NEWSLETTER 2015 | 01

Sonderforschungsbereich 754

Climate – Biogeochemistry Interactions in the Tropical Ocean

SFB 754

SFB 754 Annual Retreat

KIEL, 16TH-17TH FEB 2015

At this year's annual retreat, approximately 100 scientists participated. Most of them are active members of the SFB 754, though international experts were invited as well. The retreat was opened by Marion Knaths (sheboss), who illustrated the different behaviours of female and male scientists in working environments. She provided lots of topics of conversation for reflections in the coffee breaks. Focus of the retreat was the subprojects' presentations on their current state and their research plans for the 3rd phase. These were critically discussed and on the bases of these debates, the final list of subprojetcs and principal investigators for the 3rd phase was compiled.

N_2 fixation Workshop

GRANADA, SPAIN, 22ND FEB 2015

A one-day workshop held during the ASLO meeting in Granada, Spain, brought together 45 marine scientists from 11 countries to discuss the "Environmental Controls of marine N_2 fixation". Plenary short overview presentations have been followed by an open discussion on research priorities and open questions. The wide range of expertise – from molecular biology to global biogeochemistry and from cell to global scales modelling – stimulated dynamic and cross-disciplinary discussions. The group is currently working towards synthesis review papers to clarify the current state on knowledge and uncertainties, alongside finalising strategies for collaborative research efforts.

Young Scientist Retreat

GLÜCKSBURG, 24TH-26TH MARCH 2015

The focus of this year's SFB 754 young scientists retreat, the last retreat for the 2nd phase PhD and postdoc cohort, was "Academic Career Planning". A professional trainer gave suggestions on improving application papers, although the majority of the time was spent on discovering strength and weaknesses of the participants and learning methods on how to find his/hers career paths. In addition on the 2nd day, various former and current scientists with a doctoral degree were invited as "experts" with whom the participants were able to discuss their career paths, choice of occupation and employers. The two days were full of discussions late into the night and retreat participants left loaded with energy and motivation to start a new phase of their careers!

Publications

Brandt, P., H.W. Bange, D. Banyte, M. Dengler, S.-H. Didwischus, T. Fischer, R.J. Greatbatch, J. Hahn, T. Kanzow, J. Karstensen, A. Körtzinger, G. Krahmann, S. Schmidtko, L. Stramma, T. Tanhua and M. Visbeck (2015) On the role of circulation and mixing in the ventilation of oxygen minimum zones with a focus on the eastern tropical North Atlantic. Biogeosciences, 12, 489-512, doi: 10.5194/bg-12-489-2015

The OMZ of the eastern tropical North Atlantic (ETNA) is composed of a deep OMZ at about 400m in depth with its core region centred at about 20° W, 10° N and a shallow OMZ at about 100 m in depth, with the lowest oxygen concentrations in proximity to the coastal upwelling region off Mauritania and Senegal. The oxygen budget of the deep OMZ is given by oxygen consumption mainly balanced by the oxygen supply due to meridional eddy fluxes (about 60 %) and vertical mixing (about 20 %, locally up to 30 %). Advection by zonal jets is crucial for the establishment of the equatorial oxygen maximum. In the latitude range of the deep OMZ, it dominates the oxygen supply in the upper 300 to 400 m and generates the intermediate oxygen maximum between deep and shallow OMZs. Long-term oxygen observations show variability on interannual, decadal and multidecadal timescales that can partly be attributed to circulation changes. In comparison to the ETNA OMZ, the eastern tropical South Pacific OMZ shows a similar structure, including an equatorial oxygen maximum driven by zonal advection but overall much lower oxygen concentrations approaching zero in extended regions.

Nickelsen, L. and A. Oschlies (2015) Enhanced sensitivity of oceanic CO_2 uptake to dust deposition by iron-light colimitation. Geophys. Res. Lett., 42, doi:10.1002/2014GL062969

The iron hypothesis suggests that in large areas of the ocean phytoplankton growth and thus photosynthetic CO_2 uptake is limited by the micronutrient iron. Phytoplankton requires iron in particular for nitrate uptake, light harvesting, and electron transport in photosynthesis, suggesting a tight coupling of iron and light limitation. One important source of iron to the open ocean is dust deposition. Previous global biogeochemical modeling studies have suggested a low sensitivity of oceanic CO_2 uptake to changes in dust deposition. In this study it is shown that this sensitivity is increased significantly when iron-light colimitation, i.e., the impact of iron bioavailability on light-harvesting capabilities, is explicitly considered. Accounting for iron-light colimitation increases the shift of export production from tropical and subtropical regions to the higher latitudes of subpolar regions at high dust deposition and amplifies iron limitation at low dust deposition. These results reemphasize the role of iron as a key limiting nutrient for phytoplankton.

Schönfeld, J., W. Kuhnt, Z. Erdem, S. Flögel, N. Glock, M. Aquit, M. Frank and A. Holbourn (2015) Records of past mid-depth ventilation: Cretaceous ocean anoxic event 2 vs. recent oxygen minimum zones. Biogeosciences, 12, 1-21, doi: 10.5194/bg-12-1169-2015

The review addresses the implications of features such as finely laminated organic carbon-rich sediments and low-oxygen indicating trace fossils found both in Late Quaternary OMZ sections from the Peruvian upwelling and in deposits of the late Cenomanian OAE 2 from the north-west African shelf for constraining past bottom-water oxygenation. Holocene laminated sediments are encountered at bottom-water oxygen levels of < 7 µmol kg^{-1} under the Peruvian upwelling and < 5 µmol kg^{-1} in California Borderland basins

and the Pakistan Margin. Seasonal to decadal changes of sediment input create laminae of different composition. Bottom currents may shape similar textures that are difficult to discern from primary seasonal laminae. The millimetre-sized trace fossil Chondrites was commonly found in Cretaceous strata and Recent oxygen-depleted environments where its diameter increased with oxygen levels from 5 to 45 µmol kg^{-1}. Chondrites has not been reported in Peruvian sediments but centimetre-sized crab burrows appeared around 10 µmol kg^{-1}, which may indicate a minimum oxygen value for bioturbated Cretaceous strata. Organic carbon accumulation rates ranged from 0.7 and 2.8 g C cm^{-2} kyr^{-1} in laminated OAE 2 sections in Tarfaya Basin, Morocco, matching late Holocene accumulation rates of laminated Peruvian sediments under Recent oxygen levels below 5 µmol kg^{-1}. Sediments deposited at >10 µmol kg^{-1} showed an inverse exponential relationship of bottom-water oxygen levels and organic carbon accumulation depicting enhanced bioirrigation and decomposition of organic matter with increased oxygen supply. In the absence of seasonal laminations and under conditions of low burial diagenesis, this relationship may facilitate quantitative estimates of palaeo-oxygenation.

Dale, A.W., S. Sommer, U. Lomnitz, I. Montes, T. Treude, V. Liebetrau, J. Gier, C. Hensen, M. Dengler, K. Stolpovsky, L.D. Bryant and K. Wallmann (2015) Organic carbon production, mineralisation and preservation on the Peruvian margin. Biogeosciences, 12, 1537-1559, doi: 10.5194/bg-12-1537-2015

Carbon cycling in Peruvian margin sediments (11° and 12° S) was examined at 16 stations, from 74 m water depth down to 1024 m, using a combination of in situ flux measurements, sedimentary geochemistry and modelling. Bottom water oxygen was below detection limit down to ca. 400 m and increased to 53 µM at the deepest station. Sediment accumulation rates decreased sharply seaward of the middle shelf and subsequently increased at the deep stations. The organic carbon burial efficiency (CBE) was unusually low on the middle shelf (<20%), which may be linked to episodic ventilation of the bottom waters by oceanographic anomalies. Deposition of reworked, degraded material originating from sites higher up is proposed to explain unusually high sedimentation rates and CBE (>60%) at the deep oxygenated sites. In line with other studies, CBE was elevated under oxygen-deficient waters in the mid-water oxygen minimum zone. Organic carbon rain rates calculated from the benthic fluxes alluded to efficient mineralisation of organic matter in the water column compared to other oxygen-deficient environments. The observations suggest that a lack of oxygen does not greatly affect the degradation of organic matter in the water column but promotes the preservation of organic matter in sediments.

Ehlert, C., P. Grasse, D. Gutiérrez, R. Salvatteci and M. Frank (2015) Nutrient utilisation and weathering inputs in the Peruvian upwelling region since the Little Ice Age. Clim. Past, 11, 187–202, doi: 10.5194/cp-11-187-2015

Two sediment cores from the Peruvian shelf covering the time period between the Little Ice Age (LIA) and present were examined for changes in productivity, nutrient utilization, nitrogen, ocean circulation and material transport. For the LIA the proxies recorded weak primary productivity and nutrient utilization. The radiogenic isotope composition of the detrital sediment fraction indicates dominant local riverine input of lithogenic material due to higher rainfall in the Andean hinterland. These patterns were most likely caused by permanent El Niño-like conditions characterised by a deeper nutricline, weak upwelling and low nutrient supply. At the end of the LIA, $\delta^{30}Si_{opal}$ dropped to low values and opal productivity reached its minimum of the past 650 years. During the following transitional period of time the intensity of upwelling, nutrient supply, productivity and also wind strength and supply of dust to the shelf increased. Since about 1870, productivity has been high but nutrient utilisation has remained at levels similar to the LIA, indicating significantly increased nutrient availability. It can be suggested that during the past 650 years the $\delta^{15}N_{sed}$ signature in the Peruvian upwelling area has greatly been controlled by surface water utilisation and not by subsurface nitrogen loss processes in the water column, which only had a significant influence during modern times.

Borchard, C. and A. Engel (2015) Size-fractionated dissolved primary production and carbohydrate composition of the coccolithophore *Emiliania huxleyi*. Biogeosciences, 12, 1271-1284, doi: 10.5194/bg-12-1271-2015

The extracellular release (ER) by the widespread and bloom-forming coccolithophore *Emiliania huxleyi* grown under steady-state conditions in phosphorus-controlled chemostats is examined at present-day and high-CO_2 concentrations. ^{14}C incubations were performed to determine primary production (PP), comprised of particulate ($PO^{14}C$) and dissolved organic carbon ($DO^{14}C$). Concentration and composition of particulate combined carbohydrates (*p*CCHO) and high-molecular-weight (>1 kDa, HMW) dissolved combined carbohydrates (*d*CCHO) were determined by ion chromatography. Information on size distribution of ER products was obtained by investigating distinct size classes of $DO^{14}CC$ and HMW-*d*CCHO. The results revealed low ER during steady-state growth, corresponding to ~4.5% of PP, and similar ER rates for all size classes. Acidic sugars had a significant share on freshly produced *p*CCHO and HMW-*d*CCHO. While *p*CCHO and the smallest size fraction of HMW-*d*CCHO exhibited a similar sugar composition, dominated by high percentage of glucose (74-80 mol%), the composition of HMW-dCCHO size classes >10 kDa was significantly different, with a higher mol% of arabinose. The mol% of acidic sugars increased and that of glucose decreased with increasing size of HMW-dCCHO. It can be concluded, that larger polysaccharides follow different production and release pathways than smaller molecules, potentially serving distinct ecological and biogeochemical functions.

Conferences

Goldschmidt - Session 02d, 16-21 August, Prague (CZ), What are the Unifying Principles Common to all Three Oxygen Minimum Zones (OMZs)? James Moffett, Aurélien Paulmier

SFB 754 Intern

28. APRIL 2015
N_2-fixation workshop, organised by C. Löscher 9.00-12.00 h and 14.00-17.00 h, GEOMAR (West Shore), 1st floor, R: 124/125 (PO)

18. MAY 2015
Intense nutrient upwelling in anti-cyclones caused by sub-mesoscale instabilities by Liam Brannigan, 11.00 h, GEOMAR, Lecture hall (West Shore)

Proposal & Evaluation

Road map

06. MAY 2015 proposal – first version

22. MAY 2015 proposal – second version

29. MAY 2015 proposal – final version

3., 4. & 14. SEPT 2015 Evaluation dry-run (Wissenschafts-Zentrum, CAU, GEOMAR)

16. & 17. SEPT 2015 Evaluation (Wissenschafts-Zentrum, CAU, GEOMAR)

EDITORIAL
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