NEWS LETTER 2014 | 01

Sonderforschungsbereich 754

Climate – Biogeochemistry Interactions in the Tropical Ocean

SFB 754

SFB Retreat 2014

The SFB 754 annual retreat took place on 17th & 18th February 2014 at the Atlantic Hotel in Kiel. More than 90 scientists of the CAU, GEOMAR and MPI Bremen as well as invited international collaborators from Lima/Peru and Toulouse participated. The subprojects explained the status of the research and presented ideas for a third phase. A schedule for proposal preparation of the third phase and the evaluation 2015 were agreed upon. Furthermore reports were given on the progress of the five thematic mid-term syntheses papers (circulation & transport, pelagic biogeochemistry, benthic biogeochemistry, paleo-perspective, synthesis & modeling). Finally in a workshop on the 2nd day of the retreat, the participants worked on ideas for the third phase of the SFB 754 and decided on a plan for further research expeditions within the SFB 754 starting 2015 up to 2017.

Publications

Holtappels, M., Tiano, L., Kalvelage, T., Lavik, G., Revsbech, N. P., and Kuypers, M. M. M. (2014). Aquatic respiration rate measurements at low oxygen concentrations, PLOS ONE, 9 (2): e89369. doi:10.1371/journal.pone.0089369.

Despite its huge ecological importance, microbial oxygen respiration in pelagic waters is little studied, primarily due to methodological difficulties. Respiration measurements are challenging because of the required high resolution of oxygen concentration measurements. Here we compare 3 different methods to measure oxygen consumption rates at low oxygen concentrations, utilizing amperometric Clark type sensors (STOX), optical sensors (optodes), and mass spectrometry in combination with $^{18-18}O_2$ labeling. Oxygen concentrations and consumption rates agreed well between the different methods when applied in the same experimental setting. Oxygen consumption rates between 30 and 400 nmol L^{-1} h^{-1} were measured with standard errors of less than 3 %. Rate detection limits in the range of 1 nmol L^{-1} h^{-1}.

Zinke, J., Pfeiffer, M., Park, W., Schneider, B., Reuning, L., Dullo, W. C., Camoin, G. F., Mangini, A., Schroeder-Ritzrau, A., Garbe-Schönberg, D. and Davies, G. R. (2014) Seychelles coral record of changes in sea surface temperature bimodality in the western Indian Ocean from the Mid-Holocene to the present. Climate Dynamics. doi:10.1007/s00382-014-2082-z.

We report fossil coral records from the Seychelles comprising individual time slices of 14 – 20 sclerochronological years between 2 and 6.2 kyr BP to reconstruct changes in the seasonal cycle of western Indian Ocean sea surface temperature (SST) compared to the present (1990 – 2003). These reconstructions allowed us to link changes in the SST bimodality to orbital changes, which were causing a reorganization of the seasonal insolation pattern. Our results reveal the lowest seasonal SST range in the Mid-Holocene (6.2 – 5.2 kyr BP) and around 2 kyr BP, while the highest range is observed around 4.6 kyr BP and between 1990 and 2003. The season of maximum temperature shifts from austral spring (September to November) to austral autumn (March to May), following changes in seasonal insolation over the past 6 kyr. Model results show that in the Mid-Holocene the austral winter and spring seasons in the western Indian Ocean were warmer while austral summer was cooler. This is qualitatively consistent with the coral data from 6.2 to 5.2 kyr BP, which shows a similar reduction in the seasonal amplitude compared to the present day. Our results highlight the importance of ocean-atmosphere interactions for Indian Ocean SST seasonality throughout the Holocene.

Scholz, F., Severmann, S., McManus, J. and Hensen, C. (2014) Beyond the Black Sea paradigm: The sedimentary fingerprint of an open-marine iron shuttle. Geochimica

News

Stramma et. al (2013, doi:10.5194/bg-10-7293-2013) presented in Nature News & Views from Amala Mahadevan with the title "Ocean science: Eddy effects on biogeochemistry". (doi:10.1038/nature13048)

DFG granted new subproject B10, subprojectleaders: Prof. Eric Achterberg, Dr. Martha Gledhill (GEOMAR). "Iron stabilization and transfer in tropical oxygen minimum zones". Start: January 2014.

Conferences

46TH INTERNATIONAL LIÈGE COLLOQUIUM
May 5 – 9, 2014, Liège, Belgium
Session (A. Oschlies, J. Zhang):
Deoxygenation in a global change context

IMBER OPEN SCIENCE CONFERENCE 2014
June 23 – 27, 2014, Bergen, Norway
Session (A. Oschlies, V. Garcon, L. Stramma):
Climate-biogeochemistry interactions associated with open-ocean oxygen minimum zones

SFB 754 Cruises

METEOR M 105
Departure: Mindelo (Cap Verde) March 17, 2014
Return: Mindelo (Cap Verde) April 16, 2014
Chief scientist: Martin Visbeck

METEOR M 106
Atlantic April 19, 2014 – May 26, 2014
Chief scientist: Peter Brandt

METEOR M 107
Atlantic May 29, 2014 – July 7, 2014
Chief scientist: Stefan Sommer

SFB 754 Intern

SFB 754 YOUNG SCIENTISTS RETREAT:
August 25 – 29, 2014
Lotseninsel Schleimünde, Germany

PREPARATION 3RD PHASE:
September 15 – 16, 2014, Hohwacht, Germany
SFB 754 mid-term retreat
"proposal preparation 3rd phase"

DFG EVALUATION:
September 16 – 17, 2015

et Cosmochimica Acta, 127. pp. 368-380. doi:10.1016/j.gca.2013.11.041.

This study presents iron (Fe) concentration and Fe isotope data for a sediment core transect across the Peru upwelling area. The lateral variability of solid phase Fe concentrations and isotope compositions as well benthic fluxes and Fe mass accumulation rates is consistent with a shuttle scenario where Fe is reductively remobilized from sediments within the oxygen minimum zone, laterally transported within the anoxic water column and partiality re-precipitated within the more oxic water below the oxygen minimum zone. The data presented demonstrate that offshore transport of sediment-derived Fe may be tracked in open-marine sedimentary archives. Future studies may use these findings to evaluate the release of bio-essential Fe from continental margin sediments in the geological record.

Hahn, J., Brandt, P., Greatbatch, R. J., Krahmann, G. and Körtzinger, A. (2014) Oxygen variance and meridional oxygen supply in the Tropical North East Atlantic oxygen minimum zone. Climate Dynamics. doi:10.1007/s00382-014-2065-0.

The distribution of the mean oceanic oxygen concentration results from a balance between ventilation and consumption. In the eastern tropical Pacific and Atlantic, this balance creates extended oxygen minimum zones (OMZ) at intermediate depth. Here, we analyze hydrographic and velocity data from shipboard and moored observations, which were taken along the 23°W meridian, to study oxygen variability and meridional oxygen supply. From the well-ventilated equatorial region toward the OMZ core a northward eddy-driven oxygen flux is observed whose divergence corresponds to an oxygen supply of about 2.4 µmol kg^{-1} $year^{-1}$ at the OMZ core depth. Above the OMZ core, mesoscale eddies act to redistribute low- and high-oxygen waters associated with westward and eastward currents, respectively. Here, absolute values of the local oxygen supply >10 µmol kg^{-1} $year^{-1}$ are found, likely balanced by mean zonal advection. Eddy-driven meridional oxygen supply contributes more than 50 % of the supply required to balance the estimated oxygen consumption. The oxygen tendency in the OMZ is maximum slightly above the OMZ core and represents a substantial imbalance of the oxygen budget reaching about 20 % of the magnitude of the eddy-driven oxygen supply.

Brandt, P., Funk, A., Tantet, A., Johns, W. E. and Fischer, J. (2014) The Equatorial Undercurrent in the central Atlantic and its relation to tropical Atlantic variability. Climate Dynamics. doi:10.1007/s00382-014-2061-4.

Seasonal to interannual variations of the Equatorial Undercurrent (EUC) in the central Atlantic at 23°W are studied using observation from 1999–2011. The seasonal variations are dominated by an annual harmonic of the EUC transport and the EUC core depth (both at maximum during September), and a semiannual harmonic of the EUC core velocity (maximum during April and September). Substantial interannual variability during the period of moored observation included anomalous cold/warm equatorial Atlantic cold tongue events during 2005/2008. The easterly winds in the western equatorial Atlantic during boreal spring that represent the preconditioning of cold/warm events were strong/weak during 2005/2008 and associated with strong/weak boreal summer EUC transport. The anomalous year 2009 was instead associated with weak preconditioning and smallest EUC transport on record from January to July, but during August coldest SST anomalies in the eastern equatorial Atlantic were observed.

Duteil, O., Koeve, W., Oschlies, A., Bianchi, D., Galbraith, E., Kriest, I. and Matear, R. (2013) A novel estimate of ocean oxygen utilisation points to a reduced rate of respiration in the ocean interior. Biogeosciences, 10 (11). pp. 7723-7738. doi:10.5194/bg-10-7723-2013.

The Apparent Oxygen Utilisation (AOU) is a classical measure of the amount of oxygen respired in the ocean's interior. We show that AOU systematically overestimates True Oxygen Utilisation (TOU) in 6 coupled circulation-biogeochemical ocean models. This is due to atmosphere–ocean oxygen disequilibria in the subduction regions, consistent with previous work. We develop a simple, new, observationally-based approach which we call Evaluated Oxygen Utilisation (EOU). In this approach, we take into account the impact of the upper ocean oxygen disequilibria into the interior. The EOU approximates the TOU with less than half of the bias of AOU in all 6 models. Applying the EOU approach to a global observational dataset yields an oxygen consumption rate 25% lower than that derived from AOU-based estimates.

Llanillo, P. J., Karstensen, J., Pelegrí, J. L. and Stramma, L. (2013) Physical and biogeochemical forcing of oxygen and nitrate changes during El Niño/El Viejo and La Niña/La Vieja upper-ocean phases in the tropical eastern South Pacific along 86° W. Biogeosciences (BG), 10. pp. 6339-6355. doi:10.5194/bg-10-6339-2013.

Temporal changes in the water mass distribution and biogeochemical signals in the tropical eastern South Pacific are investigated with the help of an extended optimum multi-parameter (OMP) analysis. Two ship occupations of a meridional section along 85°50' W from 14° S to 1° N are analysed during relatively warm (El Niño) and cold (La Niña) upper-ocean phases. The largest El Niño–Southern Oscillation (ENSO) impact was found in the water properties and water mass distribution in the upper 200 m north of 10° S. ENSO promotes the vertical motion of the oxygen minimum zone (OMZ) associated with the hypoxic equatorial subsurface water (ESSW). During a cold phase the core of the ESSW is found at shallower layers, replacing shallow subtropical surface water (STW). The heave of isopycnals due to ENSO partially explains the intrusion of oxygen-rich and nutrient-poor antarctic intermediate water (AAIW) into the depth range of 150 – 500 m. The shift in the vertical location of AAIW reaching the OMZ induces changes in the amount of oxygen advected and respired inside the OMZ.

Book chapter

Bakker, D.C.E., Bange, H., Gruber, G., Johannessen, T., Upstill-Goddard, R.C., Borges, A.V., Delille, B., Löscher, C.R., Naqvi, S.W.A., Omar, A.M.S., Santana-Casiano, J.M. (2014) Air-sea interactions of natural long-lived greenhouse gases (CO_2, N_2O, CH_4) in a changing climate. In: Liss, P.S. and Johnson, M. T. (eds.) Ocean-atmosphere interactions of gases and particles. Springer Verlag. 315 pp. doi:10.1007/978-3-642-25643-1

In this chapter a comprehensive review about the biogeochemical cycling of the long-lived greenhouse gases carbon dioxide (CO_2), nitrous oxide N_2O) and methane (CH_4) in the ocean is given. Moreover, the authors describe the effects of on-going global environmental changes (such as ocean deoxygenation, acidification and warming) on the oceanic production/consumption pathways and uptake/emissions of these gases.