Copernicus Marine In Situ NetCDF Format Manual

Version 1.43

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History of the document

Version	Date	Comment
1.0	02/04/2019	TC: initialization of the document based on OceanSITES Marine In Situ user's manual
1.4	31/03/2020	Manual and Copernicus In Situ TAC NetCDF format use the same version: 1.4 §1.2 about this document: add "note on versions", "notes on version updates" §1.2 about this document: add "note on format validity" §2 data format: add "Note on format version" §2 data format: add "Note on format validity" §2.2 global attributes: document site_code (OceanSITES specific) §2.2 global attributes: document « contact » §2.2 global attributes: update Conventions §2.2 global attributes: use ISO8601 update intervals §2.2 global attributes: doi syntax: use URI §2.2 global attributes: document Distribution statement §2.2 global attributes: document pi_name §2.2 global attributes: document wmo_inst_type §2.2 global attributes: All global attributes are mandatory §2.3.1 coordinate variables: Z may be non monotonic §2.3.1 coordinate variables: position dimension may be 1 for fixed platforms §2.3.1 coordinate variables: no fill_value for time, latitude, longitude §2.3.1 coordinate variables: qc_indicator is deprecated (valid but will disappear) §2.3.1 coordinate variables: add ancillary_variables attribute §2.3.1 coordinate variables: add calendar attribute §2.3.2 coordinate variables: typo on conventions and FillValue attributes §2.3.3 data variables: add DEPTH missing dimension §2.3.3 data variables: document sensor_depth, sensor_mount, sensor_orientation, data_mode variables §2.3.4 data variables: "Fill values conventions" new chapter §3.1.10 global attributes: Last observation global attribute exception for HF-radar §3.1.13 global attributes: "Update interval of the file" new chapter §3.1.4 global attributes: institution and institution_edmo_code separators §3.1.6 global attributes: Conventions update §3.2 data mode: "Data mode: real-time, delayed mode data" new chapter §3.3 seadatanet: "SeaDataNet station identifier" chapter removed §3.6 parameters: "In situ TAC parameters" typo corrections §3.8 reference tables: Update variable data mode §4.1 hf radar: "Conventions for HF radar" new chapter §4.2 wave spectra: "Convention for wave spectral data" new chapter §4.3 vessel adcp: "Conventions for ADCP observations" new chapter §5.3 reference tables: add "conversion methods" tables §5.3 reference tables: add cdm_data_type reference table §7 abbreviations: "Abbreviations" new chapter
1.41	20/10/2020	§2.2 Conventions manual 1.41 and parameters list 3.2.0 §2.3 *_QC:long_name : add the variable name in the long name §2.3.2 Coordinate quality control variables : all attributes are mandatory §4.1.1 add REFMAX dimension for HF radar §5.1 add "A" real time data with adjusted values in reference table 1 §5.3 additional conversion method codes §5.5 add CO and TX data types in reference table 5
1.42	31/03/2021	§2.2 the attributes not listed in bold may have an empty fill value ("") §2.2 revisit "title" global attribute description §2.3.1 "uncertainty" coordinate variable attribute is not mandatory. §4.2.5 §5.2 update flag 6 from "not used" to "value below detection" (EMODnet chemistry) §2.3.3 If the value of an attribute is not known, then the attribute is omitted (no fill value for attribute). §3.1.5 Conventions global attribute updated "Copernicus-InSituTAC-FormatManual-1.42" §3.2 TEMP_DM example flag_meanings typo correction §5.5 add "MBT profiles" to XB data type
1.43	11/04/2023	§2.2 add global attribute "license" §2.2 "citation" replace "collection" by "collation" §2.2 "citation" comment clarification §2.2 "citation" mention EMODnet §2.2 "distribution_statement" remove "User must contact PI prior to any commercial use of data"

		§3.1.1 add data_type "wave-spectra data" §3.1.5 Conventions global attribute updated "CF-1.6 Copernicus-InSituTAC-FormatManual-1.43 Copernicus-InSituTAC-SRD-1.6 Copernicus-InSituTAC-ParametersList-3.2.1" §5.4 add cdm_data_type trajectoryProfile §5.5 revisit "TS" data type to include general ship underway data §2.3.1 add a note on missing sensor elevation

1 Copernicus Marine In Situ data-management principles

1.1 About Copernicus Marine In Situ

Copernicus Marine In Situ aggregates operational oceanography data and metadata for EU Copernicus service and the broader scientific community.

1.2 About this document

This document specifies the NetCDF file format of Copernicus Marine In Situ TAC used to distribute ocean In Situ data and metadata. It documents the standards used herein; this includes naming conventions as well as metadata content. It was initiated in March 2019, based on OceanSITES and Argo user's manuals.

Note on versions

Since April 2019, the Copernicus Marine In Situ Format valid versions are 1.2, 1.3 and 1.4.

The version is the combination of 3 elements:

- Major version: 1
- Minor version: 4
- Revision: March 2020

“Major version” increase will be performed whenever a considerable amount of modifications in the format are carried out (group of many changes or very important change in the structure of the NetCDF). A double dissemination period will then be required.

“Minor version” increase will be performed when changes in the format are made: new global attributes, changes in names of variables / attributes, optional attributes becoming mandatory and the other way around, etc. This could involve a double dissemination period, although a request for change or an announcement to the users should suffice..

The Copernicus Marine In Situ NetCDF Format Manual may be updated with clarifications, recommendations, additional optional attributes without changing the data format version. To track these changes it will be used the “Revision” in terms of month and year of publishing.

In case of bugs having an impact on the NetCDF format and requiring a quick fix, a third number as a patch release could be used, e.g., 1.4.1 April 2020.

Note on version updates

In order to assure the stability of the format version, a maximum of one new minor version will be released every 6 months and a major version every 2 years, only when required.

Note on format validity

Copernicus Marine In Situ TAC format files are validated by the file format checker §1.7 “Useful links, tools: Copernicus Marine In Situ file format checker”

A NetCDF file is valid if the mandatory attributes, parameters, variables are specified following the rules described in this manual.

Additional attributes, parameters or variables present in a file but not described in this manual are permitted; they will not invalidate the file format.

1.3 Copernicus Marine In Situ data management structure and data access

The data flow within Copernicus Marine In Situ is carried out by 7 regional Production Units.

The **Production Unit (PU)** assembles and quality controls Copernicus Marine In Situ-compliant files from observation networks (such as Argo, OceanSITES, GTS) and delivers these to the Copernicus **Distribution Unit (DU)**, where they are made publicly available.

The **DU** distributes the best copy of the data files. When a higher quality data file (such as calibrated data) is available, it replaces the previous version of the data file.

1.4 User Obligations

- A user of Copernicus In Situ data is expected to read and understand this manual and the documentation about the data contained in the “attributes” of the NetCDF data files which contain essential information about data quality and accuracy.
- A user of Copernicus data must comply with the requirements set forth in the attributes “distribution_statement” and “citation” of the NetCDF data files.
- A user must acknowledge use of data aggregated by Copernicus in all publications and products where such data are used, as documented in §3.1.2 “Citation, distribution statement” .

1.5 Disclaimer

Copernicus Marine In Situ data are published without any warranty, express or implied.

The user assumes all risk arising from his/her use of Copernicus Marine In Situ data.

Copernicus Marine In Situ data are intended to be research-quality and include estimates of data quality and accuracy, but it is possible that these estimates or the data themselves contain errors.

It is the sole responsibility of the user to assess if the data are appropriate for his/her use, and to interpret the data, data quality, and data accuracy accordingly.

Copernicus Marine In Situ welcomes users to ask questions and report problems to the contact addresses listed in the data files or on the Copernicus Marine In Situ internet page.

1.6 Further Information Sources and Contact Information

- Copernicus Marine In Situ website: www.marineinsitu.eu
- Copernicus Marine service : marine.copernicus.eu

1.7 Useful links, tools

Copernicus Marine In Situ file format checker

The Copernicus Marine In Situ file format checker is a java software freely available at:

NetCDF file format checker for Copernicus In Situ TAC https://doi.org/10.17882/45538

2 Copernicus NetCDF data format version 1.4

Copernicus Marine In Situ uses the NetCDF (Network Common Data Form) system, a set of software libraries and machine-independent data formats. Our implementation of NetCDF is based on the community-supported Climate and Forecast (CF) specification, which supplies a standard vocabulary and some metadata conventions.

Copernicus Marine In Situ layers several more conventions above the CF standard. These are intended to make it easier to share in-situ data, to make it simpler for the Distribution Unit to aggregate data from multiple sites, and to ensure that the data can be created and understood by the basic NetCDF utilities.

- Copernicus Marine In Situ includes standard terms for the short name of both coordinate and data variables (measurements).
- File names are created using a standard, described in chapter "File naming conventions".

A Copernicus Marine In Situ data file contains measurements such as temperature and salinity, continuously performed at different levels on a marine platform with x, y, z, t coordinates (location and time).

The requirements are drawn almost exclusively from the NetCDF Style Guide:

- Units are compliant with CF/COARDS/UDUNITS;
- The time parameter is encoded as recommended by COARDS and CF;
- Parameters are given standard names from the CF table;
- Where time is specified as an attribute, the ISO8601 standard is used.

For more information on NetCDF, UDUNITS, COARDS, CF and ISO8601 see:

- NetCDF: https://www.unidata.ucar.edu/software/netcdf/docs/index.html
- CF: http://cfconventions.org
- UDUNITS: http://www.unidata.ucar.edu/software/udunits/
- COARDS: https://ferret.pmel.noaa.gov/Ferret/documentation/coards-netcdf-conventions
- ISO8601: http://en.wikipedia.org/wiki/ISO_8601

2.1 Dimensions

NetCDF dimensions provide information on the size of the data variables and additionally tie coordinate variables to data. CF recommends that if any or all of the dimensions of a variable have the interpretations of "date or time" (T), "height or depth" (Z), "latitude" (Y), or "longitude" (X) then those dimensions should appear in the relative order T, Z, Y, X in the variable's definition (in the CDL).

There is no "unlimited" dimension in the Copernicus In Situ NetCDF format.

Name	Example	Comment
TIME	TIME=365	Number of time steps. Example: for a mooring with one value per day and a mission length of one year, TIME contains 365 time steps.
DEPTH	DEPTH=5	Number of depth levels. Example: for a mooring with measurements at nominal depths of 0.25, 10, 50, 100 and 200 meters, DEPTH=5.

LATITUDE	LATITUDE= 365	Dimension of the LATITUDE coordinate variable.
LONGITUDE	LONGITUDE=365	Dimension of the LONGITUDE coordinate variable.
POSITION	POSITION=365	Dimension of the POSITION_QC variable

2.2 Global attributes

The global attribute section of a NetCDF file describes the contents of the file overall and allows for data discovery. All fields should be human-readable and use units that are easy to understand (e.g. time_coverage_start should be in days, for a file that spans across more than a month). Copernicus Marine In Situ recommends the usage of all of these attributes which should contain meaningful information, unless there are technical reasons rendering this impossible. Attributes used by our data inventory system are required and are listed in bold type.

Global attribute names are case sensitive.

Attributes are organized by function: Discovery and identification, Geo-spatial-temporal, Conventions used, Publication information, and Provenance. Attributes that are part of the Attribute Convention for Data Discovery (ACDD) or Climate and Forecast (CF) standard, or those that appear in the NetCDF Users Guide (NUG) are so indicated, as are those that are used by GDAC inventory software.

Each global attribute listed below is mandatory. Additional global attributes are allowed. **The attributes listed in bold must have a valid content. The attributes not listed in bold may have an empty fill value (“”).**

Discovery and identification		
platform_code	platform_code=”44087”	The unique platform code within Copernicus In Situ TAC .
platform_name	platform_name = "Varna"	The human readable name of the platform.
data_mode	data_mode=”R”	Indicates if the file contains real-time, delayed-mode or mixed data. See §3.2 Data mode: real-time, delayed-mode data
title	title=”Global Ocean - In Situ Observation Copernicus”	The dataset title as mentioned in Copernicus Product Information Table.
summary	summary=”Oceanographic mooring data from CIS observatory in the Central Irminger Sea, 2005. Measured properties: temperature and salinity at ten depth levels.”	Longer free-format text describing the dataset. This attribute should allow data discovery for a human reader. A paragraph of up to 100 words is recommended.
naming_ authority	naming_authority=”Copernicus Marine In Situ”	The organization that manages data set names.
id	id=”GL_TS_MO_44087_20190409”	The “id” and “naming_authority” attributes are intended to provide a globally unique identification for each dataset. The id is the file name without the .nc suffix, which is designed to be unique.
wmo_platform_code	wmo_platform_code=”44087”	WMO (World Meteorological Organization) identifier for the platform
ices_platform_code	ices_platform_code = "35A3"	It contains the platform code assigned by ICES (International Council for the Exploration of the Sea).
source	source=”moored surface buoy”	SeaVoX-SeaDataNet platform categories L06 label

source_platform_category_code	source_platform_category_code =”41”	SeaVoX-SeaDataNet platform categories L06 code
institution_edmo_code	institution_edmo_code = "3511"	SeaDataNet EDMO code of the platform’s institution (blank separated list)
institution	institution=”Euskalmet: Basque Meteorological Agency (Spain)”	Name of the platform’s institution (semicolon separated list)
institution_references	institution_references = "http://www.euskalmet.euskadi.eus"	The references of the platform’s institution (blank separated list)
site_code	site_code=”SATS” (OceanSITES specific)	Name of the site within OceanSITES project. The site codes are available on GDAC ftp servers. Example: “SATS” for Santander Atlantic Time-Series Station
comment	comment=”Provisional data”	Miscellaneous information about the data or methods used to produce it. Any free-format text is appropriate.
contact	contact = "data.centre@socib.es cmems-service@ifremer.fr"	The contact emails for questions or feedback on the dataset (blank separated list) • institution’s contacts : if available and relevant • In Situ TAC service desk, **mandatory**
Geo-spatial-temporal		
area	area=”North Atlantic Ocean”	Geographical coverage. Try to compose of the following: North/Tropical/South Atlantic/Pacific/Indian Ocean, Southern Ocean, Arctic Ocean.
geospatial_lat_min	geospatial_lat_min=”59.8”	The southernmost latitude, a value between -90 and 90 degrees; may be string.
geospatial_lat_max	geospatial_lat_max=”59.8”	The northernmost latitude, a value between -90 and 90 degrees.
geospatial_lon_min	geospatial_lon_min=”-41.2”	The westernmost longitude, a value between -180 and 180 degrees.
geospatial_lon_max	geospatial_lon_max=”-41.2”	The easternmost longitude, a value between -180 and 180 degrees. (ACDD, GDAC)
geospatial_vertical_min	geospatial_vertical_min=”10.0”	Minimum depth or height of measurements.
geospatial_vertical_max	geospatial_vertical_max=”2000”	Maximum depth or height of measurements.
time_coverage_start	time_coverage_start=”2006-03-01T00:00:00Z”	Start date of the data in UTC. See note on time format below.
time_coverage_end	time_coverage_end=”2006-03-05T23:59:29Z”	Final date of the data in UTC. See note on time format below.
cdm_data_type	cdm_data_type=”trajectory”	The Unidata CDM (common data model) The accepted values are documented in reference table 4. (timeSeries, trajectory, trajectoryProfile, profile, grid)
data_type	data_type=”OceanSITES time-series data”	A vocabulary driven type of data. See §3.1.1 data_type
bottom_depth	bottom_depth=”37”	See 3.1.13 Bottom depth
Conventions used		
format_version	format_version=”1.4”	Copernicus In Situ NetCDF format version
Conventions	Conventions=”CF-1.6 Copernicus-InSituTAC-FormatManual-1.43 Copernicus-InSituTAC-SRD-1.6 Copernicus-InSituTAC-ParametersList-3.2.1”	Name of the conventions followed by the dataset (blank separated list).

netcdf_version	netcdf_version="netCDF-4 classic model"	NetCDF version of this file, from ncdump –k command
Publication information		
references	references="http://marine.copernicus.eu http://www.marineinsitu.eu"	Published or web-based references that describe the data or methods used to produce it (blank separated list). "http://marine.copernicus.eu http://www.marineinsitu.eu" are mandatory. Additional references may be added.
data_assembly_center	data_assembly_center="Puertos del Estado"	Data Assembly Center (DAC) in charge of this data file. The accepted values are documented in 3.1.9 Data assembly center global attribute.
update_interval	update_interval="P1D"	Update interval for the file. Use ISO 8601 Interval format: PnYnMnDTnHnM where elements that are 0 may be omitted. Examples: • Hourly → "PT1H" • Daily → "P1D" • Monthly → "P1M" Use "void" for data that are not updated on a schedule.
citation	citation="These data were collated within the Copernicus Marine Service (In Situ) and EMODnet collaboration framework. Data is made freely available by the Copernicus Marine Service and the programs that contribute to it."	The citation to be used in publications using the dataset; should include a reference to Copernicus Marine service but may contain any additional text deemed appropriate by the PI and DAC.
distribution_statement	distribution_statement="These data follow Copernicus standards; they are public and free of charge. User assumes all risk for use of data. User must display citation in any publication or product using data."	Statement describing data distribution policy.
doi	doi="https://doi.org/10.48670/moi-00036 https://doi.org/10.13155/59938 https://doi.org/10.13155/40846 https://doi.org/10.13155/53381 https://doi.org/10.13155/36230 https://doi.org/10.13155/43494 "	DOIs (Digital Object Identifier) related to data aggregated in this file. Use the DOI URI -Universal Resource Identifier (blank separated list). The list includes the DOI of the Copernicus product description (example: https://doi.org/10.48670/moi-00036)
license	license="https://marine.copernicus.eu/user-corner/service-commitments-and-licence"	The license is a legal arrangement between the depositor of the dataset (the licensee) and the data repository (Copernicus Marine service), signifying what a user is allowed to do with the dataset.
pi_name	pi_name="Marta de Alfonso"	Name of the principal investigator in charge of the platform (semicolon separated list).
qc_manual	qc_manual="Recommendations for in-situ data Near Real Time Quality Control https://doi.org/10.13155/36230 "	This field contains the name of the manual that describes the quality control procedure. There are documents for WAVES REP and BGC also.
Provenance		
date_update	date_update="2019-04-09T04:34:14Z"	The date on which this file was last updated.
history	history= "2019-04-09T04:34:14Z Creation"	Provides an audit trail for modifications to the original data. It should contain a separate line for each modification, with each line beginning with a timestamp, and including user name, modification name, and

		modification arguments. The time stamp should follow the format outlined in the note on time formats below.
last_date_observation	last_date_observation = "2019-04-09T03:00:00Z"	The last valid observation date and position.
last_latitude_observation	last_latitude_observation = "37.02600"	The last valid observation date and position.
last_longitude_observation	last_longitude_observation = "-76.15100"	The last valid observation date and position.
wmo_inst_type	wmo_inst_type = "830";	If available, the WMO instrument type is recorded in the global attribute section of the NetCDF file. The WMO code is available only for vertical profiles.

Note on time formats

Whenever time information is given in the global attributes, it ought to be a string of the format:

"YYYY-MM-DDThh:mm:ssZ" (i.e. year - month - day T hour : minute : second Z)

If higher resolution than seconds is needed, any number of decimal digits (“.s”) for the seconds is acceptable:

"YYYY-MM-DDThh:mm:ss.sZ"

In any case, the time must be in UTC. A capital “T” separates the date and the hour information. The string must end with a capital “Z”, an old indication of UTC. These formats are two (of many) described by ISO8601.

Examples

- 2005-10-24T08:00:00Z
- 2008-01-01T22:50:02.031Z

Note on lists separators in global attributes

The default separator is blank “ “

Exception : use the semicolon “;” for string having possible blank letters content

- i.e institution

Note on global attributes used in index files

Commas are not allowed in the values of these attributes and therefore have to be replaced with hyphens (-).

2.3 Variables

NetCDF variables include data measured by instruments, parameters derived from the primary measurements and coordinate variables, which may be nominal values, such as values for depth for instruments that do not directly record depth. Each variable has a specific set of attributes, some of which are mandatory.

The mandatory variables or attributes are in bold characters in the following tables.

2.3.1 Coordinate variables

The coordinate variables guide data in time and space. For this purpose, they have an “axis” attribute

defining that they point in X, Y, Z, and T dimensions.

Default values are not allowed in coordinate variables apart from Z axis (check Management of vertical axis).

Note on monotony

The TIME and vertical axis variables are strictly monotonic.

The LATITUDE and LONGITUDE variables are **not** monotonic (In Situ observations are scattered in the ocean).

Each observation is located in time, latitude, longitude and Z (vertical dimensions, e.g. immersion, sea water pressure):

- The LATITUDE,LONGITUDE and POSITION dimensions have the same length as the TIME dimension, or they may have length 1 when the position of the platform is fixed.
- The Z axis may be represented as pressure, if, for example pressure is recorded directly by an instrument and the calculation of depth from pressure would cause a loss of information. Depth is strongly preferred, since it allows data to be used more directly.

Regarding coordinates variables, all attributes in the next table except "comment", "uncertainty" and "QC_indicator" are mandatory.

Note on QC_indicator

The use of "QC_indicator'' is deprecated. We recommend not use it. It will disappear in the next format release.

Type, name, dimension, attributes	Comment
double **TIME**(TIME); TIME:long_name = "Time" ; TIME:standard_name= "time" ; TIME:units = "days since 1950-01-01T00:00:00Z" ; TIME:valid_min = -90000. ; TIME:valid_max = 90000. ; TIME:QC_indicator = 1 ; TIME:uncertainty = " " ; TIME:comment = " " ; TIME:axis = "T" ; TIME:ancillary_variables = "TIME_QC"; TIME:calendar= "standard";	Time of the measurement in days since noon, 1950-01-01. calendar: standard gregorian calendar (see http://cfconventions.org/cf-conventions/cf-conventions.html#calendar)
float **LATITUDE**(LATITUDE); LATITUDE:long_name = "Latitude of each location" ; LATITUDE:standard_name = "latitude" ; LATITUDE:units = "degree_north" ; LATITUDE:valid_min = -90. ; LATITUDE:valid_max = 90. ; LATITUDE:QC_indicator = 1 ; LATITUDE:uncertainty = " " ; LATITUDE:comment = " " ; LATITUDE:axis = "Y" ; LATITUDE:ancillary_variables = "POSITION_QC";	Latitude of the measurements. Units: degrees north; southern latitudes are negative.
float **LONGITUDE**(LONGITUDE); LONGITUDE:long_name = "Longitude of each location" ; LONGITUDE:standard_name = "longitude" ; LONGITUDE:units = "degree_east" ; LONGITUDE:valid_min = -180. ; LONGITUDE:valid_max = 180. ; LONGITUDE:QC_indicator = 1 ; LONGITUDE:uncertainty = " " ; LONGITUDE:comment = " " ; LONGITUDE:axis = "X" ; LONGITUDE:ancillary_variables = "POSITION_QC";	Longitude of the measurements. Unit: degrees east; western longitudes are negative.

float **DEPH**(TIME, DEPTH); DEPH:long_name = "Depth" ; DEPH:standard_name = "depth" ; DEPH:_FillValue = NC_FILL_FLOAT ; DEPH:units = "m" ; DEPH:positive = "down" ; DEPH:valid_min = -12000. ; DEPH:valid_max = 12000. ; DEPH:uncertainty = " " ; DEPH:comment = " " ; DEPH:axis = "Z" ; DEPH:reference = "sea_level" ; DEPH:data_mode = <X>; DEPH:ancillary_variables = "DEPH_QC";	Depth of the measurements. Mandatory when PRES as z axis is not defined.
float **PRES**(TIME, DEPTH); PRES:long_name = "Sea pressure" ; PRES:standard_name = "sea_water_pressure" ; PRES:_FillValue = NC_FILL_FLOAT ; PRES:units = "dbar" ; PRES:uncertainty = " " ; PRES:comment = " " ; PRES:axis = "Z" ; PRES:positive = "down" ; PRES:data_mode = <X>; PRES:ancillary_variables = "PRES_QC";	Sea water pressure of the measurements. Mandatory when DEPH as z axis is not defined (profiles).

Note on latitude and longitude WGS84 datum

The latitude and longitude datum is WGS84. This is the default output of GPS systems.

Copernicus Marine In Situ uses the EPSG coordinate reference system to describe geographical positions; the coordinate reference frame corresponding to WGS84 is : "urn:ogc:crs:EPSG::4326".

More on EPSG : http://www.epsg.org/

Note on TIME

By default, the time word represents the center of the data sample or averaging period.

Management of vertical axis: DEPH or PRES

There is a unique vertical axis within each file, either DEPH (ex. drifting buoys), or PRES (ex: floats). The vertical axis variable has the attribute axis="Z" and positive="down".

DEPH provides the distance from sea level in meters either provided by sensors or as nominal values, while PRES contains values measured by a sensor in dBar, both corresponding to the levels where measurements were recorded by the platform.

Vertical axis is suggested to be provided as follows:

- Time series data

  Only DEPH can be used as a vertical axis. In this case DEPH contains at each time step a list of all possible levels (nominal or not) where the sensors are recording within the file. This list is the same in all time steps with no fill_values. DEPTH dimension is equal to the maximum number of levels (total). The PRES variable if present is just another variable providing measurements wherever a sensor is recording pressure to the respective DEPH level. DEPH is strictly monotonic.

- Profiles data

  PRES or DEPH can be used as vertical axis (one or the other, but not neither nor both). The vertical axis contains at each time step the list of the levels, which provide measurements at the specific time step. This list may vary for each time step. Due to this variation, the

maximum length of a profile is used as DEPTH dimension. Thus, the vertical axis variable may contain fill values at the end of each profile. If PRES is the vertical axis, DEPH may be available too as any other variable and vice versa. The vertical axis variable should not contain empty profiles - thus fill values only. The vertical axis is strictly monotonic.

When no direct pressure or depth observation is performed, the depth estimation can be a nominal value or a convention. The estimated depth is stored in the DEPH variable, its associated QC flag is set to 7 (nominal value).

Examples of estimated depths

- The depth of a thermosalinograph fitted at 5 meters deep on a vessel: DEPH = 5 DEPH_QC=7
- The depth of a thermistor fitted at 50 meters deep on a mooring cable: DEPH=50 DEPH_QC=7
- The depth of a sealevel station set to 0 meter deep by convention: DEPH = 0 DEPH_QC=7

Note: When an atmospheric sensor elevation (altitude) is not known, the rule is to report DEPH with _FillValue and QC 9.

Data file with no valid or missing time or position

A file with no valid (or missing) time or no valid position is not distributed on Copernicus In Situ TAC.

A valid time has a TIME_QC variable set to 1, 2, 5, 7 or 8 (good, probably good, value changed, nominal, interpolated).

A valid position has a POSITION_QC variable set to 1, 2, 5, 7 or 8 (good, probably good, value changed, nominal, interpolated).

Example of coordinate variables

```
double TIME(TIME) ;
        TIME:long_name = "Time" ;
        TIME:standard_name = "time" ;
        TIME:units = "days since 1950-01-01T00:00:00Z" ;
        TIME:valid_min = -90000. ;
        TIME:valid_max = 90000. ;
        TIME:uncertainty = " " ;
        TIME:axis = "T" ;
        TIME:ancillary_variables = "TIME_QC";
        TIME:calendar= "standard";
float LATITUDE(LATITUDE) ;
        LATITUDE:long_name = "Latitude of each location" ;
        LATITUDE:standard_name = "latitude" ;
        LATITUDE:units = "degree_north" ;
        LATITUDE:valid_min = -90. ;
        LATITUDE:valid_max = 90. ;
        LATITUDE:uncertainty = " " ;
        LATITUDE:axis = "Y" ;
        LATITUDE:ancillary_variables = "POSITION_QC";
float LONGITUDE(LONGITUDE) ;
        LONGITUDE:long_name = "Longitude of each location" ;
        LONGITUDE:standard_name = "longitude" ;
        LONGITUDE:units = "degree_east" ;
        LONGITUDE:valid_min = -180. ;
        LONGITUDE:valid_max = 180. ;
        LONGITUDE:uncertainty = " " ;
        LONGITUDE:axis = "X" ;
        LONGITUDE:ancillary_variables = "POSITION_QC";
float DEPH(TIME, DEPTH) ;
        DEPH:long_name = "Depth" ;
        DEPH:standard_name = "depth" ;
        DEPH:_FillValue = 9.96921e+36f ;
        DEPH:units = "m" ;
        DEPH:positive = "down" ;
```

DEPH:valid_min = -12000. ;
DEPH:valid_max = 12000. ;
DEPH:uncertainty = " " ;
DEPH:axis = "Z" ;
DEPH:reference = "sea_level" ;
DEPH:data_mode = "R";
DEPH:ancillary_variables = "DEPH_QC";

2.3.2 Coordinate quality control variables

The coordinate variables have the same quality control variables as the data variables. If the quality control values are constant, the information is given in attributes of the coordinate variables. For details, see <PARAM>_QC in the section on data variables, and the note on quality control therein.

All attributes described in this section are mandatory

Type, name, dimension, attributes	Comment
byte **TIME_QC**(TIME); TIME_QC:long_name = "Time quality flag" ; TIME_QC:conventions = "Copernicus Marine In Situ reference table 2" ; TIME_QC:_FillValue = -127b ; TIME_QC:valid_min = 0b ; TIME_QC:valid_max = 9b ; TIME_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ; TIME_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;	Quality flag for each TIME value.
byte **POSITION_QC**(POSITION) POSITION_QC:long_name = "Position quality flag" ; POSITION_QC:conventions = "Copernicus Marine In Situ reference table 2" ; POSITION_QC:_FillValue = -127b ; POSITION_QC:valid_min = 0b ; POSITION_QC:valid_max = 9b ; POSITION_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ; POSITION_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;	Quality flag for each LATITUDE and LONGITUDE value.
byte **DEPH_QC**(TIME, DEPTH) ; DEPH_QC:long_name = "Depth quality flag" ; DEPH_QC:conventions = "Copernicus Marine In Situ reference table 2" ; DEPH_QC:_FillValue = -127b ; DEPH_QC:valid_min = 0b ; DEPH_QC:valid_max = 9b ; DEPH_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ; DEPH_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;	Depth quality flags
byte **PRES_QC**(TIME, DEPTH) ; PRES_QC:long_name = "Sea pressure quality flag" ; PRES_QC:conventions = "Copernicus Marine In Situ reference table 2" ; PRES_QC:_FillValue = -127b ; PRES_QC:valid_min = 0b ; PRES_QC:valid_max = 9b ; PRES_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ; PRES_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;	Pressure quality flags

2.3.3 Data variables, physical parameters

Data variables contain the actual measurements and indicators about their quality, uncertainty, and mode through which they were obtained. There are different options as to how the indicators are specified, whether in attributes or separate variables, which are outlined in the notes below the table.

The physical parameters variables are standardized in “Copernicus Marine In Situ TAC - physical parameters list. https://doi.org/10.13155/53381”

See 3.5 In Situ TAC parameters.

The attributes in **bold font** are mandatory; the others are optional.

If the value of an attribute is not known, then the attribute is omitted (no fill value for attribute).

Type, name, dimension, attributes	Comment
int <PARAM>(TIME, DEPTH); <PARAM>:**standard_name** = <X>; <PARAM>:**units** = <X>; <PARAM>:**_FillValue** = <X>; <PARAM>:**add_offset** = <X> ; <PARAM>:**scale_factor** = <X> ; <PARAM>:**long_name** = <X>; <PARAM>:valid_min = <X>; <PARAM>:valid_max = <X>; <PARAM>:comment = <X>; <PARAM>:uncertainty = <X>; <PARAM>:accuracy = <X>; <PARAM>:precision = <X>; <PARAM>:resolution = <X>; <PARAM>:cell_methods = <X>; <PARAM>:**coordinates** = “TIME LATITUDE LONGITUDE <X>”; <PARAM>:type_of_analysis = <X>; <PARAM>:sensor_depth = <X>; <PARAM>:sensor_mount = <X>; <PARAM>:sensor_orientation = <X>; <PARAM>:**data_mode** = <X>; <PARAM>:ancillary_variables = “<PARAM>_QC <PARAM>_DM”;	<PARAM> names and attributes are documented in Copernicus Marine In Situ TAC - physical parameters list: https://doi.org/10.13155/53381. Examples: PRES, TEMP, PSAL, DOXY. standard_name: Required, if there is an appropriate, existing standard name in CF, see reference Copernicus Marine In Situ TAC - physical parameters list. units: Mandatory, type char, see reference Copernicus Marine In Situ TAC - physical parameters list https://doi.org/10.13155/53381 _FillValue: default value of the variable type (but char, which is blank) see “Note on _FillValue variable attribute” below add_offset: This number is to be added to the data after it is read by the application that accesses the data. If both scale_factor and add_offset attributes are present, the data are first scaled before the offset is added. The attributes scale_factor and add_offset can be used together to provide simple data compression to store low-resolution floating-point data as small integers in a netCDF file. When scaled data are written, the application should first subtract the offset and then divide by the scale factor. scale_factor: The data are to be multiplied by this factor after the data are read by the application that accesses the data. long_name: Long descriptive name, see reference Copernicus Marine In Situ TAC - physical parameters list valid_min: Minimum value for valid data (add_offset and scale_factor applied) valid_max: Maximum value for valid data (add_offset and scale_factor applied) comment: Any free-format text with comments as appropriate uncertainty: type float. Overall measurement uncertainty, if constant. See "Note on uncertainty" below. accuracy: type float. Nominal sensor accuracy. See "Note on uncertainty" below. precision: type float. Nominal sensor precision. See "Note on uncertainty" below. resolution: type float. Nominal resolution of this data parameter. See "Note on uncertainty" below. cell_methods: type char. Specifies cell method as per CF convention. Example: TEMP:cell_methods=”TIME: point DEPTH: point LATITUDE: point LONGITUDE: point” Values are listed in “Note on cell method”

	coordinates: Required, if a data variable does not have 4 coordinates in its definition. See "Note on coordinates attribute". type_of_analysis: Required by some variables to get the estimator. Used values could be: "spectral analysis, crests, unknown, zero crossing" sensor_depth. type float. Nominal sensor depth(s) in meters, counting positive as per DEPTH:positive. sensor_mount type char. Values: • mounted_on_fixed_structure • mounted_on_surface_buoy • mounted_on_mooring_line • mounted_on_bottom_lander • mounted_on_moored_profiler • mounted_on_glider • mounted_on_shipborne_fixed • mounted_on_shipborne_profiler • mounted_on_seafloor_structure • mounted_on_benthic_node • mounted_on_benthic_crawler • mounted_on_surface_buoy_tether • mounted_on_seafloor_structure_riser • mounted_on_fixed_subsurface_vertical_profiler sensor_orientation type char. Values: downward, upward, horizontal data_mode="R" Indicates if the variable contains real-time, delayed-mode or mixed data. See §3.2 Data mode: real-time, delayed-mode data2 ancillary_variables: Other variables associated with <PARAM>, e.g. <PARAM>_QC (blank separated list). Example: TEMP:ancillary_variables="TEMP_QC TEMP_DM TEMP_UNCERTAINTY"
byte **<PARAM>_QC**(TIME, DEPTH); <PARAM>_QC:**long_name** = "<PARAM:long_name> quality flag"; <PARAM>_QC:**conventions** = "Copernicus Marine In Situ reference table 2"; <PARAM>_QC:**_FillValue** = -127b; <PARAM>_QC:**valid_min** = 0b; <PARAM>_QC:**valid_max**= 9b; <PARAM>_QC:**flag_values** = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b; <PARAM>_QC:**flag_meanings** = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value";	Quality flags for values of associated <PARAM>. The flag scale is specified in reference table 2, and is included in the flag_meanings attribute. <PARAM:long_name> is the parameter long name (ex: "Sea temperature quality flag") long_name: type char. fixed value conventions. type char. Required; fixed value _FillValue. type byte. Required; fixed value valid_min. type byte. Required; fixed value valid_max: type byte. Required; fixed value flag_values: type byte. Required; fixed value flag_meanings: type char. Required; fixed value
Char <PARAM>_DM(TIME, DEPTH); <PARAM>_DM:long_name = "<PARAM:long_name> method of data processing"; <PARAM>_DM:conventions = "Copernicus Marine In Situ reference table 1"; <PARAM>_DM:coordinates = "TIME LATITUDE LONGITUDE <X>"; <PARAM>_DM:flag_values ="R, A, D"; <PARAM>_DM:flag_meanings = "real-time adjusted-in-real-time delayed-mode"; <PARAM>_DM:_FillValue = " ";	Data mode for values of associated <PARAM> This is the data mode. Indicates if the data point is real-time, delayed-mode or provisional mode. It is included when the dataset mixes modes for a single variable. See section §3.2 Data mode: real-time, delayed-mode data Data mode: real-time, delayed-mode data. <PARAM:long_name> is the parameter long name (ex: "Sea temperature method of data processing") long_name: type char. Required; fixed value conventions: type char. Required; fixed value flag_values: type char. Required; fixed value flag_meanings: type char. Required; fixed value _FillValue: type char. Required; fixed value

int <PARAM>_UNCERTAINTY(TIME, DEPTH): <PARAM>_UNCERTAINTY:long_name = "<PARAM:long_name> uncertainty" <PARAM>_UNCERTAINTY:_FillValue=<X> <PARAM>_UNCERTAINTY:units = "<X>"; <PARAM>_UNCERTAINTY:add_offset = <X> ; <PARAM>_UNCERTAINTY:scale_factor = <X> ;	It is not mandatory. Overall uncertainty of the data given in <PARAM>. It should apply scale_factor and add_offset in the same way as the related variable. See "Note on uncertainty" below. <PARAM:long_name> is the parameter long name (ex: "Sea temperature method of data processing") long_name: type char. Required; fixed value _FillValue: type int. Required. units: type char. Required. Must be the same as <PARAM>:units.

Example for sea temperature measurements and associated quality flags

int TEMP(TIME, DEPTH) ;
TEMP:units = "degrees_C" ;
TEMP:long_name = "Sea temperature" ;
TEMP:standard_name = "sea_water_temperature" ;
TEMP:scale_factor = 0.001f ;
TEMP:add_offset = 0.f ;
TEMP:_FillValue = -2147483647 ;
byte TEMP_QC(TIME, DEPTH) ;
TEMP_QC:long_name = "Sea temperature quality flag" ;
TEMP_QC:conventions = "Copernicus Marine In Situ reference table 2" ;
TEMP_QC:_FillValue = -127b ;
TEMP_QC:valid_min = 0b ;
TEMP_QC:valid_max = 9b ;
TEMP_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ;
TEMP_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;

Specific attributes for sea level (SLEV)

Type, name, dimension, attributes	Comment
int SLEV(TIME, DEPTH); … SLEV:**time_sampling** = <X>; SLEV:**sea_level_datum** = <X>; SLEV:**processing_method** = <X>; SLEV:TGBM_name = <X>; SLEV:TGBM_sea_level_datum = <X>; SLEV:co_location_with_GNSS = <X>; SLEV:TGBM_ellipsoidal_height_estimate = <X>; SLEV:vertical_land_movement_estimate = <X>; SLEV:GNSS_campaign = <X>; …	time_sampling: integer in minutes, to allow for clear and fast identification of the sampling in the time series (typically: 5, 6, 10, 15, 60 min, in principle depending on the data provider). sea_level_datum: description of the reference or datum of sea level data: chart datum, geodetic datum, etc. processing_method: brief description of the data processing method: "instantaneous values", "filtered values", "average", etc. If a url address with a more detailed explanation is available, it can be inserted here. TGBM_name: name and description of the Tide Gauge Bench Mark TGBM_sea_level_datum: height (mm) of TGBM above sea level datum co_location_with_GNSS: Distance(km)/No/Unknown. Provides an easy way to detect those tide gauges with a GNSS station nearby. Additional information or "url" address, if available, could be added in the 'comment' attribute. TGBM_ellipsoidal_height_estimate: height (mm) of TGBM above estimate of ellipsoidal height available in SONEL1. vertical_land_movement_estimate: even if the tide gauge is co-located with a GNSS station, this estimate may not be available yet. The content of this attribute could be unknown or the trend, if available in SONEL: trend(mm/year) - period (initial to final year)/unknown. GNSS_campaign: Yes/No. If there is information about availability of a GNSS campaign from the station, it can be indicated here with a link to the source of

	these data in the 'comment' attribute.

Specific attributes for BGC calibrations

Type, name, dimension, attributes	Comment
<PARAM>:last_calibration_date = <X>; <PARAM>:calibration_method = <X>; <PARAM>:used_salinity = <X>; <PARAM>:salinity = <X>; <PARAM>:used_temperature = <X>; <PARAM>:temperature = <X>; <PARAM>:used_pressure = <X>; <PARAM>:pressure = <X>; <PARAM>:compensated = <X>; <PARAM>:laboratory_technique = <X>; <PARAM>:laboratory_method = <X>; <PARAM>:proxy_method = <X>; <PARAM>:last_proxy_method_date = <X>;	

Specific attribute for WAVE parameters

Type, name, dimension, attributes	Comment
<PARAM>:**type_of_analysis** = <X>;	type_of_analysis: Required for wave parameters. List of authorized values: "unknown, spectral analysis, zero crossing, crests"

Note on add_offset and scale_factor

Copernicus In Situ TAC parameters are signed integers with add offset and scale factor.

- signed integer
- "0" offset
- "0.001" scale factor (except for Beaufort wind with scale_factor =1).

Following CF recommendation, the coordinate variables (having an "axis" attribute) have no offset and scale_factor : time, latitude, longitude, pressure or depth.

Note on uncertainty

If the overall measurement uncertainty for a variable <PARAM> is reasonably well-known, it must be provided in the attribute <PARAM>:uncertainty if it is constant, or in a variable of its own, <PARAM>_UNCERTAINTY, if it is not constant. If uncertainty is given in either way, the attribute <PARAM>:accuracy is optional.

If it is impossible to estimate the overall measurement uncertainty, it is suggested to define at least the attribute <PARAM>:accuracy with the nominal sensor accuracy.

The attributes <PARAM>:precision and <PARAM>:resolution are optional; they contain the sensor precision and resolution if defined.

Note on cell methods

In the Units column, u indicates the units of the physical quantity before the method is applied.

Cell Method	Units	Description

point	u	The data values are representative of points in space or time (instantaneous).
sum	u	The data values are representative of a sum or accumulation over the cell.
maximum	u	Maximum
median	u	Median
mid_range	u	Average of maximum and minimum
minimum	u	Minimum
mean	u	Mean (average value)
mode	u	Mode (most common value)
standard_deviation	u	Standard deviation
variance	u2	Variance

Note on the coordinates attribute

There are two methods used to locate data in time and space. The preferred method is to be declared with dimensions that are coordinate variables, e.g. ATMP(TIME, DEPTH, LATITUDE, LONGITUDE).

Alternatively, a variable may be declared with fewer dimensions, e.g. ATMP(TIME). In the latter case, the 'coordinates' attribute of the variable provides the spatiotemporal reference for the data. The value of the coordinates attribute is a blank separated list of the names of auxiliary coordinate variables; these must exist in the file, and their sizes must match a subset of the data variable's dimensions; scalar coordinates do so by default. The use of coordinate variables as dimensions is preferred, because it conforms to COARDS and because it simplifies the use of the data by standard software. Note that it is permissible, but optional, to list coordinate variables as well as auxiliary coordinate variables in the coordinates attribute.

2.3.4 Fill values conventions for variables

The _FillValue variable attribute is mandatory; it is set to the default value of the variable type.

See https://Linkwww.unidata.ucar.edu/software/netcdf/docs/netcdf_8h.html

- NC_FILL_INT (-2147483647)
- NC_FILL_FLOAT (9.9692099683868690e+36f)
- NC_FILL_DOUBLE (9.9692099683868690e+36)
- NC_FILL_BYTE ((signed char)-127)

Exception : NC_FILL_CHAR ((char)0) is not used in CMEMS In Situ TAC as it can be problematic with visualization tools like ncdump and the NetCDF libraries. The character blank " " is the default fill value for CHAR variables.

3 Copernicus Marine In Situ TAC implementation of NetCDF4 CF1.6 convention

Copernicus In Situ TAC distributes data and metadata following the NetCDF4 CF1.6 conventions, this chapter describes its detailed implementation.

3.1 NetCDF global attributes

The following global must have a valid content, unless explicitly described as "may have an empty fill value"

3.1.1 NetCDF data_type family global attributes

Copernicus In Situ NetCDF files handle 6 families of data, reported in the global attribute “data_type” of NetCDF files:

- :data_type = "OceanSITES vertical profile" ;
- :data_type = "OceanSITES time-series data" ;
- :data_type = "OceanSITES trajectory data" ;
- :data_type = "OceanSITES trajectoryProfile data" ;
- :data_type = "HF radar total data" ;
- :data_type = "HF radar radial data" ;
- :data_type = "wave-spectra data";

3.1.2 Citation, distribution statement

In the global attribute section of NetCDF files, the citation and distribution statement should be reported as follows:

- distribution_statement=”These data follow Copernicus standards; they are public and free of charge. User assumes all risk for use of data. User must display citation in any publication or product using data.”
- citation="These data were collated within the Copernicus Marine Service (In Situ) and EMODnet collaboration framework. Data is made freely available by the Copernicus Marine Service and the programs that contribute to it."

An additional citation statement can be appended to the “citation” attribute.

Example: citation=" These data were collected and made freely available by the Copernicus project and the programs that contribute to it. The data were collected at the fixed observation station OOCS in the Blanes canyon head (Catalan Sea). The station is maintained by the OOCS group at CEAB-CSIC in Blanes, Spain"

3.1.3 Platform institution code

The institution where the original data is produced is described with the 2 global attributes:

- institution

- institution_edmo_code

The Edmo codes are managed by the SeaDataNet project; they are available at:

- http://seadatanet.maris2.nl/edmo/

These attributes can be a list. The attribute "institution" uses the semicolon as a separator. The attribute "institution_edmo_code" uses blank.

Example:

- institution = "Puertos del Estado (Spain); Xunta de Galicia (Spain) "
- institution_edmo_code = "2751 1624"

3.1.4 Platform codes

An individual platform may have different identification codes. The NetCDF global attributes provide this information.

Global attribute "platform_code"

It is unique within all Copernicus Distribution Units.

This attribute is used in the naming of the platform and the respective files naming.

Global attribute "platform_name"

The human readable name of the platform. This attribute may have an empty fill value.

Global attribute "wmo_platform_code"

It contains the Call Sign assigned by WMO (World Meteorological Organization).

If it does not exist (example: sea-level stations do not have Call Signs), the attribute has an empty fill value.

If this attribute has a valid value, it should be used as platform_code as well.

Global attribute "ices_platform_code"

It contains the platform code assigned by ICES (International Council for the Exploration of the Sea).

If it does not exist (example: drifting buoys do not have ICES codes), the attribute has an empty fill value.

3.1.5 Format version, convention

In the global attribute section of NetCDF files, the format version and conventions should be reported as follows:

- format_version = “1.4”
- Conventions = "CF-1.6 Copernicus-InSituTAC-FormatManual-1.43 Copernicus-InSituTAC-SRD-1.6 Copernicus-InSituTAC-ParametersList-3.2.1" ;
- netcdf_version = "netCDF-4 classic model"
  (output from ncdump -k filename)

3.1.6 WMO instrument type

This global attribute may have an empty fill value.

If available, the WMO instrument type is recorded in the global attribute section of the NetCDF file. The WMO code is available only for vertical profiles.

Example: wmo_inst_type = "830";

3.1.7 Platform category

The SeaDataNet vocabulary L06 (SeaVoX) reports platform categories, as a code and a label.

Global attributes: source, source_platform_category_code

Example of a fixed surface buoy:

- source = “moored surface buoy”
- source_platform_category_code = “41”

3.1.8 Last observation global attribute

The three “last observation” attributes are mandatory, except for HF radar data.

The last valid observation date and position is recorded in the NetCDF global attributes:

- last_latitude_observation
- last_longitude_observation
- last_date_observation

The date and position quality code is set to 1, 2, 5, 7 or 8 (good, probably good, value changed, nominal, interpolated).

A file with no valid time and position is not distributed on Copernicus In Situ TAC.

3.1.9 Data assembly center global attribute

The global attribute “data_assembly_centre” is the institution name of the Distribution Unit in charge of the aggregation and distribution of data.

Distribution Unit	data_assembly_centre
ARC – Arctic	IMR
BAL – Baltic	SMHI
BS - Black sea	IOBAS
GLO – Global	Ifremer
IBI - Iberia Biscay Ireland	Puertos del Estado
MED - Mediterranean	HCMR
NWS - North West Shelf	BSH
GLO - Global Carbon	IMR
GLO - Global HF radar	European HFR Node

3.1.10 Update interval of the file

Use ISO 8601 Interval format: PnYnMnDTnHnM

Examples

- Hourly → “PT1H”
- Daily → “P1D”
- Monthly → “P1M”

Use “void” for delayed-mode or archive data that do not need continuous updating.

Elements that are 0 may be omitted (year, month,...).

3.1.11 Bottom depth

This global attribute may have an empty fill value.

“bottom_depth” : an optional int value expressed in meters.

Example : ‘37’

On moorings or fixed buoys, this information is provided by the platform operator. If that information is not available the attribute should be omitted.

3.1.12 Reference to DOI for data traceability

List of Data Object Identifiers (DOI) related to this data file (blank separated). The DOIs are minted by data providers.

Example : ”https://doi.org/10.17882/51141”

3.2 Data mode: real-time, delayed-mode data

This chapter explains how to discriminate real-time and delayed-mode data in a Copernicus In Situ file.

- Real-time data : observations that passed automated quality controls
- Real-time data with adjustment : observations with adjustment from previous expert inspection that passed automated quality controls
- delayed-mode data : observations assessed by a scientist or a specialist

File level: global attribute ‘data_mode’

The global attribute ‘data_mode’ is used to discriminate files containing real-time data, delayed-mode data or both. **It refers to the whole file**.

- R: data with real-time quality control (or a combination of R and A data mode)
- A: real time data with adjusted values
- D: data with delayed-mode quality control
- M: data with mixed real-time and delayed-mode quality control

This global attribute is mandatory.

Variable level: variable attribute 'data_mode'

This variable attribute indicates that the variable contains real-time data, delayed-mode data or both. **It refers to the whole variable**.

- R: data with real-time quality control (all the values of this specific variable are real-time 'R')
- A: real time data with adjusted values
- D: data with delayed-mode quality control (all the values of this specific variable are delayed-mode 'D')
- M: data with mixed real-time and delayed-mode quality control (within the specific variable, 'R' and 'D' values are present)

This variable attribute is mandatory.

Value level: <PARAM>_DM variable

The variable <PARAM>_DM is used to discriminate real-time and delayed-mode data within a variable. **It refers to each individual measure in a parameter variable**.

This variable is mandatory if the attribute <PARAM>:data_mode is equal to "M" : there is a combination or real-time and delayed-mode data in <PARAM> variable.

If the variable attribute <PARAM>:data_mode is equal to "R" or "D" the variable <PARAM>_DM is not delivered: the <PARAM> variable contains either only real-time or only delayed-mode data.

The dimension of <PARAM>_DM is (TIME,DEPTH).

Example: TEMP_DM associated to the TEMP variable (sea water temperature)

```
char TEMP_DM(TIME,DEPTH) ;
    TEMP_DM:long_name = "Sea temperature method of data processing" ;
    TEMP_DM:conventions = "Copernicus Marine In Situ reference table 1" ;
    TEMP_DM:flag_values = "R",  "A", "D";
    TEMP_DM: flag_meanings = "real-time adjusted-in-real-time delayed-mode mixed";
    TEMP_DM:_FillValue = " " ;
```

3.3 Data center reference

When possible, the Distribution Unit should provide a unique id on observation, useful for feedback. Each observation is identified in the following variable:

```
char DC_REFERENCE(TIME, STRING32) ;
      DC_REFERENCE:long_name = "Station/Location unique identifier in data centre" ;
      DC_REFERENCE:conventions = "Data centre convention" ;
      DC_REFERENCE:_FillValue = " " ;
```

3.4 Direction of the profiles

The direction of the profiles is recorded in the variable DIRECTION. Therefore, we can store the profiles data, up and down casts, in a single netCDF file.

```
char DIRECTION(TIME);
      DIRECTION:long_name = "Direction of the profiles";
      DIRECTION:conventions = "A: ascending profile, D: descending profile";
      DIRECTION:FillValue = " ";
```

- For an ascending profile (up cast) : DIRECTION = "A"

- For a descending profile (down cast) : DIRECTION = “D”

3.5 In Situ TAC parameters

The valid parameters are listed in the Excel spreadsheet “In Situ TAC parameters list” available on the landing page of this document: https://doi.org/10.13155/53381

Each parameter has a variable name, a long_name, a unit, a CF standard name.

Each parameter may have a type of analysis, a valid_min and a valid_max attribute.

Each parameter <PARAM> may have a related variable <PARAM>_QC, <PARAM>_DM, <PARAM>_UNCERTAINTY, <PARAM>_ADJUSTED, <PARAM>_ADJUSTED_QC and <PARAM>_ADJUSTED_ERROR.

- PARAM_QC: the quality control flags on PARAM values
- PARAM_DM: the data mode of PARAM values
- PARAM_UNCERTAINTY: the uncertainty on PARAM values
- <PARAM>_ADJUSTED: the adjusted value of the parameter, usually the delayed-mode adjustment.
- <PARAM>_ADJUSTED_QC : the QC flag associated to the adjusted parameter
- <PARAM>_ADJUSTED_ERROR : the error associated to the adjusted parameter

3.6 Copernicus Marine In Situ parameter list

The In Situ parameters list is published on *“**Copernicus Marine In Situ TAC - physical parameters list**. https://doi.org/10.13155/53381”*

The Copernicus Marine In Situ standard names come from the CF standard names, available at: http://cfconventions.org/standard-names.html

The parameter names are based on SeaDataNet-BODC parameter discovery vocabulary available at: http://seadatanet.maris2.nl/v_bodc_vocab/welcome.aspx
Select P021, “BODC Parameter Discovery Vocabulary”

The units are compliant with UDUNITS, as implemented by the CF standard; definitions available at: http://www.unidata.ucar.edu/software/udunits

3.7 Time sampling description

“time_sampling” : an optional variable attribute with a float type.

For sea level SLEV variable, time_sampling value is mandatory. The unit is “minute”.

Example

int SLEV(TIME, DEPTH) ;
SLEV:units = "m" ;
SLEV:long_name = "Water surface height above a specific datum" ;
SLEV:standard_name = "water_surface_height_above_reference_datum" ;
SLEV:**time_sampling** = 1.f ;
SLEV:scale_factor = 0.001f ;
SLEV:add_offset = 0.f ;
SLEV:_FillValue = -2147483647 ;
SLEV:sea_level_datum = "chart datum" ;
SLEV:processing_method = "averaged and filtered values" ;
SLEV:co_location_with_GNSS = "0.293 km" ;

SLEV:GNSS_campaign = "yes" ;
SLEV:comment = "https://www.sonel.org/spip.php?page=gps&idStation=642" ;

4 Conventions for specific In Situ observations

4.1 Conventions for HF radar

High Frequency radar (HF radar) NetCDF file format mostly follows the rules described in this document. Due to the specific nature of this land-based remote sensing technology, some exceptions and differences with respect to the main rules are necessary and are listed in the following.

More information on:

- *Copernicus in situ NRT current product user manual (PUM). CMEMS-INS-PUM-013-048.* https://doi.org/10.13155/73192

4.1.1 Dimensions

For HFR radial data measured on a polar geometry the true dimensions are bearing (BEAR) and range (RNGE). In this case LATITUDE and LONGITUDE are evaluated from bearing and range, so they are no dimensions but they are geophysical variables.

Name	Example	Comment
BEAR	BEAR=72	Dimension of the BEAR coordinate variable.
RNGE	RNGE=51	Dimension of the RNGE coordinate variable.
REFMAX	REFMAX=1	Dimension of the REFMAX coordinate variable.

4.1.2 Global attributes

Besides the ones listed in section 2.2, the following global attributes are mandatory for HFR radial and total data.

Discovery and identification		
DoA_estimation_method	DoA_estimation_method =”Direction Finding” (for radials) DoA_estimation_method =”MONT: Direction Finding; TINO: Direction Finding” (for totals combined from MONT and TINO radial stations)	Direction of Arrival estimation method: specifies if the system is Direction Finding or Beam Forming. Possible values are “Direction Finding” and “Beam Forming”. In case of total data, a key:value list (elements separated by semicolon) is expected, in order to describe the method for each contributing site. **Mandatory**.
calibration_type	calibration_type =”APM” (for radials) calibration_type =”MONT: APM; TINO: APM” (for totals combined from MONT and TINO radial stations)	Specifies if calibration has been performed. Possible values are: “None”, “Ideal”, “APM”, “full”, “internal”, “physical”, “AEA”. In case of total data, a key:value list (elements separated by semicolon) is expected, in order to describe the type for each contributing site. **Mandatory**
last_calibration_date	last_calibration_date = ”2016-02-04T11:25:37Z” (for radials) last_calibration_date =	Reports the date of the last calibration. It must be specified as a string in the ISO8601 standard "YYYY-MM-DD-Thh:mm:ssZ". If unknown : N/A value is allowed

Discovery and identification		
DoA_estimation_method	DoA_estimation_method =”Direction Finding” (for radials) DoA_estimation_method =”MONT: Direction Finding; TINO: Direction Finding” (for totals combined from MONT and TINO radial stations)	Direction of Arrival estimation method: specifies if the system is Direction Finding or Beam Forming. Possible values are “Direction Finding” and “Beam Forming”. In case of total data, a key:value list (elements separated by semicolon) is expected, in order to describe the method for each contributing site. **Mandatory**.
calibration_type	calibration_type =”APM” (for radials) calibration_type =”MONT: APM; TINO: APM” (for totals combined from MONT and TINO radial stations)	Specifies if calibration has been performed. Possible values are: “None”, “Ideal”, “APM”, “full”, “internal”, “physical”, “AEA”. In case of total data, a key:value list (elements separated by semicolon) is expected, in order to describe the type for each contributing site. **Mandatory**
	”MONT: 2016-02-04T11:25:37Z; TINO: 2016-02-04T11:25:37Z” (for totals combined from MONT and TINO radial stations)	In case of total data, a key:value list (elements separated by semicolon) is expected, in order to describe the date for each contributing site. **Mandatory**.
calibration_link	calibration_link = ”carlo.mantovani@cnr.it” (for radials) calibration_link =”MONT: carlo.mantovani@cnr.it; TINO: carlo.mantovani@cnr.it” (for totals combined from MONT and TINO radial stations)	Indicates the link to a contact person able to provide data about the calibration. In case of total data, a key:value list (elements separated by semicolon) is expected, in order to describe the link for each contributing site. **Mandatory**.
Provenance		
processing_level	processing_level=”3B”	Level of processing and quality control applied to data. Valid values are listed in the table below. **Mandatory**.

The following table describes the processing levels for the identification of the different data produced during the processing workflow of a HFR. The definition of these processing levels is manufacturer-independent, i.e. the level schema is suitable to all the most common HFR. The string values are used as an overall indicator (i.e. one summarizing all measurements) of each data file in the processing_level attribute.

Processing Level	Definition	Products
LEVEL 0	Reconstructed, unprocessed instrument/payload data at full resolution; any and all communications artifacts, e.g. synchronization frames, communications headers, duplicate data removed.	Signal received by the antenna before the processing stage. (No access to these data in Codar systems).
LEVEL 1A	Reconstructed, unprocessed instrument data at full resolution, time-referenced and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing.	Spectra by antenna channel

LEVEL 1B	Level 1A data that have been processed to sensor units for next processing steps. Not all instruments will have data equivalent to Level 1B.	Spectra by beam direction
LEVEL 2A	Derived geophysical variables at the same resolution and locations as the Level 1 source data.	HFR radial velocity data
LEVEL 2B	Level 2A data that have been processed with a minimum set of QC.	HFR radial velocity data
LEVEL 2C	Level 2A data that have been reprocessed for advanced QC.	Reprocessed HFR radial velocity data
LEVEL 3A	Variables mapped on uniform space-time grid scales, usually with some completeness and consistency.	HFR total velocity data
LEVEL 3B	Level 3A data that have been processed with a minimum set of QC.	HFR total velocity data
LEVEL 3C	Level 3A data that have been reprocessed for advanced QC.	Reprocessed HFR total velocity data
LEVEL 4	Model output or results from analyses of lower level data, e.g. variables derived from multiple measurements.	Energy density maps, residence times, etc.

4.1.3 Variables

Attributes for coordinate variables and data variables required in the SDC CF extension are included in the HFR data format. In particular, the SDN extensions to CF were concerned with providing storage for standardized semantics and metadata included in the SDN profiles format. The standardized semantics are included as four mandatory parameter attributes for each data or co-ordinate variable, which are:

- **sdn_parameter_urn** – this is the URN for the parameter description taken from the P01 vocabulary.
- **sdn_parameter_name** – this is the plain language label (Entryterm) for the parameter taken from the P01 vocabulary at the time of data file creation.
- **sdn_uom_urn** – this is the URN for the parameter units of measure taken from the P06 vocabulary.
- **sdn_uom_name** - this is the plain language label (Entryterm) for the parameters' units of measure, taken from the P06 vocabulary at the time of data file creation.

4.1.4 Coordinate variables

The LATITUDE, LONGITUDE, BEAR and RNGE variables are monotonic (HFR date are provided on a fixed geographical grid).

The TIME, LATITUDE, LONGITUDE, BEAR, RNGE dimensions have the same value.

Variables of HFR total data and of HFR radial data measured on a cartesian grid have a (TIME, DEPTH, LATITUDE, LONGITUDE) dimension.

Variables of HFR radial data measured on a polar grid have a (TIME, DEPH, BEAR, RNGE) dimension.

BEAR (bearing) and RNGE (range) are the coordinate variables for radial velocity data measured on a polar geometry (e.g. Codar .ruv files). In this case, LATITUDE and LONGITUDE are data variables since

they are evaluated starting from bearing and range. Thus, the coordinates of data and QC variables for radials measured on a polar geometry shall be (TIME, DEPH, BEAR, RNGE) and RNGE dimension shall have the 'axis' attribute set to 'X' and BEAR dimension shall have the 'axis' attribute set to 'Y';.

The coordinates of data and QC variables for radials measured on a cartesian grid shall be (TIME, DEPH, LATITUDE, LONGITUDE) and LONGITUDE dimension shall have the 'axis' attribute set to 'X' and LATITUDE dimension shall have the 'axis' attribute set to 'Y'.

4.1.5 SDN namespace variables

SeaDataNet (SDN) is the European project that federates the network of EU national oceanographic data centres. SDN is a data provider for Copernicus. Each HFR station distributed in Copernicus NetCDF data file includes the following additional variables:

Name	Comment
SDN_CRUISE	Text string identifying the grouping label for the data object to which the data row belongs. For HFR data it is set equal to the site_code attribute, that is the EDIOS Series id of the HFR network.
SDN_STATION	Text string identifying the data object to which the data row belongs. For HFR data it is set equal to the platform_code attribute.
SDN_LOCAL_CDI_ID	The local identifier of the Common Data Index record associated with the data row.
SDN_EDMO_CODE	The key identifying the organization responsible for assigning the local CDI given in the European Directory of Marine Organizations (EDMO).
SDN_XLINK	Text strings containing a URI (URN or URL) pointing to a web resource such as a usage metadata document for the data object to which the array element belongs.

4.2 Convention for wave spectral data

4.2.1 Dimensions

Name	Example	Comment
TIME	TIME=24	Number of time steps. The TIME dimension is fixed (for a more efficient compression).
FREQUENCY	FREQUENCY=14	Number of frequencies in the spectra.
nv	nv=2	Number of vertices for the bounds variables.

4.2.2 Global Attributes

See 2.2 Global attributes

:data_type value is "wave-spectra data";

:cdm_data_type value is "timeSeries";

4.2.3 Coordinates variables

Type, name, dimension, attributes	Comment
double **TIME**(TIME); TIME:long_name = "Time" ; TIME:standard_name = "time" ; TIME:units = "days since 1950-01-01T00:00:00Z" ; TIME:valid_min = -90000. ; TIME:valid_max = 90000. ; TIME:QC_indicator = 1 ; TIME:uncertainty = " " ; TIME:comment = " " ; TIME:axis = "T" ; TIME:ancillary_variables = "TIME_QC" ; TIME:calendar= "standard";	Time of the measurement in days since noon, 1950-01-01.
float **LATITUDE**(LATITUDE); LATITUDE:long_name = "Latitude of each location" ; LATITUDE:standard_name = "latitude" ; LATITUDE:units = "degree_north" ; LATITUDE:valid_min = -90. ; LATITUDE:valid_max = 90. ; LATITUDE:QC_indicator = 1 ; LATITUDE:uncertainty = " " ; LATITUDE:comment = " " ; LATITUDE:axis = "Y" ; LATITUDE:ancillary_variables = "POSITION_QC" ;	Latitude of the measurements. Units: degrees north; southern latitudes are negative.
float **LONGITUDE**(LONGITUDE); LONGITUDE:long_name = "Longitude of each location" ; LONGITUDE:standard_name = "longitude" ; LONGITUDE:units = "degree_east" ; LONGITUDE:valid_min = -180. ; LONGITUDE:valid_max = 180. ; LONGITUDE:QC_indicator = 1 ; LONGITUDE:uncertainty = " " ; LONGITUDE:comment = " " ; LONGITUDE:axis = "X" ; LONGITUDE:ancillary_variables = "POSITION_QC" ;	Longitude of the measurements. Unit: degrees east; western latitudes are negative.
float **FREQUENCY**(TIME, FREQUENCY); FREQUENCY:long_name = "Central frequency of the band" ; FREQUENCY:standard_name = "wave_frequency" ; FREQUENCY:units = "s-1" ; FREQUENCY:_FillValue = NC_FILL_FLOAT ; FREQUENCY:bounds = "FREQUENCY_BOUNDS" ; FREQUENCY:QC_indicator = 1 ; FREQUENCY:uncertainty = " " ; FREQUENCY:comment = " " ; FREQUENCY:ancillary_variables = "FREQUENCY_QC" ;	FREQUENCY contains the central frequency of the bands. The lower and upper frequency bounds of each band are in FREQUENCY_BOUNDS. The frequencies can vary over time.
float **FREQUENCY_BOUNDS**(TIME, FREQUENCY, nv) ;	

Note: The use of "QC_indicator'' is deprecated. We recommend not use it. It will disappear in the next format release.

4.2.4 Coordinates quality control variables

Type, name, dimension, attributes	Comment
byte **TIME_QC**(TIME);	Quality flag for each TIME value.

TIME_QC:long_name = "quality flag" ; TIME_QC:conventions = "Copernicus Marine In Situ reference table 2" ; TIME_QC:_FillValue = NC_FILL_BYTE ; TIME_QC:valid_min = 0b ; TIME_QC:valid_max = 9b ; TIME_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ; TIME_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;	
byte **POSITION_QC**(TIME) POSITION_QC:long_name = "quality flag" ; POSITION_QC:conventions = "Copernicus Marine In Situ reference table 2" ; POSITION_QC:_FillValue = NC_FILL_BYTE ; POSITION_QC:valid_min = 0b ; POSITION_QC:valid_max = 9b ; POSITION_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ; POSITION_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;	Quality flag for each LATITUDE and LONGITUDE value.
byte **FREQUENCY_QC**(TIME, FREQUENCY) POSITION_QC:long_name = "quality flag" ; POSITION_QC:conventions = "Copernicus Marine In Situ reference table 2" ; POSITION_QC:_FillValue = NC_FILL_BYTE ; POSITION_QC:valid_min = 0b ; POSITION_QC:valid_max = 9b ; POSITION_QC:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ; POSITION_QC:flag_meanings = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value" ;	Quality flag for each FREQUENCY value

4.2.5 Data variables

The data variables for spectral data are VSPEC1D, THETA1, THETA2, STHETA1 and STHETA2.

Type, name, dimension, attributes	Comment
int <PARAM>(TIME, FREQUENCY); <PARAM>:**standard_name** = <X>; <PARAM>:**units** = <X>; <PARAM>:**_FillValue** = <X>; <PARAM>:**add_offset** = <X> ; <PARAM>:**scale_factor** = <X> ; <PARAM>:**long_name** = <X>; <PARAM>:valid_min = <X>; <PARAM>:valid_max = <X>; <PARAM>:comment = <X>; <PARAM>:uncertainty = <X>; <PARAM>:accuracy = <X>; <PARAM>:precision = <X>; <PARAM>:resolution = <X>; <PARAM>:cell_methods = <X>; <PARAM>:coordinates = <X>; <PARAM>:**type_of_analysis** = <X>; <PARAM>:**data_mode** = <X>; <PARAM>:sensor_depth = <X>; <PARAM>:sensor_mount = <X>; <PARAM>:sensor_orientation = <X>; <PARAM>:ancillary_variables = "<PARAM>_QC <PARAM>_DM";	<PARAM> names and attributes are documented in Copernicus Marine In Situ TAC - physical parameters list: https://doi.org/10.13155/53381. Examples:VSPEC1D, THETA1. standard_name: Required, if there is an appropriate, existing standard name in CF, see reference Copernicus Marine In Situ TAC - physical parameters list. units: Required, type char, see reference Copernicus Marine In Situ TAC - physical parameters list https://doi.org/10.13155/53381 _FillValue: default value of the variable type (but char, which is blank) see "Note on _FillValue variable attribute" below add_offset: This number is to be added to the data after it is read by the application that accesses the data. If both scale_factor and add_offset attributes are present, the data are first scaled before the offset is added. The attributes scale_factor and add_offset can be used together to provide simple data compression to store low-resolution floating-point data as small integers in a netCDF file. When scaled data are written, the application should first subtract the offset and then divide by the scale factor. scale_factor: The data are to be multiplied by this factor after the data are read by the application that accesses the data. long_name: Long descriptive name, see reference Copernicus Marine In Situ TAC - physical parameters list

	valid_min: Minimum value for valid data (add_offset and scale_factor applied) valid_max: Maximum value for valid data (add_offset and scale_factor applied) comment: Any free-format text with comments as appropriate uncertainty: type float. Overall measurement uncertainty, if constant. See "Note on uncertainty" below. accuracy: type float. Nominal sensor accuracy. See "Note on uncertainty" below. precision: type float. Nominal sensor precision. See "Note on uncertainty" below. resolution: type float. Nominal resolution of this data parameter. See "Note on uncertainty" below. cell_methods: type char. Specifies cell method as per CF convention. Example: TEMP:cell_methods="TIME: point DEPTH: point LATITUDE: point LONGITUDE: point" Values are listed in "Note on cell method" coordinates: Required, if a data variable does not have 4 coordinates in its definition. See "Note on coordinates attribute". type_of_analysis: Required to get the estimator. Used values could be: "spectral analysis, crests, unknown, zero crossing" data_mode="R" Indicates if the variable contains real-time, delayed-mode or mixed data. See §3.2 Data mode: real-time, delayed-mode data2 sensor_depth. type float. Nominal sensor depth(s) in meters, counting positive as per DEPTH:positive. sensor_mount type char. Values: • mounted_on_fixed_structure • mounted_on_surface_buoy • mounted_on_mooring_line • mounted_on_bottom_lander • mounted_on_moored_profiler • mounted_on_glider • mounted_on_shipborne_fixed • mounted_on_shipborne_profiler • mounted_on_seafloor_structure • mounted_on_benthic_node • mounted_on_benthic_crawler • mounted_on_surface_buoy_tether • mounted_on_seafloor_structure_riser • mounted_on_fixed_subsurface_vertical_profiler sensor_orientation type char. Values: downward, upward, horizontal ancillary_variables: Other variables associated with <PARAM>, e.g. <PARAM>_QC. List as blank string. Example: TEMP:ancillary_variables="VSPEC1D_QC VSPEC1D_DM"
byte **<PARAM>_QC**(TIME, FREQUENCY); <PARAM>_QC:**long_name** = "quality flag"; <PARAM>_QC:**conventions** = "Copernicus Marine In Situ reference table 2"; <PARAM>_QC:**_FillValue** = -127; <PARAM>_QC:**valid_min** = 0; <PARAM>_QC:**valid_max**= 9; <PARAM>_QC:**flag_values** = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b; <PARAM>_QC:**flag_meanings** = "no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed value_below_detection nominal_value interpolated_value missing_value";	Quality flags for values of associated <PARAM>. The flag scale is specified in reference table 2, and is included in the flag_meanings attribute. long_name: type char. fixed value conventions. type char. Required; fixed value _FillValue. type byte. Required; fixed value valid_min. type byte. Required; fixed value valid_max: type byte. Required; fixed value flag_values: type byte. Required; fixed value flag_meanings: type char. Required; fixed value

Char <PARAM>_DM(TIME, FREQUENCY); <PARAM>_DM:long_name = "method of data processing"; <PARAM>_DM:conventions = "Copernicus Marine In Situ reference table 1"; <PARAM>_DM:flag_values = "R", "A", "D"; <PARAM>_DM:flag_meanings = "real-time adjusted-in-real-time delayed-mode"; <PARAM>_DM:_FillValue = " ";	Data mode for values of associated <PARAM> This is the data mode. Indicates if the data point is real-time, delayed-mode or provisional mode. It is included when the dataset mixes modes for a single variable. See section §3.2 Data mode: real-time, delayed-mode data Data mode: real-time, delayed-mode data. long_name: type char. Required; fixed value conventions: type char. Required; fixed value flag_values: type char. Required; fixed value flag_meanings: type char. Required; fixed value _FillValue: type char. Required; fixed value
int <PARAM>_UNCERTAINTY(TIME, FREQUENCY): <PARAM>_UNCERTAINTY:long_name = "uncertainty" <PARAM>_UNCERTAINTY:_FillValue=<X> <PARAM>_UNCERTAINTY:units = "<X>"; <PARAM>_UNCERTAINTY:add_offset = <X> ; <PARAM>_UNCERTAINTY:scale_factor = <X> ;	It is not mandatory. Overall uncertainty of the data given in <PARAM>. It should apply scale_factor and add_offset in the same way as the related variable. See "Note on uncertainty" below. long_name: type char. Required; fixed value _FillValue: type int. Required. units: type char. Required. Must be the same as <PARAM>:units.

Specific attributes for directional variables

Type, name, dimension, attributes	Comment
<PARAM>:direction_reference = <X>; <PARAM>:direction_convention = <X>;	direction_references: type char. Example: "True North" direction_convention: type char. Example: "clockwise from North"

4.3 Conventions for vessel mounted ADCP observations

The Acoustic Doppler Current Profiler (ADCP) reports trajectories of vertical profiles of seawater currents. This sensor is fitted on moving platforms such as vessels, auv, saildrones or gliders. It can also be fitted on a fixed buoy or mooring to report time series.

The file type is time series: « TS »

A specific data type «VA» is used for vessel mounted ADCP.

ADCP parameters

- EWCT West-east current component m s-1 eastward_sea_water_velocity
- NSCT South-north current component m s-1 northward_sea_water_velocity
- VCSP Bottom-top current component m s-1 upward_sea_water_velocity

5 Reference tables

5.1 Reference table 1: data mode

The values for the variables "<PARAM>_DM", the global attribute "data_mode", and variable attributes "<PARAM>:data_mode" are defined as follows:

Value	Meaning
R	Real-time data. Observations that passed automated quality controls
D	Delayed-mode data. Observations assessed by a scientist or a specialist.
M	Mixed. This value is only allowed in the global attribute "data_mode" or in attributes to variables in the form "<PARAM>:data_mode". It indicates that the file contains data in more than one of the above states. In this case, the variable(s) <PARAM>_DM specifies which data is in which data mode.
A	Real time data with adjusted values

5.2 Reference table 2: variable quality control flag scale

The quality control flags indicate the data quality of the data values in a file, and are normally assigned after quality control procedures have been performed. These codes are used in the <PARAM>_QC, TIME_QC, POSITION_QC variables to describe the quality of each measurement.

Code	Meaning	Comment
0	No QC was performed	-
1	Good data	All QC tests passed.
2	Probably good data	These data should be used with caution
3	Bad data that are potentially correctable	These data are not to be used without scientific correction.
4	Bad data	Data have failed one or more of the tests.
5	Value changed	Data has been recovered after transmission error.
6	Value below detection	The level of the measured phenomenon was too small to be quantified/detected by the technique employed to measure it. The accompanying value is the quantification/detection limit for the technique or zero if that value is unknown.
7	Nominal value	Data were not observed but reported. Example: an instrument target depth.
8	Interpolated value	Missing data interpolated from neighboring data in space or time.
9	Missing value	The value is missing, is not reported, is not applicable…

5.3 Reference tables 3: conversion methods

5.3.1 Reference table 3.1: unit conversion method of vertical reference (sea water pressure or depth)

These codes are used in EasyCora and EasyOxygen products.

Code	Meaning	Comment
0	no_conversion_needed	no conversion performed
1	conversion_failed	no conversion is performed if "latitude" is missing
2	pres=swdensity0*g*deph*0.0001 _from_unesco_1983	-
3	pres(deph,lat) _from_unesco_1983	-

4	deph=pres/(swdensity0*g*0.0001)_from_unesco_1983	-
5	deph(pres,lat)_from_unesco_1983	-

5.3.2 Reference table 3.2: unit conversion methods of dissolved oxygen

These codes are used in EasyOxygen product.

Code	Meaning	Comment
0	no_conversion_needed	no conversion performed
1	conversion_failed	one useful variation is missing for conversion
2	ml_per_l_to_millimole_per_m3_following_SCOR_WG_142	-
3	micromole_per_kg_to_millimole_per_m3_following_SCOR_WG_142	-
4	ml_per_l_to_micromole_per_kg_following_SCOR_WG_142	_
5	millimole_per_m3_to_micromole_per_kg_following_SCOR_WG_142	-

5.4 Reference table 4: cdm_data_type

The Unidata CDM (common data model) data type used by THREDDS. More on
https://www.unidata.ucar.edu/software/netcdf-java/v4.6/CDM/index.html

https://www.unidata.ucar.edu/software/netcdf-java/v4.6/reference/FeatureDatasets/CFpointImplement.html

https://www.unidata.ucar.edu/software/netcdf-java/v4.6/tutorial/GridDatatype.html

http://cfconventions.org/Data/cf-conventions/cf-conventions-1.8/cf-conventions.html#_features_and_feature_types

cdm_data_type	definition
timeSeries	a series of data points at the same spatial location with monotonically increasing times
trajectory	a series of data points along a path through space with monotonically increasing times
profile	an ordered set of data points along a vertical line at a fixed horizontal position and fixed time
trajectoryProfile	a series of profile features located at points ordered along a trajectory
grid	a set of data points in a multidimensional grid, where each coordinate is ordered and separable

5.5 Reference table 5: data type

The data type is a bigram used in file names for a quick identification of the file content.

Data type	definition

BO	bottle data
CO	Autonomous underway pCO2 data
CT	oceanographic CTD profiles
DB	drifting buoys
DC	drifting buoy reporting calculated sea water current
FB	ferrybox
GL	gliders
HF	HF radar
ML	mini logger for fishery observing system
MO	fixed buoys, mooring time series, fixed observations
PF	profiling floats
RF	River flow
SD	Saildrone
SF	towed CTD data (ex: scanfish)
SM	Animal borne sensor data
TG	Tide gauge station
TS	ship underway data, thermosalinograph
TX	Thermistor chain data
VA	Vessel mounted ADCP
XB	XBT, XCTD or MBT profiles
XX	Not yet identified data type

6 Distribution Unit files distribution organization

Copernicus Marine NetCDF files are distributed on the Copernicus Distribution Unit ftp server. On top of the ftp server, additional distribution services are available : ERDDAP, thredds, Oceanotron.

6.1 File naming convention

The file naming convention is specified in “Copernicus System Requirements Document – SRD” http://dx.doi.org/10.13155/40846

An end user oriented description is available in “Product User Manual – PUM for In Situ multiparameter observations 013_030” http://dx.doi.org/10.13155/43494

6.1.1 File naming convention for tide gauges

Tide gauge data in the history directory may be distributed with distinct time sampling on the same period of time.
For a given platform, to discriminate the distinct time samplings, one file per sampling is generated.
The time sampling is reported is the file name’s optional information.

When only one time sampling is available, the file name’s optional information is not used.

Examples

Tarifa tide gauge has a unique time sampling

- IR_TS_TG_TarifaTG.nc

Brest tide gauge has 5 distinct time samplings

- GL_TS_TG_BrestTG_01minute.nc
- GL_TS_TG_BrestTG_02minute.nc
- GL_TS_TG_BrestTG_05minute.nc
- GL_TS_TG_BrestTG_10minute.nc
- GL_TS_TG_BrestTG_60minute.nc

6.2 Index of Copernicus In Situ files

To allow for data discovery without having to download data files themselves, an index file is created at the Distribution Unit level. This index file contains a list of all available data files and the location and time ranges of their data contents.

The index description is specified in “Copernicus System Requirements Document – SRD” http://dx.doi.org/10.13155/40846 with an end user oriented description in “Product User Manual – PUM for In Situ multiparameter observations 013_030” http://dx.doi.org/10.13155/43494

7 Glossary, definitions

This chapter gives a definition for the Copernicus Marine In Situ items described in this manual.

7.1 Observatory

An observatory is a facility that manages a series of ocean In Situ platforms.

7.2 Deployment

The deployment is the period between the launch and recovery or loss of an autonomous platform.

7.3 Sensor

A device that measures environmental parameters but does not digitize data for transmission, it needs to be connected to an instrument to produce a data stream that a computer can read. **Examples**: Transmissometer, Fluorometer, Oxygen sensor.

Parameter measured by the sensor

What was measured.

Calibration of the parameter measured by the sensor

Verification of Any operation measurement against independent measurements to derive a corrected value or a new parameter.

7.4 Distribution Unit

The **Distribution Unit** (DU) distributes the best copy of the data files. When a higher quality data file (e.g. calibrated data) is available, it replaces the previous version of the data file.
The user can access the data at either Distribution Unit, cf. section “Distribution Unit organization”.

7.5 Production Unit

The **Production Unit** (PU) assembles Copernicus Marine In Situ-compliant files from this information and delivers these to the Distribution Unit, where they are made publicly available.

8 Abbreviations

JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology,
Argo , Euro-Argo	International profiling float network (https://argo.ucsd.edu) and its European component (http://www.euro-argo.eu)
EGO, GROOM	International Glider network (http://www.ego-network.org) and its European coordination (http://www.groom-fp7.eu)
GOSUD	International Global Ocean Surface Underway Data (http://www.gosud.org)
OCEANSITES, EMSO	OceanSITES is a worldwide system of long-term, open-ocean reference stations(OceanSITES is a worldwide system of long-term, open-ocean reference stations) and its European component (http://www.emso-eu.org)
DBCP, ESURFMAR	Data Buoy collaboration panel (http://www.jcommops.org/dbcp/) and its European component (http://www.eumetnet.eu/e-surfmar)
EMODNet	European Marine Observation and Data Network (EMODnet)(http://www.emodnet.eu/) and the Physical component http://www.emodnet-physics.eu/Portal
SeaDataNet	European Network of National Oceanographic Data Centres (NODCs) (http://www.seadatanet.org)
TAC	CMEMS Thematic Assembly Centre
CIS	CMEMS Central Information System
EUROGOOS , ROOS	The European Global Ocean Observing System (http://eurogoos.eu/) and its Regional Operational Oceanographic System
Arctic ROOS	Arctic ocean ROOS
BOOS	Baltic sea ROOS
NOOS	North West Shelf region ROOS
IBI-ROOS	Iberic-Biscay-Irish sea ROOS
MOON	Mediterranean sea ROOS
Black Sea GOOS	Black sea ROOS
CMEMS	Copernicus Marine Environment Monitoring Service
NetCDF	Network Common Data Form
CF	Climate and Forecast convention for NetCDF formats
SRD	CMEMS documentation: System Requirement Document
PUM	CMEMS documentation: Product User Manual

PU	CMEMS Production Unit
DU	CMEMS Distribution Unit
URN	Universal Resource Name
HFR	High Frequency Radar
WMO	World Meteorological Organization