Baltic Sea Gas Exchange Experiment (Baltic GasEx)

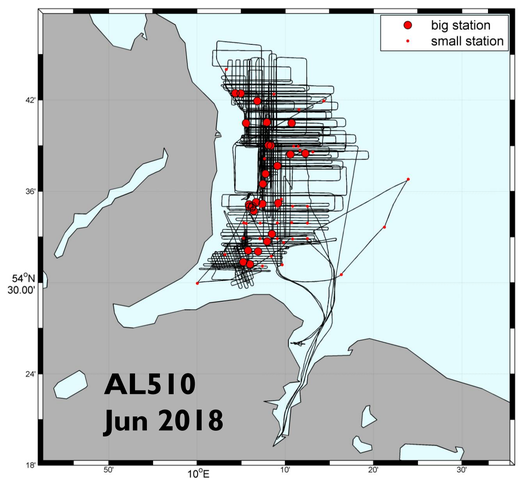
David T. Ho[1], Christa A. Marandino[2], Gernot Friedrichs[3], Anja Engel[2], Dennis Booge[2], Hermann Bange[2], Theresa Barthelmess[2], Tim Fischer[2], Toby Koffman[4], Florian Lange[3], Birgit Quack[2], Melf Paulsen[2], Peter Schlosser[4], Li Zhou[2]

Lamont-Doherty Earth Observatory
Columbia University | Earth Institute

GEOMAR

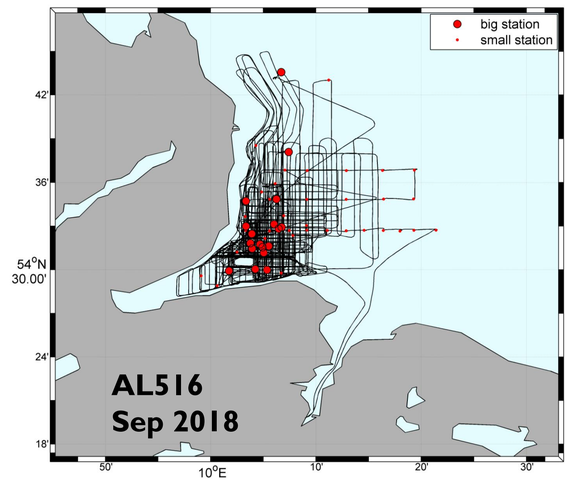
C | A | U
Christian-Albrechts-Universität zu Kiel

School of Ocean and Earth Science and Technology
University of Hawai'i at Mānoa



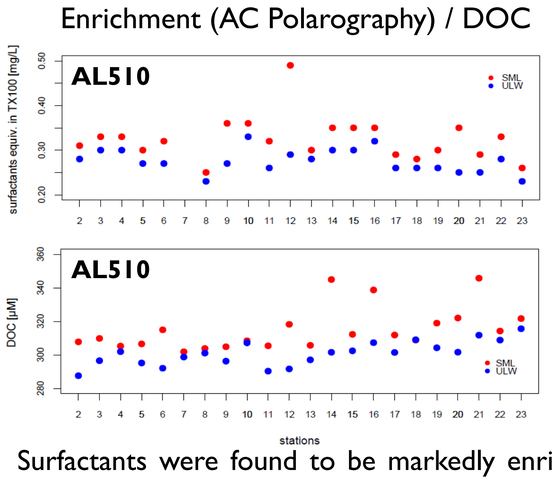
Introduction

It appears that wind speed/gas exchange parameterizations obtained in one open ocean location can be applied in another. However, it is not clear if this is the case for inland seas, where wind fetch might be different and surfactants might have a more dominant effect on gas exchange. All studies on the **influence of surfactants on gas exchange** published to date have been either based on laboratory experiments or have used artificial surfactants. The aim of Baltic GasEx, aboard the R/V Alkor was to **make simultaneous measurements of air-sea gas exchange and the natural surfactant state** during two cruises close to the Baltic Sea time-series station Boknis Eck, in spring and fall. In particular, both the $^3He/SF_6$ dual tracer and eddy covariance techniques were applied to determine gas transfer velocities. AC polarography and sum-frequency generation spectroscopy were used to quantify surface active compounds. Additional parameters (e.g., a range of trace gases, turbulence) were also measured.



Surfactants

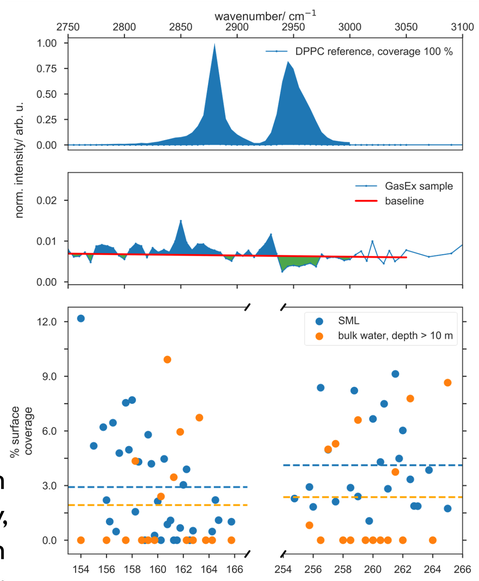
Enrichment (AC Polarography) / DOC



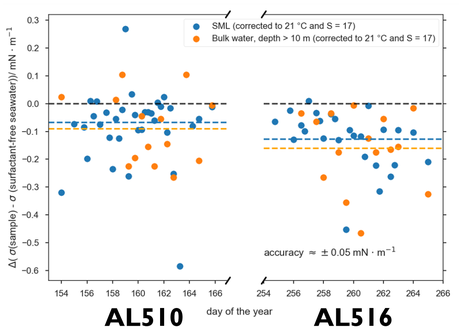
- Surfactants were found to be markedly enriched in the surface micro layer (SML) (AC polarography, VSFG, as well as additional compression isotherm measurements) in comparison with underlying water (ULW).
- Surface tension was close to the expected value for pure water (tensiometry, as well as additional *in situ* spreading oil experiments), consistent with partial surfactant coverage.

➢ **Overall, surfactant levels were found to be low (for an inland, near coast site) and similar for both cruises. A tendency for higher surfactant abundance was evident from the AC polarography data.**

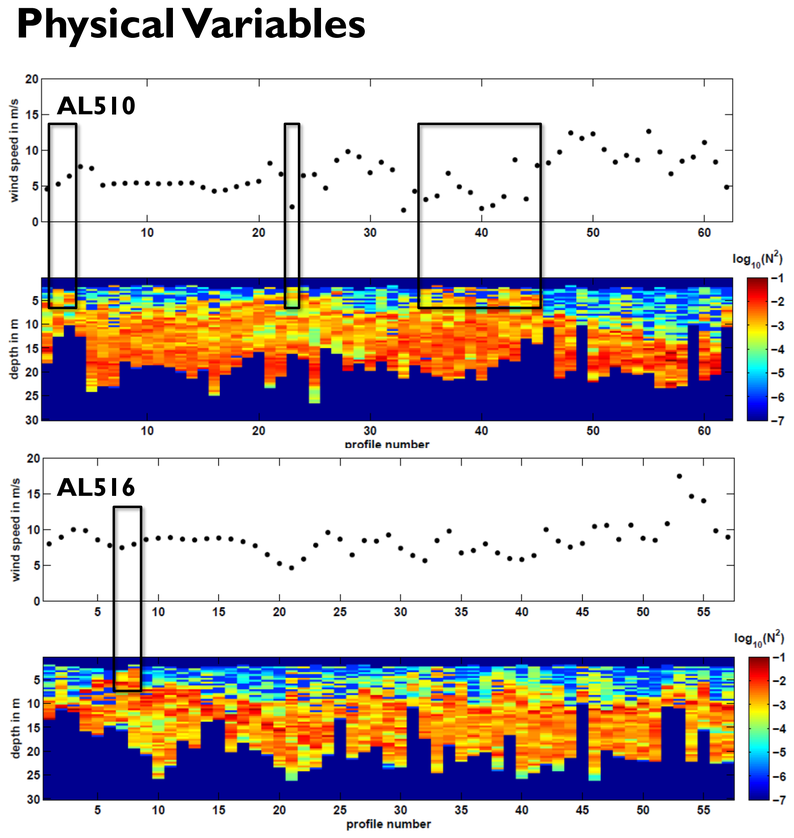
Coverage (VSFG Laser Spectroscopy)

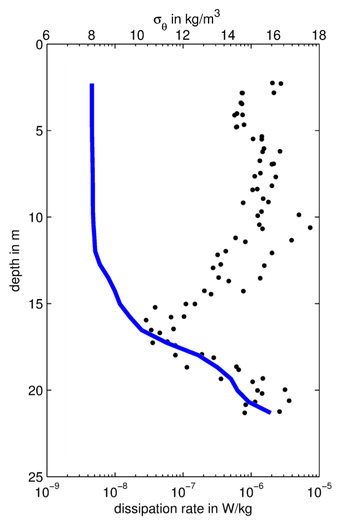


Surface Tension



Physical Variables



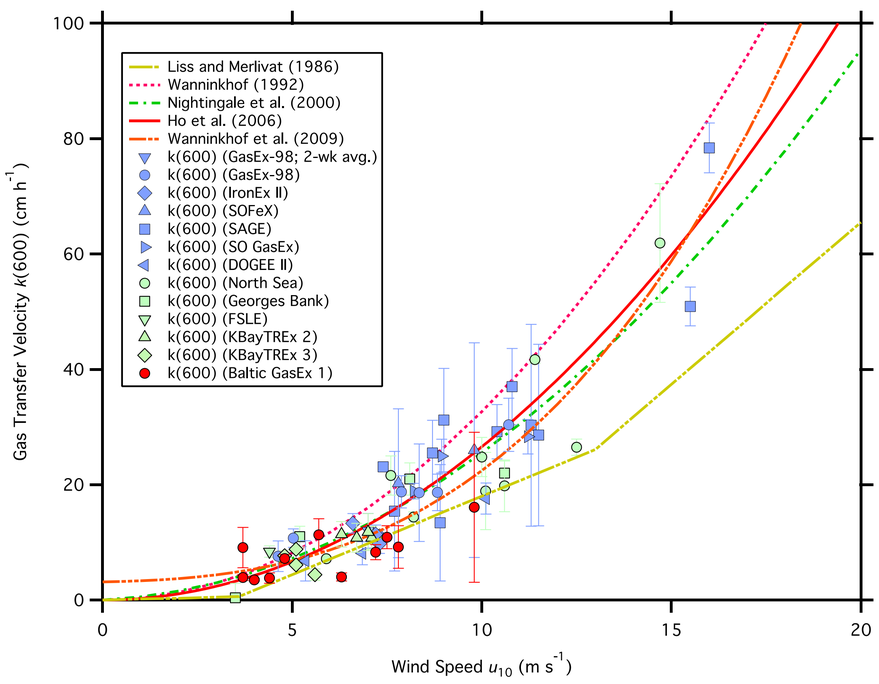


Depth profile of density (blue) and dissipation rate from microstructure sonde measurements.

Near surface stratification of the water column was calculated from microstructure sonde measurements deployed from the ship's rubber boat during every station.

➢ **At wind speed below 6 m s^{-1}, the near surface mixed layer was 5 m or less (black rectangles), which was not possible to detect with the ship's ADCP**

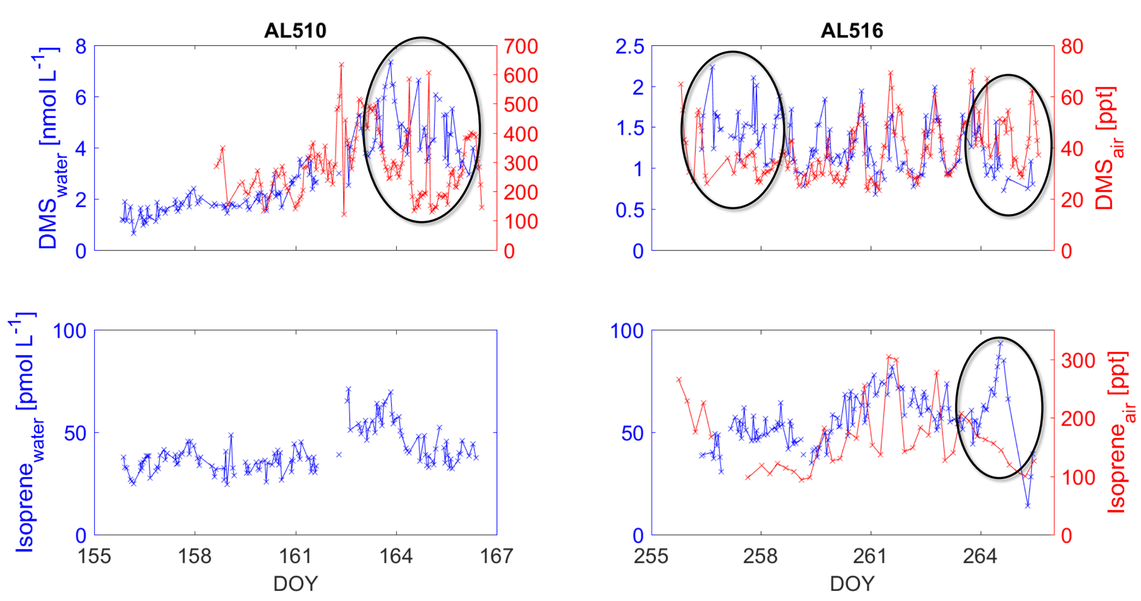
^3He/Due SF_6 Tracer Experiment



Gas transfer velocities derived from $^3He/SF_6$ dual tracer experiment during Baltic GasEx 1 (AL510) shown along with those from previous experiments, as well as frequently used wind speed/gas exchange parameterizations for the coastal and open ocean.

➢ **Gas transfer velocities from Baltic GasEx 1 are generally lower than previous experiments, especially at mean wind speeds above 6 m s^{-1}, and lower than would be predicted by frequently used wind speed/gas exchange parameterizations**

Trace Gas Measurements



DMS and isoprene air-sea concentration gradients and DMS eddy covariance fluxes were measured with atmospheric pressure chemical ionization mass spectrometry (AP-CIMS, air fluxes) and gas chromatography-mass spectrometry (GC-MS, water).

➢ **It is evident that there are times when air values do not track seawater values (black circles), which may be related to surfactant activity**

Outlook

Further data analysis is ongoing: AL516 ^3He, AL510 and AL516 CO_2 and DMS eddy covariance fluxes, computation of gas transfer velocities, evaluation of halocarbon, methane, and nitrous oxide measurements. These data will then be compared to the surfactant coverage, concentration and enrichment to determine the influence of surfactants on gas exchange. A further step will be to determine if the type of materials in the sea surface microlayer influence gas exchange.

Funding was provided in part by the US National Science Foundation through OCE-1756807 and OCE-1756757.

Affiliations

[1]Department of Oceanography, SOEST, University of Hawaii at Manoa, Honolulu, HI, USA; ho@hawaii.edu

[2]GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany; cmarandino@geomar.de, aengel@geomar.de, dbooge@geomar.de, hbange@geomar.de, tbarthelmess@geomar.de, tfischer@geomar.de, bquack@geomar.de, mepaulsen@geomar.de, lzhou@geomar.de

[3]Institute of Physical Chemistry, KMS - Kiel Marine Science - Christian-Albrechts-University, Kiel, Germany; friedrichs@phc.uni-kiel.de, lange@phc.uni-kiel.de

[4]Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY, USA; tkoffman@ldeo.columbia.edu, schlosser@ldeo.columbia.edu

HELMHOLTZ GEMEINSCHAFT