GTWS symposium 2022

Seasonal and Diurnal Variations in Organic Matter Composition Influence the Surfactant Pool in the Coastal Baltic Sea

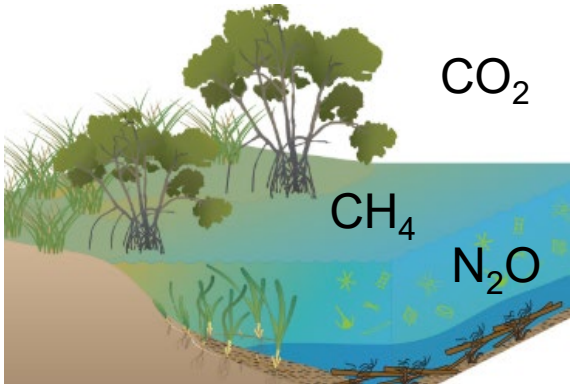
by
T. Barthelmeß and A. Engel

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

GEOMAR

Introduction
Surfactants impede gas exchange

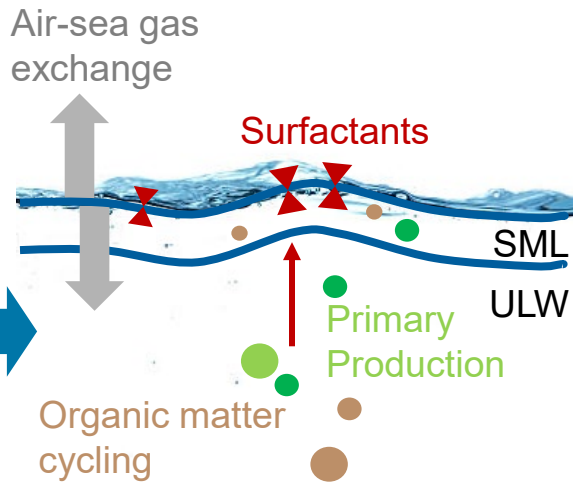
Complex coastal ecosystems cause uncertainty in global greenhouse gas budget



Macreadie et al. 2019 in Nat. Comm.

Regional and seasonal gas fluxes cannot be sufficiently estimated yet

Uncertainty in flux estimations associated to wind speed-only parameterization



Surfactants cause up to 32% reduction in CO_2 gas exchange in the open ocean

Pereira et al. 2018 in Nat. Geosci.

Introduction Which organic matter composition favors surfactant release in the Baltic Sea?

GEOMAR

Classic theory

Surfactants released during bloom conditions and concomitant with high Chl *a* levels

For example applied by Tsai and Liu 2003 to estimate global ocean surfactant coverage

Partly evident from the Baltic Sea
Schmidt and Schneider 2011 in Mar. Chem.

Sabbaghzadeh et al. 2017 in Geophys. Res. Letters

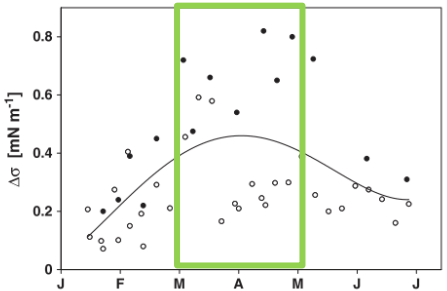


Fig. 6. Seasonal changes of Δσ: mini-ocean (solid circles), standard sample vessels of the tensiometer (open circles) and fourth order polynomial fit (solid line).

Decomposition hypothesis

Surfactants released upon microbial or photochemical org. matter processing

Peaks occure only several months after spring bloom in the Baltic Sea

Pogorzelski et al. 2006 in Hydrobiologia;
Laß et al. 2013 in J. Geophys. Res. Oceans

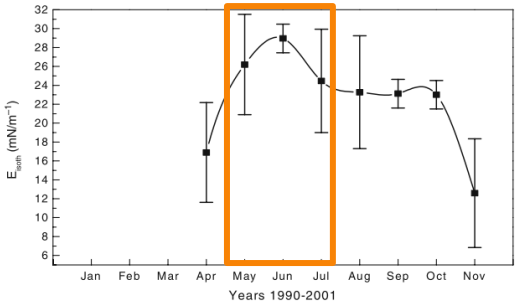


Figure 2. Seasonal variation of mean E_{both}, for natural films collected in Jelitkowo (Baltic Sea), in a one-year cycl period from 1990 to 2001 (data averaged over each month). Error bar corresponds to the standard deviation fron

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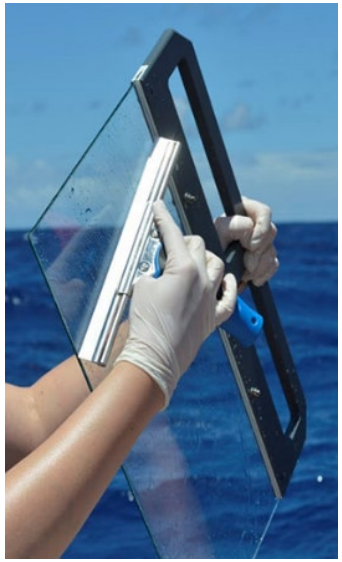
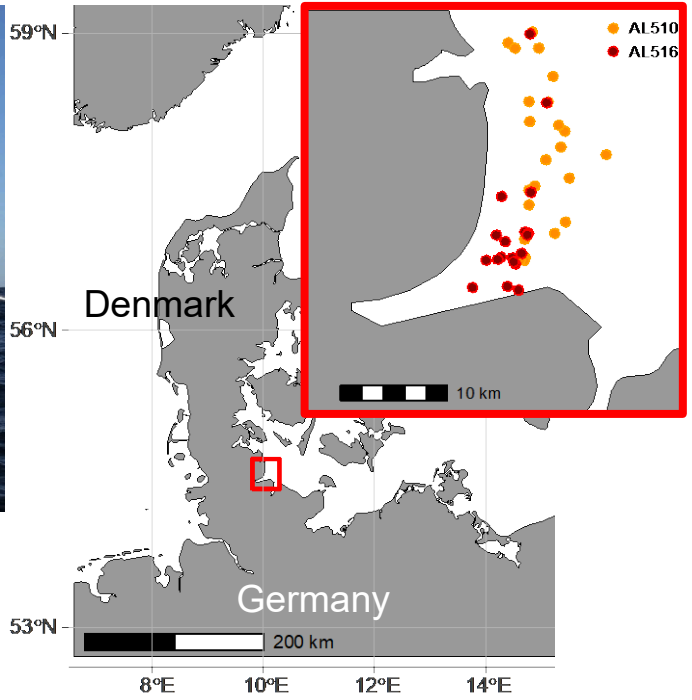
Methods

SML collection during two cruises in 2018

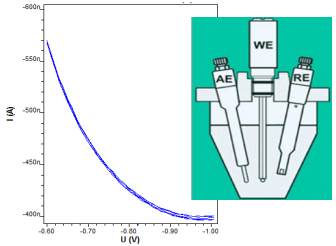
Engel et al. 2019 in Front. Mar. Sci.
Harvey et al. 1966





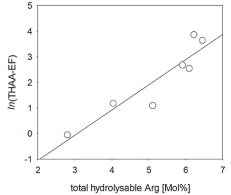
Methods

Surface activity measurements by **phase sensitive voltammetry**



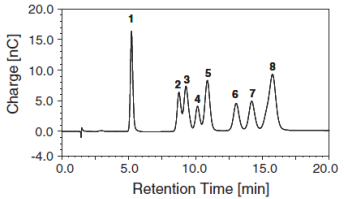
Cosović and Vojvodić 1998

Amino acid analysis by **High Performance Liquid Chromatography** (HPLC)



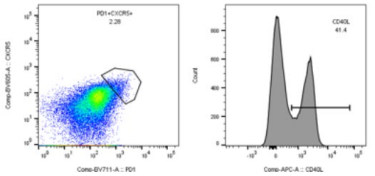
Lindroth and Mopper 1979
Dittmar et al. 2009

Carbohydrate analysis by **High Performance Anion Exchange Chromatography** (HPAEC)



Engel and Händel 2011

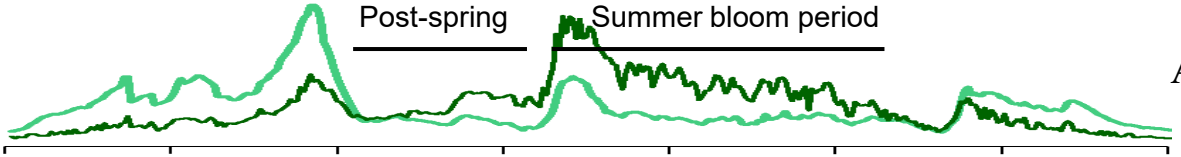
Classification of phytoplankton and bacterial cells using **Flow Cytometry**

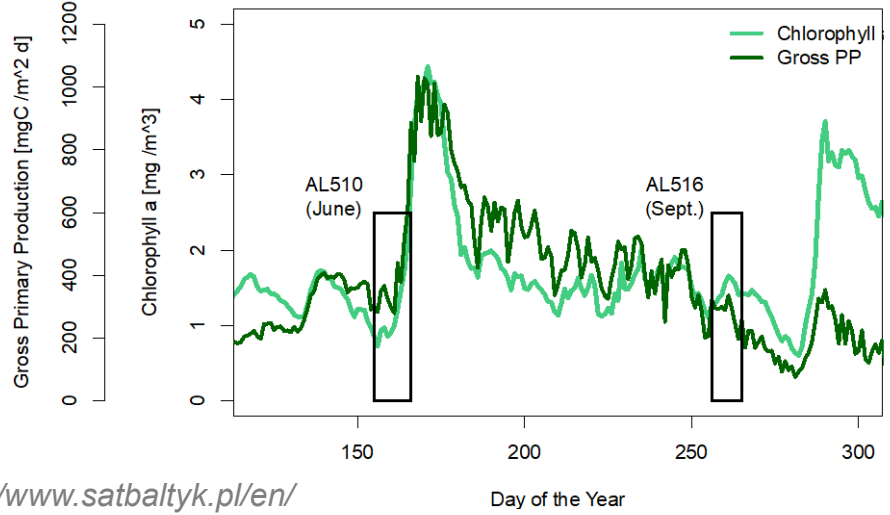


Bouvier et al. 2007

Results

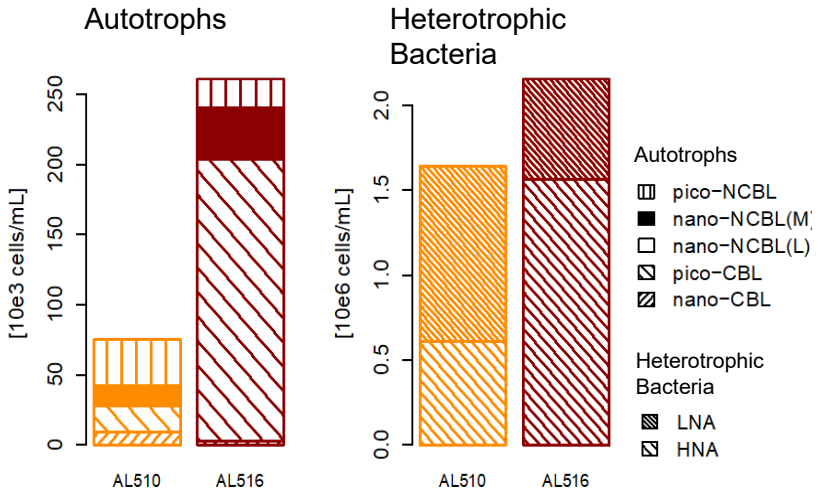
Regime shift from June to September





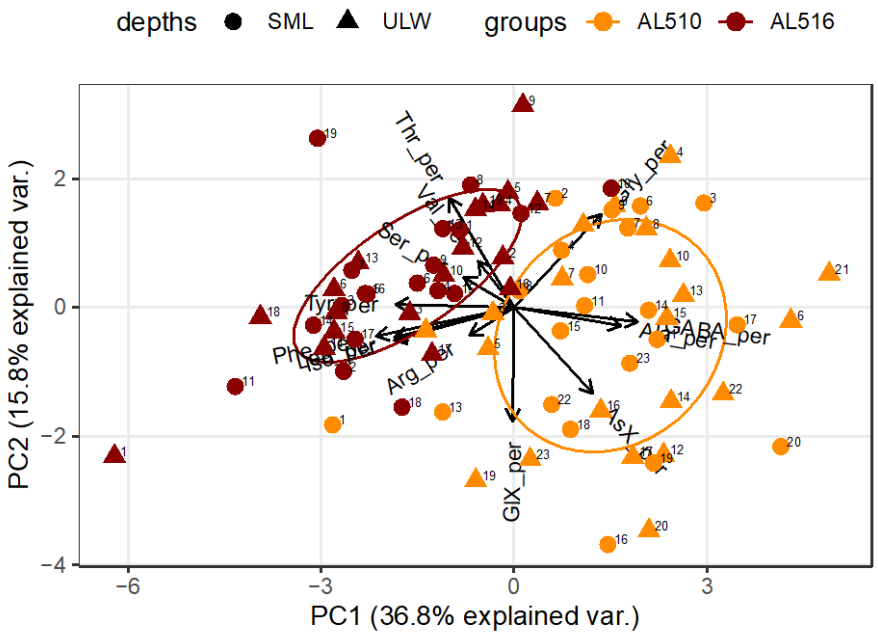
http://www.satbaltyk.pl/en/

Abundance of phytoautotrophs increased from June to September



Gross primary production enhanced during summer stratification

Results Organic matter composition changes according to season



Semi-labile organic matter contributes a greater fraction to DOC in September

June: 5.32 ± 0.55 Mol%DOC

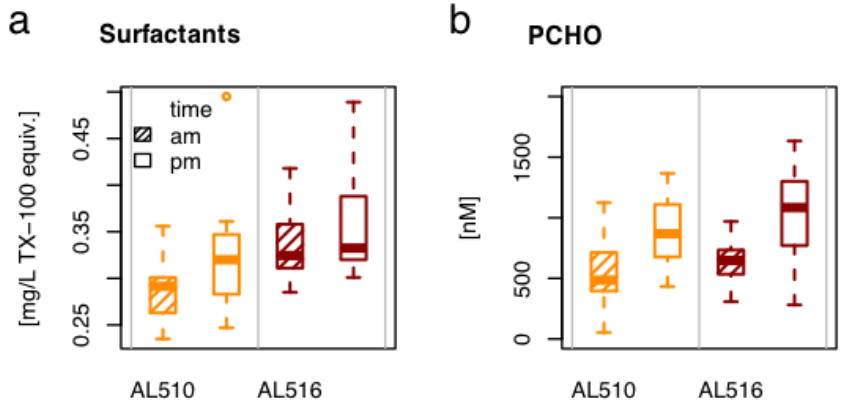
September: 7.03 ± 0.51 Mol%DOC

Surfactants variability greater within than across seasons

June: 0.30 ±0.03 mg L^{-1} (var. 28%); EF_{surf} 1.2

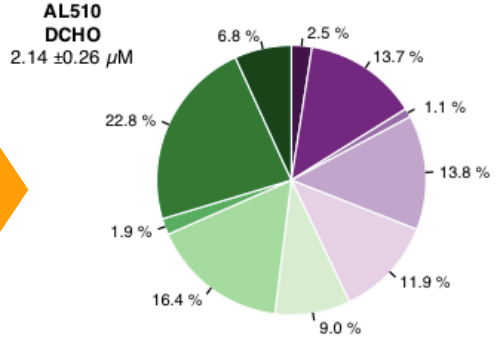
September: 0.35 ±0.05 mg L^{-1} (var. 37%); EF_{surf} 1.1

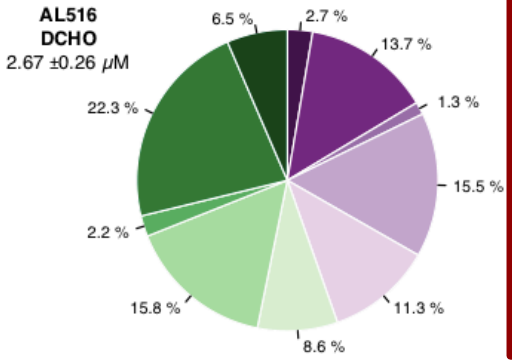
Results Surfactant concentration correlates to PCHO and exhibits diurnal cycle

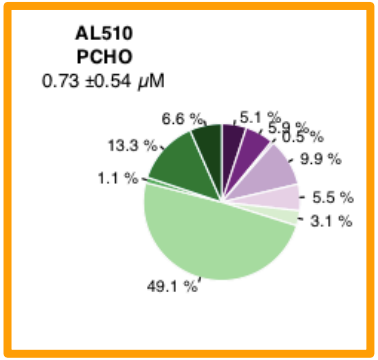


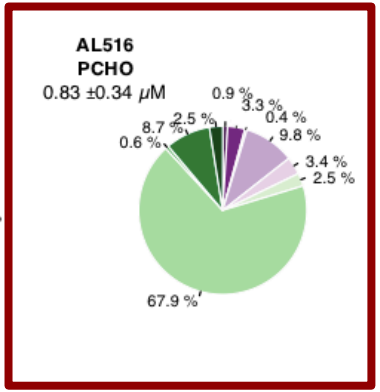
AL510 (June): Surfactant concentration differes significantly between depths and daytime

Stolle et al. 2019 in BAMS

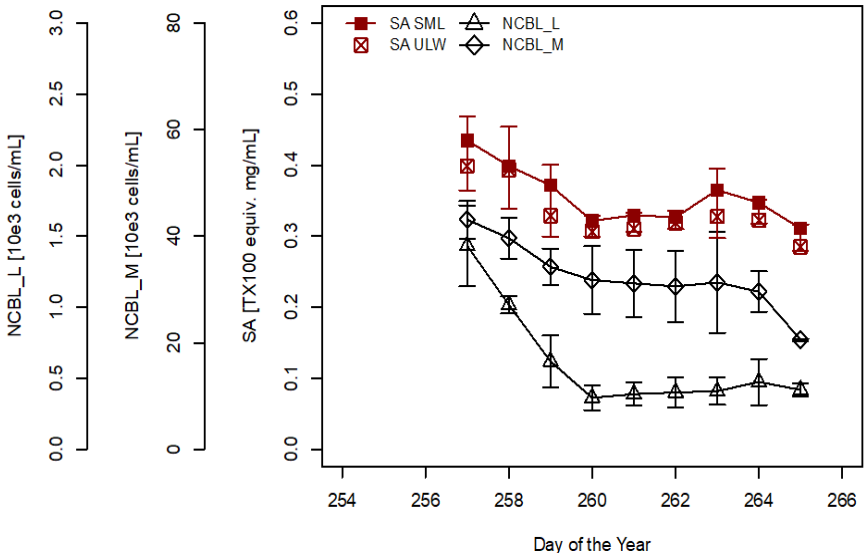






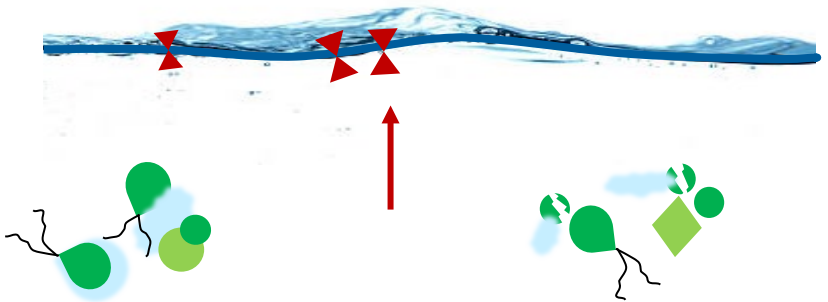


Results September surfactants release triggered by nano-phytoplankton



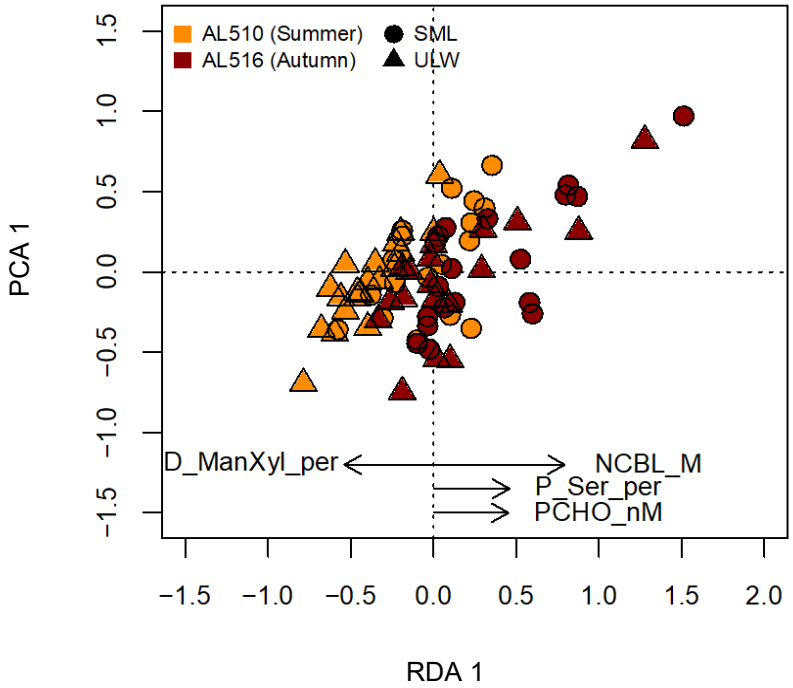
Correlation of surfactants to nano-phytoplankton:
Adj. $R^2 = 0.37$ SE ± 0.04, p-value < 0.001 ***

Concomitant release of bioavailable semi-labile organic matter (dissolved glucose and dissolved isoleucine)



Kujawinski et al. 2002 in Mar. Chemistry

Conclusion Multiple organic matter sources contribute to surfactant pool



Freshly released surfactants cause peaks

- Summer bloom periode with increased PP, labile organic matter and active bacterial community
- Transient effect as surfactants belong to the more labile organic matter pool?

Background stock of surfactants

- During the post-spring bloom phase, the organic matter was less bioavailable
- Longer-lasting effects as surfactant pool microbial processed?

Many thanks to

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