NEWSLETTER 2019 | 01

Sonderforschungsbereich 754
Climate – Biogeochemistry Interactions in the Tropical Ocean

SFB 754

Publications

Klenz, T., M. Dengler and P. Brandt (2018) Seasonal Variability of the Mauritania Current and Hydrography at 18°N. J. Geophys. Res. 123 (11), 8122-8137, doi: 10.1029/2018JC014264

Extensive field campaigns in the Mauritanian upwelling region between 2005 and 2016 are used to describe the seasonal variability of the eastern boundary circulation (EBC) off Mauritania and associated water mass distribution at 18°N. The data set includes shipboard upper ocean current, hydrographic, and oxygen measurements from nine research cruises conducted during upwelling (December to April) and relaxation (May to July) seasons. During the upwelling season, the EBC closely resembles a classical eastern boundary current regime, with a poleward undercurrent flowing beneath an equatorward coastal jet. In contrast, elevated poleward flow exceeding 30 cm/s and extending from the surface down to 250-m depth is observed during the relaxation season. The pronounced seasonal variability of the across-shore structure of the EBC can be related to local wind forcing and is in general agreement with Sverdrup balance. The EBC transport is correlated to the local wind stress curl leading the transport by 7 days. The short lead time suggests a fast response of locally forced waves adjusting the EBC to wind forcing. The meridional oxygen distribution and corresponding water mass partitioning into South and North Atlantic Central Water masses reveal a possible northerly ventilation pathway in the deeper layers of the central water stratum.

Lübbecke, J. F., P. Brandt, M. Dengler, R. Kopte, J. Lüdke, I. Richter, M. S. Martins and P. C. M. Tchipalanga (2018) Causes and evolution of the southeastern tropical Atlantic warm event in early 2016.Climate Dynamics, 1-14, doi: 10.1007/s00382-018-4582-8

A strong warm event occurred in the southeastern tropical Atlantic Ocean off Angola and Namibia in January and February 2016 with sea surface temperature anomalies reaching 3 °C. In contrast to classical Benguela Niño events, the analysis of various direct observations indicates that the warming was not predominantly forced by an equatorial Kelvin wave but instead resulted from a combination of local processes that are related to (1) a weakening of the alongshore, i.e. mainly southerly, winds and (2) enhanced freshwater input through local precipitation and river discharge. Consistent with the weakened winds, a reduction in latent heat loss from the ocean and a poleward surface current anomaly is found. The surface freshening caused a very shallow mixed layer and enhanced upper ocean stratification. This is supported by the analysis of the velocity structure of the Angola Current at 11°S, which shows that at the time of the event subsurface velocities were directed northward while surface velocities were directed southward. The shallow layer of warm and fresh surface water was thus advected poleward by the surface current. In addition, a reduction of the local upwelling and the formation of a barrier layer might have contributed to the warm surface anomaly.

Glock, N., J. Wukovits and A-S. Roy (2019) Interactions of Globobulimina Auriculata with Nematodes: Predator Or Prey? Journal of Foraminiferal Research 49 (1), 66-75, doi: 10.2113/gsjfr.49.1.66

Studies of carnivorous behaviour of benthic foraminifers are rare and mostly focused on laboratory experiments. Controlled experiments have shown that some agglutinated and intertidal species prey on meio- to macrofaunal metazoans. This study presents observations of the behaviour of specimens of the infaunal benthic foraminiferal species, *Globobulimina auriculata* and *G. turgida*, made within several hours of collection from ~117 m depth in the Alsbäck Deep of the Gullmar Fjord, Sweden. Live nematodes within the tests of *G. auriculata* were observed. Video observations recorded over a 17-hour period showed a *G. auriculata* specimen with a living nematode whose tail appeared to be entangled within the foraminifer's reticulopodial network. The nematode eventually coiled around the foraminifer's aperture and became much less active, though ingestion into the foraminifer's test was not documented. If these observations indicate feeding by *G. auriculata*, they differ from previous observations of predation by *Ammonia tepida*, which utilised external reticulopodial activity to extract the soft tissue of its prey. The *G. turgida* specimens, in contrast, relatively quickly surrounded themselves in soft sediment spheres commonly seen in deposit-feeding foraminifers, and were never observed with nematodes within their tests. It is likely that these contrasting feeding strategies might reduce competition and facilitate the coexistence of these two globobuliminid species.

Salvatecci, R., R. R. Schneider, T. Blanz and E. Mollier-Vogel (2018) Deglacial to Holocene Ocean Temperatures in the Humboldt Current System as Indicated by Alkenone Paleothermometry. Geophysical Research Letters, 46, doi: 10.1029/2018gl080634

The response of the Humboldt Current System to future global warming is uncertain. Here the alkenone-derived near-surface temperatures from multiple cores along the Peruvian coast is reconstructed to infer the driving mechanisms of upwelling changes for the last 20 kyr. The records show a deglacial warming consistent with Antarctic ice-core temperatures and a Mid-Holocene cooling, which, in combination with other paleoceanographic records, suggest a strengthening of upwelling conditions. This cooling, during the globally warm Mid-Holocene, is consistent with an intensification of the Walker Circulation and the South Eastern Pacific Subtropical Anticyclone, indicative of La Niña-like conditions in the Tropical Pacific. Surprisingly, oxygen contents in the subsurface increased and productivity was low during the Mid-Holocene, which are at odds with La Niña-like conditions. This suggests that the Humboldt Current

System reacts in multiple ways to a warmer world and may even include a reversal in the present day subsurface deoxygenation.

Bayr, T., C. Wengel, M. Latif, D. Dommenget, J. Lübbecke and W. Park (2018) Error compensation of ENSO atmospheric feedbacks in climate models and its influence on simulated ENSO dynamics. Climate Dynamics, 1-18, doi: 10.1007/s00382-018-4575-7

Common problems in state-of-the-art climate models are a cold sea surface temperature (SST) bias in the equatorial Pacific and the underestimation of the two most important atmospheric feedbacks operating in the El Niño/Southern Oscillation (ENSO): the positive, i.e. amplifying wind-SST feedback and the negative, i.e. damping heat flux-SST feedback. To a large extent, the underestimation of those feedbacks can be explained by the cold equatorial SST bias, which shifts the rising branch of the Pacific Walker Circulation (PWC) too far to the west by up to 30°, resulting in an erroneous convective response during ENSO events. Based on simulations from the KCM and CMIP5, it is investigated how well ENSO dynamics are simulated in case of underestimated ENSO atmospheric feedbacks (EAF), with a special focus on ocean–atmosphere coupling over the equatorial Pacific. While models featuring realistic atmospheric feedbacks simulate ENSO dynamics close to observations, models with underestimated EAF exhibit fundamental biases in ENSO dynamics. In models with too weak feedbacks, ENSO is not predominantly wind-driven as observed; instead ENSO is driven significantly by a positive shortwave radiation feedback. In the most biased models, the shortwave-SST feedback contributes to the SST anomaly growth to a similar degree as the ocean circulation. The results suggest that a broad continuum of ENSO dynamics can exist in climate models and explain why climate models with less than a half of the observed wind-SST feedback can still depict realistic ENSO amplitude.

Cisternas-Novoa, C., C. Lee, T. Tang, R. de Jesus and A. Engel (2019) Effects of Higher CO_2 and Temperature on Exopolymer Particle Content and Physical Properties of Marine Aggregates. Frontiers in Marine Science 5, doi: 10.3389/fmars.2018.00500

How future ocean conditions, and specifically the interaction between temperature and CO_2, might affect the formation of marine aggregates and their physical properties were investigated. Initially, mesocosms filled with coastal seawater were subjected to three different treatments of CO_2 concentration and temperature: (1) 750 ppm CO_2, 16°C, (2) 750 ppm CO_2, 20°C, and (3) 390 ppm CO_2, 16°C. Diatom-dominated phytoplankton blooms were induced in the mesocosms by addition of nutrients. In aggregates produced in roller tank experiments (RTEs) using seawater taken from the mesocosms during different stages of the bloom, physical properties (size, sinking velocity, excess density) and organic matter content were studied. As has been seen in previous experiments, no discernable differences in overall nutrient uptake, chlorophyll-a concentration, or exopolymer particle concentrations could be related to the acidification treatment in the mesocosms. However, in the aggregates formed during the RTEs, physical characteristics were different, and a synergistic effect of warmer temperature and higher CO_2 was observed during the Pre-Bloom period; at this time, the temperature had a more significant effect than CO_2 on aggregate sinking velocity. In RTEs with warmer and acidified treatment (future conditions), aggregates were larger, heavier, and settled faster than aggregates formed at present-day or only acidified conditions. During the Post-Bloom, however, aggregates formed under present and future conditions had similar physical properties. In acidified tanks at ambient temperature, aggregates were slower, smaller and less dense than those formed at the same temperature but under present CO_2 or warmer and acidified conditions. The findings point out the potential of ocean acidification and warming to modify physical properties of sinking aggregates but also emphasize the need for future experiments investigating multiple environmental stressors to clarify the importance of each factor.

Merckelbach, L., A. Berger, G. Krahmann, M. Dengler and J. Carpenter (2019) A dynamic flight model for Slocum gliders and implications for turbulence microstructure measurements. Journal of Atmospheric and Oceanic Technology, doi: 10.1175/JTECH-D-18-0168.1

The turbulent dissipation rate ε is a key parameter to many oceanographic processes. Recently gliders have been increasingly used as a carrier for microstructure sensors. The incident water velocity U is an input parameter for the calculation of the dissipation rate. Since U can not be measured using the standard glider sensor setup, the parameter is computed from a steady-state glider flight model. As **ε** scales with U^2 or U^4, depending whether it is computed from temperature or shear microstructure, flight model errors can introduce a significant bias. This study is the first to use measurements of in-situ glider flight, obtained with a profiling Doppler velocity log and an electromagnetic current meter, to test and calibrate a flight model, extended to include inertial terms. Compared to a previously suggested flight model, the calibrated model removes a bias of approximately 1 cm s^{-1} in the incident water velocity, which translates to roughly a factor of 1.2 in estimates of the dissipation rate. The results further indicate that 90% of the estimates of the dissipation rate from the calibrated model are within a factor of 1.1 and 1.2 for measurements derived from microstructure temperature sensors and shear probes, respectively.

News

Clarissa Karthäuser (B4) participated in the 2018 dance competition "Dance your PhD" of the Journal Science. https://youtu.be/6Nx-nNlM6qc

Conferences

SFB 754 ANNUAL RETREAT
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OCEANS 2019
17-20 June 2019, Marseille (France)

IMBER OPEN SCIENCE
17-21 June 2019, Brest (France)

IUGG 27
08-19 July 2019, Montreal (Canada)

GOLDSCHMIDT
18-23 August 2019, Barcelona (Spain)
Session 10j: Biogeochemical Cycles of Low Oxygen Zones and their Response to Ocean Deoxygenation

OCEAN OBS'19
16 –20 September 2019, Honolulu, Hawaii (USA)