THEME 2: Atmosphere/ocean exchange processes and the surface microlayer

Subproject: Oceanic export of organic matter: comprehensive data interpretation

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Surface Ocean Processes in the Anthropocene

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Introduction

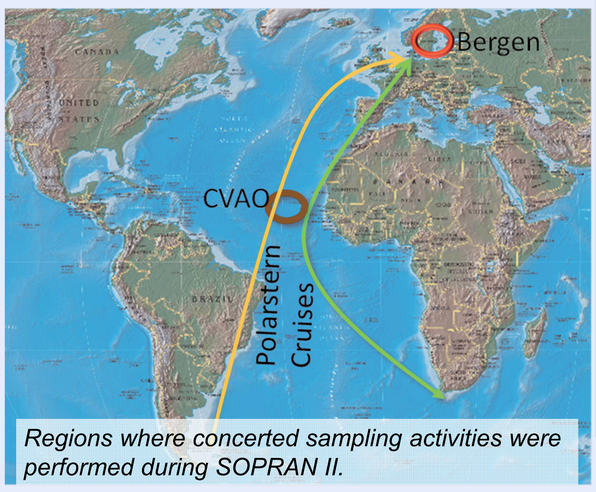
Exchange processes between air and sea play an essential role as oceans cover a substantial area of the planet. Besides sea salt, marine aerosol particles contain a significant amount of organic material which may influence their behavior towards absorption and reflection of solar radiation and therefore the earth's radiation budget. The export of organic material (in sum and single atmospheric relevant organic compounds) from the oceans into aerosol particles can make up a considerable carbon flow in the earth system and the functional connections of OM from the water column over the Sea Surface Microlayer (SML) to the atmosphere are still largely unknown. A better understanding of the transport and the transformation of organic matter from the oceans to the atmosphere is absolutely necessary. During SOPRAN II several concerted field campaigns including the simultaneous sampling of bulkwater, SML and aerosol particles were performed at different marine regions.

Objectives

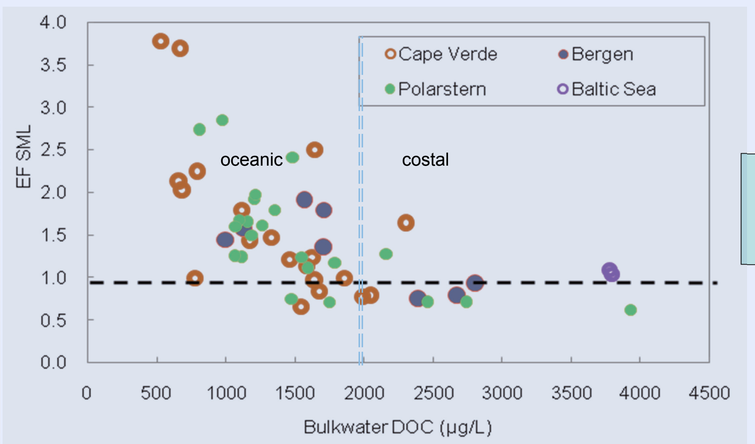
The general aim of this subproject includes a better understanding of sea-air exchange processes in terms of organic material. Sources transport and formation pathways of organic compounds in the marine compartments shall be elucidated. Specifically the chemical analysis of the enhanced sample set of SOPRAN II concerted sampling activities shall be concluded and the chemical parameters together with meteorological, biogeochemical shall be detailed interpreted. Within the data analysis a strong collaboration with other participants of SOPRAN III shall be performed.

Highlight Results

1. Interpretation of a large data series of DOC and POC in marine aerosol particles and seawater (Sea Surface Microlayer, Bulkwater) from different concerted sampling activities.



Regions where concerted sampling activities were performed during SOPRAN II.



DOC enrichment in SML compared to bulkwater DOC concentration for Atlantic and Baltic seawater .

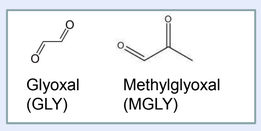
➢DOC enrichment diminished with increasing bulk water concentration Lower enrichment of DOC can be caused by biological, physical and chemical DOC removal from the SML

➢Data are being integrated into a meta analysis of OM enrichment in the SML by SOPRAN Theme 2 and 3 partners (*M. Schartau, A. Engel et al.*) to elucidate whether OM enrichment in the SML needs to be considered when parameterizing air-sea gas exchange or the formation of primary organic aerosols.

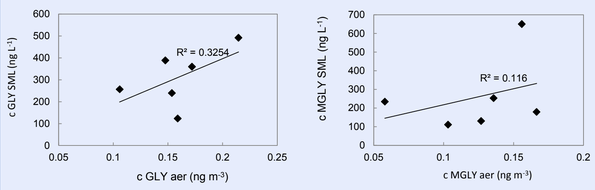
M. van Pinxteren, Müller, C., Iinuma, Y., Stolle, C., Herrmann, H., *Environ. Sci. Technol.*, 46, 10455, **2012**

N. Surandokht, Schartau, M., Engel, A., Herrmann, H., van Pinxteren ,M., Wurl ,O., Wirtz ,K., *Mar. Chem.* in preparation

2. Method adaption of an analytical method based on solvent extraction-GC-MS for a-dicarbonyls in the marine environment.*



➢Open oceans are suggested as an important (so far unknown) source for a-dicarbonyls (important compounds in aerosol particle formation/growth).



Correlation of GLY /MGLY in SML and marine aerosol particles.

➢Detected in clean marine aerosol particles in concentrations of around 0.2 ng m^{-3}.
➢Detected in Sea surface MicroLayer (nM range).
➢4 fold enrichment in SML compared to underline water.
➢Photochemical production in the SML?

- *Slight correlation of GLY (MGLY) between SML and marine aerosols*
- *Hint for interaction of GLY (MGLY) between SML and atmosphere*

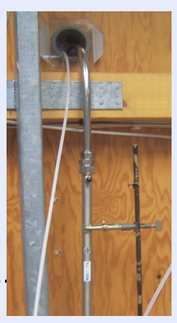
*Analytics: PFBHA derivatisation - hexane extraction - GC-MS (SIM)

M. van Pinxteren and H. Herrmann, *Atmos. Chem. Phys.*, 13, 1-12, 2013

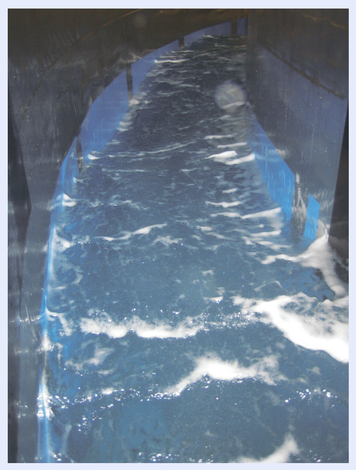
3. Aerosol sampling during the joint laboratory campaign in the AEOLOTRON wind channel in Heidelberg.

Air-sea gas exchange measurements including the effects of the natural surface micro layer and bubbles were performed filling the Aeolotron with 20 m^3 seawater from the Atlantic Ocean (*B. Jähne*, Heidelberg). Besides gas exchange studies, also aerosol particles were sampled during the experiment to investigate to what extent organic material from the SML is carried into aerosol particles.

These investigations could be performed under ***controlled conditions***, that is difficult in field studies..



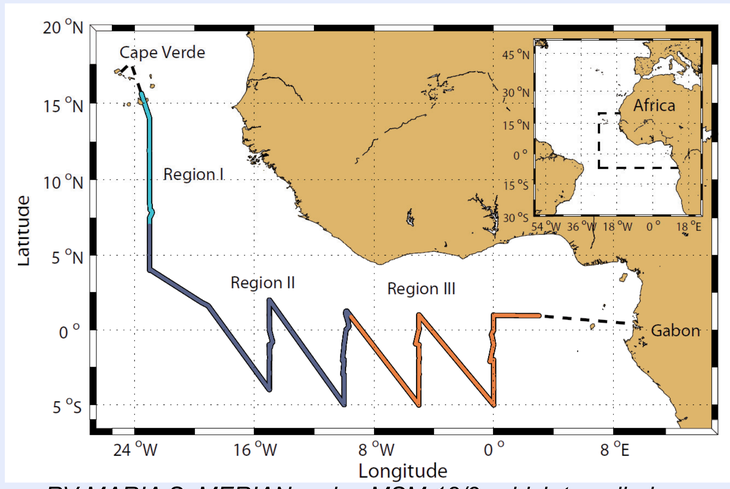
➢ *Filter sampling device for aerosol particle sampling at the Aeolotron.*



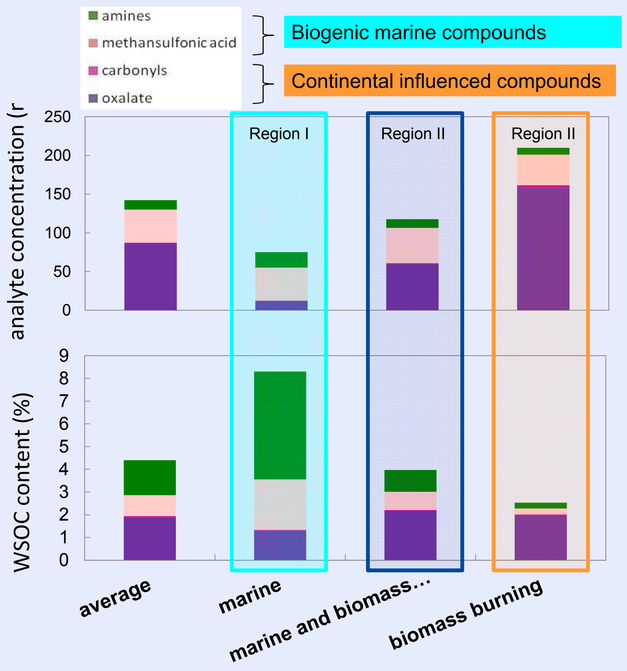
➢*Wind speed of ca. 10 m/s + bubbles in the Aeolotron.*

4. Comprehensive chemical characterization of (organic) marine aerosol particles in upwelling areas.

➢Detailed chemical analysis of marine aerosol composition was combined with information regarding air mass origin and meteorological and biogeochemical parameters to elucidate the characteristics of marine aerosols and to reveal their sources.
➢Collaboration and data synthesis with SOPRAN Theme 1 partner *A. Körtzinger* and *B. Fiedler.*



RV MARIA S. MERIAN cruise MSM 18/3, which travelled from São Vicente to Gabon.



➢According to air mass origin and chemical composition of the aerosol particles ***three main Regions*** could be established.
➢Upwelling influences on the chemical aerosol composition were found (high organic aerosol fraction).

➢*Cruise serves as a case study for*
1. Elucidating chemical composition on marine aerosols in the equatorial ocean.
2. Investigating marine and anthropogenic influences.

M. van Pinxteren , *B. Fiedler, D. van Pinxteren ,Y. Iinuma , A. Körtzinger and H. Herrmann*, J Atmos. Chem. submitted