NEWSLETTER 2016 | 04

Sonderforschungsbereich 754

Climate – Biogeochemistry Interactions in the Tropical Ocean

SFB 754

SFB 754 Early Career Scientists Kick-off Retreat

14. - 18. NOV 2016, Gottin

This November the SFB 754 early career scientists kick-off retreat took place in a remote but cozy guesthouse in Gottin, Western Pomerania. The retreat provided a great overview of the SFB 754 including several poster sessions and at the same time successfully offered the opportunity for networking of the participating 23 postdocs and 9 PhD candidates. During plenary discussions and break-out groups the important drivers of oxygen variability, the SFB 754 synthesis and different aspects of career development were discussed. We are very thankful for the support of Prof. Ralf Schiebel, Prof. Anya Waite and Dr. Thomas Frölicher, who gave interesting lectures and played an important part in the discussion rounds. In addition the retreat was supported by SFB 754 scientists A. Oschlies, I. Kriest, J. Lübbecke, J. Karstensen and H. Dietze, who gave important input with regard to the scientific SFB 754 questions and shared their academic experience. Finally, H. Mehrtens discussed the SFB 754 data management with the participants and there was also time for a workshop on diversity and bias in science. In summary the retreat was a great success and we would like to thank everyone who made this possible!

Publications

Marki, A. and Pahlow M. (2016) Microzooplankton stoichiometric plasticity inferred from modelling mesocosm experiments in the Peruvian Upwelling region. Front. Mar. Sci. 3:258, doi: 10.3389/fmars.2016.00258

OMZs are often characterised by N:P ratios far lower than the canonical Redfield ratio. Whereas the importance of variable stoichiometry in phytoplankton has long been recognised, variations in zooplankton stoichiometry have received much less attention. Observations from two shipboard mesocosm nutrient enrichment experiments were combined with an optimality-based plankton ecosystem model, designed to elucidate the roles of different trophic levels and elemental stoichiometry. Pre-calibrated microzooplankton parameter sets represent foraging strategies of dinoflagellates and ciliates in the model. The results suggest that remineralisation is largely driven by omnivorous ciliates and dinoflagellates, and highlight the importance of intraguild predation. It is hypothesized that microzooplankton respond to changes in food quality in terms of N:C ratios, rather than N:P ratios, by allowing variations in their P:C ratio. These results point towards an important biogeochemical role of flexible microzooplankton stoichiometry.

Loginova, A. N., S. Thomsen and A. Engel (2016) Chromophoric and fluorescent dissolved organic matter in and above the oxygen minimum zone off Peru. J. Geophys. Res. Oceans, doi: 10.1002/2016JC011906

As a result of nutrient upwelling, the Peruvian coastal system is one of the most productive regions in the ocean. Sluggish ventilation of intermediate waters, characteristic for the Eastern Tropical South Pacific and microbial degradation of a high organic matter load promotes deoxygenation at depth. DOM plays a key role in microbial respiration and carbon cycling, but little is known on DOM distribution and cycling in the ETSP. DOM optical properties give important insights on DOM sources, structure and biogeochemical reactivity. Here, data and a conceptual view on distribution and cycling of chromophoric DOM and fluorescent DOM in and above the OMZ off Peru is presented. Five fluorescent components were identified during PARAFAC analysis. Highest intensities of CDOM and of the amino acid-like fluorescent component occurred above the OMZ and coincided with maximum chl a concentrations, suggesting phytoplankton productivity as major source. High intensities of a marine humic-like fluorescent component, observed in subsurface waters, indicated in situ microbial reworking of DOM. FDOM release from inner shelf sediment was determined by seawater analysis and continuous glider sensor measurement and included a humic-like component with a signature typical for terrestrially derived humic acids. Upwelling supplied humic-like substances to the euphotic zone. Photo-reactions were likely involved in the production of another more altered humic-like fluorescent substance. The data show that variable biological and physical processes need to be considered for understanding DOM cycling in a highly dynamic coastal upwelling system like the ETSP off Peru.

Bristow, L., C. M. Callbeck, M. Larsen, M. A. Altabet, J. Dekaezemacker, M. Forth, M. Gauns, R. N. Glud, M. M. M. Kuypers, G. Lavik, J. Milucka, S. W. A. Naqvi, A. Pratihary, N. P. Revsbech, B. Thamdrup, A. H. Treusch and D. E. Canfield (2016) N_2 production rates limited by nitrite availability in the Bay of Bengal oxygen minimum zone. Nat. Geosci., doi: 10.1038/NGEO2847

A third or more of the fixed nitrogen lost from the oceans as N_2 is removed by anaerobic microbial processes in open ocean OMZs. These zones have expanded over the past decades and further anthropogenically induced expansion could accelerate N-loss. However, in the Bay of Bengal there has been no indication of N-loss, although oxygen levels are below the detection level of conventional methods. Here we quantify the abundance of microbial genes associated with N_2 production, measure N-transformations in incubations of sampled seawater with isotopically labelled N compounds and analyse geochemical signatures of these processes. It is shown that the Bay of Bengal supports denitrifier and anammox microbial populations, mediating low, but significant N-loss. Yet, unlike other OMZs, measurements using a highly sensitive oxygen sensor demonstrate that the Bay of Bengal has persistent concentrations of oxygen in the 10 to 200 nM range. It is proposed that this oxygen supports NO_2^- oxidation, thereby restricting the NO_2^- available for anammox or denitrification. If these traces of oxygen were removed, N-loss in the Bay of Bengal OMZ waters could accelerate to global significance.

Arévalo-Martínez, D. L., A. Kock, T. Steinhoff, P. Brandt, M. Dengler, T. Fischer, A. Körtzinger and H. W. Bange (2016) Nitrous oxide during the onset of the Atlantic Cold Tongue. J. Geophys. Res. Oceans., doi: 10.1002/2016JC012238

The tropical Atlantic exerts a major influence in climate variability through strong air-sea interactions, with the most prominent feature being the seasonal occurrence of the Atlantic Cold Tongue (ACT). This study shows that the onset and development of the ACT can be clearly observed in surface N_2O concentrations, which increase progressively as the cooling in the equatorial region proceeds during spring-summer. We observed a strong influence of the surface currents of the EEA on the N_2O distribution, which allowed identifying "high" and "low" concentration regimes that were, in turn, spatially delimited by the extent of the predominant zonal currents. Sea-to-air fluxes of N_2O from the ACT (mean 5.18±2.59 µmol m^{-2} d^{-1}) suggests that in May-July 2011 this cold-water band doubled the N_2O efflux to the atmosphere with respect to the adjacent regions, highlighting its relevance for marine tropical emissions of N_2O.

Grasse, P., E. Ryabenko, C. Ehlert, M. A. Altabet and M. Frank (2016) Silicon and nitrogen cycling in the upwelling area off Peru: A dual isotope approach. Limnol. Oceanogr. 61(5), 1661–1676, doi: 10.1002/lno.10324

In this paper a comparison of the dissolved stable isotope composition of silicate ($\delta^{30}Si(OH)_4$) and nitrate (δ^{15} NO_3^-) is presented to investigate the biogeochemical processes controlling nutrient cycling in the upwelling area off Peru, where one of the globally largest oxygen minimum zones is located. Besides strong upwelling of nutrient rich waters mainly favoring diatom growth, an anticyclonic eddy influenced the study area. A tight coupling between the Si and N-cycles in the study area is observed. Waters on the shelf showed high $Si(OH)_4$ concentrations accompanied by diminished NO_3^- concentration as a consequence of intense remineralization, high Si fluxes from the shelf sediments, and N-loss processes such as anammox/denitrification within the OMZ. Correspondingly, the surface waters show low $\delta^{30}Si(OH)_4$ values (+2‰) due to low Si utilization but relatively high δ^{15} NO_3^- (+13‰) values due to upwelling of waters influenced by N-loss processes. In contrast, as a consequence of the deepening of the thermocline in the eddy center, a pronounced $Si(OH)_4$ depletion led to the highest $\delta^{30}Si(OH)_4$ values (+3.7‰) accompanied by high δ^{15} NO_3^- values (+16‰). In the eddy center, high NO_3^-: $Si(OH)_4$ ratios favored the growth of non-siliceous organisms (Synechococcus). The data show that upwelling processes and the presence of eddies play important roles controlling the nutrient cycles and therefore also exert a major influence on the phytoplankton communities in the Peruvian Upwelling. The findings also show that the combined approach of $\delta^{30}Si(OH)_4$ and δ^{15} NO_3^- can improve our understanding of paleo records as it can help to disentangle utilization and N-loss processes.

Glock, N., V. Liebetrau, A. Eisenhauer and A. Rocholl (2016) High resolution I/Ca ratios of benthic foraminifera from the Peruvian oxygen-minimum-zone: A SIMS derived assessment of a potential redox proxy. Chem. Geol. 477, 40-53, doi: 10.1016/j.chemgeo.2016.10.025

Oceanic oxygen decline due to anthropogenic climate change is a matter of growing concern. Tropical OMZs are the most important areas of oxygen depletion in the modern oceans. A quantitative oxygen proxy in OMZs is highly desirable in order to identify and monitor recent dynamics as well as to reconstruct pre-Anthropocene changes in amplitude and extension of oxygen depletion. A previous study revealed that there are significant correlations between I/Ca ratios of foraminiferal bulk samples for different benthic foraminiferal species from the Peruvian OMZ. Nevertheless, species for which less specimens were available showed a higher variability between I/Ca ratios in different badges. To test if this might be related to intra- or inter-shell heterogeneity we focused on microanalyses of I/Ca ratios within these species in the present study. The I/Ca ratios on 8 of 11 cleaned Uvigerina striata and Planulina limbata specimens determined with SIMS showed no significant difference to previous ICP-MS measurements on bulk samples from the same species. This indicates that both techniques are suited to the analysis and that the applied cleaning protocols efficiently removed the strong iodine contaminations. Nevertheless, despite the highly significant correlation between bulk ICP-MS I/Ca ratios and bottom water oxygen concentrations for U. striata, no significant correlation was observed for the SIMS derived individual I/Ca ratios. This indicates that ICP-MS bulk analyses on pooled bulk samples might be more suitable for reliable oxygen reconstructions using I/Ca ratios.

Arteaga, L., M. Pahlow, A. Oschlies (2016) Modelled Chl:C ratio and derived estimates of phytoplankton carbon biomass and its contribution to total particulate organic carbon in the global surface ocean. Global Biogeochem. Cy., doi: 10.1002/2016GB005458

Chlorophyll is a distinctive component of autotrophic organisms, often used as an indicator of phytoplankton biomass. However, assessment of phytoplankton biomass from Chl relies on the accurate estimation of the Chl:C ratio. Here global patterns of Chl:C ratio are presented in the surface ocean obtained from a phytoplankton growth model that accounts for the optimal acclimation of phytoplankton to ambient nutrient, light, and temperature conditions. Combining Chl:C estimates with satellite Chl and POC permits to infer the phytoplankton C concentration in the surface ocean and its contribution to the total POC pool. The results suggest that the portion of POC corresponding to living phytoplankton is higher in subtropical latitudes and less productive regions and decreases towards high latitudes and productive regions. An important caveat of the model is the lack of iron limiting effects on phytoplankton physiology. Comparison of the predicted phytoplankton biomass with an independent estimate of total POC reveals a positive correlation between nitrate concentrations and non-photosynthetic POC in the surface ocean. This correlation disappears when a constant Chl:C is applied. These results highlight the importance of accounting for the variability in Chl:C and its application in distinguishing the autotrophic and heterotrophic components in the assemblage of the marine plankton ecosystem.

Conferences

ASLO AQUATIC SCIENCES MEETING
26 February - 3 March 2017,
Honolulu (Hawaii)

EGU GENERAL ASSEMBLY 2017
23 - 28 April 2017,
Vienna (Austria)

SFB 754 Intern

SFB 754 ANNUAL RETREAT
13 - 14 February 2017, Kiel

SFB 754 INTERNATIONAL CONFERENCE
3 - 7 September 2018, Kiel

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