8th SOPRAN Annual Meeting

Mainz 17./18. March 2015

Abstracts

(Compiled by Martina Lohmann – mlohmann@geomar.de)

Content

1. Modelling primary marine aerosol with focus on primary organic material

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Besides sea salt aerosol the oceans are also sources of primary organic material. This aerosol component is found as individual particles as well as mixed with sea salt in the atmosphere. Current studies show that this organic material has a different influence on cloud properties and radiation than sea salt. The characterization of the composition of primary marine aerosol is therefore a prerequisite for estimating its effects. Before the importance of the organic aerosol can be estimated it is necessary to know its emission rates to the atmosphere and characterize its dependencies. Different approaches are currently possible like the use of different parameterizations or the assumption of the mixing state during the emission process.

The poster will discuss some of the approaches for describing the emission of organic material from the oceans using modelling studies with COSMO-MUSCAT and measurements from the CVAO and the research vessel Polarstern.

2. Measurements of friction velocity and waves in the Heidelberg Aeolotron, a large annular wind/wave facility during the November 2014 SOPRAN seawater experiment

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The Heidelberg Aeolotron is an annular wind/wave facility with 10m diameter. One of the main advantages is the nearly infinite fetch, which results in the generation of much larger waves than in linear wind/wave facilities and represents the conditions at the open ocean much better.
Because of an inhomogeneous wind field and secondary currents the friction velocity u_* cannot be determined by the logarithmic wind profile. But as an advantage of the annular geometry the momentum balance in water can be used to determine u_* by measuring the water velocity in the bulk. A three axis acoustic velocity sensor was used during a large number of experiments to determine the friction at the walls and the bulk water speed. By measuring the equilibrium velocity the wind induced friction velocity was determined for a large range of wind speeds up to 22m/s. Additional experiments with TritonX-100 and natural surfactant in seawater show the influence of different wave fields on the friction velocity. Wave were measured by an imaging slope gauge, from which the mean square slope and wave number spectra were computed.

3. Investigating the global effect of mixed layer eddies on mixed layer depth and air-sea gas exchange

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Baroclinic mixed layer eddies (MLEs) are an important feature of upper ocean dynamics. By re-stratifying upper ocean fronts, they have large influences on the ocean gas uptake, ocean heat flux and the mixed layer depth. Since the scale of MLEs is below the internal Rossby radius (100m up to 10 km), they are hardly represented in current basin-scale ocean models. Consequently, such ocean models are biased with respect to MLE effects on e.g. the mixed layer depth and the air-sea gas exchange (e.g. Oschlies, 2002).
To encounter the effect of MLEs, we implement different parameterizations that are evaluated by Brüggemann and Eden (2014) for MLEs in a numerical ocean model. In a first step, we test the capability of different parameterizations for MLEs to represent the eddy fluxes in an idealized scenario of an ocean front. In a second step, we quantify the effect of MLEs on the mixed layer depth and the gas-uptake of CFC in a global ocean model by

comparing simulations with and without the implementation of the MLE parameterizations. Furthermore, we evaluate differences between the different parameterizations for MLEs and investigate which parameterization is best suited to represent the effects of MLEs.

4. Microbial control of bromocarbons in the surface ocean

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Oceanic bromocarbons are highly reactive volatile organic compounds and may contribute up to 40% of stratospheric ozone depletion in mid latitudes. High sea-air fluxes of bromocarbons in the tropical regions have been related to biological cycling in the surface ocean, mainly by phytoplankton and bacteria, but the underlying processes and magnitude of the biogenic sources and sinks are poorly known. In order to understand temporal and spatial fluctuations of oceanic bromocarbon emissions, we studied microbial removal processes in the surface ocean during a research cruise with RV SONNE (OASIS, Port Louis/Mauritius to Malé/Maledives) to the tropical Indian Ocean. Water samples were incubated with ^{13}C-labelled bromoform substrate to determine bromocarbon consumption rates. Oxygen consumption was monitored to estimate the heterotrophic activity. Attained rates are compared to observational data of bacterial abundance, bromoform ($CHBr_3$) and dibromomethane (CH_2Br_2) as well as organic matter concentrations in the water.

5. Influence of wind speed on the accumulation of organic matter in the surface microlayer during the Aeolotron experiment (2014)

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The sea surface microlayer (SML) is suggested to affect a variety of exchange processes between the ocean and the atmosphere. We investigated how SML formation, composition and stability are related to seawater biogeochemistry, microbial activity and physical factors during an experiment conducted with natural Atlantic water at the Aeolotron facility in Heidelberg. We show first data suggesting that heterotrophic as well as autotrophic microbial activity provide organic matter for SML formation. Accumulation of particulate components like transparent exopolymer particles (TEP) and bacteria in the SML decreased at higher wind speed, while dissolved organic carbon concentrations increased. Entrainment of bubbles was identified as a process enhancing accumulation of bacteria as well as of small TEP (<10 µm) in the SML. More detailed organic compound analysis is currently conducted to better understand differences in the observed accumulation patterns, and the role of an organic SML for gas exchange and primary aerosol emission.

6. Multidiurnal warm layer and inhibited gas exchange in the Peruvian upwelling regime

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Upper ocean observations off Peru are used to study air-sea gas exchange in coastal upwelling regions. Observations include high-resolution nitrous oxide (N2O) profiles in the topmost 10 meters far from ship's influence, ship based N2O profiles and transects, and ship and glider based hydrography.

We observed distinct vertical N2O gradients in the topmost 10 m of the upwelling regime. These gas gradients are associated with periods of persistent strong stratification in the oceanic top layer of longer than 24 hours up to several days ('multidiurnal warm layer') during low wind situations. The persistent stratification inhibits mixing and gas exchange between the deeper ocean layers and the topmost layer, while the wind is still sufficient to cause N2O depletion at the surface by outgassing. The findings have direct implications for air-sea gas exchange estimations in upwelling regions, when estimating oceanic gas emissions from measured concentrations a few meters below the surface.

7. Aerosol – Ocean Interaction: Oceanic Import of Dust

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Size resolved chemical composition analysis of marine aerosol and mineral dust concentrations were performed at the Cape Verde Atmospheric Observatory (CVAO). The main chemical components investigated were inorganic ions including sulfate, nitrate, ammonium, sea salt ions, organic and elemental carbon and trace metals. Results show strong seasonal variation in the dust and aerosol mass concentrations with peaks observed during the winter. Air mass analysis revealed that higher concentrations of sulfate and ammonium were observed when air mass originated from the African coast in contrast to Saharan and American air masses. Soluble trace metals show strong differences in their size fractions in comparison to the size distribution of their total concentrations. During dust storms, iron concentrations were observed to be as high as 30 µg/m³. Soluble iron showed strong pH dependency with higher soluble iron content observed at lower pHs.

8. Impact of Sahara dust on solar radiation at Cape-Verde Islands derived from MODIS and surface measurements

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Based on radiometer measurements of solar irradiance (direct and diffuse light) and Aeronet-ased Aerosol optical depth (AOD) obtained at the Cape-Verde atmospheric observatory uring a major cloud-free dust outbreak event on February 7, 2012, the relation between Saharan mineral dust outbreaks and a reduction of solar irradiance is quantified. The investigation is

representative of the eastern subtropical North Atlantic region where the wind mobilization of mineral desert dust from the Sahara results in a aerosol signal that is large enough to outweigh other aerosols such as anthropogenic and marine aerosols. Ground-based estimates of AOD show a frequency dependence as it can be expected from Mie theory. Our AOD signals agree well with satellite-based MODIS products and reveal AOD values exceeding 2.5 during the investigated dust storm event.
We also demonstrate the use of satellite imagery with an atmospheric trajectory model to simulate time series of measurements at a given location. Using this approach, variations in AOD observed during February 7, 2012 can be rationalized as spatial inhomogeneities in the atmospheric dust load being advocated laterally over the observing site. Our measurements suggest a dust forcing efficiency of around −90 W/m2/AOD at a wavelength of 380 nm, which is about 10-15% greater than reported in the literature.

9. Radar Backscatter Sensitivity Over Sea Water to Environmental Parameters

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This study shows the sensitivity of Radar Cross Section (RCS) measurements to meteorological variables which change the sea surface roughness. The RCS is measured by the Multi³Scat of the University of Hamburg that was mounted on the FINO-2 platform in the western Baltic Sea. We analyze measurements performed during a period of 27 months at different microwave frequencies, various different polarization combinations and incidence angles. Our results indicate RCS dependence on air-sea temperature difference and shows that wind exponent has not direct dependence to air-sea temperature difference. A slightly higher near-surface wind speed increase radar backscatter due to enhancing surface roughness and leads to a higher wind exponent. Analyses performed indicate the sensitivity of radar cross section to the atmospheric stability in addition to the wind speed due to its effect on surface roughness. The dependence on wind speed and stability are not separable and mixture of conditions influences the RCS.

10. Halocarbons from the Peruvian upwelling system

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Oceanic upwelling systems have been identified as important source regions for halocarbons. While methyl iodide (CH3I), the most abundant organoiodine in the marine troposphere, has been linked to photochemical sources, diiodomethane (CH2I2) and chloroiodomethane (CH2ClI) are thought to be biogenic. Especially in the tropical oceans halocarbons may be introduced into the stratosphere, where they take part in ozone depletion, as a result of very rapid uplift of surface air by tropical deep convection.
The SOPRAN cruise M91 took place onboard the RV Meteor in the Peruvian upwelling, and the first measurements of halocarbons from this region are presented here. 3 – 5 times higher CH3I (up to 35 pmol L-1), CH2I2 (up to 32 pmol L-1) and CH2ClI (up to 58 pmol L-1) compared to the tropical Atlantic were observed in the surface water. These compounds contribute significantly to the iodine content of the tropical Eastern Pacific troposphere. Halocarbon water concentrations were also related to concentrations of major phytoplankton pigments in order to identify their potential biogenic sources.

11. Halogenated short-lived compounds from the Indian Ocean

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Halogenated short-lived compounds (halocarbons) such as bromoform (CHBr3), dibromomethane (CH2Br2) and methyl iodide (CH3I) are produced naturally in the oceans by biological and photochemical processes. Despite their short atmospheric lifetimes (~24, 120 and 4 days) they can be transported into the stratosphere by tropical deep convection due to very rapid uplift of surface air where they take part in ozone destruction cycles. The Indian Ocean might play an important role in the transport to the stratosphere during the summer monsoon, but measurements of halocarbons are very sparse there.
During the OASIS cruise (SO234-2 and 235) onboard the RV Sonne, first measurements of these compounds were conducted in the region between 30° S and 10° N. We could identify a source region for halocarbons in a small upwelling band between 10° and 6° S, which could also be a significant region for transport into the stratosphere. Here, we present first results from the cruise in comparison to biological measurements.

12. MEMENTO, the MarinE MethanE and NiTrous Oxide database is now online!

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MEMENTO is an initiative started in 2009 that aims to collect available oceanic and atmospheric methane and nitrous oxide data into a global database for the computation of global concentration and flux fields. Data from about 180 campaigns with more than 100,000 nitrous oxide and 20,000 methane measurements have been collected. All data included in MEMENTO have undergone a first order quality control on the availability and range of essential and ancilliary data and their metainformation before they are imported into the database. Interested users are invited to download the data through our data portal which is accessible via the MEMENTO webpage (https://memento.geomar.de). We are furthermore looking for additional data contributions to expand our dataset.

13. The SOPRAN seawater gas exchange experiment: gas transfer velocities of weakly soluble gases

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In November of 2014, air-sea gas exchange measurements using natural seawater were performed at the large annular wind-wave tank in Heidelberg, the Aeolotron. One of the aims of the experiment was to study the effect of natural surface active material on the gas transfer velocity. Preliminary results of the gas transfer velocity measurements will be shown, with special focus on the transfer velocities of gases with low solubilities, for which the transport process is water-side controlled. Among other tracers, concentrations of He, Xe, Kr, CH3Cl, SF6 and N2O were measured using Fourier Transform Infrared Spectroscopy (FT-IR) spectroscopy and Membrane Inlet Mass Spectroscopy (MIMS). The measured gas transfer velocities will be related to the friction velocity and the mean square slope of the waves. Strongly breaking waves were simulated using a bubble generator in the experiments. Bubbles lead to an enhancement of the gas transfer velocity which is solubility dependent.

14. The SOPRAN seawater gas exchange experiment at the Heidelberg Aeolotron

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In November of 2014, air-sea gas exchange measurements using natural seawater taken from the north Atlantic were performed at the Aeolotron wind-wave tank in Heidelberg. Gas exchange velocities of a large number of trace gases (e.g. He, Xe, Kr, SF6, CO2, N2O), volatile chemical species (e.g. DMS, acetone, acetonitrile, methanol) and heat, covering a large range of solubility and diffusivity, were measured. Measuring techniques included LI-COR, FT-IR spectroscopy, MIMS, PTR-MS, and active thermography. Temperatures, water and wind velocities and wind waves were monitored as well. Eleven wind speeds ranging from 1.3 to over 20 m/s were used. An aerator was used to simulate strong breaking waves with bubble entrainment and spray formation. One goal of the experiment was to study the effects of natural surfactants present in the sea surface micro layer, which dampen waves and reduce gas transfer. This poster presents the setup of the experiment.

15. Exploring Air-Sea Gas Transfer by Active Thermography: First Results from the November 2014 Aeolotron Seawater Experiment

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Active thermography can be used to estimate local heat transfer velocities both in field and lab experiments. It is based on periodically heating a part of the water surface (size of approx. 0.25 m^2) with a laser. The temperature response of the water surface is monitored with an infrared camera in the 3 to 5 µm range. We have improved our setup lately by the use of a diffractive optical element, which allows for a much more homogeneous laser intensity profile at the water surface.

The improved setup has been used during the SOPRAN sea water experiment at the annular wind wave facility Aeolotron in Heidelberg in November 2014. Heat transfer velocities have been measured for wind speeds from 1.3 to 22 m/s with various degrees of contamination by natural surface films.

The talk and the poster will present the new measurement setup, explain the measurement technique and show first results from the seawater experiment.

16. Reactive Halogen Species in the atmosphere in the Peruvian and Mauritanian Upwelling region (incl. Cape Verde)

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Reactive halogen species (RHS) in the in the marine boundary layer have the potential to influence the ozone budget on a global scale, but their release processes are partly uncertain and little is known about their local variability. We present data from SOPRAN M91 cruise in the Peruvian upwelling region which shows IO mixing ratios of up to 2ppt. Very good agreement for MAX-DOAS and CE-DOAS measurements was achieved, which answers existing discussions on the measurement accuracy. The observed diurnal cycle of IO, especially the concentrations during sunrise allow restricting the dominant IO precursor species. Two ppt of BrO were detected during two days. During other cruises BrO concentrations were observed even below these values. On Cape Verde (Tropical Atlantic) a regular strong BrO diurnal cycle up to 5ppt is observed, IO levels below 0.5ppt. An overview of our RHS measurements at Cape Verde is presented.

17. Sensitivity of the marine N inventory to human-driven perturbations

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The marine inventory of fixed nitrogen (N), an essential nutrient controlling productivity, is determined by the balance between N2 fixation by cyanobacteria and N-loss via microbially-mediated processes under low oxygen conditions. Human-driven perturbations of ocean temperature and atmospheric N deposition impact on the magnitude of N-loss and N-gain with potential effects on oceanic N2O emissions. However, the timescale and the net effect of these changes on the N inventory is not known. This is particularly so since the degree of coupling between the major source and sink of N is debated and the sign of the feedbacks among these two opposite processes is not well defined. Here we use a global biogeochemical model to investigate how projected changes in ocean warming and atmospheric N deposition may impact the marine N inventory and affect future N2O emissions.

18. Carbonyl Sulfide in the equatorial Indian Ocean

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Carbonyl Sulfide (OCS) is the most abundant sulfur gas in the atmosphere, where it acts as an aerosol precursor and greenhouse gas. Especially in the Southern hemisphere, its atmospheric concentrations are determined by direct (OCS) or indirect (DMS, CS2) oceanic emissions. Atmospheric model studies suggest a missing source of OCS to the atmosphere from the tropical ocean. On the research cruise SO-235 in the tropical Indian Ocean, OCS concentrations in the surface ocean and the marine boundary layer were measured to study (i) oceanic sources and sinks of atmospheric OCS and (ii) production and consumption processes in the water using a simple box model. During SO-235, pronounced daily cycles were observed, resulting in the ocean being a source for atmospheric OCS only during noontime. Integrated over the whole cruise, the tropical Indian Ocean was a net sink for atmospheric OCS.

19. Model Sensitivity of Marine Carbon Export Production

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Marine biogeochemical models can be improved by developing a deeper understanding of the necessary degree of model complexity, which includes for example the investigation of non-unique solutions in parameter optimization problems. The examination of uniqueness and uncertainties of optimal parameter estimates might disclose the relevance of processes, when one observed pattern could possibly be explained equally well by different parameter settings or different parameterizations. Here, we show the results of our low-complexity marine ecosystem model CN-REcoM for variations of parameters that are crucial for export production, namely photosynthesis rate, grazing rate, and aggregation rate. Displayed are the effects of these parameter variations on chlorophylla, DIC, POC and export production. Furthermore we show how these model results compare with observed values from mesocosm experiments (PeECE III, Bergen, 2005).

20. Volatile organic compounds between winds and waves

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We have studied the air-sea gas exchange of several atmospherically relevant volatile organic compounds (VOCs) between natural seawater and air in the large annular wind-wave tank in Heidelberg, the Aeolotron. The VOCs selected bridge a great range in solubility allowing the effect of solubility on the transfer coefficient to be characterized with respect to windspeed, development of a natural surfactants, and bubbles. It was expected that wind and bubbles increase the transfer of gases through the air-sea interface, while the surfactants reduce the exchange rate. The results for transfer coefficients will be compared with those derived from the “no biology - pure physics” case examined within SOPRAN 2. Within the framework of this decidedly more holistic experiment we explored whether chemical and biological interactions occurring in natural sea water and surfactants potentially impact the ocean-atmosphere exchange of VOCs.

21. Absorbing and scattering phytoplankton blooms in relation to the impacts of Saharan dust

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In the recent years the biological response to atmospheric dust supply was studied by different microcosm and fertilization experiments, remote-sensing observations, and model simulations. This poster summarizes investigations focused on the biological response to dust deposition in the eastern tropical North Atlantic.

Dust storms, absorbing and scattering algae blooms were captured in MODIS satellite data of years 2005 to 2013. In the first step, the aerosol optical depths at 550 nm (AOD) of sensors Aqua and Terra were used as proxy for the atmospheric dust column load and the dust deposition. This linear approach was extended by the replacement with the near surface particle mass concentration (PM10) measured at the Cape Verde Atmospheric Observatory at Sao Vicente. The chlorophyll-a (Chla) level 2 products of the MODIS sensors were taken for the identification of absorbing algae blooms. Specific algae blooms were characterized by high reflectances due to enhanced scattering by coccoliothophores. Such scattering blooms were detected by increased reflectances at a wavelength of 555 nm (R555) and particulate backscattering coefficients at 443 nm (bbp443).

Each year the absorbing algae blooms started in autumn. They reached their maxima in winter between February and March. The scattering algae blooms culminated between March and May and particularly in April. The development of absorbing algae blooms (autumn) started always earlier than for scattering blooms (winter). The scattering blooms reached their maxima in offshore areas about one to three but mostly two month later.

AOD and PM10 were highest in summer and winter. The dust component PM10 suggested highest dust deposition in winter and some events in summer. Direct seasonal correlations between PM10 and algae blooms were not observed. But absorbing blooms could be supported in the offshore area by fertilization following the dust events with a time lag of about 1 to 2 month.

22. Particulate matter in the surface nepheloid layer of the eastern tropical North Atlantic observed by Argo floats

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The spatial and temporal distribution of particulate matter in the surface nepheloid layer in the eastern tropical North Atlantic was investigated on the basis of beam attenuation coefficients measured with two Argo floats from February 2008 to May 2009.

The particulate matter in the surface nepheloid layer was distributed in the uppermost water column up to about 60 m with thicknesses between 20 and 60 m. The combination of field observations with remote sensing data verified high correlations between particulate matter and phytoplankton. In the observed time period, the nonalgal particles contribute to the total beam attenuation coefficient in oligotrophic and mesotrophic areas of low to moderate Chla concentrations but their contributions were negligible in eutrophic regions of high Chla concentrations.

The offshore extensions of observed filaments of particulate matter depended on the location and season. Especially high offshore extensions of up to 750 km were identified in the area of Cape Blanc filaments in January 2009. The typical widths of filaments ranged from 11 and 72 km. The dust deposition was also determined during a strong Saharan dust storm in October 2008. The dust concentration in the mixed water layer was approximated between 0.0021 and 0.0168 g m-3.

23. Reactive Halogen Species in the Marine Boundary Layer: A global picture observed from ship cruises and coastal measurements

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Reactive halogen species (RHS) in the marine boundary layer (MBL) can have a significant influence on the marine ozone budget and the atmospheric oxidation capacity and are thus relevant for the global atmosphere. We present an overview of findings for the RHS Iodine Oxide (IO), Bromine Oxide (BrO) and Formaldehyde (HCHO) from various field measurements on ships and land performed mainly within the SOPRAN project. Different spectroscopic measurement techniques were applied. IO is found over large areas at concentrations below 1ppt. A strong correlation of atmospheric IO and iodide in sea water is observed and is thus likely to be a major source of atmospheric iodine. At coastal areas emission fluxes due to macro algae are much higher and concentrations reach locally 400ppt. On a global scale, BrO VMR are typically below the detection limit of 1.5ppt. BrO-events with higher values are observed sporadically in the Mauritanian Upwelling and due to transport from polar regions.

24. Coastal upwelling velocities inferred from helium isotope disequilibrium

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In the framework of SOPRAN, two of the main gloabal Eastern Boundary Current Upwelling Systems (EBUS) have been investigated, off the coasts of Mauritania in the northern Atlantic and of Peru in the southern Pacific. The upwelling in the EBUS is driven by alongshore winds causing an offshore transport of surface waters. The upwelled water typically exhibits high concentrations of climate relevant gases such as CO2, N2O and halogenated compounds. The oceanic upwelling velocities, however, are too small (in the order of 10-5 m/s) to be measured directly. Here we use oceanic measurements of the helium-3/helium-4 isotopic ratio as an indirect means to infer these velocities. The water that upwells into the oceanic mixed layer from below is typically enriched in the lighter isotope helium-3. This excess of helium-3 originates from venting of primordial helium through hydrothermal activity. Helium data have been collected on four cruises within the coastal upwelling regions off Mauritania and Peru. Near the coast, the helium derived upwelling velocities are in good agreement with

the wind driven flow calculated from Ekman theory. At some locations in the open ocean, however, the helium method results in much higher vertical velocities compared to the wind derived Ekman divergence. This enhanced upwelling might be attributed to eddy activity. Both advective and turbulent (derived from microstructure measurements) fluxes of nutrients into the mixed layer are determined. In coastal upwelling regions, these fluxes play a key role in fostering ocean primary productivity.

25. On the relevance of seasonal variability of bromocarbon production for global emissions and atmospheric mixing ratios

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The short-lived bromocarbons bromoform and dibromomethane are important precursors of reactive halogen species in the atmosphere that are involved in ozone depletion. These halogens are produced in the ocean and the temporal variability of their concentrations in seawater is often related to dynamics of marine phytoplankton. A recent study shows that the seasonality of observed atmospheric mixing ratios can be reproduced with an atmospheric chemistry-transport model when considering only climatological mean emission. However, emission maps derived from bottom-up methods that include the seasonal dynamics resulting from both production and meteorological conditions consistently were not available by that time and the relevance of such dynamics for mixing ratios in air remains unclear.
Here we show results of an Earth System Model including bromocarbon chemistry in ocean and atmosphere in fully coupled and atmosphere-standalone simulations. We discuss the impact of seasonal production of bromocarbons on emissions and atmospheric mixing ratio dynamics.

26. Bacterial degradation of chloro- and iodomethane in the Baltic Sea

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Monohalomethanes (CH3X), e.g iodomethane (CH3I) and chloromethane (CH3Cl), are important marine sources for atmospheric halogen radicals. Knowledge about different sources and sinks exists; however, the extent of bacterial degradation in the ocean remains enigmatic. We performed incubation experiments with natural Baltic Sea water to obtain bacterial CH3X-degradation rates. Triplicate samples were inoculated with excess CH3I (10 nM) and CH3Cl (100 nM) and concentration changes were monitored over time. Stimulated bacteria were identified by 16S rRNA sequencing approaches at the end of these incubations.

We initially observed low biological loss rates of CH3I (0.5 % d-1) and CH3Cl (1 % d-1), which are consistent with published results. Interestingly, after 4 weeks of incubation, bacterial CH3Cl-degradation increased to up to 9 % d-1. Changes of bacterial community composition were very similar in all incubations compared to the untreated controls. Nevertheless, we observed a stimulation of bacterial taxa, which are phylogenetically related to known CH3X-degraders, e.g. *Hyphomicrobium sp.* Taken together, our results show a generally low bacterial CH3X degradation in the Baltic Sea, which however still is a potential major sink of CH3X under yet to be defined conditions.

27. Dissolved methane in Sanggou Bay: implication of in situ production in an aquaculture area of China

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We measured distributions, air-sea fluxes, sediment-water fluxes and production rate of dissolved CH4 in Sanggou Bay, one of the biggest aquaculture areas in China, during June and September 2012, April and July 2013. Due to the variable hydrologic condition and the aquaculture of shellfish and kelp in the bay, CH4 concentrations showed substantially spatial and seasonal variation, which were higher in summer and autumn than in spring. CH4 in the water column was oversaturated throughout the whole year and Sanggou Bay is a net source of atmospheric CH4. CH4 budget of Sanggou Bay was also estimated with a box-model, indicating that in situ CH4 production in seawater was the dominant source of CH4, while external CH4 sources only contributed to a small proportion. This estimation was further proved by in situ incubation experiment, which suggested that net CH4 production rate of the water column in Sanggou Bay was higher than that in the adjacent Yellow Sea, especially in summer.

28. Atmosphere/ocean exchange processes and the surface microlayer

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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.
Therefore various concerted sampling activities (sampling of bulkwater, the SML and aerosol particles) were performed during SOPRAN at the CVAO and during ship cruises.
A comprehensive data interpretation of the results achieved during the MARIA S. MERIAN cruise MSM 18/3 could reveal important sources of atmospheric relevant organic compounds on aerosol particles including indications for upwelling influences. A joint manuscript was recently submitted.

Furthermore, aerosol investigations were performed during the final SOPRAN laboratory experiment in the wind-wave-channel AEOLOTRON in Heidelberg with the participation of several SOPRAN partners and external research groups.
Other joint SOPRAN activities include the preparation of a manuscript about a meta study of the enrichment of organic matter in the SML.

29. Cape Verde case studies on mineral dust modelling

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Trace metals have catalytic effect on cloud chemistry and influences the bio-geochemical cycle in the oceans, with iron being the most abundant trace metal in the earths crust and in atmospheric aerosols. The biggest source of naturally emitted iron is eolian desert dust. Its content of dissolved metal compounds determines its environmental effects. Thus to estimate the dissolution process on desert dust particles during its transport and the production of soluble material, especially by means of dissolved iron, the chemical trajectory model SPACCIM is used. In order to resolve the dissolution and precipitation processes for mineral compounds several mechanisms have been implemented into the model framework. Measurements of the Cape Verde Atmospheric Observatory (CVAO) help to evaluate the accuracy of these mechanisms. For this purpose two distinct dust storm events that have been observed at CVAO have been investigated with regard to the amount of dissolved iron.

30. Key processes of the cycle of organic Fe-binding ligands: a sensitivity study in 3D biogeochemical model

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Most dissolved iron (DFe) in the ocean is bound to organic ligands, which regulate the reactive fraction of DFe available for particle adsorption, and thus its residence time. Assumptions on ligand abundance are therefore critical for biogeochemical models including iron. Instead of fixing organic ligands to an observed mean concentration, Völker and Tagliabue (2015) firstly implemented a mechanistic description of ligand dynamics in two 3D models (PISCES and REcoM). In this study, a series of sensitivity experiments has been done with REcoM dealing with the uncertainty in some parameter values describing ligand production and loss. Ligands are produced from organic matter remineralization and phytoplankton processes, and lost through bacterial and photochemical degradation as well as phytoplankton uptake. We report the impact of varying parameter values describing these processes on the global ligand distribution, its inter-basin variability and the model-data-consistency, and further on the distribution of DFe.