# NEWSLETTER 2016 | 03

## Sonderforschungsbereich 754

Climate – Biogeochemistry Interactions in the Tropical Ocean

SFB 754

## Publications

**Löscher, C. R., H. W. Bange, R. A. Schmitz, C. M. Callbeck, A. Engel, H. Hauss, T. Kanzow, R. Kiko, G. Lavik, A. Loginova, F. Melzner, J. Meyer, S. C. Neulinger, M. Pahlow, U. Riebesell, H. Schunck, S. Thomsen and H. Wagner (2016) Water column biogeochemistry of oxygen minimum zones in the eastern tropical North Atlantic and eastern tropical South Pacific oceans. Biogeosciences, 13, 3585–3606, doi: 10.5194/bg-13-3585-2016**

Recent modeling results suggest that oceanic oxygen levels will decrease significantly over the next decades to centuries in response to climate change and altered ocean circulation. Hence, the future ocean may experience major shifts in nutrient cycling triggered by the expansion and intensification of tropical oxygen minimum zones (OMZs), which are connected to the most productive upwelling systems in the ocean. There are numerous feedbacks among oxygen concentrations, nutrient cycling and biological productivity; however, existing knowledge is insufficient to understand physical, chemical and biological interactions in order to adequately assess past and potential future changes.
In the following, one decade of research performed in the framework of the Collaborative Research Center 754 (SFB 754) focusing on climate-biogeochemistry interactions in tropical OMZs is summarized. The influence of low environmental oxygen conditions on biogeochemical cycles, organic matter formation and remineralization, greenhouse gas production and the ecology in OMZ regions of the eastern tropical South Pacific compared to the weaker OMZ of the eastern tropical North Atlantic is investigated. Based on the findings, a coupling of primary production and organic matter export via the nitrogen cycle is proposed, which may, however, be impacted by several additional factors, e.g., micronutrients, particles acting as microniches, vertical and horizontal transport of organic material and the role of zooplankton and viruses therein.

**Dale, A. W., S. Sommer, U. Lomnitz, A. Bourbonnais and K. Wallmann (2016) Biological nitrate transport in sediments on the Peruvian margin mitigates benthic sulfide emissions and drives pelagic N loss during stagnation events. Deep. Res. Part I 112, 123–136, doi: 10.1016/j.dsr.2016.02.013**

**Sommer, S., J. Gier, T. Treude, U. Lomnitz, M. Dengler, J. Cardich and A. W. Dale (2016) Depletion of oxygen, nitrate and nitrite in the Peruvian oxygen minimum zone cause an imbalance of benthic nitrogen fluxes. Deep. Res. Part I 112, 113–122, doi: 10.1016/j.dsr.2016.03.001**

Oxygen minimum zones (OMZ) are key regions for fixed nitrogen loss in both the sediments and the water column. The benthic contribution to N cycling was investigated at ten sites along a depth transect (74 – 989 m) across the Peruvian OMZ at 12°S. $O_2$ levels were below detection limit down to ~ 500 m. Benthic fluxes of $N_2$, $NO_3^-$, $NO_2^-$, $NH_4^+$, $H_2S$ and $O_2$ were measured using benthic landers. Flux measurements on the shelf were made under extreme geochemical conditions consisting of a lack of $O_2$, $NO_3^-$ and $NO_2^-$ in the bottom water and elevated seafloor sulphide release. These particular conditions were associated with a large imbalance in the benthic nitrogen cycle. The sediments on the shelf were densely covered by filamentous sulphur bacteria *Thioploca*, and were identified as major recycling sites for DIN releasing high amounts of $NH_4^+$ up to 21.2 mmol $m^{-2}$ $d^{-1}$ that were far in excess of $NH_4^+$ release by ammonification. This difference was attributed to dissimilatory nitrate (or nitrite) reduction to ammonium (DNRA) that was partly being sustained by $NO_3^-$ stored within the sulphur oxidizing bacteria. During bottom water stagnation, models indicate that Thioploca mitigate benthic sulfide emissions and continue to contribute to pelagic N loss via anammox. Benthic nitrogen and sulphur cycling in the Peruvian OMZ appears to be particularly susceptible to bottom water fluctuations in $O_2$, $NO_3^-$ and $NO_2^-$, and may accelerate the onset of pelagic euxinia when $NO_3^-$ and $NO_2^-$ become depleted.

**Burmeister, K., P. Brandt and J. F. Lübbecke (2016) Revisiting the cause of the eastern equatorial Atlantic cold event in 2009. J. Geophys. Res. Oceans, 121, doi: 10.1002/2016JC011719**

An extreme cold sea surface temperature event occurred in the Atlantic cold tongue region in boreal summer 2009. It was preceded by a strong negative Atlantic meridional mode event associated with north-westerly wind anomalies along the equator from March to May. Although classical equatorial wave dynamics suggest that westerly wind anomalies should be followed by a warming in the eastern equatorial Atlantic, an abrupt cooling took place. In the literature two mechanisms—meridional advection of subsurface temperature anomalies and planetary wave reflection—are discussed as potential causes of such an event. Here, for the first time we use in situ measurements in addition to satellite and reanalysis products to investigate the contribution of both mechanisms to the 2009 cold event. Our results suggest that meridio- nal advection is less important in cold events than in corresponding warm events, and, in particular, did not cause the 2009 cold event. Argo float data confirm previous findings that planetary wave reflection contrib- uted to the onset of the 2009 cold event. Additionally, our analysis suggests that higher baroclinic modes were involved.

**Köllner M., M. Visbeck, T. Tanhua and T. Fischer (2016) Diapycnal diffusivity in the core and oxycline of the tropical North Atlantic oxygen minimum zone. Journal of Marine Systems 160 (2016) 54–63, doi: 10.1016/j.jmarsys.2016.03.012**

Diapycnal diffusivity estimates from two Tracer Release Experiments (TREs) and microstructure measurements in the oxycline and core of the oxygen minimum zone (OMZ) in the Eastern Tropical North Atlantic (ETNA) are compared. For the first time, two TREs within the same area at different depths were realized: the Guinea Upwelling Tracer Release Experiment (GUTRE) initiated in 2008 in the oxycline at approximately 320 m depth, and the Oxygen Supply Tracer Release Experiment (OSTRE) initiated in 2012 in the core of the OMZ at approximately 410 m depth. The mean diapycnal diffusivity $D^z$ was found to be insignificantly smaller in the OMZ core with $(1.06 \pm 0.24) \times 10^{-5}$ $m^2$ $s^{-1}$ compared to $(1.11 \pm 0.22) \times 10^{-5}$ $m^2$ $s^{-1}$ 90 m shallower in the oxycline. Unexpectedly, GUTRE tracer was detected during two of the OSTRE surveys which showed that the estimated diapycnal diffusivity from GUTRE over a time period of seven years was within the uncertainty of the previous estimates over a time period of three years. The results are consistent with the $D^z$ estimates from microstructure measurements and demonstrate that $D^z$ does not vary significantly vertically in the OMZ within the depth range of 200–600 m and does not change with time. The presence of a seamount chain in the vicinity of the GUTRE injection region did not cause enhanced $D^z$ compared to the smoother bottom topography of the OSTRE injection region, although the analysis of vertical shear spectra from ship ADCP data showed elevated internal wave energy level in the seamount vicinity. However, the two tracer patches covered increasingly overlapping areas with time and thus spatially integrated increasingly similar fields of local diffusivity, as well as the difference in local stratification counteracted the influence of roughness on $D^z$. For both experiments no significant vertical displacements of the tracer were observed, thus diapycnal upwelling within the ETNA OMZ is below the uncertainty level of 5 m $yr^{-1}$.

**Aquit M., W. Kuhnt, A. Holbourn, E. H. Chellai, J. A. Lees, O. Kluth and H. Jabour (2016), Complete archive of late Turonian to early Campanian sedimentary deposition in newly drilled cores from the Tarfaya Basin, SW Morocco. Geol. Sol. Am. Bull., doi: 10.1130/B31523.1**

An expanded succession of organic-rich marlstones and limestones deposited in the Tarfaya Basin provides an outstanding opportunity to closely retrace climate evolution and sea-level changes during the Cretaceous greenhouse period. High-resolution X-ray fluorescence (XRF) scanning and bulk carbon- and oxygen-isotope records from two newly drilled sediment cores in the Tarfaya Atlantic coastal basin, which recovered a continuous Upper Turonian to Campanian succession of ~290 m thickness are presented. The XRF core scanning records reveal three long-term oscillations in the abundance of terrigenous elements (increase of Al, Ti, K, Si, and Fe normalized against Ca), which correspond to progressive transgressive phases followed by rapid regressions during the Coniacian and early Santonian. Sea-level highstands during this interval corresponding to the Coniacian–Santonian oceanic anoxic event 3 (OAE 3) are characterized by overall oxygen-depleted to anoxic conditions at the seafloor (indicated by the high organic carbon content, the presence of laminations, and low log[Mn/S], high log[V/Ca], and high log[Br/Ca]). The upper Santonian interval marks the transition from anoxic to oxic bottom-water conditions, prevalent through the early Campanian. The composite bulk carbonate $\delta^{13}C$ curve exhibits strong similarities to the global stacked $\delta^{13}C$ reference curve, characterized by negative excursions in the early Coniacian (Navigation and East Cliff events) and late Santonian (bracketed by the Haven Brow and Buckle events) and by positive excursions in the latest Turonian (Hitchwood event), middle Coniacian (Wight Fall event), and at the Santonian-Campanian boundary. During the early Campanian, enhanced accumulation of fine-grained carbonate and clay-rich hemipelagic sediments, increasing bulk carbonate $\delta^{18}O$, and low log(Br/Ca) and log(V/Ca) values indicate climate cooling, associated with a substantial improvement in bottom-water ventilation. Two long-term $\delta^{13}C$ cycles of ~2 m.y. duration, probably related to variations in Earth's orbital eccentricity, are associated with the long-term cooling trend initiating the Campanian-Maastrichtian climate transition toward a cool greenhouse state.

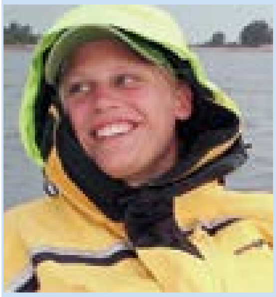
**Thomsen S., T. Kanzow, F. Colas, V. Echevin, G. Krahmann, and A. Engel (2016) Do submesoscale frontal processes ventilate the oxygen minimum zone off Peru?, Geophys. Res. Lett., 43, 8133–8142, doi: 10.1002/2016GL070548.**

The Peruvian upwelling system encompasses the most intense and shallowest oxygen minimum zone (OMZ) in the ocean. This system shows pronounced submesoscale activity like filaments and fronts. Glider-based observations off Peru during austral summer 2013 to investigate whether submesoscale frontal processes ventilate the Peruvian OMZ were carried out. The study presents observational evidence for the subduction of highly oxygenated surface water in a submesoscale cold filament. The subduction event ventilates the oxycline but does not reach OMZ core waters. In a regional submesoscale-permitting model the pathways of newly upwelled water are studied. About 50 % of upwelled virtual floats are subducted below the mixed layer within 5 days emphasizing a hitherto unrecognized importance of subduction for the ventilation of the Peruvian oxycline.

## News

### HELENA HAUSS

postdoc, subproject B8, recieved the **Best presentation from an early career scientist Award** for her oral presentation "*Dead zone or oasis in the open ocean? Zooplankton distribution and migration in low-oxygen mode water eddies*" at the ICES/PICES 6th Zooplankton Production Symposium in Bergen (9 - 13 May).



## Conferences

### SOLAS SCIENCE AND SOCIETY WORKSHOP

26 - 27 October 2016,
Brussels (Belgium)

### AGU FALL MEETING 2016

12 - 16 December 2016,
San Francisco (USA)

### ASLO AQUATIC SCIENCES MEETING

26 February - 3 March 2017,
Honolulu (Hawai'i)

## SFB 754 Intern

### SFB 754 INTERNATIONAL CONFERENCE

3 - 7 September 2018,
Kiel (Germany)

### SFB 754 EARLY CAREER SCIENTISTS RETREAT

14 - 18 November,
Gottin (Germany)

### SFB 754 ANNUAL RETREAT

13 - 14 February 2017,
Kiel (Germany)

EDITORIAL
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