

Curriculum Vitae

Dr. Tobias Steinhoff

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NORCE Norwegian Research Centre
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born 09. August 1973 in Wolfsburg/Germany
German

Education and professional experience

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| 02/2019 – today | Senior Engineer (50%), NORCE Norwegian Research Centre AS:
Work for the Ocean Thematic Centre (OTC) of the European infrastructure
Integrated Carbon Observation system (ICOS) |
| 12/2010 – today | Potdoctoral fellow, GEOMAR Helmholtz Centre for Ocean Research Kiel: <ul style="list-style-type: none">• Working in the framework of the German ICOS (Inegrated Carbon observing System) and several European projects (Carboocean, Carbochange, ENVRI+, RINGO, Bonus Integral)• Operating underway CO₂ instruments onboard a commercial vessel in the North Atlantic including maintenance and data analysis• Conducting discrete sampling program onboard the Atlantic Ocean line for carbon, nutrients, oxygen and organic parameters• Conducting several expeditions onboard German research vessels• Participated in the setup of the Cape Verde Ocean observatory (CVOO, www.cvo0.geomar.de)• Overseeing Carbon Laboratory at GEOMAR (Dissolved Inorganic Carbon, Alkalinity, pCO₂, Dissolved Organic Carbon) |
| 4/2005 – 11/2010 | Ph.D. candidate, Leibniz Institute for Marine Sciences (IFM-GEOMAR) <ul style="list-style-type: none">• Research area: Carbon and nutrient fluxes in the North Atlantic Ocean• Setting up an autonomous system for oceanic CO₂ measurements onboard the commercial vessels M/V Falstaff and M/V Atlantic Companion, crossing the North Atlantic• Conducting several cruises in the tropical Northeast Atlantic Ocean |
| 01/2005 – 03/2005 | Scientist, Leibniz Institute for Marine Sciences (IFM-GEOMAR) <ul style="list-style-type: none">• Data analysis of CO₂ data acquired from a mooring in the North Atlantic |
| 04/00-12/04 | Study of Chemistry (University of Kiel) |
| 10/95 – 03/00 | Study of Mathematics/Chemistry pursuing teaching certification (University of Kiel) |

Grants

06/15-11/17	ASTRA-OMZ, co-proponent (BMBF, 03G0243A, 383.000 €)
01/16-12/17	Establishing cooperation with University of Rio de Janeiro (DFG, STE 2491/1-1, 9.000 €)
07/17-11/17	GEOMAR seed funding "Flow-through tank" (GEOMAR, 12.000 €)

Students supervision

2019/2020	Co-supervision Lennart Gehrke, Master thesis: pCO ₂ in the Mediterranean Sea during the cruise MSM72
2018	Co-supervision Ludwig Dittmer, Bachelor thesis: CO ₂ - and O ₂ – dynamic in the upwelling area off Mauretania
Since 2017	Co-supervision Katharine Seelmann, Ph.D. thesis: Autonomous alkalinity measurements in the North Atlantic Ocean
2017	Co-supervision Rimon Lawa, Master thesis: DOC in the North Atlantic Ocean
2016	Co-supervision Frauke Bunsen, Master thesis: Mixed layer chlorophyll concentrations in the Central Irminger Sea: satellite versus in-situ data
2013-2016	Co-supervision Meike Becker, Ph.D. thesis: Autonomous ¹³ C measurements in the North Atlantic - a novel approach for identifying patterns and driving factors of the upper ocean carbon cycle
2013	Co-supervision Mirja Dunker, Master thesis (in German): Saisonalität von organischem Kohlenstoff im Oberflächenwasser des subpolaren Nordatlantiks

AOB

09/16-03/17	Deputy Chair of ICOS Ocean Monitoring Assembly
03/17-03/19	Chair of ICOS Ocean Monitoring Assembly
201-2018	project together with Lisa Hoffman (student at Muthesius school of fine arts, Kiel): sea addiction

Cruise experience

1999	<i>Meteor 45-3</i> , North Atlantic, Measurements of Dissolved inorganic carbon and alkalinity
2001	<i>Meteor 50-1 and -4</i> , North Atlantic, Measurements of Dissolved inorganic carbon and alkalinity
2002	<i>Falstaff</i> , North Atlantic, Operating instrument for pCO ₂ measurements
2003	<i>Meteor 59-2</i> , North Atlantic, Measurements of Dissolved inorganic carbon and alkalinity
2005	<i>Poseidon 320-1</i> , Mauritanian upwelling, Measurements of Dissolved inorganic carbon, alkalinity, pCO ₂ <i>Falstaff</i> , North Atlantic, Operating instrument for pCO ₂ measurements
2006	<i>Atlantic Companion</i> , North Atlantic, Operating instrument for pCO ₂ measurements

- Meteor 68-3, tropischer Atlantik
- 2008 *Polarstern ANTXXIV-4*, Atlantic, Operating instrument for pCO₂ measurements
Polarstern ANTXXV-1, North Atlantic, Operating instrument for pCO₂ measurements
- 2009 *Meteor 80-1*, tropical Atlantic, Measurements of Dissolved inorganic carbon and alkalinity
- 2010 *Polarstern ANTXXVII-1*, North Atlantic, Operating instrument for pCO₂ measurements
- 2011 *Maria S. Merian 18-3*, Tropical North Atlantic, Measurements of Dissolved inorganic carbon, alkalinity, pCO₂, deploying surface drifter for biogeochemical measurements
Atlantic Companion, North Atlantic, Operating instrument for pCO₂ measurements
- 2012 *Atlantic Companion*, North Atlantic, Operating instrument for pCO₂ measurements
- 2013 *Meteor 98*, Equatorial Atlantic, Operating instrument for pCO₂ measurements, performing direct CO₂ flux measurements by the eddy-covariance technique
- 2014 *Sonne 234-2*, Indian Ocean, SPACES training cruise for African and European students, Operating instrument for pCO₂ measurements, performing direct CO₂ flux measurements by the eddy-covariance technique, measurements with an autonomous drifter, teaching
Sonne235, Indian Ocean, SPACES training cruise for African and European students, measurements with an autonomous drifter, operating instrument for pCO₂ measurements
- 2015 *Sonne 243*, ASTRA-OMZ, East Pacific Ocean, Co-chief scientist, Operating instrument for pCO₂ measurements, performing direct CO₂ flux measurements by the eddy-covariance technique
- 2018 *Poseidon 519*, Eastern North Atlantic, chief scientist, 2 weeks of tracking an upwelling patch and observe it's biogeochemistry

Publications (since 2008):

1. Takahashi, T, S.C. Sutherland, R. Wanninkhof, C. Sweeney, R.A. Feely, D.W. Chipman, B. Hales, G. Friederich, F. Chavez, C. Sabine, A. Watson, D.C.E. Bakker, U. Schuster, N. Metzl, H. Yoshikawa-Inoue, M. Ishii, T. Midorikawa, Y. Nojiri, A. Körtzinger, T. Steinhoff, M. Hoppema, J. Olafsson, T.S. Arnarson, B. Tilbrook, T. Johannessen, A. Olsen, R. Bellerby, C.S. Wong, B. Delille, N.R. Bates und H.J.W. de Baar (2009). Climatological mean and decadal change in surface ocean pCO₂, and net sea-air CO₂ flux over the global oceans. *Deep-Sea Res. II*, 56, 554-577.
2. Telszewski, M., Chazottes, A., Schuster, U., Watson, A. J., Moulin, C., Bakker, D. C. E., González-Dávila, M., Johannessen, T., Körtzinger, A., Lüger, H., Olsen, A., Omar, A., Padin, X. A., Ríos, A. F., Steinhoff, T., Santana-Casiano, M., Wallace, D. W. R., and Wanninkhof, R.(2009). Estimating the monthly pCO₂ distribution in the North Atlantic using a self-organizing neural network. *Biogeosciences*, 6, 1405-1421.
3. Watson, A.J., U. Schuster, D.C.E. Bakker, N.R. Bates, A. Corbière, M. González-Dávila, T. Friedrich, J. Hauck, C. Heinze, T. Johannessen, A. Körtzinger, N. Metzl, J. Olafsson, A. Olsen, A. Oschlies, X. A. Padin, B. Pfeil, J.M. Santana-Casiano, T. Steinhoff, M. Telszewski, A.F. Rios, D.W.R. Wallace, R. Wanninkhof (2009). Tracking the Variable North Atlantic Sink for Atmospheric CO₂. *Science*, 326 (5958), doi:10.1126/science.1177394.
4. Steinhoff, T., T. Friedrich, S.E. Hartman, A. Oschlies, D.W.R. Wallace und A. Körtzinger (2010). Estimating mixed layer nitrate in the North Atlantic Ocean. *Biogeosciences*, 7, 795-807.
5. Bittig, H., B. Fiedler, T. Steinhoff, and A. Körtzinger (2012). A novel electrochemical calibration setup for oxygen sensors and its use for the stability assessment of Aanderaa optodes. *Limnol. Oceanogr.: Methods*, 10, 921-933.
6. Becker, M., N. Andersen, B. Fiedler, P. Fietzek, A. Körtzinger, T. Steinhoff, and G. Friedrichs (2012). Using cavity ringdown spectroscopy for continuous monitoring of δ¹³C(CO₂) and fCO₂ in the surface ocean. *Limnol. Oceanogr.: Methods*, 10, 752-766.
7. Quay, P., J. Stutsman and T. Steinhoff (2012). Primary production and carbon export rates across the subpolar North Atlantic Ocean basin based on triple oxygen isotope and dissolved O₂ and Ar gas measurements. *Global Biogeochem. Cycles*, 26 (2), doi: 10.1029/2010GB004003.
8. Pfeil, B., Olsen, A., Bakker, D. C. E., Hankin, S., Koyuk, H., Kozyr, A., Malczyk, J., Manke, A., Metzl, N., Sabine, C. L., Akl, J., Alin, S. R., Bates, N., Bellerby, R. G. J., Borges, A., Boutin, J., Brown, P. J., Cai, W.-J., Chavez, F. P., Chen, A., Cosca, C., Fassbender, A. J., Feely, R. A., González-Dávila, M., Goyet, C., Hales, B., Hardman-Mountford, N., Heinze, C., Hood, M., Hoppema, M., Hunt, C. W., Hydes, D., Ishii, M., Johannessen, T., Jones, S. D., Key, R. M., Körtzinger, A., Landschützer, P., Lauvset, S. K., Lefèvre, N., Lenton, A., Lourantou, A., Merlivat, L., Midorikawa, T., Mintrop, L., Miyazaki, C., Murata, A., Nakadate, A., Nakano, Y., Nakaoka, S., Nojiri, Y., Omar, A. M., Padin, X. A., Park, G.-H., Paterson, K., Perez, F. F., Pierrot, D., Poisson, A., Ríos, A. F., Santana-Casiano, J. M., Salisbury, J., Sarma, V. V. S. S., Schlitzer, R., Schneider, B., Schuster, U., Sieger, R., Skjelvan, I., Steinhoff, T., Suzuki, T., Takahashi, T., Tedesco, K., Telszewski, M., Thomas, H., Tilbrook, B., Tjiputra, J., Vandemark, D., Veness, T., Wanninkhof, R., Watson, A. J., Weiss, R., Wong, C. S., and Yoshikawa-Inoue, H. (2013). A uniform, quality controlled Surface Ocean CO₂ Atlas (SOCAT), *Earth Syst. Sci. Data*, 5, 125-143, doi:10.5194/essd-5-125-2013.

9. Sabine, C. L., Hankin, S., Koyuk, H., Bakker, D. C. E., Pfeil, B., Olsen, A., Metzl, N., Kozyr, A., Fassbender, A., Manke, A., Malczyk, J., Akl, J., Alin, S. R., Bellerby, R. G. J., Borges, A., Boutin, J., Brown, P. J., Cai, W.-J., Chavez, F. P., Chen, A., Cosca, C., Feely, R. A., González-Dávila, M., Goyet, C., Hardman-Mountford, N., Heinze, C., Hoppema, M., Hunt, C. W., Hydes, D., Ishii, M., Johannessen, T., Key, R. M., Körtzinger, A., Landschützer, P., Lauvset, S. K., Lefèvre, N., Lenton, A., Lourantou, A., Merlivat, L., Midorikawa, T., Mintrop, L., Miyazaki, C., Murata, A., Nakadate, A., Nakano, Y., Nakaoka, S., Nojiri, Y., Omar, A. M., Padin, X. A., Park, G.-H., Paterson, K., Perez, F. F., Pierrot, D., Poisson, A., Ríos, A. F., Salisbury, J., Santana-Casiano, J. M., Sarma, V. V. S. S., Schlitzer, R., Schneider, B., Schuster, U., Sieger, R., Skjelvan, I., Steinhoff, T., Suzuki, T., Takahashi, T., Tedesco, K., Telszewski, M., Thomas, H., Tilbrook, B., Vandemark, D., Veness, T., Watson, A. J., Weiss, R., Wong, C. S., and Yoshikawa-Inoue, H. (2013). Surface Ocean CO₂ Atlas (SOCAT) gridded data products, *Earth Syst. Sci. Data*, 5, 145-153, doi:10.5194/essd-5-145-2013.
10. Arévalo-Martínez, D.L., M. Beyer, M. Krumbholz, I. Piller, A. Kock, T. Steinhoff, A. Körtzinger, and H. W. Bange (2013). A new method for continuous measurements of oceanic and atmospheric N₂O, CO and CO₂: performance of off-axis integrated cavity output spectroscopy (OA-ICOS) coupled to non-dispersive infrared detection (NDIR). *Ocean Sci.*, 9, 1071-1087, doi:10.5194/os-9-1071-2013.
11. Fietzek, P., B. Fiedler, T. Steinhoff, and A. Körtzinger (2014). In situ quality assessment of a novel underwater pCO₂ sensor based on membrane equilibration and NDIR spectrometry. *J. Atmos. Oceanic Technol.* 31, 181-196, doi:10.1175/JTECH-D-13-00083.1.
12. Bakker, D. C. E. , B. Pfeil, K. Smith, S. Hankin, A. Olsen, S. R. Alin, C. Cosca, S. Harasawa, A. Kozyr, Y. Nojiri, K. M. O'Brien, U. Schuster, M. Telszewski, B. Tilbrook, C. Wada, J. Akl, L. Barbero, N. Bates, J. Boutin, W.-J. Cai, R. D. Castle, F. P. Chavez, L. Chen, M. Chierici, K. Currie, H. J. W. de Baar, W. Evans, R. A. Feely, A. Fransson, Z. Gao, B. Hales, N. Hardman-Mountford, M. Hoppema, W.-J. Huang, C. W. Hunt, B. Huss, T. Ichikawa, T. Johannessen, E. M. Jones, S. D. Jones, S. Jutterström, V. Kitidis, A. Körtzinger, P. Landschützer, S. K. Lauvset, N. Lefèvre, A. B. Manke, J. T. Mathis, L. Merlivat, N. Metzl, A. Murata, T. Newberger, T. Ono, G.-H. Park, K. Paterson, D. Pierrot, A. F. Ríos, C. L. Sabine, S. Saito, J. Salisbury, V. V. S. S. Sarma, R. Schlitzer, R. Sieger, I. Skjelvan, T. Steinhoff, K. Sullivan, H. Sun, A. J. Sutton, T. Suzuki, C. Sweeney, T. Takahashi, J. Tjiputra, N. Tsurushima, S. M. A. C. van Heuven, D. Vandemark, P. Vlahos, D. W. R. Wallace, R. Wanninkhof, and A. J. Watson (2014). An update to the Surface Ocean CO₂ Atlas (SOCAT version 2). *Earth Syst. Sci. Data*, 6, 69-90.
13. Le Quéré, C., Moriarty, R., Andrew, R. M., Peters, G. P., Ciais, P., Friedlingstein, P., Jones, S. D., Sitch, S., Tans, P., Arneeth, A., Boden, T. A., Bopp, L., Bozec, Y., Canadell, J. G., Chini, L. P., Chevallier, F., Cosca, C. E., Harris, I., Hoppema, M., Houghton, R. A., House, J. I., Jain, A. K., Johannessen, T., Kato, E., Keeling, R. F., Kitidis, V., Klein Goldewijk, K., Koven, C., Landa, C. S., Landschützer, P., Lenton, A., Lima, I. D., Marland, G., Mathis, J. T., Metzl, N., Nojiri, Y., Olsen, A., Ono, T., Peng, S., Peters, W., Pfeil, B., Poulter, B., Raupach, M. R., Regnier, P., Rödenbeck, C., Saito, S., Salisbury, J. E., Schuster, U., Schwinger, J., Séférian, R., Segschneider, J., Steinhoff, T., Stocker, B. D., Sutton, A. J., Takahashi, T., Tilbrook, B., van der Werf, G. R., Viovy, N., Wang, Y. P., Wanninkhof, R., Wiltshire, A. und Zeng, N. (2015) Global carbon budget 2014. *Earth System Science Data*, 7 (1). pp. 47-85. DOI 10.5194/essd-7-47-2015.

14. C. Le Quéré, R. Moriarty, R. M. Andrew, J. G. Canadell, S. Sitch, J. I. Korsbakken, P. Friedlingstein, G. P. Peters, R. J. Andres, T. A. Boden, R. A. Houghton, J. I. House, R. F. Keeling, P. Tans, A. Arneeth, D. C. E. Bakker, L. Barbero, L. Bopp, J. Chang, F. Chevallier, L. P. Chini, P. Ciais, M. Fader, R. A. Feely, T. Gkritzalis, I. Harris, J. Hauck, T. Ilyina, A. K. Jain, E. Kato, V. Kitidis, K. Klein Goldewijk, C. Koven, P. Landschützer, S. K. Lauvset, N. Lefèvre, A. Lenton, I. D. Lima, N. Metzl, F. Millero, D. R. Munro, A. Murata, J. E. M. S. Nabel, S. Nakaoka, Y. Nojiri, K. O'Brien, A. Olsen, T. Ono, F. F. Pérez, B. Pfeil, D. Pierrot, B. Poulter, G. Rehder, C. Rödenbeck, S. Saito, U. Schuster, J. Schwinger, R. Séférian, T. Steinhoff, B. D. Stocker, A. J. Sutton, T. Takahashi, B. Tilbrook, I. T. van der Laan-Luijkx, G. R. van der Werf, S. van Heuven, D. Vandemark, N. Viovy, A. Wiltshire, S. Zaehle, and N. Zeng (2015) Global Carbon Budget 2015. *Earth System Science Data*, 7, 349-396.
15. Walter, S., A. Kock, T. Steinhoff, B. Fiedler, P. Fietzek, J. Kaiser, M. Krol, M. E. Poppa, Q. Chen, T. Tanhua, and T. Röckmann (2016) Isotopic evidence for biogenic molecular hydrogen production in the Atlantic Ocean. *Biogeosciences*, 13, 323-340.
16. Bakker, D. C. E., Pfeil, B., Landa, C. S., Metzl, N., O'Brien, K. M., Olsen, A., ... Steinhoff, T., ... Xu, S. (2016). A multi-decade record of high-quality fCO₂ data in version 3 of the Surface Ocean CO₂ Atlas (SOCAT). *Earth Syst. Sci. Data*, 8(2), 383–413. <http://doi.org/10.5194/essd-8-383-2016>.
17. Lennartz, S. T. , Marandino, C. A., Hobe, M. v., Cortes, P., Quack, B., Simo, R., Booge, D., Pozzer, A., Steinhoff, T., Arevalo-Martinez, D. L. , Kloss, C., Bracher, A., Röttgers, R., Atlas, E. und Krüger, K. (2017) Direct oceanic emissions unlikely to account for the missing source of atmospheric carbonyl sulfide. *Atmospheric Chemistry and Physics*, 17, 385-402. DOI 10.5194/acp-17-385-2017.
18. Arevalo-Martinez, D. L., Kock, A., Steinhoff, T., Brandt, P., Dengler, M., Fischer, T., Körtzinger, A. und Bange, H. W. (2018) Nitrous oxide during the onset of the Atlantic Cold Tongue. *JGR - Oceans*. DOI 10.1002/2016JC012238.
19. Zavorsky, A., Goddijn-Murphy, L., Steinhoff, T. und Marandino, C. A. (2018) Bubble-Mediated Gas Transfer and Gas Transfer Suppression of DMS and CO₂. *J. Geophys. Res.: Atmospheres*, 123 (12), 6624-6647. DOI 10.1029/2017JD028071.
20. Bittig, H. C., Steinhoff, T., Claustre, H., Fiedler, B., Williams, N. L., Sauzède, R., Körtzinger, A. und Gattuso, J. P. (2018) An Alternative to Static Climatologies: Robust Estimation of Open Ocean CO₂ Variables and Nutrient Concentrations From T, S, and O₂ Data Using Bayesian Neural Networks. *Frontiers in Marine Science*, 5, 328. DOI 10.3389/fmars.2018.00328.
21. Becker, M., Steinhoff, T. und Körtzinger, A. (2018) A detailed view on the seasonality of stable carbon isotopes across the North Atlantic. *Global Biogeochemical Cycles*, 32 (9), 1406-1419. DOI 10.1029/2018GB005905.
22. Le Quéré, C. , Andrew, R. M. , Friedlingstein, P., Sitch, S., Hauck, J. , Pongratz, J., Pickers, P. A., Korsbakken, J. I. , Peters, G. P. , Canadell, J. G. , Arneeth, A., Arora, V. K., Barbero, L., Bastos, A. , Bopp, L., Chevallier, F. , Chini, L. P., Ciais, P., Doney, S. C., Gkritzalis, T., Goll, D. S., Harris, I., Haverd, V., Hoffman, F. M. , Hoppema, M. , Houghton, R. A., Hurtt, G. , Ilyina, T., Jain, A. K. , Johannessen, T. , Jones, C. D. , Kato, E. , Keeling, R. F. , Goldewijk, K. K., Landschützer, P., Lefèvre, N., Lienert, S. , Liu, Z. , Lombardozi, D., Metzl, N., Munro, D. R., Nabel, J. E. M. S. , Nakaoka, S. i., Neill, C., Olsen, A., Ono, T., Patra, P. , Pregon, A., Peters, W. , Peylin, P., Pfeil, B., Pierrot, D., Poulter, B., Rehder, G. , Resplandy, L., Robertson, E., Rocher, M., Rödenbeck, C. ,

- Schuster, U., Schwinger, J., Séférian, R., Skjelvan, I., Steinhoff, T., Sutton, A., Tans, P. P., Tian, H., Tilbrook, B., Tubiello, F. N., van der Laan-Luijkx, I. T., van der Werf, G. R., Viovy, N., Walker, A. P., Wiltshire, A. J., Wright, R., Zaehle, S. und Zheng, B. (2018) Global Carbon Budget 2018. *Earth System Science Data*, 10 (4), 2141-2194. DOI 10.5194/essd-10-2141-2018.
23. Arévalo-Martínez, D. L., Steinhoff, T., Brandt, P., Körtzinger, A., Lamont, T., Rehder, G. und Bange, H. W. (2019) N₂O emissions from the northern Benguela upwelling system. *Geophysical Research Letters*, 46 (6). pp. 3317-3326. DOI 10.1029/2018GL081648.
24. Wanninkhof, R., P. A. Pickers, A. M. Omar, A. Sutton, A. Murata, A. Olsen, B. B. Stephens, B. Tilbrook, D. Munro, D. Pierrot, G. Rehder, J. M. Santana-Casiano, J. D. Müller, J. Trinanes, K. Tedesco, K. O'Brien, K. Currie, L. Barbero, M. Telszewski, M. Hoppema, M. Ishii, M. González-Dávila, N. R. Bates, N. Metzl, P. Suntharalingam, R. A. Feely, S.-i. Nakaoka, S. K. Lauvset, T. Takahashi, T. Steinhoff and U. Schuster. A Surface Ocean CO₂ Reference Network, SOCONET and Associated Marine Boundary Layer CO₂ Measurements (2019). *Frontiers in Marine Science*, 6: 400. DOI 10.3389/fmars.2019.00400.
25. Steinhoff T, T. Gkritzalis, S.K. Lauvset, S. Jones, U. Schuster, A. Olsen, M. Becker, R. Bozzano, F. Brunetti, C. Cantoni, V. Cardin, D. Diverrès, B. Fiedler, A. Fransson, M. Giani, S. Hartman, M. Hoppema, E. Jeansson, T. Johannessen, V. Kitidis, A. Körtzinger, C. Landa, N. Lefèvre, A. Luchetta, L. Naudts, P.D. Nightingale, A. Omar, S. Pensieri, B. Pfeil, R. Castaño-Primo, G. Rehder, A. Rutgersson, R. Sanders, I. Schewe, G. Siena, I. Skjelvan, T. Soltwedel, S. van Heuven and A. Watson (2019) Constraining the Oceanic Uptake and Fluxes of Greenhouse Gases by Building an Ocean Network of Certified Stations: The Ocean Component of the Integrated Carbon Observation System, ICOS-Oceans. *Front. Mar. Sci.* 6:544, doi: 10.3389/fmars.2019.00544
26. Morgan, E. J., Lavric, J. V., Arévalo-Martínez, D. L., Bange, H. W., Steinhoff, T., Seifert, T., and Heimann, M. (2019). Air–sea fluxes of greenhouse gases and oxygen in the northern Benguela Current region during upwelling events, *Biogeosciences*, 16, 4065–4084, <https://doi.org/10.5194/bg-16-4065-2019>, 2019.
27. Arruda, R., Atamanchuk, D., Cronin, M., Steinhoff, T. and Wallace, D.W.R. (2020), At-sea intercomparison of three underway pCO₂ systems. *Limnol Oceanogr Methods*. doi:10.1002/lom3.10346
28. Kitidis, V., Shutler, J.D., Ashton, I., Warren, M., Brown, I., Findlay, H., Hartman, S.E., Sanders, R., Humphreys, M., Kivimäe, C., Greenwood, N., Hull, T., Pearce, D., McGrath, T., Stewart, B.M., Walsham, P., McGovern, E., Bozec, Y., Gac, J.-P., van Heuven, S.M.A.C., Hoppema, M., Schuster, U., Johannessen, T., Omar, A., Lauvset, S.K., Skjelvan, I., Olsen, A., Steinhoff, T., Körtzinger, A., Becker, M., Lefevre, N., Diverrès, D., Gkritzalis, T., Cattrijsse, A., Petersen, W., Voynova, Y.G., Chapron, B., Grouazel, A., Land, P.E., Sharples, J. and Nightingale, P.D. (2019). Winter weather controls net influx of atmospheric CO₂ on the north-west European shelf. *Sci Rep* 9, 20153 (2019) doi:10.1038/s41598-019-56363-5