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Interactive comment on "An Internally Consistent Dataset of δ^{13}C-DIC in the North Atlantic Ocean – NAC13v1" *by* Meike Becker et al.

Meike Becker et al.

mbecker@geomar.de

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Response to Reviewer 1

Thank you very much for this detailed review. It helped us improving the paper significantly. We hope, our answers consider all your comments and suggestions is a satisfactory way.

Please note, that changes we did in the manuscript or the dataset are italicized in the following and highlighted in red in the manuscript.

Major issues

- Certainly there exist other methods for estimating systematic differences within a

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Discussion paper

dataset. We decided for the crossover analysis since the Multi-parameter-MLR analysis is limited by the availability of other parameter such as AOU, DIC, NO_3. We now conducted a MLR based on the deep core cruise data. For cruises that are located in the North Atlantic, this MLR analysis reveals offsets in the same order and magnitude as the crossover inversion routine. For those cruises that reach into the Nordic Seas, the picture is more difficult due to the different water masses.

Answer:

There is a paragraph added to the section 'Computational Analysis' that explains the MLR analysis:

Another method for revealing systematic deviations between different cruises is a regional multi-linear regression (MLR) (Wanninkhof2003, Jutterstrom2010). In this work, a MLR based on core cruise data (deeper than 1500 m) was used to verify the suggested corrections that resulted from the crossover analysis. Moreover, some cruises without a statistically evaluable crossover could now be related to the other cruises. The following equation was used,

$$\delta^{13}\mathrm{C} - \mathrm{DIC}_{\mathrm{MLR}} = -16.9 + 0.80 \cdot \mathrm{S} - 0.080 \cdot \Theta - 0.0045 \cdot \mathrm{DIC} \quad (1)$$

with $\delta^{13}\mathrm{C} - \mathrm{DIC}_{\mathrm{MLR}}$ *being the calculated* $\delta^{13}\mathrm{C} - \mathrm{DIC}$*, S the salinity,* Θ *the potential temperature in* $^\circ$ *C and DIC the DIC concentration in* $\mu\mathrm{molkg}^{-1}$*. The DIC concentration was chosen because it is strongly related to changes in the isotope composition and DIC data were available for most cruises. Adding more parameters to the MLR, such as apparent oxygen utilization (AOU) or nutrient concentrations, did not improve the agreement between* $\delta^{13}\mathrm{C} - \mathrm{DIC}$ *and* $\delta^{13}\mathrm{C} - \mathrm{DIC}_{\mathrm{MLR}}$ *of the core cruise and reduced the amount of cruises hat could be compared via the MLR analysis. The limitation of this method is, of course, that the further away in space and time the cruises are from the core cruise, the more likely an observed offset is real. Especially, the cruises reaching into the Nordic seas show*

significant deviations, which are most likely real differences between the basins. Therefore, the offsets revealed by the MLR analysis were not taken into account for these cruises.
These sentences were added in the 'Adjustment' section:
For most cruises that took place in the North Atlantic, the offsets revealed by the MLR analysis were in the same order and magnitude as the suggested correction by the crossover inversion routine. Cruises reaching far into the Nordic Seas or the South Atlantic show huge differences, which are caused by different water mass properties in these areas.
Moreover, the results of the MLR analysis are also addressed in the detailed discussion of each cruise.

- "This dataset is not very large, consisting of data from 29 cruises. A table listing all cruises, dates, PIs, and peer-reviewed citations for each would certainly be worthwhile and possible to include."
  Answer:
  A table listing all cruises, dates, PIs and publications was added.

- "According to Table 1, some of the new data were analysed up to 8 years after the samples were collected, and some data sets were analysed over a period of approximately 2 years. There is a potential effect of storage on δ^{13}C samples, so it would very useful with some analysis of the effect of storage time on dataset accuracy, did you find any correlation between bias and time between collection and analysis in these data, or with scatter?"
  Answer:
  Yes, the new data were analyzed over a long period of time and also stored for a long time. I could not find any correlation between a cruises' bias or its scatter and storage time, analyzing period or volume of $HgCl_2$ added.
  The following sentences were added to the Conclusion:
  The reason of the deviations between single cruises could not be revealed. There

was no correlation between a cruises' bias or its scatter and storage time, analyzing period or volume of $HgCl_2$ added.

- "The collection miss the data from the Nordic Seas cruise 58GS20030922, these are available through CDIAC, for instance through GLODAPv2 cruise summary table, please include, these are probably the most extensive Nordic Seas 13C data available."
  Answer:
  We are aware of the cruise 58GS20030922. Its data were included into the analysis, but not into the final dataset, since this cruise had no crossover, not even a few samples within a crossover radius, with which it could be compared to the rest of the dataset. This was also the case for another cruise in the Nordic seas (74JC20120601). Now, we included both into the final dataset. However, since this dataset concentrates on the North Atlantic and some assumptions clearly don't hold for the Nordic Seas (3x3°, small anthropogenic influence on deep water masses) we suggest, that it would be a better choice to perform a consistency analysis focused on the Nordic seas alone, once there are enough cruises available. Also, the water mass properties of the core cruise, which was used for the MLR analysis, were too different from those of the Nordic Seas to reveal any reliable statement on systematic biases between these cruises.

  We added three more cruises to the dataset (58GS20030922, 74JC20120601 and 74JC20140606), of which the first two are located in the Nordic seas and the latter one became recently available. Therefore, all figures, tables and also the absolute numbers of samples and cruises included in the presented dataset were updated in the paper.

Issues with the dataset

- "The data that were deemed bad are still available in the data file, but flagged 9."
  Answer:

The data flagged as bad were removed from the dataset. All new original data has been submitted to CDIAC prior to submitting the paper.

- "In the datafile the "nosamp" and "cast" columns are empty. The "maxsampdepth" is largely empty, this is trivial to fill, please do so. Cruise 13, station 83, maxdepth is -82, this cannot be right, please correct."
  Answer:
  The column 'nosamp' was excluded. The columns 'maxsampdepth' and 'cast' were correctly filled.

Minor issues

All minor text issues were corrected. The manuscript was checked again for 'data were' and which vs. that.

- **Tab 3, Figure 2,3,4,5:** "has units after a backslash "/", please use parenthesis"'
  Answer:
  We prefer the backlash-version for axis labeling, which is standard in physical equations.
- **l 6:** ""making basin wide estimates".. of what, please specify"
  Answer:
  Inserted: 'anthropogenic carbon'
- **ll 24-30:** "I like this list of uses of 13C data. However, the abstract gives more, for instance 'help to describe the exchange between the ocean and the atmosphere', these should be mentioned in the main text as well, with citations to examples of these applications (I am curious about this example, and other readers may be so as well)."
  Answer:
  We deleted 'help to describe the exchange between the ocean and the atmosphere'.

However, measurements of surface ocean and atmospheric 13C with a high spatial and temporal resolution (for example on VOS) hold the potential to reveal seasonal as well as interannual changes in the isotope signature of air-sea gas exchange.

- **l 28:** "Olsen et al., 2010 did not use δ^{13}C data, but please feel free to include a citation to Olsen and Ninnemann, 2010 instead."
  Changed to Olsen and Ninnemann (2010)

- **ll 30-33:** "please include specific example for this application (citation is sufficient)."
  Answer:
  Citation added (Gruber et al., 1998)

- **l 37:** "'for basin-wide carbon flux estimates', please be more specific, what is meant, air-sea fluxes? can this be done?"
  Answer:
  The sentence was changed to 'of carbon fluxes due to primary production'

- **Fig 1:** "Fig 1., the data points are hard to see, please remove bathymetry."
  Answer:
  Bathymetry was removed.

- **l 64:** "well, I am sure that the dataset is also important for studying isotope dynamics below 1500 m, for example spatial variations should be present."
  Answer:
  For sure it is. But it is restricted by the basic assumption of a crossover analysis and we just wanted to be sure that it is handled with care in applications.

- **ll 79-80:** "I do not understand this, what other extensively quality controlled C-13 datasets are there to ensure consistency with?"

Answer:
We meant all the datasets that (hopefully) will come up in the future.
Inserted: future.

- **l 103:**"please include citations to GLODAPv2 (Olsen et al., 2016) and CARINA (Key et al., 2010)"
  Answer:
  Both citations were included.

- **l 114:** "please specify which profiles were compared, 13C vs 13C or 13C vs other parameters? Please provide one or two examples of profiles with outliers. It would certainly be useful to include property-property figures in the primary QC step, for example AOU vs 13C."
  Answer:
  For identifying outliers δ^{13}C profiles were compared. We also made AOU vs δ^{13}C plots now for those cruises with available AOU data. There were to outliers left.
  Inserted: δ^{13}*C.*

- **l 116:** "Tanhua et al describes several types of crossover analyses, please specify which was used, e.g. 'running crossover'."
  Answer:
  Included: running

- **l 133:** "you may want to add that 120 nm was the commonly used distance in CARINA; PACIFICA, and GLODAPv2 so readers understand where this number comes from."
  Answer:
  Included: which is the distance commonly used in CARINA, PACIFICA and GLODAPv2 data products.

- **l 136:** "the standard deviation .. of what, please specify."

Answer:
Included: of the offset between two cruises.

- **Fig 3:** "please specify what the various vertical lines indicate, in the caption."
  Answer:
  inserted: Crossovers between the cruises 06MT20030723 (blue dots and lines) and the core cruise 33MW19930704-1 (red crosses and lines). The C13 plots show the data and mean profiles of each cruise and the difference plots show the difference profiles with its standard deviation (black lines) as well as the crossovers offset with its standard deviation (red lines).

- **l 169:** "I do not completely understand, according to Table 4 in the supplement the crossover difference between the 06MT19941012 and the 33MW1993 cruise is not significant, still 0.07 permil is -indirectly-stated in the text. Please also clarify what it takes for a crossover to be significant."
  Answer:
  A significant crossover is a crossover that is based on enough samples to apply the statistics. Most crossovers of this cruise were with the other Meteor cruises, which had to be adjusted even more than this cruise. By applying an adjustment larger than 0.07 permil, the non-significant crossover with cruise 33MW1993 lead to the conclusion that the bias of cruise 06MT19941012 is then overcompensated.
  The sentence was changed to:
  The MLR analysis revealed a smaller offset of 0.05 *and, thus, the cruise was adjusted by -0.07 .*

- **ll 219-224:** "This passage is a bit confusing, please clarify. As I understand it, the 2002 Thalassa cruise data were not adjusted, but it had crossovers, why doesn't these data show up in Fig. 5?"
  Answer:

The first Thalassa cruise had only a few samples within the crossover radius, but not enough to be a significant crossover with statistics and a reliable offset. The comparison of both Thalassa cruises suggest, that also the first Thalassa cruise needs to be corrected. Since the samples from both cruises were analyzed in the same lab, it might be reasonable to correct both cruises with the same offset. The MLR revealed now an offset of the cruise 35TH20020611 that is in the same order as the correction suggested for cruise 35TH20060521 by the crossover routine. Unfortunately, the cruise 35TH20060521 could not be compared via the MLR analysis since we did not have DIC data. We now decided to correct both cruises.
'just a few' in line 21 replace with: only
The following sentences were added at the end of the paragraph:
The MLR analysis reveal an offset of the 35TH20020611 cruise of -0.23, which is in the same order as the correction suggested by the crossover routine for cruise 35TH20060521. Since the MLR offset for cruise 35TH20020611 is based only on five samples, we applied an adjustment of -0.25 to secure the internal consistency of these two cruises.

- **l 227:** "this is not correct; the 58GS2003 cruise can be used and is available at CDIAC."
  Answer:
  Yes, that's true, other cruises exist in that area. But, as said above, with the used crossover criterion of 3x3° no crossover with the cruises 58GS20030922 and 74JC20120601 could be observed. The MLR analysis based on the core cruise did not reveal reliable offsets for the cruises that reached into the Nordic Seas.