Synthesis Product for Ocean Time Series (SPOTS)

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Project
» EarthCube RCN for Marine Ecological Time Series (METS) (METS RCN)
» Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans (EuroSea)

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Abstract
The presented time-series data synthesis pilot product includes data from 12 fixed ship-based time-series programs. The related stations represent unique marine environments within the Atlantic Ocean, Pacific Ocean, Mediterranean Sea, Nordic Seas, and Caribbean Sea. The focus of the pilot has been placed on biogeochemical essential ocean variables: dissolved oxygen, dissolved inorganic nutrients, inorganic carbon (pH, total alkalinity, dissolved inorganic carbon, and partial pressure of CO2), particulate matter, and dissolved organic carbon. The time-series used include a variety of temporal resolutions (monthly, seasonal, or irregular), time ranges (10 to

36 years), and bottom depths (80 to 6000 meters), with the oldest samples dating back to 1983 and the most recent one corresponding to 2021. Besides having been harmonized into the same format (semantics, ancillary data, units), the data were subjected to a qualitative assessment in which the applied methods were evaluated and categorized. Additional data-quality descriptors include precision and accuracy estimates. This data product pilot facilitates a variety of applications that benefit from the collective value of biogeochemical time-series observations and forms the basis for a sustained time-series living data product, complementing relevant products for the global interior ocean carbon data (GLobal Ocean Data Analysis Project), global surface ocean carbon data (Surface Ocean CO2 Atlas; SOCAT), and global interior and surface methane and nitrous oxide data (MarinE MethanE and NiTrous Oxide product).

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Coverage

Spatial Extent: **N**:68.0167 **E**:-12.608 **S**:-45.7794 **W**:7.8667
Temporal Extent: 1983-03-05 - 2021-07-30

Dataset Description

This time-series data synthesis pilot product includes data from 12 fixed ship-based time-series programs with a focus on biogeochemical essential ocean variables. Data used in this synthesis product were made possible with funding through the following:

- EU Horizon 2020 through the EuroSea Innovation Action (grant agreement 862626)
- EU Horizon 2020 iAtlantic programme (grant agreement 818123)
- European Union’s Horizon 2020 research and innovation program (grant agreement 820989; COMFORT).
- WASCAL MRP-CCMS project from the German Federal Ministry of Education and Research (BMBF; grant agreement no. 01LG1805A).
- National Science Foundation (OCE-1259043, OCE-175651, and RISE-2028291).
- Norwegian Environment Agency under grant agreement nos. 14078029, 15078033, 16078007, 17018007, and 21087110.
- Grant-in-Aid for Scientific Research (20H04349) from the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) KAKENHI.
- Mediterranean Ocean Observing System for the Environment program (MOOSE) coordinated by CNRS-INSU and the Research Infrastructure ILICO (CNRS-IFREMER).
- The European projects CARBOOCEAN, CARBOCHANGE, SESAME, PERSEUS and COMFORT
- The Spanish Ministry of Science through the grants CTM2005/01091-MAR and CTM2008-05680-C02-01 and the Junta de Andalucía through the TECADE project (PY20_00293)
- Centro Nacional Instituto Español de Oceanografía (IEO-CSIC)

Methods & Sampling

Oceanographic data from twelve fixed ship-based time-series programs were synthesized into a pilot product with focus on biogeochemical essential ocean variables (BGC-EOV). Measurements of dissolved oxygen,

dissolved inorganic nutrients, inorganic carbon (pH, TALK, DIC, pCO2), particulate matter, and DOC were compiled from the time series programs listed below.

Methods, Sampling, and Instruments are dependent on individual time-series programs, and often vary within a single time series program from cruise-to-cruise.

Instruments are listed in the section below, with detailed metadata available at ODIS (https://oceaninfohub.org/odis/).
Additional details may be found by viewing the related datasets and publications sections below.

Time-Series Programs
Listed according to ocean/sea location, details include time series program; PIs; start/end dates (of dataset); measurement frequency; location; depth
Pacific
ALOHA: Angelicque White; 1988-2019; monthly; 22.8°N 158.0°W, Subtropical eastern North Pacific (4750m)
K2: Masahide Wakita; 1999-2020; 1-3 cruises yr-1; 47.0°N 160.0°E, Subarctic western North Pacific (6000m)
KNOT: Masahide Wakita; 1997-2020; 1-3 cruises yr-1; 44.0°N 155.0°E, Subarctic western North Pacific (6000m)
Munida: Kim Currie; 1998-2019; 6 cruises yr-1; 45.8°S 171.5°E, Southwest Pacific (1000m)
Atlantic
CVOO: Björn Fiedler; 2006-2019; 1-3 cruises yr-1; 17.6°N 24.3°W, Eastern tropical North Atlantic (3600m)
GIFT: Emma Huertas; 2005-2015; seasonal; 35.9°N 6.0°W / 35.9°N 5.7°W / 36.0°N 5.3°W, Strait of Gibraltar (315– 842m)
RADCOR: Marta Álvarez; 2013 - 2020; monthly; 43.4°N 8.4°E, Eastern Atlantic along NW Galician coast (15-80 m)
Nordic Seas
Irminger Sea time-series: Sólveig Rósa; seasonal; 1983 - 2019; 64.3°N 28.0°W, Irminger Sea (1000m)
Iceland Sea time-series: Sólveig Rósa; seasonal; 1983 - 2019; 68.0°N 12.7°W, Iceland Sea (1850m)
OWSM: Ingunn Skjelvan; 2001 - 2021; 4-12 cruises yr-1; 66.0°N 2.0°E, Norwegian Sea (2100m)
Marginal Seas
CARIACO: Frank Muller-Karger; 1995 - 2017; monthly; 10.5°N 64.7°W, Cariaco Basin of the Caribbean Sea (1300m)
DYFAMED: Laurent Coppola; 1991 - 2017; monthly; 42.3°N 7.5°E, Mediterranean/Ligurian Sea (2400m)

Glossary

- ALOHA = A Long-term Oligotrophic Habitat Assessment
- BP = Best Practices
- CARIACO = CArbon Retention In A Colored Ocean
- CARINA = CARbon IN the Atlantic
- CVOO = Cape Verde Ocean Observatory
- DOC = Dissolved Organic Carbon
- DYFAMED = DYnamique des Flux Atmospheriques en MEDiterranee (atmospheric flux dynamics in the Mediterranean)
- EOV = Essential Ocean Variables
- GLODAP = GLobal Ocean Data Analysis Project
- GIFT = GIbraltar Fixed Time-series
- HOT = Hawaii Ocean Time-series
- K2 = time series station in the North Pacific Ocean near both the Kamchatka peninsula and Kunashiri Island
- KNOT = Kyodo North Pacific Ocean Time-Series
- ODIS = Ocean Data and Information System
- OIH = Ocean Info Hub
- OWSM = Ocean Weather Station M
- PC = Particulate Carbon
- PN = Particulate Nitrogen
- POC = Particulate Organic Carbon
- PON = Particulate Organic Nitrogen
- QC = Quality Control
- RADIALES = Estudio de las series históricas de datos oceanográficos (RADIALES is one of the longest multidisciplinary programs in operation in the northern and northwestern coast of Spain)
- RADCOR = RADIALES A Coruña (the A Coruña section is part of the broader RADIALES time series

program)
- SOP = Standard Operating Procedures
- WOCE = World Ocean Circulation Experiment

Data Processing Description

The data from the 12 participating time-series programs were retrieved from data centers or directly obtained from the responsible principal investigator. In the latter case, merging, formatting, additional quality-control (QC), and archiving of existing data were carried out. Only bottle data for BGC EOVs (Biogeochemical Essential Ocean Variables) that had been measured by at least two of the participating programs were included in the pilot project, along with accompanying ancillary pressure, salinity, and temperature data. The product was created by standardizing data format, units, header names, primary QC flags, times, locations, and fill values and subsequently merging the individual datasets of each time-series program into one file. Only data that received a WOCE quality flag 2 were included in the product. Existing data were altered as little as possible without interpolation or calculation of “missing” variables. Similarly, original station-, cast- and bottle numbers were kept or created artificially if non-existent to ensure consistency. The headers, units, and flags of the individual time-series datasets were standardized to conform with the WOCE exchange bottle data format (Swift and Diggs, 2008).

The standardization process entailed unit conversions, most frequently from micromoles per liter (µmol L-1; nutrients and dissolved organic carbon (DOC)) or from micrograms per kilogram (µg kg-1; particulate matter) to micromoles per kilogram of seawater (µmol kg-1). The default procedure to convert from volumetric to gravimetric units was to use seawater density at in-situ salinity, reported laboratory temperature (otherwise assuming 20°C as laboratory conditions), and pressure of 1 atm (following recommendations from Liqing et al., 2022). For some time-series datasets, the combined concentration of nitrate and nitrite was reported. If explicit nitrite concentrations were provided, these were subtracted to obtain the nitrate values. If not, the combined concentration was renamed to nitrate assuming that the relative nitrite amount is negligible. For the HOT program specifically, low-level, high-sensitivity measurements of macronutrients (phosphate and nitrate) were available but not included in the pilot product. Particulate organic matter was derived by subtracting the particulate inorganic matter from the total particulate matter, if available. For particulate carbon (PC) and particulate nitrogen (PN), the factors 1/12.01 and 1/14.01 (inverse standard atomic masses) were used, respectively, for the unit conversion to micromoles per kilogram. If neither temperature nor pressure was provided, all corresponding data entries were excluded from the product. The potential density anomaly is the only calculated variable. Missing and excluded values were set to -999.

The information on the applied methods of each time-series program, was evaluated against, ideally, published Best Practices (BPs), and otherwise known standard operating procedures (SOPs). “SOP Flags” were assigned accordingly to each cruise of a time-series program (Lange et al., 2023). Precision (duplicate measurements) and accuracy (deviation from reference material) estimates, as provided by each time-series program’s primary quality-assurance procedure, were assigned to the bottle data. The temporal resolution of these estimates varies from estimates given for each cruise, i.e. on a cruise-to-cruise basis, to estimates given for longer time periods (covering multiple cruises) without recorded changes in applied methodology.

When additional quality control was necessary, various methods, packages, and tools were used: CANYON-B is a Bayesian neural network mapping that accurately reproduces GLODAPv2 bottle data and the biogeochemical relations contained therein (Bittig et al., 2018); AtlantOS Ocean Data QC software is an interactive tool for quality control of hydrographic cruise data (Velo et al., 2021); the work of Tanhua et al. (2010) provided rigorous quality control procedures to assure the highest possible quality and consistency. The QC was used to identify outliers and obvious errors, as well as to quantify systematic differences in reported values using crossover analysis (Lauvset & Tanhua, 2015).

Problems, Issues, Notes:
1st QC flags W bottle flags
2 = No problems noted
9 = encompasses WOCE flags 3, 4, 5, 7, 8, and 9 (samples not drawn, questionable or bad data)

"SOP flags" (Standard Operating Procedures)
1 = Methods meet required and desired Standard Operating Procedures
2 = Methods meet required Standard Operating Procedures
3 = Methods do not meet Standard Operating Procedures

BCO-DMO Processing Description

- Imported data from source file "spots.csv" into the BCO-DMO data system; kept missing data identifier of -999
- Ensured parameter/field/column names conformed with BCO-DMO naming conventions
- Rounded values to precision indicated by the PI
- Created glossary of metadata terms
- Converted Supplemental 'Product Variables' file to CSV and added NERC term URL links

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Data Files

File
Synthesis Product for Ocean Time Series (SPOTS) filename: spots.csv (Comma Separated Values (.csv), 52.67 MB) MD5:9588652d4298713f145c84ec7a5d8e67 Primary data file for dataset ID 896862, version 2

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Supplemental Files

File
Synthesis_timeline_granular_metadata.pdf (Portable Document Format (.pdf), 328.77 KB) MD5:85bb9470a2016845b81fcef376cf4a2b Figure of timeline showing the importance of granular level metadata for time series
Table1_ProductVariables_v2.csv (Comma Separated Values (.csv), 7.64 KB) MD5:9f649b8cc90a33b0198623a83accefa9 Table 1: Synthesis product variables with term matches to ontologies

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Related Publications

Bittig, H. C., Steinhoff, T., Claustre, H., Fiedler, B., Williams, N. L., Sauzède, R., Körtzinger, A., & 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. https://doi.org/10.3389/fmars.2018.00328
Methods

Flecha, S., Pérez, F. F., Murata, A., Makaoui, A., & Huertas, I. E. (2019). Decadal acidification in Atlantic and Mediterranean water masses exchanging at the Strait of Gibraltar. Scientific Reports, 9(1). https://doi.org/10.1038/s41598-019-52084-x
Related Research

Jiang, L.-Q., Pierrot, D., Wanninkhof, R., Feely, R. A., Tilbrook, B., Alin, S., Barbero, L., Byrne, R. H., Carter, B. R., Dickson, A. G., Gattuso, J.-P., Greeley, D., Hoppema, M., Humphreys, M. P., Karstensen, J., Lange, N., Lauvset, S. K., Lewis, E. R., Olsen, A., … Xue, L. (2022). Best Practice Data Standards for Discrete Chemical Oceanographic Observations. Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.705638
Methods

Karl, D. M., & Church, M. J. (2018). Station ALOHA: A Gathering Place for Discovery, Education, and Scientific Collaboration. Limnology and Oceanography Bulletin, 28(1), 10–12. Portico. https://doi.org/10.1002/lob.10285
Related Research

Lange, N., Fiedler, B., Álvarez, M., Benoit-Cattin, A., Benway, H., Buttigieg, P. L., Coppola, L., Currie, K., Flecha, S., Honda, M., Huertas, I. E., Lauvset, S. K., Muller-Karger, F., Körtzinger, A., O'Brien, K. M., Ólafsdóttir, S. R., Pacheco, F. C., Rueda-Roa, D., Skjelvan, I., … Tanhua, T. (2023). Synthesis Product for Ocean Time-Series (SPOTS) – A ship-based biogeochemical pilot. https://doi.org/10.5194/essd-2023-238
Results
,
Methods

Lauvset, S. K., & Tanhua, T. (2015). A toolbox for secondary quality control on ocean chemistry and hydrographic data. Limnology and Oceanography: Methods, 13(11), 601–608. Portico. https://doi.org/10.1002/lom3.10050
Methods

Muller-Karger, F. E., Astor, Y. M., Benitez-Nelson, C. R., Buck, K. N., Fanning, K. A., Lorenzoni, L., Montes, E., Rueda-Roa, D. T., Scranton, M. I., Tappa, E., Taylor, G. T., Thunell, R. C., Troccoli, L., & Varela, R. (2019). The Scientific Legacy of the CARIACO Ocean Time-Series Program. Annual Review of Marine Science, 11(1), 413–437. https://doi.org/10.1146/annurev-marine-010318-095150
Related Research

Olafsson, J., Olafsdottir, S. R., Benoit-Cattin, A., & Takahashi, T. (2010). The Irminger Sea and the Iceland Sea time series measurements of sea water carbon and nutrient chemistry 1983–2008. Earth System Science Data, 2(1), 99–104. https://doi.org/10.5194/essd-2-99-2010
Related Research

Skjelvan, I., Falck, E., Rey, F., & Kringstad, S. B. (2008). Inorganic carbon time series at Ocean Weather Station M in the Norwegian Sea. Biogeosciences, 5(2), 549–560. https://doi.org/10.5194/bg-5-549-2008
Related Research

Skjelvan, I., Lauvset, S. K., Johannessen, T., Gundersen, K., & Skagseth, Ø. (2022). Decadal trends in Ocean Acidification from the Ocean Weather Station M in the Norwegian Sea. Journal of Marine Systems, 234, 103775. https://doi.org/10.1016/j.jmarsys.2022.103775
Related Research

Swift, J.H. and Diggs, S.C. (2008) Description of WHP-Exchange Format for CTD/Hydrographic Data. CLIVAR and Carbon Hydrographic Data Office, UCSD Scripps Institution of Oceanography, 19pp.
Methods

Tanhua, T., van Heuven, S., Key, R. M., Velo, A., Olsen, A., & Schirnick, C. (2010). Quality control procedures and methods of the CARINA database. Earth System Science Data, 2(1), 35–49. https://doi.org/10.5194/essd-2-35-2010
Methods

Valdés, L., Bode, A., Latasa, M., Nogueira, E., Somavilla, R., Varela, M. M., González-Pola, C., & Casas, G. (2021). Three decades of continuous ocean observations in North Atlantic Spanish waters: The RADIALES time series project, context, achievements and challenges. Progress in Oceanography, 198, 102671. https://doi.org/10.1016/j.pocean.2021.102671
Related Research

Velo, A., Cacabelos, J., Lange, N., Perez, F. F., & Tanhua, T. (2021). Ocean Data QC: Software package for quality control of hydrographic sections (Version v1.4.0) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.4532402 https://doi.org/10.5281/zenodo.4532402
Software

Wakita, M., Nagano, A., Fujiki, T., & Watanabe, S. (2017). Slow acidification of the winter mixed layer in the subarctic western North Pacific. Journal of Geophysical Research: Oceans, 122(8), 6923–6935. Portico. https://doi.org/10.1002/2017jc013002 https://doi.org/10.1002/2017JC013002
Related Research

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Related Datasets

IsDerivedFrom

Coppola, L., Diamond Riquier, E., Carval, T., Irisson, J.-O., & Desnos, C. (2023). Dyfamed observatory data [Data set]. SEANOE. https://doi.org/10.17882/43749

Huertas, I. E., Flecha, S., & Pérez, F. F. (2020). *GIFT database (2005-2015): Hydrographic and carbon system parameters in the Strait of Gibraltar* [Data set]. DIGITAL.CSIC. https://doi.org/10.20350/DIGITALCSIC/10549 https://doi.org/10.20350/digitalCSIC/10549

Huertas, I. E., Flecha, S., Otero, J., & Álvarez-Salgado, X. A. (2020). *Dissolved organic carbon in the water column of the Strait of Gibraltar over 2008-2015: database generated at the GIFT (Gibraltar Fixed Time Series)* [Data set]. DIGITAL.CSIC. https://doi.org/10.20350/DIGITALCSIC/12499 https://doi.org/10.20350/digitalCSIC/12499

Karl, D. (2018) **Niskin bottle water samples and CTD measurements from the Hawaii Ocean Time-Series cruises from 1988-2016 (HOT project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2018-04-18 doi:10.1575/1912/bco-dmo.3773.1 [view at BCO-DMO]
Relationship Description: HOT Station ALOHA data was used in the compilation for the time-series data synthesis product

Lange, N. (2023). *Ship-based CVOO biogeochemical bottle dataset 2006-2019* [Data set]. PANGAEA. https://doi.pangaea.de/10.1594/PANGAEA.958597 (in review)

Muller-Karger, F., Astor, Y., Scranton, M., Taylor, G., Thunell, R., Varela, R., Benitez-Nelson, C., Buck, K., Fanning, K., Capelo, J., Gutierrez, J., Guzman, L., Lorenzoni, L., Montes, E., Rojas, J., Rondon, A., Rueda-Roa, D., Tappa, E. (2019) **Time-series Niskin-bottle sample data from R/V Hermano Gines cruises in the Cariaco Basin from 1995 through 2017 (CARIACO Ocean Time-Series Program).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2019-06-06 doi:10.1575/1912/bco-dmo.3093.1 [view at BCO-DMO]
Relationship Description: CARIACO Ocean Time Series data was used in the compilation for the time-series data synthesis product

Skjelvan, I. (2013). Dissolved inorganic carbon, alkalinity, and associated variables collected from Ocean Weather Station M (OWSM) at 66° N, 2° E in the Norwegian Sea from 2001-10-31 to 2021-07-30 (NCEI Accession 0112884) [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.3334/CDIAC/OTG_TSM_OWS_M_66N_2E https://doi.org/10.3334/cdiac/otg_tsm_ows_m_66n_2e

Wakita, M., Watanabe, S., Murata, A., & Honda, M. (2012). *Carbon dioxide, temperature, salinity and other variables collected via time series profile monitoring from Kairei, MIRAI and NATSUSHIMA in the North Pacific Ocean from 1999-05-28 to 2008-10-26 (NCEI Accession 0100115)* [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.25921/MPFZ-SV16 https://doi.org/10.25921/mpfz-sv16

Wakita, M., Watanabe, S., Murata, A., Honda, M., & Tsurushima, N. (2012). *Dissolved inorganic carbon, total alkalinity, temperature, salinity and other variables collected via time series monitoring from BOSEI MARU NO. 2, HAKUREI MARU and others in the North Pacific Ocean from 1992-06-23 to 2008-10-31 (NCEI Accession 0100219)* [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.25921/TARQ-6V91 https://doi.org/10.25921/tarq-6v91

Ólafsdóttir, S. R., Benoit-Cattin, A., & Danielsen, M. (2020). *Dissolved inorganic carbon (DIC), total alkalinity, temperature, salinity, nutrients and dissolved oxygen collected from discrete samples and profile observations during the R/Vs Arni Fridriksson and Bjarni Saemundsson Irminger Sea (FX9) time series cruises in the North Atlantic Ocean in from 2014-02-11 to 2022-08-09 (NCEI Accession 0209072)* [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.25921/VJMY-8H90 https://doi.org/10.25921/vjmy-8h90

Ólafsdóttir, S. R., Benoit-Cattin, A., & Danielsen, M. (2020). *Dissolved inorganic carbon (DIC), total alkalinity, temperature, salinity, nutrients and dissolved oxygen collected from discrete samples and profile observations during the R/Vs Arni Fridriksson and Bjarni Saemundsson time series IcelandSea (LN6) cruises in the North Atlantic Ocean from 2014-02-18 to 2022-08-16 (NCEI Accession 0209074)* [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.25921/QHED-3H84 https://doi.org/10.25921/qhed-3h84

Ólafsson, J. (2012). *Partial pressure (or fugacity) of carbon dioxide, dissolved inorganic carbon, temperature, salinity and other variables collected from discrete samples, profile and time series profile observations during the R/Vs Arni Fridriksson and Bjarni Saemundsson time series IcelandSea (LN6) cruises in the North Atlantic Ocean from 1985-02-22 to 2013-11-26 (NCEI Accession 0100063)* [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.3334/CDIAC/OTG.CARINA_ICELANDSEA https://doi.org/10.3334/cdiac/otg.carina_icelandsea

Ólafsson, J. (2016). *Partial pressure (or fugacity) of carbon dioxide, dissolved inorganic carbon, temperature, salinity and other variables collected from discrete sample and profile observations using CTD, bottle and other instruments from ARNI FRIDRIKSSON and BJARNI SAEMUNDSSON in the North Atlantic Ocean from 1983-03-*

05 to 2013-11-13 (NCEI Accession 0149098) [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.3334/CDIAC/OTG.CARINA_IRMINGERSEA_V2
https://doi.org/10.3334/cdiac/otg.carina_irmingersea_v2

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Parameters

Parameter	Description	Units
TimeSeriesSite	Time-Series Site unique identifier	unitless
CRUISE	Cruise identifier	unitless
STNNBR	Station number	unitless
CASTNO	Cast number	unitless
BTLNBR	Bottle number	unitless
DATE	Date in yyyymmdd	unitless
TIME	Time (UTC) in hhmm	unitless
LATITUDE	Latitude	decimal degrees
LONGITUDE	Longitude	decimal degrees
CTDPRS	Depth of sample in decibar from CTD pressure measurement	decibar (dbar)
SIGMA0	Sigma theta potential density anomaly referenced to 0 dbar	kilogram per cubic meter (kg/m3)
CTDTMP	Temperature of sample (ITS-90) from CTD	degrees Celsius (ITS-90)
CTDSAL	Sensor Salinity: Salinity (PSS-78) from CTD sensor	Practical Salinity Units (PSU)
CTDSAL_FLAG_W	Sensor Salinity: WOCE bottle quality flag	unitless
CTDOXY	Sensor Oxygen: Oxygen from CTD sensor	micromole per kilogram (umol/kg)
CTDOXY_FLAG_W	Sensor Oxygen: WOCE bottle quality flag	unitless
SALNTY	Bottle Salinity (PSS-78)	Practical Salinity Units (PSU)
SALNTY_FLAG_W	Bottle Salinity: WOCE bottle quality flag	unitless
SALNTY_SOPf	Bottle Salinity: Method flag	unitless
SALNTY_P	Bottle Salinity: Precision	Practical Salinity Units (PSU)
SALNTY_A	Bottle Salinity: Accuracy	Practical Salinity Units (PSU)
OXYGEN	Bottle Oxygen	micromole per kilogram (umol/kg)
OXYGEN_FLAG_W	Bottle Oxygen: WOCE bottle quality flag	unitless
OXYGEN_SOPf	Bottle Oxygen: Method flag	unitless
OXYGEN_P	Bottle Oxygen: Precision	micromole per kilogram (umol/kg)
OXYGEN_A	Bottle Oxygen: Accuracy	micromole per kilogram (umol/kg)
NITRAT	Nitrate (or nitrate + nitrite)	micromole per kilogram (umol/kg)
NITRAT_FLAG_W	Nitrate: WOCE bottle quality flag	unitless
NITRAT_SOPf	Nitrate: Method flag	unitless

NITRAT_P	Nitrate: Precision	micromole per kilogram (umol/kg)
NITRAT_A	Nitrate: Accuracy	micromole per kilogram (umol/kg)
NITRIT	Nitrite	micromole per kilogram (umol/kg)
NITRIT_FLAG_W	Nitrite: WOCE bottle quality flag	unitless
NITRIT_SOPf	Nitrite: Method flag	unitless
NITRIT_P	Nitrite: Precision	micromole per kilogram (umol/kg)
NITRIT_A	Nitrite: Accuracy	micromole per kilogram (umol/kg)
PHSPHT	Phosphate	micromole per kilogram (umol/kg)
PHSPHT_FLAG_W	Phosphate: WOCE bottle quality flag	unitless
PHSPHT_SOPf	Phosphate: Method flag	unitless
PHSPHT_P	Phosphate: Precision	micromole per kilogram (umol/kg)
PHSPHT_A	Phosphate: Accuracy	micromole per kilogram (umol/kg)
SILCAT	Silicate	micromole per kilogram (umol/kg)
SILCAT_FLAG_W	Silicate: WOCE bottle quality flag	unitless
SILCAT_SOPf	Silicate: Method flag	unitless
SILCAT_P	Silicate: Precision	micromole per kilogram (umol/kg)
SILCAT_A	Silicate: Accuracy	micromole per kilogram (umol/kg)
NH4	Ammonium	micromole per kilogram (umol/kg)
NH4_FLAG_W	Ammonium: WOCE bottle quality flag	unitless
NH4_SOPf	Ammonium: Method flag	unitless
NH4_P	Ammonium: Precision	micromole per kilogram (umol/kg)
NH4_A	Ammonium: Accuracy	micromole per kilogram (umol/kg)
TCARBN	Dissolved Inorganic Carbon	micromole per kilogram (umol/kg)
TCARBN_FLAG_W	Dissolved Inorganic Carbon: WOCE bottle quality flag	unitless
TCARBN_SOPf	Dissolved Inorganic Carbon: Method flag	unitless
TCARBN_P	Dissolved Inorganic Carbon: Precision	micromole per kilogram (umol/kg)
TCARBN_A	Dissolved Inorganic Carbon: Accuracy	micromole per kilogram (umol/kg)
ALKALI	Alkalinity	micromole per kilogram (umol/kg)
ALKALI_FLAG_W	Alkalinity: WOCE bottle quality flag	unitless

ALKALI_SOPf	Alkalinity: Method flag	unitless
ALKALI_P	Alkalinity: Precision	micromole per kilogram (umol/kg)
ALKALI_A	Alkalinity: Accuracy	micromole per kilogram (umol/kg)
PH_TOT	pH (total scale at 25 degrees Celsius and 0 decibar)	unitless
PH_TOT_FLAG_W	pH: WOCE bottle quality flag	unitless
PH_TMP	Temperature of the pH measurements	unitless
PH_TOT_SOPf	pH: Method flag	unitless
PH_TOT_P	pH: Precision	unitless
PH_TOT_A	pH: Accuracy	unitless
PCO2	Partial Pressure of CO2 (carbon dioxide)	microatmospheres (uatm)
PCO2_FLAG_W	Partial Pressure of CO2: WOCE bottle quality flag	unitless
PCO2_TMP	Partial Pressure of CO2: Temperature	degrees Celsius
PCO2_SOPf	Partial Pressure of CO2: Method flag	unitless
PCO2_P	Partial Pressure of CO2: Precision	microatmospheres (uatm)
PCO2_A	Partial Pressure of CO2: Accuracy	microatmospheres (uatm)
TPC	Particulate (organic or total) Carbon	micromole per kilogram (umol/kg)
TPC_FLAG_W	Particulate Carbon: WOCE bottle quality flag	unitless
TPC_SOPf	Particulate Carbon: Method flag	unitless
TPC_P	Particulate Carbon: Precision	micromole per kilogram (umol/kg)
TPC_A	Particulate Carbon: Accuracy	micromole per kilogram (umol/kg)
TPN	Particulate (organic or total) Nitrogen	micromole per kilogram (umol/kg)
TPN_FLAG_W	Particulate Nitrogen: WOCE bottle quality flag	unitless
TPN_SOPf	Particulate Nitrogen: Method flag	unitless
TPN_P	Particulate Nitrogen: Precision	micromole per kilogram (umol/kg)
TPN_A	Particulate Nitrogen: Accuracy	micromole per kilogram (umol/kg)
TPP	Particulate (organic or total) Phosphorus	micromole per kilogram (umol/kg)
TPP_FLAG_W	Particulate Phosphorus: WOCE bottle quality flag	unitless
TPP_SOPf	Particulate Phosphorus: Method flag	unitless
TPP_P	Particulate Phosphorus: Precision	micromole per kilogram (umol/kg)
TPP_A	Particulate Phosphorus: Accuracy	micromole per kilogram (umol/kg)
POC	Organic Particulate Carbon	micromole per kilogram (umol/kg)
POC_FLAG_W	Organic Particulate Carbon: WOCE Bottle Quality Flag	unitless
POC_SOPf	Organic Particulate Carbon: Method Flag	unitless

POC_P	Organic Particulate Carbon: Precision	micromole per kilogram (umol/kg)
POC_A	Organic Particulate Carbon: Accuracy	micromole per kilogram (umol/kg)
PON	Organic Particulate Nitrogen	micromole per kilogram (umol/kg)
PON_FLAG_W	Organic Particulate Nitrogen: WOCE bottle quality flag	unitless
PON_SOPf	Organic Particulate Nitrogen: Method flag	unitless
PON_P	Organic Particulate Nitrogen: Precision	micromole per kilogram (umol/kg)
PON_A	Organic Particulate Nitrogen: Accuracy	micromole per kilogram (umol/kg)
POP	Organic Particulate Phosphorus	micromole per kilogram (umol/kg)
POP_FLAG_W	Organic Particulate Phosphorus: WOCE bottle quality flag	unitless
POP_SOPf	Organic Particulate Phosphorus: Method flag	unitless
POP_P	Organic Particulate Phosphorus: Precision	micromole per kilogram (umol/kg)
POP_A	Organic Particulate Phosphorus: Accuracy	micromole per kilogram (umol/kg)
DOC	Dissolved Organic Carbon	micromole per kilogram (umol/kg)
DOC_FLAG_W	Dissolved Organic Carbon: WOCE bottle quality flag	unitless
DOC_SOPf	Dissolved Organic Carbon: Method flag	unitless
DOC_P	Dissolved Organic Carbon: Precision	micromole per kilogram (umol/kg)
DOC_A	Dissolved Organic Carbon: Accuracy	micromole per kilogram (umol/kg)
DOI	DOI (digital object identifier) for the source of the data values	unitless

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Instruments

Dataset-specific Instrument Name	Titration instruments
Generic Instrument Name	Automatic titrator
Dataset-specific Description	Metrohm OMNIS Titrator used by HOT & RADCOR for Oxygen measurements Tritrino Winkler used by DYFAMED for Oxygen measurements Metrohm Titrando Dual Titrator used by HOT for Oxygen measurements Dosimat 665 used by HOT for Oxygen measurements VINDTA (3S) used by CVOO and OWSM for Total Alkalinity measurements Metrohm 794 used by GIFT for Total Alkalinity measurements
Generic Instrument Description	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

Dataset-specific Instrument Name	Sea Bird Temperature Sensors
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	Seabird SBE 3P used by HOT & CVOO Seabird SBE 19P used by Munida Seabird SBE 25 used by Munida Seabird SBE 3 used by CARIACO Seabird 911+ used by K2 & KNOT Seabird 35 used by RADCOR Seabird 38 used by Munida Seabird 45 used by Munida Seabird 21 used by Munida Seabird 19 used by Munida
Generic Instrument Description	Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics, no specific unit identified. This instrument designation is used when specific make and model are not known. See also other SeaBird instruments listed under CTD. More information from Sea-Bird Electronics.

Dataset-specific Instrument Name	Elemental analyzer
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Orion EA 940 Analyzer used by HOT & DYFAMED for Total Alkalinity measurements Perkin Elmer 2400 Elemental Analyzer used by CARIACO for PIC and PON measurements Exeter Analytical CE-440 CHN used by HOT for POC and PON measurements
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	DIC instrument
Generic Instrument Name	Inorganic Carbon Analyzer
Dataset-specific Description	Marianda Company VINDTA 3D system used by RADCOR and OWSM UIC, Inc. inorganic carbon analyzer used by K2 and KNOT SOMMA system coupled to coulometer used by HOT and CVOO Coulometrics CM-5010 used by Irminger & Iceland Seas TS Coulometrics Model CM-5011 used by Irminger & Iceland Seas TS SOMMA system at NIWA (New Zealand) used by Munida
Generic Instrument Description	Instruments measuring carbonate in sediments and inorganic carbon (including DIC) in the water column.

Dataset-specific Instrument Name	Niskin bottle
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	Nutrient Analyzers
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Technicon Autoanalyzer II used by CARIACO, HOT, Irminger Sea TS, and Iceland Sea TS Luebbe Autoanalyzer III used by HOT and RADCOR SEAL Analytical QuAAtro Autoanalyser used by CVOO, K2, KNOT, and RADCOR Seal Analytical AutoAnalyser 3HR used by DYFAMED Seal Analytical AutoAnalyser AA used by HOT Continuous Flow analyser (not further specified) used by CVOO Skalar San Plus System used by CVOO and OWSM BL TEC K.K.used by K2, KNOT Alpkem RFA 300 used by HOT and OWSM Chemlab three channel autoanalyzer used by Irminger Sea and Iceland Sea TS. SkalarSan ++215 used by GIFT Manual analysis performed by CARIACO
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	Dissolved Oxygen Sensor
Generic Instrument Name	Oxygen Sensor
Dataset-specific Description	Seabird SBE43 used for CVOO & DYFAMED Seabird SBE 13 used for HOT RINKOIII used for DYFAMED
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Salinity Sensor
Generic Instrument Name	Salinity Sensor
Dataset-specific Description	Seabird SBE 4 used by HOT, CARIACO, CVOO & DYFAMED Seabird SBE 21 used by Munida Seabird SBE 35 used by RADCOR Seabird SBE 19P used by Munida Seabird SBE 16 used by Munida Seabird SBE 2 used by CVOO
Generic Instrument Description	Category of instrument that simultaneously measures electrical conductivity and temperature in the water column to provide temperature and salinity data.

Dataset-specific Instrument Name	Salinometer
Generic Instrument Name	Salinometer
Dataset-specific Description	AGE model 2100 Minisal salinometer used by HOT Guildline Portasal 8410 salinometer used by CARIACO Guildline 8400 bench salinometer used by HOT, CVOO, K2, KNOT, Irminger & Iceland Sea TS. OPTIMARE Precision salinometer OPS-20 used by CVOO PorterSal salinomters used by OWSM
Generic Instrument Description	A salinometer is a device designed to measure the salinity, or dissolved salt content, of a solution.

Dataset-specific Instrument Name	Spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	seapHox Ocean pH sensor (Satlantic/Sea-Bird Scientific) used by DYFAMED Ocean Optics S1000 used by CARIACO Spectrophotometer (not further specified) used by HOT, DYFAMED, RADCOR Combination electrode (not further specified) used by HOT Shimadzu UV-2401PC used by GIFT
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	Total Organic Carbon Analyzer
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	Shimadzu TOC-V used by HOT for DOC measurements Shimadzu TOC-L used by CARIACO for DOC measurements
Generic Instrument Description	A unit that accurately determines the carbon concentrations of organic compounds typically by detecting and measuring its combustion product (CO2). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/bs116.pdf

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Project Information

EarthCube RCN for Marine Ecological Time Series (METS) (METS RCN)

Website: https://www2.whoi.edu/site/mets-rcn/

Coverage: global

NSF Award Abstract:

This project will support coordination efforts that bring together participants in large- and small group formats to foster the necessary dialog to develop Findable, Accessible, Interoperable, and Reusable (FAIR) data solutions and practices. The project will include a Consensus Building Workshop and METS Data Working Group to develop reference implementations of a data model for adoption by the METS community; formation of regional METS user networks and a Broadening Users Workshop to identify the needs of a broader range of data end users and associated data interfaces and tools to meet those needs; and a Data Hackathon to build capacity to ingest, analyze, and integrate METS data with other disciplinary and cross-disciplinary data to accelerate scientific discovery.

This project will develop community consensus for a FAIR METS data model. The METS RCN will leverage the wealth of oceanographic coordination and community building experience and staff capacity of the Ocean Carbon and Biogeochemistry (OCB) Project Office and the infrastructure, expertise, and extensive METS data handling experience of the Biological and Chemical Oceanography Data Management Office (BCO-DMO), along with an RCN Steering Committee that comprises expertise in the fields of oceanography, data science, earth system models, statistics, and data synthesis.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans (EuroSea)

Website: https://cordis.europa.eu/project/id/862626

Project description
An integrated observation system for sustainable ocean management
Our oceans are a vital source of wealth, but ocean monitoring systems are inadequate and lower management capacity. Scientists agree that oceans need an observation system coordinated at an international level. The EU-funded EuroSea project aims to coordinate a wide range of European actors towards integrating national systems for an international observation system. The project will advance a system that will collect ocean information data important for blue growth and sustainable ocean management. It will advance technology readiness levels (TRLs) of crucial components required for ocean observation systems and improve international coordination of ocean monitoring to ensure ocean health and optimal resource utilisation.

Objective
Although the Ocean is a fundamental part of the global system providing a wealth of resources, there are fundamental gaps in ocean observing and forecasting systems, limiting the capacity in Europe to sustainably manage the ocean and its resources. Ocean observing is “big science” and cannot be solved by individual nations; it is necessary to ensure high-level integration for coordinated observations of the ocean that can be sustained in the long term. EuroSea brings together key European actors of ocean observation and forecasting with key end users of ocean observations, responding to the Future of the Seas and Oceans Flagship Initiative. Our vision is a truly interdisciplinary ocean observing system that delivers the essential ocean information needed for the wellbeing, blue growth and sustainable management of the ocean. EuroSea will strengthen the European and Global Ocean Observing System (EOOS and GOOS) and support its partners. EuroSea will increase the technology readiness levels (TRL) of critical components of ocean observations systems and tools, and in particular the TRL of the integrated ocean observing system. EuroSea will improve: European and international coordination; design of the observing system adapted to European needs; in situ observing networks; data delivery; integration of remote and in-situ data; and forecasting capability. EuroSea will work towards integrating individual observing elements to an integrated observing system, and will connect end-users with the operators of the observing system and information providers. EuroSea will demonstrate the utility of the European Ocean Observing System through three demonstration activities focused on operational services, ocean health and climate, where a dialogue between actors in the ocean observing system will guide the development of the services, including market replication and innovation supporting the development of the blue economy.

Project DOI: 10.3030/862626

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National Science Foundation (NSF)	RISE-2028291
European Commission Horizon 2020 Framework Programme (H2020 - 2014-2020)	H2020-862626

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