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GO-SHIP A16N 2023 Leg 2:
NOAA Quality Control and Data Analysis
Report for the Inorganic Carbon Parameters

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August 2025

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August 2025

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Acronyms

GO-SHIP	Global Ocean Ship-Based Hydrographic Investigations Program
AOML	Atlantic Oceanographic and Meteorological Laboratory
CIMAS	Cooperative Institute for Marine and Atmospheric Studies
GOMO	Global Ocean Monitoring and Observing Program
NSF	National Science Foundation
QC	Quality control
CRM	Certified reference material
CO_2	Carbon dioxide
DIC	Total dissolved inorganic carbon
TA	Total alkalinity
fCO_2	Fugacity of carbon dioxide
WOCE	World Ocean Circulation Experiment
CTD	Conductivity/temperature/depth
CCHDO	Clivar and Carbon Hydrographic Data Office
PI	Principal investigator
RSMAES	Rosenstiel School of Marine, Atmospheric, and Earth Science
PMEL	Pacific Marine Environmental Laboratory
mCP	meta-cresol purple
K_1, K_2	Carbonic acid dissociation constants
K_{HSO4}	Bisulfate dissociation constant
K_{HF}	Hydrogen fluoride dissociation constant
B_T/S	Total boron to salinity ratio
S_P	Salinity, practical scale
O_2	Oxygen
Stdev	Standard deviation

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Abstract

The Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP) A16N Leg 2 2023 cruise took place onboard the *NOAA Ship Ronald H. Brown* from April 13 to May 9, 2023, traveling between Rota, Spain and Reykjavik, Iceland. This technical report documents and details the quality control (QC) procedures and data analyses of the inorganic carbon parameter measurements (total alkalinity, TA (μmol kg^{-1}); total dissolved inorganic carbon, DIC (μmol kg^{-1}); pH on the total scale at 25 °C, $pH_T(25)$; and fugacity of CO_2 at 20 °C, $fCO_2(20)$ (μatm)) from 75 conductivity/temperature/depth (CTD) stations. After preliminary QC analyses at sea, secondary QC analyses and internal consistency assessments were conducted in this report as a means to standardize the QC protocols and ensure a fully consistent data set for all four inorganic carbon parameters. Analyses highlight that the inorganic carbon measurements for the A16N Leg 2 2023 cruise follow best-practice measurement protocols.

1. Introduction

The U.S. Global Ocean Ship-based Hydrographic Investigations Program (GO-SHIP) A16N 2023 Leg 2 cruise, led by Chief Scientist Leticia Barbero and Co-Chief Scientist Laura Cimoli, took place onboard the *NOAA Ship Ronald H. Brown* from April 13 to May 9, 2023, traveling between Rota, Spain and Reykjavik, Iceland (Fig. 1). Conductivity/temperature/depth (CTD) casts were conducted at 75 stations, and included measurements of physical properties (salinity (via conductivity), temperature, depth (via pressure)), inorganic carbon parameters (total alkalinity, TA; total dissolved inorganic carbon, DIC; pH on the total scale at 25 °C, $pH_T(25)$; fugacity of carbon dioxide (CO_2) at 20 °C, $fCO_2(20)$), nutrient concentrations (nitrate, nitrite, phosphate, silicate), dissolved oxygen concentration, trace gases (chlorofluorocarbons, CFCs; sulfur hexafluoride, SF_6; nitrous oxide, N_2O), and other ancillary measurements including biological sampling and organic concentrations (dissolved organic carbon). The full cruise report and complete dataset are available for download on the Clivar and Carbon Hydrographic Data Office (CCHDO) website (EXPOCODE: 33RO20230413; https://cchdo.ucsd.edu/cruise/33RO20230413). This report documents and details the quality control (QC) procedures and data analyses of the inorganic carbon parameter measurements (TA (μmol kg^{-1}), DIC (μmol kg^{-1}), $pH_T(25)$, and $fCO_2(20)$ (μatm)). An analogous report contains the published information for the GO-SHIP A16N 2023 Leg 1 cruise (Schockman, 2025).

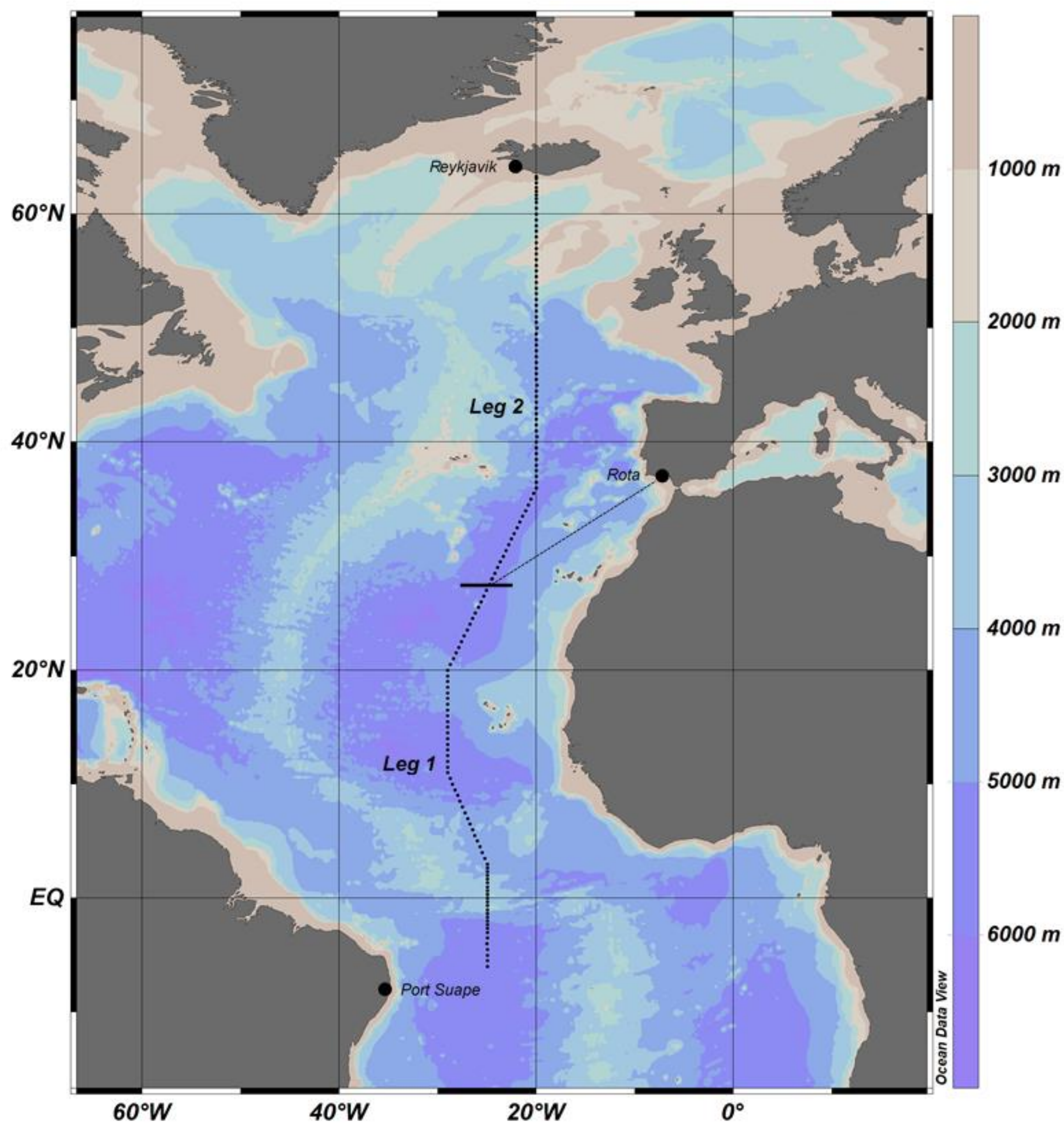

Fig. 1. GO-SHIP A16N 2023 Leg 1 and Leg 2 cruise tracks. The black horizontal bar denotes the cutoff between the two legs of the cruise.

2. Methods

2.1 Data Collation and Primary QC

Details of the measurement protocols for all parameters can be found in the full cruise report. The principal investigators (PI) and analysts for the four inorganic carbon parameters are given in Table 1, with a full list of PIs and analysts for all cruise measurements in the full cruise report. Every sample on the cruise was assigned a sample ID: sample ID = 10000*station + 100*cast + bottle number. Note that the A16N 2023 Leg 2 stations are numbered 76–150 to allow for cohesiveness with the A16N 2023 Leg 1 stations numbered 1–75. While onboard, initial quality flags were assigned to each inorganic carbon measurement following the World Ocean Circulation Experiment (WOCE) protocols as defined in Table 2 (WHP, 1998).

Table 1

PIs and analysts, along with their affiliated institutions, for each of the inorganic carbon parameter measurements. Note: RSMAES – Rosenstiel School of Marine, Atmospheric, and Earth Science; PMEL – Pacific Marine Environmental Laboratory; AOML – Atlantic Oceanographic and Meteorological Laboratory; and CIMAS – Cooperative Institute for Marine and Atmospheric Studies.

Parameter	PI(s)	Institution	Analyst	Institution
TA	Dr. Chris Langdon	U. Miami (RSMAES)	Dr. Bo Yang Jessica Leonard	U. Miami (RSMAES) U. Miami (RSMAES)
DIC	Dr. Richard Feely Dr. Rik Wanninkhof	NOAA PMEL NOAA AOML	Charles Featherstone Dana Greeley	NOAA AOML NOAA PMEL
$pH_T(25)$	Dr. Chris Langdon	U. Miami (RSMAES)	Laura Stieghorst Seamus Jameson	U. Miami (RSMAES) U. Miami (RSMAES)/ San Jose State
$fCO_2(20)$	Dr. Rik Wanninkhof	NOAA AOML	Patrick Mears Dr. Leah Chomiak	U. Miami (CIMAS) U. Miami (CIMAS)

Table 2
WOCE data quality flags used in the GO-SHIP A16N 2023 Leg 2 dataset for the inorganic carbon water samples (WHP, 1998).

Flag Value	Definition
2	Acceptable measurement
3	Questionable measurement
4	Bad measurement
6	Mean of replicate measurements
9	Sample not drawn for this measurement from this bottle

During and after the cruise, some adjustments were made to the inorganic carbon measurements unique to each parameter. For DIC, two systems (AOML3 and AOML4) were concurrently used throughout the cruise. A pipette used in the AOML3 system broke during shipping prior to the cruise, requiring that the volume of the new replacement pipette be recalibrated after the cruise. This resulted in a small, post-cruise adjustment to samples measured on that system. The average absolute difference between the AOML3 initial DIC values and corrected DIC values after the post-cruise pipette calibration was 0.39 ± 0.18 µmol kg^{-1}. The corrected DIC values for AOML3 are the values provided in the CCHDO dataset. For pH_T, measurements were performed near 25 °C, with the exact temperature recorded, and then adjusted to a temperature of 25 °C for reporting purposes (denoted as $pH_T(25)$). Additionally, pH_T measurements were corrected onboard for small perturbations caused by the indicator dye (meta-cresol purple, mCP) on the sample (for more details, see the full cruise report). A16N 2023 Leg 1 and Leg 2 used separate batches of mCP. For fCO_2, measurements were performed near 20 °C, with the exact temperature recorded, and then adjusted to a temperature of 20 °C for reporting purposes (denoted as $fCO_2(20)$). Additionally, fCO_2 samples were calibrated using standard gases measured before and after each set of up to 12 samples (for more details, see the full cruise report).

During A16N 2023 Leg 1, the recorded instrument standard deviations were observed to be high for all fCO_2 measurements. To remedy this, the gas analyzer (LI-COR) was replaced between Leg 1 and Leg 2. Subsequent QC checks were performed by the parameter leads after all corrections and adjustments were made to flag any noticeable outliers.

The precision of measurements for each of the inorganic carbon parameters was assessed through routine duplicate measurements on a subset of samples throughout the cruise (Tables 3–6; see Additional Tables section below). For full, 24-bottle Niskin casts, TA and $pH_T(25)$ generally selected two sets of duplicates randomly throughout the cast. Each duplicate pair was run back-to-back during analysis. TA and $pH_T(25)$ used one sample bottle for both measurements, so the duplicate pairs were generally the same for both parameters. For DIC, typically three sets of duplicates were randomly selected from near the bottom, mid-depth, and surface Niskin bottles. Each duplicate pair was spread out throughout the titration cell run, with duplicate measurements specifically not run back-to-back. For $fCO_2(20)$, generally one set of duplicates was randomly selected throughout the cast. The duplicate pair was run back-to-back during analysis. To read more details about duplicate measurements, please see the full cruise report.

2.2 Secondary QC

After the primary QC discussed above, the inorganic carbon data were collated to perform secondary QC checks. Measurements of TA, DIC, $pH_T(25)$, and $fCO_2(20)$ with WOCE quality flags of 2, 3, 4, and 6 (Table 2) were kept for this analysis. Internal consistency of these measurements was assessed by comparing measured and calculated values for each of the inorganic carbon parameters. Generally, the closer measured and calculated values are to one another, the more internally consistent the dataset is said to be. Calculations of the inorganic carbon parameters were made using CO2SYS (Pierrot et al., 2006; Van Heuven et al., 2011) version 3.1.1 for MATLAB (Sharp et al., 2020). All calculations were performed on the total pH_T scale using the following parameters: carbonic acid dissociation constants (K_1 and K_2) of Lueker et al. (2000), bisulfate dissociation constant (K_{HSO4}) of Dickson (1990), hydrogen fluoride dissociation constant (K_{HF}) of Perez and Fraga (1987), and total boron to salinity ratio (B_T/S) of Lee et al. (2010). Calculations generally utilized the salinities (practical scale; S_P) from discrete bottles measured onboard unless the measured salinity value was not flagged as 2 or 6, in which case the salinity value from the CTD sensor was used.

Calculated values of a parameter X obtained using inputs of Y and Z are denoted throughout the document as 'X(Y,Z)'. The difference between measured X and X(Y,Z) is a residual of X and is denoted as 'ΔX' (i.e., ΔX = X – X(Y,Z)). As all four inorganic carbon parameters were measured, and only two parameters are required for a single calculation, each inorganic carbon parameter was generally calculated using three sets of combination pairs (i.e., TA can be calculated using (DIC, pH_T(25)), (DIC, fCO_2(20)), and (pH_T(25), fCO_2(20)). If any of the inorganic carbon parameter measurements were missing for that sample, only the available combination pairs were used. Calculations using the (pH_T(25), fCO_2(20)) input pair were used for analyses in some situations, especially where one of the other inorganic carbon parameters was missing, but are generally not shown throughout the document as they are not recommended according to best practices (Patsavas et al., 2015). The residuals for each of the inorganic carbon parameters were analyzed to check for outlier sample values via a quantitative process described below.

For all 75 stations, depth profiles were created for measurements of discrete oxygen (O_2), CTD sensor O_2, discrete S_P, CTD sensor S_P, TA, DIC, pH_T(25), and fCO_2(20). These depth profiles were used in this work for visual indication of potential outliers and/or Niskin bottles fired/closed at incorrect depths.

2.3 Certified Reference Material (CRM) Checks Throughout the Cruise

CRMs provided by Dr. Andrew Dickson's laboratory at Scripps Institution of Oceanography were used to assess the accuracy of both TA and DIC measurements throughout the cruise. For TA measurements, CRMs were used to standardize the HCl acid concentration used in the TA titrations and to check that the system was functioning properly. For each DIC system, CRMs were run at the beginning of a subset of sample measurements corresponding to a specific titration cell, which typically was used for one station's worth of samples. The difference between the measured CRM DIC value and certified CRM DIC value was used to adjust the system for that specific subset of measurements. For more details, see the full cruise report.

3. Results

3.1 Primary and Secondary QC Checks

The duplicate measurements of TA, DIC, $pH_T(25)$, and $fCO_2(20)$ are provided in Tables 3–6, including both individual duplicate values and the absolute difference between the two measurements. The average ± standard deviation (stdev; 1σ) of the absolute differences between duplicates for each parameter is as follows — TA: 1.0 ± 0.8 μmol kg^{-1} (*n* = 124 duplicate measurement pairs); DIC: 1.8 ± 1.4 μmol kg^{-1} (*n* = 168 duplicate measurement pairs); $pH_T(25)$: 0.0013 ± 0.0013 (*n* = 145 duplicate measurement pairs); and $fCO_2(20)$: 0.5 ± 0.3 μatm (0.07 ± 0.06%) (*n* = 75 duplicate measurement pairs) (Table 7).

Table 7
Inorganic carbon parameter statistics from the primary and secondary QC checks. Data include the average absolute difference between duplicate measurements ± 1σ stdev for each parameter. Also shown are the mean calculated residuals (measured – calculated) ± 3σ stdev threshold values for each parameter subsetted by input pair used in the calculations.

Parameter	Measurements: Avg. duplicate difference ± 1σ stdev	Calculations: Mean residual ± 3σ stdev
TA	1.0 ± 0.8	DIC, pH_T(25): 0 ± 12
(μmol kg^{-1})	(*n* = 124)	DIC, fCO_2(20): –10 ± 12
DIC	1.8 ± 1.4	TA, pH_T(25): 0 ± 12
(μmol kg^{-1})	(*n* = 168)	TA, fCO_2(20): 8 ± 11
pH_T(25)	0.0013 ± 0.0013	TA, fCO_2(20) and DIC, fCO_2(20): –0.02 ± 0.01
	(*n* = 145)	TA, DIC: 0.00 ± 0.03
fCO_2(20)	0.5 ± 0.3	TA, pH_T(25) and DIC, pH_T(25): –5% ± 3%
(μatm)	(*n* = 75)	TA, DIC: –5% ± 7%

Residuals of TA, DIC, pH_T(25), and fCO_2(20) were calculated with the full dataset using all available sets of input pairs. The mean residuals ± 3σ stdev for residuals calculated using various sets of input pairs are provided in Table 7. These mean residuals ± 3σ stdev values were used as a quantitative threshold for quality control purposes. Any residual greater than 3σ from the mean residual value was flagged for further analysis. In contrast to the A16N 2023 Leg 1 residuals (Schockman, 2025), the residuals calculated for A16N 2023 Leg 2 were more dissimilar for a single parameter depending on which set of input parameters was used (e.g., the mean residual ± 3σ stdev thresholds for TA calculated using (DIC, pH_T(25)) and (DIC, fCO_2(20)) were different; see Table 7). Therefore, the mean residual ± 3σ stdev values were individually calculated specific to the input pairs used and these respective thresholds were implemented during the flagging process. A list of samples was collated based on these residual flagging guidelines and sent to each of the responsible PIs for additional inspection. Also included in the list were sample points originally flagged as 3 or 4 onboard, but had calculated residuals within the thresholds and no visual indications of an outlier. In these cases, the recommendation was for the PI to check the original data to determine if any of these flags should be changed to a 2.

In general, residuals calculated using one temperature independent parameter (i.e., TA or DIC) and one temperature dependent parameter ($pH_T(25)$ or $fCO_2(20)$) were preferred for flagging purposes. Due to the availability of multiple residuals for each inorganic carbon parameter, it was often clear which, if any, of the four parameters was an incorrect value. As an example, for sample ID #1030222, ΔDIC was –32.8 μmol kg^{-1} using the (TA, $pH_T(25)$) pair and –3.7 μmol kg^{-1} using the (TA,$fCO_2(20)$) pair. Similarly, ΔTA was 35.0 μmol kg^{-1} using the (DIC, $pH_T(25)$) pair and 4.4 μmol kg^{-1} using the (DIC,$fCO_2(20)$) pair. Furthermore, ΔpH_T residuals calculated using all input pairs (on the order of –0.055) were larger than the 3σ stdev threshold. It would be reasonable to state that the $pH_T(25)$ value for this sample is likely an outlier, while the TA, DIC, and $fCO_2(20)$ measurements are more internally consistent with one another. In this instance, the recommendation would be to flag this $pH_T(25)$ sample as a 3 or 4. In cases where multiple residuals for an individual sample were high and it was unclear which parameter may be incorrect, additional data and visual identification were used for further inspection.

All points visually identified as outliers in the depth profiles of TA, DIC, $pH_T(25)$, or $fCO_2(20)$ were included in the list of sample points sent to PIs for additional inspection. Depth profiles of CTD sensor O_2 and discrete O_2 were used to determine if a Niskin bottle had been misfired at an incorrect depth and/or if a Niskin bottle had leaked. Comparisons of CTD sensor S_P and discrete S_P were also used as a secondary check for Niskin bottle issues. The sampling log sheets and CTD console log sheets were checked for any reported issues at the time of the CTD cast and/or sampling during the cruise. The combination of depth profile and log sheet checks was used to assign Niskin bottle flags for each sample to be included in the full dataset on CCHDO.

Overall, the recommendations for flag changes were assembled and sent to each of the PIs/parameter leads who checked the data points and had the ultimate say for which (if any) flags should be changed. The number of recommended flag changes and the percentage of these flag changes accepted for each parameter are provided in Table 8. In some cases, the PIs/parameter leads concluded that a flagged parameter value in question was incorrect, and an updated value was provided in lieu of changing the flag designation (these values were still counted as "accepted flag changes" in Table 8). Once the data values and flags were updated, the final inorganic carbon data were submitted to CCHDO to be included with the full cruise dataset.

Table 8
The number of flag changes recommended to each inorganic carbon PI and the number of flag changes accepted (both as a number and as a percentage of the total recommended).

Parameter	Recommended flag changes	Accepted flag changes	Percentage of recommended flag changes accepted
TA	2	2	100%
DIC	2	2	100%
$pH_T(25)$	10	11	91%
$fCO_2(20)$	4	4	100%

3.2 CRM Checks Throughout the Cruise

For A16N 2023 Leg 2 DIC measurements, 65 CRMs were run on two identical systems denoted as AOML3 (n = 34) and AOML4 (n = 31). The average absolute difference between the measured CRM DIC and certified CRM DIC values was 5.8 ± 1.8 µmol kg^{-1} (1σ) for AOML3 and 0.9 ± 0.6 µmol kg^{-1} (1σ) for AOML4. The differences between measured CRM DIC and certified

CRM DIC values remained generally constant throughout time for both systems, though the differences encompassed a wider range for the AOML3 system compared to the AOML4 system (Fig. 2). The AOML3 system had differences that were consistently negative (i.e., measured CRM DIC was consistently lower than certified CRM DIC), while the AOML4 system differences were evenly distributed about zero. For additional details regarding CRM usage for HCl standardization in TA measurements, please reach out to the individual PI (Table 1).

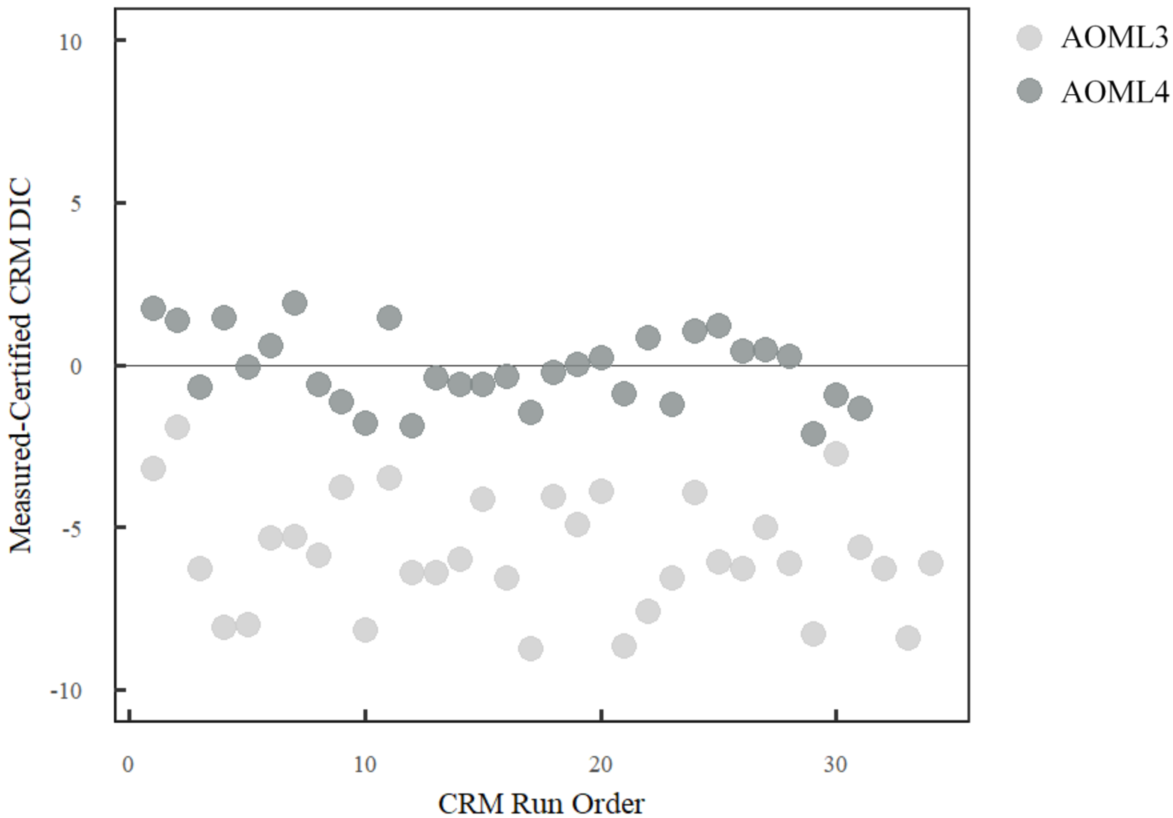

Fig. 2. Differences between measured CRM DIC and certified CRM DIC values shown in terms of the order the CRMs were measured (i.e., throughout the duration of the cruise). As specified above, each difference value between the measured CRM DIC and certified CRM DIC was used to adjust the corresponding subset of measurements for that titration cell, which was replaced approximately every 12 hours. Color denotes the DIC system (AOML3 or AOML4) that corresponds to the CRM measurement.

3.3 CO_2-System Internal Consistency

Internal consistency assessments shown below were made using the final dataset of inorganic carbon parameters on CCHDO after PI flag changes were incorporated (https://cchdo.ucsd.edu/cruise/33RO20230413). Residuals were calculated for all samples where at least three or more inorganic carbon parameters were measured using all available sets of input parameters. Only data with good (2) or duplicate (6) data flags were used for these final internal consistency assessments. (Initial internal consistency assessments were used as a means of secondary QC as described above. However, the data ultimately determined to be questionable (3) or bad (4) quality were removed from this final assessment.)

Residuals of TA and DIC (denoted as ΔTA and ΔDIC) are generally evenly distributed for the full range of measured TA and DIC (Figs. 3 and 4). For calculations of both TA and DIC, residuals calculated using $f\mathrm{CO_2}$(20) as one of the input parameters are in general further from zero compared to residuals calculated using $\mathrm{pH_T}$(25) as one of the input parameters. The offsets observed in the TA and DIC residuals calculated using $f\mathrm{CO_2}$(20) appear to be more pronounced than the A16N 2023 Leg 1 TA and DIC residuals calculated in the same manner (Schockman, 2025). In contrast, the TA and DIC residuals calculated using $\mathrm{pH_T}$(25) are evenly distributed about zero for both A16N 2023 Leg 1 and Leg 2. ΔTA and ΔDIC values calculated using the ($\mathrm{pH_T}$(25), $f\mathrm{CO_2}$(20)) input pair are not shown as they are larger in magnitude and not recommended according to best practices (Patsavas et al., 2015).

Fig. 3. Residuals of TA (ΔTA = measured TA – calculated TA; µmol kg^{-1}) shown in terms of measured TA. Color denotes the input pair used for TA calculations: (DIC, $pH_T(25)$) or (DIC, $fCO_2(20)$).

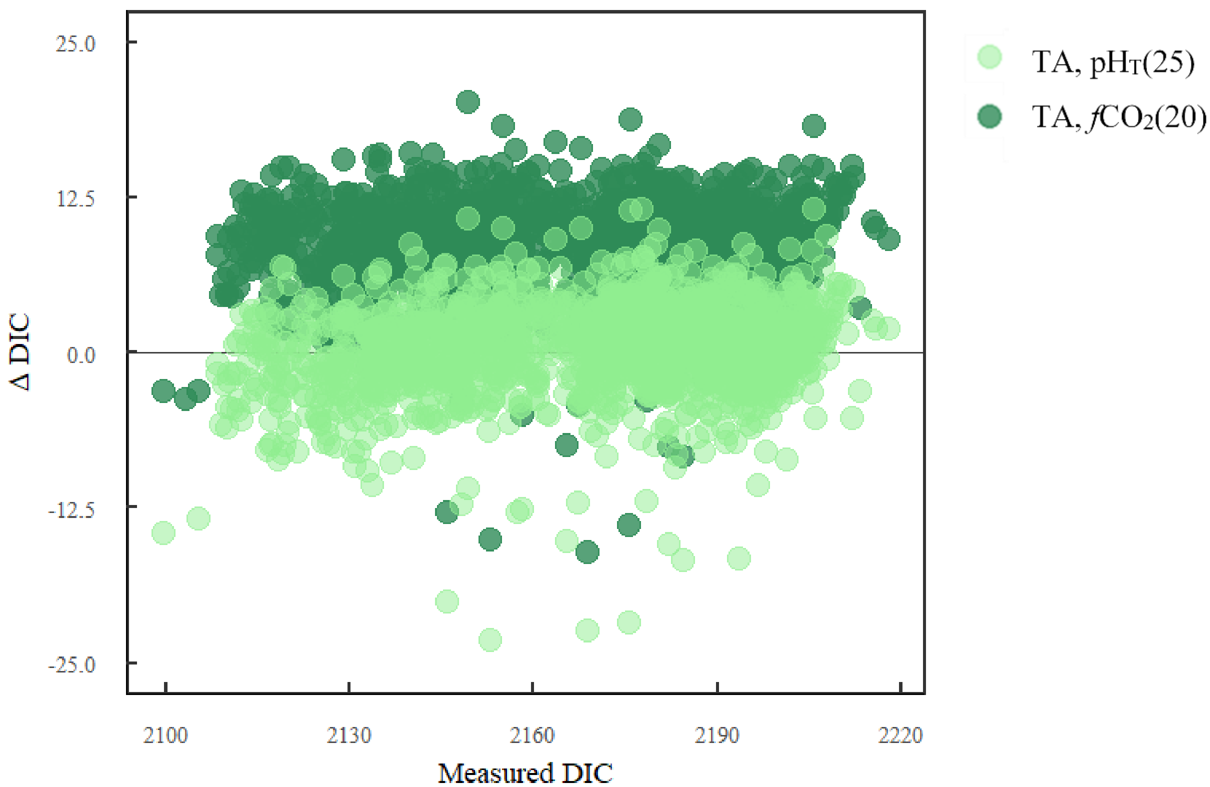

Fig. 4. Residuals of DIC (ΔDIC = measured DIC – calculated DIC; µmol kg^{-1}) shown in terms of measured DIC. Color denotes the input pair used for DIC calculations: (TA, $pH_T(25)$) or (TA, $fCO_2(20)$).

Residuals of $pH_T(25)$ (denoted as $\Delta pH_T(25)$) generally show an even distribution of residuals for the full range of measured $pH_T(25)$ (Fig. 5). $\Delta pH_T(25)$ values calculated using the (TA, DIC) input pair encompass a larger magnitude than $\Delta pH_T(25)$ values calculated using (DIC, $fCO_2(20)$) and (TA, $fCO_2(20)$). This finding is expected as it is generally recommended to pair one temperature-independent parameter (i.e., TA or DIC) with one temperature-dependent parameter (i.e., $pH_T(25)$ or $fCO_2(20)$) in calculations. $\Delta pH_T(25)$ values calculated using the (TA, DIC) input pair are generally evenly spread about zero for the full range of measured $pH_T(25)$ with no apparent slope. Similar to A16N 2023 Leg 1 (Schockman, 2025), the previously reported pH-dependent pH offset detected between measured pH and pH(TA, DIC) in many large-scale, oceanographic datasets (McElligott et al., 1998; Williams et al., 2017) is not observed for A16N 2023 Leg 2 data. $\Delta pH_T(25)$ values calculated using both (DIC, $fCO_2(20)$) and (TA, $fCO_2(20)$) are evenly distributed for the full range of measured $pH_T(25)$ though there is a consistent, negative offset in the residual values. This finding suggests that calculated $pH_T(25)$ values using $fCO_2(20)$ as one of the input parameters are consistently overestimated compared to the respective measured $pH_T(25)$ values. The negative offsets in $pH_T(25)$ residuals calculated using $fCO_2(20)$ appear to be larger in magnitude for the A16N 2023 Leg 2 data compared to Leg 1 data. A piece of equipment for $fCO_2(20)$ measurements was replaced between A16N 2023 Leg 1 and Leg 2 (see Section 2.1), which may be responsible for these observed differences.

Residuals of $fCO_2(20)$ as a percentage of measured $fCO_2(20)$ (denoted as $\Delta fCO_2(20)$ (%)) generally show an even distribution of residuals for the full range of measured $fCO_2(20)$ (Fig. 6). $\Delta fCO_2(20)$ (%) values calculated using all three sets of input pairs have a consistent, negative offset in the residual values. The negative offsets in $fCO_2(20)$ (%) residuals appear to be larger in magnitude for the A16N 2023 Leg 2 data compared to Leg 1 data. As mentioned above, $fCO_2(20)$ measurement equipment was replaced between Leg 1 and Leg 2, which may be responsible for these observed differences. Similar to $\Delta pH_T(25)$ (TA, DIC), $\Delta fCO_2(20)$ (%) values calculated using the (TA, DIC) input pair encompass a larger magnitude than $\Delta fCO_2(20)$ (%) values calculated using (DIC, $pH_T(25)$) and (TA, $pH_T(25)$), which is an expected observation.

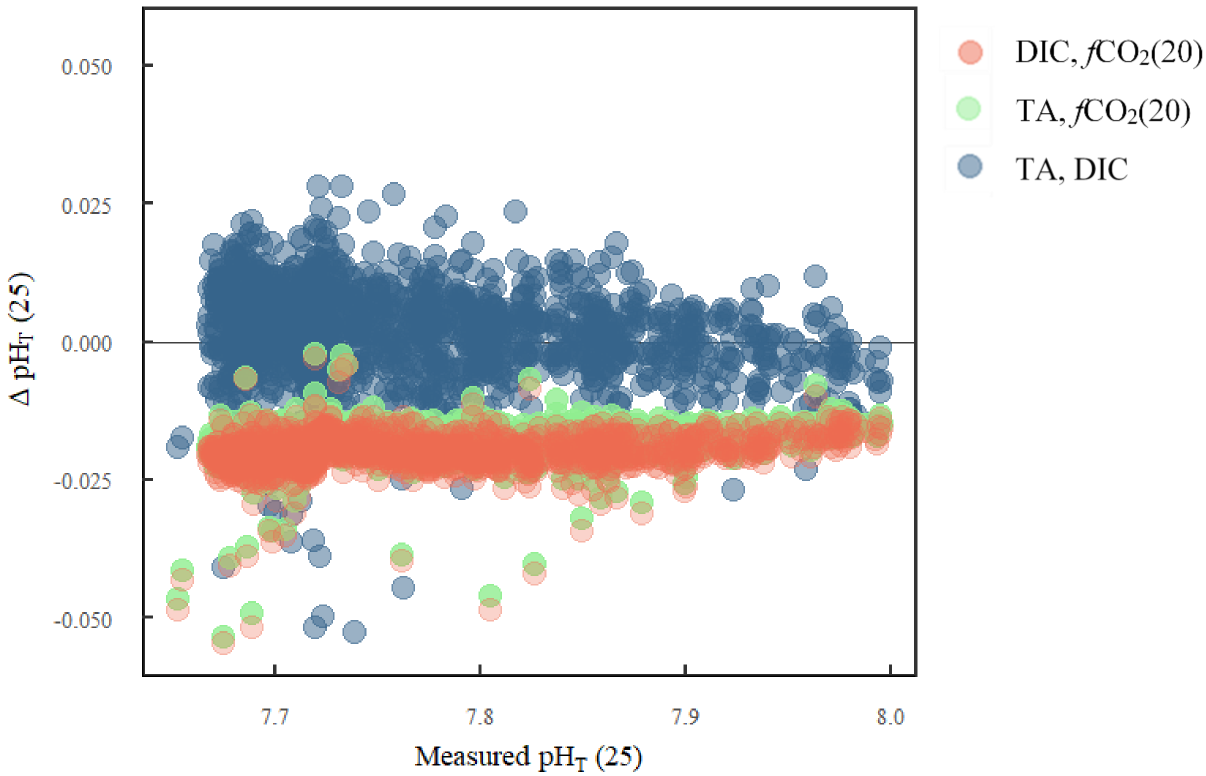

Fig. 5. Residuals of $pH_T(25)$ ($\Delta pH_T(25)$ = measured $pH_T(25)$ – calculated $pH_T(25)$) shown in terms of measured $pH_T(25)$. Color denotes the input pair used for $pH_T(25)$ calculations: (DIC, $fCO_2(20)$), (TA, $fCO_2(20)$), or (TA, DIC). Note that the (DIC, $fCO_2(20)$) and (TA, $fCO_2(20)$) points overlap such that (TA, $fCO_2(20)$) symbols are masked.

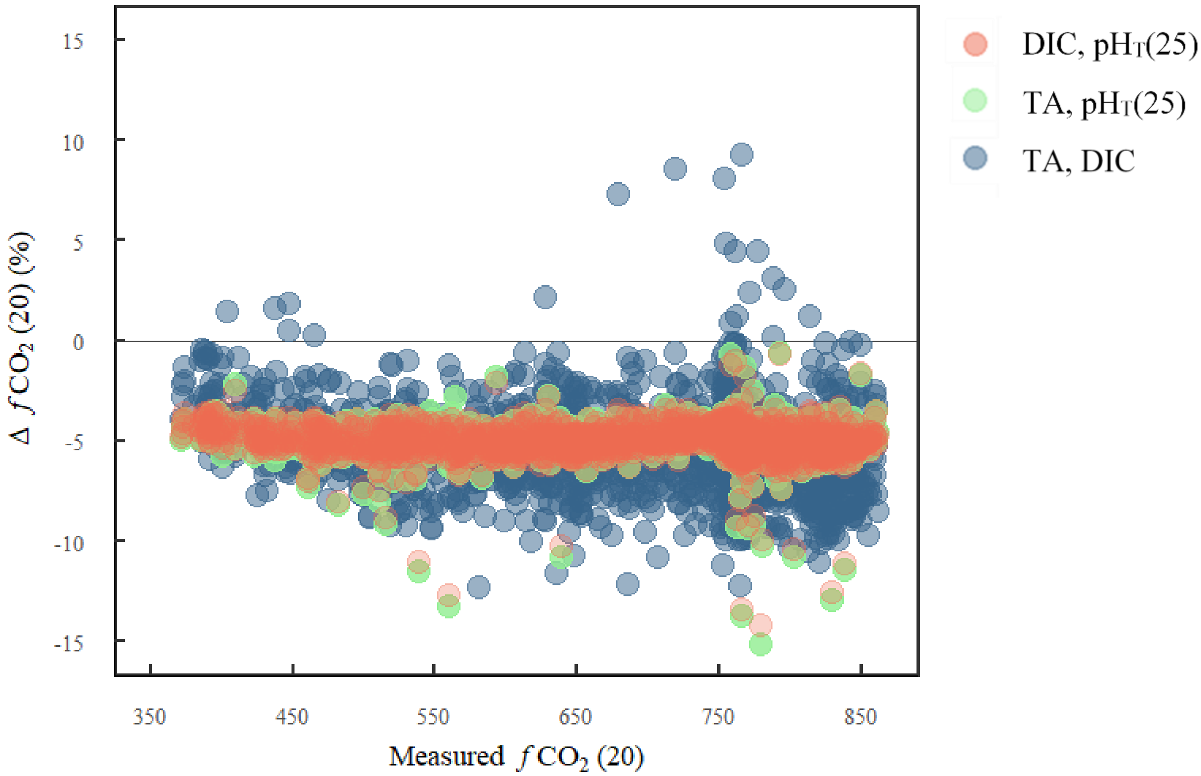

Fig. 6. Residuals of $fCO_2(20)$ as a percentage of measured $fCO_2(20)$ ($\Delta fCO_2(20)$ (%) = (measured $fCO_2(20)$ – calculated $fCO_2(20)$) / measured $fCO_2(20)$ *100) shown in terms of measured $fCO_2(20)$. Color denotes the input pair used for $fCO_2(20)$ calculations: (DIC, $pH_T(25)$), (TA, $pH_T(25)$), or (TA, DIC). Note that the (DIC, $pH_T(25)$) and (TA, $pH_T(25)$) points overlap such that (TA, $pH_T(25)$) symbols are masked.

4. Conclusions

This report highlights and describes the quality control measures of the inorganic carbon parameters for the A16N 2023 Leg 2 dataset. The full cruise report located on CCHDO's website contains additional information regarding measurement details and techniques. In general, the inorganic carbon system measurements appear to be of the highest quality standard expected of

GO-SHIP cruises. Like A16N 2023 Leg 1 (Schockman, 2025), Leg 2 also contains measurements of all four inorganic carbon parameters, allowing for a more thorough internal consistency analysis with multiple sets of calculations for each parameter. An important observation is the systematic offset observed when using $f\text{CO}_2(20)$ as an input parameter for calculations, and the corresponding offset between measured and calculated $f\text{CO}_2(20)$ values. Several reasons for these differences, including known inconsistencies in the inorganic carbon system calculations, have been described elsewhere (Woosley and Moon, 2023; Schockman et al., 2024; Schockman, 2025). Similar to A16N 2023 Leg 1, the offsets in $f\text{CO}_2(20)$ are presented as a relative (%) difference with larger absolute differences at higher $f\text{CO}_2(20)$ values that could be caused by analytical issues, in particular loss of CO_2 from the headspace during analysis. However, no such issue is apparent in laboratory tests. The internal consistency assessments described here and the notable discrepancies between measured and calculated $f\text{CO}_2(20)$ further highlight the need for more routine measurements of $f\text{CO}_2(20)$ to conduct these types of comparisons.

5. Additional Tables

Table 3
Individual duplicate measurement values of TA (μmol kg^{-1}; duplicate one and duplicate two), measured back-to-back, as well as the absolute difference between duplicates. Measurements are provided according to their sample ID.

Sample ID	TA: Duplicate One	TA: Duplicate Two	Absolute Difference
760102	2349.03	2346.26	2.77
760123	2433.78	2436.25	2.47
770118	2346.98	2347.52	0.54
780209	2325.98	2325.39	0.59
780223	2427.00	2426.85	0.15
790107	2336.68	2336.64	0.04
790116	2354.94	2353.29	1.65
800204	2340.99	2342.05	1.06
800220	2389.94	2390.83	0.89
810111	2324.46	2323.42	1.04
810123	2420.99	2421.13	0.14
820104	2342.79	2343.10	0.31
820121	2395.40	2396.82	1.42
830203	2342.92	2342.44	0.48
830215	2343.11	2344.21	1.10
840106	2337.68	2337.97	0.29
840120	2372.29	2370.00	2.29
850107	2337.19	2335.71	1.48
850116	2334.91	2336.53	1.62
860104	2340.60	2340.34	0.26
860111	2319.61	2319.71	0.10
870109	2319.88	2319.87	0.01
870120	2371.78	2372.37	0.59
880113	2328.35	2327.57	0.78
880116	2335.50	2335.61	0.11
890206	2337.06	2338.00	0.94
890213	2326.11	2327.71	1.60
900113	2337.22	2338.52	1.30
900122	2377.32	2378.05	0.73
910104	2342.44	2340.86	1.58
910112	2319.59	2318.15	1.44
920309	2322.70	2322.36	0.34
920314	2355.96	2356.28	0.32
930113	2341.01	2343.10	2.09
930119	2343.36	2342.16	1.20
940103	2332.56	2333.09	0.53

940117	2356.11	2356.61	0.50
950205	2336.69	2337.20	0.51
950216	2334.59	2334.31	0.28
960306	2333.33	2332.83	0.50
960315	2326.84	2330.11	3.27
970109	2357.87	2358.94	1.07
970119	2360.26	2359.61	0.65
980206	2317.18	2315.85	1.33
980213	2343.51	2345.23	1.72
990218	2347.82	2347.46	0.36
990223	2361.16	2362.94	1.78
1000108	2308.71	2308.41	0.30
1000117	2348.81	2349.18	0.37
1010105	2331.13	2331.00	0.13
1010111	2352.84	2351.11	1.73
1020110	2349.63	2348.10	1.53
1020121	2356.19	2357.20	1.01
1030205	2333.07	2334.45	1.38
1030220	2353.62	2353.92	0.30
1040102	2308.44	2305.27	3.17
1040113	2339.59	2339.88	0.29
1050105	2307.56	2308.30	0.74
1050116	2345.29	2343.74	1.55
1060114	2331.01	2331.10	0.09
1060119	2345.53	2344.89	0.64
1070106	2308.20	2308.62	0.42
1070116	2337.93	2339.64	1.71
1080203	2329.16	2330.27	1.11
1080214	2336.52	2335.09	1.43
1090102	2346.19	2346.28	0.09
1090123	2348.14	2347.71	0.43
1100107	2300.72	2301.98	1.26
1100119	2348.77	2346.36	2.41
1110103	2339.14	2338.84	0.30
1110118	2346.65	2346.90	0.25
1120210	2306.48	2306.75	0.27
1120220	2347.68	2347.96	0.28
1130108	2303.25	2300.22	3.03
1130117	2338.86	2336.98	1.88
1140104	2338.38	2337.60	0.78
1140121	2347.72	2345.38	2.34
1150109	2298.48	2299.22	0.74
1150116	2330.55	2330.38	0.17
1160113	2320.62	2321.21	0.59

1160121	2345.44	2347.33	1.89
1170109	2313.66	2312.70	0.96
1170113	2318.87	2318.91	0.04
1180104	2333.01	2333.20	0.19
1180119	2334.65	2336.39	1.74
1190106	2298.92	2298.70	0.22
1190121	2335.90	2336.87	0.97
1200108	2298.80	2299.65	0.85
1200112	2323.85	2324.30	0.45
1210110	2307.85	2309.48	1.63
1210118	2322.14	2324.77	2.63
1220105	2303.13	2304.03	0.90
1220115	2314.06	2314.87	0.81
1230202	2347.65	2348.68	1.03
1230217	2317.74	2316.19	1.55
1240109	2302.21	2303.93	1.72
1240119	2328.67	2327.54	1.13
1250103	2300.28	2300.51	0.23
1250123	2334.81	2333.56	1.25
1260206	2300.92	2301.60	0.68
1260214	2324.38	2324.93	0.55
1270110	2311.90	2313.68	1.78
1270118	2322.18	2322.54	0.36
1280103	2311.01	2311.64	0.63
1280113	2328.66	2329.39	0.73
1290105	2318.88	2318.94	0.06
1290114	2327.13	2328.54	1.41
1300117	2314.00	2314.60	0.60
1310221	2319.79	2318.13	1.66
1340111	2328.50	2326.60	1.90
1340115	2325.58	2324.12	1.46
1350117	2318.22	2320.42	2.20
1360103	2301.56	2301.87	0.31
1360119	2322.03	2323.82	1.79
1370112	2312.05	2310.71	1.34
1380208	2302.84	2300.36	2.48
1380222	2322.25	2320.70	1.55
1390104	2297.81	2300.10	2.29
1390114	2317.81	2318.10	0.29
1400210	2309.62	2309.72	0.10
1400217	2320.05	2321.06	1.01
1420112	2312.17	2312.62	0.45
1420119	2318.93	2319.04	0.11
1450207	2310.81	2309.10	1.71

Table 4
Individual duplicate measurement values of DIC (µmol kg^{-1}; duplicate one and duplicate two), measured randomly throughout a cell run, as well as the absolute difference between duplicates. Also included is the system on which each set of duplicates was run (AOML3 or AOML4). Measurements are provided according to their sample ID.

Sample ID	DIC: Duplicate One	DIC: Duplicate Two	Absolute Difference	System
760101	2201.89	2202.22	0.34	AOML4
760115	2166.64	2170.68	4.04	AOML4
760124	2131.83	2132.24	0.40	AOML4
770101	2200.39	2196.74	3.65	AOML3
770117	2172.05	2173.79	1.74	AOML3
770124	2127.06	2127.66	0.59	AOML3
780216	2191.18	2190.47	0.71	AOML4
780224	2140.55	2136.42	4.13	AOML4
790102	2196.76	2199.41	2.65	AOML3
790117	2170.17	2173.16	2.99	AOML3
790124	2129.13	2123.82	5.32	AOML3
800202	2197.61	2197.20	0.41	AOML4
800215	2196.03	2196.83	0.80	AOML4
800224	2132.54	2130.62	1.92	AOML4
810102	2200.16	2202.34	2.18	AOML3
810116	2191.07	2195.96	4.89	AOML3
810124	2133.40	2133.72	0.33	AOML3
820102	2199.86	2200.85	0.99	AOML4
820116	2186.50	2189.91	3.41	AOML4
820124	2127.02	2125.33	1.69	AOML4
830216	2186.41	2190.48	4.07	AOML3
830224	2125.60	2124.85	0.75	AOML3
840103	2200.01	2202.43	2.41	AOML4
840114	2205.66	2207.05	1.39	AOML4
850102	2198.49	2201.95	3.46	AOML3
850115	2197.39	2203.19	5.80	AOML3
850124	2135.36	2130.82	4.54	AOML3
860116	2183.94	2186.02	2.07	AOML4
860124	2118.65	2118.36	0.29	AOML4
870102	2198.69	2201.94	3.25	AOML3
870116	2183.99	2184.40	0.41	AOML3
870123	2120.87	2119.25	1.62	AOML3
880102	2201.64	2199.69	1.95	AOML4
880117	2168.05	2169.26	1.20	AOML4
880124	2125.62	2123.97	1.65	AOML4
890201	2204.61	2202.84	1.77	AOML3
890215	2201.93	2201.66	0.27	AOML3

890222	2117.40	2118.86	1.46	AOML3
900101	2202.68	2205.10	2.42	AOML4
900115	2198.79	2199.43	0.64	AOML4
900124	2119.60	2121.38	1.79	AOML4
910101	2201.60	2203.62	2.02	AOML3
910117	2173.03	2171.61	1.42	AOML3
920301	2204.06	2202.09	1.97	AOML4
920316	2194.41	2193.97	0.44	AOML4
920321	2138.52	2139.85	1.32	AOML4
930102	2202.54	2205.62	3.08	AOML3
930115	2203.62	2203.00	0.61	AOML3
930123	2119.35	2123.25	3.89	AOML3
940102	2198.26	2201.08	2.82	AOML4
940112	2190.88	2191.98	1.10	AOML4
940124	2122.70	2120.65	2.06	AOML4
950201	2202.22	2202.32	0.10	AOML3
950211	2200.73	2203.24	2.51	AOML3
950224	2110.70	2108.30	2.40	AOML3
960302	2199.31	2203.39	4.08	AOML4
960314	2183.08	2182.21	0.86	AOML4
960324	2110.05	2113.34	3.29	AOML4
970101	2201.02	2200.48	0.53	AOML3
970110	2205.03	2201.97	3.06	AOML3
970124	2107.59	2112.01	4.42	AOML3
980201	2206.65	2205.51	1.14	AOML4
980212	2199.85	2200.33	0.47	AOML4
990201	2205.68	2205.57	0.11	AOML3
990212	2205.06	2205.07	0.01	AOML3
990224	2112.48	2113.07	0.59	AOML3
1000102	2199.20	2201.97	2.77	AOML4
1000112	2192.70	2194.36	1.67	AOML4
1000124	2110.73	2111.47	0.74	AOML4
1010102	2200.66	2200.51	0.14	AOML3
1010113	2192.37	2190.04	2.32	AOML3
1010124	2111.24	2105.44	5.80	AOML3
1020102	2203.55	2204.13	0.58	AOML4
1020124	2113.03	2115.72	2.70	AOML4
1030202	2172.21	2170.31	1.90	AOML3
1030224	2103.02	2095.74	7.28	AOML3
1040103	2171.99	2171.14	0.86	AOML4
1040112	2162.55	2161.52	1.04	AOML4
1040124	2112.99	2114.52	1.53	AOML4
1060101	2206.10	2209.22	3.12	AOML4
1060112	2201.66	2204.52	2.86	AOML4

1060122	2133.85	2132.04	1.81	AOML4
1070101	2209.16	2208.03	1.14	AOML3
1070111	2196.74	2195.99	0.75	AOML3
1070124	2115.15	2114.57	0.58	AOML3
1080201	2204.90	2203.71	1.18	AOML4
1080211	2182.57	2183.09	0.53	AOML4
1080224	2110.21	2109.93	0.28	AOML4
1090101	2206.86	2204.01	2.84	AOML3
1090112	2184.04	2184.17	0.13	AOML3
1090124	2113.75	2116.22	2.48	AOML3
1100101	2207.86	2207.78	0.08	AOML4
1100111	2194.68	2192.10	2.57	AOML4
1100124	2116.08	2116.60	0.51	AOML4
1110101	2208.32	2208.31	0.01	AOML3
1110112	2185.71	2188.83	3.12	AOML3
1110124	2115.41	2114.25	1.16	AOML3
1120203	2203.59	2202.19	1.40	AOML4
1120214	2179.79	2177.64	2.15	AOML4
1120224	2114.87	2116.63	1.76	AOML4
1130101	2206.99	2205.03	1.95	AOML3
1130113	2188.24	2192.70	4.46	AOML3
1130124	2117.30	2113.64	3.66	AOML3
1140101	2208.49	2206.75	1.74	AOML4
1140112	2193.72	2190.45	3.28	AOML4
1140124	2112.45	2112.07	0.38	AOML4
1150124	2122.66	2122.29	0.37	AOML3
1160101	2210.89	2209.19	1.70	AOML3
1160113	2184.15	2184.55	0.41	AOML3
1160124	2122.11	2124.05	1.94	AOML3
1170101	2208.15	2208.19	0.04	AOML4
1170111	2195.88	2194.93	0.95	AOML4
1170121	2141.59	2146.58	4.98	AOML4
1180101	2209.60	2210.22	0.62	AOML3
1180113	2186.45	2192.89	6.44	AOML3
1180124	2117.96	2118.50	0.55	AOML3
1190112	2168.29	2167.77	0.51	AOML4
1190122	2116.91	2117.07	0.15	AOML4
1200102	2204.32	2206.25	1.93	AOML3
1200113	2167.55	2166.06	1.49	AOML3
1200124	2124.69	2124.18	0.51	AOML3
1210102	2204.34	2205.58	1.24	AOML4
1210113	2184.22	2185.98	1.77	AOML4
1210124	2126.41	2126.46	0.06	AOML4
1220102	2204.42	2204.05	0.37	AOML3

1220113	2190.59	2190.78	0.19	AOML3
1220124	2129.58	2128.60	0.98	AOML3
1230201	2209.14	2208.10	1.04	AOML4
1230224	2120.11	2118.61	1.49	AOML4
1240101	2210.14	2208.56	1.58	AOML3
1240113	2188.42	2190.25	1.83	AOML3
1250101	2190.12	2191.26	1.14	AOML4
1250124	2125.40	2123.45	1.95	AOML4
1260201	2193.50	2192.97	0.53	AOML3
1260211	2188.92	2188.22	0.70	AOML3
1270101	2188.28	2187.79	0.48	AOML4
1270124	2115.99	2112.86	3.14	AOML4
1280101	2181.85	2177.76	4.09	AOML3
1280121	2134.90	2132.63	2.27	AOML3
1290121	2119.15	2120.19	1.04	AOML4
1300122	2118.77	2117.46	1.31	AOML3
1310224	2125.65	2127.25	1.60	AOML4
1320121	2124.41	2126.87	2.46	AOML3
1330121	2134.68	2133.48	1.20	AOML4
1340117	2140.59	2139.15	1.44	AOML3
1350121	2139.29	2136.56	2.73	AOML4
1360101	2171.74	2170.06	1.68	AOML3
1360124	2138.41	2139.41	1.00	AOML3
1370102	2173.62	2173.05	0.57	AOML4
1370123	2144.25	2141.06	3.19	AOML4
1380201	2180.90	2180.37	0.53	AOML3
1380212	2182.66	2180.68	1.97	AOML3
1380224	2141.83	2141.04	0.79	AOML3
1390102	2173.57	2175.56	1.99	AOML4
1390113	2169.35	2170.66	1.31	AOML4
1390124	2145.61	2145.00	0.61	AOML4
1400201	2179.86	2175.75	4.11	AOML3
1400213	2154.48	2155.09	0.61	AOML3
1400224	2141.25	2144.11	2.86	AOML3
1410101	2184.42	2185.28	0.86	AOML4
1410124	2150.47	2150.18	0.28	AOML4
1420101	2182.03	2180.00	2.03	AOML3
1420109	2188.57	2190.35	1.78	AOML3
1420124	2150.62	2148.82	1.80	AOML3
1430124	2151.77	2152.76	0.99	AOML4
1440124	2152.54	2153.28	0.74	AOML4
1450201	2176.33	2171.19	5.14	AOML3
1450224	2149.20	2148.24	0.96	AOML3

Table 5
Individual duplicate measurement values of $pH_T(25)$ (duplicate one and duplicate two), measured back-to-back, as well as the absolute difference between duplicates. Measurements are provided according to their sample ID.

Sample ID	$pH_T(25)$: Duplicate One	$pH_T(25)$: Duplicate Two	Absolute Difference
760102	7.7176	7.7221	0.0045
760123	7.9940	7.9932	0.0008
770105	7.7217	7.7233	0.0016
770118	7.8048	7.8043	0.0005
780209	7.7218	7.7240	0.0022
780223	7.9813	7.9820	0.0007
790107	7.7221	7.7221	0.0000
790116	7.7422	7.7416	0.0006
800204	7.7214	7.7214	0.0000
800220	7.9114	7.9105	0.0009
810111	7.7224	7.7223	0.0000
810123	7.9797	7.9788	0.0009
820104	7.7206	7.7207	0.0000
820121	7.9505	7.9515	0.0010
830203	7.7220	7.7216	0.0004
830215	7.7108	7.7195	0.0088
840106	7.7244	7.7221	0.0023
840120	7.8863	7.8870	0.0008
850107	7.7221	7.7222	0.0001
850116	7.7192	7.7199	0.0007
860104	7.7217	7.7212	0.0005
860111	7.7211	7.7216	0.0005
870109	7.7228	7.7217	0.0011
870120	7.9048	7.9057	0.0009
880113	7.7169	7.7165	0.0004
880116	7.7293	7.7298	0.0005
890206	7.7189	7.7210	0.0021
890213	7.7128	7.7132	0.0004
900113	7.7208	7.7207	0.0001
900122	7.9322	7.9334	0.0013
910104	7.7202	7.7211	0.0009
910112	7.7162	7.7155	0.0006
920309	7.7219	7.7229	0.0010
920314	7.7373	7.7392	0.0019
930113	7.7248	7.7243	0.0005
930119	7.8124	7.8131	0.0007
940103	7.7171	7.7154	0.0017
940117	7.8586	7.8575	0.0011

950205	7.7160	7.7179	0.0019
950216	7.7866	7.7874	0.0008
960306	7.7182	7.7168	0.0013
960315	7.7421	7.7426	0.0005
970109	7.7355	7.7363	0.0008
970119	7.8822	7.8820	0.0003
980206	7.7159	7.7145	0.0014
980213	7.7390	7.7390	0.0000
990218	7.8458	7.8458	0.0000
990223	7.9329	7.9316	0.0013
1000108	7.7026	7.7031	0.0005
1000117	7.8380	7.8396	0.0016
1010105	7.7135	7.7146	0.0011
1010111	7.7278	7.7296	0.0017
1020110	7.7260	7.7248	0.0012
1020121	7.9050	7.9026	0.0024
1030205	7.7146	7.7157	0.0011
1030220	7.8750	7.8750	0.0001
1040102	7.7044	7.7036	0.0008
1040113	7.8060	7.8044	0.0015
1050105	7.7079	7.7070	0.0009
1050116	7.8475	7.8473	0.0002
1060114	7.7315	7.7326	0.0011
1060119	7.8497	7.8497	0.0000
1070106	7.7019	7.7004	0.0015
1070116	7.8011	7.7997	0.0014
1080203	7.7133	7.7129	0.0004
1080214	7.8014	7.8011	0.0003
1090102	7.7206	7.7135	0.0071
1090123	7.8807	7.8824	0.0017
1100107	7.6857	7.6878	0.0021
1100119	7.8597	7.8621	0.0024
1110103	7.7125	7.7127	0.0002
1110118	7.8528	7.8525	0.0003
1120210	7.6838	7.6836	0.0002
1120220	7.8538	7.8568	0.0030
1130108	7.6956	7.6992	0.0036
1130117	7.8266	7.8308	0.0042
1140104	7.7151	7.7144	0.0007
1140121	7.8648	7.8646	0.0003
1150109	7.6865	7.6889	0.0023
1150116	7.7868	7.7827	0.0041
1160113	7.7069	7.7096	0.0027
1160121	7.8653	7.8619	0.0035

1170109	7.6904	7.6856	0.0048
1170113	7.7005	7.7007	0.0002
1180104	7.7136	7.7115	0.0020
1180119	7.8235	7.8241	0.0006
1190106	7.6859	7.6852	0.0007
1190121	7.8438	7.8456	0.0018
1200108	7.6812	7.6815	0.0003
1200112	7.6994	7.6978	0.0015
1210110	7.6750	7.6755	0.0005
1210118	7.8005	7.7990	0.0015
1220105	7.6892	7.6889	0.0003
1220115	7.7312	7.7327	0.0016
1230202	7.7160	7.7160	0.0000
1230217	7.7783	7.7781	0.0001
1240109	7.6732	7.6733	0.0002
1240119	7.8077	7.8069	0.0008
1250103	7.6893	7.6867	0.0026
1250123	7.8326	7.8334	0.0008
1260206	7.6780	7.6773	0.0007
1260214	7.7876	7.7866	0.0010
1270110	7.6761	7.6761	0.0001
1270118	7.7963	7.7965	0.0002
1280103	7.6789	7.6780	0.0009
1280113	7.8053	7.8071	0.0018
1290105	7.6807	7.6797	0.0010
1290114	7.8113	7.8068	0.0045
1300117	7.7856	7.7839	0.0017
1310221	7.8054	7.8079	0.0025
1320108	7.6950	7.6956	0.0006
1320114	7.7777	7.7790	0.0013
1330111	7.7945	7.7940	0.0005
1330119	7.8269	7.8250	0.0020
1340111	7.8015	7.8031	0.0016
1340115	7.8094	7.8093	0.0001
1350109	7.7863	7.7873	0.0010
1350117	7.8104	7.8081	0.0023
1360103	7.6754	7.6757	0.0003
1360119	7.8007	7.8008	0.0001
1370112	7.6965	7.6970	0.0005
1370116	7.7560	7.7569	0.0009
1380208	7.6690	7.6693	0.0003
1380222	7.7881	7.7890	0.0009
1390104	7.6842	7.6862	0.0021
1390114	7.7499	7.7516	0.0018

1400210	7.6807	7.6801	0.0005
1400217	7.7756	7.7750	0.0006
1410108	7.6715	7.6732	0.0017
1410115	7.7542	7.7552	0.0010
1420112	7.7298	7.7297	0.0001
1420119	7.7739	7.7741	0.0002
1430102	7.6913	7.6914	0.0001
1430122	7.7763	7.7757	0.0006
1440106	7.6684	7.6721	0.0037
1440117	7.7746	7.7733	0.0013
1450207	7.6950	7.6950	0.0001
1450219	7.7707	7.7717	0.0011
1470112	7.7619	7.7596	0.0023
1480111	7.7317	7.7342	0.0025
1480118	7.7741	7.7722	0.0019
1490109	7.7469	7.7461	0.0009
1490113	7.7725	7.7744	0.0019
1500104	7.7442	7.7459	0.0016
1500111	7.7701	7.7713	0.0012

Table 6
Individual duplicate measurement values of $fCO_2(20)$ (µatm; duplicate one and duplicate two), measured back-to-back, as well as the absolute and relative differences between duplicates (relative difference = absolute difference / average duplicate value * 100). Measurements are provided according to their sample ID.

Sample ID	$fCO_2(20)$: Duplicate One	$fCO_2(20)$: Duplicate Two	Absolute Difference	Relative Difference (%)
760110	826.44	826.79	0.35	0.04
770115	824.03	825.25	1.22	0.15
780206	757.77	757.29	0.48	0.06
790119	518.97	518.18	0.79	0.15
800213	765.52	765.59	0.07	0.01
810103	762.17	762.91	0.74	0.10
820123	388.10	388.98	0.88	0.23
830222	402.29	402.28	0.01	0.00
840109	752.13	751.67	0.46	0.06
850117	697.53	697.12	0.41	0.06
860121	400.48	400.05	0.43	0.11
870119	537.99	537.17	0.82	0.15
880107	759.32	758.98	0.34	0.04
890223	409.43	409.28	0.15	0.04
900111	763.85	763.50	0.35	0.05
910105	759.70	759.34	0.36	0.05
920319	586.32	585.32	1.00	0.17
930108	755.35	754.93	0.42	0.06
940105	755.33	755.46	0.13	0.02
950213	726.66	726.51	0.15	0.02
960322	444.88	444.47	0.41	0.09
970123	428.74	429.00	0.26	0.06
980203	764.34	764.97	0.63	0.08
990214	715.07	715.28	0.21	0.03
1000103	761.92	762.09	0.17	0.02
1010107	757.75	758.63	0.88	0.12
1020119	502.30	501.37	0.93	0.19
1030212	659.85	659.00	0.85	0.13
1040109	739.59	739.46	0.13	0.02
1050106	787.71	787.83	0.12	0.02
1060111	790.96	791.09	0.13	0.02
1070119	532.02	530.71	1.31	0.25
1080205	776.18	776.73	0.55	0.07
1090109	821.00	821.03	0.03	0.00
1100117	528.59	527.71	0.88	0.17
1110105	774.59	774.57	0.02	0.00
1120222	511.95	511.28	0.67	0.13

1130109	812.64	813.49	0.85	0.10
1140113	799.69	799.25	0.44	0.06
1150105	770.35	770.04	0.31	0.04
1160116	593.51	592.75	0.76	0.13
1170104	774.98	775.66	0.68	0.09
1180109	829.98	830.45	0.47	0.06
1190120	558.24	558.24	0.00	0.00
1200110	828.82	829.13	0.31	0.04
1210109	841.34	840.85	0.49	0.06
1220111	846.20	846.24	0.04	0.00
1230206	798.50	798.70	0.20	0.03
1240116	637.99	636.76	1.23	0.19
1250102	785.46	785.12	0.34	0.04
1260203	808.06	808.20	0.14	0.02
1270105	819.92	819.47	0.45	0.05
1280108	684.48	685.90	1.42	0.21
1290106	800.64	800.08	0.56	0.07
1300114	624.35	624.06	0.29	0.05
1310214	625.78	625.25	0.53	0.08
1320118	608.28	608.37	0.09	0.01
1330103	838.88	838.84	0.04	0.00
1340116	591.65	591.88	0.23	0.04
1350103	833.55	832.93	0.62	0.07
1360122	600.40	600.11	0.29	0.05
1370111	844.02	844.82	0.80	0.09
1380207	839.45	839.81	0.36	0.04
1390115	670.43	670.24	0.19	0.03
1400214	671.40	670.15	1.25	0.19
1410123	635.20	635.83	0.63	0.10
1420102	794.50	794.73	0.23	0.03
1430110	845.35	844.83	0.52	0.06
1440118	653.28	653.17	0.11	0.02
1450205	812.36	812.72	0.36	0.04
1460109	733.81	732.93	0.88	0.12
1470103	812.61	812.09	0.52	0.06
1480107	771.60	771.81	0.21	0.03
1490116	645.62	645.24	0.38	0.06
1500106	689.81	689.66	0.15	0.02

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