CARBON DATA ON JOHAN HJORT JH2019205 – 58JH20190515

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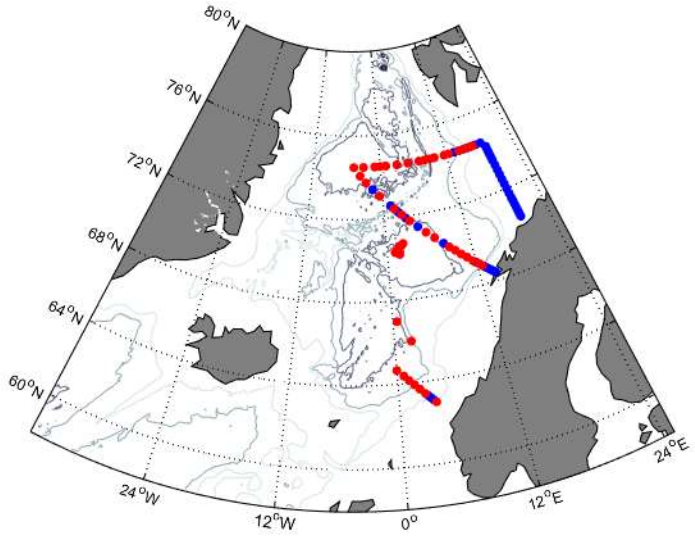



The map shows all stations on the cruise. Marked in red are those with carbon chemistry.

DIC and pH were analyzed on leg 1, AT and pH were analyzed on leg 2. All carbon samples were taken in 250mL glass bottles following SOP (Dickson et al., 2007).

Samples (full water column) were taken at stations 498-502, 547-556 and analyzed in the lab after the cruise. In addition, surface samples (shallowest niskin) were taken at stations 575-592 and analyzed in the lab after the cruise. Samples taken for later analysis were taken in 500mL glass bottles, poisoned with 1 drop $HgCl_2$, and stored dark. All samples were analyzed within 2 months of the end of the cruise.

See metadata for details on analytical methods and instruments used.

**DIC, PI onboard: Steve Jones and Tor de Lange, post-processing: Siv K. Lauvset**

Measured onboard during the first leg (stations 488-505, DIC measured only on stations 488, 492-502, 504).

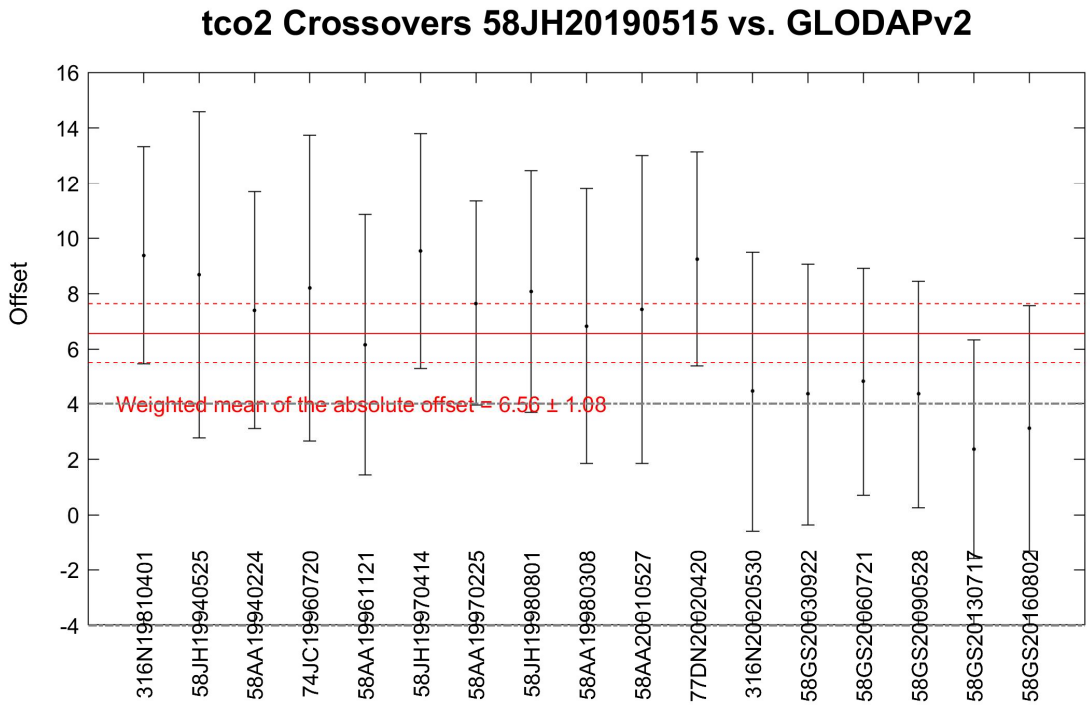
We experienced quite a lot of problems with the instrument. Especially linked to large drift in CRM values over a cell life (~100 mmol $kg^{1}$). Unknown reasons, but possible contamination and possible bad batch of KI.

For cells where the standard deviation of all CRM runs exceed 10 µmol $kg^{-1}$ all data are flagged WOCE 4 (bad). This threshold is chosen rather arbitrarily based on my judgement that this much spread in CRM runs means the data generally are bad.

On the first leg lab analyzes were made on samples from stations 498-502. For stations 498-500 we also have good data measured onboard. The two analyzes compare well but not excellently. Ship-based analyzes are generally higher than the lab-based analyzes. Mean difference (± one standard deviation) is 4.39±4.16 µmol $kg^{-1}$.

For the second leg (stations 506-592) no DIC was measured onboard, so the data in the file are samples analyzed in the lab (by Kristin Jackson-Misje) after the cruise. These are all flagged WOCE 2 (good). No detailed analysis has yet been done on the lab analyzed data so it is possible, though unlikely, some data will be flagged at a later stage. Below 1500m these data compare very well with GLODAPv2.2019.

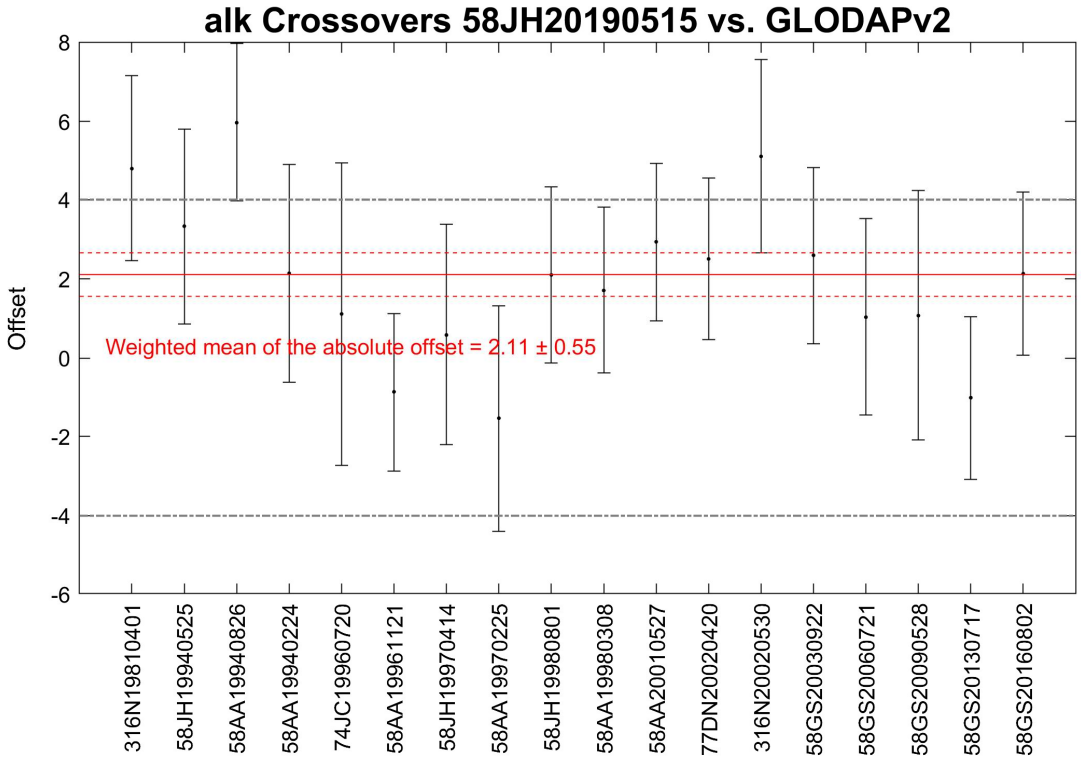
Uncertainty in DIC data are estimated to ±1.5 µmol $kg^{-1}$, based on the standard deviation of CRM-analyses.




**AT, PI onboard: Steve Jones and Tor de Lange, post-processing: Siv K. Lauvset**

Measured onboard on the second leg (stations 506-592, AT only measured on stations 516-517,519-521,523,525-530,532,534,536,538,541,543,545-558,560-561,563,565,567,569)

Overall good data. Below 1500m these data compare very well with GLODAPv2.2019




The lab-based analyzes are always 10-15 mmol $kg^{-1}$ higher than the ship-based analyzes where we have both. The reason is suspected to be evaporation prior to analysis in the lab. Measurements of DIC and pH were done on the same bottle before the AT analysis, and all analyzes were made during the warmest period of summer 2019 when temperatures in Bergen were close to or above 30°C. The lab is not air-conditioned.

None of the lab-based AT analyzes, except the surface samples along Fugløya-Bjørnøya (stations 575-592), are included in the data file. The surface samples are included, but all flagged questionable.

Uncertainty in the AT data are estimated to ±2.5 μmol $kg^{-1}$, based on the standard deviation of CRM-analyses.

**Spectrophotometric pH, PI onboard: Siv K. Lauvset and Nick Roden, post-processing: Siv K. Lauvset**

Measured on both legs of the cruise.

For stations 488,492-497,499-505,516-517,519-523,525,527-530,532 pH was measured with a temperature controlled cell. For all other stations there was no temperature control on the cell. For the latter stations the temperature at the beginning of analysis (input-T) and at the end of analysis (output-T) were recorded. The data were corrected in post-processing to 25°C from the output-T. Only pH @ 25°C is included in the data file, as well as the output-T.

On stations 519-532 there were problems with the cell. The reasons are unknown, but could be some form of contamination. On these stations the blank runs indicated high absorbance in the 487.6 wavelength (where the m-cresol purple dye absorbs). All data from these stations are flagged WOCE 4.

On the first leg the average (± standard deviation) of all good CRM runs (excluding the ones on stations 519-532) was 7.8835±0.0076. On the second leg the average (± standard deviation) of all good CRM runs (recalculated to 25°C) was 7.8781±0.0042. We have not corrected our pH measurements to the CRM pH value since this is a calculated, not certified, value. Instead we consider the standard deviation of the CRM runs a measure of uncertainty in our pH measurements. TRIS was measured during the cruise, but has not been used to correct the data.

We have not corrected for the addition of dye. Onboard and in the lab double dye analyses were run, but (by coincidence or poor planning) the range of pH over which these double dye analyses are made is very narrow (~0.1 pH units). Analyses made in the lab in late November 2019 (~6 months after the cruise ended) indicate that the correction should be on the order of -0.0039 on average. Given that the dye degrades quite quickly we have not used these results to correct the cruise data for dye addition, but include it as an uncertainty in our measured pH.

Total pH uncertainty – ±0.0085 – is estimated as the squared sum of squares of the standard deviation of CRM runs (0.0076) and the estimated influence of added dye (0.0039).

The pH data measured onboard compares well with those from 77DN20020420. Below 1500m they are nearly identical. Given the anthropogenic change, and the area of comparison (Greenland Sea), this suggests that the 2019 data are slightly too high.

pH measured on samples brought back to the lab compares well with that measured onboard. The differences range from -0.025 to 0.025 pH units, with a median of zero. The pH data measured in the lab post-cruise are 0.005 pH units higher than the data from 77DN20020420 below 1500m. This makes sense since DIC was measured before pH on these bottles and it is likely that some carbon was lost to air-sea exchange in that process.

OTHER RELEVANT DATA ON JOHAN HJORT JH2019205 – 58JH20190515

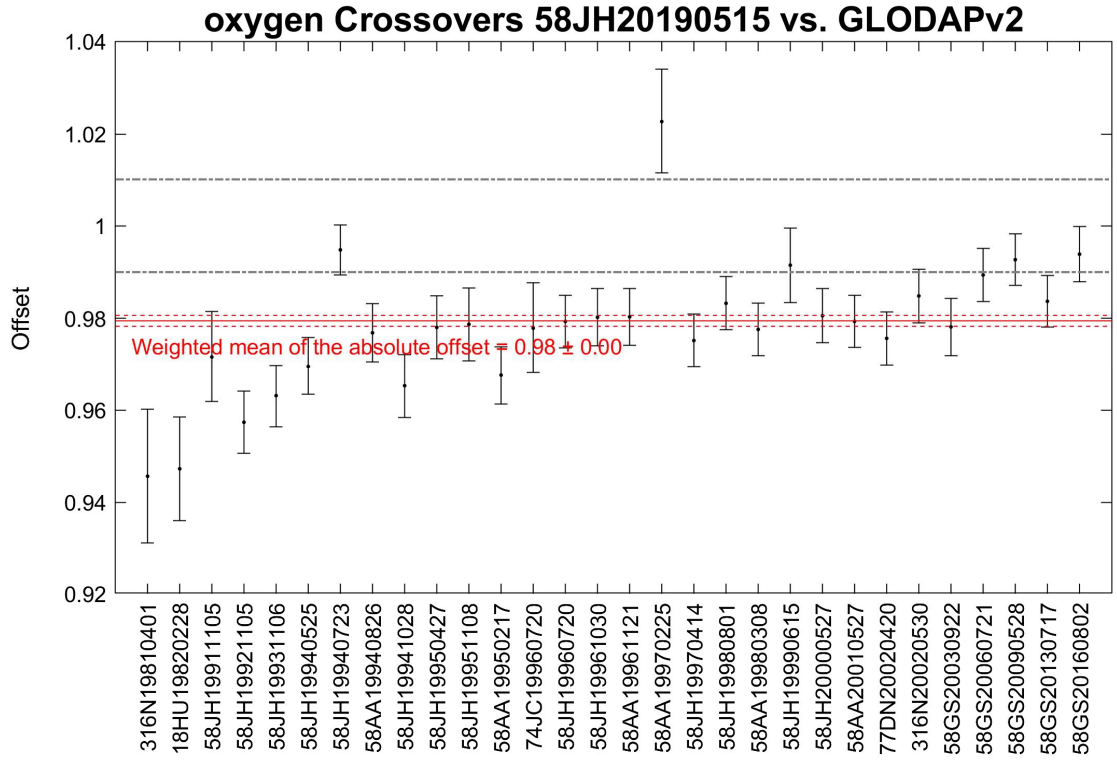
**Oxygen, PI onboard and post-processing (bottle samples): Kristin Jackson-Misje**

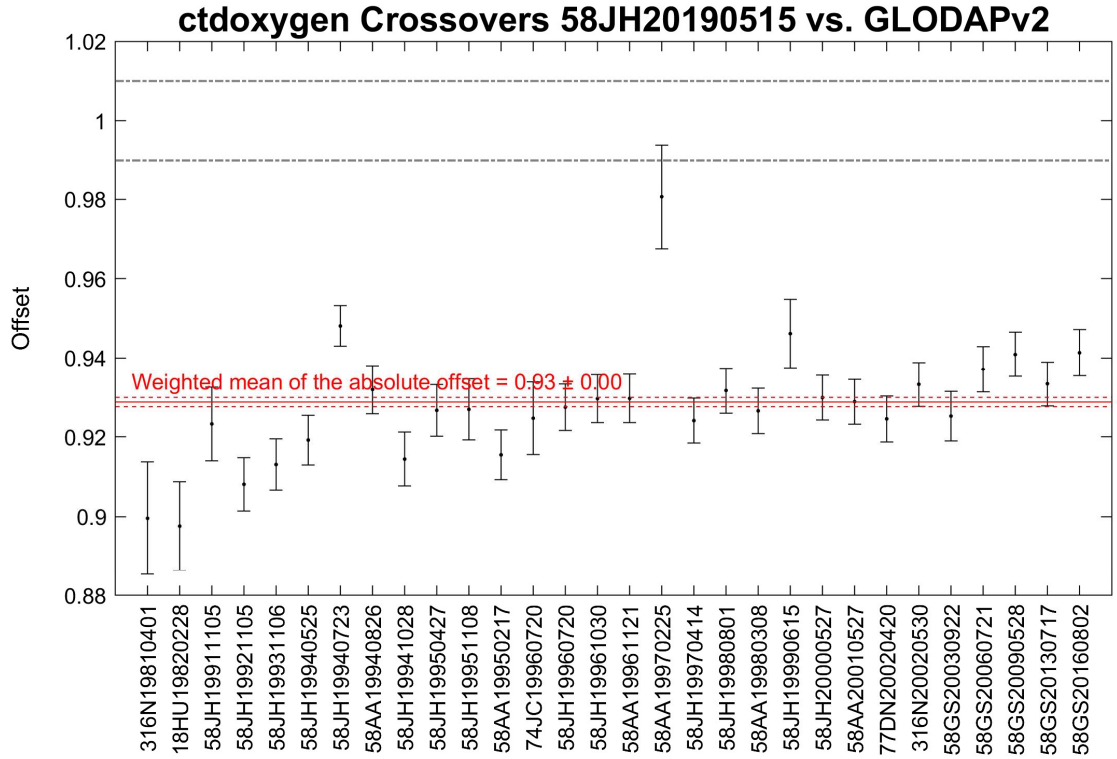
Winkler oxygen in ml/l was converted to mmol/kg using the factor 44.661 and seawater density (calculated with CTD salinity). Winkler oxygen data have no bias compared to GLODAPv2.2019. The 2019 data fit into the known trend.

The CTD oxygen appear to be biased low by about 6%.

No detailed analysis of Winkler vs. CTD oxygen have been undertaken.

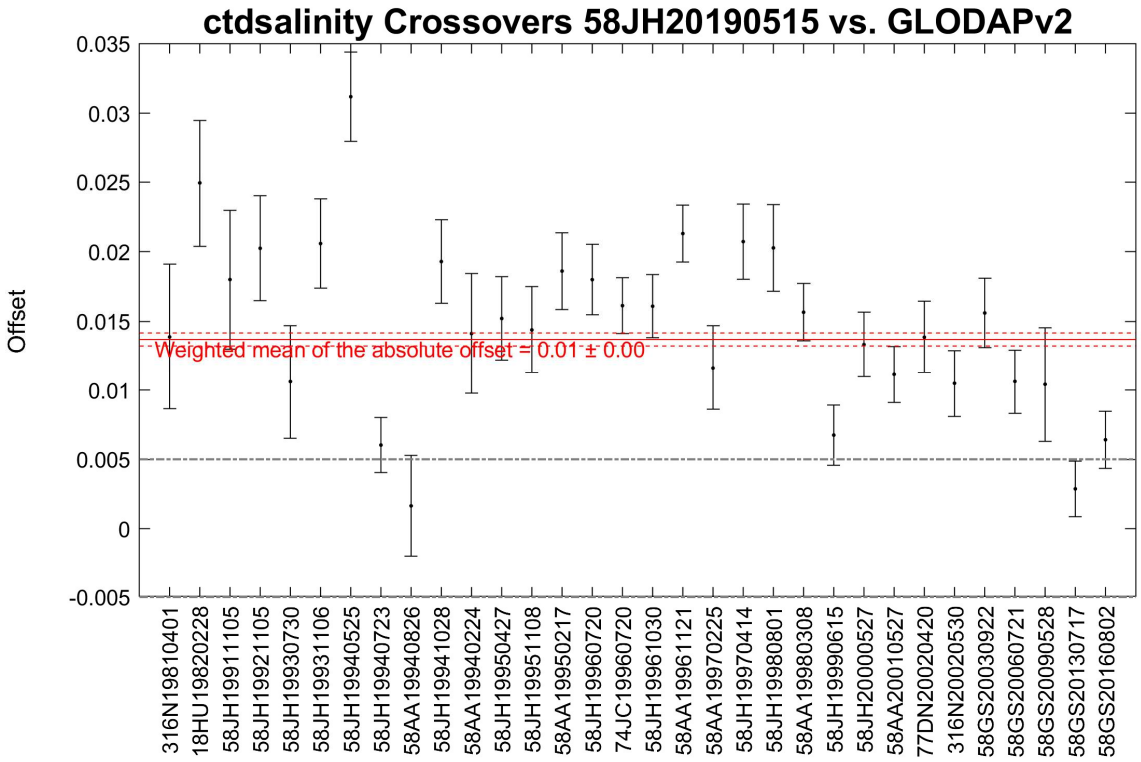
On one station all niskins were closed at the same depth, and one sample for each niskin was taken for Winkler analysis. At two of the Argo stations (501-502, and 547-548) two niskins were closed at each depth. All niskins were sampled for oxygen. Using the standard deviation of these replicate samples, the uncertainty in the Winkler oxygen data is estimated to ±0.3 μmol $kg^{-1}$.

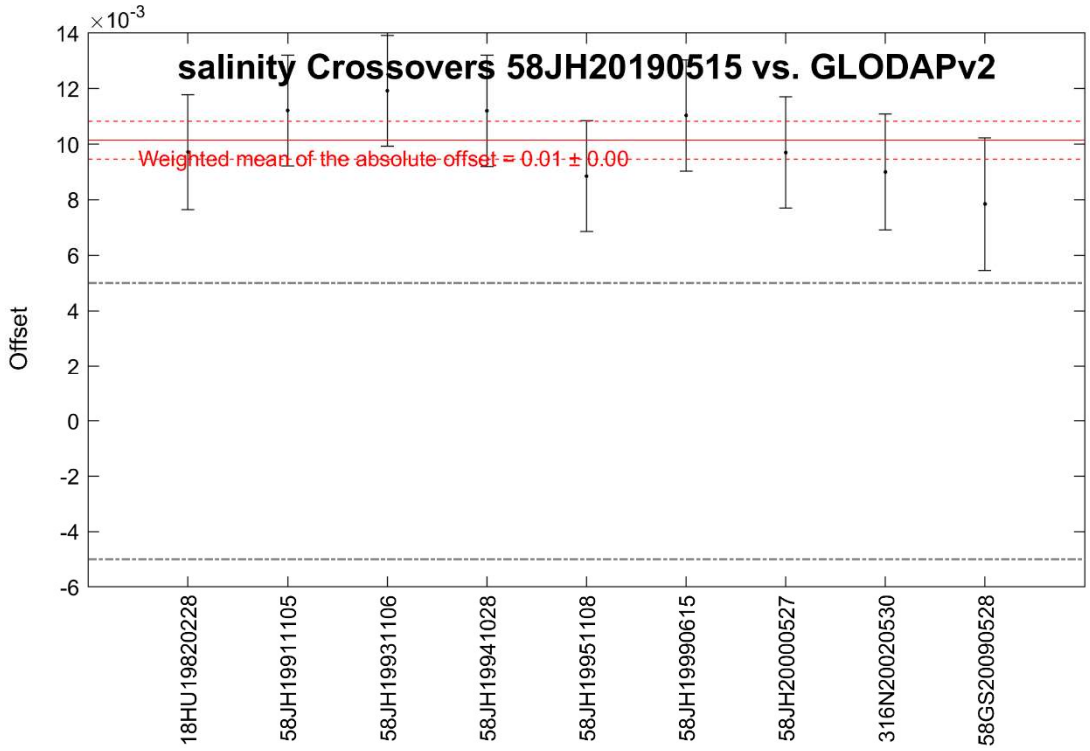



**Salinity, PI: Kristin Jackson-Misje (bottle samples)**

CTD salinity has been checked against GLODAPv2.2019 and appears to be unbiased (fits into the existing trend). Samples were taken at four depths on all stations where the carbon parameters are measured. These have been analyzed in the lab, and appear to be offset slightly high compared to GLODAPv2.2019. No detailed comparison of CTD and bottle salinities have been performed, but where the differences exceed 0.05 the CTDSAL is flagged WOCE 3.




**Nutrients, PI onboard: Monika ? (sampling), analysis and post-processing: Linda Fonnes Lunde**

Nutrient samples were taken by people from the Institute of Marine Research (IMR) onboard, and subsequently analyzed in their lab by Linda Fonnes Lunde. Units were converted from µmol/L to µmol/kg using density calculated from CTD salinity (since bottle salinities are not available on all bottles, and also appear biased).

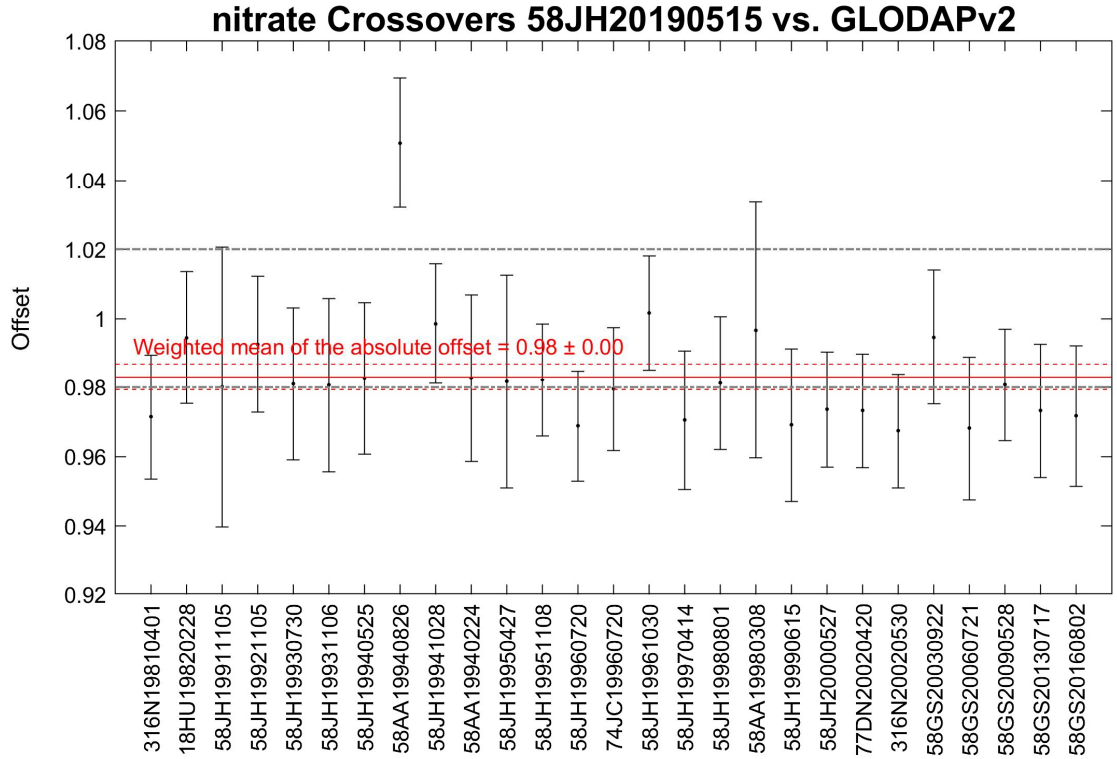
Nitrate, phosphate, and silicate were all compared with data in GLODAPv2.2019.

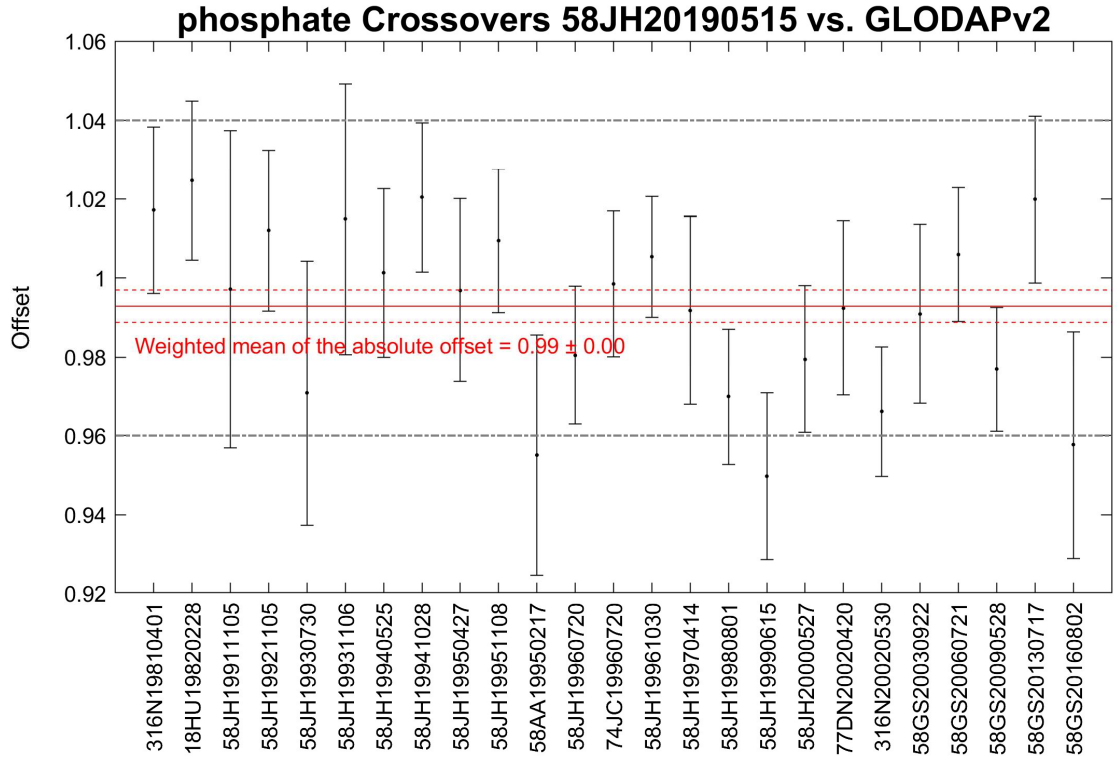
Nitrate appears to be biased slightly low (~2%). Note that nitrate in this case is NO2+NO3, even though the two are separated in the datafile.

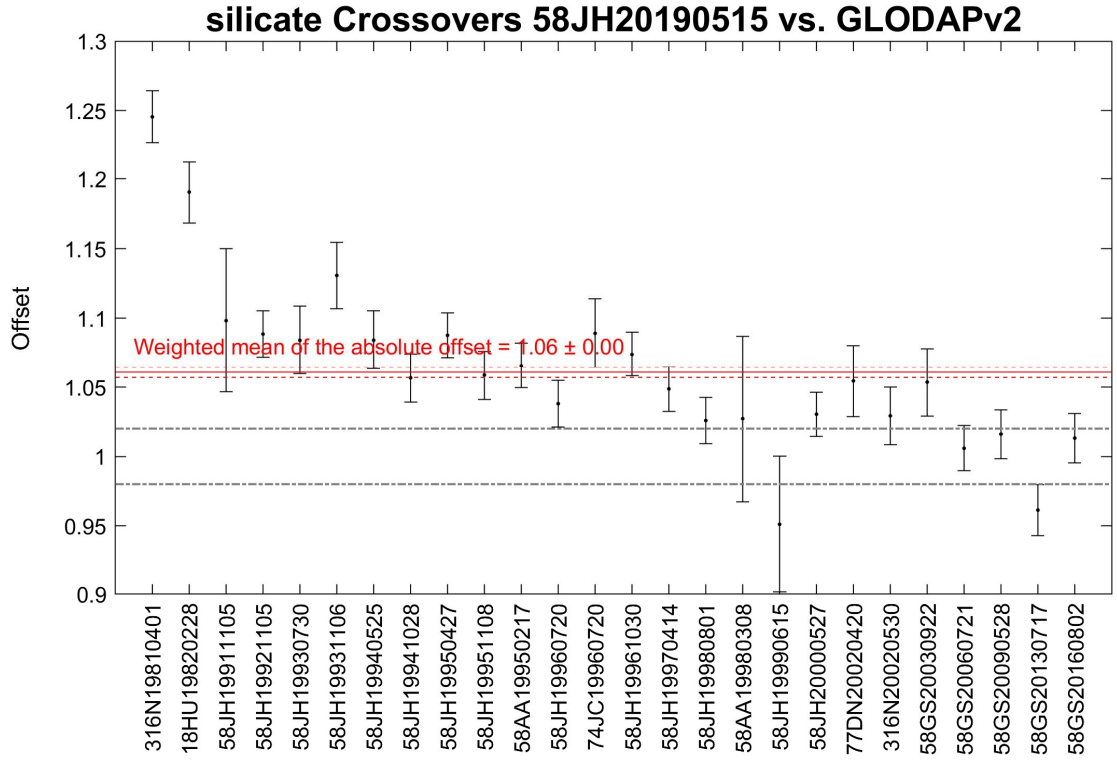
Phosphate is somewhat noisy, but within the ±4% adjustment limit.

Silicate exhibits the expected temporal trend and has no bias with the most recent cruise in GLODAPv2.2019.

Stated uncertainty (in the metadata) for all nutrients is the detection limit of the method(s) used. No other uncertainty estimate exists.




silicate Crossovers 58JH20190515 vs. GLODAPv2
Offset
Weighted mean of the absolute offset = 1.06 ± 0.00
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
316N19810401
18HU19820228
58JH19911105
58JH19921105
58JH19930730
58JH19931106
58JH19940525
58JH19941028
58JH19950427
58JH19951108
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316N20020530
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58GS20090528
58GS20130717
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