FerryBox observations Tallinn-Helsinki as a valuable data source for marine research and environmental state estimates

Villu Kikas, Aet Meerits, , Nelli Rünk, Taavi Liblik, Andres Trei, Inga Lips and Urmas Lips

Marine Systems Institute
Tallinn University of Technology

Contents

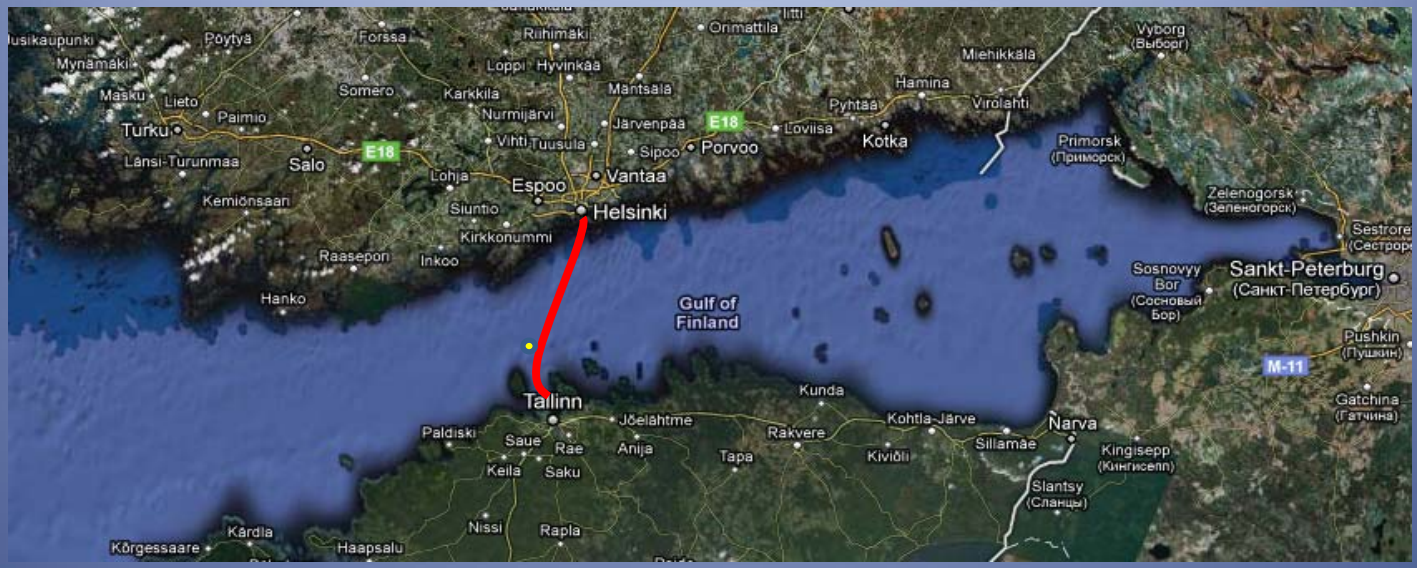
- Motivation
- Study area, Gulf of Finland
- FerryBox system
- Additional measuring systems
- Data collected spring-summer 2009,2010
- Conclusions

Motivation

Use of high resolution *in-situ* measurements and sampling:

- Classical observations are performed with low frequency or episodically
- Remote sensing methods do not reveal the vertical structure of the water column
- Essential phenomena and mechanisms may remain unnoticed

Gulf of Finland as a study area

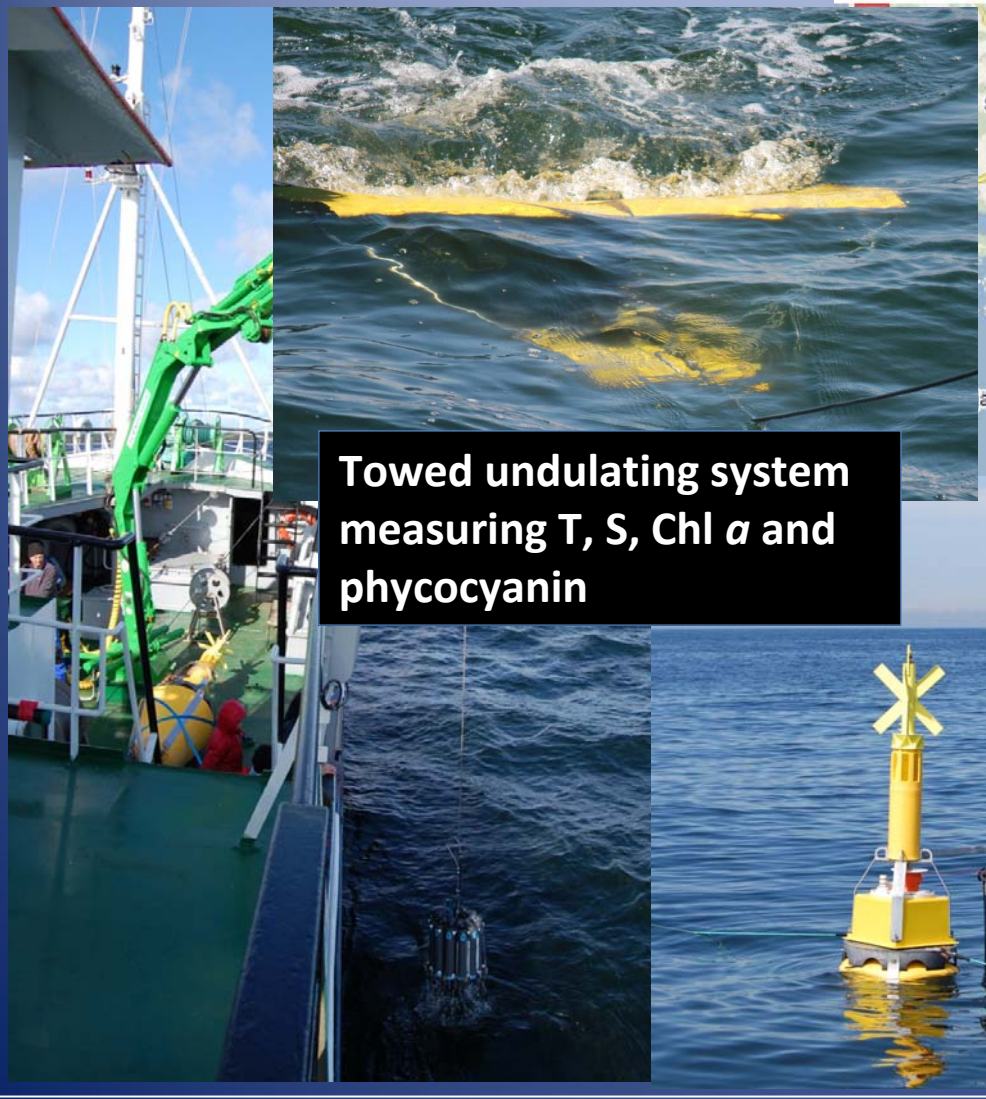


- The Gulf of Finland is a typical **deep/stratified** and **wide** estuary with a major fresh water inflow in the eastern end and relatively open water exchange with the Baltic Proper through the gulf's western boundary.
- Vertical stratification is characterized by a permanent **halocline** at depths of 60-70 m, and a **seasonal thermocline**, which forms at the depths of 10-20 m in spring-summer
- **Residual circulation** consists of an outflow of gulf's waters in the northern part and an inflow of open Baltic Sea waters in the southern part of the gulf.
- Wind-driven circulation in the Gulf of Finland is highly variable and is characterized by intense **meso-scale features – eddies, upwelling/ downwelling, coastal and frontal jet currents**, which can cause significant advection and mixing of water masses and substances (e.g. nutrients and phytoplankton).

FerryBox data, sampling and analyses

- Autonomous measurements, water intake from the surface layer (4 m) – sampling rate 20 s (spatial resolution about 150 m) - temperature (PT100, FSI thermosalinograph), salinity (FSI thermosalinograph), Chl *a* fluorescence and turbidity (SCUFA fluorometer) and since January 2010 pCO2 (Contros)
- Data retrieval once a day via GSM connection, delivered for operational models (http://sahm.ttu.ee/ferrybox/)
- Water samples once a week by Hach Sigma 900 MAX, 17 sampling points
- Nutrients (PO_4^-, NO_2^-+NO_3^-) nutrient analyzer µMac 1000 and autoanalyzer Lachat; Chl *a* analyses by spectrophotometer Thermo Helios γ; phytoplankton counting; salinity by Autosal

Additional measurment systems



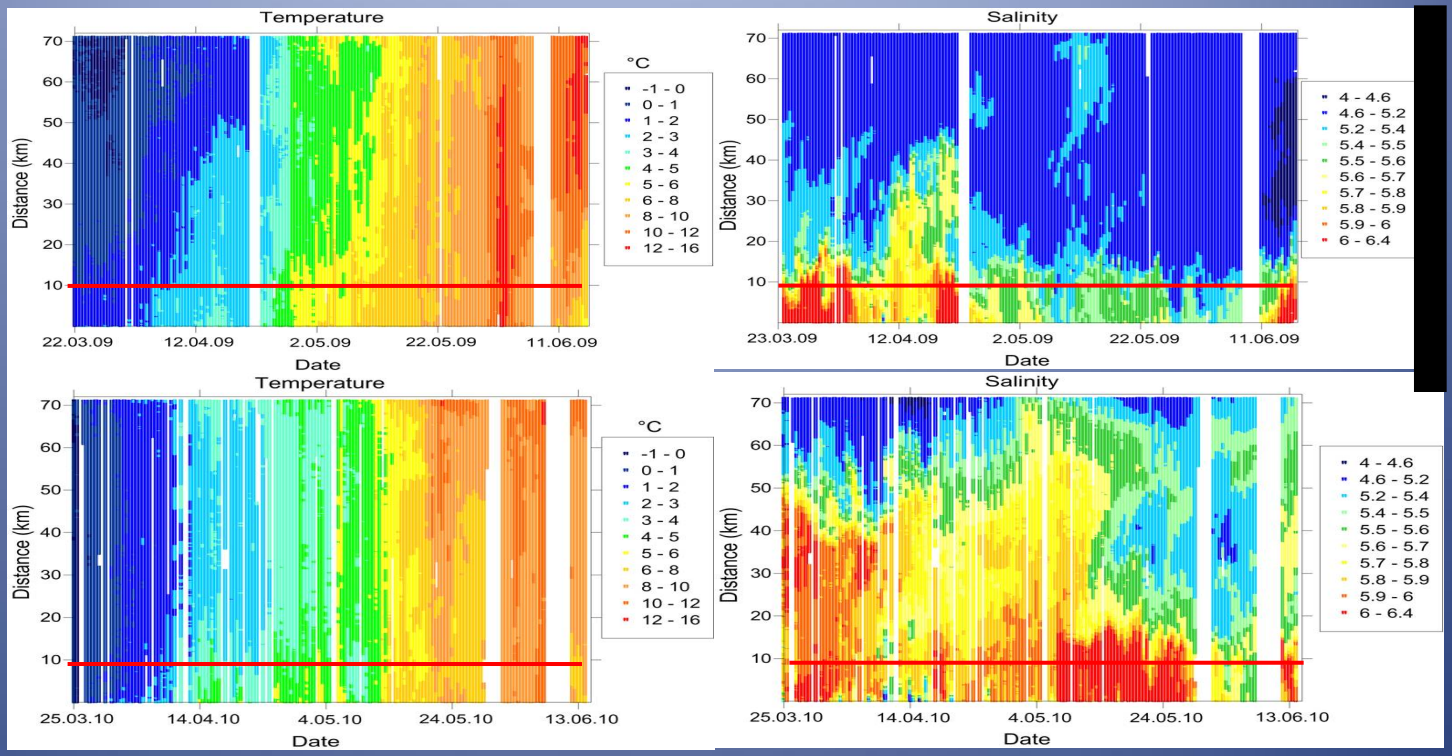
Towed undulating system measuring T, S, Chl *a* and phycocyanin

Measurements of vertical profiles of T, S, Chl *a*

Spring – FerryBox data

2009

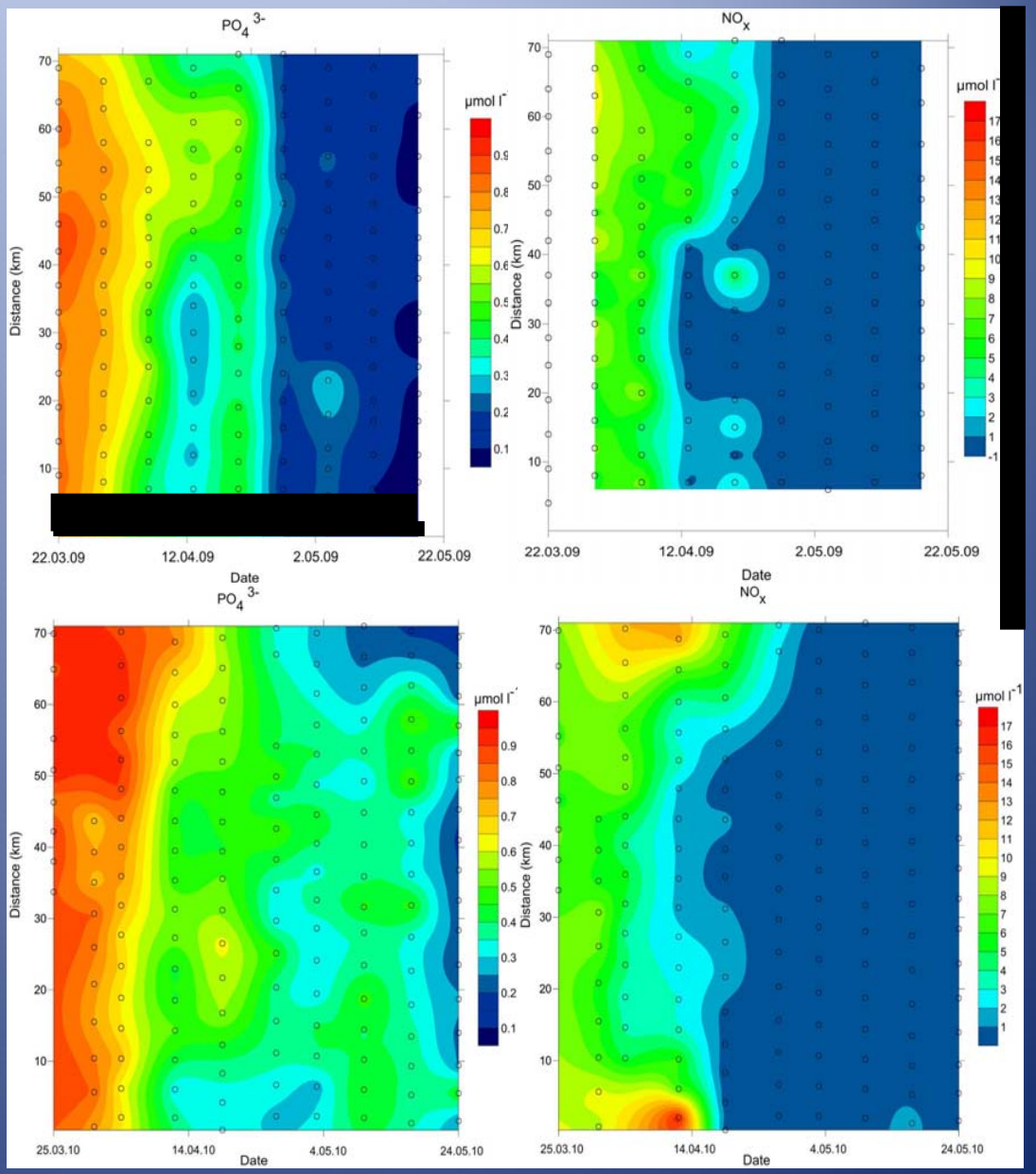
2010



Our aim is to follow the dynamics of spring bloom and related state variables using high-resolution Ferrybox measurements on board a ferry travelling daily across the Gulf of Finland between Tallinn and Helsinki

FerryBox data

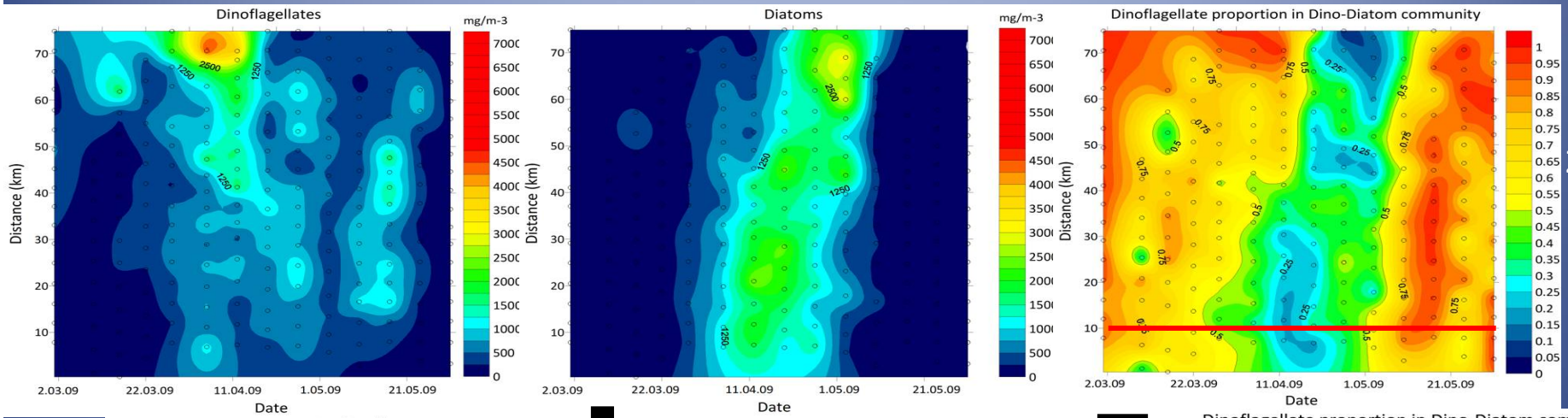
- Nitrite-nitrate concentration decreased in proportion with the phospate concentration
- Uptake close to Redfield ratio until NOx depletion was found: 14.6:1 in 2009 and 14.1:1 in 2010



Phytoplankton

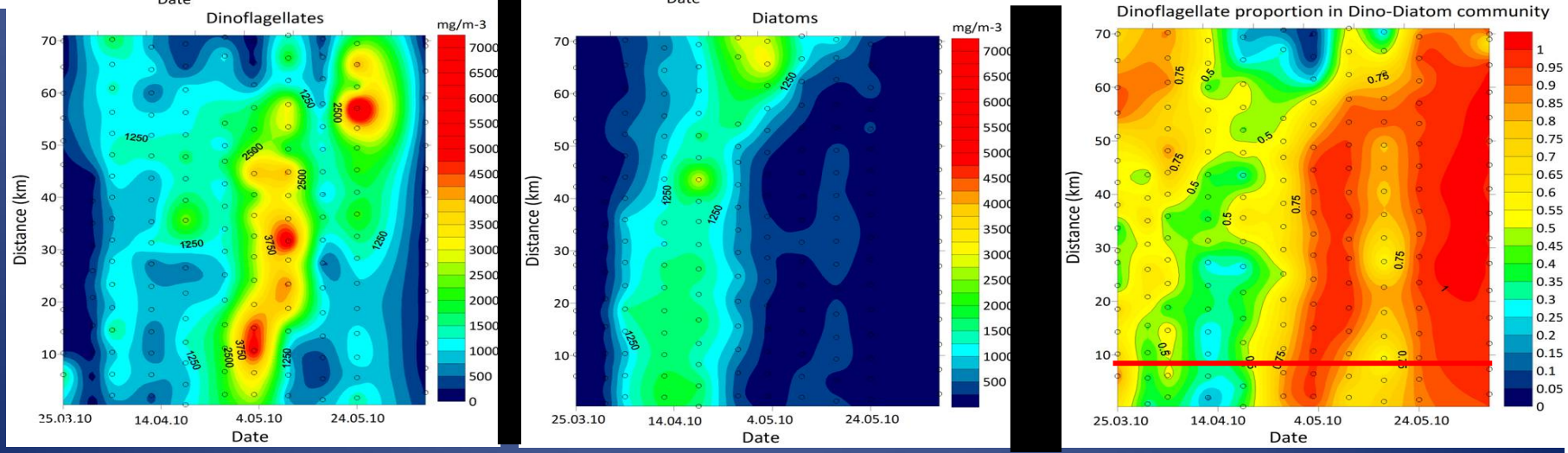
- In spring dinoflagellates and diatoms dominate; proportion of groups is very variable
- After spring bloom additional sources of nitrogen for phytoplankton growth are needed
- Two dominating groups in summer – cyanobacteria and dinoflagellates

FerryBox data



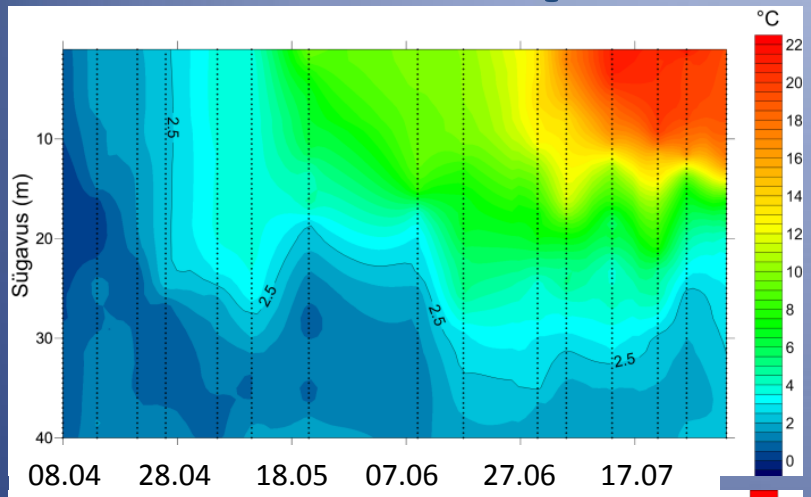
2009

2010

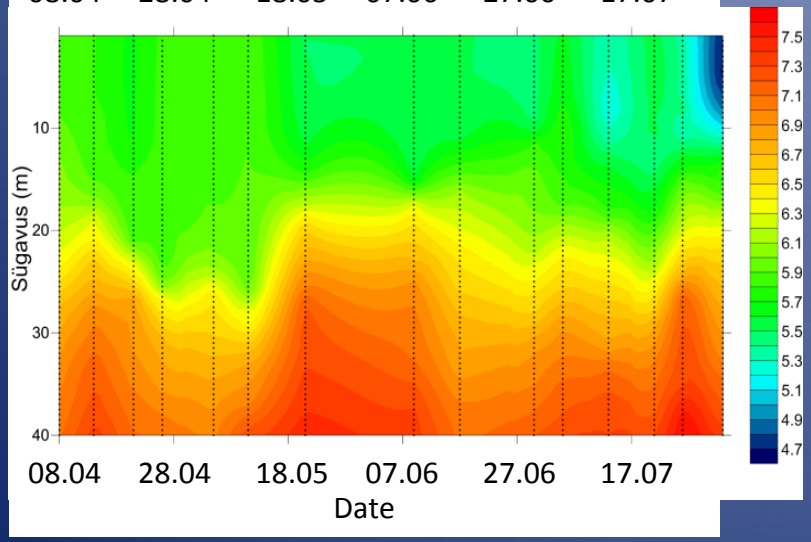


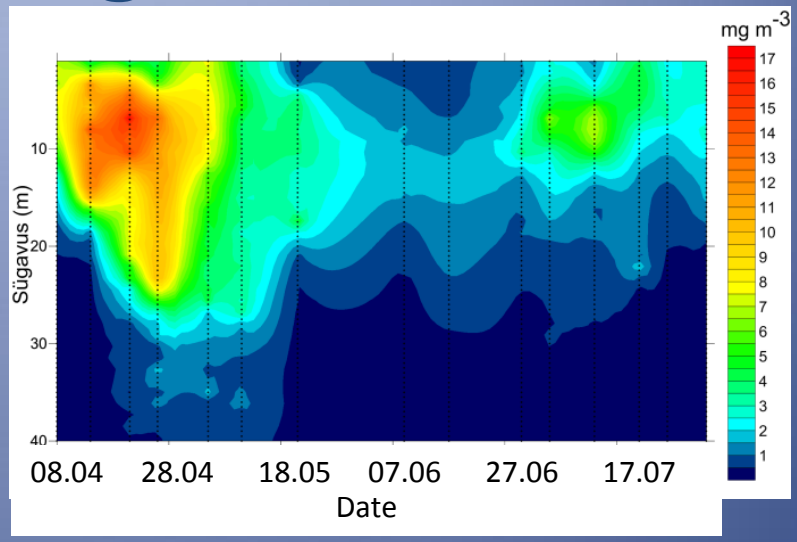
Temperature, salinity and Chl *a*
8 April – 2 August 2010

T



S

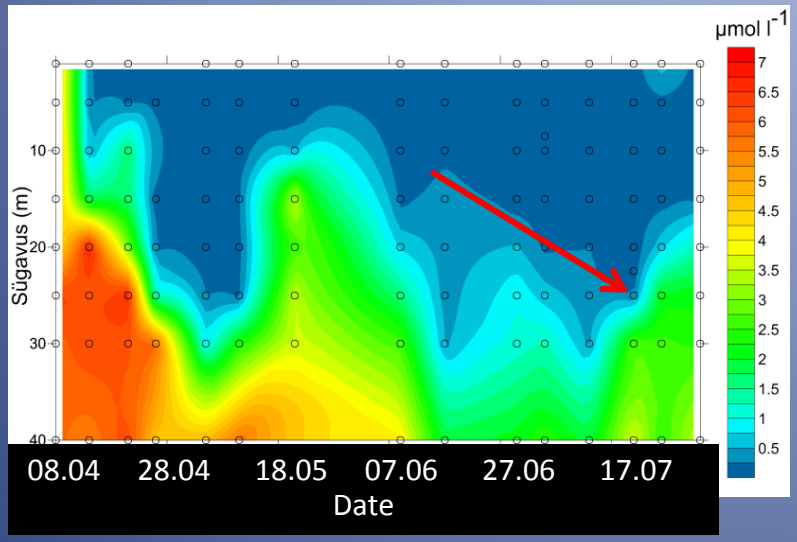


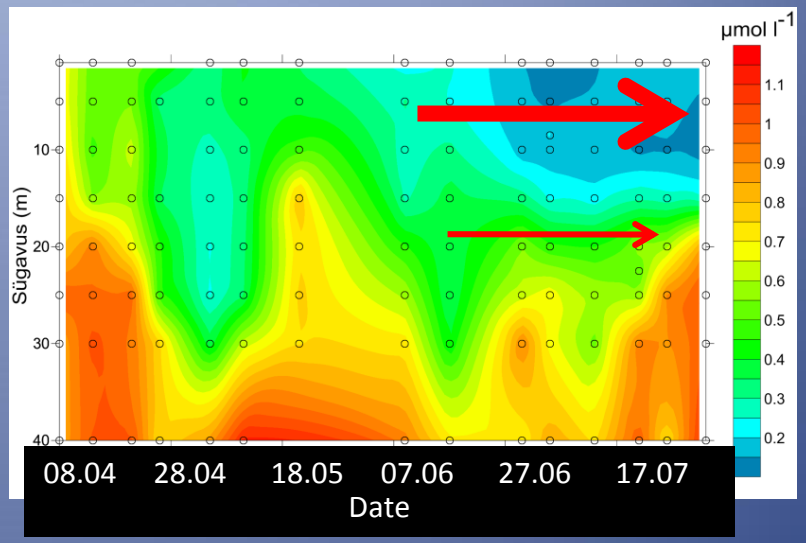


Chl *a*

CTD measurements and sampling close to the buoy station in spring-summer 2010 revealed that after the spring bloom low biomass communities were situated in the sub-surface layer (flagellates and ciliates) and a summer bloom dominated by cyanobacteria/dinoflagellates started in July

Vertical dynamics of NO_x and PO_4 8 April – 2 August 2010

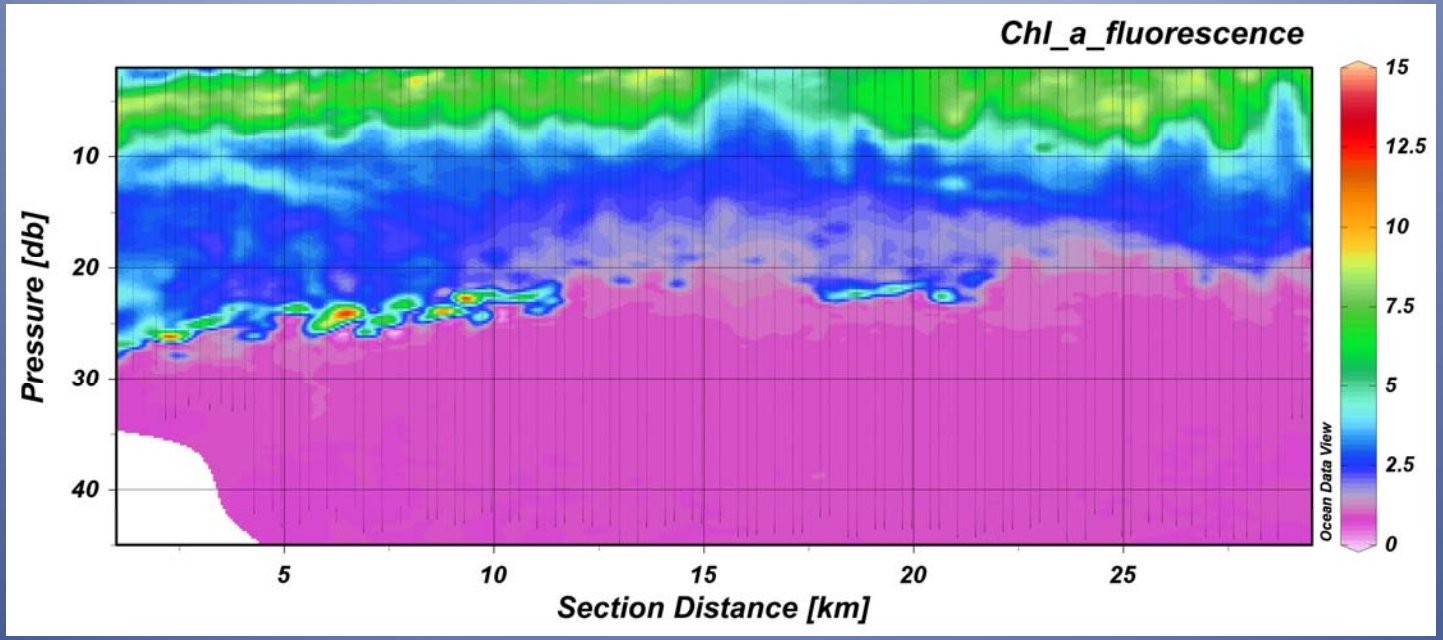


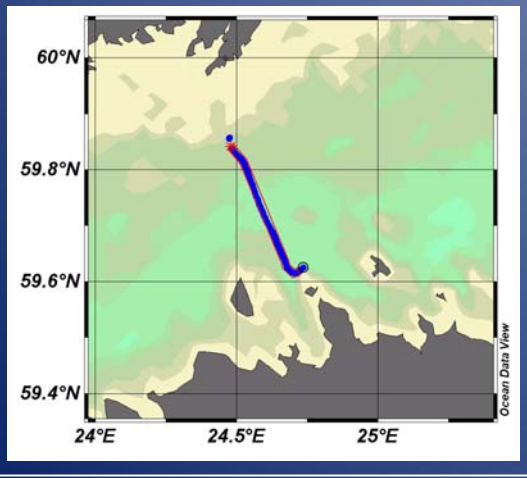


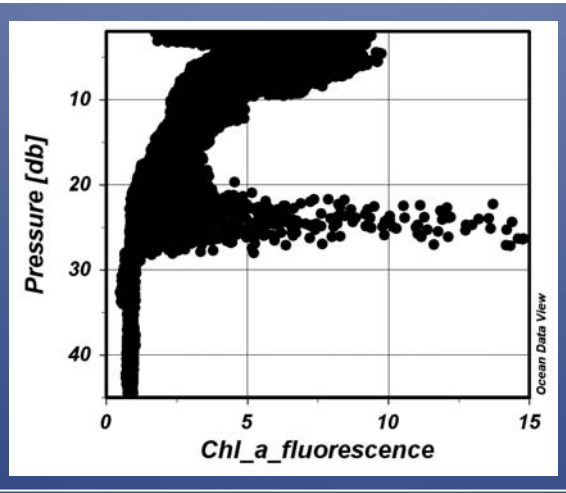
Deepening of the nitracline was not accompanied by a decrease of phosphate concentrations at those depths

However, a simultaneous decrease of phosphate concentrations is observed in the upper mixed layer

Vertical section of Chl *a* on 22 July 2010







Sub-surface maxima were observed at 52 profiles out of 92 profiles

Conclusions

- High frequent sampling of environmental variables in the surface layer in a wider area and information of state variables vertical dynamics are essential for understanding the functioning of pelagic ecosystem
  - Links between nutrient dynamics, hydrography (salinity) and spring bloom can be shown, e.g. uptake of nutrients close to the Redfield ratio
  - Phytoplankton dynamics during the spring bloom, high variability in proportions of diatoms and dinoflagellates
  - Adaptive sampling (e.g. using towed undulating vehicle) can be applied when autonomous measurements show signs of blooms (both in surface and sub-surface layers)

Acknowledgements

- Alg@line consortium
- Estonian Science Foundation
- Environmental Investment Centre

- **Thank You for Your Attention!**