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Earth System Science Data Discussions

Interactive comment on "CARINA-Oxygen: a new high-quality oxygen database for the Atlantic Ocean" *by* I. Stendardo et al.

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Specific Comments:

The use of multiplicative offsets rather than additive ones for oxygen is probably warranted here. However, more discussion of the reasons to choose this method and its implications would improve the paper. Some important points might include the following: Multiplicative offset is essentially an a priori assumption about the data rather than one that can be derived from the QC analysis. Oxygen concentrations deeper than 1500 dbar are relatively constant in the Atlantic, so it is difficult to determine whether the slope, intercept, or both is in need of revision in a crossover analysis. Tanhua et al mention that "problems in standardization are the most likely source of error, hence a multiplicative offset is deemed as appropriate." It would be helpful to reiterate this here,

with some further statement about the potential for additive offsets that arise from improper blank determination in oxygen analysis. Finally, some mention of the potential scale of errors that would be introduced by an incorrect assumption of multiplicative offsets for any particular cruise would improve the ability of readers to make appropriate assumptions about errors in their use this dataset.

Based on this comment we now added some more explanation about the choice of a multiplicative rather than an additive correction: "The oxygen offsets and their standard deviations were computed as multiplicative factors. We opted for a multiplicative instead of an additive approach for two primary reasons: First, this permits us to avoid the potential problem of obtaining negative values in low oxygen regions. Second, this reflects the fact that the preparation of the standard is the most likely source of error for the measurement, and this source of error is of multiplicative nature (see also Tanhua et al. 2009b). We suspect that choosing an additive approach would not have resulted in a drastically different adjusted database. This is because the range of oxygen values in the North Atlantic is relatively limited, so that there is little expected difference between a multiplicative and additive approach."

The authors briefly make the important point in the introduction that the secondary QC procedure described results in a more internally consistent database, but not necessarily in a more accurate one. Given the importance of this point, I would like to see it expanded on some by a brief mention in the abstract and a return to this point in the summary. This is important because some uses of oxygen data, such as air-sea gas exchange calculations, depend on accuracy and users of this database should understand the limitations it is still subject to.

We decided to clarify this concept by adding in the introduction this sentence: "For the purpose of the analysis of long-term changes, internal consistency is sufficient. However, if the goal is to compute the magnitude and variability of the air-sea gas exchange of oxygen, then high accuracy is required and this product may not provide it.". Moreover we briefly mentioned it in the abstract: "Thanks to the achieved internal

consistency, the resulting product is well suited to produce an improved climatology, or to study long-term changes in the oxygen content of the ocean. However, the adjusted database is not necessarily better suited than the unadjusted data to address questions that require a high level of accuracy, such as the computation of the saturation state."

The discussion of errors in the last paragraph of the methods section could be clarified. I usually think of accuracy as a measure of the difference from the “true value”, which is unknown in this case. I guess that equation 1 is a measure of the possibility that the analysis has biased the dataset in one direction. For example, if you had one very high cruise with many crossovers, the inversion might bias the offsets in that direction. In any case, it would be helpful to expand on the meaning of this calculation.

In this case for overall accuracy we meant the overall level of internal consistency of the oxygen data. We now added few words to clarify this concept: "As a last step, the overall level of internal consistency of the CARINA-ATL oxygen data was computed using the weighted mean (WM) of the absolute values of the offset (D) of L crossovers with their uncertainty (sigma). (Note that Tanhua et al. 2009c refers to this quantity as the overall “accuracy” of the database).

(equation 1[...]) This analysis gives a level of internal consistency of 0.8%."

A few details made clear in the Tanhua methods paper would be helpful to briefly mention here, such as interpolation of the profiles used in the crossover analysis to obtain like-density data and the use of a time factor in weighting.

We added now some more details on the method that we applied for the secondary QC: "The analysis was performed on sigma4 density surfaces, in order to better compare samples in the deep ocean. For each oxygen sample, its corresponding density was first computed, and then the data from each profile were interpolated with a Piecewise Cubic Hermite interpolating scheme to a number of standard densities. Those were selected in such a way that the interpolated values were equally distributed in depth space (Tanhua et al. 2009)." [...] Finally, the weights included also a temporal term, in

order to give less weight to offsets that are between cruises that sampled a region many years apart. This is achieved by multiplying the standard deviation of the crossovers with a time factor KT computed as follows:

KT = 1+ 0.1 Delta(year)

where, Delta(year) represents the time in years between the two cruises."

The meaning of figures 6 f, g, and h is not clear. These parts of figure 6 don’t appear to be discussed in the text. Was a second inversion applied after the first round of adjustments was made? Were further adjustments made based on this inversion or was it just a check?

Figure 6 (f, g, and h) shows results from a second inversion applied after the first round of adjustments, but this was just a check, and no further adjustments were made based on this inversion. We now added a small description of Fig. 6 f g and h in the text: "To check the results we re-run the three inversions (Fig. 6 f-h) and re-computed the adjustments using the already adjusted cruise data. As shown by the red symbols in Fig. 7, the vast majority of the recommended adjustments are now indeed within the threshold barriers."

Technical Corrections: This paper would significantly benefit from a good copy editor to correct some of the English phrasing. The end of section 4.1.9 is a particularly egregious example.

Done

The mention of cruise 29CS19771007 in the first paragraph of section 2.1 has the potential to be misleading. By only highlighting this cruise as one that was not included in the secondary QC, it implies that all other cruises were included. Table 1 shows that this in not the case. It would help the reader to clarify this.

The emphasis on this cruise should be seen in the context of the temporal distribution of CARINA. We, indeed, wanted to point out that although this represents the

earliest cruise in the database the potential user of CARINA has to be warned that this cruise has not been considered in the second QC because no data deeper than 1500m were available for computing the offsets, so we can not guarantee its consistency among the other cruises in the database regarding the oxygen data. It could be possible that the reader thinks this is the only cruise not included in the secondary QC, so we added now a short sentence at the end of the paragraph for clarification: "The only cruise in 1977 (29CS19771007) is one of the Galicia cruises (Galicia4) and has 88 stations with oxygen data only in the upper 1500m. For this reason, we did not include this cruise in the secondary QC, i.e. no adjustment is recommended (http://cdiac.ornl.gov/oceans/CARINA/Carina_inv.html and Table 1). For similar reasons, eight other cruises were not considered in the second QC and labeled as NC (Not Considered) in Table 1."

Tanhua reference cited in the second sentence of section 3 should perhaps be 2009b not a.

Done

Second paragraph of the Methods section states that only data deeper than 1500 dbar were used in the crossover analysis, but Table 1 shows that a few stations used data deeper than 1000m.

We arbitrarily decided to change the minimum depth for two cruises that were added towards the end of the project. We added now a sentence in the paragraph that explicitly mentions the exception: "For the computations of the offsets, only data deeper than 1500 dbar (about 1500 m) were used in order to eliminate from the analysis the upper water column that is more variable in time. There are two cruises (cruise # 93 and # 107), however, that did not follow this criteria. This cruises were added in the later stage of the project, and because they have only few samples deeper than 1500 m, the minimum depth for the crossovers was set manually to 1000 m."

The second paragraph of the results section lists many cruises with their adjustments.

Perhaps this would be better presented in a table.

All the adjustments are presented in Table 1, the paragraph was written to show an overview of adjustments applied to the cruises which were particularly large.

Table 1 footnotes seem to not to have been fully applied. Label e for “No deep data so not included in the 2nd level QC” seems like it applies to more than just the labeled cruises. 29CS19771007 for example.

Done

Colored bathymetry lines in Figure 1 are distracting. Making them grey or deleting them might help to reduce interference with the colored data points.

We changed the bathymetry lines to gray

Caption to figure 3 could briefly make clearer what is meant by reference cruises.

Done: "Maps showing the temporal distribution (5 year intervals) of stations that have oxygen samples in the final product of CARINA-ATL (without the 6 reference cruises from GLODAP, see section 2)..."

Does figure 4 show profiles after adjustments have been made? These are really nice looking graphs. I hope that they appear a lot larger in the final version than in the version I had to review.

Yes exactly. And unfortunately Figure 4 was designed to be a single figure for an A4 format. We had to split the figure into two parts due to the particular format of the discussion paper. It will be larger in the final version.

Interactive comment on Earth Syst. Sci. Data Discuss., 2, 103, 2009.

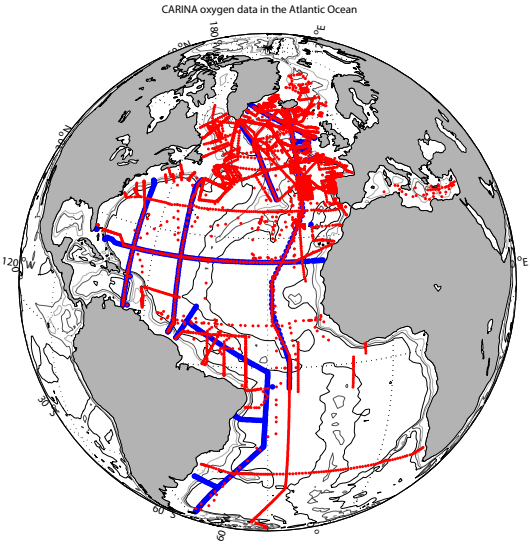

Fig. 1.