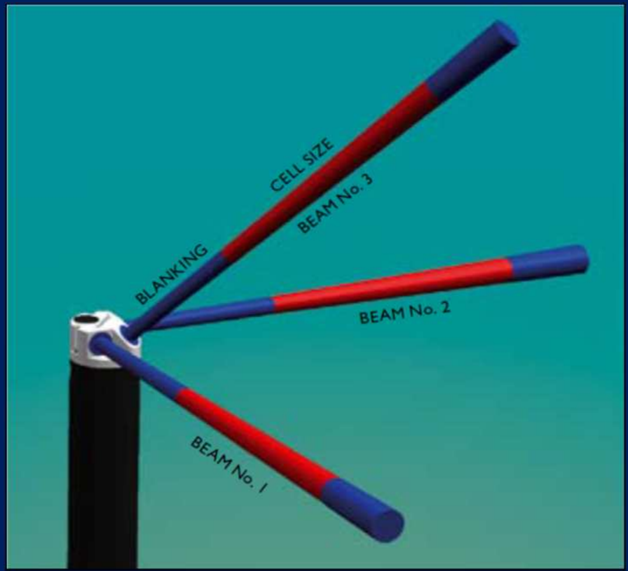


The moored profiler Aqualog was deployed at the upper part of the continental slope at the depth of 270 m in July 2007, June 2011 and September 2012.



The profiler carries the acoustic Doppler current meter and CTD probe with fluorometer or the O2 potential sensors. The profiler makes repeated round trips between the near-surface layer and the anoxic zone and provide the time series of the vertical profiles of the parameters including the amplitude of the acoustic backscatter.

Doppler current meter Nortek Aquadopp 2 MHz



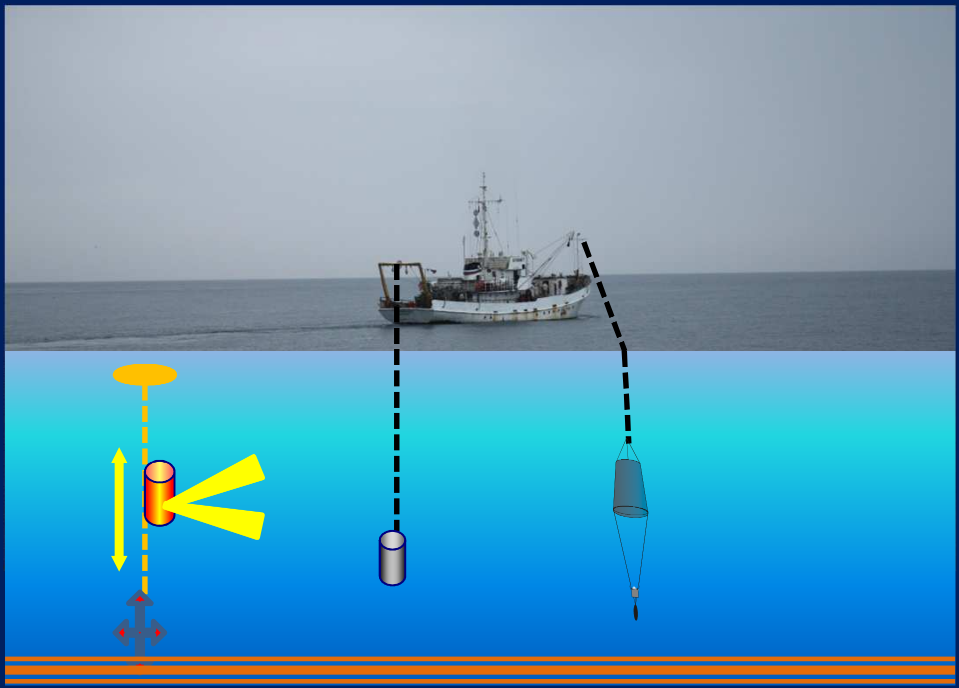
Frequency (kHz)	Nominal particle diameter (mm)
125	20
200	12
455	5
770	3
2000	1

The current meter had a side-looking sensor head transmitting and receiving sound along three narrow acoustic beams.

Different acoustic frequencies have different particle size sensitivities.

The size of zooplankton organisms is equel to 2 MHz acoustic wave length scale.

Material & Methods

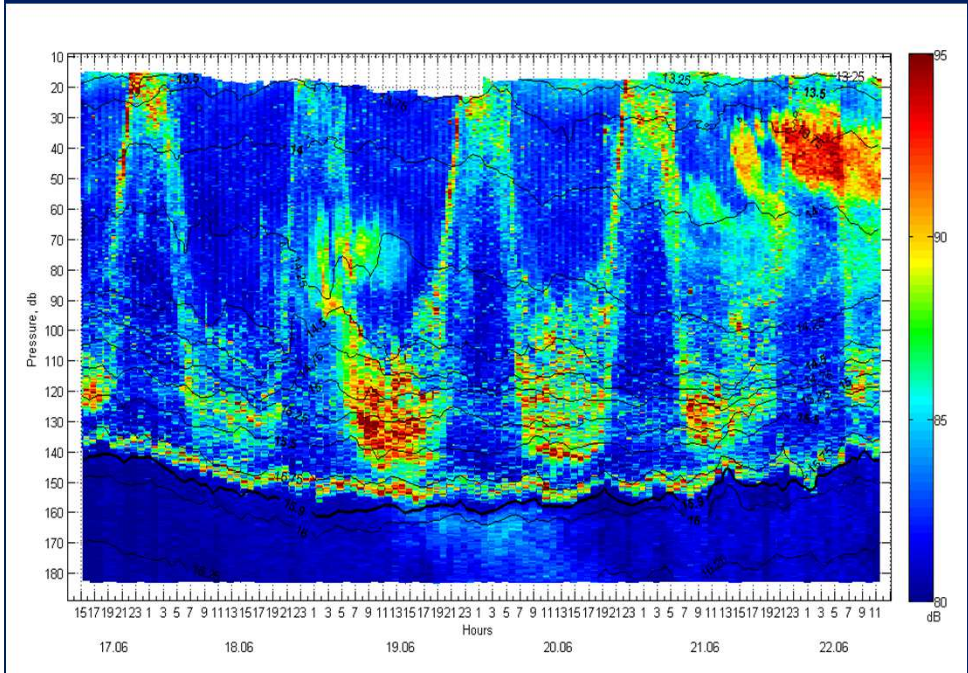


Stratified net sampling was performed nearby the moored profiler *Aqualog* to study the taxonomic and quantitative patterns of zooplankton vertical distribution.

Juday net hauls targeted aggregation layers visual in *the in-situ* backscattering data.

Ship-based CTD, O_2, and *Chl-a* profiles were obtained concurrently.

Time series of the vertical profiles of acoustic backscatter

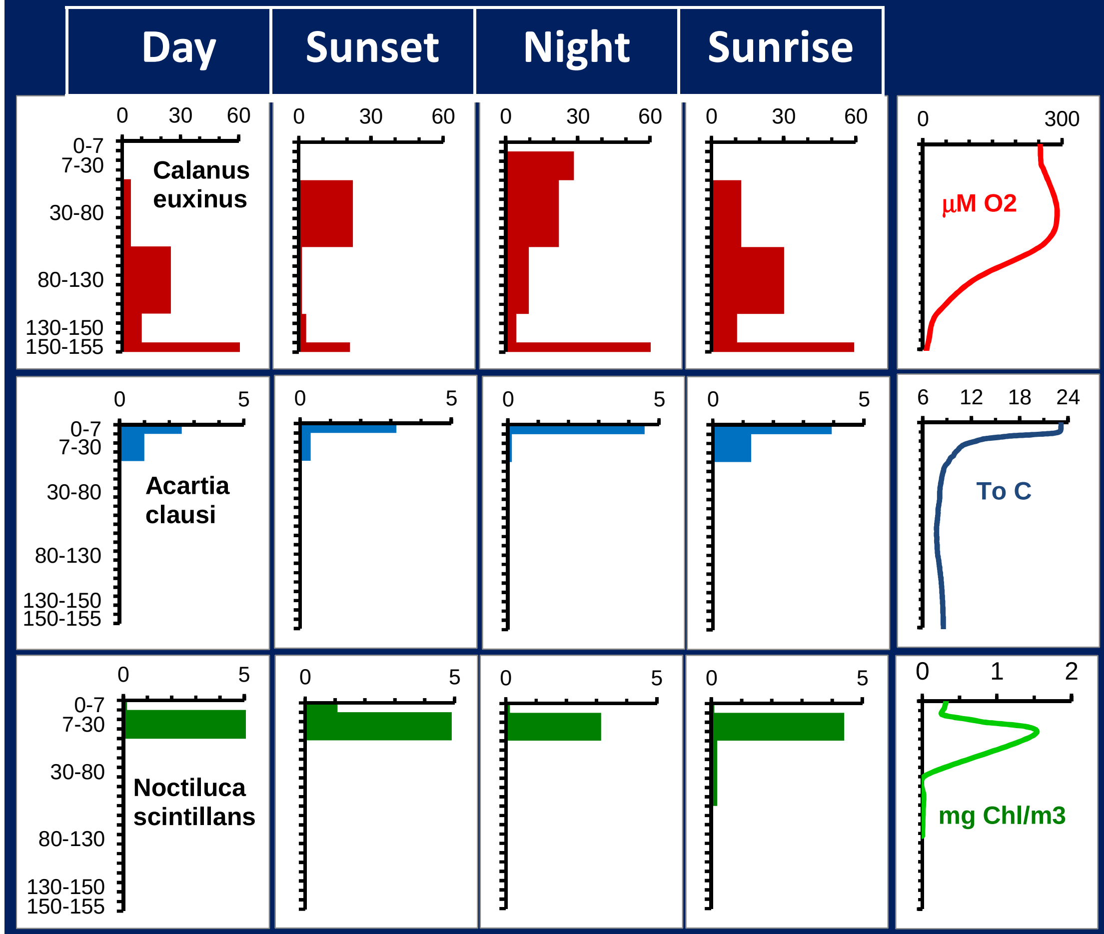


Acoustic backscatter signal (2 MHz). 17-22 June 2011

Fine-scale layer (5-7 m) of high backscatter signal was permanently registered in suboxic zone. It was associated with a density of 15.9 and its depth showed variations in relation to position of this isopicnal surface.

Above a density of 15.7 aggregation layer was seen only in the daytime and the strength of backscatter signal differed from day-to-day. This layer started upward migration two hours before the darkness, concentrated around the depth of 20 m at night and migrated downward two hours before the dawn.

Pattern of fine scale stratification revealed from the backscatter corresponded to *in-situ* zooplankton distribution.



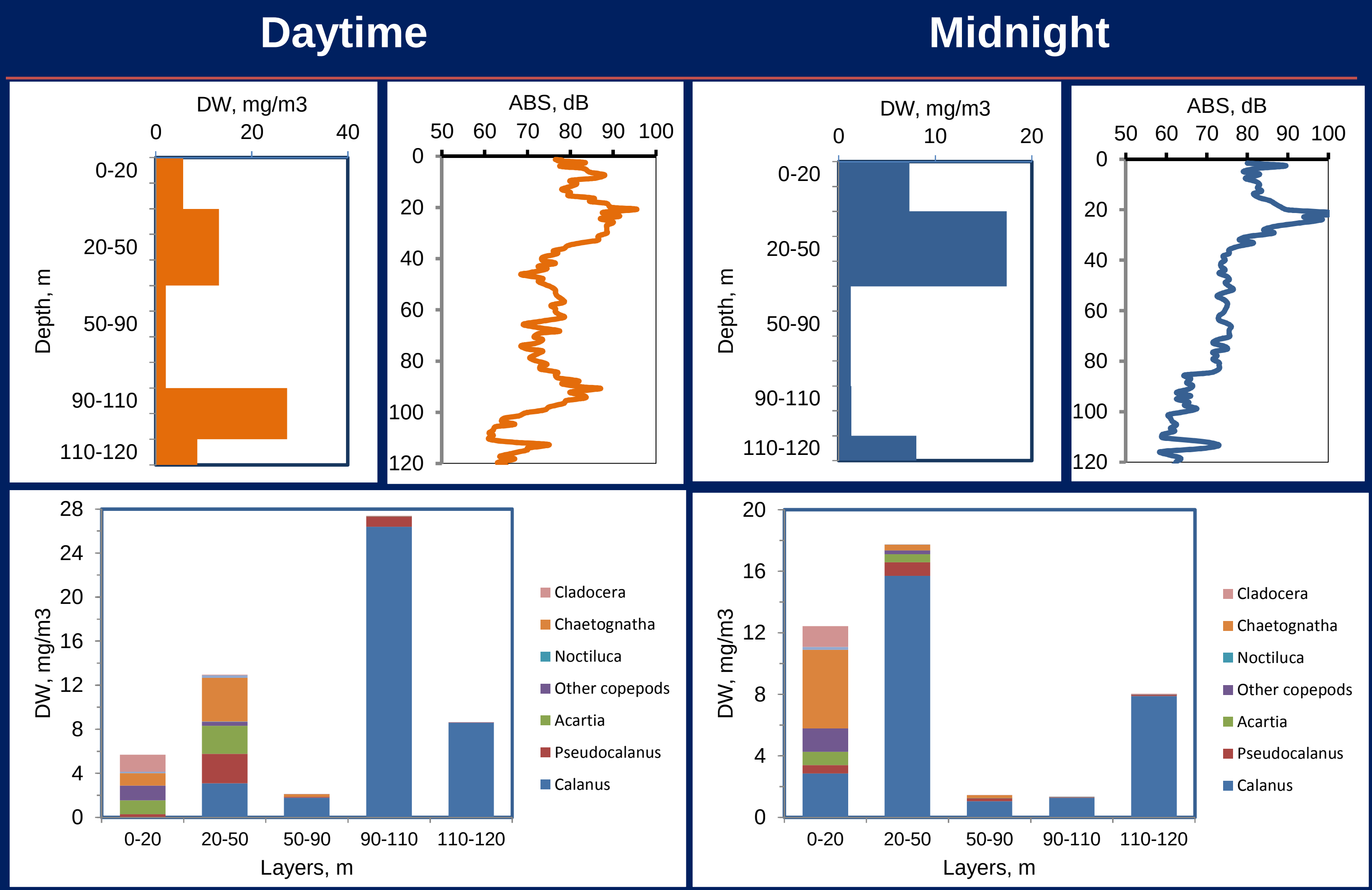
In the daytime migrating plankters were concentrated in the lower part of CIL and limited by a depth of σ=15.7 and O_2~30 μM. At night they occupied the upper layers (thermocline and partly CIL) associated with Chl-a maximum.

The lower scattering layer was created by the aggregation of diapausing *C. euxinus* surviving at O_2=3-5 μM.

Thermophilic zooplankters inhabited UML .

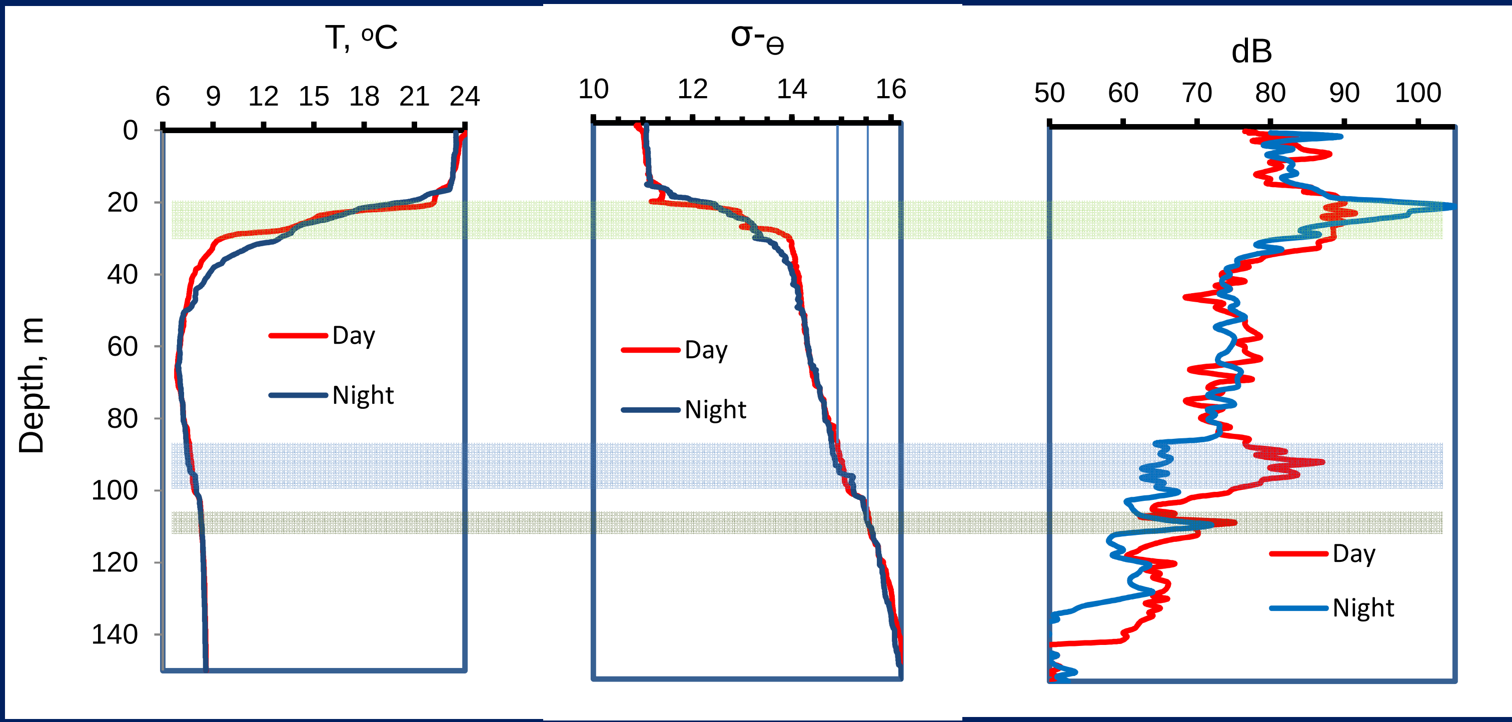
Chl-max layer was permanently occupied by *N. scintillans* and the youth of cold-water species..

Vertical distribution and composition of zooplankton in October 2012



Character of vertical distribution was similar to summer pattern: permanent fine-scale aggregation in suboxic zone; up and down migration.
Zooplankton biomass was dominated by copepods. The most abundant was C. euxinus. Its diel migration was tracked by acoustic backscatter.
Small-scale vertical migration was also observed in the upper-dwelling animals

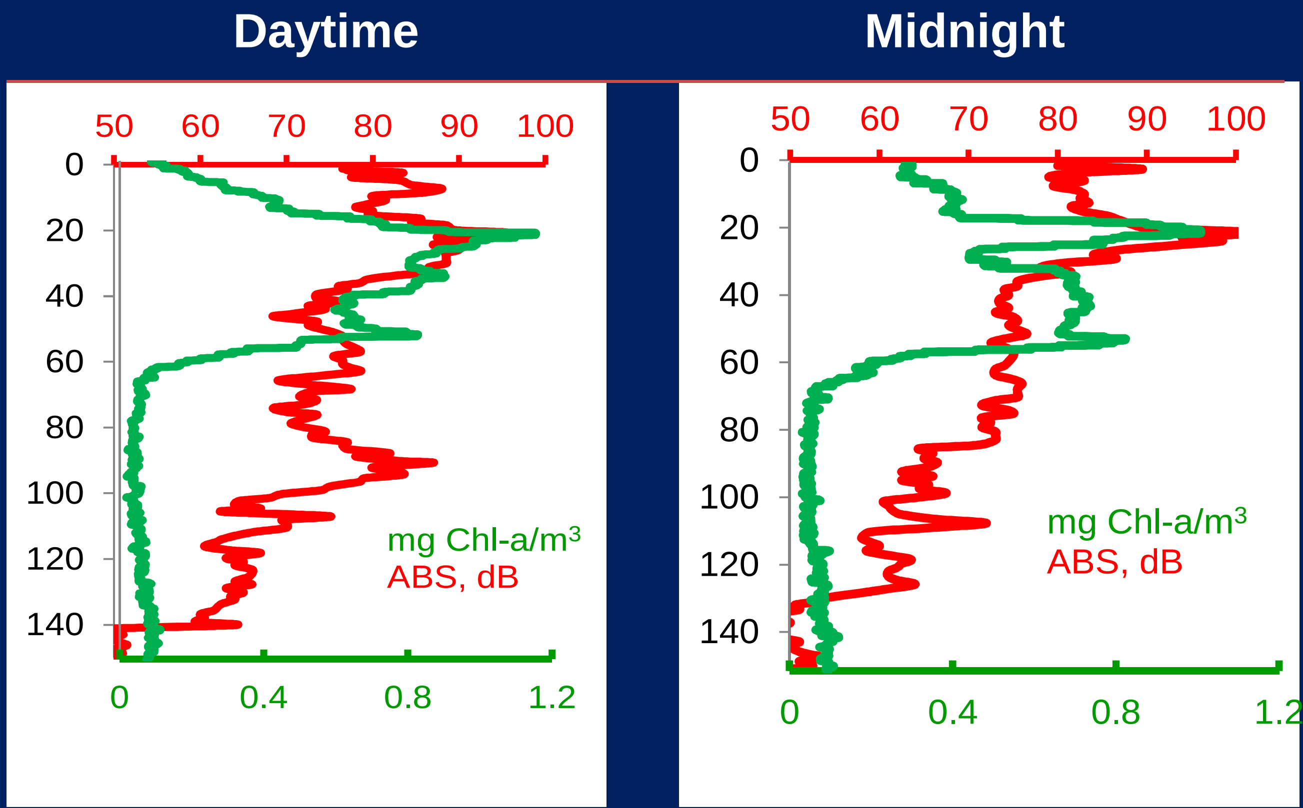
Temperature, density and fine-scale layers



There was a clear association of zooplankton thin layers and clines in T and D. In autumn, the depth of Chl-max was strongly correlated with the depth of seasonal thermo- and pycnoclines and associated with the nighttime max of zooplankton.

The main pycnocline was used by zooplankton as cue for daytime aggregation.

Relationship between phyto- and zooplankton layers



The high degree of overlap between fluorescent layer and acoustically scattering layer of zooplankton. This overlap was associated with migrators from the depth. It suggests that zooplankton may actively identify and select phytoplankton thin layer.

On the contrary, surface-dwelling zooplankters are more associated with Chl-max layer during the daytime. Interplay between food conditions and predation? Avoidance of high UV radiations?

Perspectives:

- ✓ To investigate seasonal and interannual variations in zooplankton fine-scale distribution
- ✓ To understand the mechanisms driving the formation, existing, and dissipation of fine-scale structures
- ✓ To quantify the correlation between the strength of acoustical backscatter and zooplankton abundance