



Publications

2013 (April – June)

Banyte, D., Visbeck, M., Tanhua, T., Fischer, T., Krahnemann, G. and Karstensen, J. (2013) Lateral diffusivity from tracer release experiments in the tropical North Atlantic thermocline. *Journal of Geophysical Research: Oceans*, 118 (4). pp. 1-15. doi:10.1002/jgrc.20211.

In this study, horizontal eddy mixing coefficients are estimated from the tracer release experiment, performed in the northeastern tropical Atlantic at about 300 m depth. The uncertainties of the mixing coefficients are inferred from a synthetic particle release using a high-resolution ocean circulation model. We get a meridional eddy mixing coefficient of about 500 m²/s. The zonal component is twice as large, as a result of the tracer patch stretching by prevailing zonal jets. Finally, different sampling strategies and their effect on the mixing estimates are tested.

Bertics, V.J., Löscher, C.R., Salonen, I., Dale, A.W., Gier, J., Schmitz, R. A. and Treude, T. (2013) Occurrence of benthic microbial nitrogen fixation coupled to sulfate reduction in the seasonally hypoxic Eckernförde Bay, Baltic Sea. *Biogeosciences (BG)*, 10 (3). pp. 1243-1258. doi:10.5194/bg-10-1243-2013.

This study aims to evaluate N₂ fixation, possibly by sulfate-reducing bacteria (SRB), and its role in N cycling within the seasonally hypoxic sediments from the Eckernförde Bay, Baltic Sea with monthly samplings over the course of one year. Integrated rates of N₂ fixation and sulfate reduction showed similar seasonality patterns, with highest rates in August and October, and lowest rates in February. These rate changes were positively correlated with bottom water temperature and previous reported plankton bloom activities, and negatively correlated with bottom water oxygen

concentrations. Further variables with a role in rate determination were bioturbation, bubble irrigation and winter storm events. The study also supports the hypothesis that some of the nitrogenase activity detected might be attributed to SRB.

Desai, D., Schunck, H., Löser, J. W. and LaRoche, J. (2013) Fragment recruitment on metabolic pathways: comparative metabolic profiling of metagenomes and metatranscriptomes. *Bioinformatics*, 29 (6). pp. 790-791. doi:10.1093/bioinformatics/bts721.

The authors present a user-friendly java program FROMP (Fragment Recruiting on Metabolic Pathways) for mapping and visualizing of relative and absolute enzyme abundances onto (publicly available and custom-made) metabolic pathways. The program is part of a complete bioinformatic pipeline for the analysis, organization and storage of high-throughput metagenomic (DNA) and metatranscriptomic (RNA) sequence datasets. FROMP further allows comparing of multiple samples in terms of their pathway completeness, their pathway activity and their odds ratio of enzyme enrichment.

Dietze, H. and Löptien, U. (2013) Revisiting “nutrient trapping” in global coupled biogeochemical ocean circulation models. *Global Biogeochemical Cycles*, 27. na-na. doi:10.1002/gbc.20029.

An extensive set of global coupled biogeochemical ocean circulation models was analysed. The main focus was on the equatorial Pacific where all simulations showed spurious enhanced (reduced) macronutrient (oxygen) concentrations at depth. Our results suggest that this problem, known also as “nutrient trapping”, is caused by a deficient representation of the Equatorial Intermediate (zonal) Current System and Equatorial Deep Jets rather than by an admittedly poor understanding of biogeochemistry.

Ehlert, C., Grasse, P. and Frank, M. (2013) Changes in silicate utilisation and upwelling intensity off Peru since the Last Glacial Maximum – insights from silicon and neodymium isotopes. *Quaternary Science Reviews*, 72. pp. 18-35. doi:10.1016/j.quascirev.2013.04.013.

This study, for the first time, combines stable silicon isotope composition of diatoms and radiogenic neodymium and strontium isotope compositions of past seawater extracted from Mn-Fe coatings of particles and benthic foraminifers, as well as of the detrital material itself to reconstruct silicic acid utilisation, water mass mixing, and upwelling intensity from the same marine sediments in the Peruvian upwelling region since the LGM. The combined evidence from the proxies documents that the strongest El Niño-Southern Oscillation conditions (frequency and amplitude) of the past 20,000 years have only prevailed during the past 5,000 years.

Hauss, H., Franz, J., Hansen, T., Struck, U. and Sommer, U. (2013) Relative inputs of upwelled and atmospheric nitrogen to the eastern tropical North Atlantic food web: Spatial distribution of $\delta^{15}\text{N}$ in mesozooplankton and relation to dissolved nutrient dynamics. *Deep-Sea Research Part I-Oceanographic Research Papers*, 75. pp. 135-145. doi:10.1016/j.dsr.2013.01.010.

The Eastern Tropical North Atlantic (ETNA) is characterised by a strong east to west gradient in the vertical upward flux of dissolved inorganic nitrogen (N) to the photic zone, resulting in different relative contribution of atmospheric and upwelled N sources to primary and secondary production in the area. To quantify this, the authors examined the $\delta^{15}\text{N}$ signatures in zooplankton during two cruises in fall 2009 and 2010 in the ETNA (M80-2 and M83-1). $\delta^{15}\text{N}$ values of the same species were highly variable among stations, and these spatial differences exceeded those between trophic levels. Estimated by the $\delta^{15}\text{N}$ in zooplankton,

atmospheric sources of new N contributed less than 20% close to the West African coast and in the Guinea Dome area and up to 60% at the offshore stations, depending on the depth of the nitracline.

Martin, T., Park, W. and Latif, M. (2013) Multi-Centennial Variability Controlled by Southern Ocean Convection in the Kiel Climate Model. *Climate Dynamics*, 40. pp. 2005-2022. doi:10.1007/s00382-012-1586-7.

A quasi-oscillatory multi-centennial mode of open ocean deep convection in the Atlantic sector of the Southern Ocean was found in simulations with the Kiel Climate Model (KCM). The convection is driven by an accumulation of heat at mid-depth and shuts down when anomalous surface freshening coincides with a depleted heat reservoir. The convection flip-flop has a significant impact on the Atlantic Meridional Overturning Circulation (AMOC): while bottom water production peaks during convection, the southward export of North Atlantic Deep Water reaches a maximum during the non-convective regime. Further, striking similarities to the Weddell Polynya in the 1970s were found.

McAnena, A., Floegel, S., Hofmann, P., Herrle, J.O., Griesand, A., Talbot, H.M., Rethemeyer, L., Wallmann, K., Wagner, T. (2013) Atlantic cooling associated with a marine biotic crisis during the mid-Cretaceous period. *Nature Geosciences*, doi:10.1038/NGEO1850.

Simulations using a biogeochemical model suggest that the global cooling was closely linked to the opening of early ocean basins surrounding South America and Africa, such as the South Atlantic, where large volumes of carbon from the atmosphere were buried as organic carbon rich sediments, cooling global climate. Volcanic processes also terminated the cool period, this time through massive volcanic activity in the Kerguelen Plateau region of the Indian Ocean where large volumes of CO₂ from the Earth's interior were pumped into the atmosphere. This study shows that cooling during greenhouse conditions can cause perturbations to marine ecosystems and biogeochemical cycles at scales comparable to those associated with global warming.

Schlosser, C., Streu, P. and Croot, P. (2013) Vivaspin ultrafiltration: A new approach for high resolution measurements of colloidal and soluble iron species. *Limnology and*

***Oceanography: Methods*, 11. pp. 187-201. doi:10.4319/lom.2013.11.187.**

Within the scope of this study, different Vivaspin6® ultrafiltration units with different molecular weight “cut-off” membranes were used to examine the size distribution of newly formed iron (Fe) colloids in natural seawater samples and in the presence of several different Fe chelators with varying Fe binding strength. The results of the natural seawater samples suggest that a seamless size continuum of natural organic chelators (≤5 kDa–10 kDa) is present in these seawaters and that estimates of ligand production based on 0.02 μm Anotop solubility experiments underestimates the abundance of soluble/colloidal ligands. Regarding these results, we recommend the use of Vivaspin 5 kDa membranes to separate the “truly” soluble from the colloidal Fe fraction.

Schunck, H., Lavik, G., Desai, D.K., Großkopf, T., Kalvelage, T., Löscher, C.R., Paulmier, A., Contreras, S., Siegel, H., Holtappels, M., Rosenstiel, P., Schilhabel, M.B., Graco, M., Schmitz, R.A., Kuypers, M.M., LaRoche, J. (2013, in press) Giant hydrogen sulfide plume in the oxygen minimum zone off Peru Supports Chemolithoautotrophy. *PLoS ONE*. doi:10.1371/journal.pone.0068661

This study reports the detection of a toxic hydrogen sulfide plume in continental shelf waters of Peru, displaying the first time that hydrogen sulfide was measured in the Peruvian OMZ and the largest plume ever reported for oceanic waters. High-throughput sequencing of environmental DNA and RNA showed that the inhabiting microbial community was largely composed out of nitrate reducing and sulfur oxidizing proteobacteria, which were also responsible for high rates of dark carbon fixation. This microbial lifestyle, the sulfur-driven autotrophic denitrification could be responsible for carbon fixation rates reaching almost 30 % of the photosynthetic surface rates.

The following manuscript is published for comments in *Biogeosciences Discussion*:

Stramma, L., Bange, H. W., Czeschel, R., Lorenzo, A. and Frank, M. (2013) On the role of mesoscale eddies for the biological productivity and biogeochemistry in the eastern tropical Pacific Ocean off Peru. *Biogeosciences Discuss.*, 10, 9179-9211, doi:10.5194/bgd-10-9179-2013

During the R/V Meteor cruise M90 in

November 2012, a coastal mode water eddy, an open ocean mode water eddy and an open ocean cyclonic eddy were identified and sampled. Temperature and salinity anomalies, as well as swirl velocities of both types of eddies were about twice as large as described for mean eddies in the eastern tropical Pacific Ocean. Ocean heat and salt anomalies also showed larger variability than known mean values. Furthermore, the eddies contributed significantly to productivity by maintaining pronounced subsurface maxima of chlorophyll. The authors conclude that the aging of eddies when they detach from the coast and move westward to the open ocean influences the eddies' properties. Therefore, the role of eddies can only be understood with the help of high spatial and temporal resolution oceanographic/ biogeochemical surveys.

Wagner, T., Hofmann, P. and Flögel, S. (2013) Marine black shale deposition and Hadley Cell dynamics: A conceptual framework for the Cretaceous Atlantic Ocean. *Marine and Petroleum Geology*, 43. pp. 222-238. doi:10.1016/j.marpetgeo.2013.02.005.

This study presents a conceptual framework that links organic matter quality and quantity in Cretaceous Atlantic sediments with the dominant processes that operated under the tropical-subtropical Hadley Cells. A comprehensive compilation of bulk organic geochemical data is used (total organic carbon concentration, hydrogen index, oxygen index, and kerogen type). For this, published and new data from deep ocean sites of the DSDP/ODP program are used, as well as one palaeo-shelf setting (Tarfaya), spanning a latitudinal transect from the outer subtropics to the palaeo-equator during the Albian, the Cenomanian-Turonian, and the Coniacian-Santonian. This study emphasises the potential of integrating orbital scale datasets and wide spatial coverage as a predictive tool for black shale formation across ocean basins, with the transition between the core tropics and subtropics being a zone where conditions were particularly favourable to produce expanded and homogenous black shale sections.

JOINT FB1 / SFB 754 SEMINAR

Monday, August 12th, 2013

Tobias Friedrich: **Changes in ventilation of the last 4 glacial cycles**

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