We would like to thank Anonymous Referee #2 for the thoughtful review and the constructive feedback provided. We have carefully considered all comments, as detailed in the attached document.

We appreciate the helpful comments from the reviewer #2 that help to improve the readability and coherence of the manuscript. The reviewer comments are listed below with the italicized responses following. Changes to the manuscript and their associated line number are highlighted in blue text.

RC2: ['Comment on essd-2025-759'](), Anonymous Referee #2, 24 Jan 2026

Álvarez et al. present a highly valuable data compilation product focused on the Mediterranean Sea. To my knowledge, this is the first discrete bottle based, full water column data product for this region, representing a major advance in regional data synthesis efforts. The data product is of high quality, and the manuscript merits timely publication. Below are some suggested revisions that I hope the authors will consider:

> *We appreciate the thoughtful comments from Referee #2. We hope that our CARIMED data product will be useful for the oceanographic and modeling community working in the Mediterranean Sea, helping to improve current risk assessments and support future measures for global change adaptation and mitigation. Below, we provide our responses to the comments.*

Major comments:

1. While the authors' efforts to conduct the crossover analysis are commendable, I have concerns regarding the underlying basis for this approach. In Lines 421–426, the basins in which the 2QC was conducted are listed. Please provide figures, either in the main text or in the Supplementary Material, demonstrating that seasonal and interannual natural variability in these basins is sufficiently small over time periods of decades to justify such adjustments. Without this evidence, there is a risk that real natural variability could be inadvertently removed.

> *In Section 5.1, we explain that deep and bottom waters in the Mediterranean sub-basins cannot be used as a reference layer, unlike in GLODAP for other open-ocean deep basins. The temporal evolution and changes in these deep and bottom water masses in the Mediterranean Sea are clearly evidenced by transient tracers, as shown in Li and Tanhua (2020, https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2020.00594/full). The magnitude of these interannual changes exceeds that of seasonal variability.*
>
> *We identified the Tracer Minimum Zone (TMZ) layer in Figure S2, which presents the mean vertical profiles of CFC-11, CFC-12, and SF_6 across different sub-basins. In addition, Figures S15 and S16 show the temporal evolution of these tracers within the corresponding TMZ of each area. Clearly, even within the TMZ, a temporal evolution is observed in the Alboran, Algerian, Tyrrhenian, and Ionian sub-basins. Therefore, interannual variability, although small, is still significant. This justifies the use of both crossover analysis and the assessment of the temporal evolution of each property within the TMZ layer across different sub-basins or areas (Figures S9 to S14). Only clearly identifiable biases were corrected. As a result, the CARIMED data product is more likely to be slightly under-corrected rather than overcorrected. Seasonal variability is expected to be confined to the upper layers, well above 600 dbar, which corresponds to the minimum depth of the TMZ. Therefore, we consider seasonal variability within the TMZ to be minimal.*

2. The international research community has moved away from the outdated WHP format and has adopted a new standard (https://doi.org/10.3389/fmars.2021.705638). The WHP format was originally shaped by technical constraints of its time, resulting in non-intuitive abbreviations such as ALKALI and TCARBN. Notably, such abbreviations are not used consistently by the authors themselves in the manuscript, where terms such as DIC and TA are used instead. Another example is SAMPNO (Niskin Bottle #), which can be easily confused with Sample_ID, the unique identifier for a data row.

We are aware of the proposed updated vocabulary and column headers for WHP files stored in OCADS (Table 1 in the Frontiers paper), and we agree that they are more consistent and intuitive for certain properties. However, we followed the guidelines provided by A. Kozyr, who was our OCADS point of contact. Implementing these changes would require substantial effort, as it would involve transforming the original files as well as the data products that have already been corrected, formatted, and uploaded. Additionally, such modifications would introduce inconsistencies with the GLODAP-style files currently stored in OCADS. Therefore, we prefer to wait for a broader, coordinated decision among the National Data Centers, particularly NCEI-OCADS, regarding the adoption of standardized vocabulary and header abbreviations in archived files.

3. The provided NetCDF file does not seem to follow a specific template, with numerous empty strings as attributes, impeding readability. The CMIP community provides well-established examples of standardized NetCDF file structures, and I recommend following their templates. Please pay close attention to variable class types. For example, flags, station identifiers, cast numbers, and similar fields can be stored as integers (int32 or int64) rather than doubles to save disk space. In addition, please adopt a single convention for missing values (either NaN or −999, but not both); I recommend using −999. Finally, where possible, please maintain the same variable ordering as in the Excel file to improve consistency.

The NetCDF file has been completely regenerated. The file now uses the CMIP/GO-SHIP/CCHDO profile template structure, following the standards used by in CCHDO library, the conventions = "CF-1.10 ACDD-1.3". The file uses the incomplete multidimensional array representation (CF-1.10 9.3.2) with dimensions N_PROF=2066 (profiles) × N_LEVELS=35 (max bottle samples per profile), with proper coordinate axes and full ACDD-1.3 global attributes. Furthermore, following "CF-1.10 ACDD-1.3", every profile has now defined with featureType = "trajectoryProfile", and spatial axes were included: latitude(N_PROF) (axis=Y), longitude(N_PROF) (axis=X), pressure(N_PROF, N_LEVELS) (axis=Z, positive=down). This eases readability with programs like panoply.

4. When the same variable is measured using multiple methods (e.g., CTDSAL vs. Salinity, CTDOXY vs. Oxygen), both values should be reported. Although a merged column will serve the needs of most users, providing both measurements allows additional quality control by users who wish to perform independent assessments.

We agree with the referee. CARIMED outcomes (Figure 1) solved this issued as following:

- *Individual original cruise data and metadata: they contain the original sensor and discrete data for salinity and oxygen. Only oxygen data could be properly checked, as CTDOXY and OXYGEN were both measured in several cruises (see Section 3.3 and Figure S1). This is not the case for salinity it was mostly measured as either only CTDSAL or only discrete salinometer data (MILLERO_76, GEOSECS_Leg3, OTRANTO_5), just the MEDIPROD_IV, PROSOPE & CRELEV cruises had CTDSAL and SALINITY data, only 315 samples out of 27590 compiled samples.*
- *The Aggregated original cruise contains only CTDSAL data, discrete salinometer data were assigned to the CTDSAL variable with a flag 0, this happened in the MILLERO_76, GEOSECS_Leg3 and OTRANTO_5 cruises (432 samples vs a total of 27590, Table S5). This product contains both CTDOXY values calibrated with OXYGEN (wherever possible) and OXYGEN. Missing OXYGEN were substituted with calibrated CTDOXY and viceversa and assigned a flag 0 (see Section 6.1 and Table S5)*
- *The Bias-adjusted data product: contains only CTDSAL as the previous one, and only OXYGEN. Discrete Winkler data are less abundant but more reliable, missing OXYGEN data was substituted with calibrated CTDOXY data (10860 samples) and original OXYGEN data with flag 3 from 22 samples were interpolated with the Hermitian procedure. Our aim is to provide the best data in a friendly format following the GLODAP procedures, so only single variables for oxygen and salinity were provided in the bias adjusted product.*
- *Curious users can download the two products (samples are ordered equally) or even each original cruise file and check the consistency of our approach.*

More clarifications about this issue have been added in Section 6.1 and 6.2, and Table 3 in the main manuscript.

5. Checking the internal consistency between calculated and measured pH, as well as between calculated and measured carbonate ion content, is a powerful approach for quality control of ocean carbon system variables. If this has not already been done, please consider incorporating this step into the QC procedure.

We respectfully disagree with the referee. There is substantial evidence in the recent literature cautioning against using the mean difference between calculated pH (from DIC and TA) and measured spectrophotometric pH to adjust measured pH values. Detailed discussions can be found in the review papers by Álvarez et al. (2020, https://pubs.acs.org/doi/10.1021/acs.est.9b06932) and Carter et al. (2024, https://aslopubs.onlinelibrary.wiley.com/doi/10.1002/lno.12674). This issue is further complicated when combining spectrophotometric pH measured with purified and unpurified meta-cresol purple, as was done during the CARIMED cruises (see examples in Álvarez et al., 2025, https://aslopubs.onlinelibrary.wiley.com/doi/10.1002/lom3.70023).

Regarding carbonate ion measurements, Guallart et al. (2022, https://pubs.acs.org/doi/10.1021/acs.est.1c06083) clearly demonstrate discrepancies between measured and calculated carbonate ion concentrations (from pH and TA, DIC and TA, or pH and DIC), particularly for samples with high carbonate content, such as Mediterranean Sea waters. Several Mediterranean cruises were included in this review (TALPRO 2016, HOTMIX 2014, MSM72 2018, MEDWAVES 2016), all of which support the conclusion that internal consistency should not be used to identify biases in measured data.

6. pH was reported at 25oC. Consider adding an additional column showing the pH values adjusted to the in-situ conditions.

We have added this variable in Table 3 regarding the bias adjusted data product. Correspondingly, this new variable is described in Section 6.2.

7. SECT_ID values in the NetCDF file are empty, all entries are set to −999, and should instead be stored as strings.

The column has been renamed from SECT_ID to ALIAS throughout all data products (see also Minor comment 2 below). In the new NetCDF file, ALIAS is stored as a character-array (string) variable. Values are taken directly from the source Excel file (column ALIAS), stripped of trailing whitespace, and written without any numeric encoding. Representative values such as MILLERO_76, MEDIPROD_IV, or GEOSECS_LEG3 are now fully readable in the NetCDF file.

8. Time values are not stored correctly in either the Excel or NetCDF files, all values are zero, appearing as "0000" in Excel and 0 in the NetCDF file.

Times are now written as int32 in the NetCDF file and as four-digit zero-padded strings in the WHP-Exchange CSV. Of the 27,590 bottle records, 19,554 now carry a non-zero sampling time. The remaining 8,029 records correspond to older cruises for which sampling time was not originally recorded and retain a value of 0000 (or −999 where explicitly flagged as missing).

9. The date information is currently stored as numerical values in a non-standard format. I recommend splitting the date into three separate columns (Year, Month, and Day). Alternatively, if a single column is preferred, the date should follow the ISO-8601 format (YYYY-MM-DD), which is widely supported by standard software libraries.

The date information should be YYYYMMDD (text) as indicated by NCEI-OCADS rules. Please see Section 3.2 paragraph (i).

10. All the variables should be rounded to an appropriate number of decimal places. Otherwise, the current presentation may give a misleading impression of the measurement uncertainty.

All numerical variables are now rounded to a precision consistent with measurement uncertainty and standard oceanographic practice before any output is produced. The rounding scheme applied is:

Group of variables	*Decimal places*
LATITUDE, LONGITUDE	*4*
CTDPRS, DEPTH, MAXSAMPDEPTH, OXYGEN, AOU, ALKALI, TCARBN	*1*
NITRAT, NITRIT, SILCAT	*1–2*
PHSPHT	*3*
CTDTMP, CTDSAL, THETA, SIGMA0–4, GAMMA, HELIUM, NEON, TRITUM, pH	*4*
CFC-11, CFC-12, CFC-113, CCL4, SF6, partial pressures, DELHE3	*3*
Integer fields (flags, station/cast/date/time)	*0 (stored as int32)*

11. Consider creating two separate folders: one containing the unadjusted values and another containing the bias-adjusted values. That will facilitate data use, as many programs can capture the columns automatically.

We do not clearly understand the suggestion. The final CARIMED data product contains two columns for each biogeochemical variable, the original one (NAME) and the adjusted one (NAME_2QC) as showed in Table 3 of the main manuscript. We wanted, as the referee comments, to facilitate the comparison between original and adjusted data.

12. Consider adding a table to the supplementary information showing all the QC flag changes during the QC process.

We are not sure about this question. Maybe the referee is asking about the 1QC process, how many samples have a 1QC 2, 3 and 0. We guess it relates with the first comment of Referee #1, asking about how many data was discarded from the original cruise data.

Here is a quantification of the flags for the different biogeochemical variables in the two data products. This table can be found as Table S5 in the Supplementary Information and references to this new table can be found in the main manuscript. Data discarded would be those with flag 3 in the aggregated original cruise data product. In the CARIMED Data synthesis product, some of these inorganic nutrient and oxygen data are interpolated if possible and assigned a flag 0.

Table S5. Number of data points with corresponding data flags in the two data products released within CARIMED. The data synthesis product with adjusted data contains no suspicious or wrong data (flag 3) while it contains adjusted data according to the secondary quality control (2QC) procedure.

	Aggregated original cruise data product					Bias adjusted data product			
	Total data	Flag 2	Flag 3	Flag 0	Flag 9	Flag 2	Flag 0	Flag 9	2QC
	With values	Originally measured and good	Originally measured and probably bad	Not measured but interpolated from similar variable	Not measured	Originally measured and good	Not measured but interpolated (similar variable or hermitian)	Not measured or eliminated	Adjusted data
CTDSAL	27590	27158	0	432	0	27158	432	0	2137
SALINITY	26176	746	0	25430	1414	--	--	--	--
CTDOXY	24133	15901	6	8226	3443	--	--	--	--
OXYGEN	24152	13267	25	10860	3438	13267	10882	3441	3880
NITRATE	18794	18628	166	0	8796	18628	1057	7905	4806
SILICATE	18351	18263	88	0	9239	18263	1042	8285	4783

PHOSPHATE	18548	18206	342	0	9042	18206	1118	8266	6972
DIC	4888	4762	126	0	22702	4762	0	22828	1323
TA	9187	9074	113	0	18403	9074	0	18516	1783
pH	6778	6726	50	0	20812	6726	0	20862	0

13. Consider to adopt the concept of a Sampling ID, as it uniquely identifies each data row. This is particularly important when merging measurements from multiple sources into a single file, as done in this study. See the paper mentioned above for additional details about how to derive Sample IDs.

The referee is right that creating a unique Sampling ID such as the Bedford numbers (the PI of the Meteor 84_3 cruise in 2011 Toste Tanhua insisted in using them to identify each sample from the same Station_cast_Niskin) is useful. However, as commented in Section 3.2 different situations were encountered and we could not easily set a Sampling ID using Eq (1) in Jiang et al. (Frontiers, 2022).

Sample_ID=Station_ID×10000+Cast_number×100+Niskin

Therefore, we preferred not reporting the Sampling ID we used for each cruise as it was differently defined depending on the treated cruise.

14. Access to individual cruise data files could be improved by adding, in the abstract, a link to the CARIMED page hosted on NCEI's server: https://www.ncei.noaa.gov/access/ocean-carbon-acidification-data-system/oceans/CARIMED/. This would substantially facilitate access to the underlying cruise-level datasets. In addition, please consider including the dataset DOIs in Table 1. If the table becomes overly wide, some columns could be removed (e.g., Year, which is already contained in the date field).

The referee is right. We have added the link to NCEI-OCADS-CARIMED in the abstract and in the Data availability section. CARIMED will be also accessible through the GLODAP web page (no yet released). A link to the individual cruise data is already provided in Table S2 in the Supplementary Material.

15. Strictly speaking, the use of the term "concentration" is incorrect when the variables are reported using per mass based units. According to the IUPAC Gold Book, the term "content" should be used when referring to amounts expressed per unit mass of seawater, whereas "concentration" refers to the amount of solute per unit volume of solution.

The referee is right and we are happy to correct the term concentration. We have worked with metrologist and are used to use the term "content". We have changed concentration wherever it appear in the manuscript.

Minor comments:

1. Table 1. Align the ordering with the table served through NCEI. Whatever you prefer, but it will be nice to be consistent with each other. *With the permission of the referee we prefer to keep Table 1 with the cruises ordered with time, we think is a nice way of showing the evolution of the measured variables. While in Table S2 and S4 the cruises are presented as in OCADS.*

2. Page 8, Line 171: Cruise ID is not equivalent to Section ID. The latter is a leg or transect that is frequently visited for research purposes, e.g., P16. The former refers to a specific cruise visiting that leg, e.g., P16_2025. *The column is now labelled ALIAS in all three output files (WHP-Exchange CSV, Parquet, NetCDF).*

3. Page 9, line 190. Please specify the equations or software used for this unit conversion and provide the appropriate citations. When calculating density for the conversion, please also indicate which temperature was used.

For oxygen measurements, it is essential to use the temperature at which the Winkler samples were fixed, rather than the room or water-bath temperature that may be used for other variables (e.g., DIC). *The referee is right. But it is impossible to retrieve the "fixing" temperature for winkler samples therefore we used as described in Section 3.2 paragraph (ii): "* Dissolved oxygen (O_2): Expressed in µmol kg^{-1}; data originally in mL L^{-1} were converted using the factor 44.66 mL $µmol^{-1}$ and seawater density derived from salinity and potential temperature."

4. Page 22, Table 3. Hour (HHMM). Shouldn't "hour" be time here?. *The time-of-day column is named TIME in all output products. Its long_name attribute in the NetCDF file is set to "Time (HHMM, UTC)". No field named "hour" appears now in any of the outputs.*

5. In the Excel file, Temperature has no units, only scale. *The units attribute for both CTDTMP and THETA are now set to DegreeCelsius in the NetCDF file and in the units row of the WHP-Exchange CSV. This applies to both the in-situ temperature (CTDTMP) and the potential temperature (THETA). The scale descriptor ITS-90 is retained only as a note in the long_name of CTDTMP ("CTD temperature (in situ)"), while the units field correctly reflects the physical unit.*

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