Physicochemical and phytoplankton data collected during the STRATIPHYT I and II cruises in the Northeast Atlantic Ocean. Cruises took place during the summer of 2009 and spring of 2011 aboard the R/V Pelagia.

Website: https://www.bco-dmo.org/dataset/955473
Data Type: Cruise Results
Version: 1
Version Date: 2025-03-07

Project
» Changes in vertical stratification and their impact on phytoplankton communities (STRATIPHYT)

Contributors	Affiliation	Role
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Abstract
Data include all physicochemical and phytoplankton data collected during the STRATIPHYT I and II cruises in the Northeast Atlantic Ocean. Cruises took place during the summer of 2009 and spring of 2011 aboard the R/V Pelagia. Water samples were collected in the top 250 m from at least 10 separate depths using 24 plastic samplers (General Oceanics type Go-Flow, 10 liter) during STRATIPHYT I and Teflon samplers (NIOZ design Pristine Bottles, 27 L) during STRATIPHYT II. Samplers were mounted on an ultra-clean (trace-metal free) system consisting of a fully titanium sampler frame equipped with CTD (Seabird 91; standard conductivity, temperature, and pressure sensors) and auxiliary sensors for chlorophyll autofluorescence (Chelsea Aquatracka Mk III), light transmission (Wet-Labs C-star) and photosynthetic active radiation (PAR; Satlantic). Data from the chlorophyll autofluorescence sensor were calibrated against HPLC data to determine total chlorophyll a (Chl a). Samples were taken inside a 6 m Clean Container from each depth for inorganic nutrients, flow cytometry, and phytoplankton pigments. Temperature eddy diffusivity (KT) data, referred to here as the vertical mixing coefficient, were derived from temperature and conductivity microstructure profiles measured using the commercial microstructure profiler Self Contained Autonomous Microprofiler (SCAMP). Phytoplankton consisting of photoautotrophic prokaryotic cyanobacteria and eukaryotic algae

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Coverage

Location: Northeast Atlantic in the area located between 29N and 63N
Spatial Extent: **N**:62.800035 **E**:-9.0486 **S**:28.999686 **W**:-21.740748
Temporal Extent: 2009 - 2011

Dataset Description

Data have not been made public due to unanswered questions and data quality issues. Final

review by the data submitter was not received after it was imported into the BCO-DMO data system.

Methods & Sampling

Sampling location: Northeast Atlantic in the area located between 29 degN and 63degN (~15 degW), which spans from the Canary Islands to Iceland. Water samples were collected in the top 250 m from at least 10 separate depths. During each cruise, 32 stations (separated by approximately 100 km) were sampled.

Water samples were collected in the top 250 m from at least 10 separate depths using 24 plastic samplers (General Oceanics type Go-Flow, 10 liter) during STRATIPHYT I and Teflon samplers (NIOZ design Pristine Bottles, 27 L) during STRATIPHYT II. Samplers were mounted on an ultra-clean (trace-metal free) system consisting of a fully titanium sampler frame equipped with CTD (Seabird 91; standard conductivity, temperature, and pressure sensors) and auxiliary sensors for chlorophyll autofluorescence (Chelsea Aquatracka Mk III), light transmission (Wet-Labs C-star) and photosynthetic active radiation (PAR; Satlantic). Data from the chlorophyll autofluorescence sensor were calibrated against HPLC data according to van de Poll et al. (2013) to determine total chlorophyll a (Chl a) for this study. Samples were taken inside a 6 m Clean Container from each depth for inorganic nutrients (5 mL), flow cytometry (10 mL), and phytoplankton pigments (10 L).

Temperature eddy diffusivity (KT) data, referred to here as the vertical mixing coefficient, were derived from temperature and conductivity microstructure profiles measured using the commercial microstructure profiler Self Contained Autonomous Microprofiler (SCAMP) . A detailed description of SCAMP methodology and data for both STRATIPHYT cruises have been described by Jurado et al. (2012a,b). The SCAMP was deployed at fewer stations (i.e., 17 and 14 in spring and summer, respectively) and to lower depths (up to 100 m) than the remainder of the data (23 stations and up to 250 m depth) in this study. To correct for this deficiency, data were interpolated using the spatial kriging function “krig” executed in R using the “fields” package (Furrer et al. 2012). Interpolated KT values were bounded below by the minimum value measured for each of the two cruise datasets; the upper values were left unbounded. This resulted in estimated KT values which preserved the qualitative pattern and range of values previously reported (Jurado et al. 2012a,b), i.e., continuous stratification during the summer STRATIPHYT I cruise and two distinct zones of mixing during the spring STRATIPHYT II cruise; stratification in the south and deep strong mixing in the north. SCAMP data were also used to quantify the strength of background stratification according to the square of the Brunt–Vaisala frequency. N^2 values were depth averaged over the top 100 m of the water column and classified based on the following criteria: N^2<2 x10^-5 rad^2 s^-2 for nonstratified, 2 x 10^-5<N^2<5 x 10-5 rad^2 s^-2 for weakly stratified and N^2>5 x 10^-5 rad^2 s^-2 for strongly stratified. In addition, the depth of the mixed layer (Zm), was determined as the depth at which the temperature difference with respect to the surface was 0.5degC.

Discrete water samples for dissolved inorganic phosphate (PO4), ammonium (NH4), nitrate (NO3), and nitrite (NO2) were gently filtered through 0.2 lm pore size polysulfone Acrodisk filters (32 mm, Pall), after which samples were stored at -20degC until analysis. Dissolved inorganic nutrients were analyzed onboard using a Bran+Luebbe Quaatro Auto- Analyzer for dissolved orthophosphate (Murphy and Riley 1962), inorganic nitrogen (nitrate+nitrite: NOx) (Grasshoff 1983) and ammonium (Koroleff 1969; Helder and De Vries 1979). Detection limits ranged between the two cruises from 0.06-0.10 microM for NOx, 0.010-0.028 microM for PO4 and 0.05-0.09 microM for NH4.

Phytoplankton consisting of photoautotrophic prokaryotic cyanobacteria and eukaryotic algae<20 microns were enumerated on fresh samples using a Becton-Dickinson FACSCalibur flow cytometer (FCM) equipped with an air-cooled Argon laser with an excitation wavelength of 488 nm (15 mW). Samples were measured for 10 min using a high flow rate with the discriminator set on red chlorophyll autofluorescence. Phytoplankton populations were distinguished using bivariate scatter plots of autofluorescent properties (orange autofluorescence from phycoerythrin for the cyanobacteria Synechococcus spp. and red autofluorescence from Chl a for photoautotrophs) against side scatter. The obtained list-mode files were analyzed using the freeware CYTOWIN (Vaulot 1989). Regularly throughout the cruise transect, size-fractionation was performed to provide average cell size for the different phytoplankton subpopulations. Specifically, a whole water sample (10 mL) was size-fractionated by sequential gravity filtration through 8, 5 , 3, 2, 1, 0.8, and 0.4 micron pore-size polycarbonate filters. Each fraction was then analyzed using FCM as described above. The equivalent spherical diameter for each population was determined as the size displayed by the median (50%) number of cells retained for that cluster. In total nine different phytoplankton populations were distinguished, consisting of six eukaryotic and three cyanobacterial populations, i.e., Synechococcus spp. (average size range between the two cruises of 0.9-1.0 micron), Prochlorococcus high light population (HL; 0.6 micron) and

Prochlorococcus low light population (LL; 0.7-0.8 micron). The photosynthetic eukaryotic populations consisted of two pico-sized groups, i.e., Pico I (1.0-1.4 micron) and Pico II (1.5-2.0 micron), and four nano-sized groups, i.e., Nano I (3-4 micron), Nano II (6-8 micron), Nano III (8-9 micron), and Nano IV (9 micron). To estimate the contribution of the different phytoplankton groups to carbon biomass, carbon-conversion factors were applied to FCM cell counts. Specifically, cell counts were transformed assuming spherical diameters equivalent to the average cell size determined from size fractionation and applying conversion factors of 237 fg C per cubic micrometer (Worden et al. 2004) and 196.5 fg C per cubic micrometer for pico- and nano-sized plankton (Garrison et al. 2000), respectively.

Phytoplankton taxonomic composition was determined by pigment analysis of 10 L GF/F filtered samples (47 mm, Whatman; flash frozen and stored at 2808C until analysis) using HPLC as described by Hooker et al. (2009). In short, filters were freeze-dried (48 h) and pigments extracted using 5 mL 90% acetone (v/v, 48 h, 48C, darkness) and separated using a HPLC (Waters 2695 separation module, 996 photodiode array detector) equipped with a Zorbax Eclipse XDB-C8 3.5 micrometer column (Agilent Technologies). Peak identification was based on retention time and diode array spectroscopy. Pigments standards (DHI LAB products) were used for quantification of chlorophyll a1, chlorophyll a2, chlorophyll b, chlorophyll c2, chlorophyll c3, peridinin, 19-butanoyloxyfucoxanthin, 19-hexanoyloxyfucoxanthin, fucoxanthin, neoxanthin, prasinoxanthin, alloxanthin, and zeaxanthin. The sum of Chl a and divinyl Chl a was used as indicator for algal biomass as these pigments are universal in algae and Prochlorococcus. Specific marker pigments were used to reveal the presence of taxonomically distinct pigment signatures using CHEMTAX (version 195; Mackey et al. 1996) software, thereby estimating the concentration of each taxonomic group relative to Chl a. CHEMTAX was run separately for oligotrophic and non-oligotrophic stations and for spring and summer samples. Oligotrophic areas defined by nutrient (i.e., NO30.13 lM and PO40.03 lM; van de Poll et al. 2013) or by Chl a concentrations (< 0.07 mg Chl m-3), delineating regions south of 40degN and 45degN as oligotrophic for the spring and summer, respectively. CHEMTAX was run with 500 iterations, with all elements varied (100% for Chl a and divinyl Chl a and 500% for the other pigments). Initial pigment ratios in the iterations were based on van de Poll et al. (2013), where high-light initial pigment ratios were implemented for surface samples (0-50 m) of oligotrophic stations and low-light initial pigment ratios for subsurface samples (> 50 m) of oligotrophic and all nonoligotrophic samples. To compare to taxonomic composition data provided by CHEMTAX, the percent contribution of different FCM distinguished groups to total carbon biomass (< 20 micron) was also determined. Likewise, Chl a and CHEMTAX taxonomic composition were used to determine the group-specific Chl a concentrations.

Data Processing Description

A detailed description of SCAMP methodology and data for both STRATIPHYT cruises have been described by Jurado et al. (2012a,b). The SCAMP was deployed at fewer stations (i.e., 17 and 14 in spring and summer, respectively) and to lower depths (up to 100 m) than the remainder of the data (23 stations and up to 250 m depth) in this study. To correct for this deficiency, data were interpolated using the spatial kriging function “krig” executed in R using the “fields” package (Furrer et al. 2012). Interpolated KT values were bounded below by the minimum value measured for each of the two cruise datasets; the upper values were left unbounded. This resulted in estimated KT values which preserved the qualitative pattern and range of values previously reported (Jurado et al. 2012a,b), i.e., continuous stratification during the summer STRATIPHYT I cruise and two distinct zones of mixing during the spring STRATIPHYT II cruise; stratification in the south and deep strong mixing in the north.

Flow cytometry list-mode files were analyzed using the freeware CYTOWIN (Vaulot 1989).

Taxonomically distinct pigment signatures identified using CHEMTAX (version 195; Mackey et al. 1996) software

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Related Publications

Garrison, D. L., Gowing, M. M., Hughes, M. P., Campbell, L., Caron, D. A., Dennett, M. R., … Smith, D. C. (2000). Microbial food web structure in the Arabian Sea: a US JGOFS study. Deep Sea Research Part II: Topical Studies in Oceanography, 47(7-8), 1387–1422. doi:10.1016/s0967-0645(99)00148-4 https://doi.org/10.1016/S0967-0645(99)00148-4
Methods

Helder, W., & De Vries, R. T. P. (1979). An automatic phenol-hypochlorite method for the determination of ammonia in sea- and brackish waters. Netherlands Journal of Sea Research, 13(1), 154–160. https://doi.org/10.1016/0077-7579(79)90038-3
Methods

Hooker, S. B., and others. 2009. The third SeaWiFS HPLC analysis round-robin experiment (SeaHARRE-3). NASA technical memorandum 2009-215849, Greenbelt: NASA Goddard Space Flight Center. https://ntrs.nasa.gov/citations/20100018466
Methods

Jurado, E., Dijkstra, H. A., & van der Woerd, H. J. (2012). Microstructure observations during the spring 2011 STRATIPHYT-II cruise in the northeast Atlantic. Ocean Science, 8(6), 945–957. https://doi.org/10.5194/os-8-945-2012
Methods

Jurado, E., van der Woerd, H. J., & Dijkstra, H. A. (2012). Microstructure measurements along a quasi-meridional transect in the northeastern Atlantic Ocean. Journal of Geophysical Research: Oceans, 117(C4). Portico. https://doi.org/10.1029/2011jc007137 https://doi.org/10.1029/2011JC007137
Methods

Koroleff, F. (1970) Revised version of "Direct determination of ammonia in natural waters as indophenol blue, Int. Con. Explor. Sea, C. M. 1969/C:9". ICES Information on Techniques and Methods for Sea Water Analysis Interlab. Rep. No. 3, pp 19-22.
Methods

Mackey, M., Mackey, D., Higgins, H., & Wright, S. (1996). CHEMTAX - a program for estimating class abundances from chemical markers:application to HPLC measurements of phytoplankton. Marine Ecology Progress Series, 144, 265–283. https://doi.org/10.3354/meps144265
Methods

Murphy, J., & Riley, J. P. (1962). A modified single solution method for the determination of phosphate in natural waters. Analytica Chimica Acta, 27, 31–36. doi:10.1016/s0003-2670(00)88444-5
Methods

Nychka, D., Furrer, R., Paige, J., Sain, S., Gerber, F., Iverson, M., & Johnson, R. (2001). fields: Tools for Spatial Data [dataset]. In CRAN: Contributed Packages. The R Foundation. https://doi.org/10.32614/cran.package.fields https://doi.org/10.32614/CRAN.package.fields
Software

Vaulot D. 1997. Another free Cytometry list mode analysis program http://www.cyto.purdue.edu/cdroms/cyto6/content/archive/1997/2438.htm
Methods

Worden, A. Z., Nolan, J. K., & Palenik, B. (2004). Assessing the dynamics and ecology of marine picophytoplankton: The importance of the eukaryotic component. Limnology and Oceanography, 49(1), 168–179. Portico. https://doi.org/10.4319/lo.2004.49.1.0168
Methods

van de Poll, W. H., Kulk, G., Timmermans, K. R., Brussaard, C. P. D., van der Woerd, H. J., Kehoe, M. J., Mojica, K. D. A., Visser, R. J. W., Rozema, P. D., & Buma, A. G. J. (2013). Phytoplankton chlorophyll a biomass, composition, and productivity along a temperature and stratification gradient in the northeast Atlantic Ocean. Biogeosciences, 10(6), 4227–4240. https://doi.org/10.5194/bg-10-4227-2013
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Seabird 91
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	CTD (Seabird 91; standard conductivity, temperature, and pressure sensors)
Generic Instrument Description	A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: http://www.seabird.com/

Dataset-specific Instrument Name	Becton-Dickinson FACSCalibur
Generic Instrument Name	Flow Cytometer
Dataset-specific Description	Photoautotrophic prokaryotic cyanobacteria and eukaryotic algae
Generic Instrument Description	Flow cytometers (FC or FCM) are automated instruments that quantitate properties of single cells, one cell at a time. They can measure cell size, cell granularity, the amounts of cell components such as total DNA, newly synthesized DNA, gene expression as the amount messenger RNA for a particular gene, amounts of specific surface receptors, amounts of intracellular proteins, or transient signalling events in living cells. (from: http://www.bio.umass.edu/micro/immunology/facs542/facswhat.htm)

Dataset-specific Instrument Name	Chelsea Aquatracka Mk III
Generic Instrument Name	Fluorometer
Dataset-specific Description	Auxiliary sensor for chlorophyll autofluorescence (Chelsea Aquatracka Mk III)
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	General Oceanics type Go-Flow, 10 liter
Generic Instrument Name	GO-FLO Bottle
Dataset-specific Description	24 plastic samplers (General Oceanics type Go-Flow, 10 liter) during STRATIPHYT I
Generic Instrument Description	GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Dataset-specific Instrument Name	Waters 2695 separation module, 996 photodiode array detector
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	HPLC (Waters 2695 separation module, 996 photodiode array detector) equipped with a Zorbax Eclipse XDB-C8 3.5 micrometer column (Agilent Technologies)
Generic Instrument Description	A High-performance liquid chromatograph (HPLC) is a type of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of the mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by high pressure pumping of the sample mixture onto a column packed with microspheres coated with the stationary phase. The different components in the mixture pass through the column at different rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase.

Dataset-specific Instrument Name	NIOZ design Pristine Bottles, 27 L
Generic Instrument Name	NIOZ PRISTINE ultraclean water sampler
Dataset-specific Description	Teflon samplers (NIOZ design Pristine Bottles, 27 L) during STRATIPHYT II
Generic Instrument Description	Ultraclean water sampler developed by the Royal Netherlands Institute For Sea Research (NIOZ) for the GEOTRACES Program. Individual sample bottles have a capacity of 27 litres and include butterfly valves that ensure bottles are closed when passing through the ocean surface and reopen subsurface. Teflon valves for subsampling at the base of bottles ensure drainage of settling particulates. Samplers are deployed with a Kevlar hydrowire cable with internal signal cables. A single bottle may be used (e.g. during small boat work) or an array of bottles may be mounted on a frame for shipboard CTD work. Trip mechanisms range from a weighted messenger to trip wires or hydraulics for rosette sampling.

Dataset-specific Instrument Name	Bran+Luebbe Quaatro Auto- Analyzer
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Dissolved inorganic nutrients were analyzed using a Bran+Luebbe Quaatro Auto- Analyzer
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

Dataset-specific Instrument Name	Satlantic
Generic Instrument Name	Photosynthetically Available Radiation Sensor
Dataset-specific Description	photosynthetic active radiation (PAR; Satlantic)
Generic Instrument Description	A PAR sensor measures photosynthetically available (or active) radiation. The sensor measures photon flux density (photons per second per square meter) within the visible wavelength range (typically 400 to 700 nanometers). PAR gives an indication of the total energy available to plants for photosynthesis. This instrument name is used when specific type, make and model are not known.

Dataset-specific Instrument Name	Self Contained Autonomous Microprofiler (SCAMP)
Generic Instrument Name	Precision Measurement Engineering SCAMP microstructure profiler
Dataset-specific Description	Temperature eddy diffusivity (KT) data were derived from temperature and conductivity microstructure profiles measured using the commercial microstructure profiler Self Contained Autonomous Microprofiler (SCAMP)
Generic Instrument Description	A self contained, autonomous microstructure profiler designed to measure extremely small scale (order 1 mm) fluctuations of electrical conductivity, temperature, and chlorophyll concentration in aquatic environments. It has a maximum depth rating of 100 m, a travel rate of 10 cm/s and a sampling rate of 100 Hz. The instrument is powered by internal batteries that allow it to operate continuously for at least 4 hours. The fast conductivity channel uses a PME 4-electrode conductivity microsensor while the standard conductivity channel uses a PME 4-electrode ceramic sensor. The instrument has two available fast temperature channels, each using a Thermometrics FP07 thermistor, and includes a Keller PSI PAA-10 pressure sensor. Two gradient channels are used to store d/dt computations. These data can be used to infer the levels of dissipation of turbulent kinetic energy, in-situ fluxes of heat and salt, and the microstructure behavior of these parameters. The chlorophyll fluorometer consists of a high intense blue LED and a 455 nm interface filter that illuminates a small water sample. Chlorophyll fluorescence is observed through a 685 nm interference filter by a photo diode detector. A Li-Cor LI-192SA PAR sensor can also be attached to the SCAMP. Data are stored on an internal data logger.

Dataset-specific Instrument Name	Wet-Labs C-star
Generic Instrument Name	Transmissometer
Dataset-specific Description	Light transmission
Generic Instrument Description	A transmissometer measures the beam attenuation coefficient of the lightsource over the instrument's path-length. This instrument designation is used when specific manufacturer, make and model are not known.

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Deployments

64PE309

Website	https://www.bco-dmo.org/deployment/955667
Platform	R/V Pelagia
Start Date	2009-07-15
End Date	2009-08-11

64PE334

Website	https://www.bco-dmo.org/deployment/955670
Platform	R/V Pelagia
Start Date	2011-04-06
End Date	2011-05-03

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Project Information

Changes in vertical stratification and their impact on phytoplankton communities (STRATIPHYT)

Website: https://www.nwo.nl/en/projects/83908420

NWO Award Abstract:

Global warming will change physical, chemical and biological processes in the oceans. Ocean-climate models predict that warming of the surface layer may strengthen vertical stratification, starting earlier in spring and lasting longer in autumn. This results in suppressed upward mixing of nutrients from the deep ocean. Changes in stratification will have major effects on the growth and species composition of the phytoplankton. This will subsequently impact grazing, viral lysis and sedimentation rates, with cascading effects on ecosystem functioning and biogeochemical fluxes. Little is known, however, on the exact implications of global warming for these fundamental processes. We propose to investigate how changes in vertical stratification affect phytoplankton communities (growth, losses and composition) along a North-South gradient in the Atlantic Ocean. Our study will be based on oceanographic cruises from Iceland to the Canary Islands and detailed

laboratory experiments with representative phytoplankton species, both integrated in advanced models of hydrodynamics and plankton dynamics and productivity. We have chosen for the Northeast Atlantic Ocean, because it is a key area in global ocean circulation and a large sink for atmospheric CO2, and a major determinant of the climate in Western Europe. Furthermore, the Atlantic Ocean offers a gradient from weak seasonal stratification in the North to strong permanent stratification in the (sub)tropics. This gradient offers ideal opportunities for the comparative study of different stratification regimes. Our integrated approach of physical, chemical, and biological processes, by a new multidisciplinary research team, will enable a better understanding of the implications of global warming for plankton growth in the Northeast Atlantic Ocean.

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Funding

Funding Source	Award
Netherlands Organization of Scientific Research (NWO, The Hague, The Netherlands)	ZKO-grant 839.08.420

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