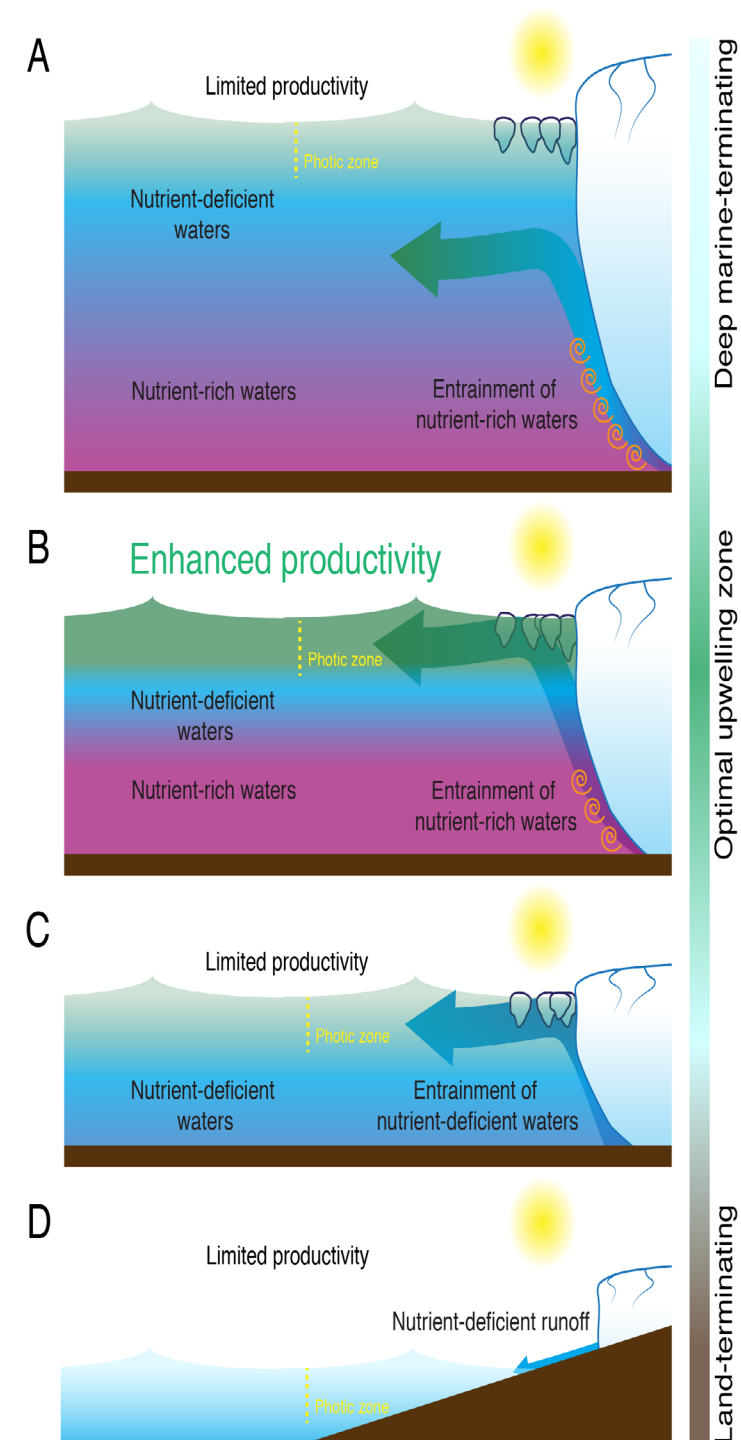


ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

Prepared by: Eric Achterberg

New scientific results

- Runoff from the Greenland Ice Sheet (GrIS) is thought to enhance marine productivity by adding bioessential iron and silicic acid to coastal waters.
- However, experimental data suggest nitrate is the main summertime growth-limiting resource in regions affected by meltwater around Greenland. While meltwater contains low nitrate concentrations, subglacial discharge plumes from marine-terminating glaciers entrain large quantities of nitrate from deep seawater.
- In the paper, we characterize the nitrate fluxes that arise from entrainment of seawater within these plumes using a subglacial discharge plume model. The upwelled flux from 12 marine-terminating glaciers is estimated to be >1000% of the total nitrate flux from GrIS discharge. This plume upwelling effect is highly sensitive to the glacier grounding line depth. For a majority of Greenland's marine-terminating glaciers nitrate fluxes will diminish as they retreat. This decline occurs even if discharge volume increases, resulting in a negative impact on nitrate availability and thus summertime marine productivity.
-
- Hopwood, M. J., D. Carroll, T. J. Browning, L. Meire, J. Mortensen, S. Krisch, E. P. Achterberg (2018): Non-linear response of summertime marine productivity to increased meltwater discharge around Greenland. Nature Communications, 9 (1), 3256, <https://doi.org/10.1038/s41467-018-05488-8>



New publications (published or in press)

- Rutgers van der Loeff, M., Kipp, L., Charette, M.A., Moore, W.S., Black, E., Stimac, I., Charkin, A., Bauch, D., Valk, O., Karcher, M., Krumpen, T., Casacuberta, N., Smethie, W., Rember, R., 2018. Radium Isotopes across the Arctic Ocean show Time Scales of Water Mass Ventilation and Increasing Shelf Inputs. *Journal of Geophysical Research: Oceans* 123, 4853-4873.
- Valk, O., Rutgers van der Loeff, M. M., Geibert, W., Gdaniec, S., Rijkenberg, M.J.A, Moran, S.B., Lepore, K, Edwards, R.L., Lu, Y and Puigcorb , J. (2018). Importance of Hydrothermal Vents in Scavenging Removal of ^{230}Th in the Nansen Basin. *Geophys. Res. Lett.* <https://doi.org/10.1029/2018GL079829>.
- Berube, P.M., Biller, S.J., Hackl, T., Hogle, S.L., Satinsky, B.M., Becker, J.W., Braakman, R., Collins, S.B., Kelly, L., Berta-Thompson, J., Coe, A., Bergauer, K., Bouman, H.A., Browning, T.J., De Corte, D., Hassler, C., Hulata, Y., Jacquot, J.E., Maas, E.W., Reinthaler, T., Sint s, E., Yokokawa, T., Lindell, D., Stepanauskas, R., & Chisholm, S.W. Single cell genomes of *Prochlorococcus*, *Synechococcus*, and sympatric microbes from diverse marine environments. *Scientific Data* 5, 180154 (2018).
- Biller, S.J., Berube, P.M., Dooley, K., Williams, M., Satinsky, B.M., Hackl, T., Hogle, S.L., Coe, A., Bergauer, K., Bouman, H.A., Browning, T.J., De Corte, D., Hassler, C., Hulston, D., Jacquot, J.E., Maas, E.W., Reinthaler, T., Sint s, E., Yokokawa, T., Chisholm, S.W.. Marine microbial metagenomes sampled across space and time. *Scientific Data* 5, 180176 (2018).
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- **Behrens, M.K., Pahnke, K.**, Schnetger, B., Brumsack, H.-J., 2018. Sources and processes affecting the distribution of dissolved Nd isotopes and concentrations in the West Pacific. *Geochim. Cosmochim. Acta* 222, 508-534.
- Doering, K., **Ehlert, C.**, Martinez, P., Frank, M., Schneider, R., 2018. Latitudinal variations of $\delta^{30}\text{Si}$ and $\delta^{15}\text{N}$ signatures along the Peruvian shelf: quantifying the effects of nutrient utilization versus denitrification over the past 600 years. *Biogeosciences Discuss.* 2018, 1-23.
- Pedreira, R.M.A., **Pahnke, K., B ning, P.**, Hatje, V., 2018. Tracking hospital effluent-derived gadolinium in Atlantic coastal waters off Brazil. *Water Research* 145, 62-72.
- **Stichel, T., Pahnke, K.**, Duggan, B., Goldstein, S.L., Hartman, A.E., **Paffrath, R.**, Scher, H., 2018. TAG plume: revisiting the hydrothermal neodymium contribution to seawater. *Front. Mar. Sci.* 5.
- Sutton, J.N., Andr , L., Cardinal, D., Conley, D.J., de Souza, G.F., Dean, J., Dodd, J., **Ehlert, C.**, Ellwood, M.J., Frings, P.J., Grasse, P., Hendry, K., Leng, M.J., Michalopoulos, P., Panizzo, V.N., Swann, G.E.A., 2018. A Review of the Stable Isotope Bio-geochemistry of the Global Silicon Cycle and Its Associated Trace Elements. *Frontiers in Earth Science* 5.

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- Achterberg, E.P., Browning, T.J., Gledhill, M. and Schlosser, C. (2019). Transition Metals and Heavy Metal Speciation. In: Encyclopedia of Ocean Sciences.
- Rapp, I., Schlosser, C., Menzel Barraqueta, J. L., Wenzel, B., Lüdke, J., Scholten, J., Gasser, B., Reichert, P., Gledhill, M., Dengler, M. and Achterberg, E. P. (2018) Controls on redox-sensitive trace metals in the Mauritanian oxygen minimum zone. *Biogeosciences Discussions*. pp. 1-49. DOI 10.5194/bg-2018-472.
- Hopwood, M. J., Santana-González, C., Gallego-Urrea, J., Sanchez, N., Achterberg, E. P., Ardelan, M. V., Gledhill, M., González-Dávila, M., Hoffmann, L., Leiknes, Ø., Santana-Casiano, J. M., Tsagaraki, T. M. and Turner, D. (2018) Fe(II) stability in seawater. *Biogeosciences Discussions*. pp. 1-29. DOI 10.5194/bg-2018-439.
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- Vieira, L.H., Achterberg, E.P., Scholten, J., Beck, A.J., Liebetrau, V., Mills, M.M., Arrigo, K.R. (2018). Benthic fluxes of trace elements in the Chukchi Sea and their transport into the Arctic Ocean. *Marine Chemistry*, <https://doi.org/10.1016/j.marchem.2018.11.001>.
- Little, S.H., Archer, C., Milne, A., Schlosser, C., Achterberg, E.P., Lohan, M.C., Vance, D. (2018). Paired dissolved and particulate phase Cu isotope distributions in the South Atlantic. *Chemical Geology*, 502, 29-43, <https://doi.org/10.1016/j.chemgeo.2018.07.022>.

New publications (published or in press)

- Hopwood, M. J., D. Carroll, T. J. Browning, L. Meire, J. Mortensen, S. Krisch, E. P. Achterberg (2018): Non-linear response of summertime marine productivity to increased meltwater discharge around Greenland. *Nature Communications*, 9 (1), 3256, <https://doi.org/10.1038/s41467-018-05488-8>
- Menzel Barraqueta, J.L., Schlosser, C., Planquette, H., Gourain, A., Cheize, M., Boutorh, J., Shelley, R., Pereira Contreira, L., Gledhill, M., Hopwood, M.J., Lherminier, P., Sarthou, G., Achterberg, E.P. (2018). Aluminium in the North Atlantic Ocean and the Labrador Sea (GEOTRACES GA01 section): roles of continental inputs and biogenic particle removal. *Biogeosciences*, 15, 5271-5286, 2018 <https://doi.org/10.5194/bg-15-5271-2018>.
- Schlosser, C., Streu, P., Frank, M., Lavik, G., Croot, P.L., Dengler, M. and Achterberg, E.P. (2018). H₂S events in the Peruvian oxygen minimum zone facilitate enhanced dissolved Fe concentrations. *Scientific Reports*, 8, 12642, <https://doi.org/10.1038/s41598-018-30580-w>.
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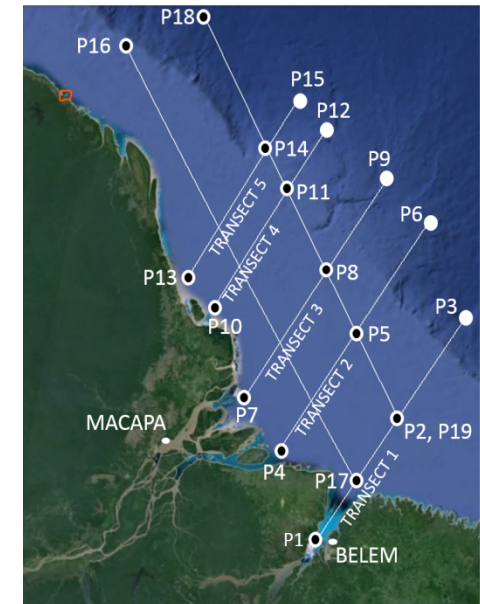
PhD thesis

- Insa Rapp (2018): Trace metal sources and cycling in tropical oxygen minimum zones. (GEOMAR, University of Kiel)
- Dagmara Rusiecka (2018) Biogeochemistry of trace metals in European shelf seas. (University of Southampton, GEOMAR)
- Jan Lukas Menzel (2018). Biogeochemistry of dissolved aluminium in the Atlantic Ocean. (GEOMAR, University of Kiel)
-
- ***Master theses:***
- Lisa Leist, 2018, Trace metal distribution on M81 in the tropical N Atlantic (supervisor: E. Achterberg).
- ***Presentations in international conferences***
- Stephan Krisch, M. Hopwood, J. Schaffer, P. Lodeiro, S.-M. Chen, C. Schlosser, T. Kanzow, E.P. Achterberg at IASC meeting in Oslo, January 2019. Title: Nioghalvfjerdbræ (79NG) Fe Fluxes; Results from PS100 (GN05).
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- Browning, T.J. and Achterberg, E.P. Nutrient controls on productivity overlying and offshore of oxygen minimum zones. Ocean Deoxygenation Conference, Kiel 2018.
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- Young, J.C., Browning, T.J., Gledhill, M., Shi, Z., Achterberg, E.P. Sources and composition of water-soluble trace elements in aerosols over the Benguela and Peruvian Oxygen Minimum Zones. Ocean Deoxygenation Conference, Kiel 2018.

Completed Cruises

- **GEOTRACES Process Study GApr11**, GEOTRACES Process Study Meteor M147 to Amazon mouth (19/04/2018 - 21/05/2018)
- Chief-Scientist: Andrea Koschinsky (IUB Bremen). Other PIs Martin Frank, Martha Gledhill, Eric Achterberg (GEOMAR), Thorsten Dittmar (ICBM, Oldenburg). Brazilian partner institutes: Universidade Federal de Rio Grande do Sul-UFRGS, Universidade Estadual do Norte Fluminense-UENF, Universidade Federal de Santa Maria-UFSM, Universidade Federale de Rio de Janeiro-UFRJ.
- The aim of the cruise is to investigate interactions of trace metals, dissolved organic matter (DOM), and particles in the Amazon estuary and the associated plume as key processes for trace metal and DOM fluxes into the Atlantic.

Cruise report: https://doi.org/10.2312/cr_m147

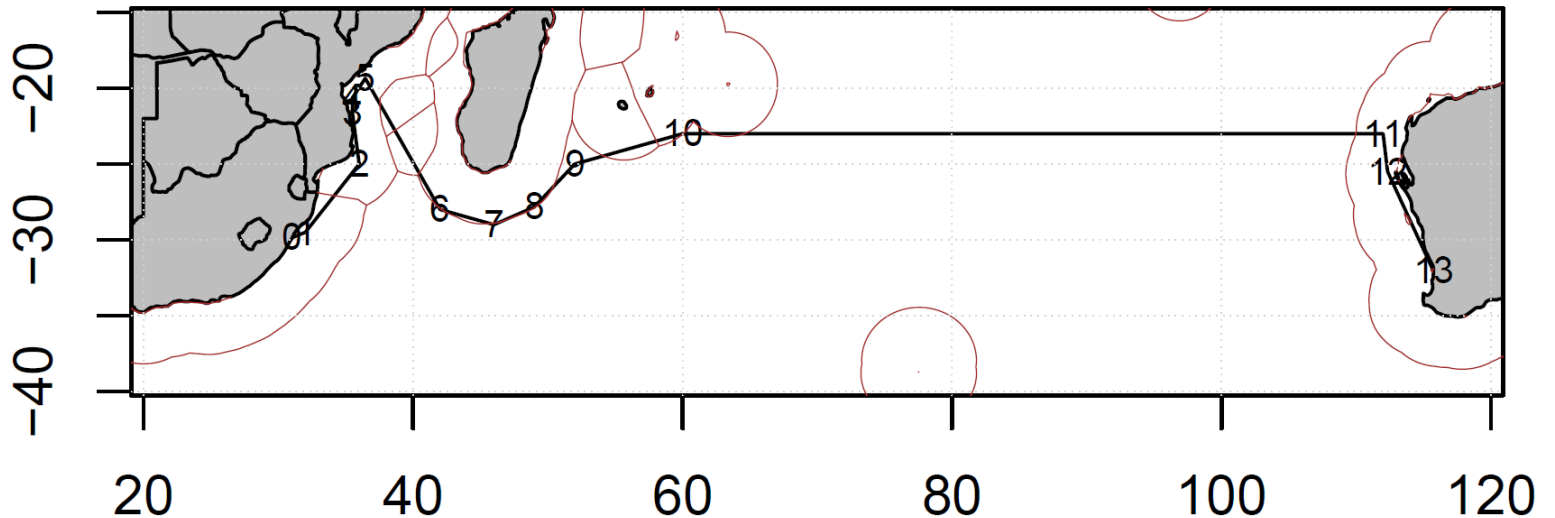


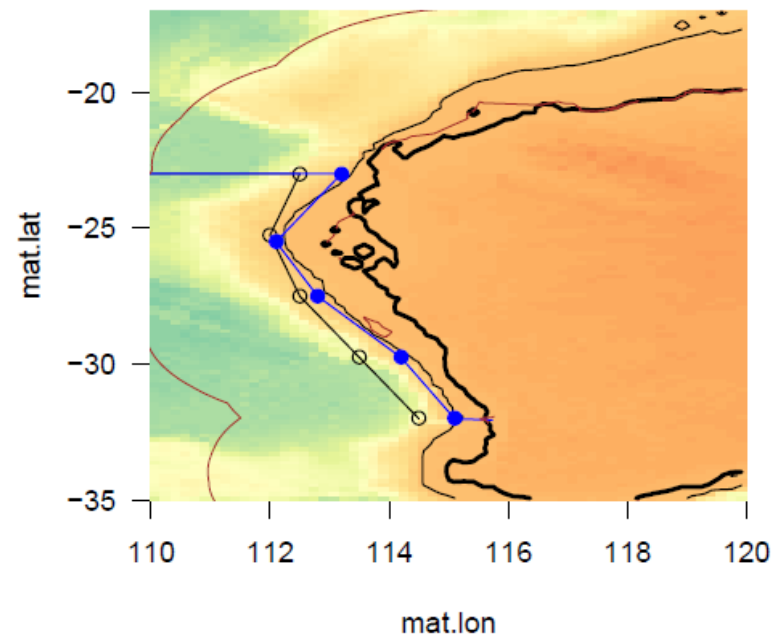
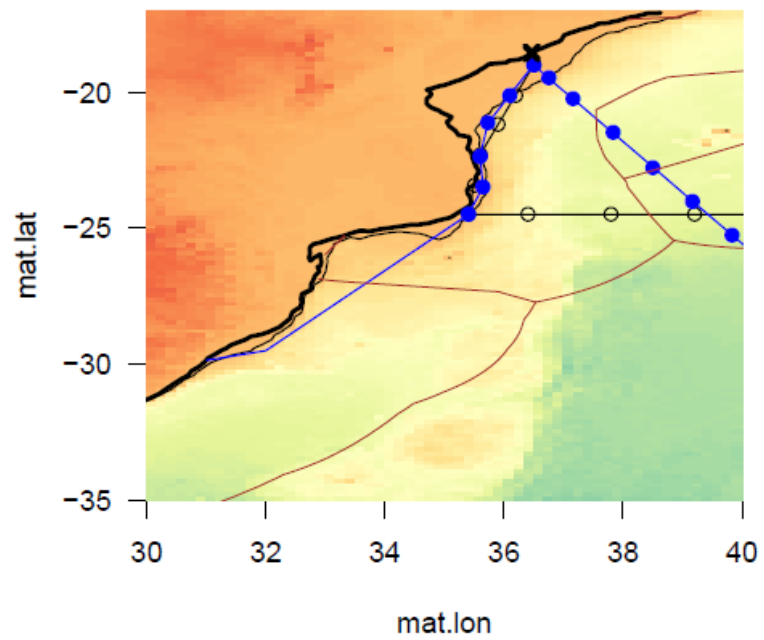
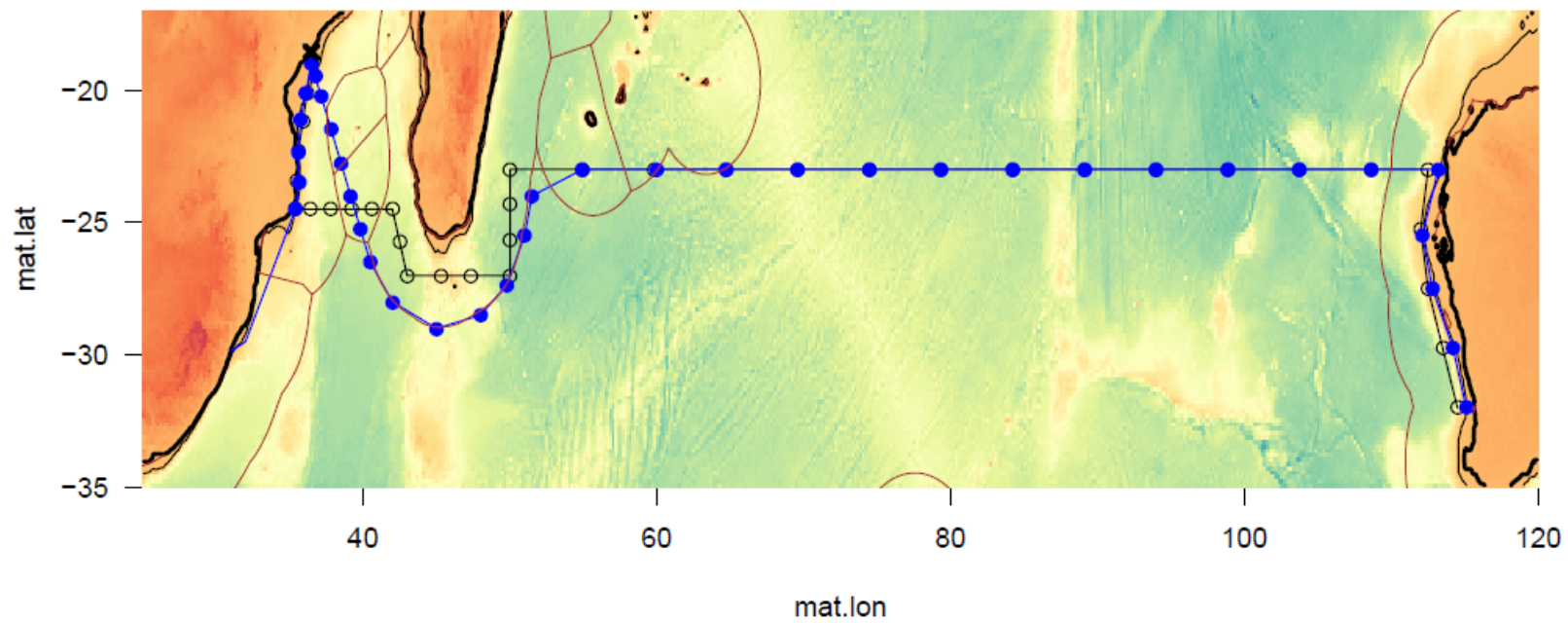
Surface and Deep Water Reference Material

- Deep water collected in the Angola Basin (Christmas 2015) is being re-bottled and will be re-distributed in the coming weeks to a number of labs to obtain initial batch precision and consensus values.
- Deep and surface waters collected in equatorial Atlantic in spring 2018. Stability and quality check on-going.
- We will collect surface Indian Ocean water in 2020 for bottling

Upcoming cruises

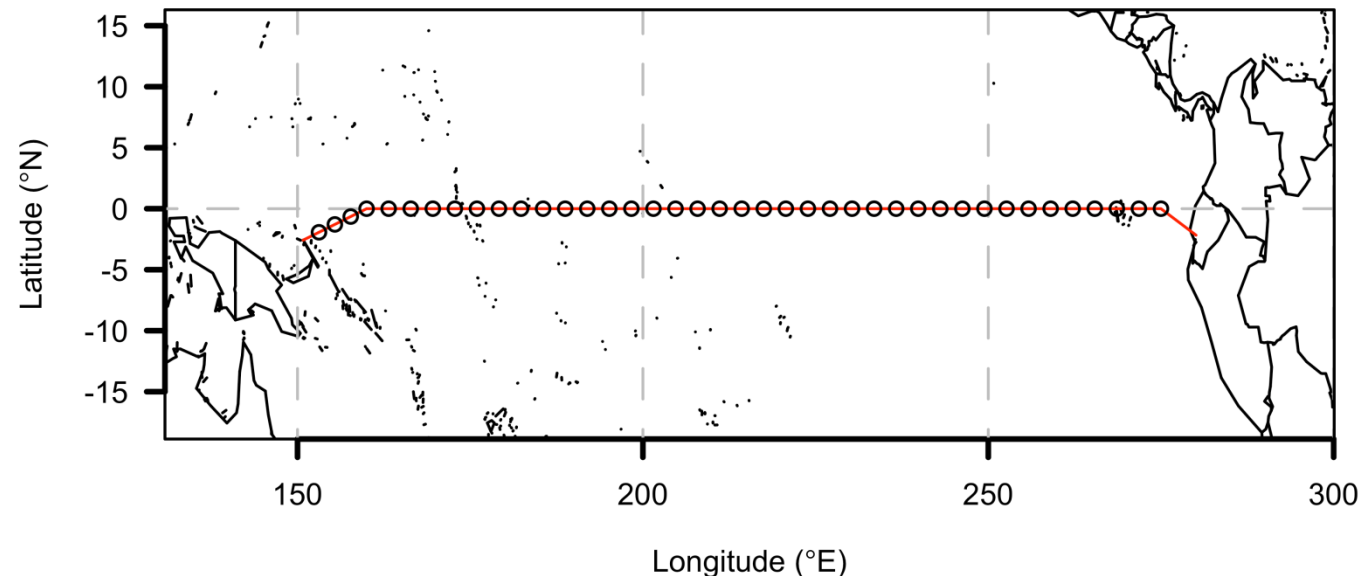
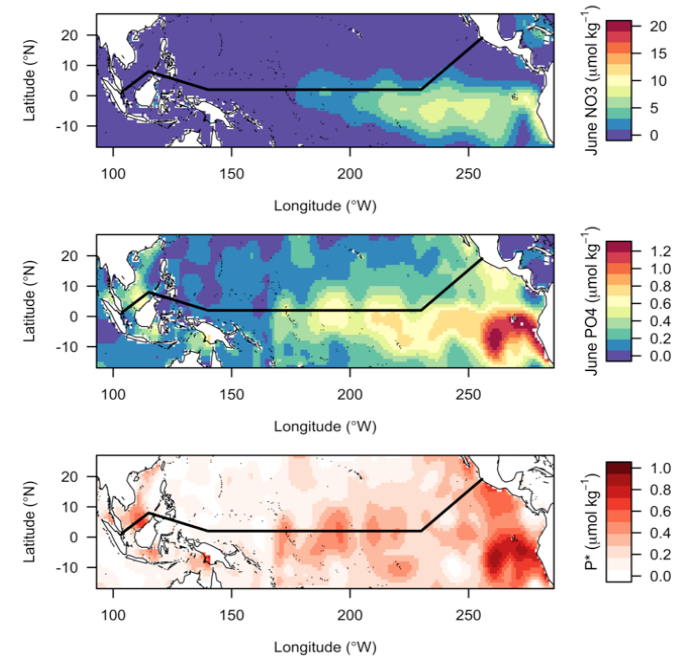
- South Indian Ocean cruise section cruise (GIO6, along 23°S).
- Scheduled for July-Aug 2020
- Focus on Mozambique shelf, Zambezi outflow (including time series of 1 year), Mozambique Channel, Madagascar Fe run-off, S Indian oligotrophic gyre, and Australian dust inputs
- PIs Achterberg, Frank, Koschinsky





Cruise GP11 Equatorial Pacific Section FS Sonne Scheduled for July-Aug 2021

- Focus:
- Equatorial Undercurrent
- Hydrothermal signatures EPR and western eq Pacific
- Gradients in surface ocean biology linked to N, P, Fe and Co supply
- Pls Achterberg, Frank, Koschinsky



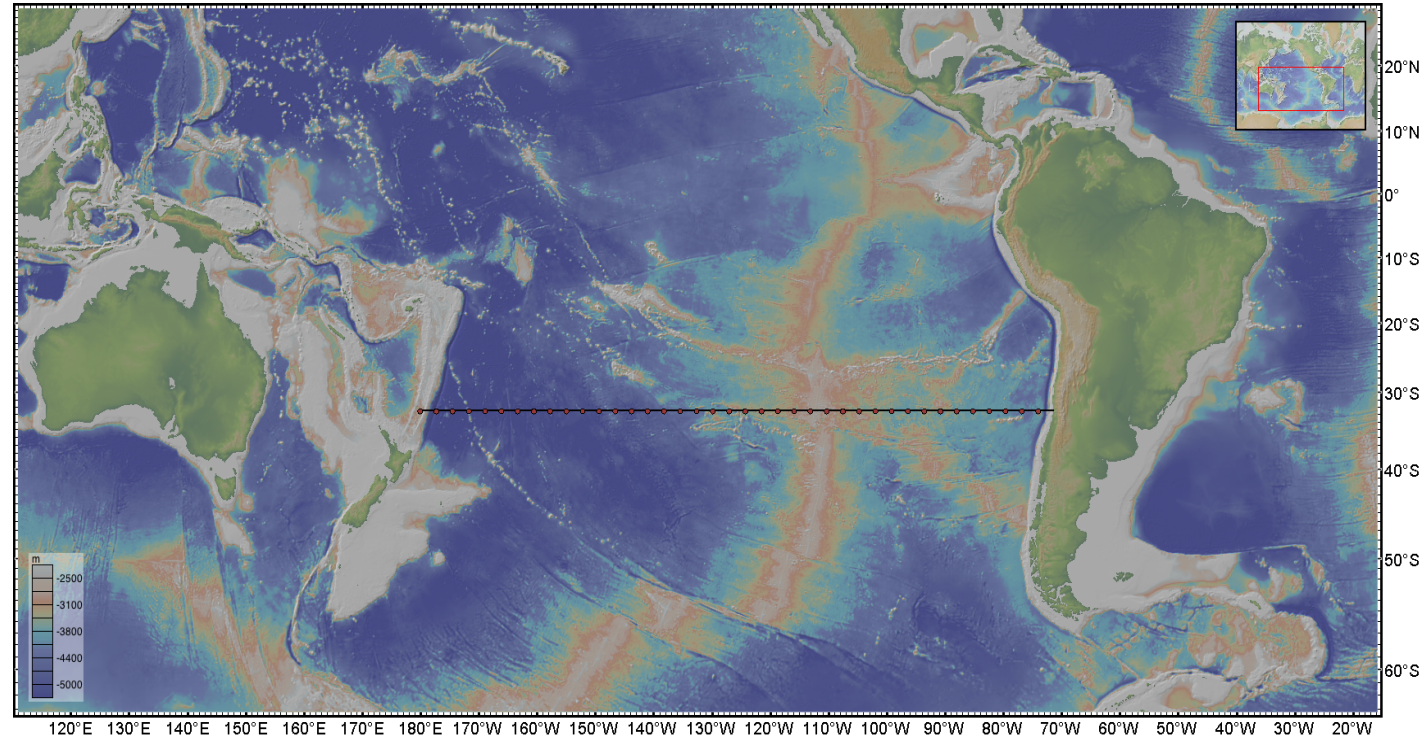
South Pacific Section GP21 Cruise

Scheduled for November 2021 – January 2022

- Cruise proposal approved for South Pacific along 32.5° S
- Link up with GP13
- Cruise will be along WOCE line P6.

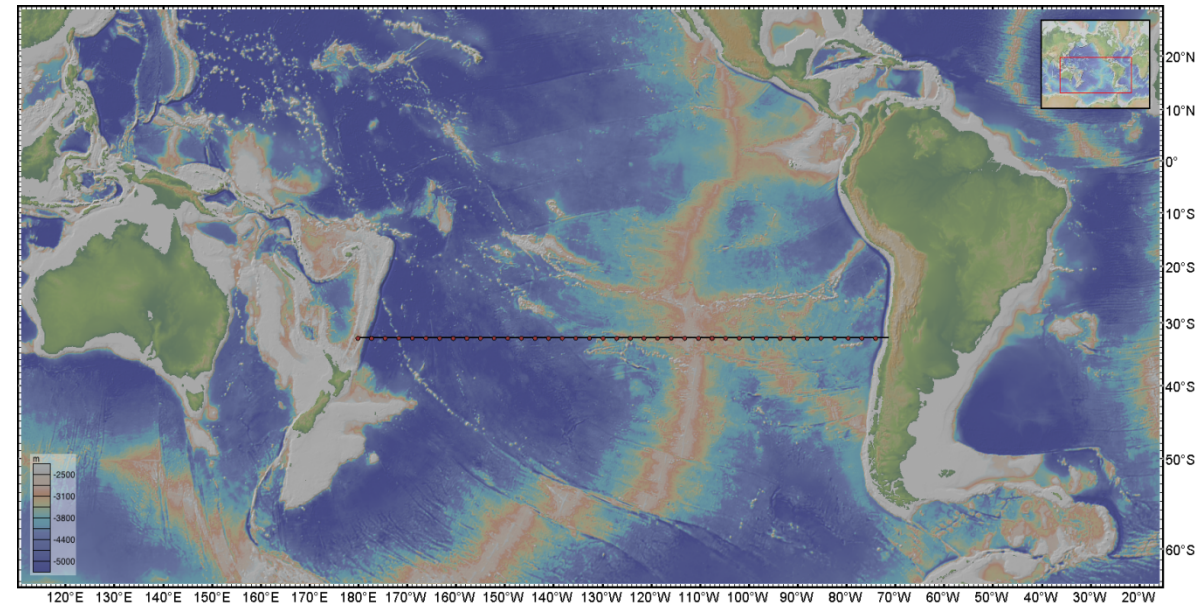
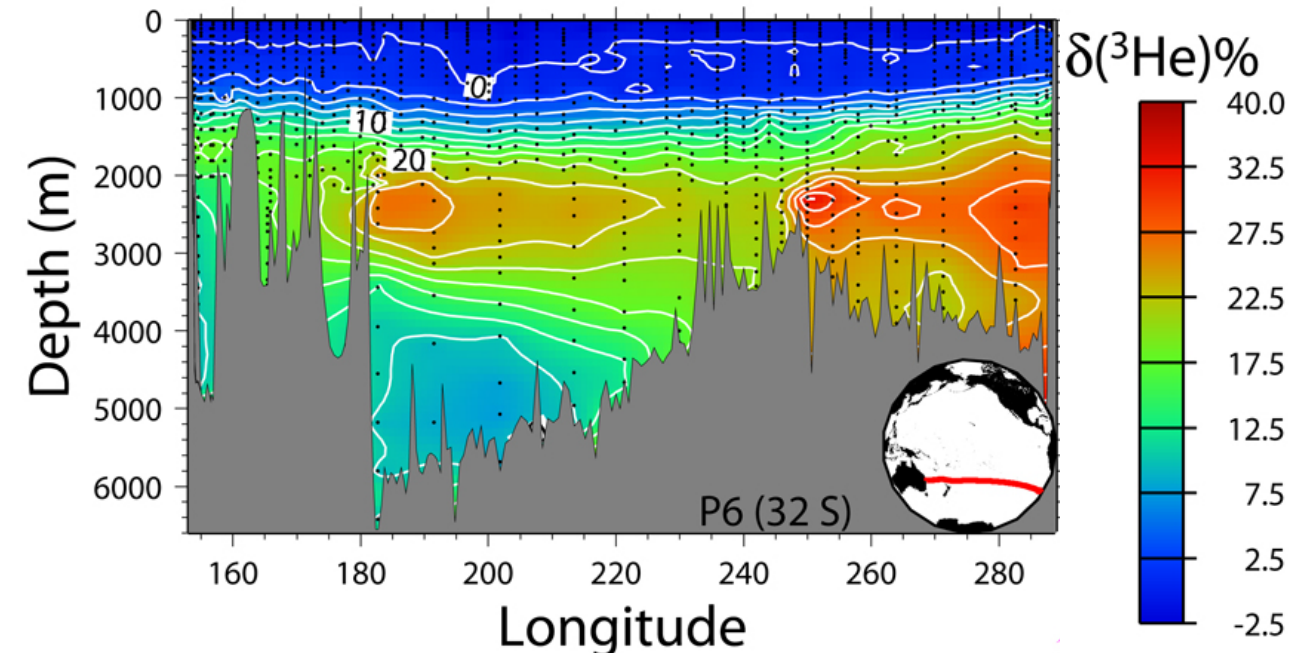
- PIs Achterberg, Frank, Koschinsky

- Cross overs with GP13 & GP19



Cruise GP21 South Pacific Section

- Focus:
- Hydrothermal release of TEIs
- Hydrothermal flow of TEIs into Southern Ocean in Pacific Deep Water through the SE Pacific



GEOTRACES Polarstern Repeat Arctic Section

ArcWatch/TransArc3

- AWI: Walter Geibert et al.
- GEOMAR: Achterberg et al.
- Proposal submitted Sept 1, 2019
- Cruise is hoped to take place in 2022 or 2023
- GEOTRACES cruise request will be submitted soon
- Focus:
 - Changes in Arctic Ocean since previous transect in 2007
 - Changes in surface ocean TEIs related to enhanced river run-off (i.e. Trans Polar Drift) and ice melt
 - Hydrothermal release of TEIs
 - Flow of TEIs into Atlantic Ocean through the Fram Strait

