NEWSLETTER 2014 | 02

Sonderforschungsbereich 754

Climate – Biogeochemistry Interactions in the Tropical Ocean

SFB 754

Publications

Duteil, O., Schwarzkopf, F. U. , Böning, C. W., and Oschlies, A. (2014). Major role of the equatorial current system in setting oxygen levels in the eastern tropical Atlantic Ocean: A high-resolution model study, Geophys. Res. Lett., Vol. 41, 2033–2040, doi: 10.1002/2013GL058888.

Understanding the reasons of the observed expansion of tropical ocean's oxygen minimum zones (OMZs) is hindered by large biases in the depiction of oxygen distribution in climate models, pointing to incorrectly represented mechanisms. Here we assess the oxygen budget in a global biogeochemical circulation model, focusing on the Atlantic Ocean. While a coarse (0.5°) configuration displays the common bias of too large and too intense OMZs, the oxygen concentration in an eddying (0.1°) configuration is higher and closer to observations. This enhancement is traced to a higher oxygen supply by a more realistic representation of the equatorial and off-equatorial undercurrents, overshadowing the concurrent increase in oxygen consumption associated with the stronger nutrient supply. The sensitivity of the eastern tropical Atlantic oxygen budget to the equatorial current intensity suggests that temporal changes in the eastward oxygen transport from the well-oxygenated western boundary region might partly explain variations in the OMZs.

Zamora, L., and Oschlies, A., (2014) Surface nitrification: a major uncertainty in marine N_2O emissions Geophys. Res. Le. doi: 10.1002/2014GL060556.

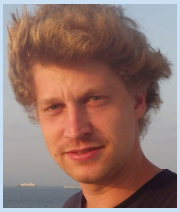
The ocean is responsible for up to a third of total global nitrous oxide (N_2O) emissions, but uncertainties in emission rates of this potent greenhouse gas are high (>100%). Here we use a marine biogeochemical model to assess six major uncertainties in estimates of N_2O production, thereby providing guidance in how future studies may most effectively reduce uncertainties in current and future marine N_2O emissions. Potential surface N_2O production from nitrification causes the largest uncertainty in N_2O emissions (estimated up to ~1.6 Tg N yr^{-1}, or 48% of modeled values), followed by the unknown oxygen concentration at which N2O production switches to N2O consumption (0.8 Tg N yr^{-1}, or 24% of modeled values). Other uncertainties are minor, cumulatively changing regional emissions by <15%. If production of N_2O by surface nitrification could be ruled out in future studies, uncertainties in marine N_2O emissions would be halved.

Perez, R. C., Hormann, V., Lumpkin, R., Brandt, P., Johns, W. E., Hernandez, F., Schmid, C. and Bourlès, B. (2013). Mean meridional currents in the central and eastern equatorial Atlantic. Clim. Dyn. doi: 10.1007/s00382-013-1968-5.

Ship-based acoustic Doppler current profiler (ADCP) velocity measurements are combined with estimates of the mean near-surface velocity derived from drifters and Argo float surface drifts (ADCP+D) to describe the mean cross-equatorial and vertical structure of the meridional currents along 23°W and 10°W. The dominant circulation features in the long-term mean ADCP+D meridional velocity in the upper 100 m are the tropical cells (TCs) located approximately between 5°S and 5°N, with near-surface poleward flow and subsurface equatorward flow that is stronger and shallower in the northern cell compared to the southern cell. Analysis of two-season means indicates that the maximum poleward velocity in the surface limb of the TCs intensifies during December–May along 23°W largely due to seasonal compensation between the geostrophic and ageostrophic components of the meridional velocity, whereas the maximum equatorward flow in the subsurface limb of the northern cell intensifies during June – November along both 23°W and 10°W due to the seasonality of the geostrophic meridional velocity.

News

SÖREN THOMSEN, PhD candidate subproject B9, received the **European Geosciences Union (EGU) Outstanding Student Poster Award** for his poster presentation "*The formation of an anticyclonic mode water eddy within the Peru-Chile Undercurrent*" (EGU2014-14926) at the last EGU conference in Vienna (April 27 – May 2, 2014).



SFB 754 Cruises

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

METEOR M 116
Atlantic, May 2, 2015 – June 3, 2015
Chief scientist: Toste Tanhua

METEOR
Atlantic, Autumn, 2015
Chief scientist: Peter Brandt

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"

SFB 754 RETREAT 2015
February 15 – 16, 2015

TEST RUNS DFG EVALUATION:
September 3, 4 & 14, 2015

DFG EVALUATION:
September 16 – 17, 2015

NOTE

SFB 754 SYNTHESIS PAPERS
submission for the special issue in Biogeosciences of the Liège Colloquium: **open from July 15 - Dec 30, 2014**.
For further information, please contact Dr. Lothar Stramma.

Stramma, L., Weller, R.A., Czeschel, R. and Bigorre, S. (2014). Eddies and an extreme water mass anomaly observed in the eastern south Pacific at the Stratus mooring. J. Geophys. Res. Oceans, Vol. 119(2), 1068-1083. doi: 10.1002/2013JC009470.

During February and March 2012 an extremely anomalous eddy oxygen anomaly of -10.5 × 10^{16} µmol was observed in the thermocline at the Stratus Ocean Reference Station (20°S, 85.5°W) in the eastern South Pacific. This anomaly was contained in an anticyclonic mode-water eddy crossing the mooring site which was the largest water property anomaly observed during the 13.5 month deployment. The water mass stayed isolated during the 11 month travel time due to high rotational speed of about 20 cm s^{-1} leading to almost zero oxygen in the subsurface layer of the anticyclonic mode-water eddy with indications of high primary production just below the mixed layer.

Loescher, C.R., Großkopf, T., Desai, F.D., Gill, D., Schunck, H., Croot, P.L., Schlosser, C., Neulinger, S.C., Pinnow, N., Lavik, G., Kuypers, M.M., LaRoche, J. and Schmitz, R.A. (2014). Facets of diazotrophy in the oxygen minimum zone waters off Peru. ISME J. doi: 10.1038/ismej.2014.71.

The biological reduction of dinitrogen gas (N_2) to ammonium (NH_4^+), also known as nitrogen fixation, is quantitatively the most important external source of new nitrogen (N) to the open ocean. We report on the composition, distribution and abundance of nifH, the functional gene marker for N_2 fixation. Our results show the presence of eight clades of diazotrophs in the oxygen minimum zone (OMZ) off Peru. Although proteobacterial clades dominated overall, two clusters affiliated to spirochaeta and archaea were identified. The observed co-occurrence of key functional genes for N_2 fixation, nitrification, anammox and denitrification suggests that a close spatial coupling of N-input and N-loss processes exists in the OMZ off Peru. Furthermore, our statistical analysis suggests that NO_2^- and PO_4^{3-} are the major factors affecting diazotrophic distribution throughout the OMZ. In view of the predicted increase in ocean deoxygenation resulting from global warming, our findings indicate that the importance of OMZs as niches for N_2 fixation may increase in the future.

Dale, A.W., Sommer, S., Ryabenko, E., Noffke, A., Bohlen, L., Wallmann, K., Stolpovsky, K., Greinert, J., Pfannkuche, O. (2014). Benthic nitrogen fluxes and fractionation of nitrate in the Mauritanian oxygen minimum zone (Eastern Tropical North Atlantic).Geochim Cosmochim Ac, Vol. 134, 234-256, doi: 10.1016/j.gca.2014.02.026.

In this study sedimentary geochemical data and in situ benthic flux measurements of dissolved inorganic nitrogen (DIN: NO_3^-, NO_2^-, NH_4^+) and oxygen (O_2) from 7 sites with variable sand content along 18°N offshore Mauritania (NW Africa). Bottom water at the shallowest station was hypoxic (O_2 = 42 µM). Isotopic ($\delta^{15}N$, $\delta^{18}O$) measurements in the benthic flux chambers at this station are used to show that (i) net benthic $^{14}N/^{15}N$ fractionation (εDEN) was 12.9 ± 1.7‰, (ii) inverse fractionation during nitrite oxidation leads to an efflux of isotopically light NO_2^- (−22 ± 1.9‰), and (iii) direct coupling between nitrification and denitrification in the sediment is negligible. Previously reported εDEN for fine-grained sediments are much lower (4–8‰). This study speculates that high benthic nitrate fractionation is driven by a combination of enhanced porewater–seawater exchange in permeable sediments and the hypoxic, high productivity environment. This could have important implications for balancing the marine N cycle if this result applies more generally to sandy margin sediments.

Scholz, F., McManus, J., Mix, A.C., Hensen, C. and Schneider, R. (2014). The impact of ocean deoxygenation on iron release from continental margin sediments. Nature Geoscience, Vol. 7, 433-437. doi:10.1038/ngeo2162.

In the oceans' high-nitrate-low-chlorophyll regions, (e. g. the Peru/Humboldt Current system and the adjacent eastern equatorial Pacific) primary productivity is limited by the micronutrient iron. Within the Peruvian upwelling area, bioavailable iron is released from the reducing continental margin sediments. The study shows that measurements of molybdenum, uranium and iron concentrations can be used as a proxy for sedimentary iron release, and use this proxy to assess iron release from the sea floor beneath the Peru upwelling system during the past 140,000 years. A coupling is observed between levels of denitrification, as indicated by nitrogen isotopes, trace metal proxies for oxygenation, and sedimentary iron concentrations. Specifically, periods with poor upper ocean oxygenation are characterized by more efficient iron retention in the sediment and a diminished iron supply to the water column. This study argues that iron release from continental margin sediments is most effective in a narrow redox window where neither oxygen nor sulphide is present. This study suggest that future deoxygenation in the Peru upwelling area would be unlikely to result in increased iron availability, whereas in weaker oxygen minimum zones partial deoxygenation may enhance the iron supply.

Book chapter

Dengg, J., Soria-Dengg, S. and Tiemann, S. (2014) Marine geosciences from a different perspective: production of "edutainment" video-clips by pupils and researchers. In: Geoscience Research and Outreach. ed. by Tong, V., Innovations in Science Education and Technology, 21. Springer, London, UK, pp. 103-119. doi: 10.1007/978-94-007-6943-4_8.

SFB Outreach is an outreach project by two major German research consortia ("Sonderforschungsbereiche", SFB) in ocean sciences (SFB 754, SFB 574), in which scientists collaborate with secondary schools to produce educational and entertaining video clips on the background of their research. Within the first 2 years, about two dozen video clips were produced covering topics from the "use of benthic foraminifera as climate proxies" to "tsunami generation". Feedback from questionnaires distributed among the participating pupils shows general enthusiasm with the project but also allows to identify strategies for improving shortcomings.

Conferences

2ND INTERNATIONAL OCEAN RESEARCH CONFERENCE "ONE PLANET, ONE OCEAN"
November 17 – 21, 2014
Barcelona, Spain
Theme Session: Low oxygen and low pH environments in coastal and ocean waters

AGU FALL MEETING
December, 15 – 19, 2014
San Francisco, USA